June 2012

VOLUME II

Environmental Assessment - Whytes Gully New Landfill Cell

Submitted to:
NSW Department of Planning and Infrastructure



REPORT

Report Number. 117625003_159_R_Rev1

wollongong
city of innovation

Golder Associates

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APPENDIX A

Director-General's requirements

NSW GOVERNMENT | Planning & Infrastructure

ontact: Felicity Greenway
Phone: (02) 9228 6338
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Mr Michael Herraman
Senior Project Manager
Wollongong City Council
Locked Bag 8821
WOLLONGONG NSW 2500

Dear Mr Herraman,

Director General's Requirements
Whytes Gully Landfill Expansion Porject, Kembla Grange

I refer to your application for the expansion of the putrescible landfill component of the Whytes Gully Resource Recovery Park, Reddalls Road, Kembla Grange.

I have attached a copy of the Director-General's requirements for the project. These requirements have been prepared in consultation with the relevant agencies, and are based on the information you have provided to date. I have also attached a copy of the agencies' comments for your information. The Department is yet to receive feedback from the NSW Office of Water. These will be forwarded to you once received.

The Department prefers landfills such as the Whytes Gully landfill to operate under a single modern planning approval. You are therefore encouraged to develop the project with this preference in mind. Further, Wollongong City Council should consider surrendering all the old consents for the existing landfill if this application is ultimately approved.

Please note that the Director-General may alter these requirements at any time.

If your proposal is likely to have a significant impact on matters of National Environmental Significance, it will require an approval under the Commonwealth *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act). This approval is in addition to any approvals required under NSW legislation. It is your responsibility to contact the Department of Environment, Water, Heritage and the Arts in Canberra (6274 1111 or http://www.environment.gov.au) to determine if the proposal requires an approval under the EPBC Act. If it is subsequently determined that an approval is required under the EPBC Act, please contact me immediately as supplementary Director-General's requirements may need to be issued.

I would appreciate it if you would contact the Department at least two weeks before you propose to submit the Environmental Assessment (EA) for the project. This will enable the Department to determine the:

- applicable fee (see Division 1A, Part 15 of the Environmental Planning and Assessment Regulation 2000); and
- number of copies (hard-copy and CD-ROM) of the EA that will be required for exhibition purposes.

Once the Department receives the EA, it will review it in consultation with the relevant agencies to determine if it adequately addresses the Director-General's requirements, and may require you revise it prior to public exhibition.

The Department is required to make all the relevant information associated with the project publicly available on its website. Consequently, I would appreciate it if you would ensure that all the documents you subsequently submit to the Department are in a suitable format for the web, and arrange for an electronic version of the EA to be hosted on a suitable website during the assessment process.

If you have any enquiries about these requirements, please contact Felicity Greenway on 9228 6338 or felicity.greenway@planning.nsw.gov.au

Yours sincerely

DKitto 11/8/11

David Kitto
Director – Mining and Industry
Major Projects Assessment
As delegate for the Director-General

Director-General's Requirements

Section 75F of the *Environmental Planning and Assessment Act 1979*

Application Number	MP11_0094
Project	Whytes Gully Landfill Expansion Project - development of a putrescible landfill 'piggy-backed' on top of existing landfill operations, including: • creation of approximately 7 million m^3 of additional landfill capacity; • waste input rates of up to 180,000 tonnes per year; and • associated infrastructure.
Location	Off Reddalls Road, Kembla Grange: • Part Lot 501 DP 1079122 • Lot 502 DP 1079122 • Lot 2 DP 240557 • Lot 52 DP 1022266 • Lot 53 DP 1022266 • Lot 51 DP 1022266
Proponent	Wollongong City Council
Date of Issue	August 2011
Expiry date	August 2013
General Requirements	The Environmental Assessment (EA) must include: • an executive summary; • a detailed description of the project including the: – waste strategy that underpins the development of the project; – need for the project: having particular regard to the aims, objectives, and guidance in the *NSW Waste Avoidance and Resource Recovery Strategy 2007* and *DECC's Guidelines for Solid Waste Landfills* – a review of the project against Clause 123 of the *State Environmental Planning Policy (Infrastructure) 2007*; – alternatives considered, including a justification for the proposal on economic, social and environmental grounds; – details of any proposed building works, including engineering and/or architectural plans; – details of the landfill design, leachate and gas management systems; – various components and stages of the project; and – the likely inter-relationship between the proposed operations and the existing operations on site including details of existing approvals, management systems and details of past environmental performance. • consideration of whether the development is consistent with the principles included in the publication *EIS Guideline: Landfilling* (Department of Planning, 1996); • a risk assessment of the potential environmental impacts of the project, identifying the key issues for further assessment; • a detailed assessment of the key issues specified below, and any other significant issues identified in the risk assessment (see above), which includes: - a description of the existing environment, using sufficient baseline data; - an assessment of the potential impacts of all stages of the project taking into consideration any relevant guidelines, policies, plans

	and statutory provisions; and - a description of the measures that would be implemented to avoid, minimise, mitigate, rehabilitate/remediate, monitor and/or offset the potential impacts of the project, including detailed contingency plans for managing any potentially significant risks to the environment. • a statement of commitments, outlining all the proposed environmental management and monitoring measures; • a conclusion justifying the project, taking into consideration: the suitability of the sites; the economic, social and environmental impacts of the project as a whole; and whether it is consistent with the objects of the *Environmental Planning and Assessment Act 1979*, and in particular the principles of ecologically sustainable development; and • a signed statement from the author of the environmental assessment certifying that the information contained in the report is neither false nor misleading.
Key Issues	• **Waste Management** – including: - identify, classify and quantify the likely waste streams that would be handled/stored/disposed of at the facility; - describe how this waste would be treated, stored, used, disposed and handled on site, and transported to and from the site, and the potential impacts associated with these issues; and - any waste recovery methods (including volumes and types of wastes diverted) and monitoring programs. • **Soil, Water and Leachate** – including: – the proposed erosion and sediment controls during construction and operation; – the proposed stormwater management system, including the capacity of onsite detention systems, and measures to treat, reuse or dispose of water; – consideration of potential acid sulfate soils, salinity, soil contamination and flooding impacts of the proposal; – potential impacts on watercourses and groundwater; and – the proposed leachate management systems. • **Air Quality and Odour** – including: – a quantitative assessment of the potential air quality and odour impacts of the project including cumulative impacts; and – a demonstration that the proposal is able to comply with the *Protection of the Environment Operations (POEO) Act 1997* and the *POEO (Clean Air) Regulation (2002).* • **Greenhouse Gas** – including: – a quantitative assessment of the scope 1 and 2 greenhouse gas emissions of the project, and an assessment of the energy efficiency of the project in comparison to industry best practice; and – a description of the measures that would be implemented to minimise the energy use of the project including landfill gas capture and electricity generation. • **Biodiversity** – including: - accurate estimates of any vegetation clearing associated with the project; - a detailed assessment of the potential impacts of the project on any terrestrial and aquatic threatened species or populations and their habitats, endangered ecological communities or groundwater dependent ecosystems; - a detailed description of the measures that would be implemented to avoid or mitigate impacts to biodiversity; and - an offset strategy to ensure that the project maintains or improves the biodiversity values of the region in the medium to long term (in accordance with NSW and Commonwealth policies).

	• **Traffic and transport** – including: – details of traffic volumes that are likely to be generated during construction and operation of the project, and an assessment of the impact of this traffic on the safety and efficiency of the surrounding road network; and – details of suitable infrastructure required to ameliorate any traffic impacts an safety impacts associated with the project. • **Noise** – including construction, operational and traffic noise. • **Heritage** – including an indigenous and non indigenous heritage assessment. • **Hazards and Risk** – including a Preliminary Hazard Analysis (PHA) of the project, and an assessment of the potential bushfire risks of the project. • **Visual** – including an assessment of the potential visual impacts of the project on the amenity of the surrounding area. • **Socio-Economic** – including a comprehensive assessment of the economic and social impacts of the project, demonstrating that it would have a net benefit for the community, paying particular attention to the potential impacts of the project on waste minimisation and resource recovery in the region. • **Rehabilitation & Final Landform** – including: – a justification of the final landform and details regarding the potential future land uses for the site; and – a detailed description of how the site would be progressively rehabilitated and integrated with the final landform.
Guidelines	The Environmental Assessment must take into account relevant State government technical and policy guidelines. While not exhaustive, guidelines which may be relevant to the project are included in the following list.
Consultation	During the preparation of the Environmental Assessment, you should consult with the relevant local, State and Commonwealth Government authorities, service providers, community groups and affected landowners. In particular you must consult with: • NSW Office of Environment and Heritage; • NSW Office of Water; • Roads and Traffic Authority. The consultation process and the issues raised must be described in the Environmental Assessment.
Deemed Refusal Period	60 days

Technical and Policy Guidelines

Aspect	Policy /Methodology
Waste	
	Waste Avoidance and Resource Recovery Strategy 2007 (DECC)
	Waste Classification Guidelines (DECC)
	Environmental Guidelines: Solid Waste Landfills 1996 (DECC)
	Environmental Guidelines: Composting and Related Organics Processing Facilities (2004)
	Composts, soil conditioners and mulches (Standards Australia, AS 4454)
	State Environmental Planning Policy (Infrastructure) 2007
Soil and Waters	
Soil	Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites (ANZECC & NHMRC) National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPC)
	State Environmental Planning Policy No. 55 – Remediation of Land
	Guidelines for Consultants Reporting on Contaminated Sites (DECCW, 2000)
	Managing Land Contamination - Planning Guidelines SEPP 55 – Remediation of Land (DUAP and EPA)
	Managing Urban Stormwater: Soils and Construction (Landcom)
	Acid Sulfate Soil Manual (ASSMAC)
	Agricultural Land Classification
	Rural Land Capability Map
Surface Water	National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ)
	National Water Quality Management Strategy: Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC/ARMCANZ)
	National Water Quality Management Strategy - Guidelines For Water Recycling: Managing Health And Environmental Risks (Phase1) (EPHC, NRMMC & AHMC)
	Using the ANZECC Guideline and Water Quality Objectives in NSW (DEC)
	National Water Quality Management Strategy - Guidelines For Water Recycling: Managing Health And Environmental Risks (Phase1) (EPHC, NRMMC & AHMC)
	Managing Urban Stormwater: Treatment Techniques (EPA)
	Managing Urban Stormwater: Source Control. Draft (EPA)
	Managing Urban Stormwater: Soils & Construction (Landcom)
	Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DEC)
	NSW Government Floodplain Development Manual – the Management of Flood Liable Land (DIPNR, 2005)
	Floodplain Risk Management Guideline: Practical Consideration of Climate Change (DECC, 2007)
	Technical Guidelines: Bunding & Spill Management (DECC)
Groundwater	National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia (ARMCANZ/ANZECC) NSW State Groundwater Policy Framework Document (DLWC)
	NSW State Groundwater Quality Protection Policy (DLWC)
	NSW State Groundwater Quantity Management Policy (DLWC) Draft

	Guidelines for the Assessment and Management of Groundwater Contamination (DECC) Draft
Biodiversity	
	Draft Guidelines for Threatened Species Assessment (DEC & DPI, 2005)
	Threatened Biodiversity Survey and Assessment - Guideline for Developments and Activities - DECCW 2009
	Threatened Species Assessment Guidelines: The Assessment of significance - DECC 2007
	Guidelines for Development Adjoining DECC Land (DECC, 2008)
	Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (NSW Fisheries, 2003)
	Policy and Guidelines: Aquatic Habitat Management and Fish Conservation (NSW Fisheries, 1999)
	Threatened Species Management Manual (NPWS, 1998)
Air Quality	
	Protection of the Environment Operations (Clean Air) Regulation 2002
	Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW (DEC)
	Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (DEC)
Odour	
	Technical Framework: Assessment and Management of Odour from Stationary Sources in NSW (DEC)
Greenhouse Gas	
	National Greenhouse Accounts (NGA) Factors 2008
	Guidelines for Energy Savings Action Plans (DEUS)
Transport	
	Guide to Traffic Generating Development (RTA)
	Road Design Guide (RTA)
	Technical Notes: Assessment and Management of Odour from Stationary Sources in NSW (DEC)
Noise	
	NSW Industrial Noise Policy (DECC)
	Environmental Criteria for Road Traffic Noise (NSW EPA)
	Environmental Noise Control Manual (DECC)
	Draft Construction Noise Guideline 2008 (DECC)
Heritage	
Aboriginal	Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC, 2005)
Risk	
	AS/NZS 4360:2004 Risk Management (Standards Australia)
	HB 203: 203:2006 Environmental Risk Management – Principles & Process (Standards Australia)
Bushfire	
	Planning for Bushfire Protection 2006 (NSW Rural Fire Service)
Hazards	
	State Environmental Planning Policy No 33– Hazardous and Offensive Development (SEPP 33)
	Planning Advisory Paper No. 6 – Guidelines for Hazardous Analysis (DUAP)

Office of Environment & Heritage

Department of Planning and Infrastructure
GPO Box 39
SYDNEY NSW 2001

Attention: Nicholas Hall

WOLLONGONG CITY COUNCIL

Notice Number	1500682
File Number	LIC11/17
Date	05-Aug-2011

Dear Mr Hall,

Whytes Gully Waste Disposal Facility - New Landfill Cells

I refer to your request for the Office of Environment and Heritage's (OEH) requirements for the Environmental Assessment (EA) regarding Wollongong City Council's proposal to construct new landfill cells at the Whytes Gully Waste Disposal Facility at Reddalls Road, Kembla Grange, received by OEH on 22 July 2011.

Please note that, although the Environment Protection Authority (EPA) is now a part of OEH, certain statutory functions and powers continue to be exercised in the name of the EPA.

OEH has considered the details of the proposal as provided by Department of Planning and Infrastructure and now includes OEH's Director General Requirements enclosed in Attachment A. In summary, OEH's key information requirements for the proposal are:

1. Waste Management;
2. Stormwater and Leachate Management;
3. Air Quality Issues (including odour and dust management);
4. Noise impacts;
5. Infrastructure and Landfill design (including leachate management, gas management and environmental monitoring);
6. Biodiversity; and
7. Aboriginal Cultural Heritage.

Based upon the information provided to the OEH, it may be necessary for the proponent to vary its existing Environment Protection Licence (Licence) it holds for the facility. A separate application to the OEH will be required if any changes to the Licence are necessary, should approval for the proposal be granted.

NSW GOVERNMENT | Office of Environment & Heritage

If you have any queries regarding the above please contact Tracey McAndrew on 4224 4124.

Yours sincerely

.....

Cate Woods

Unit Head

Waste Operations

(by Delegation)

NSW GOVERNMENT | Office of Environment & Heritage

ATTACHMENT A:

DIRECTOR GENERAL REQUIREMENTS FOR

WHYTES GULLY WASTE DISPOSAL FACILITY - NEW LANDFILL CELLS

REDDALLS ROAD, KEMBLA GRANGE

Office of Environment & Water Director General Requirements

The OEH Director General Requirements have been structured as follows:

A. Executive summary

B. The proposal

C. The location

D. Identification and prioritisation of issues

E. The environmental issues

F. List of approvals and licences

G. Compilation of mitigation measures

H. Justification for the proposal

A Executive summary

The executive summary should include a brief discussion of the extent to which the proposal achieves identified environmental outcomes.

B The proposal

1. Objectives of the proposal

- The objectives of the proposal should be clearly stated and refer to:
  a) the size and type of the operation, the nature of the processes and the products, by-products and wastes produced
  b) a life cycle approach to the production, use or disposal of products
  c) the anticipated level of performance in meeting required environmental standards and cleaner production principles
  d) the staging and timing of the proposal and any plans for future expansion
  e) the proposal's relationship to any other industry or facility.

2. Description of the proposal

General

- Detail the quantities and classification of waste to received, processed, recycled, stockpiled and landfilled.
- Provide information on the location and size of all stockpiles of unprocessed and processed/recycled waste at the premises.
- Provide information on the location of activities and processes at the premises
- Provided details on all activities to be carried out at the premises.
- Outline construction works including:
  a) actions to address any existing soil contamination
  b) any earthworks or site clearing, reuse and disposal of cleared material (including use of spoil on site)
  c) construction timetable and staging, hours of construction, proposed construction methods
  d) environment protection measures, including noise mitigation measures, dust control measures, erosion and sediment control measures.

Air

- Identify all sources of air emissions from the development.
  Note: emissions can be classed as either:
  - *point (eg emissions from stack or vent) or*
  - *fugitive (from wind erosion, leakages or spillages, associated with loading or unloading, conveyors, storage facilities, plant and yard operation, vehicle movements (dust from road, exhausts, loss from load), land clearing and construction works).*
- Provide details of the project that are essential for predicting and assessing air impacts including:
  a) the quantities and physio-chemical parameters (eg concentration, moisture content, bulk density, particle sizes etc) of materials to be used, transported, produced or stored
  b) an outline of procedures for handling, transport, production and storage
  c) the management of solid, liquid and gaseous waste streams with potential for significant air impacts.

Noise and vibration

- Identify all noise sources from the development (including both construction and operation phases). Detail all potentially noisy activities including ancillary activities such as transport of goods and raw materials.
- Specify the times of operation for all phases of the development and for all noise producing activities.
- For projects with a significant potential traffic noise impact provide details of road alignment (include gradients, road surface, topography, bridges, culverts etc), and land use along the proposed road and measurement locations – diagrams should be to a scale sufficient to delineate individual residential blocks.

Water

- Provide details of the project that are essential for predicting and assessing impacts to waters:
  a) including the quantity and physio-chemical properties of all potential water pollutants and the risks they pose to the environment and human health, including the risks they pose to Water Quality Objectives in the ambient waters (as defined on www.environment.nsw.gov.au/ieo, using technical criteria derived from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality, ANZECC 2000)
  b) the location and management of discharges with potential for water impacts
  c) drainage works and associated infrastructure; land-forming and excavations; working capacity of structures; and water resource requirements of the proposal.
- Outline site layout, demonstrating efforts to avoid proximity to water resources (especially for activities with significant potential impacts eg effluent ponds) and showing potential areas of modification of contours, drainage etc.
- Outline how total water cycle considerations are to be addressed showing total water balances for the development (with the objective of minimising demands and impacts on water resources). Include

water requirements (quantity, quality and source(s)) and proposed storm and wastewater disposal, including type, volumes, proposed treatment and management methods and re-use options.

Waste and chemicals

- Provide details of the quantity and type of non-liquid waste generated, handled, processed or disposed of at the premises. Waste must be classified according to the *Waste Classification Guidelines* (DECC, 2008).
- Provide details of non-liquid waste management at the facility, including:
  a) the transportation, assessment and handling of waste arriving at or generated at the site
  b) any stockpiling of wastes or recovered materials at the site
  c) any waste processing related to the facility, including reuse, recycling, reprocessing (including composting) or treatment both on- and off-site
  d) the method for disposing of all wastes or recovered materials at the facility
  e) the emissions arising from the handling, storage, processing and reprocessing of waste at the facility
  f) the proposed controls for managing the environmental impacts of these activities.
- Provide details of spoil disposal with particular attention to:
  a) the quantity of spoil material likely to be generated
  b) proposed strategies for the handling, stockpiling, reuse/recycling and disposal of spoil
  c) identification of the history of spoil material and whether there is any likelihood of contaminated material, and if so, measures for the management of any contaminated material
  d) designation of transportation routes for transport of spoil.
- Provide details of procedures for the assessment, handling, storage, transport and disposal of all hazardous and dangerous materials used, stored, processed or disposed of at the site, in addition to the requirements for liquid and non-liquid wastes.
- Provide details of the type and quantity of any chemical substances to be used or stored and describe arrangements for their safe use and storage.
- Reference should be made to the guidelines: *Waste Classification Guidelines* (DECC, 2008).

ESD

- Demonstrate that the planning process and any subsequent development incorporates objectives and mechanisms for achieving ESD, including:
  a) an assessment of a range of options available for use of the resource, including the benefits of each option to future generations
  b) proper valuation and pricing of environmental resources
  c) identification of who will bear the environmental costs of the proposal.

3. Rehabilitation

- Outline considerations of site maintenance, and proposed plans for the final condition of the site (ensuring its suitability for future uses).
- Include a site plan showing the estimated final topography of the site once the landfill operations have ceased and the landfill has been suitably capped.

4. Consideration of alternatives and justification for the proposal

- Consider the environmental consequences of adopting alternatives, including alternative:
  a) sites and site layouts
  b) access modes and routes
  c) waste and water management
  d) impact mitigation measures
- Selection of the preferred option should be justified in terms of:
  a) ability to satisfy the objectives of the proposal
  b) relative environmental and other costs of each alternative
  c) acceptability of environmental impacts and contribution to identified environmental objectives
  d) acceptability of any environmental risks or uncertainties
  e) reliability of proposed environmental impact mitigation measures
  f) efficient use (including maximising re-use) of land, raw materials, energy and other resources.

C The location

1. General

- Provide an overview of the affected environment to place the proposal in its local and regional environmental context including:
  a) meteorological data (eg rainfall, temperature and evaporation, wind speed and direction)
  b) topography (landform element, slope type, gradient and length)
  c) surrounding land uses (potential synergies and conflicts)
  d) geomorphology (rates of landform change and current erosion and deposition processes)
  e) soil types and properties (including erodibility; engineering and structural properties; dispersibility; permeability; presence of acid sulfate soils and potential acid sulfate soils)
  f) ecological information (water system habitat, vegetation, fauna)
  g) availability of services and the accessibility of the site for passenger and freight transport.

2. Air

- Describe the topography and surrounding land uses. Provide details of the exact locations of dwellings, schools and hospitals. Where appropriate provide a perspective view of the study area such as the terrain file used in dispersion models.
- Describe surrounding buildings that may effect plume dispersion.
- Provide and analyse site representative data on following meteorological parameters:
  a) temperature and humidity
  b) rainfall, evaporation and cloud cover
  c) wind speed and direction
  atmospheric stability class
  d) mixing height (the height that emissions will be ultimately mixed in the atmosphere)
  e) katabatic air drainage
  f) air re-circulation.

3. Noise and vibration

- Identify any noise sensitive locations likely to be affected by activities at the site, such as residential properties, schools, churches, and hospitals. Typically the location of any noise sensitive locations in relation to the site should be included on a map of the locality.
- Identify the land use zoning of the site and the immediate vicinity and the potentially affected areas.

4. Water

- Describe the catchment including proximity of the development to any waterways and provide an assessment of their sensitivity/significance from a public health, ecological and/or economic perspective. The Water Quality and River Flow Objectives on the website: www.environment.nsw.gov.au/ieo should be used to identify the agreed environmental values and human uses for any affected waterways. This will help with the description of the local and regional area.

5. Soil Contamination Issues

- Provide details of site history – if earthworks are proposed, this needs to be considered with regard to possible soil contamination.

D Identification and prioritisation of issues / scoping of impact assessment

- Provide an overview of the methodology used to identify and prioritise issues. The methodology should take into account:
  a) relevant NSW government guidelines
  b) industry guidelines
  c) EAs and EISs for similar projects
  d) relevant research and reference material
  e) relevant preliminary studies or reports for the proposal
  f) consultation with stakeholders.
- Provide a summary of the outcomes of the process including:
  a) all issues identified including local, regional and global impacts (eg increased/ decreased greenhouse emissions)
  b) key issues which will require a full analysis (including comprehensive baseline assessment)
  c) issues not needing full analysis though they may be addressed in the mitigation strategy
  d) justification for the level of analysis proposed (the capacity of the proposal to give rise to high concentrations of pollution compared with the ambient environment or environmental outcomes is an important factor in setting the level of assessment).

E The environmental issues

1. General

- The potential impacts identified in the scoping study need to be assessed to determine their significance, particularly in terms of achieving environmental outcomes, and minimising environmental pollution.
- Identify gaps in information and data relevant to significant impacts of the proposal and any actions proposed to fill those information gaps so as to enable development of appropriate management and mitigation measures. This is in accordance with ESD requirements.

Describe baseline conditions

- Provide a description of existing environmental conditions for any potential impacts.

Assess impacts

- For any potential impacts relevant for the assessment of the proposal provide a detailed analysis of the impacts of the proposal on the environment including the cumulative impact of the proposal on the receiving environment especially where there are sensitive receivers.
- Describe the methodology used and assumptions made in undertaking this analysis (including any modelling or monitoring undertaken) and indicate the level of confidence in the predicted outcomes and the resilience of the environment to cope with the predicted impacts.
- The analysis should also make linkages between different areas of assessment where necessary to enable a full assessment of environmental impacts eg assessment of impacts on air quality will often need to draw on the analysis of traffic, health, social, soil and/or ecological systems impacts; etc.
- The assessment needs to consider impacts at all phases of the project cycle including: exploration (if relevant or significant), construction, routine operation and decommissioning/closure if relevant.
- The level of assessment should be commensurate with the risk to the environment.

Describe management and mitigation measures

- Describe any mitigation measures and management options proposed to prevent, control, abate or mitigate identified environmental impacts associated with the proposal and to reduce risks to human health and prevent the degradation of the environment. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented.
- Proponents are expected to implement a 'reasonable level of performance' to minimise environmental impacts. The proponent must indicate how the proposal meets reasonable levels of performance. For example, reference technology based criteria if available, or identify good practice for this type of activity or development. A 'reasonable level of performance' involves adopting and implementing technology and management practices to achieve certain pollutant emissions levels in economically viable operations. Technology-based criteria evolve gradually over time as technologies and practices change.
- Use environmental impacts as key criteria in selecting between alternative sites, designs and technologies, and to avoid options having the highest environmental impacts.

- Outline any proposed approach (such as an Environmental Management Plan) that will demonstrate how commitments made in the EIS will be implemented. Areas that should be described include:
  a) operational procedures to manage environmental impacts
  b) monitoring procedures
  c) training programs
  d) community consultation
  e) complaint mechanisms including site contacts
  f) strategies to use monitoring information to improve performance
  g) strategies to achieve acceptable environmental impacts and to respond in event of exceedences.

6. Air

Describe baseline conditions

Provide a description of existing air quality and meteorology, using existing information and site representative ambient monitoring data. This description should particularly focus on odour and dust emissions for the site.

Assess impacts

- Identify all pollutants of concern and estimate emissions by quantity (and size for particles), source and discharge point.
- Estimate the resulting ground level concentrations of all pollutants. Where necessary (eg potentially significant impacts and complex terrain effects), use an appropriate dispersion model to estimate ambient pollutant concentrations. Discuss choice of model and parameters with the OEH.
- Describe the effects and significance of pollutant concentration on the environment, human health, amenity and regional ambient air quality standards or goals.
- Describe the contribution that the development will make to regional and global pollution, particularly in sensitive locations.
- For potentially odorous emissions provide the emission rates in terms of odour units (determined by techniques compatible with OEH procedures). Use sampling and analysis techniques for individual or complex odours and for point or diffuse sources, as appropriate.
  Note: With dust and odour, it may be possible to use data from existing similar activities to generate emission rates.

- Reference should be made to e.g. *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW* (EPA, 2001)*; Approved Methods for the Sampling and Analysis of Air Pollutants in NSW* (EPA, 2001)*; Assessment and Management of Odour from Stationary Sources in NSW* (EPA, 2001)*; Technical Notes: Draft Policy: Assessment and Management of Odour from Stationary Sources in NSW (EPA, 2001); Load Calculation Protocol for use by holders of NSW Environment Protection Licences when calculating Assessable Pollutant Loads* (EPA, 1999).

Describe management and mitigation measures

- Outline specifications of pollution control equipment (including manufacturer's performance guarantees where available) and management protocols for both point and fugitive emissions. Where possible, this should include cleaner production processes.

7. Noise and vibration

Describe baseline conditions

- Determine the existing background (LA90) and ambient (LAeq) noise levels in accordance with the *NSW Industrial Noise Policy (EPA, 2000)*.
- Determine the existing road traffic noise levels in accordance with the *NSW Road Noise Policy* (DECCW, 2011), where road traffic noise impacts may occur.
- The noise impact assessment report should provide details of all monitoring of existing ambient noise levels including:
  a) details of equipment used for the measurements
  b) a brief description of where the equipment was positioned
  c) a statement justifying the choice of monitoring site, including the procedure used to choose the site, having regards to the definition of 'noise sensitive locations(s)' and 'most affected locations(s)' described in Section 3.1.2 of the *NSW Industrial Noise Policy*
  d) details of the exact location of the monitoring site and a description of land uses in surrounding areas
  e) a description of the dominant and background noise sources at the site
  f) day, evening and night assessment background levels for each day of the monitoring period
  g) the final Rating Background Level (RBL) value
  h) graphs of the measured noise levels for each day should be provided
  i) a record of periods of affected data (due to adverse weather and extraneous noise), methods used to exclude invalid data and a statement indicating the need for any re-monitoring under Step 1 in Section B1.3 of the *NSW Industrial Noise Policy*
  j) determination of LAeq noise levels from existing industry.

Assess impacts

- Determine the project specific noise levels for the site. For each identified potentially affected receiver, this should include:
  a) determination of the intrusive criterion for each identified potentially affected receiver
  b) selection and justification of the appropriate amenity category for each identified potentially affected receiver

c) determination of the amenity criterion for each receiver

d) determination of the appropriate sleep disturbance limit.

- Maximum noise levels during night-time period (10pm-7am) should be assessed to analyse possible affects on sleep. Where LA1(1min) noise levels from the site are less than 15 dB above the background LA90 noise level, sleep disturbance impacts are unlikely. Where this is not the case, further analysis is required.
- Determine expected noise level and noise character (eg tonality, impulsiveness, vibration, etc) likely to be generated from noise sources during:

  a) site establishment

  b) construction

  c) operational phases

  d) transport including traffic noise generated by the proposal

  e) other services.

  Note: The noise impact assessment report should include noise source data for each source in 1/1 or 1/3 octave band frequencies including methods for references used to determine noise source levels. Noise source levels and characteristics can be sourced from direct measurement of similar activities or from literature (if full references are provided).

- Determine the noise levels likely to be received at the most sensitive locations (these may vary for different activities at each phase of the development). Potential impacts should be determined for any identified significant adverse meteorological conditions. Predicted noise levels under calm conditions may also aid in quantifying the extent of impact where this is not the most adverse condition.
- The noise impact assessment report should include:

  a) a plan showing the assumed location of each noise source for each prediction scenario

  b) a list of the number and type of noise sources used in each prediction scenario to simulate all potential significant operating conditions on the site

  c) any assumptions made in the predictions in terms of source heights, directivity effects, shielding from topography, buildings or barriers, etc

  d) methods used to predict noise impacts including identification of any noise models used. Where modelling approaches other than the use of the ENM or SoundPlan computer models are adopted, the approach should be appropriately justified and validated

  e) an assessment of appropriate weather conditions for the noise predictions including reference to any weather data used to justify the assumed conditions

  f) the predicted noise impacts from each noise source as well as the combined noise level for each prediction scenario under any identified significant adverse weather conditions as well as calm conditions where appropriate

  g) for developments where a significant level of noise impact is likely to occur, noise contours for the key prediction scenarios should be derived

  h) an assessment of the need to include modification factors as detailed in Section 4 of the *NSW Industrial Noise Policy*.

- Discuss the findings from the predictive modelling and, where relevant noise criteria have not been met, recommend additional mitigation measures.

- The noise impact assessment report should include details of any mitigation proposed including the attenuation that will be achieved and the revised noise impact predictions following mitigation.
- Where relevant noise/vibration criteria cannot be met after application of all feasible and cost effective mitigation measures the residual level of noise impact needs to be quantified by identifying:
  a) locations where the noise level exceeds the criteria and extent of exceedence
  b) numbers of people (or areas) affected
  c) times when criteria will be exceeded
  d) likely impact on activities (speech, sleep, relaxation, listening, etc)
  e) change on ambient conditions
  f) the result of any community consultation or negotiated agreement.
- For the assessment of existing and future traffic noise, details of data for the road should be included such as assumed traffic volume; percentage heavy vehicles by time of day; and details of the calculation process. These details should be consistent with any traffic study carried out in the EIS.

Describe management and mitigation measures

- Determine the most appropriate noise mitigation measures and expected noise reduction including both noise controls and management of impacts for both construction and operational noise. This will include selecting quiet equipment and construction methods, noise barriers or acoustic screens, location of stockpiles, temporary offices, compounds and vehicle routes, scheduling of activities, etc.
- For traffic noise impacts, provide a description of the ameliorative measures considered (if required), reasons for inclusion or exclusion, and procedures for calculation of noise levels including ameliorative measures. Also include, where necessary, a discussion of any potential problems associated with the proposed ameliorative measures, such as overshadowing effects from barriers. Appropriate ameliorative measures may include:
  a) use of alternative transportation modes, alternative routes, or other methods of avoiding the new road usage
  b) control of traffic (eg: limiting times of access or speed limitations)
  c) resurfacing of the road using a quiet surface
  d) use of (additional) noise barriers or bunds
  e) treatment of the façade to reduce internal noise levels buildings where the night-time criteria is a major concern
  f) more stringent limits for noise emission from vehicles (i.e. using specially designed 'quite' trucks and/or trucks to use air bag suspension
  g) driver education
  h) appropriate truck routes
  i) limit usage of exhaust breaks
  j) use of premium muffles on trucks
  k) reducing speed limits for trucks

l) ongoing community liaison and monitoring of complaints

m) phasing in the increased road use.

1. Water

Describe baseline conditions

- Describe existing surface and groundwater quality – an assessment needs to be undertaken for any water resource likely to be affected by the proposal and for all conditions (e.g. a wet weather sampling program is needed if runoff events may cause impacts).

  Note: Methods of sampling and analysis need to conform with an accepted standard (e.g. Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DECCW, 2004) *or be approved and analyses undertaken by accredited laboratories).*

- Provide site drainage details and surface runoff yield.
- State the ambient Water Quality and River Flow Objectives for the receiving waters. These refer to the community's agreed environmental values and human uses endorsed by the Government as goals for the ambient waters. These environmental values are published on the website: www.environment.nsw.gov.au/ieo. The EA should state the environmental values listed for the catchment and waterway type relevant to your proposal. NB: A consolidated and approved list of environmental values are not available for groundwater resources. Where groundwater may be affected the EA should identify appropriate groundwater environmental values and justify the choice.
- State the indicators and associated trigger values or criteria for the identified environmental values. This information should be sourced from the ANZECC 2000 *Guidelines for Fresh and Marine Water Quality* (http://www.deh.gov.au/water/quality/nwqms/volume1.html)(Note that, as at 2004, the NSW Water Quality Objectives booklets and website contain technical criteria derived from the 1992 version of the ANZECC Guidelines. The Water Quality Objectives remain as Government Policy, reflecting the community's environmental values and long-term goals, but the technical criteria are replaced by the more recent ANZECC 2000 Guidelines). NB: While specific guidelines for groundwater are not available, the ANCECC 2000 Guidelines endorse the application of the trigger values and decision trees as a tool to assess risk to environmental values in groundwater.
- State any locally specific objectives, criteria or targets, which have been endorsed by the government.
- Where site specific studies are proposed to revise the trigger values supporting the ambient Water Quality and River Flow Objectives, and the results are to be used for regulatory purposes (e.g. to assess whether a licensed discharge impacts on water quality objectives), then prior agreement from the OEH on the approach and study design must be obtained.
- Describe the state of the receiving waters and relate this to the relevant Water Quality and River Flow Objectives (i.e. are Water Quality and River Flow Objectives being achieved?). Proponents are generally only expected to source available data and information. However, proponents of large or high risk developments may be required to collect some ambient water quality / river flow / groundwater data to enable a suitable level of impact assessment. Issues to include in the description of the receiving waters could include:

  a) lake or estuary flushing characteristics

  b) specific human uses (e.g. exact location of drinking water offtake)

c) sensitive ecosystems or species conservation values

d) a description of the condition of the local catchment e.g. erosion levels, soils, vegetation cover, etc

e) an outline of baseline groundwater information, including, but not restricted to, depth to watertable, flow direction and gradient, groundwater quality, reliance on groundwater by surrounding users and by the environment

f) historic river flow data where available for the catchment.

Assess impacts

- No proposal should breach clause 120 of the *Protection of the Environment Operations Act* 1997 (i.e. pollution of waters is prohibited unless undertaken in accordance with relevant regulations).
- Identify and estimate the quantity of all pollutants that may be introduced into the water cycle by source and discharge point including residual discharges after mitigation measures are implemented.
- Include a rationale, along with relevant calculations, supporting the prediction of the discharges.
- Describe the effects and significance of any pollutant loads on the receiving environment. This should include impacts of residual discharges through modelling, monitoring or both, depending on the scale of the proposal. Determine changes to hydrology (including drainage patterns, surface runoff yield, flow regimes, wetland hydrologic regimes and groundwater).
- Describe water quality impacts resulting from changes to hydrologic flow regimes (such as nutrient enrichment or turbidity resulting from changes in frequency and magnitude of stream flow).
- Identify any potential impacts on quality or quantity of groundwater describing their source.
- Identify potential impacts associated with geomorphological activities with potential to increase surface water and sediment runoff or to reduce surface runoff and sediment transport. Also consider possible impacts such as bed lowering, bank lowering, instream siltation, floodplain erosion and floodplain siltation.
- Identify impacts associated with the disturbance of acid sulfate soils and potential acid sulfate soils.
- Containment of spills and leaks shall be in accordance with the *Storing and Handling Liquids: Environmental Protection - Participants Manual* (DECC, 2007), *Environmental Compliance Report: Liquid Chemical Storage, Handling and Spill Management - Part B Review of Best Practice and Regulation* (DEC, 2005) (http://www.environment.nsw.gov.au/water/bundingspill.htm) and the most recent versions of the Australian Standards referred to in the Guidelines. Containment should be designed for no-discharge.
- The significance of the impacts listed above should be predicted. When doing this it is important to predict the ambient water quality and river flow outcomes associated with the proposal and to demonstrate whether these are acceptable in terms of achieving protection of the Water Quality and River Flow Objectives. In particular the following questions should be answered:

  a) will the proposal protect Water Quality and River Flow Objectives where they are currently achieved in the ambient waters; and

  b) will the proposal contribute towards the achievement of Water Quality and River Flow Objectives over time, where they are not currently achieved in the ambient waters.

- Where a licensed discharge is proposed, provide the rationale as to why it cannot be avoided through application of a reasonable level of performance, using available technology, management practice and industry guidelines.
- Where a licensed discharge is proposed, provide the rationale as to why it represents the best environmental outcome and what measures can be taken to reduce its environmental impact.
- Reference should be made to e.g. *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004), *Guidelines for Fresh and Marine Water Quality* ANZECC 2000), *Environmental Guidelines: Use of effluent by Irrigation* (DEC, 2004).

Describe management and mitigation measures

- Outline stormwater management to control pollutants at the source and contain them within the site. Also describe measures for maintaining and monitoring any stormwater controls.
- Outline erosion and sediment control measures directed at minimising disturbance of land, minimising water flow through the site and filtering, trapping or detaining sediment. Also include measures to maintain and monitor controls as well as rehabilitation strategies.
- Describe waste water treatment measures that are appropriate to the type and volume of waste water and are based on a hierarchy of avoiding generation of waste water; capturing all contaminated water (including stormwater) on the site; reusing/recycling waste water; and treating any unavoidable discharge from the site to meet specified water quality requirements.
- Outline pollution control measures relating to storage of materials, possibility of accidental spills (eg preparation of contingency plans), appropriate disposal methods, and generation of leachate.
- Describe hydrological impact mitigation measures including:
  a) site selection (avoiding sites prone to flooding and waterlogging, actively eroding or affected by deposition)
  b) minimising runoff
  c) minimising reductions or modifications to flow regimes
  d) avoiding modifications to groundwater.
- Describe groundwater impact mitigation measures including:
  a) site selection
  b) retention of native vegetation and revegetation
  c) artificial recharge
  d) providing surface storages with impervious linings
  e) monitoring program.
- Describe geomorphological impact mitigation measures including:
  a) site selection
  b) erosion and sediment controls
  c) minimising instream works
  d) treating existing accelerated erosion and deposition
  e) monitoring program.

- Any proposed monitoring should be undertaken in accordance with the *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* (DECC, 2004).

5. Soils and contamination

Describe baseline conditions

- Provide any details (in addition to those provided in the location description - Section C) that are needed to describe the existing situation in terms of soil types and properties and soil contamination.

Assess impacts

- Identify any likely impacts resulting from the construction or operation of the proposal, including the likelihood of:
  a) disturbing any existing contaminated soil
  b) contamination of soil by operation of the activity
  c) subsidence or instability
  d) soil erosion
  e) disturbing acid sulfate or potential acid sulfate soils.
- Reference should be made to e.g. *Contaminated Sites – Guidelines for Consultants Reporting on Contaminated Sites* (EPA, 1997)*; Contaminated Sites – Guidelines on Significant Risk of Harm and Duty to Report* (EPA, 1999).

Describe management and mitigation measures

- Describe and assess the effectiveness or adequacy of any soil management and mitigation measures during construction and operation of the proposal including:
  a) erosion and sediment control measures
  b) proposals for site remediation – see *Managing Land Contamination, Planning Guidelines SEPP 55 – Remediation of Land* (Department of Urban Affairs and Planning and Environment Protection Authority, 1998)
  c) proposals for the management of these soils – see *Assessing and Managing Acid Sulfate Soils,* Environment Protection Authority, 1995 (note that this is the only methodology accepted by the OEH).

6. Waste and chemicals

Describe baseline conditions

- Describe any existing waste or chemicals operations related to the proposal.

- Describe the proposed recycling activities at the site including the types and volumes of waste received, the types and volumes recycled, and the types and volumes transported off-site for recycling.

Assess impacts

- Assess the adequacy of proposed measures to minimise natural resource consumption and minimise impacts from the handling, transporting, storage, processing and reprocessing of waste and/or chemicals.
- Reference should be made to *Waste Classification Guidelines* (DECC, 2008).

Describe management and mitigation measures

- Outline measures to minimise the consumption of natural resources.
- Outline measures to minimise environmental impacts from the recycling activities, including any increase/decrease on the current types and volumes of waste recycled at the site.
- Outline measures to avoid the generation of waste and promote the re-use and recycling and reprocessing of any waste.
- Outline measures to support any approved regional or industry waste plans.

7. Cumulative impacts

- Identify the extent that the receiving environment is already stressed by existing development and background levels of emissions (including odour emissions) to which this proposal will contribute.
- Assess the impact of the proposal against the long term air, noise and water quality objectives for the area or region.
- Identify infrastructure requirements flowing from the proposal (eg water and sewerage services, transport infrastructure upgrades).
- Assess likely impacts from such additional infrastructure and measures reasonably available to the proponent to contain such requirements or mitigate their impacts (eg travel demand management strategies).

F. List of approvals and licences

- Identify all approvals and licences required under environment protection legislation including details of all scheduled activities, types of ancillary activities and types of discharges (to air, land, water).

G. Compilation of mitigation measures

- Outline how the proposal and its environmental protection measures would be implemented and managed in an integrated manner so as to demonstrate that the proposal is capable of complying with statutory obligations under OEH licences or approvals (eg outline of an environmental management plan).

- The mitigation strategy should include the environmental management and cleaner production principles which would be followed when planning, designing, establishing and operating the proposal. It should include two sections, one setting out the program for managing the proposal and the other outlining the monitoring program with a feedback loop to the management program.

H. Justification for the Proposal

- Reasons should be included which justify undertaking the proposal in the manner proposed, having regard to the potential environmental impacts.

I. Specific Matters to Address for the Proposal

The EA should also address the following matters:

Staging Plan

- A staging plan is to be developed and included in the EA and should outline the following:
    a. A detailed site plan showing each of the proposed new landfill cells numbered in sequence of proposed filling and the location of all associated infrastructure including the new site of any infrastructure that will be relocated (e.g. leachate ponds, recycling area etc).
    b. The planned commencement and completion of construction for the first new landfill cell.
    c. The estimated life of each of the proposed new landfill cells.
    d. The planned commencement and completion of construction of any required infrastructure, including the relocation of existing infrastucture, associated with the landfill.
    Note: The timing of the construction of such infrastructure should also allow time for OEH approval of design where necessary

Cell Design

- A plan with cross sections at a suitable scale depicting the dimensions of the proposed landfill cells i.e length, width and depth, as well as details of the landfill cells floor and wall gradients.
- The proponent must demonstrate that the subsidence of existing waste beneath where new cells will be constructed will be minimal prior to the construction of the new cells.
- The proponent must demonstrate that the integrity of the cells proposed to be "piggy-backed" on existing waste will not be compromised by any subsidence of existing waste.

Stormwater and Leachate Management

- Conceptual details of the design, construction and operation of a leachate management system.
- Specifications for the proposed leachate collection drainage layer in each of the cells. The specifications must be in accordance with the *Environmental Guidelines: Solid Waste Landfills* (EPA, 1996) Benchmark Technique 2 (unless an alternative is proposed and demonstrated that it is a suitable alternative).
- Details of the layout and specification of the proposed leachate collection pipes.

- Concept details of the proposed leachate risers and leachate extraction and pumping system for the landfill.
- A report detailing the leachate storage and disposal needs and location and size of the proposed leachate storage dam(s). Where existing leachate management infrastructure is to be utilised, the proponent must demonstrate there is adequate capacity in the system to handle additional cells. The size of leachate storage dam(s) must take the form of a water balance run using monthly time steps.
- Conceptual details of the design, construction and operation of a stormwater management system. Where existing infrastructure is being utilised the proponent must demonstrate there is adequate capacity in the system to handle the proposed changes to the facility.
- The proponent must demonstrate how surface water runoff will be diverted away from the leachate collection system therefore minimising the quantity of leachate required to be stored, treated and managed on site.

J. Greenhouse Gas Emissions

- The EA should include a comprehensive assessment of, and report on, the project's predicted greenhouse gas emissions (tCO2e). Emissions should be reported broken down by:
  a) direct emissions (scope 1 as defined by the Greenhouse Gas Protocol – see reference below),
  b) indirect emissions from electricity (scope 2), and
  c) upstream and downstream emissions (scope 3)

  before and after implementation of the project, including annual emissions for each year of the project (construction, operation and decommissioning).

- The EA should inlcude a commitment to install and operate landfill gas collection and oxidation works, if required by the environment protection licence (should consent be granted).

- The EA should include an estimate of the greenhouse emissions intensity (per unit of production). Emissions intensity should be compared with best practice if possible.

- The emissions should be estimated using an appropriate methodology, in accordance with NSW, Australian and international guidelines (see below).

- The proponent should also evaluate and report on the feasibility of measures to reduce greenhouse gas emissions associated with the project. This could include a consideration of energy efficiency opportunities or undertaking an energy use audit for the site.

Guidance Material

- The Greenhouse Gas Protocol: Corporate Standard, World Council for Sustainable Business Development & World Resources Institute http://www.ghgprotocol.org/standards/corporate-standard
- National Greenhouse Accounts (NGA) Factors, Australian Department of Climate Change (Latest release), http://www.climatechange.gov.au/publications/greenhouse-acctg/national-greenhouse-factors.aspx
- National Greenhouse and Energy Reporting System, Technical Guidelines (latest release) http://www.climatechange.gov.au/en/government/initiatives/national-greenhouse-energy-reporting/tools-resources.aspx
- National Carbon Accounting Toolbox http://www.climatechange.gov.au/government/initiatives/ncat.aspx

- Australian Greenhouse Emissions Information System (AGEIS) http://ageis.climatechange.gov.au/

K. Biodiversity

- The EA should include a detailed biodiversity assessment, including assessment of impacts on threatened biodiversity, native vegetation and habitat. This assessment should address the matters included in the following sections.

- A field survey of the site should be conducted and documented in accordance with relevant guidelines, including:
  - the *Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna -Amphibians* (DECCW, 2009)
  - *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities - Working Draft* (DEC, 2004), and
  - Threatened species survey and assessment guideline information on www.environment.nsw.gov.au/threatenedspecies/surveyassessmentgdlns.htm.

  If a proposed survey methodology is likely to vary significantly from the above methods, the proponent should discuss the proposed methodology with OEH prior to undertaking the EA, to determine whether OEH considers that it is appropriate.

  Recent (less than five years old) surveys and assessments may be used. However, previous surveys should not be used if they have:
  - been undertaken in seasons, weather conditions or following extensive disturbance events when the subject species are unlikely to be detected or present, or
  - utilised methodologies, survey sampling intensities, timeframes or baits that are not the most appropriate for detecting the target subject species,

  unless these differences can be clearly demonstrated to have had an insignificant impact upon the outcomes of the surveys. If a previous survey is used, any additional species listed under the TSC Act since the previous survey took place, must be surveyed for.

  Determining the list of potential threatened species for the site must be done in accordance with the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities - Working Draft* (DEC, 2004) and the *Guidelines for Threatened Species Assessment* (Department of Planning, July 2005). The DECCW Threatened Species website http://www.environment.nsw.gov.au/threatenedspecies/ and the *Atlas of NSW Wildlife* database must be the primary information sources for the list of threatened species present. The BioBanking Threatened Species Database, the Vegetation Types databases (available on OEH website at http://www.environment.nsw.gov.au/biobanking/biobankingtspd.htm and http://www.environment.nsw.gov.au/biobanking/vegtypedatabase.htm, respectively) and other data sources (e.g. PlantNET, Online Zoological Collections of Australian Museums (http://www.ozcam.org/), previous or nearby surveys etc.) may also be used to compile the list.

- The EA should contain the following information as a minimum:
  a. The requirements set out in the *Guidelines for Threatened Species Assessment* (Department of Planning, July 2005).
  b. Description and geo-referenced mapping of study area (and spatial data files), e.g. overlays on topographic maps, satellite images and /or aerial photos, including details of map datum, projection and zone, all survey locations, vegetation communities (including classification and

methodology used to classify), key habitat features and reported locations of threatened species, populations and ecological communities present in the subject site and study area.

c. Description of survey methodologies used, including timing, location and weather conditions.
d. Details, including qualifications and experience of all staff undertaking the surveys, mapping and assessment of impacts as part of the EA.
e. Identification of national and state listed threatened biota known or likely to occur in the study area and their conservation status.
f. Description of the likely impacts of the proposal on biodiversity and wildlife corridors, including direct and indirect and construction and operation impacts. Wherever possible, quantify these impacts such as the amount of each vegetation community or species habitat to be cleared or impacted, or any fragmentation of a wildlife corridor.
g. Identification of the avoidance, mitigation and management measures that will be put in place as part of the proposal to avoid or minimise impacts, including details about alternative options considered and how long term management arrangements will be guaranteed.
h. Description of the residual impacts of the proposal. If the proposal cannot adequately avoid or mitigate impacts on biodiversity, then a biodiversity offset package is expected (see the requirements for this at point 6 below).
i. Provision of specific Statement of Commitments relating to biodiversity.

- An assessment of the significance of direct and indirect impacts of the proposal must be undertaken for threatened biodiversity known or considered likely to occur in the study area based on the presence of suitable habitat. This assessment must take into account:
  a. the factors identified in s.5A of the EP&A Act, and
  b. the guidance provided by *The Threatened Species Assessment Guideline – The Assessment of Significance (DECCW, 2007)* which is available at: http://www.environment.nsw.gov.au/resources/threatenedspecies/tsaguide07393.pdf

- Where an offsets package is proposed by a proponent for impacts to biodiversity (and a BioBanking Statement has not been sought) this package should:
  a) Meet OEH's *Principles for the use of biodiversity offsets in NSW*, which are available at: www.environment.nsw.gov.au/biocertification/offsets.htm.
  b) Identify the conservation mechanisms to be used to ensure the long term protection and management of the offset sites.
  c) Include an appropriate Management Plan (such as vegetation or habitat) that has been developed as a key amelioration measure to ensure any proposed compensatory offsets, retained habitat enhancement features within the development footprint and/or impact mitigation measures (including proposed rehabilitation and/or monitoring programs) are appropriately managed and funded.

- Where appropriate, likely impacts (both direct and indirect) on any adjoining and/or nearby OEH estate reserved under the *National Parks and Wildlife Act 1974* or any marine and estuarine protected areas under the *Fisheries Management Act 1994* or the *Marine Parks Act 1997* should be considered. Refer to the *Guidelines for developments adjoining land and water managed by the Department of Environment, Climate Change and Water* (DECC, 2010).

- With regard to the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, the assessment should identify any relevant Matters of National Environmental Significance and whether the proposal has been referred to the Commonwealth or already determined to be a controlled action.

L. Aboriginal Cultural Heritage

The EA report should contain:

- A description of the Aboriginal objects and declared Aboriginal places located within the area of the proposed development.
- A description of the cultural heritage values, including the significance of the Aboriginal objects and declared Aboriginal places, that exist across the whole area that will be affected by the proposed development, and the significance of these values for the Aboriginal people who have a cultural association with the land.
- A description of how the requirements for consultation with Aboriginal people as specified in clause 80C of the National Parks and Wildlife Regulation 2009 have been met.
- The views of those Aboriginal people regarding the likely impact of the proposed development on their cultural heritage. If any submissions have been received as a part of the consultation requirements, then the report must include a copy of each submission and your response.
- A description of the actual or likely harm posed to the Aboriginal objects or declared Aboriginal places from the proposed activity, with reference to the cultural heritage values identified.
- A description of any practical measures that may be taken to protect and conserve those Aboriginal objects or declared Aboriginal places.
- A description of any practical measures that may be taken to avoid or mitigate any actual or likely harm, alternatives to harm or, if this is not possible, to manage (minimise) harm.
- A specific Statement of Commitment that the proponent will complete an Aboriginal Site Impact Recording Form and submit it to the Aboriginal Heritage Information Management System (AHIMS) Registrar, for each AHIMS site that is harmed through the proposed development.

In addressing these requirements, the proponent must refer to the following documents:

c) *Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (Department of Planning, 2005). These guidelines identify the factors to be considered in Aboriginal cultural heritage assessments for development proposals under Part 3A of the EP&A Act.

d) *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW, 2010) - http://www.environment.nsw.gov.au/licences/consultation.htm. This document further explains the consultation requirements that are set out in clause 80C of the National Parks and Wildlife Regulation 2009. The process set out in this document must be followed and documented in the Environmental Assessment Report.

e) *Code of Practice for the Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW, 2010) - http://www.environment.nsw.gov.au/licences/archinvestigations.htm. The process described in this Code should be followed and documented where the assessment of Aboriginal cultural heritage requires an archaeological investigation to be undertaken.

Notes:

2. An Aboriginal Site Impact Recording Form (http://www.environment.nsw.gov.au/licences/DECCAHIMSSiteRecordingForm.htm) must be completed and submitted to the Aboriginal Heritage Information Management System (AHIMS) Registrar, for each AHIMS site that is harmed through archaeological investigations required or permitted through these environmental assessment requirements.

3. Under section 89A of the *National Parks and Wildlife Act* 1974, it is an offence for a person not to notify DECCW of the location of any Aboriginal object the person becomes aware of, not already recorded on the Aboriginal Heritage Information Management System (AHIMS). An AHIMS Site Recording Form should be completed and submitted to the AHIMS Registrar (http://www.environment.nsw.gov.au/contact/AHIMSRegistrar.htm), for each Aboriginal site found during investigations.

Our Ref: 497DA509 (11/852) STH10/00188
Contact: Andrea Boes 4221 2771
Your Ref: 10/09799

03 AUG 2011

Department of Planning & Infrastructure
GPO Box 39
PO Box 492
Sydney NSW 2001

Attention: David Mooney

WOLLONGONG CITY COUNCIL – PRELIMINARY ENVIRONMENTAL ASSESSMENT – WHYTES GULLY RESOURCE RECOVERY PARK – LANDFILL EXPANSION PROJECT

Dear Sir

Reference is made to your letter dated 22 July 2011 regarding the subject major project application forwarded to the Roads and Traffic Authority (RTA) for consideration.

The RTA has reviewed the information provided and considers that the following information should be addressed in the Environmental Assessment (EA):

- A Traffic Impact Study is required. As a guide Table 2.1 of the RTA Guide to Traffic Generating Developments outlines the key issues that may be considered in preparing a Traffic Impact Study. The study should include the traffic generation of the site during construction and the duration of the construction period.
- Landscaping and fencing shall not restrict vehicular sight lines on Reddalls Road. In this regard, where landscaping or fencing is proposed along the frontage, landscaping plans shall indicate clear sight lines in both directions at the access.
- The applicant should identify suitable infrastructure required to ameliorate any traffic impacts and safety impacts associated with the development.
- The RTA strongly recommends that the developer considers the environmental impacts of any proposed roadworks as part of the Statement of Environmental Effects. If these impacts are not considered, then the RTA would require the applicant to provide a separate environmental impact assessment, a 'Review of Environmental Factors' prior to commencing any works that were conditioned as requirements of the development. Note: The RTA has a responsibility to ensure that all environmental impacts are considered to the fullest extent possible under Section 111 of the Environmental Planning and Assessment Act.

The RTA will commence its detailed assessment once the aforementioned information is provided to its satisfaction. Should you require any clarification on this matter please call Andrea Boes on 4221 2771.

Yours faithfully

Brian Lefoe
Manager, Road Safety and Traffic Management
Southern Operations and Engineering Services
Roads and Traffic Authority

Level 4 , 90 Crown St, Wollongong, NSW 2500
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NSW GOVERNMENT | Office of Water

12 August 2011

Mr Nicholas Hall
Mining and Industry Assessments
Department of Planning and Infrastructure
GPO Box 39
SYDNEY NSW 2001

c: Janne Grose
t: 02 4729 8262
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e: Janne.Grose@water.nsw.gov.au

Our ref : ER21579
Your ref: 10/09799

Attention: David Mooney

Dear Mr Hall

Environmental Assessment Requirements for Whytes Gully Resource Recovery Park Landfill Expansion Project, Kembla Grange

I refer to your letter of 22 July 2011 seeking input from the NSW Office of Water (NOW) to the Director-General requirements for the above project proposal.

NOW's Environmental Assessment (EA) requirements are outlined in **Attachment A** and include:

- Groundwater and groundwater dependent ecosystems.
- Protection of watercourses as stable, natural systems; and
- Protection and enhancement of the values and functions of riparian land.

NOW requests that all referrals from the Department of Planning and Infrastructure (DoPI) for the project proposal include the following:

- Referral **cover letter**; and
- One (1) **hard copy** and one (1) **CD** copy of the EA report and any other accompanying documentation.

It would be appreciated if the proponent could be advised of NOW's requirement for a hard copy of the EA and arrange for them to provide it direct to NOW's relevant assessing officer.

Contact Details:

If you require further information please contact Janne Grose on (02) 4729 8262 at the Penrith office.

Yours sincerely

Mark Mignanelli
Manager Major Projects, Mines and Assessment

ATTACHMENT A

NSW Office of Water Comments

Environmental Assessment Requirements for Whytes Gully Resource Recovery Park Landfill Expansion Project

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Groundwater

The NSW Office of Water (NOW) is responsible for the management of the groundwater resources. The proposal needs to demonstrate that it is consistent with NSW State groundwater policy, does not impact on groundwater quality or the health of groundwater dependent ecosystems (GDEs).

To enable a comprehensive assessment of potential groundwater impacts associated with the proposal, the Environmental Assessment (EA) needs to provide the following details:

- the predicted highest groundwater table at the site;
- any works likely to intercept, connect with or infiltrate the groundwater sources;
- any proposed groundwater extraction, including purpose, location and construction details of all proposed bores and expected annual extraction volumes;
- a description of the flow directions and rates and physical and chemical characteristics of the groundwater source;
- the predicted impacts of any final landform on the groundwater regime;
- the existing groundwater users within the area (including the environment), any potential impacts on these users and safeguard measures to mitigate impacts;
- an assessment of the quality of the groundwater for the local groundwater catchment;
- how the proposed development will not potentially diminish the current quality of groundwater, both in the short and long term;
- measures for preventing groundwater pollution so that remediation is not required;
- protective measures for any groundwater dependent ecosystems (GDEs);
- proposed methods of the disposal of waste water and approval from the relevant authority; and
- the results of any models or predictive tools used.

Where potential impact/s are identified the assessment will need to identify limits to the level of impact and contingency measures that would remediate, reduce, manage or account for potential impacts to the existing groundwater resource and any dependent groundwater environment or water users, including information on:

- any proposed monitoring programs, including water levels and quality data;
- reporting procedures for any monitoring program including mechanism for transfer of information;

- an assessment of any groundwater source/aquifer that may be sterilised from future use as a water supply as a consequence of the proposal;
- identification of any nominal thresholds as to the level of impact beyond which remedial measures or contingency plans would be initiated (this may entail water level triggers or a beneficial use category);
- description of the remedial measures or contingency plans proposed; and
- any funding assurances covering the anticipated post development maintenance cost, for example on-going groundwater monitoring for the nominated period.

Licensing

Table 1 in the Preliminary EA indicates the project would involve the installation of bores on the site to enable monitoring of groundwater quality and that a licence under *the Water Act 1912* (WA 1912) would be required (page 6). Table 1 also indicates that under Part 3A provisions projects are exempt from a water use approval and water management approval.

If the proposal is likely to intercept or use groundwater, the need for a water licence should be addressed in the EA. All proposed groundwater works, including bores for the purpose of investigation, extraction, dewatering, testing or monitoring must be identified in the proposal and an approval under relevant water legislation be obtained from NOW prior to their installation.

Please note that on 1 July 2011, the Water Sharing Plan (WSP) for *the Greater Metropolitan Region Groundwater Sources* which covers the project area commenced. Under this plan, the Whytes Gully Resource Recovery Park landfill expansion project site is located within the *Sydney Basin South Groundwater Source.* Upon plan commencement, the licensing provisions of the *Water Management Act 2000* (WMA 2000) also came into effect in the plan area. Information on the WSP can be found at the following link: http://www.water.nsw.gov.au/Water-management/Water-sharing-plans/plans_commenced/default.aspx. Under the WMA 2000, groundwater monitoring bores will now require an aquifer interference approval. However, in the absence of the Aquifer Interference provisions, monitoring bores are still required to be processed under the WA 1912.

The Aquifer Interference provisions are likely to be finalised later this year and at that time this type of activity will require an aquifer interference approval. In the interim groundwater bores will be considered for licensing under the WA 1912. At this time all works that intercept groundwater for monitoring, dewatering and test purposes are required to be authorised under Part 5 of the WA 1912 until such time the Aquifer Interference provisions have been finalised.

It is recommended the proponent contact NOW prior to the installation of any groundwater bores at the site to obtain current advice.

Groundwater Dependent Ecosystems

The EA should provide details on the presence and distribution of GDEs in the vicinity of the site and:

- demonstrate that the proposed development would maintain natural patterns of groundwater flow and not disrupt groundwater levels that are critical to GDEs;
- identify any potential impacts on GDEs as a result of the proposal including:
  - the effect of the proposal on the recharge to groundwater systems;

- the potential to adversely affect the water quality of the underlying groundwater system and adjoining groundwater systems in hydraulic connections;

- the effect on the function of GDEs (habitat, groundwater levels, connectivity); and

- provide safeguard measures for any GDEs.

Riparian Land

The 1:25 000 topographic map shows watercourses are located on and adjacent to the site. The EA needs to address potential impacts of the project on existing riparian vegetation and the rehabilitation of riparian land. It is noted in Table 1 of the PEA that investigation would be made as to whether the project would impact upon riparian vegetation.

The EA needs to identify if the proponent is seeking to apply the Riparian Corridor Management Study (RCMS) or NOW's Guidelines for Controlled Activities in relation to riparian areas. The application of the RCMS is in accordance with Wollongong Council's planning maps which are available on the Council's website. It is recommended the riparian corridors as presented in the EA are either consistent with the RCMS or the NOW Guideline for Controlled Activities.

The EA needs to assess and provides details on:

- all watercourses and riparian land on the site (and also those located offsite that could potentially be affected by the proposal) including:
  a. scaled plans;
  b. the location of all watercourses;
  c. top of bank;
  d. minimum riparian corridor widths (measured from top of bank) to be protected and enhanced;
  e. the boundary of the site; and
  f. the footprint of the proposal in relation to the watercourses and riparian areas.

- potential impacts of the proposal on any watercourses and riparian areas, including areas of disturbance.

- safeguard measures to mitigate impacts, contingency plans for the remediation and rehabilitation of riparian areas in the event of potential adverse impacts and the long term management of the riparian lands.

The riparian land should be protected and conserved, or revegetated with native plant species endemic to the vegetation community of this local area at a density that would occur naturally.

The EA should also provide details on the proposed location of any APZ requirements in relation to the riparian land. Any APZs should be located outside the riparian areas but may be located adjacent to but outside the vegetated buffer.

Relevant Policies and Legislation

The following NSW Government legislation and policies are applicable to the study site:

- *Water Management Act 2000*;

- *Water Act 1912*;

- NSW State Rivers and Estuaries Policy;

- NSW Groundwater Policy Framework Document – General;
- NSW Groundwater Quantity Management Policy;
- NSW Groundwater Quality Protection Policy; and
- NSW Groundwater Dependent Ecosystem Policy.

End Attachment A
12 August 2011

APPENDIX B

Wollongong City Council Waste and Resource Recovery Strategy 2012 to 2022

Waste & Resource Recovery Strategy 2012- 2022

Wollongong City Council

wollongong
city of innovation

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Acknowledgement

This document draws heavily on and in part incorporates earlier work undertaken by several consultancies in the preparation of the Waste & Resource Recovery Strategy, and in particular that undertaken by Wright Corporate Strategy in 2010.

1 Why do we need a Waste Strategy?

Managing waste is the single biggest budget item for Council on an annual basis. It involves capital and recurrent expenditure on services that touch the lives of every member of the community. Wollongong City Council manages over 150,000 tonnes of waste at a cost that exceeds $30 Million per year.

The waste management environment is rapidly changing as it is impacted by many influences including Federal, State and Local legislation, community attitudes and expectations, limited landfill space, climate change, increasing costs and rapidly advancing technology.

With the advancement of technology, WCC will be researching and implementing the new opportunities within the areas of green electricity through capturing landfill gas; recycling facilities; alternative waste technology; education programs and collection services.

This Waste Strategy is a framework for Council and the community to make the transition to sustainable waste management. To achieve this Council will work on several focus areas including enhanced services and facilities. Other supporting measures will include policy, pricing, community and stakeholder engagement and education programs as well as establishing strategic partnerships with relevant organisations.

1.1 WCC Strategic Planning Context

This plan has been written based on the foundations established in the "Strategic Directions 2011-14"

A vibrant and liveable city

Viable and sustainable assets and services

An innovative and progressive organisation

One of the 11 key priorities in the Strategic Directions 2011-2014 is the Waste Management Strategy as follows:

"Changes in government policy and increasing environmental standards mean we need to review our current approach to Waste Management. Our revised strategy will detail a staged approach to develop waste services and waste treatment processes that meet the needs of the community, achieve improved environmental outcomes and control the financial impact of waste management on the community".

We will measure our performance through

% of municipal material recovered from landfill

TARGET

66 % by 2014

1.2 Strategic Direction

The Strategy has been formulated to dovetail with "Strategic Directions 2011-2014" and addresses three Strategic Themes and guiding principles:

STRATEGIC THEMES

- Minimise waste to landfill
- Maximise the recovery of resources
- Maximise landfill life
- Value and protect the environment
- Minimise climate change impacts

GUIDING PRINCIPLES

- Minimise the cost impost from waste management on the community;
- Create a informed and engaged community
- As a minimum, meet legislative and regulatory requirements

2 The Big Picture – What is driving our Strategy?

2.1 External Drivers

2.1.1 Environmental Sustainability

Environmental Sustainability involves maintaining and enhancing our quality of life, for both current and future generations, through a balance of economic viability, environmental conservation and restoration, and community well being. This is working collaboratively and creatively to better integrate short and long term economic, social and environmental considerations into all decision making within Council operations and services. It involves demonstrating leadership and accountability to our diverse community.
Sustainability within Waste Services refers to ensuring appropriate measures are taken to avoid, reuse, and recycle all waste materials within Council Operations as well as encouraging all users to do the same.

2.1.2 Climate Change

The NSW Office of Environment and Heritage recognises that the climate of New South Wales is changing. The average temperatures in New South Wales have been steadily rising since the 1960s. Climate change is not just about the environment; it is a diverse issue which has economic, social and environmental implications. The natural, social, and economic systems of Wollongong are all likely to be affected by the impacts of climate change.

Landfill gas emissions are a contributing factor to climate change. Reducing and minimising carbon emissions will be required through future planning of the waste cycle.

2.1.3 Legislation & Policy

2.1.3.1 Federal Legislation and Policy

National Waste Policy

The Australian Government established its National Waste Policy (NWP) which sets Australia's waste management and resource recovery direction to 2020.
The NWP has as its aims to:

- avoid the generation of waste, reduce the amount of waste (including hazardous waste) for disposal;
- manage waste as a resource;
- ensure that waste treatment, disposal, recovery and re-use is undertaken in a safe, scientific and environmentally sound manner, and

- contribute to the reduction in greenhouse gas emissions, energy conservation and production, water efficiency and the productivity of the land.

It is expected that measures will be introduced aimed at improving landfill practices and more stringent regulations, source separating wastes, reducing the toxicity of wastes to landfill, managing organics and stabilising wastes before disposal.

Companion legislation has been enacted in the area of Product Stewardship and is beginning to impact products such as e-waste (television and computers) and tyres. Council is currently working with Federal and State agencies to assess opportunities under this legislation.

Clean Energy Future

Clean Energy Future is the title given to the Australian Government's Climate Change Plan, commonly referred to as the Carbon Tax.

Putrescible landfills emit large quantities of landfill gas (mostly methane which is a greenhouse gas) resulting from the decomposition of organic material with the landfill. Emissions from landfills will be included in this legislation.

It has been estimated that the cost of the legislation will be $30 per tonne of waste[1]. The liability can be mitigated through the use of gas capture as well as reduction of organic waste to landfill.

2.1.3.2 State Legislation & Policy

Waste Avoidance and Resource Strategy (WARR Strategy)

The NSW Government during 2007 released its updated Waste Reduction and Resource Recovery Strategy 2007 which sets targets in a number of key result areas.

Table 1: NSW Government WARR Strategy Targets

Increased recovery and use of secondary resources	By 2014, to: Increase recovery and use of materials from the municipal waste stream, from 26% (in 2000) to 66% Increase recovery and use of materials from the commercial and industrial waste stream, from 28% (in 2000) to 63% and Increase recovery and use of materials from the construction and demolition sector, from 65% (in 2000) to 76%.
Reducing toxic substances in products and materials	By 2014 or earlier: To phase out priority substances in identified products as a first choice or, if not possible, to achieve maximum recovery for re-use.
Reduce litter and illegal dumping	Reduce total amount of litter reported annually. Reduction in total tonnages of illegally dumped material reported by regulatory agencies and RID squads annually.

[1] *Association: Local Government Fact Sheet re Carbon Tax,* Australian Landfill Owners, 20/07/2011

To encourage relevant parties to work towards these targets, the State Government has determined to use the waste levy (see next section) as the primary financial instrument to drive change.
In developing the Waste Strategy, council has paid special attention to the WARR Strategy, the targets and the levy.

Section 88 Waste & Environmental Levy

The NSW Government imposes a levy on all waste received for disposal at licensed landfills within what is known as the Regulated Area of NSW. It has the power to do this under the provisions of Section 88 of the *Protection of the Environment Operations Act 1997* and the levy is regulated via the *Protection of the Environment Operations (Waste) Regulation 2005*.

For 20011/12, Wollongong City Council's pays a levy of $78.60 per tonne of waste. By 2015/16 it is projected to be at $116.90 plus any intervening CPI increases. It is evident that the levy is now a substantial component of the cost of waste disposal. It is a significant incentive for landfill owners to recover and export materials from their landfill sites or to find alternative means of treating wastes that do not primarily rely on landfilling.

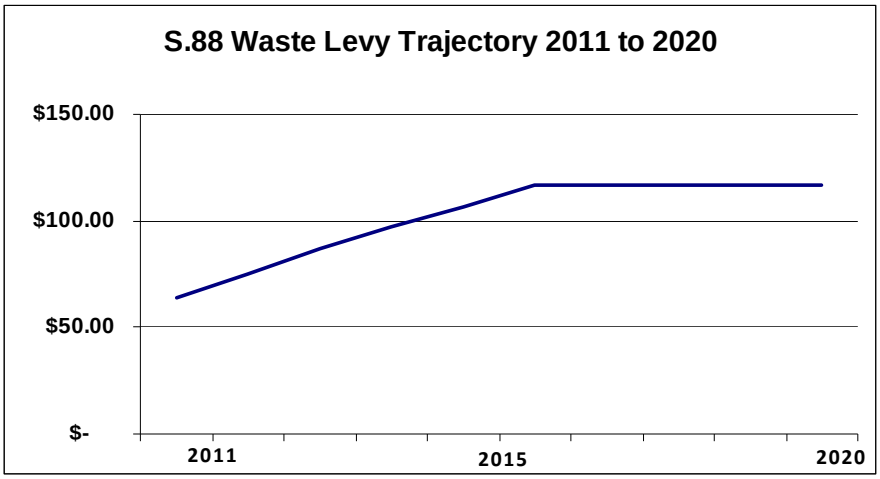


Figure 1: NSW State Waste Levy

The chart below demonstrates the rapidly escalating trajectory of the Section 88 Waste Levy as it will apply to Council and the Wollongong community.

At this point in time there is no indication of how the Section 88 Waste Levy might be adjusted beyond 2015-16, other than annual CPI increases. However, even without further step increments, the Section 88 Waste Levy provides significant incentive for change.

For Council and the Waste Strategy, the increasing Section 88 Waste Levy has the following financial implications:

- continuing to rely on landfill disposal of our wastes as the underlying waste management technology will commit the community to a future of escalating costs;
- as the cost of landfill disposal of wastes increases alternative technologies that rely less on landfill disposal become more attractive;

- increasing the amount of material that can be recovered from the waste stream makes good financial sense.

Local Government Act

The *Local Government Act 1993* (LGA) imposes on councils the responsibility to collect and dispose of waste from domestic premises within the local government area. A council is able to levy a separate charge normally called the Domestic Waste Management Charge (DWMC) for the collection and management of these domestic wastes and must not fund these from the general rates revenue (see S.504 of the LGA).

This has implications for councils in establishing a waste strategy such that costs and income attributable to the collection and disposal of domestic wastes must be identified and isolated from other costs, including those associated with the receipt and disposal of commercial and industrial wastes.

2.1.4 Technology: Present and Future

Within waste cycle there are several avenues to utilise technology to reduce the impact on the environment as well as reducing waste to landfill. Prior to entering the landfill, the recycling and reusable materials are removed. This can be achieved through the materials recycling facilities and alternative waste treatment options.

The materials recycling facilities have improved the sorting of the recyclables through mechanical, optical, and technological advances. These improvements increase the amount of material that is recovered thus reducing waste to landfill. Efficiencies have also been gained in the manufacture of the end products.

Another form of treatment of waste prior to landfill is to utilise Alternative Waste Technology (AWT). An AWT is primarily aimed at treating as much as possible of the waste stream, removing any recoverable materials and landfilling only a small residual. Outputs from an AWT plant may include recovered materials including composts or energy.

AWTs are a relatively new development and there is much research taking place on a number of fronts. Although there are now approximately 15 full production AWT plants that have been built in Australia, almost all of them have suffered technological or process challenges.

Recovering landfill gas can generate electricity that can be used internally or sent back to the electricity grid. Landfill gas can also be treated through flaring off the excess gas which will reduce the emissions into the environment.

Also within a landfill operations, there are been many advancement in treatment of contaminated water that has come in contact with waste known as leachate. The leachate is treated on-site prior to is release into the water system.

2.1.5 Regional Initiatives

WCC together with Shellharbour and Kiama councils are collaborating as a part of the Southern Councils Group [2] (SCG) on options pertaining to the collection and processing/disposal of municipal solid waste.

WCC has the size and waste generation rates to operate independently as well as having sufficient available landfill space for the foreseeable future; it should remain cognisant of the needs of its SCG neighbours and pursue regional opportunities.

The regional assessment of options[3] recommended that Shellharbour and Kiama councils should pursue development of their own facilities for processing source separated organics. It also recommended that WCC should manage its waste disposal independent of actions taken by both Shellharbour and Kiama councils.

[2] The SCG consists of 7 councils; Wollongong, Shellharbour, Kiama, Shoalhaven, Eurobodalla, Bega Valley and Wingecarribee. Only 3 are involved in the regional waste project.

[3] *Assessment of Regional Waste Processing Solutions for Wollongong City Council, Shellharbour City Council and Kiama Municipal Council* Aurecon Australia Pty Ltd August 2010

2.1.6 Community Expectation

Wollongong is a growing City that places a high value on its environment as well as waste collection and disposal. In the 2010 Wollongong Community Survey, the community have identified street cleaning and domestic, recycling and green waste collection as having high community importance. The garbage collection was also identified as having a high satisfaction rating as well. Council will widely consult with its community and other key stakeholders during this strategy implementation.

2.1.7 Population and Waste Projections

The NSW Department of Planning has estimated that the population of the Wollongong local government area (LGA) is 201,200 as at 30 June 2011. This is forecast to increase to 229,700 by 30 June 2031, and increase of 14.17%.

Table 2: Past and Projected Population of Wollongong LGA, 1996-2036

Year	Total population[a]	Growth rate[b] (%)	Growth Index (2006=100)
Past			
1996	185,300	n/a	94
2001	189,500	0.67	98
2006	194,500	0.50	100
Projected			
2011	201,200	0.67	103
2016	208,300	0.70	107
2021	215,700	0.70	111
2026	223,000	0.67	115
2031	229,700	0.59	118
2036	235,800	0.52	121

Source: past data – Australian Bureau of Statistics; projections – Department of Planning.

a Population numbers are for 30th June of the year shown

b Annual average growth rate over the five year period ending 30th June of the year shown.

WCC will have to plan and cater for this population increase. There will be a commensurate increase in the quantities of wastes to be collected and managed.

In order to make an estimation of the amount of household waste generated into the future, the amount of waste generated today needs to be divided by the population today to get a tonnage figure per capita of the population. Data provided for preparation of the waste strategy indicates that historical records on waste generation may not be reliable and are not always calculated on a consistent basis. On this basis, the per capita tonnage is assumed to remain constant throughout the planning horizon. This per capita figure can be multiplied by the expected population of Wollongong over the next 25 years to

estimate the amount of waste in each stream during that time. Table shows that the increase in waste from 96,951 tonnes generated by the sector in 2008/9 is expected to reach 120,931 tonnes in 2034/35. The general waste is expected to reduce with a corresponding increase in recycled materials. This assumption is based on existing trends as well as anticipated changes to facilities and services. Improvements will be made across the following focus areas:
Planning controls; Education; Services; Price Controls; Facilitation; Advocacy; Enforcement; Leadership; Facilities and Finance.

Table 3: Current Data and Forecasts for Household Waste

Tonnes of General and Council Waste				
	2008/9	**2010/11**	**2013/14**	**2034/35**
Garbage and Council Waste	53,929	43,797	32,574	27,600
Recyclable Materials	19,559	25,903	35,175	58,271
Garden Organics	21,426	27,878	28,442	32,114
Council Clean-up Waste	2,037	2,637	2,690	3,038
Total Generated	96,951	100,241	98,881	120,931
Percent Resource Recovery	43%	54%	64%	75%

2.2 Internal Drivers

Internal Drivers include internal policies as well as existing infrastructure and contractual arrangements.

2.2.1 Relevant Council Contractual Arrangements

Council has contracts in place for the collection and processing of domestic waste collection. The major existing contracts that will impact on the Strategy are listed below:

Table 4: Existing Major Contracts

Contract	Main Functions	Expiry Date
General Waste	• Kerbside collection of domestic garbage, disposed to landfill. • Weekly service in 80L, 120L or 240L bin • On-call annual cleanup. 2m^3;	30 June 2014
Recycling	• Kerbside collection and processing in a MRF • Fortnightly service in a 240L bin	30 June 2014
Garden Organics	• Kerbside collection and processing (composting) • Fortnightly service in a 240L bin	30 June 2014

2.2.2 Landfill Capacity

WCC operates 2 landfills; a minor non-putrescible landfill at Helensburgh that services the northern suburbs of the city and the major facility at Whytes Gully (Kembla Grange) that receives the bulk of the city's putrescible wastes, including all of the waste from the domestic collection service. Whytes Gully also receives mixed solid waste from the commercial sector.

Commercial quantities of Construction and Demolition (C&D) wastes are not accepted at either of Council's landfills. These materials are accepted at and processed by any of several privately operated facilities throughout the City. However, WCC must be cognisant of the fact that most of these facilities are reaching the end of their life very soon and should facilitate the development of replacement facilities to avoid having to accept approximately 100,000 tonnes per annum of this material at Whytes Gully.

The current operating landfill cell at Whytes Gully is projected to be full by the end of 2013. Space is available within the existing site to construct a new landfill cell. Council is currently working on the application for the new landfill cell at Whytes Gully.

Even with the increased landfill capacity that the proposed new cell will provide, WCC will still be required to implement systems and methods to minimise waste to landfill so that the remaining landfill space is preserved for as long as possible and to achieve state government diversion targets.

2.2.3 Resourcing & Financial capacity

Managing waste is a significant service within Council's budget with an annual cost in excess of $30 Million. It involves capital and recurrent expenditure on services that touch the lives of every member of the community. Wollongong City Council manages over 150,000 tonnes of waste per year.

2.2.3.1 Domestic Waste Management

Waste services includes the provision of Domestic Waste Management the resourcing of which is defined and controlled by specific legislation through the Local Government Act. Domestic Waste is the kerbside collection and disposal of normal household waste. The reasonable cost to council of providing the domestic waste management services must be obtained from the making and levying of a charge known as the Domestic Waste Management Charge (DWMC) and can not be recovered by the ordinary rate.

2.2.3.2 Operational Services

Operational Services including the management and operation of landfills, reprocessing and other waste management costs are managed on a quasi-commercial basis as a Business 1 Activity in accordance with the National Competition Policy. The capital, operational and rehabilitation resourcing requirements of waste facilities is included within Council's long term financial model based on the current 'whole of life' model for each facility. Council will consider through its long term model any future financial changes including new and enhanced infrastructure, services, legislative obligations and their impact on the whole of life cost of the facilities.

2.2.3.3 Carbon Tax

In addition the impacts of the carbon tax will need to be reviewed. The application of carbon tax will continue to beyond the life of the waste facility. A facility will be required to pay the carbon tax whilst it is emitting above the legislated threshold. It is intended that additional service costs will continue to be recovered at market price with an objective of providing a rate of return on operations.

2.2.3.4 Capital Investment

Council will need to consider on a merit basis any additional requirements for capital investment that arise out of future decisions taken in implementing this strategy. Such decisions will be evaluated through Council's business proposal process to ensure financial sustainability. Consideration may be given to all sources of funding required, including grants, loans, public private partnerships, and outsourcing.

3 Where are we now?

3.1 Municipal Services

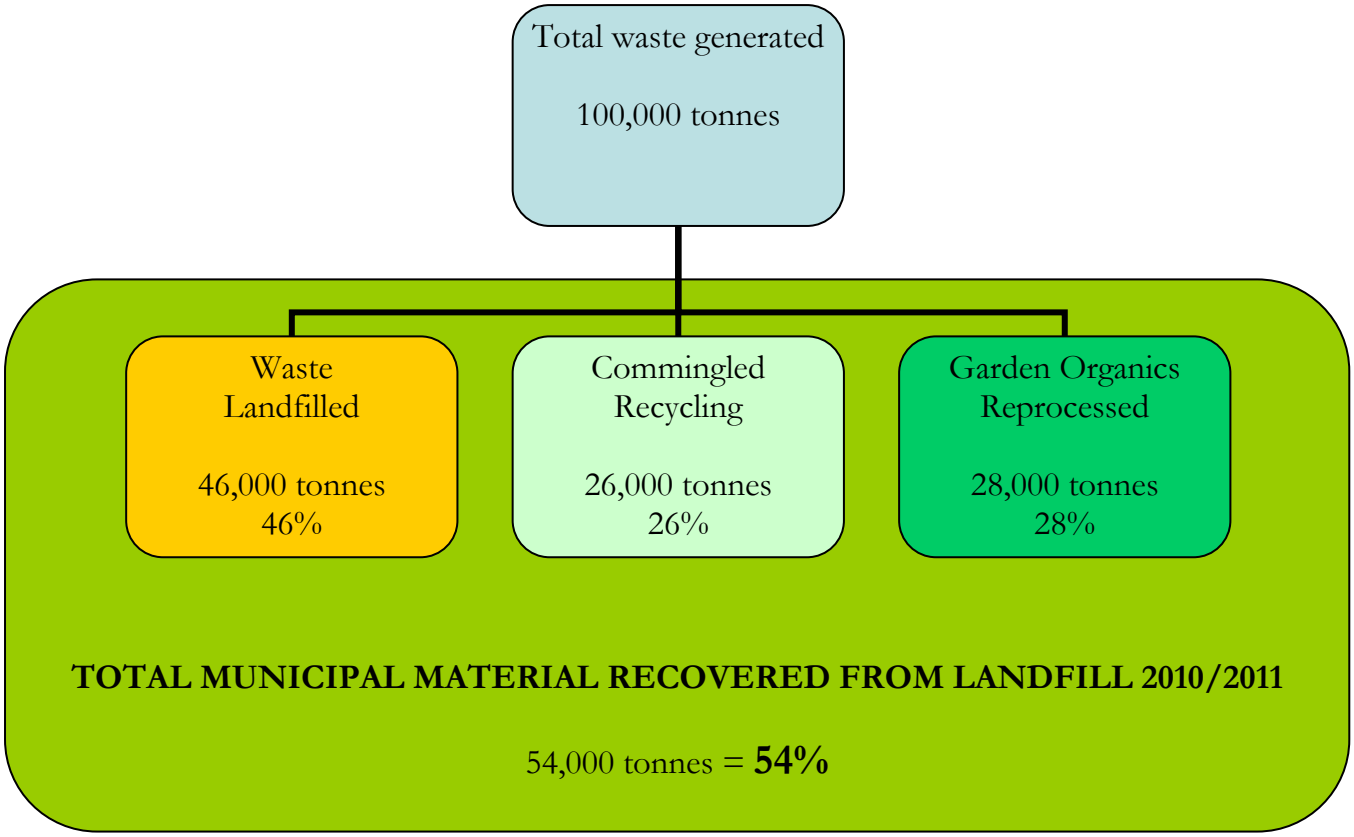
3.1.1 Domestic Waste & Recyclables

The current domestic collection services are offered to approximately 77,000 residential properties within the LGA, are all provided by contract and consist of a conventional 3-bin system (weekly garbage, fortnightly garden organics and fortnightly recycling).

For the general waste service, residents can choose the size of the mobile garbage bins with a price incentive to utilise the smaller container. The default service is a 120L garbage bin with 69% of residents using this option, 25% of services use the 80L garbage bin and only 6% use the 240L garbage bin option.

The fortnightly garden organics is processed by a contractor at WGRRP. Residents are able to take small quantities of mulch without charge. The recycling from the collection service is sorted at the Materials Recovery Facility (MRF) located at Whytes Gully Resource Recovery Park.

For the year ended 30 June 2011, the following mass of waste and recyclables were collected and recovered from the domestic waste stream:



Waste generation has been trending down for the past 8 years and the quantities of recovered material have been trending up. In 2002/03, the diversion rate was less than 20%.

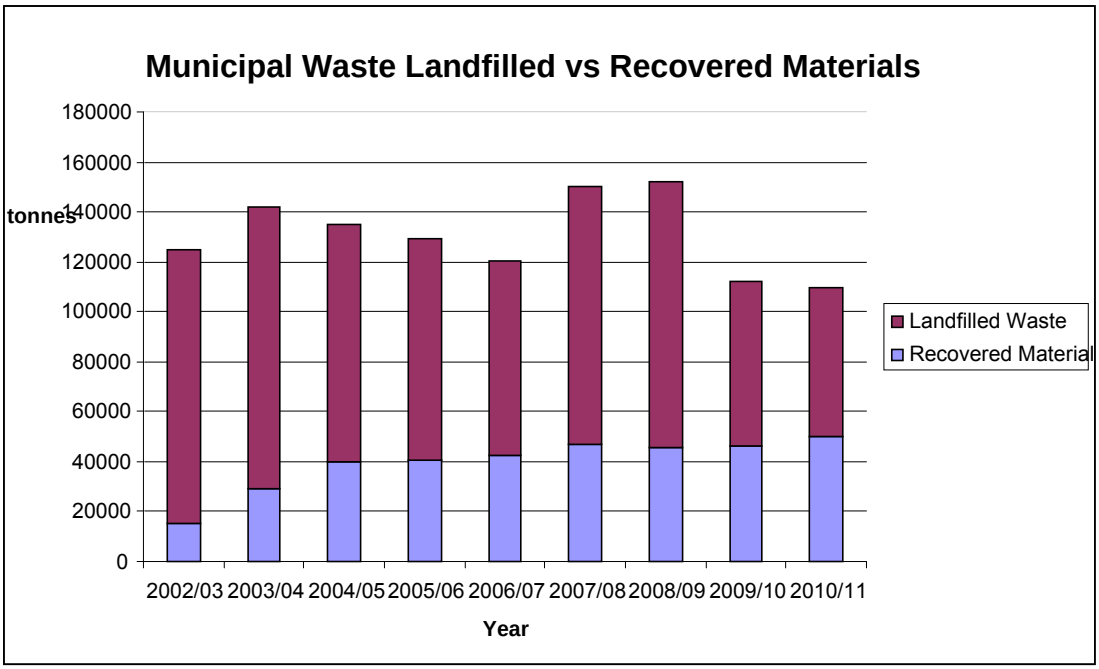


Figure 2 Municipal Waste Landfill vs Recovered Material 2003-2011

Council's target recovery rate is 66%. Council is progressing towards this target rapidly. Over the last 3 years Council's recovery rate has increased from 30% to 54% in 2011. During this time Council made some major changes to items accepted for landfilling including the diversion of e-waste (TV's & computers) and mattresses. Council also increased its education and awareness to ensure recyclable materials are not being sent to landfill. It is proposed through other major initiatives that council will continue along this trend. Council's household cleanup now recovers e-waste (TVs & computers) as well as tyres and mattresses from households. These are sent for recycling. Council also plans on working on 9 specific focus areas to continue along this trend line. The focus areas include Planning controls; Education; Services; Price Controls; Facilitation; Advocacy; Enforcement; Leadership; Facilities and Finance.
These initiatives which are detailed in section 4.

It is anticipated that the recovery will again level off after this time until a possible Alternative Waste Treatment is implemented. Investigations will occur over the next 2 years to ensure the best possible choice for Wollongong City Council in the long term. Council will determine the most appropriate alternative technology by December 2014.

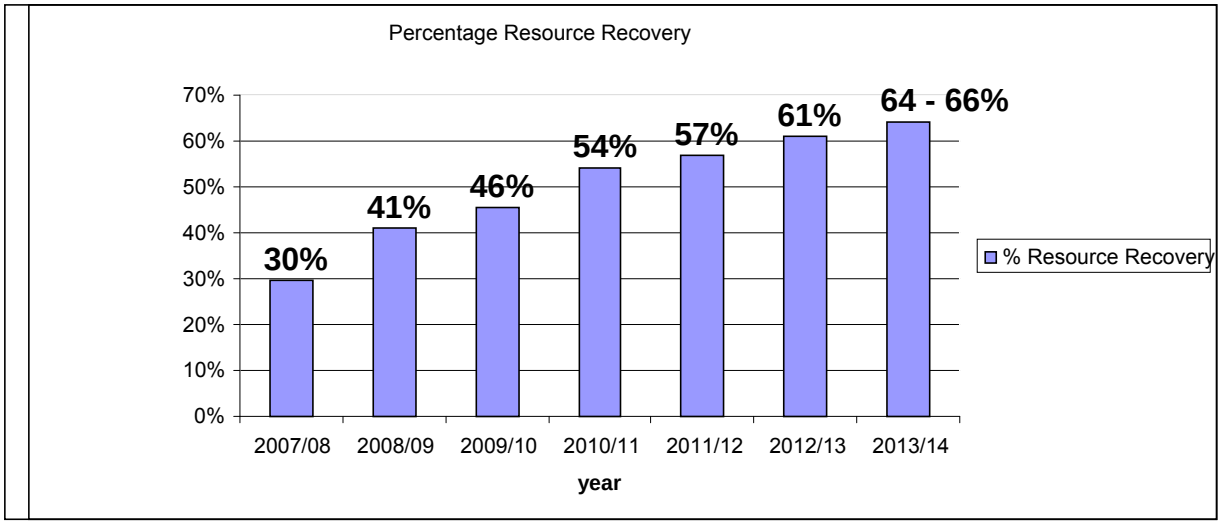


Figure 3: Municapal Waste Recovery Rates 2008-2013

The Commercial and Industrial recovery rate for Wollongong measured through Whytes Gully is minimal in 2010/11. This figure is considered to be underestimated due to recycled materials leaving the Wollongong Local Government Area and being recycled at larger facilities outside the Wollongong Local Government Area. Wollongong City Council does not have a current accurate picture of the diversion rate from the Construction & Demolition section.

3.2 Waste Disposal Facilities

Council operates it major landfill at Whytes Gully Resource Recovery Park (WGRRP). This landfill accepts the majority of the municipal solid wastes produced within the City, including putrescible, inert and C&I wastes permitted under the operating license. Being a large licensed landfill, this facility is operated to ensure compliance with the EPA license, including lined cells, leachate control, and a rigorous environmental monitoring regime.

Other facilities located at the WGRRP include inbound and outbound weighbridges, a revolve facility, a small transfer station (to separate small vehicles from the active tipping face), and recycling and garden organics drop-off areas. Garden organics are currently shredded onsite (by a contractor) and then moved off site for open windrow composting. There are plans in place for the contractor to relocate this operation to an enclosed facility on land adjacent to the WGRRP.

The recyclables MRF is also located on land at WGRRP, as well as the administration offices of the Waste Management Section of WCC.

A small licensed landfill is operated at Helensburgh to service the far northern suburbs of the city. This facility no longer accepts putrescible waste apart from dry domestic waste dropped off in small vehicles. The Helensburgh landfill also accepts builders waste and garden organics. All garden organics are shredded and then removed from the site for further processing by private contractors.

The Helensburgh landfill, which is located on the boundary with the Royal National Park and the headwaters of the Hacking River, has been accepting waste for in excess of 50

years. Due to its age and the fact that it is an unlined landfill, Council is currently working on the rehabilitation plan for the site.



Figure 4: Map of Wollongong City showing location of WCC's waste facilities

Although WCC waste facilities accept small quantities of builder's waste, neither of them accept Construction & Demolition (C&D) wastes in significant quantities. These are mostly received by private operators in the southern parts of the city. The bulk of the C&D materials are processed by private operators for reuse with landfill of the residual in privately operated landfills. The waste levy is high on these materials and is considered a strong incentive for the removal of C&D materials from landfill.

WCC has extensive data available on the generation and diversion of domestic waste and recyclables. Only limited data is available on Commercial & Industrial waste generation and recovery. This is a result of C&I collections being undertaken by private contractors generally in large capacity front-lift trucks. Anecdotally a significant quantity of C&I recyclables, particularly paper and cardboard are transported direct outside the city for processing.

Within the nine focus areas WCC will be implementing measures to address the C&I waste stream. One of the first actions for Council will be to undertake a review of the C&I sector to ensure specific actions will be targeted appropriately.

3.3 Resource Recovery

There is a range of initiatives in place designed to reduce waste to landfill and to return valuable resources into the productive economic cycle. The actions and facilities will follow the waste hierarchy.
AVOID – REDUCE – REUSE – RECYCLE – RECOVERY – LANDFILL

These include

- Targeted education and waste avoidance campaigns to increase waste diversion.
- Revolve facility located at the Whytes Gully Resource Recovery Park exists to recover reusable articles from the incoming waste stream and offer them for sale back to the general public;
- Garden Organics are shredded and removed for composting at privately operated facilities with small amounts to local residents free of charge; A portion of this material is retained on-site for residents to use free of charge.
- Recyclables materials are collected through the kerbside recyclables collection service are sorted at Materials Recycling Facility located at the WGRRP
- Recyclables collected at the transfer station at the WGRRP and at Helensburgh landfill are also transported to the MRF for sorting;
- On-call Annual Cleanup recovers recyclables materials for sorting including e-waste, mattresses, and tyres.
- Other resource recovery: facilities are provided at both Helensburgh and the WGRRP for receipt of items such as metals, used oil and e-waste.
- Council will implement landfill gas recovery at Whytes Gully within the next 12 months.
- Council also participates in a fridge buy-back scheme for second fridges greater than 10 years old.
- Office of Environment and Heritage arrange a chemical clean-out day in which residents are able to dispose of domestic quantities of a range of household chemicals, fluorescent lights, paints, gas bottles, car batteries etc. free of charge;
- WGRRP Transfer Station: facilities are provided for receipt of general mixed waste in small vehicles. The objective is to keep small vehicles separated from the active tipping face;

Table 5: Resource Recovery Rates Wollongong Local Government Area

Category	Municipal	C&I[4]
Recyclables captured	26%	10%
Organics captured	28%	2%
Waste disposed to landfill	46%	88%

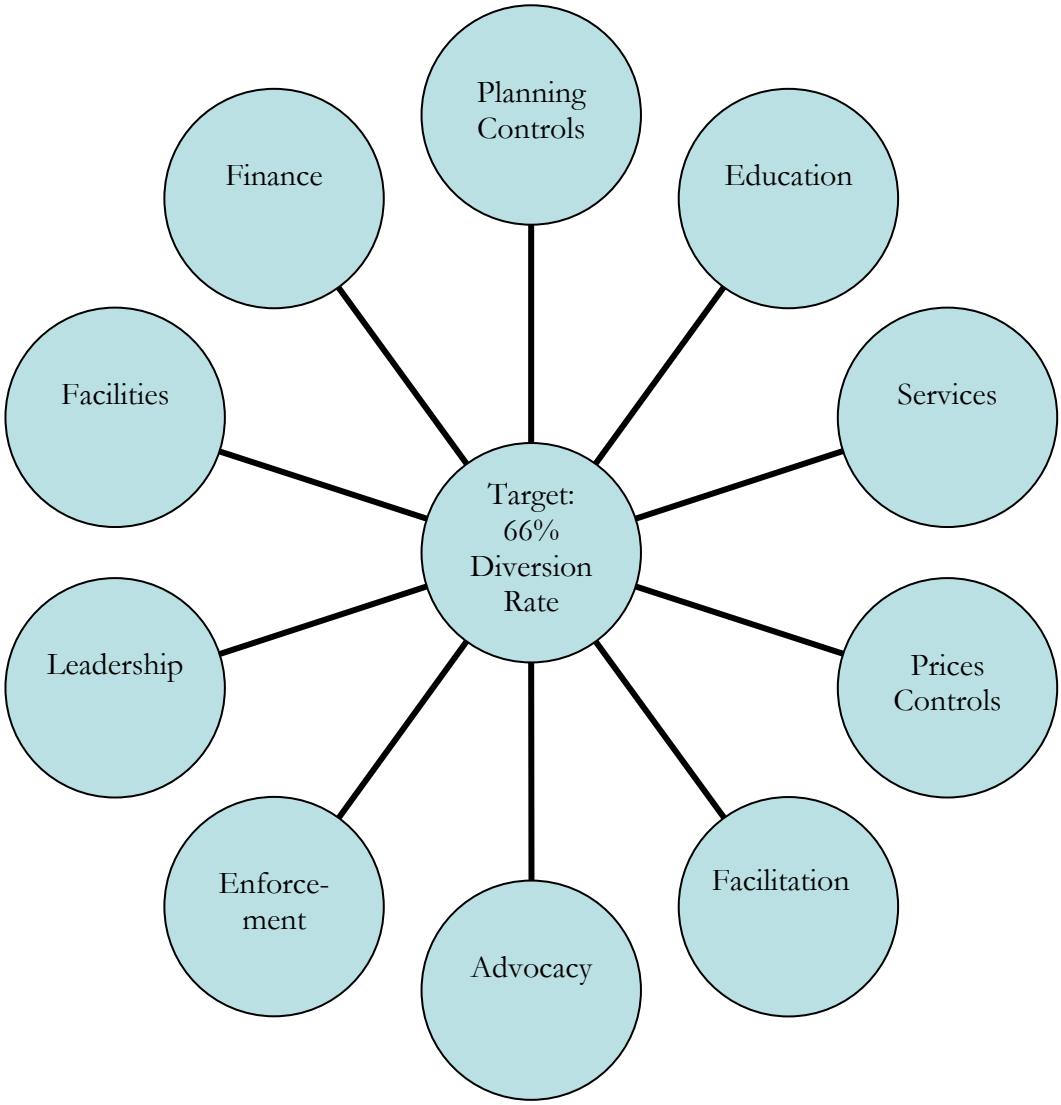
[4] Based on quantities recorded at Council facilities. It is known that there is "leakage" of recyclables outside the region so the percentage of waste to landfill is likely to be lower than that shown

4 Where are we heading?

4.1 Focus Areas

WCC will focus on key areas while working towards our target. Council will enhance existing programs, research new markets; and work with community on new initiatives within the focus areas listed below.

Given the current high diversion rate of 54% within the domestic stream, it is envisaged that improvements within the focus areas will enable WCC to meet the 66% target by 2014.



1. **Planning Controls will be reviewed** to ensure that developments produce minimal waste and appropriately manage it. Initiatives will include the following:

   - Strengthen the existing Waste Chapter of Council's Development Control Plan (DCP) to promote source separation approaches and to respond to changing waste processing infrastructure.
   - Specifically review requirements for:
     - Waste Management Plans (WMP) to address planning, demolition, construction and ongoing use of an premise prior to DA being approved
     - Demolition and deconstruction activities;
     - Multi story unit developments with attention to in unit collection receptacles, internal transport of materials to waste storage facility, waste storage facility requirements, and general access issues for collection vehicles and bin movements required to affect collections
     - Mixed residential and commercial developments requirements
     - Commercial developments waste management services to accommodate three bin systems and DA requirements to provide information on planned external and internal collection and storage facilities
   - Ensure that the DA approval processes requires Council's Waste Services Branch to review DA's for Multi-unit Dwellings (MUD) and mixed residential and commercial developments so it can ensure that adequate services can be provided to residents once the development is occupied
   - To engage with and educate planners, architects, builders, developers, peak bodies and the like, in DCP waste requirements and contemporary waste management and resource recovery practices by facilitating information briefings and workshops, training initiatives and facilitating advisory mechanisms and services

2. **Education programs will be developed** at every level throughout the community to provide information to explain and encourage use of the waste hierarchy and to also train in waste minimisation/resource recovery strategies and tools.

   - Council will review existing strategies and programs and work with the community on enhanced programs.
   - Council will manage its data through researching and auditing the garbage, recycling and organics bins (contents and infrastructure). This information will formulate more specific education programs.
   - Council will work with Multi-Unit Dwellings through auditing existing services to ensure best possible bin combinations.
   - Council will implement an illegal dumping and littering education campaign in line with the illegal dumping and littering strategy.

- Council will work with NSW State Government initiatives in terms of waste minimisation specifically in regards to food waste.

3. **Services will be maintained and enhanced to** provide the necessary services that underpin the overall objective including:

   - **Maintain On-Call Domestic Cleanup Collection Services**
     - Provide two on call domestic cleanup collection services per year to each Multi Unit Dwelling (MUDs) and Single Unit Dwelling (SUDs) respectively
     - Residents are able to place a range of materials out for collection including.
       - E-waste (televisions, computers) - recycled
       - Mattresses - recycled
       - Tyres – recycled
       - bulky waste
     - Council to work with improved arrangements to ensure e-waste is processed economically within new legislation.
   - **Investigate Public Place Litter & Waste Bins**

4. **Price controls will be reviewed** particularly for disposal of wastes to continue to encourage and reward source separation of materials and material reuse.

   - **Adopt and communicate appropriate policy bans on readily recyclable materials going to landfill**
     - Maintain the existing longstanding policy ban of not accepting construction and demolition or builders waste to the Whytes Gully Class 1 Putrescible Landfill
     - Maintain the ban on landfilling green waste and standard recyclable materials and promote to the broader community
     - Maintain and expand as appropriate the existing policy ban on e-waste, hazardous wastes and other problematic wastes such as mattresses and tyres
   - **Introduce pricing incentives to support source separation**
     - Establish and promote differential waste pricing at Council waste management facilities. Develop pricing mechanisms that encourage, reward and give incentives to waste generators to source separate materials. Charge at a higher rate for those who do not chose to source separate.

5. **Through facilitation Council can encourage** the development of industries and markets that will reuse, recycle, recover or reprocess waste materials.
   - Facilitate the development of one or more private sector construction and demolition processing and disposal facility(s) that have the capability to:
     - process source separated materials or partially mixed materials including concrete, bricks, tiles, dirt into various aggregate type products;
     - sort and process mixed builders waste to extract metals, untreated wood, paper & cardboard, plastics, plasterboard, concrete, bricks, tiles & dirt which are readily recyclable materials once separated;

- to undertake secondary processing operations on separated materials e.g. mulching or chipping wood or hammermill plaster board and screen paper fraction etc;

6. **Advocacy will continue to** will remain a high priority for Wollongong City Council. Council will continue to remain active within State and Regional programs.

   - Strategic Partnerships and Alliances
     - To form alliances and partnerships with other regional Councils to pursue collaborative and cooperative waste and resource recovery initiatives where appropriate
     - Council will work with "Approved Arrangements" with the Federal Product Stewardship scheme to assist with recycling of household e-waste.
     - To establish links with University of Wollongong to foster local research and student placement opportunities related to waste management and resource recovery.
     - To establish links with relevant local industry and organisations that may provide future opportunities to consume or utilise significant quantities of waste derived resources or be directly involved in the management of waste in a positive manner.
     - To form alliances and partnerships with organisations that may have vested interests in achieving similar outcomes :
       - Eg : Sydney Water for ensuring that household chemicals are responsibly disposed of rather than disposed of to sewer or landfill; other regional Councils who may also be promoting a three bin source separation approach.

7. **Enforcement will be strengthened through** Council implementing its actions in relation to the illegal dumping and littering strategy including.

   - Increase the effort: make access difficult.
     - lighting
     - landscaping, revegetation or beautification
     - barriers, fences, locked gates, concrete blocks, log barriers, earth mounds
   - Increase the risk of getting caught.
     - strengthen surveillance, cameras, patrols in hot spots
     - high profile compliance campaigns
     - partnerships with other Councils, agencies
     - Publicise successes
   - Reduce the rewards: deny financial benefits.
     - provide /promote free or subsidised waste services
     - issue fines to offenders
     - require offenders to clean up
   - Reduce provocations: don't give them a reason to dump.
     - provide efficient/well communicated waste services
     - reasonable waste services costs
     - foster community pride
     - keep areas free of illegally dumped material
   - Remove excuses: educate and inform the community.

- publicise waste services
- carry out education programs
- keep areas free of illegally dumped material
- install signs at hot spots

8. **Leadership:** WCC will demonstrate its leadership on this issue to the wider community by practicing the tenets of the waste hierarchy in its own operations, particularly in procurement and reuse of materials.

   - Council will conduct a review of its own activities in relation to recycling and reuse of materials.
   - This review will be undertaken through the administration functions as well as the operations and construction areas.

9. **Facilities – Council will continue to provide facilities** to Wollongong Local Government Area to facilitate resource recovery and waste disposal.

   - Provide Putrescible Landfill Capacity for Wollongong's Waste
     - Rehabilitate Stage 1 and 2 landfill cells at Whytes Gully
     - Develop the next and final Stage 3 Whytes Gully Landfill Cell which will provide the City with 45+ years landfill capacity
     - Establish on-site soil excavation operations to allow cover materials to be sourced from within the site to avoid significant costs associated with importing dirt onto the site that attracts the NSW Waste Levy
     - Augment the existing landfill leachate biological treatment plant required to make the liquid that drains from the landfill environmentally safe and suitable for disposal to the sewer system
     - Develop a landfill gas extraction and management system at Whytes Gully Landfill that minimises environmental and safety risks, and addresses climate change and carbon pricing liabilities through generating green renewable electricity from landfill gas
   - Materials Recycling Facility (MRF)
     - Develop a new Materials Recycling Facility (MRF) at the Whytes Gully Resource Recovery Park to sort commingled recyclables. This facility will replace the current outdated plant that is at the end of its useful life (contract expires in 2014).
     - The new MRF will have the capacity to accept mixed recyclable materials from a single commingled collection bin, bulk commercial mixed coloured glass; and bulk paper and cardboard. The MRF will also have the capacity to process the mixed standard recyclables streams that are recovered from the Transfer Station Free Recycling Drop-Off Area and the Sort Facility.
   - Transfer Station Drop-Off and Sort Facility
     - Develop a Transfer Station within the Whytes Gully Resource Recovery Park for mixed household direct drop-off materials, small commercial loads and Council operational waste materials. The facility will have:
       - A free drop-off area for household and business standard recyclables
       - A free drop-off area for household reusable materials.

        - A dry mixed waste sorting facility for the type of waste materials deposited at transfer stations.
- Alternative Waste Technology
    - Council will investigate Alternative Waste Technology over the next 2 years through a review of existing and new technologies.
    - Council will determine the best style of AWT for the LGA by December 2014.
    - Council will commence planning for an Alternate Waste Technology in 2015.
- Implement Landfill Gas Recovery at WGRRP
    - Investigate options and technology through engaging industry experts and industry consultation
    - Engage in tender process to implement system
    - Implement Landfill Gas Recovery System with emphasis on energy generation.
- Close Helensburgh Landfill
    - Close the existing Helensburgh Landfill which is an outdated suburban landfill from the 1960's lacking modern day environmental protection designs and undertake rehabilitation works
    - Facilitate long-term environmental protection, and care and maintenance activities
    - Investigate alternative arrangement for existing customers

10. **Finance:** Council needs not only to provide price controls but to also operate its waste business in a manner that is financially viable and sustainable in the long term.

    - Managing waste is the single biggest budget item for Council on an annual basis. It involves capital and recurrent expenditure on services that touch the lives of every member of the community. Wollongong City Council manages over 150,000 tonnes of waste at a cost that exceeds $30 Million per year.
    - Council will consider within its long term planning any future financial requirements including new and enhanced infrastructure, services and legislative obligations including the carbon tax liability. The carbon tax liability will continue beyond when waste initially Landfilled, as this material will continue to generate gas as it breaks down over time.
    - Continue to implement Sustainable Purchasing Policy which takes into consideration sustainable work practices and minimal environmental impacts. Specifically the purchasing procedures require that any Council purchase considers the following among others:
        - Only purchase goods when necessary
        - Purchase goods with recycled content
        - Purchase goods that are recycled, where available
        - Purchase good with minimal and recyclable packaging

5 Other Strategic Documents

A number of background documents provide additional and supporting information to that provided in this Strategy document. These include:

- *Wollongong City Council Waste Strategy – Assessing High-Level Options* Wright Corporate Strategy Pty Ltd January 2011
- *Resource Recovery and Waste Management to 2020 and Beyond: Document 6 – Alternative Waste Management Technologies and Practises – A Situation Analysis* Wright Corporate Strategy Pty Ltd August 2010
- *Assessment of Regional Waste Processing Solutions for Wollongong City Council, Shellharbour City Council and Kiama Municipal Council* Aurecon Australia Pty Ltd August 2010
- *Waste Composition and Analysis Study- Wollongong City Council* Waste Audit and Consultancy Services 2009
- *Waste Management Contracts: Situation /Future Directions Report* Phil Hawley & Associates April 2010

Acronyms

The following table defines the acronyms used in this document and they are listed in the order in which they first appear. They are also defined throughout the document on the first occasion on which they are used.

AWT	Alternative Waste Treatment (or Alternative Waste Technology)
C&D	Construction and Demolition
C&I	Commercial and Industrial
CPI	Consumer Price Index
DCP	Development Control Plan
ERA	Extended Regulated Area
LGA	Local Government Area
MGB	Mobile garbage bin
MRF	Materials Recovery Facility
MUD	Multi-Unit Dwelling
OEH	NSW Office of Environment and Heritage (formerly the Department of Environment and Climate Change)
SCG	Southern Councils Group
WARR	NSW Government Waste Reduction and Resource Recovery Strategy 2007
WCC	Wollongong City Council
WGRRP	Whytes Gully Resource Recovery Park
WMP	Waste Management Plan

APPENDIX C

Community Engagement and Consultation Materials

Whytes Gully New Landfill Cell Project

Wollongong City Council is starting work on the next planned stage of the Whytes Gully Waste Depot at Kembla Grange to meet the needs of the community over the next 50 years.

The Whytes Gully Waste Depot, built in 1983, was designed as a three stage facility. The first stage operated until 1993 and the second stage is now reaching the end of its lifespan.

Council is now planning for the third and final stage of the landfill site, which is expected to keep the facility up and running up until 2060.

Council has submitted a **preliminary environmental assessment** (PEA) to the Department of Planning & Infrastructure.

As part of the project, Council will consult with the community and keep them informed as we progress plans to construct the next landfill cell within the existing boundary of Whytes Gully.

To receive information updates about the project and the consultation activities you can register your contact details with the project as follows:

- Call the project's toll free information line 1800 110 055
- Email the project team at whytesgully@gmail.com
- Write to Whytes Gully New Landfill Cell Project, Locked Bag 8821, Wollongong DC NSW 2500

You can also come along to one of the community information sessions, which have been organised by the project team as part of its environmental assessment process. At these sessions, the team is seeking input from the community to ensure the proposed new landfill cell addresses community concerns appropriately.

The community information sessions will be held on

Thursday 24 November, 6-8pm
Unanderra Community Centre, cnr Princes Highway & Factory Road, Unanderra

Saturday 26 November 1-3pm
Glengarry Cottage, Reddalls Road, Kembla Grange

As well as securing the future of Whytes Gully landfill, Council is in the initial stages of developing an overall Waste Strategy to guide waste initiatives and programs for the city.

Whytes Gully New Landfill Cell Proposal Flyer.pdf

Whytes Gully Feedback Form

Whytes Gully FAQ

Whytes Gully Flow Chart

Page last updated: 23-12-2011 11:36 AM

WOLLONGONG CITY COUNCIL ▪ **Address:** Wollongong City Council, 41 Burelli Street, Wollongong NSW 2500 ▪ **Postal:** Locked Bag 8821 Wollongong DC NSW 2500 ▪ **Phone:** (02) 4227 7111 ▪ **Fax:** (02) 4227 7277 ▪ **Email:** council@wollongong.nsw.gov.au ▪ **Web:** www.wollongong.nsw.gov.au **ABN** 63 139 525 939 – GST Registered

Whytes Gully Media Release, 14 June 2011

A3660: 12 Version 1

Whytes Gully Landfill Expansion Project Launched

Wollongong City Council proposes to design and approve a new landfill cell at Whytes Gully.

A project description is now available on Council's website, www.wollongong.nsw.gov.au.

"The existing landfill at Whytes Gully will be full in the next two to three years, based on current waste levels so the design and approval of a new cell is urgently needed. The lifetime of both the existing and new landfill cells will depend on the amount of waste generated by the community" says Kathleen Packer, Acting Waste Services Manager, Wollongong City Council.

The approvals process will involve detailed environmental impact assessment and extensive community consultation.

Golder Associates, an environmental and engineering consulting firm, have been engaged by Council to carry out the environmental impact assessment and community consultation.

The project team, with input from the community, will be working to design and construct a new landfill cell while minimising impacts on neighbours, improving amenity for users and minimising the costs to the whole community.

There will be opportunities for community input throughout the project.

To receive information updates about the project and the consultation activities you can register your contact details with the project team n a number of ways:

- Call the project's toll free telephone information line, 1800 110 055.
- Email the project team at whytesgully@gmail.com.
- Write to Whytes Gully New Landfill Cell project, Locked Bag 8821, Wollongong DC, NSW 2500.

Wollongong City Council will keep the community informed as the project progresses.

Advertiser
Wednesday 20 July 2011, p2

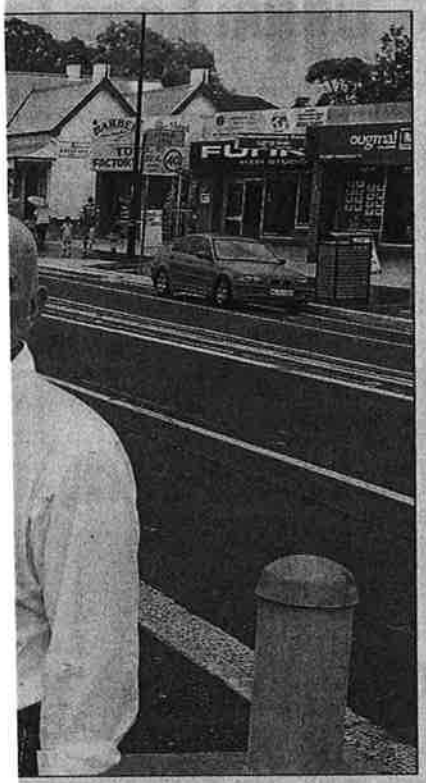
Landfill project

Wollongong City Council has engaged an environmental consultant to manage the design and construction of a new landfill cell at Whytes Gully, Kembla Grange.

The council is working with Golder Associates to prepare an environmental assessment on the proposal to construct a new cell at the Whytes Gully landfill site. A new cell is a large area specifically constructed to take a large amount of waste in the council's waste depot.

A project description is available at www.wollongong.nsw.gov.au or by calling 4227 7111.

ion Pk



erry could be a model for revitalising the town centre. Picture: SYLVIA LIBER

boost, ning is- Moran direc- te rais- o 15m y's vil- lage centres, including Albion Park, as part of the revised LEP.

"We need to provide the framework for all of the town centres to develop to their full potential," Cr Moran said.

Council calls for input on landfill plans

By ANGELA THOMPSON

THE future of landfill at Kembla Grange is up for discussion this week.

The Whytes Gully Waste Depot at Kembla Grange was designed as a three-stage facility in 1983. The first stage operated until 1993 and the second is approaching capacity.

The final stage could meet Wollongong landfill needs until 2060, depending how much residents recycled, council waste services manager Kathleen Packer said.

The council is calling for input on a new master plan for the site, at two information sessions this week.

Planning for stage three began early last year and construction is expected to be complete by November 2013.

"The project team is looking to the community for ideas on how we can ensure the next stage ... minimises impacts on ... the whole community," Mrs Packer said. "The community sessions are the main gauge of what the community wants ... in [the master plan]."

Information sessions are from 6-8pm on Thursday at Unanderra Community Centre and 1-3pm on Saturday at Glengarry Cottage, Kembla Grange.

WIN SILVER TICKETS TO

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A3660: 20 Version 2

Dear Resident

WHYTES GULLY NEW LANDFILL CELL

Wollongong City Council would like to inform residents in the area that an Environmental Assessment (EA) is being prepared for a proposed new landfill cell at Whytes Gully Resource Recovery Park. The EA is being prepared as part of a development assessment in accordance with the NSW *Environmental Planning and Assessment Act 1979* and the Director General's Requirements issued by the Department of Planning and Infrastructure on 11th August 2011.

The existing landfill at Whytes Gully Resource Recovery Park is projected to be at capacity in the next two to three years, therefore the design and approval of a new landfill cell is needed. The life of both the existing and new landfill cells will depend on the volume of waste generated by the community.

Wollongong City Council, with input from the community, will be working on how to design and construct a new landfill cell while minimising impacts on neighbours and minimising the costs to the whole community.

Wollongong City Council has engaged Golder Associates as consultants to assist Council during the approvals process for the proposed new landfill cell. Information about the project is available on Council's website, which will be regularly updated as more information is available. The website for the project is located at:

http://www.wollongong.nsw.gov.au/services/majorprojects/Pages/WhytesGullyNewLandfillCellProject.aspx

Why is Council extending the Whytes Gully landfill?
The existing landfill cells at Whytes Gully Resource Recovery Park will reach capacity in the near future. A new landfill cell at the site is therefore important to extending the life of the facility ensuring the local government area of Wollongong City Council does not run out of landfill space.

What will change at Whytes Gully?
The addition of a new landfill cell will increase the 'footprint' of the waste emplacement, making more space available for future waste. However, the overall use of the resource recovery park will not change and the new landfill cell will be located within the existing boundary of the facility. The new cell will use modern waste management practices and technologies to ensure waste is managed appropriately.

Approvals Process
The approvals process will involve a detailed environmental assessment and extensive community consultation. Final approval is likely to be required from the Minister of the Department of Planning and Infrastructure (or delegate) prior to Council being able to construct the new landfill cell.

Community Consultation
It is important that the community is consulted throughout the project and Wollongong City Council is working to ensure the community is informed and able to ask questions, make comments and provide feedback. In particular, the project team will be interested in the community's views about potential impacts and how to minimise those impacts.

Information is being provided in a number of ways including mailouts, the internet and through existing neighbourhood forums. Information is also being provided in libraries and Council noticeboards around the City.

For further information and to provide input you can:

- Come along to one of our community information sessions:
    - Thursday 24th November 6pm-8pm, Unanderra Community Centre, cnr Princes Hwy & Factory Rd, Unanderra
    - Saturday 26th November 1pm-3pm, Glengarry Cottage, Reddalls Road, Kembla Grange
- Call our toll free telephone information line, 1800 110 055
- Email us at whytesgully@gmail.com
- Write to Whytes Gully New Landfill project, Locked Bag 8821, Wollongong DC, NSW 2500

In addition the following Council website provides information and updates to the project.

http://www.wollongong.nsw.gov.au/services/majorprojects/Pages/WhytesGullyNewLandfillCellProject.aspx

WHYTES GULLY

NEW LANDFILL CELL PROPOSAL

WCC© 1291478

COMMUNITY INFORMATION AND CONSULTATION

Wollongong City Council proposes to design and construct a new landfill cell at Whytes Gully Resource Recovery Park because the existing landfill will be at capacity in the near future.

As part of the project's environmental assessment process, the project team is seeking input from the community to ensure the proposed new landfill cell addresses community concerns appropriately.

For further information and to provide input you can:

→ Come along to one of our community information sessions:

- Thursday 24th November 6pm-8pm, Unanderra Community Centre, cnr Princes Hwy & Factory Rd, Unanderra
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WOLLONGONG CITY COUNCIL

WORKING TOWARDS A SUSTAINABLE ENVIRONMENT

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FROGS OF THE ILLAWARRA



Do you want to know more about frogs of the Illawarra? Do you want to learn how to create a frog friendly garden? Have the recent heavy rains brought new frogs to your garden?

We have worked with Shellharbour and Kiama councils to prepare a Frogs of the Illawarra brochure to help community members identify frogs and create better environments for them to survive.

The Frogs of the Illawarra brochure was created as part of the Illawarra Biodiversity and Local Food Strategy for Climate Change project, a joint sustainability initiative lead by Wollongong, Shellharbour and Kiama Councils, working in partnership with funding from the NSW Environmental Trust.

You can pick up a copy of the guide at Wollongong City Council or Shellharbour City Council Administration Buildings. The Frogs of the Illawarra guide can also be downloaded from the web at http://www.wollongong.nsw.gov.au/services/sustainability/Pages/biodiversityfood.aspx.

WHYTES GULLY LAND FILL

We are working with consultants to prepare an environmental assessment of the Whytes Gully land fill site and how this can accommodate our waste for the next few years.

The existing landfill at Whytes Gully will be full in the next two to three years, based on current waste levels. Council needs to plan now for the future.

The approvals process will involve detailed environmental impact assessment and extensive community consultation. Final approval will be required from the Department of Planning and Infrastructure.

You can register to receive updates about the project and the consultation activities:

- Calling the project's toll free information line, 1800 110 055.
- Emailing the project team at whytesgully@gmail.com.
- Writing to Whytes Gully New Landfill Cell Project, Locked Bag 8821, Wollongong DC, NSW 2500.

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FOR MORE INFORMATION:
Web **www.wollongong.nsw.gov.au** Phone **4227 7111**
Address **41 Burelli Street Wollongong**
Post **Locked Bag 8821 Wollongong DC NSW 2500**

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WHYTES GULLY NEW LANDFILL CELL

Frequently Asked Questions

Background
Wollongong City Council has commenced planning for the proposed next stage of the Whytes Gully Resource Recovery Park at Kembla Grange to meet the needs of the community over the next 50 years.

The Whytes Gully Landfill, built in 1983, was conceived as a three stage facility. The first stage operated until 1993 and the second stage is now reaching the end of its lifespan. Council is now planning for the proposed third stage of the landfill site, which is expected to keep the facility up and running until 2060.

Why is Council building a new landfill cell at the Whytes Gully landfill?
The existing landfill cell at Whytes Gully Resource Recovery Park is projected to be at capacity in the next two to three years. It is therefore important to start the process of designing and seeking approval for a new landfill cell to be built at the existing facility to ensure the Wollongong local government area does not run out of landfill space.

If approved, how long will the new proposed landfill cell last?
The life of both the existing and new landfill cells will depend on the volume of waste generated by the community. Council is continuing to look at ways to educate the community about waste minimisation and recycling and to ensure user friendly facilities to encourage recycling. The Wollongong community recycled 26,000 tonnes of plastics & paper and 28,000 tonnes of garden waste in 2010/11. Stage 3 is estimated to give at least an additional 45 years of landfill space.

What will change at Whytes Gully?
The addition of a new landfill cell will make more space available for future waste disposal. The overall use of the resource recovery park will not change and the new landfill cell will be located within the existing boundary of the facility. The new cell will use modern waste management practices and technologies.

When will the landfill cell be built?
Before Council can build the new landfill cell it must prepare an environmental assessment. An environmental assessment (EA) is Council's way of addressing the Department of Planning and Infrastructure and the community's concerns. The EA will address matters such as odour, noise, traffic, heritage, flora & fauna among others.

Once the EA is approved Council will go to the tender for the construction of Stage 3. Stage 3 is expected to be completed by October 2013. .



What is the process for approving an environmental assessment?
The Department Planning and Infrastructure will review Council's proposal for the new landfill cell as well as consult with stakeholders including the community on their concerns. Upon approval the Department of Planning and Infrastructure will issue Project Approval conditions and the Office of Environment and Heritage will issue a Landfill Licence.

Who is preparing the environmental assessment?
Wollongong City Council has engaged specialist environmental consultants Golder Associates to assist Council during the approvals process for the proposed new landfill cell. Golder Associates are preparing the environmental assessment. Council went through a tender process to select the consultants and Golder were the successful tenderer because of their expertise in this field.

Is the community being consulted?
Council has already spoken to neighbours near Whytes Gully, the local neighbourhood forums and placed adverts in local papers. Our website includes details of the project.

To ensure the community has input into this project, Council is running information sessions or alternatively you can:

- call our toll free telephone information line, 1800 110 055
- email us at whytesgully@gmail.com
- write to Whytes Gully New Landfill project, Locked Bag 8821, Wollongong DC, NSW 2500.

In addition the following Council website provides information and updates to the project.
http://www.wollongong.nsw.gov.au/services/majorprojects/Pages/WhytesGullyNewLandfillCellProject.aspx

How can I have my say on the proposed new landfill cell?
To have your say, please complete the feedback form available at the two information sessions or on council's website.

We would like your feedback by **Saturday 10 December 2011.**

Alternatively, you can have your say once the EA application is submitted through the Department of Planning and Infrastructure consultation period. Specific information in regards to details regarding this will be placed on Council's website as it becomes available.

It is important that the community is consulted throughout the project and Wollongong City Council is working to ensure the community is informed and able to ask questions, make comments and provide feedback. In particular, the project team will be interested in the community's views about potential impacts and how to minimise those impacts.



WOLLONGONG CITY COUNCIL
WHYTES GULLY NEW LANDFILL CELL

Community Feedback Form

Please read the Frequently Asked Question Sheet before completing the feedback form

A new landfill cell at the Whytes Gully Resource Recovery Park is proposed because the existing landfill cell is projected to be at capacity in the next two to three years.

Do you have any comments or concerns about the proposal to build a new landfill cell at Whytes Gully?

□ Yes (please comment below or list your concerns below) □ No

_____

_____

_____

_____

_____

_____

_____

If you would like a reply, or to be kept informed of the project, please fill in the section below:

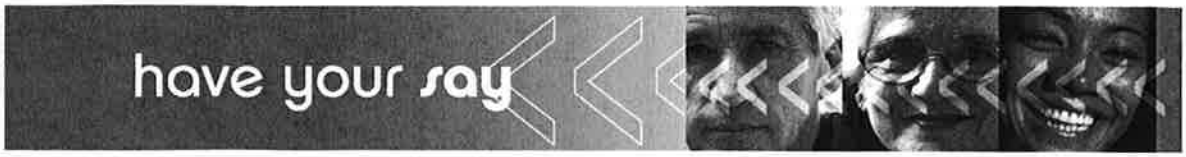
Name:	
Address:	
Suburb:	Postcode:
Telephone:	Email:

Please either place this form in the box provided, or return it by 10th December 2011 to:

- whytesgully@gmail.com or
- Whytes Gully New Landfill Cell project, Locked Bag 8821, Wollongong DC, NSW 2500

Information about your submission.

In accordance with the Local Government Act 1993, your submission including any personal information such as your name and address, will be made available for public inspection. You may request, in the form of a statutory declaration, that Council suppress the personal information in your submission from public inspection, if you consider that the personal safety of any person would be affected if the information was not suppressed. Any such request will be dealt with in accordance with the Privacy and Personal Information Act 1988. You may also make an anonymous submission however if you choose to do so Council will be unable to contact you any further as to the outcome of your submission. Additionally, anonymous submissions will be considered however it should be noted that the lack of information as to the respondent's place of living may affect Council's consideration of the potential impact of the subject proposal. Note: If Council receives a submission from any person who is legally required to provide a disclosure of any reportable political donation and / or gift under section 147 of the Environmental Planning and Assessment Act 1979, Council is legally required to publicly disclose all relevant details of the reportable political donation or gift onto Council's website. This will include the name and residential address of the person who provided the political donation or gift onto Council's website for full viewing by the general public.



WOLLONGONG CITY COUNCIL
WHYTES GULLY NEW LANDFILL CELL

Community Feedback Form

Please read the Frequently Asked Question Sheet before completing the feedback form

A new landfill cell at the Whytes Gully Resource Recovery Park is proposed because the existing landfill cell is projected to be at capacity in the next two to three years.

Do you have any comments or concerns about the proposal to build a new landfill cell at Whytes Gully?

☑ Yes (please comment below or list your concerns below) ☐ No

The closing of the old WESTERN QUEEN
LACK OF BUFFER ZONE AROUND
PERIMETER

If you would like a reply, or to be kept informed of the project, please fill in the section below:

Name: JOHN LUCAS	
Address: 181 REDDACCS RD	
Suburb: KEMBLA GRANGE	Postcode: 2526
Telephone: 42617169	Email:

Please either place this form in the box provided, or return it by 10th December 2011 to:

- whytesgully@gmail.com or
- Whytes Gully New Landfill Cell project, Locked Bag 8821, Wollongong DC, NSW 2500

Information about your submission.

In accordance with the Local Government Act 1993, your submission including any personal information such as your name and address, will be made available for public inspection. You may request, in the form of a statutory declaration, that Council suppress the personal information in your submission from public inspection, if you consider that the personal safety of any person would be affected if the information was not suppressed. Any such request will be dealt with in accordance with the Privacy and Personal Information Act 1988. You may also make an anonymous submission however if you choose to do so Council will be unable to contact you any further as to the outcome of your submission. Additionally, anonymous submissions will be considered however it should be noted that the lack of information as to the respondent's place of living may affect Council's consideration of the potential impact of the subject proposal. Note: If Council receives a submission from any person who is legally required to provide a disclosure of any reportable political donation and / or gift under section 147 of the Environmental Planning and Assessment Act 1979, Council is legally required to publicly disclose all relevant details of the reportable political donation or gift onto Council's website. This will include the name and residential address of the person who provided the political donation or gift onto Council's website for full viewing by the general public.

REF: CM2/12 File: IW-913.05.003

ITEM 4 ENDORSEMENT OF WASTE AND RESOURCE RECOVERY STRATEGY 2012-2022 FOR PUBLIC CONSULTATION

The Waste and Resource Recovery Strategy 2012–2022 is a framework for Council and the community to make the transition to sustainable waste management. The main themes for the strategy are:

- Minimise waste to landfill
- Maximise the recovery of resources
- Maximise landfill life
- Value and protect the environment
- Minimise climate change impacts.

Supporting measures will include community and stakeholder engagement; the development of policy and pricing models; the enhancement and facilitation of community education programs; and the establishment of strategic partnerships with relevant organisations.

Recommendation

1 Council endorse the Waste and Resource Recovery Strategy 2012-2022 for public consultation.

2 A further report to be submitted to Council following public consultation.

Attachments

Waste and Resource Recovery Strategy 2012-2022

Report Authorisations

Report of: Kalyan Mondal, Manager City Works
Authorised by: John Shepherd, Director Infrastructure and Works (Acting)

Background

The Waste and Resource Recovery Strategy proposes a staged approach to Waste and Resource Management. The Strategy details actions and focus areas to improve on current services; tender for new collection and processing of domestic waste contracts; and ensure landfill space in the future.

The Waste and Resource Recovery Strategy reviews the internal and external factors influencing Council's performance in waste management. It also reviews current performance and trends in relation to diverting waste from landfills.

Council staff will then review existing and new Alternative Waste Technologies (AWT) and provide a recommendation on the most suitable AWT process to Council within the next two years to further assist in waste diversion.

Proposal

Council endorse the attached Waste and Resource Recovery Strategy 2012–2022 for public consultation. A further report will be submitted to Council detailing the community feedback following the consultation period, with recommendations on any appropriate improvements/amendments.

Consultation and Communication

The development of the Waste and Resource Recovery Strategy 2012–2022 involved consultation with several internal and external stakeholders and subject matter experts.

The Waste and Resource Recovery Strategy 2012–2022 was developed with the assistance of Phil Hawley and Associates and refined by Council's Waste Services section, in consultation with Golder and Associates, ensuring consistency with the Environmental Assessment for the proposed new landfill cells at Whytes Gully due for submission in February 2012.

In addition, specific divisions within Council were consulted, including City Planning, Environmental Strategy and Planning and Finance Divisions.

Planning and Policy Impact

This Strategy will establish a framework for Council and the community to move towards sustainable Waste Management.

Risk Assessment

Endorsement of the Strategy is necessary for the progression of Council's new Landfill Cells at Whytes Gully and to proceed with the implementation of a sustainable Waste Management approach for Wollongong.

Financial Implications

The financial implications will be considered for each action within the Waste and Resource Recovery Strategy 2012–2022 individually. A long term financial model will be developed to ensure the provision for waste services is in line with the Waste and Resource Recovery Strategy.

Conclusion

The endorsement of the Waste and Resource Recovery Strategy 2012–2022 will provide the framework to guide Council's Waste Management initiatives and allow for its inclusion in the Environmental Assessment for the Whytes Gully New Landfill Cell Project.

APPENDIX D

Noise Assessment

June 2012

WHYTES GULLY NEW LANDFILL CELL

Noise Impact Assessment

Submitted to:
Wollongong City Council

REPORT

Report Number. 1178212-216

Golder Associates

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Ambient Noise Monitoring Data

1.0 INTRODUCTION

Wollongong City Council has commissioned Golder Associates (Golder) to assess the potential noise impacts associated with the construction and operation of a proposed new landfill cell within the existing Whytes Gully Resource Recovery Park (Whytes Gully RRP), Reddalls Road, Kembla Grange (the Project). This report has been undertaken in accordance with relevant noise guidelines and policies and the Director General's Requirements for the project dated August 2011, to:

- Assess the existing ambient noise environment;
- Establish noise design objectives and assessment goals;
- Provide a detailed assessment of potential noise impacts associated with the proposal;
- Assess potential noise impacts against relevant legislation and guidelines; and
- Develop noise mitigation measures as appropriate.

This report is issued subject to the limitations set out in Appendix A.

2.0 DIRECTOR-GENERAL'S REQUIREMENTS

The NSW Department of Planning and Infrastructure has issued Director-General's Requirements (DGRs) for the Project that identifies noise impacts as a key issue for consideration in the Environmental Assessment. The DGRs specify that an assessment of noise impacts be undertaken "including an assessment of construction, operational and traffic noise".

The DGRs specify that this assessment should be undertaken in accordance with the following policies and guidelines:

- NSW Industrial Noise Policy (DECC) (INP);
- NSW Road Noise Policy (DECCW 2011);
- Environmental Noise Control Manual (DECC); and
- Interim Construction Noise Guideline 2009 (DECC) (ICNG).

3.0 SITE DESCRIPTION AND PROPOSED ACTIVITIES

Existing landfill airspace at Whytes Gully RRP is projected to expire in late 2013. To address this issue, Wollongong City Council proposes to increase landfill capacity by approximately 40 years by constructing a new landfill cell within the existing Whytes Gully RRP site (the Project) to provide for additional landfill capacity within the Wollongong local government area.

It is understood the Project will not result in an increase in material being accepted at Whytes Gully RRP. The internal site layout is proposed to be reconfigured to support the staging of the proposed new landfill cell and further activities. This includes the internal road layout and may include reconfiguration of leachate and surface water ponds.

The key features of the Project include:

- Extending the site's landfill capacity for up to 40 years operation;
- Providing disposal option for residual wastes not realised by resource recovery or treatment;
- Minimising waste management footprint by extending landfill life at an existing facility, rather than through development of an alternative site; and
- Minimising waste management footprint by developing additional landfill capacity above existing contained wastes by using a "piggy back" design, in which the piggy back landfill cells would be integrated with, and sit on top of the existing landfill to minimise the footprint of the landfill area at the site.

It should be noted the Project would not result in additional intensity of use with regard to existing waste acceptance but only seeks to increase capacity at the site.

Whytes Gully RRP is located 12 km to the south of Wollongong CBD and is approximately 65 ha in size. The site rises from RL 20m to the south to RL 120m to the north east, where it meets a ridge at Farmborough Heights. The site generally has a declining slope from north-west to south-east.

The surrounding land use in the area of Whytes Gully RRP is predominantly scattered rural residential to the north and north-west with light industrial activity to the east and the south. Access to Whytes Gully RRP is via Reddalls Road to the south.

The Project will provide for landfill capacity at Whytes Gully RRP for approximately 40 years and will involve deposition and compaction of waste, placement of intermediate cover, removal of intermediate cover, capping and landscaping. The new landfill cell is proposed to be constructed in five stages (Stage 1, Stage 2A, Stage 2B, Stage 3, Stage 4) as shown in Figure 1.

Operational hours for the site are and will continue to be 07:30 – 16:30 weekdays and 08:00 – 16:00 weekends and public holidays for 364 days a year (closed on Christmas Day).

The major activities associated with the construction and operational phases will involve the use of powered plant and equipment and are summarised as follows:

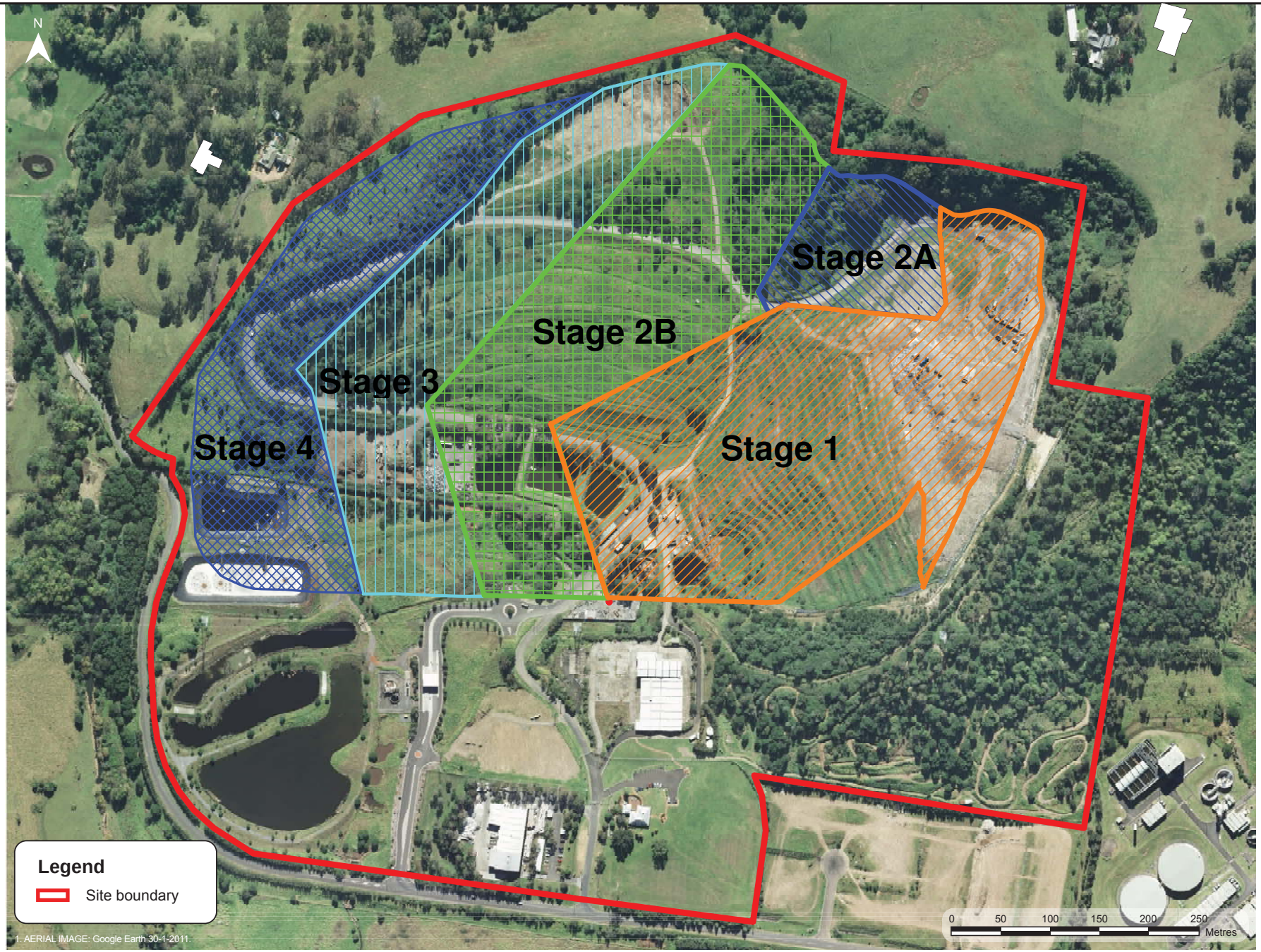
- Construction of new cells and other infrastructure;
- Deposition and compaction of waste – transportation and deposition of waste, and compaction; and
- Placement and removal of daily and intermediate cover.

It is noted that the construction and operational activities are similar and overlap.

The noise assessment has been undertaken in accordance with the following methodology:

- The spatial area for the noise assessment was identified from the study site plans, aerial photographs and the site survey. The areas that have been included in the noise assessment are shown in Figure 1.
- The locations of noise sensitive receivers and the character of the existing environment have been determined primarily through the site visits and noise monitoring undertaken by Golder staff in November 2011.
- Potential construction and operational noise impacts have been determined based on the identified plant and equipment lists using source noise data processed through the CadnaA environmental noise prediction model and evaluated against the established performance criteria.

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1. AERIAL IMAGE: Google Earth 30-1-2011.

Golder Associates

TITLE STAGING SEQUENCE

MARCH 2012

PROJECT 1178212216

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4.0 AMBIENT NOISE LEVELS

4.1 Ambient Noise Environment

The subject premises of Whytes Gully RRP are operational 7 days a week, 52 weeks a year (closed on Christmas Day) and the site is required to remain open during this time to accept all of the domestic solid waste of Wollongong Local Government Area. As a result it is not considered practicable to close down Whytes Gully RRP for the minimum necessary 7 days to undertake background noise monitoring.

Section 3.1 of the INP defines background noise as: "... the underlying level of noise present in ambient noise when all unusual extraneous noise is removed." Golder considers that given the constant daytime presence of noise from the Whytes Gully RRP site and that it cannot be practicably closed down, it is not considered to be "unusual" in the context of the INP and therefore it is accurate and representative to include the Whytes Gully RRP operations as part of the background noise monitoring in the assessment of the new landfill cell.

Whilst the measured ambient noise levels were identified to be affected by the current landfill operations, the background noise levels are not untypical of rural areas and the levels identified in Table 3 below are comparable with those quoted in Worked case study A2 of the NSW INP. This indicates that the intrusiveness criteria used in our assessment are comparable to others set to protect rural receivers.

4.2 Unattended Noise Monitoring

Ambient background noise levels were measured using noise loggers set up in the vicinity of the identified noise sensitive receivers around the Whytes Gully RRP. Although noise loggers were not located at the some of the nearest residential locations due to access difficulties, the monitoring locations used are considered to include the best alternatives and to represent the ambient background noise environment of these dwellings.

Existing ambient noise levels were monitored at three locations identified in Figure 2, between 15 and 24 November 2011. The monitoring locations are as follows.

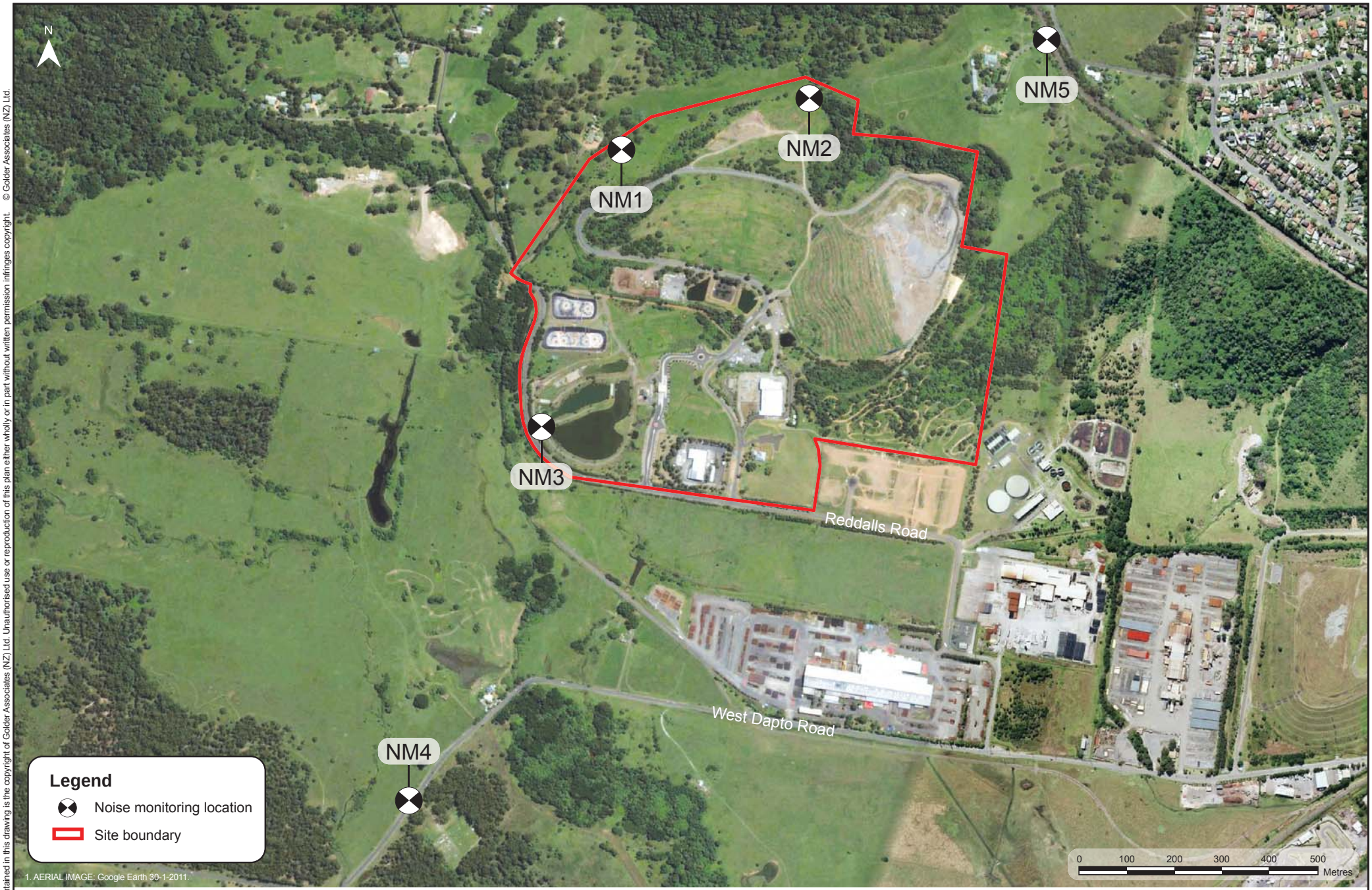
- NM1 – North-west site boundary;
- NM2 – North-east site boundary; and
- NM3 – South-east site boundary.

Noise levels were measured at a rate of 10 samples/second and the L_{Aeq}, L_{A90} and L_{A10} noise level descriptors were processed for each 15-minute time interval over the measurement period. The measured noise data for NM1, NM2 and NM3 are attached in Appendix B.

The noise measuring instrumentation used for the unattended noise monitoring is summarised below in Table 1.

Table 1: Noise Monitoring Details

Location	Noise Monitoring Date	Noise Logger Type	Serial Number
NM1	15 to 24 Nov 2011	SoundPro DL	878069
NM2	15 to 24 Nov 2011	SoundPro DL	878066
NM3	15 to 24 Nov 2011	SoundPro DL	878067



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TITLE | NOISE MONITORING LOCATIONS ATTENDED AND UNATTENDED

MARCH 2012

PROJECT | 1178212216

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4.3 Attended Noise Monitoring

Attended noise monitoring was also undertaken on 24 November 2011 at the unattended noise monitoring locations (NM1, NM2, and NM3), and also in the vicinity of the closest nearby residential dwellings located to the south-west and north-east (NM4 and NM5 respectively) of the Whytes Gully RRP on 24 November 2011 using a Quest Sound Pro Type-1 sound level meter (Serial Number BL 1090009).

The purpose of the attended measurements was to provide supporting data for the review of the background noise levels measured during the unattended survey (since the unattended measurements were potentially affected by the existing landfill operations) and to identify sources of background noise. The L_{Aeq} ambient and L_{A90} background noise levels, measured over 15 minute periods at each location are shown in Table 2 below and the monitoring locations are shown in Figure 2.

Table 2: Attended Background Noise Levels

Location	Date & Start Time	Measured L_{Aeq}	Measured L_{A90}	Observed Noise Sources
NM1	24 Nov 11 - 13:30	43	38	Bird song, distant noise from Whytes Gully RRP
NM2	24 Nov 11 - 10:10	49	45	Bird song, distant noise from metal yard and Whytes Gully RRP
NM3	24 Nov 11 - 09:20	58	55	Noise from metal yard and Whytes Gully RRP
NM4 - Resident 1 – SW of Whytes Gully RRP	24 Nov 11 - 07:55	65	46	Road traffic only
NM5 - Resident 2 – NE of Whytes Gully RRP	24 Nov 11 - 08:40	51	45	Bird song, distant noise from metal yard and Whytes Gully RRP

4.4 Processing Measured Ambient Noise Data

4.4.1 Unattended noise monitoring data

The measured L_{A90} data was processed in accordance with the requirements of the INP. This document sets out a method of determining a 'rating background level' (RBL) on which to base intrusiveness criteria. The method accounts for the variation of background noise levels by nominating a reference level that is exceeded for at least 90% of a measured time period.

Recorded surface wind speed, wind direction, temperature and relative humidity data from the Bureau of Meteorology Albion Park station recorded over 30 minute periods from 15 to 24 November 2011 was used to eliminate any weather affected noise data from the measured background noise levels.

An 'assessment background level' (ABL) is determined from the tenth percentile L_{A90} result for each identified period (day, evening or night), for each day of measurement. This corresponds to the 15 minute L_{A90} result that was exceeded by 90% of the measured L_{A90} levels in each period (the ABL is therefore roughly equivalent to the noise level exceeded for 99% of the measurement period). The 'rating background level' (RBL) for each day, evening or night period is the median of the ABLs over all measurement days. The results from the noise logging at N1, N2 and N3 are presented in Table 3 below. The INP states that where the median ABL is less than 30 dB(A), the RBL is taken to be 30 dB(A).

As discussed in Section 3, operation hours for the site are 07:30 – 16:30 weekdays and 08:00 – 16:00 weekends and public holidays and only the daytime standards are therefore applicable to the Project.

Whilst the measured L_{A90} values from the limited period of attended monitoring are generally higher than those from the long-term unattended noise monitoring, the observed measurement results indicate that there is no reason to suggest that the RBL values shown in Table 3 cannot be considered representative of the general background noise levels at these locations.

Table 3: ABL and RBL Values derived from the Unattended Noise Monitoring Data

	Day (07:00 – 18:00)	Evening (18:00 – 22:00)	Night (22:00 – 07:00)
	L_{A90}	L_{A90}	L_{A90}
NM1			
ABL range	32.4 – 38.8	30.1 – 32.8	26.2 – 31.7
Median of ABLs	34.1	31.9	29.5
RBL	**34**	32	30
NM2			
ABL range	30.0 – 37.8	28.9 – 31.6	23.9 – 30.7
Median of ABLs	32.9	30.1	27.2
RBL	**33**	30	30
NM3			
ABL range	36.1 – 44.3	37.7 – 49.8	35.2 – 41.3
Median of ABLs	39.4	44.5	36.3
RBL	**39**	45	36

Note: Numbers in Bold font are the daytime RBLs to be used in the assessment.

5.0 NOISE CRITERIA

5.1 Noise Criteria for Construction Noise

The DECC recognises that construction activities could potentially generate higher noise levels than those of an industrial operation. The construction activities associated with the Project will involve site formation and the construction of the new landfill cell.

Construction activities will be limited to the standard hours of 07:30 to 16:30 Monday to Friday and 08:00 to 13:00 on Saturdays with no work on Sundays and public holidays. Construction activities are proposed to generally occur during the standard hours but the ICNG states that the following activities have justification to be undertaken outside of standard hours:

- The delivery of oversized plant or structure;
- Emergency work; and
- Works for which it can be demonstrated that there is a need to operate outside the recommended standard hours.

The ICNG construction noise criteria are presented in Tables 4 and 5.

Table 4: DECC Construction Noise Criteria (dB(A))

Construction Time	Construction Noise Criterion ($L_{Aeq, 15\ min}$)
Recommended standard hours Monday to Friday – 07:00 to 18:00 Saturday – 08:00 to 13:00 No work on Sundays or public holidays	Noise affected: RBL + 10 dB(A) (1) Highly noise affected: 75 dB(A) (2)
Outside recommended standard hours	RBL + 5 dB(A)

Notes: (1) Where the predicted or measured $L_{Aeq, 15\ min}$ is greater than the 'noise affected' levels, all feasible and reasonable work practices to minimise noise should be applied. All potentially impacted residents should be informed the expected noise levels and duration, as well as contact details. (2) Where noise is above the highly noise affected levels, the relevant authority may require respite periods by restricting the hours that the very noisy activities can occur, taking into account times identified by the community when they are less sensitive to noise and/or if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Table 5: Construction Noise Criteria

Time Period	RBL			Noise Affected Construction Noise Criteria, $L_{Aeq, 15\ min}$		
	NM1	NM2	NM3	NM1	NM2	NM3
Monday to Friday (07:00 – 18:00) and Saturday (08:00 – 13:00)[1]	34	33	39	44	43	49
Outside recommended standard hours[2]	30	30	36	35	35	41

Notes: (1) Based on data from Table 3. (2) Based on unattended measurement data (see Appendix B).

5.2 Noise Criteria for Landfill Operations

The INP assessment procedure for industrial noise sources has two components (EPA, 2000):

- Controlling potential intrusive noise impacts in the short-term for residences; and
- Maintaining noise level amenity for particular land uses, including residences and other specified activities.

The "intrusiveness" criterion requires that the $L_{Aeq,15min}$ noise level from an industrial noise source should not exceed the existing Rating Background Level (RBL) for that period by more than 5 dB(A) (see Table 4).

These criteria apply to $L_{Aeq,15min}$ noise levels measured under specific meteorological conditions, determined as outlined in the INP (no precipitation, wind speeds <5 m s^{-1}).

The "amenity" criterion applies to the $L_{Aeq, period}$ noise level due to all industrial sources affecting a location. It sets an upper limit to the total noise level (L_{Aeq}) in an area from all industrial noise (existing and future). The criterion depends on the time of the day, area classifications and the relationship of the total measured L_{Aeq} (and contribution from existing industrial noise) to determine the Acceptable Noise Level (ANL) for the development.

The potentially affected area is considered to be classified as "Urban/Industrial Interface" under the INP for existing activities as the most affected receivers would be located within a contour delineating a 5 dB reduction in noise levels from those at the site boundary and the subject premises are operational during the day and are the main noise source during the day. The acceptable amenity levels (L_{Aeq}) which apply over the whole day, evening and night period are, therefore, as follows:

- Day (07.00 to 18.00) 65dB L_{Aeq};
- Evening (18.00 to 22.00) 55dB L_{Aeq}; and
- Night (22.00 to 07.00) 50dB L_{Aeq}.

The INP states that these criteria are best regarded as planning tools and that these criteria have been selected to preserve the amenity of at least 90% of the population living in the vicinity of industrial noise sources from the adverse effects of noise for at least 90% of the time. The INP identifies that provided these criteria are achieved most people would consider the resultant noise levels acceptable.

After determining the relevant noise levels from the intrusive and amenity criteria, the project specific noise levels (PSNL) can be assigned. According to the INP, the PSNL are the most stringent of the intrusive or amenity criteria. Table 6 summarises the noise criteria adopted for this assessment.

Table 6: Intrusive and Amenity Noise Criteria

Time Period	RBL (from Table 3)			Intrusive Criteria, $L_{Aeq,\ 15\ min}$			Amenity Criteria, $L_{Aeq,\ period}$		
	NM1	NM2	NM3	NM1	NM2	NM3	NM1	NM2	NM3
Day (07:00 – 18:00)	34	33	39	**39**	**38**	**44**	65	65	65

Notes: Intrusive Criteria = existing Rating Background Level (RBL) + 5 dB(A). The **Bold** text represents the most stringent criterion, which has been adopted for the purpose of this assessment.

5.3 Noise Criteria for Traffic on Public Roads

The criteria in Table 4 apply to noise from all operations occurring within the Project Site boundary, including on-site truck movements. Noise from truck movements on Reddalls Road is assessed under different criteria.

Whilst the NSW DECC's Environmental Criteria for Road Traffic Noise (ECRTN) has been identified in the DGR guidelines, the NSW Road Noise Policy 2011 (RNP) should actually apply because projects transitioning under the Part 3A process and projects identified as State Significant Development under the amended planning laws that have had DGRs issued prior to 1 July 2011 are to be assessed according to the ECRTN, whilst State Significant Development projects that have DGRs issued on and following 1 July 2011 are to be assessed according to the NSW RNP.

The NSW RNP criteria apply to new roads or road redevelopments or when there is a land use development with the potential to generate additional traffic on local, sub-arterial or arterial roads. Table 7 sets out the assessment criteria for residences to be applied to particular types of project, road category and land use. These criteria are for assessment against façade corrected noise levels when measured in front of a building façade.

Table 7: Road Traffic Noise Assessment Criteria for Residential Land Uses

Road Category	Type of Project/Land use	Assessment Criteria	
		Day (07:00-22:00)	Night (22:00-07:00)
Local Roads	■ Existing residences affected by noise from new local road corridors ■ Existing residences affected by noise from the redevelopment of existing local roads ■ Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq,\ 15\ hr}$ 55 dB	$L_{Aeq,\ 9\ hr}$ 50 dB

6.0 ASSESSMENT OF NOISE EFFECTS

6.1 The CadnaA Environmental Noise Prediction Model

The CadnaA environmental noise prediction model (Version 4.2) has been used to calculate the noise levels received on the properties neighbouring Whytes Gully RRP. This software model is an internationally recognised state-of-the-art predictive tool that utilises internationally approved algorithms for the calculation of noise attenuation through the built and natural environment (in this case *ISO 9613 Acoustics – Attenuation of Sound during Propagation Outdoors*).

The model has been developed using the contour data developed by Golder for each construction/operational stage and the noise inventory data set out below, with all emissions modelled as omni-directional point sources.

Five modelling scenarios have been developed to evaluate the potential noise effects from the five different construction/operation stages with the equipment working at the closest point to the nearest receiver. The effects of noise associated with the construction and operational activities at the Whytes Gully RRP will be dependent upon the locations of the construction and operational activities. As the area associated with each stage is large and the plant and equipment will be moving within the study area, the noise levels received at the residential dwellings will vary. The potential worst case scenarios with all plant and equipment operating in close proximity to one or more receivers have been modelled with the plant and equipment at two locations; either all within the northern part of the site, or all within the southern part of the site.

6.2 Noise Sources

6.2.1 Construction activities

The construction activities associated with the proposed Project will involve site formation, relocation of waste, construction of the new landfill cell and capping. It is expected that the use of excavator/loader, roller, bulldozer and truck and dog will be required for the construction works, which is similar to the plant and equipment required for the operational work. The construction noise emission inventory based on Golder and industry data and supplemented with reference to *Australian Standard AS 2436:2010 – "Guide to noise and vibration control on construction, demolition and maintenance sites* is presented in Table 8.

Table 8: Construction Noise Emission Inventory

Activities	Item	Sound Power Level (dB(A)	Estimated Source Height (m)
Excavation and new cell construction / capping	Excavator	106	1.5
	Bulldozer	108	1.5
	Roller	100	1
Construction traffic	Truck and Dog	101	1.5
Waste relocation	Dump trucks	112	1.5
	Excavator/loader	106	1.5

The ICNG provides a summary of potential noise mitigation measures and it has been assumed that the following measures will be implemented during both the construction and operational activities:

- All mobile equipment should be selected to minimise noise emissions. Equipment should be fitted with appropriate silencers and be in good working order; and

- To reduce the annoyance associated with reversing alarms, broadband reversing alarms should be used for all site equipment.

Golder considers that the proposed activities will not therefore generate tonal, low-frequency or impulsive noise effects at receivers that would justify the implementation of any modifying factor corrections.

The new landfill cell is proposed to be constructed in five stages as outlined in Table 9, as indicated, the construction of the landfill cell and subsequent capping will overlap with the operational period of the landfill.

Table 9: Construction Staging

Stage	Proposed Liner Construction Period [1]	Proposed Capping Construction Period [1]	Operation Period
1	End 2013 – 2016	End 2016 – 2019	2013 – 2018
2A	End 2017 – 2018	End 2020 – 2021	2018 – 2020
2B	End 2019 – 2031	End 2023 – 2036	2020 – 2035
3	End 2035 – 2041	End 2038 – 2047	2035 – 2046
4	End 2046 – 2050	End 2048 – 2055	2046 – 2054

Note: (1) Construction works may not be continuous during the whole period.

Although the new landfill cell would not result in additional intensity of use with regard to existing waste acceptance, additional construction vehicles movements will be generated as part of the construction works. With reference to the Whytes Gully New Landfill Cell Traffic Impact Assessment Report, GTA Consultants (NSW) Pty Ltd, it is expected that the number of additional construction vehicles during the construction of the liner for each cell will be 24 truck movements per day during the week and 16 truck movements on a Saturday.

In addition, the expected number of additional construction vehicles during the capping of each cell will also be 24 truck movements per day during the week and 16 truck movements on a Saturday,

Thus in a worst case scenario where both construction and capping are occurring the same time, up to 48 truck movements per weekday and 32 truck movements on a Saturday could be expected, with up to 8 additional trucks movements during each peak hour.

6.2.2 Operational phase

The major activities associated with the operational phase will involve the use of powered plant and equipment and they are summarised as follows:

- Deposition and compaction of waste – transportation and deposition of waste, and compaction; and
- Placement and removal of daily and intermediate cover.

The plant and equipment listed in Table 10 have been located within the subject site to model the operation of the landfill over the life of the Project (Stages 1, 2A, 2B, 3 and 4), the noise emission inventory is presented in Table 10.

Golder considers that the proposed activities will not generate tonal, low-frequency or impulsive noise effects at receivers that would justify the implementation of any modifying factor corrections.

Table 10: Operational Noise Emission Inventory

Activities	Item	Sound Power Level (dB(A)	Estimated Source Height (m)
Placement and compaction of waste	Front end loader	106	1.5
	Compactor, vibratory	108	1
	Excavator	106	1.5
Placement of immediate cover	Bulldozer	108	1.5
	Truck and Dog	101	1.5
	Roller	100	1
	Loader	106	1.5
Removal of immediate cover	Excavator/loader	106	1.5

6.3 Meteorological Conditions

6.3.1 INP requirements

The INP notes that there are two approaches for the assessment of meteorological effects, such as gradient winds and temperature inversions that may be used in the evaluation of noise propagation from source to receiver. The simple method is to use the default conditions outlined in the INP; alternatively the local meteorological data can be used to determine weather conditions that would be expected to occur at a particular site for a significant period of time.

Wind speed, wind direction, temperature and relative humidity data from the Bureau of Meteorology Albion Park station, was used to determine the prevailing wind and directions and frequency of temperature inversions.

6.3.2 Wind

Wind has the potential to increase the noise impacts upon a receiver when it is light and stable and blows from the direction of the noise source towards the receiver. As the strength of the wind increases the noise produced by the wind will begin to obscure the noise from most industrial and transport sources.

Wind effects need to be considered when wind is a feature of the potentially affected area. The INP states that where wind blows from the source to the receiver at speeds up to 3 m s^{-1} for more than 30% of the time during any season, then wind is considered to be a feature of the area and noise level predictions must be made under these conditions.

Based on the published meteorological data, the default meteorological data set used in the CadnaA model comprising 20ºC temperature, 70% relative humidity and downwind propagation as specified in ISO 9613 is applicable for this assessment.

The default setting in the CadnaA environmental noise prediction model assumes a worst-case scenario with all receivers downwind of all noise sources at wind speeds of 1-5 m s^{-1} and above ground heights of 3-11 m. Thus the CadnaA modelling and the predicted receiver noise levels include the effects of prevailing winds required under the INP.

6.3.3 Temperature inversions

Temperature inversions, when they occur, have the ability to increase noise levels by limiting the normal dispersion of sound waves. Temperature inversions can also hinder the propagation of noise by acting as a barrier containing the noise above or below the inversion or even within a stratified layer of the inversion. Temperature inversions occur predominantly at night during the winter months.

In this case, the published meteorological data indicates that the potential frequency of inversions is less than the 30% threshold required for assessment under the INP.

6.3.4 Noise receiver locations

In addition to the monitoring locations used to assess the background and amenity noise levels, the nearby resident receivers have been determined from aerial photos and site visits. For the purpose of this assessment, only the nearest residential receivers have been identified because the attenuation of noise over greater distances will ensure that sensitive receivers located further away will be exposed to lower noise levels. The following noise sensitive receivers have been identified for the purpose of this assessment (see Figure 3):

- N1 – Residence NW of Whytes Gully RRP (applicable monitoring data NM1);
- N2 – Residence NE of Whytes Gully RRP (applicable monitoring data NM2);
- N3 – Residence SW of Whytes Gully RRP (applicable monitoring data NM3)
- N4 – Residence NE of Whytes Gully RRP (applicable monitoring data NM2); and
- N5 – Closest Residence at Farmborough Heights (applicable monitoring data NM2).

All receivers are single-storey properties except for N1 and therefore receiver heights have been set at 1.5 m AGL above ground level. For N1, the receiver height has been set at 4.5 m AGL above ground level.

6.4 Predicted Noise Levels

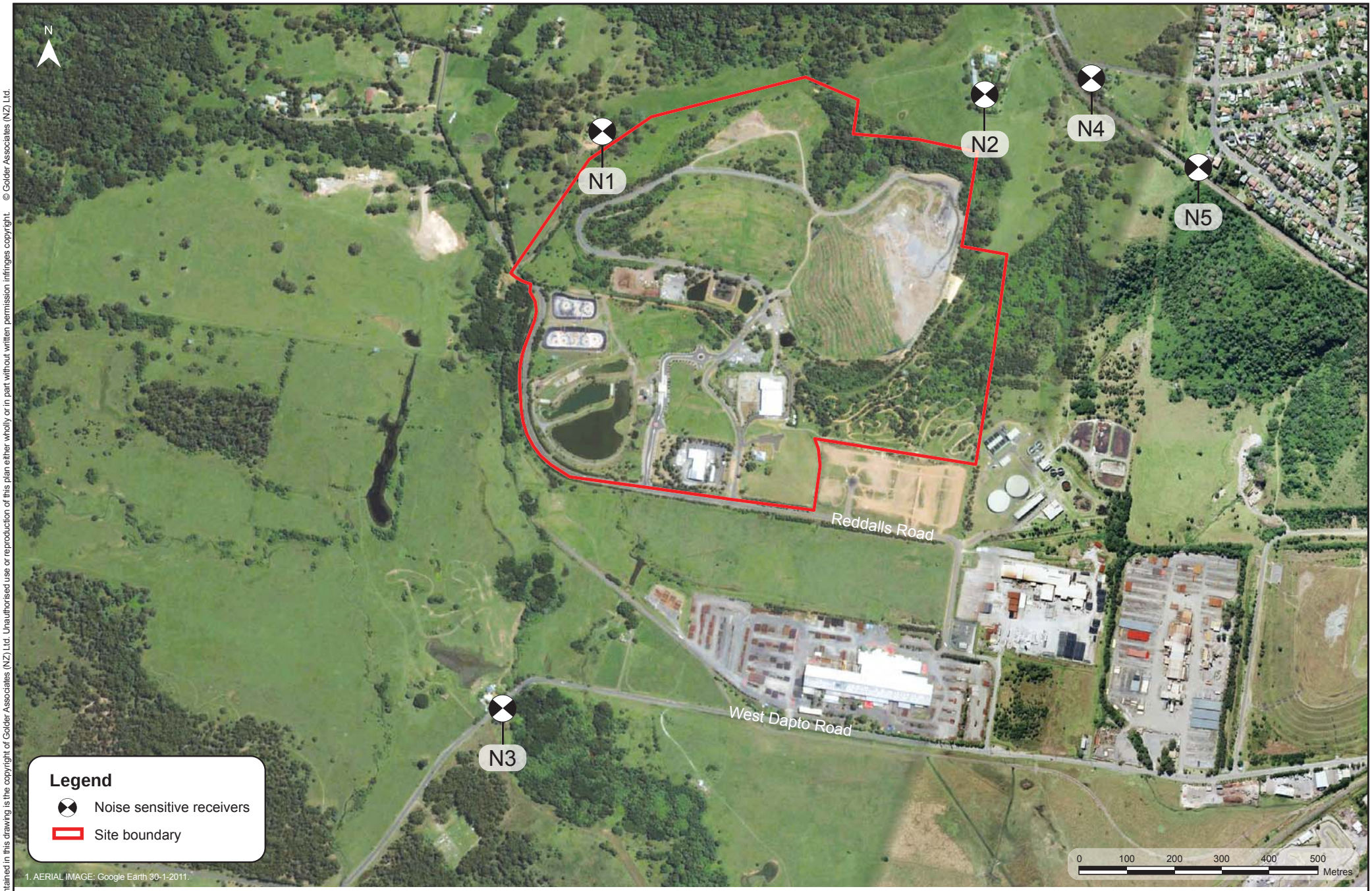
6.4.1 Construction activities

A total of 10 modelling scenarios have been developed, 2 scenarios for each stage with plant and equipment located either in the northern or southern part of each stage. Tables 11 and 12 sets out the predicted Stages 1 to 4 construction noise levels at the closest receivers to the proposed Project, taking into account site layout, distance separation, screening from existing topography, ground and atmospheric absorption, without the implementation of any mitigation measures except that all plant and equipment are assumed to be fitted with appropriate silencers and broadband reversing alarms.

Table 11: Predicted Noise Levels – Plant and Equipment Located within the Northern Part of Each Stage

Receivers	Construction Noise Criteria[1]	Stage 1	Stage 2A	Stage 2B	Stage 3	Stage 4
N1	44	27	34	35	37	42
N2	43	36	31	36	32	39
N3	49	22	28	28	25	24
N4	43	22	17	21	20	30
N5	43	14	14	15	12	23

Notes: Construction Noise Criteria: RBL + 10 dB(A). Exceedences of the Construction Noise Criteria are highlighted in **BOLD**.



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TITLE NOISE SENSITIVE RECEIVERS

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Table 12: Predicted Noise Levels – Plant and Equipment Located within the Southern Part of Each Stage

Receivers	Construction Noise Criteria[1]	Stage 1	Stage 2A	Stage 2B	Stage 3	Stage 4
N1	44	30	36	37	31	26
N2	43	29	25	30	29	28
N3	49	32	33	38	36	34
N4	43	16	12	19	19	18
N5	43	16	16	22	16	15

Notes: Construction Noise Criteria: RBL + 10 dB(A). Exceedences of the Construction Noise Criteria are highlighted in **BOLD.**

As indicated in Tables 11 and 12, compliance with the construction noise criteria is predicted during all Stages at all receivers assuming all plant and equipment are located either in the northern or southern part of each stage.

6.4.2 Operational activities

Tables 13 and 14 set out the predicted Stages 1 to 4 operational noise levels at the closest receivers to the proposed Project, taking into account site layout, distance separation, screening from existing topography, ground and atmospheric absorption, without the implementation of any mitigation measures except that all plant and equipment are assumed to be fitted with appropriate silencers and broadband reversing alarms.

Table 13: Predicted Noise Levels – Plant and Equipment Located within the Northern Part of Each Stage

Receivers	Intrusive Criteria ($L_{Aeq,15min}$)	Amenity Criteria	Stage 1	Stage 2A	Stage 2B	Stage 3	Stage 4
N1	39	65	29	25	36	**41**	**54**
N2	38	65	**43**	**45**	**44**	**43**	36
N3	44	65	25	24	29	27	27
N4	38	65	29	30	35	34	28
N5	38	65	23	27	31	30	19

Notes: Exceedences of the Intrusive Criteria are highlighted in **BOLD.**

Table 14: Predicted Noise Levels – Plant and Equipment Located within Southern Part of Each Stage

Receivers	Intrusive Criteria ($L_{Aeq,15min}$)	Amenity Criteria	Stage 1	Stage 2A	Stage 2B	Stage 3	Stage 4
N1	39	65	30	37	26	27	34
N2	38	65	29	37	29	29	29
N3	44	65	33	31	35	36	36
N4	38	65	17	23	18	19	21
N5	38	65	19	21	22	16	18

Notes: Exceedences of the Intrusive Criteria are highlighted in **BOLD.**

As indicated in Table 13, exceedences of the Intrusive Criteria are predicted during Stages 1, 2A, 2B and 3 at N2 and Stages 3 and 4 at N1 when the plant and equipment is operating within the northern part of each stage.

Whilst a worst case noise level of up to 45 dB(A) is predicted at N2, when compared against the measured daytime ambient L_{Aeq} noise levels (NM2 – unattended range 34-54 dB L_{Aeq}, median 47 dB L_{Aeq}, NM2 & NM5 - attended 49 and 51 dB L_{Aeq} respectively), the predicted noise levels are unlikely to be notable as they are at least 2 dB(A) below the measured ambient levels which included the effects of the current landfill activities.

A worst case noise level of up to 54 dB(A) is predicted at N1 during Stage 4 when the plant and equipment is operating at the northern part of Stage 4 and are likely to be the dominant noise source.

Noise from the operational activities is predicted to comply with the Amenity Criteria at all of the residential receivers during all the operation phases.

It should also be noted that the predicted noise levels are considered to be conservative as all plant and equipment have been assumed to operate concurrently and continuously on the subject site, which is unlikely to be the case under normal operational conditions.

6.4.3 Cumulative impacts

As discussed in 6.1.2, construction and operational activities are expected to be undertaken concurrently at the Whytes Gully RRP. To assess the cumulative effects of the construction and operational activities, all the plant and equipment are assumed to operate simultaneously and continuously. Tables 15 and 16 set out the cumulative predicted Stages 1 to 4 noise levels at the closest receivers to the proposed Project, assuming all plant and equipment are located either at the northern or southern part of each stage.

Because the construction and operational activities will be taking place concurrently, it is appropriate to evaluate the cumulative noise levels against the more permissive construction noise criteria.

Table 15: Predicted Noise Levels – Plant and Equipment Located within Northern Part of Each Stage

Receivers	Construction Noise Criteria[1]	Stage 1	Stage 2A	Stage 2B	Stage 3	Stage 4
N1	44	31	35	38	42	**54**
N2	43	43	**45**	**45**	43	41
N3	49	26	30	32	30	29
N4	43	28	29	35	34	32
N5	43	23	25	32	30	25

Notes: Construction Noise Criteria: RBL + 10 dB(A). Exceedences of the Construction Noise Criteria are highlighted in **BOLD**.

Table 16: Predicted Noise Levels – Plant and Equipment Located within Southern Part of Each Stage

Receivers	Construction Noise Criteria[1]	Stage 1	Stage 2a	Stage 2b	Stage 3	Stage 4
N1	44	33	37	30	33	35
N2	43	39	38	30	30	29
N3	49	34	36	38	38	36
N4	43	24	26	19	20	21
N5	43	21	24	22	18	18

Notes: Construction Noise Criteria: RBL + 10 dB(A). Exceedences of the Construction Noise Criteria are highlighted in **BOLD**.

Exceedences of the construction noise criteria are predicted during stages 2A and 2B at N1 and during stage 4 at N2 when all plant and equipment are located at the northern part of each stage. This assessment indicates that based on the information currently, available, that “highly noise affected” levels are not expected at any residential receivers and therefore respite periods are not proposed.

Exceedences of the proposed performance criteria have been predicted at times at Receivers N1 and N2 when plant and equipment is operating close to the receivers. However, at other times when the plant and equipment are further from the receivers, compliant levels are predicted.

Over the life of the landfill receiver noise levels will vary over the range of the predicted levels depending upon the relative locations of plant and equipment.

Mitigation measures are recommended in Section 6.5.

6.4.4 Construction traffic

The Traffic Impact Assessment Report, GTA Consultants (NSW) Pty Ltd identifies that 8 additional truck movements are expected from the construction activities during each peak hour. In addition, it is expected that up to 12 additional staff will involved in the construction activities with all vehicles arriving during the AM peak hour and depart during the PM peak hour, an additional 12 vehicle movements per hour are assumed.

The NSW RNP criteria apply to new roads or road redevelopments or when there is a land use development with the potential to generate additional traffic on local, sub-arterial or arterial roads and identify a daytime criterion of $L_{Aeq,\ 15\ hr}$ 55 dB. However, attended noise monitoring on 24 November 2011 at NM4 identified an existing daytime road traffic noise level of $L_{Aeq,\ 15\ hr}$ 65 which was attributed to road traffic noise. This indicates that existing road traffic noise levels may be exceeding the NSW RNP criterion by an order of magnitude and there would, therefore be no material benefit to nearby receivers if the proposed road traffic movements were required to comply with the criterion.

Golder considers that a more appropriate assessment methodology would be to determine the potential changes in road traffic noise levels resulting from the proposed construction activities and to consider what if any effects might be generated and nearby receivers using the CRTN road traffic noise calculation methodology (modified for Australian conditions).

Based on the data presented, the predicted increase in traffic noise emissions from Reddalls Road, West Dapto Road and Princes Highway are shown Tables 17 and 18. The additional construction traffic generation is predicted to increase noise emission levels by up to 1-2 dB(A) along Reddalls Road, by no more than 1 dB(A) along West Dapto Road and with no increase along Princes Highway. It should be noted that a change in noise levels of 2-3 dB(A) is the least that is normally detectable to the human ear.

Taking into consideration that there are no residential receivers along this section of Reddalls Road and that the noise levels along West Dapto Road and Princes Highway are predicted to increase by no more than 1 dB(A), negligible adverse effects from increased construction traffic noise are predicted at any of the residential receivers located along West Dapto Road and Princes Highway.

6.4.5 Operational Traffic

As discussed in the Traffic Report of the EA (refer Appendix I of the EA) and Chapter 15 of the EA operational traffic movements will not change from current levels as a result of the Project, as the Project does not propose to increase the annual volume of material received at the site beyond what has historically been accepted at the site.

Tables 17 and 18 identify that even in close proximity to the landfill site the peak levels of construction vehicle activity will not materially affect road traffic noise levels and it can, therefore, be reasonably assumed that further from the site where construction and operational landfill traffic vehicle numbers will dissipate and higher levels of overall road traffic activity can be expected there will be no effective increase in road traffic noise levels resulting from the proposed activities.

Table 17: Predicted Traffic Noise Emission Increase – AM Peak Hour

Road	Existing Traffic	% HV	Additional Construction Traffic – Light	Additional Construction Traffic – HV	Existing Road Traffic Noise Level (L_{Aeq} dB)	Road Traffic Noise Level Including Construction Traffic (L_{Aeq} dB)	Predicted Noise Increased
Reddalls Road	92	33.7%	12	8	67	68	1
West Dapto Road (West of Reddalls Road)	225	3.6%	0	0	66	66	0
West Dapto Road (East of Reddalls Road)	311	12.5%	12	8	69	70	1 (0.5)
Princes Highway (South of West Dapto Road)	726	2.9%	3	1	71	71	0 (< 0.5)
Princes Highway (North of West Dapto Road)	990	5.5%	9	7	73	73	0 (< 0.5)

Table 18: Predicted Traffic Noise Emission Increase – PM Peak Hour

Road	Existing Traffic	% HV	Additional Construction Traffic – Light	Additional Construction Traffic – HV	Existing Road Traffic Noise Level (L_{Aeq} dB)	Road Traffic Noise Level Including Construction Traffic (L_{Aeq} dB)	Predicted Noise Increased
Reddalls Road	75	6.7%	12	8	62	64	2
West Dapto Road (West of Reddalls Road)	241	1.2%	0	0	66	66	0
West Dapto Road (East of Reddalls Road)	300	2.7%	12	8	67	68	1 (0.8)
Princes Highway (South of West Dapto Road)	800	1.25%	3	1	72	72	0 (< 0.5)
Princes Highway (North of West Dapto Road)	1063	2%	9	7	72	72	0 (< 0.5)

6.5 Mitigation Options

The worst case cumulative effects of noise from the construction and operation activities are predicted to result in exceedences of the established criteria at receiver N2 by up to 2 dB(A) during phases 2A and 2B and by up to 10 dB(A) at receiver N1 during phase 4.

Section 10 of the INP specifically sets out a process for existing industrial premises that are looking to "upgrade or expand" such as Whytes Gully RRP and the Project. It is considered implementation of the Project will include this process including consideration of feasible and reasonable noise mitigation strategies and potential negotiation with management practise would be utilised to manage and control noise impacts of the Project at the source. In addition consultation with the nearby affected residential receivers is proposed to assist in reducing uncertainty, misconceptions and adverse reaction to noise. It should be noted that receivers N1 and N2 are currently exposed to noise associated with the existing Whytes Gully RRP and the proposed Project will not materially alter the existing acoustic amenity of the surrounding sensitive receivers when compared to the historic landfill activities.

Consultation and cooperation with the nearby affected residential receivers will assist in minimising uncertainty, misconceptions and adverse reaction to noise. The following community relation measures could be implemented:

- Establish contact with residents who may be affected by construction and operational noise exceedences in accordance with the INP and communicate details of the construction and operational program on a regular basis;
- Provide a community liaison phone number and permanent site contact so that noise complaints can be received and address in a timely manner; and
- Respond to any noise complaints, in a timely manner with monitoring undertaken and reported as appropriate.

Refer to the relevant Noise Chapter and Statement of Commitments within the Environmental Assessment documentation for further detail on mitigation measures of the Project.

7.0 CONCLUSIONS

This report has assessed the potential noise of the Project. Noise modelling has been used to predict the noise associated with the operation of the landfill extension.

Golder considers that the urban/industrial interface amenity category of the INP is appropriate for assessment as the most affected receivers would be located within a contour delineating a 5 dB reduction in noise levels from those at the site boundary and the Project activities are a continuation of an existing process in an area where the subject premises are operational during the day and are the main noise source during the day.

Results from the modelling suggest that the cumulative Project noise would exceed the Construction Noise Criteria at the two closest residential receivers located to the north-east and north-west of the subject site (receivers N1 and N2).

Whilst it has been identified that the proposed Project will not materially affect the existing acoustic amenity of the surrounding sensitive receivers when compared to the historic landfill activities, a number of options have been identified that would further control the effects of noise and/or achieve compliant levels at all receivers, throughout the life of the Project. In accordance with the INP these would be discussed with the regulator and likely with the affected residences and potentially include:

- Use of reduced noise emission plant and equipment;
- Use of acoustic screening;
- Liaison with the local community to provide information and respond to noise concerns.

APPENDIX A

Report Limitations

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This Document has been provided by Golder Associates (NZ) Ltd ("Golder") subject to the following limitations:

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(ii). The scope and the period of Golder's Services are as described in Golder's proposal, and are subject to restrictions and limitations. Golder did not perform a complete assessment of all possible conditions or circumstances that may exist at the site referenced in the Document. If a service is not expressly indicated, do not assume it has been provided. If a matter is not addressed, do not assume that any determination has been made by Golder in regards to it.

(iii). Conditions may exist which were undetectable given the limited nature of the enquiry Golder was retained to undertake with respect to the site. Variations in conditions may occur between investigatory locations, and there may be special conditions pertaining to the site which have not been revealed by the investigation and which have not therefore been taken into account in the Document. Accordingly, additional studies and actions may be required.

(iv). In addition, it is recognised that the passage of time affects the information and assessment provided in this Document. Golder's opinions are based upon information that existed at the time of the production of the Document. It is understood that the Services provided allowed Golder to form no more than an opinion of the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings, or any laws or regulations.

(v). Any assessments made in this Document are based on the conditions indicated from published sources and the investigation described. No warranty is included, either express or implied, that the actual conditions will conform exactly to the assessments contained in this Document.

(vi). Where data supplied by the client or other external sources, including previous site investigation data, have been used, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by Golder for incomplete or inaccurate data supplied by others.

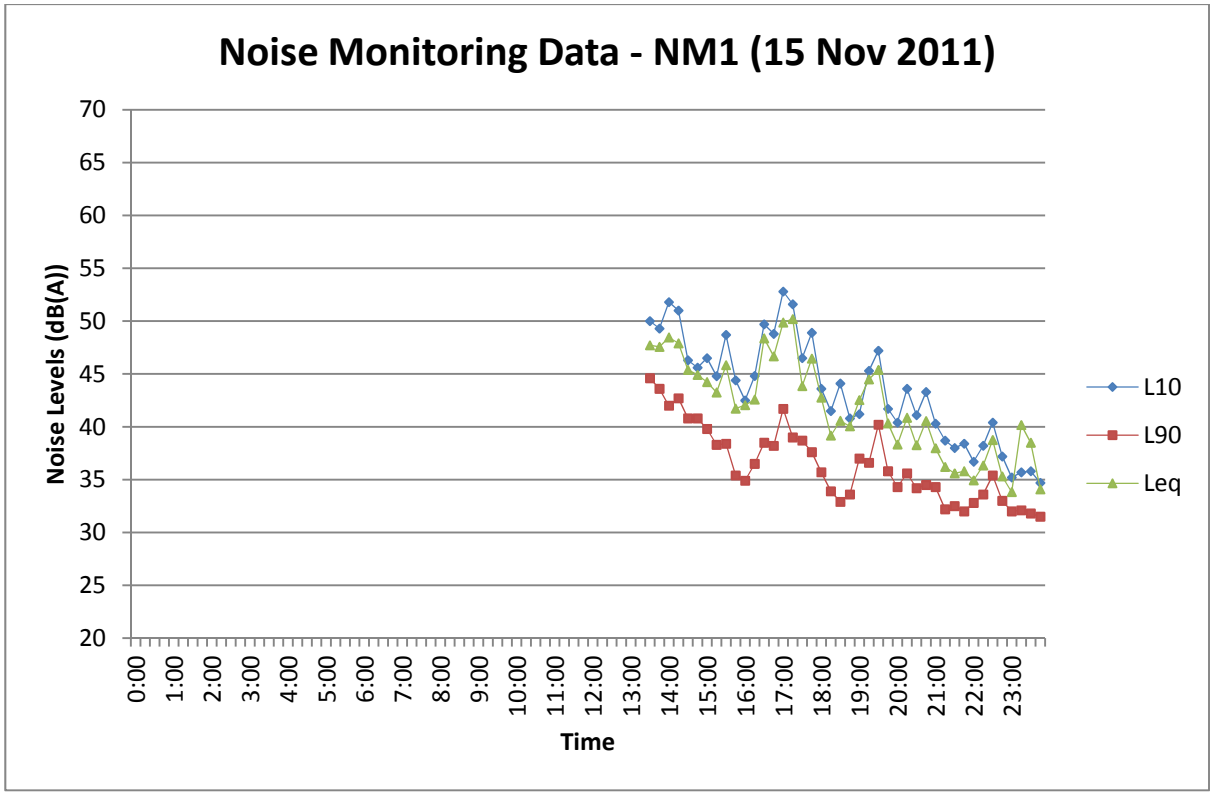
(vii). The Client acknowledges that Golder may have retained subconsultants affiliated with Golder to provide Services for the benefit of Golder. Golder will be fully responsible to the Client for the Services and work done by all of its subconsultants and subcontractors. The Client agrees that it will only assert claims against and seek to recover losses, damages or other liabilities from Golder and not Golder's affiliated companies. To the maximum extent allowed by law, the Client acknowledges and agrees it will not have any legal recourse, and waives any expense, loss, claim, demand, or cause of action, against Golder's affiliated companies, and their employees, officers and directors.

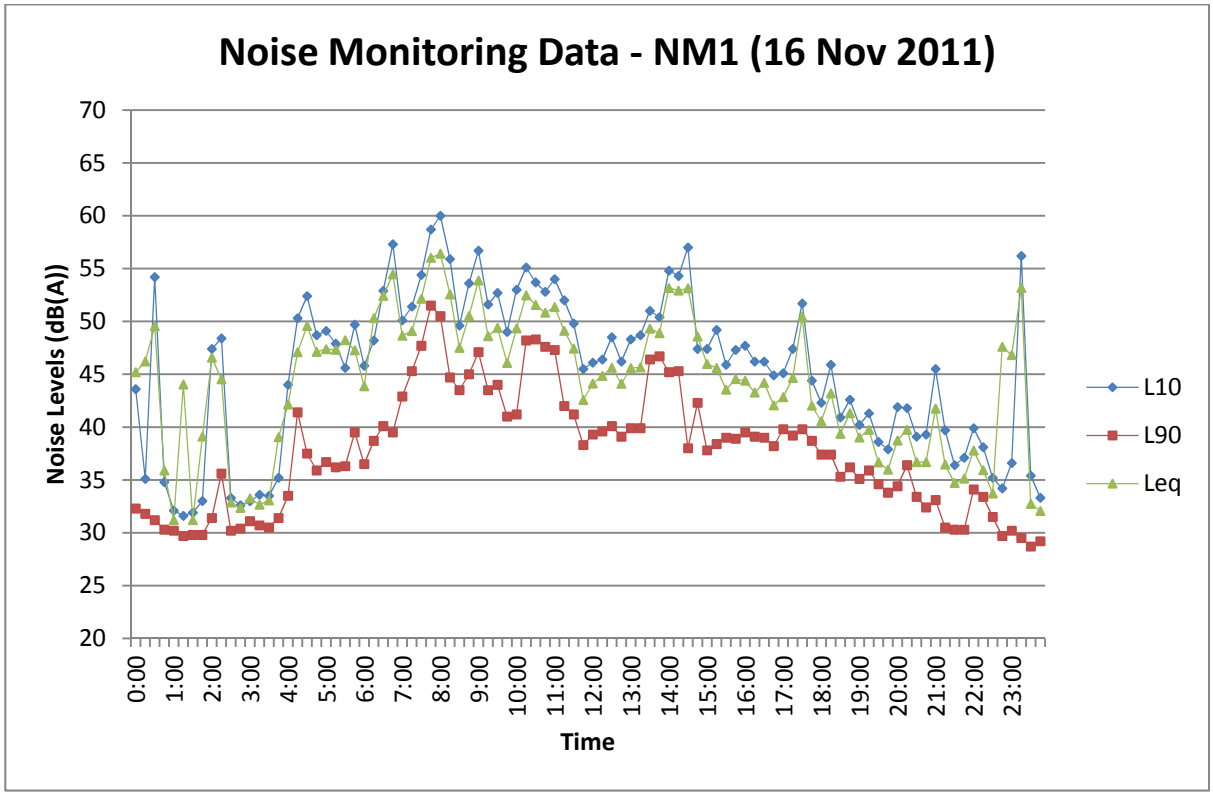
(viii). This Document is provided for sole use by the Client and is confidential to it and its professional advisers. No responsibility whatsoever for the contents of this Document will be accepted to any person other than the Client. Any use which a third party makes of this Document, or any reliance on or decisions to be made based on it, is the responsibility of such third parties. Golder accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this Document.

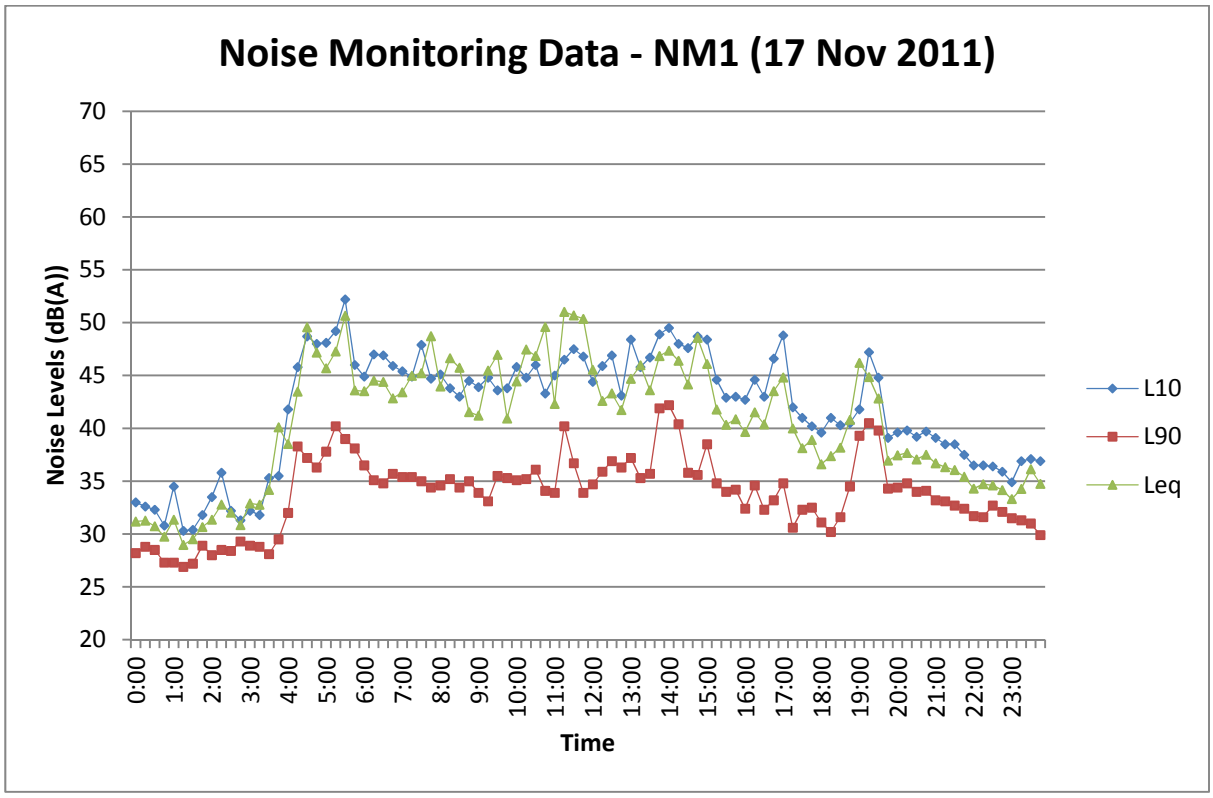
APPENDIX B

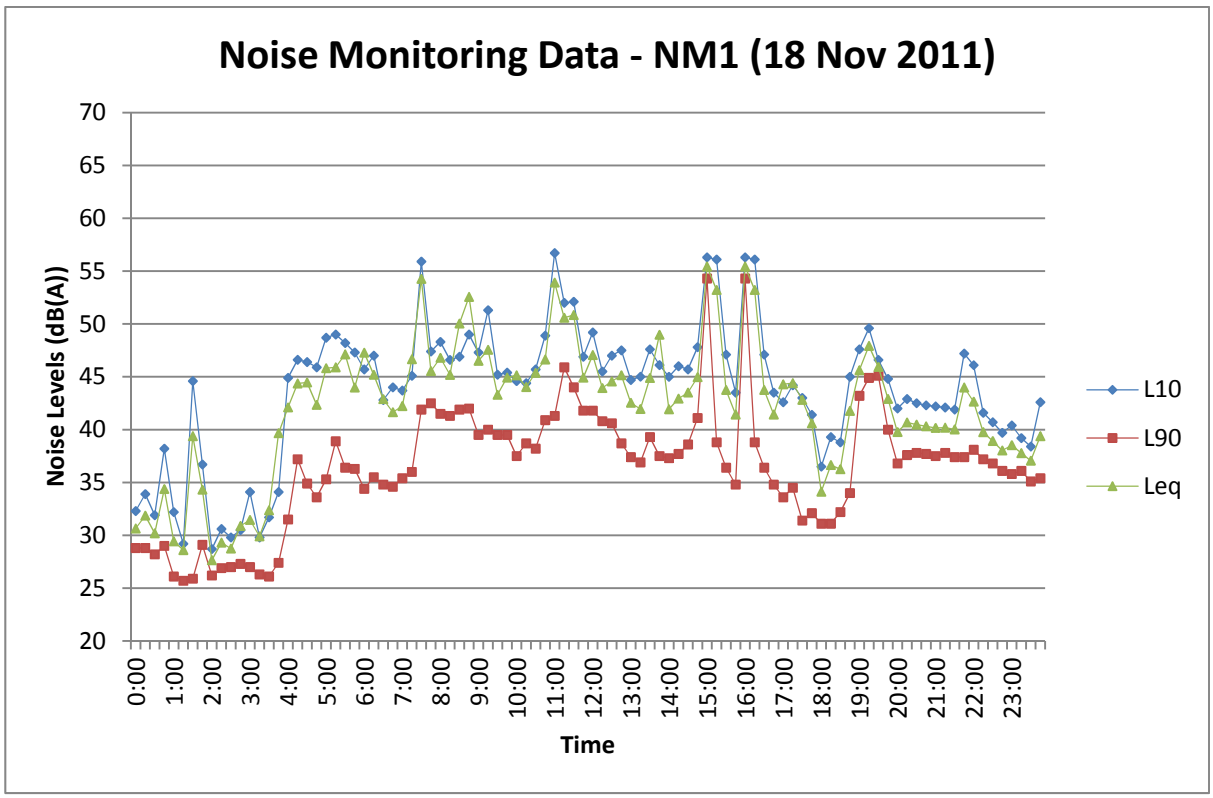
Ambient Noise Monitoring Data

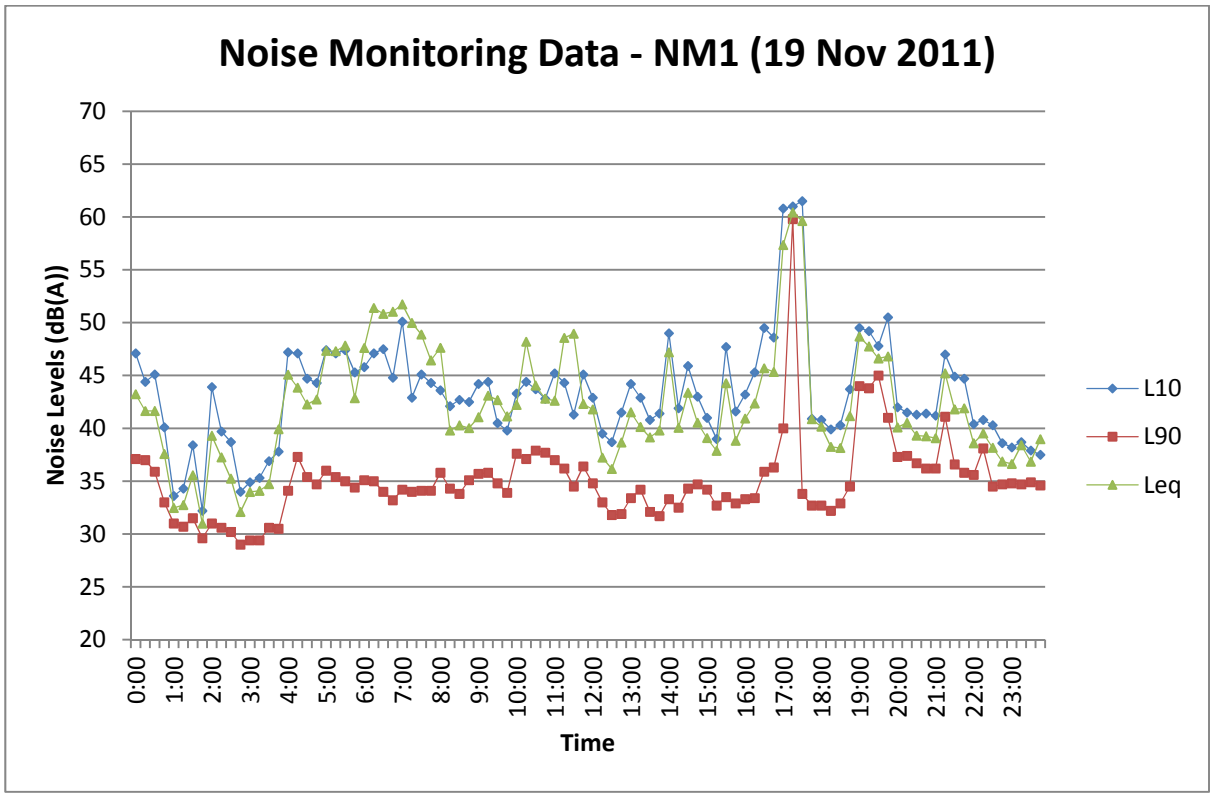
NM1

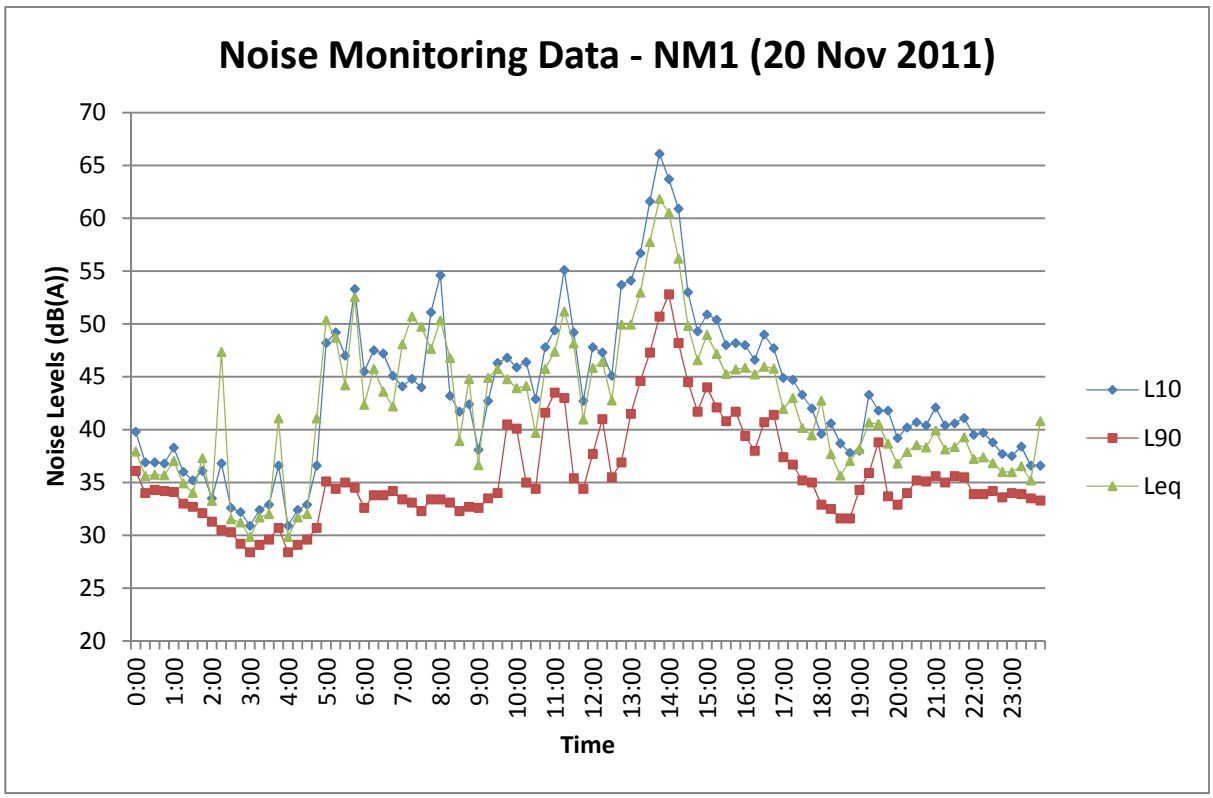

Noise Monitoring Data - NM1 (15 Nov 2011)
Noise Levels (dB(A))
70
65
60
55
50
45
40
35
30
25
20
0:00
1:00
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21:00
22:00
23:00
Time
L10
L90
Leq

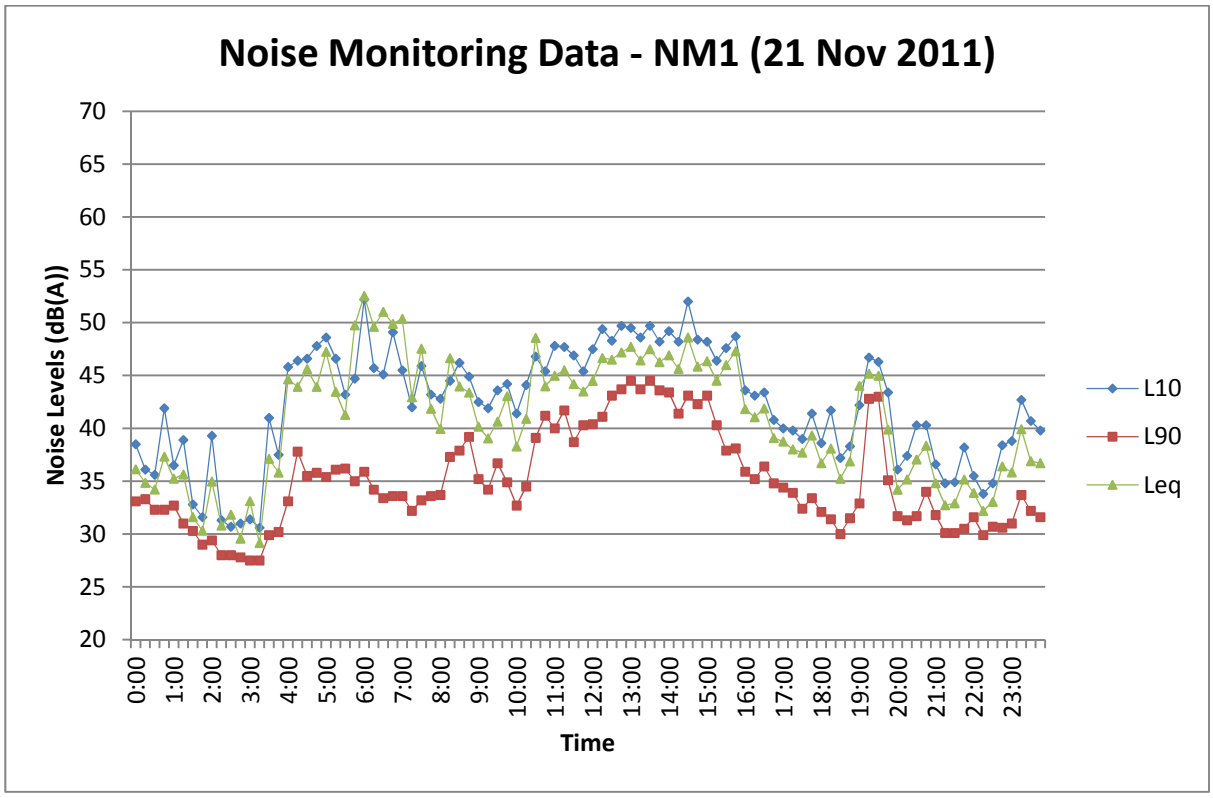

Noise Monitoring Data - NM1 (16 Nov 2011)
Noise Levels (dB(A))
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65
60
55
50
45
40
35
30
25
20
0:00
1:00
2:00
3:00
4:00
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22:00
23:00
Time
L10
L90
Leq

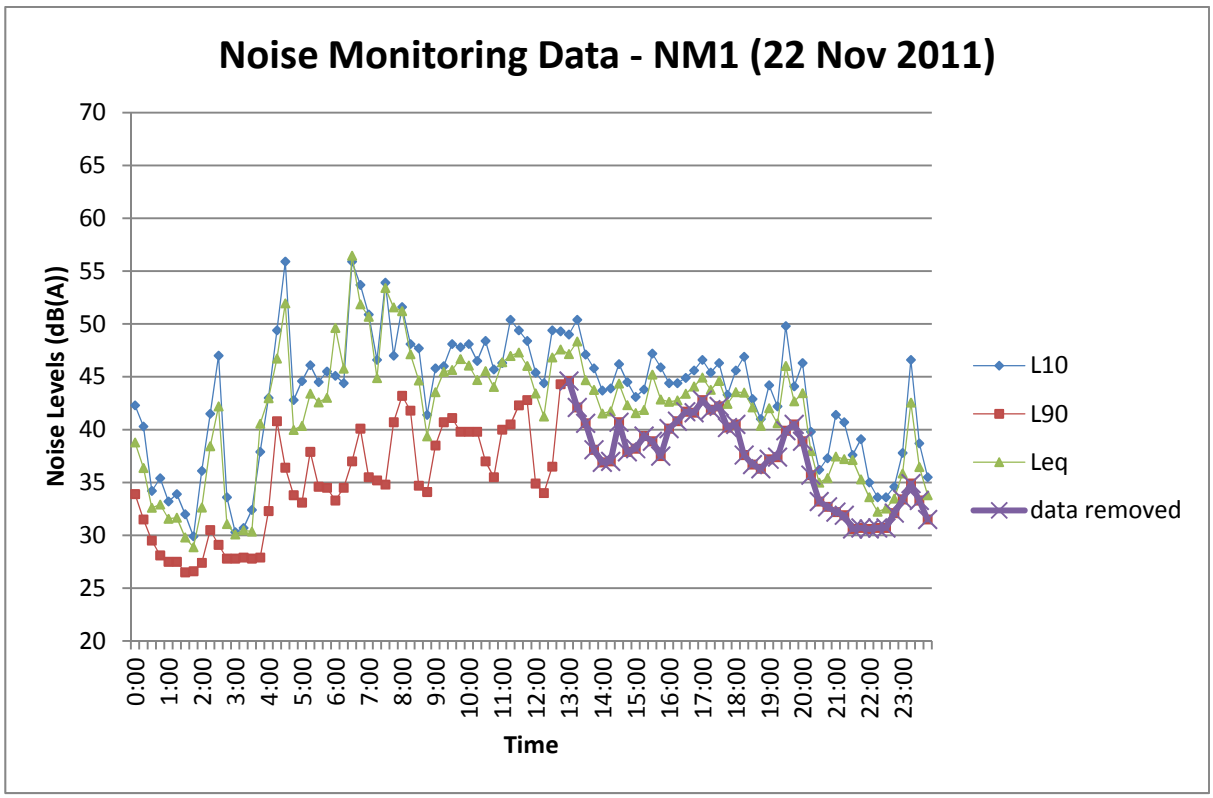

Noise Monitoring Data - NM1 (17 Nov 2011)
Noise Levels (dB(A))
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65
60
55
50
45
40
35
30
25
20
0:00
1:00
2:00
3:00
4:00
5:00
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22:00
23:00
Time
L10
L90
Leq

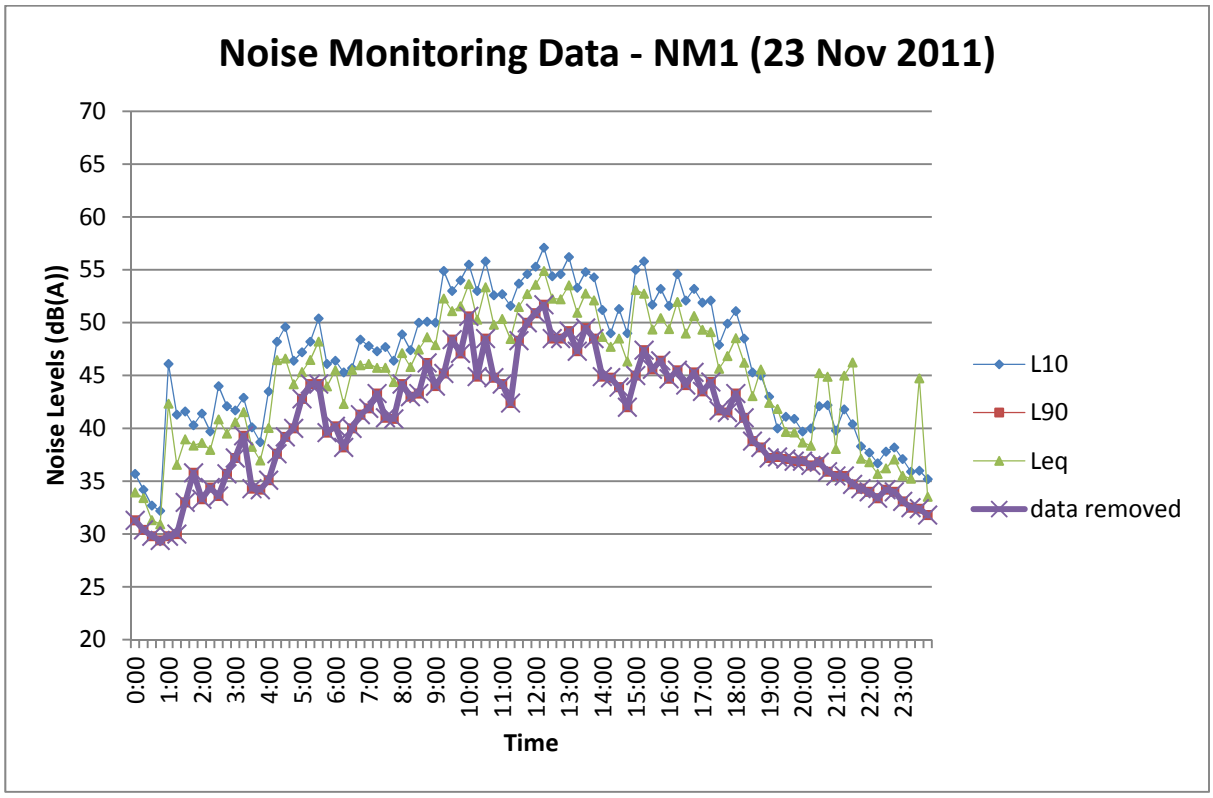

Noise Monitoring Data - NM1 (18 Nov 2011)
Noise Levels (dB(A))
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55
50
45
40
35
30
25
20
0:00
1:00
2:00
3:00
4:00
5:00
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22:00
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Time
L10
L90
Leq

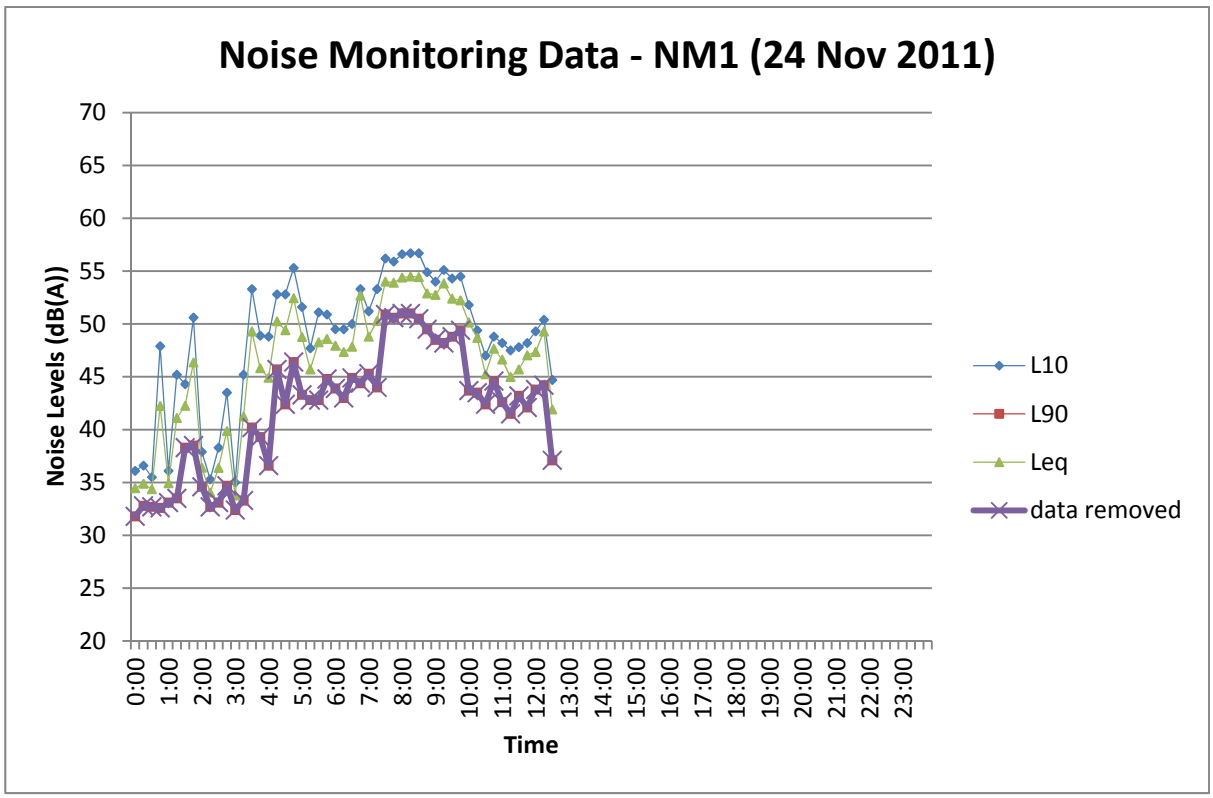

Noise Monitoring Data - NM1 (19 Nov 2011)
Noise Levels (dB(A))
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65
60
55
50
45
40
35
30
25
20
0:00
1:00
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19:00
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21:00
22:00
23:00
Time
L10
L90
Leq


Noise Monitoring Data - NM1 (20 Nov 2011)
Noise Levels (dB(A))
70
65
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45
40
35
30
25
20
0:00
1:00
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4:00
5:00
6:00
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11:00
12:00
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22:00
23:00
Time
L10
L90
Leq

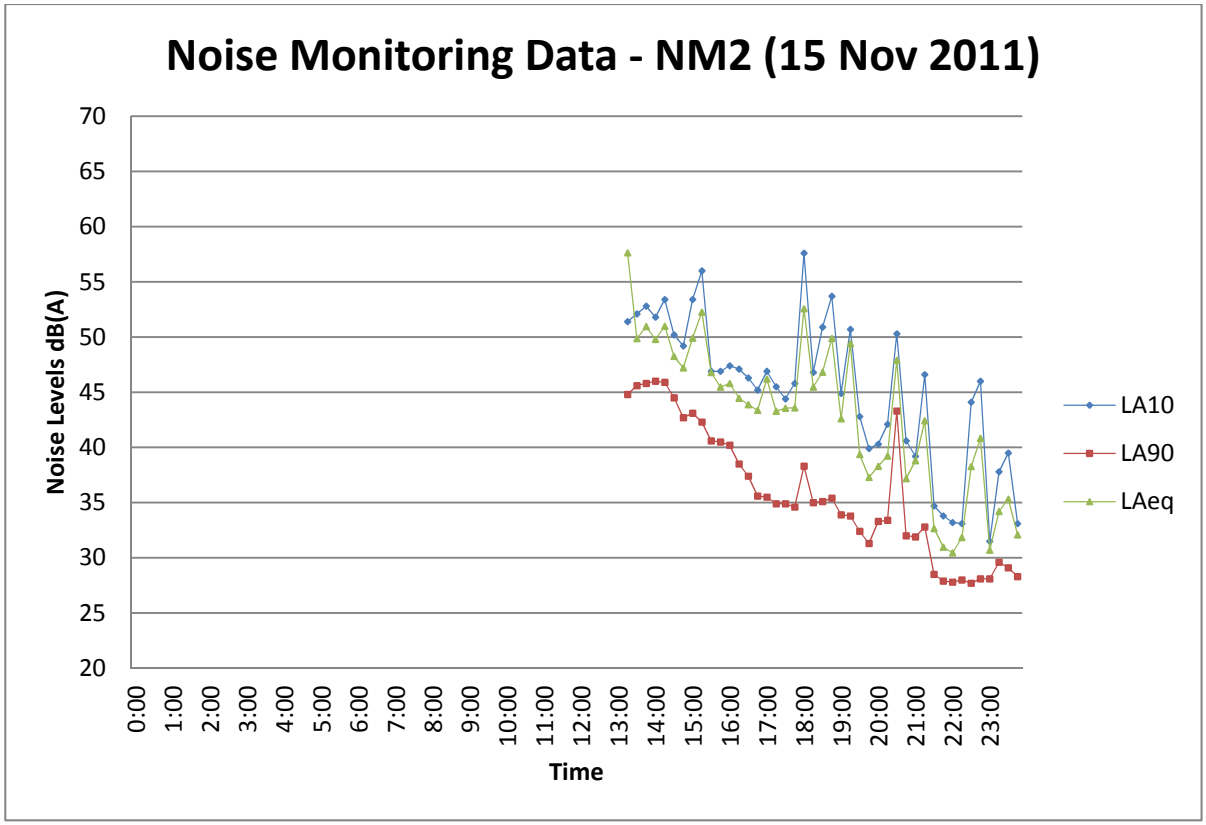

Noise Monitoring Data - NM1 (21 Nov 2011)
Noise Levels (dB(A))
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60
55
50
45
40
35
30
25
20
0:00
1:00
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22:00
23:00
Time
L10
L90
Leq

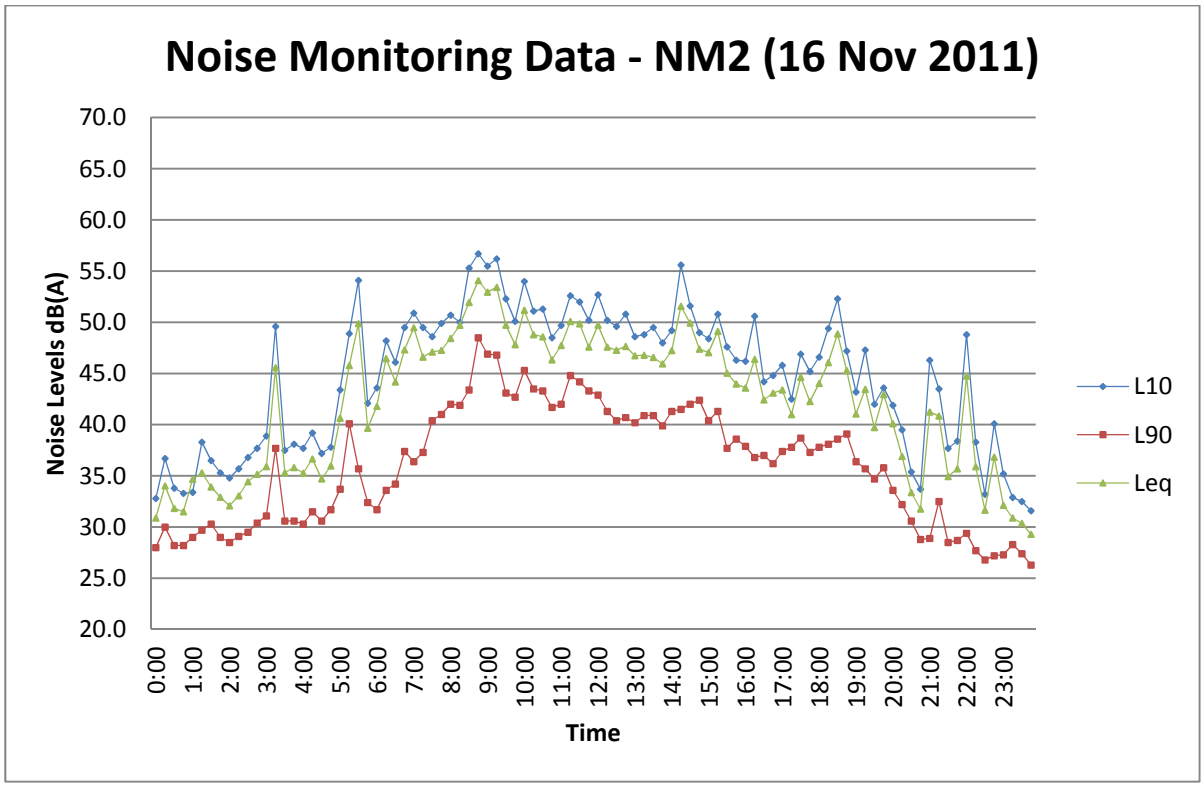

Noise Monitoring Data - NM1 (22 Nov 2011)
Noise Levels (dB(A))
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45
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35
30
25
20
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14:00
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21:00
22:00
23:00
Time
L10
L90
Leq
data removed

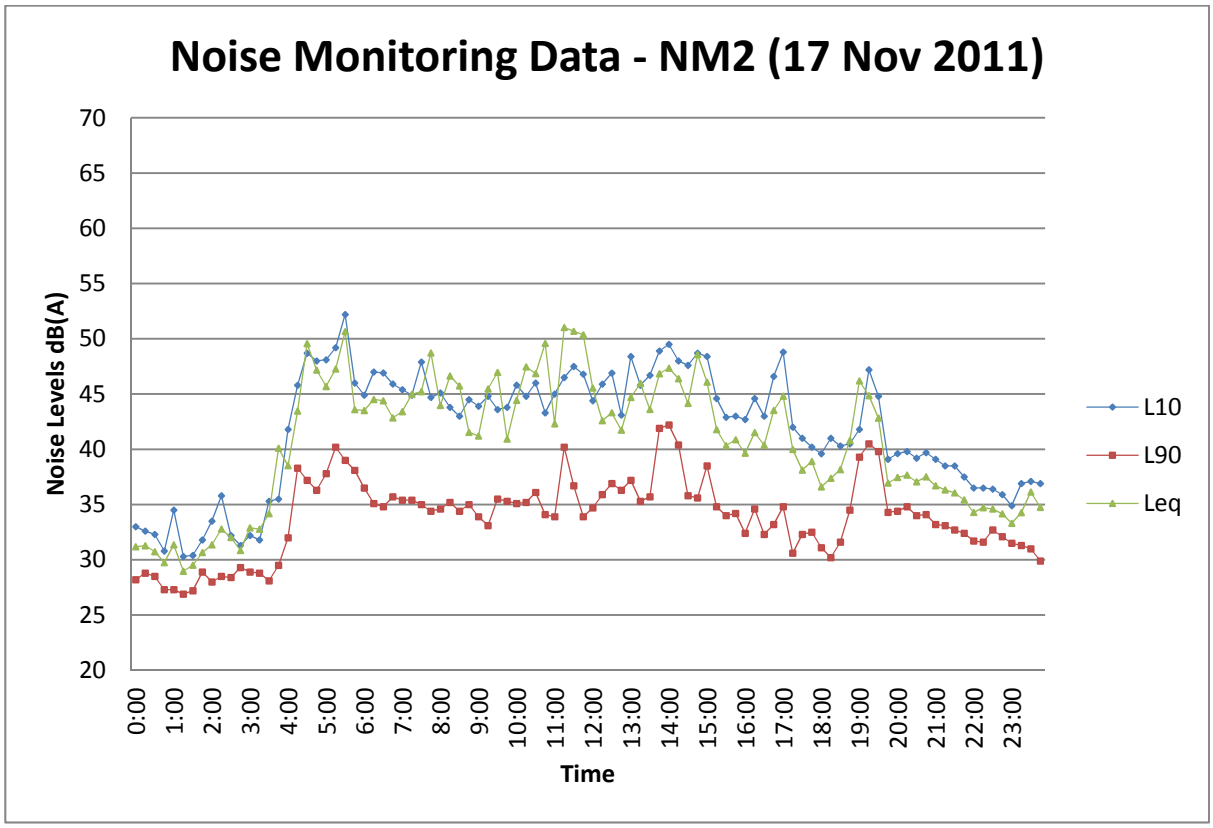

Noise Monitoring Data - NM1 (23 Nov 2011)
Noise Levels (dB(A))
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55
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45
40
35
30
25
20
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22:00
23:00
Time
L10
L90
Leq
data removed

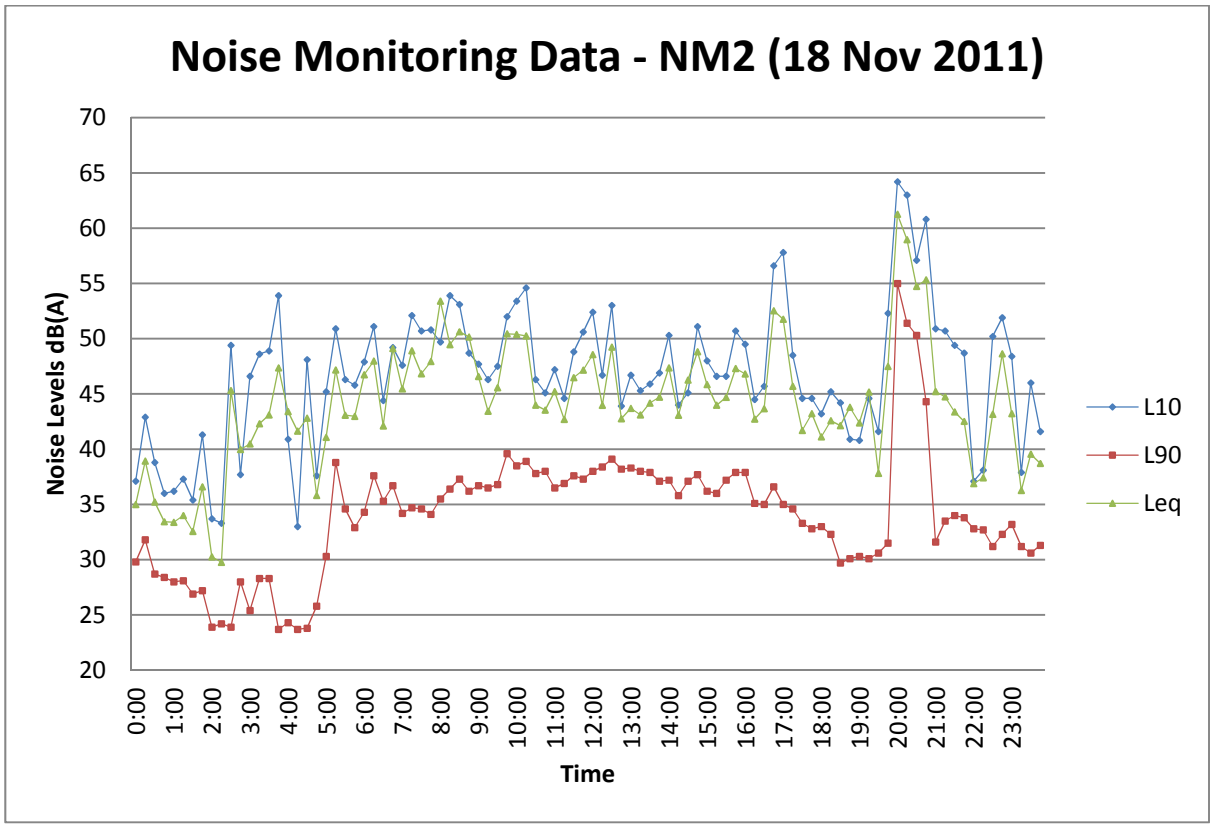

Noise Monitoring Data - NM1 (24 Nov 2011)
Noise Levels (dB(A))
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35
30
25
20
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1:00
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3:00
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14:00
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18:00
19:00
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21:00
22:00
23:00
Time
L10
L90
Leq
data removed

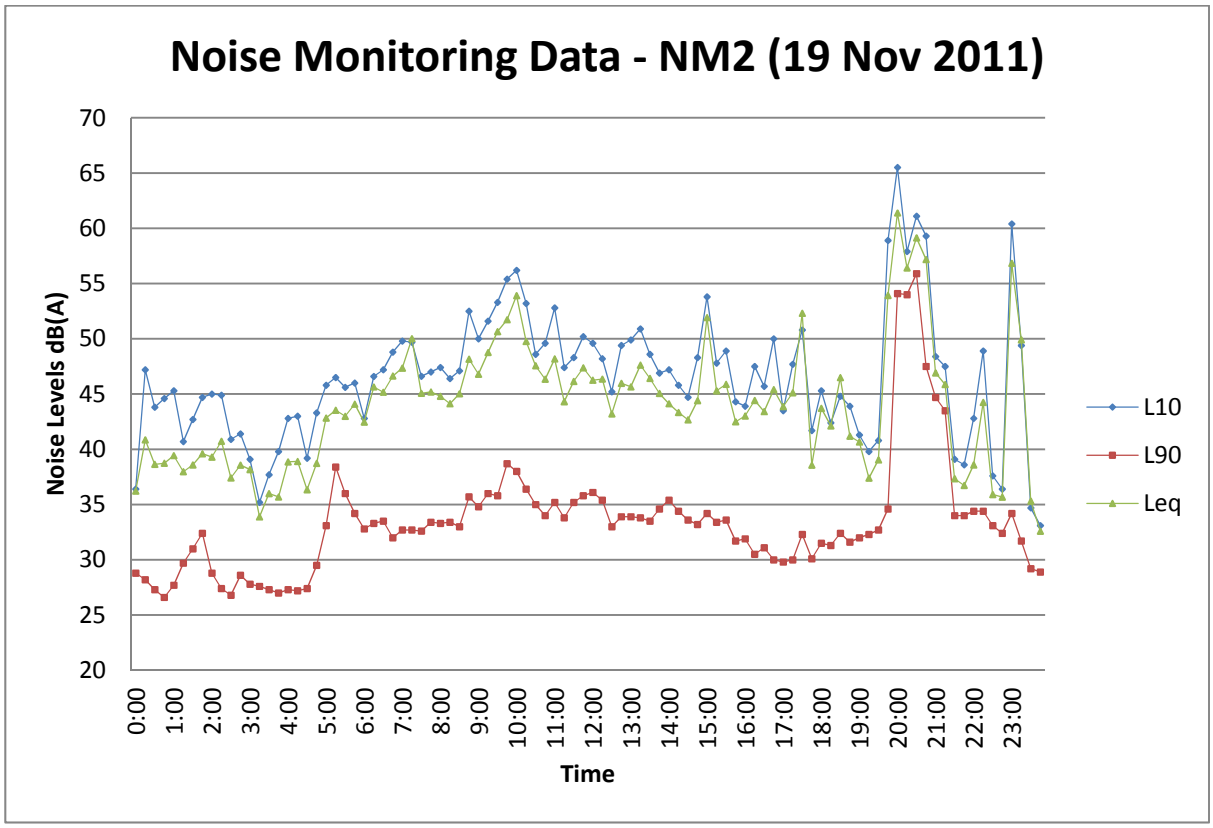
NM2

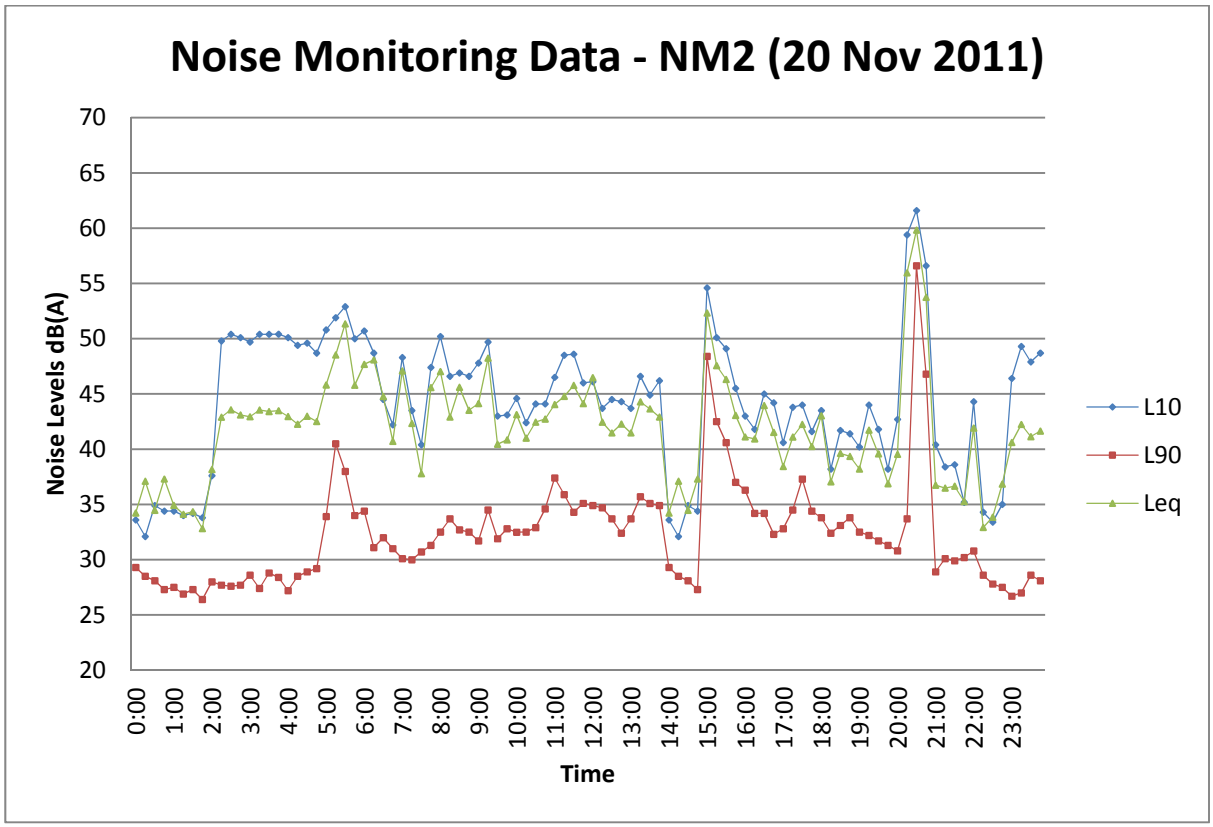

Noise Monitoring Data - NM2 (15 Nov 2011)
Noise Levels dB(A)
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55
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35
30
25
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22:00
23:00
Time
LA10
LA90
LAeq

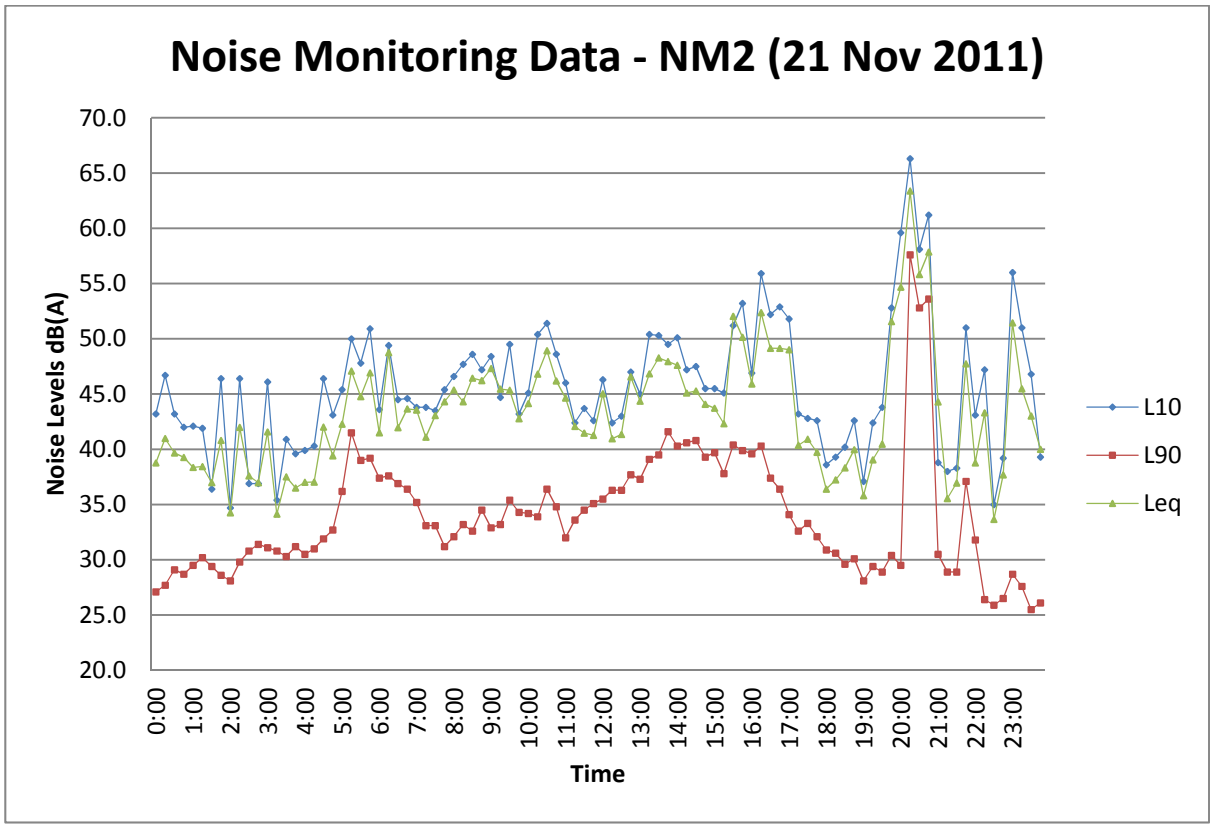

Noise Monitoring Data - NM2 (16 Nov 2011)
Noise Levels dB(A)
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50.0
45.0
40.0
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Time
L10
L90
Leq

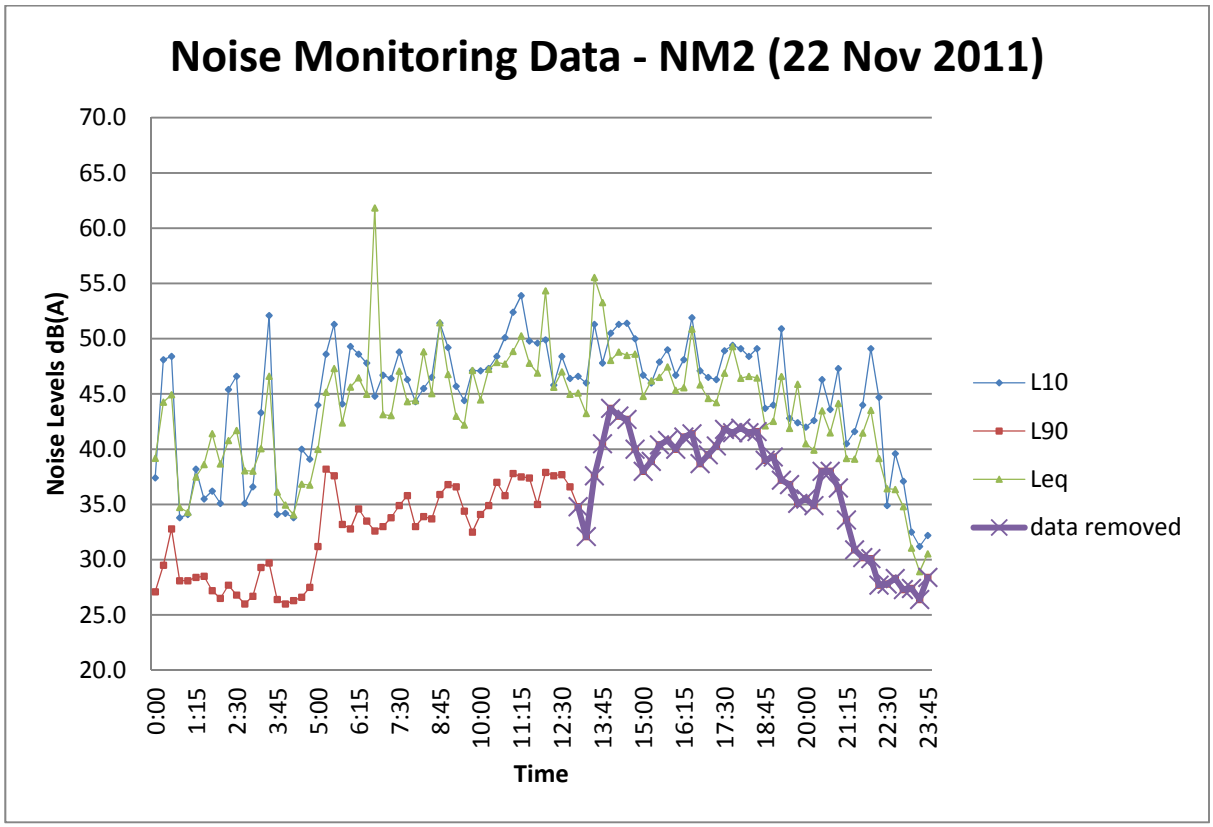

Noise Monitoring Data - NM2 (17 Nov 2011)
Noise Levels dB(A)
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55
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45
40
35
30
25
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L10
L90
Leq

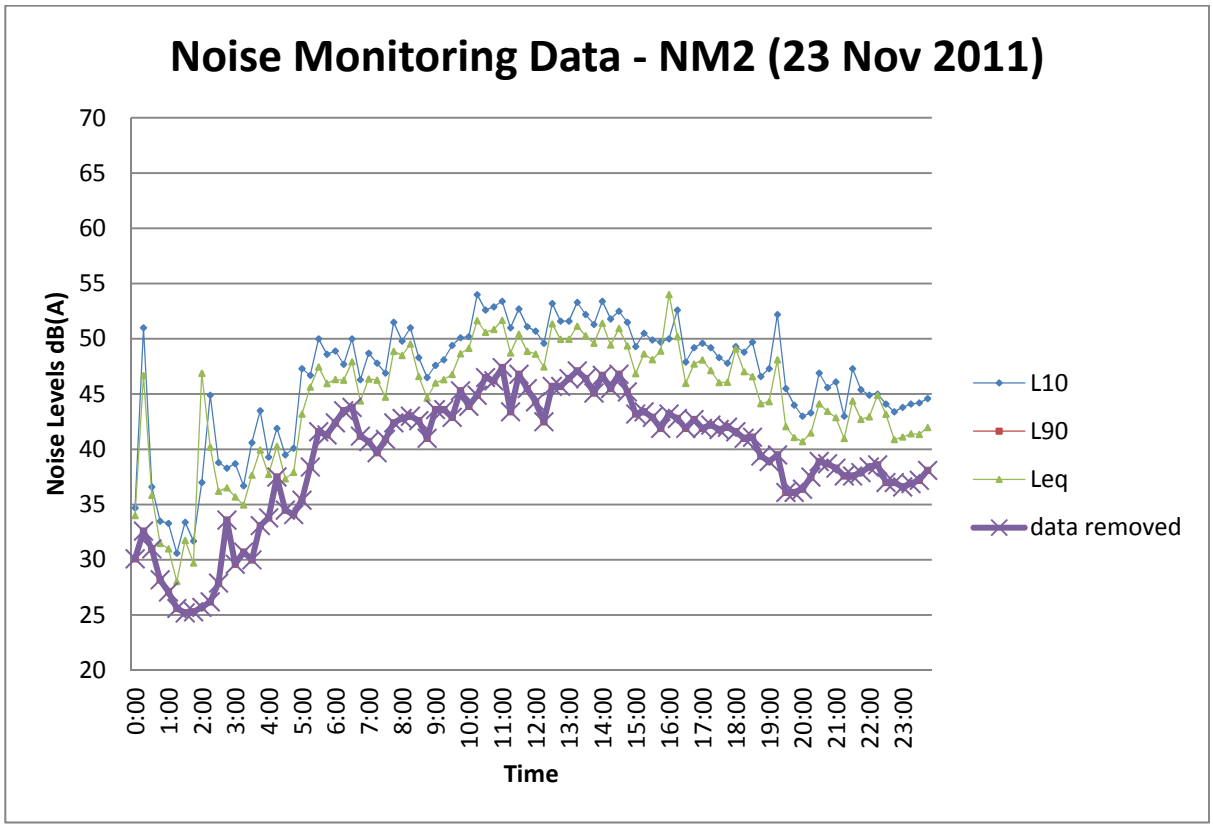

Noise Monitoring Data - NM2 (18 Nov 2011)
Noise Levels dB(A)
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22:00
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Time
L10
L90
Leq

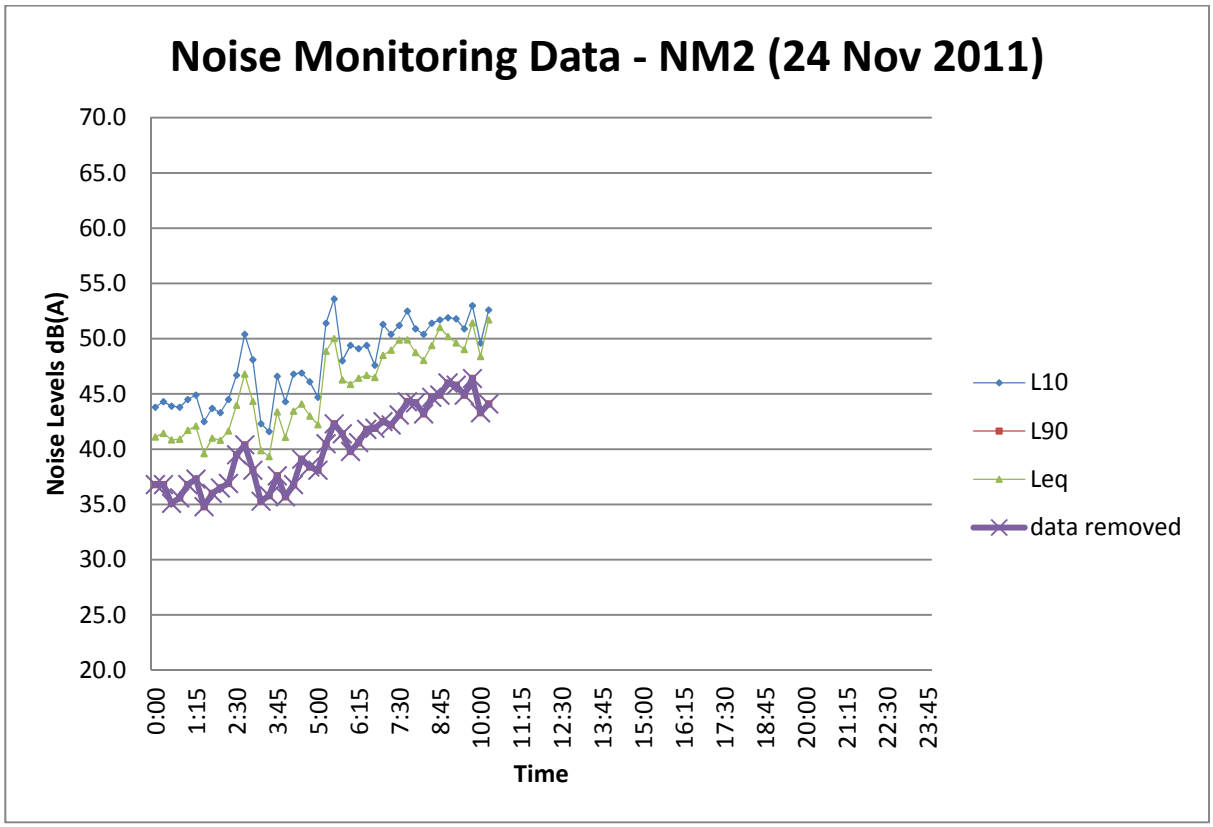

Noise Monitoring Data - NM2 (19 Nov 2011)
Noise Levels dB(A)
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35
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25
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13:00
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15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Time
L10
L90
Leq


Noise Monitoring Data - NM2 (20 Nov 2011)
Noise Levels dB(A)
70
65
60
55
50
45
40
35
30
25
20
0:00
1:00
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Time
L10
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Leq

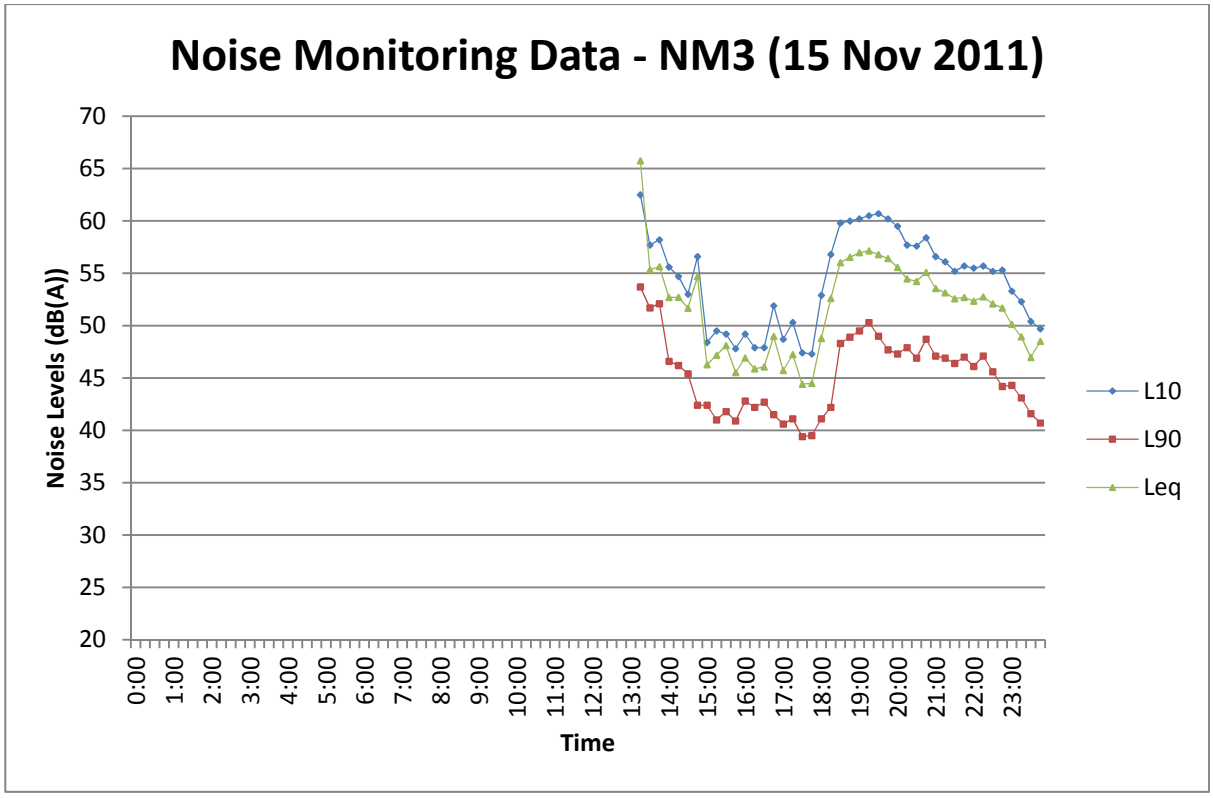

Noise Monitoring Data - NM2 (21 Nov 2011)
Noise Levels dB(A)
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13:00
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Time
L10
L90
Leq

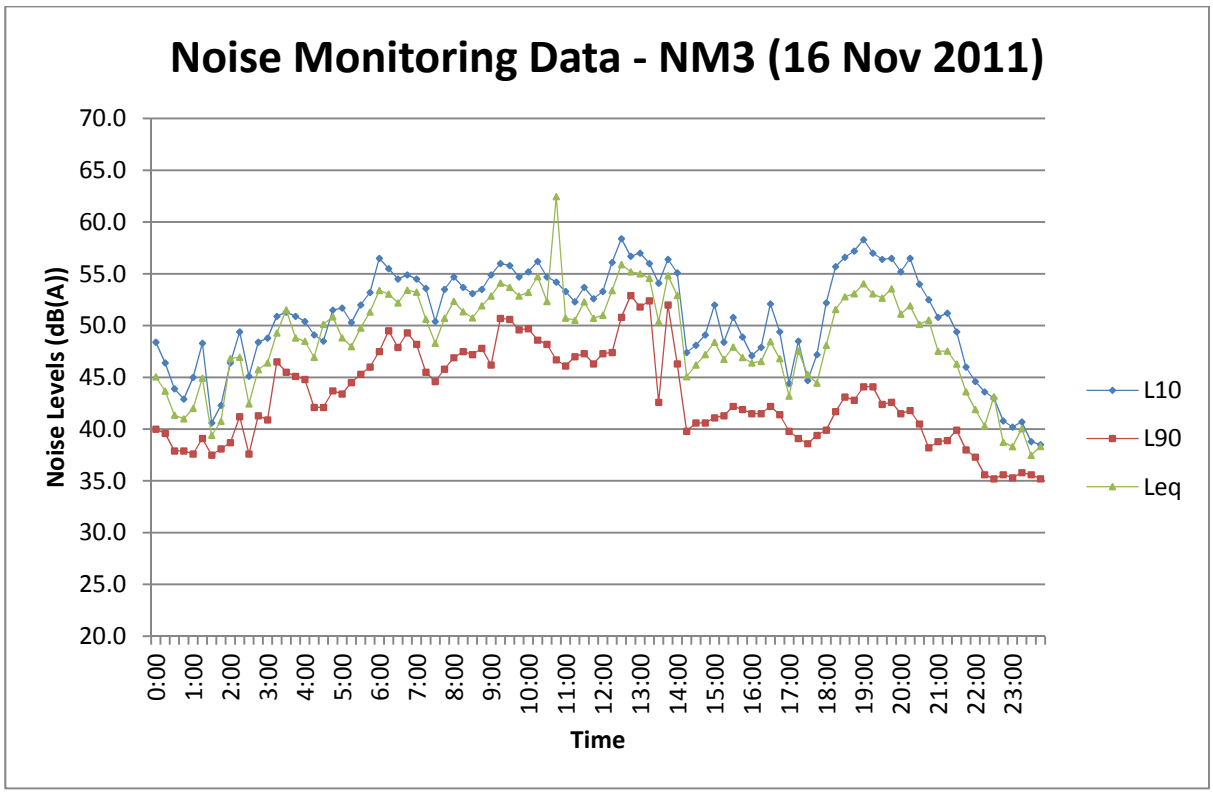

Noise Monitoring Data - NM2 (22 Nov 2011)
Noise Levels dB(A)
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L90
Leq
data removed

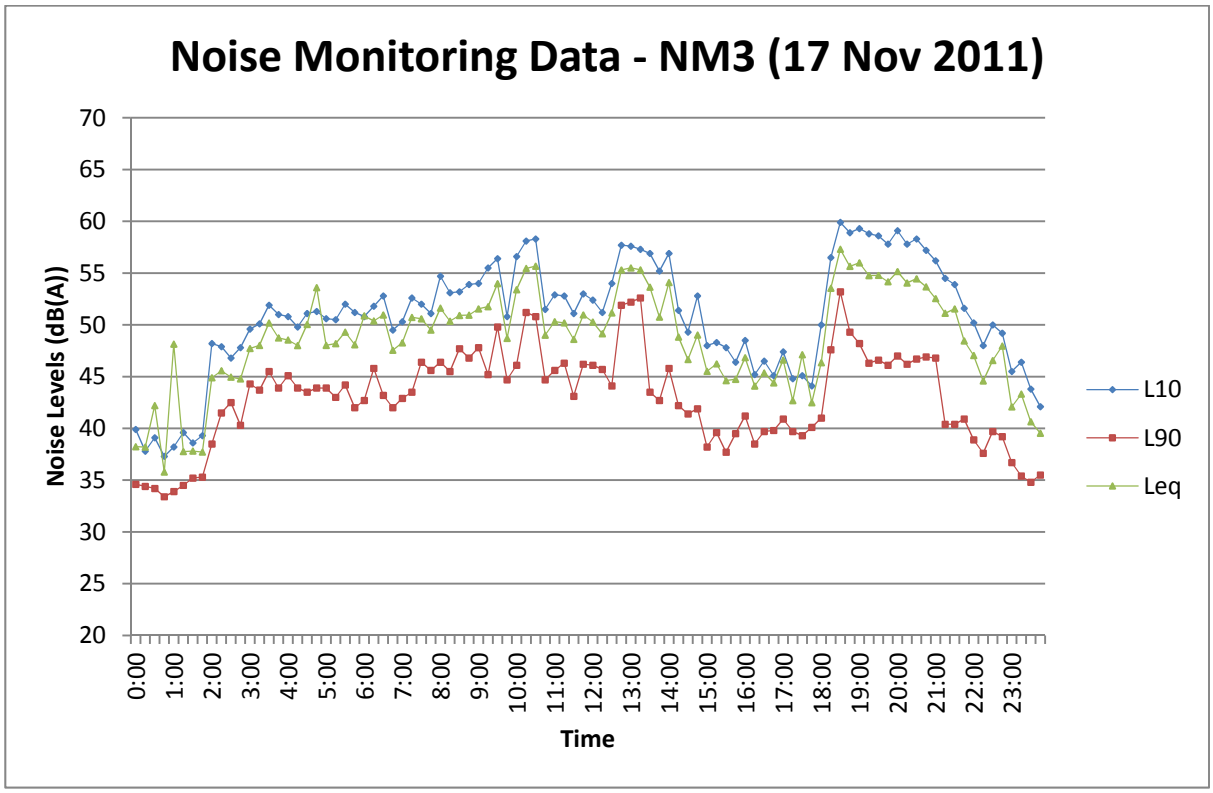

Noise Monitoring Data - NM2 (23 Nov 2011)
Noise Levels dB(A)
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50
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40
35
30
25
20
0:00
1:00
2:00
3:00
4:00
5:00
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12:00
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14:00
15:00
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23:00
Time
L10
L90
Leq
data removed

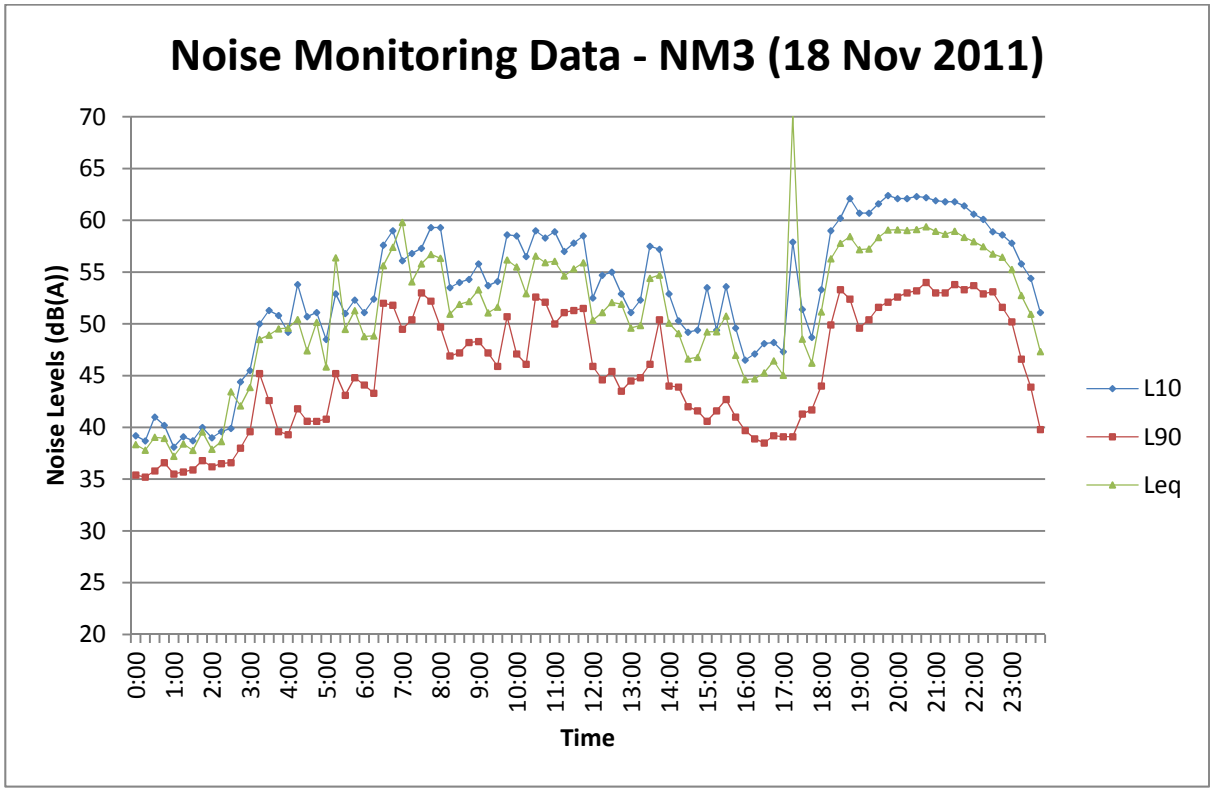

Noise Monitoring Data - NM2 (24 Nov 2011)
Noise Levels dB(A)
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50.0
45.0
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25.0
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0:00
1:15
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13:45
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23:45
Time
L10
L90
Leq
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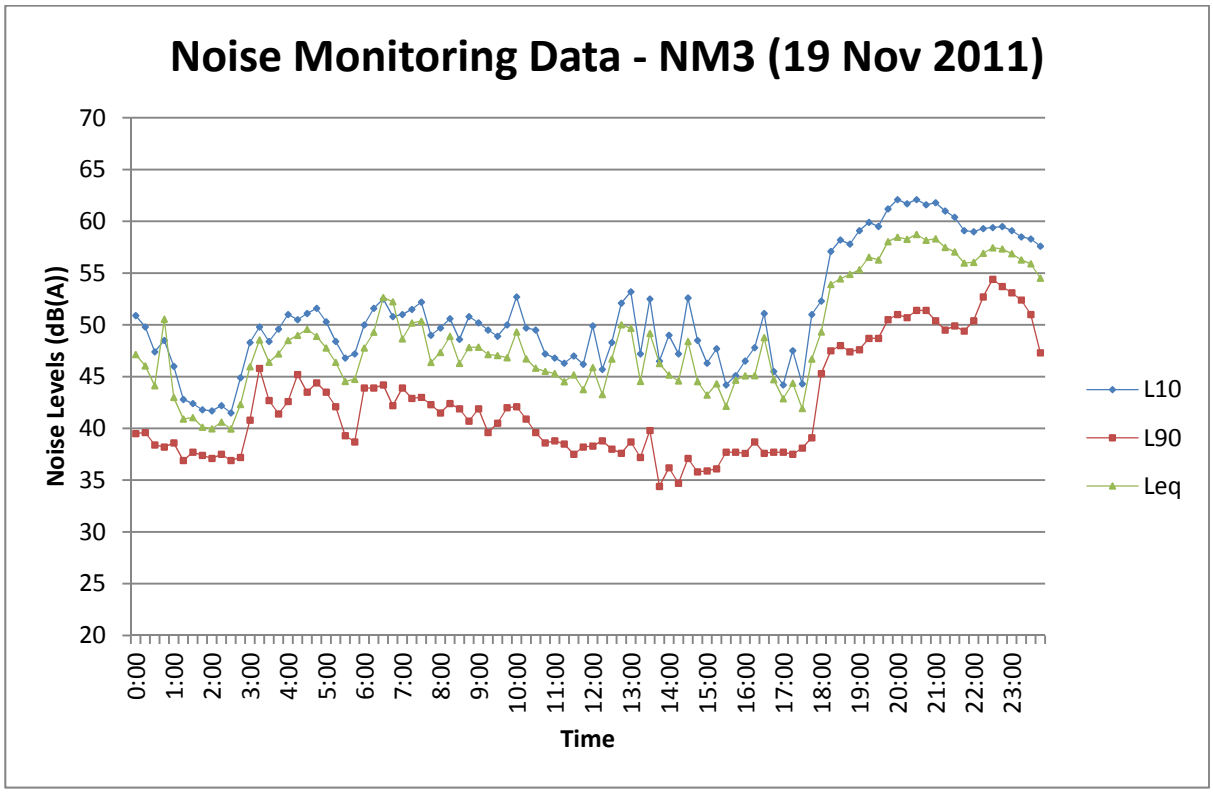
NM3

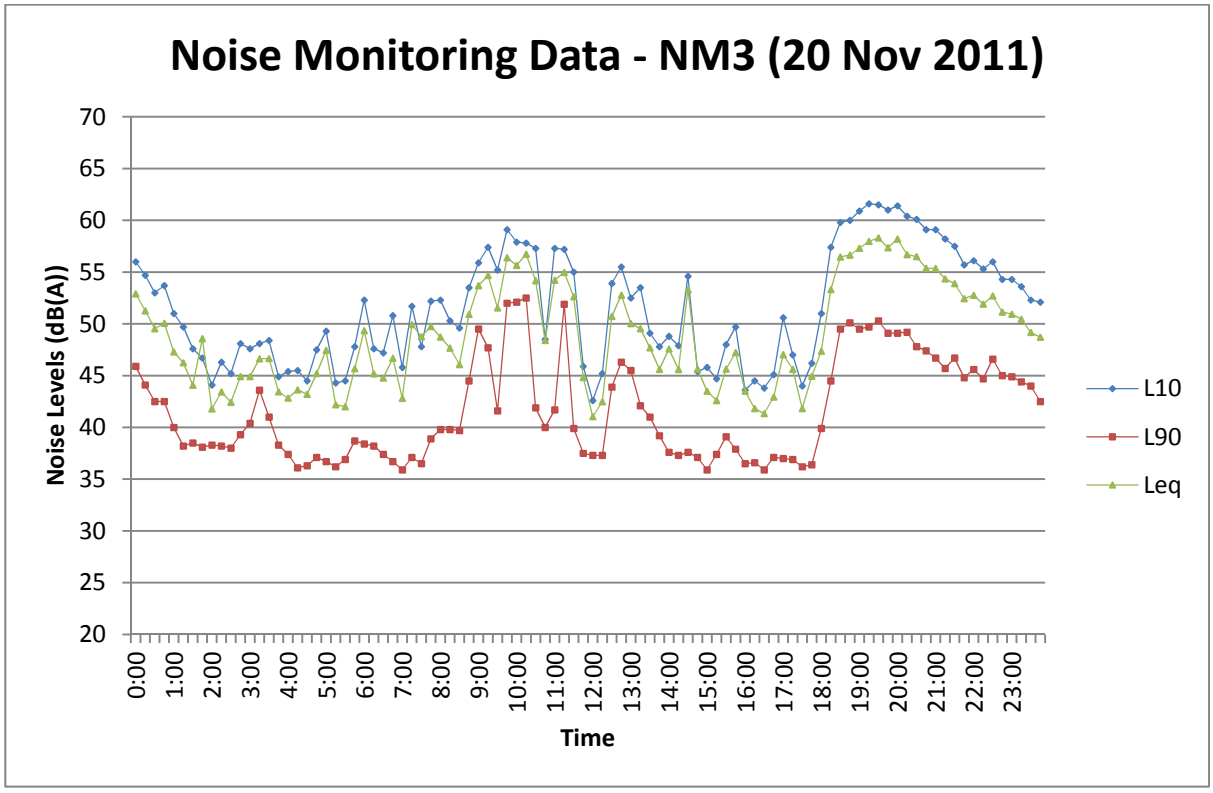

Noise Monitoring Data - NM3 (15 Nov 2011)
Noise Levels (dB(A))
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23:00
Time
L10
L90
Leq

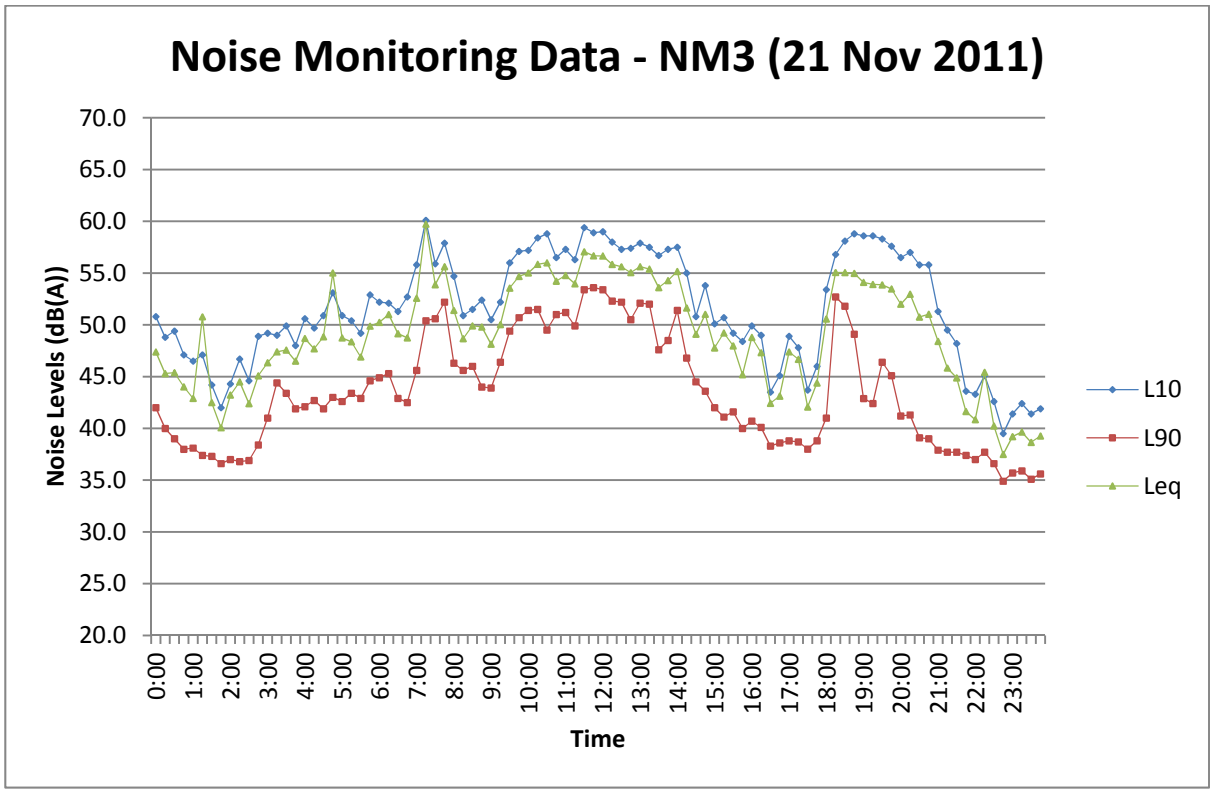

Noise Monitoring Data - NM3 (16 Nov 2011)
Noise Levels (dB(A))
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23:00
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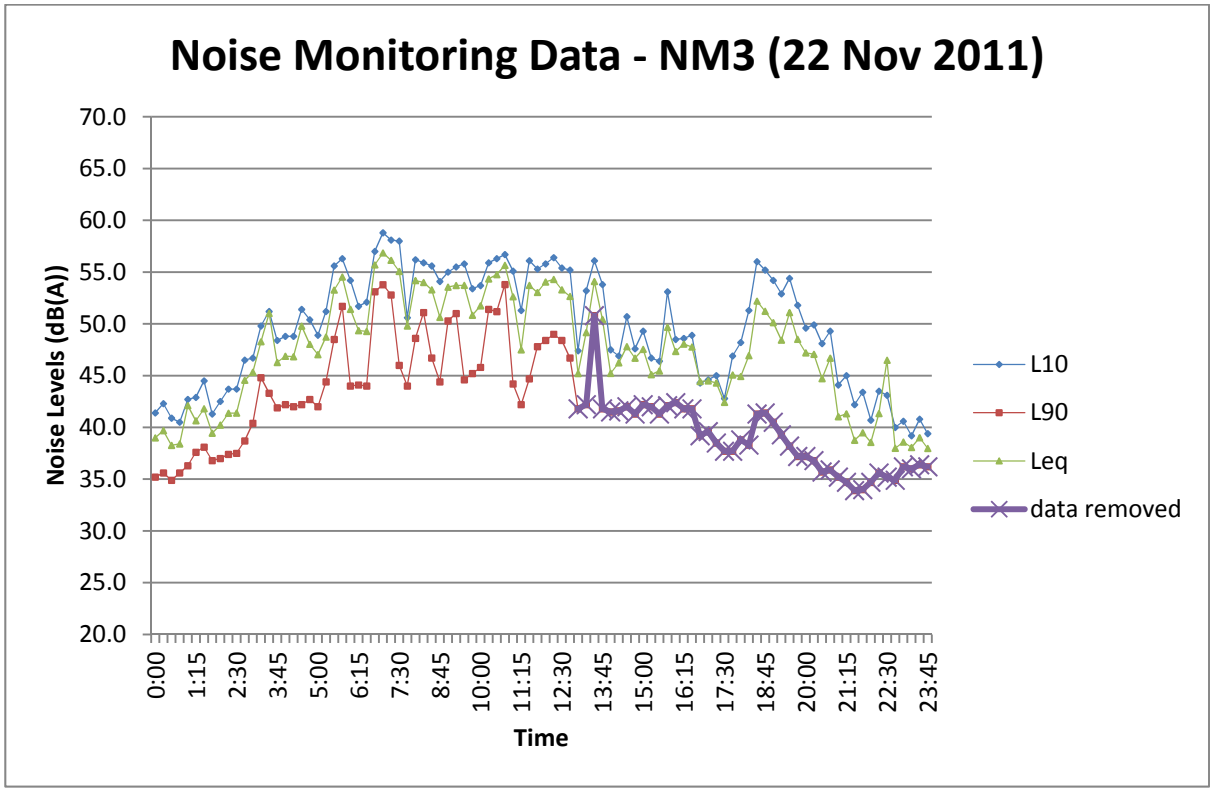

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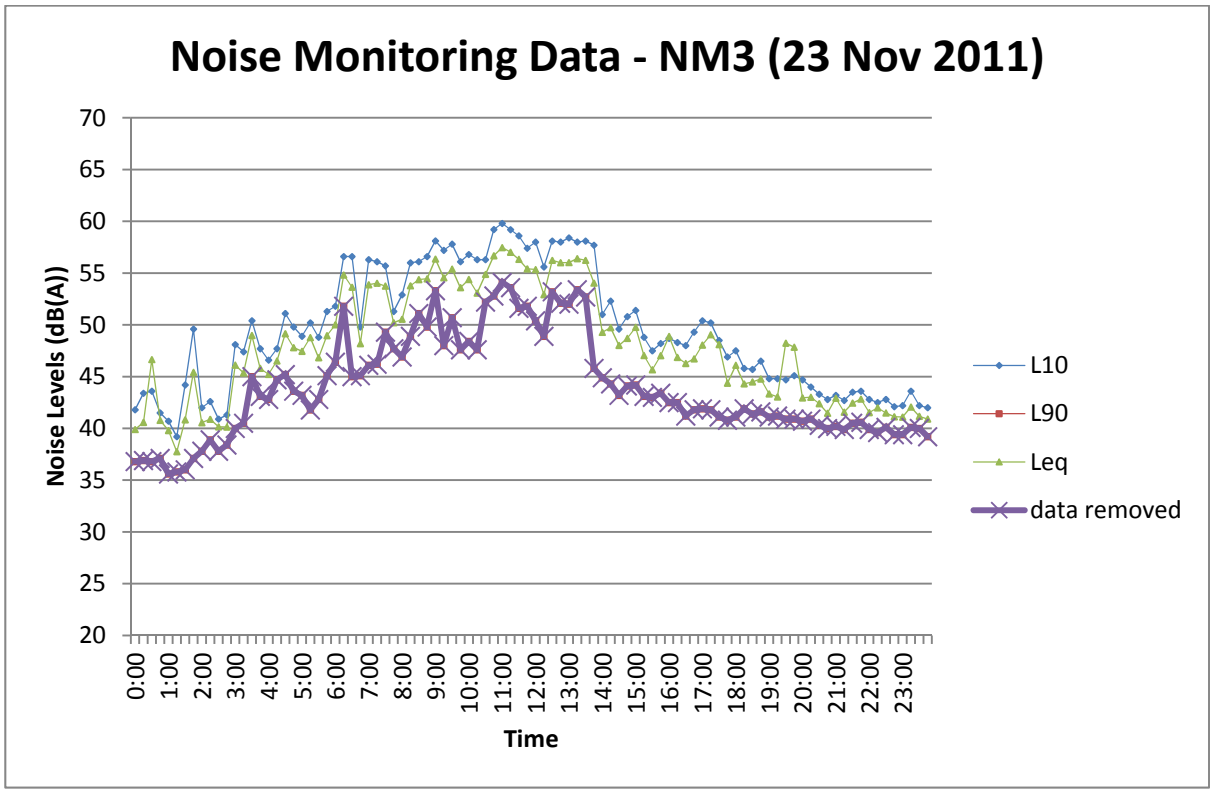

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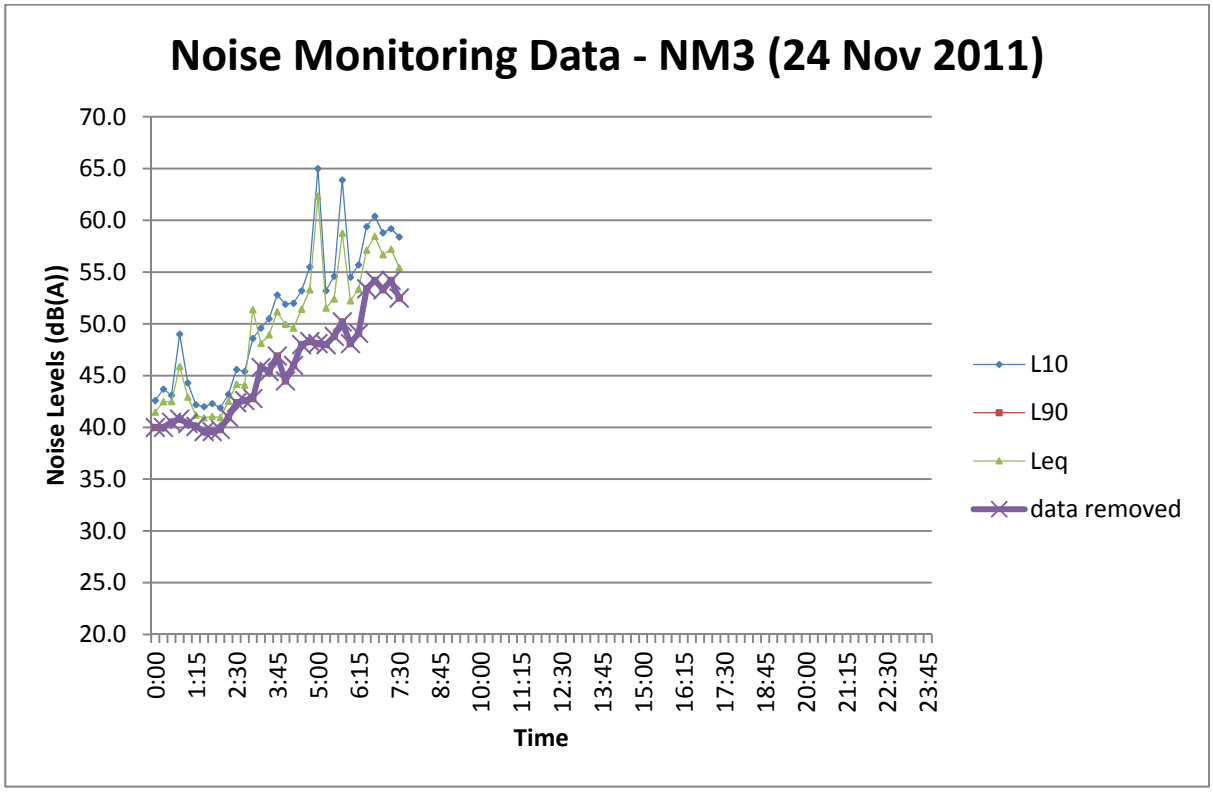

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APPENDIX E

Greenhouse Gas Assessment

March 2012

WHYTES GULLY LANDFILL SITE

Greenhouse Gas Emissions Assessment

Submitted to:
Wollongong City Council

REPORT

Report Number. 117625003_138_R_Rev0

Distribution:

1 Copy - Wollongong City Council

Golder Associates

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1.0 INTRODUCTION

Golder Associates has been commissioned by Wollongong City Council (WCC) to undertake a Greenhouse Gas (GHG) emissions assessment of the Whytes Gully Resource Recovery Park (RRP) in order to support the submission of the Environmental Assessment (EA) for the proposed Whytes Gully New Landfill Cell (the Project).

GHG emissions have been identified as an issue for consideration in the EA by the Department of Planning and Infrastructure and as such the Director General's Requirements (DGRs) require an assessment of the potential impacts of GHG emissions during construction and operation of the Project.

1.1 Scope of Work

The scope of work for the GHG assessment as detailed by the DGRs includes the following:

- Quantitative assessment of the Scope 1 and Scope 2 GHG emissions for the Project; and
- Assessment of the energy efficiency of the Project in comparison to industry best practice (I.e. landfill gas capture and/or energy generation).

In order to estimate quantitative GHG emissions the following elements require specific review:

1) Emissions associated with the construction of Project including electricity and fuel usage.
2) Emissions associated with the operation of the Project. These include:
    - Waste emissions produced from the deposition of new waste only;
    - Fuel emissions produced from the operation of plant and fixed equipment used for the operational purposes;
    - Emissions from consumption of electricity by operational activities such as leachate treatment and general operations (office, weighbridge etc.); and
    - Emissions produced following the closure of the Project.
3) Emissions associated with the combustion of LFG collected in the new waste accepted as a result of the Project.

The boundaries of the assessment are further defined in Section 3.2.

2.0 OVERVIEW OF SITE HISTORY AND EXPANSION DESIGN

The Whytes Gully RRP was established in 1984 at a site known as Whyte's farm. As identified within the Environmental Impact Statement (EIS) prepared by Scott and Furphy in 1982, the site is defined by two gullies known as the western and eastern gullies separated by a central north-south trending ridgeline. Whyte's farm initially comprised an area of 35.6 ha of mostly cleared, improved grazing land owned by Mr Whyte for a period of 40 years prior to the sites development as a landfill.

An area of land to the south of Whyte's farm adjacent to the eastern gully was also purchased by WCC to accommodate the Whytes Gully RRP development as a landfill. A stockyard remains near the central western boundary of the site which is remnant from this prior use.

2.1.1 Western Gully

Development consent for landfilling in the Western Gully was granted in 1984, in accordance with the Western Gully EIS. Landfilling commenced in the Western Gully in 1984.

Site Preparation - We understand that colluvium and residual soil were stripped from the natural slopes during preparation works prior to landfill being placed in the area. From discussions with WCC staff involved in this stripping operation it appears that the natural slopes are likely to have been almost completely stripped to rockhead, but that colluvium and residual soil were not removed to full depth at the base of the natural slopes.

Lining - The Western Gully landfill is unlined.

Leachate Collection –Collection of leachate was originally through a central 100 mm diameter perforated pipe located at the base of the landfill. From discussions with Council staff we understand that this pipe did not have filter protection and became non-functional early on during the filling process. These discussions also indicate that an alternate leachate collection system was constructed. Leachate collection horizons were established successively at approximate 5 m vertical intervals within the landfill mass. At the low point on each horizon, flows in the finger drains enter a shallow 300 mm concrete or HDPE pipe and are conveyed to the base of the landfill batter; with a pipe pit installed at each horizon. At the toe of the landfill batter the shallow 300 mm pipe extends through the landfill bund wall to the current leachate collection pit near the landfill access road, from where it is transferred to the leachate collection ponds.

Irrigation of leachate is also understood to have historically been undertaken on the Western Gully Landfill but has not been practiced in recent years.

Volume - The Western Gully Landfill received approximately 980,000 cubic meters (cu.m.) of waste during its 9.5 year life from 1984 to 1993 (Forbes Rigby, 2001).

Filling - Landfilling commenced following the construction of a large soil bund wall at the toe of the landfill with a height of 5 m and a crest elevation of RL 35 m. The bund wall extends from one side of the Western Gully to the other. After site preparation, waste was subsequently placed in the gully behind the bund wall. Once waste was placed to the height of the bund wall, a second, smaller, bund wall was placed to a height of approximately 37.5 m AHD. Waste was then placed to the crest level of the second bund wall. This filling technique of bund construction followed by waste filling was continued throughout the life of the landfill with each bund wall being approximately 2.5 m high.

Bund wall and cover material was won from site preparation works prior to filling of each lift. The external bund wall surfaces were subsequently vegetated following completion of each lift.

Capping – the Western Gully landfill is covered with a varying depth of cover materials comprising generally low to medium plasticity sandy clay ranging in thickness from 0.3 m to 2.5 m (Golder 2012).

Final Profile - The final profile of the landfill batter comprises an average surface slope of approximately 20% with indistinct benches at approximate 5 m to 10 m vertical intervals. The landfill surface above RL 80 m has gentler slopes, generally flatter than 10%.

Landfill Gas Collection – Approximately 40 vertical landfill gas extraction wells were previously installed and operated in all areas of the Western Gully Landfill. These gas wells were abandoned in approximately 2005. Some or all of these wells may be exposed, renovated, and reactivated to restore active gas extraction prior to the start of construction for the New Landfill Cell project.

2.1.2 Eastern Gully

Development consent for landfilling in the Eastern Gully was granted in 1993 in accordance with the "Whytes Gully Landfill Extension Environmental Impact Statement" undertaken by Maunsell in 1992.

Site Preparation - As with the Western Gully it is understand that colluvium and residual soil were stripped from the natural slopes during preparation works prior to landfill being placed in the area. From discussions with WCC staff involved in this stripping operation it appears that the natural slopes are likely to have been almost completely stripped to rockhead, but that colluvium and residual soil were not removed to full depth at the base of the natural slopes.

Leachate Barrier - The Eastern Gully landfill was constructed as a lined landfill, with the barrier component of the lining system comprising a high density polyethylene (HDPE) geomembrane liner (2 mm thickness). The HDPE geomembrane liner has a textured surface in sloped areas to enhance landfill stability.

The HDPE geomembrane liner is underlain by a groundwater drainage layer comprising an approximate 500 mm thick fine gravel layer that is intended to collect any groundwater seepage from natural materials below the liner. This layer incorporates a 100 mm diameter collection pipe that drains by gravity to a surface water pond at the toe of the landfill. Sampling shows that water collected in the groundwater system may be impacted by leachate. We understand that when high water levels develop in the surface water pond, it is generally pumped to the leachate management system.

Leachate Collection - The HDPE geomembrane liner is overlain by a blanket leachate drainage layer comprising an approximate 300 mm thick clean sand layer. This layer incorporates two 300 mm diameter leachate collection pipes that drain by gravity to the toe of the landfill – one pipe drains Stage 1 and the other pipe drains Stage 2 (refer below for stage description). Collected leachate is transferred to leachate ponds.

Filling - has been undertaken in four stages. Stage 1 commenced in 1993 and was located in the upper portion of the Eastern Gully. Stage 2, located on the lower section of the Eastern Gully commenced in 2001. Stages 1 and 2 together received approximately 1,250,000 cu.m. of waste to the year 2004. Stage 3 is located over the Stage 1 and Stage 2 filling area and had an estimated 610,000 cu.m. capacity over a five year period (2004 to 2009). Stage 4, located in the upper portion of the gully over Stage 3 and Stage 1 is currently underway and has an estimated 750,000 cu.m. capacity over a four year period (2009 to 2013) with completion of filling expected in 2013 (Forbes Rigby, 2001 and WCC Drawing No. 1475, 2004, Survey Drawings KFW dated December 2000, December 2001, June 2004 and December 2009 drawing numbers 2982, 3156, 3705, 4600 respectively).

Landfill Gas to Energy Facility - A landfill gas extraction system and energy turbine was previously installed at the site in 2000 and decommissioned in April 2004. Only the subsurface infrastructure for this system remains with gas manifolds still visible on the Western Gully landfill.

Capping - Capping materials encountered had a variable composition of materials throughout the existing cap. The thickness of the capping observed by Golder (2012) ranged from 0.1 m (GAHA04) to 0.6 m (GAHA01) across the Eastern Gully landfill.

Final Profile - The current landfill batter has an average slope of approximately 25% and is terraced with benches at 2 m to 3 m vertical intervals, bench widths at 3m to 5m, and slope inclinations of 2H:1V to 3H:1V between benches.

Landfill Gas Collection – Approximately 30 vertical landfill gas extraction wells were previously installed and operated in the Eastern Gully Landfill, primarily in the Stage 3 portion. These gas wells were abandoned in approximately 2005.

Refer to the draft Landfill Environmental Management Plan (LEMP) as part of the EA documentation for the existing drawings of the Western Gully and Eastern Gully landfills.

2.2 Current Operations

Current filling operations at the site are in the eastern part of the Eastern Gully landfill. The Eastern Gully landfill has been gradually filled to its current (as of July 2011) filling level of approximately RL 87.5 m AHD. The proposed final fill level of the Eastern Gully landfill is RL 105 m AHD.

Landfill lids are used as temporary daily covers, while imported soil is used as intermediate cover.

2.3 Details of Landfill Expansion

The future landfill operation is proposed to comprise a number of new stages (Stage 1, Stage 2A, Stage 2B, Stage 3, Stage 4), which will cover current and previous landfill areas in addition to previously unfilled areas. Table 1 outlines the approximate airspace volumes and tonnages for each stage of the Project. We understand that the volume of cover material used for daily cover and temporary capping is 30% by weight based on historical operations at the site. The estimated extended life of the landfill is approximately 40 years (until 2053) and assumes filling will commence in late 2013.

Table 1: Approximate Staging Volumes and Tonnages

	Airspace Volume (m^3)	Life of Cell	Waste Tonnage^
			Cover 30%
Stage 1	612,428	4.1	428,700
Stage 2A	342,754	2.4	239,928
Stage 2B	2,133,574	15.2	1,493,501
Stage 3	1,588,669	11.3	1,112,068
Stage 4	1,006,799	7.2	704,759
Total	**5,684,223**	**40.2**	**3,978,956**

Note: *^Tonnages calculated using a density of 0.8 t/m^3 for waste.*

The details of the stages of the Project are summarised as follows:

- Stage 1 covers the Eastern Gully landfill, a section of the Western Gully landfill and a non-landfilled area at the foot of the Eastern Gully landfill that is currently occupied by roads and stormwater infrastructure;
- Stage 2 covers part of the Western Gully landfill, a non-landfilled area at the toe of the Western Gully landfill that is currently occupied by roads and stormwater infrastructure and a non-landfilled ridge line between the Eastern and Western Gully landfills;
- Stage 3 covers part of the Western Gully landfill and a non-landfilled area at the toe of the Western Gully that is currently occupied by roads, the green waste process area and stockpiling areas; and
- Stage 4 covers an area to the west of the Western Gully landfill that has previously not been landfilled as well a non-landfilled area at the toe of the Western Gully landfill that is currently occupied by roads and the primary and Secondary Leachate Ponds.

3.0 GREENHOUSE GAS ASSESSMENT METHODOLOGY

3.1 Regulatory Guidance

The following regulatory guidance was used in the preparation of the GHG emissions assessment:

- *National Greenhouse and Energy Reporting (Measurement) Determination 2008 as amended*;
- *National Greenhouse and Energy Reporting (Measurement) Technical Guidelines 2011* (NGER Guidelines);
- NGER Solid Waste Calculator Version 1.6; and
- National Greenhouse Accounts Factors by Department of Climate Change and Energy Efficiency - July 2011 (NGA Factors).
- Department of Energy, Utilities and Sustainability (2005) “Guidelines for Energy Savings Action Plans”.

3.2 Assessment Boundary

The assessment boundary is confined to:

- Emissions resulting from the direct construction of the Project and only includes fuel and electricity emissions from plant and fixed sources;
- Emissions resulting from the operation of the Project including emissions from:
  - Waste only;
  - Electricity usage from site office and leachate treatment plant; and
  - Fuel usage from plant and generators.
- Emissions that occur following the cessation of the Project including emissions from:
  - Waste; and
  - Electricity emissions from leachate treatment.

A Landfill Gas (LFG) gas resource is potentially available within the existing Whytes Gully RRP landfill and it is understood that LFG collection and/or utilisation is proposed to be implemented as part of the Project commitments.

Other emissions not included in this assessment are emissions associated with the delivery of the waste to the Project. These are classified as Scope 3 emissions and are not required in accordance with the DGRs.

3.2.1 Emission Scopes

Emissions that arise from direct sources are classified as Scope 1 and can be considered emissions occurring from within the assessment boundary (e.g. emissions from waste, fuel use, energy use). Emissions that arise from an activity outside the assessment boundary are classified Scope 2 and occur from the consumption of electricity produced (e.g. electricity produced at a power station).

3.2.2 Greenhouse Gases Assessed

The greenhouse gases considered in this assessment are:

- Methane;
- Carbon Dioxide; and

- Nitrous Oxide.

Depending on the specific activity, only some of these greenhouse gases are required to be assessed. For example, only methane is considered for emissions from landfill. Carbon dioxide is considered to be biogenic and would have been emitted regardless.

3.3 Waste Data

The NGER Solid Waste Emissions Calculator (Version 1.6) is a default Method 1 emissions calculator used to estimate methane generated from waste disposal. Methane generation is estimated using waste stream data for the site and the Tier 2 First Order Decay (FOD) Model provided in the IPCC Guidelines for National Greenhouse Gas Inventories.

3.3.1 Waste Tonnages

Waste tonnages inputs are required for the NGER model in order to estimate the emissions arising from waste over time. Typically, estimates are required for tonnage deposited prior to installation of weighbridges. These are generally based on a combination of anecdotal evidence, volume estimates or averages from the known existing weighbridge data.

Waste tonnage data adopted for this GHG assessment was based on the average annual weighbridge data for the previous three years (2009 to 2011) as provided by WCC. These three years of data are considered to provide the most realistic data in terms of tonnages accepted and cover material used.

3.3.2 Waste Stream Designation

The NGER Solid Waste Emissions Calculator incorporates default waste composition percentages for the Municipal Solid Waste (MSW), Commercial & Industrial (C&I) and Construction & Demolition (C&D) waste stream categories, as outlined in the NGER (measurement) Technical Guidelines 2010, Section 5.11. As the Project only accepts MSW and C&I waste, the waste data was evaluated to estimate the average accepted percentage of MSW and C&I waste accepted for use in the modelling.

Waste stream data adopted for this assessment was based on the average annual weighbridge data for the previous three years (2009 to 2011) as provided by WCC.

3.3.3 Waste Mix Types

Default NGER waste mix percentages for both MSW and C&I were adopted for this assessment.

3.4 Fuel and Electricity Emissions

The emission factors used to calculate both fuel and electricity emissions from on site activities were adopted from NGER Technical Guidelines (2011). Fuel and electricity emissions for the site are associated with all plant and fixed equipment used in addition to peripheral activities including site office and the weighbridge.

3.5 Landfill Gas Emissions

Emissions associated with the combustion of LFG collected in the proposed new waste of the Project have been assessed. The gases assessed are nitrous oxide and methane as described in Table 2.3.2A (NGER 2011 Technical Guidelines).

A collection efficiency of 50% has been adopted for this assessment. This value is considered to be acceptable (and conservative) amongst current landfill operators where landfill cell are engineered and landfill gas management is undertaken by a competent contractor. This would include provisions for the installation of sacrificial horizontal gas collection.

4.0 EMISSIONS ASSESSMENT RESULTS

4.1 Landfill Methane Emissions

The estimated methane emissions from the waste to be deposited within the proposed new landfill cell are detailed in Figure A below. This also estimates the emissions associated with each stage of the Project (including emissions post closure). Emissions are predicted to peak at the cessation of filling in 2053 at approximately 105 000 tCO_2e. This is following a deduction of 10 percent from methane oxidation.

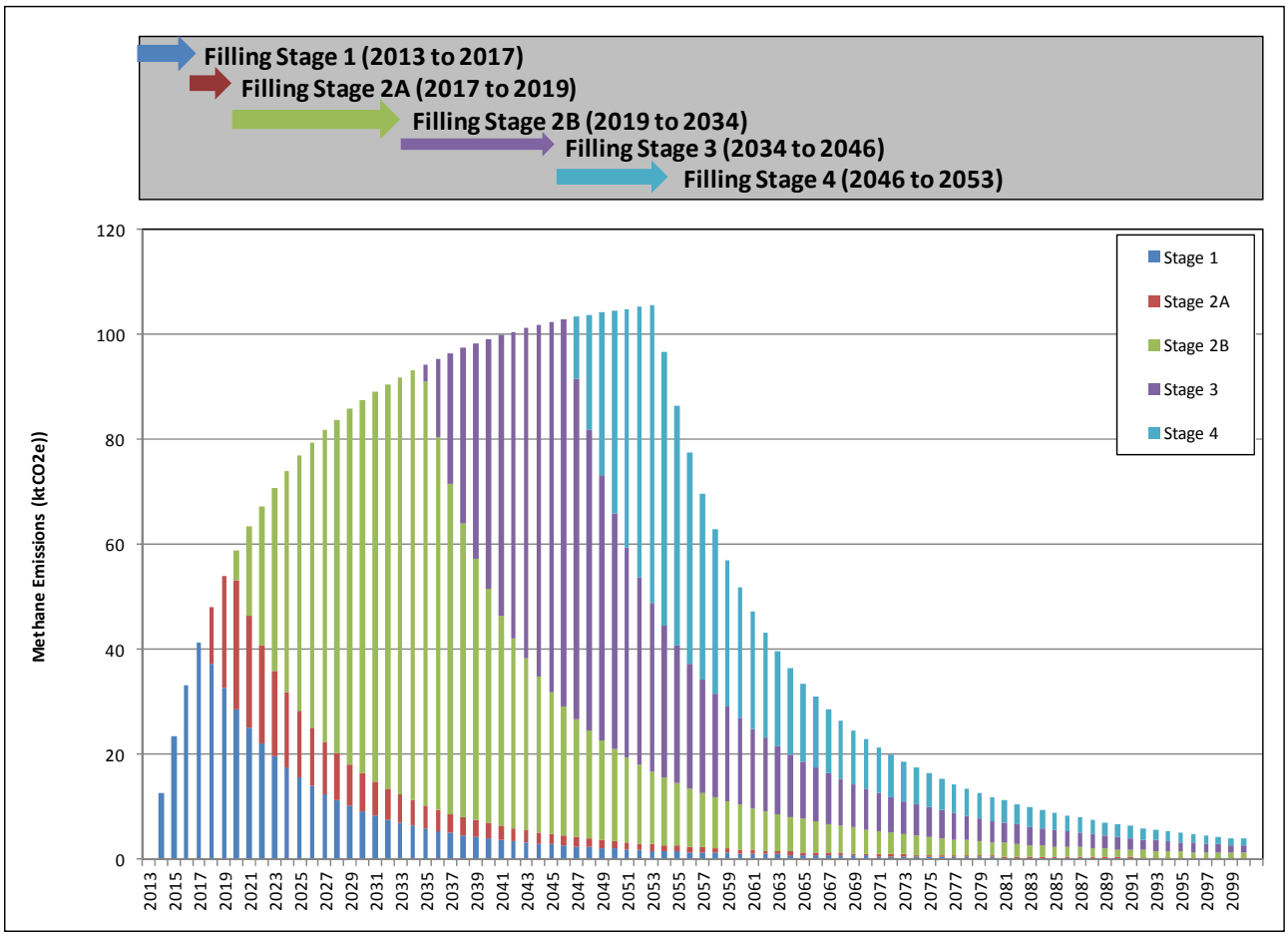


Figure A: Methane Emissions from Waste

The following table provides a summary of estimated annual emissions from landfill for the Project.

Table 2: Estimated Annual Landfill Emissions

Year Ending	Methane Generated ($ktCO_2e$)	Emissions - Post CH_4 Oxidation ($ktCO_2e$)
2013	0	0
2014	14.04	12 635
2015	26.20	23.58
2053 (peak)	117.37	105.63

4.2 Fuel and Electricity Emissions

Fuel emissions assessed are for diesel fuel only and have been estimated using emission factors as the fuel usage information provided by WCC was considered unusually low. Therefore a conservative estimate is provided. Usage data were based on the typical fuel consumptions of the plant proposed for both the operation and construction of the Project. The operational emissions were conservatively based on a 6 day per week, 10 hours per day operation and included a compactor, an excavator, a front end loader, a haulage truck and one generator.

Fuel usage during the construction phases would not be continuous as construction of the liner and capping will only be required prior to placement of the waste within the cell. Therefore the annual fuel usage has been estimated for the entire Project (assumed to be a total of 20 years) and averaged over the operational life of the Project (assumed as 40 years) to obtain an annual fuel emission. Plant utilised include a roller, an excavator, a dozer and includes provisions for a further 2 excavators and 3 trucks for the relocation of waste from the existing Eastern Gully landfill.

Table 3 details the fuel related emission estimates for the Project.

Table 3: Annual Emissions Associated with Fuel Combustion

Source	Annual Quantity (kL)	Energy Content Factor (GJ/kL)	Energy Content (GJ)	Emission Factor[(1)] kg CO_{2-e}/GJ	Emission (tCO_2-e)
Operational Consumption					
Fuel Data - Diesel	334	38.6	12,892	CO_2 – 69.2	892
				CH_4 – 0.1	1.0
				N_2O – 0.2	3.0
Total					***896***
Construction Consumption					
Fuel Data - Diesel	167	38.6	6,450	CO_2 – 69.2	446
				CH_4 – 0.1	1.0
				N_2O – 0.2	1.0
Total					***448***

1. Emission Factors taken from the NGA Factors Workbook 2010

The operational electricity usage for the site has been estimated at 1,036 MWh per year. This was estimated through electricity invoices provided by WCC for three quarters with the last quarter being averaged from the first three and conservatively doubling the electricity consumption of the leachate treatment plant to account for possible leachate treatment plant upgrades.

The electricity consumption as a result of the construction phase of the Project has been estimated at 10% of the normal annual operational usage.. Table 4 provides a summary of the estimated electricity related emissions for the site.

Table 4: Annual Emissions Associated with Electricity Consumption

Source	Annual Quantity	Emission Factor[(1)]	Emission (tCO_{2-e})
Operational Consumption	1,036,000 kWh	0.89 kg CO_2/kWh	922
Construction Consumption	103,600 kWh	0.89 kg CO_2/kWh	92
Annual Total			**1,014**

1. Emission Factors taken from the NGA Factors July 2011

4.3 Emissions Associated with the Combustion of Landfill Gas

The emissions associated with the combustion of landfill gas have been estimated based on a 50% gas capture efficiency during the operation of a LFG gas management system involving either flaring or electricity generation. Table 5 below summarises the estimated annual emissions associated with the combustion of LFG.

Table 5: Annual Emissions Associated with the Combustion of LFG

Year	Quantity of CH_4 Collected (m^3)	N_2O Emissions (tCO_2e)	CH_4 Emissions (tCO_2e)	Total Combustion Emissions (tCO_2e)
2013	0	0	0	0
2014	981,120	1.1	177	178.1
2015	1,830,840	2.1	331	333.1
2053 (closure)	8,216,880	9.3	1,487	1,496.3

4.4 Energy Efficiency Considerations

Measures to reduce energy consumption during the construction and operation of the Project predominantly include the adoption of energy efficient plant and construction techniques to reduce the quantity of fuel emissions. This may include measures such as operating plant from side to side rather than up and down slopes. Additional efficiencies could be achieved by efficient maintenance of plant and equipment.

In order to monitor the effectiveness of energy efficiencies, an Energy Savings Action Plan for the Project would be completed in accordance with the "Guidelines for Energy Savings Action Plans (DEUS 2005).

Further measures to potentially reduce energy consumption of the Project include proposed capture and utilisation of LFG. During the construction of the Project, it is proposed that infrastructure to capture LFG be installed on a progressive basis.

Preliminary modelling (refer to Figure B below) indicates that LFG production would support flaring or electricity generation. Assuming a 50 percent capture efficiency methane emissions would be reduced in 2014 from 12,635 tCO_2e to 6,318 tCO_2e and during peak LFG generation (2053) from 105,632 tCO_2e to 52,816 tCO_2e.

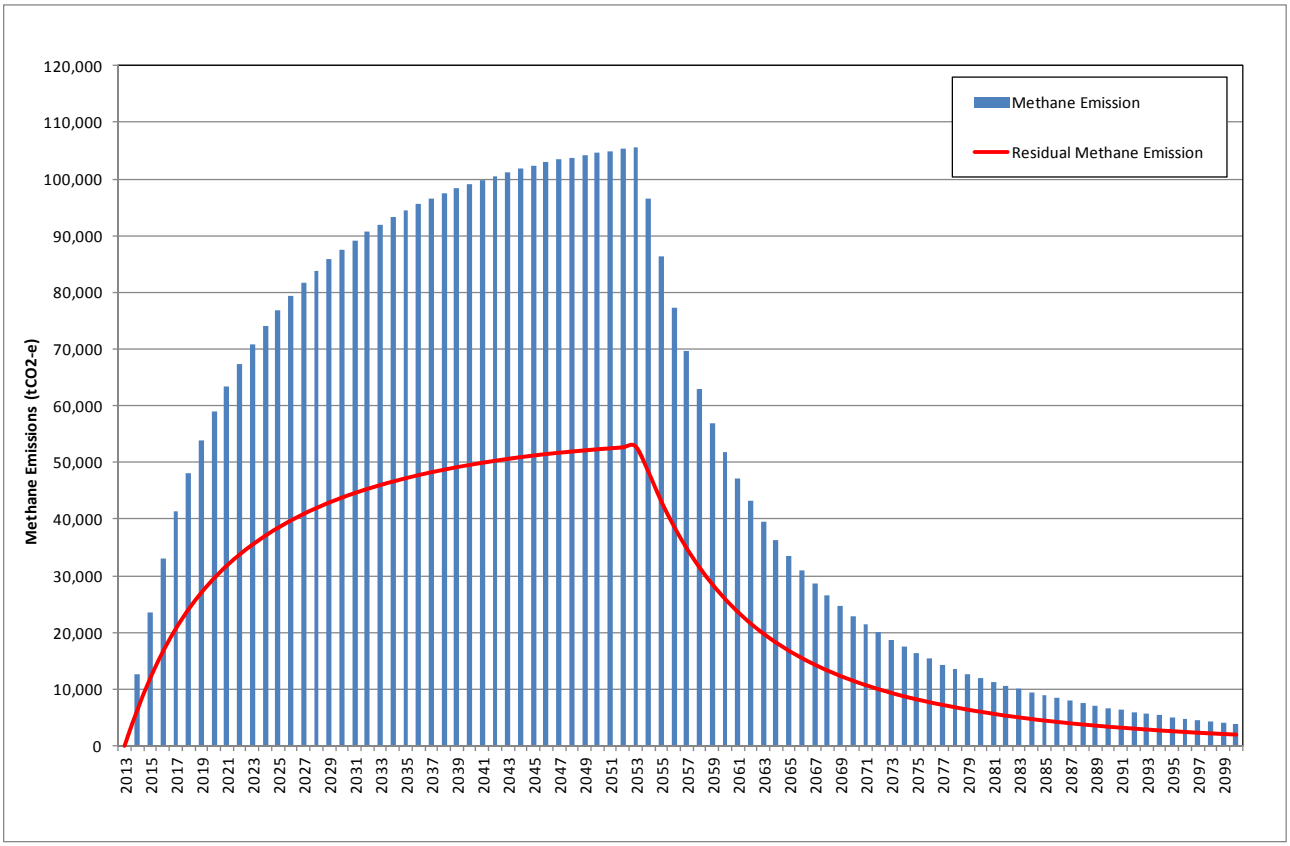


Figure B: Residual Methane Emissions Following Capture and Combustion

Table 6: Estimated Annual Landfill Emissions Following Combustion @ 50% Capture

Year Ending	Methane Emissions (tCO_2e)	Residual Emissions - Post CH_4 Oxidation (tCO_2e)
2013	0	0
2014	12,635	6,318
2015	23,583	11,792
2053 (peak)	105,632	52,816

4.5 Annual Net Estimated Emissions

Table 7 summarises the estimated net annual emissions for the Project. Initially, no landfill gas would be generated from the waste deposited in the first year of the Project. From 2014, emissions would be mitigated assuming 50 percent capture efficiencies can be achieved.

Table 7: Estimated Project Annual Net Emissions (tCO_2e)

Activity	2013	2014	2015	2053 (Peak)
Landfill Emissions Post Oxidation (Scope 1)	0	6,318	11,792	52,816
Fuel Emissions – Operational (Scope 1)	896	896	896	896
Fuel Emissions – Construction (Scope 1)	448	448	448	448
Electricity Emissions – Operational (Scope 2)	922	922	922	922
Electricity Emissions – Construction (Scope 2)	92	92	92	92
Combustion Emissions (Scope 1)	0	178	333	1,496
Total Emissions	**2,358**	**8,854**	**14,483**	**56,670**

5.0 CONCLUSIONS

A GHG assessment of the Project has been undertaken to assess the potential Scope 1 and Scope 2 emissions of the Project including emissions from all construction and operational activities. These include:

- Emissions from landfilled waste (including post closure);
- Emission emitted during the construction of the Project including fuel and electricity usage; and
- Emissions emitted during the operation of the Project including all fuel and electricity usage associated with plant, operation of the leachate treatment plant, weighbridge and offices.

The results of the GHG assessment estimates annual GHG emission for 2013 (proposed first year of operation of the Project) of 2,358 tCO_2e. Emissions without mitigation would increase over time peaking in 2053 at 56,670 tCO_2e. During the proposed first year of operation (2013) the bulk of the emissions are Scope 2 (electricity consumption). However over time, it has been identified that landfill gas will form the bulk of the Project emissions.

Following the implementation of energy efficiency measures including LFG extraction and combustion, it is considered a reduction in GHG emissions can be achieved. In 2014 (first year of gas production/extraction), site emissions are estimated to be reduced from 14,946 tCO_2e (without gas capture) to 8,854 tCO_2e (with gas capture). At the peak rate of emission for the project (2053), emissions would be significantly reduced as a result of capture and combustion of methane from 107,765 tCO_2e to 56,670 tCO2e.

6.0 REFERENCES

- Department of Climate Change and Energy Efficiency (July 2011) “National Greenhouse and Energy Reporting System Measurement - Technical Guidelines for the estimation of greenhouse gas emissions from facilities in Australia”.
- Department of Climate Change and Energy Efficiency “NGER Solid Waste Calculator V1.6”
- Department of Energy, Utilities and Sustainability (2005) “Guidelines for Energy Savings Action Plans”.
- Forbes and Rigby (2001) “Review of Environmental factors for Proposed Deviation of Reddalls Road, Kembla Grange”
- GHD (March 2010) “Whytes Gully Landfill Site: Landfill Gas Generation and Emissions Report”
- Golder Associates Pty Ltd, January 2012, Whytes Gully New Landfill Cell, Geotechnical Investigation Report
- Maunsell (1992) “Whytes Gully Landfill Extension Environmental Impact Statement”
- Scott and Furphy (1982) “Environmental Impact Statement – Proposed Waste Disposal Depot at Reddalls Road West Dapto”

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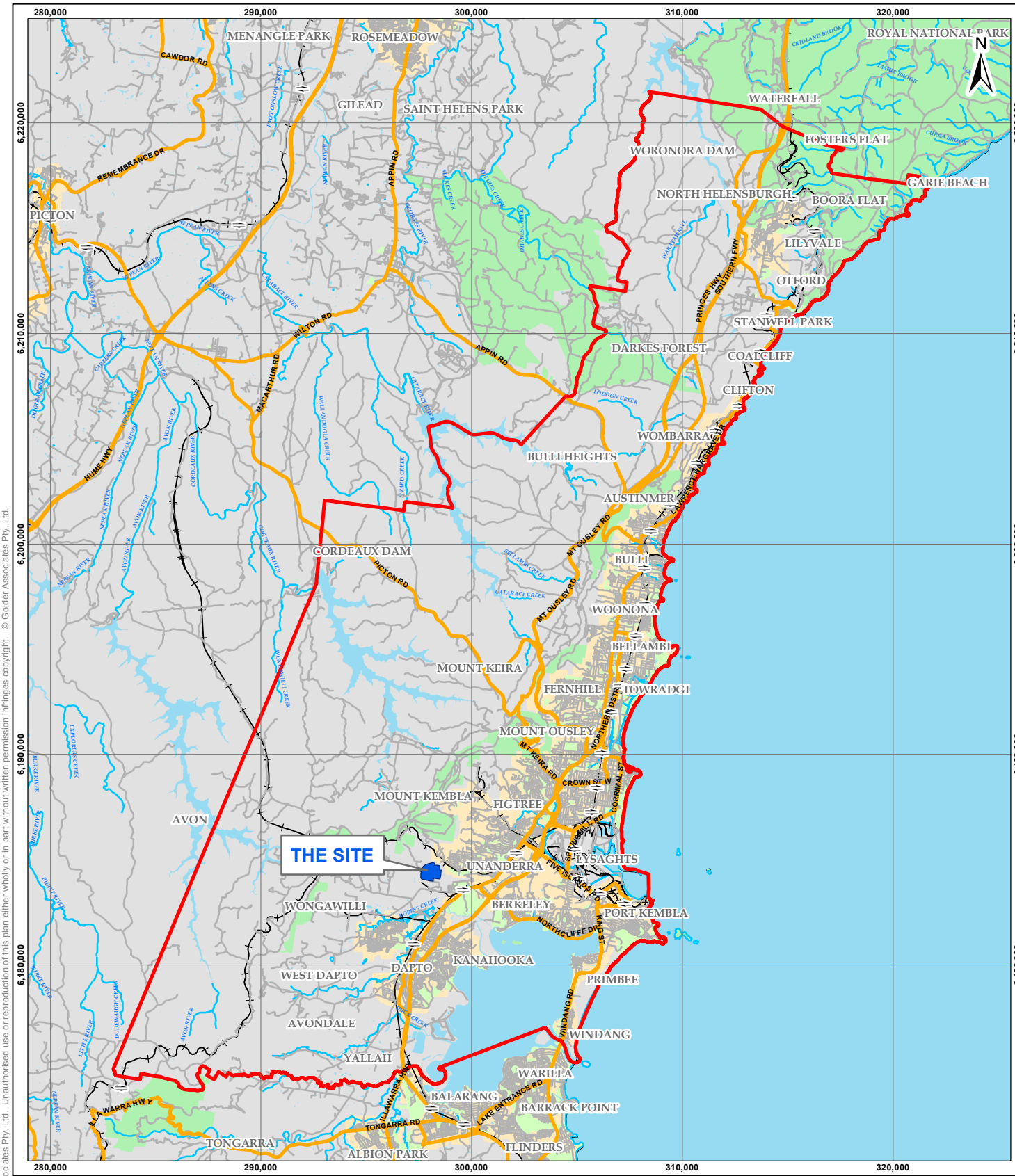
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https://aupws.golder.com/117625003wollongongcitycouncilnewcellwhytesgully/project doc/3065 greenhouse gas issues/117625003_138_r_rev0.docx

APPENDIX A

Figures



GREENHOUSE GAS EMISSIONS ASSESSMENT

Wollongong City Council

REGIONAL AREA



LEGEND

- Site Location
- Wollongong Local Government Area Boundary

0 1 2 4 6 8 Kilometres

SCALE (at A4) 1:250,000

Coordinate System: GDA 1994 MGA Zone 56

PROJECT: 117625003
DATE: 14/12/2011
DRAWN: FA
CHECKED: BJF

FIGURE 1

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File Location: J:\GIS\Jobs\117625003_Wollongong Council_New Landfill Cell_Whytes Gully\Workspaces\117625003_138_M_F0001_RegionalLocation.mxd

298,000



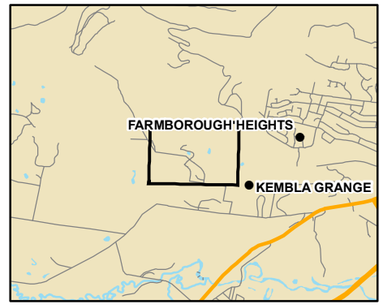
6,184,000

298,000

WHYTES GULLY NEW LANDFILL CELL GREENHOUSE GAS EMISSIONS ASSESSMENT

WOLLONGONG CITY COUNCIL

SITE LAYOUT



LEGEND

- Gas Well
- Gas Pipes
- Site Boundary
- Approximate Extent Of Waste

NOTES

Historic locations digitised by Golder from reports supplied by Wollongong City Council

Aerial Ortho-Photograph provided by AAM Pty. Ltd. taken on 16 May 2011, Reference 18763A. Image Georeferenced.

0 12.5 25 50 75 100 125 metres

SCALE (at A3) 1:3,800

Coordinate System: GDA 1994 MGA Zone 56

PROJECT: **117625003**
DATE: **14/12/2011**
DRAWN: **FA**
CHECKED: **BJF**

FIGURE 2

Golder Associates

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APPENDIX B

Modelling Outputs

Australian Government
Department of Climate Change and Energy Efficiency

Read "Solid Waste Disposal on Land User Guide" for important information on:
- the landfill facility activities that must be reported (energy/emissions)
- how to use this calculator

Please click here for user guide!

NGER solid waste calculator Version 1.6 © Commonwealth of Australia 2010 ISBN: 978-1-921298-53-0 This work is copyright. Apart from any use as permitted under the Copyright Act 1968, no part may be reproduced by any process without prior written permission from the Commonwealth. Requests and inquiries concerning reproduction and rights should be addressed to the: Commonwealth Copyright Administration, Attorney-General's Department, 3-5 National Circuit, BARTON ACT 2600 Email: commonwealth.copyright@ag.gov.au Or posted at: http://www.ag.gov.au
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http://www.climatechange.gov.au/en/government/initiatives/national-greenhouse-energy-reporting.aspx
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Sections of NGER (Measurement) Determ. 2008 amended, IPCC 2006 Guidelines Vol. 5	NGER Section 5.5	NGER Section 5.4	NGER Section 5.4/IPCC Equation 3.6	NGER Section 5.4	NGER Section 5.10	NGER Section 5.11	NGER Section 5.11	NGER Section 5.11	IPCC Sections 3.2.3, 3.7.2.2	IPCC Sections 3.2.3, 3.2.2, 3.7.2.2	IPCC Sections 3.2.3, 3A1.3	IPCC Section 3.2.3

NSW	Select State/Territory, enter landfill opening year and enter Waste (kt), Q_{cap}, Q_{flared}, Q_{ox}	No input required in the fields below				Waste streams (proportions of total) Note: defaults can be overridden in accordance with NGER Determination	Waste mix types - Municipal Solid Waste (proportions of total) Note: defaults can be overridden in accordance with NGER Determination									Waste mix types - Commercial and Industry (proportions of total) Note: defaults can be overridden in accordance with NGER Determination										Waste mix type proportions (adjusted for licensing restrictions if necessary) Note: these values are calculated and no input is required										Fraction of DOC that decomposes (DOCf) (default 0.5) Note: only override default with robust evidence in accordance with IPCC 2006 Guidelines Vol. 5										Note: only override default with robust evidence in accordance with IPCC 2006 Guidelines Vol. 5		
Financial year ending - input landfill opening year in cell below	Waste received landfill (kt)	Q_{cap} (CH_4 only) (m^3)	CH_4 captured (Q_{cap}+Q_x+Q_{flared} in kt CO_2-e)	CH_4 (kt CO_2-e)	CH_4gen (kt CO_2-e)	Emissions E_j (CO_2-e) (kt)	Municipal Solid Waste	Commercial and Industrial	Construction and Demolition (calculated by deduction)	Food	Paper and paper board	Garden and park	Wood and wood waste	Textiles	Sludge	Nappies	Rubber and Leather	Inert (including concrete, metal, plastic, glass) (by deduction)	Food	Paper and paper board	Garden and park	Wood and wood waste	Textiles	Sludge	Nappies	Rubber and Leather	Inert (including concrete, metal, plastic, glass) (by deduction)	Food	Paper and paper board	Garden and park	Wood and wood waste	Textiles	Sludge	Nappies	Rubber and Leather	Inert (including concrete, metal, plastic, glass)	Food	Paper and paper board	Garden and park	Wood and wood waste	Textiles	Sludge	Nappies	Rubber and Leather	Concrete, metal, plastic and glass	Methane Correction Factor (MCF)	Decomposition delay (months) (IPCC default is 6)	Fraction of CH_4 in landfill gas (F)
2013	96.18	0	0.0000	0.0000	0.0000	0.0000000	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2014	96.18	0	0.0000	12.9139	12.9139	11.6225046	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2015	96.18	0	0.0000	24.1031	24.1031	21.6928293	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2016	96.18	0	0.0000	33.8297	33.8297	30.4467648	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2017	96.18	0	0.0000	42.3134	42.3134	38.0821007	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2018	96.18	0	0.0000	49.7388	49.7388	44.7649088	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2019	40.79	0	0.0000	56.2609	56.2609	50.6347754	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2020	0.00	0	0.0000	54.5729	54.5729	49.1156462	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2021	0.00	0	0.0000	47.7388	47.7388	42.9649236	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2022	0.00	0	0.0000	41.9084	41.9084	37.7175636	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2023	0.00	0	0.0000	36.9225	36.9225	33.2302092	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2024	0.00	0	0.0000	32.6478	32.6478	29.3830431	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2025	0.00	0	0.0000	28.9732	28.9732	26.0758643	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2026	0.00	0	0.0000	25.8054	25.8054	23.2248233	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2027	0.00	0	0.0000	23.0663	23.0663	20.7597041	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2028	0.00	0	0.0000	20.6907	20.6907	18.6216625	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2029	0.00	0	0.0000	18.6237	18.6237	16.7613424	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2030	0.00	0	0.0000	16.8192	16.8192	15.1373078	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2031	0.00	0	0.0000	15.2386	15.2386	13.7147362	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2032	0.00	0	0.0000	13.8493	13.8493	12.4643307	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2033	0.00	0	0.0000	12.6238	12.6238	11.3614136	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2034	0.00	0	0.0000	11.5391	11.5391	10.3851702	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2035	0.00	0	0.0000	10.5756	10.5756	9.5180196	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2036	0.00	0	0.0000	9.7168	9.7168	8.7450685	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2037	0.00	0	0.0000	8.9486	8.9486	8.0537738	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2038	0.00	0	0.0000	8.2593	8.2593	7.4337894	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2039	0.00	0	0.0000	7.6387	7.6387	6.8747959	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2040	0.00	0	0.0000	7.0781	7.0781	6.3702759	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2041	0.00	0	0.0000	6.5702	6.5702	5.9131905	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2042	0.00	0	0.0000	6.1087	6.1087	5.4978664	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2043	0.00	0	0.0000	5.6883	5.6883	5.1194339	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2044	0.00	0	0.0000	5.3041	5.3041	4.7737018	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2045	0.00	0	0.0000	4.9523	4.9523	4.4570532	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2046	0.00	0	0.0000	4.6293	4.6293	4.1663578	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2047	0.00	0	0.0000	4.3321	4.3321	3.8988984	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2048	0.00	0	0.0000	4.0581	4.0581	3.6523088	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2049	0.00	0	0.0000	3.8050	3.8050	3.4245225	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2050	0.00	0	0.0000	3.5708	3.5708	3.2137284	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2051	0.00	0	0.0000	3.3537	3.3537	3.0183346	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2052	0.00	0	0.0000	3.1522	3.1522	2.8369367	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2053	0.00	0	0.0000	2.9648	2.9648	2.6682919	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2054	0.00	0	0.0000	2.7903	2.7903	2.5112970	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2055	0.00	0	0.0000	2.6277	2.6277	2.3649691	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2056	0.00	0	0.0000	2.4760	2.4760	2.2284301	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2057	0.00	0	0.0000	2.3343	2.3343	2.1008925	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2058	0.00	0	0.0000	2.2018	2.2018	1.9816487	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2059	0.00	0	0.0000	2.0778	2.0778	1.8700602	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2060	0.00	0	0.0000	1.9617	1.9617	1.7655497	0.57	0.43	0.00	0.35	0.13

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Read "Solid Waste Disposal on Land User Guide" for important information on:
- the landfill facility activities that must be reported (energy/emissions)
- how to use this calculator

Please click here for user guide!

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Sections of NGER (Measurement) Determ. 2008 amended, IPCC 2006 Guidelines Vol. 5	NGER Section 5.5	NGER Section 5.4	NGER Section 5.4/IPCC Equation 3.6	NGER Section 5.4	NGER Section 5.10	NGER Section 5.11	NGER Section 5.11	NGER Section 5.11	IPCC Sections 3.2.3, 3.7.2.2	IPCC Sections 3.2.2, 3.7.2.2	IPCC Sections 3.2.3, 3A1.3	IPCC Section 3.2.3

| NSW | Select State/Territory, enter landfill opening year and enter Waste (kt), Q_{cap}, Q_{flared}, Q_{ox} | No input required in the fields below | | | | Waste streams (proportions of total) Note: defaults can be overridden in accordance with NGER Determination | | | Waste mix types - Municipal Solid Waste (proportions of total) Note: defaults can be overridden in accordance with NGER Determination | | | |

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Sections of NGER (Measurement) Determ. 2008 amended, IPCC 2006 Guidelines Vol. 5	NGER Section 5.5	NGER Section 5.4	NGER Section 5.4/IPCC Equation 3.6	NGER Section 5.4	NGER Section 5.10	NGER Section 5.11	NGER Section 5.11	NGER Section 5.11	IPCC Sections 3.2.3, 3.7.2.2	IPCC Sections 3.2.2, 3.7.2.2	IPCC Sections 3.2.3, 3A1.3	IPCC Section 3.2.3

NSW	Select State/Territory, enter landfill opening year and enter Waste (kt), Q_{cap}, Q_{flared}, O_x		No input required in the fields below			Waste streams (proportions of total) Note: defaults can be overridden in accordance with NGER Determination			Waste mix types - Municipal Solid Waste (proportions of total) Note: defaults can be overridden in accordance with NGER Determination										Waste mix types - Commercial and Industry (proportions of total) Note: defaults can be overridden in accordance with NGER Determination										Waste mix type proportions (adjusted for licensing restrictions if necessary) Note: these values are calculated and no input is required										Fraction of DOC that decomposes (DOCf) (default 0.5) Note: only override default with robust evidence in accordance with IPCC 2006 Guidelines Vol. 5										Note: only override default with robust evidence in accordance with IPCC 2006 Guidelines Vol. 5		
Financial year ending - input landfill opening year in cell below	Waste received landfill (kt)	Q_{cap} (CH_4 only) (m^3)	CH_4 captured (Q_{cap}*O_x*Q_{flared} in kt CO_2-e)	CH_4 (kt CO_2-e)	CH_4gen (kt CO_2-e)	Emissions E_j (CO_2-e) (kt)	Municipal Solid Waste	Commercial and Industrial	Construction and Demolition (calculated by deduction)	Food	Paper and paper board	Garden and park	Wood and wood waste	Textiles	Sludge	Nappies	Rubber and Leather	Inert (including concrete, metal, plastic, glass) (by deduction)	Food	Paper and paper board	Garden and park	Wood and wood waste	Textiles	Sludge	Nappies	Rubber and Leather	Inert (including concrete, metal, plastic, glass) (by deduction)	Food	Paper and paper board	Garden and park	Wood and wood waste	Textiles	Sludge	Nappies	Rubber and Leather	Inert (including concrete, metal, plastic, glass)	Food	Paper and paper board	Garden and park	Wood and wood waste	Textiles	Sludge	Nappies	Rubber and Leather	Concrete, metal, plastic and glass	Methane Correction Factor (MCF)	Decomposition delay (months) (IPCC default is 6)	Fraction of CH_4 in landfill gas (F)
2021	19.37	0	0.0000	0.0000	0.0000	0.0000000	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2022	96.18	0	0.0000	2.6009	2.6009	2.3408145	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2023	96.18	0	0.0000	15.1674	15.1674	13.6507044	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2024	96.18	0	0.0000	26.0621	26.0621	23.4559036	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2025	96.18	0	0.0000	35.5384	35.5384	31.9845490	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2026	96.18	0	0.0000	43.8089	43.8089	39.4280424	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2027	96.18	0	0.0000	51.0524	51.0524	45.9471212	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2028	96.18	0	0.0000	57.4188	57.4188	51.6769151	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2029	96.18	0	0.0000	63.0346	63.0346	56.7311588	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2030	96.18	0	0.0000	68.0063	68.0063	61.2057005	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2031	96.18	0	0.0000	72.4238	72.4238	65.1814279	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2032	96.18	0	0.0000	76.3630	76.3630	68.7287055	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2033	96.18	0	0.0000	79.8882	79.8882	71.8994088	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2034	96.18	0	0.0000	83.0540	83.0540	74.7486198	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2035	96.18	0	0.0000	85.9067	85.9067	77.3160427	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2036	96.18	0	0.0000	88.4858	88.4858	79.6371858	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2037	96.18	0	0.0000	90.8248	90.8248	81.7423480	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2038	96.18	0	0.0000	92.9527	92.9527	83.6574438	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2039	3.12	0	0.0000	94.8941	94.8941	85.4046930	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2040	0.00	0	0.0000	84.1755	84.1755	75.7579853	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2041	0.00	0	0.0000	74.5594	74.5594	67.1034991	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2042	0.00	0	0.0000	66.2833	66.2833	59.6550140	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2043	0.00	0	0.0000	59.1398	59.1398	53.2258517	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2044	0.00	0	0.0000	52.9552	52.9552	47.6964491	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2045	0.00	0	0.0000	47.5837	47.5837	42.8253307	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2046	0.00	0	0.0000	42.9032	42.9032	38.6129230	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2047	0.00	0	0.0000	38.8112	38.8112	34.9300686	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2048	0.00	0	0.0000	35.2212	35.2212	31.6991229	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2049	0.00	0	0.0000	32.0608	32.0608	28.8547351	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2050	0.00	0	0.0000	29.2687	29.2687	26.3418332	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2051	0.00	0	0.0000	26.7933	26.7933	24.1139438	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2052	0.00	0	0.0000	24.5909	24.5909	22.1317917	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2053	0.00	0	0.0000	22.6246	22.6246	20.3621314	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2054	0.00	0	0.0000	20.8631	20.8631	18.7767734	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2055	0.00	0	0.0000	19.2797	19.2797	17.3517701	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2056	0.00	0	0.0000	17.8519	17.8519	16.0667371	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2057	0.00	0	0.0000	16.5603	16.5603	14.9042857	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2058	0.00	0	0.0000	15.3884	15.3884	13.8495491	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2059	0.00	0	0.0000	14.3220	14.3220	12.8897857	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2060	0.00	0	0.0000	13.3489	13.3489	12.0140474	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2061	0.00	0	0.0000	12.4588	12.4588	11.2129019	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2062	0.00	0	0.0000	11.6424	11.6424	10.4782001	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2063	0.00	0	0.0000	10.8921	10.8921	9.8028806	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2064	0.00	0	0.0000	10.2009	10.2009	9.1808064	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2065	0.00	0	0.0000	9.5629	9.5629	8.6066269	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2066	0.00	0	0.0000	8.9730	8.9730	8.0756621	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2067	0.00	0	0.0000	8.4265	8.4265	7.5838057	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2068	0.00	0	0.0000	7.9194	7.9194	7.1274426	0.57	0.43	0.00	0.35	0.13

Australian Government
Department of Climate Change and Energy Efficiency

Read "Solid Waste Disposal on Land User Guide" for important information on:
- the landfill facility activities that must be reported (energy/emissions)
- how to use this calculator

Please click here for user guide!

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Sections of NGER (Measurement) Determ. 2008 amended, IPCC 2006 Guidelines Vol. 5	NGER Section 5.5	NGER Section 5.4	NGER Section 5.4/IPCC Equation 3.6	NGER Section 5.4	NGER Section 5.10	NGER Section 5.11	NGER Section 5.11	NGER Section 5.11	IPCC Sections 3.2.3, 3.7.2.2	IPCC Sections 3.2.3, 3.2.2, 3.7.2.2	IPCC Sections 3.2.3, 3A1.3	IPCC Section 3.2.3

NSW	Select State/Territory, enter landfill opening year and enter Waste (kt), Q_{cap}, Q_{flared}, O_x	No input required in the fields below				Waste streams (proportions of total) Note: defaults can be overridden in accordance with NGER Determination				Waste mix types - Municipal Solid Waste (proportions of total) Note: defaults can be overridden in accordance with NGER Determination												Waste mix types - Commercial and Industry (proportions of total) Note: defaults can be overridden in accordance with NGER Determination												Waste mix type proportions (adjusted for licensing restrictions if necessary) Note: these values are calculated and no input is required									Fraction of DOC that decomposes (DOCf) (default 0.5) Note: only override default with robust evidence in accordance with IPCC 2006 Guidelines Vol. 5									Note: only override default with robust evidence in accordance with IPCC 2006 Guidelines Vol. 5		
Financial year ending - input landfill opening year in cell below	Waste received landfill (kt)	Q_{cap} (CH_4 only) (m^3)	CH_4 captured (Q_{cap}*O_x*Q_{flared} in kt CO_2-e)	CH_4 (kt CO_2-e)	CH_4gen (kt CO_2-e)	Emissions E_j (CO_2-e) (kt)	Municipal Solid Waste	Commercial and Industrial	Construction and Demolition (calculated by deduction)	Food	Paper and paper board	Garden and park	Wood and wood waste	Textiles	Sludge	Nappies	Rubber and Leather	Inert (including concrete, metal, plastic, glass) (by deduction)	Food	Paper and paper board	Garden and park	Wood and wood waste	Textiles	Sludge	Nappies	Rubber and Leather	Inert (including concrete, metal, plastic, glass) (by deduction)	Food	Paper and paper board	Garden and park	Wood and wood waste	Textiles	Sludge	Nappies	Rubber and Leather	Inert (including concrete, metal, plastic, glass)	Food	Paper and paper board	Garden and park	Wood and wood waste	Textiles	Sludge	Nappies	Rubber and Leather	Concrete, metal, plastic and glass	Methane Correction Factor (MCF)	Decomposition delay (months) (IPCC default is 6)	Fraction of CH_4 in landfill gas (F)
2039	93.06	0	0.0000	0.0000	0.0000	0.0000000	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2040	96.18	0	0.0000	12.4947	12.4947	11.2452119	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2041	96.18	0	0.0000	23.7399	23.7399	21.3659238	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2042	96.18	0	0.0000	33.5140	33.5140	30.1629522	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2043	96.18	0	0.0000	42.0380	42.0380	37.8342404	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2044	96.18	0	0.0000	49.4977	49.4977	44.5479697	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2045	96.18	0	0.0000	56.0491	56.0491	50.4442262	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2046	96.18	0	0.0000	61.8235	61.8235	55.6411877	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2047	96.18	0	0.0000	66.9316	66.9316	60.2384185	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2048	96.18	0	0.0000	71.4666	71.4666	64.3199157	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2049	96.18	0	0.0000	75.5074	75.5074	67.9566481	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2050	96.18	0	0.0000	79.1207	79.1207	71.2086734	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2051	96.18	0	0.0000	82.3632	82.3632	74.1269042	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2052	62.52	0	0.0000	85.2829	85.2829	76.7545815	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2053	0.00	0	0.0000	83.4014	83.4014	75.0612409	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2054	0.00	0	0.0000	73.4816	73.4816	66.1334723	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2055	0.00	0	0.0000	64.9776	64.9776	58.4708319	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2056	0.00	0	0.0000	57.6676	57.6676	51.9008182	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2057	0.00	0	0.0000	51.3661	51.3661	46.2294951	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2058	0.00	0	0.0000	45.9179	45.9179	41.3260777	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2059	0.00	0	0.0000	41.1927	41.1927	37.0734263	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2060	0.00	0	0.0000	37.0814	37.0814	33.3732960	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2061	0.00	0	0.0000	33.4925	33.4925	30.1432117	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2062	0.00	0	0.0000	30.3487	30.3487	27.3138867	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2063	0.00	0	0.0000	27.5855	27.5855	24.8269599	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2064	0.00	0	0.0000	25.1482	25.1482	22.6333805	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2065	0.00	0	0.0000	22.9908	22.9908	20.6917130	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2066	0.00	0	0.0000	21.0744	21.0744	18.9669777	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2067	0.00	0	0.0000	19.3662	19.3662	17.4295954	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2068	0.00	0	0.0000	17.8383	17.8383	16.0544653	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2069	0.00	0	0.0000	16.4670	16.4670	14.8203361	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2070	0.00	0	0.0000	15.2323	15.2323	13.7090986	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2071	0.00	0	0.0000	14.1170	14.1170	12.7053275	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2072	0.00	0	0.0000	13.1065	13.1065	11.7958478	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2073	0.00	0	0.0000	12.1882	12.1882	10.9693794	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2074	0.00	0	0.0000	11.3514	11.3514	10.2162409	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2075	0.00	0	0.0000	10.5868	10.5868	9.5281009	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2076	0.00	0	0.0000	9.8864	9.8864	8.8977701	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2077	0.00	0	0.0000	9.2434	9.2434	8.3190272	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2078	0.00	0	0.0000	8.6516	8.6516	7.7864719	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2079	0.00	0	0.0000	8.1060	8.1060	7.2954026	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2080	0.00	0	0.0000	7.6019	7.6019	6.8417129	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2081	0.00	0	0.0000	7.1353	7.1353	6.4218047	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2082	0.00	0	0.0000	6.7028	6.7028	6.0325148	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2083	0.00	0	0.0000	6.3012	6.3012	5.6710533	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2084	0.00	0	0.0000	5.9277	5.9277	5.3346516	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2085	0.00	0	0.0000	5.5800	5.5800	5.0220178	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2086	0.00	0	0.0000	5.2559	5.2559	4.7302996	0.57	0.43	0.00	0.

Australian Government
Department of Climate Change and Energy Efficiency

Read "Solid Waste Disposal on Land User Guide" for important information on:
- the landfill facility activities that must be reported (energy/emissions)
- how to use this calculator

Please click here for user guide!

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Sections of NGER (Measurement) Determ. 2008 amended, IPCC 2006 Guidelines Vol. 5	NGER Section 5.5	NGER Section 5.4	NGER Section 5.4/IPCC Equation 3.6	NGER Section 5.4	NGER Section 5.10	NGER Section 5.11	NGER Section 5.11	NGER Section 5.11	IPCC Sections 3.2.3, 3.7.2.2	IPCC Sections 3.2.2, 3.7.2.2	IPCC Sections 3.2.3, 3A1.3	IPCC Section 3.2.3

NSW	Select State/Territory, enter landfill opening year and enter Waste (kt), Q_{cap}, Q_{flared}, O_x	No input required in the fields below				Waste streams (proportions of total) Note: defaults can be overridden in accordance with NGER Determination			Waste mix types - Municipal Solid Waste (proportions of total) Note: defaults can be overridden in accordance with NGER Determination										Waste mix types - Commercial and Industry (proportions of total) Note: defaults can be overridden in accordance with NGER Determination										Waste mix type proportions (adjusted for licensing restrictions if necessary) Note: these values are calculated and no input is required										Fraction of DOC that decomposes (DOCf) (default 0.5) Note: only override default with robust evidence in accordance with IPCC 2006 Guidelines Vol. 5										Note: only override default with robust evidence in accordance with IPCC 2006 Guidelines Vol. 5		
Financial year ending - input landfill opening year in cell below	Waste received landfill (kt)	Q_{cap} (CH_4 only) (m^3)	CH_4 captured (Q_{cap}*O_x+Q_{flared} in kt CO_2-e)	CH_4 (kt CO_2-e)	CH_4gen (kt CO_2-e)	Emissions E_i (CO_2-e) (kt)	Municipal Solid Waste	Commercial and Industrial	Construction and Demolition (calculated by deduction)	Food	Paper and paper board	Garden and park	Wood and wood waste	Textiles	Sludge	Nappies	Rubber and Leather	Inert (including concrete, metal, plastic, glass) (by deduction)	Food	Paper and paper board	Garden and park	Wood and wood waste	Textiles	Sludge	Nappies	Rubber and Leather	Inert (including concrete, metal, plastic, glass) (by deduction)	Food	Paper and paper board	Garden and park	Wood and wood waste	Textiles	Sludge	Nappies	Rubber and Leather	Inert (including concrete, metal, plastic, glass)	Food	Paper and paper board	Garden and park	Wood and wood waste	Textiles	Sludge	Nappies	Rubber and Leather	Concrete, metal, plastic and glass	Methane Correction Factor (MCF)	Decomposition delay (months) (IPCC default is 6)	Fraction of CH_4 in landfill gas (F)
2052	33.66	0	0.0000	0.0000	0.0000	0.0000000	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2053	96.18	0	0.0000	4.5192	4.5192	4.0672652	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2054	96.18	0	0.0000	16.8295	16.8295	15.1465884	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2055	96.18	0	0.0000	27.5069	27.5069	24.7562462	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2056	96.18	0	0.0000	36.7986	36.7986	33.1187306	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2057	96.18	0	0.0000	44.9119	44.9119	40.4207319	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2058	96.18	0	0.0000	52.0212	52.0212	46.8190533	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2059	96.18	0	0.0000	58.2728	58.2728	52.4455377	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2060	96.18	0	0.0000	63.7902	63.7902	57.4111723	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2061	69.58	0	0.0000	68.6772	68.6772	61.8095077	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2062	0.00	0	0.0000	69.4507	69.4507	62.5056597	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2063	0.00	0	0.0000	60.8898	60.8898	54.8007827	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2064	0.00	0	0.0000	53.5754	53.5754	48.2178295	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2065	0.00	0	0.0000	47.3105	47.3105	42.5794669	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2066	0.00	0	0.0000	41.9305	41.9305	37.7374293	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2067	0.00	0	0.0000	37.2974	37.2974	33.5676775	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2068	0.00	0	0.0000	33.2960	33.2960	29.9663702	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2069	0.00	0	0.0000	29.8295	29.8295	26.8465099	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2070	0.00	0	0.0000	26.8168	26.8168	24.1351518	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2071	0.00	0	0.0000	24.1901	24.1901	21.7710787	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2072	0.00	0	0.0000	21.8921	21.8921	19.7028650	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2073	0.00	0	0.0000	19.8747	19.8747	17.8872645	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2074	0.00	0	0.0000	18.0976	18.0976	16.2878666	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2075	0.00	0	0.0000	16.5266	16.5266	14.8739757	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2076	0.00	0	0.0000	15.1330	15.1330	13.6196831	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2077	0.00	0	0.0000	13.8923	13.8923	12.5030786	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2078	0.00	0	0.0000	12.7840	12.7840	11.5056116	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2079	0.00	0	0.0000	11.7906	11.7906	10.6115443	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2080	0.00	0	0.0000	10.8972	10.8972	9.8075009	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2081	0.00	0	0.0000	10.0912	10.0912	9.0820898	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2082	0.00	0	0.0000	9.3618	9.3618	8.4255884	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2083	0.00	0	0.0000	8.6996	8.6996	7.8296792	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2084	0.00	0	0.0000	8.0969	8.0969	7.2872299	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2085	0.00	0	0.0000	7.5468	7.5468	6.7921081	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2086	0.00	0	0.0000	7.0434	7.0434	6.3390211	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2087	0.00	0	0.0000	6.5816	6.5816	5.9234165	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2088	0.00	0	0.0000	6.1570	6.1570	5.5413135	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2089	0.00	0	0.0000	5.7659	5.7659	5.1892712	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2090	0.00	0	0.0000	5.4048	5.4048	4.8642830	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2091	0.00	0	0.0000	5.0708	5.0708	4.5637168	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2092	0.00	0	0.0000	4.7614	4.7614	4.2852620	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2093	0.00	0	0.0000	4.4743	4.4743	4.0268826	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2094	0.00	0	0.0000	4.2075	4.2075	3.7867793	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2095	0.00	0	0.0000	3.9593	3.9593	3.5633565	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2096	0.00	0	0.0000	3.7280	3.7280	3.3551944	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2097	0.00	0	0.0000	3.5123	3.5123	3.1610260	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2098	0.00	0	0.0000	3.3108	3.3108	2.9797167	0.57	0.43	0.00	0.35	0.13	0.17	0.01	0.02	0.00	0.04	0.01	0.28	0.22	0.16	0.04	0.13	0.04	0.02	0.00	0.04	0.38	0.29	0.14	0.11	0.06	0.03	0.01	0.02	0.02	0.32	0.84	0.49	0.47	0.23	0.50	0.50	0.50	0.50	0.50	1.0	6.00	0.50
2099	0.00	0	0.0000	3.1225	3.1225	2.8102475	0.57	0.43	0.00	0.35	0.

APPENDIX F

Flora and Fauna Assessment

BIOSIS
RESEARCH



Whytes Gully
New Landfill Cell
Terrestrial and Aquatic
Flora and Fauna Assessment

A report prepared for
Golder Associates Pty. Ltd.

March 2012

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ABBREVIATIONS

Biodiversity	The variety of biological life (plants and animals)
CAMBA	*China-Australia Migratory Bird Agreement*
DCP	Development Control Plan
DGRs	Director Generals Requirements
DoPI	Department of Planning and Infrastrcture
EEC	Endangered Ecological Community
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
FM Act	*Fisheries Management Act 1995*
Golder	Golder Associates Pty. Ltd.
ILGW	Illawarra Lowlands Grassy Woodland
ISTR	Illawarra Subtropical Rainforest
JAMBA	*Japan-Australia Migratory Bird Agreement*
KTP	Key Threatening Process (as defined in the TSC Act)
LEP	local environmental plan
LGA	local government area
Locality	10 kilometre radius of Subject Site

MNES	Matters of National Environmental Significance, as listed under the EPBC Act
NPWS	NSW National Parks and Wildlife Service (now part of the DECCW)
OEH	NSW Office of Environment and Heritage (formerly NSW Department of Environment, Climate Change and Water)
PEA	Preliminary Environmental Assessment
PMST	SEWPaC Protected Matters Search Tool database (http://www.environment.gov.au/epbc/pmst/index.html)
POEO Act	NSW *Protection of the Environment Operations Act 1997*
ROKAMBA	*Republic of Korea-Australia Migratory Bird Agreement*
SEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities (formerly the Commonwealth Department of the Environment, Water, Heritage and the Arts)
Study Area	Area of direct impact and any areas subject to potential indirect impacts
Subject Site	Area of direct impact
TSC Act	*Threatened Species Conservation Act 1995*
sp.	species (singular)
spp.	species (plural)
ssp.	subspecies
var.	variety
WCC	Wollongong City Council

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SUMMARY

Wollongong City Council (WCC) is planning to develop a new landfill cell within the Whytes Gully Resource Recovery Park to meet future landfill needs (referred to as The Project). This report assesses the ecological significance of the general and threatened flora and fauna species and endangered ecological communities that occur, or have the potential to occur, within the Study Area in regard to the expected impact of the proposed works.

The Study Area covers 65 hectares (Figure 1). The Study Area currently operates as the Whytes Gully Resource Recovery Park and receives landfill from the WCC local government area (LGA). The majority of the Study Area supports grassland with the patches of regrowth scrub and woodland/open forest.

Section 1.0 introduces the projects, details the aims of this assessment and provides a description of the site.

Section 2.0 outlines the methodology used during the current assessment. This included a habitat based flora and fauna assessment (aquatic and terrestrial), detailed surveys for birds and bat as well as targeted surveys for the following threatened species:

- White-flowered Wax Plant *Cynanchum elegans;*
- Illawarra Socketwood *Daphnandra* sp. Illawarra;
- Lilly Pilly *Syzigium paniculatum*;
- Green and Golden Bell Frog *Litoria* aurea; and,
- Australian painted Snipe *Rostratula australis*.

Section 3.0 outlines the results of the current assessment. This assessment identified several significant biodiversity values within the Study Area, including:

- Illawarra Subtropical Rainforest Endangered Ecological Community (EEC). Identified in the north-east of the Study Area;
- Two threatened fauna species, the Grey-headed Flying-fox *Pteropus poliocephalus* and Southern Myotis *Myotis macropus* (probable detection), were recorded in the Study Area;
- There is also a high likelihood of an additional five fauna species occurring in the Study Area for foraging purposes. These species are highly mobile microchiropteran bats which include:
  - Eastern Bentwing-bat *Minopterus schreibersii oceanensis*;

- Eastern Freetail Bat *Mormopterus norfolkensis*;
- Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris*;
- Eastern False Pipistrelle *Falsistrellus tasmaniensis*;
- Greater Broad-nosed Bat *Scoteanax rueppellii*;

Potential habitat for the Green and Golden Bell Frog *Litoria aurea* and Australian Painted Snipe *Rostratula autralis* was recorded within the Study Area. Targeted surveys for these species were undertaken between November 2011 and January 2012. Neither species was recorded.

An assessment according to the *Draft Guidelines for Threatened Species Assessment* (DEC & DPI 2005) was undertaken for the EEC and species listed above.

No threatened flora species were detected.

Section 4.0 outlines the potential impacts of The Project and suggested mitigation measures. Potential impacts include:

- Vegetation removal;
- Reduced habitat for flora and fauna species;
- Changes to soil hydrology;
- Modifications to a drainage line flowing into Dapto Creek;
- Potential indirect impacts to Dapto Creek downstream of the overflow of the surface water ponds; and,
- Indirect impacts from the construction phase of The Project.

Key mitigation measures include:

- Undertaking additional targeted surveys for Green and Golden Bell Frog in peak breeding period for 2012/2013 to confirm results of the current surveys;
- The current water quality monitoring programme is being expanded to include additional upstream and downstream locations along Dapto Creek; and,
- The Project has been designed to minimise removal of native vegetation, particularly within the Illawarra Subtropical Rainforest EEC.

Provided that the mitigation measures above are adhered to, The Project is not considered likely to have a significant impact on biodiversity values present in the Study Area.

1.0 INTRODUCTION

Biosis Research Pty. Ltd. (Biosis) was commissioned by Golder Associates Pty. Ltd. (Golder), on behalf of Wollongong City Council (WCC), to undertake a flora and fauna assessment to inform the environmental assessment for a new landfill cell at the Whytes Gully Resource Recovery Park (Figure 1).

In order to meet future landfill capacity needs, WCC is planning to develop a new landfill cell within the current boundary of the existing Whytes Gully Resource Recovery Park. The conceptual design has highlighted that The Project will be completed in four stages, the first of which is to be available for operational use to accept WCC waste by late 2013. It is anticipated that the new landfill cell would be integrated with, and sit on top of, the existing two landfill cells through a "piggy-back" style landfill in order to meet the required capacity. These works are referred to as The Project.

The Project is being assessed under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The Preliminary Environmental Assessment (PEA) was submitted to the Department of Planning and Infrastructure (DoPI) on the 30th June 2011 and Director General's Requirements (DGRs) for The Project on the 11th August 2011.

This report assesses the conservation significance of terrestrial and aquatic flora and fauna within the Study Area, and potential impacts of The Project on threatened species, populations or ecological communities that occur, or have the potential to occur, in the Study Area. This assessment has been undertaken in accordance with the requirements of the EP&A Act, *Threatened Species Conservation Act 1995* (TSC Act), *Fisheries Management Act 1994* (FM Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) along with DGRs issued for The Project.

For the purposes of this assessment, the following definitions are used;

- **Subject Site** – this area has been defined as the new landfill cell footprint, as provided by Golder (dated 22/12/2011). The Subject Site is the key area of investigation to assess the biodiversity constraints to a proposed Whytes Gully new landfill cell (Figure 2).
- **Study Area** – includes the Subject Site and any additional areas which are likely to be affected by the proposal, either directly or indirectly. For the terrestrial ecology assessment this area is considered to include all areas within the fenced Whytes Gully Resource Recovery Park, the stand of vegetation and tracked area to the south-east forming part of the property and the unnamed drainage line that exits south of Reddalls Road (Figure 2).

  The aquatic ecology assessment considers areas beyond the above described study area in order to confirm the presence of barriers to fish movement. The extended area examined included Dapto Creek upstream and downstream of the Whytes Gully Resource Recovery Park to its confluence with Mullet Creek.

- **Locality** – a 10 kilometre buffer surrounding the Subject Site.

1.1 Aims

The general aim of this report is to undertake a terrestrial and aquatic flora and fauna study that adequately addresses assessment requirements of The Project.

The specific aims are to:

- Conduct a literature review and database search of the Locality;
- Undertake an assessment of the general flora and fauna values of the Study Area, with a focus on the potential of the Study Area to support threatened terrestrial and aquatic flora and fauna species, populations or ecological communities that are listed on the TSC Act, FM Act and/or EPBC Act, and have been identified as potentially occurring in the area;
- Provide a brief assessment of the habitat values of the Study Area;
- Identify potential impacts to identified biodiversity values;
- Assess the need for Assessments of Significance for any threatened flora and fauna species, populations and ecological communities listed on the TSC Act, FM Act and/or the EPBC Act occurring or potentially occurring in the Study Area;
- Conduct Assessments of Significance as required; and
- Provide mitigation measures to avoid, mitigate and/or minimise the environmental impacts of The Project.

The environmental assessment (EA) is required to address the DGR's issued by DoPI. The DGR's for The Project were issued on the 11th August 2011. The DGR's relevant to this assessment, along with the section of this report where they are addressed, are listed in Table 1 below.

Table 1: DGR's for Whytes Gully with the relevant section of the report

Section	Requirement	Relevant Report Section
General Requirements	A description of the measures that would be implemented to avoid, minimise, mitigate, rehabilitate/remediate, monitor and/or offset the potential impacts of the project, including any contingency plans for managing any potentially significant risks to the environment.	Section 4.2 (Mitigation Measures)
	Accurate estimates of any vegetation clearing associated with the project.	Section 4.1 (Potential Impacts)

Section	Requirement	Relevant Report Section
	A detailed assessment of the potential impacts of the project on any terrestrial and aquatic threatened species or populations and their habitats, endangered ecological communities or groundwater dependant ecosystems.	Section 3.1.3 (Threatened Ecological Communities) Section 3.2.1 (Threatened Flopra Species) Section 3.4.1 (Threatened Fauna Species) Section 3.5.2 (Significant Aquatic Flora) Section 3.5.3 (Significant Aquatic Fauna) No groundwater dependant ecosystems occur with the Study Area.
	A detailed description of the measures that would be implemented to avoid or mitigate impacts to biodiversity.	Section 4.2 (Mitigation Measures)
	An offset strategy to ensure that the project maintains or improves the biodiversity values of the region in the medium to long term (in accordance with NSW and Commonwealth policies).	The Project will result in minimal impacts to biodiversity. Through implementation of mitigation measures outlined in Section 4.2, particularly weed control and revegetation works, the biodiversity values of the region will be improved.
Office of Environment and Heritage (OEH)	The EA should contain the following information as a minimum:	
	a. The requirements set out in the *Guidelines for Threatened Species Assessment* (Department of Planning, July 2005).	The assessment has been undertaken in accordance with these guidelines. Assessments of significance (Appendix 3) have been undertaken according to criteria set out in Appendix 3 of this document
	b. Description and geo-referenced mapping of study area (and spatial data files), e.g. overlays on topographic maps, satellite images and/or aerial photos, including details of map datum, projection and zone, all survey locations, vegetation communities (including classification and methodology used to classify), key habitat features and reported locations of threatened species populations and ecological communities present in the subject site and study area.	Figures 1 – 9

Section	Requirement	Relevant Report Section
	c. Description of survey methodologies used, including timing, location and weather conditions.	Section 2 (Methods)
	d. Details, including qualifications and experience of all staff undertaking the surveys, mapping and assessment of impacts as part of the EA	Appendix 8 - Curriculum Vitae of Key Personnel
	e. Identification of national and state listed threatened biota known or likely to occur in the study area and their conservation status.	Section 3.1.3 (Threatened Ecological Communities) Section 3.2.1 (Threatened Flopra Species) Section 3.4.1 (Threatened Fauna Species) Section 3.4.2 (Predicted Species) Section 3.4.3 (Migratory Species) Section 3.5.2 (Significant Aquatic Flora) Section 3.5.3 (Significant Aquatic Fauna)
	f. Description of the likely impacts of the proposal on biodiversity and wildlife corridor, including direct and indirect and construction and operation impacts. Wherever possible, quantify these impacts such as the amount of each vegetation community or species habitat to be cleared or impacted, or any fragmentation of a wildlife corridor.	Section 4.1 (Potential Impacts)
	g. Identification of the avoidance, mitigation and management measures that will be put in place as part of the proposal to avoid or minimise impacts, including details about alternative options considered and how long term management arrangements will be guaranteed.	Section 4.2 (Mitigation Measures)
	h. Description of the residual impacts of the proposal. If the proposal cannot adequately avoid or mitigate impacts on biodiversity, then a biodiversity offset package is expected.	Section 4.1 (Potential Impacts) Section 5.0 (Conclusion)

Section	Requirement	Relevant Report Section
	i. Provision of specific Statement of Commitments relating to biodiversity.	

1.2 Site Description

The Whytes Gully Resource Recovery Park is located on public land approximately 1.5 kilometres north-west of Kembla Grange and approximately nine kilometres southwest of the Wollongong Central Business District (Figure 1 and Figure 2). The Subject Site currently operates as the Whytes Gully Resource Recovery Park and receives waste from the WCC LGA.

The majority of the Study Area supports exotic grassland with the patches of regrowth scrub and woodland/open forest. This vegetation is generally in poor condition with weeds throughout the understorey. An area of forest and subtropical rainforest in the north east of the Study Area is in better condition, with all native vegetation layers intact. Aquatic habitats across the Study Area include a number of surface water ponds, consisting of three large interconnected ponds, five small dams and several other additional water bodies associated with the operations of the Whytes Gully Resource Recovery Park. These provide habitat of varying condition for a range of fauna species.

2.0 METHODS

Terrestrial and aquatic ecological surveys were undertaken between the 1st June 2011 and 10th January 2012 in varying weather conditions as detailed below.

Table 2: Summary of survey dates and weather conditions

Survey Type	Date	Weather	Temperature
Initial terrestrial ecology site inspection	1 June 2011	Cool and overcast with heavy showers during the first part of the day	14.5 – 17.9°C
Diurnal fauna surveys	7 June & 10 June 2011	Dry and cool with gusty south westerly winds	7 June 6.6 – 14.9°C 10 June 10.6 – 16.1°C
Nocturnal fauna surveys	7 June & 10 June 2011	Dry and cool with gusty south westerly winds	7 June 6.6 – 14.9°C 10 June 10.6 – 16.1°C
Flora survey	10 June 2011	Cool, dry, windy conditions	10.6 – 16.1°C
Targeted flora survey	19 July 2011	Cool overcast conditions with some showers	10.7 – 18.3°C
Aquatic survey	5 Sept 2011	Cool and overcast, with periods of light drizzle in the morning and clearing by the afternoon	14 – 18.8°C
Targeted fauna surveys			
Round 1	2 Nov 2011	Moderate overcast conditions with some showers later in the evening	14.1 – 20.1°C
Round 2	14 Nov 2011	Moderate overcast conditions with some showers later in the evening	18.9 – 21.3°C
Round 3	28 Nov 2011	Moderate clear conditions, windy on the coast	18.6- 23.7°C
Round 4	10 Jan 2012	Moderately overcast and still conditions	11.7 – 29.8°C

Methodology for each of these surveys is outlined further below.

2.1 Taxonomy

The plant taxonomy (method of classification) used in this report follows Harden (1990, 1992, 1993, 2002). In the body of this report plants are referred to by their scientific names followed by common name (where available) in the first instance and then by their common name only.

Names of vertebrates follow the Census of Australian Vertebrates (CAVs) maintained by SEWPaC. In the body of this report vertebrates are referred to by both their common and scientific names when first mentioned. Subsequent references to these species cite the common name only. Common and scientific names are included in the Appendices.

2.2 Legislation

Commonwealth and State legislation and policies that apply to the Study Area with regard to terrestrial flora and fauna are listed below.

2.2.1 Environmental Protection and Biodiversity Conservation Act 1999 (Commonwealth)

The EPBC Act is a Commonwealth mechanism that requires proposed actions to be assessed in terms of their potential impact upon "Matters of National Environmental Significance" (MNES). Eight MNES are currently listed under the EPBC Act, including;

- World Heritage properties;
- Natural heritage places;
- Wetlands of international importance (Ramsar wetlands);
- Threatened species and ecological communities;
- Migratory species;
- Commonwealth marine areas;
- The Great Barrier Reef Marine Park; and
- Nuclear actions (including uranium mining).

Where a potential impact on a MNES is likely to occur as a result of a proposed action, the significance of that impact must be assessed. Guidelines for determining whether an impact is significant are provided under the Act. Where a proposed action will, or is likely to, have a significant impact on a MNES, a referral to the Commonwealth Minister for SEWPaC should be prepared. The purpose of the referral is to determine whether a proposed action requires approval and/or further assessment under the EPBC Act.

2.2.2 Environmental Planning and Assessment Act 1979 (NSW)

Director Generals Requirements (DGRs) were received from the Department of Planning and Infrastructure (DoPI) on the 11 August 2011 and The Project is to be assessed in

accordance with Part 3A of the EP&A Act. In accordance with Section 5, the objectives of the EP&A Act include:

- *a) To encourage:*

  vi) The protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities and their habitats.

  vi) Ecologically sustainable development (including the precautionary principle as defined under the *Protection of the Environment Administration Act 1991*).

The assessment process under Part 3A of the EP&A Act provides a single assessment and approval regime for major State infrastructure projects, State significant development and other projects, plans or programs declared by the Minister for Planning. Projects assessed under Part 3A are exempt from having to obtain some approvals required under alternative assessment pathways. For example Species Impact Statement (SIS) are not required. However, The Project would be required to address a range of factors, including those identified within s.5A of the EP&A Act, to determine the potential impacts to threatened species, populations or communities occurring or considered likely to occur within the Study Area. These assessments are undertaken according to the *Draft Guidelines for Threatened Species Assessment* (DEC & DPI 2005), which sets out an impact assessment for projects being assessed under Part 3A of the EP&A Act.

An assessment has been undertaken with reference to s.5A of the EP&A Act and *Draft Guidelines for Threatened Species Assessment* (DEC & DPI 2005; DECC 2007; DEC 2004) for the Illawarra Subtropical Rainforest EEC, Grey-headed Flying-fox, Eastern Bentwing-bat, Southern Myotis, Yellow-bellied Sheathtail-bat, Eastern Freetail Bat, Eastern False Pipistrelle and Greater Broad-nosed Bat (Appendix 3).

The Minister for Planning and Infrastructure is the consent authority for all major projects and critical infrastructure assessed under Part 3A of the EP&A Act.

Although not required to be considered by Part 3A projects, the Wollongong Local Environmental Plan (West Dapto) (LEP) 2010, which nominally applies to the study area and subject site at Kembla Grange, addresses a range of land management practices and environmental issues relevant to this aquatic aspects of this project. Those objectives relevant to the proposal are:

- To establish development controls for the land to which this Plan applies in order to facilitate the timely provision of physical and social infrastructure, the orderly phasing of the development of land, the protection of riparian vegetation corridors and items of environmental and cultural heritage and the management of stormwater and to provide for appropriate management of land that will contribute to biodiversity conservation; and,
- To identify, protect and manage environmentally and culturally sensitive areas at West Dapto and Dapto Regional Centre, including waterways, riparian corridors,

biological corridors, remnant native vegetation and associated buffers and items of environmental heritage.

For consistency, the mitigation measures relevant to riparian and aquatic ecosystems take the objectives of the West Dapto LEP into account.

2.2.3 Threatened Species Conservation Act 1995 (NSW)

The TSC Act protects all threatened plants and animals native to NSW (with the exception of fish and marine plants). It provides for the identification, conservation and recovery of threatened species, populations and communities. It also aims to reduce the threats faced by those species.

Impacts to species listed under the TSC Act are normally assessed according to Section 94 of the Act. However, as The Project is being assessed under Part 3A of the EP&A Act, Assessments of Significance (Seven Part Tests) are not required for threatened species, populations or communities, and Species Impact Statements (SIS) will not be required for any threatened species, populations or communities where a significant impact is expected. Part 3A Assessments of Significance have been undertaken to assess whether a significant impact is expected for threatened species or ecological communities (see above and Appendix 3).

2.2.4 Fisheries Management Act 1994 (NSW)

The FM Act aims to conserve threatened species, populations and ecological communities of fish and marine vegetation native to NSW and to promote ecologically sustainable development, including the conservation of biological diversity. It also aims to reduce the threats faced by native fish and marine vegetation in NSW.

As with the TSC Act (see above), if a planned development or activity is likely to have an impact on an aquatic threatened species, population or ecological community this must be taken into account in the development approval process. However, as The Project is being assessed under Part 3A of the EP&A Act, Assessments of Significance (Seven Part Tests) are not required for threatened species, populations or communities, and Species Impact Statements (SIS) will not be required for any threatened species, populations or communities where a significant impact is expected. Part 3A Assessments of Significance have been undertaken to assess whether a significant impact is expected for threatened species Wollongong LEP (West Dapto) 2010.

2.3 Background Review

A list of documents used to prepare this report is located in the References section of this report. Records of threatened species, populations and communities were obtained from the NSW National Parks and Wildlife Service (NPWS) Atlas of NSW Wildlife within a 10 kilometres radius of the Study Area (Figure 3 and Figure 4). Fish records were obtained from the Department of Primary Industries (DPI) protected species records viewer.

Threatened species, populations and communities listed on the EPBC Act and predicted to occur within a 10 kilometres radius of the Study Area were obtained from the SEWPaC Protected Matters Search Tool (PMST). Database searches were conducted in May 2011 prior to the field surveys. Aquatic database searches were undertaken in September 2011.

Literature reviewed includes;

- The Draft Illawarra Biodiversity Strategy 2010 (the Strategy) (WCC *et al* 2010a; WCC *et al* 2010b);
- The *Native Vegetation of the Illawarra Escarpment and Coastal Plain* (NPWS 2002); and,
- *Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands. Version 1.0*. (SCIVI) by Tozer *et al* (2006).

2.4 Consultation

The following specialists were consulted about the threatened flora and fauna occurring in the Study Area:

- Gary Leonard – Wollongong City Council
- Jen Byrne and Paul Wearne – Office of Environment and Heritage

2.5 Flora Survey

The general flora survey conducted over the Study Area applied the following methods:

- Determination of the vegetation communities present within the Study Area and comparison to those mapped as occurring within relevant vegetation mapping;
- The boundary between varying vegetation communities observed in the field was walked and tracked using a hand held GPS unit;
- An assessment of each vegetation community was conducted including a species inventory, abundance and description of the vegetation structure;
- Random meanders were conducted through the Study Area to opportunistically search for threatened species, assess potential habitat for threatened species and determine changes in vegetation community;
- The general condition of the vegetation was assessed based on disturbance history, the degree of infestation by exotic species and vegetation structure; and,
- An assessment of the likelihood for threatened species to occur within the Study Area was conducted. The assessment criteria used is summarised in Section 2.8.

The three categories used to evaluate general habitat value were Good, Moderate or Poor as detailed below:

- Good: containing a high number of indigenous species; no weeds present or weed invasion restricted to edges and track margins; vegetation community contains original layers of vegetation; vegetation layers (ground, shrub, canopy etc.) are intact;
- Moderate: containing a moderate number of indigenous species; moderate level of weed invasion; weeds occurring in isolated patches or scattered throughout; one or more of original layers of vegetation are modified; vegetation layers (ground, shrub, canopy etc.) are largely intact; and,
- Poor: containing a low number of indigenous species; high level of weed invasion; weeds occurring in dense patches or scattered throughout; one or more of the original layers of vegetation are highly modified; one or more original vegetation layers (ground, shrub, canopy etc.) are modified or missing.

2.5.1 Targeted Flora Survey

Targeted flora surveys were conducted on 19 July 2011 for *Cynanchum elegans*, *Daphnandra sp. Illawarra*, *Szygium paniculatum* and to map the boundaries of the Illawarra Subtropical Rainforest Endangered Ecological Community (EEC). These surveys applied the following methods:

- A combination of line transects and random meanders were conducted through identified areas of potential threatened species habitat;
- Line transects (east to west) were conducted at approximately two metre intervals;
- Random meanders were conducted where dense vegetation and steep terrain restrict the walking of transects to ensure all potential habitat were thoroughly surveyed; and,
- Transects and random meanders were tracked by hand held GPS.

2.6 Fauna Survey

General fauna surveys consisted of a combination a habitat based assessment followed by diurnal and nocturnal investigations. Targeted fauna surveys were also undertaken for two threatened species considered likely to occur within the Study Area.

2.6.1 Fauna Habitat Assessment

Prior to diurnal and nocturnal or targeted surveys being undertaken, a habitat based assessment of the Study Area was undertaken by three zoologists. The objective of this assessment was to identify the range of species and fauna habitats within the Study Area, with a particular emphasis on threatened and migratory species, likely to occur.

Fauna habitats were assessed by examining the following characteristics of the Study Area:

- Structure and floristics of the canopy;

- Understorey and ground cover vegetation;
- Abundance and size range of hollows and fissures in trees;
- Structure and composition of the litter layer;
- Disturbances, including weed invasion, clearing, rubbish or fire;
- Potential foraging, nesting or roosting resources; and,
- Connectivity to off site habitats.

The following criteria were used to evaluate habitat values:

- Good: good condition endemic vegetation supporting a full range of fauna habitat components are usually present (e.g. hollow bearing trees, fallen timber, feeding and roosting resources) and habitat linkages to other remnant ecosystems in the landscape are intact;
- Moderate: Some fauna habitat components are missing (for example, old-growth trees and fallen timber), although linkages with other remnant habitats in the landscape are usually intact, but sometimes degraded; and,
- Poor: Many fauna habitat elements in low quality remnants have been lost, including old growth trees (for example, due to past timber harvesting or land clearing) and fallen timber, and tree canopies are often highly fragmented. Habitat linkages with other remnant ecosystems in the landscape have usually been severely compromised by extensive clearing in the past.

Other features considered in the fauna habitat assessment included; habitat corridors and vegetation communities present.

Diurnal and nocturnal field surveys were then designed accordingly[1].

2.6.2 Diurnal and Nocturnal Fauna Surveys

Diurnal survey techniques comprised the use of the following techniques:

- Two 30 minute dawn bird surveys and one 30 minute dusk bird survey were undertaken by two zoologists at 3 locations including the surface water reed beds 1 and 2 located in the south-west of the Study Area, the closed forest habitat in the north and the open forest/woodland habitat located in the south-east of the Study Area (Figure 5). Birds were recognised by calls, flight patterns and plumage;
- Direct sightings and observations of other signs and traces such as tracks and scats and aural recognition of calls;
- Active searches for reptiles, amphibians and small mammals by turning logs, rocks and other debris for native fauna in locations of preferential habitat such the closed

[1] Note that field surveys were based on the proposed impacts as per the footprint shown in the PEA. As such, more emphasis was placed on those areas located in the south-west of the Study Area prior to the revision of the footprint.

forest, open forest/woodland and around aquatic environments of the Study Area; and,

- Assessments of other microhabitats as hollows, culverts and artificial habitat features.

Standard nocturnal survey techniques comprised the use of the following techniques:

- Ultrasonic bat detectors (Anabat) – four Anabat detectors (Titley Electronics) were deployed across the Study Area for three consecutive nights to record microbat echolocation calls (Figure 5). The Anabat devices were positioned in potential microbat flyways or foraging areas. The graphic signature of the microbat calls was examined in the program ANALOOK which were compared against a reference library of calls to determine the species recorded (Churchill 2008; Pennay *et al.* 2004);
- Call playback – nocturnal call playback was conducted over two nights (Figure 5) for the Barking Owl *Ninox connivens*, Powerful Owl *Ninox strenua* and Masked Owl *Tyto novaehollandiae*. An initial listening period was carried out for ten minutes, followed by ten minutes of spotlighting. The calls of each of the target species were played intermittently for five minutes, followed by a further ten minute listening period. After all calls had been played, another ten minutes of spotlighting and listening was undertaken to check for birds attracted by the calls but not vocalising;
- Spotlighting - Spotlighting was conducted on foot by two zoologists throughout the Study Area over two nights using 75-W spotlights for two hours. Vehicle traverses were also conducted along established roads at a speed not exceeding 5 km/h when travelling between survey locations within the Study Area (Figure 5); and,
- Motion activated cameras – two motion-activated cameras were deployed in the Study Area for two nights (Figure 5). Areas containing evidence of fauna activity and stands of vegetation were targeted. A standard bait of rolled oats, honey and peanut butter were used to attract fauna to the field of view of the camera.

Table 3 summarises fauna survey effort within the Study Area.

Table 3: Summary of standard fauna field survey effort

Survey Technique	Description	Total Survey Effort
Bird Surveys	• Two 30 minute dawn surveys • One 30 minute dusk survey • Undertaken by two zoologists	180 person minutes
Active searching	• Undertaken during diurnal habitat assessment and opportunistically	Approximately 480 person minutes

Survey Technique	Description	Total Survey Effort
Anabat surveys	• Four Anabats • Deployed for three nights	12 bat detector nights
Motion Activated Camera surveys	• Two Motion Activated Cameras • Deployed for three nights	6 motion activated camera nights
Call playback	• Two nights • Two locations • 45 minutes per location	180 minutes
Spotlighting	• Two zoologists • Two nights • 120 minutes per night	480 person minutes

The presence of fauna species utilising the Study Area was also determined through consideration of suitable habitats, with species of animal present on the site recorded opportunistically during the course of habitat assessments and other routine surveys.

Following winter fauna surveys and habitat assessments, additional targeted fauna surveys were conducted to determine the presence of threatened species thought to potentially occur within the Study Area (Section 2.6.3).

2.6.3 Targeted Fauna Surveys

Following standard fauna field surveys and habitat assessment, subsequent targeted surveys were undertaken for the Green and Golden Bell Frog (GGBF) and Australian Painted Snipe (APS).

Field surveys were undertaken in accordance with DEC (2004), DECC (2009) and DEWHA (DEWHA 2010a; DEWHA 2010b) guidelines specific to the field survey of threatened frog and bird species in proposed development areas.

Surveys were undertaken by zoologists familiar with the advertisement call, ecology and identification of the GGBF and APS over of period of four days/nights between 2nd November 2011 and 10th January 2012, when the GGBF were active at known reference sites. Two additional surveys are planned for the peak GGBF breeding season between January and March 2012 to confirm the results of the current surveys, which will provide a total of six survey nights.

Field surveys were undertaken following the seasonal and climatic recommendations in the GGBF guidelines:

- Seasonal: November and January to conform with DECCW and DSEWPC recommendations of between September and February and to target peak breeding season in January and February

- Weather Conditions: Warm temperatures, no wind and within one week of heavy rainfall
- Timing: Between dusk and dawn

Temperature, relative humidity and rainfall immediately before and during the survey are presented in the Table below. The accumulative rainfall total was also recorded during the seven day prior to field surveys and is also shown in Table 3 below.

Table 4: Weather conditions during field investigations and accumulative rainfall 7 days prior to surveys

Date	Temperature (ºC)		Relative Humidity at 3 pm	Rainfall (mm) on survey night	Accumulative rainfall (mm) 7 days prior to survey
	Min	Max			
2 Nov 2011	14.1	20.1	63%	0.2	2.2
11 Nov 2011	15.6	21.3	66%	0.2	16.6
28 Nov 2011	16.8	23.7	82%	0	104.2
10 Jan 2012	11.7	29.8	45%	0	2.8

Source: Bureau of Meteorology (2011). Temperature, humidity and rainfall data collected from Bellambi Weather Station.

At the commencement of each nightly survey, the Port Kembla Heritage Park reference site was surveyed to determine whether the GGBF was active. During this check an initial five minute passive listening period was undertaken to determine if the species was calling unsolicited. This was followed by a period of call playback in an attempt to elicit the advertisement call of the male GGBF and a limited period of active searching, as the purpose of checking reference sites was to determine whether the species was active.

The Whytes Gully inter-connected surface water polishing pond system was then surveyed for a minimum of four person hours provided the species had been identified at a nearby reference site on that day. An additional 2.5 person hours of survey was conducted in the three small decommissioned surface water ponds located to the east of the surface water polishing ponds and a drainage line located along the south-western boundary and a further two hours of survey was conducted at the two small surface water ponds located adjacent to the existing site office. A total of 8.5 person hours of active searching is deemed sufficient over the 4.2 hectares of potential habitat of the Study Area.

During detailed nocturnal surveys of each water body, an initial five minute period of passive listening was undertaken to detect the call of male frogs. This was followed by a period of call playback (broadcast of frog calls) in an attempt to elicit a response from any frogs that might be present. Following call playback each water body was then carefully

searched for frogs using hand-held spotlights and binoculars. Area searches and transects of vegetation surrounding those water bodies, considered to be suitable habitat, for the GGBF and APS were undertaken. Active searching of refuge sites (e.g. under logs, rocks or tin) were also undertaken for the GGBF.

2.7 Aquatic Survey

2.7.1 Stream order

The Strahler method was used to determine the stream order of each waterway flowing through and adjacent to the study area. The Wollongong topographic map 1:25,000 (third edition 9029-2S) (Land Information Centre 2000) was referred to when calculating stream order using the Strahler method.

2.7.2 HABSCORE Assessment

The assessment of aquatic habitats was undertaken using the HABSCORE assessment methodology. Barbour *et al.* (1999) describes this methodology as follows: 'HABSCORE is a visually based habitat assessment that evaluates the structure of the surrounding physical habitat that influences the quality of the water resource and the condition of the resident aquatic community' (Barbour *et al.* 1999). HABSCORE assessments utilise visually based habitat characteristics to classify the quality of the water resource and the condition of the resident aquatic community. The descriptors and categories for the HABSCORE assessment used in this survey are provided in Appendix 4. At each survey site, an assessment of the waterway and its riparian condition was undertaken and classified based on the presence and condition of the following features:

- Pool substrate characterisation;
- Pool variability;
- Channel flow status;
- Bank vegetation (score for each bank);
- Bank stability (score for each bank);
- Width of riparian zone (score for each bank); and
- Epifaunal substrate / available cover.

The aquatic habitat within the Study Area was described in terms of four category types (adapted from Barbour *et al.* 1999 and Fairfull and Witheridge 2003. The four categories used to evaluate habitat value are Optimal, Suboptimal, Marginal or Poor, as detailed below:

Optimal: watercourses that contain numerous large, permanent pools and generally have flow connectivity except during prolonged drought. They provide extensive and diverse aquatic habitat for aquatic flora and fauna.

Suboptimal: watercourses that contain some larger permanent and semi-permanent refuge pools, which would persist through prolonged drought but become greatly reduced in extent. These watercourses should support a relatively diverse array of aquatic biota including some fish, freshwater crayfish and aquatic macroinvertebrates. There may also be some aquatic plant species present.

Marginal: watercourses that contain some small semi-permanent refuge pools which are unlikely to persist through prolonged drought. Flow connectivity would only occur during and following significant rainfall. These pools may provide habitat for some aquatic species including aquatic macroinvertebrates and freshwater crayfish.

Poor: ephemeral drainage lines that only contain flow during and immediately after significant rainfall. Permanent or semi-permanent pools that could provide refuge for aquatic biota during prolonged dry weather are absent.

2.7.3 Water Quality Analysis

Measurements of Dissolved Oxygen (DO), pH, Electrical Conductivity (EC), Temperature and Turbidity were taken using a calibrated TPS 90FLT Field Lab Analyser Water Quality Meter. Water quality was taken where available water enabled the Water Quality Meter to be used effectively, usually greater than 30cm in depth. Alkalinity was also assessed (where possible) using a Hach Alkalinity Kit.

2.8 Likelihood of occurrence criteria

The likelihood of occurrence assessment for threatened flora and fauna, and migratory species, was based on previous records collated from database searches, data collected during the field survey, the current (known) distribution of these species and the presence and condition of suitable habitat in the Study Area. The likelihood of occurrence assessments for threatened flora and fauna are provided in Appendix 2.

The criteria used to assess the likelihood of threatened or migratory species to occur within the Study Area is presented in Table 5.

Table 5: Likelihood of occurrence criteria for threatened or migratory species

Likelihood of occurrence	Assessment Criteria
Low	Species considered to have a low likelihood of occurrence include species not recorded in the field surveys that fit one or more of the following criteria: • Have not been recorded previously in the Study Area or Locality and the Study Area is beyond the known distribution or range.

Likelihood of occurrence	Assessment Criteria
	• Are dependent on a narrow range or specific habitats that do not or are not likely to occur in the Study Area. • Are considered locally extinct. • Are a non-cryptic perennial flora species that were targeted during field surveys. • Are flora species that have a very limited range and highly specific dispersal mechanisms.
Moderate	Species considered to have a moderate likelihood of occurrence include species not recorded in the field surveys that fit one or more of the following criteria: • There are infrequent recorded for the species in the Study Area and Locality. • Preferential habitats of the species are present in the Study Area but these are mainly in a poor or modified condition. • May use or occur in habitats within the Study Area opportunistically during seasonal migration but are unlikely to be present on permanent basis as a populations or vagrant individuals.
High	Species considered to have a high likelihood of occurrence include species recorded during the field surveys or species not recorded that fit one or more of the following criteria: • Have a high incidence of previous records in the Study Area and Locality. • Preferentially use habitats that are present in the Study Area which are abundant and/or in good condition. • Resident populations are known in the Study Area or Locality. • Are known to regularly use habitats of the site or Locality or are highly likely to visit the site during seasonal dispersal or migration.

2.9 Limitations

Flora and fauna field surveys were conducted over three days in early winter 2011. The survey effort and methodology was based on the nature, scope and aims of The Project and the landscape context of the Study Area, while aiming to optimise the potential for flora and fauna species to be recorded, particularly threatened species.

In relation to the amount of survey effort and its timing, a reasonable sample of the spectrum of flora and fauna species and assessment of the ecological processes that are likely to occur in the Study Area has been made from the field surveys with the aid of desktop assessments and background research. However, the full spectrum of flora and fauna species and ecological processes likely to occur in the Study Area cannot be fully quantified or described in this report. It is also recognised that conditions, including the presence of threatened species, can change with respect to seasonal and timing differences. Winter is not the optimal time for detecting many flora and fauna species.

Anabat bat detectors and remote cameras were deployed at a time of year and during conditions when many species are likely to be inactive. Thus they cannot be deemed to provide a representative sample of the fauna species likely to be present within the Study Area.

These limitations have been addressed by identifying potential habitats for flora and fauna species and assessing the likelihood for these species to occur within the Study Area and Locality based on previous records, the type and condition of habitats present, the land use throughout the Study Area and the landscape context at the Locality scale.

Targeted flora and fauna surveys were undertaken when species are likely to be detectable and active. To overcome GGBF detectability limitations, additional surveys for the GGBF will be undertaken during the peak breeding season of late January/February 2012 to confirm the results of this report.

This assessment has relied on a previous regional vegetation survey and mapping project and as such the limitations of the surveys by NPWS (2002) apply, to some extent, to this survey and assessment.

This assessment has relied on threatened species data provided by NPWS and publicly available data from SEWPaC. The limitations of the collection, processing, management and distribution of the data sourced from these parties are relevant to the current assessment.

3.0 RESULTS

An inventory of the flora and fauna species recorded during the survey has been provided in Appendix 1.

3.1 Vegetation Communities

3.1.1 Previous Vegetation Mapping

Vegetation mapping projects reviewed prior to field surveys include:

- The *Native Vegetation of the Illawarra Escarpment and Coastal Plain* (NPWS 2002); and,
- The broad scale regional vegetation mapping *Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands. Version 1.0*. (SCIVI) by Tozer *et al* (2006).

Due to the local relevance this assessment adopts the descriptions of native plant communities by NPWS (2002). The mapping by NPWS (2002) has identified three vegetation communities within the Study Area:

- Moist Box-Red Gum Foothills Forest;
- Coastal Grassy Red Gum Forest; and,
- Lowland Dry Subtropical Rainforest.

Two of these vegetation communities correspond with TSC Act listed Endangered Ecological Communities (EEC's):

- Coastal Grassy Red Gum Forest corresponds with the TSC Act listed Illawarra Lowland Grassy Woodland (ILGW) EEC; and,
- Lowland Dry Subtropical Rainforest corresponds with the TSC Act listed Illawarra Subtropical Rainforest (ISTR) EEC.

The presence/absence of these vegetation communities was confirmed during field surveys (see Section 3.1.2). ISTR was found to occur within the Study Area; however ILGW was not.

3.1.2 Vegetation Communities of the Study Area

Five vegetation communities were identified within the Study Area during the current assessment. These communities are described below. The distribution of the vegetation communities over the Study Area is shown in Figure 7.

Lowland Dry Subtropical Rainforest

Lowland Dry Subtropical Rainforest occurs along a south facing slope within the northeast of the Study Area (Figure 7). The vegetation community is shown in Plate 1.

The canopy is dominated by *Ficus rubiginosa* Port Jackson Fig, to 30 metres with *Toona australis* Red Cedar, and *Livistona australis* Cabbage Palm, occurring less frequently. The midstorey forms a sub-canopy, to approximately 10 metres, composed of small trees including *Ficus coronata* Sandpaper Fig, *Cassine australis* Red Olive Plum, *Pittosporum undulatum* Sweet Pittosporum, *Syzygium australe* Brush Cherry and *Doryphora sassafras* Sassafras. Vines including *Cissus antarctica* Water Vine, *Cissus hypoglauca* Giant Water Vine, *Parsonsia straminea* Common Silkpod and *Pandorea pandorana* Wonga Wonga Vine, growing over the canopy and sub canopy, add to the dense cover. *Acacia* spp. are common at the edges of the community. The shrub and ground layers are sparse. The shrub layer grows to approximately four metres and includes *Eupomatia laurina* Bolwarra, *Maclura cochinchinensis* Cockspur Thorn, *Notelaea longifolia* Large Mock-olive, *Wilkiea huegeliana* Veiny Wilkiea and *Pittosporum spinescens* Wallaby Apple as well as juvenile trees such as *Cryptocarya glaucescens* Jackwood, *Dendrocnide excels* Giant Stinging Tree and *Diploglottis australis* Native Tamarind. Ground layer species include ferns; such as *Adiantum formosum* Giant Maidenhair, *Asplenium flabellifolium* Necklace Fern, *Doodia aspera* Prickly Rasp Fern and *Pellaea falcata* Sickle Fern; as well as grasses; such as *Carex longebrachiata* and *Poa labillardierei* Tussock Grass as well as *Gymnostachys anceps* Settler's Flax. Surface boulders and loose rock occur throughout.

Woody weeds, dominated by *Lantana camara* Lantana, occur densely at the edges of the community and very sparsely through areas where the dense canopy cover of the native species limits the spread of exotic species.

The boundaries of this community correspond, generally, with the NPWS (2002) mapping, although refinements were made during the current surveys (Figure 7).

A diversity of indigenous species is present within all structural layers and weeds are predominately restricted to exposed edges. The condition of this community is assessed as being in good condition in the core, but, due to invasion by woody weeds, is assessed as being in poor to moderate condition at the edges.

The Lowland Dry Subtropical Rainforest present within the Study Area corresponds with the TSC Act listed ISTR EEC.

Moist Box Redgum Foothills Forest

Moist Box Redgum Foothills Forest occurs within the north east of the Study Area in a relatively narrow strip adjoining the Lowland Dry Subtropical Rainforest occurring downslope (Figure 7).

The distribution of the community within the Study Area is determined by the presence of *Eucalyptus quadrangulata* White-topped Box. White Topped Box reaching approximately 25 metres dominates the community, with *Eucalyptus tereticornis* Forest Red Gum occurring less frequently. The midstorey and shrub layer are composed of similar species to the Lowland Dry Subtropical Rainforest. Dominant midstorey species include Sweet

Pittosporum and Red Olive Plum with *Acacia* spp. occurring at the edges. Dominant shrub layer species include Large Mock-olive, and *Clerodendrum tomentosum*. The ground layer is dominated by *Carex longebrachiata* and Tussock Grass.

Lantana is common at the edges and has not currently spread to within the community.

The boundaries of this community correspond, generally, with the NPWS (2002) mapping.

The Moist Box Redgum Foothills Forest present within the Study Area represents a simplified form of the community. The species composition is significantly less diverse than the NPWS (2002) community description due to the relatively small patch size. The structural layers are intact. Weeds are predominately restricted to the edges. The condition of this community is assessed as being in moderate condition.

Forest Red Gum Open Forest/Woodland

Forest Red Gum Open Forest/Woodland occurs in relatively small patches in the north of the Study Area and in a larger area in the east of the site.

The canopy is dominated by *Eucalyptus tereticornis* Forest Red Gum, to approximately 20 metres. In the eastern part of the Study Area *Eucalyptus sclerophylla* Hard Leaved Scribbly Gum and *Angophora floribunda* Rough-barked Apple occur sparsely throughout. The canopy species occur primarily as stands of regrowth with few mature specimens. Indigenous species within the midstorey include *Acacia mearnsii* Black Wattle and *Acacia melanoxylon* Blackwood. These *Acacia* spp. are coloniser species and may also have been planted during revegetation works within the Study Area. The shrub layer is predominately dominated by Lantana. *Hakea salicifolia* Willow-leaved Hakea, occurs sparsely in the shrub layer in the eastern part of the Study Area. The ground layer vegetation is sparse where Lantana dominates the shrub layer. Indigenous species include clumps of *Imperata cylindrical* Blady Grass, in the eastern part of the site and *Glycine tabacina* occurs sparsely throughout. *Pennisetum clandestinum* Kikuyu Grass dominates the ground layer with other exotic species including dense clumps of *Ageratina adenophora* Crofton Weed, *Senecio madagascariensis* Fireweed, *Foeniculum vulgare*, Fennel, and *Conyza bonariensis* Flaxleaf Fleabane are also common on the edges.

This community is classified according to the criteria detailed by Specht (1995) and is not included within the NPWS (2002) vegetation mapping. Forest Red Gum Open Woodland in the northwest section of the Study Area roughly corresponds with the location of Coastal Red Gum Grassy Forest according to NPWS (2002); however the presence of this vegetation community could not be confirmed due to the degraded nature of the Forest Red Gum Open Forest/Woodland.

As the canopy and midstorey are highly simplified in their species composition and the shrub and ground layers are dominated by exotic species the condition of this community is assessed as being poor.

Acacia Scrub/Exotic

Acacia Scrub/Exotic vegetation community occurs in disturbed areas that have been previously cleared, as well as revegetated areas around the edges of landfill. The canopy is predominately absent; however Forest Red Gum does occur sparsely as relatively immature regrowth. The majority of the area mapped as Acacia Scrub/Exotic is dominated by Black Wattle and Blackwood with Lantana dominating the understorey. Parts of the community are dominated by exotic species where the *Acacia* spp. become sparse. Vegetation along Redalls Road is dominated by Lantana as well as other woody weeds including *Ligustrum sinense* Small-leaved Privet, *Ricinus communis* Castor Oil Plant and *Solanum mauritianum* Wild Tobacco Bush. Individual trees growing as weeds in this area include *Erythrina X sykesii* Coral tree, *Pinus radiata* Radiata Pine, and *Grevillea robusta* Silky Oak. Understorey species occur around the edges of the community including exotic grasses such as Kikuyu Grass, Rhodes Grass, and *Eragrostis curvula* African Lovegrass. Other understory weed species include Fennel, *Verbena bonariensis* Purpletop, *Sida rhombifolia* and Paddy's Lucerne. Crofton Weed grows in dense clumps in moist areas particularly on the southern edge of the Lowland Dry Subtropical Rainforest.

As the community is highly simplified in the canopy and mid storey and dominated by exotic species in the understorey the condition of this community is assessed as being poor.

Closed Exotic Grassland

Closed Exotic Grassland is the most common vegetation community, occurring throughout the Study Area in cleared areas as well as over the landfill. Exotic grasses are dominant throughout, including Kikuyu Grass, African Lovegrass, Rhodes Grass and *Cynodon dactylon* Common Couch. Fireweed occurs sparsely throughout. Native species include *Glycine tabaccina* occurring sparsely throughout and Blady Grass in clumps around the edges of the Acacia Scrub/Exotic vegetation community.

Structural layers are not present and the vegetation is dominated by exotic species. The condition of this community is assessed as being an unnatural landscape.

Planted

Planted trees to 20 metres occur along the road leading from the weigh bridge around the landfill areas. Plantings also occur in the stand of vegetation along the north-west and central ridge. This work was done as part of the 1990s Environmental Assessment (EA) approval conditions. Planted trees are species indigenous to the Locality and include Forest Red Gum, *Eucalyptus crebra* Narrow-leaved Ironbark, *Eucalyptus paniculata* Grey Ironbark, and *Casuarina glauca* Swamp Oak.

Planted areas occur adjacent to Closed Exotic Grasslands and Acacia Scrub/Exotic vegetation communities. *Acacia* spp. and weeds occurring within these communities occur throughout planted areas.

3.1.3 Threatened Ecological Communities

Two threatened ecological communities are mapped by NPWS (2002) as occurring within the Study Area, as described in Section 3.1.1. The flora survey has found one threatened ecological community occurs within the Study Area:

- Lowland Dry Subtropical Rainforest corresponds with the TSC Act listed Illawarra Subtropical Rainforest (ISTR) EEC.

This corresponds with the NPWS (2002) mapping which shows this community to occur in the north east of the Study Area. The boundaries of this community have been defined more accurately during this assessment.

An assessment according to Appendix 3 of the Draft Guidelines for Threatened Species Assessment (DEC & DPI 2005) has been undertaken for the ISTR in Appendix 3 of this report. This assessment concluded that The Project is considered unlikely to have a significant impact on the ISTR EEC.

Areas mapped by NPWS (2002) as Coastal Grassy Red Gum Forest, which corresponds with the ILGW EEC, were mapped during the current assessment as Forest Red Gum Open Forest/Woodland. Due to their degraded state these vegetation communities are not considered to represent the EEC community as mapped by NPWS (2002).

3.2 Flora

A total of 87 plant species were recorded from the Study Area during the current survey. The flora species inventory includes 64 locally occurring native species and 23 introduced species (Appendix 1). Of the 23 introduced species, two are listed as noxious under Order 20 of the NSW *Noxious Weeds Act 1993* for the Wollongong LGA (Appendix 1):

- Lantana - Class 4; and,
- African Lovegrass - Class 4

The legal requirement for a Class 4 noxious weed is *"the growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold or knowingly distributed".*

3.2.1 Threatened Flora Species

A total of 14 threatened flora species (or their habitats) listed under the TSC Act and EPBC Act have been previously recorded within the Locality (Appendix 2).

Based on potential habitats, and/or previous records within the Study Area and the Locality, three threatened species were considered likely to occur;

- *Cynanchum elegans* White-flowered Wax Plant;
- *Daphnandra sp. 'Illawarra'* Illawarra Socketwood; and,
- *Syzygium panniculatum* Magenta Lilly Pilly.

A comprehensive targeted survey conducted within potential habitat for each of these species did not record any of the three species listed above.

This report concludes there is a low likelihood of any threatened flora species occurring within the Study Area.

3.3 Fauna Habitats

The following four major fauna habitats are present within the Study Area:

- Aquatic Environments – including the three surface water ponds located in the south-western section of the Study Area, ephemeral drainage lines, decommissioned ponds and various other water bodies (including the Primary and Secondary Leachate Ponds);
- Open Forest/Woodland – highly disturbed habitat encompassing the Forest Red Gum Open Forest/Woodland located in the south-eastern section of the Study Area;
- Closed Forest – encompassing the Moist Box Redgum Foothills Forest and Lowland Dry Subtropical Rainforest located in the north-eastern section of the Study Area; and,
- Cleared and Disturbed – including the operational areas of the Whytes Gully Resource Recovery Park, easements, Cleared Exotic Grasslands and Acacia Scrub.

The fauna habitats present within the Study Area and their condition are discussed in the following sections.

3.3.1 Aquatic Environments

Aquatic habitats across the Study Area include an artificial wetland consisting of three surface water ponds (surface water reed beds 1 and 2 and the surface water polishing pond), five small ponds (four being decommissioned and one still used as a surface water pond) and several water bodies associated with the operations of the Whytes Gully Resource Recovery Park including two leachate dams. The main aquatic habitats have been mapped and numbered in Figure 8.

Surface water reed beds 1 and 2 and the surface water polishing pond allow sediments from stormwater runoff through the site to naturally settle before overflow to a tributary of Dapto Creek. These three interconnected surface water ponds (grouped and numbered as 1 Figure 8) contain areas of fringing and emergent vegetation. This vegetation is host to sheltering and nesting habitat for water birds such as the Purple Swamphen *Porphyrio*

porphyrio and the Dusky Moorhen *Gallinula tenebrosa*, as well as small grassland birds such as the Golden-headed Cisticola *Cisticola exilis*. The three open water bodies not only provide ideal foraging habitat for grebes, ducks, swamphens and swans, but also for microbat species, including the threatened Southern Myotis *Myotis macropus* which was recorded at this location using an Anabat detector. The Southern Myotis typically hunts over pools of water catching insects and small fish by raking their feet across the water surface. These areas provide potential habitat for the threatened Green and Golden Bell Frog *Litoria aurea* and Australian Painted Snipe *Rostratula australis.*

Three small decommissioned surface water ponds (numbered 2, 3 and 4 in Figure 8) located to the east of the surface water polishing pond, and a drainage line located along the south-western boundary, provide potential Green and Golden Bell Frog habitat. Although ponds 2 and 4 and the drainage line to the west are unlikely to provide sufficient shelter and floating vegetation to be breeding sites for this species, they may be used as dispersal ponds in a local context. Pond 3 contains emergent (*Typha* sp. and sedges) and floating (*Azolla* sp.) vegetation which are essential Green and Golden Bell Frog habitat requirements. Given that field surveys were not undertaken during the peak breeding season for the Illawarra population, the presence/absence of this species could not be determined and further field investigations are recommended during the species active period (September to February with the most optimal time around January–February after heavy rain/storm events).

Two small surface water ponds (numbered 5 and 6 in Figure 8) are located adjacent to the existing site office. Both are significantly disturbed and contain large amounts of urban refuse which has been washed down from the landfill above through ephemeral drainage lines and surface water flow. Dam 5 contains some emergent vegetation, predominately *Typha* sp., which had died off in the cooler months of the survey period. This emergent and limited fringing vegetation is likely to be used by water birds and amphibians for nesting and sheltering. Despite appearing highly polluted, Purple Swamphen were observed nesting in the dense *Typha* sp. thickets of this dam. Dam 6 had no floating or emergent vegetation and is not considered to be a significant habitat for fauna species.

The water bodies associated with the operations of the Resource Recovery Plant (numbered 7 and 8) are of least ecological significance. These ponds have little to no fringing or emergent vegetation, providing no sheltering habitat for water birds or amphibians. Australian Wood Ducks *Chenonetta jubata* were observed in and around pond 7 during field surveys. This species can often be found around deeper lakes that may be unsuitable for other water bird foraging habitat, as it prefers to forage on land. No fauna was observed in or around the Primary or Secondary Leachate Ponds (numbered 8).

A drainage line running from the large Reed Beds (ponds 1, 2, 3 and 4 Figure 8) south into Dapto Creek contained dense stands of *Typha* sp. as well as floating vegetation. This drainage line runs south under Reddalls Road into a contained basin, before continuing into Dapto Creek. This drainage line provides habitat for a number of amphibian species,

and the Common Froglet *Crinia signifera* and Verreaux's Tree Frog *Litoria verreauxii* were recorded calling from this drainage line.

The aquatic habitat within the Study Area is man made, and has been designed to filter sediment laden stormwater from disturbed areas prior to release into Dapto Creek. Thus they are subject to levels pollution from this runoff. These ponds were not created as fauna habitat, and as such many of the essential fauna habitat components, such as significant areas of dense vegetation and floating aquatic vegetation, are missing. Despite this these areas support a variety of fauna and provide resources for many fauna species. Based on this aquatic environments within the Study Area are considered to be in moderate condition for terrestrial species.

3.3.2 Open Forest/Woodland

The open forest/woodland habitat is located in the eastern section of the Study Area and along the northern boundary. This habitat type consists of a highly disturbed Forest Red Gum Open Forest/Woodland. This habitat has been subject to high levels of disturbance through clearing, creation of tracks, weed infestation and litter from the adjacent landfill.

The canopy of this habitat consists predominately of Forest Red Gum and Rough-barked Apple reaching approximately 25 metres. Rough-barked trees such as the Rough-barked Apple provide foraging habitat for the White-throated Treecreeper *Cormobates leucophae* which eat ants, beetles and larvae from the trunks of live and dead trees, fallen branches and among leaf litter.

Canopy trees provided foraging and nesting habitat for bird species such as the Eastern Yellow Robin *Eopsaltria australis*, Grey Fantail *Rhipidura albiscapa* and the Rufous Whistler *Pachycephala rufiventris*. This habitat also supports common arboreal mammal species such as the Common Brushtail Possum *Trichosurus vulpecula* and Common Ringtail Possum *Pseudocheirus peregrinus*. Little to no hollow-bearing trees are present throughout the open forest/woodland habitat. Tree hollows provide critical shelter and nesting habitat for a range of hollow dependent fauna such as threatened species of microbat and birds. Those that do occur are in limited capacity and should be retained where possible. Despite a lack of suitable roosting hollows, this habitat type is likely to provide foraging habitat for microchiropteran bat species, such as forest bats (*Vespadelus* spp.) and the threatened Greater Broad-nosed Bat *Scoteanax rueppellii* and which have previously been recorded within this habitat type in the wider Locality. The threatened Grey-headed Flying Fox was recorded foraging on Balloon Vine within this habitat type.

Although the Study Area supports several stands of *Casuarina glauca* Swamp Oak, no specific Glossy-black Cockatoo *Calyptorhynchus lathami* feed trees were present.

The shrub layer is dominated by Lantana and exotic flora species. These species provide habitat and protection for small birds (e.g. fairy wrens, Silvereyes *Zosterops lateralis* and Red-browed Finches *Neochmia temporalis*), reptiles (e.g. Grass Skinks), and exotic ground-dwelling mammals such as European Rabbit *Oryctolagus cuniculus* and Black Rat *Rattus rattus*.

Exotic grasses dominate the groundcover. Given the dense nature of the shrub and groundcover layers, very few accumulations of logs, woody debris and leaf litter appropriate for ground fauna shelter are present.

Areas of Open Forest/Woodland are heavily disturbed; despite this these areas support a moderate level of fauna habitat features including a protective shrub layer with moderate canopy cover. However given the high level of disturbance and close proximity to the landfill resulting, they are deemed to be in low to moderate condition.

3.3.3 Closed Forest

The closed forest habitat is located in the upper north-eastern section of the Study Area, above the existing landfill and contains both Moist Box Redgum Foothills Forest and the endangered ecological community, Lowland Dry Subtropical Rainforest.

The canopy of the closed forest consists predominately of Port Jackson Fig, Red Cedar and Cabbage Palm frequently reaching heights of between 20 to 30 metres. This habitat is likely to support common arboreal mammal species, such as the Brushtail Possum and Common Ringtail Possum, both recorded during field investigations.

The threatened Grey-headed Flying-fox, although not recorded in this habitat, is likely to forage on the fruit of rainforest plants in this habitat, such as figs and Lilly Pilly. Other threatened species that may use this habitat on occasion as a foraging resource or dispersal refuge include the Superb Fruit-Dove *Ptilinopus superbus* and Wompoo Fruit-Dove *Ptilinopus magnificus*.

There is a dense midstorey of mesic species to approximately 10 metres providing sheltering and foraging habitat for small birds. At the edges the understorey is heavily infested with Lantana. Lantana provides habitat and food (fruits) for many species, including declared vermin and other pests, but also for native species, especially birds. A variety of small native bird species including Red-browed Finch *Neochmia temporalis*, Superb Fairy-Wren *Malurus cyaneus* and White-browed Scrubwren *Sericornis frontalis* were recorded foraging and nesting in the Lantana-dominated shrub layer.

Large rock boulders are interspersed throughout the closed forest; however no overhangs or ledges are considered to be suitable for fauna habitat.

The closed forest habitat supports a high level of fauna habitat features that are important in the maintenance of native fauna diversity and life cycles of the Locality and are therefore considered to be in good condition.

3.3.4 Cleared and Disturbed Habitat

The majority of the Study Area has been cleared of native vegetation for the operations of the Whytes Gully Resource Recovery Park (Figure 8). The two existing landfills and associated access roads, easements and operational areas of the site were originally

developed from rural farm land. The majority of the site reflects the past land use and contain pastures likely to be once used for grazing cattle.

Fauna habitat features within this habitat type are limited, with little foraging or breeding opportunities available. However, large flocks of scavenger bird species, including the Australian Raven *Corvus coronoides,* Silver Gull *Larus novaehollandiae, Pelican Pelecanus conspicillatus* and Australian White Ibis *Threskiornis molucca* were frequently seen foraging on refuse in the landfill area. These species are considered to be opportunistic and do not naturally rely on this habitat as a food source.

Flowering garden plantings and stands of Acacia Scrub/exotics including Black Wattle and Small-leaved Privet occur around the operation buildings and along access roads, providing foraging habitat for birds and generalist arboreal mammals.

The cleared areas of this habitat consisted of closed grasslands devoid of canopy cover once used as pasture for cattle grazing. These areas support foraging and browsing habitat for native mammals including the Swamp Wallaby *Wallabia bicolor* and a range of feral mammal species including Fallow Deer *Dama dama* and European Rabbit *Oryctolagus cuniculus*. Generalist bird species using the grassland areas of this habitat include Willie Wagtail *Rhipidura leucophrys*, Magpie-lark *Grallina cyanoleuca* and Australian Magpie *Gymnorhina tibicen,* as well as a number of exotic bird species including Common Myna *Acridotheres tristis* and the Red-whiskered Bulbul *Pycnonotus jocosus.*

Two birds of prey, the Nankeen Kestral *Falco cenchroides* and the Grey Goshawk *Accipiter novaehollandiae* were recorded flying over this habitat and perching on the fringe of the open forest/woodland habitat. The presence of these species is indicative of the high availability of prey in the Locality including small birds (particularly honeyeaters), reptiles, small mammals (including exotic rodents) and insects.

Although the cleared and disturbed areas of the Subject Site contain foraging habitat for several generalist native fauna species, they lack many of the features essential to many fauna species. These areas are deemed to be in poor condition.

3.4 Fauna

A total of 76 fauna species were recorded in the Study Area (Appendix 1), which included 68 (89%) native species. A total of six introduced fauna species were recorded (Table 3).

Table 6: Summary of fauna recorded during the field survey

Group	Native species	Introduced species	Threatened species	Migratory species
Amphibians	5	0	0	0
Reptiles	2	0	0	0
Birds	52	2	0	0
Mammals	9	4	2	0

Group	Native species	Introduced species	Threatened species	Migratory species
TOTAL	**68**	**6**	**2**	**0**

Of the native mammals recorded in the current field investigations, four probable records of the threatened Southern Myotis *Myotis macropus* were detected using a stationary Anabat positioned over surface water reed bed 1. Table 4 below provides a summary of call analysis.

Table 7: Summary of Microbat call analysis

Common Name	Scientific Name	Confidence level of call identification		
		Definite	Probable	Possible
Southern Myotis	*Myotis macropus*	0	4	0

Based on the habitats and number of database records it is likely that additional native fauna species will utilise the Study Area either for sheltering, roosting/nesting and foraging on a regular basis.

3.4.1 Threatened Fauna Species

A total of 68 threatened fauna species (or their habitats) listed under the TSC Act and/or EPBC Act have previously been recorded within the Locality or are predicted to occur (Appendix 2).

3.4.1.1 Recorded Species

Two threatened species, the Grey-headed Flying-fox and Southern Myotis (probable detection) were recorded within the Study Area during the current winter survey. These two species are discussed below.

Grey-headed Flying-fox *Pteropus poliocephalus*

TSC Act listing: Vulnerable

EPBC Act listing: Vulnerable

Grey-headed Flying-fox occurs along the NSW coast, extending further inland in the north. This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. It roosts in large colonies (camps), commonly in dense riparian vegetation. Bats commute daily to foraging areas, usually within 15 kilometres of the day roost (Tidemann 1995) although some individuals may travel up to 70 kilometres (Augee and Ford 1999).

The Grey-headed Flying-fox was recorded foraging on exotic flora species in the open forest/woodland habitat during field investigations. There is also potential foraging habitat for this species in areas of closed forest as well as remnant and planted vegetation across the remainder of the Study Area; however this habitat is not considered to be limiting.

Several known Grey-headed Flying-fox camps are located within the Illawarra region. No camps occur within the Study Area; however the closest known camp is located approximately 1.5 kilometres north of the Study Area on Mount Kembla.

An assessment according to Appendix 3 of the *Draft Guidelines for Threatened Species Assessment* (DEC & DPI 2005) has been undertaken for the Grey-headed Flying-fox in Appendix 3 of this report. This assessment concluded that The Project is considered unlikely to have a significant impact on the Grey-headed Flying-fox.

The Grey-headed Flying-fox is also listed as vulnerable under the EPBC Act. The Project is unlikely to have a significant impact on this species according to *EPBC Act Policy Statement 1.1* (DEWHA 2009).

Southern Myotis *Myotis macropus*

TSC Act listing: Vulnerable

The Southern Myotis' distribution is scattered and mainly coastal extending, to South Australia along the Murray River. It roosts close to water, in a variety of roost types including caves, mines or tunnels, under bridges, in buildings, tree hollows, and even in dense foliage. Colonies occur close to water bodies, ranging from rainforest streams to large lakes and reservoirs. They catch aquatic insects and small fish with their large hind claws, and also catch flying insects (Richards et al. 2008).

Four probable records of Southern Myotis were detected using an Anabat bat detector located over surface water reed bed 1 during field investigations (Figure 5). This habitat is not considered to be limiting as few aquatic prey species, including fish and prawns, are likely to be present in this water body. No roosts are likely to be present within the Study Area.

An assessment according to Appendix 3 of the *Draft Guidelines for Threatened Species Assessment* (DEC & DPI 2005) has been undertaken for this species in Appendix 3 of this report. This assessment concluded that The Project is considered unlikely to have a significant impact on the Southern Myotis.

3.4.2 Predicted Species

Based on preferred habitats and the proximity of previous records, there is a medium or higher likelihood of an additional 16 species occurring in the Study Area. The follow section details the required assessments and/or additional surveys required for project approval.

Eleven of these species are likely to use the Study Area on rare occasions, are vagrant species or are restricted to areas that are not likely to be impacted. These include:

- Blue-billed Duck;
- Freckled Duck;
- Gang-gang Cockatoo;

- White-fronted Chat;
- Varied Sittella;
- Scarlet Robin;
- Flame Robin;
- Pink Robin;
- Barking Owl;
- Masked Owl; and,
- Sooty Owl.

Where there is potential habitat (foraging or breeding resources) for threatened species in the Study Area, further consideration must be given to the likely impact of The Project on these species. The Project may impact on threatened species by causing any of the following:

- Death or injury of individuals;
- Loss or disturbance of limiting foraging resources; and,
- Loss or disturbance of limiting breeding resources.

Limiting resources are specialised habitat components that species are dependent on for their ongoing survival. Such limiting resources are predominantly associated with specialised breeding habitats (such as tree hollows or suitable nest/maternity roost sites) that occur at low densities, with high levels of competition from a range of species. However, for some species, limiting resources include specialised foraging habitats that have a restricted distribution (e.g. Koalas feeding only on specific tree species). As the Study Area does not provide limiting foraging or breeding habitat for these species, and the proposed project is unlikely to result in death or injury, the abovementioned species are not discussed further.

Seven species are likely to use the site more frequently, or may be impacted by The Project. These species are discussed further below.

Green and Golden Bell Frog

TSC Act listing: Endangered
EPBC Act listing: Vulnerable

Two ponds, numbered 2 and 5, provide sub-optimal habitat for Green and Golden Bell Frog. Ponds 1, 3 6 and the western drainage line also have the potential to provide foraging and dispersal habitat for this species. Although the Study Area is within the historical range of the species, no records have been recorded since the 1970's (Jen Byrne, OEH, pers. comm., NPWS Atlas of NSW Wildlife) and it is believed that non-

coastal populations have been impacted by Chytrid fungus (Paul Wearne, OEH, pers. comm.).

Most existing locations for the species occur as small, coastal, or near coastal populations, with records occurring between south of Grafton and northern Victoria (NSW Government, 2009). The species is found in marshes, dams and stream sides, particularly those containing bullrushes or spikerushes. Preferred habitat includes water bodies that are unshaded, are free of predatory fish, have a grassy area nearby and have diurnal sheltering sites nearby such as vegetation or rocks (NPWS, 1999e; White, 1996), although the species has also been recorded from highly disturbed areas including disused industrial sites, brick pits, landfill areas and cleared land. Breeding usually occurs in summer. Tadpoles, which take approximately 10-12 weeks to develop (DECC 2008), feed on algae and other vegetative matter. Adults eat insects as well as other frogs, including juveniles of their own species (DEC 2005g).

Heavily disturbed former or current industrial areas are known to support populations of the Green and Golden Bell Frog, and it is believed that one of the reasons these populations persist in heavily disturbed environments is the fungicidal properties of chemicals present in former and current industrial sites (Threlfall et al. 2008). In particular copper levels of greater than 0.06 milligrams per litre (Threlfall et al. 2008) and salinity levels of greater than 1 part per thousand (Johnson et al. 2003) are theorised to inhibit the growth of Chytrid zoospores.

Water quality testing undertaken by Golder in July 2011 across the aquatic habitats of the Study Area indicated that copper and/or salinity levels at ponds 1, 5 and 6 (Figure 8) are known to inhibit the growth of chytrid fungus while still being within the parameters that allow the Green and Golden Bell Frog to persist. The results of water testing are shown below in Table 8:

Table 8: Results of water quality testing across the aquatic habitats of the Study Area (Golder 2011)

Water quality parameters	Surface Water Ponds located in south-west portion of Study Area (grouped and numbered 1 in Figure 8)			Surface Water Pond (numbered 5 in Figure 8)	Surface Water Pond (numbered 6 in Figure 8)
	Golder Sampling Location				
	GASW01	GASW02	GASW03	GASW05	GASW06
Salinity (g/kg)	**1.10**	0.96	0.85	**4.93**	**9.54**
Copper (mgL^{-1})	0.0013	0.008	0.005	<0.010	0.040
Zinc (mgL^{-1})	0.009	0.013	0.013	<0.050	0.172

* Figures in bold indicate levels considered to inhibit the growth of Chytrid zoospores.

These results indicate that the Green and Golden Bell Frog may be able to persist in the waterbodies present within the Whytes Gully Whytes Gully Resource Recovery Park, despite non-coastal populations being impacted by Chytrid fungus, due to salinity and copper levels that are likely to inhibit the growth of Chytrid zoospores.

Targeted surveys undertaken between the 2nd November 2011 and 10th January 2012 failed to detect the species, despite the species being active at known reference sites. An additional two surveys are planned for the peak breeding period in January and February to confirm the results of these surveys.

As a precautionary approach an assessment under Appendix 3 of the *Draft Guidelines for Threatened Species Assessment* (DEC & DPI 2005) has been undertaken for this species in Appendix 3 of this report. This assessment concluded that The Project is unlikely to have a significant impact on the GGBF. This conclusion is based on surveys indicating the species is not present within the Study Area.

The GGBF is also listed as vulnerable under the EPBC Act. The Project is unlikely to have a significant impact on this species according to *EPBC Act Policy Statement 3.19* (DEWHA 2009). Again, this conclusion is based on surveys indicating the species is not present within the Study Area.

Australian Painted Snipe *Rostratula australis*

TSC Act listing: Endangered
EPBC Act listing: Vulnerable and Migratory

The surface water reed beds (and other associated water bodies) located in the south-west corner of the Study Area (numbered 1 in Figure 8) provide potential habitat for the Australian Painted Snipe. The Australian Painted Snipe is most likely largely under-surveyed due to its cryptic nature, temporal occurrence at many wetlands and propensity to seek refuge in dense vegetation even when present.

This species is usually found in shallow inland wetlands including farm dams, lakes, rice crops, swamps and waterlogged grassland. They prefer freshwater wetlands, ephemeral or permanent, although they have been recorded in brackish waters (Marchant and Higgins, 1993). The Australian Painted Snipe has a scattered distribution throughout many parts of Australia, with a single record from Tasmania. Though some individuals are apparently resident in some areas, other individuals appear to be nomadic, temporarily occupying areas where suitable habitat exists.

Although the Australian Painted Snipe can occur across Australia, the areas of most sensitivity to the species are those wetlands where the birds frequently occur and are known to breed.

Targeted surveys undertaken between the 2nd November 2011 and 10th January 2012 failed to detect the species, despite the species being observed at Koona Bay (approximately 9 kilometres south) in October 2011 (Birds Australia Network). An additional two surveys are planned for January and February to confirm the results of these surveys.

As a precautionary approach an assessment under Appendix 3 of the *Draft Guidelines for Threatened Species Assessment* (DEC & DPI 2005) has been undertaken for this species in Appendix 3 of this report. This assessment concluded that The Project is unlikely to have a significant impact on the APS. This conclusion is based on surveys indicating the species is not present within the Study Area.

The APS is also listed as vulnerable and a s migratory species under the EPBC Act. The Project is unlikely to have a significant impact on this species according to *EPBC Act Policy Statement 1.1* (DEWHA 2009). Again, this conclusion is based on surveys indicating the species is not present within the Study Area.

Microchiropteran Bats

In addition to the Southern Myotis, five microchiropteran bats are likely to utilise the Study Area on occasion for foraging purposes. The aquatic environments, particularly the three Surface water Ponds forming an artificial wetland system in the south-west of the Study Area, are likely to be used for both foraging for insects and drinking; however this habitat is not considered to be limiting. At the time of survey, only the Southern Myotis was recorded (four 'probable calls' identified). No roosting habitat was observed for any of these species.

Eastern False Pipistrelle *Falsistrellus tasmaniensis*

TSC Act listing: Vulnerable

The Eastern False Pipistrelle's distribution extends east of the Great Dividing Range throughout the coastal regions of NSW, from the Queensland border to the Victorian border. This species prefers wet high-altitude sclerophyll and coastal mallee habitat, preferring wet forests with a dense understorey but being found in open forests at lower altitudes (Churchill, 2008). The Eastern False Pipistrelle roosts in tree hollows and sometimes in buildings in colonies of between 3 and 80 individuals and apparently hibernates in winter. It is known to change roosts every night. This species forages for beetles, bugs and moths below or near the canopy in forests with an open structure, or along trails (Law *et al.* 2008). It has a large foraging range, up to 136 ha (Churchill, 2008; Law, 2008). Records show movements of up to 12 kilometres between roosting and foraging sites (Menkhorst and Lumsden 1995).

An assessment under Appendix 3 of the *Draft Guidelines for Threatened Species Assessment* (DEC & DPI 2005) has been undertaken for this species in Appendix 3 of this

report. This assessment concluded that The Project is unlikely to have a significant impact on the Eastern False Pipistrelle.

Eastern Freetail-bat *Mormopterus norfolkensis*

TSC Act listing: Vulnerable

The Eastern Freetail-bat's distribution extends east of the Great Dividing Range from southern Queensland to south of Sydney (Churchill, 2008). Most records are from dry eucalypt forests and woodland. Individuals tend to forage in natural and artificial openings in forests, although it has also been caught foraging low over a rocky river within rainforest and wet sclerophyll forest habitats. The species generally roosts in hollow spouts of large mature eucalypts (including paddock trees), although individuals have been recorded roosting in the roof of a hut, in wall cavities, and under metal caps of telegraph poles. Foraging generally occurs within a few kilometres of roosting sites (Churchill, 2008; Hoye et al., 2008).

An assessment under Appendix 3 of the *Draft Guidelines for Threatened Species Assessment* (DEC & DPI 2005) has been undertaken for this species in Appendix 3 of this report. This assessment concluded that The Project is unlikely to have a significant impact on the Eastern Freetail-bat.

Greater Broad-nosed Bat *Scoteanax rueppellii*

TSC Act listing: Vulnerable

The Greater Broad-nosed Bat occurs along the Great Dividing Range, generally at 500 m but up to 1200 m, and in coastal areas. It occurs in woodland and rainforest, but prefers open habitats or natural or human-made openings in wetter forests. Often hunts along creeks or river corridors. This species generally flies slowly and directly at a height of 30 m or so to catch beetles and other large, flying insects. It is also known to eat other bats and spiders. The Greater Broad-nosed Bat roosts in hollow tree trunks and branches (Churchill, 2008). The Greater Broad-nosed Bat has been recorded recently at Yallah (G.Leonard, WCC, pers. comm.).

An assessment under Appendix 3 of the *Draft Guidelines for Threatened Species Assessment* (DEC & DPI 2005) has been undertaken for this species in Appendix 3 of this report.. This assessment conclude that The Project is unlikely to have a significant impact on the Greater Broad-nosed Bat

Eastern Bentwing -bat *Miniopterus schreibersii oceanensis*

TSC Act listing: Vulnerable

The Eastern Bentwing-bat occurs from Victoria to Queensland, on both sides of the Great Dividing Range. It forms large maternity roosts (up to 100,000 individuals) in caves and mines in spring and summer. Individuals may fly several hundred kilometres to their wintering sites, where they roost in caves, culverts, buildings, and bridges. They occur in a broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands. The Eastern Bentwing Bat has a fast, direct flight and forages for flying insects (particularly moths) above the tree canopy and along waterways (Churchill, 2008; Hoye and Hall, 2008).

No suitable roost sites were recorded during the current surveys; however the proximity of the Study Area to the Illawarra Escarpment and the known nightly foraging range for this species indicate that the species is likely to forage within the Study Area on occasion.

An assessment under Appendix 3 of the *Draft Guidelines for Threatened Species Assessment* (DEC & DPI 2005) has been undertaken for this species in Appendix 3 of this report. This assessment concluded that The Project is unlikely to have a significant impact on the Eastern Bentwing-bat.

Yellow-bellied Sheathtail-bat

TSC Act listing: Vulnerable

The Yellow-bellied Sheathtail-bat is found throughout NSW (Richards, 2008). They have been reported from southern Australia between January and June (Churchill, 2008). This species occurs in a wide range of habitats throughout eastern and northern Australia, including wet and dry sclerophyll forest, open woodland, acacia shrubland, mallee, grasslands and desert (Churchill, 2008). They roost in tree hollows in colonies of up to 30 (but more usually two to six) and have also been observed roosting in animal burrows, abandoned Sugar Glider nests, cracks in dry clay, hanging from buildings and under slabs of rock. It is high-flying, making it difficult to detect. The Yellow-bellied Sheathtail-bat forages above the canopy of eucalypt forests, but comes lower to the ground in mallee or open country (Churchill, 2008; Richards, 2008).

An assessment under Appendix 3 of the *Draft Guidelines for Threatened Species Assessment* (DEC & DPI 2005) has been undertaken for this species in Appendix 3 of this report. This assessment concluded that The Project is unlikely to have a significant impact on the Yellow-bellied Sheathtail-bat.

3.4.3 Migratory Species

Australia is a signatory to international agreements aimed at protecting migratory species. These include the *Japan Australia Migratory Bird Agreement* (JAMBA), the *China Australia Migratory Bird Agreement* (CAMBA), the *Republic* of *Korea Australia Migratory Bird Agreement* (RoKAMBA), and the *Bonn Convention on the Conservation of Migratory*

Species of Wild Animals. Migratory species are considered to be Matters of National Environmental Significance and as such are protected under the EPBC Act.

A total of 43 migratory species have been predicted to occur within the Locality. No migratory species were recorded during field surveys.

While migratory species of bird may potentially use the Locality, the Study Area would not be classed as an 'important habitat' as defined under by DEWHA (2009a) in that the site does not contain:

- Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species;
- Habitat utilised by a migratory species which is at the limit of the species range; and,
- Habitat within an area where the species is declining.

The Study Area has not been identified as being internationally important, nor does it support:

- At least 0.1 per cent of the flyway population of a single species;
- At least 2000 migratory shorebirds; or,
- At least 15 shorebird species.

Thus it is not deemed to support an important population as defined by EPBC Act Policy Statement 3.21 (DEWHA 2009b).

As such, it is unlikely that The Project would significantly affect migratory species.

3.5 Aquatic Ecology

Aquatic ecology assessments were carried out using a combination of habitat-based assessment and water quality sampling. Survey effort was most rigorous within areas identified within the Subject Site as well as areas most likely to contain habitat for threatened species. Further survey effort was conducted outside of the main Study Area to determine whether sufficient barriers to fish movement were present downstream of the Subject Site.

A total of five sites were assessed during the field surveys. These site locations are shown in Figure 6. The completion of habitat assessments in the field was undertaken using HABSCORE methodology and noting general habitat characteristics. Raw data is presented in Appendix 4 & 5.

3.5.1 Aquatic Habitat Assessment

3.5.1.1 Whytes Gully Recovery Park surface water pond

The surface water pond site lies at the south western section of the Whytes Gully Resource Recovery Park and is the largest artificial retention pond within the study area (Plate 8). This site was found to have limited flow by nature of being an artificial wetland, and has been subject to moderate disturbance levels owing to sparse riparian vegetation, artificial hydrological regime, and the immediate surrounding land use of the Whytes Gully Resource Recovery Park. This provides marginal aquatic habitat quality, as determined by the HABSCORE method and includes areas with aquatic vegetation and organic debris within the riparian zone.

Waterbody type, size and flow characteristics

The artificial wetland measures approximately 120 m from bank to bank, with maximum water depths estimated at 0.5 m to >1.5m. The in-stream substrate is predominantly clay and silt with no flow. The wetland is fed by surface water run-off directed into the series of wetlands and ponds constructed in the south-western area of the Whytes Gully Resource Recovery Park.

Habitat cover

Aquatic vegetation present consists of beds of *Typha* sp. and scattered rush beds (*Juncus* sp.) along the edge of the wetland. Apart from these macrophytes and a small percentage of Coarse Particulate Organic Material (CPOM), there is minimal in-stream cover and no shading throughout the day. This wetland is quite exposed offering minimal cover and refuge for fish species. There was no evidence of fallen branches or logs within the wetland and it is unlikely these features exist given there are no mature trees within the riparian zone.

Land use, riparian vegetation and disturbance

The surface water ponds, by nature are subject to artificial hydrological regimes being constructed to act as settling ponds for sediments and surface water flowing throughout the Recovery Park. The ponds are at the lowest point of the Recovery Park, receiving flows from across the Park, and are expected to receive a high input of sediments. The riparian zone is sparsely vegetated with few trees and no shrub layer. Exotic grasses dominate the banks of the wetland providing some stability against erosion.

Threatened Species Habitats

Habitats within the artificial wetlands provide no spawning, foraging or sheltering habitats for aquatic threatened species due to minimal in-stream cover. Both upstream and downstream barriers are present which inhibit fish movement from the wetland. As a result colonisation and movement between the Study Area and downstream waterbodies is

unlikely to occur, as the site is rarely connected to downstream waterbodies. The quality of the water is likely to be nutrient high with low oxygen levels inhibiting the ability for many fish species to colonise this wetland. Consequently this waterbody does not support habitat for threatened fish species. During heavy rainfall, run-off from the surface water ponds of Whyte's Gully Whytes Gully Resource Recovery Park may flow into downstream waterbodies.

3.5.1.2 Dapto Creek, opposite Resource Recycling Park

Dapto Creek opposite the Whytes Gully Resource Recovery Park Site, flows south parallel to Reddalls Road along the boundary of the Whytes Gully Resource Recovery Park (Plate 9). The location of this site is shown in Figure 6.

Aquatic habitats within this section of Dapto Creek are classified by Strahler as Stream Order 5 and flows along the south-western border of the Whytes Gully Resource Recovery Park. The habitat at this Site was found to be moderately turbid, have poor flow and have been subjected to moderate disturbance levels due to cleared riparian vegetation, grazing and stock access. This provides suboptimal aquatic habitat quality, as determined by the HABSCORE method and includes areas with aquatic vegetation and organic debris within the riparian zone. Water quality analysis indicated that, apart from a low dissolved oxygen level, all parameters were within the ANZECC guidelines.

Waterbody type, size and flow characteristics

The stream width ranged from approximately 1 -10 m. The flow of the creek was reduced to standing pools with some run and riffle habitat present within the downstream sections of the Site at the time of the field assessment. The creek was generally shallow ranging from 0.1 m to greater than 1.2 m in depth. The streambed was dominated by clay and silt substrates. There was evidence of stock crossing in the shallow sections of the creek and this disturbance is likely to have contributed to the high suspended sediment load observed within the water channel.

Habitat cover

Along with the presence of in-stream logs, branches and fallen debris within the Site, aquatic vegetation (macrophytes) provided an additional source of cover for aquatic fauna. Emergent macrophytes dominated in stream cover with parts of the channel choked with beds of *Typha* sp. and filamentous algae covering in-stream debris. Willows, *Persicaria decipiens* and Curled Dock were also present along the left bank. The available habitat cover is considered to be of low to moderate value for habitat for aquatic fauna species.

Land use, riparian vegetation and disturbance

The right bank is predominantly used for pasture and grazing land use, supporting a mostly cleared riparian zone dominated by Coral Trees (*Erythrina* sp.), Willows (*Salix* sp.)

and exotic grasses. The shrub layer was largely absent along much of the reach of the right bank; however dense patches of Blackberry and Lantana were present. The riparian zone, (extending approximately 10 m deep) on the left bank was structurally more diverse than that of the right bank, which extended for only 3 metres deep. Both banks were dominated by exotic grasses, trees and shrubs with a patchy distribution of native canopy (wattles). Both banks were moderately stable, largely due to the high vegetation cover of mostly exotic species. Disturbance through stock access to the waterway is evident in the creek shallows.

Threatened Species Habitats

Habitats within the this Site provide limited spawning habitats, foraging and sheltering habitats for aquatic threatened species being relatively shallow, highly disturbed and provide moderate habitat cover in the form of aquatic macrophytes and fallen debris. There is very little ability for fish to move upstream or downstream within this section of Dapto Creek. The creek becomes effectively dry, travelling through private properties downstream. During the survey the channel of the creekline was observed to be very shallow with terrestrial vegetation fringing the banks of Dapto Creek. The headwaters of Dapto Creek extend only ~500 metres upstream from this site providing few habitat extents available for fish upstream of the site. There are significant barriers to fish movement within this section of Dapto Creek and therefore colonisation and movement between this area of Dapto Creek and downstream waterbodies is unlikely to occur.

3.5.1.3 Dapto Creek (Reddalls Road crossing)

Dapto Creek (Reddalls Road crossing) is located approximately 800 metres north of the entrance to the Recovery Park (Plate 10) and marks the furthermost upstream extent of the study area. Aquatic habitat within this section are classified by the Strahler method as Stream Order 5, and flows along the western boundary of the Whytes Gully Resource Recovery Park and crossing Reddalls Road. The habitat was found to have a variety of habitat cover, substrate and flow characterisation. This provides sub-optimal aquatic habitat quality, as determined by the HABSCORE method and includes areas with aquatic vegetation and organic debris within the riparian zone. Water quality analysis indicated that all parameters were within the ANZECC guidelines.

Waterbody type, size and flow characteristics

Channel width ranged from 0.1 m to 6 m and was generally wide along its reach (average width 4 - 5 m). The majority of the creek was a slow moving pool. Short distance of run and riffle were observed immediately upstream of the Reddalls Road crossing. There were multiple aquatic habitats due to large woody debris, mixed substrates and undercut banks. Streambeds ranged from sand substrates to cobble/pebble substrates with maximum water depths ranging to approximately 1.3 m in depth. Substrate structure was diverse consisting of a mix of sand, cobble, pebble, boulder and gravel present. Much of the shallow substrates were covered by filamentous algae.

Habitat cover

Along with the presence of cobble/pebble substrates, logs and branches, aquatic vegetation (macrophytes) provided an additional source of cover for aquatic fauna. Aquatic vegetation within this reach of Dapto Creek was generally dominated by emergent macrophytes overhanging the creekline banks *Ageratina riparia,* Nasturium *Rorippa nasturtium-aquaticum*) *Veronica anagallis-aquatica* and Persicaria *Persicaria decipiens*. A high percentage of filamentous algae was also present throughout the creek. In-stream cover was good with overhanging terrestrial vegetation, branches, wood debris and aquatic vegetation providing good habitat and shading along the bank edges throughout the day.

Land use, riparian vegetation and disturbance

Land use on the left bank was considerably better than the right bank. The riparian zone of the right hand side bank is bordered by Reddalls Road which limits the extent of the riparian zone to 2 metres. Beyond Reddalls Road the landuse of the area is semi-rural and mainly used as pasture and grazing lands. The vegetation along this right bank was dominated by exotic grasses, shrubs (*Lantana* sp.*)* and Coral Trees *Erythrina* sp.. The left bank supported a more structurally diverse riparian zone with native and exotic vegetation extending up to 8 metres deep along the steep incline that separates Dapto Creek from the Whytes Gully Resource Recovery Park. Bank erosion was mostly minimal with grasses stabilising both banks. The bridge and road crossing at this creek is a potential source of pollution and disturbance.

Threatened Species Habitats

The habitats present within the upper reaches of Dapto Creek have a moderate potential to provide preferential habitats such as cobble-bottom pools with considerable emergent vegetation cover and large woody debris. This provides potential spawning, foraging and/or sheltering habitats for aquatic threatened species. However, the presence of downstream barriers to fish movement (extensive areas where the creekline runs dry and artificial weirs) mean that colonisation and movement between the upper reaches of Dapto Creek and downstream waterbodies is unlikely to occur.

3.5.1.4 Dapto Creek, West Dapto Road bridge crossing

This site lies approximately 500 metres downstream of the Whytes Gully Resource Recovery Park, approximately 1 kilometre west from the intersection of Reddalls Road and West Dapto Road. Aquatic habitat within this site was assessed 20 metres downstream and 80 metres upstream due to limited safe access to the waterbody. The site was considered to be in marginal condition due to surrounding land use and the highly modified riparian zone, however provides some habitat cover, as determined by the HABSCORE method.

Waterbody type, size and flow characteristics

This reach of Dapto Creek varied in-stream width from dry (upstream of the road) to 7 metres wide. The average depth in wetted areas was approximately 1 metres deep. There was no flow present and the substrate was found to be a mix of clay/ silt with some gravel, sand and pebble present.

Habitat cover

The banks of the creek within this reach were heavily vegetated downstream of West Dapto Road by Camphor Laurels *Cinnamomum camphora*) and Coral Trees. These exotic canopy species provide plenty of shading throughout the day that increases the habitat cover available for fish. The dense trees also drop debris, CPOM and branches into the creek providing habitat variability and in-stream cover. Filamentous algae dominated aquatic vegetation with duckweed floating on the surface. The in-stream cover provided good aquatic habitat with a mixture of woody debris (logs, branches, sticks), branch piles, overhanging terrestrial vegetation and CPOM.

Land use, riparian vegetation and disturbance

Both the left and right bank had a riparian width of 8 m deep. Beyond this vegetated area the land use is highly disturbed through grazing and pasture land practises. The right and left bank supported a structurally diverse riparian zone with a mixture of mostly exotic mature trees, shrubs and understory. The West Dapto Road bridge crossing is a potential source of pollution and disturbance at this reach of Dapto Creek.

Threatened Species Habitats

The habitats within Dapto Creek downstream of the West Dapto Road crossing provide a limited availability of spawning, foraging or sheltering habitats for aquatic threatened species; however these sparse habitats are bordered by significant barriers to fish movement (upstream being dry at the time of survey) and becoming dry and exposed channelled over private property before flowing into Mullet Creek where a weir has been established. This weir located just upstream of William Beach Park in Mullet Creek effectively restricts fish travelling upstream into headwater creeks such as Dapto Creek and therefore inhibits colonisation and movement between Dapto Creek and downstream waterbodies such as Mullet Creek.

3.5.1.5 Mullet Creek, William Memorial Beach Park

Mullet Creek, at William Beach Park, was the most downstream of all sites assessed (of which Robin and Dapto creek flow into) and flows into Lake Illawarra, south of Wollongong (at Purrah Bay and Koong-Burray Bay) (Plate 12). This site lies downstream of the Recovery Park at William Beach Memorial Park. Aquatic habitat within the William Beach Memorial Park locality was assessed and included the downstream area of Mullet Creek from the fish weir (opposite the intersection of Quarter Sessions Road and Prince Edward

Drive). This site was included in the Study area due to the convergence of Robin and Dapto Creek and also as a means of considering diadromous species (such as the Australian Grayling) and its potential for upstream migration from the ocean. The site was considered to be in marginal condition due to surrounding land use and the highly modified riparian zone as determined by the HABSCORE method. In-stream barriers within the waterway at this location, such as the weir, make it unlikely that fish would be able to migrate upstream.

Waterbody type, size and flow characteristics

This reach of Mullet Creek varied in stream width from 10 metres approximately to 20 metres wide. The depth ranged from approximately 1 – 3 metres deep. There was no flow present and the substrate was found to be a mix of clay, silt and sand with some gravel and pebble present.

Habitat cover

Both banks at Mullet creek within this reach were sparsely vegetated with scattered patches of native and exotic vegetation resulting in a small degree of shading. Aquatic vegetation such as beds of *Typha* sp. fringes the waterline in some areas providing habitat and refuge for fish. Areas along the banks which contain large wetted rocks as reinforcement provide good aquatic habitat as well as woody debris (logs, branches, sticks), overhanging terrestrial vegetation and CPOM.

Land use, riparian vegetation and disturbance

The surrounding land use is highly urbanised; with a mix of residential and recreational zoning. Golf and fishing are popular recreational activities undertaken in the area with locals fishing for mullet, black bream, eels, trevally, flounder, drummers and estuary rays (local fisherman pers.comm). The Kembla Grange Golf Course is located on the left hand side of Mullet Creek. The right hand side is largely cleared grazing paddocks. As such, the riparian zone is highly disturbed with small areas of isolated trees and shrubs. For the most part the banks are bare of vegetation, being dominated only by exotic vegetation. At this location Mullet Creek is predominantly saline due to its close proximity to the Lake Illawarra and in-flows from the coean. Potential sources of pollution include runoff from the golf course and rubbish from recreational use.

Threatened Species Habitats

The habitats within Mullet Creek at William Beach Memorial Park provide a moderate availability of spawning, foraging or sheltering habitats for aquatic threatened species; however due to the presence of the weir it is unlikely to support fish migration travelling upstream from this locality. Colonisation and movement between the upper reaches of Dapto Creek and downstream waterbodies such as Mullet Creek is unlikely to occur for this reason.

3.5.2 Significant Aquatic Flora

No aquatic flora species listed under the FM and/or EPBC Acts have been identified for consideration in relation to the Study Area or have the potential to inhabit the Wollongong LGA. There are no known threatened aquatic flora populations or aquatic EECs listed under the FM, TSC or EPBC Acts for the Wollongong LGA.

3.5.3 Significant Aquatic Fauna

A total of four aquatic fauna species listed under the FM and/or EPBC Acts, or their habitats have been identified for consideration in relation to the Study Area or have the potential to occur in the Wollongong LGA (Australian Grayling *Prototractes maraena*, Murray Cod *Maccullochella peelii*, Trout Cod *Maccullochella macquariensis* and Macquarie Perch *Macquaria australasica*). Of these the Trout Cod and Macquarie Perch are listed on the FM Act and all these species are listed under the EPBC Act.

No targeted surveys (e.g. electrofishing, seine netting or line fishing) were undertaken for threatened fauna. Instead the availability of potential habitats for these species was assessed. If potential habitat were to be found during the aquatic habitat assessments for any of the above species, targeted surveys would then be recommended to assess the frequency of use and importance of these habitats for these species.

Likelihood of occurrence of these four species was considered to be low, based on a lack of suitable habitat, in-stream barriers, and lack of recent records (Appendix 2). There are three records of Trout Cod occurring in Lake Cataract Dam from 1994 (NSW DPI 2011); however there is no connectivity from this area into Dapto is Creek due to the Illawarra escarpment.

No preferential habitats were observed to occur within the Whytes Gully Resource Recovery Park boundary, Dapto Creek or upstream of Mullet Creek. On the basis of previous records and the absence of suitable habitats, the likelihood of occurrence for each of these species was considered low (Appendix 2). Due to the presence of downstream barriers to fish movement (e.g. exposed banks, dams, extensive areas of dry areas and artificial weirs) within Dapto Creek and Mullet Creek there are no opportunities for fish to utilise habitats within the upper reaches of Dapto Creek. The availability of habitats were considered to be in poor condition due to shallowness, dis-connectivity, low flow rates and prevalence of exotics weed species.

3.5.4 Riparian Buffer Widths

This section defines the Riparian Corridor Management Study (RCMS) riparian buffer widths to be considered in the planning and design of the proposal. These riparian buffer widths are based on the Wollongong (West Dapto) LEP 2010 and Wollongong DCP 2009 in order to identify appropriate riparian buffer widths using the RCMS method. Table 13

below describes the minimum environmental land objectives to be applied under categorisation of waterbodies surrounding the Study Area.

The RCMS riparian buffer widths herein are based on the aquatic habitat assessments and criteria of Table 13. Aquatic flora and fauna RCMS riparian buffer width mapping according to the convention of this report is provided in Figure 9. RCMS riparian buffer widths of this assessment are suitable to be adopted as an alternative to the Strahler stream order method identified within the Wollongong (West Dapto) LEP 2010 and DCP 2009.

The RCMS stream classification system, developed by the former DIPNR, identified minimum riparian corridor widths along watercourses. The incorporation of riparian corridor outcomes into LEPs is consistent with the state governments approach to provide better upfront planning and certainty, rather than deferring to the development stage and referrals under the *Rivers and Foreshores Improvement Act 1948.*

DIPNR's stream mapping work was initially developed for the RCMS in the Wollongong LGA. The RCMS process has since been widely adopted and applied to Sydney's Northwest and Southwest Growth Centres, other LGAs and land release sites.

The stream classification uses three categories which reflect the environmental significance of watercourses and a summary of Riparian Corridor Objectives is presented in Table 13.

The aquatic habitat assessment recommends using the riparian corridor objectives created within the RCMS process and as such three categories occur in proximity to the study area based on the criteria in Table 13 (Appendix 7):

- Category 1 (Environmental Corridor);
- Category 2 (Terrestrial and Aquatic Habitat); and,
- Category 3 (Bank Stability and Water Quality) (Figure 9).

3.5.5 Surface Water Quality

The physio-chemical water quality results for this survey are detailed in Appendix 5. The water quality data is compared with guideline values such as the ANZECC guidelines for the Protection of Aquatic Ecosystems (ANZECC 2000).

Temperature varied between sites, with a range of 15 - 19.4°C. These variable temperatures are considered normal, being subject to seasonal, ambient and time-of-day temperature fluctuations. All sites were slightly alkaline, with pH ranging from 7.47 to 8.6. All but one of the pH values (Whytes Gully Resource Recovery Park surface water pond, pH 8.29) fall within the ANZECC guidelines (pH >6.5 – 8). Water quality testing undertaken by Golder in July 2011 indicated that, relative to other waterbodies, Pond 1 (Figure 8) had elevated salinity records. The elevated pH level observed at the surface

water ponds is likely to be a result of the relatively high salinity previously recorded at this location. With the exception of Mullet Creek (due to its saline nature), conductivity fell within the ANZECC guidelines for all sites (0.1 – 563 µs/mS).

Low flow conditions and high in-stream organic loads from historic and ongoing landuse can result in depressed dissolved oxygen levels within affected waterbodies. Dapto Creek (opposite Whytes Gully Resource Recovery Park) and Mullet Creek fell below the ANZECC guidelines for dissolved oxygen levels. However, results within Dapto Creek (crossing Reddalls Road and West Dapto Road) indicated dissolved oxygen levels that were within the ANZECC guidelines. This is most likely due to the presence of moderate flow with fringing macrophytes at Dapto Creek (Reddalls Road) and a larger waterbody extent (7 metres width and >1 metre depth) at West Dapto Road. Dissolved oxygen levels also vary widely with temperature and the time of day the sample is taken, especially within waterbodies of a shallow nature. Turbidity levels varied across the sites from 2.4 – 106 NTU. Whytes Gully Resource Recovery Park surface water pond recorded the highest turbidity reading (106 NTU). This result supports the premise that this surface water pond receives run-off flowing from across the park into the surface water pond. In contrast, Dapto Creek crossing West Dapto Road had the lowest turbidity recording (2.4) and is likely to result from the minimal flow present and dry upper extent at the time of survey.

The natural creek hydrology and water quality of the surface waters surrounding the Whytes Gully Resource Recovery Park has largely been modified by historic and on-going land use practises (farming and agriculture). A predominantly cleared landscape with small patches of vegetation remaining and riparian vegetation clearance throughout the area have lead to higher sediment inputs and erosional activity that has had detrimental impacts to the surface water quality of Dapto and Mullet Creek. Conversely, sites with an intact riparian zone recorded a higher surface water quality result, indicative of forested catchments and the natural processes that are in place.

4.0 IMPACT ASSESSMENT

4.1 Potential Impacts

The potential impacts of The Project with regards to flora include:

- Potential clearing of 0.49 hectares of native vegetation and 25.56 hectares non-native or disturbed native vegetation.

Table 9: Detailed calculations of vegetation to be cleared (See Figure 7)

Vegetation Community	Cleared
Native vegetation communities	
Forest-Redgum Open Forest/Closed Woodland	0.477 ha
Illawarra Dry Subtropical Rainforest	0.116 ha
Non-native or disturbed vegetation communities	
Acacia Scrub/Exotic	6.119 ha
Closed Exotic Grassland	18.917 ha
Planted vegetation	0.526 ha

- Additional removal of Illawarra Dry Subtropical Rainforest, Moist-Box Redgum Foothills Forest and Forest Redgum Open Forest/Woodland Communities as a result of clearing associated with a perimeter firebreak and instakllation of fire hydrant outlets;
- Additional impacts to retained native vegetation, including edge effects leading to potential increased weed invasion;
- Trimming of the lower branches of native trees (to a height of 2 metres) retained on site for the purposes of bushfire protection;
- Potential drying of the soil along the top edge of the drain and a localised effect on native vegetation caused by drainage works within the edge of the Illawarra Subtropical Rainforest;
- Reduced area of habitat for native vegetation; and,
- Indirect impacts to vegetation resulting from the construction phase of The Project.

Potential impacts of The Project with regards to fauna include:

- Reduction in foraging habitat for six microchiropteran bat species (Eastern False Pipistrelle, Eastern Freetail-bat, Greater Broad-nosed Bat, Eastern Bentwing-bat, Southern Myotis and Yellow-bellied Sheathtail-bat);
- Reduction in foraging habitat for the Grey-headed Flying-fox;

- Reduction in foraging habitat for native birds, mammals and reptiles in the open forest/woodland and closed forest habitats;
- Removal of understory flora including woody weeds such as Lantana which provides important foraging and sheltering habitat for small native birds;
- Removal of woody debris, logs and/or grass thickets which provide sheltering habitat for reptiles and small mammals;
- Removal of potential foraging and dispersal habitat for the Green and Golden Bell Frog and Australian Painted Snipe;
- Removal of sub-optimal habitat for the Green and Golden Bell Frog and Australian Painted Snipe;
- Modification to foraging and drinking habitats for native fauna over the surface water reed beds 1 and 2 and the surface water polishing pond; and,
- Potential changes in flow received to the drainage line running from the Subject Site into Dapto Creek which may impact on downstream habitats used by native fauna.

The potential impacts of The Project with regards to aquatic ecology include the facilitation of up to three Key Threatening Processes (KTP's) listed under Schedule 6 of the FM Act and one listed under Schedule 3 of the TSC Act. A full assessment of these KTPs is included within Appendix 6. A summary of the consideration of the KTP's which would potentially relate to the proposal are as follows:

- 'Degradation of native riparian vegetation along NSW waterways' (FM Act). The proposal will involve the modification of the existing surface water ponds within the Recovery Park. Some native vegetation fringes these ponds which may be removed during the construction phase. Following the re-structuring of the surface water ponds, native vegetation along the banks of the ponds will be re-instated. Provided this revegetation occurs, the native riparian vegetation will not be degraded by the proposed works;
- 'Removal of large woody debris from NSW rivers and streams' (FM Act). The surface water ponds to be modified currently do not have large canopy trees surrounding the ponds. No large woody debris were observed within the ponds and given the lack of surrounding canopy this habitat feature is unlikely to be present within the surface water ponds to be re-structured. As these habitat features are absent from the site this KTP will not be triggered;
- 'Instream structures and other mechanisms that alter natural flow' (FM Act). The proposal will involve modifying the current lay-out of the surface water ponds receiving water run-off from across the Whytes Gully Resource Recovery Park. No instream structures will be installed. The proposal will, however, alter the current natural flow of water that exits the Whytes Gully Resource Recovery Park. This

change may be temporary and as a result the natural flow of the waterway will not be permanently altered; and,

- 'Alteration to the natural flow regime' (TSC Act). The proposal will involve modifying the current lay-out of the surface water ponds receiving water run-off from across the Recovery Park. This alteration to the current flow of water across the Whytes Gully Resource Recovery Park will be temporary with the surface water ponds being re-structured with similar capacity to continue in their function as settling ponds for surface water run-off. The natural flow should not be permanently disrupted as a result of the proposal.

4.2 Mitigation Measures

The following measures are recommended to avoid, mitigate and minimise these impacts:

- The re-design of the cells has substantially minimised the need to remove the ISTR EEC. A total of 0.01 hectares of ISTR will be removed. This removal will be undertaken along the southwest edge of this EEC, in areas containing high levels of weed invasion.
- Clearing for the purposes of bushfire protection should be restricted to non-native vegetation communities (Acacia Scrub/Exotic, Closed Exotic Grassland, Planted – see Figure 7) where possible. Clearing of ISTR and Moist-Box Redgum Foothills Forest will be avoided and clearing of Forest-Redgum Open Forest/Woodland will be minimised.
- Trimming of trees for bushfire protection should not be undertaken in ISTR and Moist-Box Redgum Foothills Forest vegetation communities. As stated in the bushfire report, these communities are not subject to this requirement.
- Removal of other native vegetation communities and fauna habitats throughout the Study Area should be avoided and minimised wherever possible.
- Undertaking additional targeted surveys for Green and Golden Bell Frog in peak breeding period for 2012/2013 to confirm results of the current surveys undertaken in November/December 2011and early January 2012.
- Removal of waterbodies and associated vegetation should be undertaken over the spring or summer months when fauna species are most active. This allows fauna to retreat to surrounding habitats such as Dapto Creek and farm dams.
- Undertake protection of all retained trees. Tree protection measures such as temporary fencing should be implemented for any trees potentially indirectly impacted by The Proposal.
- Install protective fencing around all retained native vegetation. This is particularly important for areas of Illawarra Subtropical Rainforest EEC where there is a risk of indirect impact.
- Installation of sediment and erosion controls as required.

- Ensure machinery parking, equipment or materials storage compounds, temporary stockpiling of excavated material and work areas are well outside sensitive natural features including retained native vegetation, wetlands and drainage line.
- Logs removed with any vegetation removal should be relocated into areas of retained vegetation, in a sensitive manner, for the purpose of providing fauna habitat.
- A weed control program should be undertaken. Bush regeneration techniques conducted by a suitably qualified contractor are recommended as this approach will lead to an improvement in the condition of native vegetation communities, reduce the requirement for weed control in the long term, reduce the risk of over clearing impacting fauna habitats and reduce potential harm to the ISTR EEC.
    - The implementation of a vegetation management plan associated with bushfire protection, including removal of Lantana and other weeds, are likely to benefit natural, unassisted regeneration of native vegetation communities.
- Undertake revegetation of cleared and disturbed areas using a range of native species of local provenance for the purpose of managing weeds, controlling soil erosion, and maintaining fauna habitat.
- Maintain suitable buffer distances from nearby waterways (Figure 9). These buffer distances are recommended based on the stream orders of waterways and the subsequent categories identified within the Wollongong DCP (2009). As all construction works are to be undertaken within the Whytes Gully Resource Recovery Park boundary, these buffer distances should be maintained without any difficulty. The appropriate Riparian Land Objectives for each of these waterways should also be considered (Table 13; Appendix 7).
    - The unnamed drainage line flowing south from Whytes Gully Resource Recovery Park is considered to be a Category 3 waterway.
    - Dapto Creek, (opposite the Whytes Gully Resource Recovery Park) and Dapto Creek (Reddalls Road crossing) are considered to be Category 2 waterways**.**
    - Dapto Creek (West Dapto Road bridge crossing) and Mullet Creek are considered to be Category 3 waterways.
- Following the re-shaping and modification of existing surface water ponds, landscaping should be considered to establish a greater width of native vegetation along the edge of the ponds to provide a more robust riparian buffer. It is recommended that the vegetation buffer be constructed to an average width of 5 metres where possible to improve the aquatic habitats present on site.
- The current water quality monitoring program be extended. Ideally the expanded water quality monitoring program will include at least one monitoring location on

Dapto Creek, upstream of the discharge point for the Whytes Gully Resource Recovery Park, as a control and a minimum of two locations downstream of the Whytes Gully Resource Recovery Park along Dapto Creek. An upstream monitoring location is important to detect any changes in turbidity or nutrients recorded immediately downstream of the Recovery Park.

4.3 Assessment of Significance

An Assessment of Significance, according to EPBC Act Policy Statement 1.1 (DEWHA 2009a) was carried out for the Grey-headed Flying-fox. This self assessment determined that a significant impact to this matter of national environmental significance (MNES) would not result from the proposed action.

Assessments of Significance as set out by Appendix 3 of the *Draft Guidelines for Threatened Species Assessment* (DEC & DPI 2005) have been conducted for the following EEC and species (Appendix 3);

- Illawarra Subtropical Rainforest EEC;
- Green and Godlen Bell Frog;
- Australian Painted Snipe;
- Grey-headed Flying-fox;
- Eastern Bentwing-bat;
- Southern Myotis; and,
- Hollow-dependent microbats, including:
  - Yellow-bellied Sheathtail-bat;
  - Eastern Freetail Bat;
  - Eastern False Pipistrelle; and
  - Greater Broad-nosed Bat.

The Assessments of Significance have concluded, providing recommended avoidance and mitigation measures are adhered to, The Project is considered unlikely to have a significant impact on the threatened species or the EEC assessed.

Additional surveys for the Green and Golden Bell Frog will be undertaken in peak breeding season of January/February 2012 to confirm the results of the recent targeted survey undertaken between November/December 2011 and early January 2012. The results of these additional surveys will be reported accordingly.

5.0 CONCLUSION

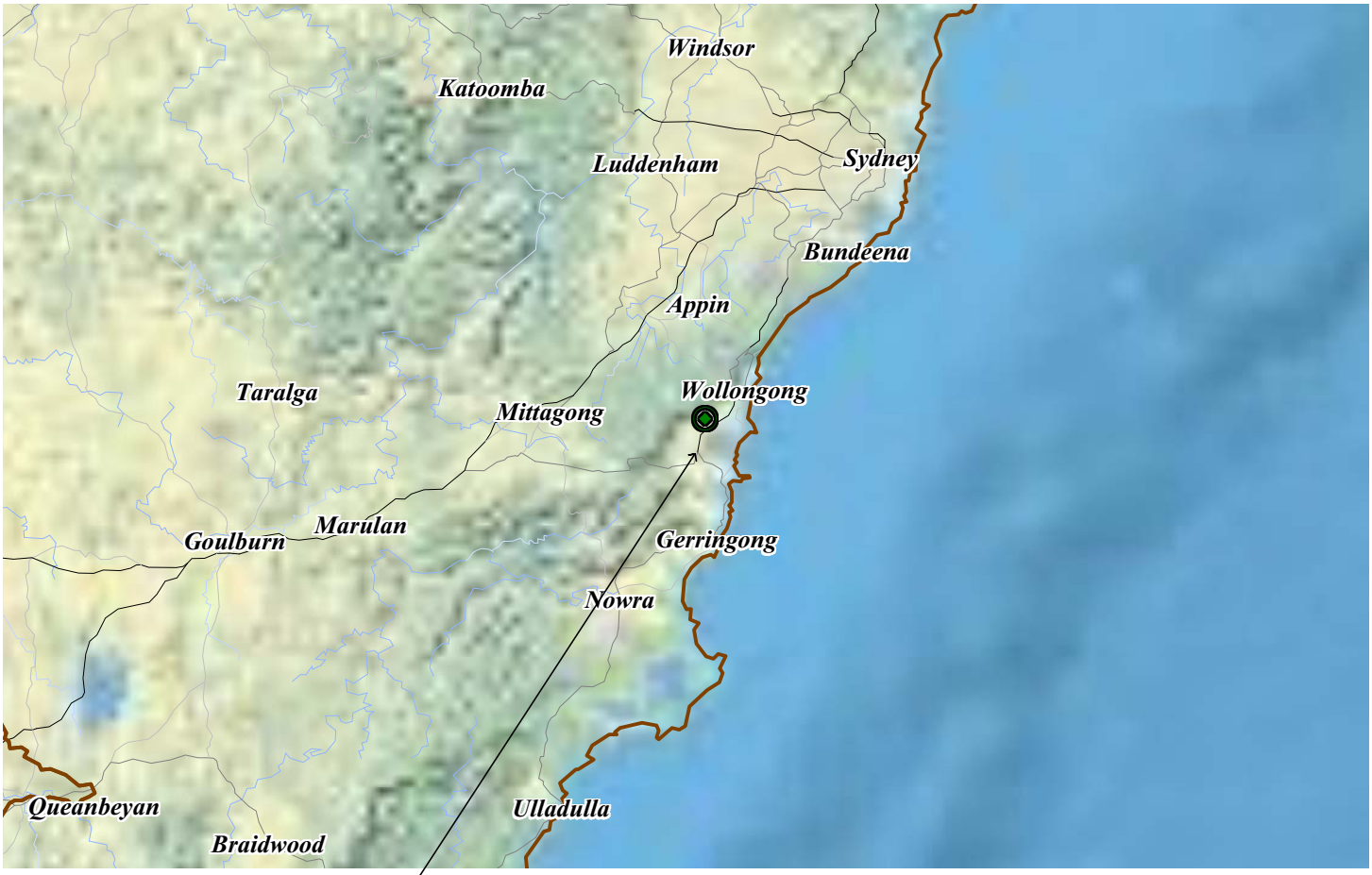
A flora and fauna assessment has been conducted for the Study Area in regard to the proposed Whytes Gully New Landfill Cell.

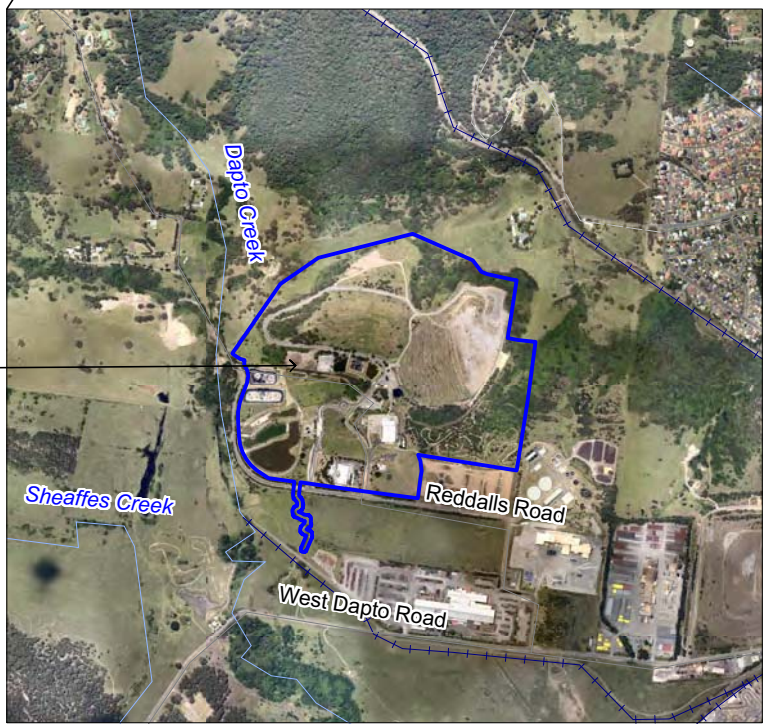
This assessment has recorded one EEC and two threatened fauna species within the Study Area and has concluded an additional five fauna species are likely to occur within the Study Area and may potentially be impacted by The Project.

Assessments of Significance for these EEC and species have concluded that, providing recommended avoidance and mitigation measures are adhered to, The Project is unlikely to have a significant impact on the threatened species or the EEC assessed.

A primary recommendation has been to expand the current water quality monitoring program, already operating within the Whytes Gully Resource Recovery Park, to include the adjacent water way, Dapto Creek. This monitoring program is currently being extended to assist in satisfying current POEO Act licensing requirements. This additional monitoring will better inform the levels of nutrients, sediments and characteristics of water entering the Dapto Creek system downstream of the Whytes Gully Resource Recovery Park.

FIGURES





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Figure 1: Location of the Study Area in a regional context

Date: 5 August 2011	Drawn by: ANP
File number: 12379	Checked by: BC
Location: P:\12300s\12379\Mapping\12379 F1_Locality.WOR	

Scale: 0 0.25 0.5 0.75 1.0 kilometres

N W E S



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Figure 2: The Location of the Study Area and Subject Site in a Local Context.

Date: 16 January 2011	Drawn by: ANP
File number: 12379	Checked by: BC
Location:-..P:\12300s\12379\Mapping\12379 F2_Overview.WOR	

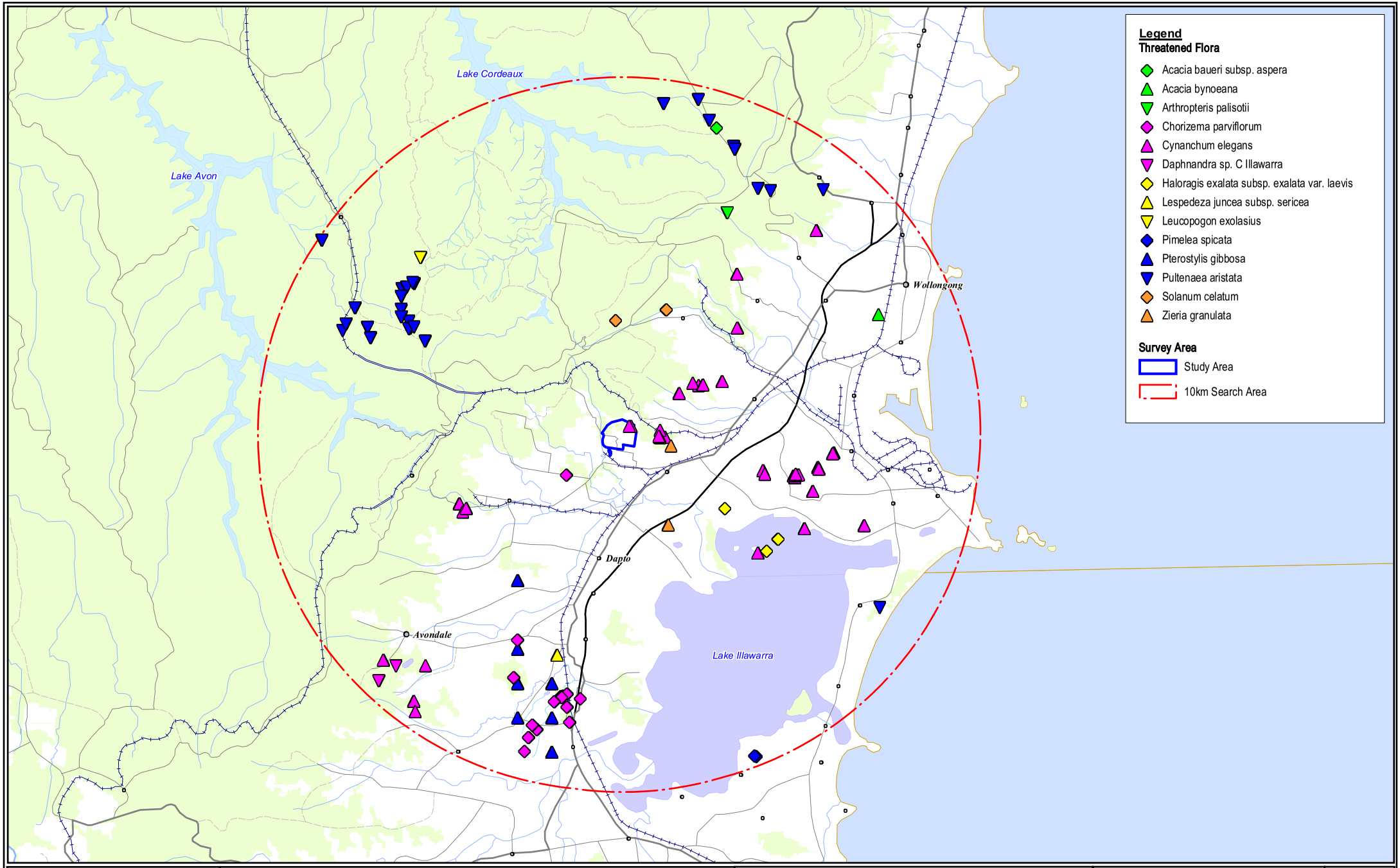
Acknowledgements:
Aerial Imagery - NearMap
This product incorporates Data which is copyright to the Commonwealth of Australia (c.2003-)

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metres

Scale: 1:5,000 at A3
Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

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Figure 2



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Figure 3: TSC Act flora previously recorded in a 10km radius of the Study Area.

Date: 5 August 2011	Drawn by: ANP
File number: 12379	Checked by: BC
Location:-..P:\12300s\12379\Mapping\12379 F3_Threatened Flora.WOR	

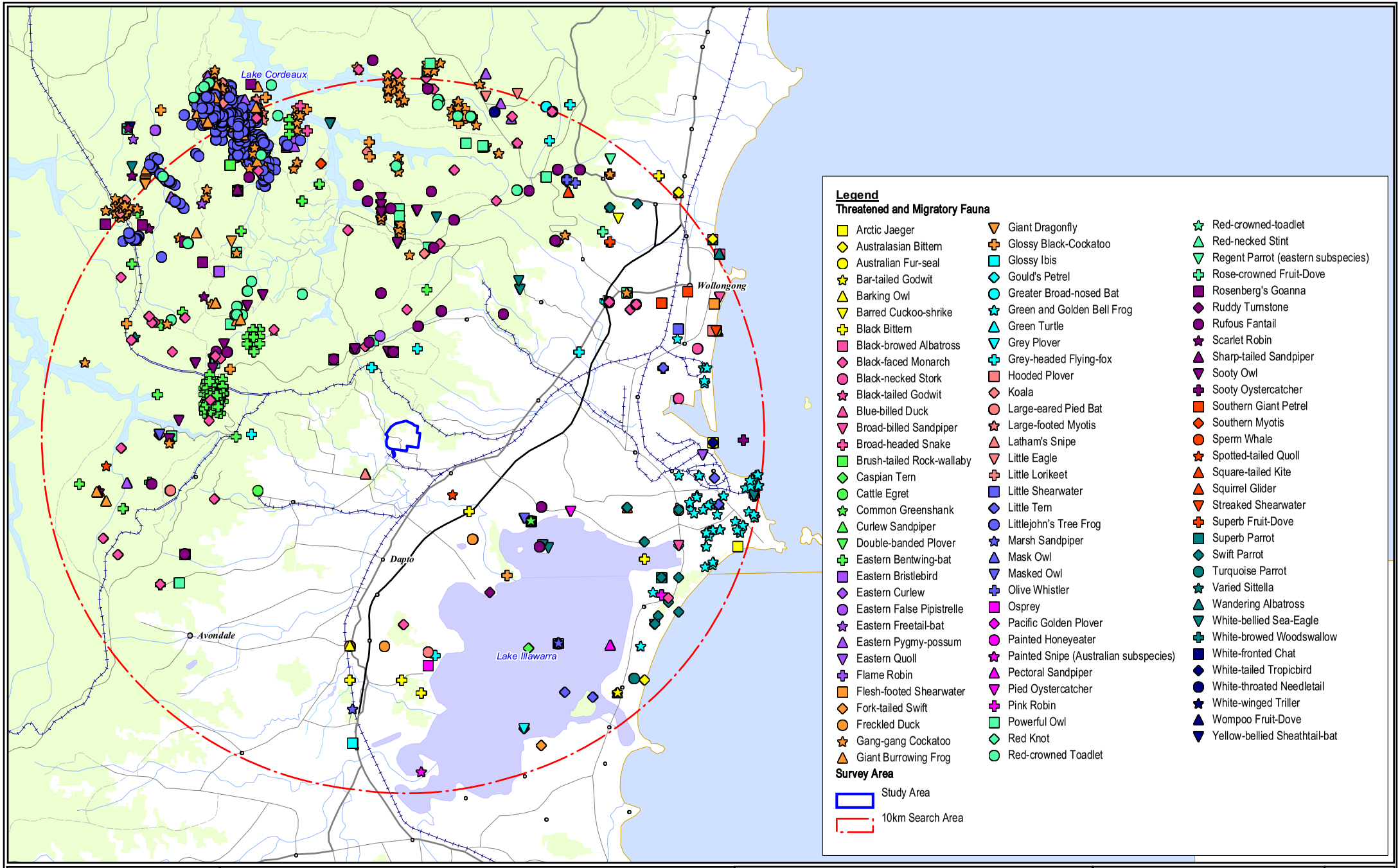
Acknowledgements:
Species data - OEH
This product incorporates Data which is copyright to the Commonwealth of Australia (c.2003-)

0 1 2 3 4 5
kilometres

Scale: 1:100,000 at A3
Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

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Figure 3



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Figure 4: TSC Act fauna previously recorded in a 10km radius of the Study Area.

Date: 5 August 2011	Drawn by: ANP
File number: 12379	Checked by: BC
Location:-..P:\12300s\12379\Mapping\12379 F4_Threatened Fauna.WOR	

Acknowledgements:
Species Data - OEH
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0 1 2 3 4 5
kilometres

Scale: 1:100,000 at A3
Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

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Figure 4



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Figure 5: Survey Effort.

Date: 5 August 2011	Drawn by: ANP
File number: 12379	Checked by: BC
Location:-..P:\12300s\12379\Mapping\12379 F5_Survey Effort.WOR	

Acknowledgements:
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metres

Scale: 1:5,000 at A3
Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

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Figure 5

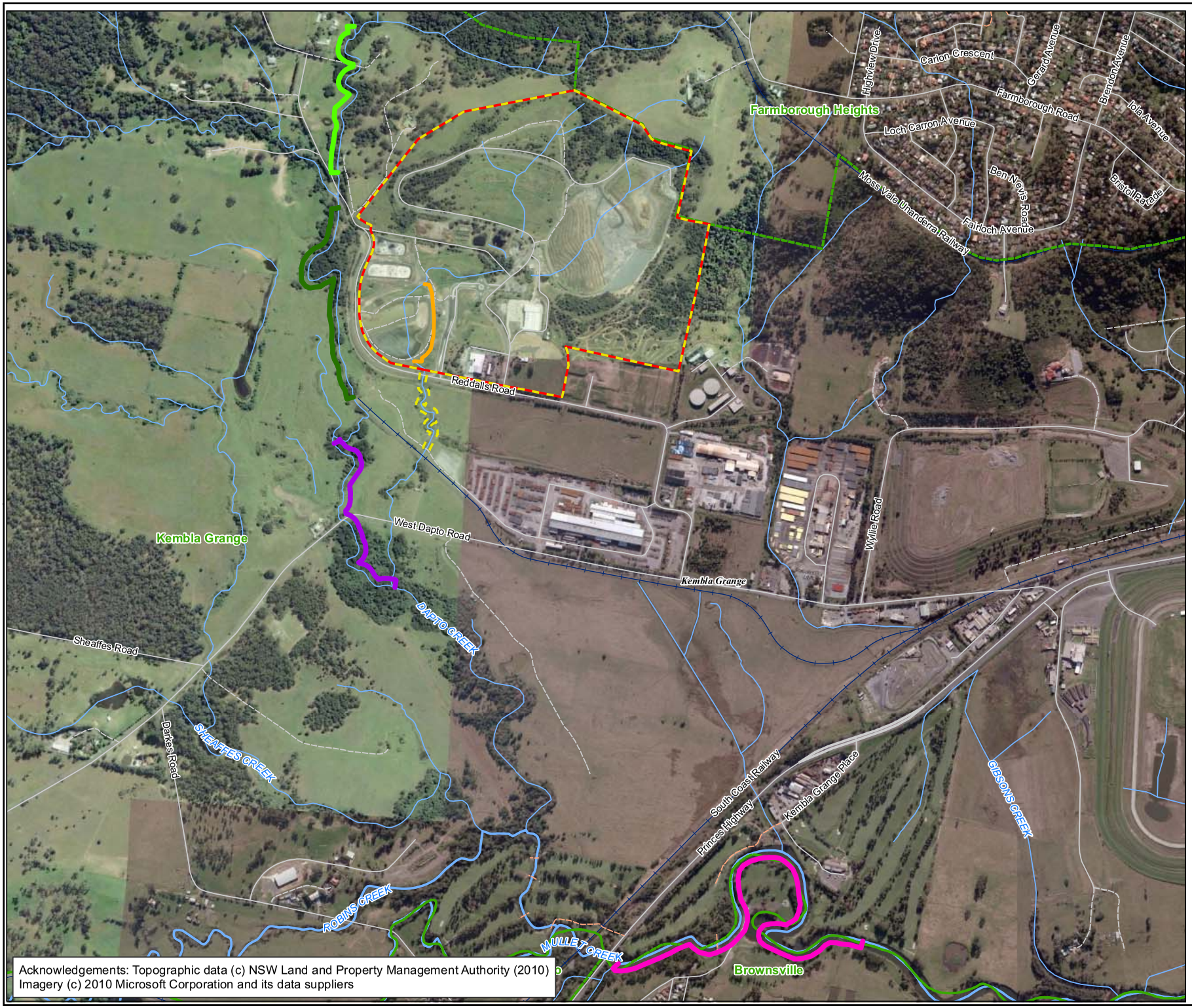


Figure 6: Aquatic Habitat Assessment Locations

0 100 200 300 400 500

Metres
Scale: 1:10,000 @ A3
Coordinate System: GDA 1994 MGA Zone 55

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Date: 13 October 2011, File number: 13724
Checked by: JKD Drawn by: JMS
Location:P:\13700s\13724\Mapping\13724_F6_AssessmentSites.mxd



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Figure 7: Vegetation communities, fauna habitats and threatened species of the Study Area.

Date: 16 January 2012	Drawn by: ANP
File number: 12379	Checked by: BC
Location:-..P:\12300s\12379\Mapping\12379 F7_Biosis Vegetation.WOR	

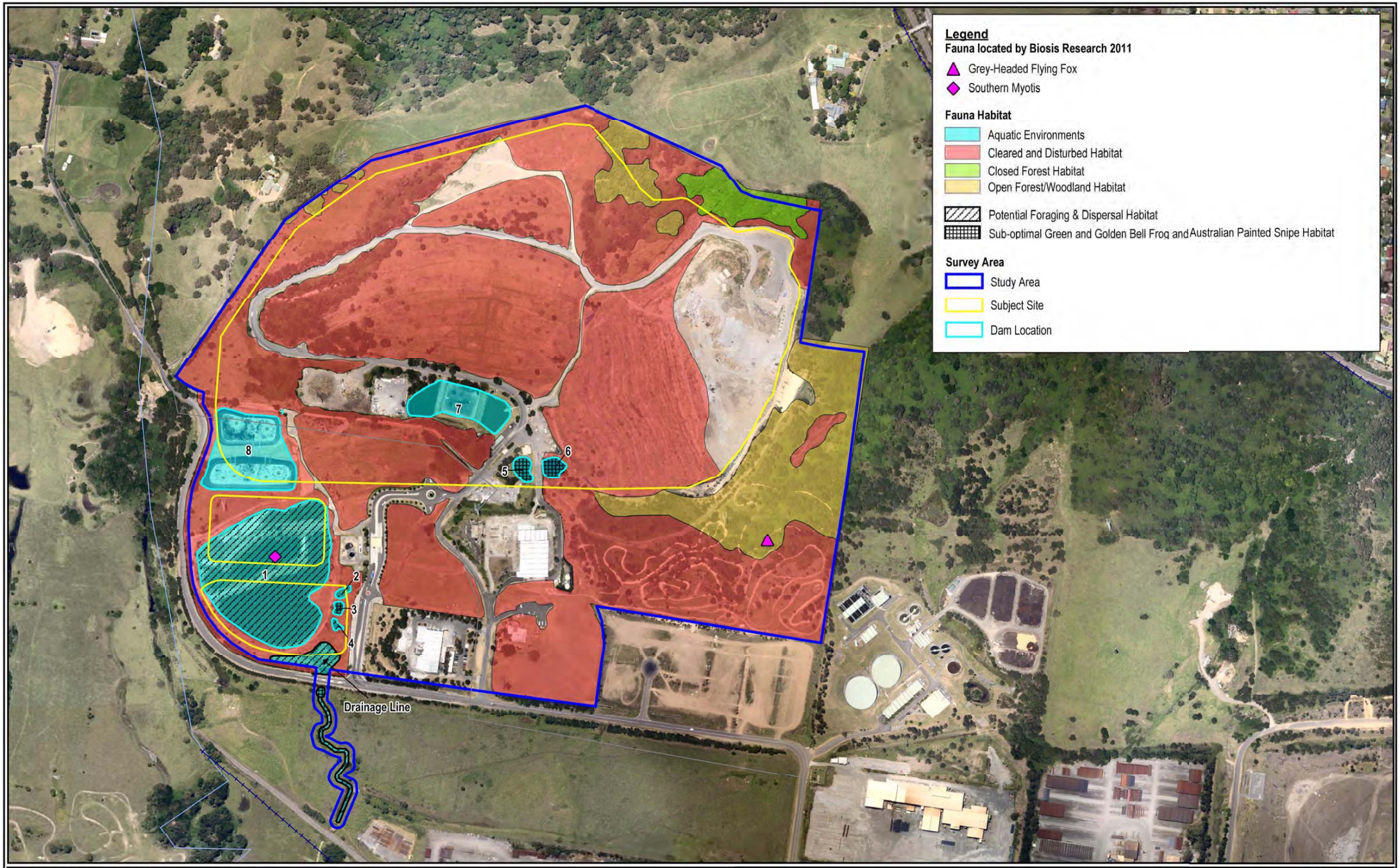
Acknowledgements:
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metres

Scale: 1:5,000 at A3
Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

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Figure 7



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Figure 8: Fauna Habitats and Threatened Fauna Species Recorded.

Date: 16 January 2012	Drawn by: ANP
File number: 12379	Checked by: BC
Location:-..P:\12300s\12379\Mapping\12379 F8_Fauna Habitat.WOR	

Acknowledgements:
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metres

Scale: 1:5,000 at A3
Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

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Figure 8

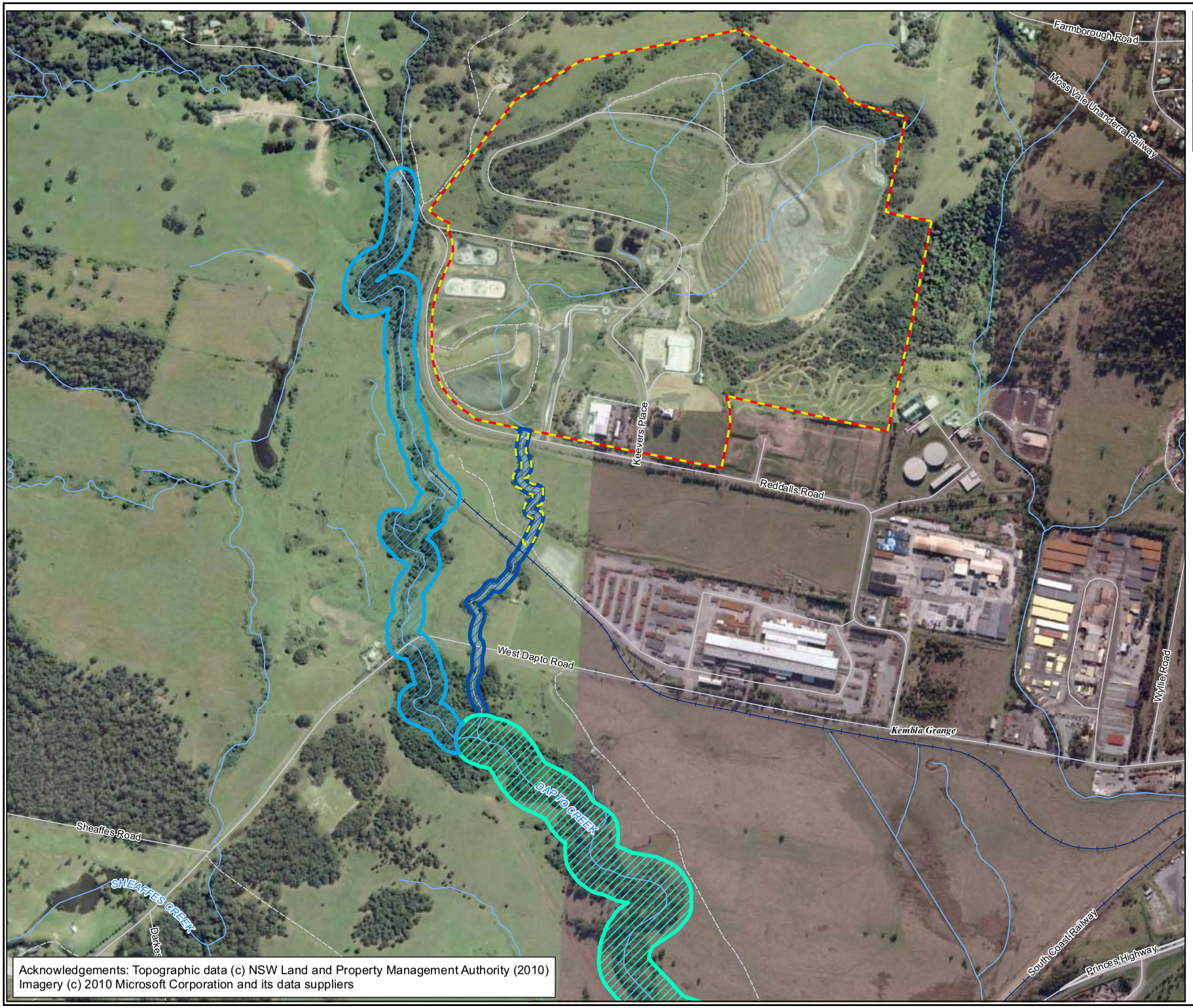


Figure 9: Recommended Buffer Distances along Waterways

PLATES

Plate 1: Lowland Dry Subtropical Rainforest



Plate 2: Redgum Forest Open Forest/Woodland



Plate 3: Acacia scrub/Exotic



Plate 4: Anabat set up in the closed forest habitat located in the northern portion of the Study Area



Plate 5: Results of the Motion Activated Camera Survey



Plate 6: Cleared and disturbed fauna habitat



Plate 7: Aquatic fauna habitats



Plate 8: Whytes Gully surface water pond (facing west)



Plate 9: Dapto Creek, Reddalls Road (downstream)



Plate 10: Dapto Creek crossing Reddalls Road (upstream)



Plate 11: Dapto Creek, West Dapto Road bridge crossing (downstream)



Plate 12: Mullet Creek, William Beach Park (downstream)



APPENDICES
APPENDIX 1

Flora and fauna species inventories

Flora species recorded during the current field investigations

Family Name	Latin Name	Common Name	Nox' weed class	Forest Red Gum Open Forest/ Woodland	Acacia scrub /Exotic	Planted	Grass land	Rainforest	Moist Box-Red Gum Forest
Native species									
Malvaceae	*Abutilon oxycarpum var. oxycarpum*							*	*
Fabaceae (Mimosoideae)	*Acacia binervata*	Two-veined Hickory			*	*		*	*
Fabaceae (Mimosoideae)	*Acacia longifolia*			*	*				
Fabaceae (Mimosoideae)	*Acacia mearnsii*	Black Wattle		*	*	*	*		*
Fabaceae (Mimosoideae)	*Acacia melanoxylon*	Blackwood		*	*				*
Adiantaceae	*Adiantum formosum*	Giant Maidenhair						*	*
Rhamnaceae	*Alphitonia excelsa*	Red Ash		*					
Myrtaceae	*Angophora floribunda*	Rough-barked Apple		*					
Aspleniaceae	*Asplenium aethiopicum*							*	*
Aspleniaceae	*Asplenium flabellifolium*	Necklace Fern						*	*
Cyperaceae	*Carex longebrachiata*	Bergalia Tussock						*	*
Celastraceae	*Cassine australis*	Red Olive Plum						*	*
Casuarinaceae	*Casuarina glauca*	Swamp Oak		*	*	*			
Vitaceae	*Cissus antarctica*	Water Vine						*	
Vitaceae	*Cissus hypoglauca*	Giant Water Vine						*	
Verbenaceae	*Clerodendrum tomentosum*							*	*

Family Name	Latin Name	Common Name	Nox' weed class	Forest Red Gum Open Forest/ Woodland	Acacia scrub /Exotic	Planted	Grass land	Rainforest	Moist Box-Red Gum Forest
Lauraceae	*Cryptocarya glaucescens*	Jackwood						*	*
Urticaceae	*Dendrocnide excelsa*	Giant Stinging Tree						*	
Convolvulaceae	*Dichondra repens*	Kidney Weed						*	*
Ebenaceae	*Diospyros australis*	Black Plum						*	*
Sapindaceae	*Diploglottis australis*	Native Tamarind						*	
Blechnaceae	*Doodia aspera*	Prickly Rasp Fern						*	*
Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark				*			
Myrtaceae	*Eucalyptus paniculata*	Grey Ironbark				*			
Myrtaceae	*Eucalyptus quadrangulata*	White-topped Box							*
Myrtaceae	*Eucalyptus sclerophylla*	Hard Leaved Scribbly Gum		*					
Myrtaceae	*Eucalyptus tereticornis*	Forest Red Gum		*	*	*			*
Eupomatiaceae	*Eupomatia laurina*	Bolwarra						*	
Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry						*	*
Moraceae	*Ficus coronata*	Creek Sandpaper Fig						*	
Moraceae	*Ficus rubiginosa*	"Port Jackson Fig, Rusty Fig"						*	*
Luzuriagaceae	*Geitonoplesium cymosum*	Scrambling Lily						*	*
Euphorbiaceae	*Glochidion ferdinandi*	Cheese Tree		*			*		
Fabaceae (Faboideae)	*Glycine tabacina*						*		

Family Name	Latin Name	Common Name	Nox' weed class	Forest Red Gum Open Forest/ Woodland	Acacia scrub /Exotic	Planted	Grass land	Rainforest	Moist Box-Red Gum Forest
Proteaceae	*Grevillea robusta*	Silky Oak			*	*			
Araceae	*Gymnostachys anceps*	Settler's Flax						*	*
Proteaceae	*Hakea salicifolia*	Willow-leaved Hakea		*					
Poaceae	*Imperata cylindrica*	Blady Grass		*					
Arecaceae	*Livistona australis*	Cabbage Palm						*	
Myrtaceae	*Lophostemon confertus*	Brush Box		*			*		
Moraceae	*Maclura cochinchinensis*	Cockspur Thorn						*	*
Asclepiadaceae	*Marsdenia rostrata*	Common Milk Vine						*	
Myrtaceae	*Melaleuca decora*			*			*		
Myrtaceae	*Melaleuca styphelioides*	Prickly-leaved Tea Tree		*					*
Rutaceae	*Melicope micrococca*	Hairy-leaved Doughwood						*	
Oleaceae	*Notelaea longifolia*	Large Mock-olive						*	
Poaceae	*Oplismenus aemulus*							*	
Bignoniaceae	*Pandorea pandorana*	Wonga Wonga Vine						*	
Apocynaceae	*Parsonsia straminea*	Common Silkpod						*	
Adiantaceae	*Pellaea falcata*	Sickle Fern						*	
Poaceae	*Phragmites australis*	Common Reed					*		
Pittosporaceae	*Pittosporum revolutum*	Rough Fruit Pittosporum						*	

Family Name	Latin Name	Common Name	Nox' weed class	Forest Red Gum Open Forest/ Woodland	Acacia scrub /Exotic	Planted	Grass land	Rainforest	Moist Box-Red Gum Forest
Pittosporaceae	*Pittosporum spinescens*	Wallaby Apple						*	
Pittosporaceae	*Pittosporum undulatum*	Sweet Pittosporum		*			*	*	
Poaceae	*Poa labillardieri*	Tussock						*	
Polypodiaceae	*Pyrrosia rupestris*	Rock Felt Fern						*	
Smilacaceae	*Smilax australis*	Sarsaparilla						*	
Menispermaceae	*Stephania japonica*							*	
Moraceae	*Streblus brunonianus*	Whalebone Tree						*	
Myrtaceae	*Syzygium australe*	Brush Cherry						*	
Meliaceae	*Toona australis*	Red Cedar						*	
Ulmaceae	*Trema aspera*	Native Peach						*	
Urticaceae	*Urtica incisa*	Stinging Nettle						*	
Monimiaceae	*Wilkiea huegeliana*	Veiny Wilkiea						*	
Exotic species									
Asteraceae	*Ageratina adenophora*	Crofton Weed		*	*	*	*	*	
Asclepiadaceae	*Araujia sericifera*	Moth Vine			*	*	*		
Asparagaceae	*Asparagus aethiopicus*	Asparagus Fern							*
Asteraceae	*Bidens pilosa*	Cobbler's Pegs		*	*			*	
Poaceae	*Chloris gayana*	Rhodes Grass			*	*	*		
Asteraceae	*Conyza bonariensis*	Flaxleaf Fleabane		*	*		*		
Poaceae	*Cynodon dactylon*	Common Couch					*		
Asteraceae	*Delairea odorata*	Cape Ivy			*	*		*	*

Family Name	Latin Name	Common Name	Nox' weed class	Forest Red Gum Open Forest/ Woodland	Acacia scrub /Exotic	Planted	Grass land	Rainforest	Moist Box-Red Gum Forest
Poaceae	*Eragrostis curvula*	African Lovegrass	N4				*		
Fabaceae (Faboideae)	*Erythrina X sykesii*	Coral tree			*	*			
Apiaceae	*Foeniculum vulgare*	Fennel			*	*			
Verbenaceae	*Lantana camara*	Lantana	N4	*	*	*	*	*	*
Oleaceae	*Ligustrum sinense*	Small-leaved Privet			*	*			
Oleaceae	*Olea europaea ssp. africana*			*	*				
Asteraceae	*Onopordum acanthium*				*		*		
Poaceae	*Pennisetum clandestinum*	Kikuyu Grass		*	*	*	*		
Pinaceae	*Pinus radiata*	Radiata Pine			*				
Euphorbiaceae	*Ricinus communis*	Castor Oil Plant						*	
Asteraceae	*Senecio madagascariensis*	Fireweed					*		
Fabaceae (Caesalpinioideae)	*Senna pendula*						*		
Malvaceae	*Sida rhombifolia*	Paddy's Lucerne			*		*		
Solanaceae	*Solanum mauritianum*	Wild Tobacco Bush			*				
Verbenaceae	*Verbena bonariensis*	Purpletop			*		*		

Fauna species recorded during the current field investigations

Key

U – Introduced species

V – Species listed as 'vulnerable'

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)
AMPHIBIANS				
Hylidae	*Litoria fallax*	Eastern Dwarf Tree Frog		
Hylidae	*Litoria peronii*	Peron's Tree Frog		
Hylidae	*Litoria verreauxii*	Verreaux's Frog		
Hylidae	*Litoria tyleri*	Tyler's Tree Frog		
Myobatrachidae	*Limnodynastes peroni*	Striped Marsh Frog		
Myobatrachidae	*Crinia signifera*	Common Eastern Froglet		
BIRDS				
Pycnonotidae	*Pycnonotus jocosus*	Red-whiskered Bulbul		U
Sturnidae	*Acridotheres tristis*	Common Myna		U
Accipitridae	*Accipiter novaehollandiae*	Grey Goshawk		
Anatidae	*Anas castanea*	Chestnut Teal		
Anatidae	*Anas superciliosa*	Pacific Black Duck		
Anatidae	*Aythya australis*	Hardhead		
Anatidae	*Chenonetta jubata*	Australian Wood Duck		
Anatidae	*Cygnus atratus*	Black Swan		
Ardeidae	*Egretta novaehollandiae*	White-faced Heron		
Ardeidae	*Ardea intermedia*	Intermediate Egret		
Artamidae	*Grallina cyanoleuca*	Magpie-lark		
Artamidae	*Gymnorhina tibicen*	Australian Magpie		
Artamidae	*Strepera graculina*	Pied Currawong		
Cacatuidae	*Cacatua galerita*	Sulphur-crested Cockatoo		
Cacatuidae	*Cacatua roseicapilla*	Galah		
Cacatuidae	*Calyptorhynchus funereus*	Yellow-tailed Black-Cockatoo		
Charadriidae	*Vanellus miles*	Masked Lapwing		
Cinclosomatidae	*Psophodes olivaceus*	Eastern Whipbird		
Climacteridae	*Cormobates leucophaeus*	White-throated Treecreeper		
Corvidae	*Corvus coronoides*	Australian Raven		
Cuculidae	*Cuculus pallidus*	Pallid Cuckoo		
Dicruridae	*Rhipidura albiscapa*	Grey Fantail		
Dicruridae	*Rhipidura leucophrys*	Willie Wagtail		

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)
Falconidae	*Falco cenchroides*	Nankeen Kestrel		
Falconidae	*Falco peregrinus*	Peregrine Falcon		
Halcyonidae	*Dacelo novaeguineae*	Laughing Kookaburra		
Hirundinidae	*Hirundo neoxena*	Welcome Swallow		
Laridae	*Larus novaehollandiae*	Silver Gull		
Maluridae	*Malurus cyaneus*	Superb Fairy-wren		
Meliphagidae	*Acanthorhynchus tenuirostris*	Eastern Spinebill		
Meliphagidae	*Lichenostomus chrysops*	Yellow-faced Honeyeater		
Meliphagidae	*Meliphaga lewinii*	Lewin's Honeyeater		
Meliphagidae	*Phylidonyris novaehollandiae*	New Holland Honeyeater		
Muscicapidae	*Cisticola exilis*	Golden-headed Cisticola		
Muscicapidae	*Megalurus timoriensis*	Tawny Grassbird		
Pachycephalidae	*Colluricincla harmonica*	Grey Shrike-thrush		
Pachycephalidae	*Pachycephala pectoralis*	Golden Whistler		
Pardalotidae	*Acanthiza nana*	Yellow Thornbill		
Pardalotidae	*Acanthiza pusilla*	Brown Thornbill		
Pardalotidae	*Pardalotus punctatus*	Spotted Pardalote		
Passeridae	*Neochmia temporalis*	Red-browed Finch		
Pelecanidae	*Pelecanus conspicillatus*	Australian Pelican		
Petroicidae	*Eopsaltria australis*	Eastern Yellow Robin		
Phalacrocoracidae	*Phalacrocorax melanoleucos*	Little Pied Cormorant		
Podicipedidae	*Tachybaptus novaehollandiae*	Australasian Grebe		
Psittacidae	*Platycercus elegans*	Crimson Rosella		
Psittacidae	*Trichoglossus haematodus*	Rainbow Lorikeet		
Rallidae	*Fulica atra*	Eurasian Coot		
Rallidae	*Gallinula tenebrosa*	Dusky Moorhen		
Rallidae	*Porphyrio porphyrio*	Purple Swamphen		
Threskiornithidae	*Threskiornis molucca*	Australian White Ibis		
Zosteropidae	*Zosterops lateralis*	Silvereye		
MAMMALS				
Canidae	*Vulpes vulpes*	Fox		U
Cervidae	*Cervus timorensis*	Rusa Deer		U
Leporidae	*Oryctolagus cuniculus*	Rabbit		U

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)
Muridae	*Rattus rattus*	Black Rat		U
Macropodidae	*Wallabia bicolor*	Swamp Wallaby		
Petauridae	*Pseudocheirus peregrinus*	Common Ringtail Possum		
Phalangeridae	*Trichosurus vulpecula*	Common Brushtail Possum		
Pteropodidae	*Pteropus poliocephalus*	Grey-headed Flying-fox	V	V
Vespertilionidae	*Myotis macropus*	Southern Myotis		V
REPTILES				
Chelidae	*Chelodina longicollis*	Eastern Long-necked Turtle		
Scincidae	*Ctenotus robustus*	Robust Ctenotus		
		unidentified skink sp.		

APPENDIX 2

Terrestrial flora, fauna and aquatic species listed on the TSC and/or EPBC Acts previously recorded in the Locality and likelihood of occurrence in the Study Area

TSC and/or EPBC Act listed flora previously recorded in the Locality and likelihood of occurrence on the Study Area

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Likelihood of occurrences
Asclepiadaceae	*Cynanchum elegans*	White-flowered Wax Plant	E	E1	Restricted to eastern NSW where it is distributed from Brunswick Heads on the north coast to Gerroa in the Illawarra region. The species has been recorded as far west as Merriwa in the upper Hunter River valley. Catchment Management Regions include Hawkesbury/Nepean , Hunter/Central Rivers, Northern Rivers, Southern Rivers and Sydney Metropolitan (DEC 2005s). Cynanchum elegans usually occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest; *Leptospermum laevigatum*, *Banksia integrifolia subsp. integrifolia; Eucalyptus tereticornis* open forest and woodland; *Eucalyptus maculata* open forest and woodland; and *Melaleuca armillaris* scrub to open scrub (DEC 2005s). Flowering occurs between August and May, with a peak in November. Flower abundance on individual plants varies from sparse to prolific (DEC 2005s).	Low
Davalliaceae	*Arthropteris palisotii*	Lesser Creeping Fern		E1	May be extinct in NSW. Found in rainforest where it usually grows on tree trunks (Harden and Murray 2000)..	Low
Epacridaceae	*Leucopogon exolasius*	Woronora Beard-heath	V	V	Occurs in Hawkesbury/Nepean and Sydney Metropolitan Catchment (DEC 2005t), restricted to the Woronora and Grose Rivers (Harden 1991). The plant occurs in woodland on sandy alluvium and rocky sandstone hillsides near creeks, and on low nutrient soils (Powell 2007). Flowering occurs in August and September (Harden 1991). Associated species include *Eucalyptus piperita,* Sydney Peppermint and *E. sieberi*, Silvertop Ash and the shrubs *Pultenaea flexilis*, Graceful Bush Pea, *Leptospermum trinervium*, Flakey-Barked Tea-Tree, and	Low

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Likelihood of occurrences
					Dillwynia retorta (Powell 2007).	
Fabaceae (Faboideae)	*Chorizema parviflorum*	Eastern Flame Pea		EP	Heath and sclerophyll woodland and forest on heavy soils (Harden 2002). The endangered population has been recorded from between Austinmer and Albion Park in the local government areas of Wollongong and Shellharbour. All known sites (excluding the site at Austinmer) occupy woodland or forest dominated by Forest Red Gum and/or *E. longifolia*, Woollybutt. At Austinmer, the species is recorded from a coastal headland. (DEC 2005e).	Low
Fabaceae (Faboideae)	*Lespedeza juncea ssp. sericea*			EP	Known from just one roadside population of approximately 200 plants. Located in a small strip of open forest dominated by Forest Red Gum, Woollybutt, and *Melaleuca decora* on Budgong Sandstone. Also originally recorded in Kikuyu grassland directly across the road from this site. This grassland was subsequently cleared and the species has not regenerated (DEC 2005k) .	Low
Fabaceae (Faboideae)	*Pultenaea aristata*	Prickly Bush-pea	V	V	Restricted to the Woronora Plateau, a small area between Helensburgh, south of Sydney, and Mt Keira above Wollongong. The species occurs in either dry sclerophyll woodland or wet heath on sandstone. Flowering has been recorded in winter and spring (DEC 2005o).	Low
Fabaceae (Mimosoideae)	*Acacia baueri ssp. aspera*	Acacia baueri subsp. Aspera		V	Occurs in the Hawkesbury/Nepean, Southern Rivers, and Sydney Metropolitan Catchment Authority Regions. More specifically it occurs on the Kings Tableland in the central Blue Mountains and with sporadic occurrences on the Woronora Plateau in the Royal National Park, Mt. Keira district and at Wedderburn. May also occur on the escarpment/Woronora Plateau in the Flat Rock Junction and Stanwell Tops area of the	Low

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Likelihood of occurrences
					Illawarra (DEC 2005a). *A. baueri subsp. aspera* occurs in dry to damp heath associated with more open areas within Sandstone Woodland (Keith 1994) dominated by Silvertop Ash, *Eucalyptus. Rossii*, Inland Scribbly Gum, and *Allocasuarina distyla*, Scrub Heath, and *Banksia ericifolia*, Heath Leaved Banksia. The geology is Hawkesbury Sandstone and soil landscapes include Maddens Plains, Bundeena and Lucas Heights (NPWS 2000a).	
Fabaceae (Mimosoideae)	*Acacia bynoeana*	Bynoe's Wattle	V	E1	Bynoe's Wattle is found in central eastern NSW, in the following catchment regions – Hawkesbury/Nepean, Hunter/Central Rivers, Southern Rivers, and Sydney Metropolitan. More specifically it is found from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains. It has recently been found in the Colymea and Parma Creek areas west of Nowra (DEC 2005b). It seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and recently burnt patches (DEC 2005b). It grows in sandy clay soils often containing ironstone gravels (Fairley 2004). Main vegetation types include heath or dry sclerophyll forest on sandy soils (DEC 2005b). Associated overstorey species include *Corymbia gummifera,* Red Bloodwood, *Corymbia maculata,* Spotted Gum, *Eucalyptus parramattensis,* Parramatta Red Gum, *Banksia serrate,* Old Man Banksia and *Angophora bakeri*, Narrow Leaved Apple (DEC 2005b). Flowering period is mainly summer.	Low
Haloragaceae	*Haloragis exalata ssp. exalata*	Square Raspwort	V	V	Square Raspwort is known from a few scattered locations in south-eastern NSW including the Nepean River (near Sydney), Lake Illawarra, the Wallaga Lake - Tilba area and the Geehi Valley in Kosciuszko National Park. There are isolated records	Low

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Likelihood of occurrences
					from northern NSW (Mt Kaputar National Park and Tuggolo State Forest). It also occurs in Victoria. Square Raspwort occurs in damp places near watercourses. It regenerates only from seed. The species appears to be favoured by soil disturbance (DEC 2005i).	
Monimiaceae	*Daphnandra sp. 'Illawarra'*	Illawarra Socketwood	E	E1	Occupies the rocky hillsides and gullies of the Illawarra lowlands, occasionally extending onto the upper escarpment slopes. Associated vegetation includes rainforest and moist eucalypt forest (DEC 2005f).	Low
Orchidaceae	*Pterostylis gibbosa*	Illawarra Greenhood	E	E1	Known from a small number of populations in the Hunter region, the Illawarra region and the Shoalhaven region. It is apparently extinct in western Sydney which is the area where it was first collected (1803) (DEC 2005n). All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage. In the Illawarra region, the species grows in woodland dominated by Forest Red Gum, Woolbutt and *Melaleuca decora.* The Illawarra Greenhood is a deciduous orchid that is only visible above the ground between late summer and spring and only when soil moisture levels can sustain its growth. The leaf rosette grows from an underground tuber in late summer, followed by the flower stem in winter (DEC 2005n).	Low
Rutaceae	*Zieria granulata*	Hill Zieria	E	E1	Occurs in the Kiama district where it grows on dry rocky ridges in sclerophyll forest to rainforest margins (Harden 2002). The species primarily occupies the coastal lowlands between Oak Flats and Toolijooa, in the local government areas of Shellharbour and Kiama. The typical habitat is dry ridge tops and rocky outcrops on shallow volcanic soils. Less frequently found on the moist slopes of the Illawarra escarpment and in low-lying areas on Quaternary sediments. Associated vegetation	Low

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Likelihood of occurrences
					includes Honey Myrtle scrub, Forest Red Gum woodland and rainforest margins, although the species has been recorded from a number of other vegetation types (DEC 2005u).	
Solanaceae	*Solanum celatum*	Solanum celatum		E1	Restricted to an area from Wollongong to just south of Nowra, and west to Bungonia. Majority of records are prior to 1960 and the majority of populations are likely to have been lost to clearing. Grows in rainforest clearings, or in wet sclerophyll forests. Flowers August to October and produces fruit December to January (DEC 2005p).	Low
Thymelaeaceae	*Pimelea spicata*	Spiked Rice-flower	E	E1	Once widespread on the Cumberland Plain, Spiked Rice Flower occurs in two disjunct areas, the Cumberland Plain and the Illawarra. Catchment areas are Hawkesbury/Nepean, Southern Rivers, and Sydney Metropolitan Catchment (NPWS 2000b). In the Illawarra region, Spiked Rice Flower is found in open woodland and also in coastal grassland communities with emergent shrubs. Dominant species within the woodland habitat include Forest Red G, *Eucalyptus eugenioides,* Thin Leaved Stringy Bark, *Themeda australis*, Kangaroo Grass, and *Lomandra longifolia*.Spiny Headed Mat Rush. In the coastal Illawarra it occurs commonly in *Banksia integrifolia*, Coast Banksia, open woodland with a more well developed shrub and grass understorey (NPWS 2004). Spiked Rice Flower sporadically throughout the year, with flowering likely to depend upon climatic conditions, particularly rainfall. Flowering times recorded for Spiked Rice Flower vary. Rye (1990) noted flowering period as May - January; Benson and McDougall (2001) noted peak flowering period as March/ April (NPWS 2000b).	Low

TSC and/or EPBC Act listed terrestrial fauna previously recorded in the Locality and likelihood of occurrence on the Study Area

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
Amphibians						
Hylidae	*Litoria aurea*	Green and Golden Bell Frog	V	E1	Most existing locations for the species occur as small, coastal, or near coastal populations, with records occurring between south of Grafton and northern VIC (NSW Government 2009). The species is found in marshes, dams and stream sides, particularly those containing bullrushes or spikerushes. Preferred habitat contains water bodies that are unshaded, are free of predatory fish, have a grassy area nearby and have diurnal sheltering sites nearby such as vegetation or rocks (NPWS 1999e; White and Pyke 1996), although the species has also been recorded from highly disturbed areas including disused industrial sites, brick pits, landfill areas and cleared land. Breeding usually occurs in summer. Tadpoles, which take approximately 10-12 weeks to develop (DECC 2008), feed on algae and other vegetative matter. Adults eat insects as well as other frogs, including juveniles of their own species (DEC 2005h).	Low (Medium prior to targeted surveys). Potential foraging and dispersal habitat located in the aquatic habitats of the Study Area. Salinity, copper and zinc levels are at levels known to inhibit the growth of cytrid fungus however species has not been recorded west of Lake Illawarra for over 40 years. Not recorded in targeted surveys and not considered to be present within Study Area. Further surveys in January/February 2012 will confirm the current results.
Hylidae	*Litoria littlejohni*	Littlejohn's Tree Frog	V	V	The species is distributed along the eastern slopes of the Great Dividing Range from Watagan State Forest near Wyong, south to Buchan in north-eastern VIC. It is not known from coastal habitats (DEH, 2005). Occurs in wet and dry sclerophyll forests and heath communities associated with sandstone outcrops between 280 and 1000 m {Barker, 1995). Littlejohn's Tree Frog prefers permanent and semi-permanent rock flowing streams, but individuals have also been collected from semi-permanent dams with some emergent	Negligible. No suitable habitat is present within the Study Area.

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
					vegetation (Barker, 1995). Forages both in the tree canopy and on the ground, and has been observed sheltering under rocks on high exposed ridges during summer. The species breeds in autumn but will also breed after heavy rainfall in spring and summer (NSW Scientific Committee, 2000). The species has been recorded calling in all seasons with variously reported peak calling periods (DEH, 2005). Eggs are laid in loose gelatinous masses attached to submerged twigs; eggs and tadpoles are most often recorded in slow-flowing pools that receive extended exposure to sunlight (DEW, 2007 9056 /id).	
Myobatrachidae	*Heleioporus australiacus*	Giant Burrowing Frog	V	V	Prefers hanging swamps on sandstone shelves adjacent to perennial non-flooding creeks (Daly, 1996, Recsei, 1996). Can also occur within shale outcrops within sandstone formations. Known from wet and dry forests and montane woodland in the southern part range (Daly, 1996). Individuals can be found around sandy creek banks or foraging along ridge-tops during or directly after heavy rain. Males often call from burrows located in sandy banks next to water (Barker, 1995). Spends the majority of its time in non-breeding habitat 20-250m from breeding sites (Penman, 2008).	Negligible. No suitable habitat is present within the Study Area.
Myobatrachidae	*Pseudophryne australis*	Red-crowned Toadlet		V	Occurs on wetter ridge tops and upper slopes of sandstone formations on which the predominant vegetation is dry open forests and heaths. This species typically breeds within small ephemeral creeks characterised by a series of shallow pools that feed into larger semi-perennial streams (Thumm, 1997). Breeds all year round (Thumm, 2002)	Negligible. No suitable habitat is present within the Study Area.
Birds						
Accipitridae	*Hieraaetus*	Little Eagle		V	The Little Eagle is most abundant in lightly timbered	Low. Species was not

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
	morphnoides				areas with open areas nearby providing an abundance of prey species (NSW Scientific Committee 2009b). It has often been recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. The Little Eagle nests in tall living trees within farmland, woodland and forests (Marchant and Higgins 1993).	recorded during field investigation. May be observed flying over the Study Area on occasion.
Accipitridae	*Lophoictinia isura*	Square-tailed Kite		V	Typically inhabits coastal forested and wooded lands of tropical and temperate Australia (Marchant and Higgins 1993). In NSW it is often associated with ridge and gully forests dominated by Eucalyptus longifolia, Corymbia maculata, E. elata, or E. smithii (NPWS 1999f). Individuals appear to occupy large hunting ranges of more than 100 km^2. They require large living trees for breeding, particularly near water with surrounding woodland /forest close by for foraging habitat. Nest sites are generally located along or near watercourses, in a tree fork or on large horizontal limbs (Marchant and Higgins 1993).	Low. Species was not recorded during field investigation. May be observed flying over the Study Area on occasion.
Accipitridae	*Pandion haliaetus*	Osprey	M	V	Found in coastal waters, inlets, estuaries and offshore islands. Occasionally found 100 km inland along larger rivers (Pizzey, 1997). It is water-dependent, hunting for fish in clear, open water. The Osprey occurs in terrestrial wetlands, coastal lands and offshore islands. It is a predominantly coastal species, generally using marine cliffs as nesting and roosting sites. Nests can also be made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea (Marchant, 1993).	Low. Species was not recorded during field investigation. May be observed flying over the Study Area on occasion.
Anatidae	*Oxyura australis*	Blue-billed Duck		V	Almost wholly aquatic, preferring deep water in large, permanent wetlands with an abundant aquatic flora (Marchant, 1990).	Medium. May use Surface water Ponds in the south-west of the Study Area on occasion.

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
						Preferred habitat occurs nearby at Lake Illawarra where it has been previously recorded.
Anatidae	*Stictonetta naevosa*	Freckled Duck		V	The Freckled Duck breeds in permanent fresh swamps that are heavily vegetated. Found in fresh or salty permanent open lakes, especially during drought. Often seen in groups on fallen trees and sand spits (Simpson, 1996).	Medium. May use Surface water Ponds in the south-west of the Study Area on occasion. Preferred habitat occurs nearby at Lake Illawarra where it has been previously recorded.
Ardeidae	*Botaurus poiciloptilus*	Australasian Bittern	E	E1	The Australasian Bittern is distributed across south-eastern Australia. Often found in terrestrial and estuarine wetlands, generally where there is permanent water with tall, dense vegetation including Typha spp. and Eleoacharis spp. (DECC 2005; NPWS 1999a). Typically this bird forages at night on frogs, fish and invertebrates, and remains inconspicuous during the day. The breeding season extends from October to January with nests being built amongst dense vegetation on a flattened platform of reeds (DECC 2005).	Low. Minimal foraging and sheltering habitat available in the Study Area.
Ardeidae	*Ixobrychus flavicollis*	Black Bittern		V	The Black Bittern is found along the coastal plains within NSW, although individuals have rarely being recorded south of Sydney or inland. It inhabits terrestrial and estuarine wetlands such as flooded grasslands, forests, woodlands, rainforests and mangroves with permanent water and dense waterside vegetation (DEC 2005d; NPWS 1999b). The Black Bittern typically roosts on the ground or in trees during the day and forages at night on frogs, reptiles, fish and invertebrates (DEC 2005d). The breeding season extends from December to March. Nests are constructed of reeds and sticks in	Low. Minimal foraging and sheltering habitat available in the Study Area.

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
					branches overhanging the water.	
Cacatuidae	*Callocephalon fimbriatum*	Gang-gang Cockatoo		V	In summer, occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests (Higgins 1999). Also occur in subalpine Snow Gum woodland and occasionally in temperate or regenerating forest (Forshaw and Cooper 1981). In winter, occurs at lower altitudes in drier, more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas (Shields and Crome 1992). It requires tree hollows in which to breed (Gibbons and Lindenmayer 1997).	Medium. May utilise the open forest/woodland for foraging purposes on occasion. Habitat is not considered to be limiting and not suitable nesting habitat occurs within the Study Area.
Cacatuidae	*Calyptorhynchus lathami*	Glossy Black-cockatoo		V	Inhabits forest with low nutrients, characteristically with key Allocasuarina species. Tends to prefer drier forest types (NPWS 1999d). Often confined to remnant patches in hills and gullies. Breed in hollows stumps or limbs, either living or dead (Higgins 1999).	Low. No suitable nesting habitat present and no specific foraging trees were recorded in the Study Area.
Campephagidae	*Coracina lineata*	Barred Cuckoo-shrike		V	Found in rainforests, vine thickets and their margins. Also found in eucalypt forests and clearing in secondary growth forests (Pizzey and Knight 1997).	Low. Minimal foraging habitat located in the closed forest habitat of the Study Area. Habitat not considered to be limiting.
Charadriidae	*Thinornis rubricollis*	Hooded Plover		C1	Prefers sandy ocean beaches, especially those that are broad and flat (Marchant, 1993).	Negligible. No suitable habitat is present within the Study Area.
Ciconiidae	*Ephippiorhynchus asiaticus*	Black-necked Stork		E1	Found in swamps, mangroves and mudflats. Can also occur in dry floodplains and irrigated lands and occasionally forages in open grassy woodland. Nests in live or dead trees usually near water (Pizzey and Knight 1997).	Low. Minimal foraging and sheltering habitat available in the Study Area.
Columbidae	*Ptilinopus magnificus*	Wompoo Fruit-Dove		V	Mainly occurs in large undisturbed patches of tall tropical or subtropical rainforest. Occasionally	Low. Minimal foraging habitat located in the

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
					occurs in patches of monsoon forest, closed gallery forest, wet sclerophyll forest, tall open forest, open woodland or vine thickets near rainforest (Higgins and Davies 1996).	closed forest habitat of the Study Area. Habitat not considered to be limiting.
Columbidae	*Ptilinopus regina*	Rose-crowned Fruit-Dove		V	Occurs in tall tropical and subtropical, evergreen or semi-deciduous rainforest, especially with dense growth of vines. Prefers large patches of rainforest, but sometimes occurs in remnant patches surrounded by suboptimal habitat including farmlands (Higgins and Davies 1996).	Low. Minimal foraging habitat located in the closed forest habitat of the Study Area. Habitat not considered to be limiting.
Columbidae	*Ptilinopus superbus*	Superb Fruit-Dove		V	The Superb Fruit Dove's NSW distribution ranges from northern NSW to as far south as Moruya (DEC 2005q). It is found in rainforests, closed forests (including mesophyll vine forests) and sometimes in eucalypt and acacia woodlands where there are fruit-bearing trees (Higgins and Davies 1996). It forages in the canopy of fruiting trees such as figs and palms. Nests are constructed high in the canopy throughout September to January (DEC 2005q).	Low. Minimal foraging habitat located in the closed forest habitat of the Study Area. Habitat not considered to be limiting.
Diomedeidae	*Diomedea exulans*	Wandering Albatross	VM	E1	A marine, pelagic and aerial species. Versatile feeders in pelagic and shelf waters. Breed on subantarctic and antarctic islands (Marchant, 1990).	Negligible. No suitable habitat is present within the Study Area.
Diomedeidae	*Thalassarche melanophris*	Black-browed Albatross	VM	V	Inhabits Antarctic, subantarctic and subtropical waters. Although generally pelagic the species also occurs on the continental shelf and can be seen from land (NPWS 1999c).	Negligible. No suitable habitat is present within the Study Area.
Haematopodidae	*Haematopus fuliginosus*	Sooty Oystercatcher		V1	The Sooty Oystercatcher is found on undisturbed tidal rocks on ocean shores and islands. Occasionally it is observed on sandspits and mudflats (Pizzey, 1997). It forages on exposed rock or coral at low tide for limpets and mussels. The Sooty Oystercatcher breeds in spring and summer almost exclusively offshore or on isolated promontories (DECCW, 2005)}.	Negligible. No suitable habitat is present within the Study Area.

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
Haematopodidae	*Haematopus longirostris*	Pied Oystercatcher		E1	An intertidal forager found on undisturbed sandy beaches and spits, tidal mudflats and estuaries. Its food supply (beach macro invertebrates) have been negatively affected by human impacts (NSW Scientific Committee, 2010). The Pied Oystercatcher is restricted to the littoral zone of beaches and estuaries, nesting on the ground above the tideline. A pair will re-nest in the same spot each year, rarely shifting their territory (NSW Scientific Committee, 2010). Occasionally the Pied Oystercatcher is found in paddocks near the coast (Pizzey, 1997).	Negligible. No suitable habitat is present within the Study Area.
Laridae	*Sterna albifrons*	Little Tern	M	E1	The Little Tern favours sheltered coasts, harbours, bays, lakes, inlets, estuaries, coastal lagoons and ocean beaches especially with sand-spits and sand islets (Higgins, 1996; Morcombe, 2003). It forages over shallow waters close inshore or over sandbars and reefs (Morcombe, 2003 19054 /id).	Negligible. No suitable habitat is present within the Study Area.
Meliphagidae	*Epthianura albifrons*	White-fronted Chat		V	The White-fronted Chat occupies foothills and lowlands below 1000 m above sea level. In NSW it occurs mostly in the southern half of the state, occurring in damp open habitats along the coast, and near waterways in the western part of the state (Higgins *et al.* 2001). The White-fronted Chat is found in damp open habitats, particularly wetlands containing saltmarsh areas that are bordered by open grasslands or lightly timbered lands. Along the coastline, they are found in estuarine and marshy grounds with vegetation less than 1 m tall. The species is also observed in open grasslands and sometimes in low shrubs bordering wetland areas. Inland, the species is often observed in open grassy plains, saltlakes and saltpans that are along the margins of rivers	Medium. Species may utilise the habitats of the Surface water Ponds in the south-west of the Study Area on occasion as marginal foraging or dispersal habitat. Habitat is not considered to be limiting.

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
					and waterways (Higgins *et al.* 2001). In Victoria White-fronted Chats have been observed breeding from late July through to early March. Nests are built in low vegetation and in the Sydney region nests have also been observed in low isolated mangroves (NSW Scientific Committee 2009d). An Endangered Population occurs in the Sydney Metropolitan CMA area, at Newington Nature Reserve near Homebush and at Towra Point Nature Reserve (NSW Scientific Committee 2009e).	
Meliphagidae	*Grantiella picta*	Painted Honeyeater		V	Found mainly in dry open woodlands and forests, where it is strongly associated with mistletoe (Higgins *et al.* 2001). Often found on plains with scattered eucalypts and remnant trees on farmlands.	Low. Limited foraging habitat available in the open forest/woodland habitat. Given the immature nature of this habitat however, no mistletoe was recorded.
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella		V	The Varied Sittella is a sedentary species which inhabits a wide variety of dry eucalypt forests and woodlands, usually with either shrubby understorey or grassy ground cover or both, in all climatic zones of Australia. Usually inhabit areas with rough-barked trees, such as stringybarks or ironbarks, but also in mallee and acacia woodlands, paperbarks or mature Eucalypts (Higgins and Peter 2002; NSW Scientific Committee 2010). The Varied Sittella feeds on arthropods gleaned from bark, small branches and twigs. It builds a cup-shaped nest of plant fibres and cobweb in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years (NSW	Medium. May utilise the rough bark trees of the open forest/woodland habitat on occasion for foraging purposes. Habitat is not considered to be limiting.

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
					Scientific Committee 2010).	
Pachycephalidae	*Pachycephala olivacea*	Olive Whistler		V	Found in a range of habitats including alpine thickets, wetter rainforest/woodlands, riparian vegetation and heaths (Pizzey and Knight 1997).	Low. Marginal habitat located in the closed forest habitat of the Study Area. Habitat not considered to be limiting.
Pardalotidae	*Dasyornis brachypterus*	Eastern Bristlebird	E	E1	Found in coastal woodlands, dense scrub and heathlands, particularly where it borders taller woodlands (Pizzey, 1997).	Low. Marginal habitat located in the open forest/woodland habitat of the Study Area. Habitat not considered to be limiting.
Petroicidae	*Petroica boodang*	Scarlet Robin		V	During the breeding season the Scarlet Robin is found in eucalypt forests and temperate woodlands, often on ridges and slopes. During autumn and winter it moves to more open and cleared areas. It has dispersive or locally migratory seasonal movements. The Scarlet Robin forages amongst logs and woody debris for insects which make up the majority of its diet (NSW Scientific Committee 2009c). The nest is an open cup of plant fibres and cobwebs, sited in the fork of a tree (often a dead branch in a live tree, or in a dead tree or shrub) which is usually more than 2 m above the ground (NSW Scientific Committee 2009c). It is conspicuous in open and suburban habitats (Morcombe 2003).	Medium. Marginal habitat located in the open forest/woodland habitat of the Study Area. Habitat not considered to be limiting.
Petroicidae	*Petroica phoenicea*	Flame Robin		V	Flame Robins are found in a broad coastal band from southern Queensland to just west of the South Australian border (Australian Museum 2009). The species is also found in Tasmania. The preferred habitat in summer includes moist eucalyptus forests and open woodlands, whilst in winter prefers open woodlands and farmlands (NSW Scientific	Medium. Marginal habitat located in the open forest/woodland habitat of the Study Area. Habitat not considered to be limiting.

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
					Committee 2009a). It is considered migratory. The Flame Robin breeds from about August to January (Morcombe 2003).	
Petroicidae	*Petroica rodinogaster*	Pink Robin		V	The Pink Robin is found in dense, dank forests and treefern gullies (Pizzey and Knight 1997). During the winter months the Pink Robin disperses north (as far up as the central coast of NSW) and west (as far as the ACT area) into more open forests, woodlands and scrublands (DECCW 2005).	Medium. Marginal habitat located in the open forest/woodland habitat of the Study Area. Habitat not considered to be limiting.
Procellariidae	*Macronectes giganteus*	Southern Giant-Petrel	EM	E1	The Southern Giant-Petrel is a marine species found throughout the Antarctic to subtropical waters occasionally venturing to inshore waters (Marchant and Higgins 1990; Morcombe 2003).	Negligible. No suitable habitat is present within the Study Area.
Procellariidae	*Pterodroma leucoptera leucoptera*	Gould's Petrel	E	V1	The Gould's Petrel is a marine species which only comes to shore to breed. It breeds exclusively on Cabbage Tree Island, 1.4 km offshore from Port Stephens and on nearby Boondelbah Island. The first arrival of Gould's petrel on cabbage tree Island occurs from mid to late September. Fledglings depart the island from late March to early May (DEC, 2005).	Negligible. No suitable habitat is present within the Study Area.
Procellariidae	*Puffinus assimilis*	Little Shearwater		V	The Little Shearwater is pelagic marine species found in subantarctic and subtropical (occasionally tropical) waters and often seen in continental shelf waters. It breeds on subtropical and subantarctic islands (Marchant, 1990).	Negligible. No suitable habitat is present within the Study Area.
Procellariidae	*Puffinus carneipes*	Flesh-footed Shearwater	M	V	The Flesh-footed Shearwater is an oceanic species usually found beyond the edge of the continental shelf (Morcombe, 2003).	Negligible. No suitable habitat is present within the Study Area.
Psittacidae	*Lathamus discolor*	Swift Parrot	E	E1	The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects (Forshaw and Cooper 1981). The Swift Parrot is dependent on flowering resources across a wide	Low. Marginal habitat located in the open forest/woodland habitat of the Study Area in times of drought. No

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
					range of habitats in its wintering grounds in NSW (Shields and Crome 1992). Favoured feed trees include winter flowering species such as Swamp Mahogany Eucalyptus robusta, Spotted Gum Corymbia maculata, Red Bloodwood C. gummifera, Mugga Ironbark E. sideroxylon, and White Box E. albens. Commonly used lerp infested trees include Grey Box E. microcarpa, Grey Box E. moluccana and Blackbutt E. pilularis (DEC 2005r). This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability (Pizzey and Knight 1997).	known feed trees were recorded in the Study Area. Habitat not considered to be limiting.
Psittacidae	*Neophema pulchella*	Turquoise Parrot		V	Occurs in open woodlands and eucalypt forests with a ground cover of grasses and understorey of low shrubs (Morris 1980). Generally found in the foothills of the Great Divide, including steep rocky ridges and gullies (Higgins 1999). Nest in hollow-bearing trees, either dead or alive; also in hollows in tree stumps. Prefer to breed in open grassy forests and woodlands, and gullies that are moist (Higgins 1999).	Low. Marginal habitat located in the open forest/woodland habitat of the Study Area. Habitat not considered to be limiting.
Psittacidae	*Polytelis anthopeplus monarchoides*	Regent Parrot (eastern subsp)	V	E1	In southeast Australia they are found in riparian or littoral River Red Gum Eucalyptus camaldulensis forests and adjacent Black Box E. largiflorens woodlands, and in nearby open mallee woodland or shrubland, as well as Belah Casuarina cristata, Buloke Allocasuarina leuhmanniana or Slender Cypress Pine Callitris preissii (Higgins 1999). They breed in the hollows of large trees (usually River Red Gums and less often River Red Gum-Black Box woodlands), often near watercourses (Higgins 1999).	Low. Marginal habitat located in the open forest/woodland habitat of the Study Area. Habitat not considered to be limiting.
Psittacidae	*Polytelis swainsonii*	Superb Parrot	V	V	Found mainly in open, tall riparian River Red Gum forest or woodland. Often found in farmland including grazing land with patches of remnant	Low. Marginal habitat located in the open forest/woodland habitat

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
					vegetation. Breeds in hollow branches of tall Eucalypt trees within 9 km of feeding areas (Higgins 1999).	of the Study Area. Habitat not considered to be limiting.
Rostratulidae	*Rostratula australis*	Australian Painted Snipe	VM	E1	Usually found in shallow inland wetlands including farm dams, lakes, rice crops, swamps and waterlogged grassland. They prefer freshwater wetlands, ephemeral or permanent, although they have been recorded in brackish waters (Marchant and Higgins 1993).	Medium (High prior to targeted surveys). May use the Surface water Ponds in the south-west of the Study Area for foraging and sheltering habitat. Not recorded in targeted surveys and not considered to be a permanent resident.
Scolopacidae	*Limicola falcinellus*	Broad-billed Sandpiper	M	V	Occurs in sheltered parts of coasts, such as estuaries, harbours, embayments and lagoons, which have shell or sandbanks nearby (Higgins, 1996).	Negligible. No suitable habitat is present within the Study Area.
Scolopacidae	*Limosa limosa*	Black-tailed Godwit	M	V	Mainly coastal, usually in sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats (Higgins, 1996).	Negligible. No suitable habitat is present within the Study Area.
Strigidae	*Ninox connivens*	Barking Owl		V	Generally found in open forests, woodlands, swamp woodlands and dense scrub. Can also be found in the foothills and timber along watercourses in otherwise open country (Pizzey and Knight 1997). Territories are typically 2000 ha in NSW habitats (DEC 2005c).	Medium. Potential foraging habitat across the vegetated habitats of the Study Area. Habitat not considered to be limiting.
Strigidae	*Ninox strenua*	Powerful Owl		V	The Powerful Owl occupies wet and dry eucalypt forests and rainforests. It may inhabit both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas (Debus and Chafer 1994b; Debus and Chafer 1994a). Large mature trees with hollows at least 0.5 m deep are required for nesting (Garnett 1992). Tree hollows are particularly important for the Powerful Owl	Low. Very minimal foraging habitat available, however Common Ringtail Possum observed which this species is know to prey upon. Habitat not considered to be limiting.

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
					because a large proportion of the diet is made up of hollow-dependent arboreal marsupials (Gibbons and Lindenmayer 1997). Nest trees for this species are usually emergent with a diameter at breast height of at least 100 cm (Gibbons and Lindenmayer 1997). It has a large home range of between 450 and 1450 ha (DEC 2005m).	
Tytonidae	*Tyto novaehollandiae*	Masked Owl		V	The Masked Owl may be found across a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting (Higgins 1999). It has mostly been recorded in open forests and woodlands adjacent to cleared lands. They nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead (Higgins 1999). The nest hollows are usually located within dense forests or woodlands (Gibbons and Lindenmayer 1997). Masked Owls prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet (Gibbons and Lindenmayer 1997; Higgins 1999). It has a large home range of between 500 to 1000 ha (DEC 2005l).	Medium. Potential foraging habitat across the vegetated habitats of the Study Area. Habitat not considered to be limiting.
Tytonidae	*Tyto tenebricosa*	Sooty Owl		V	The Sooty Owl is often found in tall old-growth forests, including temperate and subtropical rainforests. In NSW it is mostly found on escarpments with a mean altitude <500 m. The Sooty Owl nests and roosts in hollows of tall emergent trees, mainly eucalypts (Higgins 1999) often located in gullies (Gibbons and Lindenmayer 1997). Nests have been located in trees 125 to 161 cm in diameter (Gibbons and Lindenmayer 1997).	Medium. Potential foraging habitat across the vegetated habitats of the Study Area. Habitat not considered to be limiting.
Mammals						
Burramyidae	*Cercartetus nanus*	Eastern Pygmy-possum		V	Patchily distributed from the coast to the Great Dividing Range, and as far as Pillaga, Dubbo,	Negligible. No suitable habitat is present within

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
					Parkes and Wagga Wagga on the western slopes. Inhabits rainforest through to sclerophyll forest and tree heath. Banksias and myrtaceous shrubs and trees are a favoured food source. Soft fruits are eaten when flowers are unavailable and it also feeds on insects (DEC, 2005, Ward, 2008). Will often nest in tree hollows, but can also construct its own nest (Turner, 1995). Because of its small size it is able to utilise a range of hollow sizes including very small hollows (Gibbons, 1997). Individuals will use a number of different hollows and an individual has been recorded using up to 9 nest sites within a 0.5 ha area over a 5 month period (Ward, 1990). It is mainly solitary, and each individual uses several nests. Home ranges of males are generally less than 0.75 ha, and those of females are smaller (Ward, 2008).	the Study Area.
Dasyuridae	*Dasyurus viverrinus*	Eastern Quoll		E1	This species occurs in a variety of habitats including scrub, heathland, cultivated land and dry sclerophyll forest (Strahan 1995; NPWS 1999). Den sites can consist of a number of chambers in range of structure from underground burrows, hollow logs, rock piles and hay sheds. The Eastern Quoll is a solitary feeder with males often travelling over a kilometre in a night to forage (Strahan 1995). Females restrict their movements to a few hundred metres around their dens. This species feeds on agricultural pests, insects and large animals including ground-nesting birds and small mammals (NPWS 1999).	Negligible. No suitable habitat is present within the Study Area.
Emballonuridae	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail Bat		V	Found throughout NSW (Richards 2008). They have been reported from southern Australia between January and June (Churchill 1998b). Reported from a wide range of habitats throughout eastern and northern Australia, including wet and	High. May utilise the open forest/woodland, closed forest and aquatic habitats of the Study Area for foraging

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
					dry sclerophyll forest, open woodland, acacia shrubland, mallee, grasslands and desert (Churchill 1998b). They roost in tree hollows in colonies of up to 30 (but more usually two to six) and have also been observed roosting in animal burrows, abandoned Sugar Glider nests, cracks in dry clay, hanging from buildings and under slabs of rock. It is high-flying, making it difficult to detect. It forages above the canopy of eucalypt forests, but comes lower to the ground in mallee or open country (Churchill 2008; Richards 2008).	purposes. Further Assessment of this species is required (see Appendix 3).
Macropodidae	*Petrogale penicillata*	Brush-tailed Rock-wallaby	V	E1	Occurs along the Great Dividing Range south to the Shoalhaven, and also occurs in the Warrumbungles and Mt Kaputar. Habitats range from rainforest to open woodland. It is found in areas with numerous ledges, caves and crevices, particularly where these have a northerly aspect. Individuals defend a specific rock shelter, emerging in the evening to forage on grasses and forbs, as well as browse in drier months. Home sizes range from 2-30 ha (Eldridge and Close 1995).	Negligible. No suitable habitat is present within the Study Area.
Molossidae	*Mormopterus norfolkensis*	Eastern Freetail Bat		V	Distribution extends east of the Great Dividing Range from southern Queensland to south of Sydney (Churchill 1998b). Most records are from dry eucalypt forests and woodland. Individuals tend to forage in natural and artificial openings in forests, although it has also been caught foraging low over a rocky river within rainforest and wet sclerophyll forest habitats. The species generally roosts in hollow spouts of large mature eucalypts (including paddock trees), although individuals have been recorded roosting in the roof of a hut, in wall cavities, and under metal caps of telegraph poles. Foraging generally occurs within a few kilometres of roosting sites (Churchill 2008; Hoye *et al.* 2008).	High. May utilise the open forest/woodland, closed forest and aquatic habitats of the Study Area for foraging purposes. Further Assessment of this species is required (see Appendix 3).

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
Petauridae	*Petaurus norfolcensis*	Squirrel Glider		V	Sparsely distributed along the east coast and immediate inland areas as far west as Coonabarabran in the northern part of the state (DEC, 1999) and as far west as Tocumwal along the southern border of the state (NSW Government, 2009). Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range. Requires abundant hollow-bearing trees and a mix of eucalypts, banksias and acacias (Van der Ree, 2008). Within a suitable vegetation community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked (Menkhorst, 1988). They live in family groups of 2-10 individuals and maintain home ranges of 0.65 and 10.5 ha, varying according to habitat quality and food resource availability (Quin, 1995; Goldingay, 2004). Family groups occupy multiple hollows over time (Van der Ree, 2008).	Low. Little to no suitable breeding or foraging habitat available. Habitat isolated from large suitable habitat corridors.
Phascolarctidae	*Phascolarctos cinereus*	Koala	N	V	In NSW the Koala mainly occurs on the central and north coasts with some populations in the western region (DEC 2005j). Koalas feed almost exclusively on eucalypt foliage, and their preferences vary regionally (Martin *et al.* 2008). Primary feed trees include Eucalyptus robusta, E. tereticornis, E. punctata, E. haemostoma and E. signata (DoP 1995). They are solitary with varying home ranges. In high quality habitat home ranges may be 1-2 ha and overlap, while in semi-arid country they are usually discrete and around 100 ha (Martin *et al.* 2008).	Low. Little to no foraging habitat available throughout the Study Area. No specific feed trees recorded.
Pteropodidae	*Pteropus poliocephalus*	Grey-headed Flying-fox	V	V	Occurs along the NSW coast, extending further inland in the north. This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and	Recorded. May utilise the open forest/woodland, closed forest and aquatic

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
					banksia woodlands. Roosts in large colonies (camps), commonly in dense riparian vegetation. Bats commute daily to foraging areas, usually within 15 km of the day roost (Tidemann 1995) although some individuals may travel up to 70 km (Augee and Ford 1999).	habitats of the Study Area for foraging purposes. Further Assessment of this species is required (see Appendix 3).
Vespertilionidae	*Chalinolobus dwyeri*	Large-eared Pied Bat	V	V	Occurs from the Queensland border to Ulladulla, with largest numbers from the sandstone escarpment country in the Sydney Basin and Hunter Valley (van dyck and Strahan 2008). Primarily found in dry sclerophyll forests and woodlands, but also found in rainforest fringes and subalpine woodlands (Churchill 2008; Hoye and Schulz 2008). Forages on small, flying insects below the forest canopy. Roosts in colonies of between three and 80 in caves, Fairy Martin nests and mines, and beneath rock overhangs, but usually less than 10 individuals. Likely that it hibernates during the cooler months (Churchill 2008). The only known existing maternity roost is in a sandstone cave near Coonabarabran (Pennay 2008).	Low. No suitable sandstone habitats located within Study Area.
Vespertilionidae	*Falsistrellus tasmaniensis*	Eastern False Pipistrelle		V	Distribution extending east of the Great Dividing Range throughout the coastal regions of NSW, from the Queensland border to the Victorian border. Prefers wet high-altitude sclerophyll and coastal mallee habitat, preferring wet forests with a dense understorey but being found in open forests at lower altitudes (Churchill 2008). Apparently hibernates in winter. Roosts in tree hollows and sometimes in buildings in colonies of between 3 and 80 individuals. Often change roosts every night. Forages for beetles, bugs and moths below or near the canopy in forests with an open structure, or along trails (Law *et al.* 2008). Has a	High. May utilise the open forest/woodland, closed forest and aquatic habitats of the Study Area for foraging purposes. Further Assessment of this species is required (see Appendix 3).

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
					large foraging range, up to 136 ha (Churchill 2008; Law *et al.* 2008). Records show movements of up to 12 km between roosting and foraging sites (Menkhorst and Lumsden 1995).	
Vespertilionidae	*Miniopterus schreibersii oceanensis*	Eastern Bentwing Bat		V	Occurs from Victoria to Queensland, on both sides of the Great Dividing Range. Forms large maternity roosts (up to 100,000 individuals) in caves and mines in spring and summer. Individuals may fly several hundred kilometres to their wintering sites, where they roost in caves, culverts, buildings, and bridges. They occur in a broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands. Has a fast, direct flight and forages for flying insects (particularly moths) above the tree canopy and along waterways (Churchill 2008; Hoye and Hall 2008).	High. May utilise the open forest/woodland, closed forest and aquatic habitats of the Study Area for foraging purposes. Further Assessment of this species is required (see Appendix 3).
Vespertilionidae	*Myotis macropus*	Southern Myotis		V	Scattered, mainly coastal distribution extending to South Australia along the Murray River. Roosts in caves, mines or tunnels, under bridges, in buildings, tree hollows, and even in dense foliage. Colonies occur close to water bodies, ranging from rainforest streams to large lakes and reservoirs. They catch aquatic insects and small fish with their large hind claws, and also catch flying insects (Richards *et al.* 2008).	Recorded. May utilise the aquatic habitats of the Study Area for foraging purposes. Further Assessment of this species is required (see Appendix 3).
Vespertilionidae	*Scoteanax rueppellii*	Greater Broad-nosed Bat		V	Occurs along the Great Dividing Range, generally at 500 m but up to 1200 m, and in coastal areas. Occurs in woodland and rainforest, but prefers open habitats or natural or human-made openings in wetter forests. Often hunts along creeks or river corridors. Flies slowly and directly at a height of 30 m or so to catch beetles and other large, flying insects. Also known to eat other bats and spiders. Roosts in hollow tree trunks and branches	High. May utilise the open forest/woodland, closed forest and aquatic habitats of the Study Area for foraging purposes. Further Assessment of this species is required (see Appendix 3).

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
					(Churchill 2008; Richards *et al.* 2008).	
Reptiles						
Elapidae	*Hoplocephalus bungaroides*	Broad-headed Snake	V	E1	Mainly occurs in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they generally use rock crevices and exfoliating rock during the cooler months and tree hollows during summer (Webb, 1996; Webb, 1998).	Negligible. No suitable habitat is present within the Study Area.
Varanidae	*Varanus rosenbergi*	Rosenberg's Goanna		V	This species is a Hawkesbury/Narrabeen sandstone outcrop specialist (Wellington, 1985). Occurs in coastal heaths, humid woodlands and both wet and dry sclerophyll forests (Cogger, 1992). Termite mounds are a critical habitat component (DEC, 2005).	Negligible. No suitable habitat is present within the Study Area.

Table 10: FM and/or EPBC Act listed aquatic species previously recorded in the Locality and likelihood of occurrence on the Study Area

Scientific Name	Common Name	EPBC status	DPI listed	Species Info	Potential habitat?
Macquaria australasica	Macquarie Perch	EN	EN	Macquarie Perch are found in the Murray-Darling Basin (particularly upstream reaches) of the Lachlan, Murrumbidgee and Murray rivers, and parts of south-eastern coastal NSW, including the Hawkesbury and Shoalhaven catchments. Macquarie perch are found in both river and lake habitats; especially the upper reaches of rivers and their tributaries (DEWHA 2009a).	Low. The habitat within the study area has been highly modified with little riparian vegetation remaining and minimal in stream habitat variability. The lack of woody debris, deep pools and fast flowing water make it unlikely that the Macquarie Perch would be resident in the study area.
Prototroctes maraena	Australian Grayling	V		The Australian Grayling occurs in streams and rivers on the eastern and southern flanks of the Great Dividing Range from Sydney southwards to the Otway Ranges in Victoria, and Tasmania. Australian grayling do not occur in the inland Murray–Darling Basin system. Grayling is a diadromous species; migrating between freshwater streams and the ocean. This species has been found in clear, gravel-bottomed streams with alternating pools and riffles, and granite outcrops, and also in muddy-bottomed, heavily silted habitats (NSW DPI 2006).	Low. This species would have historically used the upper reaches of waterways similar to Dapto Creek for breeding. This species has not been recorded within the area for many years (closest sighting was in 1975 Yalwal Creek in Morton National Park). The habitats from the bay to upstream of the Whytes Gully Resource Recovery Park have been highly modified with many instream structures disrupting any potential for upstream migration of this species.

Scientific Name	Common Name	EPBC status	DPI listed	Species Info	Potential habitat?
Maccullochella macquariensis	Trout Cod	EN	EN	The Trout Cod is endemic to the southern Murray-Darling river system, including the Murrumbidgee and Murray Rivers, and the Macquarie River in central NSW. Trout Cod are often found close to cover and in relatively fast currents, especially in fairly deep water close to the bank, and often congregate around large woody debris (snags). They tend to remain at the one site and have small home ranges (DEWHA 2009b).	Low. There are three historical records of this species within the Cataract Dam in 1994. Despite this the study area does not support the variety of habitat features including deep pools, large woody debris and turgid running water favoured by this species.
Maccullochella peelii	Murray Cod	V		The Murray Cods natural distribution extends throughout the Murray-Darling basin ranging west of the divide from south east Queensland, through NSW into Victoria and South Australia. It is found in the waterways of the Murray–Darling Basin in a wide range of warm water habitats that range from clear, rocky streams to slow flowing turbid rivers, billabongs and large deep holes. Murray Cod is entirely a freshwater species and will not tolerate high salinity levels(National Murray Cod Recovery Team 2009).	Low. The study area does not support preferred habitat for this species. Salinity levels can be high at times and there is a lack of habitat variability required to sustain this species with shallow muddy substrates.

APPENDIX 3

Threatened Flora and Fauna Assessments

As this proposal is a development application assessed under Part 3A of the Environment and Planning Assessment Act 1979 this assessment addresses the six questions set out in Appendix 3 of the Draft Guidelines for Threatened Species Assessment (DEC & DPI 2005).

The considerations described in Appendix 3 below each question are addressed where these are relevant to the Illawarra Subtropical Rainforest EEC, Grey-headed Flying-fox, Eastern Bentwing-bat, Southern Myotis, Yellow-bellied Sheathtail-bat, Eastern Freetail Bat, Eastern False Pipistrelle, Greater Broad-nosed Bat, Green and Golden Bell Frog and Australian Painted Snipe.

Although field surveys have been undertaken during the recommended season for GGBF, individuals were only detected through visual observation at the reference site and were not calling. Additional field investigations will be conducted for this species during the peak January/February season to confirm the results to date.

'Key Thresholds' described in step 5 of the guidelines have been referred to in assessing the significance of potential impacts.

Illawarra Subtropical Rainforest EEC

Lowland Dry Subtropical Rainforest as mapped by NPWS (2002) occurs within the north-east section of the Study Area as shown in Figure 7. This community equates to the TSC Act listed EEC Illawarra Subtropical Rainforest (ISTR).

The boundary of the Subject Site (Figure 2) is directly adjacent to the ISTR. There is potential for the community to be impacted during the construction phase of The Project and during the ongoing operation of the New Landfill Cell. This assessment is based on the following potential impacts to the ISTR;

- Clearing of vegetation;
- Changes to hydrology caused by drainage works;
- Reduced area of habitat for native vegetation; and
- Indirect impacts to vegetation resulting from the construction phase of the proposal.

A detailed vegetation descriptions for the ISTR community is included in Section 3.1.2 of this report.

How is the proposal likely to affect the lifecycle of a Threatened Species and / or population?

Not applicable, ISTR is not a species or population.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Potential removal of vegetation along the south-east edge of the community will increase the light entering the community and exacerbate weed invasion on the edge of the community. This will also reduce the size of the patch and therefore increase the edge to volume ratio which reduces the quality of the habitat through an increased threat of weed invasion throughout the community.

Drainage works proposed within the south east edge of the ISTR will affect the soil hydrology of the area by causing drying along the top edge of the drain. As a certain level of soil moisture is required to support the flora species that comprise this community this will have an effect on the habitat for ISTR. The ISTR vegetation to be retained is up slope of proposed drainage works therefore this effect is likely to be localised.

GIS calculations have found:

- The area of ISTR mapped within Study Area is 0.56 hectares
- The area of ISTR mapped by NPWS (2002b) within the Locality (10 kilometres radius around Study Areas) is 194.025 hectares.

The area of potential impact from the proposal to ISTR within the Study Area has been estimated to be approximately 0.01 hectare. This figure is based on a previous works area boundary provided by Golder and discussions with Golder regarding drainage design in this section of the Subject Site. This amount of vegetation removal would represents 1.8% of the ISTR mapped within the Study Area and 0.005% of the ISTR mapped within the Locality.

Given the limited area of disturbance, based on the figure above, the proposal is unlikely to significantly affect ISTR and its habitat as a result of the current proposal. If the work area within the ISTR changes this will require further assessment.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Not applicable. No threatened species or populations are considered likely to occur within the ISTR.

How is the proposal likely to affect current disturbance regimes?

The area of ISTR potentially impacted by the proposal is currently impacted by weed invasion caused by previous clearing and soil disturbance at the edge of the community. The proposal will remove native vegetation along the edge and increase the threat of weed invasion further into the patch of vegetation.

How is the proposal likely to affect habitat connectivity?

The potential impacts of the proposal on the ISTR are restricted to the edge of the patch of vegetation adjoining the cleared area of the current landfill. Therefore the proposal is not likely to have a significant effect on habitat connectivity for the community.

How is the proposal likely to affect critical habitat?

Not applicable there is no listed critical habitat occurring within or adjacent to the Study Areas.

In regard to Step 5 of the *Draft Guidelines for Threatened Species Assessment* (DEC & DPI 2005; the four 'Key Thresholds' listed are included below and are addressed in relation to the potential impact of the proposal.

The development application needs to contain a justification of the preferred option based on:

Whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts will maintain or improve biodiversity values.

The recommendations in this report (Section 4.2) include measures to avoid and mitigate potential impacts of the proposal.

Potential impacts of the proposal to ISTR are

- Clearing of vegetation;
- Changes to hydrology caused by drainage works;
- Reduced area of habitat for native vegetation; and
- Indirect impacts to vegetation resulting from the construction phase of the proposal.

A summary of recommendations to avoid or mitigate these impacts includes;

- Minimise removal of native vegetation where possible;
- Tree protection measures;
- Fencing to protect retained vegetation of the ISTR;
- Silt Fencing;
- Storage of machinery, materials and stockpiles within cleared areas; and
- Weed control within the ISTR using bush regeneration methods.

While the proposal will require the removal of vegetation along the edge of the ISTR the recommendations summarised above will mitigate the indirect impacts of the proposal on the community and ensure impacts are restricted to the development footprint. Weed control within the ISTR will mitigate the affect of increased weed invasion caused by the proposal and will improve habitat within the community.

The recommendations summarised above are considered adequate to avoid and/or mitigate potential impacts of the proposal and therefore maintain the biodiversity values of ISTR.

Whether or not the proposal is likely to reduce the long-term viability of a local population of the species, population or ecological community.

Given the scale of the potential impacts on the habitat for ISTR as documented above the proposal is not considered likely to reduce the long-term viability of the EEC.

Whether or not the proposal is likely to accelerate the extinction of the species, population or ecological community or place it at risk of extinction.

Given the scale of the potential impacts on the habitat for ISTR as documented above the proposal is not considered likely to reduce accelerate the extinction of the EEC or place it at risk of extinction.

Whether or not the proposal will adversely affect critical habitat.

Not applicable there is no listed critical habitat occurring within or adjacent to the Study Areas.

Conclusion

The potential impacts of the proposal have been assessed on ISTR occurring within the Study Area. The questions and factors of consideration included in Appendix 3 of the *Draft Guidelines for Threatened Species Assessment* (DECC 2005) have been addressed specifically in relation to vegetation removal and the indirect impacts of construction on the ISTR.

This assessment concludes the impact of the proposal on ISTR occurring within the Study Area is **unlikely** to have a significant impact on the habitat or habitat connectivity of the Threatened Ecological community and will not represent a significant affect on the current disturbance regime.

Grey-headed Flying-fox

The Grey-headed Flying-fox *Pteropus poliocephalus* is listed as Vulnerable under Schedule 2 of the TSC Act and the EPBC Act. Grey-headed Flying-foxes are partially migratory megachiropteran bats that are primarily found in coastal areas, within 200 kilometres of the east coast of Australia, from Bundaberg in Queensland to Melbourne in Victoria (Eby, 2000).

The potential impacts of The Project are described in Section 4.1 of this report. In summary, with regard to the Grey-headed Flying-fox, the main impact will be the removal of up to 7.1 hectares of foraging habitat. Although the species was recorded in the open forest/woodland habitat of the Study Area, this foraging habitat is not considered to be limiting in the Locality.

How is The Project likely to affect the lifecycle of a threatened species and/or population?

The Grey-headed Flying-fox is a canopy-feeding frugivore, blossom-eater and nectarivore of rainforests, open forests, woodlands, Melaleuca swamps and Banksia woodlands (Eby, 1995). Their major food source is Myrtaceae blossom (mostly eucalypt) and fruits such as native figs (Ficus spp.) and cultivated fruit orchards (Churchill, 2008). Bats commute daily to foraging areas, usually within 15 kilometres of the day roost (Strahan, 1995), although some individuals may travel up to 70 kilometres. Grey-headed Flying-foxes seasonally congregate in large camps of up to 200,000 individuals (Churchill, 2008). The availability of blossom in the surrounding area influences the number of bats in a camp (Churchill, 2008). Pregnant Grey-headed Flying-foxes congregate in maternity camps, giving birth to a single young a couple of weeks later (Churchill, 2008).

Given the high mobility of this species (able to travel up to 70 kilometres from a camp site) and the availability of suitable foraging and roosting habitat within the Locality, The Project is not likely to displace or disrupt the lifecycle Grey-headed Flying-fox in the Illawarra region.

The nearest known camp is located along Dapto Creek in Mount Kembla, approximately 1.6 kilometres north-west of the Study Area. Two additional camps occur in the Locality which are located at Figtree Creek (7000+ individuals and 6.3 kilometres from the Study Area) and American (1000+ individuals and 5 kilometres from the Study Area). Given that several roost sites occur in the Locality of the Study Area, over 15 records of this species occur within 10 kilometres of the Study Area dated to 2009. No camps or roost sites were located within the Study Area; therefore The Project is not likely to disrupt the breeding cycle or dormancy period of the Grey-headed Flying-fox in the Locality.

Although the Grey-headed Flying-fox was recorded foraging on exotic flora, the Study Area also supports a number of native fruit diet species including Lilly Pilly, Port Jackson Fig and Cabbage Palm, as well as several Eucalypts known to be a component of the blossom diet for the species (Eby and Law 2008). Given the presence of both native and

exotic known feed species there is a high likelihood that individuals will forage within the Study Area on occasion, although the extent of suitable habitat not considered to be a limiting foraging resource and The Project is not likely to affect the migration and dispersal ability of the Grey-headed Flying-fox in the Locality.

How is The Project likely to affect the habitat of a threatened species, population or ecological community?

The Project would impact potential native and exotic foraging habitat for the Grey-headed Flying-fox through the removal of open forest/woodland and closed forest habitat. Up to 0.5 hectares of open forest/woodland and 0.1 hectares closed forest habitat (known foraging habitat) would be removed from the Study Area and up to an additional further 6.6 hectares of exotic plantings and acacia scrub (limited potential foraging habitat) occurring throughout the Study Area.

The Project is unlikely to further introduce additional weeds, vermin or feral species or remove any key habitat features used by the Grey-headed Flying-fox that would significantly affect this species in the Locality.

Given the availability of known and potential habitat within the Locality (including protected habitat within Illawarra Escarpment State Conservation Area), that no breeding habitat would be impacted and the high mobility of this species, it is considered unlikely that The Project would have significant negative impacts on the Grey-headed Flying-fox habitat within the Locality.

Does The Project affect any threatened species that are at the limit of its known distribution?

Populations of the Grey-headed Flying-fox are found within 200 kilometres of the eastern coast of Australia, from Bundaberg in Queensland to Melbourne in Victoria (DEC 2005t). The Study Area is not at, or near, the limit of distribution for this species.

How is The Project likely to affect the current disturbance regimes?

Current disturbance regimes within the Study Area include grazing, edge effects from the current highway, rural development and associated infrastructure and operation area of the Whytes Gully Resource Recovery Plant. The Project will result in permanent disturbance from the landfill expansion and associated infrastructure such as further clearing of foraging habitat in the form of both native and exotic vegetation and increases in urban refuse and pollution within the Study Area.

How is The Project likely to affect habitat connectivity?

The Project is likely to remove and/or modify up to 7.1 hectares of known and potential foraging habitat from the Study Area. The areas of this habitat to be removed (predominantly in the open forest/woodland and closed forest habitats) are somewhat contiguous with intact vegetation that would remain east of the Study Area. Given the availability of surrounding foraging habitat, particularly to the north in the Illawarra

Escarpment State Conservation Area, the degraded nature of the proposed vegetation to be removed and the high mobility of the Grey-headed Flying-fox (able to travel up to 70 kilometres in a night), it is considered unlikely that The Project would create or intensify existing barriers for this species.

How is The Project likely to affect critical habitat?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the *TSC Act*, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Grey-headed Flying-fox (DECC 2008).

Conclusion

Based on the above assessment and the 'key thresholds' listed in the steps of the assessment processes, The Project is considered **unlikely** to have a significant impact on the Grey-headed Flying-fox as:

- The proposal is not likely to reduce the long-term viability of a local population of the Grey-headed Flying-fox;
- The proposal is not likely to accelerate the extinction of the Grey-headed Flying-fox or place it at risk of extinction; and
- The proposal will not adversely affect critical habitat for the Grey-headed Flying-fox.

Eastern Bentwing-bat

The Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) is listed as Vulnerable under Schedule 2 of the TSC Act. Although not recorded during field investigations, 150 records of this species occur within 10 kilometres of the Study Area (recorded between 1996 and 2009).

The potential impacts of The Project are described in Section 4.1 of this report. In summary, with regard to the Eastern Bentwing-bat the main impact will be the removal of up to 7.1 hectares of foraging habitat.

How is The Project likely to affect the lifecycle of a threatened species and/or population?

The Eastern Bentwing-bat uses a broad range of habitats including rainforests, wet and dry sclerophyll forests, open woodlands and open grasslands (Churchill 2008). The Eastern Bentwing-bat is an obligate cave dwelling species; however it also utilises a number of man-made structures such as mine shafts and road culverts for roosting. Maternity caves used for birthing and rearing of young during spring and summer tend to have specific and stable temperature and humidity regimes. These caves can contain a large number of individuals and are used year after year (Churchill 2008).

Given the high mobility of this species (able to travel up to 40 kilometres in one night from a roost site) and the availability of suitable foraging and roosting habitat within the Locality, The Project is not likely to displace or disrupt the lifecycle or affect the migration and dispersal ability Eastern Bentwing-bat in the Illawarra/south coast region.

Wombeyan Caves, located approximately 80 kilometres west and Bungonia Caves, located approximately 80 kilometres southwest, are the two closest maternity caves. During the non-breeding season each population disperses to other caves within its territorial range. In the Illawarra region, Eastern Bentwing-bats enter a dormancy period by selecting hibernation caves (or artificial structures mentioned above) cold enough to reduce their metabolic rate and prolong fat reserves built up during the summer. Given that no suitable maternity, non-maternity or hibernation caves or structures are present within the Study Area, The Project is not likely to disrupt the breeding cycle, dormancy period or roosting behaviour of the Eastern Bentwing-bat to compromise the species lifecycle.

The Study Area provides potential foraging habitat in the form of the open forest/woodland and closed forests habitats, as well as the constructed surface water ponds. The Project is likely to directly remove and/or modify approximately 7.1 hectares of potential foraging habitat for this species. Therefore the removal of potential foraging habitat in the Study Area is not considered to be limiting in the Locality.

How is The Project likely to affect the habitat of a threatened species, population or ecological community?

The Project would impact potential foraging habitat for the Eastern Bentwing-bat through the removal of open forest/woodland and closed forest habitats, as well as the constructed surface water ponds.

Potential foraging grounds in aquatic habitats may be impacted by direct modification and/or increased runoff into waterways due to The Project. Sedimentation barriers are expected to be installed as part of the construction phase which would reduce direct run-off into waterways.

The Project is unlikely to further introduce additional weeds, vermin or feral species or remove any key habitat features used by the Eastern Bentwing-bat that would significantly affect this species in the Locality.

Given the availability of known and potential habitat within the Locality (including protected habitat within Illawarra Escarpment State Conservation Area), that no breeding habitat would be impacted and the high mobility of this species, it is considered unlikely that The Project would have significant negative impacts on the Eastern Bentwing-bat habitat within the Locality.

Does The Project affect any threatened species that are at the limit of its known distribution?

Eastern Bentwing-bat populations are found along the east and northwest coasts of Australia (DEC 2005k). The Study Area is not at, or near, the limit of distribution for either of these species.

How is The Project likely to affect the current disturbance regimes?

The Study Area has been subjected to ongoing disturbances from grazing and farming to the existing Whytes Gully Resource Recovery Plant and associated infrastructure. The Project is likely to result in further disturbance including the permanent removal of foraging habitat in the open forest/woodland, closed forest and across the surface water ponds and other water bodies.

How is The Project likely to affect habitat connectivity?

The Project is likely to remove and/or modify up to 7.1 hectares of potential foraging habitat from the Study Area. The areas of this habitat to be removed (predominantly in the open forest/woodland and closed forest habitats) are somewhat contiguous with intact vegetation that would remain east of the Study Area. Given the availability of surrounding foraging habitat, particularly to the north in the Illawarra Escarpment State Conservation Area, the degraded nature of the proposed vegetation to be removed and the high mobility of the Eastern Bentwing-bat (able to travel up to 40 kilometres in a night), it is considered unlikely that The Project would create or intensify existing barriers for this species.

How is The Project likely to affect critical habitat?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the *TSC Act*, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Eastern Bentwing-bat (DECC 2008a).

Conclusion

Based on the above assessment and the 'key thresholds' listed in the steps of the assessment processes, The Project is considered **unlikely** to have a significant impact on the Eastern Bentwing-bat as:

- The proposal is not likely to reduce the long-term viability of a local population of the Eastern Bentwing-bat;
- The proposal is not likely to accelerate the extinction of the Eastern Bentwing-bat or place it at risk of extinction; and
- The proposal will not adversely affect critical habitat for the Eastern Bentwing-bat.

Southern Myotis

The Southern Myotis (*Myotis macropus*) is both listed as Vulnerable under Schedule 2 of the *TSC Act*. Four probable records of this species were detected using a stationary Anabat positioned over Surface water Reed Bed 1 (numbered 1 on Figure 6), during the field investigations. An additional two records occur within the Locality (recorded in 2011) of the Study Area (DECCW 2011). No other records occur within 10 kilometres.

The potential impacts of The Project are described in Section 4.1 of this report. In summary, with regard to the Southern Myotis the main impact will be the removal of up to 4.2 hectares of foraging habitat. Although the species was recorded in the wetland habitat (Surface water Reed Bed 1) of the Study Area, this foraging habitat is not considered to be limiting in the Locality.

How is The Project likely to affect the lifecycle of a threatened species and/or population?

The Southern Myotis generally roost close to water in caves, mine shafts, hollow-bearing trees, storm water culverts, buildings, under bridges and in dense foliage (Churchill 1998a). This species requires permanent water bodies, including streams, lakes and reservoirs for foraging (Churchill 2008). The Southern Myotis most commonly forages by raking the surface of waterbodies with their large, clawed feet to catch aquatic insects and small fish. This species also forages aerially taking prey such as moths, beetles, crickets and flies (Churchill 2008, Richards *et al.* 2008).

Given the high mobility of this species and the availability of suitable foraging and roosting habitat within the Locality, The Project is not likely to displace or disrupt the lifecycle or affect the migration and dispersal ability Southern Myotis in the Illawarra/south coast region.

Colonies of several hundred Southern Myotis are known to roost together, however more commonly this species roosts in groups of less than 15 in close proximity to a still water body. Most intact stands of vegetation surrounding the permanent aquatic habitats of the Study Area have been removed and as such, no suitable roost sites were located during the field investigations. Therefore, The Project is not likely to disrupt the breeding cycle, dormancy period or roosting behaviour of the Southern Myotis to compromise this species lifecycle.

The Study Area provides known and/or potential foraging habitat over the interconnected ponds forming part of the surface water pond system in the south-west (grouped and numbered 1 in Figure 6). The Project is likely to directly remove and/or modify approximately 4.2 hectares of potential foraging habitat for this species. This habitat is not considered to be limiting however, as few aquatic prey species including fish and prawns are likely to be present in this surface water pond system. Therefore the removal of potential foraging habitat in the Study Area is not considered to be limiting in the Locality.

How is The Project likely to affect the habitat of a threatened species, population or ecological community?

The Project would impact potential foraging habitat for the Southern Myotis through the direct modification and increased runoff into surface water pond system habitat in the south-western portion of the Study Area. This habitat is not considered to be limiting however, as few aquatic prey species including fish and prawns are likely to be present in this surface water pond system (consisting of Surface water Reed Beds 1 and 2 and the Surface water Polishing Pond). The Project is unlikely to further introduce additional weeds, vermin or feral species or remove any key habitat features that would significantly affect this species in the Locality.

Given the availability of known and potential habitat within the Locality (including protected habitat within Illawarra Escarpment State Conservation Area), that no breeding habitat would be impacted and the high mobility of this species, it is considered unlikely that The Project would have significant negative impacts on the Southern Myotis habitat within the Locality.

Does The Project affect any threatened species that are at the limit of its known distribution?

Southern Myotis populations are found along the coast from the north-west of Australia, across the top-end and south to western Victoria (DEC 2005w). The Study Area is not at, or near, the limit of distribution for either of these species.

How is The Project likely to affect the current disturbance regimes?

The Study Area has been subjected to ongoing disturbances from grazing and farming to the existing Whytes Gully Resource Recovery Plant and associated infrastructure. The Project is likely to result in further disturbance including the permanent removal of foraging habitat across the surface water ponds and water bodies of the Study Area.

How is The Project likely to affect habitat connectivity?

The Project is likely to remove and/or modify up to 4.2 hectares of potential foraging habitat from the Study Area. The areas of this habitat to be removed (aquatic environments) are somewhat contiguous with Dapto Creek and surrounding farm dams/wetlands that would remain south and west of the Study Area. Given the availability of surrounding foraging habitat, the limiting nature of the existing water bodies and the high mobility of the Southern Myotis, it is considered unlikely that The Project would create or intensify existing barriers for this species.

How is The Project likely to affect critical habitat?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the *TSC Act*, the Director-General

maintains a register of critical habitat. To date, no critical habitat has been declared for the Southern Myotis (DECC 2008a).

Conclusion

Based on the above assessment and the 'key thresholds' listed in the steps of the assessment processes, The Project is considered **unlikely** to have a significant impact on the Southern Myotis as:

- The proposal is not likely to reduce the long-term viability of a local population of the Southern Myotis;
- The proposal is not likely to accelerate the extinction of the Southern Myotis or place it at risk of extinction; and
- The proposal will not adversely affect critical habitat for the Southern Myotis.

Hollow-dependent Microbats

The Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris*, Eastern Freetail Bat *Mormopterus norfolkensis*, Eastern False Pipistrelle *Falsistrellus tasmaniensis* and Greater Broad-nosed Bat *Scoteanax rueppellii* are listed as Vulnerable under Schedule 2 of the *TSC Act*. These four species have been considered together for this assessment based on their similar habitat requirements (ie tree hollow-dependant).

Note: a taxonomic revision of Australian molossids has lead to a change of the Eastern Freetail Bat's scientific name from *Mormopterus norfolkensis* to *Micronomus norfolkensis* (Churchill 2008) however, as Census of Australian Vertebrates and DPC are yet to adopt the name change, *Mormopterus norfolkensis* is used in this report.

No hollow-dependant microbats were detected during the field surveys, however given the records of these species in the area, and limited, yet suitable habitat foraging occurring within the Study Area, it is considered that these species may utilise the Study Area on occasion for foraging purposes only. The following list shows the number records of each of these mircrobats occurring within 10 kilometres of the Study Area (recorded in 1995 and 2007):

- Yellow-bellied Sheathtail-bat – two (OEH 2011)
- Eastern Freetail Bat – five (OEH 2011)
- Eastern False Pipistrelle – four (OEH 2011)
- Greater Broad-nosed Bat – two (OEH 2011)

The potential impacts of The Project are described in Section 4.1 of this report. In summary, with regard to the four hollow-dependant microbats, the main impact will be the removal of up to 7.1 hectares of foraging habitat.

How is The Project likely to affect the lifecycle of a threatened species and/or population?

All four bat species are known to be tree-hollow dependent (Churchill 2008). The Greater Broad-nosed Bat and Eastern Freetail Bat tend to forage along gaps and edges of forests and bushland patches (Churchill 2008), whereas the Eastern False Pipistrelle and Yellow-bellied Sheathtail-bat are faster fliers with greater manoeuvrability. The Eastern False Pipistrelle forages below or within the forest canopy while the Yellow-bellied Sheathtail-bat forages above the canopy (Churchill 2008).

Given the high mobility of all four species and the availability of suitable foraging and roosting habitat within the Locality, The Project is not likely to displace or disrupt the lifecycles or affect the migration and dispersal abilities of the Yellow-bellied Sheathtail-bat, Eastern Freetail Bat, Eastern False Pipistrelle or Greater Broad-nosed Bat in the Illawarra/south coast region.

Very few hollow-bearing trees suitable for roosting habitat were located across the Study Area. Although bat detectors (Anabats) were stationed within or nearby each habitat type of the Study Area, none of these species were recorded during field investigations. It is considered that The Project is not likely to disrupt the breeding cycle, dormancy period or roosting behaviour of the Yellow-bellied Sheathtail-bat, Eastern Freetail Bat, Eastern False Pipistrelle or Greater Broad-nosed Bat so that the lifecycle of these species is compromised.

The Study Area provides potential foraging habitat for the four bat species within the open forest/woodland and closed forest habitats, as well as the constructed surface water ponds. The Project is likely to directly remove and/or modify approximately 7.1 hectares of potential foraging habitat for these species. The removal of this potential foraging habitat in the Study Area is not considered to be limiting in the Locality.

How is The Project likely to affect the habitat of a threatened species, population or ecological community?

The Project would impact potential foraging habitat for the four bat species through the removal of open forest/woodland and closed forest habitats, as well as the constructed surface water ponds.

Potential foraging grounds in aquatic habitats may be impacted by direct modification and/or increased runoff into waterways due to The Project. Sedimentation barriers are expected to be installed as part of the construction phase which would reduce direct run-off into waterways.

The Project is unlikely to further introduce additional weeds, vermin or feral species or remove any key habitat features used by the Yellow-bellied Sheathtail-bat, Eastern Freetail Bat, Eastern False Pipistrelle or Greater Broad-nosed Bat that would significantly affect these species in the Locality.

Given the availability of known and potential habitat within the Locality (including protected habitat within Illawarra Escarpment State Conservation Area), that no breeding habitat would be impacted and the high mobility of these species, it is considered unlikely that The Project would have significant negative impacts on the Yellow-bellied Sheathtail-bat, Eastern Freetail Bat, Eastern False Pipistrelle or Greater Broad-nosed Bat habitat within the Locality.

Does The Project affect any threatened species that are at the limit of its known distribution?

The Yellow-bellied Sheathtail-bat has a large distribution extending across northern and eastern Australia (DEC 2005). The Eastern Freetail Bat is found along the entire east coast from south Queensland to southern New South Wales (DEC 2005m). The Eastern False Pipistrelle has populations occurring from southern Queensland to Victoria and Tasmania (DEC 2005l), while the Greater Broad-nosed Bat is also found along coastal

eastern Australia from north-eastern Victoria to the Atherton Tableland, Queensland (DEC 2005r). As a result the Study Area is not at, or near, the limit of distribution for any of these species.

How is The Project likely to affect the current disturbance regimes?

The Study Area has been subjected to ongoing disturbances from grazing and farming to the existing Whytes Gully Resource Recovery Plant and associated infrastructure. The Project is likely to result in further disturbance including the permanent removal of foraging habitat in the open forest/woodland, closed forest and across the artificial surface water ponds.

How is The Project likely to affect habitat connectivity?

The Project is likely to remove and/or modify up to 7.1 hectares of potential foraging habitat from the Study Area. The areas of this habitat to be removed (predominantly in the open forest/woodland and closed forest habitats) are somewhat contiguous with intact vegetation that would remain east of the Study Area. Given the availability of surrounding foraging habitat, particularly to the north in the Illawarra Escarpment State Conservation Area, the degraded nature of the proposed vegetation to be removed and the high mobility of the Yellow-bellied Sheathtail-bat, Eastern Freetail Bat, Eastern False Pipistrelle or Greater Broad-nosed Bat, it is considered unlikely that The Project would create or intensify existing barriers for these species.

How is The Project likely to affect critical habitat?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the *TSC Act*, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Yellow-bellied Sheathtail-bat, Eastern Freetail Bat, Eastern False Pipistrelle or the Greater Broad-nosed Bat (DECC 2008a).

Conclusion

Based on the above assessment and the 'key thresholds' listed in the steps of the assessment processes, The Project is considered **unlikely** to have a significant impact on the Yellow-bellied Sheathtail-bat, Eastern Freetail Bat, Eastern False Pipistrelle or the Greater Broad-nosed Bat as:

- The proposal is not likely to reduce the long-term viability of a local population of these species;
- The proposal is not likely to accelerate the extinction of these four microbat species or place them at risk of extinction; and
- The proposal will not adversely affect critical habitat for the four microbat species.

Green and Golden Bell Frog

The Green and Golden Bell Frog is listed as endangered under Schedule 1 of the TCS Act and Vulnerable under the EPBC Act.

How is The Project likely to affect the lifecycle of a threatened species and/or population?

The Green and Golden Bell Frog generally breeds during September-February with a peak around January-February after heavy rain or storms (SEWPaC 2011a; Daly 1995; White 2001) . Males call mostly at night, but occasionally by day (NSW DEC 2005g). Populations in the Illawarra appear to have a narrower window of opportunity for breeding than other populations, with breeding commonly beginning late December or early January (Jen Byrne, OEH, pers. comm.).

The Green and Golden Bell Frog has a high fecundity with average clutch sizes containing approximately 3700 eggs (Pyke and White 2001; SEWPaC 2011a). Spawn is laid among aquatic vegetation and has been observed in December, January and February (Daly 1995). Metamorphosis appears to take six weeks on average following the hatching of eggs (Anstis 2002; SEWPaC 2011a).

Although in the historical range, no records of the GGBF occur within the Study Area and the most recent record in the Locality west of Lake Illawarra dates back to 1971. Following the three targeted surveys for the GGBF undertaken within the Study Area during November 2011, no individuals have been recorded. Although The Project will remove 4.2 ha of habitat identified as being sub-optimal breeding and/or dispersal habitat, The Project is unlikely to threat the lifecycle of the species as it is not considered to occur within the Study Area.

Although field surveys have been undertaken during the recommended season for GGBF, individuals were only detected through visual observation at the reference site and were not calling. Additional field investigations will be conducted for this species during the peak January/February 2012 season to confirm the results to date.

How is The Project likely to affect the habitat of a threatened species, population or ecological community?

Recent literature detailing GGBF habitat in NSW by White and Pyke (2008) suggests that suitable breeding habitat for the species consists of ponds or slowly moving water bodies that are shallow (i.e. less than 1 metre deep), sunny (i.e. exposed to direst sunlight for at least six hours a day during the spring/summer season), fish-free, contain open water, and experience certain kinds of disturbance regime such as through fluctuating water level or inflow of salty water (Pyke and White 1996; Pyke and White 2001; White and Pyke 2008; Pyke *et al.* 2002). The species also requires foraging and sheltering habitat in the form of low vegetation or solid object such as rock, timber and other human artifacts as well as submerged and floating vegetation over the water body.

The GGBF has not been recorded in or adjacent to the Study Area however, three small decommissioned surface water ponds (numbered 2, 3 and 4 in Figure 8) located to the east of the surface water polishing pond, and a drainage line located along the south-

western boundary, provide sub-optimal and/or dispersal Green and Golden Bell Frog habitat. Although ponds 2 and 4 and the drainage line to the west are unlikely to provide sufficient shelter and floating vegetation to be breeding sites for this species, they may be used as dispersal ponds in a larger context. Pond 3 contains emergent (Typha sp. and sedges) and floating (Azolla sp.) vegetation which are essential GGBF habitat requirements.

The potential impacts of The Project are described in Section 4.1 of this report. In summary, with regard to the GGBF the main impact will be the removal of up to 4.2 hectares of sub-optimal and/or dispersal habitat. Given the lack of recent records of this species west of Lake Illawarra and that the species was not detected in the Study Area during the targeted surveys, the Study Area is not considered to be important habitat nor is it likely to have an adverse affect on the extent of GGBF habitat in the locality.

Does The Project affect any threatened species that are at the limit of its known distribution?

The green and golden bell frog predominately occurs in coastal lowland areas in New South Wales and Victoria. The species was once very common and was regularly found in residential gardens, around farms and on commercial and industrial properties (DECC 2008).

The Study Area is not at, or near, the limit of distribution for this species.

How is The Project likely to affect the current disturbance regimes?

Disturbance regimes thought to account for the recent disappearance and overall decline GGBF numbers in NSW outlined in the *Best Practice Guidelines for Green and Golden Bell Frog habitat* (DECC 2008) are thought to include:

- Loss of habitat;
- Disease (frog chytrid fungus);
- Introduced fish (e.g. plague minnow *Gambusia holbrooki* and carp *Cyprinus carpio*, which ear the eggs, tadpoles and hatchlings;
- Competition of habitat resources.

The Study Area has been subjected to ongoing disturbances from grazing and farming to the existing Whytes Gully Resource Recovery Plant and associated infrastructure. The Project is likely to result in further disturbance including the permanent removal of sub-optimal breeding and/or dispersal habitat across the surface water ponds and water bodies of the Study Area.

Given that the species is not considered to occur within the Study Area, further disturbance regimes are not likely to affect the GGBF populations of the locality.

How is The Project likely to affect habitat connectivity?

Green and Golden Bell Frog (GGBF) populations in NSW have undergone a significant decline in numbers over the past few decades. Of the 31 populations known to exist in 1995, seven are considered to be extinct and four to be probably extinct leaving only 20 known populations comprised of 24 sub-populations (White and Pyke 2008).

Three extant populations are known to occur in Illawarra; Bellambi Lagoon, Port Kembla and Woonona (although no frogs recorded this season to date). The Port Kembla GGBF population occurs approximately 1 kilometre to the east of the Study Area. This population is comprised of four sub-populations and is considered to be a stronghold in the Illawarra (Jen Byrne, OEH, pers. comm.). The only record of the species west of Lake Illawarra occurs along Green Mountain Road and is dated back to 1971 (. Both historically and following recent surveys, no individuals have been recorded in or adjacent to the Study Area.

Given the absence of the species west of Lake Illawarra and physical barriers between the Port Kembla population and the Study Area including the lake, Southern Freeway, South Coast Railway, Northcliff Drive and the suburbs of Kembla Grange, Cringila and Warrawong, it is unlikely that the proposed works would create or intensify existing barriers for this species in the Illawarra region.

How is The Project likely to affect critical habitat?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the *TSC Act*, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the GGBF and the proposed action would not impact any other critical habitat.

Conclusion

Based on the above assessment and the 'key thresholds' listed in the steps of the assessment processes, The Project is considered **unlikely** to have a significant impact on the GGBF as:

- The proposal is not likely to reduce the long-term viability of a local population of the GGFB in the Illawarra;
- The proposal is not likely to accelerate the extinction of the GGBF or place it at risk of extinction; and
- The proposal will not adversely affect critical habitat for the GGBF.

Although field surveys have been undertaken during the recommended season for GGBF, individuals were only detected through visual observation at the reference site and were not calling. Additional field investigations will be conducted for this species during the peak January/February 2012 season to confirm the results to date.

Australian Painted Snipe

The Australian Painted Snipe is listed as endangered under Schedule 1 of the TCS Act and Vulnerable under the EPBC Act.

How is The Project likely to affect the lifecycle of a threatened species and/or population?

The Australian Painted Snipe has been recorded breeding in all months in Australia which is thought to be a response to wetland conditions rather than during a particular season (SEWPaC 2011b). Eggs have been recorded from mid August to March in the southern extent of the population, with breeding in northern Queensland also recorded between May and October (Lowe 1963).

It nests on the ground amongst tall reed-like vegetation near water, and feeds near the water's edge and on mudflats, taking invertebrates, such as insects and worms, and seeds (Environment Australia 2003). The Australian Painted Snipe often breeds near nesting Red-necked Avocets *Recurvirostra novaehollandiae*, Banded Stilts *Cladorhynchus leucocephalus*, Red-kneed Dotterels *Erythrogonys cinctus* and Black-tailed Native-hens *Gallinula ventralis*.

The Australian Painted Snipe generally lays two to six eggs with up to four clutches in a year. Incubation takes 15–21 days. Hatchlings are well-developed and are able to leave the nest shortly after hatching however they tend to be brooded and dependent on the parent for the first few days. The incubation of the eggs, and all care of the young, is undertaken by the male (Marchant & Higgins 1993).

Historic records of the APS in the Illawarra region date back to 1970, 1971 and 1986 at Macquarie Rivulet, Wollongong and Shellharbour Swamp respectively (Illawarra Bird Observers Club: Members' Monthly Sightings Sept/Oct 2011). A number of recent sightings in October 2011 however indicate that the species has returned to the area. Table 9 shows recent records at Howards Bay and Koona Bay made by the Illawarra Bird Observers Club in October 2011.

Table 11: October 2011 Australian Painted Snipe Observations (Data collected by Illawarra Bird Observers Club 2011)

Date	Location	Number Observed	Habitat
17-Oct-11	Koona Bay, Lake Illawarra	5	Saltmarsh
19-Oct-11	Koona Bay, Lake Illawarra	6	Saltmarsh
21-Oct-11	Koona Bay, Lake Illawarra	2 (1m+1f)	Saltmarsh

Date	Location	Number Observed	Habitat
21-Oct-11	Haywards Bay, Lake Illawarra	8	Saltmarsh

All records of APS in the Illawarra region occur in the protected bays of Lake Illawarra approximately nine kilometers from the Study Area. Despite the above sightings of the species occurring almost concurrently with the targeted surveys at the Study Area during November 2011, no individuals were recorded. Although The Project will remove 4.2 ha of identified habitat, The Project is unlikely to threat the lifecycle of the species as it is not considered to occur within the Study Area. A precautionary approach is being adopted however, and a further two survey nights will be conducted to confirm this decision in the optimal breeding period over January/February 2012.

How is The Project likely to affect the habitat of a threatened species, population or ecological community?

The Australian Painted Snipe inhabits many different types of shallow, brackish or freshwater terrestrial wetlands, especially temporary ones, which have muddy margins and small, low-lying islands. Suitable wetlands usually support a mosaic of low, patchy vegetation, as well as lignum and canegrass (Birds Australia 2011).

It is not known to permanently reside at any site, and may be nomadic, moving round areas of suitable habitat. The Murray–Darling drainage system appears to be a stronghold for the species with many sightings coming from this region.

The inter-connected sediment ponds of the Study Area provide marginal foraging and nesting habitat for the APS. Dense fringing and emergent vegetation surround the water bodies, although it is typically up to 2m in height and the steep banks provide little to no muddy margins suitable for foraging.

The potential impacts of The Project are described in Section 4.1 of this report. In summary, with regard to the APS the main impact will be the removal of up to 4.2 hectares of marginal habitat. Given that the species was not detected in the Study Area during the targeted surveys despite being recorded in the locality and the Study Area has not been identified as being important habitat, The Project is not likely to have an adverse affect on the extent of APS habitat in the locality.

Does The Project affect any threatened species that are at the limit of its known distribution?

Records of the APS generally refer to single birds, though there have been sightings of small groups of 3-4 and flocks up to about 30 (Marchant and Higgins 1993). The species has a scattered distribution throughout much of Australia, excluding Tasmania (from where there is only one record) and Cape York Peninsula (SEWPaC 2011b).

The movements of the APS are poorly understood (Birds Australia 2011). The species is possibly dispersive in response to the flooding and drying out of wetlands, and they are capable of travelling great distances. However, over 90% of all records are received between August and March, introducing a possible seasonal element into their pattern of movements; it is unknown where they generally occur outside these times.

Given the widespread distribution of APS throughout Australia, the Study Area is not at or near the limit of distribution for either of these species.

How is The Project likely to affect the current disturbance regimes?

The APS is threatened by the drainage of wetlands and the diversion of water from major rivers for irrigation, which prevents shallow wetlands from forming (SEWPaC 2011b). The APS habitat within the Study Area has been subjected to ongoing disturbances from the existing Whytes Gully Resource Recovery Plant and associated infrastructure. Waterbodies are highly polluted and frequently subject to high levels of noise, odour and run-off from the upslope landfill. The Project is likely to result in further disturbance including the permanent removal of marginal habitat surrounding the surface water ponds of the Study Area. This is not considered to affect APS populations in the Illawarra given that the species has not been recorded in the Study Area and generally occurs in the protected bays and rivulets of Lake Illawarra nine kilometres away.

How is The Project likely to affect habitat connectivity?

The Project is likely to remove up to 4.2 hectares of marginal APS habitat from the Study Area. The areas of this habitat to be removed are somewhat contiguous with Dapto Creek and surrounding farm dams/wetlands that would remain south and west of the Study Area. The APS has not been recorded in or adjacent to the Study Area and given the high mobility of the species, it is considered unlikely that The Project would create or intensify existing barriers for this species.

How is The Project likely to affect critical habitat?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the *TSC Act*, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the APS and the proposed action would not impact any other critical habitat.

Conclusion

Based on the above assessment and the 'key thresholds' listed in the steps of the assessment processes, The Project is considered **unlikely** to have a significant impact on the APS as:

- The proposal is not likely to reduce the long-term viability of a local population of the APS in the Illawarra;

- The proposal is not likely to accelerate the extinction of the APS or place it at risk of extinction; and
- The proposal will not adversely affect critical habitat for the APS.

APPENDIX 4

HABSCORE Descriptors and Categories

Modified HABSCORE Assessment. Modified from (Barbour et al. 1999) used for aquatic habitat assessments.

	Whytes Gully surface water pond	**Dapto Creek Opposite Resource park**	**Dapto Creek Reddalls Road Crossing**	**Dapto Creek West Dapto Road**	**Mullets Creek William Beach Park**
	5/09/2011	5/09/2011	5/09/2011	5/09/2011	5/09/2011
High Gradient					
Riffle Quality	N/A	N/A	N/A	N/A	N/A
Embeddedness	N/A	N/A	N/A	N/A	N/A
Velocity-depth regime	N/A	N/A	N/A	N/A	N/A
Low Gradient					
Pool substrate characterisation	6	14	14	6	11
Pool variability	10	12	11	11	10
High and Low Gradient					
Channel Flow Status	12	11	15	13	13
Bank vegetation - LB	5	8	7	7	2
Bank vegetation - RB	5	6	7	7	2
Bank Stability - LB	6	6	6	5	3
Bank Stability - RB	6	7	6	5	3
Width of riparian zone - LB	1	5	4	3	2
Width of riparian zone - RB	1	2	4	3	2
Epifaunal substrate / available cover	6	8	10	10	15
	41%	56%	60%	50%	45%
< 25 = Poor					
26 - 50 = Marginal					
51 - 75 = Suboptimal					
> 76 = Optimal					

APPENDIX 5

Water Quality results

Table 12: Water quality results at habitat assessment locations and ANZECC guidelines

	ANZECC Guideline	Whytes Gully surface water ponds	Dapto Creek Opposite Resource park	Dapto Creek Reddalls Road Crossing	Dapto Creek West Dapto Road	Mullets Creek William Beach Park
Temp (ºC)	-	16.7	15.4	15.1	15	19.4
pH	6.5 – 8.0	8.29	7.7	7.6	7.75	7.47
Conductivity (µS/cm)	125 – 2200	0.1	480	563	470	22.2
Turbidity (NTU)	6.0 – 50	106.7	37	2.7	2.4	5.9
Dissolved Oxygen (mg/L)	> 6.0	11.94	4.91	6.89	6.02	4.64
Alkalinity (as CaCO3 mg/L)	-	133	63	77	N/A	56

APPENDIX 6
Listed Aquatic Key Threatening Processes

Potential impacts of the proposal

Degradation of riparian and in-stream vegetation

'The degradation of native riparian vegetation along NSW water courses' is listed as a KTP under Schedule 6 of the FM Act. The Final Determination in the FM Act for this KTP lists some of the impacts as:

- Increasing the amount of sediment and nutrients reaching streams as runoff, and increasing light penetration of the water body;
- Reducing the inputs of organic carbon, via leaves, twigs, and branches;
- Reducing the amount of large woody debris entering the aquatic ecosystem and thereby negatively impacting on habitat and spawning sites of several vulnerable and endangered species listed under the FM Act; and,
- Destabilising river banks.

'Degradation of native riparian vegetation along NSW waterways' (FM Act). The proposal will involve the modification of the existing surface water ponds within the Recovery Park. Some native vegetation fringes these ponds which may be removed during the construction phase. Following the re-structuring of the surface water ponds, native vegetation along the banks of the ponds will be re-instated. Provided this revegetation occurs, the native riparian vegetation will not be degraded by the proposed works.

Removal of large woody debris

'The removal of large woody debris' is listed as a KTP under Schedule 6 of the FM Act. As defined in the Final Determination under the FM Act for this KTP, large woody debris provides:

- Habitat for benthic plants;
- Organic enrichment by capturing detritus and contributing to secondary production by degradation of the debris itself;
- Refuges from predators and interactions between competitors;
- Velocity refuges that minimise energy costs of swimming;
- Spawning sites essential for successful reproduction;
- Refuge and spawning habitats in the riparian zone during overbank flooding;
- Erosion prevention by sedimentary stabilisation of stream banks and riparian zones; and,

- Temperature and drought refuges formed by scouring of deep holes adjacent to large woody debris.

'Removal of large woody debris from NSW rivers and streams' (FM Act). The surface water ponds to be modified currently do not have large canopy trees surrounding the ponds. No large woody debris were observed within the ponds and given the lack of surrounding canopy this habitat feature is unlikely to be present within the surface water ponds to be re-structured. As these habitat features are absent from the site this KTP will not be triggered

The installation of in-stream structures

'The installation and operation of in-stream structures and other mechanisms that alter natural flow regimes of river and streams' is listed as a KTP under Schedule 6 of the FM Act and under the TSC Act. The Final Determination in the FM Act for this KTP lists some of the impacts as:

- Changes to natural seasonality and variability of flow regimes (duration, extent and rate), as a result of water regulation for flood mitigation and irrigation, impact on native species by disrupting natural environmental cues necessary for reproductive cycles (including migration, spawning, growth and recruitment);
- Reduction of habitat due to changes in the area, frequency and duration of inundation of floodplains and terminal wetlands limits distributions and reduces spawning successes; and,
- Alteration to the natural flow regimes by in-stream structures and other mechanisms can cause changes in physical, chemical and biological conditions that in turn alter the biota. Disruption of ecological processes may continue long after initial flow alteration, causing continued decline in biological diversity.

'Instream structures and other mechanisms that alter natural flow' (FM Act). The proposal will involve modifying the current lay-out of the surface water ponds receiving water run-off from across the Whytes Gully Resource Recovery Park. No instream structures will be installed. The proposal will however alter the current natural flow of water that exits the Whytes Gully Resource Recovery Park. Potential impacts include:

- Downstream degradation of water quality and aquatic habitat through increased sedimentation, pollutants and altered hydrology. Pollution could potentially enter waterways via runoff, airborne transport of spray and dust, or a spillage event and could result in physical or chemical changes in water quality;
- Physical changes - sedimentation can have detrimental ecological effects, including a reduction in substrate and depth heterogeneity, smothering and killing of demersal eggs, smothering of macroinvertebrates, smothering of food sources, smothering of vegetation, impacts on fish respiration (gills become clogged),

reduced feeding ability, transportation of pollutants attached to sediment and reduced light penetration for aquatic vegetation; and,

- Chemical changes - that is, chemical contaminants with the potential to exert toxic effects at concentrations that might be encountered in the environment. Free chemicals or chemical compounds utilised during construction works could potentially be toxic to aquatic biota in small concentrations.

The construction and operation of the proposal has the potential to affect immediate and downstream aquatic ecosystems associated through changes to water flows and quality. This change in flow may be temporary and as a result the natural flow of the waterway will not be permanently altered. Therefore, impacts are considered unlikely if effective mitigation

APPENDIX 7

Riparian Corridor Objectives (Wollongong DCP 2009)

Table 13: Summary of Riparian Corridor Objectives

Riparian Land Objectives	Category 1 Environmental Corridor	Category 2 Terrestrial & Aquatic Habitat	Category 3 Bank Stability & Water Quality
Provide continuity for movement of terrestrial and aquatic habitat	50m from top of bank	30m from top of bank	10m from top of bank
Maximise the protection of terrestrial and aquatic habitat	Yes		
Minimise sedimentation and nutrient transfer			Yes
Maintain/restore the natural functions of watercourses		Yes	
Maintain a continuous riparian corridor to provide linkages between stands of remanent vegetation for the movement of terrestrial and aquatic fauna	Yes		
Provide bank stability			Yes
Maintain the viability of native riparian vegetation	Yes	Yes	
Minimise 'edge effects' of the riparian corridor / urban interface by the provision of a suitable riparian corridor width	Yes	Yes	

Riparian Land Objectives	Category 1 Environmental Corridor	Category 2 Terrestrial & Aquatic Habitat	Category 3 Bank Stability & Water Quality
Maintain adequate riparian corridor width, based on geomorphological and environmental considerations and to maintain or improve bank stability	Yes	Yes	
Protect water quality of the watercourse through an adequate riparian corridor width (with regard to category 3 streams the recommendation is simply to protect water quality)	Yes	Yes	Yes
Emulate a naturally functioning stream with a suitable riparian corridor width		Yes	Yes
Restore the vegetation, geomorphic structure, hydrology and water quality of the riparian corridor to its original (pre European) state, where practicable (with regard to category 3 the recommendation is to protect riparian vegetation wherever possible)	Yes	Yes	Yes
Locate infrastructure or utility services (i.e. electricity, water, sewerage etc) outside the riparian corridor, wherever practicable	Yes		
Minimise the number of road crossings and such crossings are designed to maintain riparian connectivity		Yes	
Maintain the riparian connectivity by the use of piered crossings in preference to pipes or culverts	Yes		
Minimise the impact of walkways, cycle ways and general access points by using ecologically informed design principles	Yes		

Riparian Land Objectives	Category 1 Environmental Corridor	Category 2 Terrestrial & Aquatic Habitat	Category 3 Bank Stability & Water Quality
Provide suitable vegetated habitat refuges for terrestrial and aquatic fauna, wherever possible			Yes
Restrict the encroachment of flood compatible development (e.g. playing fields) to the edge of the riparian corridor	Yes	Yes	
Treat stormwater run-off outside the riparian corridor before discharge into the watercourse	Yes	Yes	Yes

APPENDIX 8

Curriculum Vitae of Key Personnel

The key personnel that were used to deliver the natural heritage - terrestrial and aquatic, components for the Whytes Gull Part 3A Project are presented in the following table.

Curriculum vitae for each of these staff members are presented in below.

Name	Role	Qualifications	Years of Experience
Nathan Garvey	Project Manager, zoological surveys, quality assurance, report review, and client liaison.	Bachelor of Science, University of New South Wales, Sydney Graduate Diploma (Biological Science), University of New South Wales, Sydney	10
Kylie Reed	Zoological surveys, reporting	Bachelor of Environmental Science (Hons I) (Wildlife research and pest animal ecology) University of Wollongong	5
Jodie Cooper	Zoological surveys	Bachelor of Applied Science (Parks Recreation and Heritage Management)	4
Ben Coddington	Botanical surveys, reporting	Bachelor of Landscape Management and Conservation 2005 University of Western Sydney , Richmond. Advanced Certificate in Urban Horticulture 1998 NSW College of TAFE, Ryde Campus.	10
Brett Morrisey	Botanical surveys	Bachelor of Applied Science (Coastal Management)	10
Josephine Dessmann	Aquatic surveys, reporting	Bachelor of Science Hons 1st class (Ecology), University of New South Wales	5
Layla Watson	Aquatic surveys	BAppSc (Marine Science and Management), Southern Cross University 2004 Honours (Marine Science), University of New England, 2007	5

NATHAN GARVEY: **CURRICULUM VITAE**

POSITION:
Resource Group Manager & Zoologist, Biosis Research Pty. Ltd., Wollongong, New South Wales

PROFESSIONAL AFFILIATIONS AND MEMBERSHIPS:
Environment Institute of Australia and New Zealand (EIANZ)
Ecological Consultants Association of New South Wales (ECANSW)
Australian Mammal Society (AMS)
Australasian Bat Society (ABS)
Field Naturalists Club of Victoria (FNCV)
Victorian Planning and Environmental Law Association (VPELA)

QUALIFICATIONS AND TRAINING:
Bachelor of Science, University of New South Wales, Sydney
Graduate Diploma (Biological Science), University of New South Wales, Sydney
NSCA Occupational Health and Safety Workplace Committee Course
Senior First Aid – St Johns Ambulance
SafeTrek Four Wheel Drive, Driver Training Program
EIANZ Expert Witness Masterclass
Biobanking Assessor Accreditation Training Course
Victorian RBA & AUSRIVAS Training Course

EMPLOYMENT PROFILE:

2010 – Present	Resource Group Manager, Biosis Research Pty. Ltd. Wollongong, NSW
2008 – 2010	Consultant Zoologist, Biosis Research Pty. Ltd., Ballarat, Victoria
2008 – 2008	Zoologists, Biosis Research Pty. Ltd., Melbourne, Victoria
2007 – 2008	Technical Assistant, Biosis Research Pty. Ltd., Melbourne, Victoria
2005 – 2007	Project Manager/Ecologist, Cumberland Ecology Pty. Ltd., Sydney, NSW
2003 – 2005	Casual Research Assistant, University of New South Wales

FIELDS OF COMPETENCE:
Project management
Fauna survey and habitat assessment
Identification of Australian vertebrates
Field survey for species of zoological significance
Methodology - research and development
Assessment of Significance (Seven Part Test)
Species Impact Statement
Review of Environmental Factors
Conservation planning and management
Impact minimisation (mitigation) guidelines
Impact monitoring
Rare and threatened species management
Koala habitat assessment and management
Macropod ecology and management
Microchiropteran bat ecology and management
Expert witness testimony

PROFESSIONAL EXPERIENCE:
Nathan Garvey is a zoologist and the Resource Group Manager of Biosis Research Pty. Ltd. Wollongong office. Nathan has ten years zoological experience across south-eastern Australia.

He is experienced in all areas of fauna survey and assessment, including conducting targeted fauna surveys, development of fauna management plans, Koala habitat assessment and has specialist skills in mammalogy and wind farms and has particular expertise in management and assessment of large scale infrastructure projects.

Nathan has previously worked managing large scale implementation of kangaroo population management, development of Macrofauna management plans and as an ecological consultant. Since coming to Biosis Research Nathan has participated in a wide variety of projects, from fauna habitat assessments including Koala habitat assessments, targeted fauna survey, grassland assessments and major infrastructure projects. Nathan has managed the flora and fauna components of a number of large scale major projects, including wind farm developments, gas-fired power stations, roads developments and other infrastructure projects. He has helped develop novel techniques for assessing impacts to threatened fauna. He possesses strong project management skills.

Project Manager: AGL Camden North Gas Project.

Project Manager/Zoologist: preparation of the Biodiversity Management Plan for BHP Billiton Illawarra Coal Appin Area 9 Subsidence Management Plan

Project Manager: ongoing monitoring of the effects of longwall mining on terrestrial ecological values of creeks and swamps in the Sydney Catchment Authority special areas.

Project Manager: East Lynne fibre optic cable flora and fauna assessment

Project Manager/Zoologist: fauna habitat assessment for 193 Lawrence Hargrave Drive, Coalcliff, including assessment of habitat for microbats.

Zoologist: fauna habitat assessment for proposed rezoning of land at Yerriyong.

Project Manager/Zoologist: revised biodiversity assessment for BHP Billiton Illawarra Coal's Appin Area 9 Colliery. Included revised impact assessment and provision of management recommendations.

Project Manager/Zoologist: targeted surveys for the Green and Golden Bell Frog at Gujarat NRE's No. 1 site as Russell Vale to inform their application for an upgrade of surface works under Part 3A of the *Environmental Planning and Assessment Act 1979*. This included provision of advice and a referral of the project under the *Environmental Protection and Biodiversity Conservation act 1995*.

Project Manager/Zoologist: assessment of the flora and fauna values of the proposed National Broadband Network (NBN) route through the Minnamurra Wetlands. Including flora and fauna assessment, preparation of assessment report and referral to the Federal Environment Minister for determination of whether the project constitutes a controlled impact.

Project Manager/Zoologist: assessment of the flora and fauna values at the potential Dundas Tablelands Wind Farm site. Including bird utilisation surveys, fauna habitat assessment, methodology development, targeted Microchiropteran bat surveys and liaison with regulators.

Project Manager/Zoologist: assessment of the flora and fauna values at the proposed Tarrone Gas-fired Power Station and associated gas pipeline. Including targeted surveys for the Southern Bent-wing Bat, Growling Grass Frog, Southern Toadlet, Brown Toadlet, Swamp Skink and Glassy Grass Skink.

Expert Witness Testimony: An expert witness statement was prepared regarding fauna issues related to the Tarrone Gas-fired Power Station. Included close liaison and consultation with regulators such as the Department of Sustainability and Environment.

Zoologist: targeted surveys for threatened species, including the Brolga and Southern Bent-wing Bat at the proposed Penshurst Wind Farm. This project involved the development of novel assessment techniques to determine potential impacts and guide the development of appropriate avoidance measures. Techniques include home range modelling for breeding Brolgas and development of a bat habitat utilisation model using ANABAT bat call detectors.

Project Manager/Zoologist: assessment of the flora and fauna values of the Halladale Speculant 3D Transitional Seismic Survey area. Including targeted surveys for the Growling Grass Frog, Little Penguin, Rufous Bristlebird, Hooded Plover and input into the referral under the *Environment Protection and Biodiversity Conservation Act 1999*, and associated management plans.

Project Manager/Zoologist: assessment of the potentials impacts to flora and fauna resulting from the upgrade of the Western Highway between Dimboola and Kiata. Including assessment of impacts to threatened species, and on Matters of National Environmental Significance.

Project Manager/Zoologist: assessment of the flora and fauna values of the Halladale Blackwatch Project. Including targeted fauna surveys and detailed project management.

Expert Witness Testimony: appearance as an expert witness regarding Koalas and Koala habitat. This was the first case to appear before the Victorian Civil and Administrative Tribunal regarding the new provisions of the Ballarat planning scheme to protect Koalas.

Project Manager/Zoologist: development of a translocation plan for the Corangamite Water Skink at the Holcim Colac Quarry. Including liaison with the Department of Sustainability and Environment and undertaking annual monitoring.

Project Manager/Zoologist: ongoing advice and annual monitoring of the Growling Grass Frog, Striped Legless Lizard and Golden Sun Moth at the Aurora residential development.

Project Manager/Zoologist: assessment of the flora and fauna values of the proposed Dimboola and Kiata passing lanes on the Western Highway.

Project Manager/Zoologist: targeted surveys for the growling Grass Frog at key locations along the water pipeline associated with the Victorian Desalination Project.

Zoologist: assessment of flora and fauna values associated with the Victorian Desalination Project.

Project Manager/Ecologist: management of the kangaroo population at the former Australian defence Industries site. Including implementation of a large scale, non-lethal, program to manage the kangaroo population.

PUBLICATIONS:

Garvey, N., Ben-Ami, D., Ramp, D. & Croft, D. *Survival behaviour of swamp wallabies during prescribed burning and wildfire*. Wildlife Research, 37 (1), 1-12.

SELECTED PREVIOUS EXPERIENCE: CONSULTANT REPORTS:

Nathan has written over 100 unpublished consultant reports, a selection of which is included below:

Biosis Research 2011. 193 Lawrence Hargrave drive. Coalcliff: Flora and Fauna Assessment. Unpublished Report for Cardno. Authors: **N.Garvey** & B.Coddington.

Biosis Research 2011. Gujarat NRE No. 1 Colliery Green and Golden Bell Frog Surveys, March 2011. Unpublished Report for Gujarat Coking Coal Pty. Ltd. Author: **N.Garvey.**

Biosis Research 2011. Dendrobium Colliery Ecological Monitoring Program. Annual Monitoring Report, Financial Year 2009/2010. Unpublished report for BHP Billiton Illawarra Coal. Authors: M.Roberts & **N.Garvey**.

Biosis Research 2011. Appin Area 9 Revised Biodiversity Assessment. Unpublished Report for BHP Billiton Illawarra Coal. Authors: B. Morrisey, M.Roberts & **N.Garvey**

Biosis Research 2010. Penshurst Wind Farm: Targeted Fauna Assessment Report. Unpublished report for RES Australia Pty. Ltd. Authors: M. Venosta & **N. Garvey**.

Biosis Research 2010. Tower Hill, Swan Hill. Flora and Fauna Assessment. Unpublished report for VicUrban. Authors: S.Arber & **N.Garvey**

Biosis Research 2010. Lavery Avenue, Mount Clear: Flora and Fauna Assessment. Unpublished report for Charles Lloyd Property Group Pty. Ltd. Authors: **N. Garvey** & S. Arber.

Biosis Research 2010. Sanctuary Estate Koala Habitat Assessment. Unpublished Report for Project Now. Author: N. Garvey.

Biosis Research 2010. Murra Warra Wind Farm: Preliminary Flora and Fauna Assessment. Unpublished report for RES Australia Pty. Ltd. Authors: **N. Garvey** & S. Arber.

Biosis Research 2010. Colac Quarry Corangamite Water Skink Translocation Plan. Unpublished report for Holcim Pty. Ltd. Author: **N.Garvey**

Biosis Research 2010. 425 Richards Street, Canadian: Koala Management Plan. Unpublished report for Beveridge Williams & Co. Pty. Ltd. Author. **N. Garvey**.

Biosis Research 2010. Western Highway, Kiata. Proposed Overtaking Lanes: Flora and Fauna Assessment. Unpublished report for VicRoads. Authors: N. Garvey & S. Arber.

Biosis Research 2010. Western Highway, Dimboola. Proposed Overtaking Lanes: Flora and Fauna Assessment. Unpublished report for VicRoads. Authors: **N. Garvey** & S. Arber.

Biosis Research 2010. University of Ballarat Technology Park: Flora and Fauna Assessment. Unpublished report for Beca Pty. Ltd. Authors: **N. Garvey** & S. Arber.

Biosis Research 2010. Raglan Elmhurst Road, Elmhurst: Flora and Fauna Assessment. Unpublished report for Pyrenees Shire Council. Authors: **N. Garvey** & S. Arber.

Biosis Research 2010. Ballarat Western Employment Zone: Flora and Fauna Assessment. Unpublished report for Ballarat City Council. Authors: **N. Garvey** & S. Arber.

Biosis Research 2010. Flora, Terrestrial Fauna and Net Gain Assessment of Department of Education Land, Smythesdale, Victoria. Unpublished report for the Department of Education. Authors. **N. Garvey** & S. Arber.

Biosis Research 2010. Sailors Gully, Stages 3 and 4: Koala Habitat Assessment. Unpublished report for W.V. Pelchen Pty. Ltd. Author: **N.Garvey**

Biosis Research 2010. 17 Hermitage Avenue, Canadian: Koala Habitat Assessment. Unpublished report for I. & Y. Moyle. Authors. **N. Garvey** & S. Arber.

Biosis Research 2010. 194 Greenhill Road, Mount Helen: Koala Management Plan. Unpublished report for TGM Group Pty. Ltd. Author: **N.Garvey**.

Biosis Research 2010. 194 Greenhill Road, Mount Helen: Koala Habitat Assessment. Unpublished report for TGM Group Pty. Ltd. Author: **N.Garvey**.

Biosis Research 2009. Halladale Speculant 3d Transitional Seismic Survey: Flora and Fauna Assessment. Unpublished report for Origin Energy. Authors: **N. Garvey** & S. Arber.

Biosis Research 2009. Creswick Treatment Plant Growling Grass Frog Plan Of Management. Unpublished report for Central Highlands Water. Authors: D. Gilmore, K. Sofo & **N. Garvey**.

Biosis Research 2009. Flora and Fauna Assessment, Holcim Warrnambool Quarry. Unpublished report for Holcim Pty. Ltd. Authors: **N. Garvey** & S. Arber

Biosis Research 2009. 2001 Geelong Road, Mount Helen – Koala Habitat Assessment. Unpublished report for Chris Seels. Author: **N. Garvey**

Biosis Research 2009. Tarrone Gas-Fired Power Station Growling Grass Frog Targeted Surveys. Unpublished report for URS Australia Pty. Ltd. Author: N. Garvey

Biosis Research 2009. Flora, Fauna and Habitat Hectare Investigation of the Calder Freeway / Kings Road Interchange and Kings Road Duplication, Taylors Lakes, Victoria. Unpublished report for VicRoads. Authors: S. Gilbert, **N. Garvey** & D. Gilmore

Biosis Research 2009. Flora And Terrestrial Fauna Assessment of the Duncans Road Interchange, Werribee, Victoria. Unpublished report for VicRoads. Authors: S. Mueck & **N.Garvey**

Biosis Research 2009. Assessment of Critical Habitat Under the EPBC Act for Three Species in the Bonang-Goongerah Area, East Gippsland, Victoria. Unpublished report for Environment East Gippsland. Authors: C. Meredith, M. Venosta & **N. Garvey**

Biosis Research 2009. Flora and Terrestrial Fauna Assessment of Aurora South, Epping North, Victoria. Unpublished report for GCorp Property. Authors: S. Gilbert & **N. Garvey**

Biosis Research 2009. Annual Monitoring Of Growling Grass Frog Population at Aurora, Epping North. Unpublished report for VicUrban. Authors, S. Koehler & **N.Garvey**.

Biosis Research 2009. Annual Monitoring Of Golden Sun Moth Population at Aurora, Epping North. Unpublished report for VicUrban. Authors, S. Koehler & **N.Garvey**.

Biosis Research 2009. Flora and Terrestrial Fauna Assessment of a Proposed Wind Farm, Pykes Hill, Victoria. Unpublished report for Future Energy Pty. Ltd. Authors: R. Steer, **N. Garvey** & J. Miller.

Biosis Research 2008. Addendum Report. Flora and Fauna Assessment: Desalination Project Spring 2008 Flora and Fauna Survey. Unpublished report for GHD Pty. Ltd. Authors: **N. Garvey**, S. Koehler, D. Gilmore, R. Steer.

Biosis Research 2008. Flora, Terrestrial Fauna & Net Gain Assessment of Western Highway Roadside Vegetation: Ballarat to Burrumbeet Duplication, Victoria. Unpublished report for VicRoads. J. Miller, D. Peeters & **N. Garvey**

Biosis Research 2008. Flora and Terrestrial Fauna Assessment and Review of Proposed Willow Control Works, Kangaroo Creek Water Supply Reserve, Bullarto South, Victoria. Unpublished report for Central Highlands Water. Authors: D. Peeters & **N. Garvey**

Biosis Research 2008. Flora and Terrestrial Fauna Assessment of the Proposed Pakenham Racecourse, Nar Nar Goon, Victoria. Authors: S. Mueck, D. Gilmore & **N. Garvey**

Biosis Research 2008. Flora And Fauna Assessment: Desalination Project: Spring 2008 Flora And Fauna Survey. Unpublished report for GHD Pty. Ltd. Authors: **N. Garvey**, S. Koehler, D. Gilmore & R. Steer.

Biosis Research 2008. Flora, Fauna and Net Gain Assessment of Kororoit Creek Road Duplication, Millers Road to Grieve Parade, Altona, Victoria. Unpublished report for VicRoads. Authors: **N. Garvey**, S. Gilbert & C. Bloink.

Cumberland Ecology 2007. Majura Training Range: Draft Macrofauna Management Plan. Unpublished report for the Department of Defence.

Cumberland Ecology 2007. Belconnen Naval Transmitting Station: Draft Macrofauna Management Plan. Unpublished report for the Department of Defence.

Cumberland Ecology 2006. St Marys Macrofauna Management Plan: Annual Report. Unpublished report for Maryland Development Company.

Cumberland Ecology 2006. Emirates Wolgan Valley Resort, Lithgow, NSW: Public Environment Report for a Project Application under Part 9 of the EPBC Act. Report for Emirates Hotels (Australia) Pty. Ltd.

Garvey, N. 2005. Mortality, Migration and Habitat Use By the Swamp Wallaby Wallabia Bicolour Following Low and High Intensity Fires. Unpublished Grad. Dip. Thesis, University of New South Wales.

KYLIE REED **CURRICULUM VITAE**

POSITION:

Zoologist, Biosis Research Pty. Ltd.

PROFESSIONAL AFFILIATIONS* AND MEMBERSHIPS:

*Ecological Society of Australia
*Ecological Consultants Association of NSW
*Birds Australia

QUALIFICATIONS:

Bachelor of Advanced Environmental Science (Hons I) (Life Sciences), University of Wollongong
Senior First Aid 2010
General Boat Licence 2010
PADI Scuba diving certification 2002
Animal Ethics Committee Accreditation

EMPLOYMENT PROFILE:

2010 -	Zoologist, Biosis Research Pty. Ltd.
2008-2010	Environmental Education Tours, Boronia Tours
2008-2010	Field Ecologist, UBM Ecological Consultants
2007-2008	Project Support Officer, Omega Environmental

FIELDS OF COMPETENCE:

Fauna survey and impact assessment
Habitat assessment
Threatened terrestrial fauna monitoring, especially those involving the assessment of impacts and the testing of the effectiveness of proposed mitigation measures
Home range and habitat utilisation assessments using radio tracking
Fauna population census and abundance estimation
Ecological data interpretation and analysis
Provision of natural resource management plans

PROFESSIONAL EXPERIENCE:

Kylie Reed is a Zoologist with Biosis Research's Wollongong Office. Kylie has four years experience in applied conservation biology and consulting, including ecological surveys, land management, scientific research and pest and weed management. Her field skills consist of terrestrial and arboreal mammal trapping, frog, reptile and bird surveys, spotlighting, bat trapping and call analysis, fauna habitat assessment and vegetation surveys.

Kylie has been involved with community environmental education programs in the greater Sydney region and NSW South Coast and has undertaken an extensive range of both threatened and general wildlife population surveys and monitoring covering a wide variety of habitats in eastern Australia including wet and dry sclerophyll forests, rainforests, wetlands, swamps and coastal dunes. Through this work, she has developed strong research and project management skills.

Kylie has extensive experience in report preparation, including fauna impact assessments in accordance with the relevant state and commonwealth legislation (Environment Protection and Biodiversity Conservation Act 1999, the Threatened Species Conservation Act 1995 and the Environmental Planning and Assessment Act 1979). She is also a current member of the Ecological Consultants Association of NSW and Birds Australia.

A sample of key professional experience is presented below:

Project Manager/Zoologist: Ongoing monitoring of Wongawilli and NEBO Lease Area creeks and swamps in the Avon and Cordeaux Catchments to inform Gujarat NRE FCGL Pty Ltd. of any impacts Longwall Mining is having on Amphibian populations, including targeted surveys for Littlejohn's Tree Frog and the Giant Burrowing Frog.

Project Manager/Zoologist: Ongoing monitoring of Wongawilli Lease Area ridgelines in the Avon and Cordeaux Catchments to inform Gujarat NRE FCGL Pty Ltd. of any impacts Longwall Mining is having on reptile populations.

Project Manager/Zoologist: Ongoing monitoring of Dendrobium Lease Area 2 and 3 creeks and swamps in the Avon and Cordeaux catchments to inform BHP Billiton Illawarra coal of any impacts Longwall mining is having on Amphibian populations.

Project Manager/Zoologist: Monitoring point set-up for No. Colliery East Lease Area Ecological Monitoring Program for ongoing Amphibian Surveys. Gujarat NRE FCGL Pty Ltd.

Project Manager/Zoologist: Targeted surveys for the Green and Golden Bell Frog at Gujarat NRE's No. 1 site as Russell Vale to inform their application for an upgrade of surface works under Part 3A of the Environmental Planning and Assessment Act 1979. This included provision of advice and a referral of the project under the Environmental Protection and Biodiversity Conservation act 1995.

Project Manager/Zoologist: Targeted surveys for the Giant Burrowing Frog *Heleioporus australiacus* at West Ulladulla supplement existing surveys undertaken by Biosis Research. Assessment of Significance report to determine the impact the proposal would have on this species.

Project Manager/Zoologist: Supervision of vegetation clearing works undertaken at West Ulladulla. Hollow-bearing Tree Assessment and rescuing injured or startled wildlife.

Zoologist: Fauna habitat assessment and assessment of impacts Whytes Gully Resource Recovery Park New Landfill Cell Part 3A project West Dapto, Golder and Associates.

Zoologist: Fauna habitat assessment and assessment of impacts for the Camden Northern Expansion Area Modification. AGL Energy Limited.

Zoologist: Deployment of microbat detectors and analysis of calls for 193 Lawrence Hargrave Drive, Coalcliff.

Zoologist: Hollow-bearing Tree Assessment at North Nowra to accompany clients submission to Council regarding rezoning of the new Local Environment Plan.

Zoologist: Assessment of the flora and fauna values of the proposed expansion of Jamberoo Action Park, Jamberoo. Including flora and fauna assessment, preparation of assessment report and referral to the State and/or Federal Environment Minister for determination of whether the project constitutes a controlled impact.

Zoologist: Assessment of the flora and fauna values of the proposed expansion of Tahmoor Colliery Reject Emplacement Area. Including flora and fauna assessment and preparation of assessment report.

Zoologist: Targeted pitfall survey of Pink-tailed Worm-lizard & Striped Legless Lizard in association with ACT Gov Territory and Municipal Services (Conservation, Planning and Research) proposed re-zoning and residential expansion of Canberra suburbs.

SELECTED PREVIOUS EXPERIENCE: CONSULTANT REPORTS:

Biosis Research 2011 – *Flora and fauna assessment, Whytes Gully Resource Recovery Park New Landfill Cell Part 3A project West Dapto.* Unpublished report prepared for Golder and Associates on behalf of Wollongong City Council.

Biosis Research 2011 – Camden Gas Project: Northern Expansion Part 3A Flora and Fauna Assessments. Unpublished report prepared for AECOM on behalf of AGL Gas Production (Camden) Pty Limited.

Biosis Research 2011 – *Jamberoo Action Park Flora and Fauna Assessment, Jamberoo.* Unpublished report prepared for JBA Panning Pty. Ltd.

Biosis Research 2011 – *Targeted Surveys for the Green and Golden Bell Frog* Litora aurea *at Dam 6, NRE Colliery No. 1 Russel Vale.* Unpublished report prepared for Gujarat NRE FCGL Pty Ltd.

Biosis Research 2011 – *Flora and Fauna Assessment Coller Road Industrial Subdivision Ulladulla.* Unpublished report prepared for Cowman Stoddard on behalf of Shoalhaven City Council.

Biosis Research 2011 – *Flora and Fauna Survey and Constraints Assessment - Tahmoor Colliery Reject Emplacement Area.* Unpublished report prepared for Cardno Pty. Ltd on behalf of Xstrata.

Biosis Research 2011 – *Proposed Rezoning Maldon Employment Lands Flora and Fauna Survey and Constraints Assessment.* Unpublished report prepared for Wollondilly Shire Council.

Biosis Research 2011 – *Flora and Fauna Survey and Assessment of Significance for the demolition of Wongawilli Pit Top Dumper House.* Unpublished report prepared for Cardno Pty. Ltd on belhalf of Gujarat NRE FCGL Pty Ltd.

UBM Ecological Consultants 2010 – *Flora & Fauna Surveys & Site Assessments for Various Sydney Water Properties in the Blue Mountains and Hawkesbury Region.* Unpublished report prepared for Sydney Water Corporation.

UBM Ecological Consultants 2009 – *Fauna Surveys in Support of Proposed Wildlife Corridors on the Kurnell Peninsula.* Unpublished report prepared for the Department of Environment and Climate Change.

UBM Ecological Consultants 2009 – *Flora & Fauna Study and Assessment of Significance for a proposed development of a Campus at 44-50 Third Avenue, Berkshire Park.* Unpublished report prepared for St Bishoy Coptic Orthodox College.

UBM Ecological Consultants 2009 – *Flora & Fauna Study and Assessment of Significance Salt Pan Creek Reserve, Padstow.* Unpublished report prepared for Bankstown City Council.

UBM Ecological Consultants 2009 – *Flora & Fauna Surveys & Site Assessments for Sydney Water Properties: Dural SPO924, Castle Hill STP, Thornleigh Reservoir, Rouse Hill STP & Quakers Hill STP.* Unpublished report prepared for Sydney Water Corporation.

UBM Ecological Consultants 2009 – *Vegetation Management Plan for Bidjigal Reserve.* Unpublished report prepared for the Bidjigal Reserve Trust.

UBM Ecological Consultants 2009 – *Property Environmental Management Plans: Dural SPO924, Castle Hill STP, Thornleigh Reservoir, Rogan Hill Reservoir & Quakers Hill STP.* Unpublished report prepared for Sydney Water Corporation.

JODIE COOPER CURRICULUM VITAE

POSITION:

Field Zoologist

QUALIFICATIONS:

Bachelor of Applied Science (Parks, Recreation & Heritage)
Bachelor of Applied Science (Ecotourism)
Statement of Attainment in Conservation & Land Management (ArcGIS)
Masters in Natural Resource Management (ongoing)
St Johns First Aid 2011
4WD & Defensive Driving
Certificate 1 in Construction
OHS Consultation Certificate

EMPLOYMENT PROFILE:

2011 – now	Field Zoologist, Biosis Research Pty Ltd
2010 – 2011	Research Assistant, Biosis Research Pty Ltd
2009 – 2010	Assistant Manager, Yarrangobilly Caves – Kosciuszko National Park
2009	Laboratory Assistant, Elizabeth Macarthur Agricultural Institute
2008 – 2009	Discovery Ranger, NSW NPWS, Department of Environment, Climate Change and Water
2007	Field Staff, Parklands Albury – Wodonga
2006	Field Staff, Department of Land and Soil Services

FIELDS OF COMPETENCE:

- ✓ Fauna survey and identification of frogs, mammals and birds
- ✓ Habitat assessment
- ✓ Terrestrial fauna monitoring,
- ✓ Threatened species survey and assessment

PROFESSIONAL EXPERIENCE:

Jodie Cooper is a Field Zoologist with the Biosis Research's Wollongong office. She has four years experience in ecological surveys, land management, scientific research, applied clerical administration, and pest and weed management. Jodie has developed these skills whilst working at the NSW Department of the Environment, Climate Change and Water (DECCW) and in the consultancy industry.

Jodie's fieldwork covers a number of habitat areas including, rainforests, wet and dry sclerophyll forests, wetlands and coastal dunes in regions encompassing the Illawarra Escarpment, Alpine and Sub-Alpine areas and the NSW South Coast, She has also been involved with threatened species and general wildlife population management, and research and community environmental education programs. These have included threatened shorebird conservation sites, and population surveys of the Greater Glider, Glossy Black Cockatoo and Potoroo within Morton National Park, with the later involving the implementation of fox-baiting programs to aid in the recovery of this species. She has also participated in the research of botanic pathogenic disease hosted by both native and agricultural crop species. Through this, Jodie has developed strong research and project management skills.

Jodie's field skills consist of terrestrial and arboreal mammal trapping, frog, reptile and bird surveys, spotlighting, bat trapping and detection, fauna habitat assessment and vegetation surveys.

Examples of recent projects are provided below.

Field Zoologist: Biosis Research 2011/2012 – Wongawilli Colliery Ecological Monitoring Program, Amphibian Surveys. Gujarat NRE FCGL Pty Ltd.

Field Zoologist: Biosis Research 2011/2012 – Dendrobium Colliery Ecological Monitoring Program, Amphibian Surveys. BHP Billiton Illawarra Coal.

Field Botanist: Biosis Research 2011/2012 – Wongawilli Colliery Ecological Monitoring Program, Flora Surveys. Gujarat NRE FCGL Pty Ltd.

Field Botanist: Biosis Research 2011/2012 – Dendrobium Colliery Ecological Monitoring Program, Flora Surveys. BHP Billiton Illawarra Coal.

Field Zoologist/Project Manager: Biosis Research 2011 – Targeted Littlejohn's Tree Frog Surveys, Dendrobium Colliery, BHP Billiton Illawarra Coal.

Field Zoologist: Biosis Research 2011 – Targeted Green and Golden Bell Frog Surveys and Australian Painted Snipe Surveys, Whites Gully Resource Recovery Centre, Kembla Grange.

Field Zoologist: Biosis Research 2011 – Targeted Green and Golden Bell Frog Surveys, NRE. No.1 Pittop Colliery, Russelvale.

Field Zoologist/Project Manager: Biosis Research 2011 – Tree Removal and fauna rescue Supervision, Woodhill. Private Developer.

Field Zoologist: Biosis Research 2011 – Optus Fibre Optic Cable Flora and Fauna Assessment, East Lynne. Optus Telecommunications.

Field Zoologist: Biosis Research 2011 – Yerriyong Flora and Fauna Assessment, Nowra. Locale Consulting Pty Ltd.

Field Zoologist: Biosis Research 2011 – Whytes Gully Flora and Fauna Assessment. Golder and Associates.

Field Zoologist: Biosis Research 2011 **–** Wongawilli Colliery Ecological Monitoring Program, Winter Targeted Littlejohn's Tree Frog Surveys. Gujarat NRE FCGL Pty Ltd.

Field Zoologist: Biosis Research 2011 – Dendrobium Colliery Ecological Monitoring Program, Winter Targeted Littlejohn's Tree Frog Surveys. BHP Billiton Illawarra Coal.

Field Zoologist: Biosis Research 2011 – NRE No.1 Colliery Ecological Monitoring Program, Amphibian Surveys. Gujarat NRE FCGL Pty Ltd.

Field Zoologist: Biosis Research 2010/2011 – Wongawilli Colliery Ecological Monitoring Program, Amphibian Surveys. Gujarat NRE FCGL Pty Ltd.

Field Zoologist: Biosis Research 2010/2011 – Dendrobium Colliery Ecological Monitoring Program, Amphibian Surveys. BHP Billiton Illawarra Coal.

Field Botanist: Biosis Research 2010/2011 – Wongawilli Colliery Ecological Monitoring Program, Flora Surveys. Gujarat NRE FCGL Pty Ltd.

Field Botanist: Biosis Research 2010/2011 – Dendrobium Colliery Ecological Monitoring Program, Flora Surveys. BHP Billiton Illawarra Coal.

Field Zoologist: Biosis Research 2011 – Hollow Bearing Tree Assessment, Nowra. Southbank Pty Ltd

Field Zoologist: Biosis Research 2011 – Targeted Giant Burrowing Frog Surveys Heleioporus australiacus, Ulladulla. Cowman Stoddart Pty Ltd

Field Zoologist: Biosis Research 2011 – Jamberoo Action Park Fauna Assessment, Jamberoo. JBA Panning Pty. Ltd.

Field Zoologist: Biosis Research 2011 – Targeted Surveys for the Green and Golden Bell Frog Litora aurea at Dam 6, NRE Colliery No. 1 Russel Vale. Gujarat NRE FCGL Pty Ltd.

Field Zoologist: Biosis Research 2010 – Targeted Pink-tailed Worm Lizard Aprasia parapulchella Surveys, Queenbeyan. Manidis Roberts Consultants.

BEN CODDINGTON CURRICULUM VITAE

POSITION:

Botanist, Biosis Research Pty Ltd.

QUALIFICATIONS:

Bachelor of Landscape Management and Conservation, University of Western Sydney, Richmond (2002-2006).

Senior First Aid 2011

Advanced Certificate in Urban Horticulture NSW College of TAFE, Ryde Campus (1995-1998).

EMPLOYMENT PROFILE:

2010-2011	Botanist, Biosis Research Pty Ltd
2009-2010	Bushcare Officer, Pittwater Council
2008-2009	Biodiversity Officer, Ku-ring-gai Municipal Council
2007	Greencorps team leader, Greening Australia in partnership with Ku-ring-gai Municipal Council
2007	Bushcare volunteer supervisor, Urban Bushland Management. Supervisor for five sites in the Mosman Council area
2007	Self employed, Native landscape gardens and design
2006	Bushcare volunteer supervisor, Urban Bushland Management. Supervisor for three sites in the Hawkesbury City Council LGA
2006	Teaching assistant, University of Western Sydney, 'Introduction to Biology'
2005	Riverbank flora assessment, Penrith City Council. Assistance with an Honours project observing Freshwater Mussels in the Hawkesbury-Nepean
2004	Bush Regeneration, Australian Areas Management and Repair
1996 – 2000	Bush Regeneration, Total Earth Care team member and supervisor

FIELDS OF COMPETENCE:

flora survey and identification

native vegetation classification and mapping

bushland management & site assessment

native plant and weed identification

threatened species assessment (including EECs)

habitat restoration

weed density mapping

project management and report preparation

monitoring rehabilitation of vegetation

options and constraints assessment

PROFESSIONAL EXPERIENCE:

Ben is a botanist with Biosis Research, Wollongong Office. Ben has over 10 years experience working with native bushland and conducting flora surveys. Ben's has extensive experience in bushland restoration throughout the Sydney bioregion including the littoral zone, the Woronora Plateau, the Illawarra region, the high shale ridges and Hawkesbury Sandstone of Ku-ring-gai and the Central Coast as well as the Cumberland Plain and the Blue Mountains. Ben has experience in professional training and community education and has worked in Local Government managing bushland reserves and coordinating councils Bushcare program. Ben has a current working knowledge of the key legislation relevant to the management of natural areas in NSW.

Projects have included; mapping threatened ecological communities; conducting environmental impact assessment; conducting flora surveys and monitoring; review of ecological surveys and assessments accompanying development applications; and managing grant funded environmental restoration projects.

A sample of key professional experience is presented below

Botanist: Monitoring of Wongawilli and NEBO lease areas. Monitoring of creeks and upland swamps in the Avon and Cordeaux Catchments to assess any impacts of longwall mining (Biosis Research 2010 ongoing with Gujarat NRE FCGL Pty Ltd).

Botanist: Ongoing monitoring of Dendrobium Area 2 and 3a lease areas. Monitoring of creeks and upland swamps in the Cordeaux Catchment assess any impacts of longwall mining. (Biosis Research 2010 ongoing with BHP Billiton Illawarra Coal).

Project Manager/Botanist: Longwall end of panel flora and fauna field inspections and reporting for Longwall 6 Dendrobium Area 3a and Longwall 703 Appin West Colliery (Biosis Research 2011 BHP Billiton Illawarra Coal).

Project Manager/Botanist: Longwall end of panel flora and fauna field inspections and reporting for Longwall 11 Wongawilli Colliery (Biosis Research 2011 Gujarat NRE FCGL Pty Ltd).

Botanist: Participated in ACARP research project being conducted by University of Queensland focussing on the use of remote controlled ultra light aircraft to capture aerial imagery as a method for monitoring impacts to vegetation from Longwall mining. Conducted flora surveys in upland swamps in Dendrobium Area 3a to ground truth aerial imagery (Biosis Research 2011 with University of Queensland, BHP Billiton Illawarra Coal).

Project Manager / Field Botanist: Flora and fauna assessment conducted at Yerriyong NSW over a 137 hectare study area. Field survey included habitat assessment for threatened flora and fauna species and vegetation community mapping. A constraints analysis included determining whether the study area is of High Conservation Value according to the DECCW 2010, *South Coast Regional Conservation Plan* (Biosis Research 2011 with Locale Consulting on behalf of Shoal Haven City Council).

Field Botanist: Targeted flora survey for threatened species *Tetratheca juncea* conducted over an 11 hectare study area at Redhead Beach Port Macquarie (Biosis Research 2011with Hindmarsh Pty Ltd).

Project Manager /Field Botanist: Flora and fauna assessment Picton Sewerage Scheme Part 3A Project. Field survey included assessment of three study areas and Assessment of Significance for threatened ecological community Shale Sandstone Transition Forest (Biosis Research 2011 with Sydney Water).

Field Botanist, Biosis Research 2010/2011: Flora and fauna assessment Glenfield Sewerage Treatment Plant Sludge Lagoon Infill Project (Biosis Research 2011 Sydney Water).

Project Manager/Field Botanist: Flora and Fauna Assessment Minnamurra Wetlands National Broadband Network Fibre Optic Cable Installation (Biosis Research 2011 with Transfield Services).

Project Manger/Field Botanist: Flora and fauna assessment Jamberoo Action Park Expansion Project (Biosis Research 2010, 2011 Jamberoo Action Park).

SELECTED PREVIOUS EXPERIENCE: CONSULTANT REPORTS:

Biosis Research 2011 – *Flora and fauna assessment Whytes Gully Resource Recovery Park New Landfill Cell Part 3A project West Dapto.* Prepared for Golder and Associates on behalf of Wollongong City Council.

Biosis Research 2011 – *Flora and fauna assessment Creek Restoration & Flood Mitigation Works Mt Druitt Creek North, Ropes Creek.* Prepared for Halcrow on behalf of Blacktown City Council.

Biosis Research 2011 – *Flora and Fauna Survey and Constraints Assessment Proposed Motorsports Facility, Yerriyong, NSW.* Prepared for Locale Consulting Pty. Ltd on behalf of Shoalhaven City Council

Biosis Research 2011 – *Terrestrial Flora & Fauna Assessment Picton Sewerage Scheme Boundary Modifications, Picton, Thirlmere, Tahmoor NSW.* Prepared for Sydney Water.

Biosis Research 2011 – *Flora and Fauna Assessment Dendrobium Area 3A: Longwall 6 End of Panel Report.* Prepared for Gujarat NRE.

Biosis Research 2011 – *Flora and Fauna Assessment Appin Area 7: Longwall 703 End of Panel Report.* Prepared for BHP Billiton Illawarra Coal.

Biosis Research 2011 – *Glenfield STP Sludge Lagoon: Terrestrial and Aquatic Flora and Fauna Assessment.* Prepared for Sydney Water

Biosis Research 2011 – *Homebush Bay Bridge: Terrestrial and Aquatic Flora and Fauna Assessment*. Prepared for Fairmead Business Pty Ltd

Biosis Research 2011 – *NBN Transit Fibre Minnamurra Wetlands Route: Flora and Fauna Assessment.* Prepared for Cardno on behalf of Transfield Services.

Biosis Research 2011 – *Jamberoo Action Park Flora and Fauna Assessment, Jamberoo.* Unpublished report prepared for JBA Panning Pty. Ltd.

BRETT MORRISEY: **CURRICULUM VITAE**

POSITION:

Consultant Botanist, Biosis Research Pty Ltd

QUALIFICATIONS:

B. App. Sc (Coastal Management). 1993
University of New England, Lismore.
Certificate 2 Bushland Regeneration, 1995
NSW College of TAFE, Ryde Campus

EMPLOYMENT PROFILE:

2009	Consultant Botanist, Biosis Research
2003 – 2009	Project Officer - Environmental Consulting, Total Earth Care Pty Ltd, Sydney
2001 – 2003	Bush Regeneration Supervisor, Total Earth Care Pty Ltd, Sydney
2000 – 2001	Tour/Interpretive Guide, Jungle Adventures Pty Ltd, Cape Tribulation
1996 – 1999	Beachwatch Field Officer, NSW Environment Protection Authority, Sydney

FIELDS OF COMPETENCE:

Flora survey and identification
Bushland management & site assessment
Native plant and weed identification
Threatened species assessment (including EECs)
Native vegetation classification and mapping
Habitat restoration
Weed density mapping
Project management and report preparation
Monitoring rehabilitation of vegetation
Options and constraints assessment

PROFESSIONAL EXPERIENCE:

Brett is a botanist with Biosis Research, Wollongong office. Brett has 10 years experience working with indigenous plant species in flora surveys, natural area restoration and weed management. Brett's experience includes consulting projects involving both flora and fauna assessment. Brett has undertaken flora assessments including targeted surveys for a wide range of threatened species, populations and ecological communities in a variety of locations across the Sydney basin bioregion stretching from littoral zones to the eastern ranges through the Central Coast, Sydney Metropolitan, Southern Highlands, Illawarra and South Coast districts. Brett has also been involved with restoration projects throughout the Sydney region involving the translocation of threatened flora species, soil translocations, revegetation, weed control and bush regeneration projects. This experience spans the supervision of on ground restoration works, project management and cost estimation for restoration projects.

Brett has participated in surveys and prepared reports for flora and fauna assessments, vegetation and weed density mapping, bush regeneration scopes of works, vegetation management plans, bushland management plans and vegetation monitoring programmes.

Examples of recent projects are provided below.

Botanist, general vegetation and targeted threatened flora surveys and vegetation mapping ground truthing for the preparation a constraints analysis for an upgrade of the TransGrid Dapto

Zone Substation. Targeted flora surveys located the threatened flora species *Pterostylis gibbosa*, specimens of the threatened population *Chorizema parviflorum* and areas of Illawarra Lowlands Grassy Woodland EEC. Recommendations were made to minimise the potential for impacts to threatened biodiversity and to prepare TSC Act assessments of significance.

Botanist, general vegetation and targeted threatened flora surveys and vegetation mapping ground truthing for the preparation of Biodiversity Management Plan for longwall mining in the Douglas Park locality. The focus was on identifying and mapping the threatened ecological communities Cumberland Plain Woodland, Shale Sandstone Transition Forest and Moist Shale Woodland. Reporting included the review of regional biodiversity surveys and plans, Part 3A Environmental Assessments and formulation of appropriate performance measures and actions to monitor and manage mining related impacts.

Botanist, flora surveys of riparian, ridgeline and upland swamp plant communities at long term monitoring sites in the Metropolitan Special Area. Surveys carried out in areas subject to longwall mining and reference areas.

Botanist, general vegetation targeted threatened flora surveys to assess the impacts of the installation of underground powerlines for the Metropolitan Colliery at Helensburgh. The EEC Southern Sydney Sheltered Forest on Transitional Sandstone Soils was present on the route. TSC Act assessments of significance were prepared for threatened biodiversity.

Ecologist, general vegetation and diurnal fauna surveys and targeted threatened flora surveys and vegetation condition assessment for a constraints analysis to inform the planning and construction of a telecommunications tower at Tongarra. The threatened plant species *Solanum celatum* was located during flora surveys and the site supported Illawarra Lowlands Grassy Woodland EEC. TSC Act assessments of significance were prepared for threatened biodiversity.

Botanist, targeted exotic flora species survey, weed density mapping, resilience assessment and preparation of vegetation management measures for a Vegetation Plan of Management for a residential and tourist development at North Nowra. Subject site included areas of the threatened ecological community Illawarra Subtropical Rainforest.

Botanist, general vegetation and targeted threatened flora surveys and vegetation condition assessment for a constraints analysis to inform rezoning of six precincts for possible urban development in Picton, Thirlmere and Tahmoor. The focus was on identifying and mapping the threatened ecological communities Cumberland Plain Woodland and Shale Sandstone Transition Forest.

Botanist, general vegetation and targeted threatened flora surveys and vegetation condition assessment for a constraints analysis to inform the expansion of the Tahmoor Colliery Reject Emplacement Area. Threatened flora located were *Persoonia bargoensis* and *Pomaderris brunnea* Rufous Pomaderris. Vegetation assessment and mapping included areas of the threatened ecological community Shale Sandstone Transition Forest.

Botanist/Assisting Zoologist, general vegetation and targeted threatened flora and fauna surveys and vegetation condition assessment for a proposed industrial subdivision of a 19ha site on the southwestern outskirts of Ulladulla in the Shoalhaven LGA. TSC and EPBC Act Assessments of Significance were prepared for several threatened flora species with potential habitat on or known from the subject site.

Botanist/Assisting Zoologist, general vegetation and targeted threatened flora and fauna surveys and vegetation condition assessment for a proposed rezoning of a 70ha property at Bangalee in the Shoalhaven LGA. TSC and EPBC Act Assessments of Significance were prepared for multiple threatened flora species with potential habitat on or recorded from the subject site.

Ecologist, general vegetation and targeted threatened flora and fauna surveys and vegetation condition assessment for a Part 3A gas infrastructure project in south-western Sydney. An EPBC Act assessment of significance for Cumberland Plain Shale Woodland was prepared.

Botanist, general vegetation and targeted threatened flora surveys and plant community mapping for a telecommunications tower at Cordeaux Colliery. An assessment of significance for *Pultenaea aristata*.

Botanist, general vegetation and targeted threatened flora surveys, plant community mapping and constraints assessment for 33kv overhead/underground power line between Springhill and Wongawilli. Assessment of significance for Illawarra Lowland Grassy Woodland EEC.

Botanist, targeted exotic flora species survey, weed density mapping, resilience assessment and vegetation management measures for a Weed Management Plan at Dendrobium Mine Pit Top, Mount Kembla.

Botanist, general vegetation and targeted threatened flora surveys and plant community mapping of the main bushland reserves in the Kogarah LGA.

SELECTED PREVIOUS EXPERIENCE: CONSULTANT REPORTS:

A sample of reports that Brett has prepared or contributed to in his professional ecological consulting career are listed below:

2011 Biodiversity Offset Strategy. Princes Highway Upgrade, Foxground Berry Bypass. (for AECOM on behalf of RMS)

2011 Camden Gas Project: Northern Expansion Part 3A Flora and Fauna Assessments. (AGL Gas Production Pty Ltd)

2011 Flora and Fauna Survey and Constraints Assessment Tahmoor. Colliery Refuse Emplacement Area (for Cardno on behalf of Xstrata Coal)

2010 Terrestrial Flora and Fauna Assessment. Proposed Telstra Tower. 2595 Illawarra Hwy, Tongarra (for Aurecon on behalf of Telstra)

2010 Picton, Thirlmere, Tahmoor Local Environmental Study - Flora and Fauna Survey and Constraints Assessment (for Cardno on behalf of Wollondilly Shire Council).

2010 Flora and Fauna Assessment. Coller Road Industrial Subdivision, Ulladulla (Shoalhaven City Council)

2009 Flora & Fauna Assessment – Twin Creeks Reserve, Turramurra (Prepared for Networks Alliance).

2009 Flora Biodiversity Study – Kogarah Local Government Area (Prepared for Kogarah City Council).

2009 Flora & Fauna Assessment, Property EMP and VMP – Prospect Reservoir (Prepared for Sydney Water).

2009 7-part Tests for Blue Gum High Forest CEEC & Sydney Turpentine-Ironbark Forest EEC. Proposed multi-dwelling residential development, Beaconsfield Pde, Lindfield. (Prepared for Staldone Corporation).

2008 Flora & Fauna Assessment and VMP – Northern Sites Package 1. (Prepared for Sydney Water).

2008 Flora and Fauna Assessment. Cochlear Global Headquarters Project – Stage 1, Macquarie University. (Prepared for DEM).

2008 EPBC Act Significant Impact Assessments for Sydney Turpentine Ironbark Forest and Cumberland Plain Woodland EEC's, *Acacia pubescens* (Downy Wattle) and Grey Headed Flying-Fox - Potts Hill Reservoir. (Prepared for Sydney Water).

2007 Biodiversity Assessments - Cardiff, Floraville, and Jewells. (Prepared for Lake Macquarie Council).

2007 Preliminary Flora and Fauna Assessment. Proposed 33kV Powerline, Terry Hills Zone Substation to Sydney East Bulk Supply Point. (Prepared for EnergyAustralia).

2007 Targeted Threatened Species Survey. Proposed Scour Pipeline, Ashfield to Liverpool Sewer Pipeline Upgrade, Chullora. (Prepared for Leighton Contractors Pty Ltd).

2007 Restoration Plan. Noorumba Reserve, Rosemeadow (Prepared for Campbelltown City Council).

2007 Targeted Threatened Species Survey, St Patricks Estate Asset Protection Zone (Prepared for Lend Lease Developments).

2006/07Citywide Bushland Management Plan. Holroyd City Council (Prepared for Holroyd City Council).

2006 Vegetation Management Plan. Allied Mills Grain Milling Facility, Picton Road, Maldon. (Prepared for Kellogg, Brown & Root Pty Ltd).

2005 Vegetation Management Plan. Windsor Road Upgrade, Mile End Rd to Boundary Rd, Rouse Hill. (Prepared for NSW RTA).

2005 Translocation Plan for Downy Wattle *Acacia pubescens,* Lyn Pde Extension, Prestons (Prepared for AMBS).

CURRICULUM VITAE

JOSEPHINE DESSMANN

POSITION:
Ecologist, Biosis Research Pty Ltd., Sydney

QUALIFICATIONS:
Bachelor of Science Hons 1st class (Ecology), University of New South Wales
Current general boat licence expires 2013
Rail Industry Safety Induction Certificate 2011
Reptile survey and identification course, Ecological Consultants Association 2011
Advanced 4WD course 2010
Senior First Aid Certificate, St John Ambulance 2009
AGS 5 Project Management Course 2009
OHS Consultation Course, NSCA 2009
NSW Construction Site OH&S Induction Certificate 2008

PROFESSIONAL AFFILIATIONS AND MEMBERSHIPS:
Birds Australia
Australian Bird Study Association, Secretary
Royal Zoological Society of NSW, Scientific Member
Frog and Tadpole Society

EMPLOYMENT PROFILE:

2011-	Ecologist, Biosis Research Pty. Ltd.
2010-2011	Zoologist, Biosis Research Pty. Ltd.
2009-2010	Executive Research Assistant, Biosis Research Pty. Ltd.
2008-2009	Technical Assistant, Biosis Research Pty. Ltd.
2008-2008	Field Assistant, Providence Petrel recovery project, Lord Howe Island, NSW.
2008-2008	Research Assistant, The Evolution and Ecology Research Centre, University of New South Wales Sydney NSW
2008-2008	Intern, Smithsonian Tropical Research Institute, Panama.
2007-2007	Field Assistant, Save the Gouldian fund, East Kimberley WA
2006-2007	Research Assistant, University of New South Wales Sydney NSW

FIELDS OF COMPETENCE:
Zoology
Field and laboratory experimental techniques
Terrestrial and aquatic ecology
Monitoring and experimental design
Flora and fauna threatened species surveys
Identification of threatened flora and fauna
Literature reviews

PROFESSIONAL EXPERIENCE SUMMARY:

Josephine is an Ecologist with the Sydney Research Group of Biosis Research. In her five years in ecological research she has authored and co-authored reports for government departments, private industry and peer reviewed journals. Josephine has undertaken habitat assessments (including aquatic HABSCORE assessments), threatened species surveys and has undertaken water quality monitoring in freshwater ecosystems, ecological research and fauna trapping

throughout Sydney, the Illawarra, Central Coast, ACT, northern Victoria, the east Kimberley WA and far western NSW. She is experienced in standard and specialised field survey techniques, including Elliott, cage and pitfall traps, hair tubes, Anabat, harp traps, mist nets, call playback, spotlight surveys, radio-tracking and herpetology surveys. Extensive field experience targeting passerine birds has provided her with a well developed knowledge of avian behavioural ecology. As well as strengths in the area of birds, she is also experienced in the ecology and identification of mammals, reptiles, and amphibians.

Josephine has experience working on a range of projects including liner, industrial and residential developments.

Josephine has five years experience in ecological research. A sample of key professional experience is presented below.

Zoologist, Flora and fauna assessment for Blackheath to Katoomba north transmission line replacement (*2011 for Endeavour Energy*).

Zoologist, Striped Legless Lizard (*Delma impar*) tile survey set-up and monitoring (*2011 for Environment & Sustainable Development Directorate*).

Project Manager and Ecologist, Aquatic assessment of proposed extension to Whytes Gully Recycling Recovery Park under Part 3A assessment (*2011 for Golder Associates*).

Project Manager and Ecologist, Aquatic Ecological Health Monitoring for waterways within the Penrith Local Government Area (*2011 for Penrith City Council*).

Project Manager and Ecologist, AUSRIVAS aquatic ecological health monitoring of mining impact and reference sites for Mangoola mine (*2011 for Xstrata Coal*).

Project Manager and Zoologist, Mt Druitt North Flood Mitigation and Revegetation Works Flora and Fauna Assessment (*2011 for Halcrow*).

Project Manager and Zoologist, Australian Catholic University, Strathfield Masterplan Flora and Fauna Assessment under Part 3A (*2011 for Hassell*).

Project Manager and Ecologist, Silverwater Pipeline Bridge dismantling and decommission Terrestrial and Aquatic Flora and Fauna Assessment (*2011 for Worley Parsons*).

Zoologist, Alpine Way Flora and Fauna Assessment for road maintenance works. Project involved targeted surveys for threatened Owls using call play-back and spotlighting, as well as spotlighting for arboreal mammals and undertaking habitat assessments (*2011 for KMH*).

Project Manager and Aquatic Ecologist, AUSRIVAS aquatic ecological health monitoring of impact and reference sites (*2011 for Gujarat*).

Project Manager and Zoologist, Flora and Fauna Assessment under Part 3A for the installation of a Bulk Water Pumping Station to supply water to the new township proposed in Googong, NSW (*2011 for Manidis Roberts*).

Project Manager and Zoologist, Infra –red camera survey and Seven Part Test to assess the potential impacts associated with the refurbishment works at the Fanny Durack Aquatic Centre, Petersham to individuals of the endangered inner west population of Long-nosed Bandicoots (*Perameles nasuta*) (*2011 for Marrickville Council*).

Project Manager and Zoologist, Letter of opinion, advice and identification of Long-nosed Bandicoot habitat (*2011 for Marrickville Council*).

Zoologist, Summer monitoring of terrestrial hair tubes and infra-red cameras deployed in bushland at Tomago to monitor habitat connectivity in relation to the power augmentation project (*2011 and 2010 for TransGrid*).

Zoologist, Site inspections, supervision and monitoring of two-stage vegetation clearing in relation to the Great Western Highway upgrades at Lawson (*2011, 2010 & 2009 for Abigroup*)

Ecologist, Threatened grassland reptile monitoring using pit falling, rock-turning, tiling (2010-2011 for ACT Land Development Corporation).

Ecologist, Targeted surveys for threatened species, *Diuris tricolor* within Carrington West Wing extension area (*2010 for Environmental Management Group Australia*).

Project Manager and Zoologist, Prepared site specific management plan for the endangered inner west population of Long-nosed Bandicoot (*2010 for Paynter Dixon*)

Zoologist, Options and constraints assessment for proposed additional crossing of the Clarence River (*2010 for Arup*).

Zoologist, Terrestrial fauna habitat assessment for proposed Yass Dam wall raising (*2010 for Department of Services, Technology and Administration*)

Zoologist, Glenorie substation terrestrial fauna impact assessment (*2010 for Energy Australia*).

Zoologist, Terrestrial fauna assessment under Part 3A for Remondis integrated recycling park (*2010 for National Environmental Consulting Services*)

Zoologist, Targeted Littlejohn's Tree Frog (*Litoria littlejohni*) winter surveys (*2010 & 2009 for BHP*).

Zoologist, Terrestrial fauna surveys for an impact assessment for proposed sportsground extensions at Kenthurst Park (*2010 for The Hills Shire Council*)

Zoologist, Terrestrial fauna assessment for proposed integrated aquaculture and horticulture greenhouse development (*2010 for JBA Urban Planning)*

Zoologist, Fauna assessment - Identifying potential habitat for *Litoria raniformis* throughout central northern Victoria (*2010 for Transfield services Australia*)

Ecologist, Targeted surveys for threatened species; *Aprasia parapulchella* and Hoary-sunray (*2010 for Manidis Roberts*)

Primary author, Scoping study for Cobourg Peninsula Ecological Character Description (*2009 for DEWHA*).

Zoologist, Conducted targeted Golden Sun Moth (*Synemon plana*) surveys in Macgregor west, ACT (*2009 for Village Building Co. Ltd.*).

Zoologist, Frog monitoring to assess the potential impacts of subsidence in Dendrobium, seasonal surveys *(2009 & 2010 for BHP Billiton).*

Zoologist, Desktop flora and fauna impact assessments for School site upgrades associated with Building the Education Revolution (*2009 for AbiGroup contractors*).

Zoologist, Monitoring of two-stage vegetation clearing in relation to the Carlton to Matcham Road early works at Erina Heights (*2009 for RTA*).

Zoologist, Terrestrial fauna impact assessment for the proposed Hammondcare development site at Hammondville (*2009 for Morgan Moore & Associates*).

Zoologist, Targeted fauna surveys (including Elliott trapping, cage trapping, hair tubes, call playback and Anabat surveys) for biodiversity study in Baulkham Hills Shire Council (*2009 for Baulkham Hills Shire Council*).

Zoologist Assistant, Targeted autumn fauna surveys of preferred route of Gerringong to Bomaderry Princess Highway Upgrade (*2009 for Maunsell Australia*).

Zoologist, Terrestrial fauna habitat assessment and targeted fauna surveys for Littlejohn's Tree Frog, Giant Burrowing Frog, Red-crowned Toadlet, Green and Golden Bell Frog, Broad-headed Snake and Rosenberg's Goanna for NRE Gujarat's proposed Wonga longwall mines (*2009 for ERM Australia*).

Zoologist, Murrumbidgee River to Googong Reservoir Pipeline: Grassland fauna surveys (*2008 for Ecowise Environmental ACT*).

Zoologist, Googong Urban Release flora and fauna surveys, Googong (*2009 for Ecowise*).

Zoologist, Targeted Growling Grass Frog (*Litoria raniformis*) surveys (*2008 for GHD Pty Ltd VIC*).

Field Assistant, Monitored Providence petrel breeding ecology to determine optimum translocation age of chicks in order to maintain philopatric behaviours *(2008 for the Waterbirds, Wetlands and River Research Laboratory UNSW).*

Intern, Designed and conducted experiments on speciation and mate choice using the butterfly species *Heliconius Melpomene Erato* and *H.Cydno* (*2008 for the Smithsonian Tropical Research Institute, Panama*).

Research Assistant, Performed diet and genetics experiments using populations of tropical Nerrid flies; *Telostylinus lineolatus* and *T. angusticollis* (*2008 for The evolution and ecology research centre, UNSW*).

Field Assistant, Located nests and collected behavioural observation data on Gouldian Finches in the East Kimberley, WA for a PhD project on the natural history and breeding ecology of the Gouldian Finch *(2008 for research project for PhD candidate at MQU).*

Research Assistant, Conducted diet experiments using the study species *Teleogryllus commodus*, to explore the effect that diet has on performance, longevity and reproductive activities (*2007 for The evolution and ecology research centre*, *UNSW*).

Chief Investigator, Sex allocation in the cooperatively breeding Chestnut crowned babbler (*Pomatostomus ruficeps*). Field techniques included mist-netting, banding and bleeding of adults/nestlings, and behavioural data collection (2005/2006 *Honours Project UNSW, Fowlers Gap Arid Zone Research Station, NSW*).

MANUSCRIPTS/CO AUTHOR:

Andrew F. Russell, **Josephine Dessmann**, Dean J. Portelli, Simon C. Griffith (In Prep). Breeding Ecology of the Chestnut-crowned Babbler (*Pomatostomus ruficeps*)

2011 James Brazill-Boast, **Josephine Dessmann**, Gareth Davies, Sarah Pryke and Simon Griffith. Breeding habitat selection in the endangered Gouldian Finch (*Erythrura gouldiae*) at two spatial scales. *Emu*.

2009 Alexei A. Maklakov, Matthew D. Hall, Stephen J. Simpson, **Josephine Dessmann**, Fiona J. Clissold, Felix Zajitschek, Simon P. Lailvaux, David Raubenheimer, Russell Bonduriansky and Robert C. Brooks. Sex differences in nutrient-dependent reproductive ageing. *Ageing Cell*, **8**, *3*, 324-330.

2008 Alexei A. Maklakov, Stephen J. Simpson, Felix Zaijtscheck, Matthew D. Hall, **Josephine Dessmann**, Fiona J. Clissold, David Raubenheimer, Russell Bonduriansky and Robert C. Brooks. Sex-specific fitness effects of nutrient intake on reproduction and lifespan. *Current Biology*, **18**, 1062–1066.

LAYLA WATSON CURRICULUM VITAE

POSITION:

Research Assistant, Biosis Research Pty. Ltd.

PROFESSIONAL AFFILIATIONS AND MEMBERSHIPS:

Current Sea Guardian, Australian Marine Conservation Society

QUALIFICATIONS:

BAppSc (Marine Science and Management)
Southern Cross University, 2004
Honours (Marine Science)
University of New England, 2007

EMPLOYMENT PROFILE:

2010 – Current Research Assistant - Biosis Research, Sydney.
2009 – 2010 Technical Assistant - Biosis Research, Sydney.
2000 – 2008 Customer Relations Manager - Digitone Communications, Coffs Harbour.

FIELDS OF COMPETENCE:

Aquatic and terrestrial habitat assessments, surveys and monitoring
Flora and Fauna threatened species surveys and assessment
Identification of threatened flora and fauna
AUSRIVAS macroinvertebrate surveys and macropyhte surveys
Fish salvage and threatened fish surveys
Native fauna survey and monitoring, identification and habitat assessment
Field and laboratory techniques
Proposal and report preparation
Coordinating and preparing logistical support

PROFESSIONAL EXPERIENCE:

Layla Watson is a Research Assistant with the Sydney Resource Group of Biosis Research. Layla has undertaken habitat assessments, threatened species surveys, ecological research and fauna trapping throughout Sydney, the Illawarra, Central Coast, ACT and throughout Victoria.

In her time at Biosis Research Layla has gained extensive experience in conducting aquatic surveys involving habitat assessments, macrophyte surveys, habitat photo analysis, fish salvage, threatened fish surveys and ongoing monitoring. Layla has completed numerous surveys involving the use of Rapid Bioassessment (RBA) methodology, utilising macroinvertebrates and water quality to assess stream ecological health. Layla is also highly skilled herpetology survey techniques and has undertaken grassland reptile surveys, including targeted Striped Legless Lizard (*Delma impar*) surveys in the ACT. Layla is also experienced in conducting terrestrial threatened flora and fauna surveys and undertaken habitat and tree assessments within the Sydney and Hunter valley region.

Prior to her time with Biosis Research, Layla's expertise related to marine science and surveys where she has completed extensive fieldwork investigating the spatial distribution of subtidal epibiotic assemblages in marine environments. She has also gained experience with pelagic fish survey methods and marine mammals surveys.

A sample of Layla's key professional experience is presented below.

Aquatic Ecologist, Mangoola Coal Mine Stream Health Monitoring, autumn sample. (2011 for *Xstrata Mangoola*).

Aquatic Ecologist, Fish survey of the Werribee River for the Geelong Pipeline *(2011)* for *Abigroup Contractors).*

Aquatic Ecologist, Wongawilli Aquatic Ecology Monitoring, autumn sample. (2011 for *Gujarat NRE)*.

Aquatic Ecologist, Nebo Aquatic Ecology Monitoring, autumn sample. (2011 for *Gujarat NRE)*.

Ecologist, Inspections for two-stage vegetation clearing in relation to the Maitland to Minimbah Third Track (2011 for *Hunter 8 Alliance*).

Research Assistant, Flora and Fauna Assessment, Strathfield *(*2011 for *Hassell, Pty Ltd).*

Ecologist, Monitoring for two-stage vegetation clearing in relation to the Great Western Highway upgrades at Lawson (2011 for *AbiGroup Contractors*).

Aquatic Ecologist, Penrith City Council AUSRIVAS Surveys, autumn sample *(*2011 for *Penrith City Council).*

Ecologist, Inspections for two-stage vegetation clearing in relation to the Great Western Highway upgrades at Lawson (2011 for *AbiGroup Contractors*).

Aquatic Ecologist, Dwarf galaxias (*Galaxiella pusilla*) surveys for the Proposed Frankston Bypass, Tuerong and Balcombe Creek, Victoria. Peninsula Link. (2011 for *AbiGroup*)

Aquatic Ecologist, Fish salvage and translocation for the Proposed Frankston Bypass, Carrum to Mount Martha, Victoria. Peninsula Link. (2011 for *AbiGroup*)

Aquatic Ecologist, Dwarf galaxias (*Galaxiella pusilla*) surveys for the Proposed Frankston Bypass, Carrum to Mount Martha, Victoria. Peninsula Link. (2011 for *AbiGroup*)

Aquatic Ecologist, Victorian Glenelg Basin Rapid Bioassessment Reference River Health Program 2010/2011 (2011 for *Vic EPA*)

Aquatic Ecologist, Victorian Bunyip Basin Rapid Bioassessment Reference River Health Program 2010/2011 (2011 for *Vic EPA*)

Aquatic Ecologist, Victorian La Trobe Basin Rapid Bioassessment Reference River Health Program 2010/2011 (2011 for *Vic EPA*)

Aquatic Ecologist, Victorian Mitchell Basin Rapid Bioassessment Reference River Health Program 2010/2011 (2011 for *Vic EPA*)

Ecologist, Striped Legless Lizard (*Delma impar*) tiling in the ACT. (2010 for *ACT Land Development Agency, ACT*)

Ecologist, Grassland Reptile Surveys. (2010 for *ACT Land Development Agency, ACT*)

Research Assistant, Spring Farm test excavation. (*2010 for Networks Alliance*)

Aquatic Ecologist, Wongawilli Aquatic Ecology Monitoring, spring sample. (2010 for *Gujarat NRE*)

Aquatic Ecologist, Belrose Road Corridor Aquatic Monitoring, spring sample. (2010 for *Worley Parsons*)

Aquatic Ecologist, Caddies Creek AUSRIVAS survey, spring sample. (2010 for *Worley Parsons*).

Aquatic Ecologist, Aquatic Flora and Flora Assessment of the proposed Lake Wallace Project, Nimmitabel water supply. (2010 for *Cooma-Monaro Shire Council*).

Aquatic Ecologist, Mangoola Coal Mine Stream Health Monitoring, spring sample. (2010 for *Xstrata Mangoola*).

Ecologist, Bandicoot Habitat Assessment along the Sydney Light Rail-Lilyfield to Dulwich Hill (2010 for *Department of Transport and Infrastructure*).

Research Assistant, Erskine Park Section 87 Archaeological Excavation. (2010 for *NSW RTA).*

Ecologist, Monitoring for two-stage vegetation clearing in relation to the Great Western Highway upgrades at Lawson (*2010 for AbiGroup Contractors*).

Ecologist, Inspections for two-stage vegetation clearing in relation to the Great Western Highway upgrades at Lawson (*2010 for AbiGroup Contractors*).

Aquatic Ecologist, Surface Water Quality Monitoring for the Belrose Road Corridor. (2010 for *Worley Parsons*)

Aquatic Ecologist, Wet Weather Turbidity Monitoring for the Belrose Road Corridor. (2010 for *Worley Parsons*)

Aquatic Ecologist, Mosquito Risk Assessment for the Warriewood Road Development, Warriewood. (2010 for *Worley Parsons*)

Aquatic Ecologist, RBA Signal2 Assessment for the Warriewood Road Development, Warriewood. (2010 for *Worley Parsons*)

Aquatic Ecologist, Wollondilly Shire Council Local Environmental Study - Aquatic Ecology. (2010 for *Cardno Forbes Rigby / Wollondilly Shire Council*).

Research Assistant, Flora and Fauna Assessment, St Vincent de Paul Society, Lewisham (2010 for *Paynter Dixon Constructions Pty. Ltd*).

Aquatic Ecologist, Caddies Creek Stream Health Monitoring, spring sample. (2009 for *Worley Parsons*).

Other key professional experience**:**

Marine Ecologist, Marine Debris Surveys (2007 *National Marine Science Centre, Coffs Harbour).*

Marine Ecologist, Seasonal Humpback Whale Migrations (2004-2006 *Southern Cross University, Lismore*).

Marine Ecologist, Threatened Shorebird Research (2005 *National Marine Science Centre, Coffs Harbour*).

Marine Ecologist, The effect of Cetacean sounds on shark behaviour (2004 *Southern Cross University, Lismore*).

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APPENDIX G

Soil and Water

APPENDIX G1

Geotechnical Investigation Report

June 2012
Report No. 117625003_159_R_Rev1

March 2012

WHYTES GULLY NEW LANDFILL CELL

Geotechnical Investigation Report

Submitted to:
Wollongong City Council

REPORT

Report Number. 117625003_077_R_Rev1

Distribution:

Wollongong City Council
Golder Associates

Golder Associates

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1.0 INTRODUCTION

A geotechnical investigation was undertaken at the Whytes Gully Resource Recovery Park (WGRRP) in July and August 2011 by Golder Associates (Golder) on behalf of Wollongong City Council (Council). The purpose of investigation was to provide subsurface information to inform the environmental assessment and detailed design of the Whytes Gully New Landfill Cell.

Additional geotechnical investigations were undertaken for the New Cell Floor at WGRRP in December 2011 by Golder on behalf of Council. These additional investigations were carried out in general accordance with our proposal Variation #4, Golder reference 117625003_054_L_Rev1, dated 4 November 2011. Authorisation to proceed was received via email from Council on 21 November 2011. Other aspects of the work carried out as part of Variation #4 were presented in separate reports.

1.1 Background

The WGRRP is owned and operated by Council under Environment Protection Licence 5862. Existing landfill airspace at the WGRRP is projected to expire in late 2013. As part of a coordinated delivery of resource recovery and waste services in the Wollongong Local Government Area (LGA), Council are proposing to increase landfill capacity at the site by constructing a new landfill cell within the existing WGRRP, to the south of the existing landfill footprint and piggy-backing waste over the existing western and eastern gully landfills. This is estimated to provide more than 5 million cubic metres of additional airspace, projected to extend the life of the landfill by up to 50 years.

1.2 Objectives of the Geotechnical Investigation

The objectives of the geotechnical investigations were to inform planning and design development of the proposed new landfill cell. The investigations were targeted to provide subsurface information for the existing landfill cap, the foundation conditions for the proposed new landfill cell footprint and proposed borrow pit areas across the site.

2.0 SITE DESCRIPTION

2.1 Regional Setting

The Wollongong Council area is located 80 kilometres south of Sydney and covers approximately 714 km^2. It is bordered by the Royal National Park to the north, Lake Illawarra to the south, the Tasman Sea to the east and the Illawarra escarpment to the west.

2.2 Site Location

The WGRRP is located approximately 10 km to the south west of the Wollongong Central Business District (CBD) and is approximately 50 ha in size. Figure 1 presents the site locality and identifies the WGRRP regional context.

The WGRRP is located on Reddalls Road, Kembla Grange NSW. The site is generally bounded by Reddalls Road to the south and west, rural residential lands to the north, north-east and north-west, and a water treatment plant to the south east. An industrial area lies to the south of Reddalls Road and Dapto Creek lies to the west.

The residential suburb of Farmborough Heights is located approximately 360 m to the north east over a ridgeline.

2.3 Existing Site

WGRRP includes historical and existing landfills (Western and Eastern Gully), a transfer station, private roads, stormwater ponds, a leachate management system (including treatment plant and ponds), a materials recovery facility, a recycling area, weighbridge and administration and amenities buildings, as shown on Figure 2. The site also includes buildings previously housing a solid waste to energy facility.

2.4 Property Details

The Whytes Gully RRP site is owned by Council and consists of:

- Part Lot 501, DP 1079122;
- Lot 502, DP 1079122;
- Lot 2, DP 240557;
- Lot 52, DP 1022266;
- Lot 53, DP 1022266; and
- Lot 51, DP 1022266.

This land is zoned as IN2 Light Industrial under the *Wollongong Local Environment Plan (West Dapto) 2010* (the LEP).

2.5 Previous Investigations

A number of investigations have been carried out across the site prior to this current phase of work. Information from these previous investigations has been reviewed during the preparation of this study and includes the following documents:

- *Preliminary Geotechnical Investigation of Possible Waste Disposal Depot at Whytes Gully, Reddalls Road, West Dapto* (Golder Associates, March 1981)
- *Proposed Waste Disposal Depot at Reddall's Road West Dapto, Environmental Impact Statement* (Scott and Furphy Engineers, February 1982)

- *Proposed Waste Disposal Depot at Reddall's Road West Dapto, Environmental Impact Statement Addenda* (Scott and Furphy Engineers, January 1983)
- *Site Investigations and Geotechnical Assessments for the Phase Two Development of a Waste Disposal Depot at Whytes Gully, West Dapto* (Maunsell, September 1992)
- *Supplement for the Whytes Gully Waste Depot – Stage 2 Landfill Management Plan to Wollongong City Council, Leachate Treatment Options* (Maunsell, March 1993)
- *Geotechnical Assessment – Proposed Extension to Whytes Gully Waste Disposal Depot* (R Britten, Council of the City of Wollongong, pers. comm., 18 July 1991)
- *Whytes Gully Landfill Extension Environmental Management Plan* (Maunsell, May 1998)
- *Whytes Gully Landfill Extension Landfill Management Plan* (Maunsell, October 1992)
- *Review of Environmental Factors for Proposed Deviation of Reddalls Road, Kembla Grange* (Forbes Rigby, February 2001)
- *Preliminary Geotechnical Investigation Proposed Leachate/Stormwater Ponds Whytes Gully Waste Disposal Dept Reddalls Road, Kembla Grange* (Jon Thompson, Coffey Geosciences, pers. comm., 18 December 2001)
- *Whytes Gully Landfill Leachate Management Study* (Forbes Rigby, August 2002)
- *Whytes Gully Landfill Surface Water and Leachate Management Plan 2008 Draft* (RIENCO Consulting, November 2008)
- *Technical Review of the Groundwater Monitoring Network for Whytes Gully Waste Management Facility* (Earth2Water, 29 April 2008)
- *Report on Geotechnical Investigation, Characterisation of Capping Material Whytes Gully Landfill Kembla Grange* (Douglas Partners, April 2009)
- *Whytes Gully Waste Disposal Depot Borrow Pit Geotechnical Investigation Laboratory Report* (Wollongong City Council Geotechnical Services, 27 June 2010)
- *Whytes Gully Waste Disposal Depot New Cell Floor Investigation Laboratory Report* (Wollongong City Council Geotechnical Services, 26 June 2010)
- *Small Vehicle Transfer Station Whytes Gully Waste Disposal Depot Kembla Grange* (Kevin Bogie, Wollongong City Council pers. comm., 1 May 2010)
- *Report for Whytes Gully and Helensburgh Landfill Sites Landfill Gas Surface Emissions, Building Accumulation and Manifold Monitoring* (GHD, April 2011).

The locations of previous site investigations are shown on Figure 3, Historical Site Investigation Locations.

2.6 Scope of the Geotechnical Investigation

The geotechnical investigations comprised drilling of boreholes, excavation of test pits and hand auger holes and associated field and laboratory testing. The investigation locations are shown on Figure 4, Current Site Investigation Locations.

2.6.1 Existing Landfill Cap

The following test pits and hand auger holes were carried out to investigate the composition and extent of the existing capping materials across the Eastern and Western Gully landfills:

- Nine (9) hand augers (GAHA01 to GAHA09) undertaken across the capping on the eastern cell; and
- Thirty (30) test pits (TP21 to TP32 and TP35 to TP52) undertaken across the capping on the Western Gully Landfill.

2.6.2 New Cell Floor Area

The following test pits and boreholes were carried out to allow assessment of foundation conditions for the proposed new landfill cell:

- Seven (7) cored boreholes (GABH01, GABH02 , GABH03, GABH04, GABH05, GABH06D, d GABH06S);
- Two (2) test pits (TP06 and TP07); and
- Three (3) monitoring wells (GABH205, GABH206 and GABH207), carried out as part of Variation #4.

2.6.3 Potential Borrow Pit Areas

The following test pits and hand augers were undertaken to allow an assessment of materials encountered within selected potential borrow pit areas for re-use during construction and/or operation of the proposed new landfill cell:

- Nine (9) test pits (TP01, TP02, TP03, TP04, TP05, TP08, TP09, TP10 and TP11) within the lower hairpin area;
- Two (2) hand augers (GAHA15 and GAHA16) and 9 test pits (TP12 to TP20) within the western ridge area;
- One (1) hand auger (GAHA17) and two (2) test pits (TP33 & TP34) within the inside hairpin area; and
- Five (5) hand augers (GAHA10 to GAHA14) in the central ridge area.

2.6.4 Hydrogeological Assessment

In conjunction with the scope of works described above, the following investigations were undertaken to investigate hydrogeological conditions at the site. These investigations are reported in the *Whytes Gully New Landfill Cell, Hydrogeological Investigation Report* (ref: 117625003-070-R-Rev0, dated March 2012) (Golder 2012c) and *Addendum - Installation and Monitoring of Additional Groundwater Monitoring Wells at Alternative Waste Technology, New Cell Floor and Mixed Recycling Facility Areas, Whytes Gully Resource Recovery Park, Kembla Grange* (ref: 117625003-162-M-Rev0, dated March 2012) (Golder 2012r):

- Eleven monitoring wells (GMW101, GMW102, GMW103, GMW104, GMW105, GMW106, GMW107, GMW109S, GMW109D, GMW110 and GMW111) were installed along the perimeter of the Site;
- Two (2) groundwater monitoring wells (GMW108S and GMW108D) in the new cell floor area;
- Installation of standpipe piezometers in the new cell floor GABH01, GABH02 , GABH03, GABH04, GABH05, GABH06D, and GABH06S), development and measurement of static water levels;
- Hydraulic (slug) testing of three cored boreholes in the new cell floor to assess permeability of underlying strata; and
- Installation of standpipe piezometers in the new cell floor for Variation #4 (GABH205, GABH206 and GABH207), development and measurement of static water levels.

2.7 Site History and Development

The WGRRP was established in 1984 at a site known as Whyte's farm. The site is defined by two gullies known as the western and eastern gullies separated by a central north-south trending ridgeline. The farm comprised an area of 35.6 Ha of mostly cleared, improved grazing land owned by Mr Whyte for a period of 40 years prior to development as a landfill (Scott and Furphy, 1982). An area of land to the south of Whyte's farm adjacent to the eastern gully was also purchased to accommodate the site's development as a landfill. A stockyard remains near the central western boundary of the site which is remnant from this prior use.

2.7.1.1 Western Gully

Development consent for landfilling in the western gully was granted in 1983, for which an Environmental Impact Statement (EIS) was prepared by Scott and Furphy (1982). Landfilling commenced in the western gully in 1984, as shown on Figure 2.

The western gully landfill is unlined and is covered with varying depth of cover materials comprising natural clayey sandy soil materials won onsite and imported coal wash. The final profile of the landfill comprises a series of slopes and indistinct benches with an average surface slope of approximately 20%.

The western gully landfill received approximately 980,000 cum of waste during its 9.5 year life from 1984 to 1993 (Forbes Rigby, 2001).

Leachate management for the western gully comprised collection of leachate through surface and subsurface drains to a leachate retention pond for treatment prior to release to surface waters. Irrigation of the leachate over the eastern gully by pumping to a tank at the top of the gully was used to increase treatment when required, and was also provided as a fire fighting system (Scott and Furphy, 1982).

Surface water management for the western gully landfill comprised up-gradient diversion drains and treatment of runoff from landfill areas as leachate.

We understand that colluvium and residual soil were stripped from the natural slopes during preparation works prior to landfill being placed in the area. From discussions with people involved in this stripping operation it appears that the natural slopes are likely to have been almost completely stripped to rockhead, but that colluvium and residual soil were not removed to full depth at the base of the natural slopes.

2.7.1.2 Eastern Gully

The eastern gully landfill was constructed as a lined landfill, with a lining system comprising a high density polyethylene (HDPE) geomembrane overlain by a leachate drainage layer supplemented with leachate collection pipes.

Leachate is drained by gravity to the toe of the landfill and transferred to leachate ponds.

The HDPE liner is underlain by a groundwater drainage layer to manage groundwater seepages from springs located in the gully. Groundwater collected from this system drains under gravity to a pond at the toe of the landfill.

The landfill is covered with intermediate cover of approximately 300 mm depth. The profile of the landfill comprises a series of terraced benches with an average surface slope of approximately 25%.

Filling in the eastern Gully has been undertaken in four stages. Stage 1 commenced in 1993 and was located in the upper portion of the gully, and Stage 2, located on the lower section of the gully, commenced in 1993 and received approximately 1,250,000 cum of waste to the year 2004. Stage 3 is located in the lower portion of the gully over the Stage 2 filling area and had an estimated 610,000 cum capacity over a five year period. Stage 4, located in the upper portion of the gully over Stage 1 is currently underway and has an estimated 750,000 cum capacity over a five year period with completion of filling expected in 2013 (Forbes Rigby, 2001 and WCC Drawing No. 1475, 2004).

We understand that colluvium and residual soil were stripped from the natural slopes during preparation works prior to landfill being placed in the area. From discussions with people involved in this stripping

operation it appears that the natural slopes are likely to have been almost completely stripped to rockhead, but that colluvium and residual soil were not removed to full depth at the base of the natural slopes. We note that a liner was placed below the landfill for this area of the site.

2.8 Topography

The northwest and eastern extents of the landfill are bounded by ridgelines, with a small central north-south trending ridgeline separating the two historical gullies, the upslope portion of which remains clearly visible today. The site rises from RL 15 m at the south west to RL 100 m at the north east.

2.9 Hydrology

The general surface water drainage direction on the site is from the north east towards the south west. The catchment area of the site is approximately 50 ha and extends from a ridge to the north of the site to Reddalls Road to the south. Runoff from this catchment is directed to the stormwater ponds at the south west corner of the site before discharge to Dapto Creek.

Currently (2011), stormwater runoff from the landfill is generally directed along the eastern and western edges of both the Eastern Gully landfill and the Western Gully landfill through a series of swales and benches and a drain along the central ridge. There is currently a pond system on site to capture and treat the sediment runoff generated from the landfill activities. Run-on to the site is minimal due to the site being bounded by ridgelines.

2.10 Hydrogeology

2.10.1 Regional Hydrogeological Setting

Regionally the site is located within the southern portion of the Sydney Basin, a geological basin stretching from the Illawarra Plateau in the south to the Lower Hunter Valley region in the north, and incorporating the topographically low Cumberland Basin in the centre. Generally, the dip of the geological formations within the Sydney Basin is from the topographically higher ground in the north and south towards the topographic low ground in the centre of the basin, although this varies locally based on structural features.

The regional hydrogeological setting of the site includes groundwater resources associated principally with the sandstone formations of the Hawkesbury Sandstone, Narrabeen Group, Illawarra Coal Measures and the Shoalhaven Group. Each of these geological groups generally comprise varying proportions of sandstone, siltstone, claystone, shale and coal. Groundwater resources are generally described as occurring as stacked aquifer systems associated with the sandstone formations, separated by lower permeability strata acting as aquitards. Structural contours presented on the 1:100,000 geological map 'Wollongong-Port Hacking' (Department of Primary Industries, 1985) indicate a local geological dip direction approximately towards the north to northwest in the vicinity of the site, which would be expected to influence the regional groundwater flow direction.

2.10.2 Local Hydrogeological Setting

On the site scale, groundwater occurrence is generally associated with two shallow systems: groundwater present in the upper weathered and fractured profile of the local bedrock geology, and groundwater present in the unconsolidated deposits that infill the two gullies at the site at the toe of the sloping topography. Water levels measured in wells installed within the shallow weathered bedrock in the sloping northern portion of the site generally range from 5 to 10 metres below ground level (mbgl), whereas water levels in wells installed in both the shallow bedrock and unconsolidated material in the flatter southern portion of the site are shallower, generally on the order of 1 to 3 mbgl. The water level associated with GABH03 is approximately 0.4 m above ground level, indicating local artesian conditions within the shallow bedrock at this location.

Shallow groundwater flow associated with the weathered bedrock horizon is inferred to be sympathetic to the sloping topography of the northern portion of the site, with a south to southwest flow direction. Anecdotal information indicates that a number of springs were present in the two former gullies in which the existing landfill cells were developed. Groundwater within the unconsolidated deposits on the southern portion of the site also exhibits a south-southwest flow direction. Where nested wells were installed, an upward vertical

hydraulic gradient was evident between the shallow weathered bedrock and the overlying unconsolidated deposits, which is likely attributable to the significant hydraulic gradient from the sloping terrain on the northern portion of the site. On the basis of the lithological logs and water level observations, it is considered that the weathered bedrock groundwater system is semi-confined beneath the unconsolidated deposits, but there is likely to be a degree of hydraulic connectivity between the systems.

Hydraulic testing of wells completed within both the shallow weathered bedrock and in the unconsolidated deposits indicated hydraulic conductivity values on the order of 10^{-5} to 10^{-6} m/s, which is consistent with the range of published values for the lithologies encountered.

2.11 Geology and Soil

Based on the 1:100,000 geological map 'Wollongong-Port Hacking', the WGRRP is on the boundary of two major geological formations. The southern part of the site is underlain by alluvial sands, silts and clays associated with Dapto Creek and sandstone of the Budgong Sandstone formation underlies these alluvial soils. The central part of the site is underlain by red, brown and grey lithic sandstone that forms part of the Budgong Sandstone formation. The northern portion of the site is underlain by interbedded lithic sandstone, coal, carbonaceous claystone, siltstone and claystone of the Pheasants Nest Formation. It appears that the Pheasants Nest formation is mainly encountered on the ridgelines.

The EIS (1982) indicates that prior to land-filling, volcanic sandstone covered most of the site with a transition to andesitic sandstone with coal seams, carbonaceous shale and mudstone in the higher section (above approximately RL 100 mAHD) and a zone of alluvium, gravels and sands in the lower sections (below approximately RL 30 mAHD). Bedrock is reported to appear at the surface in the upper sections of the site. The EIS (1992) for the Eastern Gully also notes that a relatively thick layer of colluvium was found along the base of the Eastern Gully.

The "Geology and Natural Slope Stability Zones in the City of Greater Wollongong, Figure 19, Sheets 1 and 2" (Rec. Geol. Surv. NSW, 14(2): Bowman) characterise the upper natural slopes as "moderately unstable, generally topographically high-relief land underlain by potentially unstable material requiring thorough investigation before development" and the site area at the toe of the natural slopes as "stable land with no landslip problems."

Historical photographs taken from ground-level in the eastern gully at a time before landfill development have been provided to Golder by Council. The appearance of the surface topography and conditions in these photographs is generally consistent with the presence of colluvium and potentially perched groundwater levels within the gully slopes. We understand that colluvium was to be stripped from natural slopes prior to construction of landfill, but note that some materials could remain close to the toe of the natural slopes in the central and northern portions of the site.

3.0 GEOTECHNICAL INVESTIGATION METHODOLOGY

The geotechnical investigation was carried out in two mobilisations between 18 June and 15 August and 14 December and 16 December respectively, at the investigation locations shown on Figure 4. The investigation locations were selected following review of previous stages of work, outlined in reports listed in Section 2.5.

3.1 Underground Services Location

Prior to commencement of fieldwork, Dial Before You Dig buried services plans were obtained. An accredited service locator was engaged by Golder to identify the presence of underground services across the site. No buried services were identified in the vicinity of planned test locations.

3.2 Borehole Drilling – Cored Boreholes and Monitoring Wells

Seven cored boreholes and thirteen groundwater monitoring wells were drilled using a track-mounted drilling rig. The boreholes were advanced through upper soil materials to practical refusal using solid flight augers fitted with a tungsten-carbide (TC) or V-shaped bit. Drilling was then continued into bedrock using HQ3 diamond coring techniques, producing 61 mm diameter rock core, with the exception of monitoring wells GMW101 and GMW108 which were cored using NMLC methods (52mm core diameter). Wash-bore drilling techniques were utilised to advance borehole GMW109 below the water table to top of rock. Drilling fluid comprised water only, that is, no artificial polymers were added during the drilling process. This was done to allow for development of the wells following completion of drilling. The borehole drilling operations were supervised by a Golder geotechnical engineer.

Standard Penetration Tests (SPTs) were carried out at regular intervals in the soil. Soil samples were collected from SPTs and auger cuttings. Rock core was placed in core trays, photographed, and Point Load Strength Index tests were carried out at approximately 1.5 metre intervals to assess the intact strength of the rock. Rock core photography and point load testing were carried out as soon as practicable following recovery of the core.

Three additional boreholes were drilled during a second mobilisation in December 2011. The boreholes were drilled using a track-mounted drilling rig and advanced through upper soil materials to practical refusal using solid flight augers fitted with a tungsten-carbide (TC) bit. Standard Penetration Tests (SPTs) and undisturbed tube samples (U75) were carried out at regular intervals in the soil to collect representative soil samples. A shallow groundwater monitoring well was installed in each of the three boreholes with screening from 8 mbegl to 1.5 mbegl.

Groundwater monitoring wells were installed in all boreholes on completion of drilling and water levels monitored throughout the period of investigation. Refer to Golder 2012c and Golder 2012r for details of monitoring well installation and results.

3.3 Test Pitting

Fifty two test pits were excavated using a 20 tonne excavator. Test pits carried out in the borrow pit areas were advanced to practical bucket refusal on weathered rock or to a maximum depth of 2 m. Test pits undertaken within the existing landfill areas were advanced to investigate the extent of the existing landfill cap.

Bulk disturbed samples were obtained where clayey materials were encountered from test pits undertaken within the borrow areas.

Where test pits were undertaken within the existing landfill areas, representative samples of the capping fill materials were collected.

At the completion of excavation, the depth of all test pits was measured, the test pits were photographed and then backfilled with cuttings, tamped and tracked over by the excavator. The operations were supervised by a Golder engineer.

3.4 Hand Auger Holes

Seventeen hand auger holes were carried out across the landfill cap and potential borrow areas wherever excavator access proved difficult. Hand auger holes undertaken within the potential borrow areas were advanced to practical refusal or to a maximum depth of 1.8m. Hand auger holes undertaken within the existing landfill areas were advanced until waste was encountered.

3.5 Survey Locations

The investigations locations undertaken during the first mobilisation, and their ground surface elevations were surveyed following completion. Coordinates were also recorded by Golder personnel using a hand held GPS. Survey coordinates (in GDA94) and reduced levels (Australian Height Datum, AHD) are shown on the investigation reports presented in Appendix A.

Survey for the investigation locations for Variation #4 will be undertaken at a later date and the results presented in a separate memorandum.

3.6 Geotechnical Laboratory Testing

A select number of soil samples were collected and sent to NATA accredited laboratories for analysis. Samples were chosen to obtain a reasonable geographic distribution across the site as well as representation of the various subsurface materials encountered in both the existing capping and borrow pit areas. Soils potentially suitable for re-use for landfill construction and/or operation were targeted for testing.

Laboratory testing was also carried out for the Maunsell 1992 and Douglas 2009 investigations and the amount of testing carried out for all these stages of work are summarised in Table 1.

Table 1: Summary of Geotechnical Laboratory Testing

Geotechnical Laboratory Tests	Testing Quantities				
	Golder 2011			Douglas Partners 2009	Maunsell 1992
	New Cell Floor	Existing Capping Area	Borrow Pit Areas	Existing Capping Area	
Atterberg Limits including Linear Shrinkage	5	5	8	10	64
Particle Size Distribution	-	5	8	-	64
Moisture Content	5	5	8	10	63
Moisture Density Relationship	-	5	7	-	-
Coefficient of Permeability	-	5	5	-	-
Compaction Tests	-	-	-	5	4
Falling Head Permeability	-	-	-	5	-
Emerson Class Number	-	5	8	-	-
Oedometer	5	-	-	-	-
Slake Durability	-	-	1	-	-
UCS	-	-	-	-	59

Laboratory Certificates and Summary tables of the results of the testing are provided in Appendix B.

4.0 RESULTS OF GEOTECHNICAL INVESTIGATION

4.1 General Field Observations

Rain showers occurred on at least part of the day from the 18 to 29 June and mostly fine conditions prevailed from 30 June to the end of the investigation on 15 August 2011.

Heavy rain occurred in week prior to second mobilisation with mostly fine conditions from the 12 December to the end of the investigation on 16 December 2011.

4.1.1 Existing Landfill Cap

The landfill area was undulating with terracing evident across the both the Eastern and Western Gully landfills. The terracing on the Eastern Gully landfill was more pronounced and restricted access for excavation equipment. General waste was observed outcropping at isolated locations.

The thickness of the capping observed by Golder (2011) ranged from 0.3 m (in TP42) to 2.5m (in TP40) across the Western Gully Landfill and 0.1 m (GAHA04) to 0.6 m (GAHA01) across the Eastern Gully. The thickness of the existing cap was also assessed in the Douglas 2009 report and ranged from 0.55 m to 2.0 m.

4.1.2 New Cell Floor Area

The new cell floor area currently consists of two distinct levels:

- The northern 'upper level' comprising old Reddalls Road and old surface water and leachate ponds. Amenities and lunch room to the east, and
- Lower lying grassed area

4.1.3 Potential Borrow Pit Areas

The location of the potential borrow pits is shown on Figure 2. The potential borrow pits are described as follows:

- Central Ridge Pit: Consists of sloping hills with thickly vegetated surface
- Western Ridge Pit: Sloping and vegetated
- Inside Hairpin Pit: Sloping and thickly vegetated.
- Lower Hairpin Pit Sloping and vegetated

4.2 Subsurface Conditions

The results of the investigation carried out by Golder (2011), as well as information obtained from previous investigations were used to compile an inferred subsurface profile.

Prior to land-filling, volcanic sandstone covered most of the site with a transition to andesitic sandstone with coal seams, carbonaceous shale and mudstone in the higher section (above approximately RL 100 mAHD). However for simplicity and consistency with previous phases of work, we have used the terminology of "Sandstone" and "Siltstone" to represent the rock types across the site.

We have inferred that subsurface conditions generally consist of fill, colluvial / alluvial soils, residual soil and sandstone and siltstone rock. The thickness of the different units varies throughout the site. Our inferred summary of the Subsurface Units are given in Table 2. Geological Sections indicating inferred Unit thickness and depths are provided in Figures 5 to 8.

Table 2: Summary of Generalised Subsurface Conditions

Unit	Description
Unit 41: FILL	Fill was encountered in zones of the proposed new cell floor (up to about 1.2 m deep) and generally comprised clayey soils with some sands. Fill in the existing landfill cap is mixed soils (clays and sands) with pockets of gravels, slag and coal-wash. Landfill including plastic and rubble is present beneath the capping material.
Unit 42: COLLUVIAL / ALLUVIAL SOILS	Mostly silty clay and clay with zones of sands and gravels and traces of cobbles. Soils in the upper 2 m to 3 m are soft to firm in parts and strength improves with depth. Distinction between the colluvial soils on the lower slopes and the alluvial soils at the very bottom of the slopes is often difficult. From an engineering perspective the soils are of similar consistency and, for the purposes of this report, can both be included within Unit 42.
Unit 43: RESIDUAL SOIL and Extremely Weathered ROCK	Mostly clay with varying quantities of gravel, silt and sand. Clay is medium plasticity and generally stiff to very stiff with zones of medium dense to dense sand. Extremely weathered rock is extremely low to very low strength, typically sandstone with some siltstone and can be remoulded into a soil by hand.
Unit 44: Weathered SANDSTONE	Fine to medium grained, brown, low to medium strength, highly weathered to moderately weathered, with some iron stained jointing, jointing frequency typically 100mm to 300mm.
Unit 45: Fresh SANDSTONE	Fine to medium grained, grey, medium to high strength, generally slightly weathered to fresh, fracture spacing typically between 300mm to 1m.
Unit 46: Weathered SILTSTONE	Light brown, very low strength to low strength, highly weathered to moderately weathered, some zones interbedded with sandstone
Unit 47: Fresh SILTSTONE	Grey, low to medium strength, slightly weathered to fresh, encountered sparsely throughout the site

To generalise the geological conditions, the site has been broken up into four different areas. Inferred boundaries for these are shown in Figure 9 and are described below:

Geological Area 1 – Pheasants Nest Formation: This area is located on the upper slopes across the northern portion the site. Residual soils (Unit 43) are generally less than 2m thick overlying weathered sandstone (Unit 44), which grades into fresh sandstone (Unit 45) at depths typically less than 10m. Maunsell (1992) observed zones of siltstone (Units 5a and 5b) greater than about 15 m depth, but these were not observed in Golder 2011.

Geological Area 2 – Budgong Sandstone Formation: This area is located across the southern portion of the site. This sandstone generally has a weathering profile (Unit 44) that extends to depths up to 15m. Zones of weathered siltstone (Unit 46), up to approximately 3m thick, are located intermittently throughout this formation.

Geological Area 3 – Colluvial / Alluvial Soils: This geological area consists of Unit 42 material and is located across the southern portion of the site. The thickness of this material varies to a maximum of approximately 11m. This geological area is expected to be underlain by Budgong Sandstone. Based on the existing geological information it is difficult to assess the nature of these soils. However, colluvial soils are more likely to be located close to and below the toe of the natural slopes (pre-landfilling), and alluvial soils at the very bottom and beyond the toe of the slopes.

Geological Area 4 – Capping Layer and Landfill: This geological area is located across the northern slope. The capping material consists of generally variable clays and sands. Landfill waste is located beneath the capping layer and consists of general waste such as paper, plastic, wood, rubble and other materials. The depth to the base of the general waste fill is not well defined, however old topographical data suggests that the thickness of the fill could be up to 65 m. This geological area is expected to be underlain by the Pheasants Nest Formation.

4.3 Geotechnical Laboratory Testing Results

Laboratory Test Certificates and summary tables of the results of testing are provided in Appendices B and C.

4.3.1 Existing Landfill Cap

The results of the geotechnical analysis indicate variable composition of the materials throughout the existing cap. The plasticity of the clays encountered range from low to high plasticity and the quantity of sand and clay vary throughout, with more clay present across the Western Gully Landfill than the Eastern. Laboratory permeability test results are in the order of 10^{-9} to 10^{-10} m/s. The permeability results provided are for laboratory compacted samples and it is noted that these permeability values would be expected to be an order of magnitude lower than the permeability achievable during construction.

The majority of samples have Emerson Class Numbers indicating the soils have the potential for moderate dispersive behaviour. It should be noted that when remoulded for construction purposes, soils with Emerson Class Numbers of 3, as encountered here, are generally considered to have a moderate to high potential for dispersive behaviour.

4.3.2 Potential Borrow Pit Areas

The results of the geotechnical analysis indicate variable composition of the materials throughout the potential borrow areas. The samples tested are distributed across the four proposed borrow pit areas described earlier.

The soil samples tested indicate generally low to high plasticity clayey soils and laboratory permeability test results are in the order of 10^{-9} to 10^{-10} m/s. The laboratory permeability results would be expected to be an order of magnitude lower than that achievable during construction.

The soil samples have Emerson Class Numbers indicating the soils have the potential for moderate dispersive behaviour, however may have a moderate to high potential for dispersive behaviour when remoulded.

The result of the slake durability test carried out on a sample of moderate to slightly weathered sandstone, located close to the Lower Hairpin borrow pit, indicates the sandstone rock is likely to be highly durable.

Rock Testing

Point load testing was carried out on suitable rock core samples for the Golder 2011 and Maunsell 1992 investigations. The point load results for the Golder 2011 investigation are summarised in Appendix C. The results of the point load testing indicate that rock strength varies from extremely low to high to very high strength. The point load test results generally give a higher axial load than diametric load which indicates a weaker plane which is likely associated with the bedding of the rock.

Uniaxial Compressive Strength (UCS) tests were carried out on rock core samples for the Maunsell 1992 investigation. The results of these tests indicate that the rock strength varies from low to high strength and an indicative correlation between UCS and point loads was presented by Maunsell 1992 as UCS = 20 $I_{s\ axial}$. The results of the UCS tests are summarised in Appendix C.

5.0 DISCUSSION OF GEOTECHNICAL INVESTIGATION RESULTS

The proposed development involves extending the existing landfill to the south. The new landfill cell is proposed to "piggy-back" the existing landfill and extends across the colluvial / alluvial soils in Geological Area 3. Potential borrow pits have been identified in areas around the proposed landfill to source material for construction purposes.

Potential geotechnical issues are identified below and are based on the results of the Golders 2011 investigation as well as previous investigations by others. The types of analyses that will likely be required to consider these issues are also identified.

5.1 New Landfill Cell

The proposed extension will "piggy-back" the existing landfill and extend across compressible colluvial / alluvial soils. This has the potential to result in total and differential settlements across the new landfill liner and cap. Additionally, stability of the newly formed landfill slopes may need to be managed carefully.

5.1.1 Settlement and Compressibility

Total and differential settlements of the proposed landfill will need to be assessed. This assessment will need to consider the variable foundation conditions for the proposed cell (i.e. the existing waste cells and colluvial / alluvial soils) and the potential short-term impacts associated with a temporary increase in elevation of groundwater.

The settlement assessment should consider the magnitude of short and long term settlements and their potential impact on the development of the new landfill, particularly under the final capped cell arrangement. The influence of groundwater levels, both current and potential future levels, on longer-term compressible soils should be considered. One-dimensional consolidation theories could be used to provide a clearer understanding of the likely settlement behaviours of, and impacts on, the proposed cell as it is filled over time. Where required, two-dimensional numerical modelling may be used to assess potential deformations across the piggy-back cell liner due to the variable nature of waste materials.

Relevant design parameters for the soils and waste materials should be developed based on the results of investigations completed to date and experience with similar types of materials.

Additionally, a loading trial will likely be required to provide further support in development of design parameters for the existing waste material.

5.1.2 Slope Stability

Stability of the proposed landfill extension will need to be assessed at varying stages of development of the cell. The stability analyses should consider the shear strengths of the existing waste and cell construction materials and the underlying natural materials including colluvial, alluvial and residual soils. Design cases should be assessed accounting for the increasing load placed across the existing slopes and foundation soils as the new cell develops over time, with consideration to variable groundwater levels and seismic conditions. Particular attention should be given to the interface behaviour between the existing capped landfill cell and the proposed extension where a piggy-back liner system will be constructed.

Relevant design parameters for the soils and waste materials should be developed based on the results of investigations completed to date and our experience with similar types of materials.

5.1.3 Site Preparation

Prior to placement of materials required to construct the new landfill cell, all vegetation and topsoil should be stripped from the existing landfill (top of the capping layer) and the proposed cell extension footprint (proposed cell floor).

Following site stripping, the existing landfill cap will be regraded to provide a suitable foundation for the piggy back liner. Consideration will be given to temporary stability of the slope during these works.

The proposed new cell floor is generally across the colluvial / alluvial soils of Geological Area 3 and comprises silty, sandy and gravelly clays with zones of clayey sands. Most of the clays tested are medium plasticity with varying amounts of sands and silts present. Laboratory permeability of these soils is expected to be variable and in the order of 10^{-8} to 10^{-9} m/s. High groundwater is expected within the colluvial / alluvial soils so any proposed excavations to establish cell floor grades may need to be limited in depth.

Chart 1 shows the results of Atterberg classification testing on existing capping soils. Most of the results are on soils sampled from the Western Gully landfill cap and are expected to be mixed composition but predominantly clayey. The laboratory results indicate that these capping soils are likely to have a moderate to high potential for dispersive behaviour and permeabilities in the order of order of 10^{-9} to 10^{-10} m/s.

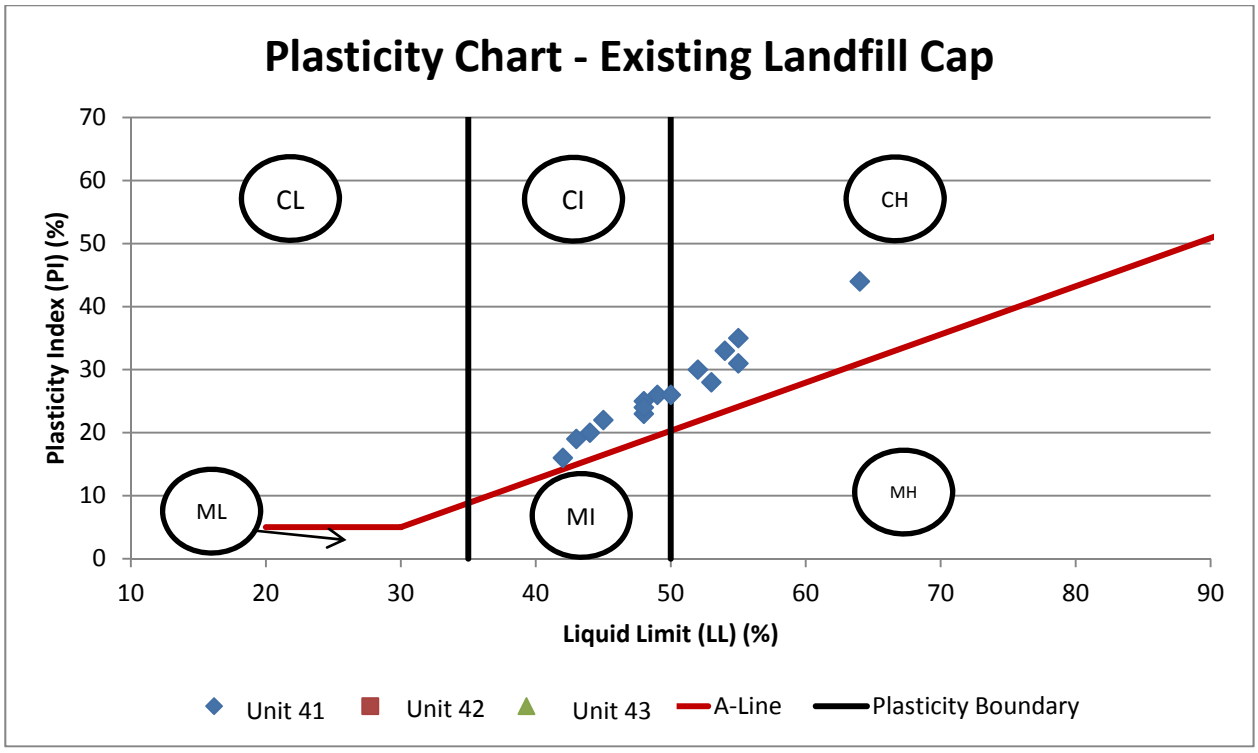


Chart 1: Existing Landfill Cap - Plasticity Chart

Zones of slag and coal wash materials were also observed across both the Eastern and Western Gully Landfill areas.

Although the range of thicknesses of the capping material across the Western Gully Landfill varied between 0.6 m and 2.5 m, it was generally between about 0.5 m and 1.5 m thick. The relatively flat slopes of the Western Gully landfill are in the order of 20%; however the clayey nature of the materials may result in difficult traffic conditions following periods of rainfall.

The capping materials across the Eastern Gully landfill are more variable in nature, generally comprising silty clays and clayey silts, with some zones of sands and gravels. Given the range of materials encountered and likely presence of slag materials in this area, we consider that the hand augers carried out may not be entirely representative of all the materials that might be present. The capping materials across the Eastern Gully landfill are also thinner than the west, with thicknesses generally less than 0.5 m and expected to be variable given the distinct terraced nature of the slopes. Reworking of this area may require more care during construction not to penetrate the cap and reveal the underlying waste materials.

Depending on the thickness of existing capping materials, they may be able to be reused for the proposed works.

Based on the expected materials within both the Western and Eastern Gully landfill caps, we expect that following rework, clean soils may need to be imported to provide material of suitable quality for construction of a structural bridging layer prior to construction of an overlying piggy-back liner system, or in some areas a final capping system.

5.1.4 Seismic Design

Slope stability assessments for the proposed extension to the landfill should consider seismic loading as a design loadcase, which should be applied in addition to the issues identified in Section 5.1.2. Depending on the type of soils present below the existing landfill, assessment of liquefaction potential may be required. From assessment of existing geological information the soils in the site area appear to be generally cohesive materials, which would tend to have a lower liquefaction potential than loose granular soils.

5.2 Potential Borrow Pit Areas

It is likely that materials sourced from elsewhere on site will be used for construction of some components of the proposed landfill cell, for cover materials used during landfill operations, or for general site fill. Four borrow areas across the site have been investigated, as indicated in Figure 2. Materials won from these borrow areas have been tested to assess their feasibility for reuse.

The potential for reuse of materials from the borrow areas depends on their properties including their composition, permeability, particle size distribution and dispersive potential. The results of laboratory testing and on site observations are used to carry out assessment.

A preliminary assessment of each of the Geotechnical Units is provided below. Chart 2 shows a distribution of Atterberg Limits for soil materials (i.e. Geotechnical Units 41 to 43) likely to be won from borrow areas.

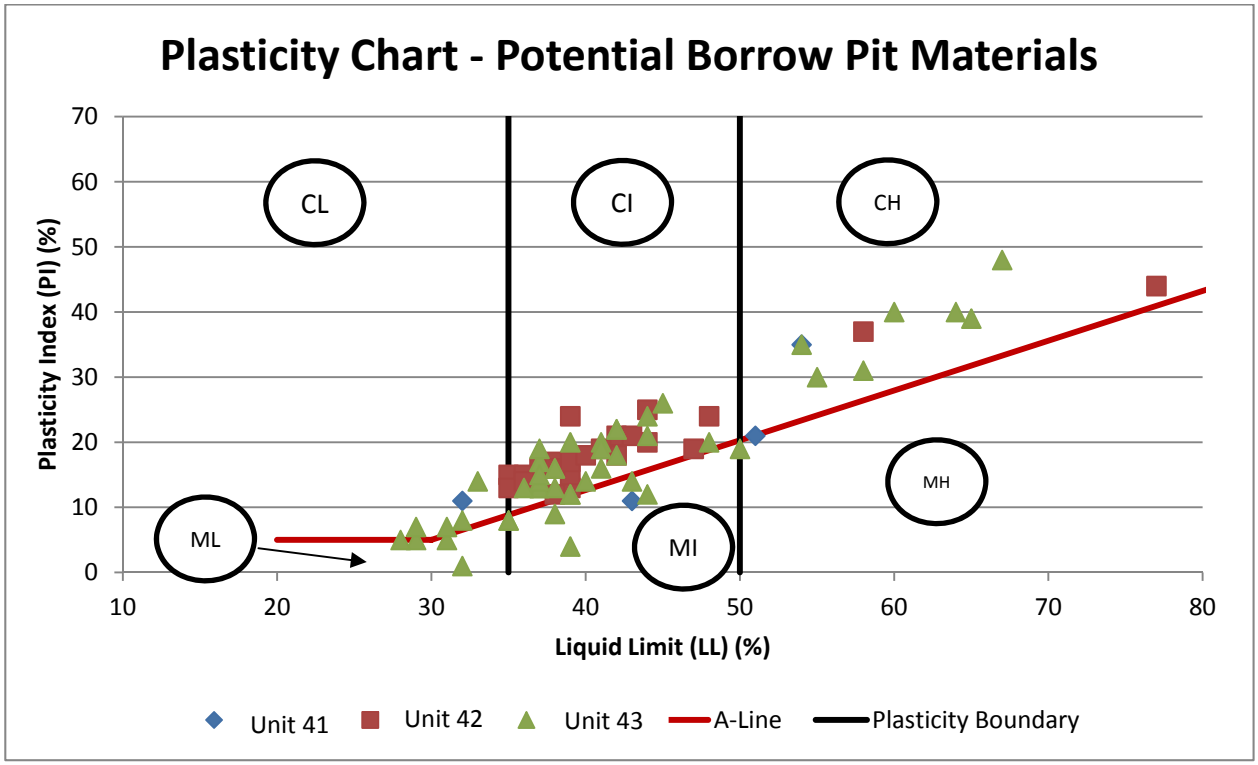


Chart 2: Potential Borrow Pit Area - Plasticity Chart

The materials likely to be won from borrow areas and their potential for reuse are described below.

- Unit 41 – Fill: Only minor fill was encountered across the borrow pit areas. Due to the variable and uncontrolled nature of fill materials, it is likely that if encountered, they will only be able to be reused as

general fill. These materials are likely to able to be excavated using conventional hydraulic excavation equipment.

Topsoil was encountered in areas and is generally in the order of 200 mm to 300 mm thick, high in silt content and organic material and should be stripped and stockpiled for later use.

- Unit 42 – Colluvial / Alluvial Soils: Limited amounts of these materials may be encountered in the Lower Hairpin Borrow Area. The materials are generally medium plasticity clay with some zones of silts, sands and gravels. Due to the variable nature of these materials it is unlikely that they are suitable for use in low-permeability components of the landfill liner or cap, however they may be able to be used as general fill or cover material. These materials are likely to able to be excavated using conventional hydraulic excavation equipment, however due to the high groundwater table in these areas; target excavation depths are likely to be limited.

- Unit 43 – Residual soil/extremely weathered rock: These materials were encountered across all of the currently proposed borrow areas. The thickness of this Unit is generally less than 1 m in the Lower Hairpin, less than 0.5 m in the Western Ridge and less than 2 m in the Inside Hairpin. Across the Central Ridge, this Unit is likely to be in the order of 1 to 3m thick. These materials are likely to able to be excavated using conventional hydraulic excavation equipment fitted with toothed buckets.

  The residual soil and extremely weathered rock (which can be remoulded to a soil by hand) is generally low to medium plasticity with some areas of higher plasticity. There is variable sand content through the material. The remoulded material is moderate to highly dispersive and has laboratory permeabilities in the order of 10^{-9} to 10^{-10} m/s. Due to the variable composition of the material it is likely to be capable to be reused as general fill or as cover material.

  Groundwater is expected to be beneath the residual soil profile.

- Units 44, 45, 46 and 47 – Weathered and Fresh Rocks: The rock profiles in the potential borrow areas indicate variable composition, weathering and strength. Based on the likely excavatability and resulting rock mixture, it is likely that these Units may be suitable for use as general fill, or possibly as structural fill if processed to remove large particles. The weathered rocks will likely be able to excavated using excavators, which may need to be fitted with rock breakers in areas. The fresh rocks will likely require rock breakers and dozers fitted with ripping tynes. Alternatively, rock saws may be able to be used.

  Groundwater could be expected to be encountered between 5 m and 10 m in the weathered rock profile.

Borrow materials will be considered further in the *Materials Feasibility Assessment - Borrow Areas* (ref: 117625003_152_R_RevA, dated March 2012) (Golder 2012s) to be issued for the Project.

6.0 ADDITIONAL REFERENCES

Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) *Australia and New Zealand Guidelines for Fresh and Marine Waters.* ANZECC, Canberra

Victoria (2010) *Best Practice Environmental Management Siting, Design, Operation and Rehabilitation of Landfills*, Publication 788.1, EPA Victoria, Carlton.

Standards Australia 2002, *Australian Standard Earth-retaining Structures (*AS 4678 -2002), Standards Australia, Sydney.

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Report Signature Page



Bernie Francis
Principal Geotechnical Engineer



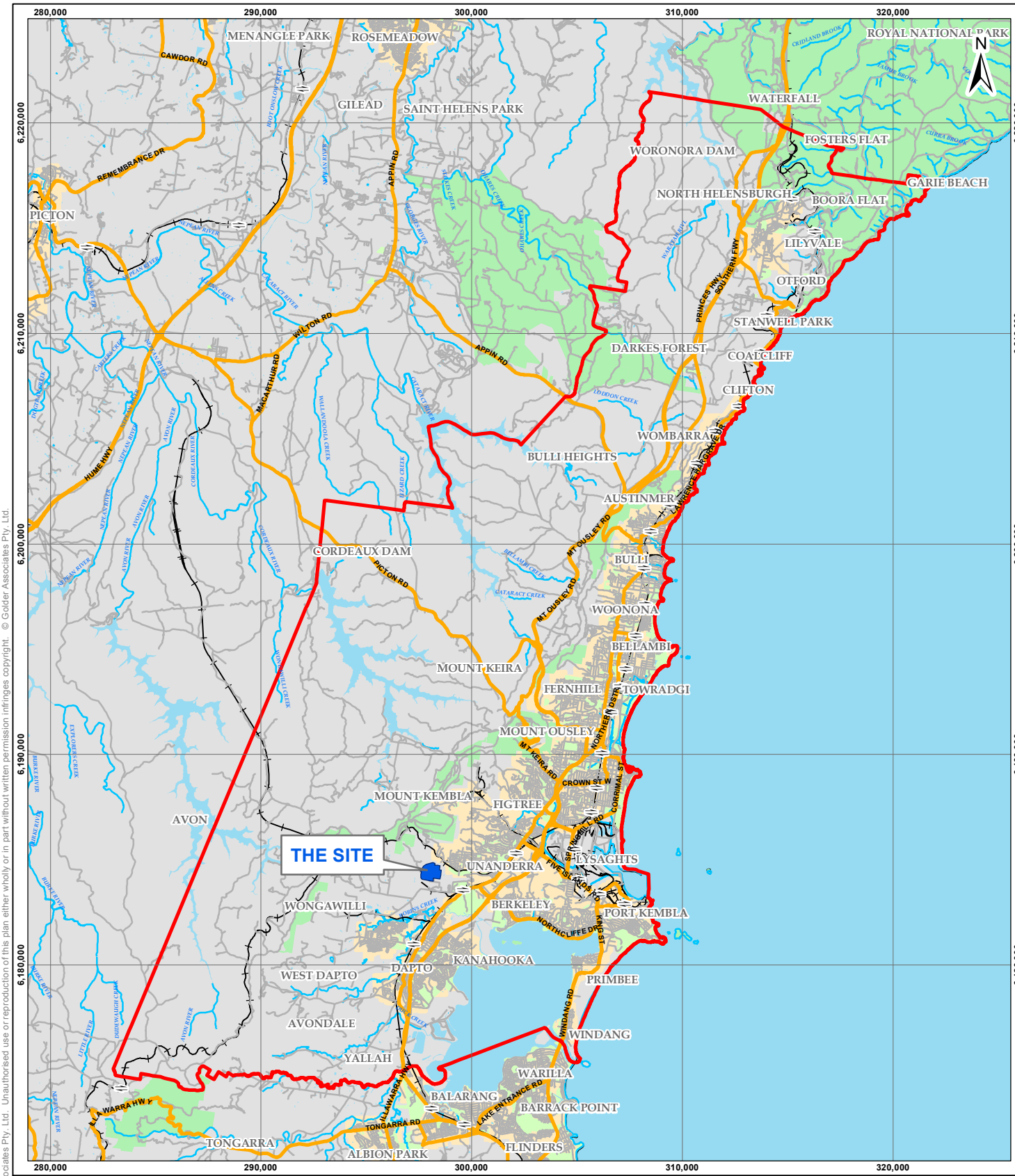
Jacinta McMahon
Project Manager

BC/BJF/bc

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https://aupws.golder.com/117625003wollongongcitycouncilnewcellwhytesgully/project doc/203 a geotechnical study/report/final report - rev1 - mar 2012/117625003_r_077_rev1_geotechnical investigation report final.docx



GEOTECHNICAL INVESTIGATION REPORT

Wollongong City Council

REGIONAL AREA



LEGEND

- Site Location
- Wollongong Local Government Area Boundary

0 1 2 4 6 8 Kilometres

SCALE (at A4) 1:250,000

Coordinate System: GDA 1994 MGA Zone 56

PROJECT: 117625003
DATE: 5/12/2011
DRAWN: AJW
CHECKED: BJF

FIGURE 1

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298,000



6,184,000

298,000

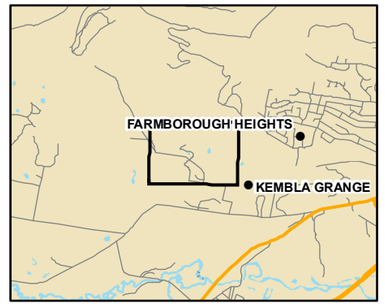
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WHYTES GULLY NEW LANDFILL CELL GEOTECHNICAL INVESTIGATION REPORT

WOLLONGONG CITY COUNCIL

SITE LAYOUT



LEGEND

- Site Boundary
- Approximate Extent Of Waste
- Final Landfill Footprint
- Extraction Zones (December, 2011)

NOTES

Historic locations digitised by Golder from reports supplied by Wollongong City Council

Aerial Ortho-Photograph provided by AAM Pty. Ltd. taken on 16 May 2011, Reference 18763A. Image Georeferenced.

0 12.5 25 50 75 100 125 metres

SCALE (at A3) 1:3,800

Coordinate System: GDA 1994 MGA Zone 56

PROJECT: **117625003**
DATE: **9/01/2012**
DRAWN: **FA**
CHECKED: **BJF**

FIGURE 2

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298,000

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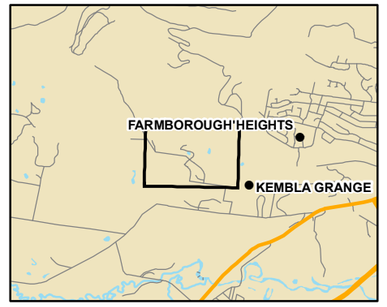
Historic locations digitised by Golder from reports supplied by Wollongong City Council

Aerial Ortho-Photograph provided by AAM Pty. Ltd. taken on 16 May 2011, Reference 18763A. Image Georeferenced.

WHYTES GULLY NEW LANDFILL CELL GEOTECHNICAL INVESTIGATION REPORT

WOLLONGONG CITY COUNCIL

HISTORICAL SITE INVESTIGATION LOCATIONS



LEGEND

- Monitoring Well Location
- Monitoring Well Installed 2009 (Wollongong City Council, 2009 Ref W9872 & W10441)
- Test Pit Location Preliminary Geotechical Investigation of Possible Waste Disposal Depot at Whytes Gully (Golder, 1981)
- Test Pit Location Preliminary Geotechnical Investigation Proposed Leachate/Stormwater Ponds (Coffey, 2001)
- Test Pit Locaiton Geotechnical Assessment - Proposed Extenstion to Whytes Gully Waste Disposal Depot (WCC, 1991 Ref W5142 & W5276)
- Investigation Location Estimated from WCC, 2010 Ref 10338
- Borehole Location Geotechnical Assessment - Proposed Extenstion to Whytes Gully Waste Disposal Depot (WCC, 1991 Ref W5142 & W5276)
- Borehole Location, 2003 Ref DES57300 (Wollongong City Council, May 2010 ref W10393)
- Borehole Location April 2005 Ref DES14150 (Wollongong City Council, April 2009 Ref W9872)
- Borehole Location (Douglas Partners, 2009)
- Borehole Location (Wollongong City Council, June 2010 Ref W10441 & W10338)
- Borehole Location New Cell Floor Geotechnical Investigation, 2010 (Wollongong City Council, June 2010 ref W10441 & W10338)
- Borrow Pit Geotechnical Investigation, 27 June 2010
- CPT Location (Douglas Partners, 2009)
- Site Boundary
- Final Landfill Footprint
- Approximate Extent Of Waste

0 15 30 60 90 120 150 metres

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Coordinate System: GDA 1994 MGA Zone 56

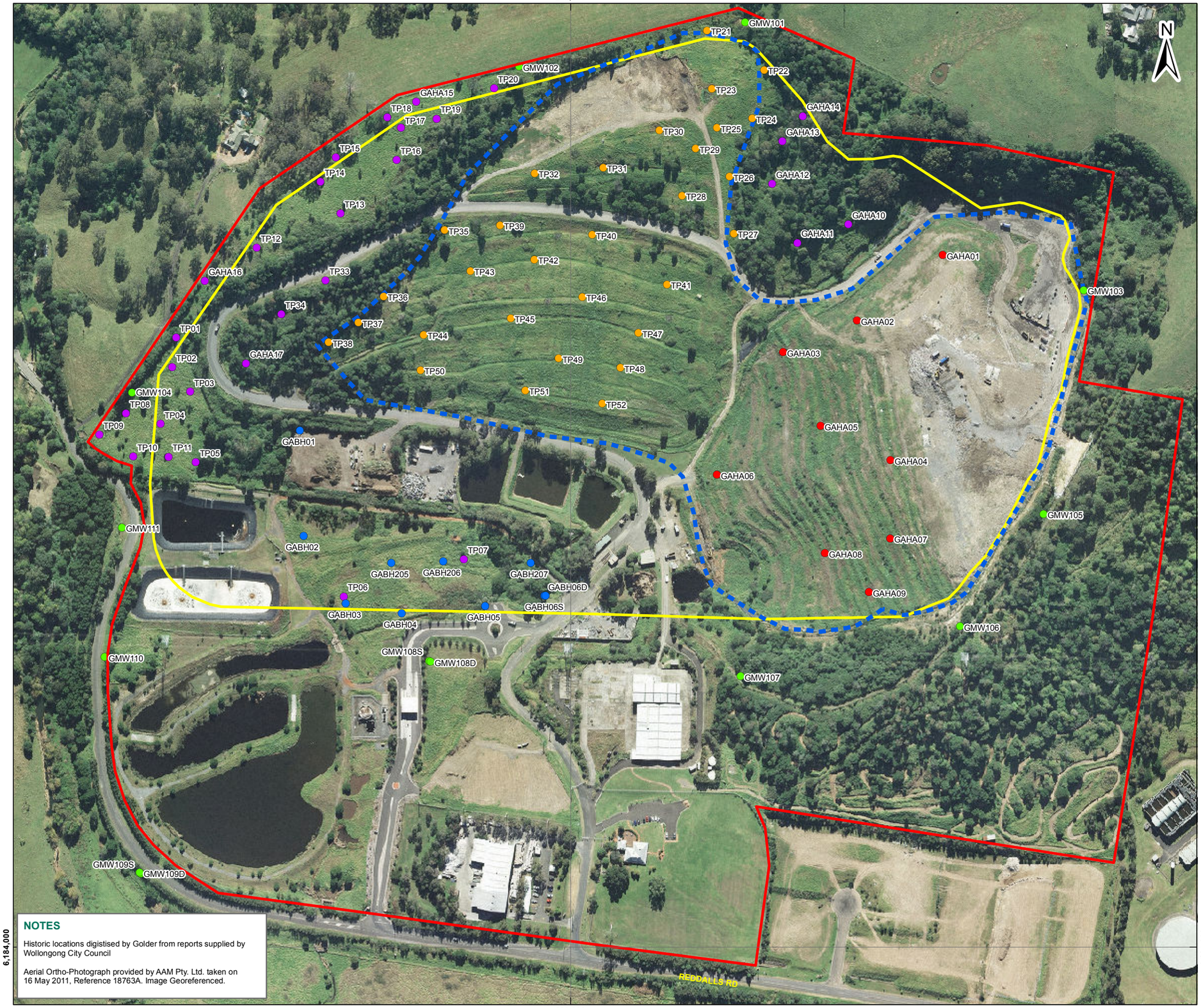
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FIGURE 3

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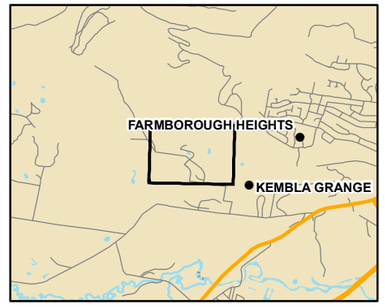
Historic locations digitised by Golder from reports supplied by Wollongong City Council

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WHYTES GULLY NEW LANDFILL CELL GEOTECHNICAL INVESTIGATION REPORT

WOLLONGONG CITY COUNCIL

CURRENT SITE INVESTIGATION LOCATIONS



LEGEND

- New Cell Floor Investigation Location and Monitoring Well
- Ground Water Monitoring Well
- Exisiting Capping Hand Auger Location
- Exisiting Capping Test Pit Location
- Borrow Pit Test Pit Hand Auger Investigation Location
- Site Boundary
- Final Landfill Footprint
- Approximate Extent Of Waste

0 12.5 25 50 75 100 125 metres

SCALE (at A3) 1:3,600

Coordinate System: GDA 1994 MGA Zone 56

PROJECT: 117625003
DATE: 6/03/2012
DRAWN: FA
CHECKED: BJF

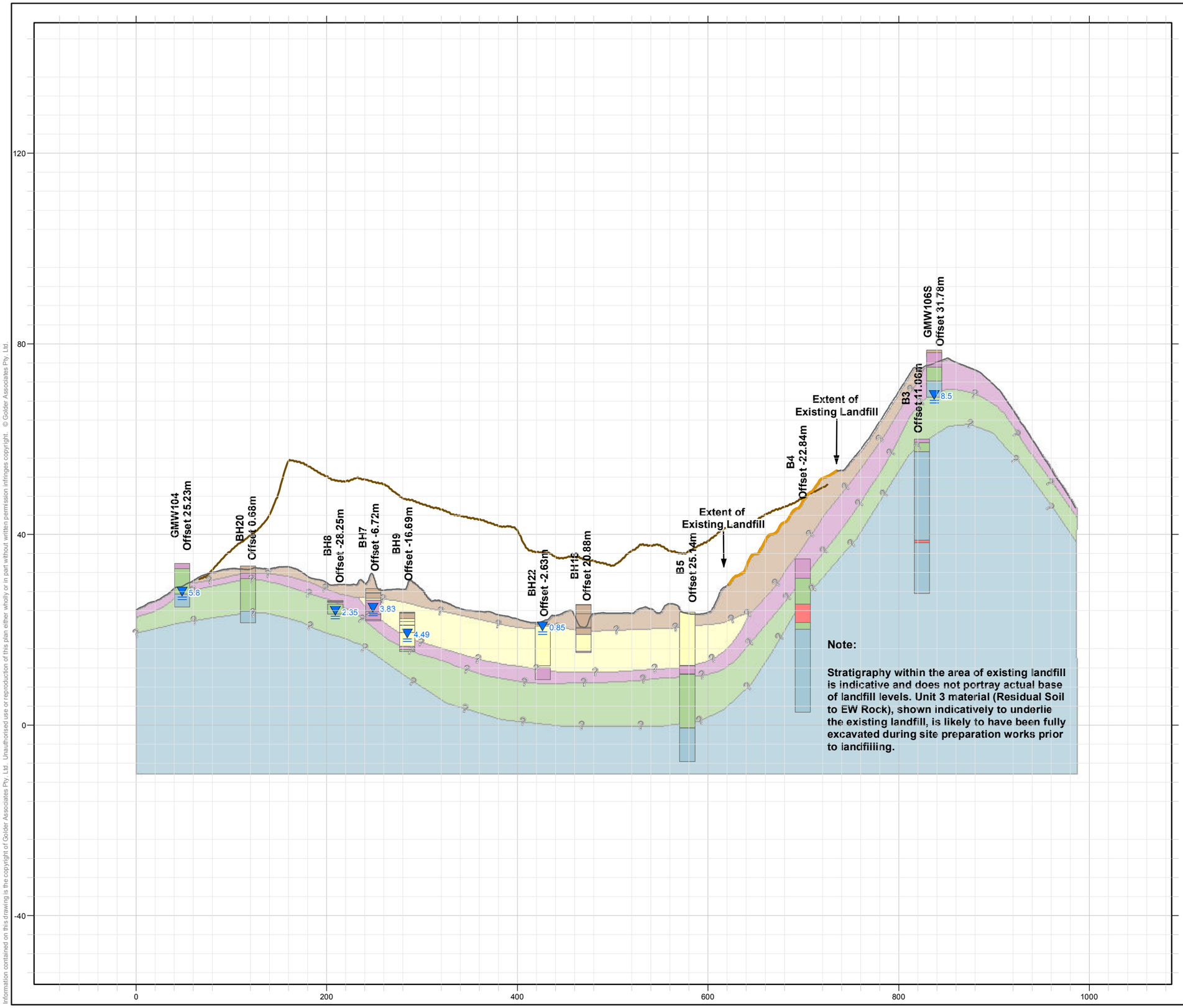
FIGURE 4

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WHYTES GULLY NEW LANDFILL CELL GEOTECHNICAL INVESTIGATION REPORT

WOLLONGONG CITY COUNCIL

SECTION A



Legend

- 5.8 Groundwater Depth (m)
- Unit 41 (Fill)
- Unit 42 (Colluvium/Alluvium)
- Unit 43 (Residual Soil to EW Rock)
- Unit 44 (HW to MW Sandstone)
- Unit 45 (SW to FR Sandstone)
- Unit 46 (HW to MW Siltstone)
- Unit 47 (SW to FR Siltstone)
- Approximate Design Surface (New Landfill Cell)

EW = Extremely Weathered
HW = Highly Weathered
MW = Moderately Weathered
SW = Slightly Weather
FR = Fresh

NOTES

Existing ground surface based on (survey by KF Williams) KF110290-SV01, dated 06/06/2011.

0 15 30 60 90 120 Metres

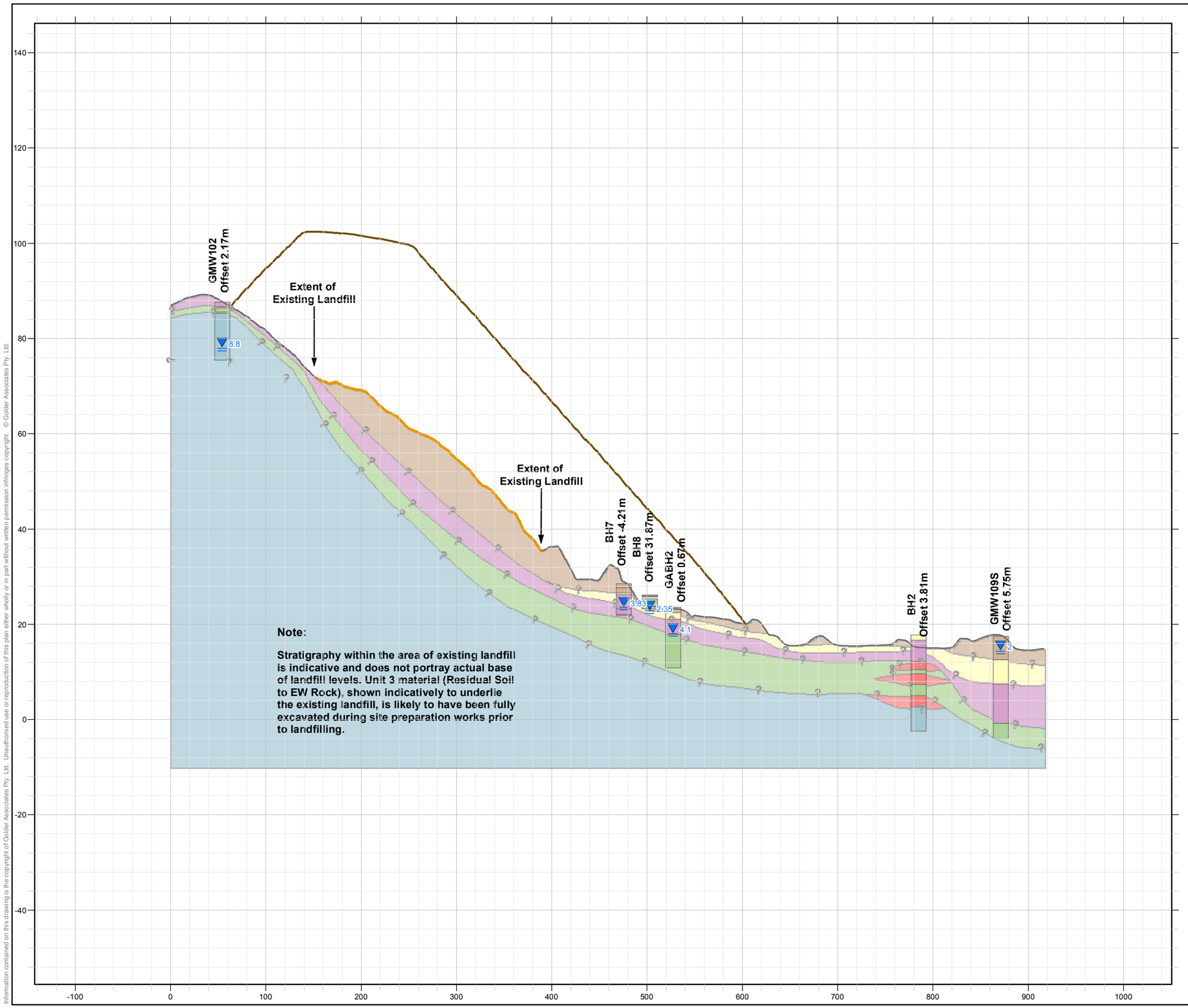
SCALE (at A3) 1:4,000
Vertical Exaggeration 1:5

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DATE: **5/03/2012**
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FIGURE 5

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File Location: J:\GIS\Jobs\117625003_Wollongong Council_New Landfill Cell_Whytes Gully\Workspaces\117625003_077_R_Rev1_F0005_SectionA.mxd



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WHYTES GULLY NEW LANDFILL CELL
GEOTECHNICAL INVESTIGATION REPORT

WOLLONGONG CITY COUNCIL

SECTION B



Legend

- 5.8 Groundwater Depth (m)
- Unit 41 (Fill)
- Unit 42 (Colluvium/Alluvium)
- Unit 43 (Residual Soil to EW Rock)
- Unit 44 (HW to MW Sandstone)
- Unit 45 (SW to FR Sandstone)
- Unit 46 (HW to MW Siltstone)
- Unit 47 (SW to FR Siltstone)
- Approximate Design Surface (New Landfill Cell)

EW = Extremely Weathered
HW = Highly Weathered
MW = Moderately Weathered
SW = Slightly Weather
FR = Fresh

NOTES

Existing ground surface based on (survey by KF Williams) KF110290-SV01, dated 06/06/2011.

0 15 30 60 90 120 Metres

SCALE (at A3) 1:4,000
Vertical Exaggeration 1:5

PROJECT: **117625003**
DATE: **5/03/2012**
DRAWN: **AJW/FA**
CHECKED: **BJF**

FIGURE 6

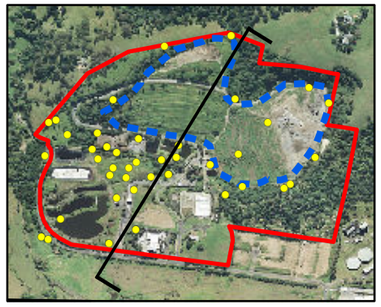
Golder Associates

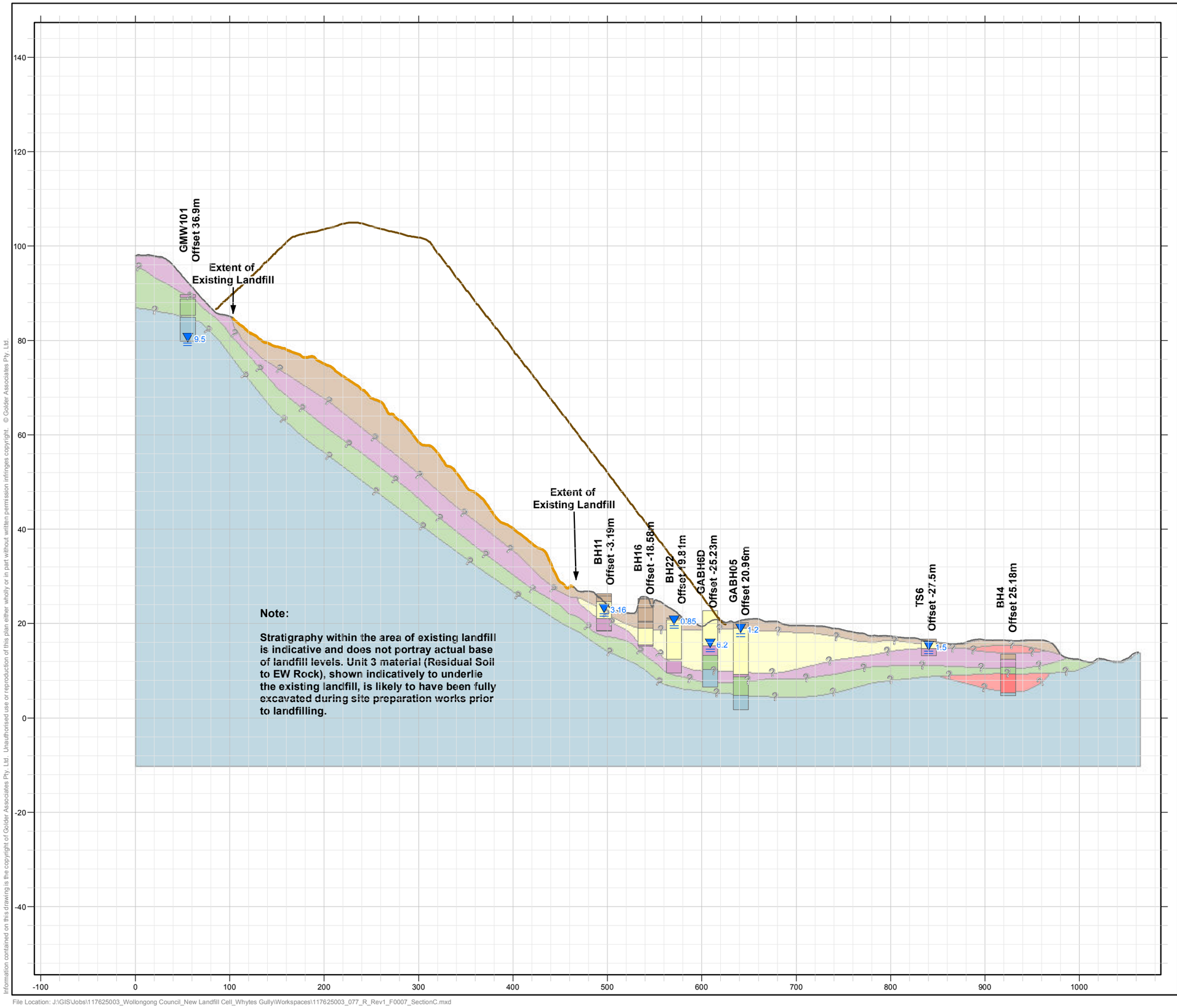
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WHYTES GULLY NEW LANDFILL CELL GEOTECHNICAL INVESTIGATION REPORT

WOLLONGONG CITY COUNCIL

SECTION C





Legend

- 5.8 Groundwater Depth (m)
- Unit 41 (Fill)
- Unit 42 (Colluvium/Alluvium)
- Unit 43 (Residual Soil to EW Rock)
- Unit 44 (HW to MW Sandstone)
- Unit 45 (SW to FR Sandstone)
- Unit 46 (HW to MW Siltstone)
- Unit 47 (SW to FR Siltstone)
- Approximate Design Surface (New Landfill Cell)

EW = Extremely Weathered
HW = Highly Weathered
MW = Moderately Weathered
SW = Slightly Weather
FR = Fresh

NOTES

Existing ground surface based on (survey by KF Williams) KF110290-SV01, dated 06/06/2011.

0 15 30 60 90 120 Metres

SCALE (at A3) 1:4,000
Vertical Exaggeration 1:5

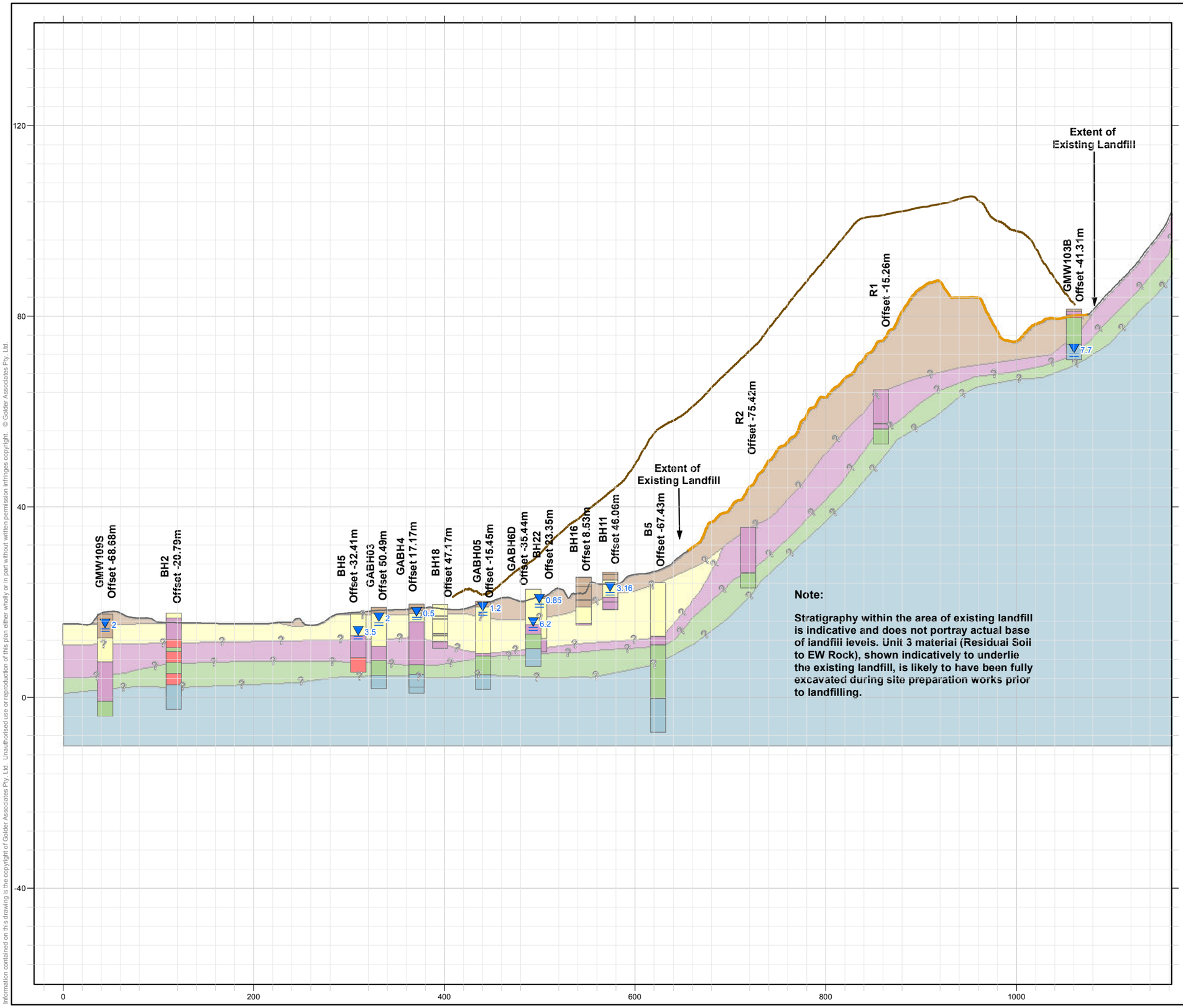
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DATE: **5/03/2012**
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FIGURE 7

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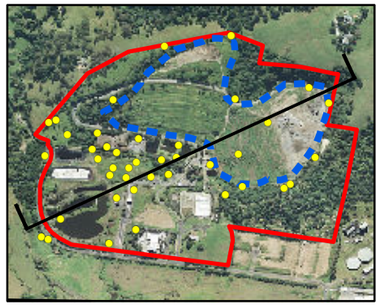


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WHYTES GULLY NEW LANDFILL CELL
GEOTECHNICAL INVESTIGATION REPORT

WOLLONGONG CITY COUNCIL

SECTION D



Legend

- 5.8 Groundwater Depth (m)
- Unit 41 (Fill)
- Unit 42 (Colluvium/Alluvium)
- Unit 43 (Residual Soil to EW Rock)
- Unit 44 (HW to MW Sandstone)
- Unit 45 (SW to FR Sandstone)
- Unit 46 (HW to MW Siltstone)
- Unit 47 (SW to FR Siltstone)
- Approximate Design Surface (New Landfill Cell)

EW = Extremely Weathered
HW = Highly Weathered
MW = Moderately Weathered
SW = Slightly Weather
FR = Fresh

NOTES

Existing ground surface based on (survey by KF Williams) KF110290-SV01, dated 06/06/2011.

0 15 30 60 90 120 Metres

SCALE (at A3) 1:4,000
Vertical Exaggeration 1:5

PROJECT: **117625003**
DATE: **5/03/2012**
DRAWN: **AJW/FA**
CHECKED: **BJF**

FIGURE 8

Golder Associates

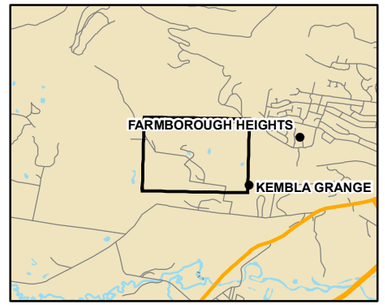
File Location: J:\GIS\Jobs\117625003_Wollongong Council_New Landfill Cell_Whytes Gully\Workspaces\117625003_077_R_Rev1_F0008_SectionD.mxd



WHYTES GULLY NEW LANDFILL CELL GEOTECHNICAL INVESTIGATION REPORT

WOLLONGONG CITY COUNCIL

GEOLOGICAL AREAS



LEGEND

- Site Boundary
- Approximate Extent Of Existing Landfill Boundary
- Extraction Zones (December, 2011)

Geological Area

- Area 1 - Pheasants Nest Formation
- Area 2 - Budgong Sandstone Formation
- Area 3 - Alluvial Soils
- Area 4 - Capping Layer and Landfill

NOTES

Historic locations digitised by Golder from reports supplied by Wollongong City Council

Aerial Ortho-Photograph provided by AAM Pty. Ltd. taken on 16 May 2011, Reference 18763A. Image Georeferenced.

0 15 30 60 90 120 150 metres

SCALE (at A3) 1:4,500

Coordinate System: GDA 1994 MGA Zone 56

PROJECT: **117625003**
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FIGURE 9

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APPENDIX A

Site Investigation Reports (Borehole, Groundwater Monitoring Holes, Test Pits and Hand Augers) and Explanatory Notes

Provided on DVD

APPENDIX B

Laboratory Test Certificates and Summary Tables

Provided on DVD

APPENDIX C

Point Load and UCS Test Results

Provided on DVD

APPENDIX G2

Preliminary Environmental Site Assessment (PESA)

June 2012
Report No. 117625003_159_R_Rev1

March 2012

WHYTES GULLY NEW LANDFILL CELL

Preliminary Environmental Site Assessment (PESA)

Submitted to:
Wollongong City Council

REPORT

Report Number. 117625003-046-R-Rev0

Distribution:

1 copy - Wollongong City Council (electronic)
1 copy - Golder Associates

Golder Associates

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1.0 INTRODUCTION

Golder Associates Pty Ltd (Golder Associates) was retained by Wollongong City Council (Council) to prepare a preliminary environmental site assessment (PESA) for Whytes Gully Resource Recovery Park (Whytes Gully RRP) (the "site") located at Reddalls Road, Kembla Grange, NSW, comprising:

- A desktop study comprising a review of historical documentation to assess historical and current uses of the site which could have resulted in soil and/or groundwater contamination; and
- Sampling of soil and groundwater in the proposed cell areas, leachate pond and stormwater pond locations to assess contamination due to historical landfilling activities.

The PESA was carried out by Golder Associates in accordance with our proposal P07625008-001-P-Rev0 (Tender Exhibit 5) dated 20 October 2010.

1.1 Objectives

The objectives of the PESA are to:

- Review historical information relevant to the site to determine the presence of past landfilling and associated activities at the site, which could have resulted in soil and/or groundwater contamination;
- Undertake a PESA to assess the presence of contamination in soil and groundwater; and
- Provide a PESA report detailing the historical activities and the results of the soil and groundwater investigations to enable further detailed investigations or the preparation of a remediation action plan to be scoped as a separate phase of works.

1.2 Scope of Services

The scope of work for the desktop study comprised a review of the following:

- Current and historical Certificates of Title to provide a history of ownership and land use;
- Selected historical aerial photographs from the Department of Lands and Council to provide evidence of the history of development of the site and indications of potential sources of contamination. In particular, historical aerial photographs would be used to provide an indication of the extent of areas disturbed during landfilling activities;
- Online records held by NSW Office of Environment and Heritage (OEH) (formerly Department of Environment, Climate Change and Water (DECCW)) databases to identify notices under the *Contaminated Land Management Act 1997*, sites notified under Section 60 of the *Contaminated Land Management Act 1997* and environment protection licences issued under the *Protection of the Environment Operations Act 1997*;
- Details of groundwater bores within a one kilometre radius of the site that are registered on the groundwater bore database maintained by the NSW Office of Water;
- Published topographical, geological and soil maps of the area;
- Dangerous Goods Licenses held by Workcover NSW;
- Previous environmental site assessment reports and any relevant information that may be made available for the site;
- Interviews with staff who could contribute to the historical information of the site; and
- A physical inspection of the site and surrounding land uses to identify potential environmental concerns.

The scope of work for the soil and groundwater sampling comprised the following:

Prior to field work:

- Provisional sampling locations were be selected based on the results of the desktop review to meet the objectives of the PESA; and
- The provisional locations were checked with services plans obtained by "Dial Before You Dig" and cleared by a subcontracted specialist cable locator for all intrusive works.

Fieldwork:

- Sampling points targeted the areas identified in the desktop review as on-site potential sources of contamination;
- Soil samples were collected at locations identified in Table 11 and Table 12 as well as Figure 3;
- Soil samples were field headspace screened by the use of a Photo Ionisation Detector (PID) for volatile organic compounds (VOCs);
- The soil encountered was logged using Golder Associates' technical procedure for soil logging;
- Test pit locations were backfilled with the excavated material;
- Boreholes and test pits were surveyed; and
- Wells were installed in the boreholes and developed in accordance with Golder Technical Procedures. Groundwater sampling analysis was undertaken for 19 boreholes installed as part of the geotechnical and hydrogeological investigations.

1.3 Site Visit

As part of the desktop study scope of works, a site visit was undertaken by Kelly Dohle of Golder Associates on 8 June 2011. The site visit included a short interview with Larry Monaghan of Wollongong City Council and a walkover of the site. Findings of the site visit, including anecdotal information are presented in Section 5.0.

2.0 SITE DESCRIPTION

Characteristics of the site are presented in the following sections based on the Golder Associates' site visits and the documents reviewed.

2.1 Site Location and Setting

The site is located at Reddalls Road, Kembla Grange, NSW. Site location, setting and layout details for Whytes Gully RRP are provided in Table 1. The site locality is shown in Figure 1 and a site plan is shown in Figure 2.

Table 1: Site Location and Setting - Whytes Gully RRP

Item	Data	Source
Current Owner	Wollongong City Council	Council
Street Address	Reddalls Road Kembla Grange, NSW, 2526	Council
Legal Description	Lot 2, DP 240557 Lot 501-502, DP 1079122 Lot 51-53, DP 1022266	Council
Current Zoning	IN2 Light Industrial E3 Environmental Management (along Dapto Creek, west of site)	Wollongong Local Environment Plan (West Dapto) 2010 (LEP)
Site Area	Approx 65 ha	SixViewer
Site Coordinates	297600 – 298600 mE 6184000 – 6184900 mN	Site Aerial Photogrammetry by KFW Williams (20 July 2011, 18763A)
Site use	Landfill activities (since 1984)	Council
Existing Infrastructure	Transfer station, private roads, stormwater ponds, leachate management system (including treatment plant and ponds), a materials recovery facility, a recycling area, weighbridge and administration and amenities buildings (refer to the existing site layout provided in Figure 2). The site also includes buildings previously housing a solid waste to energy facility.	Site observations/ Aerial photographs
Surrounding Land Use	Predominantly scattered rural residential to the north and north-west with light industrial activity to the east and the south. To the immediate west of the site is a watercourse (Dapto Creek) and vegetation beyond Reddalls Road.	Site observations/ Aerial photographs

2.2 Site Topography and Surface Water

The landfill is sited on a south facing slope, which is dominated by an east-west trending ridgeline to the north. The landfill is located in two historical gullies, the western gully and the eastern gully, which correspond to the two landfill developments at the site; the eastern gully landfill and the western gully landfill. The northwest and eastern extents of the landfill are bounded by ridgelines, with a small central north-south trending ridgeline separating the two historical gullies, the upslope portion of which is still visible today. The site rises from RL 15 m at the south west to RL 100 m to the north east.

The nearest natural surface water feature is Dapto Creek, located approximately 100 m west of the site. Dapto Creek, along with a number of minor surface drainage channels, appears to drain towards the south, through commercial/residential neighbourhoods, and discharges into Mullet Creek approximately 1.5 km south of the site. Mullet Creek continues to flow towards the southeast and drains into Lake Illawarra approximately 5 km southeast of the site. The Wollongong Local Environment Plan (West Dapto) 2010 (LEP) indicates that the area southwest of the site is classified as a Flood Planning Area.

2.3 Soil and Landscape

The site is located close to the Illawarra escarpment and is predominantly cleared with small patches of vegetation. The 1:100 000 Soil Landscape Series Sheet 9029-9129, Wollongong-Port Hacking (Soil Conservation Service of NSW, 1990) indicates that the soil on the site is primarily of the Gwynneville residual soil landscape group with some pockets of Hawkesbury colluvial soil located along the upper slopes at the north of the site and Fairy Meadow soil (of swamp origins) located at the southwest and southeast boundaries of the site. A description of each of the soil landscape groups is included in Table 2.

Table 2: Description of Soil Landscape Groups – Whytes Gully

Soil Landscape Group	Origin	Description		
		Landscape	Soil	Limitations
Gwynneville	Residual	Footslopes of the Illawarra Escarpment and isolated rises of the Wollongong Plain, local relief 10-70 m, slopes 3-25%, broad to moderately (250-850 m) rounded ridges and gently inclined slopes, structural benches and occasional rock outcrops and extensively cleared tall open-forest and open-forest.	Shallow (50-100 cm) Brown Podzolic Soils and Xanthozems on upper slopes, Lithosols on simple slopes and shallow (<50 cm) Brown Earths on midslopes and lower slopes.	Extreme erosion hazard, steep slopes, mass movement hazard, local flooding, reactive subsoil and impermeable, low wet bearing strength clay subsoil.
Illawarra Escarpment	Colluvial	Steep to very steep slopes on Quaternary talus, gradients 20-50%, large landslips are very common, mostly uncleared tall open-forest (wet sclerophyll forest) and closed-forest (rainforest). ,	Deep colluvial soils, Red and Brown Podzolic Soils occur midslopes, Siliceous Sands occur along drainage lines, Lithosols occur where talus is recent.	Mass movement and rockfall hazard, steep slopes and extreme erosion hazard, reactive, low wet bearing strength subsoils, low to moderate soil fertility.
Fairy Meadow	Swamp	Alluvial plains, floodplains, valley flats and terraces below the Illawarra escarpment, almost completely cleared low forest and woodland.	Friable Alluvial Soils and Siliceous Sands on the upper floodplains with dark brown sand and heavy clays on lower alluvial flats, Prairie Soils and Yellow Podzolic Soils.	Flood hazard, low wet bearing strength, highly permeable soil, high seasonal water tables.

A review of the EIS (1982) indicates that:

- The steeper sloping sections of the site are overlain by a variable thickness of colluvium (fine sand and silt) and residual soil (silty to sandy clays of medium to high plasticity), broadly corresponding with the Illawarra Escarpment and Gwynneville soil landscape groups described in Table 2, respectively. It is understood that the colluvium underlying the landfill has been removed.
- The gullies generally feature 0.2-0.4 m of topsoil, 0.4-0.8 m of clayey silt and 2-3 m of the silty to sandy clay; and
- The lower sections of the site feature a zone of alluvium, gravels and sands which corresponds to the Fairy Meadow soil landscape group described in Table 2.

A search of acid sulfate soil for the subject site was carried out through a review of the website maintained by the Australian Soil Resource Information Service (ASRIS). According to the ASRIS, there is a low probability (type B4) of occurrence of acid sulfate soil related to the site. The NSW Natural Resources Atlas sourcing information from the Salinity Hazard Map of NSW (DIPNR, unknown date) does not indicate a soil salinity hazard at the site. A copy of the acid sulfate soil and soil salinity search results is provided in Appendix B.

2.4 Site Geology

Based on the 1:100,000 geological map 'Wollongong-Port Hacking' (Department of Mineral Resources, 1985) the Whytes Gully Resource Recovery Park is on the boundary of two major geological formations. The southern part of the site is underlain by fluvial sands, silts and clays associated with Dapto Creek. Sandstone of the Budgong Sandstone formation underlies these alluvials. The Budgong Sandstone formation typically composes red, brown and grey lithic sandstone. The northern portion of the site is underlain by interbedded lithic sandstone, coal, carbonaceous claystone, siltstone and claystone of the Pheasants Nest Formation. It appears that the Pheasants Nest formation is mainly encountered on the ridgelines.

The EIS (1982) indicates that prior to landfilling, volcanic sandstone covered most of the site with a transition to andesitic sandstone with coal seams, carbonaceous shale and mudrock in the higher section (above approximately RL 100 mAHD) and a zone of alluvium, gravels and sands in the lower sections (below approximately RL 30 mAHD). Bedrock is reported to appear at the surface in the upper sections of the site.

The geotechnical investigation carried out by Golder Associates (Golder 2012a) summarised the four geological areas encountered on site as follows.

Geological Area 1 – Pheasants Nest Formation: This area is located on the upper slopes across the northern portion the site. The material encountered is generally weathered sandstone that grades into a fresh sandstone at depths typically less than 10 m. The residual soil is generally less than 2 m thick. Siltstone was encountered in zones throughout the sandstone at depths greater than about 15 m (based on the Maunsell 1992 investigation). Siltstone was not encountered in the Golder 2012a investigation.

Geological Area 2 – Budgong Sandstone Formation: This area is located across the southern portion of the site. This sandstone generally has a weathering profile that extends to depths up to 15 m. Zones of weathered siltstone, up to approximately 3m thick, are located intermittently throughout this formation.

Geological Area 3 – Alluvial Soils: This geological area consists of colluvial / alluvial soil material (silty clay and silt with some sands and sub angular gravels and cobbles) and is located across the middle and south west portion of the site. The thickness of this material varies to a maximum of approximately 11m. This geological area is expected to be underlain by Budgong Sandstone.

Geological Area 4 – Capping Layer and Landfill: This geological area is located across the northern slope. The capping material consists of generally low to medium plasticity sandy clay and is typically less than 1.5m thick. Landfill waste is located beneath the capping layer and consist of general waste such as paper, plastic, wood, rubble and other materials. The depth to the base of the general waste fill is not well defined, however old topographical data suggests that the thickness of the fill could be up to 52 m within the Eastern Gully landfill. This geological area is expected to be underlain by the Pheasants Nest Formation.

2.5 Site Hydrogeology

Regionally the site is located within the southern portion of the Sydney Basin, a geological basin stretching from the Illawarra Plateau in the south to the Lower Hunter Valley region in the north, and incorporating the topographically low Cumberland Basin in the centre. Generally, the dip of the geological formations within the Sydney Basin is from the topographically higher ground in the north and south towards the topographic low ground in the centre of the basin, although this varies locally based on structural features.

The regional hydrogeological setting of the area includes groundwater resources associated principally with the sandstone formations of the Hawkesbury Sandstone, Narrabeen Group, Illawarra Coal Measures and the Shoalhaven Group. Each of these geological groups generally comprise of varying proportions of sandstone,

siltstone, claystone, shale and coal. Groundwater resources are generally described as occurring as stacked aquifer systems associated with the sandstone formations, separated by lower permeability strata acting as aquitards. Structural contours presented on the 1:100,000 geological map 'Wollongong-Port Hacking' (Department of Mineral Resources, 1985) indicate a local geological dip direction approximately towards the north to northwest in the vicinity of Whytes Gully RRP, which would be expected to influence the regional groundwater flow direction.

Groundwater occurrence at Whytes Gully RRP is generally associated with two shallow systems: groundwater present in the upper weathered and fractured profile of the local bedrock geology, and groundwater present in the unconsolidated deposits that infill the two gullies at the site at the toe of the sloping topography. Water levels measured in wells installed within the shallow weathered bedrock in the sloping northern portion of the site generally range from 5 to 10 metres below ground level (mbgl), whereas water levels in wells installed in both the shallow bedrock and unconsolidated material in the flatter southern portion of the site are shallower, generally on the order of 1 to 3 mbgl. The water level associated with GABH03 is approximately 0.4 m above ground level, indicating local artesian conditions within the shallow bedrock at this location.

The NSW Natural Resource Atlas Database identified nine licensed groundwater monitoring wells within a 1 km radius of the site. It should be noted that the records relate to wells located to the northwest, and northeast of the site (up hydraulic gradient) which are authorised for a range of uses including domestic stock, irrigation stock and one town water supply test bore. It is, however, uncertain whether local businesses or residents down hydraulic gradient from the landfill are using groundwater for commercial (i.e. golf course watering, etc) or domestic water supply purposes.

The groundwater quality reported in these records is generally fresh to mildly brackish. It should be noted, however, that these records provide general indications only as there is limited salinity records for these wells and the wells they are located 200 m to 950 m from the site.

The available information pertaining to these wells is summarised in Table 3. Copies of the well records are presented in Appendix A

Table 3: Summary of licensed groundwater wells within 1 km of the site

Well ID	Purpose	Year Installed	Depth (m)	Driller's Log (m)	SWL (m)	Water Bearing Zones (m)	Salinity (ppm)	Approx Distance & Direction from Site
GW102523	Domestic Stock	1999	102.00	0.00-1.00 soil and clay 1.00-16.00 clay 16.00-24.00 clay and sandstone 24.00-27.00 coal 27.00-42.00 siltstone grey 42.00-45.00 shale 45.00-102.00 siltstone grey	-	0.00-102.00	-	950 m NW
GW105699	Domestic	2004	132.00	0.00-3.00 clay 3.00-26.00 sandstone, light grey 26.00-132.00 siltstone, light	113.00	11.50-12.00	-	900 m NW
GW103624	Domestic Stock	2001	60.00	0.00-6.00 orange clay 6.00-60.00 grey siltstone	12.00	34.50-36.00	1340	450 m NW
GW012581	Stock	1956	37.10	0.00-0.30 soil 0.30-3.04 clay red yellow plastic gravel 3.04-4.57 clay red plastic 4.57-5.18 clay white plastic gravel 4.57-5.18 boulders 5.18-8.22 clay multicoloured gravel plastic, shale sandstone, boulders 8.22-11.58 clay moist 11.58-15.24 clay green sandy water supply, boulders small 15.24-16.76 clay multicoloured sandy water supply, gravel boulder 16.76-19.81 green very soft rotten decomposed water supply 19.81-22.86 sandstone slightly soft 22.86-31.39 sandstone slightly hard 31.39-34.74 sandstone fractured broken water supply 34.74-37.18 sandstone light blue some hard bands dark	4.20-7.60	11.50-19.70 31.30-34.60	501-1000	350 m NW

Well ID	Purpose	Year Installed	Depth (m)	Driller's Log (m)	SWL (m)	Water Bearing Zones (m)	Salinity (ppm)	Approx Distance & Direction from Site
GW017768	General Use Stock	1959	9.10	0.00-0.91 topsoil 0.91-2.43 clay sand 2.43-4.87 clay bands 4.87-5.79 gravel water supply 5.79-6.70 gravel clay 6.70-9.14 sandstone yellow water supply	1.30	4.80-5.70 6.70-9.10	Good	400 m WNW
GW013023	Domestic Stock	1956	15.20	0.00-0.30 soil 0.30-1.52 clay yellow plastic 1.52-2.59 coal soft 2.59-6.40 clay light grey yellow slightly sandy 6.40-6.70 mud shale bands water supply, clay 6.70-8.22 shale dark soft 8.22-8.83 shale light grey soft 8.83-10.97 shale light grey 10.97-11.88 shale light grey fractured water supply 11.88-15.24 shale light grey hard small dark bands	0.90	6.40-6.70 10.90-11.80	-	700 m NNE
GW017381	Irrigation Stock	-	31.30	0.00-13.41 clay stones, rock decomposed 13.41-26.82 basalt rock water supply 26.82-28.34 rock water supply 28.34-31.39 shale	13.40	15.80-15.90 26.80-28.30	-	400 m NNE
GW016480	Stock	1983	41.00	-	-	-	-	200 m NE
GW075139	Town Water Supply (Test Bore)	2006	193.00	0.00-14.00 claystone 14.00-61.00 siltstone 61.00-128.00 sandstone 128.00-145.00 siltstone 145.00-162.00 sandstone 162.00-193.00 siltstone	15.00	15.00-16.00 66.00-67.00 93.00-94.00 102.00-103.00 126.00-127.00 156.00-157.00 162.00-163.00 192.00-193.00	-	300 m E

3.0 HISTORICAL RECORDS REVIEW

3.1 Aerial Photographs

The aerial photograph review, which was conducted to develop a general history of the development of the site and surrounding properties, is summarised in Table 4. Copies of the aerial photographs are included in Appendix C.

Table 4: Summary of Historical Aerial Photographs

Photograph	Comments
Year: 1951 Run: 19 South Coast Catchment 14,200 ft ASL 1:12,000 (approx.)	***Site:*** The site appears to be in use for agricultural purposes and is generally characterised by fenced, grassed pastures. A residential farmhouse (Glengarry Cottage, the current Whytes Gully RRP Administration Building), is located at the south of the site and west of the 1951 Reddalls Road alignment (which runs from the southeast to northwest of the site and is located to the north of the current Reddalls Road alignment). Two small sets of structures, assumed to be farmhouses or ancillary buildings, are located north of the 1951 Reddalls Road alignment within the footprint of the current Recycling Area and Surface Water Ponds. Two creeks run through the site, one through the eastern gully and one through the western gully, and drain into Dapto Creek approximately 500 m south of the site. ***Surrounding Area:*** The areas surrounding the site are also similarly characterised by fenced, grassed pastures, with some residential farmhouses and ancillary structures. A residential farmhouse (the current north-eastern neighbour in Lot 1 DP 628538) is visible in the 1951 aerial photograph. Beyond the residence, approximately 300 m northeast of the eastern gully, the current rail corridor is also present. A watercourse (Dapto Creek) runs immediately west of the site and some dense vegetation is located north of the site along the southern slopes of the Illawarra escarpment.
Year: 1961 Run: 3 Greater Wollongong Area 6,050 ft ASL 1:13,000 (approx.)	***Site:*** The site appears similar to that shown in the 1951 aerial photograph. ***Surrounding Area:*** The area surrounding the site appears similar to that shown in the 1951 aerial photograph.
Year: 1963 Run: 5W Wollongong 16,500 ft ASL 1:40,000 (approx.)	***Site:*** The site appears similar to that shown in the 1961 aerial photograph. ***Surrounding Area:*** The area surrounding the site appears similar to that shown in the 1961 aerial photograph.
Year: 1970 Run: 5W Wollongong 16,200 ft ASL 1:57,500 (approx.)	***Site:*** Two surface water dams are now present in the western gully and one dam is now present in the lower eastern gully. The number of ancillary farm structures north of Reddalls Road appears to have decreased since the previous image. The site otherwise appears similar to that shown in the 1963 aerial photograph. ***Surrounding Area:*** Light industrial development in the areas located to the south of the site (along West Dapto Road) and urban development (primarily the construction of residential dwellings) in Farmborough Heights, located northeast of the site, have commenced since the previous image. Elsewhere, the area surrounding the site appears similar to that shown in the 1963 aerial photograph.

Photograph	Comments
Year: 1974 Run: 9 Wollongong 2,743 m ASL 1:16,000 (approx.)	***Site:*** An additional surface water dam, are now present south of dams in the 1970 photograph in the western gully and one dam is now present in the upper eastern gully. The site otherwise appears similar to that shown in the 1970 aerial photograph. ***Surrounding Area:*** Light industrial development in the areas located to the south of the site (along West Dapto Road) and urban development in Farmborough Heights, located northeast of the site, have continued since the previous image. Elsewhere, the area surrounding the site appears similar to that shown in the 1970 aerial photograph.
Year: 1975 Run: 8 Wollongong 6,401 m ASL 1:40,000 (approx.)	***Site:*** The site appears similar to that shown in the 1974 aerial photograph. ***Surrounding Area:*** The area surrounding the site appears similar to that shown in the 1974 aerial photograph.
Year: 1984 Run: 21 Wollongong 2,896 m ASL 1:16,000 (approx.)	***Site:*** The clearing of vegetation for the preparation of the Western Gully Cell has commenced and the roadway providing access to the site from the south (currently known as Keever Place) has been constructed since the 1975 photograph. The three existing surface water dams are now present to the immediate south of the Western Gully Cell. ***Surrounding Area:*** Light industrial development in the areas located to the south of the site (along West Dapto Road) has continued and the density of vegetation north of the site appears to have increased since the previous image. Elsewhere, the area surrounding the site appears similar to that shown in the 1975 aerial photograph.
Year: 1988 Run: 22 Wollongong 2,804 m ASL 1:16,300 (approx.)	***Site:*** Since the previous image, filling of the Western Gully Cell has continued and the extent of filling has expanded further northwest. The site otherwise appears similar to that shown in the 1984 aerial photograph. ***Surrounding Area:*** The area surrounding the site appears similar to that shown in the 1984 aerial photograph.
Year: 1994 Run: 13 Wollongong 4,389 m ASL 1:25,000 (approx.)	***Site:*** Since the previous image, the clearing of vegetation, excavation and the preparation of the northern (upper) portion of the Eastern Gully Cell has occurred in the previously open, vegetated gully featuring a surface dam. A partial base lining system in the central part of the cell and an access road around the perimeter of the current footprint of the Eastern Gully Cell are also now present. Since the previous image, filling of the Western Gully Cell has continued, the extent of filling has expanded further north and west and the road accessing the western side of the cell has been relocated further to the northwest. Two larger surface water dams are now present further to the south of the Western Gully Landfill. The areas surrounding the two larger dams are sparsely vegetated, suggestive of recent earthworks. ***Surrounding Area:*** Since the previous image, a residential dwelling has been constructed to the northwest of the Western Gully Cell (currently, the nearest residential neighbour to the site located in Lot 1 DP 240557). The area surrounding the site otherwise appears more densely vegetated but otherwise similar to that shown in the 1988 aerial photograph.

Photograph	Comments
Year: 2000 Run: 7 Wollongong 1:50,000 (approx.)	***Site:*** Since the previous photograph, landfilling in the northern (upper) portion of the Eastern Gully Cell has continued and the clearing of vegetation, excavation and the preparation of a base lining system has occurred in southern (lower) portion of the cell. An access road across the north of the Western Gully Cell has been recently constructed and vegetation cover at the ridge north of the Western Gully Cell and around the two surface water dams located at the southwest of the site has increased. The existing Material Recovery Facility (MRF) and Solid Waste and Energy Recycling Facility (SWERF) have been constructed in previously open, grassed areas to the west and north of the administration building, respectively. South of the Western Gully Cell, the recycling centre is also now present and access roads also appear to have been constructed in the southeast portion of the site. ***Surrounding Area:*** Since the previous image, the filtration plant, consisting of enclosed and open aboveground circular tanks and associated structures, have been constructed on the previously open, grassed area to the east of the site. Development of the previously open area south of the filtration plant for commercial/industrial purposes also appears to have commenced since the previous image. The surrounding areas to the north and east of site appear similar to that shown in the 1994 aerial photograph.
Year: 2002 Run: 13 Wollongong 1:25,000 (approx.)	***Site:*** The major change since the previous image is that Reddalls Road has been realigned so that is passes to the southwest of the site between Dapto Creek and the two surface water dams. Since the previous photograph, landfilling has also commenced in the recently lined southern (lower) portion of the Eastern Gully Cell, vegetation cover over the northern (upper) portion of the Eastern Gully Cell has increased and the recycling area has expanded to the west. The site otherwise appears similar to that shown in the 2000 aerial photograph. ***Surrounding Area:*** The area surrounding the site appears similar to that shown in the 2000 aerial photograph.
Year: 2005 Run: 13 Wollongong 1:25,000 (approx.)	***Site:*** Since the previous image, landfilling in the lower (southern) half of the Eastern Gully Cell has progressed and the vegetation on the ridge north of the Western Gully Cell appears to have regrown. The two surface water dams visible in the previous photograph in the southwest portion of the site, near Reddalls Road, have been replaced with three constructed surface water ponds and two leachate ponds. The bases of the leachate ponds appear to be lined. The exiting leachate treatment plant has also been installed since the previous image. The site otherwise appears similar to that shown in the 2002 aerial photograph. ***Surrounding Area:*** The industrial site located southeast of the site has undergone further redevelopment including the paving of the site and the construction of additional structures, assumed to be warehouses. The area surrounding the site otherwise appears similar to that shown in the 2002 aerial photograph.

Photograph	Comments
Year 2011 16 May 2011 KFW Williams (image presented as Figure 2)	***Site:*** Since the previous image, landfilling in the central section of the Eastern Gully landfill has proceeded and the active tipping face has moved to the east. The surface water dams in the south western part of the site near Reddalls Road are now filled with water and their batters are vegetated with grass. A new site access road has been built in the south of the site adjacent to the surface water ponds. A new weighbridge has been constructed on this access road. The site otherwise appears similar to that shown in the 2005 aerial photograph. ***Surrounding Area:*** Immediately to the south east of the site, a cul de sac and what appears to be a subdivision of land has been constructed. The area surrounding the site otherwise appears similar to that shown in the 2005 aerial photograph.

3.2 Certificates of Title

A summary of the ownership of the site based on a review of historical Certificates of Title is presented in Table 5. Copies of the Certificates of Title are included as Appendix D.

Table 5: Summary of Land Title Information

Date of Issue	Document ID	Owner	Comment
Lot 2 DP 240557 (Northern half of site comprising the Eastern and Western Gully Cells)			
Prior to April 1983	Old System	Unknown	
April 1983 - October 1994	Vol 15018 Folio 150	Wollongong City Council	35.6 ha in area
October 1994 - Present	Lot 2 DP 240557	Wollongong City Council	Current lot
Lot 502 DP 1079122 (Old Reddalls Road alignment in the southwest portion of the site)			
Prior to 2007	Crown Land		
2007 - Present	Lot 502 DP 1079122	Wollongong City Council	Current lot
Part Lots 52 & 53 DP 1022266 (Areas surrounding the SWERF and Glengarry Cottage)			
Prior to 1987	Crown Land		
1987 - 1988	Lot 1 DP 723106	Unknown	
1988 - 2001	Lot 301 in DP 776338*	Wollongong City Council	Consolidation of previous titles (Lot 201 DP 708258 & Lot 1 DP 7223106)
2001 - Present	Part Lots 52 & 53 DP 1022266	Wollongong City Council	Subdivision of land in 2001 to form part of current Lots 52 & 53 DP 1022266
Lot 501 DP 1079122, Lot 51 DP 1022266 and part Lots 52 & 53 DP 1022266 (Southern half of the site comprising the areas surrounding the surface water and leachate ponds, MRF, SWERF and Glengarry Cottage)			
Prior to 1983	PA57030 (Old System)	Unknown	
1983 - 1985	Vol 15135 Folio 54	West Dapto Industrial Development Pty Ltd	

Date of Issue	Document ID	Owner	Comment
1985 -1985	Lot 1 DP 628845	Unknown	Subdivision of land in 1985 to form Lots 101-102 DP 636535 and Lots 201-203 DP 708258 (Lot 202 is south of the site)
1985 - 1986	Lots 101 and 102 DP 636535	Wollongong City Council	Transferred to road reserve 1986
1985 - 1988	Lot 201 DP 708258	Wollongong City Council	Consolidated with Lot 1 DP 723106 in 1988 to form Lot 301 DP 776338 (*refer above)
1985 - 2001	Lot 203 DP 708258	West Dapto Industrial Development Pty Ltd	Subdivision of land in 2001 to form Lots 50 & 51 DP 1022266 and part Lots 52 & 53 DP 1022266
2001 - 2011	Lot 50 DP 1079122	Wollongong City Council	Transferred to Lot 501 DP 1079122 in 2011
2011 - Present	Lot 501 DP 1079122 in 2011	Wollongong City Council	Current lot
2001 - Present	Lots 51 - 53 DP 1022266	Wollongong City Council	Current lots

3.3 Summary of the History of the Site

A history of infrastructure and operations development at Whytes Gully RRP is provided in this section incorporating development approval history.

All locations referred to in this section are shown in Figure 2 –Site Layout.

The Whytes Gully RRP was established in 1984 at a site known as Whyte's farm. As discussed in Chapter 6 of the EA (Golder 2012k), the site is defined by two gullies known as the western and eastern gullies separated by a central north-south trending ridgeline. Whyte's farm initially comprised an area of 35.6 ha of mostly cleared, improved grazing land owned by Mr Whyte for a period of 40 years prior to the sites development as a landfill (Scott and Furphy, 1982).

An area of land to the south of Whyte's farm adjacent to the eastern gully was also purchased by Wollongong City Council to accommodate the Whytes Gully RRP development as a landfill. A stockyard, located near the central western boundary of the site, is a remnant from this prior use.

3.3.1 Western Gully

Development consent for landfilling in the Western Gully was granted in 1984, for which an Environmental Impact Statement (EIS) was prepared by Scott and Furphy (1982). Landfilling commenced in the Western Gully in 1984.

Filling of the Western Gully landfill commenced following the construction of a soil bund wall with a crest height of RL 35 m AHD at the toe of the landfill. The bund wall extends from one side of the gully to the other. Waste was subsequently placed in the gully behind the bund wall. Once an entire lift of waste equal to the height of the bund wall was placed behind the bund wall, a second bund wall was placed on top of the first bund wall and partially on top of placed waste to a height of approximately 37.5 m AHD. Waste was placed behind the bund wall to the crest level of the bund wall. Access to the filling area was achieved via access roads around the bund walls.

This filling technique of bund construction followed by waste filling was continued to be used during the life of the landfill with each bund wall being approximately 2.5 m high. Bund wall and cover material was won from

the cell floor prior to filling of each lift. The external bund wall surfaces were subsequently vegetated following completion of each lift.

Surface water management for the Western Gully Landfill comprised up-gradient diversion drains and treatment of runoff from landfill areas as leachate (also refer to a more description of site surface water management in the Environmental Assessment (Golder 2012k)). Litter fences and security fences surrounded the landfill area.

Leachate management for the Western Gully Landfill comprised collection of leachate through surface and subsurface drains to a leachate retention pond to provide a degree of treatment prior to release to surface waters. Irrigation of the leachate over the eastern gully by pumping to a tank at the top of the gully was used to increase treatment when required, and was also provided as a fire fighting system (Scott and Furphy, 1982).

The Western Gully Landfill is unlined and is covered with varying depth of cover materials comprising generally low to medium plasticity sandy clay ranging in thickness from 0.3 m to 2.5 m (Golder 2012a). The final profile of the landfill comprises a series of terraced benches with an average surface slope of around 20%.

The Western Gully Landfill received approximately 980,000 cubic meters (cu.m) of waste during its 9.5 year life from 1984 to 1993 (Forbes Rigby, 2001).

We understand that colluvium and residual soil were stripped from the natural slopes during preparation works prior to landfill being placed in the area. From discussions with people involved in this stripping operation it appears that the natural slopes are likely to have been almost completely stripped to rockhead, but that colluvium and residual soil were not removed to full depth at the base of the natural slopes.

3.3.2 Eastern Gully

Development consent for landfilling in the Eastern Gully was granted in 1993, which granted the approval of the construction and operation of a lined landfill (Maunsell 1992).

The eastern gully landfill was constructed as a lined landfill, with the barrier component of the lining system comprising a high density polyethylene (HDPE) geomembrane liner (2 mm thickness). The HDPE geomembrane liner has a textured surface in sloped areas to enhance landfill stability.

The HDPE geomembrane liner is overlain by a leachate drainage layer comprising an approximate 300 mm thick clean sand layer. This layer incorporates 300 mm diameter leachate collection pipes that drain by gravity to the toe of the landfill. Collected leachate is transferred to leachate ponds.

The HDPE geomembrane liner is underlain by a groundwater drainage layer comprising an approximate 500 mm thick fine gravel layer that is intended to collect any seepage from natural materials below the liner. This layer incorporates a 100 mm diameter collection pipe that drains by gravity to a surface water pond at the toe of the landfill. Water collected in this system may be impacted by leachate, as discussed in Section 12 of the EA (Golder 2012k).

The landfill area is terraced with an average batter of approximately 25%. General waste was observed outcropping at isolated locations. Capping materials encountered had a variable composition of materials throughout the existing cap. The thickness of the capping observed by Golder (2011) ranged from 0.1 m (GAHA04) to 0.6 m (GAHA01) across the Eastern Gully.

Filling in the Eastern Gully has been undertaken in four stages. Stage 1 commenced in 1993 and was located in the upper portion of the gully. Stage 2, located on the lower section of the Eastern Gully also commenced in 1993 and received approximately 1,250,000 cu.m of waste to the year 2004. Stage 3 is located in the lower portion of the Eastern Gully over the Stage 2 filling area and had an estimated 610,000 cu.m capacity over a five year period. Stage 4, located in the upper portion of the gully over Stage 1 is currently underway and has an estimated 750,000 cum capacity over a five year period with completion of filling expected in 2013 (Forbes Rigby, 2001 and WCC Drawing No. 1475, 2004).

Redevelopment of the surface water management at the site was undertaken during filling of the Eastern Gully.

We understand that colluvium and residual soil were stripped from the natural slopes during preparation works prior to landfill being placed in the area. From discussions with people involved in this stripping operation it appears that the natural slopes are likely to have been almost completely stripped to rockhead, but that colluvium and residual soil were not removed to full depth at the base of the natural slopes. We note that a liner was placed below the landfill for this area of the site.

3.3.3 Site Access

Access to the Whytes Gully RRP has changed several times during its operation based on changes to the alignment of Reddalls Rd and changes to the site access point. Prior to site development, Reddalls Rd turned to the north west to the east side of Glengarry Cottage. A section of the road was realigned around the time of commencement of landfilling such that the road continued westward to the south of Glengarry Cottage and then turning north between the current MRF location and Glengarry Cottage. The site entrance at this time was located via a currently disused weighbridge (refer Figure 2).

At the time of commencement of the Eastern Gully Landfill it was recognised that the location of Reddalls Road presented difficulties for the long term development of the landfill and for local residents who had to pass through the facility to access the local road network. To address these issues Reddalls Road was approved to deviate to the south west in 2001.

In 2007 the current entrance and weighbridge was approved and located to the west of the existing Materials Recovery Facility and east of the Leachate Treatment Plant.

3.3.4 Surface Water and Leachate Treatment

Three ponds originally constructed for the Western Gully landfill are located at the toe of the landfill. The ponds comprise two stormwater ponds with a capacity of 3,000 cu.m and 4,200 cu.m, respectively and a former leachate pond with a capacity of 8,000 cu.m. Surface water from the landfills is discharged into these ponds, from where the water runs into the surface water management system described above. One of these ponds receives groundwater from the groundwater under drain system of the Eastern Gully landfill. The water collected in the under drain system was sampled by Golder (2011) and found to be impacted by leachate. All of these ponds will be decommissioned as part of the construction of the new cell.

Approval to relocate leachate and surface water ponds was granted in 2003 (Approval reference D2240/02). These new ponds comprise a series of leachate and wetland ponds (Surface Water Reed Beds 1 and 2) and a Surface Water Polishing Pond in addition to a leachate treatment plant (Refer to Figure 2).

4.0 REGULATORY AGENCY RECORDS SEARCH

4.1 Contaminated Land Management Act 1997

A search of the NSW Office of Environment and Heritage's (OEH) online register for contaminated land notices indicated that the OEH does not hold any records relating to contamination of the site or within 1 km of the site. A copy of the search results for the contaminated land notices within the Wollongong City Council area is provided in Appendix E.

A search was undertaken of the NSW OEH / EPA register of NSW contaminated sites which identifies sites notified by owners or occupiers where they believe the sites are contaminated (as required by Section 60 of the Contaminated Land Management Act 1997). There are no notifications listed for the site.

4.2 Protection of the Environment Operations Act 1997 (POEO)

A search of OEH's online database records indicated that the Whytes Gully RRP operates under an existing Environment Protection Licence (EPL) (EPL No. 5862).

In addition, Thiess Services was also issued a licence waste storage, transfer, separating or processing on site and Whytes Gully Environmental was issued a licence for the generation of electrical power from gas (associated with the SWERF) but OEH records indicate these licences have since been, respectively, withdrawn and surrendered. The issue of a licence for the recovery of general waste (13382) for PAR Recycling Services is currently pending. This application is understood to relate to activities associated with the MRF. A summary of the EPLs issued for activities on the site is presented in Table 6 below and a copy of selected search results is provided in Appendix E. Non-compliances with EPLs 5862 and 10554 were recorded and are also summarised in Table 6.

Table 6: Summary of EPLs at the site

EPL Number	Licence Holder	Address	Activities	Non-compliance details
5862 (issued)	Wollongong City Council	Reddalls Rd	Waste disposal (application to land) including putrescible and non-putrescible general solid waste and asbestos waste	8 incidents of leachate overflow into the stormwater dam (2008(1), 2007(3), 2001(2), 2000(1), 1999(1)). 1 incident of TSS in stormwater discharge exceeding limit (2007). 2 incidents of incomplete stormwater discharge analytical program (2008, 2001).
13259 (withdrawn)	Theiss Services Pty Ltd	110 Reddalls Rd	Waste storage, transfer, separating or processing	None
10554 (surrendered)	Whytes Gully Environmental Pty Ltd	Lot 203 Reddalls Rd	Generation of electrical power from gas	16 incidents (2002, 2001) including a range of deviations from the analytical methods and program, detection limits and analyte concentrations exceeding limits, incorrect calibration and non-conforming waste processed through the SWERF.
13382 (pending)	PAR Recycling Services Pty Ltd	115 Reddalls Rd	Recovery of general waste	None

The OEH records also indicate that a number of licences relating have been issued to properties within 1 km of the site. A summary of the EPLs issued is presented in Table 7 below and a copy of selected search results is provided in Appendix E.

Table 7: Summary of EPLs for properties within 1 km of the site

EPL Number	Licence Holder	Address	Activities	Non-compliance details	Approx. Distance & Direction from Site
13171 (issued)	Soilco Pty Ltd	61 Reddalls Rd	Composting, waste storage – other types of waste	None	100m S
11894 (issued)	APC Socotherm Pty Ltd	Lot 562 Reddalls Rd	Metal coating, metal waste generation	2 incidents - incomplete Pollution Reduction Programs (PRPs) due to fire damage at plant (2009)	400 m NW
10776 (issued)	Bredero Shaw Australia Pty Ltd	66 West Dapto Rd	Metal coating, metal waste generation	9 incidents - incomplete PRPs (2008, 2007, 2006)	400 m SE
12978 (issued)	Onesteel Trading Pty Ltd	132 West Dapto Rd	Metal processing	None	500 m S
11529 (withdrawn)	Onesteel Trading Pty Ltd	Lot 111 cnr West Dapto & Reddalls Rds	Metal processing	None	500 m S

The licences for offsite properties within 1 km of the site (presented in Table 7) involve a range of potentially contaminating activities relating to metal coating, processing and waste generation. A licence (13171) for composting and waste storage activities is also issued to Soilco who we understand do not operate within the site.

The remaining four licences (11894, 10776, 12978 and 11529) which apply to sites within 1 km of the site relate to metal coating, processing and metal waste generation. Three of these properties are located south to southeast of the site and considered to be downgradient of the site. One property is located northwest of the site but separated from the site by the Western Ridge and Dapto Creek. As a result, the offsite activities listed in Table 7 are considered to have a low potential for impact on the site. Potential contamination issues are considered more likely to arise as a result of the onsite activities associated with the storage, transfer, separating or processing of waste (identified in Table 6).

4.3 NSW WorkCover Dangerous Goods

A search of the Stored Chemical Information Database (SCID) and microfiche records held by WorkCover NSW was performed. Relevant correspondence from WorkCover NSW, including historical applications to keep Dangerous Goods and locality maps of the storage areas, is presented in Appendix F. The search indicated that WorkCover NSW holds three Dangerous Goods Licences for the site, as follows:

- The EDL Group Operation Pty Ltd (Energy Developments Ltd) applied to keep dangerous goods comprising 3000 kg of liquefied petroleum gas (UN1075, Class 2.1) in two above ground tanks located within the Theiss Recycling Plant (Licence Number 35/034444, issued 7/06/2000, expiry 24/03/2007);
- Wollongong City Council applied to keep dangerous goods comprising 1000 L of sodium hydroxide liquid (UN1824, Class 8) in a dosing tank located within the leachate treatment plant (Licence Number 35/036253, application dated 17/09/2003); and

- Whytes Gully Environmental applied to keep a range of dangerous goods associated with the SWERF and contained in storage areas within and immediately surrounding the SWERF (Licence Number 35/034856, amendment dated 24/07/2002 and renewal application dated 14/05/2003). The details of the dangerous goods included in Licence 35/034856 are summarised in Table 8 below.

Table 8: Summary of NSW WorkCover Dangerous Goods Licence 35/034856

Depot Number	Depot Type	Goods Stored in Depot	Class	Quantity
1	Roofed store (bunded drums)	UN 1993 Flammable Liquid, N.O.S.	3	4100 L
2	Roofless store (bunded drums)	UN 1824 Sodium Hydroxide Solution	8	820 L
3	Above-ground storage tank	UN 1993 Flammable Liquid, N.O.S.	3	15000 L
4	Cylinder store	UN 1066 Nitrogen, Compressed	2.2	63 m^3
5	Roofless store (bunded drums)	UN 1824 Sodium Hydroxide Solution	8	615 L
6	Roofed store (bunded drums)	UN 2014 Hydrogen Peroxide, Aqueous Solution	5.1	205 L
7	Roofed store (bunded drums)	UN 1230 Methanol	3	200 L
8	Flammable liquids cabinet	UN 1263 Paint	3	250 L
9	Roofed store	UN 2672 Ammonia Solution	8	1025 L
10	Exempt – storage area (roofed store)	UN 00C2 Combustible Liquid 2	C2	3000 L
11	Exempt – storage area (bunded drums)	UN 00C1 Diesel	C1	820 L
AA	Above-ground storage tank	UN 1075 Petroleum Gases, Liquefied	2.1	15000 L
AB	Cylinder store	UN 1002 Air, Compressed UN 1006 Argon, Compressed UN 1013 Carbon Dioxide UN 1046 Helium, Compressed UN 1049 Hydrogen, Compressed UN 1066 Nitrogen, Compressed	2.2	51 m^3
AC	Flammable liquids cabinet	UN 1263 Paint	3	250 L
AD	Flammable liquids cabinet	UN 1263 Paint	3	100 L
AE1	Cylinder store	UN 1021 Acetylene, Dissolved	2.1	54 m^3
AE2	Cylinder store	UN 1075 Petroleum Gases, Liquefied	2.2	81 kg
AF	Cylinder store	UN 1072 Oxygen, Compressed UN 1956 Compressed Gas, N.O.S.	2.2	132 m^3
AG	Exempt – storage area (bunded drums)	UN 00C2 Combustible Liquid 2	C2	800 L

Based on site observations and information provided by Council, the SWERF is understood to no longer be in operation. Infrastructure associated with the SWERF is understood to have been removed and the dangerous goods listed in the table above are no longer present on site.

5.0 CURRENT SITE ACTIVITIES AND OBSERVATIONS

5.1 General

As part of the desktop study scope of works, a site visit was undertaken by Kelly Dohle of Golder Associates on 8 June 2011. The site visit included a short interview with Larry Monaghan of Wollongong City Council and a walkover of the site. Findings of the site visit, including anecdotal information are presented in Table 9.

Table 9: Summary of Interview with Larry Monaghan (Wollongong City Council)

	Item	Description
General Site Information	Sewer plans	No sewer onsite, septic tanks are used (pumped out), one near new weighbridge, one at old SWERF, a very small one at the old amenities building, one at Glengarry Cottage.
Site Layout	Period of construction of amenities	Amenities built in 1984
	Details of pits, ponds, lagoons, soakaways etc	Leachate irrigation previously undertaken on Eastern Gully (prior to construction of Eastern Gully landfill).
	Areas of the site where imported fill has been placed	Old farmhouse location, used as a wetland. Works onsite were cut and fill. Old surface water ponds (replaced with the current ponds) were built from material in Eastern Gully.
	Past and present underground storage tanks on the site	No USTs
	Past and present above ground storage tanks on the site	Used to have a 2000 L diesel above ground tank, bunded, located in plant service area. Removed due to theft of fuel (hose would be cut, some spillage). Working area slab in plant service area was placed after use of the area as plant service area commenced.

	Item	Description
Historical Site Use	Details of past activities within and external to the buildings	Landfilling in eastern and western gullies. Amenities building, fuel storage shed, chemical storage shed and old SWERF facility – uses have remained consistent. Area for plant servicing near amenities building was originally unpaved, is now paved. Area where old farm house was located (next to current scrap steel processing area) was once used as a lined treatment wetland, then drained, removed and filled. 2 x 5,000 L leachate storage tanks. Two large surface water ponds previously located south of old Reddalls Rd, built using materials from Eastern Gully and removed/flattened when replaced by current ponds. One 10,000 L water tank for fire fighting in Western Gully no longer in use.
	Details of any environmental incidents such as fires, floods, discharges that have occurred on the site	One fire outside of waste, in Stage 1 Eastern Gully. A couple of small fires believed to be within the waste material, immediately extinguished. Eight incidents of leachate overflow into the stormwater dam (2008(1), 2007(3), 2001(2), 2000(1), 1999(1)) have been recorded (refer EPL 5862)
Statutory Matters and Previous Reports	Existing statutory consents (licences, permits etc) approvals and notices with respect to air emissions, waste water discharge, disposal of solid wastes, noise etc	No current dangerous goods licence. The site currently operates under EPL 5862.
	Any documentation relating to past or current breaches in statutory requirements in relation to environmental matters pertaining to land, operations, health and safety or off-site impacts	The following non-compliances have been recorded (refer EPL 5862): ■ Eight incidents of leachate overflow into the stormwater dam (2008(1), 2007(3), 2001(2), 2000(1), 1999(1)); ■ One incident of TSS in stormwater discharge exceeding limit (2007); and ■ Two incidents of incomplete stormwater discharge analytical program (2008, 2001).
	Records of environmental incidents on site – spills, leaks, emissions to air etc	Leachate pond overflowing drainage paths

	Item	Description
	Details of any environmental remediation that has occurred on the site	None known
Current Activities on Site	Information on utilities such as electricity, sewer, gas, water, oil etc	Shown on survey plan (power), septic systems as previously noted. Water to amenities.
	Details of material and chemical storage areas	Small chemical storage shed near amenities building. Contains anti-foaming, cleanup equipment, used to store BR90 (a biological powdered additive used for odour management in leachate ponds). No inventory onsite.
	Inventory of chemicals, chemical products and any other hazardous products and other substance used or stored on site	Fuel storage shed. Has always been in the same location. Refer below for additional details.
	Storage of recyclable waste on site	Temporary storage of various recyclable wastes on site, such as green waste, tyres, scrap metal, gas bottles, mattresses, cardboard, electronic waste, etc. These wastes are temporarily stored on hardstand prior to removal from site. Temporary storage of waste oil in steel container on bunded concrete slab.
Other Hazardous Substances	Asbestos	Never accepted at the site, according to anecdotal evidence. It should be noted, however, that the landfill is licensed to accept asbestos waste.
	Polychlorinated biphenyl compounds (PCBs)/ Mercury	Transformers on poles as indicated on plan. Oldest is near old surface water and leachate ponds. All are dated since site development as a landfill. No testing conducted as age suggests PCBs are unlikely to be present.
	Lead Based Paint	Not used
	Ozone depleting substances	A couple of old air-conditioning/refrigeration systems ones at old weighbridge, other newer closed system at amenities, SWERF, new weighbridge and Glengarry Cottage. Type of refrigerants unknown.
	Pesticides/Herbicides	Rat baits used around the site. Roundup kept in the chemical storage shed.
	Solvents	Detergent based degreasers stored in the chemical storage shed.

5.2 Surrounding Area

The areas surrounding the site can be characterised in three major zones:

- Predominantly scattered rural residential to the north and north-west of the site;
- Light industrial activity to the east and the south of the site; and
- A watercourse (Dapto Creek) and vegetation to the immediate west of the site beyond Reddalls Road.

6.0 SAMPLING AND ANALYSIS PLAN AND SAMPLING METHODOLOGY

6.1 Data Quality Objectives

The NSW Department of Environment and Conservation (DEC) *Guidelines for the NSW Site Auditor Scheme (2nd Edition)* 2006 (DEC 2006) states that data quality objectives (DQOs) must be adopted for all assessment and remediation programs. The process is used to define the type, quantity and quality of data needed to support decisions relating to the environmental condition of a site.

DQOs provide a systematic approach for defining the criteria that a data collection design should satisfy, including when, where and how to collect samples or measurements; determination of tolerable decision error rates; and the number of samples or measurements that should be collected.

The US Environmental Protection Agency (USEPA) describes the DQO process as a seven-step iterative planning approach used to prepare plans for environmental data collection. The DQOs for this investigation are summarised below.

Step 1: State the problem

The PESA was conducted to identify potential areas of contamination and identify whether previous and current site activities have resulted in contamination of the site. The objectives of the PESA are:

- Review historical information relevant to the site to determine the presence of past landfilling and associated activities at the site, which could have resulted in soil and/or groundwater contamination.
- Undertake a PESA to assess the presence of contamination in soils and groundwater.
- Provide a PESA report detailing the historical activities and the results of the soil and groundwater investigations.

Step 2: Identify the decisions

A number of decisions were to be made based on the data collected during the desktop study. The decisions to be made during the PESA include:

- Where were previous and current activities that were potentially contaminating conducted at the site?
- What is the hydraulic gradient and principal drainage mechanisms for groundwater entering and leaving the site?
- Is leachate impacting groundwater as it moves through the site?

Step 3: Identify inputs to decision

Inputs to the decision principally comprise data collected during desktop study, field investigations, laboratory analysis and assessment criteria (Refer Section 1.1, 4.0 and 9.0) which can be summarised as follows:

- Review of background information provided by Council and regulatory agencies as described in Section 1.1;
- Analytical data from analysis of soil and sediment samples collected across the site;
- Groundwater levels measured from monitoring well installations using an interface level dip meter;
- Groundwater field parameters measured using a hand held water quality meter;
- Groundwater, surface water and leachate sample chemical analyses reported by a NATA accredited laboratory; and

- Field logs and observations made by field engineers / scientists relating to ground conditions.

Step 4: Define the study boundaries

The soil contamination investigation study was mostly confined to judgemental investigation locations selected based on the outcomes of the Phase 1 Preliminary Environmental Site Assessment in an area at the toe of the Western and Eastern Gully landfills, which includes two backfilled ponds. A further investigation location (GACS-06) is located on the ridge to the west of the Western Gully landfill to assess the potential impacts of farming activities. The hydrogeological investigation study was limited by the site boundaries and was aimed to characterise groundwater conditions across the site. Groundwater samples were collected in July and August 2011.

Step 5: Develop a decision rule

The following decision rules regarding data assessment based on project objectives (refer to Step 1 above) and data quality based on data quality indicators have been applied to the investigation:

- If measured concentrations of contaminants in groundwater at the chosen locations exceed the adopted assessment criteria for the investigation then the results will be further evaluated in the context of the potential impacts to exposed populations and possible remediation required; and
- If measured concentrations of contaminants in soil at the chosen locations exceed the adopted assessment criteria for the investigation then the results will be further evaluated in the context of the potential impacts to exposed populations and possible remediation required.

Step 6: Specify limits on decision errors

The tolerable limits for decision errors are the data quality indicators achievable during this assessment. The data quality indicators for this assessment are as follows:

- **1. Accuracy:** A measure of the closeness of the results to the actual results. Accuracy is assessed through the comparison of results for intra-laboratory duplicates at the primary laboratory and inter-laboratory duplicates analysed by secondary laboratories (where these are conducted). Accuracy is also assessed by measuring the extent to which an analytical result reflects the known concentration as measured by the recovery obtained from internal laboratory spikes, control samples or certified reference materials.
- **2. Precision:** A measure of the repeatability of results by the laboratory. This is assessed through the analysis of duplicates both internally and externally.
- **3. Completeness:** The percentage of acceptable data obtained compared to the amount of data needed to achieve a particular level of confidence in the results. Acceptable data are obtained when samples are collected and analysed in accordance with the quality control procedures and the data quality indicators meet the data quality objectives.

The following acceptable limits for field and laboratory quality control and quality assurance (QA/QC) data have been set for the investigation.

QA/QC Samples

The analyses of laboratory and field QA/QC samples are mechanisms for checking the accuracy and precision of analytical data in order to ensure that the data quality objectives are being met. The QA/QC samples collected in the field during this sampling round included trip blanks, field duplicates and field triplicates.

The following data quality indicators have been developed for this investigation.

Field QA/QC samples

- Relative percentage difference (RPD) to be 0-30% field duplicates where measured concentrations are greater than twenty times Limits of Reporting (LOR);
- RPD to be 0-50% for field duplicates where measured concentrations are greater than ten times but less than twenty times the LOR;
- Any RPD acceptable where one or both samples are below ten times the LOR;
- Method, trip and rinsate blank results less than laboratory LOR;
- Intra laboratory and inter-laboratory field duplicates will be collected at a frequency of at least 1 in 20; and
- Limits of Reporting should be a maximum of 1/5, and preferably 1/10 of the acceptance criteria concentration.

Laboratory QA/QC

In addition to field QA/QC samples, the primary and secondary analytical laboratories (ALS and Envirolab, respectively) have used laboratory and batch specific QA/QC processes including laboratory duplicates, laboratory blanks, surrogate spikes, matrix spikes and laboratory control samples.

Data Validation

To ensure that data of known quality is reported and to identify whether data is suitable to fulfil the overall project objectives, analytical data validation is conducted. The validation process is based upon the following data validation guidance documents:

- NEPC, 1999, National Environment Protection (Assessment of Site Contamination) Measure (NEPC, 1999); and
- USEPA, June 2008, USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review (USEPA, 2008).

The analytical data validation process involves the checking of analytical procedure compliance and the assessment of accuracy, precision and completeness of analytical data.

Analytical data validation summary sheets are presented in Appendix J.

Step 7: Optimise the design for obtaining data

The investigation was primarily designed to gain a preliminary understanding of the presence of contaminants in soil and groundwater at the Whytes Gully Resource Recovery Park. This was achieved by conducting a Phase 1 contamination desktop study as well as a limited soil contamination investigation and a site wide hydrogeological investigation. In cases where soil contamination is identified during the investigation, additional investigation locations may be added to delineate the extent of such contamination.

Monitoring wells were installed in a way that characterises groundwater conditions upgradient of potential sources of contamination (the landfill) and downgradient of potential sources of contamination. Monitoring wells were screened to target the aquifer most likely of being impacted by the landfill. Should groundwater contamination be identified, further monitoring wells may be installed to delineate the extent of such contamination.

6.2 Sampling Rationale

Based on the outcomes of the desktop study, the main contaminating activities on site have been identified as:

- Landfilling (waste placement and operation);
- Runoff from operational areas;
- Backfill of the former lined treatment wetland; and
- Backfill of old surface water ponds located south of old Reddalls Road.

6.2.1 Soil Investigation

Based on the main potentially contaminating activities identified, the following contaminants of potential concern (COPC's) have been identified for soil contamination.

Table 10: Contaminants of Potential Concern (Soil)

Contaminant	Rationale
Heavy metals	Potentially present in runoff from landfilled areas.
Polycyclic aromatic hydrocarbons (PAHs)	Potentially present in runoff from landfilled areas.
Polychlorinated biphenyls (PCBs)	Potentially present in runoff from landfilled areas. Low potential for PCBs in transformers.
Phenols	Potentially present in runoff from landfilled areas.
Organochlorine pesticides (OCPs)	Potential remnant from previous farming activities. Potentially present in runoff from landfilled areas.

For the soil contamination investigation locations, the following sampling rationale was used.

Table 11: Sampling rationale soil contamination investigation

Location ID	Rationale
GACS01	Sediment analysis of surface water pond
GACS02	Investigation of area adjacent to old stockyard
GACS03	Sediment analysis of surface water pond
GACS04	Investigation of area of old farm house and backfilled surface water ponds (wetland).
GACS05	Investigation of area of old farm house and backfilled surface water ponds (wetland).
GACS06	Site coverage and investigation of area to the north of the Western Gully Landfill.
GABH01	Not sampled due to insufficient sample volume (shallow rock)
GABH02	Investigation of area of old farm house and backfilled surface water ponds (wetland).
GABH03	Investigation of area of old farm house and backfilled surface water ponds (wetland).
GABH04	Investigation of area of old farm house and backfilled surface water ponds (wetland).
GABH05	Investigation of area of old farm house and backfilled surface water ponds (wetland).
GABH06	Investigation of area of old farm house and backfilled surface water ponds (wetland).

Samples were analysed from near surface material (to a depth of 1.2m) to assess the quality of fill and the potential for impact by runoff from the landfill. The analytical results for these samples (see Section 9.1) were below the assessment criteria, avoiding the requirement for analysis of deeper samples to allow vertical delineation of contamination.

6.2.2 Groundwater Investigation

A number of gaps were identified in the hydrogeological knowledge of the site, with the potential to affect the potential to assess leachate migration in groundwater. The following key gaps were identified prior to the investigation:

- Water level data to the north of the old and current landfill cells (i.e. up hydraulic gradient) was limited;
- There appeared to be limited groundwater monitoring coverage down hydraulic gradient from key areas of potential contamination sources (e.g. old landfill cell, current landfill cell, leachate pond);
- There was limited groundwater monitoring coverage of the southern and south-western (i.e. down hydraulic gradient) property boundary, representing the point of compliance for groundwater quality migrating off-site; and
- Limited information was available regarding the hydraulic properties of the alluvial/colluvial and underlying weathered rock aquifers.

To address the identified gaps, a program of drilling, well installation, groundwater sampling and hydraulic testing was designed and implemented. Well installation locations were selected to provide long term monitoring locations that are unlikely to require relocation or decommissioning during construction of the new landfill cells (based on the current proposed development footprint). A summary of the newly installed wells is provided in Table 12 below.

Table 12: Additional well installation locations and rationale

Well ID	Location	Unit screened	Rationale
GMW101	North of western gully landfill	Shallow rock	Upgradient data coverage
GMW102	Northwest of western gully landfill	Shallow rock	Upgradient data coverage
GMW103	Northeast of active cell (eastern gully landfill)	Shallow rock	Upgradient coverage - boundary
GMW104	West of western gully landfill	Shallow rock	Cross-gradient coverage - boundary
GMW105	East of active cell (eastern gully landfill), eastern ridge	Shallow rock	Cross-gradient coverage
GMW106	Southeast of eastern gully landfill	Shallow rock	Cross/downgradient coverage
GMW107	South of eastern gully landfill	Shallow rock	Cross/downgradient coverage
GMW108	South of future cells (east of weigh station)	s- alluvials d-shallow rock	Downgradient coverage
GMW109	Southwest corner of property	s- alluvials d-shallow rock	Downgradient coverage - boundary
GMW110	West of proposed leachate pond	Shallow rock	Downgradient coverage - boundary
GMW111	West of proposed new cells	Shallow rock	Downgradient coverage - boundary
GABH01	Within proposed cell footprint	Shallow rock	New cell footprint coverage
GABH02	Within proposed cell footprint	Shallow rock	New cell footprint coverage
GABH03	Within proposed cell footprint	Shallow rock	New cell footprint coverage
GABH04	Within proposed cell footprint	Shallow rock	New cell footprint coverage
GABH05	Within proposed cell footprint	Shallow rock	New cell footprint coverage
GABH06	Within proposed cell footprint	s- alluvials d-shallow rock	New cell footprint coverage

Well ID	Location	Unit screened	Rationale
BH6	Existing monitoring well near main site entry		Downgradient coverage

At each drilling location, one well was installed into shallow weathered rock to provide site-wide coverage of this shallow groundwater system. In addition, three locations (GMW108, GMW109 and GABH06) were completed as paired wells with an additional shallow well completed in the alluvial/ colluvial soil profile overlying the shallow rock.

6.3 Sampling Methods

For the soil contamination investigation, the following sampling methods were used.

Table 13: Sampling methods soil contamination investigation

Location ID	Sampling method	Date sampled
GACS01	Sampling of sediments from a trowel	05/07/2011
GACS02	Shallow grab sample from test pit excavated with an excavator	05/07/2011
GACS03	Sampling of sediments from a trowel	05/07/2011
GACS04	Shallow grab sample from test pit excavated with an excavator	05/07/2011
GACS05	Shallow grab sample from test pit excavated with an excavator	05/07/2011
GACS06	Shallow grab sample from test pit excavated with an excavator	05/07/2011
GABH02	Surface grab sample from bore hole drilled with solid flight auger (V-bit)	11/08/2011
GABH03	Surface grab sample from bore hole drilled with solid flight auger (V-bit)	29/07/2011
GABH04	Surface grab sample from bore hole drilled with solid flight auger (V-bit)	11/08/2011
GABH05	Surface grab sample / push tube sample from bore hole drilled with solid flight auger (V-bit)	27/07/2011
GABH06	Surface grab sample from bore hole drilled with solid flight auger (V-bit)	15/08/2011

For quality control and detailed sampling procedures, please refer to Section 8.0.

All groundwater samples were collected using disposable bailers. Prior to groundwater sampling, the water levels within the groundwater wells were measured using a water level meter, then purged using bailers until the water quality parameters measured at the well head were observed to stabilise. During the purging process, indicator parameters (pH, temperature, EC, ORP and DO) were measured using a 90FLMV Water Quality Meter which was calibrated prior to use (refer to Appendix G for calibration certificates and copies of field sampling forms).

Samples were placed directly into appropriately preserved bottles provided by the laboratory and placed into an ice cooled esky to await transport to the laboratory.

Primary and duplicate groundwater samples were analysed by ALS Laboratory Services, and the triplicate groundwater sample was analysed by Envirolab Services, both of which are National Association of Testing Authorities (NATA) accredited for the analyses performed.

6.4 Field Screening

The soil samples were screened for the presence of volatile organic compounds using a Photoionisation Detector (PID) with a 10.6 eV lamp. The PID provides a relative indication of the presence of volatile organic compounds (VOCs) in the soil sample to assist in sample selection for laboratory analysis.

The PID was calibrated prior to use in accordance with the manufacturer instructions using standard isobutylene gas at a concentration of 100 ppm. PID calibration records are presented in Appendix G.

Samples for PID screening were collected in plastic bags filled to half their capacity. The bag was then shaken and allowed to stand for at least 5 minutes. The inlet of the PID nose tube was then introduced through the plastic bag and the maximum reading on the display recorded.

The results of the PID screening are reported in Table 7 in Appendix H. The results of the field screening are discussed in Section 9.1 of this report.

Groundwater samples collected were screened for field parameters (pH, temperature, EC, ORP and DO) using a 90FLMV Water Quality Meter which was calibrated prior to use (refer to Appendix G for calibration certificates and copies of field sampling forms).

7.0 ENVIRONMENTAL ASSESSMENT CRITERIA

7.1 Soil and Pond Sediment Contamination

The site will continue to be used as a landfill, which comprises commercial / industrial land use as defined in the NSW OEH Site Auditor Guidelines (OEH 2006). It is therefore appropriate to compare the results of the soil analysis against the health based soil investigation levels for commercial / industrial land use (HIL F), from Table 5-A in *Schedule B(1): Guidelines on Investigation Levels for Soil and Groundwater of the National Environment Protection (Assessment of Site Contamination) Measure*, 1999 (NEPC 1999).

For petroleum hydrocarbons, the threshold concentrations for soils provided in the NSW EPA Contaminated Sites *Guidelines for Assessing Service Station Sites* (1994) have been adopted as conservative screening criteria.

The adopted assessment criteria for soils are presented in Table 14.

Table 14: Soil Assessment Criteria

Analyte	HIL F (mg/kg)	NSW EPA Service Station Guidelines (mg/kg)
Arsenic	500	-
Cadmium	100	-
Chromium VI	500	-
Copper	5,000	-
Lead	1,500	-
Mercury (inorganic)	75	-
Nickel	3,000	-
Zinc	35,000	-
Benzo(a)pyrene	5	-
Total PAH	100	-
PCBs (total)	50	-
Aldrin + Dieldrin	50	-
Chlordane	250	-
DDT + DDD+ DDE	1000	-
Heptachlor	50	-
Phenol	42,500	-
TPH C_6-C_9	-	65
TPH C_{10}-C_{36}	-	1,000
Benzene	-	1
Toluene	-	130

Analyte	HIL F (mg/kg)	NSW EPA Service Station Guidelines (mg/kg)
Ethyl benzene	-	50
Total xylenes	-	25

7.2 Groundwater Quality Assessment Criteria

The Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (2000), "Australian and New Zealand Guidelines for Fresh and Marine Water Quality" (ANZECC 2000) were adopted as the groundwater quality assessment criteria for the site. In assigning levels of protection for aquatic ecosystems, the ANZECC (2000) guidelines recognise three types of ecosystems: high conservation value systems, slightly to moderately disturbed systems, and heavily disturbed systems. The guidelines describe slightly to moderately disturbed ecosystems as ecosystems in which aquatic biological diversity may have been adversely affected to a relatively small but measurable degree by human activity.

For the purposes of this assessment the ANZECC guideline values for a slightly to moderately disturbed ecosystem are considered to be appropriate considering the nature of the catchment, pertaining to a 95% level of species protection for a freshwater ecosystem. This is considered to be conservative given the land use and heavily modified nature of the site, but acknowledges the environmental values of the adjacent land.

Table 15 provides a summary of the adopted criteria for the analytical suite. Only analytes for which high or moderate reliability trigger values are available and that were detected above the laboratory limit of reporting (LOR) have been included in Table 15. Low reliability criteria have not been considered. There are six metals for which hardness modified trigger values (HMTV) are available in the ANZECC (2000) guidelines (Cd, Cr, Cu, Pb, Ni, Zn in Table 3.4.3 of ANZECC 2000), which recognize the lower toxicity of these metals with increasing hardness. The hardness modification is calculated according to the specific hardness value for each sample, hence HMTV have not been included in Table 15 but are discussed in Section 9.2.1.

Table 15: ANZECC Criteria for Groundwater Samples

Group	Analytes	95% Protection of Species Fresh Water (µg/L)
Metals & Metalloids [1]	Aluminium [2]	55
	Arsenic	13 [3]
	Cadmium	0.2
	Chromium VI	1.0 [4]
	Copper	1.4
	Lead	3.4
	Manganese	1900
	Mercury (inorganic)	0.6
	Nickel	11
	Zinc	8.0 [4]
Non-Metallic Inorganics	Ammonia	900 [4,5]

[1] Trigger values for metals apply to bioavailable (soluble) fraction of total concentrations (filtered samples).

[2] Criterion only applies for pH>6.5

[3] Criterion is for Arsenic V, this is the more conservative of the Arsenic trigger values. Where this is exceeded the criterion of 24 µg/L for Arsenic III should be considered when interpreting the results.

[4] Figure may not protect key test species from chronic toxicity (this refers to experimental chronic figures or geometric mean for species) – check Section 8.3.7 of ANZECC 2000 guidelines for spread of data and its significance.

[5] Ammonia trigger value corresponds to a water pH of 8.0, and must be adjusted when different pH values are recorded.

7.3 Assumptions and Limitations of Criteria

The NSW EPA *Guidelines for Assessing Service Station Sites* (EPA 1994) criterion of 10 mg/L for TPH (no visible oil and grease) has not been used for assessing hydrocarbon concentrations in water. TPH was used as a screening analysis. Where TPH was detected analysis of specific compounds was required e.g. BTEX, PAH or PCBs.

It is assumed that unknown petroleum hydrocarbons sources will be identified in the TPH analyses as present within the C_6-C_{36} hydrocarbon range.

Limitations of the ANZECC (2000) criteria for fresh water are summarised as footnotes in Table 15 in the previous section.

Soil criteria have been nominated based on the assumption of the proposed commercial/industrial use of the site.

8.0 QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC)

8.1 Soil and Pond Sediment Contamination Analysis

8.1.1 Field QA/QC

Details of the field QA/QC protocols adopted during the investigation are provided in Table 16 below.

Table 16: Field QA/QC protocols

Control	Details
Sampling team	All fieldwork was conducted directly by, or under the supervision of, Golder field staff Adam Muller, Parnel Richards, Paul O'Brien and Tony Zhou who are experienced field practitioners trained in the sampling techniques employed during this investigation.
Decontamination procedures between sampling events	Soil samples were collected as grab samples collected with a trowel (GACS01 and GACS03); grab samples collected from the test pit walls using a trowel or from the centre of the excavator bucket (GACS02 and GACS04-06) or as grab samples directly from the drill auger (GABH01-06). Drill auger samples were collected from the upper most layer of soil drilled. Drill augers and trowels were thoroughly rinsed using a phosphate free detergent (Decon 90) and de-ionised water between sampling locations. A rinsate sample was collected from the sampling trowel on 05 July 2011 and 26 July 2011 and analysed for metals, PCB, OCP, Phenols, PAHs, TPH, TRH and BTEX in accordance with the adopted QA/QC protocols for the investigation.
Logs	Logs for each borehole and groundwater well installation are provided in APPENDIX K.
Chain of custody	Chain of custody sheets are provided in APPENDIX I.
Sample splitting techniques	Duplicate split samples were collected by taking a sample at the same depth interval and the same geology from the sampling device and dividing it into two parts. The samples were placed in two separate jars for laboratory analysis.
Duplicate frequency	2 intra-laboratory and 2 inter-laboratory duplicate soil samples were collected resulting in a duplicate frequency of 4 duplicates to 11 primary soil samples which complied with the requirements set out in Section 6.1.
Rinsate sample results	The rinsate samples collected on 05 July 2011 and 26 July 2011 recorded concentrations below the laboratory LOR for each analyte.
Trip spikes	No trip spikes were required for this investigation as TPH and BTEX were not identified as a major contaminant of potential concern.
Trip blank results	The trip blank samples submitted for VOC analysis with samples collected on 05 July 2011 and 26 July 2011 recorded concentrations below the laboratory LOR for each analyte.
Field instrument calibration	Instrument calibration records are provided in Appendix G.

Control	Details
Field duplicate sample results	Sampling round 05 July 2011, refer to Appendix J: ■ 5 RPDs could be calculated for primary sample and intra-laboratory duplicate pair. No samples exceeded the acceptable LOR based RPD criteria; and ■ 7 RPDs could be calculated for primary sample and inter-laboratory triplicate pair. No samples exceeded the acceptable LOR based RPD criteria. Sampling round 27 July to 29 July 2011, refer to Appendix J: ■ 9 RPDs could be calculated for primary sample and intra-laboratory duplicate pair. No samples exceeded the acceptable LOR based RPD criteria; and ■ 5 RPDs could be calculated for primary sample and inter-laboratory triplicate pair. No samples exceeded the acceptable LOR based RPD criteria. Sampling round 11 August and 15 August 2011, refer Appendix J (no duplicate samples were collected)

8.1.2 Laboratory QA/QC

Details of the laboratory QA/QC protocols adopted during the investigation are provided in Table 17.

Table 17: Laboratory QA/QC protocols

Control	Details
Chain of custody forms	Chain of custody sheets are provided in Appendix I
Holding times	The extraction and analysis for both the primary and secondary laboratories generally took place within the recommended holding times stated by the primary laboratory with the following exceptions: ■ For batch ES1117692, analysis of soil pH was conducted 4-5 days outside of holding time; ■ For batch ES1116709, analysis of soil pH for samples GABH06_0.0-0.2_260711 and GABHFD01_260711 and PCB, OCP, phenolics and TPH rinsate water analysis for sample RB_260711 was conducted 2 days outside of holding time; and ■ For batch ES1114651, analysis of soil pH and PCB, OCP, Phenolics and TPH rinsate water analysis conducted 1 day outside of holding time. The soil pH values measures that are beyond the holding time may still be used as a guide. The rinsate samples were analysed outside the recommended holding time for organic analytes, but may be used as a guide in the assessment of the efficacy of the decontamination procedures in the field. These exceedances are not expected to affect the quality of results for the COPC.

Control	Details
Analytical methods	The analytical methods adopted for this investigation are identified in the laboratory certificates in Appendix I.
Laboratory accreditation	■ Primary Laboratory (ALS Environmental Pty Ltd, NATA accreditation number 825); and ■ Secondary laboratory (Envirolab Services Pty Ltd NATA accreditation number 2901).
Surrogates and spikes	The details of surrogates and spikes used in the laboratory QA/QC procedures are contained within the corresponding certificates in Appendix I. A total of 225 laboratory surrogates were analysed by the primary and secondary laboratories. All results were within the acceptable limits set for this investigation. The following laboratory control samples (LCS) were outside the acceptable limits set for this investigation. Batch 1116709: LCS recoveries for copper (118%) and Lead (117%) are greater than the upper control limits of 114% and 111% respectively. LCS recovery for total PCBs (121%) exceeds the upper control limit of 117%. LCS recovery for total PCBs (123%) exceeds the upper control limit of 107%. LCS recovery of Pentachlorophenol (100%) exceeds the upper control limit of 95.6%. Batch 1114651: LCS recovery for copper (87.6%) is less than the lower control limit of 89.2%. All other matrix spike samples analysed by the primary laboratory were within the acceptable limits set by this investigation. Soil LCS recovery exceedances for Metals and PCBs are not expected to affect the overall data quality of this batch as the recoveries are only slightly outside of acceptable control limits. The following matrix spike samples analysed by the secondary laboratory were outside the acceptable limit set by this investigation: ■ Batch 58255: Dieldrin = 936%; ■ Batch 59335: pp-DDD = 1115%. We consider that the overall quality of the batches is not compromised by the two exceeding matrix spikes in samples analysed by the secondary laboratory.
Laboratory detection limits	All primary laboratory Limits of Reporting were below the adopted assessment criteria for this investigation.
Laboratory duplicate results	The results of the internal laboratory duplicate sample analyses for the primary and secondary laboratories are contained within the certificates in Appendix I. All laboratory duplicate samples analysed met the acceptable limits set for this investigation.
Laboratory blank results	The results of the internal laboratory method blank analyses for the primary and secondary laboratories are contained within the certificates in Appendix I. All results were below the stated limit of detection for the laboratory.

8.1.3 QA/QC Data Evaluation

An evaluation of QA/QC results expressed as Data Quality Indicators (DQIs) is provided in Table 18.

Table 18: QA/QC data evaluation

DQI	Evaluation
Completeness	Field considerations: ■ Where possible all samples were collected; ■ Sampling procedures were appropriate and were complied with; ■ Experienced samplers were engaged in the fieldwork; and ■ All documentation is present and correct. Laboratory considerations: ■ All samples submitted to the laboratory were analysed according as specified in this report; ■ All analytes were analysed according to the requirements of this report; ■ Appropriate laboratory methods were used and LORs were below the adopted assessment criteria; ■ All sampling documentation is complete; and ■ Sample holding times were complied with the exception of pH in soil and for rinsate samples. Based on the above evaluation the amount of usable data collected during this investigation is usable. The soil pH values measures are beyond the holding time, but may still be used as a guide. The rinsate samples were analysed outside the recommended holding time for organic analytes, but may be used as a guide in the assessment of the efficacy of the decontamination procedures in the field.
Precision	As outlined in Appendix J, Golder is satisfied that field and laboratory procedures were appropriate and complied with. Based on the above the precision of the data can be considered appropriate for the investigation.
Accuracy	Field considerations: ■ Sampling procedures were appropriate and were complied with. Laboratory considerations: ■ With the exception of some laboratory spike results, all laboratory internal QA/QC results were within acceptable limits for the investigation. However, the exceptions are considered to not affect the accuracy of the investigation. Based on the above the accuracy of the data can be considered appropriate for the investigation.

Based on the evaluation of DQIs the data collected during this investigation can be considered reliable for the basis of forming an opinion on the likelihood of soil contamination occurring on site.

8.2 Groundwater Analysis

All groundwater samples were collected using disposable bailers. Prior to groundwater sampling, the water levels within the groundwater wells were measured using a water level meter, then purged until the water quality parameters measured at the well head were observed to stabilise. During the purging process, indicator parameters (pH, temperature, EC, ORP and DO) were measured using a 90FLMV Water Quality Meter which was calibrated prior to use (refer to Appendix G for calibration certificates and copies of field sampling forms).

Samples were placed directly into appropriately preserved bottles provided by the laboratory and placed into an ice cooled esky to await transport to the laboratory.

Primary and duplicate groundwater samples were analysed by ALS Laboratory Services, and the triplicate groundwater sample was analysed by Envirolab Services, both of which are National Association of Testing Authorities (NATA) accredited for the analyses performed.

8.2.1 Quality Assurance and Quality Control Samples

The following Quality Assurance and Quality Control (QA/QC) samples were collected in conjunction with the investigation program:

- The collection of two duplicate samples in the field was used to assess the field and laboratory techniques. The results of the duplicate analyses are included in Appendix H, and in the data validation report in Appendix J;
- The collection of one triplicate sample in the field was used to assess the laboratory precision. The results of the triplicate analysis are included in Appendix H, and in the data validation report in Appendix J;
- Three travel blanks and three travel spikes to assess the potential for cross-contamination or volatile losses associated with sample storage and handling procedures; and
- Four rinsate blanks to assess the efficacy of the equipment decontamination procedures.

8.2.2 Field and Laboratory Analytical Program

The primary and QA/QC samples were analysed for the following field and laboratory analytical suite:

- Field suite (temperature, pH, electrical conductivity (EC), dissolved oxygen (DO), oxidation reduction potential (ORP));
- Cations and anions (calcium, magnesium, sodium, potassium, chloride, sulphate, fluoride, alkalinity);
- Metals and metalloids (aluminium, arsenic, cadmium, chromium, copper, iron, manganese, mercury, nickel, lead and zinc);
- Nitrate, ammonia, total Kjeldahl nitrogen (TKN);
- Total petroleum hydrocarbons (TPH);
- Volatile organic compounds (VOCs);
- Polycyclic aromatic hydrocarbons (PAHs);
- Speciated phenolics;
- Polychlorinated biphenyls (PCBs);
- Organochlorine Pesticides (OCPs);

- Biochemical oxygen demand (BOD); and
- Total organic carbon (TOC).

8.2.3 Quality Assurance and Quality Control

The quality of the groundwater analytical data was assessed in terms of the data quality indicators described above. The full data validation report is provided in Appendix J, with the key points summarised below:

- The majority of calculated relative percent difference (RPD) values between primary and duplicate/triplicate groundwater samples were within acceptable tolerance limits. The one exception was the RPD value (60%) for dissolved iron between primary sample GABH02 (0.08 mg/L) and triplicate sample QC201 (0.02 mg/L). However, the reported concentrations are relatively low, and the RPD exceedance is not considered to have affected the integrity of the data set;
- Analyte concentrations in travel blanks and rinsate blanks were below the laboratory LORs;
- Travel spike recovery values were within the acceptable tolerance ranges; and
- The majority internal QA/QC checks routinely performed by the laboratories, including the assessment of spikes, blanks, duplicates and surrogates, were within acceptable tolerance limits. The few non-conformances identified were marginal, and are typically associated with internal “dynamic control limits” that are more conservative than the default tolerance limits adopted by Golder. Review of the individual non-conformances has indicated that the overall data quality is not affected.

Overall Golder is satisfied that the groundwater data is suitable for environmental interpretive use.

9.0 RESULTS

9.1 Soil and Pond Sediments

A total of eleven samples were submitted for laboratory analysis from a total of eleven sampling locations (GACS01 through to GACS06 and GABH02 through to GABH06). Two samples (GACS01 and GACS03) were sediment samples collected from surface water ponds. The remaining samples were shallow soil samples collected from various locations across the site. A detailed sampling rationale and a brief description of each location is shown in Table 11. The investigation locations are shown on Figure 3.

9.1.1 Field Screening

9.1.1.1 Visual and Olfactory Observations

Soil samples were ranked for the presence of visual and olfactory contamination in general accordance with the system described in Table 19.

Table 19: Environmental ranking system for soils

Visible Contamination		**Odorous Soil**	
Rank	**Description**	**Rank**	**Description**
0	No visible evidence of contamination	A	No odour
1	Slight evidence of visual contamination (trace quantities)	B	Slightly offensive odour
2	Visible contamination (e.g. more than trace)	C	Moderately offensive odour
3	Obviously contaminated (e.g. significant colour and staining)	D	Strongly offensive odour

Most soil samples collected during the field investigations were described as 0A indicating no evidence of visual contamination and no odours. Samples GACS01 (0.0-0.2m), GACS03 (0.0-0.2m), GACS05 (0.5-0.6m) and GACS01 (1.0-1.2m), potentially exhibited some visible evidence of contamination and odour. Further field screening for volatile compounds and laboratory analysis indicated no contamination for the analytes tested.

9.1.1.2 Field Screening for Volatile Organic Compounds

Soil samples were screened for the presence of volatile organic compounds (VOCs e.g. BTEX compounds) using a photo-ionisation detector (PID). The PID calibration record is included in Appendix G.

PID readings were below 4ppm indicating a low probability of VOC contamination in the materials sampled.

9.1.2 Laboratory Analysis

The results of the laboratory analysis are summarised in Table 20 below. No concentrations of contaminants above the criteria were encountered.

Table 20: Summary of General Study Area Results

Analyte	Adopted Criteria (mg/kg)	No of Analyses	Minimum (mg/kg)	Maximum (mg/kg)	No of Exceedances
Arsenic	500	11	<5	14	0
Cadmium	100	11	<1	<1	0
Copper	500	11	15	146	0
Chromium	5,000	11	4	54	0
Lead	1500	11	7	555	0
Mercury	75	11	<0.1	<0.1	0
Nickel	3,000	11	2	11	0
Zinc	35,000	11	32	1040	0
Benzene	1	11	<0.2	<0.2	0
Toluene	1.4	11	<0.5	<0.5	0
Ethylbenzene	3.1	11	<0.5	<0.5	0
Xylene	14	11	<0.5	<0.5	0
C_6-C_9 TPH	65	11	<10	<10	0
C_{10}-C_{36} TPH	1,000	11	<50	130	0
PAH	100	11	<0.5	<0.5	0
Benzo(a)pyrene	5	11	<0.5	<0.5	0
PCB	50	11	<0.10	<0.10	0
Aldrin + Dieldrin	50	11	<0.1	<0.1	0
Chlordane	250	11	<0.1	<0.1	0
DDT + DDD+ DDE	1000	11	<0.3	<0.3	0
Heptachlor	50	11	<0.05	<0.05	0
Phenol	42,500	11	<0.5	<0.5	0

9.2 Groundwater

9.2.1 Groundwater Analytical Results

Groundwater samples were collected from 21 wells between 17 and 25 August 2011. At the time of sampling GMW107 was found to be dry, and GMW102 and GMW106 only contained enough water for the measurement of field water quality parameters. The water quality results summary table is presented Appendix H, and copies of laboratory certificates of analysis are included in Appendix I.

In the following discussion of groundwater quality, well locations have been grouped into the following representative water types for consideration of certain results:

- Upgradient and cross-gradient wells (shallow sandstone): GMW101 to GMW107;
- Downgradient (shallow sandstone): GMW108D, GMW109D, GMW110, GMW111, GABH01, GABH02, GABH03, GABH04, GABH05, GABH06D; and
- Downgradient (alluvium/ colluvium): GMW108S, GMW109S, GABH06S and BH6 (a pre-existing monitoring well).

9.2.1.1 Groundwater Quality Field Parameters

The measured field water quality parameters from the upgradient and cross-gradient wells were generally indicative of low salinity, oxidising water with a mildly acidic pH. In comparison, the wells installed downgradient of the landfill cells (both within the alluvium and shallow sandstone), the pH values were approximately one unit higher, the EC values were approximately 2000 µs/cm higher, and the DO values were approximately 1 mg/L lower. These subtle changes in water quality indicator parameters may suggest minor leachate impact on groundwater quality downgradient of the existing landfill cells.

The downgradient pH and EC values are consistent with the range of values reported for the licensed groundwater monitoring points BH1 and BH3, which are located down hydraulic gradient from the landfill cells, and BH4A, BH5A and BH6A which are reported to be located to the immediate south of the southern leachate pond.

9.2.1.2 Laboratory Analytical Results

Major Cations and Anions

Major cations (Ca^{2+}, Mg^{2+}, K^{+} and Na^{+}) and anions (SO_4^{2-}, CO_3^{2-}, HCO_3^{-} and Cl^{-}) were analysed to characterise the general groundwater chemistry across the site. Water types are classified according to the major ion concentrations expressed as milliequivalents per litre (meq/L), with only ions comprising greater than 20% of the total being considered in the classification. The summary of water types is presented in Table 21 below.

Table 21: Summary of Chemical Water Types

Sample ID	Water Type
GMW103	Ca-Na-Mg-Cl-HCO3
GMW104	Na-Ca-Mg-HCO3-Cl
GMW105	Na-Ca-HCO3-Cl
GMW108S	Na-Mg-Ca-Cl-HCO3
GMW108D	Na-Mg-Cl-HCO3
GMW109S	Na-Ca-Mg-Cl-HCO3
GMW109D	Na-Ca-Mg-Cl-HCO3
GMW110	Na-Mg-Cl-HCO3
GMW111	Na-Mg-Cl-HCO3
GABH01	Na-Mg-Ca-Cl-HCO3

Sample ID	Water Type
GABH02	Na-Mg-Ca-Cl-HCO3
GABH03	Na-Ca-Mg-Cl-HCO3
GABH04	Na-Mg-Ca-Cl
GABH05	Na-Mg-Ca-Cl-HCO3
GABH06S	Na-Cl-HCO3
GABH06D	Na-Cl-HCO3
BH6	Na-Mg-Cl-HCO3

In general, the samples exhibit a dominant sodium chloride signature, with lesser proportional concentrations of calcium, magnesium and bicarbonate also present. The groundwater signature likely reflects the typical sodium chloride signature of rainfall close to the coast. Bicarbonate is potentially attributable to a combination of dissolution of carbonate minerals in the rock matrix, and from the influence of landfill leachate in which bicarbonate is generated as a byproduct of organic matter decomposition.

These results are presented graphically in a Piper Diagram (Diagram 1), which is a plot of the relative percentage of the various major ions in each sample. The Piper plot indicates a relatively tight cluster of cation compositions, and anion compositions ranging between chloride and bicarbonate dominant. The results of recent surface water sampling from Dapto Creek, and from the leachate collection well, have been included in the plot for reference. In general, the Piper plot indicates relatively similar water types between the upgradient, downgradient and creek water samples, and a leachate signature that is relatively distinct from the water samples. Hence, any leachate influence on groundwater or surface water quality is inferred to be limited.

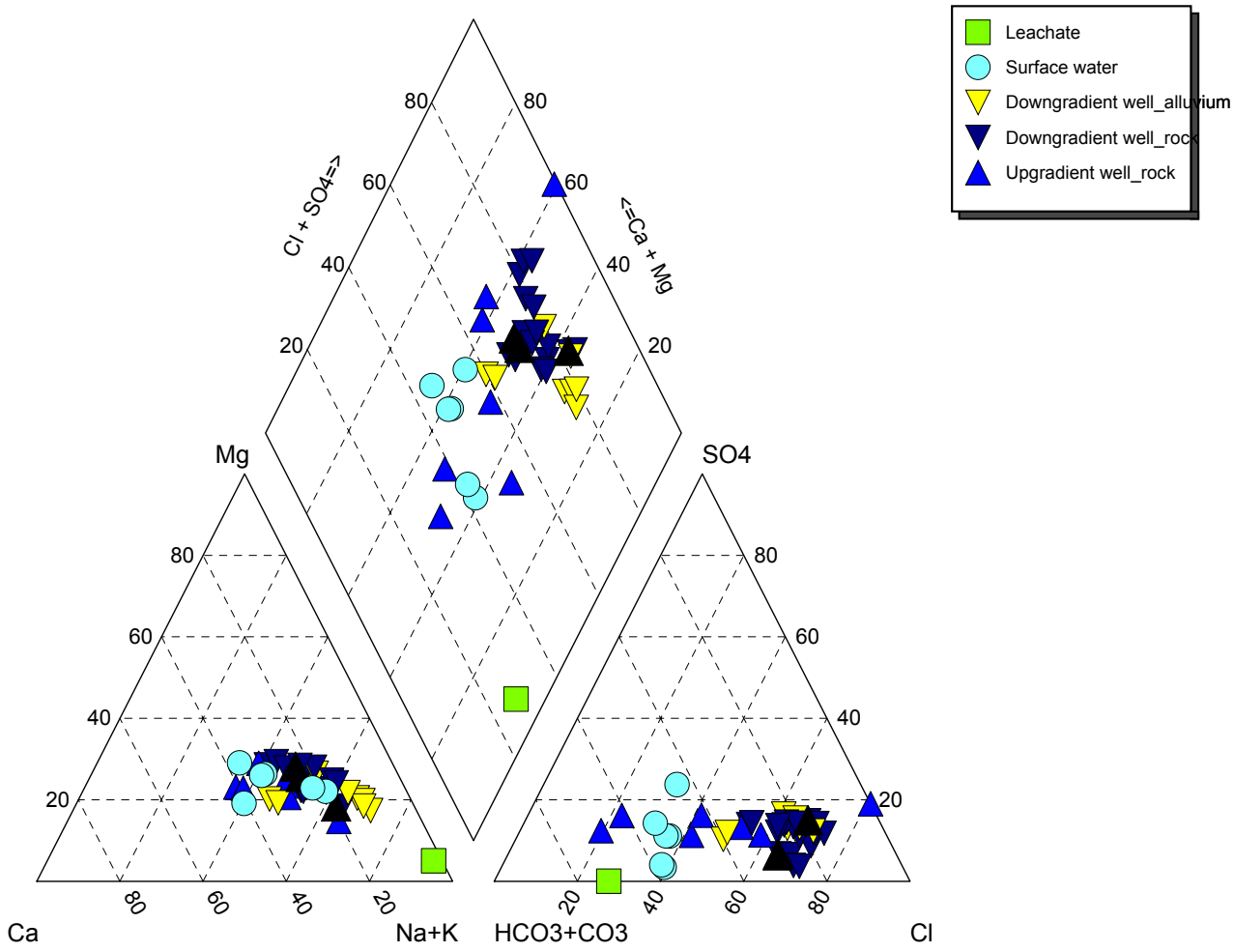


Diagram 1: Piper Diagram of upgradient and downgradient groundwater samples, creek samples and leachate

A bivariate plot of EC versus total alkalinity is presented in Diagram 2, with a roughly linear relationship evident with increasing EC and alkalinity values. The leachate sample has been omitted from this plot due to scale, but would appear in the extreme upper right corner of the plot approximately in line with the linear trend indicated by the water samples. This plot indicates that whilst the upgradient and cross-gradient well locations and creek sample locations have a greater *proportional* concentration of bicarbonate than the downgradient wells (as reflected in the Piper plot), the downgradient wells have greater *absolute* concentrations of alkalinity and EC. This trend suggests a degree of leachate influence on groundwater quality down hydraulic gradient from the filled gullies, however the absolute concentrations of leachate indicator parameters are generally low.

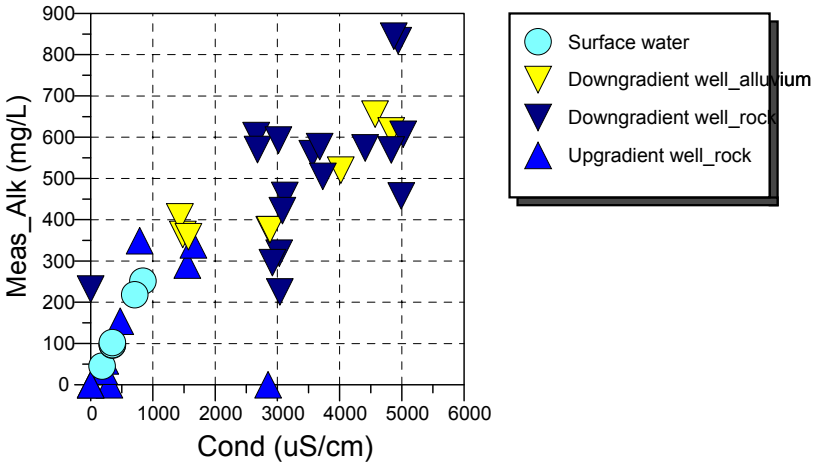


Diagram 2: Bivariate plot of electrical conductivity versus alkalinity.

Metals and Metalloids

A suite of dissolved metals and metalloids was analysed for each sample, which indicated generally low concentrations of most dissolved metals with many below the laboratory LOR. There were a number of minor exceedances of the ANZECC (2000) trigger values. However, when the hardness modification was applied to the assessment criteria for the relevant six metals for each of the samples, the only metals concentrations that still exceeded their criterion were aluminium at GMW105 (which is a marginal exceedance) and manganese at GMW109S.

Hence, the concentrations of metals and metalloids in groundwater are generally acceptable with reference to the ANZECCC (2000) criteria, and do not appear to be negatively influenced by the historical landfill operations.

Nutrients, TOC and BOD

Nitrogen-based nutrients, TOC and BOD were analysed to provide an indication of potential leachate impact to groundwater. In general, nitrate and nitrite concentrations were either low or below the laboratory LOR across the site. It is noted that an errata slip issued with the ANZECC (2000) guidelines indicated that trigger values for nitrate should be deleted and replaced with “under review”; no new nitrate criteria have been issued to date.

Ammonia and TKN concentrations were also generally low or below the laboratory LOR across the site, with the following notable exceptions:

- The highest ammonia and TKN concentrations were reported for well GMW109S, which is located just outside the site boundary in the southwest corner of the site, down hydraulic gradient from the stormwater dam. Review of preliminary results of more recent monitoring confirmed the elevated concentrations. It is unusual that these concentrations appear on the site boundary when they are not reflected in results from upgradient alluvial wells located closer to the landfill cells and leachate ponds. It is possible that seepage from the stormwater dam is contributing to this groundwater quality issue. The concentration is slightly higher than the pH-adjusted ammonia criterion for this location, and should be re-evaluated following future monitoring events to assess whether this is a persistent or transient phenomenon;
- An anomalously high TKN concentration was reported for GMW101, which is upgradient from the northern extent of landfilling in the western gully. This well was found to be dry during a recent monitoring event, but will be re-evaluated during future monitoring if/when sufficient water is present to collect a sample;

- Elevated TOC concentrations were reported for:
  - GMW101 at a concentration of 23 mg/L. As with the elevated TKN concentration, the TOC concentration in upgradient well GMW101 is suspect as impact from landfill operations would not be anticipated upgradient from the landfill cells. This will be re-evaluated during future monitoring events;
  - GMW109S at a concentration of 16 mg/L, which is notably higher than concentrations reported for the rest of the site. This correlates with the elevated ammonia and TKN concentrations for this location, and suggests that leakage or overflow from the stormwater dam may have contributed to the presence of leachate indicator parameters at this location.
- The only reported detections of BOD above the LOR were in GMW110 and GMW111 at concentrations of 5 mg/L in both wells. While the presence of detectable BOD at these locations suggests a leachate impact to groundwater quality, they are sufficiently low to not be considered a significant risk to groundwater quality. As a basis for comparison, the BOD concentration in a recently analysed leachate sample was 1,430 mg/L.

Volatile and Semi-volatile Organic Analytes

The majority of organic analytes were below the laboratory LOR, and detect concentrations above the LOR were below the ANZECC criteria where available. The organic analytes detected above the LOR are summarised below:

- Chloroform was reported at a concentration of 3 µg/L in triplicate sample QC201. This compound was reported as being below the laboratory LOR (5 µg/L) for the parent sample (GABH02) and duplicate sample (QC101). There is no ANZECC criterion available for chloroform, but the concentration is very low and is not considered to be of concern at the site. The presence of chloroform will be evaluated during future monitoring;
- The phenolic compounds 2-methylphenol and 2,4-dimethylphenol were detected at concentrations of 0.5 µg/L and 0.7 µg/L, respectively, in GMW104. There are no ANZECC criteria available for these compounds, but the concentrations are very low and is not considered to be of concern at the site. The presence of these compounds will be evaluated during future monitoring;
- Naphthalene was detected at a concentration of 0.4 µg/L in GMW111. This concentration is below the ANZECC criterion of 16 µg/L. Naphthalene was also detected at a concentration of 6.2 µg/L in a recent leachate sample. GMW111 is located to the west of the northern leachate pond, and the presence of naphthalene at this location suggests a minor impact to groundwater quality from leachate. However, the concentration is not considered to be indicative of a significant risk to groundwater quality. The presence of naphthalene will be evaluated during future monitoring;
- Total xylene (sum of meta-, para- and ortho- isomers) was detected at a concentration of 6 µg/L in GABH02. This concentration is below the ANZECC criteria of 200 µg/L (para-xylene) and 350 µg/L (ortho-xylene). Total xylene was also detected at a concentration of 34 µg/L in a recent leachate sample. GABH02 is located a short distance downgradient from the western gully landfill cell, and is approximately 50 m east of the northern leachate pond. The presence of xylene at this location suggests a minor impact to groundwater quality from leachate. However, the concentration is not considered to be indicative of a significant risk to groundwater quality. The presence of xylene will be evaluated during future monitoring;
- TPH detections were reported as follows (similar concentrations were reported for the equivalent carbon ranges for the TRH analyses):
  - C_6-C_9 fraction in GABH02 (30 µg/L) – this correlates to the xylene detections reported above;
  - C_{15}-C_{28} carbon range in GMW110 (430 µg/L) and GMW111 (1090 µg/L);

- C_{29}-C_{36} carbon range in GMW111 (770 µg/L); and
- Elevated TPH concentrations were also reported in a recent leachate sample, and the presence of TPH in groundwater at these locations suggests a minor impact to groundwater quality from leachate.

The presence of what are predominantly trace concentrations of VOCs and SVOCs in groundwater downgradient from the landfill cells and in proximity to the leachate ponds suggests a degree of leachate impact to groundwater quality in these areas. Most analyte concentrations were very low (i.e. close to the LOR), however the TPH concentrations in groundwater in the vicinity of the leachate ponds warrant close scrutiny during future monitoring events. Whilst the concentrations are significantly lower than those reported for raw leachate, the locations of GMW110 and GMW111 are located outside the western site boundary. The presence of TPH should be evaluated during future monitoring to assess whether these concentrations are persistent over time, and whether further assessment is warranted to evaluate whether these concentrations represent a risk to potential receptors. It is worth noting that all TPH fractions were below the limit of reporting for surface water samples collected from the adjacent Dapto Creek.

10.0 CONCLUSIONS

10.1 Desktop Investigation

Based on the desktop investigation performed for the Whytes Gully RRP, the following conclusions can be drawn:

- It is understood that historical use of the site has largely been rural prior to the commencement of landfill operations;
- Landfilling operations in the Western Gully Cell commenced in 1984 and landfilling operations in the Eastern Gully commenced in 1993;
- The construction of landfill associated infrastructure and amenities including surface water and leachate ponds, the MRF and the SWERF also occurred during the period from 1985 to 2001;
- WorkCover NSW holds three Dangerous Goods Licences for the site. Based on site observations and information provided by Council, the dangerous goods are understood to no longer present on site, with the exception of sodium hydroxide stored as part of the LTP;
- Whytes Gully RRP operates under an existing Environment Protection Licence (EPL) (EPL No. 5862). Non-compliances between 2001 and 2008 have been recorded involving leachate overflow into the stormwater dam and incomplete analytical programs; and
- Based on the site history and existing site conditions landfilling is considered a likely potential source of contamination.

10.2 Preliminary Soil Contamination Assessment

Based on the preliminary soil contamination assessment performed for the Whytes Gully RRP, the following conclusions can be drawn:

- Golder undertook limited sampling, field screening and laboratory analysis of:
  - sediments from two surface water ponds;
  - surface soils from the area adjacent to the old stockyard; and
  - surface soils from the area of the old farm house and backfilled surface water ponds.
- No contaminants above the selected criteria for commercial / industrial landuse (HIL-F) were encountered in the samples analysed.

10.3 Groundwater Assessment

Groundwater quality at the site differs slightly between wells installed upgradient and cross-gradient from the current landfill cells, which exhibit limited (if any) influence from landfill leachate, and those installed downgradient from the landfill cells and related infrastructure that exhibit a degree of impact from landfill leachate. Whilst the concentrations of most leachate indicator parameters are relatively low in the groundwater samples, there is an increasing concentration trend between the upgradient and downgradient wells, as summarised in Table 22.

Table 22: Summary of Leachate Indicator Parameters by Water Type (average concentrations)

Analyte	Units	Shallow Rock		Alluvium	Surface Water	Leachate [3]
		UG [1]	DG [2]			
pH	-log{H}	5.7	6.7	6.6	7.3	8.1
ORP	mV	82	145	31	209	-33
EC	µS/cm	1440	3860	3223	463	22,700
DO	mg/L	3.1	2.4	2.9	7.5	2.4
Total Alkalinity (as CaCO3)	mg/L	232	524	490	135	7060
Ammonia as N	mg/L	0.03	0.03	1.63	0.28	0.69
TKN as N	mg/L	0.2	0.41	1.03	2.65	17.7
TOC	mg/L	8.7	2.5	9.0	12	1780
BOD	mg/L	<2	<2	<2	3.7	1430

1. UG = upgradient wells
2. DG = downgradient wells
3. Leachate data from pond influent sample collected in December 2011

The majority of water quality analytes detected above the laboratory LOR are below the relevant ANZECC (2000) assessment criteria, where available. The groundwater quality issues of primary interest appear to the presence of organic compounds in groundwater at boundary monitoring wells GMW110 and GMW111 (naphthalene and TPH), and the presence of leachate indicator parameters at elevated concentrations at boundary monitoring well GMW109S (ammonia, TKN and TOC). These issues will require close scrutiny during future monitoring events to assess whether the concentrations are persistent over time, and whether they represent a potential risk to off-site receptors.

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12.0 LIMITATIONS AND USE OF THIS REPORT

Your attention is drawn to the document “Limitations”, which is included in Appendix L of this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. The document is not intended to reduce the level of responsibility accepted by Golder Associates, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

Report Signature Page

GOLDER ASSOCIATES PTY LTD





Daniel Dohle
Senior Waste Management Engineer

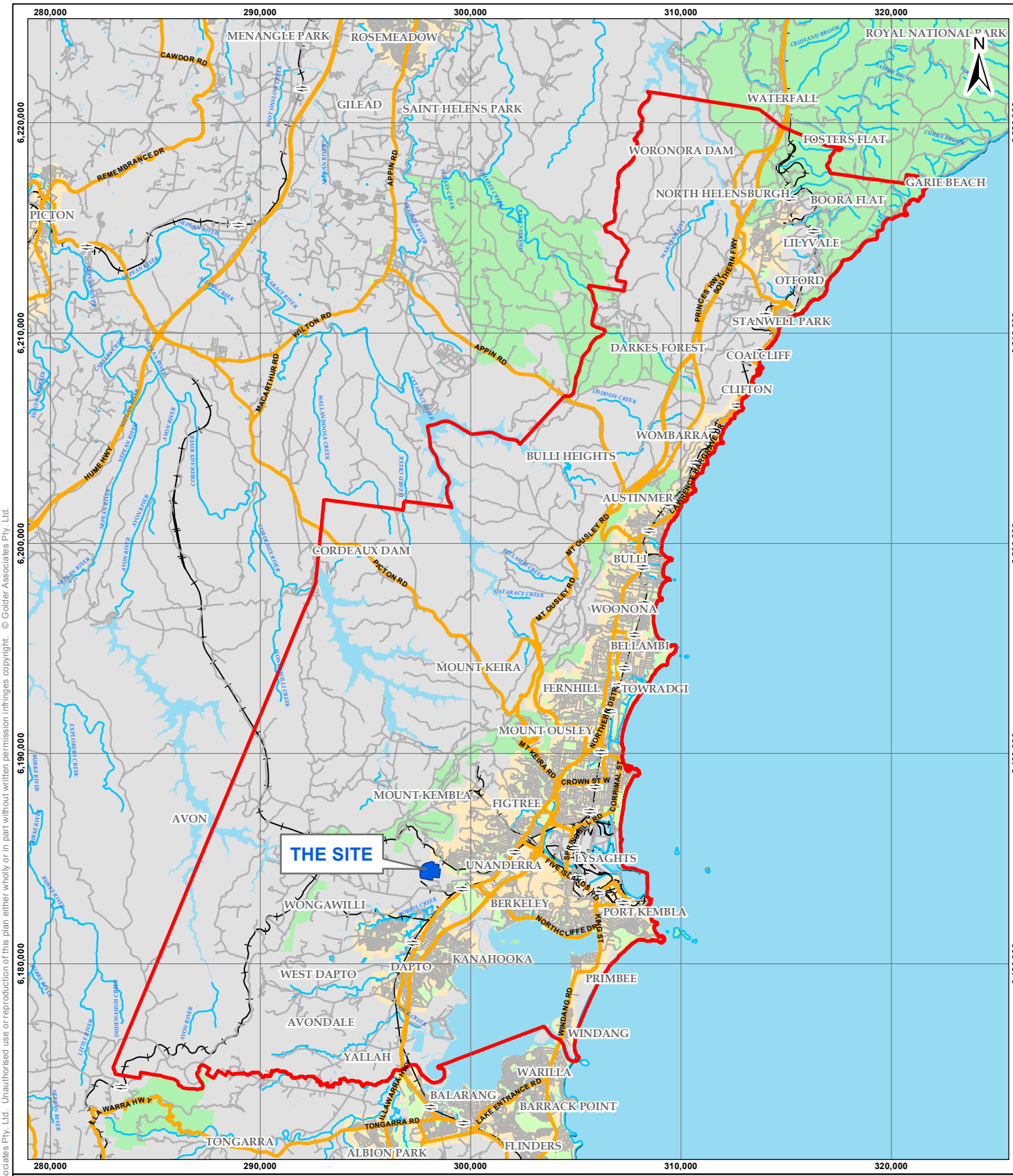
Jacinta McMahon
Principal Environmental Engineer

DD:PR/JLM:SPD/dd:pr

A.B.N. 64 006 107 857

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https://aupws.golder.com/117625003wollongongcitycouncilnewcellwhytesgully/project doc/207 soil, water and sediments contamination study/117625003-046-r-rev0-pesa.docx



WHYTES GULLY NEW LANDFILL CELL
PRELIMINARY ENVIRONMENTAL
SITE ASSESSMENT

Wollongong City Council

REGIONAL AREA



LEGEND

- Site Location
- Wollongong Local Government Area Boundary

0 1 2 4 6 8 Kilometres

SCALE (at A4) 1:250,000

Coordinate System: GDA 1994 MGA Zone 56

PROJECT: **117625003**
DATE: **25/01/2012**
DRAWN: **AJW/FA**
CHECKED: **JMC**

FIGURE 1

COPYRIGHT

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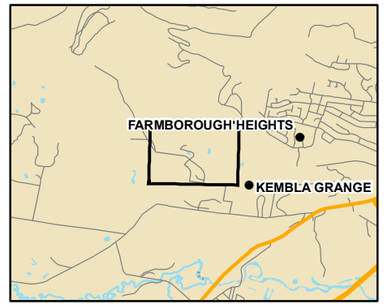
Golder Associates

File Location: J:\GIS\Jobs\117625003_Wollongong Council_New Landfill Cell_Whytes Gully\Workspaces\117625003_046_R_F0001_Rev0_Figure1_RegionalLocation.mxd

WHYTES GULLY NEW LANDFILL CELL PRELIMINARY ENVIRONMENTAL SITE ASSESSMENT

WOLLONGONG CITY COUNCIL

SITE LAYOUT



298,000

N

Western Gully Landfill

Current Tipping Area

Eastern Gully Landfill

Waste Oil Drop Off

Old Weighbridge

Recoverables Drop Off and Buy Back

Secondary Leachate Pond

Green Waste Area

Small Vehicles Recyclables Drop Off

Leachate Treatment Plant

Primary Leachate Pond

Former SWERF Building

Weighbridge

Surface Water Reed Beds

Materials Recycling Facility

Glengarry Cottage

Surface Water Polishing Pond

Main Site Entry

Surface Water Discharge Point

Secondary Site Entry

REDDALL'S ROAD

6,184,000

298,000

LEGEND

- Site Boundary
- Extent of Waste
- Extent of Landfill Works

NOTES

Historic locations digitised by Golder from reports supplied by Wollongong City Council

Aerial Ortho-Photograph provided by AAM Pty. Ltd. taken on 16 May 2011, Reference 18763A. Image Georeferenced.

0 15 30 60 90 120 150 metres

SCALE (at A3) **1:3,800**

Coordinate System: GDA 1994 MGA Zone 56

PROJECT:	**117625003**
DATE:	**1/02/2012**
DRAWN:	**FA**
CHECKED:	**JMc**

FIGURE 2

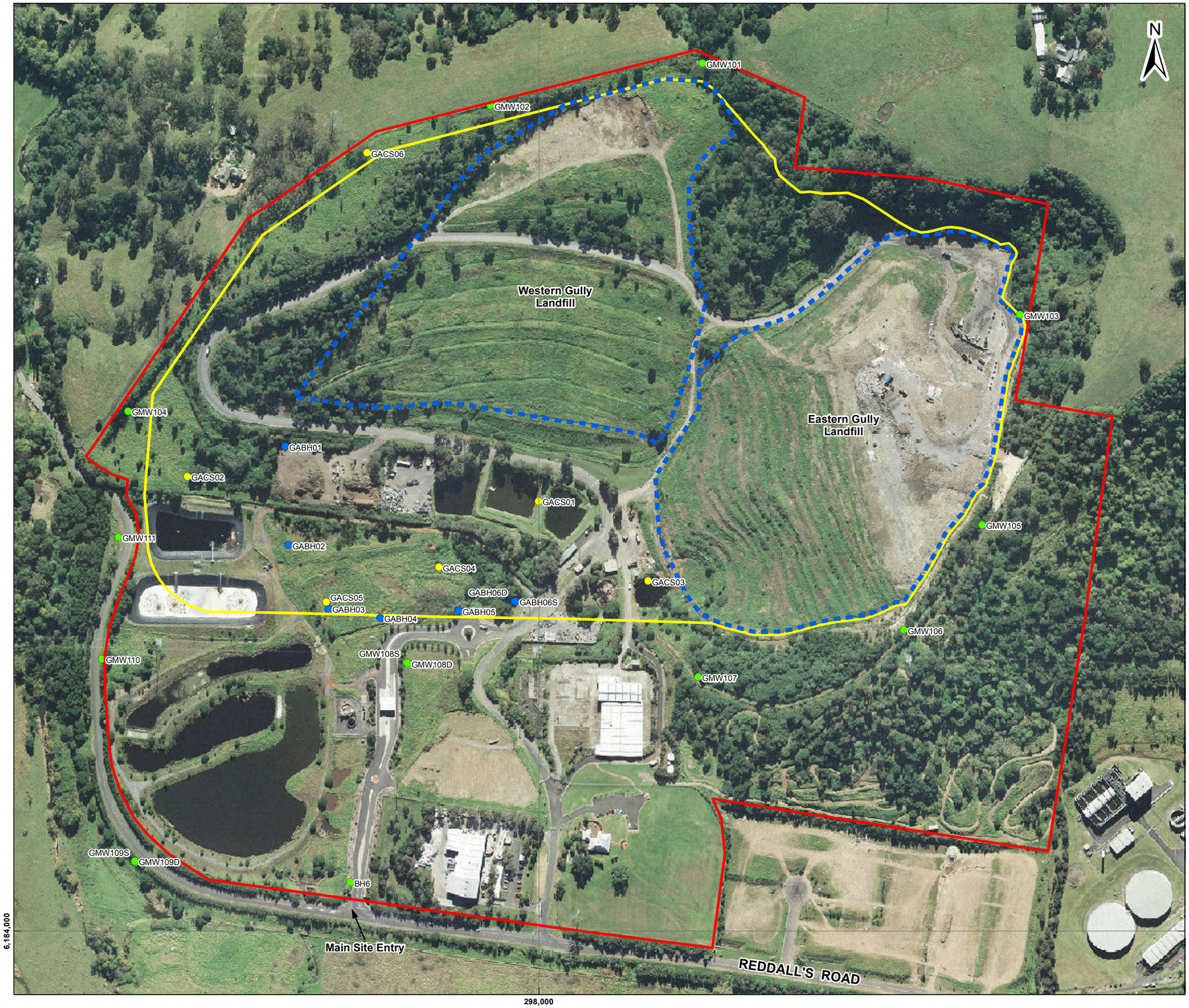
Golder Associates

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File Location: J:\GIS\Jobs\117625003_Wollongong Council_New Landfill Cell_Whytes Gully\Workspaces\117625003_046_R_F0002_General_Site_Details_Rev1.mxd

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298,000



6,184,000

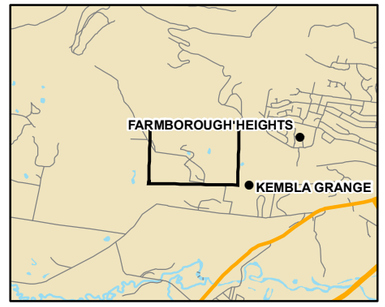
298,000

6,184,000

WHYTES GULLY NEW LANDFILL CELL PRELIMINARY ENVIRONMENTAL SITE ASSESSMENT

WOLLONGONG CITY COUNCIL

INVESTIGATION LOCATIONS



LEGEND

- Contamination Investigation Location
- New Cell Floor Investigation Locations
- Groundwater Monitoring Well
- Approximate Extent of Waste
- Extent of Landfill Works
- Site Boundary

NOTES

Historic locations digitised by Golder from reports supplied by Wollongong City Council

Aerial Ortho-Photograph provided by AAM Pty. Ltd. taken on 16 May 2011, Reference 18763A. Image Georeferenced.

0 15 30 60 90 120 150 metres

SCALE (at A3) 1:3,800

Coordinate System: GDA 1994 MGA Zone 56

PROJECT:	117625003
DATE:	1/02/2012
DRAWN:	FA
CHECKED:	JMc

FIGURE 3

Golder Associates

File Location: \\Syd1-s-file02\jobs\GIS\Jobs\117625003_Wollongong Council_New Landfill Cell_Whytes Gully\Workspaces\117625003_046_R_F0003_InvestigationLocation_Rev0.mxd

APPENDIX A

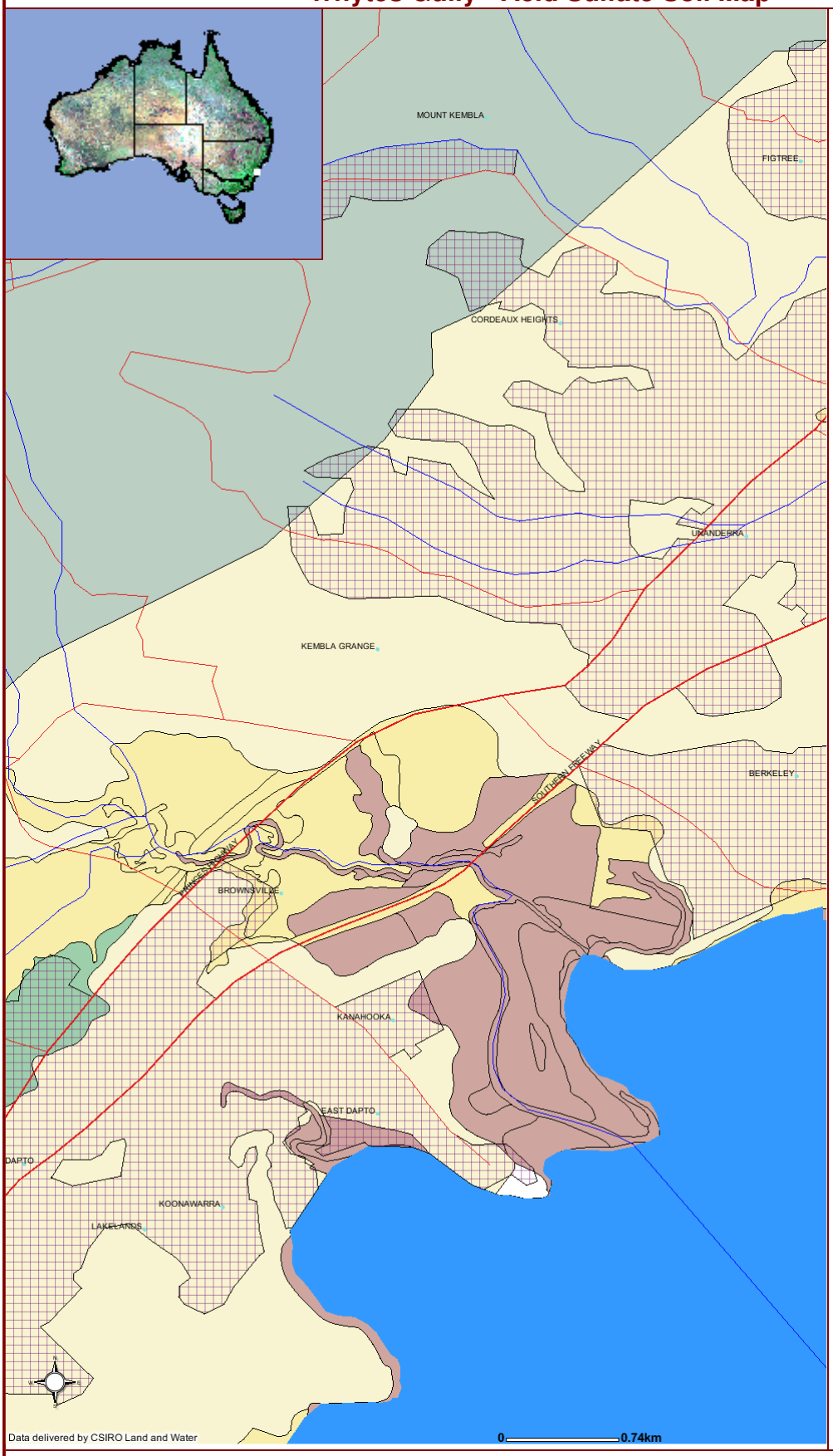
Groundwater Bore Search Results

Provided on DVD

APPENDIX B

Acid Sulfate Soil and Soil Salinity Search Results

Whytes Gully - Acid Sulfate Soil Map



Locations
Roads (1:250K)
Highway
Other Roads
Streams
Major
Minor
Builtup Areas
Inland Water Bodies
CSIRO Archived Profiles
Archived
Not Archived
CSIRO All Profiles
National Acid Sulfate Soils (NatASS)

- A1 High Probability/High Confidence
- A2 High Probability/Moderate Confidence
- A3 High Probability/Low Confidence
- A4 High Probability/Very Low Confidence
- B1 Low Probability/High Confidence
- B2 Low Probability/Moderate Confidence
- B3 Low Probability/Low Confidence
- B4 Low Probability/Very Low Confidence
- C1 Extremely Low Probability/High Confidence
- C2 Extremely Low Probability/Moderate Confidence
- C3 Extremely Low Probability/Low Confidence
- C4 Extremely Low Probability/Very Low Confidence

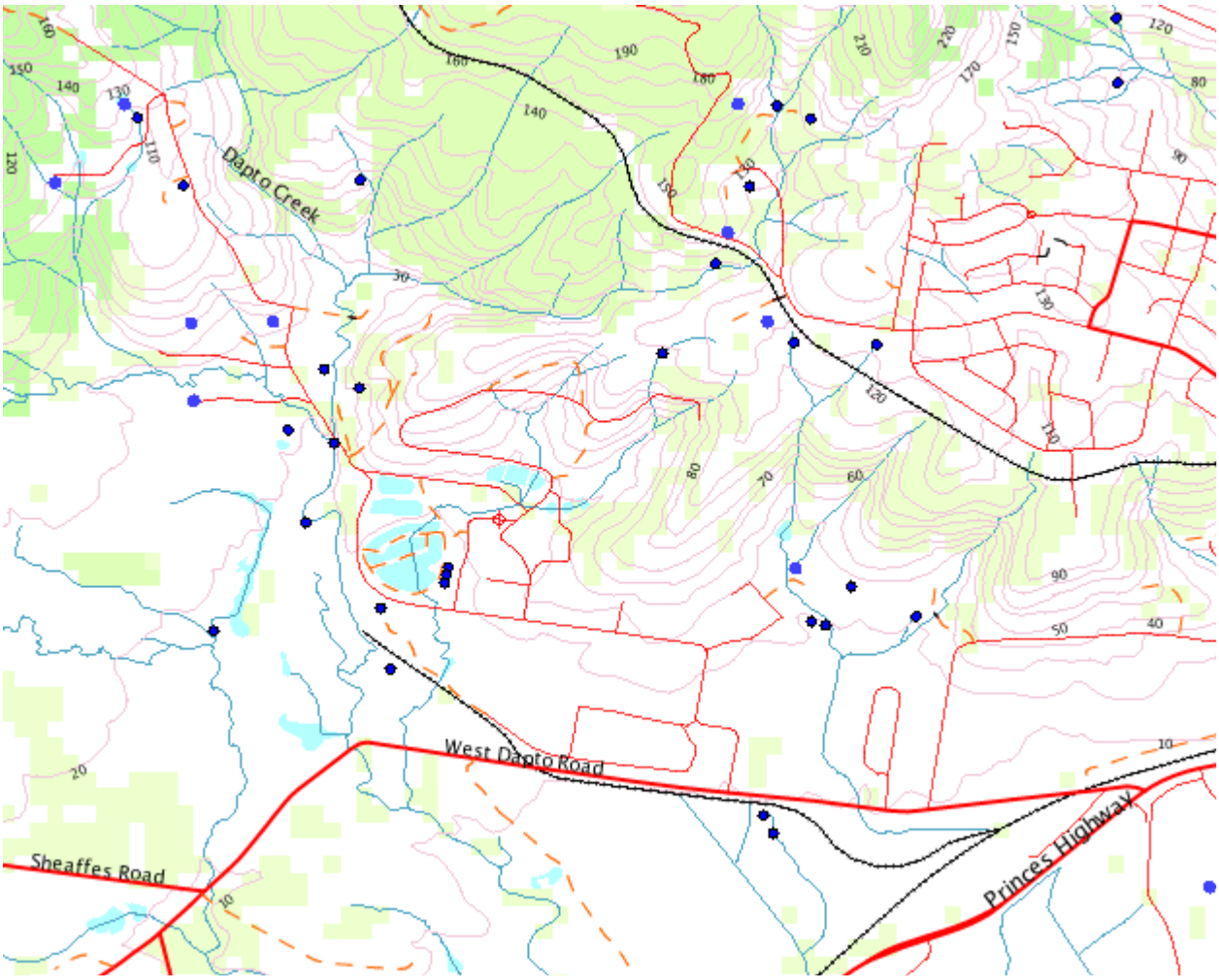
Base-Map

PR 10 Jun 2011

117625003 Whytes Gully - Soil Salinity Hazard

Map created with NSW Natural Resource Atlas - http://www.nratlas.nsw.gov.au

Tuesday, January 31, 2012



0 3 Km

Legend

Symbol	Layer	Custodian
High Moderate Very high	Salinity hazard	
	Cities and large towns renderImage: Cannot build image from features	
Cowra	Populated places renderImage: Cannot build image from features	
	Towns	
	Groundwater Bores	
	Catchment Management Authority boundaries	
	Major rivers	



Topographic base map

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APPENDIX C

Aerial Photographs

1951



1961



1963



1970



1974



1975



1984



1988



1994



2000



2002



2005



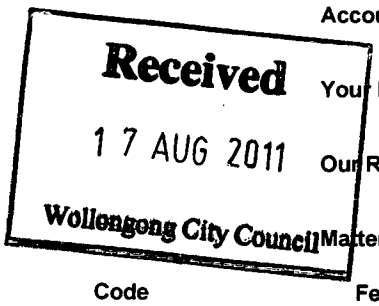
APPENDIX D

Certificates of Titles

CHARGING SUMMARY

ESPREON
AN SAI GLOBAL COMPANY

WOLLONGONG CITY
LOCKED BAG 8821
WOLLONGONG
NSW 2500



Account: 8289460001

Your Reference: P&R:RMC (28.15.01.023)

Our Reference: SSR21561559

Matter Name: REQ. TO ISSUE CT 501/1079122

Date	Item	Description	Code	Fee	GST	Auth Fee*	Auth GST	Total
15/07/20	Registration Disbursement #	LODGE REQUEST	SSRREGDISB	0.00	0.00	99.50	0.00	99.50
16/08/20	Register	NSW - LTO	SSRREGNSW	25.80	2.58	0.00	0.00	28.38
TOTALS:				**25.80**	**2.58**	**99.50**	**0.00**	**127.88**

* Fees paid to authorities have been paid as your agent.

Fee item has been invoiced.

CONTROLLED

Do not use this report for reconciliation with your Invoice, and indicates the projected cost of the placed item(s).

BOX 39U
(AG378107)

NEW SOUTH WALES

CERTIFICATE OF TITLE

REAL PROPERTY ACT, 1900

TORRENS TITLE REFERENCE	
501/1079122	
EDITION	DATE OF ISSUE
1	15/8/2011
CERTIFICATE AUTHENTICATION CODE	
JCKW-XG-JJQG	

I certify that the person described in the First Schedule is the registered proprietor of an estate in fee simple (or such other estate or interest as is set forth in that Schedule) in the land within described subject to such exceptions, encumbrances, interests and entries as appear in the Second Schedule and to any additional entries in the Folio of the Register.

REGISTRAR GENERAL

LAND

LOT 501 IN DEPOSITED PLAN 1079122
AT KEMBLA GRANGE.
LOCAL GOVERNMENT AREA: WOLLONGONG.
PARISH OF KEMBLA COUNTY OF CAMDEN
TITLE DIAGRAM: DP1079122

FIRST SCHEDULE

WOLLONGONG CITY COUNCIL

SECOND SCHEDULE
---
1. RESERVATIONS AND CONDITIONS IN THE CROWN GRANT(S)
2. NOTIFICATION IN GOVERNMENT GAZETTE DATED 13.5.1966 FOLIOS 1916/18: EASEMENT FOR TRANSMISSION LINE AFFECTING THE PART SHOWN DESIGNATED (C) IN THE TITLE DIAGRAM
   U957772 EASEMENT NOW VESTED IN IN ILLAWARRA ELECTRICITY
3. DP708258 RESTRICTION(S) ON THE USE OF LAND
4. DP1022266 RESTRICTION(S) ON THE USE OF LAND
5. DP1080155 EASEMENT FOR OVERHEAD POWER LINE(S) 6 METRE(S) WIDE AFFECTING THE PART(S) SHOWN SO BURDENED IN DP1080155
6. DP1080155 EASEMENT FOR UNDERGROUND CABLES 4 METRE(S) WIDE AFFECTING THE PART(S) SHOWN SO BURDENED IN DP1080155
7. DP1080155 EASEMENT FOR PADMOUNT SUBSTATION 2.75 METRE(S) WIDE AFFECTING THE PART(S) SHOWN SO BURDENED IN DP1080155
8. DP1080155 RESTRICTION(S) ON THE USE OF LAND
9. AD438285 EASEMENT FOR OVERHEAD POWER LINE(S) 9 METRE(S) WIDE AFFECTING THE SITE DESIGNATED (A) IN DP1079122

**** END OF CERTIFICATE ****

ANY ATTEMPT TO ALTER THIS CERTIFICATE COULD RESULT IN HEAVY FINES OR IMPRISONMENT (S.141 REAL PROPERTY ACT).

WARNING: BEFORE DEALING WITH THIS LAND, SEARCH THE CURRENT FOLIO OF THE REGISTER

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Information provided through Tri-Search an approved LPI*NSW* Information Broker

LAND AND PROPERTY INFORMATION NEW SOUTH WALES - TITLE SEARCH

FOLIO: 2/240557

SEARCH DATE	TIME	EDITION NO	DATE
23/6/2011	1:35 PM	1	14/10/1994

LAND

LOT 2 IN DEPOSITED PLAN 240557
AT WEST DAPTO
LOCAL GOVERNMENT AREA WOLLONGONG
PARISH OF KEMBLA COUNTY OF CAMDEN
TITLE DIAGRAM DP240557

FIRST SCHEDULE

THE COUNCIL OF THE CITY OF WOLLONGONG

SECOND SCHEDULE (2 NOTIFICATIONS)

---

1 RESERVATIONS AND CONDITIONS IN THE CROWN GRANT(S)
2 DP649679 EASEMENT FOR ELECTRICITY PURPOSES 20.115 WIDE
AFFECTING THE PART(S) SHOWN SO BURDENED IN DP649679

NOTATIONS

NOTE: THE CERTIFICATE OF TITLE FOR THIS FOLIO OF THE REGISTER DOES NOT INCLUDE SECURITY FEATURES INCLUDED ON COMPUTERISED CERTIFICATES OF TITLE ISSUED FROM 4TH JANUARY, 2004. IT IS RECOMMENDED THAT STRINGENT PROCESSES ARE ADOPTED IN VERIFYING THE IDENTITY OF THE PERSON(S) CLAIMING A RIGHT TO DEAL WITH THE LAND COMPRISED IN THIS FOLIO.
UNREGISTERED DEALINGS: NIL

*** END OF SEARCH ***

ANY ENTRIES PRECEDED BY AN ASTERISK DO NOT APPEAR ON THE CURRENT EDITION OF THE CERTIFICATE OF TITLE. WARNING: THE INFORMATION APPEARING UNDER NOTATIONS HAS NOT BEEN FORMALLY RECORDED IN THE REGISTER.

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LAND AND PROPERTY INFORMATION NEW SOUTH WALES - TITLE SEARCH

FOLIO: 502/1079122

SEARCH DATE	TIME	EDITION NO	DATE
23/6/2011	1:40 PM	1	5/12/2007

LAND

LOT 502 IN DEPOSITED PLAN 1079122
AT KEMBLA GRANGE
LOCAL GOVERNMENT AREA WOLLONGONG
PARISH OF KEMBLA COUNTY OF CAMDEN
TITLE DIAGRAM DP1079122

FIRST SCHEDULE

WOLLONGONG CITY COUNCIL

SECOND SCHEDULE (4 NOTIFICATIONS)

---

1 LAND EXCLUDES MINERALS
2 THE LAND HEREIN IS PUBLIC ROAD
3 AD438285 EASEMENT FOR OVERHEAD POWER LINE(S) 9 METRE(S) WIDE AFFECTING THE SITE DESIGNATED (A) IN THE TITLE DIAGRAM
4 AD438285 EASEMENT FOR OVERHEAD POWER LINE(S) 45.72 METRE(S) WIDE AFFECTING THE SITE DESIGNATED (B) IN THE TITLE DIAGRAM

NOTATIONS

AC990882 NOTE: CLOSED ROAD GAZ 9.3.2007 FOL.1721
UNREGISTERED DEALINGS: NIL

*** END OF SEARCH ***

ANY ENTRIES PRECEDED BY AN ASTERISK DO NOT APPEAR ON THE CURRENT EDITION OF THE CERTIFICATE OF TITLE. WARNING: THE INFORMATION APPEARING UNDER NOTATIONS HAS NOT BEEN FORMALLY RECORDED IN THE REGISTER.

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LAND AND PROPERTY INFORMATION NEW SOUTH WALES - TITLE SEARCH

FOLIO: 51/1022266

SEARCH DATE	TIME	EDITION NO	DATE
23/6/2011	1:41 PM	2	5/12/2007

LAND

LOT 51 IN DEPOSITED PLAN 1022266
AT WEST DAPTO
LOCAL GOVERNMENT AREA WOLLONGONG
PARISH OF KEMBLA COUNTY OF CAMDEN
TITLE DIAGRAM DP1022266

FIRST SCHEDULE

THE COUNCIL OF THE CITY OF WOLLONGONG

SECOND SCHEDULE (3 NOTIFICATIONS)

1 RESERVATIONS AND CONDITIONS IN THE CROWN GRANT(S)
2 DP708258 RESTRICTION(S) ON THE USE OF LAND
3 AD438285 EASEMENT FOR OVERHEAD POWER LINE(S) 9 METRE(S) WIDE AFFECTING THE SITE DESIGNATED (A) IN DP1079122

NOTATIONS

UNREGISTERED DEALINGS: NIL

*** END OF SEARCH ***

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LAND AND PROPERTY INFORMATION NEW SOUTH WALES - TITLE SEARCH

FOLIO: 52/1022266

SEARCH DATE	TIME	EDITION NO	DATE
23/6/2011	1:42 PM	4	28/5/2010

LAND

LOT 52 IN DEPOSITED PLAN 1022266
AT WEST DAPTO
LOCAL GOVERNMENT AREA WOLLONGONG
PARISH OF KEMBLA COUNTY OF CAMDEN
TITLE DIAGRAM DP1022266

FIRST SCHEDULE

THE COUNCIL OF THE CITY OF WOLLONGONG

SECOND SCHEDULE (7 NOTIFICATIONS)

---

1 NOTIFICATION IN GOVERNMENT GAZETTE DATED 13.5.1966 FOLIOS 1916/18: EASEMENT FOR TRANSMISSION LINE AFFECTING THE PART SHOWN SO BURDENED IN THE TITLE DIAGRAM
U957772 EASEMENT NOW VESTED IN ILLAWARRA ELECTRICITY
2 LAND EXCLUDES MINERALS AS TO PART AND IS SUBJECT TO RESERVATIONS AND CONDITIONS IN FAVOUR OF THE CROWN SEE MEMORANDUM S700000A (1/723106) AND CROWN GRANT (POR 9)
3 DP708258 RESTRICTION(S) ON THE USE OF LAND AFFECTING THE PART SHOWN SO BURDENED IN THE TITLE DIAGRAM
4 EXCEPTING LAND BELOW A DEPTH FROM THE SURFACE OF 20 METRES WITHIN THE PART SHOWN SO INDICATED IN THE TITLE DIAGRAM
5 DP1022266 RIGHT OF CARRIAGEWAY VARIABLE WIDTH APPURTENANT TO THE LAND ABOVE DESCRIBED
6 DP1022266 EASEMENT FOR SERVICES VARIABLE WIDTH APPURTENANT TO THE LAND ABOVE DESCRIBED
7 DP1118812 EASEMENT FOR OVERHEAD POWER LINE(S) 9 METRE(S) WIDE AFFECTING THE PART(S) SHOWN SO BURDENED IN DP1118812

NOTATIONS

UNREGISTERED DEALINGS: NIL

*** END OF SEARCH ***

PO SYD7399 PRINTED ON 23/6/2011

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LAND AND PROPERTY INFORMATION NEW SOUTH WALES - TITLE SEARCH

FOLIO: 53/1022266

SEARCH DATE	TIME	EDITION NO	DATE
23/6/2011	1:42 PM	1	22/1/2001

LAND

LOT 53 IN DEPOSITED PLAN 1022266
AT WEST DAPTO
LOCAL GOVERNMENT AREA WOLLONGONG
PARISH OF KEMBLA COUNTY OF CAMDEN
TITLE DIAGRAM DP1022266

FIRST SCHEDULE

THE COUNCIL OF THE CITY OF WOLLONGONG

SECOND SCHEDULE (7 NOTIFICATIONS)

---

1 NOTIFICATION IN GOVERNMENT GAZETTE DATED 13.5.1966 FOLIOS 1916/18: EASEMENT FOR TRANSMISSION LINE AFFECTING THE PART SHOWN SO BURDENED IN THE TITLE DIAGRAM
U957772 EASEMENT NOW VESTED IN ILLAWARRA ELECTRICITY
2 LAND EXCLUDES MINERALS AS TO PART AND IS SUBJECT TO RESERVATIONS AND CONDITIONS IN FAVOUR OF THE CROWN SEE MEMORANDUM S700000A (1/723106) AND CROWN GRANT (POR 9)
3 DP708258 RESTRICTION(S) ON THE USE OF LAND AFFECTING THE PART SHOWN SO BURDENED IN THE TITLE DIAGRAM
4 EXCEPTING LAND BELOW A DEPTH FROM THE SURFACE OF 20 METRES WITHIN THE PART SHOWN SO INDICATED IN THE TITLE DIAGRAM
5 DP1022266 RIGHT OF CARRIAGEWAY VARIABLE WIDTH AFFECTING THE PART(S) SHOWN SO BURDENED IN THE TITLE DIAGRAM
6 DP1022266 EASEMENT FOR SERVICES VARIABLE WIDTH AFFECTING THE PART(S) SHOWN SO BURDENED IN THE TITLE DIAGRAM
7 DP1022266 RESTRICTION(S) ON THE USE OF LAND

NOTATIONS

NOTE: THE CERTIFICATE OF TITLE FOR THIS FOLIO OF THE REGISTER DOES NOT INCLUDE SECURITY FEATURES INCLUDED ON COMPUTERISED CERTIFICATES OF TITLE ISSUED FROM 4TH JANUARY, 2004. IT IS RECOMMENDED THAT STRINGENT PROCESSES ARE ADOPTED IN VERIFYING THE IDENTITY OF THE PERSON(S) CLAIMING A RIGHT TO DEAL WITH THE LAND COMPRISED IN THIS FOLIO.
UNREGISTERED DEALINGS: NIL

*** END OF SEARCH ***

PO SYD7399 PRINTED ON 23/6/2011

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LAND AND PROPERTY INFORMATION NEW SOUTH WALES - HISTORICAL SEARCH

SEARCH DATE

24/6/2011 2:36PM

FOLIO: 1/628845

Recorded	Number	Type of Instrument	C.T. Issue
28/3/1988		TITLE AUTOMATION PROJECT	LOT RECORDED FOLIO NOT CREATED

*** END OF SEARCH ***

ANY ENTRIES PRECEDED BY AN ASTERISK DO NOT APPEAR ON THE CURRENT EDITION OF THE CERTIFICATE OF TITLE. WARNING: THE INFORMATION APPEARING UNDER NOTATIONS HAS NOT BEEN FORMALLY RECORDED IN THE REGISTER.

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LAND AND PROPERTY INFORMATION NEW SOUTH WALES - HISTORICAL SEARCH

SEARCH DATE

24/6/2011 10:42AM

FOLIO: 1/723106

First Title(s): 1/723106
Prior Title(s): CROWN LAND

Recorded	Number	Type of Instrument	C.T. Issue
23/11/1987	DP723106	DEPOSITED PLAN	LOT RECORDED FOLIO NOT CREATED
11/4/1988	FI65974	FOLIO INSTRUCTION	FOLIO CREATED EDITION 1
18/7/1988	DP776338	DEPOSITED PLAN	FOLIO CANCELLED

*** END OF SEARCH ***

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LAND AND PROPERTY INFORMATION NEW SOUTH WALES - HISTORICAL SEARCH

SEARCH DATE

23/6/2011 2:00PM

FOLIO: 2/240557

First Title(s): SEE PRIOR TITLE(S)
Prior Title(s): VOL 15018 FOL 150

Recorded	Number	Type of Instrument	C.T. Issue
5/6/1987		TITLE AUTOMATION PROJECT	LOT RECORDED FOLIO NOT CREATED
14/7/1987		CONVERTED TO COMPUTER FOLIO	FOLIO CREATED CT NOT ISSUED
14/10/1994	DP649679	DEPOSITED PLAN	EDITION 1
27/10/2010	AF837617	DEPARTMENTAL DEALING	

*** END OF SEARCH ***

ANY ENTRIES PRECEDED BY AN ASTERISK DO NOT APPEAR ON THE CURRENT EDITION OF THE CERTIFICATE OF TITLE. WARNING: THE INFORMATION APPEARING UNDER NOTATIONS HAS NOT BEEN FORMALLY RECORDED IN THE REGISTER.

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LAND AND PROPERTY INFORMATION NEW SOUTH WALES - HISTORICAL SEARCH

SEARCH DATE

23/6/2011 5:48PM

FOLIO: 50/1022266

First Title(s): OLD SYSTEM
Prior Title(s): 203/708258

Recorded	Number	Type of Instrument	C.T. Issue
22/1/2001	DP1022266	DEPOSITED PLAN	FOLIO CREATED EDITION 1
23/6/2005	DP1080155	DEPOSITED PLAN	EDITION 2
6/2/2007	DP1079122	DEPOSITED PLAN	
6/6/2007	AD174325	DEPARTMENTAL DEALING	
5/12/2007	AD438285	GRANT OF EASEMENT	EDITION 3
24/7/2008	AE104125	DEPARTMENTAL DEALING	

*** END OF SEARCH ***

ANY ENTRIES PRECEDED BY AN ASTERISK DO NOT APPEAR ON THE CURRENT EDITION OF THE CERTIFICATE OF TITLE. WARNING: THE INFORMATION APPEARING UNDER NOTATIONS HAS NOT BEEN FORMALLY RECORDED IN THE REGISTER.

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LAND AND PROPERTY INFORMATION NEW SOUTH WALES - HISTORICAL SEARCH

SEARCH DATE

23/6/2011 5:44PM

FOLIO: 51/1022266

First Title(s): OLD SYSTEM
Prior Title(s): 203/708258

Recorded	Number	Type of Instrument	C.T. Issue
22/1/2001	DP1022266	DEPOSITED PLAN	FOLIO CREATED EDITION 1
5/12/2007	AD438285	GRANT OF EASEMENT	EDITION 2

*** END OF SEARCH ***

PO SYD7399 PRINTED ON 23/6/2011

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LAND AND PROPERTY INFORMATION NEW SOUTH WALES - HISTORICAL SEARCH

SEARCH DATE

23/6/2011 5:46PM

FOLIO: 52/1022266

First Title(s): 1/723106 OLD SYSTEM
Prior Title(s): 203/708258 301/776338

Recorded	Number	Type of Instrument	C.T. Issue
22/1/2001	DP1022266	DEPOSITED PLAN	FOLIO CREATED EDITION 1
26/2/2001	7439600	LEASE	EDITION 2
11/2/2008	DP1118812	DEPOSITED PLAN	EDITION 3
28/5/2010	AF511061	DETERMINATION OF LEASE	EDITION 4

*** END OF SEARCH ***

ANY ENTRIES PRECEDED BY AN ASTERISK DO NOT APPEAR ON THE CURRENT EDITION OF THE CERTIFICATE OF TITLE. WARNING: THE INFORMATION APPEARING UNDER NOTATIONS HAS NOT BEEN FORMALLY RECORDED IN THE REGISTER.

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LAND AND PROPERTY INFORMATION NEW SOUTH WALES - HISTORICAL SEARCH

SEARCH DATE

23/6/2011 5:47PM

FOLIO: 53/1022266

First Title(s): 1/723106 OLD SYSTEM
Prior Title(s): 203/708258 301/776338

Recorded	Number	Type of Instrument	C.T. Issue
22/1/2001	DP1022266	DEPOSITED PLAN	FOLIO CREATED EDITION 1

*** END OF SEARCH ***

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LAND AND PROPERTY INFORMATION NEW SOUTH WALES - HISTORICAL SEARCH

SEARCH DATE

24/6/2011 11:08AM

FOLIO: 201/708258

First Title(s): OLD SYSTEM
Prior Title(s): VOL 15135 FOL 54

Recorded	Number	Type of Instrument	C.T. Issue
21/2/1985	DP708258	DEPOSITED PLAN	FOLIO CREATED EDITION 1
18/6/1985	V785828	DEPARTMENTAL DEALING	EDITION 2
18/7/1988	DP776338	DEPOSITED PLAN	FOLIO CANCELLED

*** END OF SEARCH ***

ANY ENTRIES PRECEDED BY AN ASTERISK DO NOT APPEAR ON THE CURRENT EDITION OF THE CERTIFICATE OF TITLE. WARNING: THE INFORMATION APPEARING UNDER NOTATIONS HAS NOT BEEN FORMALLY RECORDED IN THE REGISTER.

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LAND AND PROPERTY INFORMATION NEW SOUTH WALES - HISTORICAL SEARCH

SEARCH DATE

24/6/2011 2:48PM

FOLIO: 202/708258

First Title(s): OLD SYSTEM
Prior Title(s): VOL 15135 FOL 54

Recorded	Number	Type of Instrument	C.T. Issue
21/2/1985	DP708258	DEPOSITED PLAN	FOLIO CREATED EDITION 1
2/4/1985	V662207	DEPARTMENTAL DEALING	EDITION 2
18/9/1985	V953875	DEPARTMENTAL DEALING	
18/9/1985	V939050	MORTGAGE	EDITION 3
24/9/1993	I669065	TSFR BY MTGEE-POWER OF SALE	EDITION 4
20/1/1999	5535192	MORTGAGE	EDITION 5
6/8/1999	6073730	CAVEAT	
4/2/2002	8325549	CAVEAT	
1/10/2003	AA26836	WITHDRAWAL OF CAVEAT	
1/10/2003	AA26837	WITHDRAWAL OF CAVEAT	
1/10/2003	AA26839	DISCHARGE OF MORTGAGE	
1/10/2003	AA26840	TRANSFER	EDITION 6
16/11/2005	AB917032	TRANSFER	
16/11/2005	AB917033	MORTGAGE	EDITION 7
27/3/2008	DP1120230	DEPOSITED PLAN	FOLIO CANCELLED RESIDUE REMAINS

*** END OF SEARCH ***

PO SYD7399 PRINTED ON 24/6/2011

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LAND AND PROPERTY INFORMATION NEW SOUTH WALES - HISTORICAL SEARCH

SEARCH DATE

24/6/2011 2:49PM

FOLIO: 203/708258

First Title(s): OLD SYSTEM
Prior Title(s): VOL 15135 FOL 54

Recorded	Number	Type of Instrument	C.T. Issue
21/2/1985	DP708258	DEPOSITED PLAN	FOLIO CREATED EDITION 1
2/4/1985	V662207	DEPARTMENTAL DEALING	EDITION 2
18/9/1985	V953875	DEPARTMENTAL DEALING	
18/9/1985	V939050	MORTGAGE	EDITION 3
20/8/1992	E701269	DISCHARGE OF MORTGAGE	
20/8/1992	E701270	DISCHARGE OF MORTGAGE	
20/8/1992	E701271	TRANSFER	EDITION 4
2/2/1993	I63470	CAVEAT	
28/2/1994	U65862	WITHDRAWAL OF CAVEAT	
3/7/1995	U957772	REQUEST	
3/10/2000	6840677	REJECTED - CAVEAT	
22/1/2001	DP1022266	DEPOSITED PLAN	FOLIO CANCELLED

*** END OF SEARCH ***

ANY ENTRIES PRECEDED BY AN ASTERISK DO NOT APPEAR ON THE CURRENT EDITION OF THE CERTIFICATE OF TITLE. WARNING: THE INFORMATION APPEARING UNDER NOTATIONS HAS NOT BEEN FORMALLY RECORDED IN THE REGISTER.

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LAND AND PROPERTY INFORMATION NEW SOUTH WALES - HISTORICAL SEARCH

SEARCH DATE

24/6/2011 10:10AM

FOLIO: 203/708258

First Title(s): OLD SYSTEM
Prior Title(s): VOL 15135 FOL 54

Recorded	Number	Type of Instrument	C.T. Issue
21/2/1985	DP708258	DEPOSITED PLAN	FOLIO CREATED EDITION 1
2/4/1985	V662207	DEPARTMENTAL DEALING	EDITION 2
18/9/1985	V953875	DEPARTMENTAL DEALING	
18/9/1985	V939050	MORTGAGE	EDITION 3
20/8/1992	E701269	DISCHARGE OF MORTGAGE	
20/8/1992	E701270	DISCHARGE OF MORTGAGE	
20/8/1992	E701271	TRANSFER	EDITION 4
2/2/1993	I63470	CAVEAT	
28/2/1994	U65862	WITHDRAWAL OF CAVEAT	
3/7/1995	U957772	REQUEST	
3/10/2000	6840677	REJECTED - CAVEAT	
22/1/2001	DP1022266	DEPOSITED PLAN	FOLIO CANCELLED

*** END OF SEARCH ***

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LAND AND PROPERTY INFORMATION NEW SOUTH WALES - HISTORICAL SEARCH

SEARCH DATE

24/6/2011 10:33AM

FOLIO: 301/776338

First Title(s): OLD SYSTEM 1/723106
Prior Title(s): 201/708258 1/723106

Recorded	Number	Type of Instrument	C.T. Issue
21/7/1988	DP776338	DEPOSITED PLAN	FOLIO CREATED EDITION 1
3/7/1995	U957772	REQUEST	
22/1/2001	DP1022266	DEPOSITED PLAN	FOLIO CANCELLED

*** END OF SEARCH ***

ANY ENTRIES PRECEDED BY AN ASTERISK DO NOT APPEAR ON THE CURRENT EDITION OF THE CERTIFICATE OF TITLE. WARNING: THE INFORMATION APPEARING UNDER NOTATIONS HAS NOT BEEN FORMALLY RECORDED IN THE REGISTER.

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LAND AND PROPERTY INFORMATION NEW SOUTH WALES - HISTORICAL SEARCH

SEARCH DATE

23/6/2011 5:41PM

FOLIO: 501/1079122

Recorded	Number	Type of Instrument	C.T. Issue
6/2/2007	DP1079122	DEPOSITED PLAN	LOT RECORDED FOLIO NOT CREATED

*** END OF SEARCH ***

ANY ENTRIES PRECEDED BY AN ASTERISK DO NOT APPEAR ON THE CURRENT EDITION OF THE CERTIFICATE OF TITLE. WARNING: THE INFORMATION APPEARING UNDER NOTATIONS HAS NOT BEEN FORMALLY RECORDED IN THE REGISTER.

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LAND AND PROPERTY INFORMATION NEW SOUTH WALES - HISTORICAL SEARCH

SEARCH DATE

23/6/2011 5:43PM

FOLIO: 502/1079122

First Title(s): THIS FOLIO
Prior Title(s): CROWN LAND

Recorded	Number	Type of Instrument	C.T. Issue
6/2/2007	DP1079122	DEPOSITED PLAN	LOT RECORDED FOLIO NOT CREATED
6/2/2007	AC918564	DEPARTMENTAL DEALING	FOLIO CREATED CT NOT ISSUED
13/3/2007	AC990882	DEPARTMENTAL DEALING	
5/12/2007	AD438285	GRANT OF EASEMENT	EDITION 1

*** END OF SEARCH ***

ANY ENTRIES PRECEDED BY AN ASTERISK DO NOT APPEAR ON THE CURRENT EDITION OF THE CERTIFICATE OF TITLE. WARNING: THE INFORMATION APPEARING UNDER NOTATIONS HAS NOT BEEN FORMALLY RECORDED IN THE REGISTER.

Req:R369201 /Doc:CT 15018-150 CT /Rev:07-Mar-2011 /Sts:OK.OK /Prt:23-Jun-2011 17:53 /Pgs:ALL /Seq:1 of 4
Ref:PO SYD7399 /Src:T

[redacted]ICATE OF TITLE

NEW SOUTH WALES — [redacted]PROPERTY ACT, 1900

Vol. 15018 Fol. 150

First Title Old System

Prior Title IVA 38167

EDITION ISSUED 5 4 1983

I certify that the person named in the First Schedule is the registered proprietor of an estate in fee simple (or such other estate or interest as is set out below) in the land described subject to the recordings appearing in the Second Schedule and to the provisions of the Real Property Act, 1900.

Registrar General.

CANCELLED

S

LAND REFERRED TO

Lot 2 in Deposited Plan 240557 at West Dapto in the City of Wollongong Parish of Kembla County of Camden.

SEE AUTO FOLIO

FIRST SCHEDULE

THE COUNCIL OF THE CITY OF WOLLONGONG.

SECOND SCHEDULE

GRY AA
1. Reservations and conditions, if any, contained in the Crown Grant above referred to.
2. CAUTION. The land within described is held subject to any subsisting interest (as defined in Section 28A Real Property Act,1900). 5.4.1983

(Page 1) Vol. 15018 Fol. 150

PERSONS ARE CAUTIONED AGAINST ALTERING OR ADDING TO THIS CERTIFICATE OR ANY NOTIFICATION HEREON

WARNING: THIS DOCUMENT MUST NOT BE REMOVED FROM THE REGISTRAR GENERAL'S OFFICE!

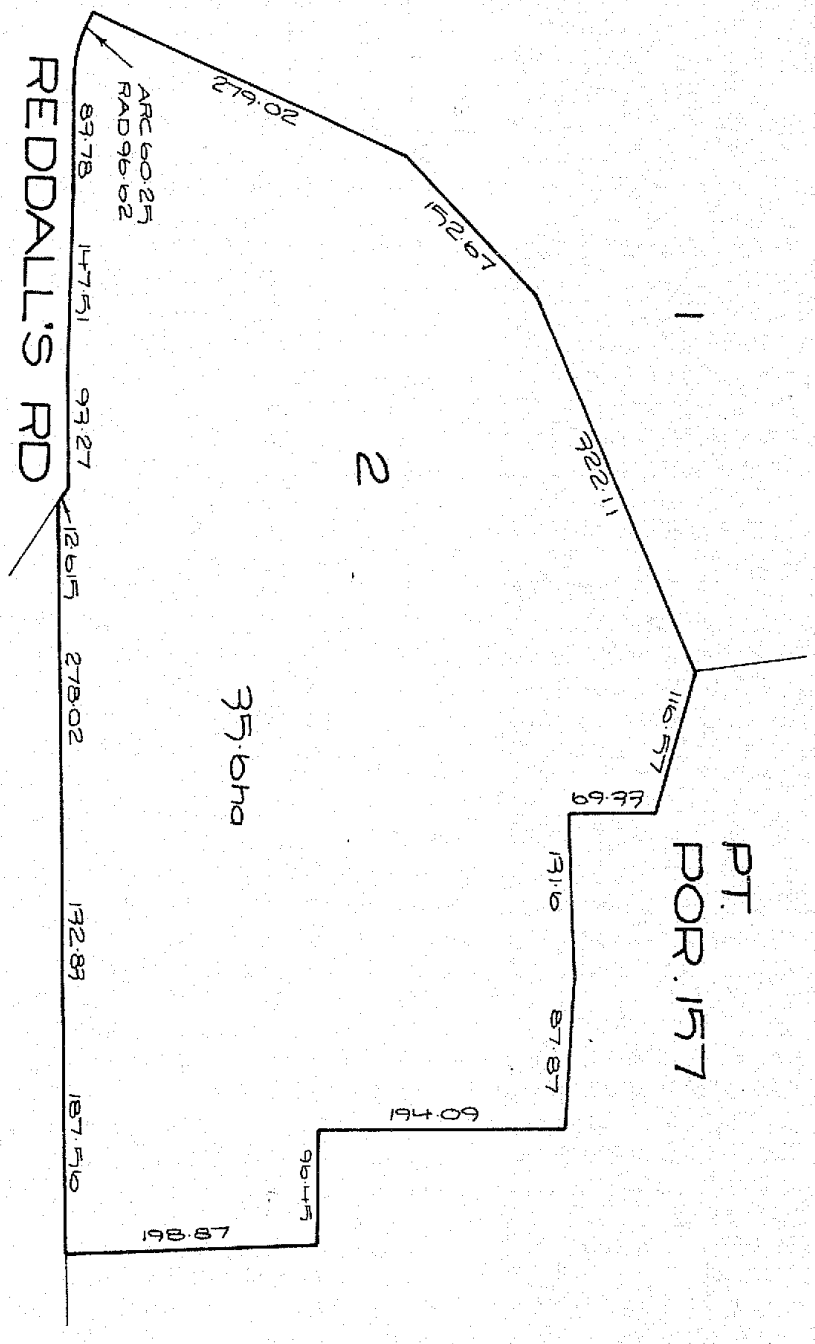
 NOTE: ENTRIES RULED THROUGH AND AUTHENTICATED BY THE SEAL OF THE REGISTRAR GENERAL ARE CANCELLED

Vol. 15018 Fol. 150

IVA 38167 6/6/08

PLAN SHOWING LOCATION OF LAND

LENGTHS ARE IN METRES



D.P. 240557

Vol. 15018 Fol. 150

FIRST SCHEDULE (continued)

REGISTERED PROPRIETOR	Registrar General

SECOND SCHEDULE (continued)

PARTICULARS	Registrar General	CANCELLATION

NOTATIONS AND UNREGISTERED DEALINGS

NOTE: ENTRIES RULED THROUGH AND AUTHENTICATED BY THE SEAL OF THE REGISTRAR GENERAL ARE CANCELLED

Vol. 15018 Fol. 150

FIRST SCHEDULE (continued)

REGISTERED PROPRIETOR	Registrar General

SECOND SCHEDULE (continued)

PARTICULARS	Registrar General	CANCELLATION

NOTATIONS AND UNREGISTERED DEALINGS

NOTE: ENTRIES RULED THROUGH AND AUTHENTICATED BY THE SEAL OF THE REGISTRAR GENERAL ARE CANCELLED

Req:R370538 /Doc:CT 15135-054 CT /Rev:23-Dec-2010 /Sts:OK.SC /Prt:24-Jun-2011 10:15 /Pgs:ALL /Seq:1 of 2
Ref:PO SYD7399 /Src:T

[redacted]ICATE OF TITLE

[redacted] PROPERTY ACT, 1900

15135054

NEW SOUTH WALES

First Title Old System

Prior Title P.A. 57030

Vol. 15135 Fol. 54

EDITION ISSUED

12 10 1983

I certify that the person named in the First Schedule is the registered proprietor of an estate in fee simple (or such other estate or interest as is set out below) in the land described subject to the recordings appearing in the Second Schedule and to the provisions of the Real Property Act, 1900.

Registrar General.

CANCELLED

15135 Fol. 54

PERSONS ARE CAUTIONED AGAINST ALTERING OR ADDING TO THIS CERTIFICATE OR ANY NOTIFICATION HEREON (Page 1) Vol.

NOTE: ENTRIES RULED THROUGH AND AUTHENTICATED BY THE SEAL OF THE REGISTRAR GENERAL ARE CANCELLED

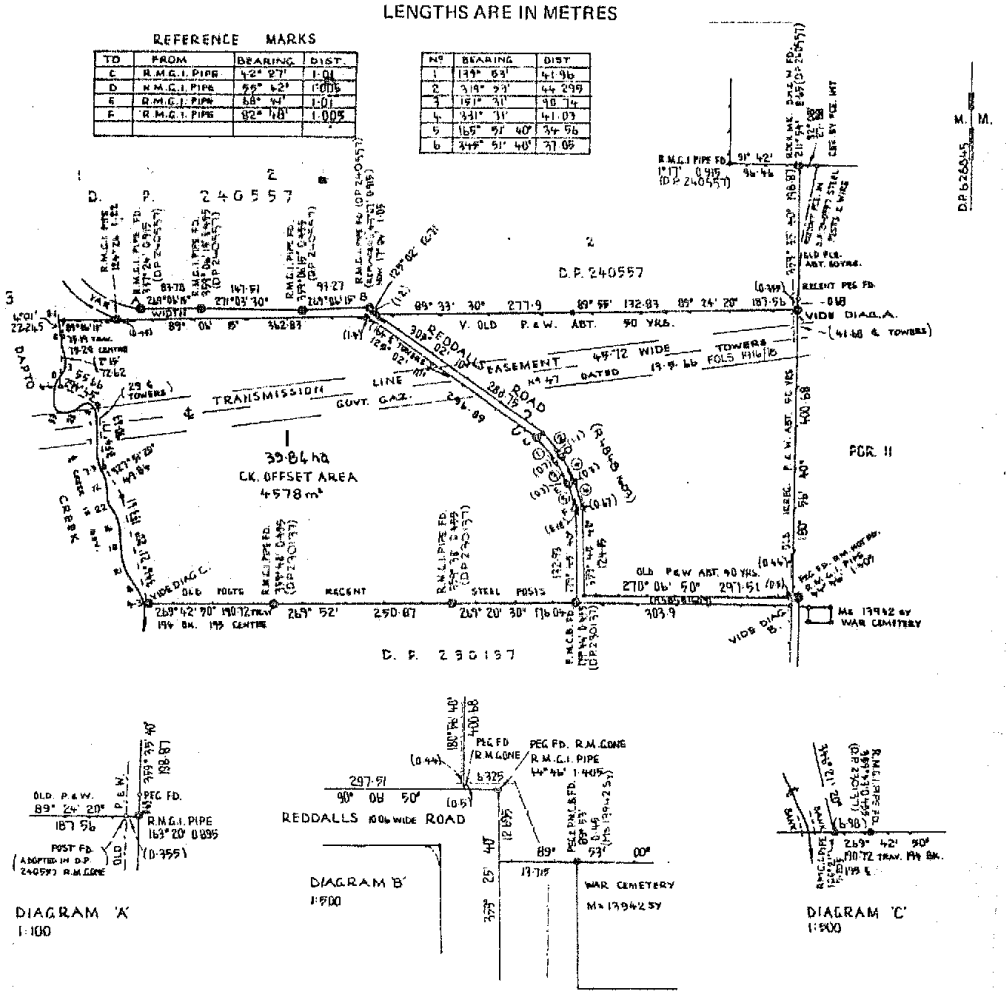
PLAN SHOWING LOCATION OF LAND

LENGTHS ARE IN METRES

REFERENCE MARKS

TO	FROM	BEARING	DIST.
C	R.M.G.I. PIPE	42° 27'	1.01
D	R.M.G.I. PIPE	95° 42'	1.005
E	R.M.G.I. PIPE	68° 47'	1.01
F	R.M.G.I. PIPE	82° 48'	1.005

No	BEARING	DIST.
1	139° 53'	41.96
2	219° 23'	44.299
3	151° 31'	18.74
4	241° 31'	41.03
5	169° 57' 40"	54.96
6	349° 57' 40"	37.09



LAND REFERRED TO

Lot 1 in Deposited Plan 628845 at Kembla Grange in the City of Wollongong Parish of Kembla County of Camden.

FIRST SCHEDULE

~~WEST DAPTO INDUSTRIAL DEVELOPMENT PTY. LIMITED.~~

SECOND SCHEDULE

1. Reservations and conditions contained in the Crown Grant.
2. Notification in Government Gazetted dated 13-5-1966 Folios 1916/18 Easement for transmission line affecting the land shown so burdened in Deposited Plan 628845.
3. Book 3486 No. 343 Mortgage to The Commonwealth Trading Bank of Australia.

Vol. 15135 Fol. 54

L.O. 1066 D. West, Government Printer

FIRST SCHEDULE (continued)

REGISTERED PROPRIETOR — Registrar General

The Council of the City of Wollongong as regards Lots 101 and 102 in DP636535 and Lot 201 in DP708258 and West Dapto Industrial Developments Pty. Limited as regards the residue being Lots 202 and 203 in DP708258 by Transfer V566932. Registered 13-2-1985.

DP/~~SP~~708258 Registered 20-2-1985
This folio is cancelled as to whole/~~part~~ upon ~~closure~~ road
of computer folios for lots 201, 202 ~ 203 in the
abovementioned plan.

The residue of land in this folio comprises
roads (Lots 101 ~ 102 in DP636535).

SECOND SCHEDULE (continued)

PARTICULARS — Registrar General — CANCELLATION

Interests created pursuant to Section 88B Conveyancing Act, 1919,
by the registration of DP 708258

Registered 13-2-1985

~~Book 3486 No.343 Mortgage W134972 Discharged as to part being Lots 6~~
Book 3486 No.343 Mortgage W134972 Discharged as to part being Lots 101 and 102 in DP.636535. Registered 18.3.1986.

NOTATIONS AND UNREGISTERED DEALINGS

DP 636535 Regd 25/1/84
CT 4-10-1984
DP708258 R.
V566932 T R.
V134972 R.
(Lots 101 & 102)

Req:R370538 /Doc:CT 15135-054 CT /Rev:23-Dec-2010 /Sts:OK.SC /Prt:24-Jun-2011 10:15 /Pgs:ALL /Seq:2 of 2
Ref:PO SXD7399 /Src:T

APPENDIX E

CLM Notice & EPL Search Results

Office of Environment & Heritage

You are here: Home > Contaminated land > Record of EPA notices

Search results

Your search for: LGA: Wollongong City Council

Matched 25 notices relating to 11 sites.

Search Again
Refine Search

Suburb	Address	Site Name	Notices related to this site
Bulli	7 Molloy Street	Scrapmetal Yard	1 former
Dapto	178 Kanahooka Road	Slag Dump	3 former
Fairy Meadow	46-58 Montague Street	Former Caltex Fuel Depot	2 former
Lysaghts	Springhill Road	BHP Area 21	1 former
Lysaghts	2 Five Islands Road	BHP No.2 Steelworks (Flat Products)	1 current and 2 former
Port Kembla	Darcy Road	Orica Chemnet Port Kembla	1 current
Port Kembla	Flinders Street	Port Kembla Bunkering Facility	2 current
Port Kembla	Military and Darcy Roads	Port Kembla Copper	1 current and 3 former
Stanwell Tops	Plateau Road	Christian Conference Centre	1 current
Unanderra	45-49 Princes Highway	Prime - Unanderra	3 former
Yallah	Tallawarra Road	Tallawarra Power Station	1 current and 3 former

Page 1 of 1

20 June 2011

Rate this site

Office of Environment & Heritage

You are here: Home > Environment protection licences > POEO Public Register > Search for licences, applications and notices

Licence summary

Search Again | Return to Previous Page

Summary Licence No: 5862

View this licence (PDF document 168 kb)

Licence holder: WOLLONGONG CITY COUNCIL
Premises: WHYTE'S GULLY WASTE DISPOSAL FACILITY
REDDALLS ROAD, KEMBLA GRANGE, NSW, 2526
LGA: WOLLONGONG **Catchment:** Illawarra Coast
Administrative fee: $3,520.00
Licence status: Issued
Activity type: Waste disposal by application to land
Licence review: Complete date 14 Aug 2008
Complete date 14 Nov 2003
Due date 14 Aug 2013

Applications

Number	Application type	Current status	Date received
1502805	s.58 Licence Variation	Pending	25 Jul 2011

Notices

Number	Issue date	Notice type
1004923	27 Mar 2001	s.58 Licence Variation
1006649	14 Jun 2001	s.58 Licence Variation
1010783	18 Oct 2001	s.58 Licence Variation
1013124	15 Mar 2002	s.58 Licence Variation
1018823	08 Jul 2002	s.58 Licence Variation
1040733	14 Mar 2005	s.58 Licence Variation
1046062	10 Oct 2005	s.58 Licence Variation
1080328	20 Nov 2007	s.58 Licence Variation
1092800	17 Oct 2008	s.58 Licence Variation
1095240	26 Nov 2008	s.58 Licence Variation

Annual Returns

Start date	End date	Date received	Non-compliance	LBL data
29-May-2010	28-May-2011	25-Jul-2011	No	Not available
29-May-2009	28-May-2010	28-Jul-2010		Not available
29-May-2008	28-May-2009	28-Jul-2009		Not available

29-May-2007	28-May-2008	28-Jul-2008	yes	Not available
29-May-2006	28-May-2007	26-Jul-2007	No	Not available
29-May-2005	28-May-2006	26-Jul-2006	No	Not available
29-May-2004	28-May-2005	27-Jul-2005	No	Not available
29-May-2003	28-May-2004	26-Jul-2004	No	Not available
30-Oct-2002	28-May-2003	25-Jul-2003	No	Not available
30-Oct-2001	29-Oct-2002	30-Dec-2002	No	Not available
30-Oct-2000	29-Oct-2001	20-Dec-2001	yes	Not available
30-Oct-1999	29-Oct-2000	13-Dec-2000	yes	Not available

Rate this site

Office of Environment & Heritage

Non-Compliance detail

Search Again | Return to Licence Summary

Summary

Licence number: 5862
Annual Return Start: 29 May 2007
Annual Return End: 28 May 2008
Date Received: 28 Jul 2008

Licence Condition number	Type of non-compliance	No. of incidents
L1.3	Following heavy periods of rain, there were overflows of leachate to the stormwater dam in June 2007, November 2007, December 2007 & February 2008.	4
L3.3	The total suspended solid (TSS) discharged from the site to the stream was 180 mg/L on 7/12/2007 & exceeded the 50 mg/L limit. Caused by earthworks on the premises being washed away during rainfall event.	1
M2.1	The concentrations of total organic carbon and fluoride were not tested in one sample of stormwater discharging from the site as not enough sample was available to undertake the tests.	1

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Office of Environment & Heritage

Non-Compliance detail

Search Again | Return to Licence Summary

Summary

Licence number: 5862
Annual Return Start: 30 Oct 2000
Annual Return End: 29 Oct 2001
Date Received: 20 Dec 2001

Licence Condition number	Type of non-compliance	No. of incidents
M2.1	Storm water discharged from site was not tested for alkalinity and temperature	0
-	Leachate overflowed under continuous wet weather conditions in Febuary and March 2001. NOTE: Licensee indicated that this was a breach of L3.4 & L3.5 however these don't appear on licence	0

Rate this site

Office of Environment & Heritage

Non-Compliance detail

Search Again | Return to Licence Summary

Summary

Licence number: 5862
Annual Return Start: 30 Oct 1999
Annual Return End: 29 Oct 2000
Date Received: 13 Dec 2000

Licence Condition number	Type of non-compliance	No. of incidents
L3.5	Leachate overflow, under condition of dry weather occurred on 9 December 1999	0
L3.5	Leachate overflow under conditions of dry weather on 22 March 2000	0

Office of Environment & Heritage

Application summary

Your search for: **Suburb -** Kembla Grange

Search again | Return to previous page

Summary of Application No: 13259

Applicant:	**THIESS SERVICES PTY LTD**
Premises:	WEST DAPTO MRF 110 Reddalls Road KEMBLA GRANGE 2526 **LGA:** Wollongong **Catchment:** Wollongong Coast
Status :	Withdrawn
Application type:	New Licence
Licence type:	Premises
Activity type:	*Waste Storage, Transfer, Separating or Processing
Received:	17 Mar 10

21 June 2011

Rate this site

Office of Environment & Heritage

Licence summary

Search Again | Return to Previous Page

Summary Licence No: 10554

View this licence (PDF document 200 kb)

Licence holder: WHYTES GULLY ENVIRONMENTAL PTY LTD
Premises: WHYTES GULLY LANDFILL
LOT 203, REDDALLS ROAD, DAPTO, NSW, 2530
LGA: WOLLONGONG **Catchment:** Illawarra Coast
Administrative fee: $2,375.00
Licence status: Surrendered
Activity type: Generation of electrical power from gas
Licence review: Complete date 19 Aug 2004
Due date 02 Jun 2006

Applications

Number	Application type	Current status	Date received
1016997	s.58 Licence Variation	Issued	23 Apr 2002
1026789	s.58 Licence Variation	Issued	15 Apr 2003
1042138	s.80 Approval of the Surrender of a Licence	Issued	01 Nov 2004

Notices

Number	Issue date	Notice type
1004356	13 Mar 2001	s.58 Licence Variation
1005267	27 Mar 2001	s.58 Licence Variation
1010189	26 Feb 2002	s.58 Licence Variation
1016997	31 May 2002	s.58 Licence Variation
1019056	15 Jul 2002	s.58 Licence Variation
1023762	06 Feb 2003	s.58 Licence Variation
1026789	30 May 2003	s.58 Licence Variation
1028898	31 Oct 2003	s.58 Licence Variation
1042138	08 Nov 2004	s.80 Approval of the Surrender of a Licence

Annual Returns

Start date	End date	Date received	Non-compliance	LBL data
02-Jun-2004	08-Nov-2004	21-Jan-2005	No	Not available

02-Jun-2003	01-Jun-2004	02-Dec-2004	No	Not available
02-Jun-2002	01-Jun-2003	30-Jul-2003	No	Not available
02-Jun-2001	01-Jun-2002	26-Jul-2002	yes	Not available
02-Jun-2000	01-Jun-2001	10-Aug-2001	yes	Not available

Rate this site

Office of Environment & Heritage

Non-Compliance detail

Search Again | Return to Licence Summary

Summary

Licence number: 10554
Annual Return Start: 02 Jun 2001
Annual Return End: 01 Jun 2002
Date Received: 26 Jul 2002

Licence Condition number	Type of non-compliance	No. of incidents
-	Some deviations made from the specific test methods in order to obtain meaningful results for certain compounds. Had no material effect on the reported results	0
Arsenic	Arsenic level in engine exhaust exceeded licence limit on 18 July 2001.	0

Rate this site

Office of Environment & Heritage

Non-Compliance detail

Search Again | Return to Licence Summary

Summary

Licence number: 10554
Annual Return Start: 02 Jun 2000
Annual Return End: 01 Jun 2001
Date Received: 10 Aug 2001

Licence Condition number	Type of non-compliance	No. of incidents
-	Chlorine as hydrogen chloride - unable to maintain the extensive run times at full load to complete sampling on 15-16 June 2000; and 1-2 March 2001	0
-	Total Fluoride - sodium hydroxide ws used as the absorbing solution in preference to demineralised water for testing on: 15-16 June 2000; 14-15 July 2000; and 3-4 August 2000; and 1-2 March 2001	0
-	Flow Rate and Velocity - for the greenwaste gasifier reformer exhaust measurements were taken from only one sampling traverse on 15-16 June 2000; 14 -15 July 2000; and 3-4 August 2000	0
-	Sulfur dioxide, sulphuric acid and sulfur trioxide - due to nature of commissioning process - unable to maintain extensive run times at full load required to complete sampling on 15-16 June 2000	0
-	Total gaseous and particulate metals - analysis was performed using nitric acid digestion in preference to hydrofluoric acid digestion for testing on 15-16 June 2000; 14-15 July 2000; 3-4 August 2000; and 1-2 March 2001	0
-	Arsenic level in greenwaste gasifier reformer exhaust exceeded limit on 14-15 July 2000 and 3-4 August 2000	0
-	Chlorine content of greenwaste gasifier reformer exhaust unable to be determined from sampling on 15-16 June 2000	0
-	Chromium V1 detection limits not achieved during testing on 15-16 June 2000, 14-15 July 2000 and 1-2 March 2001	0
-	Greenwaste gasifier reformer test program completed three days late due to illness within the independent testing company	0
-	Hexachlorocyclohexane detection limit not achieved for testing on 15-16 June 2000; 14-15 July 2000; and 3-4 August 2000. No result reported on 1-2 March 2000 due to sample contamination at the laboratory doing the analysis	0
-	Non conforming waste (paper from outside WCC area) processed through SWERF for biofertiliser trial	0

-	Opacity monitor not calibrated correctly	0
-	Sulfur oxides exceeded limit on 15-16 June 2000; 14-15 July 2000; and 1-2 March 2001	0
-	VOC destruction efficiency not determined during testing on 14-15 June 2000	0

Rate this site

Office of Environment & Heritage

Application summary

Search Again | Return to Previous Page

Summary Application No: 13382

Applicant: PAR RECYCLING SERVICES PTY LTD
Premises: West Dapto MRF
115 Reddalls Road, KEMBLA GRANGE, NSW, 2526
LGA: WOLLONGONG **Catchment:** Illawarra Coast
Application type: New licence
Application status: Pending
Activity type: Recovery of general waste
Received: 03 Dec 2010

Rate this site

Office of Environment & Heritage

Licence summary

Search Again | Return to Previous Page

Summary Licence No: 13171

View this licence (PDF document 128 kb)

Licence holder: **SOILCO PTY LIMITED**
Trading as: SOILCO PTY LIMITED

Premises: KEMBLA GRANGE
61 Reddalls Rd, KEMBLA GRANGE, NSW, 2526
LGA: WOLLONGONG **Catchment:** Illawarra Coast

Administrative fee: $1,760.00

Licence status: Issued

Activity type: Composting
Waste storage - other types of waste

Licence review: Due date 28 Oct 2014

Annual Returns

Start date	End date	Date received	Non-compliance	LBL data
28-Oct-2010	27-Oct-2011	22-Dec-2011		Not available
28-Oct-2009	27-Oct-2010	20-Dec-2010	No	Not available

Rate this site

Office of Environment & Heritage

Licence summary

Search Again | Return to Previous Page

Summary Licence No: 11894

View this licence (PDF document 133 kb)

Licence holder: APC SOCOTHERM PTY LIMITED
Premises: APC SOCOTHERM PTY LTD
LOT 562 REDDALLS ROAD, KEMBLA GRANGE, NSW, 2526
LGA: WOLLONGONG **Catchment:** Illawarra Coast
Administrative fee: $1,650.00
Licence status: Issued
Activity type: Metal coating
Metal waste generation
Licence review: Complete date 25 Aug 2011
Complete date 25 Aug 2006
Due date 25 Aug 2016

Notices

Number	Issue date	Notice type
1032916	17 Dec 2007	s.58 Licence Variation
1085617	16 May 2008	s.58 Licence Variation
1090857	28 Aug 2008	s.58 Licence Variation
1110460	27 Apr 2010	s.58 Licence Variation
1118061	09 Aug 2010	s.58 Licence Variation

Annual Returns

Start date	End date	Date received	Non-compliance	LBL data
25-Aug-2010	24-Aug-2011	24-Oct-2011	No	Not available
25-Aug-2009	24-Aug-2010	22-Oct-2010	No	Not available
25-Aug-2008	24-Aug-2009	23-Oct-2009	yes	Not available
25-Aug-2007	24-Aug-2008	28-Oct-2008	No	Not available
25-Aug-2006	24-Aug-2007	25-Oct-2007	No	Not available
25-Aug-2005	24-Aug-2006	26-Oct-2006	No	Not available
25-Aug-2004	24-Aug-2005	25-Oct-2005	No	Not available
25-Aug-2003	24-Aug-2004	26-Oct-2004	No	Not available

Rate this site

Office of Environment & Heritage

Non-Compliance detail

Search Again | Return to Licence Summary

Summary

Licence number: 11894
Annual Return Start: 25 Aug 2008
Annual Return End: 24 Aug 2009
Date Received: 23 Oct 2009

Licence Condition number	Type of non-compliance	No. of incidents
U2.1	PRP2 - Item 4 and Item 5: Fire at plant in November 2008 - unable to complete scheduled works due partial plant destruction.	1
U2.1	PRP3 - Item 2: Fire at plant in November 2008 - Unable to complete scheduled works due to partial plant destruction.	1

Rate this site

Office of Environment & Heritage

Licence summary

Search Again | Return to Previous Page

Summary Licence No: 10776

View this licence (PDF document 122 kb)

Licence holder: BREDERO SHAW AUSTRALIA PTY LTD
Premises: BREDERO SHAW
66 WEST DAPTO ROAD, KEMBLA GRANGE, NSW, 2526
LGA: WOLLONGONG **Catchment:** Illawarra Coast
Administrative fee: $1,760.00
Licence status: Issued
Activity type: Metal waste generation
Metal coating
Licence review: Complete date 14 Oct 2009
Complete date 14 Oct 2004
Due date 14 Oct 2014

Notices

Number	Issue date	Notice type
1014175	18 Feb 2002	s.58 Licence Variation
1026913	19 May 2003	s.58 Licence Variation
1030227	23 Jan 2004	s.58 Licence Variation
1037184	28 May 2004	s.58 Licence Variation
1040518	13 Oct 2004	s.58 Licence Variation
1044111	10 Feb 2005	s.58 Licence Variation
1074300	11 Dec 2007	s.58 Licence Variation
1097012	14 May 2009	s.58 Licence Variation
1106339	14 Sep 2009	s.58 Licence Variation
1108358	02 Nov 2009	s.58 Licence Variation
1110267	16 Feb 2010	s.58 Licence Variation
1112087	17 Mar 2010	s.58 Licence Variation

Annual Returns

Start date	End date	Date received	Non-compliance	LBL data
29-Jun-2010	28-Jun-2011	19-Aug-2011	No	Not available
29-Jun-2009	28-Jun-2010	23-Aug-2010	No	Not available
29-Jun-2008	28-Jun-2009	18-Aug-2009	No	Not available
29-Jun-2007	28-Jun-2008	27-Aug-2008	yes	Not available
29-Jun-2006	28-Jun-2007	22-Aug-2007	yes	Not available
29-Jun-2005	28-Jun-2006	21-Aug-2006	yes	Not available

29-Jun-2004	28-Jun-2005	25-Aug-2005	No	Not available
29-Jun-2003	28-Jun-2004	19-Aug-2004	No	Not available
29-Jun-2002	28-Jun-2003	15-Aug-2003	No	Not available
29-Jun-2001	28-Jun-2002	22-Jul-2002	No	Not available
29-Jun-2000	28-Jun-2001	24-Aug-2001	No	Not available

Rate this site

Office of Environment & Heritage

Non-Compliance detail

Search Again | Return to Licence Summary

Summary

Licence number: 10776
Annual Return Start: 29 Jun 2007
Annual Return End: 28 Jun 2008
Date Received: 27 Aug 2008

Licence Condition number	Type of non-compliance	No. of incidents
U	PRP works 4, 5 & 6 not completed. Completion date deferred.	3

Rate this site

Non-Compliance detail

Search Again | Return to Licence Summary

Summary

Licence number: 10776
Annual Return Start: 29 Jun 2006
Annual Return End: 28 Jun 2007
Date Received: 22 Aug 2007

Licence Condition number	Type of non-compliance	No. of incidents
4	Current work downturn with no profit funds. PRP4 has now commenced for completion during this period (2007 - June 2008).	1
5	Current work downturn with no profit funds. PRP4 has now commenced for completion during this period (2007 - June 2008).	1
6	Current work downturn with no profit funds. PRP4 has now commenced for completion during this period (2007 - June 2008).	1

Rate this site

Office of Environment & Heritage

Non-Compliance detail

Search Again | Return to Licence Summary

Summary

Licence number: 10776
Annual Return Start: 29 Jun 2005
Annual Return End: 28 Jun 2006
Date Received: 21 Aug 2006

Licence Condition number	Type of non-compliance	No. of incidents
U4	Not completed	1
U5	Not completed	1
U6	Not completed	1

Office of Environment & Heritage

Application summary

Your search for: **Suburb -** Kembla Grange

Search again | Return to previous page

Summary of Application No: 11529

Applicant:	**ONESTEEL TRADING PTY LIMITED** **Trading as :** ONESTEEL STEEL AND TUBE
Premises:	ONESTEEL / BHP / TUBEMAKERS LOT 111 CNR WEST DAPTO & REDDALLS ROADS KEMBLA GRANGE 2526 **LGA:** Wollongong **Catchment:** Wollongong Coast
Status :	Withdrawn
Application type:	New Licence
Licence type:	Premises
Activity type:	Metal processing
Received:	19 Sep 01

21 June 2011

Rate this site

Office of Environment & Heritage

Licence summary

Search Again | Return to Previous Page

Summary Licence No: 12978

View this licence (PDF document 111 kb)

Licence holder: **ONESTEEL TRADING PTY LIMITED**
Trading as: ONESTEEL OIL AND GAS PIPE

Premises: OneSteel Oil and Gas Pipe
132 West Dapto Road, KEMBLA GRANGE, NSW, 2526
LGA: WOLLONGONG **Catchment:** Illawarra Coast

Administrative fee: $1,650.00

Licence status: Issued

Activity type: Metal processing

Licence review: Due date 10 Nov 2013

Notices

Number	Issue date	Notice type
1095287	10 Dec 2008	s.58 Licence Variation
1097522	11 Feb 2009	s.58 Licence Variation
1098867	20 Mar 2009	s.58 Licence Variation
1100630	18 May 2009	s.58 Licence Variation
1118665	24 Dec 2010	s.58 Licence Variation
1124478	21 Feb 2011	s.58 Licence Variation
1502128	11 Nov 2011	s.58 Licence Variation

Annual Returns

Start date	End date	Date received	Non-compliance	LBL data
10-Nov-2010	09-Nov-2011	09-Jan-2012		Not available
10-Nov-2009	09-Nov-2010	18-Nov-2010	No	Not available
10-Nov-2008	09-Nov-2009	22-Dec-2009	No	Not available

APPENDIX F

Dangerous Goods Search Results

NSW GOVERNMENT | WorkCover NEW SOUTH WALES



Our Ref: D11/067716
Your Ref: Parnel Richards

08 June 2011

Attention: Parnel Richards
Golder Associates Pty Ltd
124 Pacific Highway
St Leonards NSW 2065

Dear Mr Richards,

RE SITE: 115 Reddalls Road Kembla Grange

I refer to your site search request received by WorkCover NSW on 01 June 2011 requesting information on licences to keep dangerous goods for the above site.

Enclosed are copies of the documents that WorkCover NSW holds on Dangerous Goods Licences 35/036253, 35/034856 and 35/034444 relating to the storage of dangerous goods at the above-mentioned premises, as listed on the Stored Chemical Information Database (SCID).

If you have any further queries please contact the Dangerous Goods Licensing Team on (02) 4321 5500.

Yours Sincerely

Diana Hayes
Senior Licensing Officer
Dangerous Goods Notification Team

Application for Licence to Keep Dangerous Goods

WorkCover NEW SOUTH WALES

Expiry 24/3/2001

Application for ☑ new licence ☐ amendment ☐ transfer ☐ renewal of expired licence

PART A – Applicant and site information

1 Name of applicant EDL Group operation Pty Ltd — ACN

ENERGY DEVELOPMENTS LTD | 055 555 416

2 Postal address of applicant — Suburb/Town — Postcode

8/48 BOUNDRY RD | RICHLANDS | 4077

3 Trading name or site occupier's name

AS ABOVE.

4 Contact for licence inquiries

Phone | Fax | Name

07 3275 5555 | 07 3211 0799 |

5 Previous licence number (if known) 35/ 034444

6 Previous occupier (if known)

Licence issued 26/6/00

7 Site to be licensed

No | Street

| REDDELLS RD. (WHYTES GULLY REFUSE TIP)

Suburb / Town | Postcode

KEMPLA GRANGE | 2530

8 Main business of site CONVERTING WASTE TO ENERGY. 3610

9 Site staffing: Hours per day 24 Days per week 7

10 Emergency contact

Phone | Name

0408 751 890 | STEVE SHEAN.

11 Major supplier of dangerous goods

12 If a new site or for amendments to depots

Plan stamped by: Name of Accredited Consultant — Date stamped

KEITH MASTERS | 6/3/2000

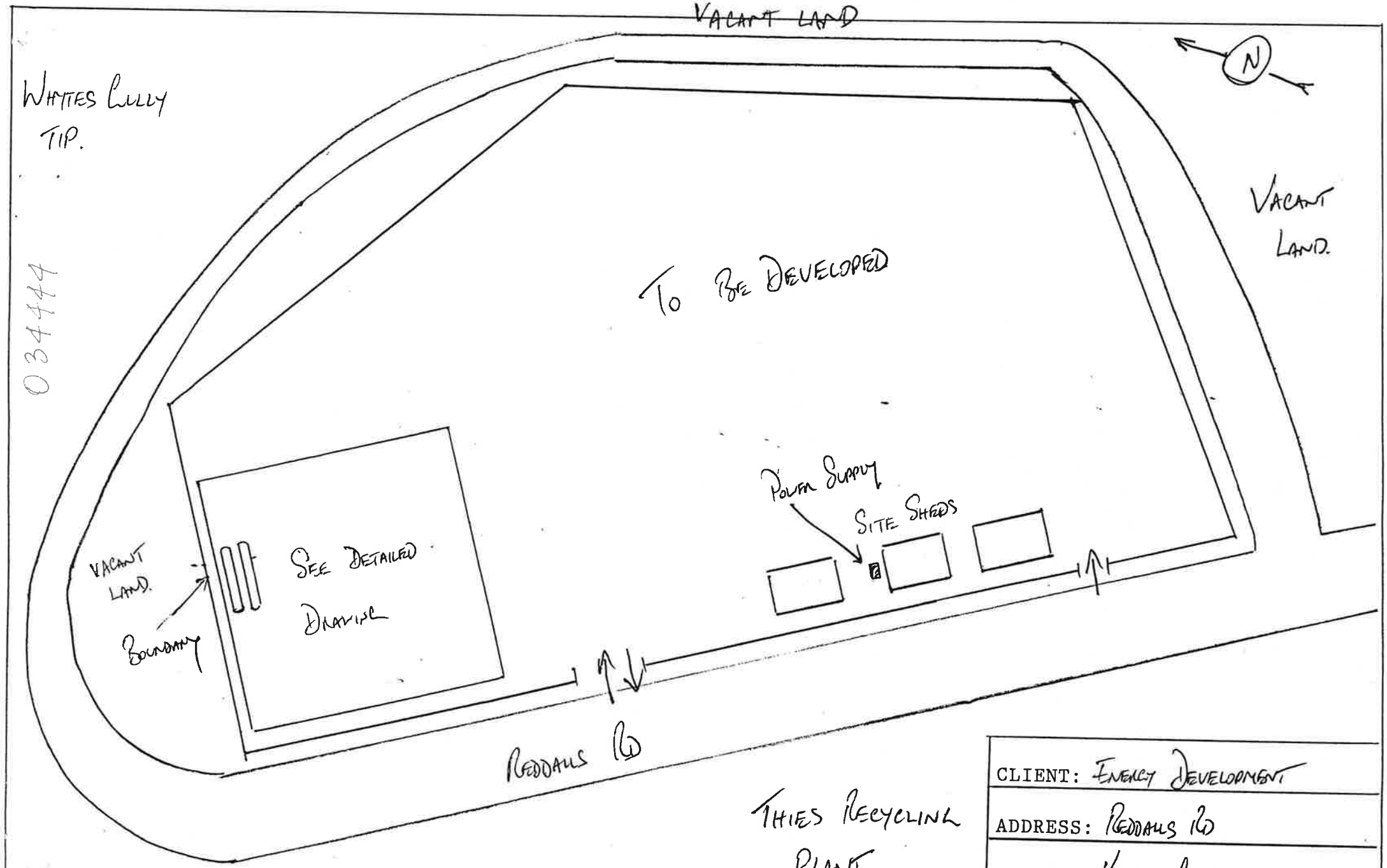
I certify that the details in this application (including any accompanying computer disk) are correct and cover all licensable quantities of dangerous goods kept on the premises.

13 Signature of applicant — Date

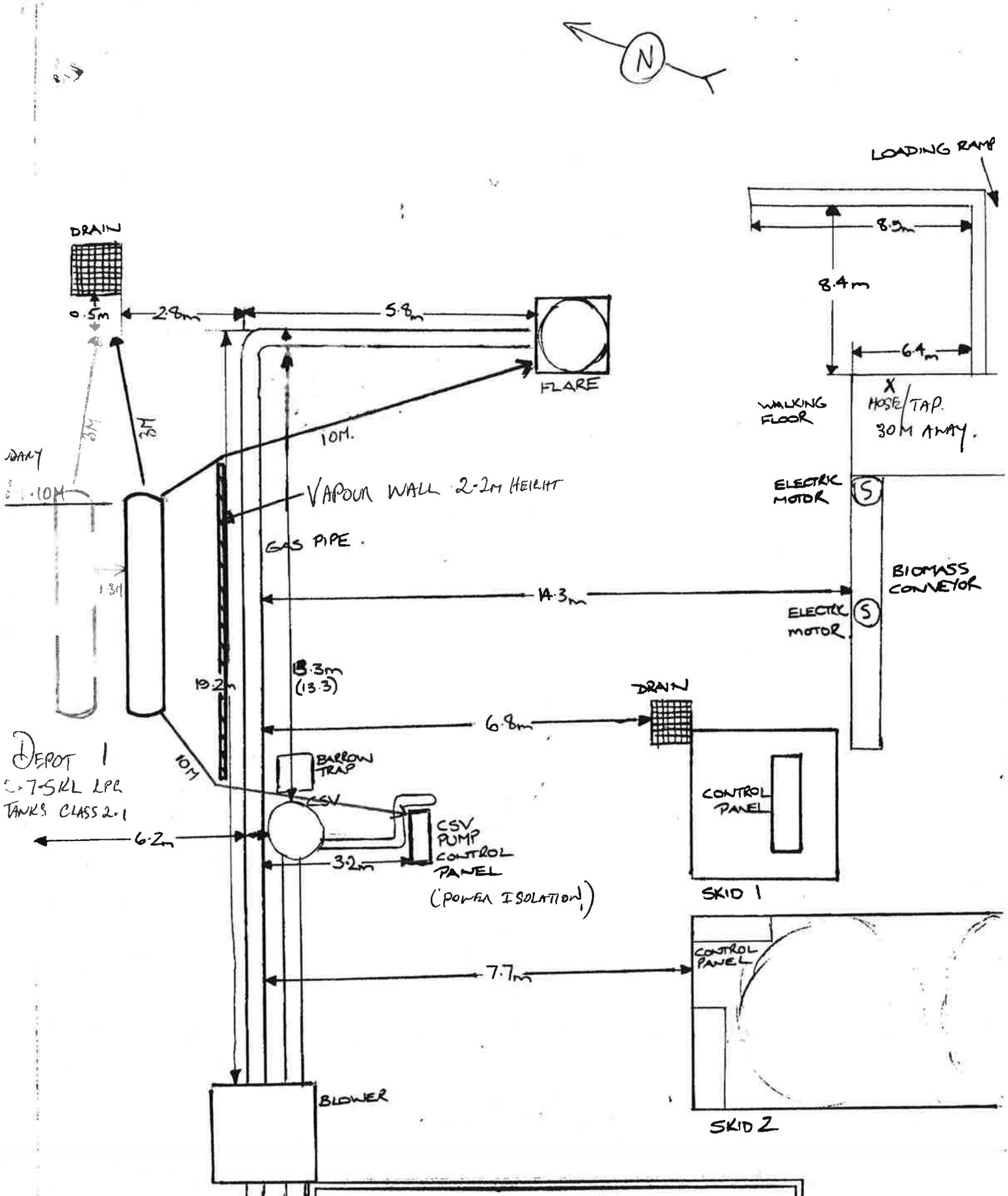
A.J. Pobjoy on behalf of EDL | 1/2/00.

Please send your application, marked *CONFIDENTIAL*, to:

Dangerous Goods Licensing, Level 3, Locked Bag 10, Clarence Street, SYDNEY NSW 2000


VACANT LAND
WHITES GULLY TIP.
N
VACANT LAND.
TO BE DEVELOPED
POWER SUPPLY
SITE SHEDS
VACANT LAND.
BOUNDARY
SEE DETAILED DRAWING
REDDALLS RD
THIES RECYCLING PLANT
CLIENT: ENERGY DEVELOPMENT
ADDRESS: REDDALLS RD
KEMBLA GRANGE.
ORIGINATOR:

034444



Depot (Title)	1
for (Quantity)	3000kg / 1SCR01

of DG Class 2.1 as shown in this plan conforms with the Dangerous Goods Act 1975 and Australian Standard AS 1596 - 1997

Signature: [signature] Date: 6/3/2000

Name (printed) KEITH WATERS

200-1262

PART C – Dangerous Goods Storage *Complete one section per depot.*

If you have more depots than the space provided, photocopy sufficient sheets first.

Depot Number	Type of depot	Depot Class	Maximum storage capacity
1	ABOVE GROUND TANK	2.1	7500 Lts / 3000 kg

UN Number	Correct Shipping Name	PG Class (I, II, III)	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
1075	PETROLEUM GASES LIQUIFIED	2.1	LPGAS	7500 3000	L kg

Depot Number	Type of depot	Depot Class	Maximum storage capacity

UN Number	Correct Shipping Name	PG Class (I, II, III)	Product or common name	Typical quantity	Unit, e.g. L, kg, m³

Depot Number	Type of depot	Depot Class	Maximum storage capacity

UN Number	Correct Shipping Name	PG Class (I, II, III)	Product or common name	Typical quantity	Unit, e.g. L, kg, m³

Depot Number	Type of depot	Depot Class	Maximum storage capacity

UN Number	Correct Shipping Name	PG Class (I, II, III)	Product or common name	Typical quantity	Unit, e.g. L, kg, m³

pplication for Licence to Keep
Dangerous Goods

Application for: New Licence ☑ Amendment ☐ Transfer ☐ Renewal of expired licence ☐

PART A - *Applicant and site information* (See page 2 of Guidance Notes)

1 Name of applicant | ACN
Wollongong City Council

2 Postal Address of Applicant | Suburb/Town | Postcode
Locked Bag 8821 | South Coast Mail Centre | 2521

3 Trading Name or Site Occupier's Name
Whytes Gully Waste Disposal Depot

4 Contact for Licence Inquiries
Phone | Fax | Name
(02) 42277184 | (02) 42288153 | Mr Lindsay Dunstan

5 Previous Licence Number (if known) 35/ N/A 036253

6 Previous Occupier (if known) N/A

7 Site to be Licensed
No | Street | Suburb
Lot 50 | Reddalls Rd. | Kembla Grange

8 Main Business of Site Waste Disposal Depot

9 Site staffing: Hours per day 9 Days per week 7

10 Site Emergency Contact
Phone | Name
(02) 42628365 | Mr David Storm

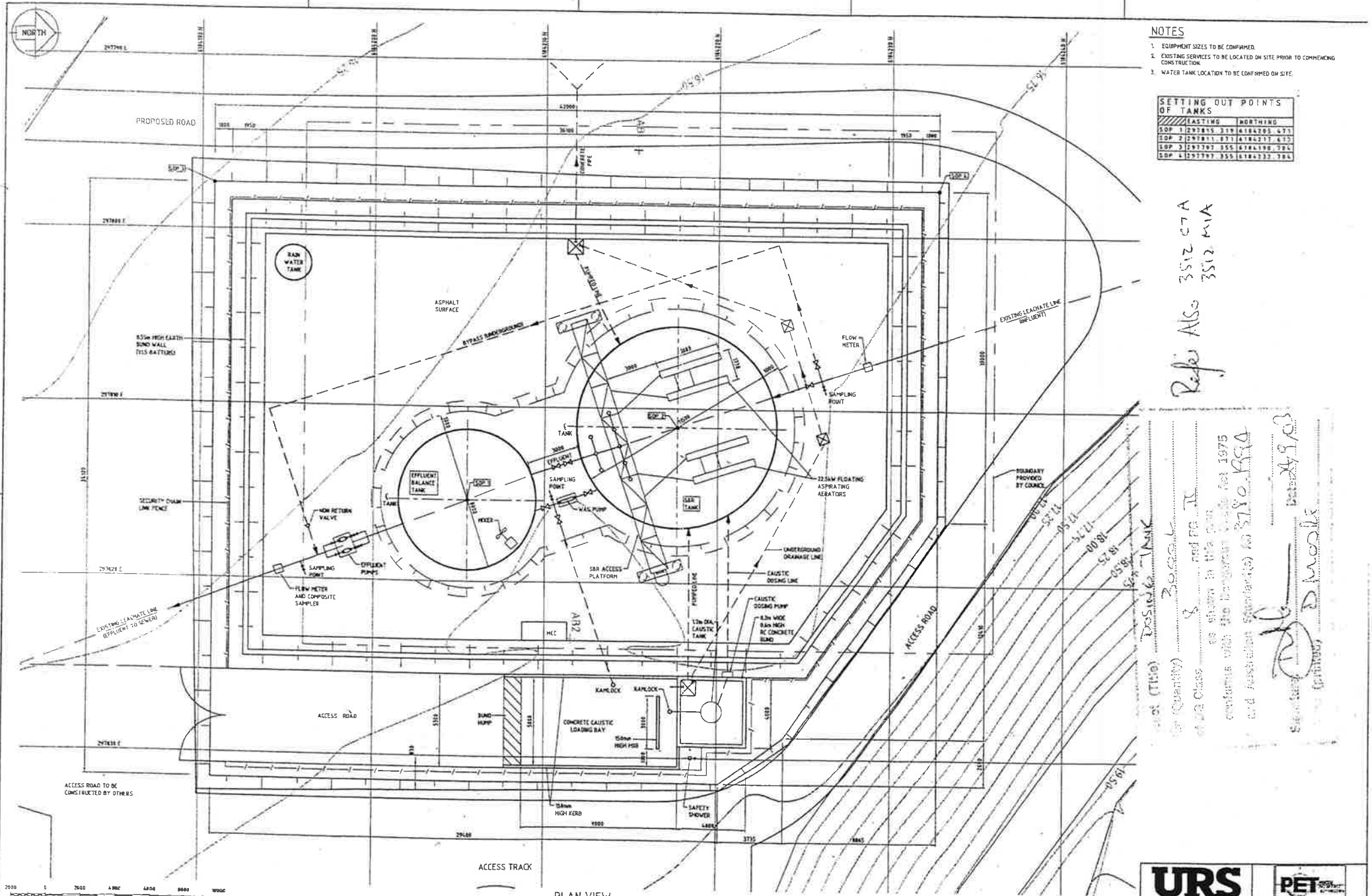
11 Major Supplier of Dangerous Goods Best Supplier

12 If a new site or for amendments to depots - see page 4 of Guidance Notes.
Plans Stamped by: | Signature of Competent Person | Printed Name | Date stamped
D Moore | 29/09/2003

I certify that the details in this application (including any accompanying computer disk) are correct and cover all licensable quantities of dangerous goods kept on the premises.

13 Signature of Applicant | Printed Name
L G Dunstan

Please send your application marked Confidential, to: **Dangerous Goods Licensing,**
WorkCover NSW, Locked Bag 2906, LISAROW NSW 2252
Hotline: (02) 4321 5500 - Fax: (02) 9287 5500



PLAN VIEW
SCALE 1:100

NOTES

1. EQUIPMENT SIZES TO BE CONFIRMED.
2. EXISTING SERVICES TO BE LOCATED ON SITE PRIOR TO COMMENCING CONSTRUCTION.
3. WATER TANK LOCATION TO BE CONFIRMED ON SITE.

SETTING OUT POINTS OF TANKS	EASTING	NORTHING
SOP 1	297815.319	6184205.671
SOP 2	297811.871	6184217.613
SOP 3	297797.355	6184198.784
SOP 4	297797.355	6184232.784

3512 C7 A
3512 M1A

Refer Also

Issued for Tender
Issued for Construction
Issued for Approval (Title)
Issued for Approval (Quantity)
As Built Class
Issued for Approval (Quantity)
Issued for Approval (Quantity)

Boorak
Andrews Pl
as shown in the plans
conform with the requirements of the Act 1975
and Australian Standards AS 3780 1994

Date 4/9/03

Signature
Name (Print)
Position

Approved
Date

A	ISSUED FOR CONSTRUCTION	APRIL	K.E.	19/9/03
	DESCRIPTION	DRAWN	APPRD	DATE

DATUM AHD	SURVEYOR	DRAWN	J. Ng	DATE 19/9/03
AZIMUTH MGA	FIELD BOOK	CHECKED	KE	DATE 19/9/03
RELATED PLANS		DESIGNED	GW	DATE 19/9/03
		CHECKED	KE	DATE 19/9/03

APPROVED
SENIOR DESIGN ENGINEER — DATE
MANAGER DESIGN — DATE

SCALES: AS SHOWN
NORTH POINT

FOR CONSTRUCTION

CITY OF WOLLONGONG

WHYTES GULLY LEACHATE TREATMENT PLANT
GENERAL ARRANGEMENT

URS
Level 3, 116 MILLER STREET, NORTH SYDNEY, N.S.W. 2060.
Telephone: (02) 89255500
Facsimile: (02) 89255505

PET
ONE McCAULEY ST & AUSTRALIA AVE WARRAWEE, NSW 2074
Telephone: (02) 93147488
Facsimile: (02) 84864334

WOLLONGONG City of Innovation
DESIGN DIVISION
Ph: 02 42277777

DESIGN PLS No.
FILE NUMBER
SHEET 1 OF 8 SHEETS
A1 ORIGINAL
DRAWING No. 3512
SHEET No. C1
ISSUE A

100mm ON ORIGINAL PLAN

What is a depot? See page 5 of the Guidance Notes

PART C - Dangerous Goods Storage Complete one section per depot

If you have more depots than that space provided, photocopy sufficient sheets first

Depot Number	Type of Depot (see page 5)	Depot Class	Maximum Storage Capacity
1	Leachate Treatment Plant	8	3,000 L

UN Number	Proper Shipping Name	Class	PG (I, II, III)	Product or Common Name	Typical Quantity	Unit eg L, kg, m^3
1824	Sodium Hydroxide Liquid	8	II	**Caustic Soda Liquid**	1,000	L

Licence No. 35/034856

APPLICATION FOR RENEWAL

OF LICENCE TO KEEP DANGEROUS GOODS

ISSUED UNDER AND SUBJECT TO THE PROVISIONS OF THE DANGEROUS GOODS ACT, 1975 AND REGULATION THEREUNDER

DECLARATION: Please renew licence number 35/034856 to 6/06/2004 . I confirm that all the licence details shown below are correct (amend if necessary).

JOHN SIMPSON 14/5/03

(Signature) *(Please print name)* *(Date signed)*

for: WHYTES GULLY ENVIRONMENTAL PTY LTD

*THIS **SIGNED** DECLARATION SHOULD BE **RETURNED TO:***

WorkCover New South Wales
Dangerous Goods Licensing Section
LOCKED BAG 2906
LISAROW NSW 2252

Enquiries:ph (02) 43215500
fax (02) 92875500

Details of licence on 17 April 2003

Licence Number 35/034856 **Expiry Date** 6/06/2003

Licensee WHYTES GULLY ENVIRONMENTAL PTY LTD ACN 070 941 767
BRIGHTSTAR ENVIRONMENTAL

Postal Address: BRIGHTSTAR ENVIRONMENTAL P O BOX 535 RICHLANDS QLD 4077

Licensee Contact BEN SHEEHAN Ph. 07 3275 5652 Fax. 07 ~~3217 0711~~ 3217 0950

Premises Licensed to Keep Dangerous Goods
WHYTES GULLY ENVIRONMENTAL PTY LTD BRIGHTSTAR ENVIRONMENTAL
LOT 203 REDDALLS RD KEMBLA GRANGE 2526

Nature of Site WASTE DISPOSAL SERVICES

Major Supplier of Dangerous Goods VARIOUS

Emergency Contact for this Site ~~WILL LANCASTER~~ Ph. 02 4261 0100 JOHN SIMPSON

Site staffing 12 HRS ~~7 DAYS~~ 5 DAYS

Details of Depots

Depot No.	Depot Type	Goods Stored in Depot	Qty
1	**ROOFED STORE**	**Class 3**	**4100 L**
	UN 1993 FLAMMABLE LIQUID, , N.O.S.		4100 L
10	**EXEMPT - STORAGE AREA**	**Class C2**	**3000 L**
	UN 00C2 COMBUSTIBLE LIQUID 2		3000 L
11	**EXEMPT - STORAGE AREA**	**Class C1**	**820 L**
	UN 00C1 DIESEL		820 L
2	**ROOFLESS STORE**	**Class 8**	**820 L**
	UN 1824 SODIUM HYDROXIDE SOLUTION		820 L
3	**ABOVE-GROUND TANK**	**Class 3**	**15000 L**
	UN 1993 FLAMMABLE LIQUID, , N.O.S.		15000 L
4	**CYLINDER STORE**	**Class 2.2**	**63 M3**
	UN 1066 NITROGEN, COMPRESSED		63 M3
5	**ROOFLESS STORE**	**Class 8**	**615 L**
	UN 1824 SODIUM HYDROXIDE SOLUTION		615 L
6	**ROOFED STORE**	**Class 5.1**	**205 L**
	UN 2014 HYDROGEN PEROXIDE, AQUEOUS SOLUTION		205 L
7	**ROOFED STORE**	**Class 3**	**200 L**
	UN 1230 METHANOL		200 L

Licence No. 35/034856

APPLICATION FOR RENEWAL

OF LICENCE TO KEEP DANGEROUS GOODS

ISSUED UNDER AND SUBJECT TO THE PROVISIONS OF THE DANGEROUS GOODS ACT, 1975 AND REGULATION THEREUNDER

	UN 1263 PAINT		250 L	
9	**ROOFED STORE**	**Class 8**	**1025 L**	
	UN 2672 AMMONIA SOLUTION			1025 L
AA	**ABOVE-GROUND TANK**	**Class 2.1**	**15000 L**	
	UN 1075 PETROLEUM GASES, LIQUEFIED		15000 L	
AB	**CYLINDER STORE**	**Class 2.2**	**51 M3**	
	UN 1002 AIR, COMPRESSED			8 M3
	UN 1006 ARGON, COMPRESSED			8 M3
	UN 1013 CARBON DIOXIDE			8 M3
	UN 1046 HELIUM, COMPRESSED			8 M3
	UN 1049 HYDROGEN, COMPRESSED			8 M3
	UN 1066 NITROGEN, COMPRESSED			11 M3
AC	**FLAMMABLE LIQUIDS CABINET**	**Class 3**	**250 L**	
	UN 1263 PAINT		250 L	
AD	**FLAMMABLE LIQUIDS CABINET**	**Class 3**	**100 L**	
	UN 1263 PAINT		100 L	
AE1	**CYLINDER STORE**	**Class 2.1**	**54 M3**	
	UN 1001 ACETYLENE, DISSOLVED			54 M3
AE2	**CYLINDER STORE**	**Class 2.1**	**81 KG**	
	UN 1075 PETROLEUM GASES, LIQUEFIED		81 KG	
AF	**CYLINDER STORE**	**Class 2.2**	**132 M3**	
	UN 1072 OXYGEN, COMPRESSED			66 M3
	UN 1956 COMPRESSED GAS, N.O.S.			66 M3
AG	**EXEMPT - STORAGE AREA**	**Class C2**	**800 L**	
	UN 00C2 COMBUSTIBLE LIQUID 2			800 L

Application for Licence to Keep Dangerous Goods

WorkCover NEW SOUTH WALES

Application for ☐ new licence ☑ amendment ☐ transfer ☐ renewal of expired licence

PART A – Applicant and site information See page 2 of Guidance Notes

1 Name of applicant | ACN

WHYTES GULLY ENVIRONMENTAL PTY LTD | 070 941 767

2 Postal address of applicant | Suburb/Town | Postcode

PO BOX 535 | RICHLANDS | 4077

3 Trading name or site occupier's name

BRIGHTSTAR ENVIRONMENTAL

4 Contact for licence inquiries

Phone | Fax | Name

07-3275 5652 | 07-3217 0711 | BEN SHEEHAN

5 Previous licence number (if known) 35/ 034856 AND 35/034444

6 Previous occupier (if known) WOLLONGONG CITY COUNCIL

7 Site to be licensed

No | Street

LOT 203 | REDDALLS ROAD

Suburb / Town | Postcode

WEST DAPTO Kembla Grange 2526 | 2530

8 Main business of site SOLID WASTE ENERGY AND RECYCLING

9 Site staffing: Hours per day 12 Days per week 7

10 Site emergency contact

Phone | Name

02-4261 0100 / 0417 818 584 | WILL LANCASTER

11 Major supplier of dangerous goods VARIOUS

12 If a new site or for amendments to depots – see page 4 of Guidance Notes.

Plan stamped by: Name of Accredited Consultant | Date stamped

T+V GRAINGER (CONSULTANTS) | 23/7/02

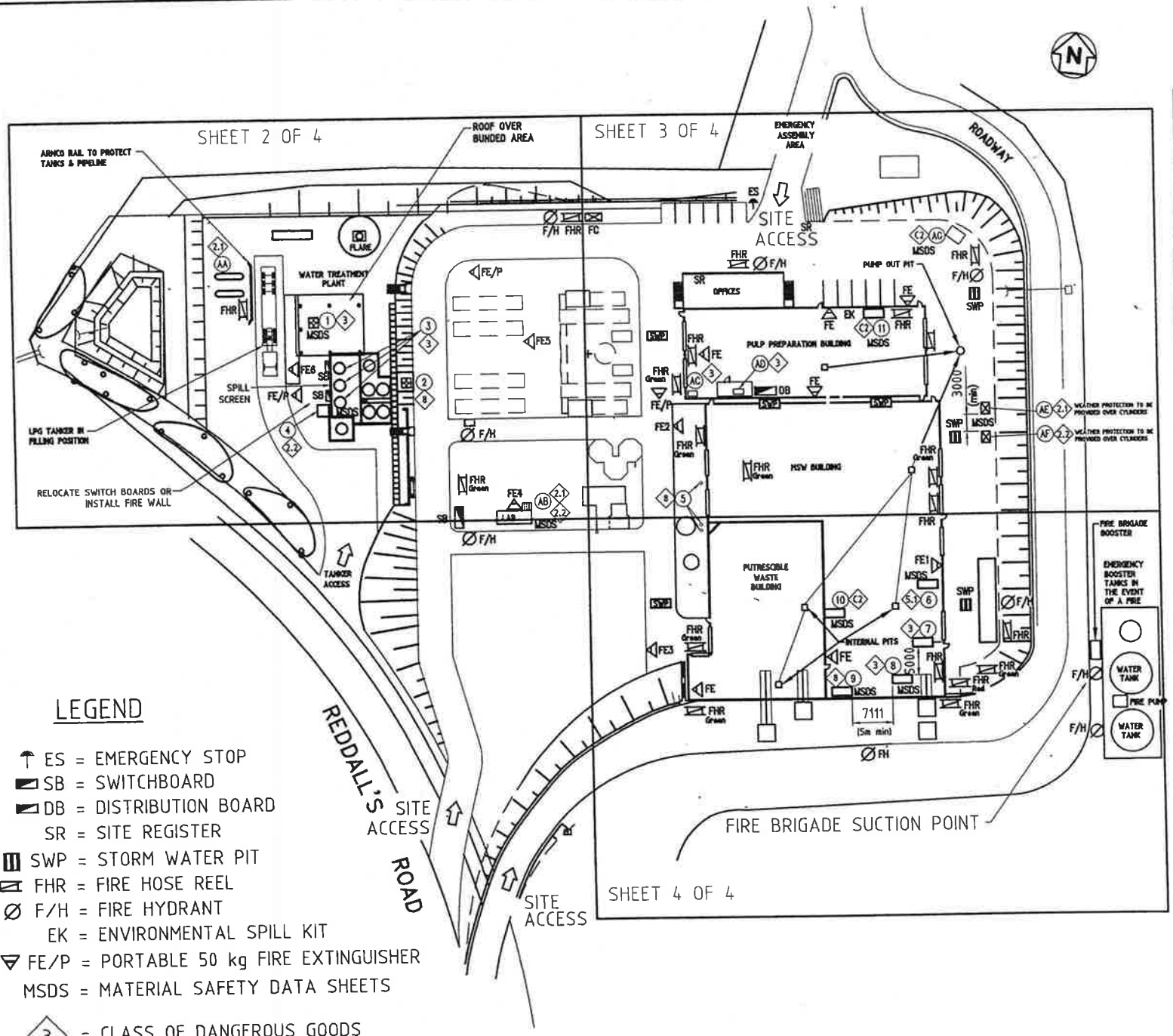
I certify that the details in this application (including any accompanying computer disk) are correct and cover all licensable quantities of dangerous goods kept on the premises.

13 Signature of applicant | Printed name | Date

RICK RALPH | 25-7-02

RECEIVED 29 JUL 2002 SCIENTIFIC SERVICES BRANCH

Please send your application, marked CONFIDENTIAL, to: Dangerous Goods Licensing, WorkCover NSW, Level 2, GPO Box 5364, SYDNEY NSW 2001



LEGEND

- ES = EMERGENCY STOP
- SB = SWITCHBOARD
- DB = DISTRIBUTION BOARD
- SR = SITE REGISTER
- SWP = STORM WATER PIT
- FHR = FIRE HOSE REEL
- F/H = FIRE HYDRANT
- EK = ENVIRONMENTAL SPILL KIT
- FE/P = PORTABLE 50 kg FIRE EXTINGUISHER
- MSDS = MATERIAL SAFETY DATA SHEETS
- (3) = CLASS OF DANGEROUS GOODS
- (A) = DANGEROUS GOODS DEPOT
- EMP = EMERGENCY MEETING POINT

DEPOT LIST

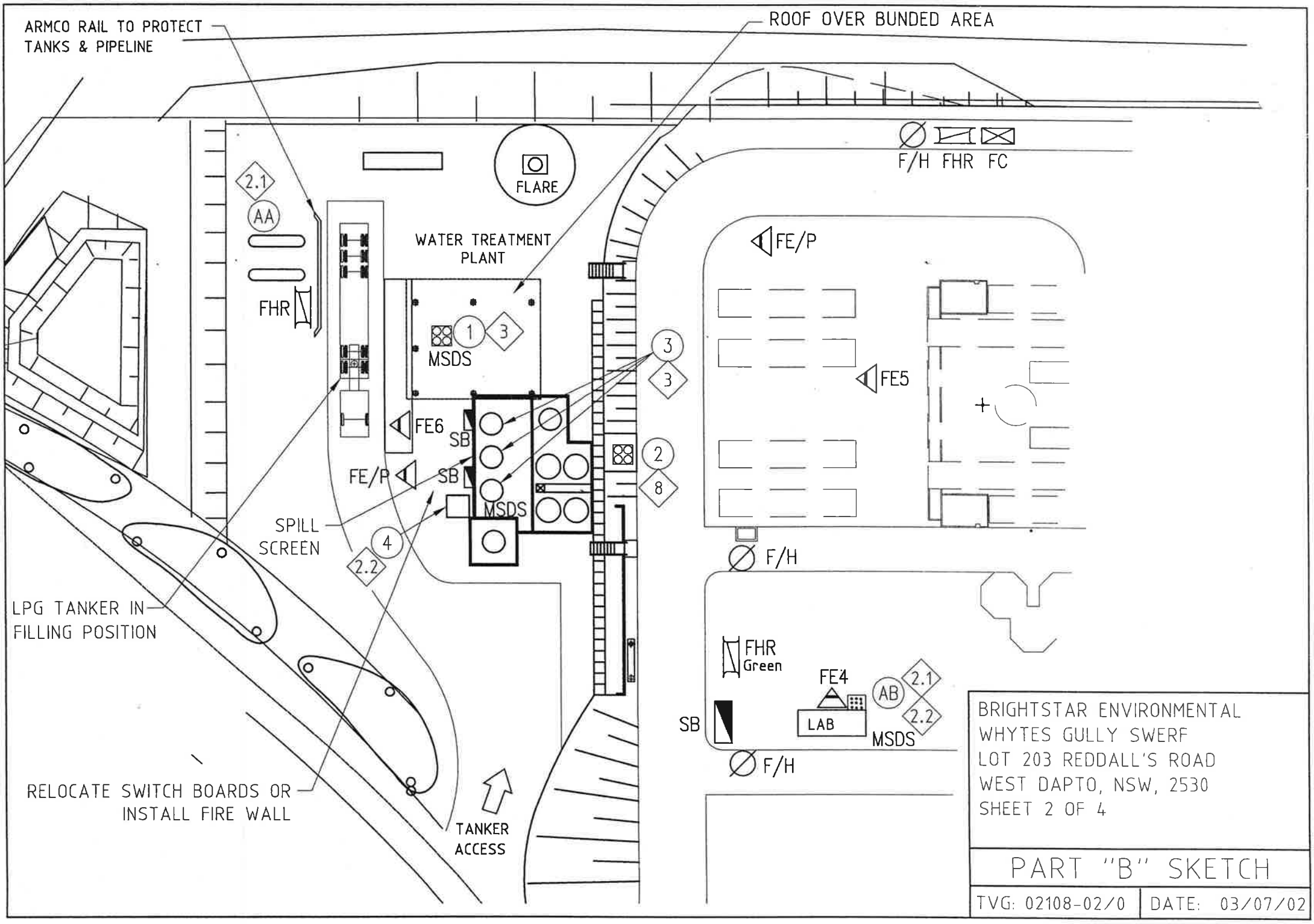
No.	TYPE	SIZE	PRODUCT	CLAS	j
1	BUNDED DRUMS	4100 L	SYNOIL	3	11
2	BUNDED DRUMS	820 L	SODIUM HYDROXIDE	8	11
3	AGST	3x5 kL	SYNOIL	3	11
4	GAS CYLINDERS	63 m³	NITROGEN	2.2	-
5	BUNDED DRUMS	3x205L	SODIUM HYDROXIDE	8	11
6	BUNDED DRUMS	205L	HYDROGEN PEROXIDE	5.1/8	11
7	BUNDED DRUMS	200 L	METHANOL	3/6.1	11
8	CABINET	250L	PAINT	3	11
9	ROOFED STORE	1025L	AQUA AMMONIA	8	111
10	ROOFED STORE	3x1000L	LUBE OIL	C2	-
11	BUNDED DRUMS	820 L	DIESEL	C1	-
AA	AGST	2x7.5kL	LPG	2.1	-
AB	CYLINDER STORE	11m³	NITROGEN	2.2	-
AB	CYLINDER STORE	7.3m³	CO_2	2.2	-
AB	CYLINDER STORE	7.3m³	ARGON	2.2	-
AB	CYLINDER STORE	7.3m³	HYDROGEN	2.1	-
AB	CYLINDER STORE	7.3m³	HELIUM	2.2	-
AB	CYLINDER STORE	7.1m³	AIR	2.1	-
AC	CABINET	250L	PAINT	3	11
AD	CABINET	100L	PAINT	3	11
AE	CYLINDER STORE	9x6m³	ACETYLENE	2.1	-
	CYLINDER STORE	9 x 9 kg	LPG		
AF	CYLINDER STORE	9x7m³	OXYGEN	2.2	-
	CYLINDER STORE	9x7m³	ARGON		
AG	BUNDED DRUMS	800 L	WASTE OIL	C2	-

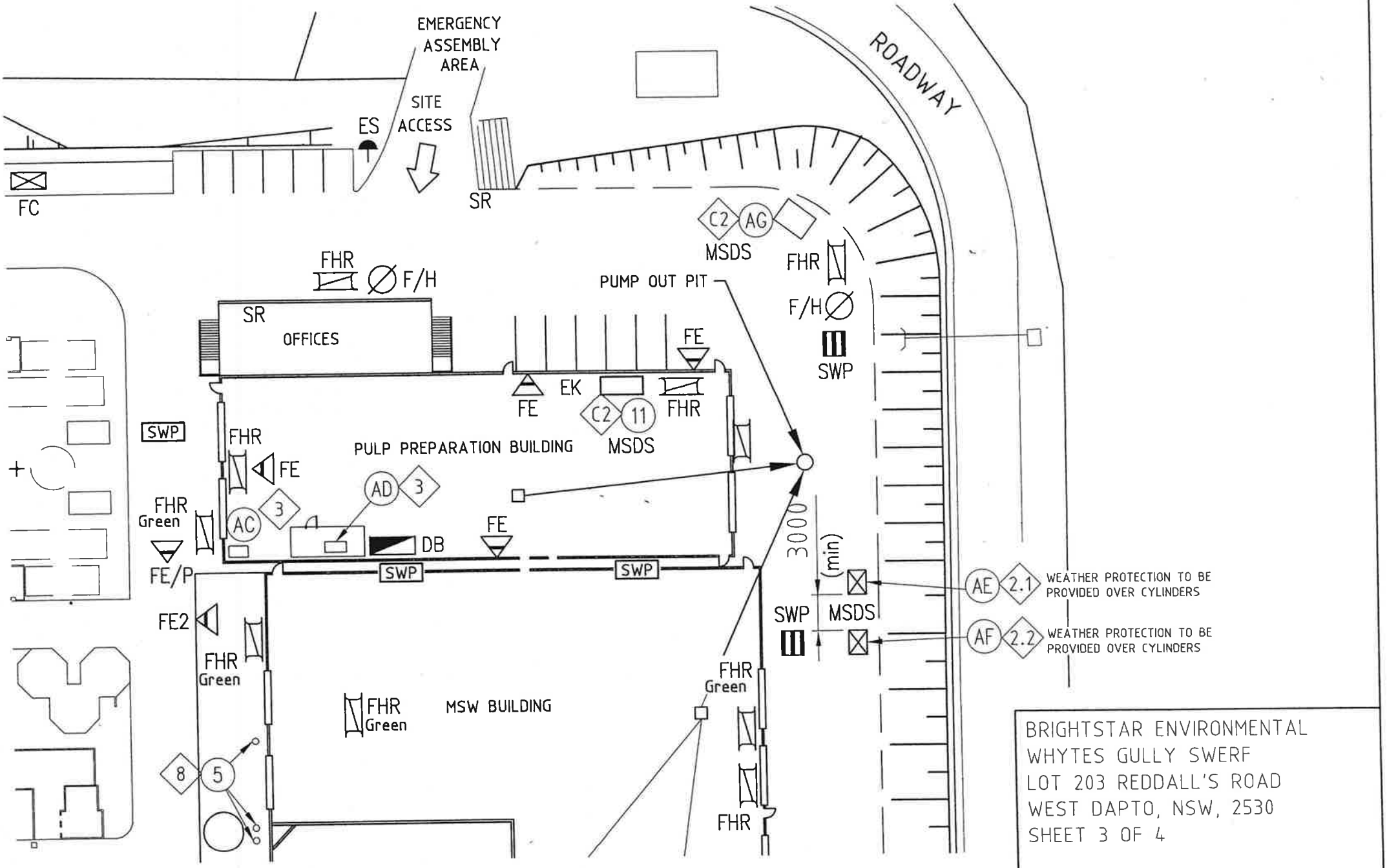
BRIGHTSTAR ENVIRONMENTAL
WHYTES GULLY SWERF
LOT 203 REDDALL'S ROAD
WEST DAPTO, NSW, 2530
SHEET 1 OF 4

PART "B" SKETCH

TVG: 02108-02/0 | DATE: 03/07/02

9580/55

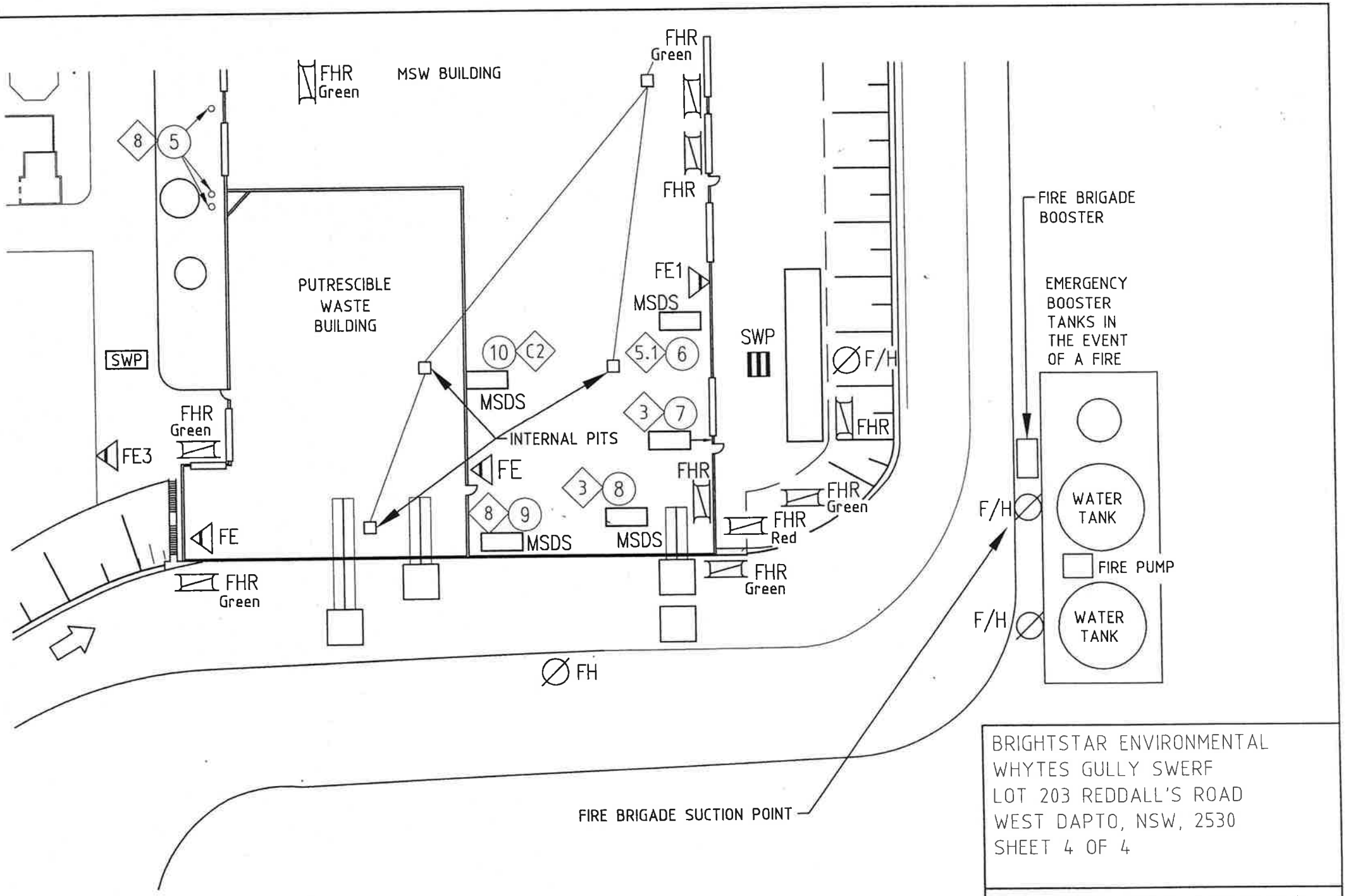

ARMCO RAIL TO PROTECT TANKS & PIPELINE
ROOF OVER BUNDED AREA
F/H FHR FC
FLARE
2.1
AA
WATER TREATMENT PLANT
FHR
1
3
MSDS
FE/P
FE5
FE6
SB
FE/P
SB
MSDS
SPILL SCREEN
4
2.2
3
3
2
8
F/H
LPG TANKER IN FILLING POSITION
FHR Green
FE4
AB
2.1
2.2
SB
LAB
MSDS
F/H
RELOCATE SWITCH BOARDS OR INSTALL FIRE WALL
TANKER ACCESS
BRIGHTSTAR ENVIRONMENTAL
WHYTES GULLY SWERF
LOT 203 REDDALL'S ROAD
WEST DAPTO, NSW, 2530
SHEET 2 OF 4
PART "B" SKETCH
TVG: 02108-02/0
DATE: 03/07/02



BRIGHTSTAR ENVIRONMENTAL
WHYTES GULLY SWERF
LOT 203 REDDALL'S ROAD
WEST DAPTO, NSW, 2530
SHEET 3 OF 4

PART "B" SKETCH

TVG: 02108-02/0 | DATE: 03/07/02


FHR
Green
MSW BUILDING
FHR
Green
FHR
FIRE BRIGADE
BOOSTER
EMERGENCY
BOOSTER
TANKS IN
THE EVENT
OF A FIRE
8
5
PUTRESCIBLE
WASTE
BUILDING
FE1
MSDS
SWP
10
C2
5.1
6
F/H
SWP
MSDS
3
7
FHR
Green
FE3
INTERNAL PITS
FHR
FE
FHR
3
8
FHR
Green
8
9
FHR
Red
F/H
WATER
TANK
FE
MSDS
MSDS
FHR
Green
FIRE PUMP
FHR
Green
F/H
WATER
TANK
FH
FIRE BRIGADE SUCTION POINT
BRIGHTSTAR ENVIRONMENTAL
WHYTES GULLY SWERF
LOT 203 REDDALL'S ROAD
WEST DAPTO, NSW, 2530
SHEET 4 OF 4
PART "B" SKETCH
TVG: 02108-02/0
DATE: 03/07/02

35/034856

What is a depot? See page 5 of the Guidance Notes.

PART C – Dangerous Goods Storage *Complete one section per depot.*

If you have more depots than the space provided, photocopy sufficient sheets first.

Depot Number	Type of depot (see page 5)	Depot Class	Maximum storage capacity
1	BUNDED DRUMS Roof Flam. ed Store	3	4,100L

UN Number	Proper Shipping Name	Class (I, II, III)	PG	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
1993	FLAMMABLE LIQUID N.O.S	3	II	SYNOIL	4100	L

Depot Number	Type of depot (see page 5)	Depot Class	Maximum storage capacity
2	BUNDED DRUMS Roof Flam	8	820L

UN Number	Proper Shipping Name	Class (I, II, III)	PG	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
1824	SODIUM HYDROXIDE SOLUTION	8	II	SODIUM HYDROXIDE	820	L

Depot Number	Type of depot (see page 5)	Depot Class	Maximum storage capacity
3	ABOVE GROUND STORAGE TANKS	3	3x5000 L

UN Number	Proper Shipping Name	Class (I, II, III)	PG	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
1993	FLAMMABLE LIQUID N.O.S.	3	II	SYNOIL	3x5000	L

Depot Number	Type of depot (see page 5)	Depot Class	Maximum storage capacity
4	CYLINDERS	2.2	63m3

UN Number	Proper Shipping Name	Class (I, II, III)	PG	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
1066	COMPRESSED GAS	2.2	-	NITROGEN	63	m3

35/034856

PART C – Dangerous Goods Storage *Complete one section per depot.*

If you have more depots than the space provided, photocopy sufficient sheets first.

Depot Number	Type of depot	Depot Class	Maximum storage capacity
5	BUNDED DRUMS Roofed	8	3 x 205 L

UN Number	Correct Shipping Name	Class	PG (I, II, III)	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
1824	SODIUM HYDROXIDE SOLUTION	8	II	SODIUM HYDROXIDE	3x205	L

Depot Number	Type of depot	Depot Class	Maximum storage capacity
6	BUNDED DRUMS Roofed	5.1/8	205 L

UN Number	Correct Shipping Name	Class	PG (I, II, III)	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
2014	HYDROGEN PEROXIDE AQUEOUS SOLUTION	5.1	II	HYDROGEN PEROXIDE	205	L

Depot Number	Type of depot	Depot Class	Maximum storage capacity
7	BUNDED DRUMS Roofed	3/6.1	200 L

UN Number	Correct Shipping Name	Class	PG (I, II, III)	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
1230	METHANOL	3	II	METHANOL	200	L

Depot Number	Type of depot	Depot Class	Maximum storage capacity

UN Number	Correct Shipping Name	Class	PG (I, II, III)	Product or common name	Typical quantity	Unit, e.g. L, kg, m³

35/034856

What is a depot? See page 5 of the Guidance Notes.

PART C – Dangerous Goods Storage *Complete one section per depot.*

If you have more depots than the space provided, photocopy sufficient sheets first.

Depot Number	Type of depot (see page 5)	Depot Class	Maximum storage capacity
8	FLAMMABLE LIQUIDS CABINET	3	250 L

UN Number	Proper Shipping Name	Class	PG (I, II, III)	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
1263	PAINT PRODUCTS	3	II	PAINT	250	L

Depot Number	Type of depot (see page 5)	Depot Class	Maximum storage capacity
9	ROOFED STORE	8	1025 L

UN Number	Proper Shipping Name	Class	PG (I, II, III)	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
2672	AMMONIA SOLUTION	8	III	AMMONIA	1025	L

exempt storage area

Depot Number	Type of depot (see page 5)	Depot Class	Maximum storage capacity
10	ROOFED STORE	C2	3 x 1000 L

UN Number	Proper Shipping Name	Class	PG (I, II, III)	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
0002	COMBUSTIBLE LIQUID	C2	–	LUBE OIL	3 x 1000	L

exempt Roofed

Depot Number	Type of depot (see page 5)	Depot Class	Maximum storage capacity
11	BUNDED DRUMS	C1	820 L

UN Number	Proper Shipping Name	Class	PG (I, II, III)	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
0001	PETROLEUM FUEL	C1	–	DIESEL	820	L

35/034856

What [illegible] depot? See page 5 of the Guidance Notes.

PART C – Dangerous Goods Storage *Complete one section per depot.*

If you have more depots than the space provided, photocopy sufficient sheets first.

Depot Number	Type of depot (see page 5)	Depot Class	Maximum storage capacity
AA	ABOVE GROUND STORAGE TANK	2.1	2x7.5KL

UN Number	Proper Shipping Name	Class	PG (I, II, III)	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
1075	LIQUEFIED PETROLEUM GAS	2.1	–	LPG	2x7.5	KL

Depot Number	Type of depot (see page 5)	Depot Class	Maximum storage capacity
AB	CYLINDER STORE	2.2	11m3

UN Number	Proper Shipping Name	Class	PG (I, II, III)	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
1066	COMPRESSED GAS	2.2	–	NITROGEN	11	m3

Depot Number	Type of depot (see page 5)	Depot Class	9.0 Maximum storage capacity
AB	CYLINDER STORE	2.2	7.3m3

UN Number	Proper Shipping Name	Class	PG (I, II, III)	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
1013	COMPRESSED GAS	2.2	–	CARBON DIOXIDE	7.3	m3

8.0

Depot Number	Type of depot (see page 5)	Depot Class	Maximum storage capacity
AB	CYLINDER STORE	2.2	7.3m3

UN Number	Proper Shipping Name	Class	PG (I, II, III)	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
1006	COMPRESSED GAS	2.2	–	ARGON	7.3	m3

35/034856

What is a depot? See page 5 of the Guidance Notes.

PART C – Dangerous Goods Storage *Complete one section per depot.*

If you have more depots than the space provided, photocopy sufficient sheets first.

Depot Number	Type of depot (see page 5)	Depot Class	Maximum storage capacity
AB	CYLINDER STORE	2.1	7.3 m³

UN Number	Proper Shipping Name	Class (I, II, III)	PG	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
1049	COMPRESSED GAS	2.1	–	HYDROGEN	7.3	m³

Depot Number	Type of depot (see page 5)	Depot Class	Maximum storage capacity
AB	CYLINDER STORE	2.2	7.3 m³

UN Number	Proper Shipping Name	Class (I, II, III)	PG	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
1046	COMPRESSED GAS	2.2	–	HELIUM	7.3	m³

Depot Number	Type of depot (see page 5)	Depot Class	Maximum storage capacity
AB	CYLINDER STORE	2.1	7.1 m³

UN Number	Proper Shipping Name	Class (I, II, III)	PG	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
1002	COMPRESSED GAS	2.1	–	AIR	7.1	m³

Depot Number	Type of depot (see page 5)	Depot Class	Maximum storage capacity
AC	FLAMMABLE LIQUIDS CABINET	3	250 L

UN Number	Proper Shipping Name	Class (I, II, III)	PG	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
1263	PAINT PRODUCTS	3	II	PAINT	250	L

35/034856

What is a depot? See page 5 of the Guidance Notes.

PART C – Dangerous Goods Storage *Complete one section per depot.*

If you have more depots than the space provided, photocopy sufficient sheets first.

Depot Number	Type of depot (see page 5)	Depot Class	Maximum storage capacity
AD	FLAMMABLE LIQUIDS CABINET	3	100L

UN Number	Proper Shipping Name	Class	PG (I, II, III)	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
1263	PAINT PRODUCTS	3	II	PAINT	100	L

Depot Number	Type of depot (see page 5)	Depot Class	Maximum storage capacity
AE	CYLINDER STORE	2.1	9x6m³ / 9x9KG

UN Number	Proper Shipping Name	Class	PG (I, II, III)	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
AE 1001	COMPRESSED GAS	2.1	—	ACETYLENE	9x6	m³
AG 1075	LIQUIFIED PETROLEUM GAS	2.1	—	LPG	9x9	KG

Depot Number	Type of depot (see page 5)	Depot Class	Maximum storage capacity
AF	CYLINDER STORE	2.2	9X7.3m³ / 9x7.3m3

UN Number	Proper Shipping Name	Class	PG (I, II, III)	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
1072	COMPRESSED GAS	2.2	—	OXYGEN	9x7.3	m3 = 66m³
1956	COMPRESSED GAS	2.2	-	ARGON	9x7.3	m3 = 66m³

Depot Number	Type of depot (see page 5)	Depot Class	Maximum storage capacity
AG	BUNDED DRUMS exempt Rodlem	C2	800L

UN Number	Proper Shipping Name	Class	PG (I, II, III)	Product or common name	Typical quantity	Unit, e.g. L, kg, m³
00C2	COMBUSTIBLE LIQUID	C2	—	WASTE OIL	800	L

APPENDIX G

Sampling Records & Calibration Certificates

APPENDIX G1

Calibration Certificates (Soil)

Provided on DVD

APPENDIX G2

Sampling Records and Calibration Certificates (Groundwater)

March 2012
Report No. 117625003-046-R-Rev0

Provided on DVD

APPENDIX H

Summary Data Tables

APPENDIX H1

Summary Data Tables (Soil)

			pH Value	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury
		Units	pH Unit	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
		LOR	0.1	5	1	2	5	5	2	5	0.1
Sample ID	Depth (m bgl)	Date									
GACS01_0.0-0.2M_050711	0.0-0.2	05/07/2011	8.2	<5	<1	16	29	23	4	180	<0.1
GACS02_0.0-0.1M_050711	0.0-0.1	05/07/2011	6.3	5	<1	6	21	29	3	55	<0.1
GACS03_0.0-0.2M_050711	0.0-0.2	05/07/2011	8.3	<5	<1	9	119	12	7	62	<0.1
GACS04_0.0-0.1M_060711	0.0-0.1	06/07/2011	7.6	<5	<1	11	30	18	5	56	<0.1
GACS05_1.0-1.2M_050711	1.0-1.2	05/07/2011	7.3	<5	<1	8	26	18	3	46	<0.1
GACS06_0.4-0.5M_070711	0.4-0.5	07/07/2011	5.7	<5	<1	4	15	7	2	32	<0.1
GABH06_0.0-0.2_260711	0.0-0.2	26/07/2011	7.3	<5	<1	13	29	26	5	56	<0.1
GABH03_0.0-0.2_290711	0.0-0..2	29/07/2011	7.6	5	<1	11	26	25	5	47	<0.1
GABH05_0.0-0.2_290711	0.0-0.2	29/07/2011	7.8	14	<1	27	146	555	11	1040	<0.1
GABH02_0.0-0.2M	0.0-0.2	11/08/2011	8.0	7	<1	54	19	24	3	38	<0.1
GABH04_0.0-0.2M	0.0-0.2	10/08/2011	8.3	5	<1	30	55	23	10	124	<0.1
HIL-F Criteria (Commercial/Industrial)			-	**500**	**100**	**500**	**5000**	**1500**	**3000**	**35000**	**75**

Notes

LOR: Limit of Reporting

All total results are expressed as mg/kg (dry weight) unless otherwise specified

- indicates not analysed or no criteria available

m bgl: metres below ground level

Appendix H1
SUMMARY OF ANALYTICAL RESULTS
SOIL: pH and Metals
117625003
Whytes Gully New Cell
Wollongong City Council

			Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benz(a)anthracene	Chrysene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Indeno(1.2.3.cd)pyrene	Dibenz(a.h)anthracene	Benzo(g.h.i)perylene	Sum of PAHs
		Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
		LOR	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Sample ID	Depth (m bgl)	Date																	
GACS01_0.0-0.2M_050711	0.0-0.2	05/07/2011	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GACS02_0.0-0.1M_050711	0.0-0.1	05/07/2011	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GACS03_0.0-0.2M_050711	0.0-0.2	05/07/2011	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GACS04_0.0-0.1M_060711	0.0-0.1	06/07/2011	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GACS05_1.0-1.2M_050711	1.0-1.2	05/07/2011	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GACS06_0.4-0.5M_070711	0.4-0.5	07/07/2011	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GABH06_0.0-0.2_260711	0.0-0.2	26/07/2011	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GABH03_0.0-0.2_290711	0.0-0..2	29/07/2011	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GABH05_0.0-0.2_290711	0.0-0.2	29/07/2011	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GABH02_0.0-0.2M	0.0-0.2	11/08/2011	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
GABH04_0.0-0.2M	0.0-0.2	10/08/2011	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
HIL-F Criteria (Commercial/Industrial)															**5**				**100**

Notes

LOR: Limit of Reporting

All total results are expressed as mg/kg (dry weight) unless otherwise specified

- indicates not analysed or no criteria available

m bgl: metres below ground level

Appendix H1

SUMMARY OF ANALYTICAL RESULTS

SOIL: Polycyclic Aromatic Hydrocarbons (PAH)

117625003

Whytes Gully New Cell

Wollongong City Council

			Phenol	2-Chlorophenol	2-Methylphenol	3- & 4-Methylphenol	2-Nitrophenol	2.4-Dimethylphenol	2.4-Dichlorophenol	2.6-Dichlorophenol	4-Chloro-3-Methylphenol	2.4.6-Trichlorophenol	2.4.5-Trichlorophenol	Pentachlorophenol
		Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
		LOR	0.5	0.5	0.5	1.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	2.0
Sample ID	Depth (m bgl)	Date												
GACS01_0.0-0.2M_050711	0.0-0.2	05/07/2011	<0.5	<0.5	<0.5	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2.0
GACS02_0.0-0.1M_050711	0.0-0.1	05/07/2011	<0.5	<0.5	<0.5	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2.0
GACS03_0.0-0.2M_050711	0.0-0.2	05/07/2011	<0.5	<0.5	<0.5	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2.0
GACS04_0.0-0.1M_060711	0.0-0.1	06/07/2011	<0.5	<0.5	<0.5	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2.0
GACS05_1.0-1.2M_050711	1.0-1.2	05/07/2011	<0.5	<0.5	<0.5	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2.0
GACS06_0.4-0.5M_070711	0.4-0.5	07/07/2011	<0.5	<0.5	<0.5	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2.0
GABH06_0.0-0.2_260711	0.0-0.2	26/07/2011	<0.5	<0.5	<0.5	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2.0
GABH03_0.0-0.2_290711	0.0-0..2	29/07/2011	<0.5	<0.5	<0.5	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2.0
GABH05_0.0-0.2_290711	0.0-0.2	29/07/2011	<0.5	<0.5	<0.5	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2.0
GABH02_0.0-0.2M	0.0-0.2	11/08/2011	<0.5	<0.5	<0.5	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2.0
GABH04_0.0-0.2M	0.0-0.2	10/08/2011	<0.5	<0.5	<0.5	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2.0
HIL-F Criteria (Commercial/Industrial)			**42500**											

Notes

LOR: Limit of Reporting

All total results are expressed as mg/kg (dry weight) unless otherwise specified

- indicates not analysed or no criteria available

m bgl: metres below ground level

Appendix H1
SUMMARY OF ANALYTICAL RESULTS
SOIL: Phenolic Compounds
117625003
Whytes Gully New Cell
Wollongong City Council

			Total PCBs
		Units	mg/kg
		LOR	0.10
Sample ID	Depth (m bgl)	Date	
GACS01_0.0-0.2M_050711	0.0-0.2	05/07/2011	<0.10
GACS02_0.0-0.1M_050711	0.0-0.1	05/07/2011	<0.10
GACS03_0.0-0.2M_050711	0.0-0.2	05/07/2011	<0.10
GACS04_0.0-0.1M_060711	0.0-0.1	06/07/2011	<0.10
GACS05_1.0-1.2M_050711	1.0-1.2	05/07/2011	<0.10
GACS06_0.4-0.5M_070711	0.4-0.5	07/07/2011	<0.10
GABH06_0.0-0.2_260711	0.0-0.2	26/07/2011	<0.10
GABH03_0.0-0.2_290711	0.0-0.2	29/07/2011	<0.10
GABH05_0.0-0.2_290711	0.0-0.2	29/07/2011	<0.10
GABH02_0.0-0.2M	0.0-0.2	11/08/2011	<0.10
GABH04_0.0-0.2M	0.0-0.2	10/08/2011	<0.10
HIL-F Criteria (Commercial/Industrial)			**50**

Notes

LOR: Limit of Reporting

All total results are expressed as mg/kg (dry weight) unless otherwise specified

- indicates not analysed or no criteria available

m bgl: metres below ground level

Appendix H1
SUMMARY OF ANALYTICAL RESULTS
SOIL: Polychlorinated Biphenyls (PCBs)
117625003
Whytes Gully New Cell
Wollongong City Council

			BTEX								TPH					TRH					
			Benzene	Toluene	Ethylbenzene	meta- & para-Xylene	ortho-Xylene	Total Xylenes	Sum of BTEX	Naphthalene	C6 - C9 Fraction	C10 - C14 Fraction	C15 - C28 Fraction	C29 - C36 Fraction	C10 - C36 Fraction (sum)	C6 - C10 Fraction	C6 - C10 Fraction minus BTEX (F1)	>C10 - C16 Fraction	>C16 - C34 Fraction	>C34 - C40 Fraction	>C10 - C40 Fraction (sum)
		Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
		LOR	0.2	0.5	0.5	0.5	0.5	0.5	0.2	1	10	50	100	100	50	10	10	50	100	100	50
Sample ID	Depth (m bgl)	Date																			
GACS01_0.0-0.2M_050711	0.0-0.2	05/07/2011	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	<10	<50	<100	<100	<50	<10	<10	<50	<100	<100	<50
GACS02_0.0-0.1M_050711	0.0-0.1	05/07/2011	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	<10	<50	<100	<100	<50	<10	<10	<50	<100	<100	<50
GACS03_0.0-0.2M_050711	0.0-0.2	05/07/2011	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	<10	<50	<100	<100	<50	<10	<10	<50	<100	<100	<50
GACS04_0.0-0.1M_060711	0.0-0.1	06/07/2011	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	<10	<50	<100	<100	<50	<10	<10	<50	<100	<100	<50
GACS05_1.0-1.2M_050711	1.0-1.2	05/07/2011	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	<10	<50	<100	<100	<50	<10	<10	<50	<100	<100	<50
GACS06_0.4-0.5M_070711	0.4-0.5	07/07/2011	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	<10	<50	<100	<100	<50	<10	<10	<50	<100	<100	<50
GABH06_0.0-0.2_260711	0.0-0.2	26/07/2011	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	<10	<50	<100	<100	<50	<10	<10	<50	<100	<100	<50
GABH03_0.0-0.2_290711	0.0-0..2	29/07/2011	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	<10	<50	<100	<100	<50	<10	<10	<50	<100	<100	<50
GABH05_0.0-0.2_290711	0.0-0.2	29/07/2011	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	<10	<50	<100	130	130	<10	<10	<50	160	<100	160
GABH02_0.0-0.2M	0.0-0.2	11/08/2011	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	<10	<50	<100	<100	<50	<10	<10	<50	<100	<100	<50
GABH04_0.0-0.2M	0.0-0.2	10/08/2011	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<1	<10	<50	<100	<100	<50	<10	<10	<50	<100	<100	<50
NSW EPA 1994 Guidelines for Assessing Service Station Sites			**1**	**130**	**50**			**25**			**65**				**1000**						

Notes

LOR: Limit of Reporting

All total results are expressed as mg/kg (dry weight) unless otherwise specified

- indicates not analysed or no criteria available

m bgl: metres below ground level

Appendix H1
SUMMARY OF ANALYTICAL RESULTS
SOIL: TPH and BTEX
117625003
Whytes Gully New Cell
Wollongong City Council

			alpha-BHC	Hexachlorobenzene (HCB)	beta-BHC	gamma-BHC	delta-BHC	Heptachlor	Aldrin	Dieldrin	Heptachlor epoxide	trans-Chlordane	cis-Chlordane	alpha-Endosulfan	4.4`-DDE	4.4`-DDD	4.4`-DDT	Endrin	beta-Endosulfan	Endrin aldehyde	Endosulfan sulfate	Endrin ketone	Methoxychlor
		Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
		LOR	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.2	0.05	0.05	0.05	0.05	0.05	0.2
Sample ID	Depth (m bgl)	Date																					
GACS01_0.0-0.2M_050711	0.0-0.2	05/07/2011	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2
GACS02_0.0-0.1M_050711	0.0-0.1	05/07/2011	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2
GACS03_0.0-0.2M_050711	0.0-0.2	05/07/2011	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2
GACS04_0.0-0.1M_060711	0.0-0.1	06/07/2011	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2
GACS05_1.0-1.2M_050711	1.0-1.2	05/07/2011	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2
GACS06_0.4-0.5M_070711	0.4-0.5	07/07/2011	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2
GABH06_0.0-0.2_260711	0.0-0.2	26/07/2011	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2
GABH03_0.0-0.2_290711	0.0-0..2	29/07/2011	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2
GABH05_0.0-0.2_290711	0.0-0.2	29/07/2011	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2
GABH02_0.0-0.2M	0.0-0.2	11/08/2011	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2
GABH04_0.0-0.2M	0.0-0.2	10/08/2011	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2
HIL-F Criteria (Commercial/Industrial)								**50**		**50**			**250**			**1000**							

Notes

LOR: Limit of Reporting

All total results are expressed as mg/kg (dry weight) unless otherwise specified

- indicates not analysed or no criteria available

m bgl: metres below ground level

Appendix H1
SUMMARY OF ANALYTICAL RESULTS
SOIL: Organochlorine Pesticides (OCP)
117625003
Whytes Gully New Cell
Wollongong City Council

Sample ID	Date	Depth	PID Reading	Visual/ Olfactory Ranking	Description
		mbgl	ppm	See Below	
GACS01_0.0-0.2M_050711	05/07/2011	0.0-0.2	0.2	2A	SILT: dark brown with some fine to coarse, sub-angular gravel, wet, with some black staining, nil odour
GACS02_0.0-0.1M_050711	05/07/2011	0.0-0.1	0.1	0A	Refer log (TP05)
GACS02_0.5-0.6M_050711	05/07/2011	0.5-0.6	0.0	0A	
GACS02_1.0-1.1M_050711	05/07/2011	1.0-1.1	0.0	0A	
GACS03_0.0-0.2M_050711	05/07/2011	0.0-0.2	0.9	1C	SILT: dark brown with some fine to coarse, sub-angular gravel, wet, 5% organics (grass, reeds), decomposing odour
GACS04_0.0-0.1M_060711	06/07/2011	0.0-0.1	0.0	0A	Refer log (TP07)
GACS04_0.5-0.6M_060711	06/07/2011	0.5-0.6	0.3	0A	
GACS04_1.0-1.1M_060711	06/07/2011	1.0-1.1	0.4	0A	
GACS04_1.5-1.6M_060711	06/07/2011	1.5-1.6	0.0	0A	
GACS04_1.9-2.0M_060711	06/07/2011	1.9-2.0	0.0	0A	
GACS05_0.0-0.1M_050711	05/07/2011	0.0-0.1	0.0	0A	Refer log (TP06)
GACS05_0.5-0.6M_050711	05/07/2011	0.5-0.6	0.0	1B	
GACS05_1.0-1.2M_050711	05/07/2011	1.0-1.2	0.0	1B	
GACS06_0.0-0.1M_070711	07/07/2011	0.0-0.1	0.6	-	Refer log (TP18)
GACS06_0.4-0.5M_070711	07/07/2011	0.4-0.5	0.3	-	
GABH01_0.0-0.2M_150811	15/08/2011	0.0-0.2	0.1	0A	Refer log (GABH01)
GABH02_0.0-0.2M_110811	11/08/2011	0.0-0.2	0.6	0A	Refer log (GABH02)
GABH02_0.5-0.7M_110811	11/08/2011	0.5-0.7	0.2	0A	
GABH02_1.0-1.2M_110811	11/08/2011	1.0-1.2	0.2	0A	
GABH03_0.0-0.2M_290711	29/07/2011	0.0-0.2	0.4	0A	Refer log (GABH03)
GABH03_0.5-0.7M_290711	29/07/2011	0.5-0.7	0.5	0A	
GABH03_1.0-1.2M_290711	29/07/2011	1.0-1.2	3.4	0A	
GABH04_0.0-0.2M_100811	10/08/2011	0.0-0.2	0.0	0A	Refer log (GABH04)
GABH04_0.5-0.7M_100811	10/08/2011	0.5-0.7	0.0	0A	
GABH04_1.0-1.2M_100811	10/08/2011	1.0-1.2	0.0	0A	
GABH05_0.0-0.2M_290711	29/07/2011	0.0-0.2	0.3	0A	Refer log (GABH05)
GABH05_0.5-0.7M_290711	29/07/2011	0.5-0.7	0.4	0A	
GABH05_1.0-1.2M_290711	29/07/2011	1.0-1.2	0.3	0A	
GABH06_0.0-0.2M_260711	26/07/2011	0.0-0.2	0.5	0A	Refer log (GABH06D)
GABH06_0.5-0.7M_260711	26/07/2011	0.5-0.7	0.2	0A	
GABH06_1.0-1.2M_260711	26/07/2011	1.0-1.2	0.2	0A	

Notes

m bgl: metres below ground level

PID: Photo-Ionisation Detector

- indicates not analysed

Visual/Olfactory Rankings	
0 = No visible evidence of contamination	A = No non-natural odours identified
1 = Slight evidence of visible contamination	B = Slight non-natural odours identified
2 = Visible contamination	C = Moderate non-natural odours identified
3 = Significant visible contamination	D = Strong non-natural odours identified

Appendix H1
SUMMARY OF ANALYTICAL RESULTS
SOIL: Field Screening
117625003
Whytes Gully New Cell
Wollongong City Council

APPENDIX H2

Summary Data Tables (Groundwater)

February 2012
Report No. 117625003-046-R-Rev0

Appendix H2: Water Quality Results Summary Table
Whytes Gully New Landfill Cell
Project No. 117625003_046_R_Rev0

Analytes	Unit	LOR	ANZECC	Well ID	GMW101	GMW102	GMW103	GMW104	GMW105	GMW106	GMW107	GMW108S	GMW108D	GMW109S	GMW109D	GMW110	GMW111
				Sample Date	17/08/2011	17/08/2011	18/08/2011	17/08/2011	17/08/2011	17/08/2011	17/08/2011	22/08/2011	22/08/2011	18/08/2011	22/08/2011	25/07/2011	25/07/2011
				Type	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary
				Primary Sample	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lab Report No	ES1118241	NA	ES1118241	ES1118241	ES1118241	NA	NA	ES1118241	ES1118241	ES1118241	ES1118241	ES1115894	ES1115894
				Lab Sample No	009	NA	010	011	012	NA	NA	013	014	015	016	001	002
Field Parameters																	
Static Water Level	mBTOC				10.09	9.28	7.65	6.335	10.655	9.33	-	2.48	1.92	3.31	2.93	3.93	6.19
Static Water Level	mBGL				9.57	8.75	7.12	5.825	10.095	8.68	-	1.9	1.335	2.775	2.36	3.44	5.63
Static Water Level	mAHD				80.582	79.489	73.655	27.609	77.043	69.262	-	16.993	17.642	14.532	14.93	16.171	16.403
Field-pH	pH units				7.79	8.22	0.59 *	7.33	5.78	5.13	-	7.10	6.71	6.40	-	6.73	7.07
Field-temp	°C				17	16.8	18.7	17.1	17	16.8	-	17.9	17.0	18.1	-	18.1	18.4
Field-redox	mV				19	42	90	87	157	95	-	53	4131	-23	-	134.6	123.9
Field-EC	µS/cm				2850	301	1554	787	231	-	-	4020	3120	1432	-	3562	3016
Field Dissolved oxygen	ppm				2.37	0.97	2.73	5.03	3.1	4.26	-	1.23	1.20	5.3	-	3.08	3.72
Major Ions																	
Total Hardness as CaCO3	mg/L	1			869	-	510	235	39	-	-	988	669	474	343	1040	875
Hydroxide Alkalinity as CaCO3	mg/L	1			-	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	mg/L	1			-	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	mg/L	1			-	-	290	349	58	-	-	520	459	407	232	560	593
Total Alkalinity as CaCO3	mg/L	1			-	-	290	349	58	-	-	520	459	407	232	560	593
Sulfate as SO4 - Turbidimetric	mg/L	1			154	-	86	50	11	-	-	271	214	83	27	284	218
Chloride	mg/L	1			484	-	326	58	30	-	-	1010	717	297	361	911	828
Calcium	mg/L	1			183	-	130	48	9	-	-	168	126	119	73	170	141
Magnesium	mg/L	1			100	-	45	28	4	-	-	138	86	43	39	150	127
Sodium	mg/L	1			247	-	133	118	33	-	-	531	436	181	173	534	564
Potassium	mg/L	1			12	-	1	1	<1	-	-	<1	<1	6	1	2	3
Fluoride	mg/L	0.1			-	-	0.6	0.9	0.4	-	-	0.7	0.8	0.2	0.4	0.6	0.6
Total Anions	meq/L	0.01			-	-	16.8	9.65	2.23	-	-	44.5	33.8	18.2	15.4	42.8	39.7
Total Cations	meq/L	0.01			-	-	16	9.86	2.21	-	-	42.8	32.3	17.5	14.4	44.1	42.1
Ionic Balance	%	0.01			-	-	2.36	1.04		-	-	1.94	2.31	2.05	3.28	1.49	2.86
Nutrients																	
Ammonia as N	mg/L	0.01	0.9		0.07	-	0.02	0.02	0.01	-	-	<0.01	<0.01	3.22	0.09	0.03	0.02
Nitrite as N	mg/L	0.01			-	-	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	-	<0.01	<0.01	<0.01
Nitrate as N	mg/L	0.01			-	-	1.03	0.02	0.48	-	-	<0.01	<0.01	-	<0.01	0.01	0.02
Nitrite + Nitrate as N	mg/L	0.01			-	-	1.03	0.02	0.48	-	-	<0.01	<0.01	-	<0.01	0.01	0.02
Total Kjeldahl Nitrogen as N	mg/L	0.1			12.3 *	-	0.2	0.2	<0.1	-	-	<0.1	<0.1	2.4	0.1	1.9	0.3
Total Organic Carbon	mg/L	1			23 *	-	2	1	<1	-	-	2	1	16	<1	2	<1
Biochemical Oxygen Demand	mg/L	2			-	-	-	<2	<2	-	-	<2	<2	-	<2	5	5
Metals and Metalloids (dissolved) **																	
Aluminium	mg/L	0.01	0.055		0.01	-	0.01	0.02	0.06	-	-	<0.01	0.02	0.01	0.01	<0.01	<0.01
Arsenic	mg/L	0.001	-		<0.001	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	0.002	<0.001	<0.001	<0.001
Cadmium	mg/L	0.0001	0.0002		<0.0001	-	<0.0001	<0.0001	<0.0001	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	-		0.002	-	0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.0014		0.023	-	0.002	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	mg/L	0.001	0.0034		<0.001	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	0.003
Manganese	mg/L	0.001	1.9		0.096	-	0.061	0.389	0.041	-	-	0.726	0.026	4.17	0.656	<0.001	<0.001
Nickel	mg/L	0.001	0.011		0.03	-	0.002	0.001	<0.001	-	-	0.002	<0.001	0.01	<0.001	0.012	0.01
Zinc	mg/L	0.005	0.008		0.018	-	0.01	0.008	0.01	-	-	0.012	0.008	0.02	0.01	0.159	0.752
Iron	mg/L	0.05	-		<0.05	-	<0.05	<0.05	<0.05	-	-	0.07	<0.05	10.1	<0.05	<0.05	<0.05
Mercury	mg/L	0.0001	0.0006		<0.0001	-	<0.0001	<0.0001	<0.0001	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

* Values suspected of being anomalous or due to transcription error - to be reassessed during future works.
** All reported exceedances of the ANZECC (2000) criteria for copper, nickel and zinc were below the HMTVs calculated for each sample.

Notes:
NA = not applicable
- = not analysed

Prepared by: AB Date: 15/12/2011
Checked by: LJ Date: 06/01/2012

Appendix H2: Water Quality Results Summary Table
Whytes Gully New Landfill Cell
Project No. 117625003_046_R_Rev0

Analytes	Unit	LOR	ANZECC	Well ID	GABH01	GABH02	QC101	QC201	GABH03	GABH04	GABH05	GABH06S	GABH06D	QC100	BH6
				Sample Date	18/08/2011	19/08/2011	19/08/2011	19/08/2011	19/08/2011	19/08/2011	22/08/2011	17/08/2011	18/08/2011	18/08/2011	18/08/2011
				Type	Primary	Primary	Duplicate	Triplicate	Primary	Primary	Primary	Primary	Primary	Duplicate	Primary
				Primary Sample	NA	NA	GABH02	GABH02	NA	NA	NA	NA	NA	GABH06D	NA
				Lab Report No	ES1118241	ES1118241	ES1118241	60493	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241
				Lab Sample No	001	002	018	1	003	004	005	006	007	017	008
Field Parameters															
Static Water Level	mBTOC				2.905	4.725	4.725	4.725	0.18	0.94	5.72	1.89	1.37	1.37	1.34
Static Water Level	mBGL				2.33	4.195	4.195	4.195	-0.375	0.44	5.25	1.3	0.8	0.8	1.4
Static Water Level	mAHD				28.011	18.768	18.768	18.768	19.033	17.794	15.079	20.783	21.249	21.249	14.902
Field-pH	pH units				6.69	6.68	6.68	6.68	6.83	6.48	6.68	6.52	6.83	6.83	6.65
Field-temp	°C				17.4	17.2	17.2	17.2	17.0	17.3	17.9	17.8	18.7	18.7	18.8
Field-redox	mV				28	131	131	131	110	138	85	99	139	139	-6
Field-EC	µS/cm				2660	4940	4940	4940	5020	4990	4410	2870	3030	3030	4570
Field Dissolved oxygen	ppm				5.92	1.93	1.93	1.93	1.42	1.14	1.54	2.62	1.42	1.42	2.28
Major Ions															
Total Hardness as CaCO3	mg/L	1			830	1260	1260	1400	1560	1500	1260	411	575	583	808
Hydroxide Alkalinity as CaCO3	mg/L	1			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	mg/L	1			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	mg/L	1			604	834	844	910	607	458	574	376	319	319	656
Total Alkalinity as CaCO3	mg/L	1			604	834	844	910	607	458	574	376	319	319	656
Sulfate as SO4 - Turbidimetric	mg/L	1			208	157	156	160	214	287	242	220	220	221	293
Chloride	mg/L	1			596	1120	1120	1200	1300	1320	1080	605	745	740	1060
Calcium	mg/L	1			161	242	242	250	325	293	245	64	115	118	124
Magnesium	mg/L	1			104	159	159	180	183	188	158	61	70	70	121
Sodium	mg/L	1			364	596	592	580	512	520	495	475	453	451	747
Potassium	mg/L	1			2	3	3	3.6	2	1	<1	<1	<1	<1	<1
Fluoride	mg/L	0.1			0.5	0.6	0.6	0.52	0.6	0.6	0.6	1	0.5	0.6	1
Total Anions	meq/L	0.01			33.2	51.5	51.7	NA	53.2	52.4	47	29.2	32	31.8	49.1
Total Cations	meq/L	0.01			32.5	51.2	51	NA	53.6	52.7	46.8	28.9	31.2	31.3	48.6
Ionic Balance	%	0.01			1.12	0.36	0.7	-2.4	0.33	0.36	0.22	0.51	1.22	0.93	0.5
Nutrients															
Ammonia as N	mg/L	0.01	0.9		0.04	<0.01	<0.01	<0.005	0.04	0.01	0.02	<0.01	0.01	<0.01	0.04
Nitrite as N	mg/L	0.01			<0.01	<0.01	<0.01	NA	<0.01	-	<0.01	<0.01	<0.01	NA	<0.01
Nitrate as N	mg/L	0.01			0.02	0.05	<0.01	0.013	0.01	-	0.05	0.03	<0.01	NA	0.08
Nitrite + Nitrate as N	mg/L	0.01			0.02	0.05	<0.01	NA	0.01	-	0.05	0.03	<0.01	NA	0.08
Total Kjeldahl Nitrogen as N	mg/L	0.1			0.1	0.2	<0.1	0.2	<0.1	0.2	0.1	0.3	<0.1	<0.1	0.4
Total Organic Carbon	mg/L	1			3	5	4	5	3	2	2	<1	2	3	<1
Biochemical Oxygen Demand	mg/L	2			<2	<2	<2	<5	<2	-	<2	<2	<2	NA	<2
Metals and Metalloids (dissolved) **															
Aluminium	mg/L	0.01	0.055		<0.01	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	mg/L	0.001	-		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	mg/L	0.0001	0.0002		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002
Chromium	mg/L	0.001	-		<0.005	<0.005	<0.005	<0.001	<0.005	<0.001	0.002	<0.001	<0.001	<0.001	<0.005
Copper	mg/L	0.001	0.0014		<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Lead	mg/L	0.001	0.0034		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003
Manganese	mg/L	0.001	1.9		0.437	0.437	0.427	0.430	0.327	0.18	0.224	0.016	0.012	0.013	0.405
Nickel	mg/L	0.001	0.011		0.002	0.004	0.003	0.003	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.002
Zinc	mg/L	0.005	0.008		0.016	0.01	0.008	0.012	0.011	0.018	0.012	0.009	0.013	0.012	0.014
Iron	mg/L	0.05	-		0.97	0.08	<0.05	0.02	<0.05	<0.05	0.48	<0.05	<0.05	<0.05	<0.05
Mercury	mg/L	0.0001	0.0006		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

* Values suspected of being anomalous or due to transcription error - to be reassessed during
** All reported exceedances of the ANZECC (2000) criteria for copper, nickel and zinc were bel

Notes:
NA = not applicable
- = not analysed

Prepared by: AB Date: 15/12/2011
Checked by: LJ Date: 06/01/2012

Appendix H2: Water Quality Results Summary Table
Whytes Gully New Landfill Cell
Project No. 117625003_046_R_Rev0

Analytes	Unit	LOR	ANZECC	Well ID	GMW101	GMW102	GMW103	GMW104	GMW105	GMW106	GMW107	GMW108S	GMW108D	GMW109S	GMW109D	GMW110	GMW111
				Sample Date	17/08/2011	17/08/2011	18/08/2011	17/08/2011	17/08/2011	17/08/2011	17/08/2011	22/08/2011	22/08/2011	18/08/2011	22/08/2011	25/07/2011	25/07/2011
				Type	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary
				Primary Sample	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lab Report No	ES1118241	NA	ES1118241	ES1118241	ES1118241	NA	NA	ES1118241	ES1118241	ES1118241	ES1118241	ES1115894	ES1115894
				Lab Sample No	009	NA	010	011	012	NA	NA	013	014	015	016	001	002
Volatile Organic Compounds																	
Monocyclic Aromatic Hydrocarbons																	
Styrene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Isopropylbenzene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
n-Propylbenzene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.3.5-Trimethylbenzene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
sec-Butylbenzene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.2.4-Trimethylbenzene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
tert-Butylbenzene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
p-Isopropyltoluene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
n-Butylbenzene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Oxygenated Compounds																	
Vinyl Acetate	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
2-Butanone (MEK)	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
4-Methyl-2-pentanone (MIBK)	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
2-Hexanone (MBK)	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
Sulfonated Compounds																	
Carbon disulfide	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Fumigants																	
2.2-Dichloropropane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.2-Dichloropropane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
cis-1.3-Dichloropropylene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
trans-1.3-Dichloropropylene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.2-Dibromoethane (EDB)	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Halogenated Aliphatic Compounds																	
Dichlorodifluoromethane	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
Chloromethane	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
Vinyl chloride	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
Bromomethane	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
Chloroethane	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
Trichlorofluoromethane	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
1.1-Dichloroethene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Iodomethane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
trans-1.2-Dichloroethene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.1-Dichloroethane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
cis-1.2-Dichloroethene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.1.1-Trichloroethane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.1-Dichloropropylene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Carbon Tetrachloride	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.2-Dichloroethane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Trichloroethene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Dibromomethane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.1.2-Trichloroethane	µg/L	5	6500		<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.3-Dichloropropane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Tetrachloroethene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.1.1.2-Tetrachloroethane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
trans-1.4-Dichloro-2-butene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
cis-1.4-Dichloro-2-butene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.1.2.2-Tetrachloroethane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.2.3-Trichloropropane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Pentachloroethane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.2-Dibromo-3-chloropropane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Hexachlorobutadiene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Monocyclic Aromatic Hydrocarbons																	
Chlorobenzene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Bromobenzene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
2-Chlorotoluene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
4-Chlorotoluene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.3-Dichlorobenzene	µg/L	5	260		<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.4-Dichlorobenzene	µg/L	5	60		<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.2-Dichlorobenzene	µg/L	5	160		<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.2.4-Trichlorobenzene	µg/L	5	170		<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.2.3-Trichlorobenzene	µg/L	5	10		<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Trihalomethanes																	
Chloroform	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Bromodichloromethane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Dibromochloromethane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Bromoform	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5

Notes:
NA = not applicable
- = not analysed

Prepared by: AB Date: 15/12/2011
Checked by: LJ Date: 06/01/2012

Appendix H2: Water Quality Results Summary Table
Whytes Gully New Landfill Cell
Project No. 117625003_046_R_Rev0

Analytes	Unit	LOR	ANZECC	Well ID	GABH01	GABH02	QC101	QC201	GABH03	GABH04	GABH05	GABH06S	GABH06D	QC100	BH6
				Sample Date	18/08/2011	19/08/2011	19/08/2011	19/08/2011	19/08/2011	19/08/2011	22/08/2011	17/08/2011	18/08/2011	18/08/2011	18/08/2011
				Type	Primary	Primary	Duplicate	Triplicate	Primary	Primary	Primary	Primary	Primary	Duplicate	Primary
				Primary Sample	NA	NA	GABH02	GABH02	NA	NA	NA	NA	NA	GABH06D	NA
				Lab Report No	ES1118241	ES1118241	ES1118241	60493	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241
				Lab Sample No	001	002	018	1	003	004	005	006	007	017	008
Volatile Organic Compounds															
Monocyclic Aromatic Hydrocarbons															
Styrene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Isopropylbenzene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
n-Propylbenzene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.3.5-Trimethylbenzene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
sec-Butylbenzene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.2.4-Trimethylbenzene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
tert-Butylbenzene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
p-Isopropyltoluene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
n-Butylbenzene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Oxygenated Compounds															
Vinyl Acetate	µg/L	50			<50	<50	<50	NA	<50	<50	<50	<50	<50	<50	<50
2-Butanone (MEK)	µg/L	50			<50	<50	<50	NA	<50	<50	<50	<50	<50	<50	<50
4-Methyl-2-pentanone (MIBK)	µg/L	50			<50	<50	<50	NA	<50	<50	<50	<50	<50	<50	<50
2-Hexanone (MBK)	µg/L	50			<50	<50	<50	NA	<50	<50	<50	<50	<50	<50	<50
Sulfonated Compounds															
Carbon disulfide	µg/L	5			<5	<5	<5	NA	<5	<5	<5	<5	<5	<5	<5
Fumigants															
2.2-Dichloropropane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.2-Dichloropropane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
cis-1.3-Dichloropropylene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
trans-1.3-Dichloropropylene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.2-Dibromoethane (EDB)	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Halogenated Aliphatic Compounds															
Dichlorodifluoromethane	µg/L	50			<50	<50	<50	<10	<50	<50	<50	<50	<50	<50	<50
Chloromethane	µg/L	50			<50	<50	<50	<10	<50	<50	<50	<50	<50	<50	<50
Vinyl chloride	µg/L	50			<50	<50	<50	<10	<50	<50	<50	<50	<50	<50	<50
Bromomethane	µg/L	50			<50	<50	<50	<10	<50	<50	<50	<50	<50	<50	<50
Chloroethane	µg/L	50			<50	<50	<50	<10	<50	<50	<50	<50	<50	<50	<50
Trichlorofluoromethane	µg/L	50			<50	<50	<50	<10	<50	<50	<50	<50	<50	<50	<50
1.1-Dichloroethene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Iodomethane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
trans-1.2-Dichloroethene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.1-Dichloroethane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
cis-1.2-Dichloroethene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.1.1-Trichloroethane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.1-Dichloropropylene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Carbon Tetrachloride	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.2-Dichloroethane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Trichloroethene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Dibromomethane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.1.2-Trichloroethane	µg/L	5	6500		<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.3-Dichloropropane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Tetrachloroethene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.1.1.2-Tetrachloroethane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
trans-1.4-Dichloro-2-butene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
cis-1.4-Dichloro-2-butene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.1.2.2-Tetrachloroethane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.2.3-Trichloropropane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Pentachloroethane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.2-Dibromo-3-chloropropane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Hexachlorobutadiene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Monocyclic Aromatic Hydrocarbons															
Chlorobenzene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Bromobenzene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
2-Chlorotoluene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
4-Chlorotoluene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.3-Dichlorobenzene	µg/L	5	260		<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.4-Dichlorobenzene	µg/L	5	60		<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.2-Dichlorobenzene	µg/L	5	160		<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.2.4-Trichlorobenzene	µg/L	5	170		<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.2.3-Trichlorobenzene	µg/L	5	10		<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Trihalomethanes															
Chloroform	µg/L	5			<5	<5	<5	3	<5	<5	<5	<5	<5	<5	<5
Bromodichloromethane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Dibromochloromethane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Bromoform	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5

Notes:
NA = not applicable
- = not analysed

Prepared by: AB Date: 15/12/2011
Checked by: LJ Date: 06/01/2012

Appendix H2: Water Quality Results Summary Table
Whytes Gully New Landfill Cell
Project No. 117625003_046_R_Rev0

Analytes	Unit	LOR	ANZECC	Well ID	GMW101	GMW102	GMW103	GMW104	GMW105	GMW106	GMW107	GMW108S	GMW108D	GMW109S	GMW109D	GMW110	GMW111
				Sample Date	17/08/2011	17/08/2011	18/08/2011	17/08/2011	17/08/2011	17/08/2011	17/08/2011	22/08/2011	22/08/2011	18/08/2011	22/08/2011	25/07/2011	25/07/2011
				Type	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary
				Primary Sample	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lab Report No	ES1118241	NA	ES1118241	ES1118241	ES1118241	NA	NA	ES1118241	ES1118241	ES1118241	ES1118241	ES1115894	ES1115894
				Lab Sample No	009	NA	010	011	012	NA	NA	013	014	015	016	001	002
Phenolic Compounds																	
Phenol	µg/L	0.2	320		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
2-Chlorophenol	µg/L	0.2	490		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
2-Methylphenol	µg/L	0.2			<0.5	-	<0.5	0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
3- & 4-Methylphenol	µg/L	0.4			<1.0	-	<1.0	<0.9	<1.0	-	-	<1.0	<0.9	<1.0	<0.9	<2.0	<2.0
2-Nitrophenol	µg/L	0.2			<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
2.4-Dimethylphenol	µg/L	0.2			<0.5	-	<0.5	0.7	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
2.4-Dichlorophenol	µg/L	0.2	160		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
2.6-Dichlorophenol	µg/L	0.2			<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
4-Chloro-3-Methylphenol	µg/L	0.2	10		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
2.4.6-Trichlorophenol	µg/L	0.2	20		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
2.4.5-Trichlorophenol	µg/L	0.2			<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
Pentachlorophenol	µg/L	0.4			<1.0	-	<1.0	<0.9	<1.0	-	-	<1.0	<0.9	<1.0	<0.9	<2.0	<2.0
Polynuclear Aromatic Hydrocarbons																	
Naphthalene	µg/L	0.2	16		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	0.4
Acenaphthylene	µg/L	0.2			<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Acenaphthene	µg/L	0.2			<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Fluorene	µg/L	0.2			<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Phenanthrene	µg/L	0.2			<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Anthracene	µg/L	0.2			<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Fluoranthene	µg/L	0.2			<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Pyrene	µg/L	0.2			<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Benz(a)anthracene	µg/L	0.2			<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Chrysene	µg/L	0.2			<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Benzo(b)fluoranthene	µg/L	0.2			<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Benzo(k)fluoranthene	µg/L	0.2			<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Benzo(a)pyrene	µg/L	0.2			<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Indeno(1.2.3.cd)pyrene	µg/L	0.2			<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Dibenz(a.h)anthracene	µg/L	0.2			<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Benzo(g.h.i)perylene	µg/L	0.2			<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Sum of polycyclic aromatic hydrocarbons	µg/L	0.5			-	-	-	-	-	-	-	-	-	-	-	-	0.4
BTEX																	
Benzene	µg/L	1	950		<1	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
Toluene	µg/L	2			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Ethylbenzene	µg/L	2			<2	-	<2	<2	<2	-	-	<2	<2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	200		<2	-	<2	<2	<2	-	-	<2	<2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	350		<2	-	<2	<2	<2	-	-	<2	<2	<2	<2	<2	<2
Total Xylenes	µg/L	2			<2	-	<2	<2	<2	-	-	<2	<2	<2	<2	<2	<2
Sum of BTEX	µg/L	1			<1	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
Total Petroleum Hydrocarbons																	
C6 - C9 Fraction	µg/L	20			<20	-	<20	<20	<20	-	-	<20	<20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100			<100	-	<100	<100	<100	-	-	<100	<100	<100	<100	430	1090
C29 - C36 Fraction	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	770
C10 - C36 Fraction (sum)	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	430	1860
Total Recoverable Hydrocarbons																	
C6 - C10 Fraction	µg/L	20			<20	-	<20	<20	<20	-	-	<20	<20	<20	<20	<20	<20
C6 - C10 Fraction minus BTEX (F1)	µg/L	20			<20	-	<20	<20	<20	-	-	<20	<20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100			<100	-	<100	<100	<100	-	-	<100	<100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100			<100	-	<100	<100	<100	-	-	<100	<100	<100	<100	500	1640
>C34 - C40 Fraction	µg/L	100			<100	-	<100	<100	<100	-	-	<100	<100	<100	<100	<100	370
>C10 - C40 Fraction (sum)	µg/L	100			<100	-	<100	<100	<100	-	-	<100	<100	<100	<100	500	2010

Notes:
NA = not applicable
- = not analysed

Prepared by: AB Date: 15/12/2011
Checked by: LJ Date: 06/01/2012

Appendix H2: Water Quality Results Summary Table
Whytes Gully New Landfill Cell
Project No. 117625003_046_R_Rev0

Analytes	Unit	LOR	ANZECC	Well ID	GABH01	GABH02	QC101	QC201	GABH03	GABH04	GABH05	GABH06S	GABH06D	QC100	BH6
				Sample Date	18/08/2011	19/08/2011	19/08/2011	19/08/2011	19/08/2011	19/08/2011	22/08/2011	17/08/2011	18/08/2011	18/08/2011	18/08/2011
				Type	Primary	Primary	Duplicate	Triplicate	Primary	Primary	Primary	Primary	Primary	Duplicate	Primary
				Primary Sample	NA	NA	GABH02	GABH02	NA	NA	NA	NA	NA	GABH06D	NA
				Lab Report No	ES1118241	ES1118241	ES1118241	60493	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241
				Lab Sample No	001	002	018	1	003	004	005	006	007	017	008
Phenolic Compounds															
Phenol	µg/L	0.2	320		<0.5	<0.5	<0.5	<10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Chlorophenol	µg/L	0.2	490		<0.5	<0.5	<0.5	<10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Methylphenol	µg/L	0.2			<0.5	<0.5	<0.5	<10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
3- & 4-Methylphenol	µg/L	0.4			<0.9	<0.9	<0.9	<20	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
2-Nitrophenol	µg/L	0.2			<0.5	<0.5	<0.5	<10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2.4-Dimethylphenol	µg/L	0.2			<0.5	<0.5	<0.5	<10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2.4-Dichlorophenol	µg/L	0.2	160		<0.5	<0.5	<0.5	<10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2.6-Dichlorophenol	µg/L	0.2			<0.5	<0.5	<0.5	<10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4-Chloro-3-Methylphenol	µg/L	0.2	10		<0.5	<0.5	<0.5	NA	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2.4.6-Trichlorophenol	µg/L	0.2	20		<0.5	<0.5	<0.5	<10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2.4.5-Trichlorophenol	µg/L	0.2			<0.5	<0.5	<0.5	<10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Pentachlorophenol	µg/L	0.4			<0.9	<0.9	<0.9	<100	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
Polynuclear Aromatic Hydrocarbons															
Naphthalene	µg/L	0.2	16		<0.5	<0.5	<0.5	0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthylene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluorene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Phenanthrene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Anthracene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoranthene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Pyrene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benz(a)anthracene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chrysene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(b)fluoranthene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(k)fluoranthene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibenz(a.h)anthracene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(g.h.i)perylene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sum of polycyclic aromatic hydrocarbons	µg/L	0.5			-	-	-	0.1	-	-	-	-	-	-	-
BTEX															
Benzene	µg/L	1	950		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	µg/L	2			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Ethylbenzene	µg/L	2			<2	<2	<2	<1	<2	<2	<2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	200		<2	4	4	<2	<2	<2	<2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	350		<2	2	2	3	<2	<2	<2	<2	<2	<2	<2
Total Xylenes	µg/L	2			<2	6	6	3	<2	<2	<2	<2	<2	<2	<2
Sum of BTEX	µg/L	1			<1	6	6	3	<1	<1	<1	<1	<1	<1	<1
Total Petroleum Hydrocarbons															
C6 - C9 Fraction	µg/L	20			<20	30	30	<10	<20	<20	<20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50			<50	<50	<50	86	<50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100			<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50			<50	<50	<50	<100	<50	<50	<50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50			<50	<50	<50	86	<50	<50	<50	<50	<50	<50	<50
Total Recoverable Hydrocarbons															
C6 - C10 Fraction	µg/L	20			<20	40	40	NA	<20	<20	<20	<20	<20	<20	<20
C6 - C10 Fraction minus BTEX (F1)	µg/L	20			<20	30	30	NA	<20	<20	<20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100			<100	<100	<100	NA	<100	<100	<100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100			<100	<100	<100	NA	<100	<100	<100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L	100			<100	<100	<100	NA	<100	<100	<100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100			<100	<100	<100	NA	<100	<100	<100	<100	<100	<100	<100

Notes:
NA = not applicable
- = not analysed

Prepared by: AB Date: 15/12/2011
Checked by: LJ Date: 06/01/2012

Appendix H2: Water Quality Results Summary Table
Whytes Gully New Landfill Cell
Project No. 117625003_046_R_Rev0

	Well ID	GMW101	GMW102	GMW103	GMW104	GMW105	GMW106	GMW107	GMW108S	GMW108D	GMW109S	GMW109D	GMW110	GMW111
	Sample Date	17/08/2011	17/08/2011	18/08/2011	17/08/2011	17/08/2011	17/08/2011	17/08/2011	22/08/2011	22/08/2011	18/08/2011	22/08/2011	25/07/2011	25/07/2011
	Type	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary
	Primary Sample	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Lab Report No	ES1118241	NA	ES1118241	ES1118241	ES1118241	NA	NA	ES1118241	ES1118241	ES1118241	ES1118241	ES1115894	ES1115894
	Lab Sample No	009	NA	010	011	012	NA	NA	013	014	015	016	001	002
Analytes	**Unit**	**LOR**	**ANZECC**											
Organochlorine Pesticides														
Aldrin	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
alpha-BHC	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
beta-BHC	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
delta-BHC	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
4.4`-DDD	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
4.4`-DDE	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
4.4`-DDT	µg/L	0.010	0.01	<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Dieldrin	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
alpha-Endosulfan	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
beta-Endosulfan	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Endosulfan sulfate	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Endrin	µg/L	0.010	0.02	<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Endrin aldehyde	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Endosulfan (sum)	µg/L	0.010	0.2	<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Endrin ketone	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Heptachlor	µg/L	0.005	0.09	<0.005	-	<0.005	<0.005	<0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005
Heptachlor epoxide	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Hexachlorobenzene (HCB)	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
gamma-BHC	µg/L	0.010	0.2	<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Methoxychlor	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
cis-Chlordane	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
trans-Chlordane	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Total Chlordane (sum)	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Oxychlordane	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Sum of DDD + DDE + DDT	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Polychlorinated Biphenyls (as Aroclors)														
Total Polychlorinated biphenyls	µg/L	0.10		<0.10	-	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1016	µg/L	0.10		<0.10	-	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1221	µg/L	0.10		<0.10	-	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1232	µg/L	0.10		<0.10	-	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1242	µg/L	0.10	0.6	<0.10	-	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1248	µg/L	0.10		<0.10	-	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1254	µg/L	0.10		<0.10	-	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1260	µg/L	0.10		<0.10	-	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	<0.10	<0.10

Notes:
NA = not applicable
- = not analysed

Prepared by: AB Date: 15/12/2011
Checked by: LJ Date: 06/01/2012

Appendix H2: Water Quality Results Summary Table
Whytes Gully New Landfill Cell
Project No. 117625003_046_R_Rev0

Analytes	Unit	LOR	ANZECC	Well ID	GABH01	GABH02	QC101	QC201	GABH03	GABH04	GABH05	GABH06S	GABH06D	QC100	BH6
				Sample Date	18/08/2011	19/08/2011	19/08/2011	19/08/2011	19/08/2011	19/08/2011	22/08/2011	17/08/2011	18/08/2011	18/08/2011	18/08/2011
				Type	Primary	Primary	Duplicate	Triplicate	Primary	Primary	Primary	Primary	Primary	Duplicate	Primary
				Primary Sample	NA	NA	GABH02	GABH02	NA	NA	NA	NA	NA	GABH06D	NA
				Lab Report No	ES1118241	ES1118241	ES1118241	60493	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241
				Lab Sample No	001	002	018	1	003	004	005	006	007	017	008
Organochlorine Pesticides															
Aldrin	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
alpha-BHC	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
beta-BHC	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
delta-BHC	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
4.4`-DDD	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
4.4`-DDE	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
4.4`-DDT	µg/L	0.010	0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Dieldrin	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
alpha-Endosulfan	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
beta-Endosulfan	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Endosulfan sulfate	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Endrin	µg/L	0.010	0.02		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Endrin aldehyde	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Endosulfan (sum)	µg/L	0.010	0.2		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Endrin ketone	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Heptachlor	µg/L	0.005	0.09		<0.005	<0.005	<0.005	<0.010	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Heptachlor epoxide	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Hexachlorobenzene (HCB)	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
gamma-BHC	µg/L	0.010	0.2		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Methoxychlor	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
cis-Chlordane	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
trans-Chlordane	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Total Chlordane (sum)	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Oxychlordane	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Sum of DDD + DDE + DDT	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Polychlorinated Biphenyls (as Aroclors)															
Total Polychlorinated biphenyls	µg/L	0.10			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1016	µg/L	0.10			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1221	µg/L	0.10			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1232	µg/L	0.10			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1242	µg/L	0.10	0.6		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1248	µg/L	0.10			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1254	µg/L	0.10			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1260	µg/L	0.10			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

Notes:
NA = not applicable
- = not analysed

Prepared by: AB Date: 15/12/2011
Checked by: LJ Date: 06/01/2012

APPENDIX I

Certificates of Analysis & Chain of Custody Records

APPENDIX I1

Laboratory Certificates (Soil)

Provided on DVD

APPENDIX I2

Laboratory Certificates (Groundwater)

March 2012
Report No. 117625003-046-R-Rev0

Provided on DVD

APPENDIX J

Data Validation

APPENDIX J1

Data Validation (Soil)

DATA VALIDATION SUMMARY SHEET (Sydney)

Project Name:	Whytes Gully New Cell	**Project Number:**	117625003
Primary Laboratory:	ALS	**Workorder Number:**	ES1117692
Secondary Laboratory:	ELS	**Workorder Number:**	
Date Sampled:	10/08/2011-11/08/2011	**Sample Medium:**	Soil

Sample Information

Number of Primary Samples:	2	**Number of Triplicate Samples:**	0
Number of Duplicate Samples:	0	**Number of Other QAQC Samples:**	0

Documentation and Sample Handling Information

	Y/N	Comments
COC completed properly?	Y	
All requested analysis completed?	Y	
Samples received intact and chilled?	Y	3.6°c
Samples analysed within appropriate holding times?	N	Soil pH analysed 4-5 days outside of appropriate holding times due to laboratory processing error
Sample volumes sufficient for QC analysis?	Y	
Are there non-NATA accredited methods used?	N	
Chromatograms supplied as appropriate?	N/A	
Laboratory reports signed by authorised personnel?	Y	

QAQC Sample Information (Method Blank - MB, Rinsate Blank - RB, Field Blank - FB, Trip Blank - TB)

Type	Sample ID	Comments
MB	-	All MB results from this batch are less than the LOR

Trip Spike Information

Analyte	Spike Concentrations	Recovery Concentration	% Recovery	Comments

Laboratory Control Samples (LCS) Analyses

Analyte Group	Comments
All	All LCS recoveries from this batch are within acceptable control limits.

Matrix Spike (MS) Analyses

Analyte Group	Comments
All	All MS recoveries from this batch are within acceptable control limits.

Laboratory Duplicates (LD) Analyses

Analyte Group	Analyte(s)	Sample ID	Comments
All			All LD RPDs from this batch are within acceptable control limits

Field Duplicates (FD) Analyses

Analyte Group	Primary ID	Duplicate ID	Comments
			No FD were analysed with this batch

Field Triplicates (FT) Analyses

Analyte Group	Primary ID	Triplicate ID	Comments
			No FT were analysed with this batch

Surrogate Compound Monitoring Analyses

Analyte Group	Sample ID	Comments
All		All surrogate compound recoveries are within acceptable control limits.

Overall Comments

The soil pH values measures are beyond the holding time due to laboratory processing error, but may still be used as a guide. This exceedance is not expected to affect the overall data quality of this batch.

Overall, this batch is acceptable for environmental interpretative purposes.

Note: Data validation assesses each analyte in terms of all the data validation variables and only the exceedances and outliers are reported in this form.

*When concentrations are less than the LOR for both primary and duplicate/triplicate results, no RPDs are calculated

Performed By: AM
Date: 28/10/2011

Checked By: MB
Date: 31/10/2011

DATA VALIDATION SUMMARY SHEET (Sydney)

Project Name:	Whytes Gully New Cell	**Project Number:**	117625003
Primary Laboratory:	ALS	**Workorder Number:**	ES1116709
Secondary Laboratory:	ELS	**Workorder Number:**	59331
Date Sampled:	26/07/2011-29/07/2011	**Sample Medium:**	Soil

Sample Information

Number of Primary Samples:	3	**Number of Triplicate Samples:**	1
Number of Duplicate Samples:	1	**Number of Other QAQC Samples:**	2

Documentation and Sample Handling Information

	Y/N	Comments
COC completed properly?	Y	
All requested analysis completed?	Y	
Samples received intact and chilled?	Y	6.8°c, ice present.
Samples analysed within appropriate holding times?	N	Soil pH analysis for samples GABH06_0.0-0.2_260711 and GABHFD01_260711 conducted 2 days outside of appropriate holding time. PCB, OCP, Phenolics and TPH rinsate water analysis for sample RB_260711 conducted 2 days outside of appropriate holding time.
Sample volumes sufficient for QC analysis?	Y	
Are there non-NATA accredited methods used?	N	
Chromatograms supplied as appropriate?	N/A	
Laboratory reports signed by authorised personnel?	Y	

QAQC Sample Information (Method Blank - MB, Rinsate Blank - RB, Field Blank - FB, Trip Blank - TB)

Type	Sample ID	Comments
MB	-	All MB results from this batch are less than the LOR

Trip Spike Information

Analyte	Spike Concentrations	Recovery Concentration	% Recovery	Comments

Laboratory Control Samples (LCS) Analyses

Analyte Group	Comments
Soil - Metals	LCS recoveries for copper (118%) and Lead (117%) are greater than the upper control limits of 114% and 111% respectively.
Soil - PCBs	LCS recovery for total PCBs (121%) exceeds the upper control limit of 117%.
Water - PCBs	LCS recovery for total PCBs (123%) exceeds the upper control limit of 107%.
Water - Phenolic Compounds	LCS recovery of Pentachlorophenol (100%) exceeds the upper control limit of 95.6%.
	All other LCS recoveries from this batch are within acceptable control limits.

Matrix Spike (MS) Analyses

Analyte Group	Comments
All	All MS recoveries from this batch are within acceptable control limits.

Laboratory Duplicates (LD) Analyses

Analyte Group	Analyte(s)	Sample ID	Comments
All			All LD RPDs from this batch are within acceptable control limits

Field Duplicates (FD) Analyses

Analyte Group	Primary ID	Duplicate ID	Comments
	GABH06_0.0-0.2_260711	GABHFD01_260711	All FD RPDs are within acceptable control limits

Field Triplicates (FT) Analyses

Analyte Group	Primary ID	Triplicate ID	Comments
	GABH06_0.0-0.2_260711	GABH_FT01_260711	All FT RPDs are within acceptable control limits

Surrogate Compound Monitoring Analyses

Analyte Group	Sample ID	Comments
All		All surrogate compound recoveries are within acceptable control limits.

Overall Comments

Soil LCS recovery exceedances for Metals and PCBs are not expected to affect the overall data quality of this batch as the recoveries are only slightly outside of acceptable control limits.

Water LCS recovery exceedances are not expected to affect the overall data quality of this batch as they only affect the data quality of the water rinsate QC sample.

Soil pH analysis for samples GABH06_0.0-0.2_260711 and GABHFD01_260711 are beyond the holding time, but may still be used as a guide. This exceedance is not expected to affect the overall data quality of this batch.

Analysis of PCB, OCP, Phenolics and TPH rinsate water analysis for sample RB_260711 is beyond the limit of the holding time, but good decontamination procedures in the field indicate usability of the data. This exceedance is not expected to affect the overall data quality of this batch.

Overall, this batch is acceptable for environmental interpretative purposes.

Note: Data validation assesses each analyte in terms of all the data validation variables and only the exceedances and outliers are reported in this form.

*When concentrations are less than the LOR for both primary and duplicate/triplicate results, no RPDs are calculated

Performed By: AM
Date: 28/10/2011

Checked By: MB
Date: 31/10/2011

Whytes Gully New Cell
Duplicate Analysis RPDs
117625003

Sample ID	GABH06_0.0-0.2_260711	GABHFD01_260711/	GABH_FT01_260711
Sample Type	Primary	Field Duplicate	Field Triplicate
Date Sampled	26/07/2011	26/07/2011	26/07/2011

Analyte	Units	LOR				RPDs Primary vs Duplicate	RPDs Primary vs Inter Duplicate
Arsenic	mg/kg	5	<5	<5	<4	NA	NA
Cadmium	mg/kg	1	<1	<1	<0.5	NA	NA
Chromium	mg/kg	2	13	11	9	16.7	36.4
Copper	mg/kg	5	29	30	25	3.4	14.8
Lead	mg/kg	5	26	24	21	8.0	21.3
Nickel	mg/kg	2	5	5	5	0.0	0.0
Zinc	mg/kg	5	56	65	48	14.9	15.4
Mercury	mg/kg	0.1	<0.1	<0.1	<0.1	NA	NA
Total Polychlorinated biphenyls	mg/kg	0.1	<0.10	<0.10	ND	NA	NA
alpha-BHC	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Hexachlorobenzene (HCB)	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
beta-BHC	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
gamma-BHC	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
delta-BHC	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Heptachlor	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Aldrin	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Heptachlor epoxide	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
trans-Chlordane	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
alpha-Endosulfan	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
cis-Chlordane	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Dieldrin	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
4.4`-DDE	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Endrin	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
beta-Endosulfan	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
4.4`-DDD	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Endrin aldehyde	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Endosulfan sulfate	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
4.4`-DDT	mg/kg	0.2	<0.2	<0.2	<0.1	NA	NA
Endrin ketone	mg/kg	0.05	<0.05	<0.05	-	NA	NA
Methoxychlor	mg/kg	0.2	<0.2	<0.2	<0.1	NA	NA
Phenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2-Chlorophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2-Methylphenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
3- & 4-Methylphenol	mg/kg	1	<1.0	<1.0	<2	NA	NA
2-Nitrophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2.4-Dimethylphenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2.4-Dichlorophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2.6-Dichlorophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
4-Chloro-3-Methylphenol	mg/kg	0.5	<0.5	<0.5	-	NA	NA
2.4.6-Trichlorophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2.4.5-Trichlorophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
Pentachlorophenol	mg/kg	2	<2.0	<2.0	<10	NA	NA
Naphthalene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Acenaphthylene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Acenaphthene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Fluorene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Phenanthrene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Anthracene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Fluoranthene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Pyrene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Benz(a)anthracene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Chrysene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Benzo(b)fluoranthene	mg/kg	0.5	<0.5	<0.5		NA	NA
Benzo(k)fluoranthene	mg/kg	0.5	<0.5	<0.5	<0.2	NA	NA
Benzo(a)pyrene	mg/kg	0.5	<0.5	<0.5	<0.05	NA	NA
Indeno(1.2.3.cd)pyrene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Dibenz(a.h)anthracene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Benzo(g.h.i)perylene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Sum of polycyclic aromatic hydrocarbo	mg/kg	0.5	<0.5	<0.5	-	NA	NA
Benzene	mg/kg	0.2	<0.2	<0.2	<0.2	NA	NA
Toluene	mg/kg	0.5	<0.5	<0.5	<0.5	NA	NA
Ethylbenzene	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
meta- & para-Xylene	mg/kg	0.5	<0.5	<0.5	<2	NA	NA
ortho-Xylene	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
Sum of BTEX	mg/kg	0.2	<0.2	<0.2	-	NA	NA
Total Xylenes	mg/kg	0.5	<0.5	<0.5	-	NA	NA
Naphthalene	mg/kg	1	<1	<1	-	NA	NA
C6 - C9 Fraction	mg/kg	10	<10	<10	<25	NA	NA
C10 - C14 Fraction	mg/kg	50	<50	<50	<50	NA	NA
C15 - C28 Fraction	mg/kg	100	<100	<100	<100	NA	NA
C29 - C36 Fraction	mg/kg	100	<100	110	<100	9.5	NA
C10 - C36 Fraction (sum)	mg/kg	50	<50	110	-	75.0	NA
C6 - C10 Fraction	mg/kg	10	<10	<10	-	NA	NA
C6 - C10 Fraction minus BTEX (F1)	mg/kg	10	<10	<10	-	NA	NA
>C10 - C16 Fraction	mg/kg	50	<50	<50	-	NA	NA
>C16 - C34 Fraction	mg/kg	100	<100	150	-	40.0	NA
>C34 - C40 Fraction	mg/kg	100	<100	<100	-	NA	NA
>C10 - C40 Fraction (sum)	mg/kg	50	<50	150	-	100.0	NA

Legend
ND = Not Detected (RPDs not calculated if both primary and duplicate results are below LOR)
- = Not analysed/calculated
Acceptable RPDs: RPD <= 30%
RPD > 30%, Analyis result < 10 times LOR
RPD <= 50%, Analysis result > 10 times LOR and < 20 times LOR

DATA VALIDATION SUMMARY SHEET (Sydney)

Project Name:	Whytes Gully New Cell	**Project Number:**	117625003
Primary Laboratory:	ALS	**Workorder Number:**	ES1114651
Secondary Laboratory:	ELS	**Workorder Number:**	58255
Date Sampled:	05/07/2011-07/07/2011	**Sample Medium:**	Soil

Sample Information

Number of Primary Samples:	6	**Number of Triplicate Samples:**	1
Number of Duplicate Samples:	1	**Number of Other QAQC Samples:**	2

Documentation and Sample Handling Information

	Y/N	Comments
COC completed properly?	Y	
All requested analysis completed?	Y	
Samples received intact and chilled?	Y	2.1°c, ice present
Samples analysed within appropriate holding times?	Y	Samples were received on Friday 8/7/11, however a delay in processing resulted in holding time breach for pH analysis. Rinsate blank "RB01" was analysed 1 day out of holding time.
Sample volumes sufficient for QC analysis?	Y	
Are there non-NATA accredited methods used?	N	
Chromatograms supplied as appropriate?	N/A	
Laboratory reports signed by authorised personnel?	Y	

QAQC Sample Information (Method Blank - MB, Rinsate Blank - RB, Field Blank - FB, Trip Blank - TB)

Type	Sample ID	Comments
RB	GACS_RB01_05071	All results less than the LOR
TB	T.Blank	All results less than the LOR
MB	-	All MB results from this batch are less than the LOR

Trip Spike Information

Analyte	Spike Concentrations	Recovery Concentration	% Recovery	Comments
				No Trip Blanks were submitted with this batch

Laboratory Control Samples (LCS) Analyses

Analyte Group	Comments
Metals	LCS recovery for copper (87.6%) is less than the lower control limit of 89.2%.
	All other LCS analysis from this batch are within acceptable control limits.

Matrix Spike (MS) Analyses

Analyte Group	Comments
	All MS recoveries from this batch are within acceptable control limits.

Laboratory Duplicates (LD) Analyses

Analyte Group	Analyte(s)	Sample ID	Comments
All			All LD RPDs from this batch are within acceptable control limits

Field Duplicates (FD) Analyses

Analyte Group	Primary ID	Duplicate ID	Comments
	GACS05_1.0-1.2M_050711	GACS_FD02_050711	All FD RPDs are within acceptable control limits

Field Triplicates (FT) Analyses

Analyte Group	Primary ID	Triplicate ID	Comments
	GACS05_1.0-1.2M_050711	GACS_FT02_050711	All FT RPDs are within acceptable control limits

Surrogate Compound Monitoring Analyses

Analyte Group	Sample ID	Comments
All		All surrogate compound recoveries are within acceptable control limits.

Overall Comments

Analysis of soil pH are beyond the holding time, but may still be used as a guide. This exceedance is not expected to affect the overall data quality of this batch.

Analysis of the rinsate sample is beyond the limit of the holding time, but good decontamination procedures in the field indicate usability of the data.

Low LCS recovery for Copper is not expected to affect the overall data quality of this batch as the recovery is only slightly less than the lower control limit,

ALS state that: LCS recovery for Chromium falls outside ALS Dynamic Control Limit. However, they are within the acceptance criteria based on ALS DQO. No further action is required.

ALS state that: Level of reporting raised for toluene due to ambient background levels in the laboratory.

Overall, this batch is acceptable for environmental interpretative purposes.

Note: Data validation assesses each analyte in terms of all the data validation variables and only the exceedances and outliers are reported in this form.

*When concentrations are less than the LOR for both primary and duplicate/triplicate results, no RPDs are calculated

Performed By:	AM	**Checked By:**	MB
Date:	28/10/2011	**Date:**	31/10/2011

Whytes Gully New Cell
Duplicate Analysis RPDs
117625003

Sample ID	GACS05_1.0-1.2M_050711	GACS_FD02_050711	GACS_FT02_050711
Sample Type	Primary	Field Duplicate	Field Triplicate
Date Sampled	5/07/2011	5/07/2011	5/07/2011

Analyte	Units	LOR				RPDs Primary vs Duplicate	RPDs Primary vs Inter Duplicate
Arsenic	mg/kg	5	<5	<5	5	NA	0.0
Cadmium	mg/kg	1	<1	<1	0.6	NA	50.0
Chromium	mg/kg	2	8	10	10	22.2	22.2
Copper	mg/kg	5	26	27	14	3.8	60.0
Lead	mg/kg	5	18	24	24	28.6	28.6
Nickel	mg/kg	2	3	4	3	28.6	0.0
Zinc	mg/kg	5	46	45	25	2.2	59.2
Mercury	mg/kg	0.1	<0.1	<0.1	<0.1	NA	NA
Total Polychlorinated biphenyls	mg/kg	0.1	<0.10	<0.10	ND	NA	NA
alpha-BHC	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Hexachlorobenzene (HCB)	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
beta-BHC	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
gamma-BHC	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
delta-BHC	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Heptachlor	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Aldrin	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Heptachlor epoxide	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
trans-Chlordane	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
alpha-Endosulfan	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
cis-Chlordane	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Dieldrin	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
4.4`-DDE	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Endrin	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
beta-Endosulfan	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
4.4`-DDD	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Endrin aldehyde	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Endosulfan sulfate	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
4.4`-DDT	mg/kg	0.2	<0.2	<0.2	<0.1	NA	NA
Endrin ketone	mg/kg	0.05	<0.05	<0.05	-	NA	-
Methoxychlor	mg/kg	0.2	<0.2	<0.2	<0.1	NA	NA
Phenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2-Chlorophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2-Methylphenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
3- & 4-Methylphenol	mg/kg	1	<1.0	<1.0	<2	NA	NA
2-Nitrophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2.4-Dimethylphenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2.4-Dichlorophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2.6-Dichlorophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
4-Chloro-3-Methylphenol	mg/kg	0.5	<0.5	<0.5	-	NA	-
2.4.6-Trichlorophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2.4.5-Trichlorophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
Pentachlorophenol	mg/kg	2	<2.0	<2.0	<10	NA	NA
Naphthalene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Acenaphthylene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Acenaphthene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Fluorene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Phenanthrene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Anthracene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Fluoranthene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Pyrene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Benz(a)anthracene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Chrysene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Benzo(b)fluoranthene	mg/kg	0.5	<0.5	<0.5		NA	NA
Benzo(k)fluoranthene	mg/kg	0.5	<0.5	<0.5	<0.2	NA	NA
Benzo(a)pyrene	mg/kg	0.5	<0.5	<0.5	<0.05	NA	NA
Indeno(1.2.3.cd)pyrene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Dibenz(a.h)anthracene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Benzo(g.h.i)perylene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Sum of polycyclic aromatic hydrocarbo	mg/kg	0.5	<0.5	<0.5	-	NA	-
Benzene	mg/kg	0.2	<0.2	<0.2	<0.2	NA	NA
Toluene	mg/kg	0.5	<0.5	<0.5	<0.5	NA	NA
Ethylbenzene	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
meta- & para-Xylene	mg/kg	0.5	<0.5	<0.5	<2	NA	NA
ortho-Xylene	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
Sum of BTEX	mg/kg	0.2	<0.2	<0.2	-	NA	-
Total Xylenes	mg/kg	0.5	<0.5	<0.5	-	NA	-
Naphthalene	mg/kg	1	<1	<1	-	NA	-
C6 - C9 Fraction	mg/kg	10	<10	<10	<25	NA	NA
C10 - C14 Fraction	mg/kg	50	<50	<50	<50	NA	NA
C15 - C28 Fraction	mg/kg	100	<100	<100	<100	NA	NA
C29 - C36 Fraction	mg/kg	100	<100	<100	<100	NA	NA
C10 - C36 Fraction (sum)	mg/kg	50	<50	<50	-	NA	-
C6 - C10 Fraction	mg/kg	10	<10	<10	-	NA	-
C6 - C10 Fraction minus BTEX (F1)	mg/kg	10	<10	<10	-	NA	-
>C10 - C16 Fraction	mg/kg	50	<50	<50	-	NA	-
>C16 - C34 Fraction	mg/kg	100	<100	<100	-	NA	-
>C34 - C40 Fraction	mg/kg	100	<100	<100	-	NA	-
>C10 - C40 Fraction (sum)	mg/kg	50	<50	<50	-	NA	-

Legend
ND = Not Detected (RPDs not calculated if both primary and duplicate results are below LOR)
- = Not analysed/calculated
Acceptable RPDs: RPD <= 30%
RPD > 30%, Analyis result < 10 times LOR
RPD <= 50%, Analysis result > 10 times LOR and < 20 times LOR

APPENDIX J2

Data Validation (Groundwater)

March 2012
Report No. 117625003-046-R-Rev0

DATA VALIDATION SUMMARY SHEET (Sydney)

Project Name:	Whytes Gully New Cell	**Project Number:**	117625003
Primary Laboratory:	ALS	**Workorder Number:**	ES1118241
Secondary Laboratory:	ELS	**Workorder Number:**	60493
Date Sampled:	17/8/11-22/8/11	**Sample Medium:**	Water

Sample Information

Number of Primary Samples:	16	**Number of Triplicate Samples:**	0
Number of Duplicate Samples:	2	**Number of Other QAQC Samples:**	9

Documentation and Sample Handling Information

	Y/N	Comments
COC completed properly?	Y	
All requested analysis completed?	Y	
Samples received intact and chilled?	Y	
Samples analysed within appropiate holding times?	Y	
Sample volumes sufficient for QC analysis?	Y	
Are there non-NATA accredited methods used?	N	
Chromatograms supplied as appropriate?	N/A	
Laboratory reports signed by authorised personnel?	Y	

QAQC Sample Information (Method Blank - MB, Rinsate Blank - RB, Field Blank - FB, Trip Blank - TB)

Type	Sample ID	Comments
RB	QC300_17/8/11	All results are less than the LOR
RB	QC301_18/8/11	All Resuts are less than the LOR
RB	QC302_19/8/11	All results are less than the LOR
RB	QC303_22/8/11	All results are less than the LOR
TB	Trip Blank1	All results are less than the LOR
TB	Trip Balnk2	All results are less than the LOR
TB	Trip Blank3	All results are less than the LOR
MB	-	All MB results from this batch are less than the LOR

Trip Spike Information

Analyte	Spike Concentrations	Recovery Concentration	% Recovery	Comments
Benzene	20	17	85	All Trip spike recoveries from this batch are within acceptable limits
Toluene	20	18	90	
Ethylbenzene	20	18	90	
meta- & para-Xylene	20	18	90	
ortho-Xylene	20	19	95	
Benzene	20	16	80	
Toluene	20	18	90	
Ethylbenzene	20	17	85	
meta- & para-Xylene	20	18	90	
ortho-Xylene	20	18	90	

Laboratory Control Samples (LCS) Analyses

Analyte Group	Comments
Metals	LCS recovery of Lead (8.2%) is less than the lower control limit of 90%. LCS rercovery of Mercury (84.5%) is less than the lower control limits of 86%.
Phenolic compounds	LCS recovery of 2-chlorophenol (55.5%), 2-Methylphenol (54.3%), 2-Nitrophenol (50.5%) and 2.6-Dichlorophenol (61.8%) are less than the lower contol limits of 63.8%, 55.9%, 62.7% and 64.3% respectivley.

Matrix Spike (MS) Analyses

Analyte Group	Comments
Sulfate as SO42-	MS recovery in sample GABH1_18/8/11 was not determined due to background level being greater than or equal to 4x spike level.
Nitrate plus Nitrite as N	MS recovery in anonymous sample was not determined due to background level being greater than or equal to 4x spike level.
Phenolic compounds	MS recovery of 4-chloro-3-methylphenol of 68.5% is slighlty less than the lower data quality objective of 70%
BTEXN	Benzene MS recovery in anonymous sample was not determined due to background level being greater than or equal to 4x spike level.

Laboratory Duplicates (LD) Analyses

Analyte Group	Analyte(s)	Sample ID	Comments
All			All LD RPDs from this batch are within acceptable control limits

Field Duplicates (FD) Analyses

Analyte Group	Primary ID	Duplicate ID	Comments
	GABH6D_18/8/11	QC100	All FD RPDs are within acceptable control limits
	GABH2_19/8/11	QC101	All FD RPDs are within acceptable control limits

Field Triplicates (FT) Analyses

Analyte Group	Primary ID	Triplicate ID	Comments
	GABH2_19/8/11	QC201	All FT RPDs are within acceptable control limits

Surrogate Compound Monitoring Analyses

Analyte Group	Sample ID	Comments
All		All surrogate compound recoveries are within acceptable control limits.

Overall Comments

Low LCS recoveries for metals and Phenolics are not expected to affect the overall data quality as the recoveries are only slighlty less than the lower control limits.

Benzene MS recovery is not expected to affect the overall data quality as this analysis was performed on an anonymous sample and two other MS recoveries from this batch for Benzene are within acceptable limits

Low MS recovery for Phenolics are not expected to affect the overall data quality as the recoveries are only slighlty less than the lower control limits.

ALS state that: Insufficient sample volume for Alkalinity and Fluoride analysis.
ALS state that: LCS recoveries for some elements fall outside ALS Dynamic control limit, however, they are within the acceptance criteria based on ALS DQO. No further action is required.

ALS state that: LOR for Chromium has been raised in particular sample(s) due to matrix interference(s).
ALS state that: LCS recovery for Mercury falls outside ALS Dynamic Control Limit. However, it is within the acceptance criteria based on ALS DQO. No further action is required.

ALS state that: Poor matrix spike recovery due to sample heterogeneity. Confirmed by re-extraction and re-analysis.

ALS state that: GABH2 19/8/11 sample results has been confirmed by reanalysis.

ALS state that: Level of reporting raised for toluene due to ambient background levels in the laboratory.

ALS state that: Sample TRIP SPIKE contains volatile compounds spiked into the sample containers prior to dispatch from the laboratory. BTEX compounds spiked at 20 ug/L. This batch is acceptable for environmental interpretative purposes.

Note: Data validation assesses each analyte in terms of all the data validation variables and only the exceedances and outliers are reported in this form.

*When concentrations are less than the LOR for both primary and duplicate/triplicate results, no RPDs are calculated

Performed By:	AM	**Reviewed By:**	**LBJ**
Date:	28/10/2011	**Date:**	23/01/2012

Whytes Gully New Cell
Duplicate Analysis RPDs
117625003

Sample ID	GABH6D_18/8/11	QC100_18/8/11	-
Sample Type	Primary	Field Duplicate	Field Triplicate
Date Sampled	18/08/2011	18/08/2011	-

Analyte	Units	LOR				RPDs Primary vs Duplicate	RPDs Primary vs Inter Duplicate
Total Hardness as CaCO3	mg/L	1	575	583	-	1.4	NA
Hydroxide Alkalinity as CaCO3	mg/L	1	<1	<1	-	NA	NA
Carbonate Alkalinity as CaCO3	mg/L	1	<1	<1	-	NA	NA
Bicarbonate Alkalinity as CaCO3	mg/L	1	319	319	-	0.0	NA
Total Alkalinity as CaCO3	mg/L	1	319	319	-	0.0	NA
Sulfate as SO4 - Turbidimetric	mg/L	1	220	221	-	0.5	NA
Chloride	mg/L	1	745	740	-	0.7	NA
Calcium	mg/L	1	115	118	-	2.6	NA
Magnesium	mg/L	1	70	70	-	0.0	NA
Sodium	mg/L	1	453	451	-	0.4	NA
Potassium	mg/L	1	<1	<1	-	NA	NA
Aluminium	mg/L	0.01	<0.01	<0.01	-	NA	NA
Arsenic	mg/L	0.001	<0.001	<0.001	-	NA	NA
Cadmium	mg/L	0.0001	<0.0001	<0.0001	-	NA	NA
Chromium	mg/L	0.001	<0.001	<0.001	-	NA	NA
Copper	mg/L	0.001	<0.001	<0.001	-	NA	NA
Lead	mg/L	0.001	<0.001	<0.001	-	NA	NA
Manganese	mg/L	0.001	0.012	0.013	-	8.0	NA
Nickel	mg/L	0.001	<0.001	<0.001	-	NA	NA
Zinc	mg/L	0.005	0.013	0.012	-	8.0	NA
Iron	mg/L	0.05	<0.05	<0.05	-	NA	NA
Mercury	mg/L	0.0001	<0.0001	<0.0001	-	NA	NA
Fluoride	mg/L	0.1	0.5	0.6	-	18.2	NA
Ammonia as N	mg/L	0.01	0.01	<0.01	-	0.0	NA
Total Kjeldahl Nitrogen as N	mg/L	0.1	<0.1	<0.1	-	NA	NA
Total Anions	meq/L	0.01	32	31.8	-	0.6	NA
Total Cations	meq/L	0.01	31.2	31.3	-	0.3	NA
Total Organic Carbon	mg/L	1	2	3	-	40.0	NA
Styrene	µg/L	5	<5	<5	-	NA	NA
Isopropylbenzene	µg/L	5	<5	<5	-	NA	NA
n-Propylbenzene	µg/L	5	<5	<5	-	NA	NA
1.3.5-Trimethylbenzene	µg/L	5	<5	<5	-	NA	NA
sec-Butylbenzene	µg/L	5	<5	<5	-	NA	NA
1.2.4-Trimethylbenzene	µg/L	5	<5	<5	-	NA	NA
tert-Butylbenzene	µg/L	5	<5	<5	-	NA	NA
p-Isopropyltoluene	µg/L	5	<5	<5	-	NA	NA
n-Butylbenzene	µg/L	5	<5	<5	-	NA	NA
Vinyl Acetate	µg/L	50	<50	<50	-	NA	NA
2-Butanone (MEK)	µg/L	50	<50	<50	-	NA	NA
4-Methyl-2-pentanone (MIBK)	µg/L	50	<50	<50	-	NA	NA
2-Hexanone (MBK)	µg/L	50	<50	<50	-	NA	NA
Carbon disulfide	µg/L	5	<5	<5	-	NA	NA
2.2-Dichloropropane	µg/L	5	<5	<5	-	NA	NA
1.2-Dichloropropane	µg/L	5	<5	<5	-	NA	NA
cis-1.3-Dichloropropylene	µg/L	5	<5	<5	-	NA	NA
trans-1.3-Dichloropropylene	µg/L	5	<5	<5	-	NA	NA
1.2-Dibromoethane (EDB)	µg/L	5	<5	<5	-	NA	NA
Dichlorodifluoromethane	µg/L	50	<50	<50	-	NA	NA
Chloromethane	µg/L	50	<50	<50	-	NA	NA
Vinyl chloride	µg/L	50	<50	<50	-	NA	NA
Bromomethane	µg/L	50	<50	<50	-	NA	NA
Chloroethane	µg/L	50	<50	<50	-	NA	NA
Trichlorofluoromethane	µg/L	50	<50	<50	-	NA	NA
1.1-Dichloroethene	µg/L	5	<5	<5		NA	NA
Iodomethane	µg/L	5	<5	<5	-	NA	NA
trans-1.2-Dichloroethene	µg/L	5	<5	<5	-	NA	NA
1.1-Dichloroethane	µg/L	5	<5	<5	-	NA	NA
cis-1.2-Dichloroethene	µg/L	5	<5	<5	-	NA	NA
1.1.1-Trichloroethane	µg/L	5	<5	<5		NA	NA
1.1-Dichloropropylene	µg/L	5	<5	<5	-	NA	NA
Carbon Tetrachloride	µg/L	5	<5	<5	-	NA	NA
1.2-Dichloroethane	µg/L	5	<5	<5	-	NA	NA
Trichloroethene	µg/L	5	<5	<5	-	NA	NA
Dibromomethane	µg/L	5	<5	<5			NA
1.1.2-Trichloroethane	µg/L	5	<5	<5	-	NA	NA
1.3-Dichloropropane	µg/L	5	<5	<5	-	NA	NA
Tetrachloroethene	µg/L	5	<5	<5	-	NA	NA
1.1.1.2-Tetrachloroethane	µg/L	5	<5	<5	-	NA	NA
trans-1.4-Dichloro-2-butene	µg/L	5	<5	<5	-	NA	NA
cis-1.4-Dichloro-2-butene	µg/L	5	<5	<5	-	NA	NA
1.1.2.2-Tetrachloroethane	µg/L	5	<5	<5	-	NA	NA
1.2.3-Trichloropropane	µg/L	5	<5	<5	-	NA	NA
Pentachloroethane	µg/L	5	<5	<5	-	NA	NA
1.2-Dibromo-3-chloropropane	µg/L	5	<5	<5	-	NA	NA
Hexachlorobutadiene	µg/L	5	<5	<5	-	NA	NA
Chlorobenzene	µg/L	5	<5	<5	-	NA	NA
Bromobenzene	µg/L	5	<5	<5	-	NA	NA
2-Chlorotoluene	µg/L	5	<5	<5	-	NA	NA
4-Chlorotoluene	µg/L	5	<5	<5	-	NA	NA
1.3-Dichlorobenzene	µg/L	5	<5	<5	-	NA	NA
1.4-Dichlorobenzene	µg/L	5	<5	<5	-	NA	NA
1.2-Dichlorobenzene	µg/L	5	<5	<5	-	NA	NA
1.2.4-Trichlorobenzene	µg/L	5	<5	<5	-	NA	NA
1.2.3-Trichlorobenzene	µg/L	5	<5	<5	-	NA	NA
Chloroform	µg/L	5	<5	<5	-	NA	NA
Bromodichloromethane	µg/L	5	<5	<5	-	NA	NA
Dibromochloromethane	µg/L	5	<5	<5	-	NA	NA
Bromoform	µg/L	5	<5	<5	-	NA	NA
Phenol	µg/L	0.2	<0.5	<0.5	-	NA	NA
2-Chlorophenol	µg/L	0.2	<0.5	<0.5	-	NA	NA
2-Methylphenol	µg/L	0.2	<0.5	<0.5	-	NA	NA
3- & 4-Methylphenol	µg/L	0.4	<0.9	<0.9	-	NA	NA
2-Nitrophenol	µg/L	0.2	<0.5	<0.5	-	NA	NA
2.4-Dimethylphenol	µg/L	0.2	<0.5	<0.5	-	NA	NA
2.4-Dichlorophenol	µg/L	0.2	<0.5	<0.5	-	NA	NA
2.6-Dichlorophenol	µg/L	0.2	<0.5	<0.5	-	NA	NA
4-Chloro-3-Methylphenol	µg/L	0.2	<0.5	<0.5	-	NA	NA
2.4.6-Trichlorophenol	µg/L	0.2	<0.5	<0.5	-	NA	NA
2.4.5-Trichlorophenol	µg/L	0.2	<0.5	<0.5	-	NA	NA
Pentachlorophenol	µg/L	0.4	<0.9	<0.9	-	NA	NA
Naphthalene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Acenaphthylene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Acenaphthene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Fluorene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Phenanthrene	µg/L	0.2	<0.5	<0.5	-	NA	NA

Anthracene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Fluoranthene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Pyrene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Benz(a)anthracene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Chrysene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Benzo(b)fluoranthene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Benzo(k)fluoranthene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Benzo(a)pyrene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Indeno(1.2.3.cd)pyrene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Dibenz(a.h)anthracene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Benzo(g.h.i)perylene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Sum of polycyclic aromatic hydrocarbon	µg/L	0.5			-	NA	NA
Benzene	µg/L	1	<1	<1	-	NA	NA
Toluene	µg/L	2	<5	<5	-	NA	NA
Ethylbenzene	µg/L	2	<2	<2	-	NA	NA
meta- & para-Xylene	µg/L	2	<2	<2	-	NA	NA
ortho-Xylene	µg/L	2	<2	<2	-	NA	NA
Total Xylenes	µg/L	2	<2	<2	-	NA	NA
Sum of BTEX	µg/L	1	<1	<1	-	NA	NA
Naphthalene	µg/L	5	<5	<5	-	NA	NA
C6 - C9 Fraction	µg/L	20	<20	<20	-	NA	NA
C10 - C14 Fraction	µg/L	50	<50	<50	-	NA	NA
C15 - C28 Fraction	µg/L	100	<100	<100	-	NA	NA
C29 - C36 Fraction	µg/L	50	<50	<50	-	NA	NA
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	-	NA	NA
C6 - C10 Fraction	µg/L	20	<20	<20	-	NA	NA
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	-	NA	NA
>C10 - C16 Fraction	µg/L	100	<100	<100	-	NA	NA
>C16 - C34 Fraction	µg/L	100	<100	<100	-	NA	NA
>C34 - C40 Fraction	µg/L	100	<100	<100	-	NA	NA
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	-	NA	NA
Aldrin	µg/L	0.01	<0.010	<0.010	-	NA	NA
alpha-BHC	µg/L	0.01	<0.010	<0.010	-	NA	NA
beta-BHC	µg/L	0.01	<0.010	<0.010	-	NA	NA
delta-BHC	µg/L	0.01	<0.010	<0.010	-	NA	NA
4.4`-DDD	µg/L	0.01	<0.010	<0.010	-	NA	NA
4.4`-DDE	µg/L	0.01	<0.010	<0.010	-	NA	NA
4.4`-DDT	µg/L	0.01	<0.010	<0.010	-	NA	NA
Dieldrin	µg/L	0.01	<0.010	<0.010	-	NA	NA
alpha-Endosulfan	µg/L	0.01	<0.010	<0.010	-	NA	NA
beta-Endosulfan	µg/L	0.01	<0.010	<0.010	-	NA	NA
Endosulfan sulfate	µg/L	0.01	<0.010	<0.010	-	NA	NA
Endrin	µg/L	0.01	<0.010	<0.010	-	NA	NA
Endrin aldehyde	µg/L	0.01	<0.010	<0.010	-	NA	NA
Endosulfan (sum)	µg/L	0.01	<0.010	<0.010	-	NA	NA
Endrin ketone	µg/L	0.01	<0.010	<0.010	-	NA	NA
Heptachlor	µg/L	0.005	<0.005	<0.005	-	NA	NA
Heptachlor epoxide	µg/L	0.01	<0.010	<0.010	-	NA	NA
Hexachlorobenzene (HCB)	µg/L	0.01	<0.010	<0.010	-	NA	NA
gamma-BHC	µg/L	0.01	<0.010	<0.010	-	NA	NA
Methoxychlor	µg/L	0.01	<0.010	<0.010	-	NA	NA
cis-Chlordane	µg/L	0.01	<0.010	<0.010	-	NA	NA
trans-Chlordane	µg/L	0.01	<0.010	<0.010	-	NA	NA
Total Chlordane (sum)	µg/L	0.01	<0.010	<0.010	-	NA	NA
Oxychlordane	µg/L	0.01	<0.010	<0.010	-	NA	NA
Sum of DDD + DDE + DDT	µg/L	0.01	<0.010	<0.010	-	NA	NA
Total Polychlorinated biphenyls	µg/L	0.1	<0.10	<0.10	-	NA	NA
Aroclor 1016	µg/L	0.1	<0.10	<0.10	-	NA	NA
Aroclor 1221	µg/L	0.1	<0.10	<0.10	-	NA	NA
Aroclor 1232	µg/L	0.1	<0.10	<0.10	-	NA	NA
Aroclor 1242	µg/L	0.1	<0.10	<0.10	-	NA	NA
Aroclor 1248	µg/L	0.1	<0.10	<0.10	-	NA	NA
Aroclor 1254	µg/L	0.1	<0.10	<0.10	-	NA	NA
Aroclor 1260	µg/L	0.1	<0.10	<0.10	-	NA	NA

Legend

ND = Not Detected (RPDs not calculated if both primary and duplicate results are below LOR)

- = Not analysed/calculated

Acceptable RPDs: RPD <= 30%

RPD > 30%, Analyis result < 10 times LOR

RPD <= 50%, Analysis result > 10 times LOR and < 20 times LOR

Whytes Gully New Cell
Duplicate Analysis RPDs
117625003

Sample ID	GABH2_19/8/11	QC101_19/8/11	QC201_19/8/11		
Sample Type	Primary	Field Duplicate	Field Triplicate		
Date Sampled	19/08/2011	19/08/2011	19/08/2011		
				RPDs	RPDs
Analyte	**Units**	**LOR**		Primary vs Duplicate	Primary vs Inter Duplicate
Total Hardness as CaCO3	mg/L	1	1260	1260	1400	0.0	10.5
Hydroxide Alkalinity as CaCO3	mg/L	1	<1	<1	<1	NA	NA
Carbonate Alkalinity as CaCO	mg/L	1	<1	<1	<1	NA	NA
Bicarbonate Alkalinity as CaC	mg/L	1	834	844	910	1.2	8.7
Total Alkalinity as CaCO3	mg/L	1	834	844	910	1.2	8.7
Sulfate as SO4 - Turbidimetric	mg/L	1	157	156	160	0.6	1.9
Chloride	mg/L	1	1120	1120	1200	0.0	6.9
Calcium	mg/L	1	242	242	250	0.0	3.3
Magnesium	mg/L	1	159	159	180	0.0	12.4
Sodium	mg/L	1	596	592	580	0.7	2.7
Potassium	mg/L	1	3	3	3.6	0.0	18.2
Aluminium	mg/L	0.01	<0.01	<0.01		NA	NA
Arsenic	mg/L	0.001	<0.001	<0.001	<0.001	NA	NA
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	NA	NA
Chromium	mg/L	0.001	<0.005	<0.005	<0.001	NA	NA
Copper	mg/L	0.001	0.001	<0.001	<0.001	0.0	0.0
Lead	mg/L	0.001	<0.001	<0.001	<0.001	NA	NA
Manganese	mg/L	0.001	0.437	0.427	0.43	2.3	1.6
Nickel	mg/L	0.001	0.004	0.003	0.003	28.6	28.6
Zinc	mg/L	0.005	0.01	0.008	0.012	22.2	18.2
Iron	mg/L	0.05	0.08	<0.05	0.02	46.2	120.0
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	NA	NA
Fluoride	mg/L	0.1	0.6	0.6	0.52	0.0	14.3
Ammonia as N	mg/L	0.01	<0.01	<0.01		NA	NA
Total Kjeldahl Nitrogen as N	mg/L	0.1	0.2	<0.1	0.2	66.7	0.0
Total Anions	meq/L	0.01	51.5	51.7	-	0.4	NA
Total Cations	meq/L	0.01	51.2	51	-	0.4	NA
Total Organic Carbon	mg/L	1	5	4	5	22.2	0.0
Styrene	µg/L	5	<5	<5	<1	NA	NA
Isopropylbenzene	µg/L	5	<5	<5	<1	NA	NA
n-Propylbenzene	µg/L	5	<5	<5	<1	NA	NA
1.3.5-Trimethylbenzene	µg/L	5	<5	<5	3	NA	50.0
sec-Butylbenzene	µg/L	5	<5	<5	<1	NA	NA
1.2.4-Trimethylbenzene	µg/L	5	<5	<5	<1	NA	NA
tert-Butylbenzene	µg/L	5	<5	<5	<1	NA	NA
p-Isopropyltoluene	µg/L	5	<5	<5	-	NA	NA
n-Butylbenzene	µg/L	5	<5	<5	<1	NA	NA
Vinyl Acetate	µg/L	50	<50	<50	<10	NA	NA
2-Butanone (MEK)	µg/L	50	<50	<50	-	NA	NA
4-Methyl-2-pentanone (MIBK)	µg/L	50	<50	<50	-	NA	NA
2-Hexanone (MBK)	µg/L	50	<50	<50	<1	NA	NA
Carbon disulfide	µg/L	5	<5	<5	-	NA	NA
2.2-Dichloropropane	µg/L	5	<5	<5	<1	NA	NA
1.2-Dichloropropane	µg/L	5	<5	<5	<1	NA	NA
cis-1.3-Dichloropropylene	µg/L	5	<5	<5	<1	NA	NA
trans-1.3-Dichloropropylene	µg/L	5	<5	<5	<1	NA	NA
1.2-Dibromoethane (EDB)	µg/L	5	<5	<5	<1	NA	NA
Dichlorodifluoromethane	µg/L	50	<50	<50	<10	NA	NA
Chloromethane	µg/L	50	<50	<50	<10	NA	NA
Vinyl chloride	µg/L	50	<50	<50	-	NA	NA
Bromomethane	µg/L	50	<50	<50	<10	NA	NA
Chloroethane	µg/L	50	<50	<50	<10	NA	NA
Trichlorofluoromethane	µg/L	50	<50	<50	<10	NA	NA
1.1-Dichloroethene	µg/L	5	<5	<5	<1	NA	NA
Iodomethane	µg/L	5	<5	<5	-	NA	NA
trans-1.2-Dichloroethene	µg/L	5	<5	<5	<1	NA	NA
1.1-Dichloroethane	µg/L	5	<5	<5	<1	NA	NA
cis-1.2-Dichloroethene	µg/L	5	<5	<5	<1	NA	NA
1.1.1-Trichloroethane	µg/L	5	<5	<5	<1	NA	NA
1.1-Dichloropropylene	µg/L	5	<5	<5	<1	NA	NA
Carbon Tetrachloride	µg/L	5	<5	<5	<1	NA	NA
1.2-Dichloroethane	µg/L	5	<5	<5	<1	NA	NA
Trichloroethene	µg/L	5	<5	<5	<1	NA	NA
Dibromomethane	µg/L	5	<5	<5	<1	NA	NA
1.1.2-Trichloroethane	µg/L	5	<5	<5	<1	NA	NA
1.3-Dichloropropane	µg/L	5	<5	<5	<1	NA	NA
Tetrachloroethene	µg/L	5	<5	<5	<1	NA	NA
1.1.1.2-Tetrachloroethane	µg/L	5	<5	<5	<1	NA	NA
trans-1.4-Dichloro-2-butene	µg/L	5	<5	<5	-	NA	NA
cis-1.4-Dichloro-2-butene	µg/L	5	<5	<5	-	NA	NA
1.1.2.2-Tetrachloroethane	µg/L	5	<5	<5	<1	NA	NA
1.2.3-Trichloropropane	µg/L	5	<5	<5	<1	NA	NA
Pentachloroethane	µg/L	5	<5	<5	-	NA	NA
1.2-Dibromo-3-chloropropane	µg/L	5	<5	<5	<1	NA	NA
Hexachlorobutadiene	µg/L	5	<5	<5	<1	NA	NA
Chlorobenzene	µg/L	5	<5	<5	<1	NA	NA
Bromobenzene	µg/L	5	<5	<5	<1	NA	NA
2-Chlorotoluene	µg/L	5	<5	<5	<1	NA	NA
4-Chlorotoluene	µg/L	5	<5	<5	-	NA	NA
1.3-Dichlorobenzene	µg/L	5	<5	<5	<1	NA	NA
1.4-Dichlorobenzene	µg/L	5	<5	<5	<1	NA	NA
1.2-Dichlorobenzene	µg/L	5	<5	<5	<1	NA	NA
1.2.4-Trichlorobenzene	µg/L	5	<5	<5	<1	NA	NA
1.2.3-Trichlorobenzene	µg/L	5	<5	<5	<1	NA	NA
Chloroform	µg/L	5	<5	<5	3.0	NA	50.0
Bromodichloromethane	µg/L	5	<5	<5	<1	NA	NA
Dibromochloromethane	µg/L	5	<5	<5	<1	NA	NA
Bromoform	µg/L	5	<5	<5	<1	NA	NA
Phenol	µg/L	0.2	<0.5	<0.5	<10	NA	NA
2-Chlorophenol	µg/L	0.2	<0.5	<0.5	<10	NA	NA
2-Methylphenol	µg/L	0.2	<0.5	<0.5	<10	NA	NA
3- & 4-Methylphenol	µg/L	0.4	<0.9	<1.0	<10	NA	NA
2-Nitrophenol	µg/L	0.2	<0.5	<0.5	<10	NA	NA
2.4-Dimethylphenol	µg/L	0.2	<0.5	<0.5	<10	NA	NA
2.4-Dichlorophenol	µg/L	0.2	<0.5	<0.5	<10	NA	NA
2.6-Dichlorophenol	µg/L	0.2	<0.5	<0.5	<10	NA	NA
4-Chloro-3-Methylphenol	µg/L	0.2	<0.5	<0.5	-	NA	NA
2.4.6-Trichlorophenol	µg/L	0.2	<0.5	<0.5	<10	NA	NA
2.4.5-Trichlorophenol	µg/L	0.2	<0.5	<0.5	<10	NA	NA
Pentachlorophenol	µg/L	0.4	<0.9	<1.0	<100	NA	NA
Naphthalene	µg/L	0.2	<0.5	<0.5	0.1	NA	133.3
Acenaphthylene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Acenaphthene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Fluorene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Phenanthrene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA

Anthracene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Fluoranthene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Pyrene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Benz(a)anthracene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Chrysene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Benzo(b)fluoranthene	µg/L	0.2	<0.5	<0.5	<0.2	NA	NA
Benzo(k)fluoranthene	µg/L	0.2	<0.5	<0.5		NA	NA
Benzo(a)pyrene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Indeno(1.2.3.cd)pyrene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Dibenz(a.h)anthracene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Benzo(g.h.i)perylene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Sum of polycyclic aromatic hyd	µg/L	0.5			-	NA	NA
Benzene	µg/L	1	<1	<1	<1	NA	NA
Toluene	µg/L	2	<5	<5	<1	NA	NA
Ethylbenzene	µg/L	2	<2	<2	<1	NA	NA
meta- & para-Xylene	µg/L	2	4	4	<2	0.0	66.7
ortho-Xylene	µg/L	2	2	2	3	0.0	40.0
Total Xylenes	µg/L	2	6	6	-	0.0	NA
Sum of BTEX	µg/L	1	6	6	-	0.0	NA
Naphthalene	µg/L	5	<5	<5	-	NA	NA
C6 - C9 Fraction	µg/L	20	30	30		0.0	NA
C10 - C14 Fraction	µg/L	50	<50	<50	86	NA	52.9
C15 - C28 Fraction	µg/L	100	<100	<100	<100	NA	NA
C29 - C36 Fraction	µg/L	50	<50	<50	<100	NA	NA
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	-	NA	NA
C6 - C10 Fraction	µg/L	20	40	40	<10	0.0	120.0
C6 - C10 Fraction minus BTEX	µg/L	20	30	30	-	0.0	NA
>C10 - C16 Fraction	µg/L	100	<100	<100	-	NA	NA
>C16 - C34 Fraction	µg/L	100	<100	<100	-	NA	NA
>C34 - C40 Fraction	µg/L	100	<100	<100	-	NA	NA
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	-	NA	NA
Aldrin	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
alpha-BHC	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
beta-BHC	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
delta-BHC	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
4.4`-DDD	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
4.4`-DDE	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
4.4`-DDT	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
Dieldrin	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
alpha-Endosulfan	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
beta-Endosulfan	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
Endosulfan sulfate	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
Endrin	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
Endrin aldehyde	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
Endosulfan (sum)	µg/L	0.01	<0.010	<0.010	-	NA	NA
Endrin ketone	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
Heptachlor	µg/L	0.005	<0.005	<0.005	<0.01	NA	NA
Heptachlor epoxide	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
Hexachlorobenzene (HCB)	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
gamma-BHC	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
Methoxychlor	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
cis-Chlordane	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
trans-Chlordane	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
Total Chlordane (sum)	µg/L	0.01	<0.010	<0.010	-	NA	NA
Oxychlordane	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
Sum of DDD + DDE + DDT	µg/L	0.01	<0.010	<0.010	-	NA	NA
Total Polychlorinated biphenyl	µg/L	0.1	<0.10	<0.10	<0.1	NA	NA
Aroclor 1016	µg/L	0.1	<0.10	<0.10	<0.1	NA	NA
Aroclor 1221	µg/L	0.1	<0.10	<0.10	<0.1	NA	NA
Aroclor 1232	µg/L	0.1	<0.10	<0.10	<0.1	NA	NA
Aroclor 1242	µg/L	0.1	<0.10	<0.10	<0.1	NA	NA
Aroclor 1248	µg/L	0.1	<0.10	<0.10	<0.1	NA	NA
Aroclor 1254	µg/L	0.1	<0.10	<0.10	<0.1	NA	NA
Aroclor 1260	µg/L	0.1	<0.10	<0.10	<0.1	NA	NA

Legend

ND = Not Detected (RPDs not calculated if both primary and duplicate results are below LOR)

- = Not analysed/calculated

Acceptable RPDs: RPD <= 30%

RPD > 30%, Analyis result < 10 times LOR

RPD <= 50%, Analysis result > 10 times LOR and < 20 times LOR

DATA VALIDATION SUMMARY SHEET (Sydney)

Project Name:	Whytes Gully New Cell	**Project Number:**	117625003
Primary Laboratory:	ALS	**Workorder Number:**	ES1118791
Secondary Laboratory:	-	**Workorder Number:**	-
Date Sampled:	29/08/2011	**Sample Medium:**	Water

Sample Information

Number of Primary Samples:	1	**Number of Triplicate Samples:**	0
Number of Duplicate Samples:	0	**Number of Other QAQC Samples:**	0

Documentation and Sample Handling Information

	Y/N	Comments
COC completed properly?	Y	
All requested analysis completed?	Y	
Samples received intact and chilled?	Y	
Samples analysed within appropiate holding times?	Y	
Sample volumes sufficient for QC analysis?	Y	
Are there non-NATA accredited methods used?	N	
Chromatograms supplied as appropriate?	N/A	
Laboratory reports signed by authorised personnel?	Y	

QAQC Sample Information (Method Blank - MB, Rinsate Blank - RB, Field Blank - FB, Trip Blank - TB)

Type	Sample ID	Comments
MB	-	All MB results from this batch are less than the LOR

Trip Spike Information

Analyte	Spike Concentrations	Recovery Concentration	% Recovery	Comments
				No Trip Spikes were analysed with this batch

Laboratory Control Samples (LCS) Analyses

Analyte Group	Comments
BOD	BOD LCS recovery is within acceptable control limits

Matrix Spike (MS) Analyses

Analyte Group	Comments
All	No MS results are required to be reported

Laboratory Duplicates (LD) Analyses

Analyte Group	Analyte(s)	Sample ID	Comments
All			All LD RPDs from this batch are within acceptable control limits

Field Duplicates (FD) Analyses

Analyte Group	Primary ID	Duplicate ID	Comments
			No FD were analysed with this batch

Field Triplicates (FT) Analyses

Analyte Group	Primary ID	Triplicate ID	Comments
			No FT were analysed with this batch

Surrogate Compound Monitoring Analyses

Analyte Group	Sample ID	Comments
All		No Surrogate results were reported with this batch

Overall Comments

This batch is acceptable for environmental interpretative purposes.

Note: Data validation assesses each analyte in terms of all the data validation variables and only the exceedances and outliers are reported in this form.

*When concentrations are less than the LOR for both primary and duplicate/triplicate results, no RPDs are calculated

Performed By: AM
Date: 28/10/2011

Reviewed By: LBJ
Date: 23/01/2012

DATA VALIDATION SUMMARY SHEET (Sydney)

Project Name:	Whytes Gully New Cell	**Project Number:**	117625003
Primary Laboratory:	ALS	**Workorder Number:**	EW1102582
Secondary Laboratory:	ELS	**Workorder Number:**	60727
Date Sampled:	25/08/2011	**Sample Medium:**	Water

Sample Information

Number of Primary Samples:	9	**Number of Triplicate Samples:**	1
Number of Duplicate Samples:	1	**Number of Other QAQC Samples:**	0

Documentation and Sample Handling Information

	Y/N	Comments
COC completed properly?	Y	
All requested analysis completed?	Y	
Samples received intact and chilled?	Y	
Samples analysed within appropiate holding times?	Y	
Sample volumes sufficient for QC analysis?	Y	
Are there non-NATA accredited methods used?	N	
Chromatograms supplied as appropriate?	N/A	
Laboratory reports signed by authorised personnel?	Y	

QAQC Sample Information (Method Blank - MB, Rinsate Blank - RB, Field Blank - FB, Trip Blank - TB)

Type	Sample ID	Comments
MB	-	All MB results from this batch are less than the LOR

Trip Spike Information

Analyte	Spike Concentrations	Recovery Concentration	% Recovery	Comments
				No Trip Spike was submitted with this batch

Laboratory Control Samples (LCS) Analyses

Analyte Group	Comments
All	All LCS recoveries are within acceptable contorl limits

Matrix Spike (MS) Analyses

Analyte Group	Comments
All	All MS recoveries are within acceptable control limits

Laboratory Duplicates (LD) Analyses

Analyte Group	Analyte(s)	Sample ID	Comments
All			All LD RPDs from this batch are within acceptable control limits

Field Duplicates (FD) Analyses

Analyte Group	Primary ID	Duplicate ID	Comments
	GABH2_25/8/11	QC104_25/8/11	All RPDs are within acceptable control limits

Field Triplicates (FT) Analyses

Analyte Group	Primary ID	Triplicate ID	Comments
	GABH2_25/8/11	QC204_25/8/11	Nitrate as N RPD exceeds acceptable LOR based control limits

Surrogate Compound Monitoring Analyses

Analyte Group	Sample ID	Comments
All		No Surrogate results were reported with this batch

Overall Comments

This batch is acceptable for environmental interpretative purposes.

Note: Data validation assesses each analyte in terms of all the data validation variables and only the exceedances and outliers are reported in this form.

*When concentrations are less than the LOR for both primary and duplicate/triplicate results, no RPDs are calculated

Performed By: AM
Date: 28/10/2011

Reviewed By: LBJ
Date: 23/01/2012

Whytes Gully New Cell
Duplicate Analysis RPDs
117625003

Sample ID	GABH2_25/08/11	QC104_25/08/11	QC204_25/08/11
Sample Type	Primary	Field Duplicate	Field Triplicate
Date Sampled	25/08/2011	25/08/2011	25/08/2011

Analyte	Units	LOR				RPDs Primary vs Duplicate	RPDs Primary vs Inter Duplicate
Nitrite as N	mg/L	0.01	<0.01	<0.01	-	NA	NA
Nitrate as N	mg/L	0.01	0.05	<0.01	0.13	133.3	NA
Nitrite + Nitrate as N	mg/L	0.01	0.05	<0.01	-	133.3	NA
Biochemical Oxygen Demand	mg/L	2	<2	<2	<5	NA	NA

Legend
ND = Not Detected (RPDs not calculated if both primary and duplicate results are below LOR)
- = Not analysed/calculated
Acceptable RPDs: RPD <= 30%
RPD > 30%, Analyis result < 10 times LOR
RPD <= 50%, Analysis result > 10 times LOR and < 20 times LOR

DATA VALIDATION SUMMARY SHEET (Sydney)

Project Name:	Whytes Gully New Cell	**Project Number:**	117625003
Primary Laboratory:	ALS	**Workorder Number:**	ES1115894
Secondary Laboratory:	-	**Workorder Number:**	-
Date Sampled:	25/07/2011	**Sample Medium:**	Water

Sample Information

Number of Primary Samples:	2	**Number of Triplicate Samples:**	0
Number of Duplicate Samples:	0	**Number of Other QAQC Samples:**	0

Documentation and Sample Handling Information

	Y/N	Comments
COC completed properly?	Y	
All requested analysis completed?	Y	
Samples received intact and chilled?	Y	
Samples analysed within appropiate holding times?	N	TKN and Ammonia were extracted one day outside of the appropriate holding time. All other analysis were perfomed within appropriate holding time
Sample volumes sufficient for QC analysis?	Y	
Are there non-NATA accredited methods used?	N	
Chromatograms supplied as appropriate?	N/A	
Laboratory reports signed by authorised personnel?	Y	

QAQC Sample Information (Method Blank - MB, Rinsate Blank - RB, Field Blank - FB, Trip Blank - TB)

Type	Sample ID	Comments
MB	-	All MB results from this batch are less than the LOR

Trip Spike Information

Analyte	Spike Concentrations	Recovery Concentration	% Recovery	Comments

Laboratory Control Samples (LCS) Analyses

Analyte Group	Comments
Fumigants	LCS recovery of trans-1.3-Dichloropropylene of 79.1% is slightly less than the lower control limit of 79.3%.

Matrix Spike (MS) Analyses

Analyte Group	Comments
Sulfate as SO42-	MS recovery in anonymous sample was not determined due to background level being greater than or equal to 4x spike level.
Organochlorine Pesticides	MS recovery of beta-BHC of 42.9% in anonymous sample was less than the lower data quality objective of 43.8%.

Laboratory Duplicates (LD) Analyses

Analyte Group	Analyte(s)	Sample ID	Comments
All			All LD RPDs from this batch are within acceptable control limits

Field Duplicates (FD) Analyses

Analyte Group	Primary ID	Duplicate ID	Comments
			No FD were analysed with this batch

Field Triplicates (FT) Analyses

Analyte Group	Primary ID	Triplicate ID	Comments
			No FT were analysed with this batch

Surrogate Compound Monitoring Analyses

Analyte Group	Sample ID	Comments
All		All surrogate compound recoveries are within acceptable control limits.

Overall Comments

Inability to calculate sulfate MS recovery is not expeced to affect the overall data quality of this batch as this analysis was conducted on an anonymous sample

Low beta-BHC MS recovery is not expected to affect the overall data quality of this batch as the recovery wqas only slightly less than the lower control limit

As stated by ALS: Level of reporting raised for toluene due to ambient background levels in the laboratory.
This batch is acceptable for environmental interpretative purposes.

Note: Data validation assesses each analyte in terms of all the data validation variables and only the exceedances and outliers are reported in this form.

*When concentrations are less than the LOR for both primary and duplicate/triplicate results, no RPDs are calculated

Performed By: AM
Date: 28/10/2011

Reviewed By: LBJ
Date: 23/01/2012

APPENDIX K

Borelogs and Explanatory Notes

Provided on DVD

APPENDIX L

Limitations

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APPENDIX G3

Hydrogeological Investigation Report

June 2012
Report No. 117625003_159_R_Rev1

March 2012

WHYTES GULLY NEW LANDFILL CELL

HYDROGEOLOGICAL INVESTIGATION REPORT

Submitted to:
Wollongong City Council

REPORT

Report Number. 117625003_070_R_Rev0

Golder Associates

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1.0 INTRODUCTION

A combined hydrogeological and geotechnical investigation was undertaken at the Whytes Gully Resource Recovery Park (WGRRP) in July and August 2011 by Golder Associates Pty Ltd (Golder) on behalf of Wollongong City Council (Council). The purpose of investigation was to provide subsurface information to inform the environmental assessment and detailed design of the Whytes Gully New Landfill Cell.

This report presents the results of the hydrogeological investigation. The results of the geotechnical investigation are presented in a separate report *Whytes Gully New Landfill Cell, Geotechnical Investigation Report* (ref: 117625003_077_R_Rev1, dated March 2012), (Golder 2012a) and have been considered in the conceptualisation of hydrogeological conditions at the site.

1.1 Background

The WGRRP is owned and operated by Council under Environment Protection Licence 5862. Existing landfill airspace at the WGRRP is projected to expire in late 2013. As part of a coordinated delivery of resource recovery and waste services in the Wollongong Local Government Area (LGA), Council are proposing to increase landfill capacity at the site by constructing a new landfill cell within the existing WGRRP, to the south of the existing landfill footprint and piggy-backing waste over the existing western and eastern gully landfills. This is estimated to provide more than 6 million cubic metres of additional airspace, projected to extend the life of the landfill by up to 40 years.

1.2 Objectives of Hydrogeological Investigation

The objective of the hydrogeological investigation was to provide information to support the design of the new landfill cells (in particular the cell base levels and liner system requirements), assess the vulnerability of the local groundwater resource to landfilling activities, and to provide a groundwater monitoring network for future groundwater quality monitoring.

1.3 Scope of Hydrogeological Investigation

Prior to commencing site investigations, a review of existing information on existing monitoring wells and groundwater data was conducted and data gaps identified. The following investigations were then undertaken:

- Installation and development of 13 monitoring wells for the future groundwater monitoring network. Installation of boreholes included the recovery of rock core;
- Installation and development of seven monitoring wells in the new landfill cell footprint to provide information on foundation conditions. Installation of boreholes included the recovery of rock core;
- Hydraulic testing (slug tests) of two alluvial and five shallow rock monitoring wells;
- Water level measurement and sampling of 20 new monitoring wells and one existing well (MW6) for groundwater quality analysis;
- Collection of QA/QC samples; and
- Survey of all new monitoring well locations.

2.0 SITE DESCRIPTION

2.1 Regional Setting

The Wollongong Council area is located 80 kilometres south of Sydney and covers approximately 714 km^2. It is bordered by the Royal National Park to the north, Lake Illawarra to the south, the Tasman Sea to the east and the Illawarra escarpment to the west.

2.2 Site Location

The WGRRP is located approximately 10 km to the south west of the Wollongong Central Business District (CBD) and is approximately 65 ha in size. Figure 1 presents the site locality and identifies the WGRRP regional context.

The WGRRP is located on Reddalls Road, Kembla Grange NSW. The site is generally bounded by Reddalls Road to the south and west, rural residential lands to the north, north-east and north-west, and a water treatment plant to the south east. An industrial area lies to the south of Reddalls Road and Dapto Creek lies to the west.

The residential suburb of Farmborough Heights is located approximately 360 m to the north east over a ridgeline.

2.3 Existing Site

WGRRP includes historical and existing landfills (Western and Eastern Gully), a transfer station, private roads, stormwater ponds, a leachate management system (including treatment plant and ponds), a materials recovery facility, a recycling area, weighbridge and administration and amenities buildings, as shown on Figure 2. The site also includes buildings previously housing a solid waste to energy facility.

2.4 Property Details

The Whytes Gully RRP site is owned by Council and consists of:

- Part Lot 501, DP 1079122;
- Lot 502, DP 1079122;
- Lot 2, DP 240557;
- Lot 52, DP 1022266;
- Lot 53, DP 1022266; and
- Lot 51, DP 1022266.

This land is zoned as IN2 Light Industrial under the *Wollongong Local Environment Plan (West Dapto) 2010* (the LEP).

2.5 Previous Investigations

A number of investigations have been carried out across the site prior to this current phase of work. Information from these previous investigations has been reviewed during the preparation of this study and includes the following documents:

- *Preliminary Geotechnical Investigation of Possible Waste Disposal Depot at Whytes Gully, Reddalls Road, West Dapto* (Golder Associates, March 1981)
- *Proposed Waste Disposal Depot at Reddall's Road West Dapto, Environmental Impact Statement* (Scott and Furphy Engineers, February 1982)

- *Proposed Waste Disposal Depot at Reddall's Road West Dapto, Environmental Impact Statement Addenda* (Scott and Furphy Engineers, January 1983)
- *Site Investigations and Geotechnical Assessments for the Phase Two Development of a Waste Disposal Depot at Whytes Gully, West Dapto* (Maunsell, September 1992)
- *Supplement for the Whytes Gully Waste Depot – Stage 2 Landfill Management Plan to Wollongong City Council, Leachate Treatment Options* (Maunsell, March 1993)
- *Geotechnical Assessment – Proposed Extension to Whytes Gully Waste Disposal Depot* (R Britten, Council of the City of Wollongong, pers. comm., 18 July 1991)
- *Whytes Gully Landfill Extension Environmental Management Plan* (Maunsell, May 1998)
- *Whytes Gully Landfill Extension Landfill Management Plan* (Maunsell, October 1992)
- *Review of Environmental Factors for Proposed Deviation of Reddalls Road, Kembla Grange* (Forbes Rigby, February 2001)
- *Preliminary Geotechnical Investigation Proposed Leachate/Stormwater Ponds Whytes Gully Waste Disposal Dept Reddalls Road, Kembla Grange* (Jon Thompson, Coffey Geosciences, pers. comm., 18 December 2001)
- *Whytes Gully Landfill Leachate Management Study* (Forbes Rigby, August 2002)
- *Whytes Gully Landfill Surface Water and Leachate Management Plan 2008 Draft* (RIENCO Consulting, November 2008)
- *Technical Review of the Groundwater Monitoring Network for Whytes Gully Waste Management Facility* (Earth2Water, 29 April 2008)
- *Report on Geotechnical Investigation, Characterisation of Capping Material Whytes Gully Landfill Kembla Grange* (Douglas Partners, April 2009)
- *Whytes Gully Waste Disposal Depot Borrow Pit Geotechnical Investigation Laboratory Report* (Wollongong City Council Geotechnical Services, 27 June 2010)
- *Whytes Gully Waste Disposal Depot New Cell Floor Investigation Laboratory Report* (Wollongong City Council Geotechnical Services, 26 June 2010)
- *Small Vehicle Transfer Station Whytes Gully Waste Disposal Depot Kembla Grange* (Kevin Bogie, Wollongong City Council pers. comm., 1 May 2010)
- *Report for Whytes Gully and Helensburgh Landfill Sites Landfill Gas Surface Emissions, Building Accumulation and Manifold Monitoring* (GHD, April 2011).

The locations of previous site investigations are shown on Figure 3, Historical Site Investigation Locations.

2.6 Site History and Development

The WGRRP was established in 1984 at a site known as Whyte's farm. The site is defined by two gullies known as the western and eastern gullies separated by a central north-south trending ridgeline. The farm comprised an area of 35.6 ha of mostly cleared, improved grazing land owned by Mr Whyte for a period of 40 years prior to development as a landfill (Scott and Furphy, 1982). An area of land to the south of Whyte's farm adjacent to the eastern gully was also purchased to accommodate the site's development as a landfill. A stockyard remains near the central western boundary of the site which is remnant from this prior use.

2.6.1.1 Western Gully

Development consent for landfilling in the western gully was granted in 1983, for which an Environmental Impact Statement (EIS) was prepared by Scott and Furphy (1982). Landfilling commenced in the western gully in 1984, as shown on Figure 2.

The western gully landfill is unlined and is covered with varying depth of cover materials comprising natural clayey sandy soil materials won onsite and imported coal wash. The final profile of the landfill comprises a series of slopes and indistinct benches with an average surface slope of approximately 20%.

The western gully landfill received approximately 980,000 m^3 of waste during its 9.5 year life from 1984 to 1993 (Forbes Rigby, 2001).

Leachate management for the western gully comprised collection of leachate through surface and subsurface drains to a leachate retention pond for treatment prior to release to surface waters. Irrigation of the leachate over the eastern gully by pumping to a tank at the top of the gully was used to increase treatment when required, and was also provided as a fire fighting system (Scott and Furphy, 1982).

Surface water management for the western gully landfill comprised up-gradient diversion drains and treatment of runoff from landfill areas as leachate.

We understand that colluvium and residual soil were stripped from the natural slopes during preparation works prior to landfill being placed in the area. From discussions with people involved in this stripping operation it appears that the natural slopes are likely to have been almost completely stripped to rockhead, but that colluvium and residual soil were not removed to full depth at the base of the natural slopes.

2.6.1.2 Eastern Gully

The eastern gully landfill was constructed as a lined landfill, with a lining system comprising a high density polyethylene (HDPE) geomembrane overlain by a leachate drainage layer supplemented with leachate collection pipes.

Leachate is drained by gravity to the toe of the landfill and transferred to leachate ponds.

The HDPE liner is underlain by a groundwater drainage layer to manage groundwater seepages from springs located in the gully. Groundwater collected from this system drains under gravity to a pond at the toe of the landfill.

The landfill is covered with intermediate cover of approximately 300 mm depth. The profile of the landfill comprises a series of terraced benches with an average surface slope of approximately 25%.

Filling in the eastern Gully has been undertaken in four stages. Stage 1 commenced in 1993 and was located in the upper portion of the gully, and Stage 2, located on the lower section of the gully, commenced in 2001 and received approximately 1,250,000 m^3 of waste to the year 2004. Stage 3 is located in the lower portion of the gully over the Stage 2 filling area and had an estimated 610,000 m^3 capacity over a five year period. Stage 4, located in the upper portion of the gully over Stage 1 is currently underway and has an estimated 750,000 m^3 capacity over a five year period with completion of filling expected in 2013 (Forbes Rigby, 2001 and WCC Drawing No. 1475, 2004).

We understand that colluvium and residual soil were stripped from the natural slopes during preparation works prior to landfill being placed in the area. From discussions with people involved in this stripping

operation it appears that the natural slopes are likely to have been almost completely stripped to rockhead, but that colluvium and residual soil were not removed to full depth at the base of the natural slopes. We note that a liner was placed below the landfill for this area of the site.

2.7 Topography

The northwest and eastern extents of the landfill are bounded by ridgelines, with a small central north-south trending ridgeline separating the two historical gullies, the upslope portion of which remains clearly visible today. The site rises from RL 15 m at the south west to RL 100 m at the north east.

2.8 Hydrology

The general surface water drainage direction on the site is from the north east towards the south west. The catchment area of the site is approximately 50 ha and extends from a ridge to the north of the site to Reddalls Road to the south. Runoff from this catchment is directed to the stormwater ponds at the south west corner of the site before discharge to Dapto Creek.

Currently (2011), stormwater runoff from the landfill is generally directed along the eastern and western edges of both the Eastern Gully landfill and the Western Gully landfill through a series of swales and benches and a drain along the central ridge. There is currently a pond system on site to capture and treat the sediment runoff generated from the landfill activities. Run-on to the site is minimal due to the site being bounded by ridgelines.

Previous studies have indicated the presence of a number of springs within the eastern gully prior to landfill development.

2.9 Geology and Soil

Based on the 1:100,000 geological map 'Wollongong-Port Hacking', the WGRRP is on the boundary of two major geological formations. The southern part of the site is underlain by alluvial sands, silts and clays associated with Dapto Creek, which were deposited on sandstone of the Budgong Sandstone formation. The central part of the site is underlain by red, brown and grey lithic sandstone that forms part of the Budgong Sandstone formation. The northern portion of the site is underlain by interbedded lithic sandstone, coal, carbonaceous claystone, siltstone and claystone of the Pheasants Nest Formation. It appears that the Pheasants Nest formation is mainly encountered on the ridgelines.

The EIS (1982) indicates that prior to land-filling, volcanic sandstone covered most of the site with a transition to andesitic sandstone with coal seams, carbonaceous shale and mudstone in the higher section (above approximately RL 100 mAHD) and a zone of alluvium, gravels and sands in the lower sections (below approximately RL 30 mAHD). Bedrock is reported to appear at the surface in the upper sections of the site. The EIS (1992) for the Eastern Gully also notes that a relatively thick layer of colluvium was found along the base of the Eastern Gully.

The "Geology and Natural Slope Stability Zones in the City of Greater Wollongong, Figure 19, Sheets 1 and 2" (Rec. Geol. Surv. NSW, 14(2): Bowman) characterise the upper natural slopes as "moderately unstable, generally topographically high-relief land underlain by potentially unstable material requiring thorough investigation before development" and the site area at the toe of the natural slopes as "stable land with no landslip problems."

Historical photographs taken from ground-level in the eastern gully at a time before landfill development have been provided to Golder by Council. The appearance of the surface topography and conditions in these photographs is generally consistent with the presence of colluvium and potentially perched groundwater levels within the gully slopes. We understand that colluvium was to be stripped from natural slopes prior to construction of landfill, but note that some materials could remain close to the toe of the natural slopes in the central and northern portions of the site.

2.10 Hydrogeology

2.10.1 Regional Hydrogeological Setting

Regionally the site is located within the southern portion of the Sydney Basin, a geological basin stretching from the Illawarra Plateau in the south to the Lower Hunter Valley region in the north, and incorporating the topographically low Cumberland Basin in the centre. Generally, the dip of the geological formations within the Sydney Basin is from the topographically higher ground in the north and south towards the topographic low ground in the centre of the basin, although this varies locally based on structural features.

The regional hydrogeological setting of the site includes groundwater resources associated principally with the sandstone formations of the Hawkesbury Sandstone, Narrabeen Group, Illawarra Coal Measures and the Shoalhaven Group. Each of these geological groups generally comprises varying proportions of sandstone, siltstone, claystone, shale and coal. Groundwater resources are generally described as occurring as stacked aquifer systems associated with the sandstone formations, separated by lower permeability strata acting as aquitards. Structural contours presented on the 1:100,000 geological map 'Wollongong-Port Hacking' (Department of Primary Industries, 1985) indicate a local geological dip direction approximately towards the north to northwest in the vicinity of the site, which would be expected to influence the regional groundwater flow direction.

2.10.2 Local Hydrogeological Setting

On the site scale, groundwater occurrence is generally associated with two shallow systems: groundwater present in the upper weathered and fractured profile of the local bedrock geology, and groundwater present in the unconsolidated deposits that infill the two gullies at the site at the toe of the sloping topography. Water levels measured in wells installed within the shallow weathered bedrock in the sloping northern portion of the site (including the upgradient site boundary) generally range from 5 to 10 metres below ground level (mbgl), whereas water levels in wells installed in both the shallow bedrock and unconsolidated material in the flatter southern portion of the site are shallower, generally on the order of 1 to 3 mbgl. The water level associated with GABH03 is approximately 0.4 m above ground level, indicating local artesian conditions within the shallow bedrock at this location.

Shallow groundwater flow associated with the weathered bedrock horizon is inferred to be sympathetic to the sloping topography of the northern portion of the site, with a south to southwest flow direction (refer to Figure 5, Appendix A). Anecdotal information indicates that a number of springs were present in the two former gullies in which the existing landfill cells were developed. Groundwater within the unconsolidated deposits on the southern portion of the site also exhibits a south-southwest flow direction. Where nested wells were installed, an upward vertical hydraulic gradient was evident between the shallow weathered bedrock and the overlying unconsolidated deposits, which is likely attributable to the significant hydraulic gradient from the sloping terrain on the northern portion of the site. On the basis of the lithological logs and water level observations, it is considered that the weathered bedrock groundwater system is semi-confined beneath the unconsolidated deposits, but there is likely to be a degree of hydraulic connectivity between the systems.

Hydraulic testing of wells completed within both the shallow weathered bedrock and in the unconsolidated deposits indicated hydraulic conductivity values on the order of 10^{-5} to 10^{-6} m/s, which is consistent with the range of published values for the lithologies encountered.

Further detailed discussion of the local hydrogeology of the site is presented in the following sections of this report.

2.10.3 Summary of Previous Hydrogeological Investigations

A number of limited hydrogeological investigations have previously been performed at the site, typically as components of geotechnical investigations assessing site suitability for landfill development. A brief overview of previous hydrogeological investigations and observations at the site is provided below.

Golder (1981)

Golder performed a geotechnical investigation in 1981 as a preliminary site suitability assessment for landfill development, which included 11 test pits and one hand auger location. The results of the investigation noted the following: "*The eastern side slope of the eastern gully shows evidence of past and present soil instability in local areas on the slope. These local slip failures would also indicate the presence of natural springs."* No specific documentation of observed spring locations was provided.

WCC (1991)

In an investigation undertaken by Council in 1991, four boreholes were installed along the central ridgeline between the eastern and western gullies, and one was installed within the eastern gully. The purpose of the boreholes was to investigate the availability of ripped rock from this ridgeline to substitute as cover materials on the western gully landfill (refer to Figure 3 for borehole locations). A groundwater sample was collected from open borehole number 5, located in the eastern gully, due to "odorous groundwater" being noted. The water level in the borehole was consistent with the water level in the nearby pond.

Results indicated a pH of 5.96, conductivity of 1648 μS/cm, BOD of 44 mg/L and TKN of 0.11 mg/L, suggesting that the water quality reflected leachate impact which was presumed to be flowing east from the western gully landfill along the bedding plane and fracture zone of the sandstone (WCC, March 1991). The odour in the bore was noted at RL 21 m which occurred at the top of a highly fractured sandstone layer.

It is noted that leachate irrigation was occurring in the eastern gully at the time, and as such subsurface infiltration and migration of irrigated leachate could have resulted in the degraded water quality reported for borehole 5.

Maunsell (1992)

A combined geotechnical and environmental investigation was performed by Maunsell in 1992 to assess the suitability of the Eastern Gully for development of a landfill cell. The investigation comprised of 13 boreholes and 18 test pits, with 10 of the boreholes completed as piezometers. In conjunction with the drilling program, eight falling head tests and 22 packer tests were performed to assess rock mass permeability, and groundwater samples were collected from most boreholes for chemical analysis. Drilling details and the range of reported water levels for the boreholes are summarised in Table 2.

The permeability testing results are summarised in Table 1 below. With the exception of a couple of outliers, the test results indicated decreasing permeability with decreasing fracture density, which by extension correlated to decreasing permeability with depth.

Table 1: Summary of Permeability Testing Results (Maunsell, 1992)

Test type	Total tests	Hydraulic conductivity (m/s)		
		Min	Max	Geometric Mean
Falling head	5	1.3×10^{-9}	2.4×10^{-5}	4.9×10^{-7}
Packer test	22	1.0×10^{-9}	5.0×10^{-7}	6.6×10^{-8}

Groundwater samples were also collected from selected boreholes (during drilling) and from selected wells following well installation, and analysed for a range of general water quality and leachate indicator parameters. There was evidence of leachate impact in groundwater samples in the form of elevated biochemical oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), alkalinity, and total kjeldahl nitrogen (TKN) concentrations in certain wells, particularly B5, D1 and D2 located close to the filled western gully. Lesser concentrations of these analytes were also reported for the other investigation

locations. It is possible that the groundwater quality impacts reflect a combination of leachate irrigation effects in the eastern gully, and potentially a degree of leachate infiltration to groundwater from the filled western gully.

WCC (2003)

Geotechnical reports prepared by WCC Geotechnical Services include borehole logs for locations BH1 to BH22, as well as three additional locations (denoted as 'metals area', 'entry gate' and 'crib room'). Figure 3 shows locations of historical investigations. A borehole summary is provided in Table 2.

The reported water levels were measured over a time period of several months, and cannot therefore be correlated in terms of a site-wide piezometric surface. In addition BH1 to BH22 were open core holes and were not completed as wells/piezometers. Basic well construction details were provided for the three 'additional' wells mentioned above.

In general, the borelogs indicate a variable thickness of colluvial and alluvial sediments overlying predominantly sandstone and shale bedrock. The drilling to date appears to have identified perched groundwater in the unconsolidated material, and an underlying shallow aquifer in the upper weathered rock horizon (boreholes just drilled to refusal on bedrock have water levels within the overlying soil, whereas cored locations exhibit water levels within the underlying rock).

Table 2: Summary of drilling locations (shaded rows denote cored locations)

Borehole ID	Total Drilling Depth (mbgl)		Depth to Water (mbgl)	Corresponding lithology
	Auger refusal	Coring		
Maunsell (1992)				
B1	1.5	35.52	12.45 - 12.90	Sandstone / siltstone interbeds
B2	0.82	36.87	11.10 - 11.65	Sandstone / siltstone interbeds
B3	0.74	32.45	8.20 - 16.55	Sandstone / siltstone interbeds
B4	2.02	32.00	11.30 - 11.90	Sandstone / siltstone interbeds
B5	8.89	31.14	2.70 - 2.95	Sandstone / siltstone interbeds
B6	--	32.47	25.80 - 26.00	Sandstone / siltstone interbeds
D1	2.72	19.92	5.95 - 6.50	Sandstone / siltstone interbeds
D2	1.31	21.00	3.35 - 5.20	Sandstone / siltstone interbeds
D3	1.22	20.23	19.15 - 19.50	Sandstone / siltstone interbeds
D4	2.84	26.37	19.80 - 21.80	Sandstone / siltstone interbeds
R1	7.97	11.50	3.30 - 3.70	Clayey silt / clay / weathered sandstone
R2	9.70	12.95	4.98 - 5.35	Clayey silt / clay / weathered sandstone
R3	1.15	11.00	8.30 - 8.60	Clayey silt / clay / weathered sandstone
WCC				
BH1	3.34	9.98	6.52 - 6.73	Sandstone (overlying shale band)
BH2	3.96	10.07	4.13 - 4.29	Core loss
BH3	2.6	10.80	8.35 - 8.53	Sandstone
BH4	3.47	9.45	2.60 - 5.46	Sandstone / claystone
BH5*	4.89	--	4.76	Weathered sandstone
BH6*	9.70	--	0.15 – 0.48	Fill (natural soil noted as wet at ~3.5 mbgl)
BH7*	6.64	--	0.80 – 3.83	Fill / Gravelly clay
BH8*	3.0	--	2.35	Weathered sandstone

Borehole ID	Total Drilling Depth (mbgl)		Depth to Water (mbgl)	Corresponding lithology
	Auger refusal	Coring		
BH9*	10.5	--	2.55 – 4.49	Sandy gravelly clay
BH10*	11.15	--	3.39 – 3.74	Clayey sand / Sandy clay
BH11*	7.95	--	3.16	Gravelly sandy clay
BH12	1.17	10.05	7.48	Sandstone
BH13	3.2	11.40	0.00	Sandstone
BH14	1.32	8.09	3.97	Sandstone (highly fractured)
BH15	2.32	10.00	6.94	Sandstone (weathered)
BH16*	10.60	--	4.39	Sandy silty clay
BH17*	8.28	--	1.31	Gravelly clayey sand
BH18*	9.3	--	1.07	Silty clay
BH19*	14.5	--	2.68	Sandy silty clay
BH20*	2.65	11.61	8.74 – 9.62	Sandstone
BH21*	2.02	10.16	5.19	Sandstone
BH22*	11.98	--	0.85 – 2.00	Sandy silty clay
Crib Room*	7.5	--	2.43	Sandy clay
Metals Area*	10.5	--	7.03	Gravelly clay
Entry Gate	6.0	--	1.53	Silty clay

* Indicates locations within the footprint of the proposed cell development area that would presumably be destroyed during development and are therefore unsuitable for long-term monitoring (assuming wells are currently present at these locations).

2.11 Climate

Climate data for the site was sourced from the Bureau of Meteorology website (www.bom.gov.au), referencing the closest automatic weather station (AWS) or gauging station to the site for which the data type was available. These included:

- Dapto Bowling Club (068022): Rainfall data from 1906 to present;
- Bellambi AWS: Temperature, wind speed and humidity data from 1997; and
- Nowra Royal Australian Navy Air Station AWS: Mean daily evaporation data from 1969 to 1997 (converted to monthly data).

The region exhibits a typical temperate climate with a strong maritime influence. Mean maximum and minimum temperatures range from 24.9 ºC to 16.7 ºC in January, and 17.9 ºC to 8.2 ºC in July.

Mean monthly and annual rainfall figures, as well as the mean number of rain days are presented in Table 3. The majority of rainfall occurs during the summer months. Mean annual rainfall of 1112 mm is fairly typical of eastern NSW. The mean monthly pan evaporation measurements for the Nowra RAN air station is also shown in Table 3, and exceeds mean monthly rainfall for every month except May and June.

Table 3: Monthly Climate Statistics (BOM, 2011)

Statistic Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Rainfall (mm)	106.2	125.3	129.3	104.8	96.6	107.6	55.7	65.5	57.8	80.4	88.7	90.1	1112
Mean max temperature (°C)	24.9	25.0	24.0	22.1	19.7	17.7	16.8	18.0	20.1	21.4	22.1	24.0	21.3
Mean min temperature (°C)	19.0	19.3	18.1	15.5	13.1	11.0	10.0	10.5	12.4	13.9	15.7	17.5	14.7
Mean monthly evaporation (mm)*	192.2	159.6	142.6	117	93	84	96.1	127.1	144	173.6	180	210.8	1716

*Mean data for years 1969 to 1997.

3.0 HYDROGEOLOGICAL INVESTIGATION METHODOLOGY

3.1 Rationale for Well Installation Locations

A number of gaps were identified in the hydrogeological knowledge of the site, with the potential to affect both cell design considerations and the potential for leachate migration in groundwater. The following key gaps were identified prior to the investigation:

- Water level data to the north of the old and current landfill cells (i.e. up hydraulic gradient) was limited;
- There appeared to be limited groundwater monitoring coverage down hydraulic gradient from key areas of potential contamination sources (e.g. old landfill cell, current landfill cell, leachate pond);
- There was limited groundwater monitoring coverage of the southern and south-western (i.e. down hydraulic gradient) property boundary, representing the point of compliance for groundwater quality migrating off-site; and
- Limited information was available regarding the hydraulic properties of the alluvial/colluvial and underlying weathered rock aquifers.

To address the identified gaps, a program of drilling, well installation, groundwater sampling and hydraulic testing was designed and implemented in conjunction with the geotechnical investigations. Well installation locations were selected to provide long term monitoring locations that are unlikely to require relocation or decommissioning during construction of the new landfill cells (based on the current proposed development footprint). A summary of the newly installed wells is provided in Table 4 below.

Table 4: Additional well installation locations and rationale

Well ID	Location	Unit screened	Rationale
GMW101	North of western gully landfill	Shallow rock	Upgradient data coverage
GMW102	Northwest of western gully landfill	Shallow rock	Upgradient data coverage
GMW103	Northeast of active cell (eastern gully landfill)	Shallow rock	Upgradient coverage - boundary
GMW104	West of western gully landfill	Shallow rock	Cross-gradient coverage - boundary
GMW105	East of active cell (eastern gully landfill), eastern ridge	Shallow rock	Cross-gradient coverage
GMW106	Southeast of eastern gully landfill	Shallow rock	Cross/downgradient coverage
GMW107	South of eastern gully landfill	Shallow rock	Cross/downgradient coverage
GMW108	South of future cells (east of weigh station)	s- alluvials d-shallow rock	Downgradient coverage
GMW109	Southwest corner of property	s- alluvials d-shallow rock	Downgradient coverage - boundary
GMW110	West of proposed leachate pond	Shallow rock	Downgradient coverage - boundary
GMW111	West of proposed new cells	Shallow rock	Downgradient coverage - boundary
GABH01	Within proposed cell footprint	Shallow rock	New cell footprint coverage
GABH02	Within proposed cell footprint	Shallow rock	New cell footprint coverage
GABH03	Within proposed cell footprint	Shallow rock	New cell footprint coverage
GABH04	Within proposed cell footprint	Shallow rock	New cell footprint coverage
GABH05	Within proposed cell footprint	Shallow rock	New cell footprint coverage
GABH06	Within proposed cell footprint	s- alluvials d-shallow rock	New cell footprint coverage

At each drilling location, one well was installed into shallow weathered rock to provide site-wide coverage of this shallow groundwater system. In addition, three locations (GMW108, GMW109 and GABH06) were completed as paired wells with an additional shallow well completed in the alluvial/ colluvial soil profile overlying the shallow rock.

3.2 Monitoring Well Installation

3.2.1 Preparation

Prior to the commencement of the drilling and well installation programme, the following tasks were completed:

- permission was obtained from Council to drill and install the wells;
- bore licenses were obtained from the NSW Office of Water (NOW);
- underground utilities clearance of the proposed drilling locations was completed using Dial-Before-You-Dig services maps, and a licensed service locater; and
- screening of proposed drilling locations for sensitive flora or fauna, and areas of known aboriginal heritage significance.

3.2.2 Borehole Drilling

A total of twenty groundwater monitoring wells were installed in boreholes drilled using a track-mounted drilling rig. The boreholes were advanced through upper soil materials to practical refusal using solid flight augers fitted with a tungsten-carbide (TC) or V-shaped bit. Drilling was then continued into bedrock using HQ3 diamond coring techniques, producing 61 mm diameter rock core, with the exception of monitoring wells GMW101 and GMW108 which were cored using NMLC methods (52 mm core diameter). Wash-bore drilling techniques were utilised to advance borehole GMW109 below the water table to top of rock. Drilling fluid comprised water only; that is, no artificial polymers were added during the drilling process. This was done to allow for completion of the boreholes as monitoring wells without compromising the groundwater quality. The borehole drilling operations were supervised by a Golder geotechnical engineer.

Various soil and core samples were collected for geotechnical testing and analysis at each location. Refer to Golder 2012a for details of geotechnical investigation results.

3.2.3 Monitoring Well Installation

Groundwater monitoring wells were installed in all boreholes (GABH01 to GABH06D and GMW101 to GMW111) following completion of drilling.

Well installation was conducted in accordance with *Minimum Construction Requirements for Water Bores in Australia (LWBC, 2003)*, as well as in compliance with Golders' technical procedures.

The following steps were undertaken during well installation:

- Lithological logs for each drilling location were reviewed to assess the interval to be targeted for monitoring by each well, such that well construction details could be modified on the basis of observed lithological conditions;
- The wells were constructed of 50 mm diameter PVC pipe, with factory slotted PVC screen (0.4 mm slots) and the remainder of the well constructed from blank PVC casing extending to approximately 1 m above ground level;
- Washed and graded filter sand was poured into the annulus between the well screen and borehole wall, ensuring that the sand covered the entire screened level to a minimum of 0.5 m above the well screen;
- A layer of bentonite pellets were poured on top of the sand and hydrated to seal off the well screen from surface water inflows;

- The annular space above the bentonite seal was backfilled with cement grout to just below ground level;
- The surface completion comprised above ground lockable stainless steel monuments set in concrete; and
- Monitoring wells were registered with the NOW following installation via submission of a completed "Form A" for each well.

3.2.4 Monitoring Well Development

Following installation, the wells were developed to remove suspended fines from the drilling process, and to improve the hydraulic connection between the well and the surrounding formation. Well development consisted of purging of the wells to visual clarity and stabilisation of water quality parameters (pH and EC).

3.3 Groundwater Sampling

All groundwater samples were collected using disposable bailers. Prior to groundwater sampling, the water levels within the groundwater wells were measured using a water level meter, then purged until the water quality parameters measured at the well head were observed to stabilise. During the purging process, indicator parameters (pH, temperature, EC, ORP and DO) were measured using a 90FLMV Water Quality Meter which was calibrated prior to use (refer to APPENDIX D for calibration certificates and copies of field sampling forms).

Samples were placed directly into appropriately preserved bottles provided by the laboratory and placed into an ice cooled esky to await transport to the laboratory.

Primary and duplicate groundwater samples were analysed by ALS Laboratory Services, and the triplicate groundwater sample was analysed by Envirolab Services, both of which are National Association of Testing Authorities (NATA) accredited for the analyses performed.

3.3.1 Quality Assurance and Quality Control Samples

The following Quality Assurance and Quality Control (QA/QC) samples were collected in conjunction with the investigation program:

- The collection of two duplicate samples in the field was used to assess the field and laboratory techniques. The results of the duplicate analyses are included in Table E1, APPENDIX E, and in the data validation report in APPENDIX F;
- The collection of one triplicate sample in the field was used to assess the laboratory precision. The results of the triplicate analysis are included in Table E1, APPENDIX E, and in the data validation report in APPENDIX F;
- Three each: travel blanks and travel spikes to assess the potential for cross-contamination or volatile losses associated with sample storage and handling procedures; and
- Four rinsate blanks to assess the efficacy of the equipment decontamination procedures.

3.3.2 Field and Laboratory Analytical Program

The primary and QA/QC samples were analysed for the following field and laboratory analytical suite:

- Field suite (temperature, pH, electrical conductivity (EC), dissolved oxygen (DO), oxidation reduction potential (ORP));
- Cations and anions (calcium, magnesium, sodium, potassium, chloride, sulphate, fluoride, alkalinity);
- Metals and metalloids (aluminium, arsenic, cadmium, chromium, copper, iron, manganese, mercury, nickel, lead and zinc);

- Nitrate, ammonia, total Kjeldahl nitrogen (TKN);
- Total petroleum hydrocarbons (TPH);
- Volatile organic compounds (VOCs);
- Polycyclic aromatic hydrocarbons (PAHs);
- Speciated phenolics;
- Polychlorinated biphenyls (PCBs);
- Organochlorine Pesticides (OCPs);
- Biochemical oxygen demand (BOD); and
- Total organic carbon (TOC).

3.4 Hydraulic Testing

Hydraulic tests, comprising rising and falling head slug tests, were performed using a solid slug of approximately 3 L volume, a calibrated water level meter and a calibrated vented In-Situ Troll™ level logger.

The hydraulic testing methodology is summarised below:

3.4.1 Falling Head Test Methodology

- A manual water level reading (reading 1) was recorded;
- A level logger was suspend and fixed at a known distance below the water level, allowing room for the slug to be inserted above;
- The level logger was started manually, recording measurements of pressure (kPa), depth (cm) and Temperature (ºC) every second;
- Another manual water level reading (reading 2) was recorded;
- The slug was inserted so that it was fully submerged, but did not contact the Troll, as quickly as possible, with the aim of providing an “instant” volume addition;
- Another manual water level reading (reading 3) was recorded; and
- Water level recovery was recorded using the level logger until 90% recovery of the static (starting) water level was achieved.

3.4.2 Rising Head Test Methodology

- A manual water level reading (reading 4) was recorded;
- The slug was removed as quickly as possible, with the aim of providing an “instant” volume reduction;
- Another manual water level reading (reading 5) was recorded;
- Water level recovery was recorded using the level logger until 90% recovery of the static (starting) water level was achieved;
- A final manual water level reading (reading 6) was recorded; and
- The level logger was stopped and the recorded data were downloaded and checked.

4.0 RESULTS OF HYDROGEOLOGICAL INVESTIGATION

4.1 Subsurface Lithology

The results of the investigation carried out by Golder (2011), as well as information obtained from previous investigations were used to compile an inferred subsurface profile. The following summary of the subsurface lithology has been included from Golder 2012a for ease of reference.

Prior to land-filling, volcanic sandstone covered most of the site with a transition to andesitic sandstone with coal seams, carbonaceous shale and mudstone in the higher section (above approximately RL 100 mAHD). However for simplicity and consistency with previous phases of work, we have used the terminology of "Sandstone" and "Siltstone" to represent the rock types across the site.

We have inferred that subsurface conditions generally consist of fill, colluvial / alluvial soils, residual soil and sandstone and siltstone rock. The thickness of the different units varies throughout the site. Our inferred summary of the Subsurface Units are given in Table 5.

Table 5: Summary of Generalised Subsurface Conditions

Unit	Description
Unit 1: FILL	Fill was encountered in zones of the proposed new cell floor (up to about 1.2 m deep) and generally comprised clayey soils with some sands. Fill in the existing landfill cap is mixed soils (clays and sands) with pockets of gravels, slag and coal-wash. Landfill including plastic and rubble is present beneath the capping material.
Unit 2: COLLUVIAL / ALLUVIAL SOILS	Mostly silty clay and clay with zones of sands and gravels and traces of cobbles. Soils in the upper 2 m to 3 m are soft to firm in parts and strength improves with depth. Distinction between the colluvial soils on the lower slopes and the alluvial soils at the very bottom of the slopes is often difficult. From an engineering perspective the soils are of similar consistency and both are included within Unit 2.
Unit 3: RESIDUAL SOIL and Extremely Weathered ROCK	Mostly clay with varying quantities of gravel, silt and sand. Clay is medium plasticity and generally stiff to very stiff with zones of medium dense to dense sand. Extremely weathered rock is extremely low to very low strength, typically sandstone with some siltstone and can be remoulded into a soil by hand.
Unit 4a: Weathered SANDSTONE	Fine to medium grained, brown, low to medium strength, highly weathered to moderately weathered, with some iron stained jointing, jointing frequency typically 100mm to 300mm.
Unit 4b: Fresh SANDSTONE	Fine to medium grained, grey, medium to high strength, generally slightly weathered to fresh, fracture spacing typically between 300mm to 1m.
Unit 5a: Weathered SILTSTONE	Light brown, very low strength to low strength, highly weathered to moderately weathered, some zones interbedded with sandstone
Unit 5b: Fresh SILTSTONE	Grey, low to medium strength, slightly weathered to fresh, encountered sparsely throughout the site

To generalise the geological conditions, the site has been broken up into four different areas. Inferred boundaries for these are shown in Figure 4 and are described below:

Geological Area 1 – Pheasants Nest Formation: This area is located on the upper slopes across the northern portion the site. Residual soils (Unit 3) are generally less than 2m thick overlying weathered sandstone (Unit 4a), which grades into fresh sandstone (Unit 4b) at depths typically less than 10m. Maunsell (1992) observed zones of siltstone (Units 5a and 5b) greater than about 15 m depth, but these were not reported in Golder 2012a.

Geological Area 2 – Budgong Sandstone Formation: This area is located across the southern portion of the site. This sandstone generally has a weathering profile (Unit 4a) that extends to depths up to 15m. Zones of weathered siltstone (Unit 5a), up to approximately 3m thick, are located intermittently throughout this formation.

Geological Area 3 – Colluvial / Alluvial Soils: This geological area consists of Unit 2 material and is located across the southern portion of the site. The thickness of this material varies to a maximum of approximately 11m. This geological area is expected to be underlain by Budgong Sandstone. Based on the existing geological information it is difficult to assess the nature of these soils. However, colluvial soils are more likely to be located close to and below the toe of the natural slopes (pre-landfilling), and alluvial soils at the very bottom and beyond the toe of the slopes.

Geological Area 4 – Capping Layer and Landfill: This geological area is located across the northern slope. The capping material consists of generally variable clays and sands. Landfill waste is located beneath the capping layer and consists of general waste such as paper, plastic, wood, rubble and other materials. The depth to the base of the general waste fill is not well defined, however old topographical data suggests that the thickness of the fill could be up to 65 m. This geological area is expected to be underlain by the Pheasants Nest Formation.

4.1.1 Inferred Water Bearing Units

The following water bearing units were encountered during the drilling program:

- **Shallow unconsolidated sediments** hosting a perched water system. This hydrostratigraphic unit is generally comprised of geological Units 1 and 2 as described in the previous section, and is only present in the southern portion of the site (note: this definition does not include leachate present within the current landfill cells). This unit is inferred comprise the buried southerly extension of the landfilled eastern and western gullies; and

- **Shallow weathered rock aquifer** hosting water that has either infiltrated from the unconsolidated sediments, or that originated in part as recharge further up on the escarpment. This hydrostratigraphic unit is generally comprised of geological Units 3, 4a and 5a as described in the previous section. This unit comprises the shallowest water bearing unit in the northern portion of the site, and is buried beneath the alluvial/colluvial sediments in the southern portion of the site. The interval of primary interest is the transition zone between residual soil and competent rock, comprising extremely to moderately weathered sandstone and siltstone with a high fracture frequency.

4.2 Well Construction Details

Well construction details are provided with the borehole reports in APPENDIX B and are summarised in Table 6.

Table 6: Well Construction Details

Well No.	Well Installation Date	Drilling Details			Screened Depth		Geology Screened
		Top of Casing (mAHD)	Surface Elevation (mAHD)	Total Depth (mbgl)	(mbgl)	(mAHD)	
GMW101	12 Jul 2011	90.672	90.152	10.30	7.1 - 10.30	83.05 - 79.85	Sandstone, coarse grained, SW-Fr, brown becoming grey, iron staining covering bedding partings at 100-300 mm spacing.
GMW102	9 Aug 2011	88.769	88.239	12.50	6.5 – 12.5	81.74 - 75.74	Sandstone, coarse and fine grained, Fr, interbedded with Conglomerate, fine grained, Fr. Sub-vertical and bedding plane fracturing at 300-1000 mm spacing, stained.
GMW103	14 Jul 2011	81.305	80.775	10.0	5.5 – 10.0	75.28 - 70.78	Siltstone, MW, subvertical bedding, interbedded with sandstone, fine grained, MW becoming fresh with depth. Defect spacing 30 to 300 mm, iron staining.
GMW104	10 Aug 2011	33.944	33.434	9.05	5.5 - 9.05	27.93 - 24.38	Sandstone, fine grained, MW becoming Fr with depth, defect spacing 100 to 300 mm, stained.
GMW105	8 Aug 2011	87.698	87.138	12.2	6.2 - 12.2	80.94 - 74.94	Sandstone, fine to med grained, MW, with some siltstone laminations and conglomerate seams. Defect spacing 100 to 300 mm, stained.
GMW106	15 Aug 2011	78.592	77.942	9.0	3.0 - 9.0	74.94 - 68.94	Sandstone, fine to med grained, MW – SW, with some siltstone laminations. Defect spacing 100 to 1000 mm, iron staining.
GMW107	15 Jul 2011	41.719	41.089	10.0	5.5 – 10.0	35.59 – 31.09	Siltstone with sandstone laminations, HW and and Sandstone, fine grained with siltstone laminations, HW – SW. Defect spacing 30 to 300 mm, iron staining.
GMW108S	18 Jul 2011	19.473	18.893	12.15	2.0 - 12.15	16.89 - 6.64	Clay and sandy clay, becoming gravelly clay at depth, med to high plasticity, fine to medium grained sand.
GMW108D	19 Jul 2011	19.562	18.977	15.0	12.5 - 15.0	6.48 - 3.98	Sandstone, fine grained, HW – MW, sub-horizontal bedding, defect spacing 30-100 mm, stained.
GMW109S	21 Jul 2011	17.842	17.307	10.24	1.24 -10.24	16.07 – 7.07	Fill clay, medium plasticity, overlying clayey sand, clay and sandy clay, high plasticity with some organic bands.
GMW109D	26 Jul 2011	17.290	17.860	21.3	15.5 - 21.3	1.79 - (-4.01)	Sandy silty clay, high plasticity, fine grained sand, overlying sandstone, fine grained, EW-MW, 30-100 mm defect spacing, iron staining.
GMW110	21 Jul 2011	20.101	19.611	9.5	3.5 – 9.5	16.11 - 10.11	Sandstone, fine to med grained, HW-SW, some siltstone laminations, 30-100 mm defect spacing, iron staining.
GMW111	21 Jul 2011	22.593	22.033	8.25	4.0 – 8.25	18.03 – 13.78	Sandstone, fine to med grained, some siltstone laminations, HW-MW, interbedded with siltstone, MW. Defect spacing 30-100 mm, staining.
GABH01	15 Aug 2011	30.916	30.341	6.48	3.0 – 6.48	27.34 – 23.86	Sandstone, fine to med grained, MW to SW becoming Fr at depth, some siltstone laminations. Defect spacing 300-1000 mm, staining.
GABH02	11 Aug 2011	23.493	22.963	12.4	6.5 – 12.4	16.46 - 10.56	Sandstone, fine to med grained, HW-MW, defect spacing 30-100 mm, staining, sub-vertical fracturing.

Well No.	Well Installation Date	Drilling Details			Screened Depth		Geology Screened
		Top of Casing (mAHD)	Surface Elevation (mAHD)	Total Depth (mbgl)	(mbgl)	(mAHD)	
GABH03	29 July 2011	19.213	18.658	15.0	11.5 – 15.0	7.16 – 3.66	Sandstone, fine grained, EW – SW, defect spacing 100-300 mm, iron staining.
GABH04	11 Aug 2011	18.734	18.234	16.26	10.0 – 16.26	8.23 – 1.97	Clay, overlying Sandstone, fine to medium grained, HW-Fr, trace siltstone laminations, defect spacing 10-100 mm, in weathered section, 30-1000 mm in Fr rock, staining.
GABH05	27 July 2011	20.799	20.329	18.5	13.0 – 18.5	7.33 – 1.88	Sandstone, fine grained, with siltstone laminations, HW-SW, defect spacing 10 – 300 mm, iron staining.
GABH06S	27 July 2011	22.673	22.083	8.15	5.15 – 8.15	16.93 – 13.93	Clay, high plasticity and clayey sand, fine grained, high plasticity.
GABH06D	15 Aug 2011	22.619	22.049	12.5	8.0 – 12.5	14.05 – 9.55	Silty clay, overlying sandstone, fine grained, HW-Fr, defect spacing 30-100 mm in weathered rock, 1000-3000 mm in fresh rock.
BH6^	18 Mar 2009	16.242	16.302	5.8	1.6^ - 5.8	14.7^ - 10.5	Silty clay, high plasticity and sandy clay, medium plasticity. Note: overlying is Fill material, including slag.

Note: ^The 2009/10 Annual Monitoring Report describes BH6 as being installed by WCC. BH6 lithology is assumed to be that of BH3 "New Entry Gate" WCC reference W9872, installed by WCC in March 2009. The location and measured depth of BH6 (from 2009/10 Annual Monitoring Report, GHD 2010) are consistent with the bore report and location for BH3.

4.3 Groundwater Elevation and Flow Direction

4.3.1 Depth to Groundwater

Groundwater levels were measured prior to well sampling and prior to hydraulic testing. The measured water levels are presented in Table 7.

The measured depth to groundwater ranged from 0.38 m above ground level in GABH03 to 10.10 m below ground level (mbgl) in GMW105. Groundwater elevation values ranged from 14.53 m AHD in GMW109S to 80.58 m AHD in GMW101. GMW107 was dry at the time of monitoring. The inferred water table is presented graphically in Figure 4, APPENDIX A.

In general, the measured depth to groundwater was greatest in the northern portion of the site, in wells installed along the ridgelines of the infilled gullies, and was shallowest in the wells installed within the alluvial plain at the base of the slope.

Water level measurements at paired well locations (GMW108, GMW109 and GABH06) confirmed an upward hydraulic gradient between the shallow rock horizon and the overlying alluvial/ residual soil. The average upward gradient was greatest at GABH06 (0.15 m/m), which is located closest to the steeply sloping portion of the site, and reduced with distance from the escarpment (0.08 m/m at GMW108, and 0.02 m/m at GMW109). This is attributed to the influence of the hydraulic head from the elevated northern portion of the site, and the relatively low permeability (silt/ clay) of the overlying residual and alluvial soils. It is inferred that the shallow weathered rock water bearing zone is semi-confined where it occurs beneath alluvial deposits, with a degree of hydraulic connectivity to the overlying soils.

Cell Footprint Area

The depth to water table was evaluated in slightly more detail in the proposed cell footprint area to the east of the leachate ponds. A pressure transducer was installed in monitoring well GABH06S in December 2011, and preliminary evaluation of the hydrograph for the first month of logged data indicated a relatively minor fluctuation in water level between approximately 1.15 and 1.40 mbgl (approximately RL 20.7 and 20.9 m AHD).

In addition, three new shallow monitoring wells (BH205, BH206 and BH207) were recently installed within the alluvium in the cell footprint area to the west of GABH06S to provide additional data coverage to support cell design considerations. The wells were screened from the alluvium/sandstone interface to approximately 1.5 mBGL to assess the water table depth in the alluvium. The wells had not yet been surveyed at the issue date of this report (data will follow in an addendum), however preliminary analysis of the measured water levels relative to the approximate ground surface elevation from a topographic map indicated that the reduced levels in these wells varied between approximately 18.7 and 20.8 mAHD.

It is noted that there is an inherent inaccuracy in this estimate due to the use of a topographic map for datum reference, and more detailed assessment of the water levels associated with these wells will be provided in an addendum once available.

4.3.2 Groundwater Flow Direction

A potentiometric map was produced based on the measured groundwater elevations (Figure 5, APPENDIX A). As the majority of monitoring wells were screened within the shallow weathered/ fractured rock horizon, the piezometric contours reflect the shallow rock water bearing zone. Separate contours have not been prepared for the wells completed in the alluvium as they were installed on a linear transect along a common groundwater flow path. However the alluvial water levels were compared to the shallow rock water levels to draw conclusions regarding groundwater flow in the alluvium. The piezometric contour interval in Figure 4 is 10 m from 80 m AHD to 20 m AHD (i.e. in the steeper topography in the northern portion of the site), and then changes to 1 m contour intervals below 20 m AHD.

The potentiometric analysis indicates that groundwater flow generally conforms to local topography, with a flow direction predominantly towards the southwest. It is noted that due to a lack of groundwater monitoring data within the filled gullies, professional judgement has been applied to adjust the linear interpolation of

water level data from wells on the site boundary to reflect the expected influence of the original topography (i.e. gullies and central ridgeline) on the piezometric surface. Prior to landfilling, the central ridgeline would have been expected to provide a local groundwater divide with respect to shallow groundwater flow in the eastern and western gullies. The actual piezometric surface beneath the current cell footprints may vary slightly from that presented in Figure 4, and will be evaluated in the future if groundwater or leachate monitoring wells are installed within the cells. Installation of an additional monitoring well on the central ridgeline immediately north of the access road would assist with this interpretation, as well as the evaluation of potentially recoverable materials from this area (i.e. rippable rock above the water table).

Given the consistency of alluvial water levels relative to underlying shallow rock water levels at the paired wells, and the thickening of the alluvial/colluvial deposits towards the southwest, the groundwater flow direction in the alluvial material was inferred to be towards the southwest consistent with the shallow rock water bearing zone. This is supported by the decreasing water level trend between locations GABH06S, GMW108S and GMW109S, located on what is inferred to be a common groundwater flow path.

The hydraulic gradient is steeper on the slopes and becomes flatter to the south west in the alluvial plains. The hydraulic gradient on the slopes is relatively steep and generally ranges from 0.10 to 0.15 m/m. The hydraulic gradient rapidly decreases by approximately an order of magnitude in the alluvial plain to between 0.010 and 0.015 m/m.

Table 7: Summary of Water Level Measurements

Well ID	Monitoring Date	Top of Casing (m AHD)	Depth to groundwater (m BTOC)	(mbgl)	Screened depth (m AHD)	Static Groundwater Level (m AHD)
GMW101	17 Aug 2011	90.672	10.09	10.09	83.05 - 79.85	80.58
GMW102	17 Aug 2011	88.769	9.28	8.75	81.74 - 75.74	79.49
GMW103	17 Aug 2011	81.305	7.65	7.12	75.28 - 70.78	73.66
GMW104	17 Aug 2011	33.944	6.37	5.86	27.93 - 24.38	27.57
	26 Aug 2011		6.33	5.83		27.61
GMW105	17 Aug 2011	87.698	10.53	9.97	80.94 - 74.94	77.17
	26 Aug 2011		10.66	10.10		77.04
GMW106	17 Aug 2011	78.592	9.20	8.55	74.94 - 68.94	69.39
	20 Aug 2011		9.33	8.68		69.26
GMW107	17 Aug 2011	41.719	Dry	Dry	35.59 – 31.09	Dry
GMW108S	22 Aug 2011	19.473	2.62	2.04	16.89 - 6.64	16.85
	20 Sept 2011		2.48	1.90		16.99
GMW108D	22 Aug 2011	19.562	2.12	1.54	6.48 - 3.98	17.44
	20 Sept 2011		1.92	1.34		17.64
GMW109S	17 Aug 2011	17.842	3.11	2.58	16.07 – 7.07	14.73
	26 Aug 2011		3.15	2.62		14.69
	20 Sept 2011		3.31	2.78		14.53
GMW109D	26 July 2011	17.290	3.03	2.46	1.79 - (- 4.01)	
	26 Aug 2011		2.86	2.29		15.00
	20 Sept 2011		2.93	2.36		14.93

Well ID	Monitoring Date	Top of Casing (m AHD)	Depth to groundwater (m BTOC)	(mbgl)	Screened depth (m AHD)	Static Groundwater Level (m AHD)
GMW110	25 Jul 2011	20.101	2.93	3.44	16.11 - 10.11	16.17
GMW111	25 Jul 2011	22.593	3.93	5.63	18.03 – 13.78	16.40
GABH01	17 Aug 2011	30.916	6.19	2.45	27.34 – 23.86	27.90
	20 Sept 2011		3.02	2.33		28.01
GABH02	19 Aug 2011	23.493	2.91	4.12	16.46 - 10.56	18.84
	22 Aug 2011		4.65	4.20		18.77
GABH03	19 Aug 2011	19.213	4.72	- 0.37	7.16 – 3.66	19.02
	20 Sept 2011		0.19	- 0.38		19.03
GABH04	19 Aug 2011	18.734	0.18	0.44	8.23 – 1.97	17.79
GABH05	21 Aug 2011	20.799	0.94	5.28	7.33 – 1.88	15.05
	26 Aug 2011		5.75	5.25		15.08
GABH06S	17 Aug 2011	22.673	5.72	1.42	16.93 – 13.93	20.66
	20 Sept 2011		2.01	1.30		20.78
GABH06D	18 Aug 2011	22.619	1.89	0.79	14.05 – 9.55	21.26
	20 Sept 2011		1.36	0.80		21.25
BH6*	17 Aug 2011	16.242	1.37	1.40	14.7^ - 10.5	14.90

Notes:
m BTOC = metres below top of casing
mbgl = metres below ground level
*construction details from BH3 log (WCC reference W9897)
^ filter pack depth (screened depth not available)

4.4 Hydraulic Testing

Hydraulic testing was carried out on two groundwater wells screened in alluvium (GMW108S and GMW109S) and five groundwater wells screened in shallow rock (GABH02, GABH05, GMW104, GMW105, GMW108D and GMW109D) to estimate the hydraulic conductivity of the subsurface materials adjacent to the well screen intervals. The results of the tests are presented in APPENDIX C and the interpreted hydraulic conductivity values are presented in Table 8.

Table 8: Summary of Slug Test Analysis Results

Bore Reference	Screened zone geology	Transmissivity (m^2/s)	Aquifer Thickness (m)	Hydraulic Conductivity (m/s)
GABH02	Sandstone, HW-MW	$3.7x10^{-5}$	8.10	$5x10^{-6}$
GABH05	Sandstone with siltstone laminations, HW-SW	$4.6x10^{-5}$	13.10	$4x10^{-6}$
GMW104	Sandstone, MW-Fresh	$1.6x10^{-7}$	3.15	$5x10^{-8}$
GMW105	Sandstone with siltstone laminations, MW-Fresh	$3.2x10^{-5}$	2.15	$1x10^{-5}$
GMW108D	Sandstone, HW-MW	$1.1x10^{-4}$	13.45	$7x10^{-6}$
GMW108S	Sandy silty clay	$5.8x10^{-5}$	10.06	$6x10^{-6}$
GMW109D	Sandy silty clay/ sandstone, EW-MW	$2.5x10^{-5}$	9.78	$3x10^{-6}$
GMW109S	Sandy clay	$1.0x10^{-4}$	6.99	$1x10^{-5}$

Note that as no observation bores were used during the hydraulic testing, which is a limitation inherent in the nature of slug testing, the value given for storativity in the analysis is an estimate only. This value has not been optimised or fitted as part of the analysis.

The hydraulic conductivity at wells installed in alluvium ranged from1 x 10^{-5} m/s to 6 x 10^{-6} m/s, and from 1 x 10^{-5} m/s to 5 x 10^{-8} m/s for shallow fractured rock. These results are generally consistent with the published range for silty alluvial materials, and are generally on the upper end for sandstone (Freeze and Cherry, 1979). The relatively higher permeability of the sandstone results reflects the well completion targeting the most highly weathered and fractured portion of the sandstone, whereas the test result for GMW104 (fresh sandstone) reflects the mean of the published range.

The geometric mean of the hydraulic conductivity values calculated from the hydraulic testing ($3.3x10^{-6}$ m/s) was approximately an order of magnitude higher than the geomean of the packer test results reported for the site by Maunsell ($4.9x10^{-7}$ m/s), and is approximately two orders of magnitude greater than the geomean of the falling head test results reported by Maunsell ($6.6x10^{-8}$ m/s). The reason for this discrepancy is uncertain, although it may be partially attributable to the greater proportion of lower permeability deep drilling intervals (e.g. fresh to slightly weathered sandstone and siltstone) included in the Maunsell hydraulic testing regime (it is noted that the test result for GMW104, screened within relatively fresh sandstone, is similar to the Maunsell results for relatively fresh sandstone).

4.5 Groundwater Quality Analysis

Groundwater samples were collected from the newly installed monitoring wells and existing well BH6 and submitted to an analytical laboratory for analysis of a suite of general water quality parameters and potential leachate indicator parameters in accordance with the project proposal. The purpose of the water quality analysis was to document baseline water quality conditions prior to redevelopment of the site as a basis of reference for future post-development monitoring. A summary of field and laboratory water quality results is presented in Table E-1, APPENDIX E.

4.5.1 Groundwater Quality Assessment Criteria

The Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (2000), "Australian and New Zealand Guidelines for Fresh and Marine Water Quality" (ANZECC 2000) were adopted as the groundwater quality assessment criteria for the site. In assigning levels of protection for aquatic ecosystems, the ANZECC (2000) guidelines recognise three types of ecosystems: high conservation value systems, slightly to moderately disturbed systems, and heavily disturbed systems. The guidelines describe slightly to moderately disturbed ecosystems as ecosystems in which aquatic biological diversity may have been adversely affected to a relatively small but measurable degree by human activity.

For the purposes of this assessment the ANZECC guideline values for a slightly to moderately disturbed ecosystem are considered to be appropriate considering the nature of the catchment, pertaining to a 95% level of species protection for a freshwater ecosystem. This is considered to be conservative given the land use and heavily modified nature of the site, but acknowledges the environmental values of the adjacent land.

Table 9 provides a summary of the adopted criteria for the analytical suite. Only analytes for which high or moderate reliability trigger values are available and that were detected above the laboratory limit of reporting (LOR) have been included. There are six metals for which hardness modified trigger values (HMTV) are available in the ANZECC (2000) guidelines (Cd, Cr, Cu, Pb, Ni, Zn; Table 3.4.3), which recognize the lower toxicity of these metals with increasing hardness. The hardness modification is calculated according to the specific hardness value for each sample, hence HMTV have not been included in Table 9 but are discussed in the section 4.5.3.

Table 9: ANZECC Criteria for Groundwater Samples

Group	Analytes	95% Protection of Species Fresh Water (µg/L)
Metals & Metalloids [1]	Aluminium [2]	55
	Arsenic	13 [3]
	Cadmium	0.2
	Chromium VI	1.0 [4]
	Copper	1.4
	Lead	3.4
	Mercury (inorganic)	0.6
	Nickel	11
	Silver	0.05
	Zinc	8.0 [4]
Non-Metallic Inorganics	Ammonia	900 [4,5]

[1] Trigger values for metals apply to bioavailable (soluble) fraction of total concentrations (filtered samples).

[2] Criterion only applies for pH>6.5

[3] Criterion is for Arsenic V, this is the more conservative of the Arsenic trigger values. Where this is exceeded the criterion of 24 µg/L for Arsenic III should be considered when interpreting the results.

[4] Figure may not protect key test species from chronic toxicity (this refers to experimental chronic figures or geometric mean for species) – check Section 8.3.7 of ANZECC 2000 guidelines for spread of data and its significance.

[5] Ammonia trigger value corresponds to a water pH of 8.0, and must be adjusted when different pH values are recorded.

4.5.2 Quality Assurance and Quality Control

The quality of the groundwater analytical data was assessed in terms of the data quality indicators described in Section 3.3. The full data validation report is provided in APPENDIX F, with the key points summarised below:

- The majority of calculated relative percent difference (RPD) values between primary and duplicate/triplicate groundwater samples were within acceptable tolerance limits. The one exception was the RPD value (60%) for dissolved iron between primary sample GABH02 (0.08 mg/L) and triplicate sample QC201 (0.02 mg/L). However, the reported concentrations are relatively low, and there is no water quality criterion for iron, so the RPD exceedance is not considered to have affected the integrity of the data set;
- Analyte concentrations in travel blanks and rinsate blanks were below the laboratory LORs;
- Travel spike recovery values were within the acceptable tolerance ranges; and
- The majority internal QA/QC checks routinely performed by the laboratories, including the assessment of spikes, blanks, duplicates and surrogates, were within acceptable tolerance limits. The few non-conformances identified were marginal, and are typically associated with internal “dynamic control limits” that are more conservative than the default tolerance limits adopted by Golder. Review of the individual non-conformances has indicated that

Overall Golder is satisfied that the data is suitable for environmental interpretive use.

4.5.3 Groundwater Analytical Results

Groundwater samples were collected from 21 wells between 17 and 25 August 2011. At the time of sampling GMW107 was found to be dry, and GMW102 and GMW106 only contained enough water for a measurement of field water quality parameters. The water quality results summary table is presented as Table E1, APPENDIX E, and copies of laboratory certificates of analysis are included in APPENDIX G.

In the following discussion of groundwater quality, well locations have been grouped into the following representative water types for consideration of certain results:

- Upgradient and cross-gradient wells (shallow sandstone): GMW101 to GMW107;
- Downgradient (shallow sandstone): GMW108D, GMW109D, GMW110, GMW111, GABH01, GABH02, GABH03, GABH04, GABH05, GABH06D; and
- Downgradient (alluvium/ colluvium): GMW108S, GMW109S, GABH06S and BH6.

In addition, the results of recent surface water samples from Dapto Creek, and a leachate sample collected from the influent sump adjacent to the leachate ponds have been referenced for comparison purposes.

4.5.3.1 Groundwater Quality Field Parameters

The measured field water quality parameters from the upgradient and cross-gradient wells were generally indicative of low salinity, oxidising water with a mildly acidic pH. In comparison, the wells installed downgradient of the landfill cells (both within the alluvium and shallow sandstone), the pH values were approximately one unit higher, the EC values were approximately 2000 µs/cm higher, and the DO values were approximately 1 mg/L lower. These subtle changes in water quality indicator parameters may suggest minor leachate impact on groundwater quality downgradient of the existing landfill cells.

The downgradient pH and EC values are consistent with the range of values reported for the licensed groundwater monitoring points BH1 and BH3, which are located down hydraulic gradient from the landfill cells, and BH4A, BH5A and BH6A which are reported to be located to the immediate south of the southern leachate pond.

4.5.3.2 Laboratory Analytical Results

Major Cations and Anions

Major cations (Ca^{2+}, Mg^{2+}, K^{+} and Na^{+}) and anions (SO_4^{2-}, CO_3^{2-}, HCO_3^{-} and Cl^{-}) were analysed to characterise the general groundwater chemistry across the site. Water types are classified according to the major ion concentrations expressed as milliequivalents per litre (meq/L), with only ions comprising greater than 20% of the total being considered in the classification. The summary of water types is presented in Table 10 below.

Table 10: Summary of Chemical Water Types

Sample ID	Water Type
GMW103	Ca-Na-Mg-Cl-HCO3
GMW104	Na-Ca-Mg-HCO3-Cl
GMW105	Na-Ca-HCO3-Cl
GMW108S	Na-Mg-Ca-Cl-HCO3
GMW108D	Na-Mg-Cl-HCO3
GMW109S	Na-Ca-Mg-Cl-HCO3
GMW109D	Na-Ca-Mg-Cl-HCO3
GMW110	Na-Mg-Cl-HCO3
GMW111	Na-Mg-Cl-HCO3
GABH01	Na-Mg-Ca-Cl-HCO3
GABH02	Na-Mg-Ca-Cl-HCO3
GABH03	Na-Ca-Mg-Cl-HCO3
GABH04	Na-Mg-Ca-Cl
GABH05	Na-Mg-Ca-Cl-HCO3
GABH06S	Na-Cl-HCO3
GABH06D	Na-Cl-HCO3
BH6	Na-Mg-Cl-HCO3

In general, the samples exhibit a dominant sodium chloride signature, with lesser proportional concentrations of calcium, magnesium and bicarbonate also present. The groundwater signature likely reflects the typical sodium chloride signature of rainfall close to the coast. Bicarbonate is potentially attributable to a combination of dissolution of carbonate minerals in the rock matrix, and from the influence of landfill leachate in which bicarbonate is generated as a byproduct of organic matter decomposition.

These results are presented graphically in a Piper Diagram (Figure 4.1), which is a plot of the relative percentage of the various major ions in each sample. The Piper plot indicates a relatively tight cluster of cation compositions, and anion compositions ranging between chloride and bicarbonate dominant. The results of recent surface water sampling from Dapto Creek, and from the leachate collection well, have been included in the plot for reference. In general, the Piper plot indicates relatively similar water types between the upgradient, downgradient and creek water samples, and a leachate signature that is relatively distinct from the water samples. Hence, any leachate influence on groundwater or surface water quality is inferred to be limited.

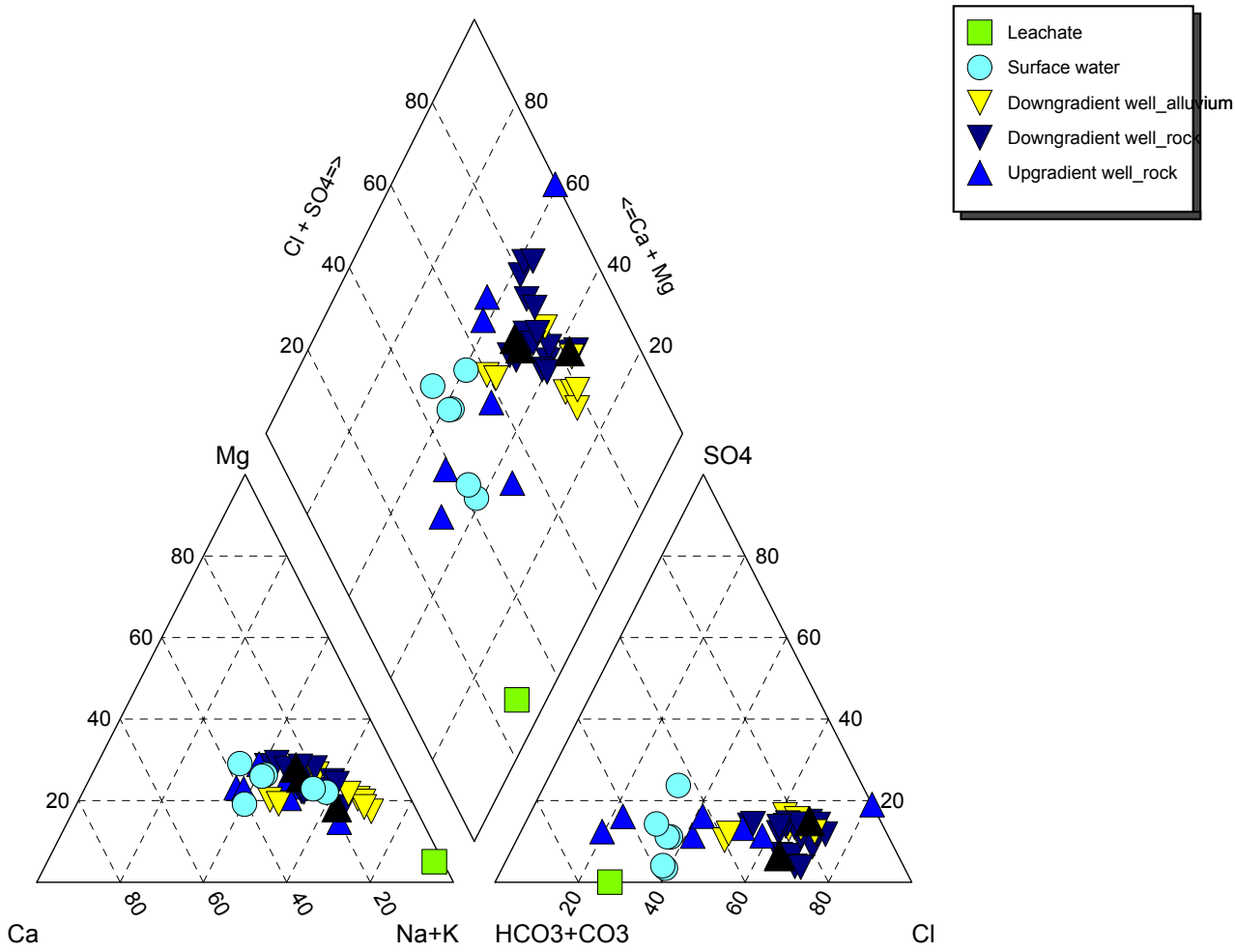


Figure 4.1: Piper Diagram of upgradient and downgradient groundwater samples, creek samples and leachate.

A bivariate plot of EC versus total alkalinity is presented in Figure 4.2, with a roughly linear relationship evident with increasing EC and alkalinity values. The leachate sample has been omitted from this plot due to scale, but would appear in the extreme upper right corner of the plot approximately in line with the linear trend indicated by the water samples. This plot indicates that whilst the upgradient and cross-gradient well locations and creek sample locations have a greater *proportional* concentration of bicarbonate than the downgradient wells (as reflected in the Piper plot), the downgradient wells have greater *absolute* concentrations of alkalinity and EC. This trend suggests a leachate influence on groundwater quality down hydraulic gradient from the filled gullies.

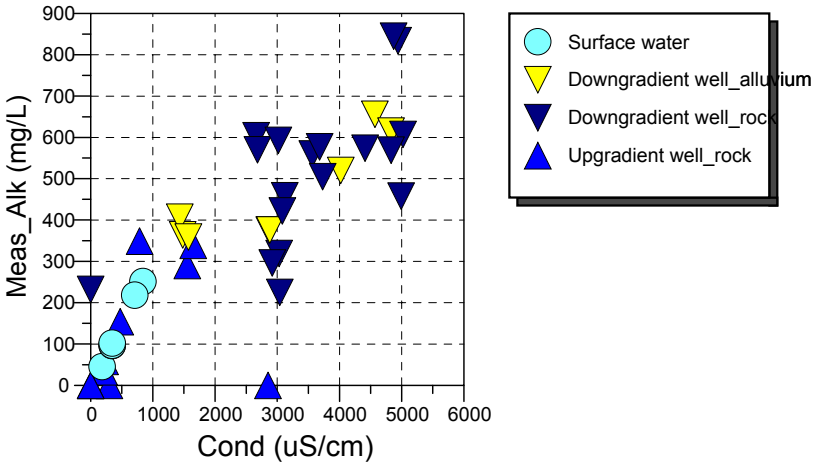


Figure 4.2: Bivariate plot of electrical conductivity versus alkalinity.

Metals and Metalloids

A suite of dissolved metals and metalloids was analysed for each sample, which indicated generally low concentrations of most dissolved metals with many below the laboratory LOR. There were a number of minor exceedances of the ANZECC (2000) trigger values. However, when the hardness modification was applied to the assessment criteria for the relevant six metals for each of the samples, the only metals concentrations that still exceeded their criterion were aluminium at GMW105 (which is a marginal exceedance) and manganese at GMW109S.

Hence, the concentrations of metals and metalloids in groundwater are generally acceptable with reference to the ANZECCC (2000) criteria, and do not appear to be negatively influenced by the historical landfill operations.

Nutrients, TOC and BOD

Nitrogen-based nutrients, TOC and BOD were analysed to provide an indication of potential leachate impact to groundwater. In general, nitrate and nitrite concentrations were either low or below the laboratory LOR across the site. It is noted that an errata slip issued with the ANZECC (2000) guidelines indicated that trigger values for nitrate should be deleted and replaced with “under review”; no new nitrate criteria have been issued to date.

Ammonia and TKN concentrations were also generally low or below the laboratory LOR across the site, with the following notable exceptions:

- The highest ammonia and TKN concentrations were reported for well GMW109S, which is located just outside the site boundary in the southwest corner of the site, down hydraulic gradient from the stormwater dam. Review of preliminary results of more recent monitoring confirmed the elevated concentrations. It is unusual that these concentrations appear on the site boundary when they are not reflected in results from upgradient alluvial wells located closer to the landfill cells and leachate ponds. It is possible that seepage from the stormwater dam is contributing to this groundwater quality issue, however the ammonia concentration is higher than those reported for the licensed stormwater dam monitoring point. Anecdotal information suggests that a sewer main may also be present in the road alignment close to the location of GMW109S, and a leak from a sewer main also result in an elevated ammonia concentration. The ammonia concentration is slightly higher than the pH-adjusted ammonia criterion for this location, and should be re-evaluated following future monitoring events to assess whether this is a persistent or transient phenomenon;
- An anomalously high TKN concentration was reported for GMW101, which is upgradient from the northern extent of landfilling in the western gully. This well was found to be dry during a recent

monitoring event, but will be re-evaluated during future monitoring if/when sufficient water is present to collect a sample;

- Elevated TOC concentrations were reported for:
  - GMW101 at a concentration of 23 mg/L. As with the elevated TKN concentration, the TOC concentration in upgradient well GMW101 is suspect as impact from landfill operations would not be anticipated upgradient from the landfill cells. This will be re-evaluated during future monitoring events;
  - GMW109S at a concentration of 16 mg/L, which is notably higher than concentrations reported for the rest of the site. This correlates with the elevated ammonia and TKN concentrations for this location, and suggests that leakage or overflow from the stormwater dam may have contributed to the presence of leachate indicator parameters at this location. Results of recent monitoring indicate that the TOC concentration at this location had dropped below the laboratory LOR (<1 mg/L), such that the August 2011 result may have been a temporary spike; and
- The only reported detections of BOD above the LOR were in GMW110 and GMW111 at concentrations of 5 mg/L in both wells. While the presence of detectable BOD at these locations suggests a leachate impact to groundwater quality, they are sufficiently low to not be considered a significant risk to groundwater quality. As a basis for comparison, the BOD concentration in a recently analysed leachate sample was 1,430 mg/L.

Volatile and Semi-volatile Organic Analytes

The majority of organic analytes were below the laboratory LOR, and detect concentrations above the LOR were below the ANZECC criteria where available. The organic analytes detected above the LOR are summarised below:

- Chloroform was reported at a concentration of 3 µg/L in triplicate sample QC201. This compound was reported as being below the laboratory LOR (5 µg/L) for the parent sample (GABH02) and duplicate sample (QC101). There is no ANZECC criterion available for chloroform, but the concentration is very low and is not considered to be of concern at the site. The presence of chloroform will be evaluated during future monitoring;
- The phenolic compounds 2-methylphenol and 2,4-dimethylphenol were detected at concentrations of 0.5 µg/L and 0.7 µg/L, respectively, in GMW104. There are no ANZECC criteria available for these compounds, but the concentrations are very low and are not considered to be of concern at the site. The presence of these compounds will be evaluated during future monitoring;
- Naphthalene was detected at a concentration of 0.4 µg/L in GMW111. This concentration is below the ANZECC criterion of 16 µg/L. Naphthalene was also detected at a concentration of 6.2 µg/L in a recent leachate sample. GMW111 is located to the west of the northern leachate pond, and the presence of naphthalene at this location suggests a minor impact to groundwater quality from leachate. However, the concentration is not considered to be indicative of a significant risk to groundwater quality. It is further noted that naphthalene was below the laboratory LOR in more recent monitoring (December 2011). The presence of naphthalene will be evaluated during future monitoring;
- Total xylene (sum of meta-, para- and ortho- isomers) was detected at a concentration of 6 µg/L in GABH02. This concentration is below the ANZECC criteria of 200 µg/L (meta- and para-xylene) and 350 µg/L (ortho-xylene). Total xylene was also detected at a concentration of 34 µg/L in a recent leachate sample. GABH02 is located a short distance downgradient from the western gully landfill cell, and is approximately 50 m east of the northern leachate pond. The presence of xylene at this location suggests a minor impact to groundwater quality from leachate. However, the concentration is not considered to be indicative of a significant risk to groundwater quality. It is further noted that xylene was below the laboratory LOR at all wells during more recent (December 2011) monitoring. The presence of xylene will be evaluated during future monitoring;

- TPH detections were reported as follows (similar concentrations were reported for the equivalent carbon ranges for the TRH analyses):
  - C_6-C_9 fraction in GABH02 (30 µg/L) – this correlates to the xylene detections reported above;
  - C_{15}-C_{28} carbon range in GMW110 (430 µg/L) and GMW111 (1090 µg/L);
  - C_{29}-C_{36} carbon range in GMW111 (770 µg/L);
  - Elevated TPH concentrations were also reported in a recent leachate sample, and the presence of TPH in groundwater at these locations suggests a minor impact to groundwater quality from leachate; and
  - A review of more recent monitoring results (December 2011) indicated that TPH was below the laboratory LOR at these locations, suggesting this may be a temporary or transient issue.

The presence of what are predominantly trace concentrations of VOCs and SVOCs in groundwater downgradient from the landfill cells and in proximity to the leachate ponds suggests a degree of leachate impact to groundwater quality in these areas, although the absence of some of these compounds during the most recent monitoring event may suggest that they were a transient phenomenon. Most analyte concentrations were very low (i.e. close to the LOR), however the TPH concentrations in groundwater in the vicinity of the leachate ponds warrant close scrutiny during future monitoring events. Whilst the concentrations are significantly lower than those reported for raw leachate, and the concentration had dropped below the laboratory LOR in subsequent monitoring, the locations of GMW110 and GMW111 are outside the western site boundary. The presence of TPH should be evaluated during future monitoring to assess whether detectable concentrations return, and whether further assessment is warranted to evaluate whether these concentrations represent a risk to potential receptors.

It is worth noting that all TPH fractions were below the limit of reporting for surface water samples collected from downstream locations in Dapto Creek.

4.5.4 Summary of Groundwater Quality

Groundwater quality at the site differs slightly between wells installed upgradient and cross-gradient from the current landfill cells, which exhibit limited (if any) influence from landfill leachate, and those installed downgradient from the landfill cells and related infrastructure that exhibit a degree of impact from landfill leachate. Whilst the concentrations of most leachate indicator parameters are relatively low in the groundwater samples, there is an increasing concentration trend between the upgradient and downgradient wells, as summarised in Table 11.

Table 11: Summary of Leachate Indicator Parameters by Water Type (average concentrations)

Analyte	Units	Shallow Rock		Alluvium	Surface Water	Leachate [3]
		UG [1]	DG [2]			
pH	-log{H}	5.7	6.7	6.6	7.3	8.1
ORP	mV	82	145	31	209	-33
EC	µS/cm	1440	3860	3223	463	22,700
DO	mg/L	3.1	2.4	2.9	7.5	2.4
Total Alkalinity (as CaCO3)	mg/L	232	524	490	135	7060
Ammonia as N	mg/L	0.03	0.03	1.63	0.28	0.69
TKN as N	mg/L	0.2	0.41	1.03	2.65	17.7
TOC	mg/L	8.7	2.5	9.0	12	1780
BOD	mg/L	<2	<2	<2	3.7	1430

1. UG = upgradient wells
2. DG = downgradient wells
3. Leachate data from pond influent sample collected in December 2011

The majority of water quality analytes detected above the laboratory LOR are below the relevant ANZECC (2000) assessment criteria, where available. The groundwater quality issues of primary interest appear to the the presence of organic compounds in groundwater at boundary monitoring wells GMW110 and GMW111 (naphthalene and TPH), and the presence of leachate indicator parameters at elevated concentrations at boundary monitoring well GMW109S (ammonia, TKN and TOC). These issues will require close scrutiny during future monitoring events to assess whether the concentrations are persistent over time, and whether they represent a potential risk to off-site receptors.

With regards to surface water quality in Dapto Creek, a previous study (Beardsmore and Ganjayia, 2006) identified elevated concentrations of total N, TKN, nitrate and nitrite, and ammonia at a surface water sampling location downstream from the site, and attributed this to "…ground water seepage and runoff from Whytes Gully Waste Disposal Site". The data and monitoring locations were compared to more recent (December 2011 and January 2012) surface monitoring data collected both upstream and downstream from the site. The general observation from the more recent monitoring results is that overflow into the surface drain from the stormwater pond is a more likely source of surface water quality impacts to Dapto creek than groundwater seepage. In addition, there were several instances where concentrations of these analytes were more elevated in the upstream sample location than downstream, suggesting that the rural land uses in the vicinity of the site also potentially contribute to water quality impacts in Dapto Creek.

4.6 Environmental Values of the Local Groundwater Resource

The environmental values of a groundwater resource relate to the human and ecological uses of the resource, and include values that are commonly referred to as the 'beneficial uses' of the groundwater resource.

The relevance of various potential environmental values to the project were considered on the basis of the on-site and adjacent land uses, water supply development in the vicinity of the site, and whether environmental features were present on or around the site that could potentially be considered as receptors for groundwater flowing off-site. On this basis, the following environmental values were considered to be potentially relevant to the site and warranted further consideration:

- Drinking water supply;
- Groundwater users (primary industry use and industrial use); and
- Groundwater Dependant Ecosystems.

4.6.1 Groundwater Users (Domestic and Commercial)

A search of the NOW registered bore database (via the web-based NSW Natural Resources Atlas) identified nine licensed groundwater bores within a 1 km radius of the site. It should be noted that the records relate to wells located to the northwest, and northeast of the site (up hydraulic gradient) and are authorised for a range of uses including domestic stock, irrigation stock and one town water supply test bore. It is, however, uncertain whether local businesses or residents down hydraulic gradient from the landfill are using groundwater for commercial (i.e. golf course watering, etc) or domestic water supply purposes. The limited number of registered bores down hydraulic gradient from the site did not suggest significant development of the groundwater resource for domestic or commercial purposes.

The groundwater quality reported in these records is generally fresh to mildly brackish. It should be noted, however, that these records provide general indications only as there is limited salinity records for these wells and the wells they are located 200 m to 950 m from the site. The available information pertaining to these wells is summarised in Table 12.

Table 12: Summary of licensed groundwater wells within 1 km of the site

Well ID	Purpose	Year Installed	Depth (m)	SWL (m)	Water Bearing Zones (m)	Salinity (ppm)	Approx Distance & Direction from Site
GW102523	Domestic Stock	1999	102.00	-	0.00-102.00	-	950 m NW
GW105699	Domestic	2004	132.00	113.00	11.50-12.00	-	900 m NW
GW103624	Domestic Stock	2001	60.00	12.00	34.50-36.00	1340	450 m NW
GW012581	Stock	1956	37.10	4.20-7.60	11.50-19.70 31.30-34.60	501-1000	350 m NW
GW017768	General Use Stock	1959	9.10	1.30	4.80-5.70 6.70-9.10	Good	400 m WNW
GW013023	Domestic Stock	1956	15.20	0.90	6.40-6.70 10.90-11.80	-	700 m NNE
GW017381	Irrigation Stock	-	31.30	13.40	15.80-15.90 26.80-28.30	-	400 m NNE
GW016480	Stock	1983	41.00	-	-	-	200 m NE

Well ID	Purpose	Year Installed	Depth (m)	SWL (m)	Water Bearing Zones (m)	Salinity (ppm)	Approx Distance & Direction from Site
GW075139	Town Water Supply (Test Bore)	2006	193.00	15.00	15.00-16.00 66.00-67.00 93.00-94.00 102.00-103.00 126.00-127.00 156.00-157.00 162.00-163.00 192.00-193.00	-	300 m E

4.6.2 Groundwater Dependent Ecosystems

Groundwater dependent ecosystems (GDEs) are ecosystems that are wholly or partially dependent on groundwater for their biodiversity and natural ecological processes. The following actions were undertaken to assess the potential presence of high-value GDEs in the vicinity of the site:

- Review of the locations of identified high-value GDEs presented in the recently commenced macro Water Sharing Plan (WSP) for the Greater Metropolitan Region (NOW, July 2011);
- A direct enquiry with NOW regarding their draft state wide GDE catalogue; and
- Review of the results of an ecological survey of the site (Biosis, 2012).

Information from NOW indicated that there were no known high-value GDEs within at least 10 km of the site. In addition, the Biosis (2012) ecological survey concluded that no GDEs were present within or in the vicinity of the site. Hence, GDE's were not considered to be a relevant environmental value for groundwater in the vicinity of the site and were not considered further.

4.7 Summary of Conceptual Hydrogeological Model

The results of the historical data review and recent investigation have been combined to refine the conceptual hydrogeological model for the site, with particular regard to issues related to the design of the new cells.

The current investigation confirmed and expanded on the characterisation of the two shallow groundwater systems considered to be of greatest relevance to the site:

- **Shallow unconsolidated sediments** hosting a perched water system. This hydrostratigraphic unit is generally comprised of surficial fill material, alluvium and colluvium, and is only present in the southern portion of the site (note: this definition does not include leachate present within the current landfill cells). This unit is inferred comprise the buried southerly extension of the landfilled eastern and western gullies; and
- **Shallow weathered rock aquifer** hosting water that has either infiltrated from the unconsolidated sediments, or that originated as recharge further up on the escarpment. This hydrostratigraphic unit is generally comprised of residual soil and underlying weathered and fractured sandstone and siltstone. This unit comprises the shallowest water bearing unit in the northern portion of the site, and is buried beneath the alluvial/colluvial sediments in the southern portion of the site. The interval of primary interest is the transition zone between residual soil and competent rock, comprising extremely to moderately weathered sandstone and siltstone with a high fracture frequency.

4.7.1 Groundwater Depth and Flow Direction

The potentiometric analysis indicated that groundwater flow generally conforms to local topography, with a flow direction predominantly towards the southwest. Groundwater in the steeply sloping terrain in the northern portion of the site is characterised by a steep hydraulic gradient and a greater depth to groundwater than in the southern portion of the site. Anecdotal evidence from historical investigation reports indicates that springs were previously present in the eastern and western gullies. This is a relatively common hydrogeological occurrence in steeply sloping terrain where the water table “daylights” either along a plane of contact with a low permeability geological unit, or at changes in slope. Whilst the upward hydraulic gradient implied by the presence of springs would act to reduce the potential for deep drainage of leachate into the underlying geology, it would also have presented a water management challenge for the cells constructed within the gullies in terms of controlling ingress to the waste and attendant leachate production.

In contrast to the northern portion of the site, the hydraulic gradient is considerably flatter below the alluvial plain in the southern portion of the site. The influence of the substantial hydraulic head gradient in the north of the site is reflected in an upward hydraulic gradient between the buried weathered sandstone water bearing zone and the overlying alluvial and colluvial deposits. This gradient should act to reduce the potential for deep drainage of leachate into the bedrock geology. The depth to groundwater in the alluvial/colluvial sediments is considerably shallower than in the northern portion of the site, with most locations reported a depth to groundwater between 1 and 2 mbgl. In particular, the shallowest depth to groundwater in the proposed cell footprint at the toe of the filled gullies is approximately 1 mbgl. Whilst there is a little variation between monitoring locations in this area, the potential shallow water table in this area will require consideration in terms of establishing base levels for the cell, to prevent groundwater pressure on the base of the liner and to maintain the desired separation between the water table and the base of waste as specified in the BPEM.

4.7.2 Groundwater Quality and Beneficial Uses

The groundwater quality assessment identified a degree of leachate impact to groundwater quality in the southern portion of the site. A number of leachate indicator parameters were observed to be elevated in the wells downgradient from the landfill cells relative to the upgradient wells, although most of these were still below the relevant assessment criteria, where available. Elevated concentrations of organic analytes and leachate indicator parameters were identified in three downgradient boundary monitoring wells, although some of these dropped below the laboratory LOR during the most recent monitoring event. These concentrations should be closely monitored during future monitoring events to assess their persistence, and whether they represent a potential risk to downgradient groundwater receptors.

Based on the relatively low permeability values indicated by hydraulic testing, and brackish baseline water quality, there appears to be limited beneficial use potential for the groundwater resource associated with the alluvial deposits and underlying weathered sandstone aquifer. There are a number of registered private bores located to the north of the site accessing both shallow and deep groundwater resources; however there is very limited groundwater supply development downgradient from the site (which is consistent with the limited land development to the immediate south of the site). The most relevant environmental value downgradient from the site appears to be the possible aquatic ecosystem associated with Dapto Creek, which may receive baseflow from groundwater in the alluvial deposits. A combined surface water and groundwater monitoring program is recommended to assess whether leachate impact to groundwater in the alluvial deposits is posing an unacceptable impact to the creek.

5.0 IMPLICATIONS OF HYDROGEOLOGICAL INVESTIGATION RESULTS

5.1 Groundwater Monitoring Network

The recently installed groundwater monitoring network appears to provide adequate spatial and vertical coverage of the site to provide a suitable baseline dataset for design purposes, and to facilitate ongoing compliance monitoring during future development of the cell extensions.

The following monitoring program is recommended in order to provide a robust baseline dataset of groundwater quality. This monitoring program should be reviewed following completion of an annual quarterly monitoring cycle to optimise the program based on the observations from the baseline data set (i.e. reduce the frequency and analytical suite to focus on groundwater quality indicators identified as being of relevance to the site).

The following suites of analytes are considered for the proposed monitoring regime:

- General water quality parameters:
  - Field water quality suite (temperature, pH, EC, ORP and DO);
  - Cations and anions (calcium, magnesium, sodium, potassium, chloride, sulphate, fluoride, speciated alkalinity);
- Leachate indicator suite:
  - Nitrate, nitrite, ammonia, total Kjeldahl nitrogen (TKN);
  - Biochemical oxygen demand (BOD);
  - Total organic carbon (TOC);
- Metals and metalloids (aluminium, arsenic, cadmium, chromium, copper, iron, manganese, mercury, nickel, lead and zinc);
- Organic suite - limited (for quarterly monitoring):
  - TPH;
  - Benzene, toluene, ethylbenzene and xylenes (BTEX) + naphthalene;
- Organic suite - extended (for annual monitoring):
  - TPH;
  - VOCs (includes BTEX); and
  - SVOCs (includes PAHs, pesticides, speciated phenols and PCBs).

A proposed monitoring frequency is provided in Table 13. It is noted that the proposed program is in addition to current monitoring undertaken in conjunction with the EPL conditions. Observations to date indicate that some of the organic analytical suites are unlikely to be relevant for ongoing monitoring once the baseline dataset has been established, and would be culled with regard to future monitoring.

In addition, the nominated wells may be modified if new wells are installed, or if a revision to the number of monitoring locations can be rationalised following review of the monitoring results.

Table 13: Proposed Groundwater Monitoring Program for Baseline Water Quality Assessment

Well No.	General Water Quality Suite	Leachate Indicator Suite	Metals and metalloids	Organic Suite - limited	Organic Suite - extended	Rationale for Location
GMW101	Quarterly	Quarterly	Annually	Quarterly	Annually	Upgradient data coverage
GMW103	Quarterly	Quarterly	Annually	Quarterly	Annually	Upgradient coverage - boundary
GMW104	Quarterly	Quarterly	Annually	Quarterly	Annually	Cross-gradient coverage - boundary
GMW105	Quarterly	Quarterly	Annually	Quarterly	Annually	Cross-gradient coverage
GMW106	Quarterly	Quarterly	Annually	Quarterly	Annually	Cross/downgradient coverage
GMW108S	Quarterly	Quarterly	Annually	Quarterly	Annually	Downgradient coverage
GMW108D	Quarterly	Quarterly	Annually	Quarterly	Annually	Downgradient coverage
GMW109S	Quarterly	Quarterly	Annually	Quarterly	Annually	Downgradient coverage - boundary
GMW109D	Quarterly	Quarterly	Annually	Quarterly	Annually	Downgradient coverage - boundary
GMW110	Quarterly	Quarterly	Annually	Quarterly	Annually	Downgradient coverage - boundary
GMW111	Quarterly	Quarterly	Annually	Quarterly	Annually	Downgradient coverage - boundary
GABH01	Quarterly	Quarterly	Annually	Quarterly	Annually	New cell footprint coverage
GABH02	Quarterly	Quarterly	Annually	Quarterly	Annually	New cell footprint coverage
GABH03	Quarterly	Quarterly	Annually	Quarterly	Annually	New cell footprint coverage
GABH06S	Quarterly	Quarterly	Annually	Quarterly	Annually	New cell footprint coverage
GABH06D	Quarterly	Quarterly	Annually	Quarterly	Annually	New cell footprint coverage
BH6^	Quarterly	Quarterly	Annually	Quarterly	Annually	Downgradient coverage - boundary

Note: ^The 2009/10 Annual Monitoring Report describes BH6 as being installed by WCC. BH6 lithology is assumed to be that of BH3 "New Entry Gate" WCC reference W9872, installed by WCC in March 2009. The location and measured depth of BH6 (from 2009/10 Annual Monitoring Report, GHD 2010) are consistent with the bore report and location for BH3.

5.2 Comparison with BPEM

The hydrogeological investigation has provided information relevant to the BPEM hydrogeological considerations for landfill siting. Investigation of the hydrogeological conditions has shown that, in general:

- Whilst the fractured rock aquifer could potentially support domestic water supply, the water quality is marginal based on EC values and the anticipated yield would be relatively low. The alluvial groundwater resource is also considered to be of poor quality and low yielding with regard to potential beneficial uses. A review of registered bores within approximately 2 km of the site indicates limited water supply development, and all of the bores are located either up- or cross-hydraulic gradient from the site. The relative value of the shallow fractured rock aquifer for potable water supply, and the likelihood for substantial water supply development in the foreseeable future, is considered to be low, especially given the moratorium on new entitlements under the Greater Metropolitan Region WSP;
- The base of the landfilled waste in the extension area could be sited at least two metres above the long-term undisturbed depth to groundwater, depending on the depth of excavation option adopted. It is recommended that monitoring of groundwater levels at the site is continued to establish long-term values, particularly in the cell footprint area to the east of the leachate ponds;
- The hydrogeological setting (upward hydraulic gradient, relatively low permeability formations, limited water supply development and no identified GDEs in the vicinity of the site) is conducive to land use for

landfilling operations, and would appear to represent a relatively low risk in the event of a leachate release to groundwater. The clayey nature of the shallow alluvial/ colluvial soils would promote attenuation of leachate constituents in the event of a release, and would likely limit the migration potential of leachate constituents in groundwater;

- The location of the cell footprint is above the flood line associated with the 100 yr ARI storm event, and is therefore not prone to flooding; and
- The proposed extension area is not located within 100 m of surface waters. It is noted however that elements of the existing landfill infrastructure are sited within 100 m of Dapto Creek.

The results of the site investigation are generally consistent with the hydrogeological siting considerations of the BPEM, and indicated that the hydrogeological conditions encountered do not preclude the proposed extension to the existing landfill cells.

5.2.1 Implications for Design

The results of the hydrogeological investigation will be used to inform key issues for landfill design. The implications of the site conditions on landfill design issues will be considered in detail in the conceptual and detailed design documentation and include:

- Depth of Subgrade – consideration of options for extent of excavation with respect to groundwater management requirements. Currently available water level information in the alluvial material in this location suggests a depth to water between 1 and 2 mbgl, with a logged water level in GABH06S at 1 mbgl. There appears to be some variation in the measured depth to water in this area on the basis of preliminary results from recently installed shallow wells, and this will require further detailed analysis when surveyed levels are available to support decisions regarding establishing cell base levels, and assessing whether the requisite two metres clearance can be achieved between the water table and the base of waste as per the BPEM. It is likely that upon commencement of construction of a cell liner in the footprint area, the loss of direct rainfall recharge will result in a modest decline in the water table elevation beneath the cells. However, the potential ongoing contribution of upward groundwater leakage from the underlying weathered sandstone into the alluvial soils may limit the degree of water table depression beneath the cell footprint.
- Slope Stability – consideration groundwater pressure on stability of lining system. Currently the depth to groundwater (or leachate) beneath and within the current landfill cells is not well known, as the monitoring infrastructure within the cells is not considered to be reliable. It would be advisable to install leachate monitoring wells within the cells to assess the actual saturated thickness at the base of the waste to support assumptions in the slope stability analysis.
- Landfill Lining System – the relatively shallow water table in the proposed cell footprint area will require consideration in terms of options evaluation for landfill lining systems and the requirement for a groundwater underdrain. In the event that more detailed monitoring of water table levels in the cell footprint area indicates shallow water levels (either across the base or localised), additional design options to address a shallow water table should be considered.

6.0 REFERENCES

Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) *Australia and New Zealand Guidelines for Fresh and Marine Waters.* ANZECC, Canberra

EPA Victoria (2010) *Best Practice Environmental Management Siting, Design, Operation and Rehabilitation of Landfills*, Publication 788.1, EPA Victoria, Carlton.

Fetter, C.W. (2001) *Applied Hydrogeology – 4th ed.* Macmillan College Publishing Company, New York, NY.

Freeze R and JA Cherry (1979) *Groundwater*, Prentice-Hall, Englewood Cliffs N.J.

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Report Signature Page

GOLDER ASSOCIATES PTY LTD



Lange Jorstad
Principal Hydrogeologist



Ray Hatley
Principal Hydrogeologist

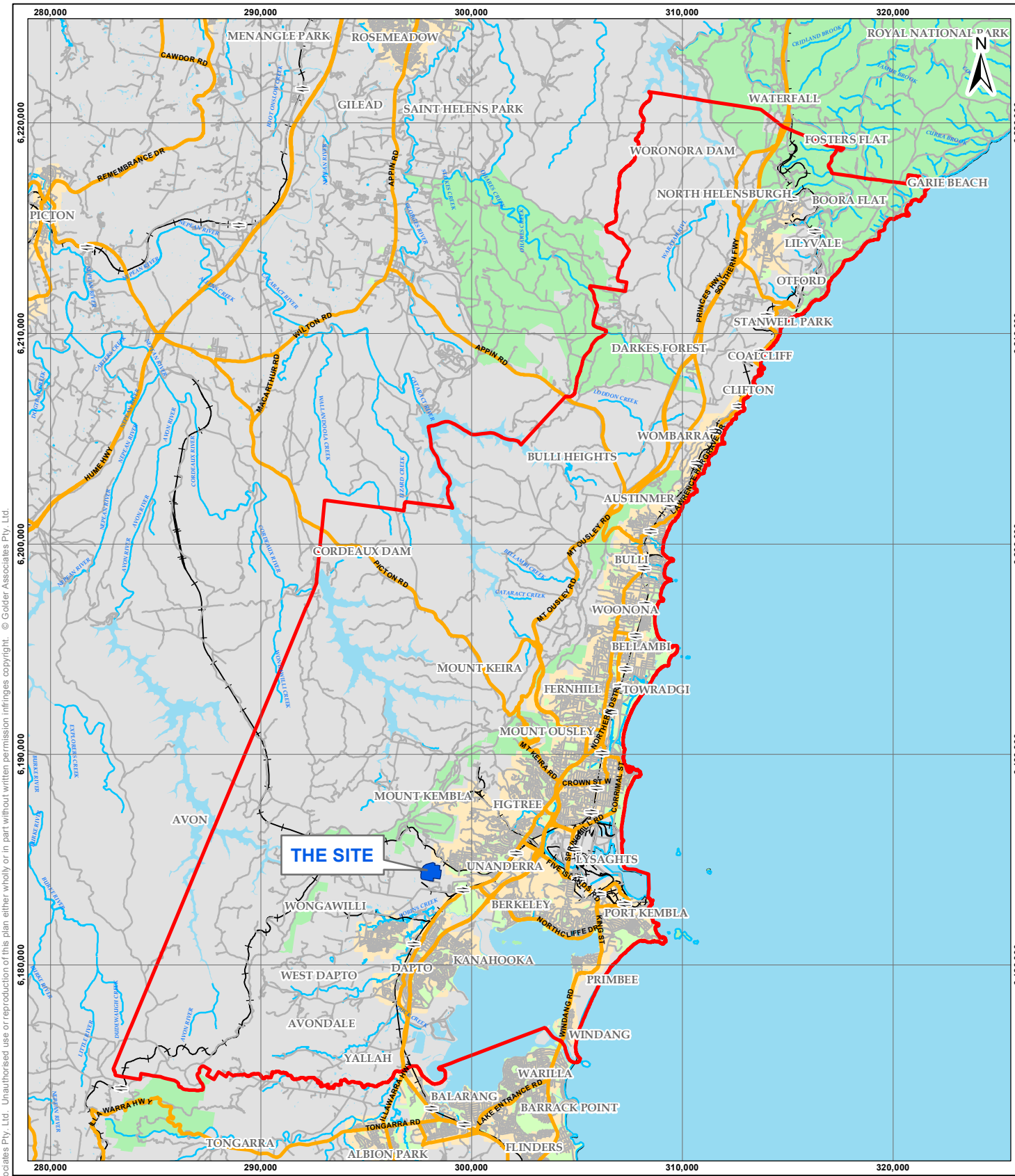
LJ/RH/kd

A.B.N. 64 006 107 857

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APPENDIX A

Figures



HYDROGEOLOGICAL INVESTIGATION REPORT

Wollongong City Council

REGIONAL AREA



LEGEND

- Site Location
- Wollongong Local Government Area Boundary

0 1 2 4 6 8 Kilometres

SCALE (at A4) 1:250,000

Coordinate System: GDA 1994 MGA Zone 56

PROJECT: 117625003
DATE: 14/12/2011
DRAWN: FA
CHECKED: JMc

FIGURE 1

Golder Associates

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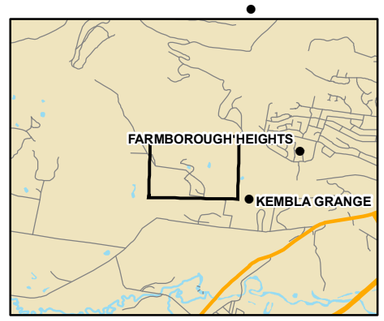
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WHYTES GULLY NEW LANDFILL CELL HYDROGEOLOGICAL INVESTIGATION REPORT

WOLLONGONG CITY COUNCIL

SITE LAYOUT





LEGEND

- Site Boundary
- Final Landfill Footprint
- Approximate Extent Of Waste

NOTES

Historic locations digitised by Golder from reports supplied by Wollongong City Council

Aerial Ortho-Photograph provided by AAM Pty. Ltd. taken on 16 May 2011, Reference 18763A. Image Georeferenced.

0 12.5 25 50 75 100 125 metres

SCALE (at A3) 1:3,800

Coordinate System: GDA 1994 MGA Zone 56

PROJECT:	117625003
DATE:	16/01/2012
DRAWN:	FA
CHECKED:	JMc

FIGURE 2

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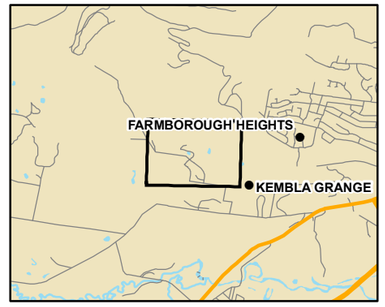
6,184,000

298,000

WHYTES GULLY NEW LANDFILL CELL HYDROGEOLOGICAL INVESTIGATION REPORT

WOLLONGONG CITY COUNCIL

HISTORICAL INVESTIGATION LOCATIONS



LEGEND

- New Cell Floor Investigation Location and Monitoring Well
- Groundwater Monitoring Well
- Borehole Location Phase Two (September 1992)
- Borehole Location Geotechnical Assessment - Proposed Extenstion to Whytes Gully Waste Disposal Depot (WCC, 1991 Ref W5142 & W5276)
- Borehole Location New Cell Floor Geotechnical Investigation, 2010 (Wollongong City Council, June 2010 ref W10441 & W10338)
- Groundwater Spring
- Approximate Extent Of Waste
- Extent_of_Landfill_Works_20120123
- Site Boundary

NOTES

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FIGURE 3

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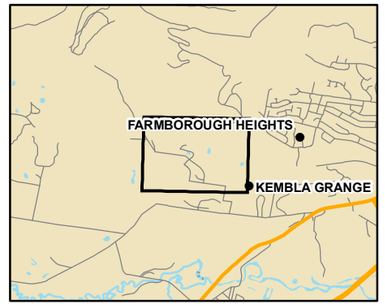
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298,000

WHYTES GULLY NEW LANDFILL CELL HYDROGEOLOGICAL INVESTIGATION REPORT

WOLLONGONG CITY COUNCIL

GEOLOGICAL AREAS



LEGEND

- Site Boundary
- Approximate Extent Of Existing Landfill Boundary
- Extraction Zones (December, 2011)

Geological Area

- Area 1 - Pheasants Nest Formation
- Area 2 - Budgong Sandstone Formation
- Area 3 - Alluvial Soils
- Area 4 - Capping Layer and Landfill

NOTES

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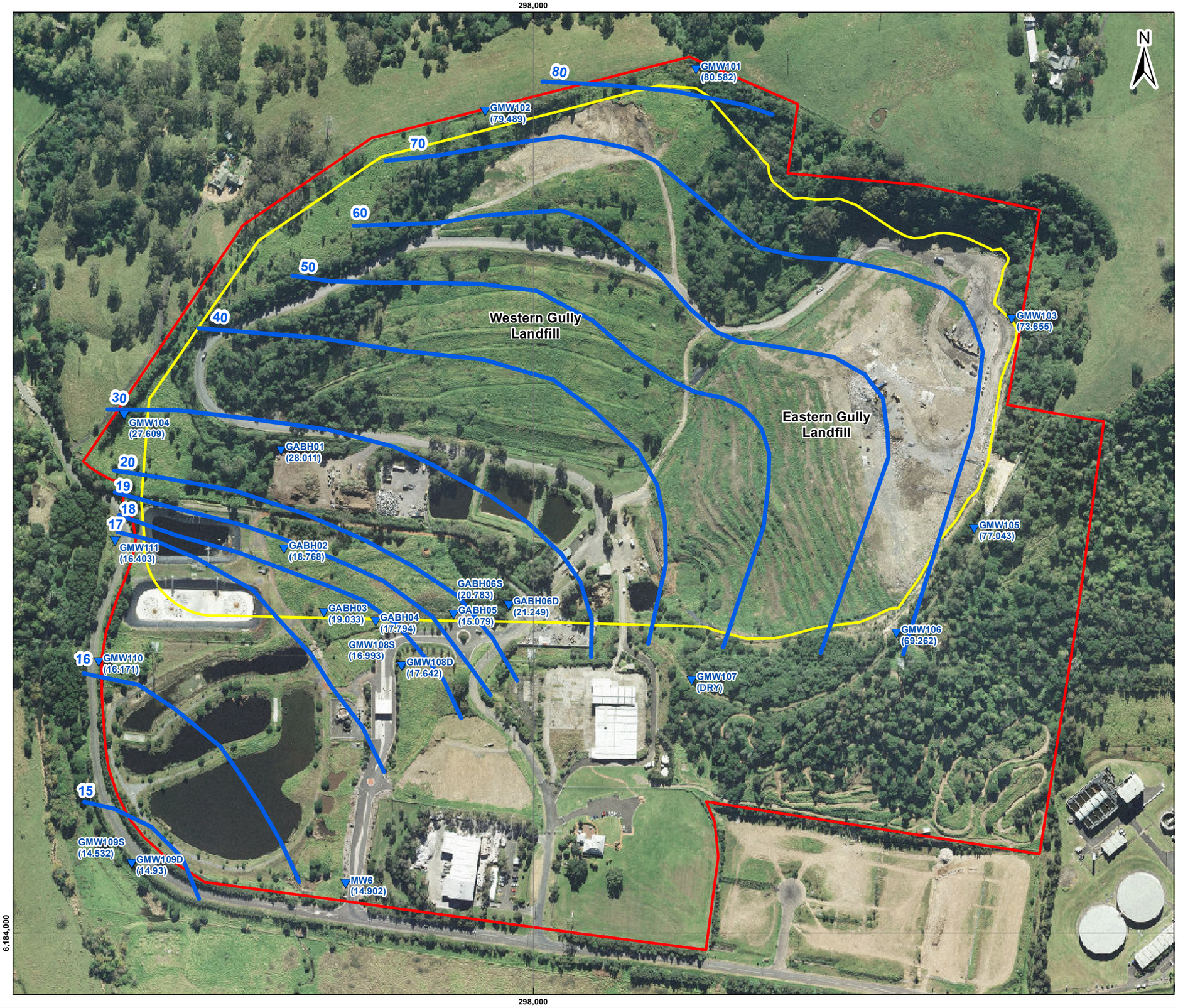
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FIGURE 4

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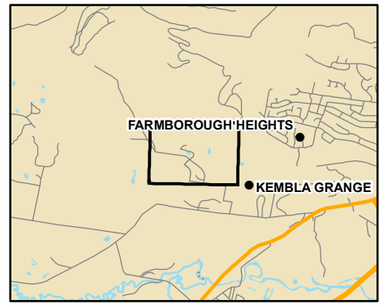


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WHYTES GULLY NEW LANDFILL CELL HYDROGEOLOGICAL INVESTIGATION REPORT

WOLLONGONG CITY COUNCIL

GROUNDWATER CONTOURS



LEGEND

- Groundwater Level (mAHD) - August 2011
- Groundwater Contours
- Site Boundary
- Extent_of_Landfill_Works_20120123

Note: groundwater elevation contours have been estimated by linear interpolation between well locations, with minor adjustments based on professional judgement. Actual groundwater elevations in areas of limited data coverage (e.g. within the existing cells) may differ to an unknown extent from the estimated contour locations presented.

NOTES

Historic locations digitised by Golder from reports supplied by Wollongong City Council

Aerial Ortho-Photograph provided by AAM Pty. Ltd. taken on 16 May 2011, Reference 18763A. Image Georeferenced.

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Coordinate System: GDA 1994 MGA Zone 56

PROJECT: **117625003**
DATE: **23/01/2012**
DRAWN: **RB**
CHECKED: **LBJ**

FIGURE 5

Golder Associates

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APPENDIX B

Borehole lithology and well installation logs

Provided on DVD

APPENDIX C

Hydraulic Testing Analysis

Summary of slug test analysis results

Table 1: Summary of Slug Test Analysis Results

Bore Reference	Transmissivity (m^2/s)	Aquifer Thickness (m)	Hydraulic Conductivity (m/s)
GABH02	$3.7x10^{-5}$	8.10	$5x10^{-6}$
GABH05	$4.6x10^{-5}$	13.10	$4\ x10^{-6}$
GMW104	$1.6x10^{-7}$	3.15	$5x10^{-8}$
GMW105	$3.1x10^{-5}$	2.15	$1x10^{-5}$
GMW108D	$1.0x10^{-4}$	13.45	$7x10^{-6}$
GMW108S	$6.0x10^{-5}$	10.06	$6x10^{-6}$
GMW109D	$2.5x10^{-5}$	9.78	$3x10^{-6}$
GMW109S	$1.0x10^{-4}$	6.99	$1x10^{-5}$

Note that as no unpumped bores were used as observation bores during the hydraulic testing, which is a limitation inherent in the nature of slug testing, the value given for storativity in the analysis is an estimate only. This value has not been optimised or fitted as part of the analysis.

The hydraulic conductivity values show a limited range and are reasonable values expected for a silty sand (Fetter , 2001)

(Full reference: *Fetter, C.W. Applied Hydrogeology – 4th ed. 2001)*

HYDROBENCH REPORT

Project	Whytes Gully
Site	New Landfill Cell
Source Well	GABH02
Test Name	Slug Test
Test Date/Time	22/08/2011, 15:51
Interval	top: 4.70 m bottom: 12.80 m

Basic Data

Test Interval	8.10 m		
Porosity	0.10		
Well Radius	0.025 m	Tubing Radius	0.025 m
Inclination	0.0 deg		
Test Volume	15.904 l		
Well Type	Source		

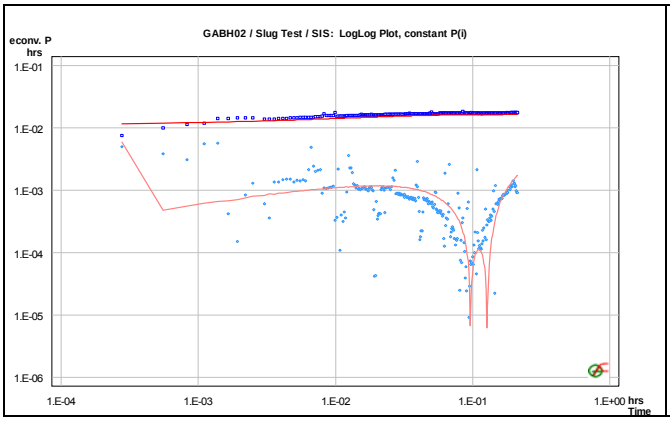
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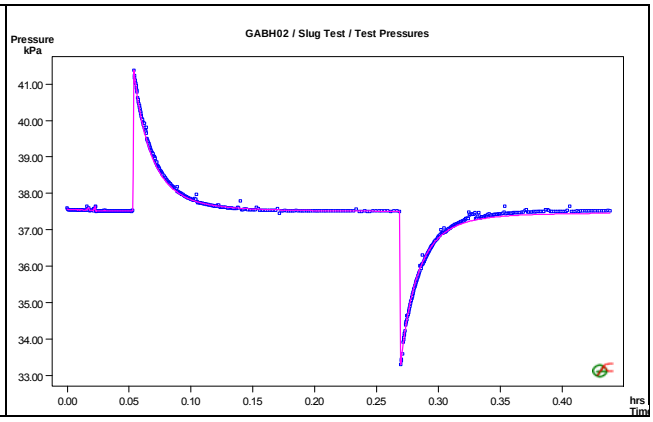
Analysis "GM"

Static Pressure: 37.48 kPa

Shell Parameters:

Name	Transmissivity [m²/s]	Storativity [-]	Radius [m]	Flow Dimension [-]
Shell 1	3.7e-05	1.6e-05	- -	2.0





HYDROBENCH REPORT

Project	Whytes Gully
Site	New Landfill Cell
Source Well	GABH05
Test Name	Slug Test
Test Date/Time	26/08/2011, 11:34
Interval	top: 5.72 m bottom: 18.82 m

Basic Data

Test Interval	13.10 m		
Porosity	0.10		
Well Radius	0.025 m	Tubing Radius	0.025 m
Inclination	0.0 deg		
Test Volume	25.722 l		
Well Type	Source		

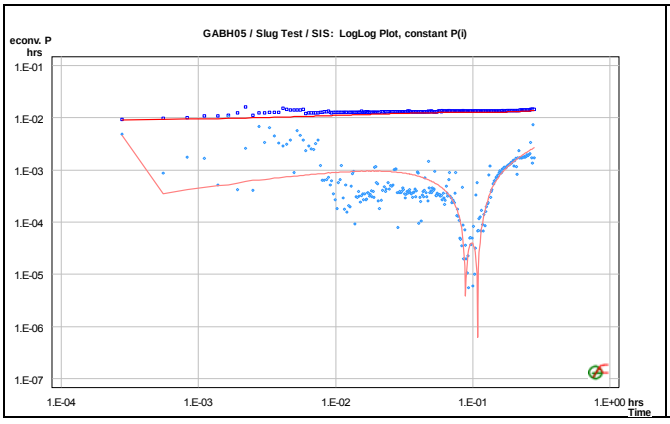
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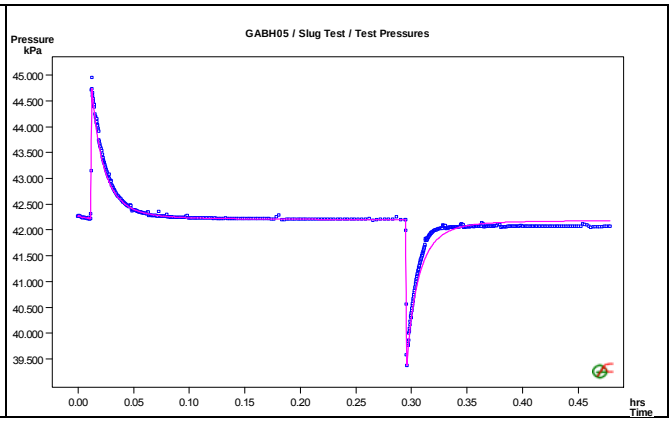
Analysis "SIS"

Static Pressure: 42.19 kPa

Shell Parameters:

Name	Transmissivity [m²/s]	Storativity [-]	Radius [m]	Flow Dimension [-]
Shell 1	4.6e-05	2.6e-05	- -	2.0





HYDROBENCH REPORT

Project	Whytes Gully
Site	New Landfill Cell
Source Well	GMW104
Test Name	Slug Test
Test Date/Time	26/08/2011, 10:44
Interval	top: 6.30 m bottom: 9.45 m

Basic Data

Test Interval	3.15 m		
Porosity	0.10		
Well Radius	0.025 m	Tubing Radius	0.025 m
Inclination	0.0 deg		
Test Volume	6.185 l		
Well Type	Source		

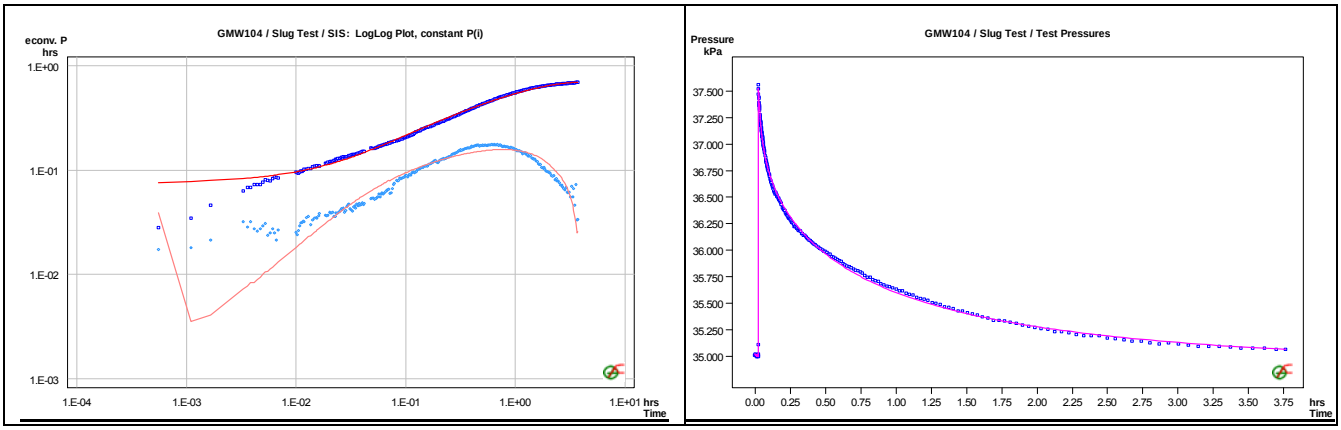
Analysis Results

Analysis "SIS"

Static Pressure: 34.80 kPa

Shell Parameters:

Name	Transmissivity [m²/s]	Storativity [-]	Radius [m]	Flow Dimension [-]
Shell 1	5.3e-06	6.2e-06	4.84	2.0
Shell 2	1.6e-07	6.2e-06	- -	2.0



HYDROBENCH REPORT

Project	Whytes Gully
Site	New Landfill Cell
Source Well	GMW105
Test Name	Slug Test
Test Date/Time	26/08/2011, 13:59
Interval	top: 10.66 m bottom: 12.81 m

Basic Data

Test Interval	2.15 m		
Porosity	0.10		
Well Radius	0.025 m	Tubing Radius	0.025 m
Inclination	0.0 deg		
Test Volume	4.221 l		
Well Type	Source		

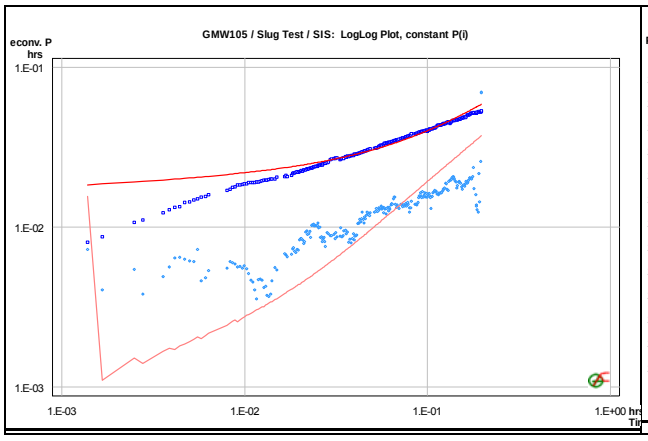
Analysis Results

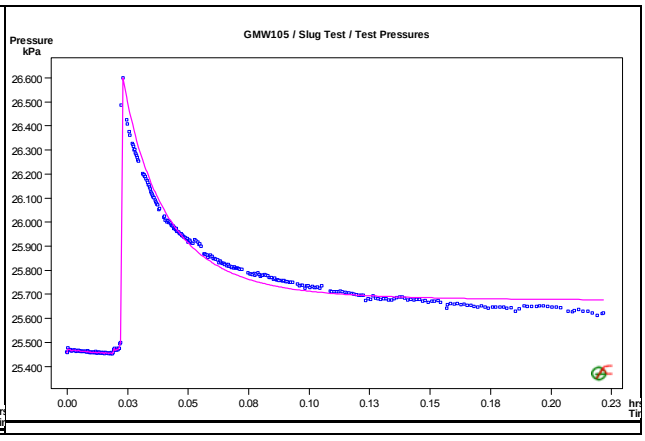
Analysis "SIS"

Static Pressure: 25.67 kPa

Shell Parameters:

Name	Transmissivity [m²/s]	Storativity [-]	Radius [m]	Flow Dimension [-]
Shell 1	3.2e-05	4.2e-06	- -	2.0





HYDROBENCH REPORT

Project	Whytes Gully
Site	New Landfill Cell
Source Well	GMW108D
Test Name	Slug Test
Test Date/Time	22/07/2011, 11:00
Interval	top: 2.05 m bottom: 15.50 m

Basic Data

Test Interval	13.45 m		
Porosity	0.10		
Well Radius	0.025 m	Tubing Radius	0.025 m
Inclination	0.0 deg		
Test Volume	26.409 l		
Well Type	Source		

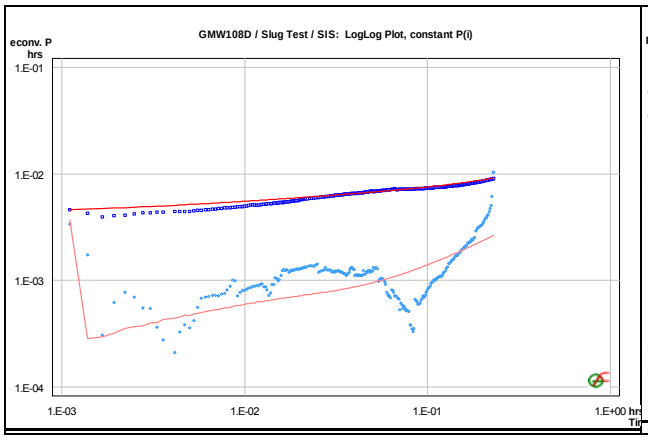
Analysis Results

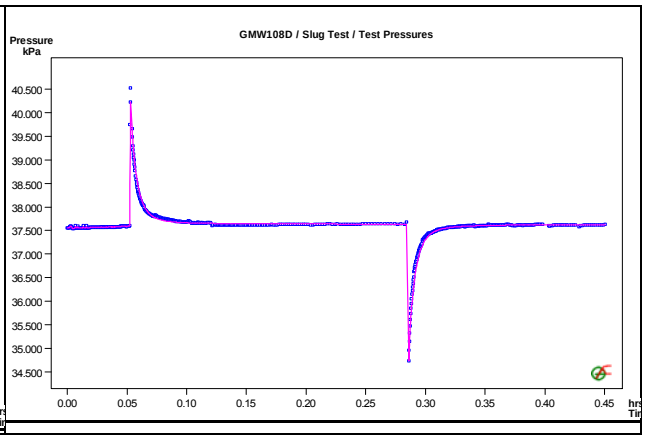
Analysis "HW01"

Static Pressure: 37.63 kPa

Shell Parameters:

Name	Transmissivity [m²/s]	Storativity [-]	Radius [m]	Flow Dimension [-]
Shell 1	1.1e-04	2.6e-05	- -	2.0





HYDROBENCH REPORT

Project	Whytes Gully
Site	New Landfill Cell
Source Well	GMW108S
Test Name	Slug Test
Test Date/Time	22/07/2011, 09:45
Interval	top: 2.54 m bottom: 12.60 m

Basic Data

Test Interval	10.06 m		
Porosity	0.10		
Well Radius	0.025 m	Tubing Radius	0.025 m
Inclination	0.0 deg		
Test Volume	19.753 l		
Well Type	Source		

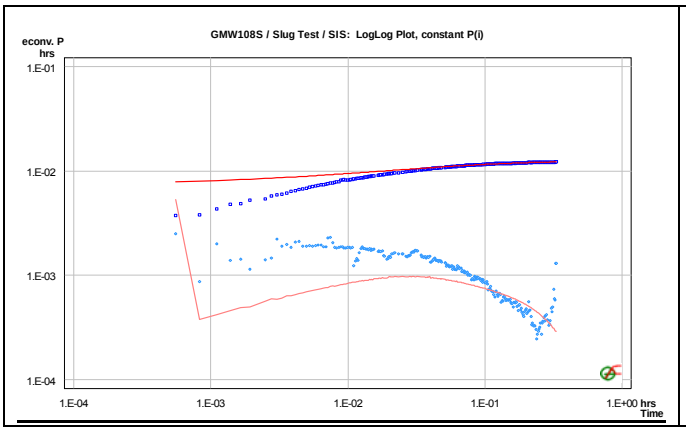
Analysis Results

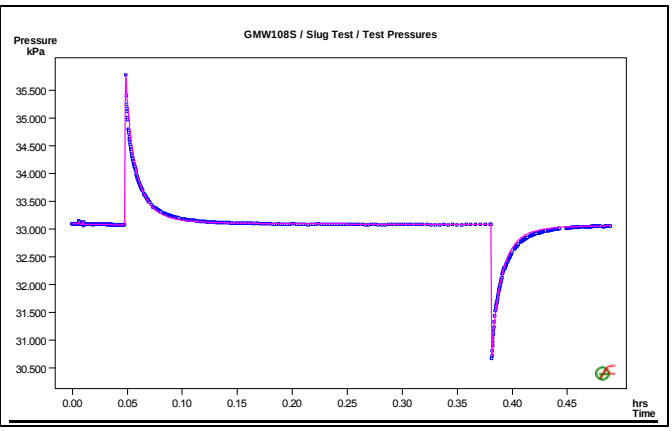
Analysis "HW01"

Static Pressure: 33.08 kPa

Shell Parameters:

Name	Transmissivity [m²/s]	Storativity [-]	Radius [m]	Flow Dimension [-]
Shell 1	5.8e-05	2.0e-05	- -	2.0





HYDROBENCH REPORT

Project	Whytes Gully
Site	New Landfill Cell
Source Well	GMW109D
Test Name	Slug Test
Test Date/Time	26/08/2011, 16:12
Interval	top: 2.86 m bottom: 12.64 m

Basic Data

Test Interval	9.78 m		
Porosity	0.10		
Well Radius	0.025 m	Tubing Radius	0.025 m
Inclination	0.0 deg		
Test Volume	19.203 l		
Well Type	Source		

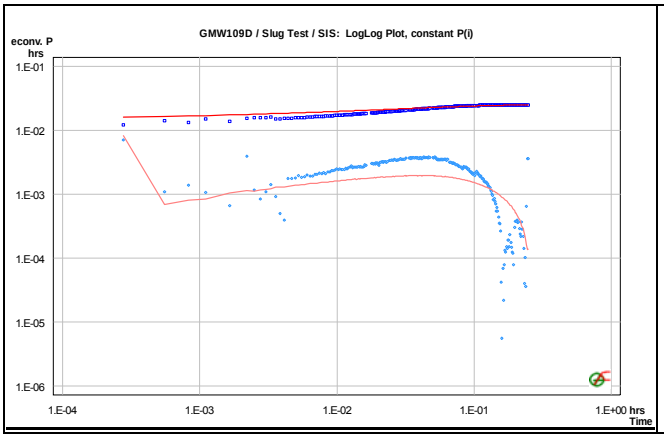
Analysis Results

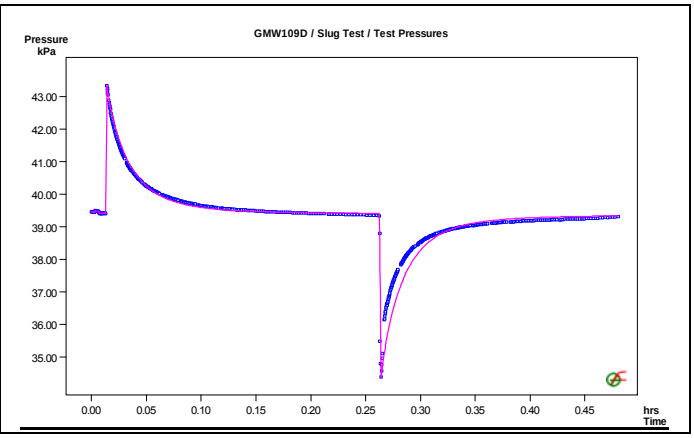
Analysis "HW01"

Static Pressure: 39.37 kPa

Shell Parameters:

Name	Transmissivity [m²/s]	Storativity [-]	Radius [m]	Flow Dimension [-]
Shell 1	2.5e-05	1.9e-05	- -	2.0





HYDROBENCH REPORT

Project	Whytes Gully
Site	New Landfill Cell
Source Well	GMW109S
Test Name	Slug Test
Test Date/Time	26/08/2011, 16:55
Interval	top: 3.15 m bottom: 10.14 m

Basic Data

Test Interval	6.99 m		
Porosity	0.10		
Well Radius	0.025 m	Tubing Radius	0.025 m
Inclination	0.0 deg		
Test Volume	13.725 l		
Well Type	Source		

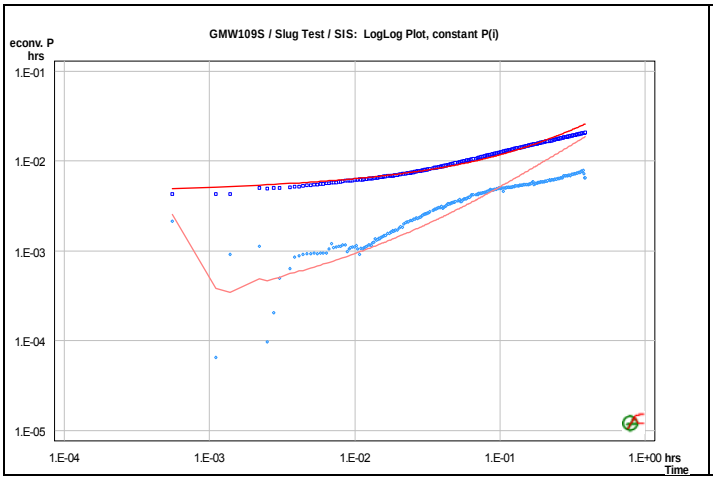
Analysis Results

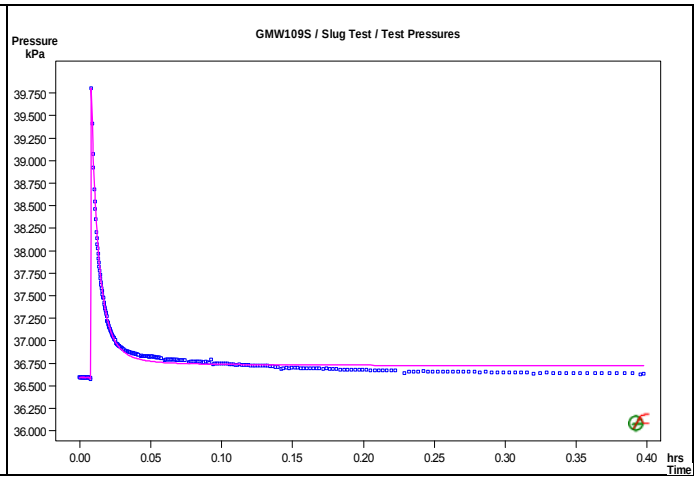
Analysis "HW01"

Static Pressure: 36.72 kPa

Shell Parameters:

Name	Transmissivity [m²/s]	Storativity [-]	Radius [m]	Flow Dimension [-]
Shell 1	1.0e-04	1.4e-05	- -	2.0





APPENDIX D

Field Sampling Forms and Equipment Calibration Certificates

Provided on DVD

APPENDIX E

Water Quality Results Summary Table

Table E1: Water Quality Results Summary Table
Whytes Gully New Landfill Cell
Project No. 117625003_070_R_Rev0

Analytes	Unit	LOR	ANZECC	Well ID	GMW101	GMW102	GMW103	GMW104	GMW105	GMW106	GMW107	GMW108S	GMW108D	GMW109S	GMW109D	GMW110	GMW111
				Sample Date	17/08/2011	17/08/2011	18/08/2011	17/08/2011	17/08/2011	17/08/2011	17/08/2011	22/08/2011	22/08/2011	18/08/2011	22/08/2011	25/07/2011	25/07/2011
				Type	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary
				Primary Sample	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lab Report No	ES1118241	NA	ES1118241	ES1118241	ES1118241	NA	NA	ES1118241	ES1118241	ES1118241	ES1118241	ES1115894	ES1115894
				Lab Sample No	009	NA	010	011	012	NA	NA	013	014	015	016	001	002
Field Parameters																	
Static Water Level	mBTOC				10.09	9.28	7.65	6.335	10.655	9.33	-	2.48	1.92	3.31	2.93	3.93	6.19
Static Water Level	mBGL				9.57	8.75	7.12	5.825	10.095	8.68	-	1.9	1.335	2.775	2.36	3.44	5.63
Static Water Level	mAHD				80.582	79.489	73.655	27.609	77.043	69.262	-	16.993	17.642	14.532	14.93	16.171	16.403
Field-pH	pH units				7.79	8.22	0.59 *	7.33	5.78	5.13	-	7.10	6.71	6.40	-	6.73	7.07
Field-temp	°C				17	16.8	18.7	17.1	17	16.8	-	17.9	17.0	18.1	-	18.1	18.4
Field-redox	mV				19	42	90	87	157	95	-	53	4131	-23	-	134.6	123.9
Field-EC	µS/cm				2850	301	1554	787	231	-	-	4020	3120	1432	-	3562	3016
Field Dissolved oxygen	ppm				2.37	0.97	2.73	5.03	3.1	4.26	-	1.23	1.20	5.3	-	3.08	3.72
Major Ions																	
Total Hardness as CaCO3	mg/L	1			869	-	510	235	39	-	-	988	669	474	343	1040	875
Hydroxide Alkalinity as CaCO3	mg/L	1			-	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	mg/L	1			-	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	mg/L	1			-	-	290	349	58	-	-	520	459	407	232	560	593
Total Alkalinity as CaCO3	mg/L	1			-	-	290	349	58	-	-	520	459	407	232	560	593
Sulfate as SO4 - Turbidimetric	mg/L	1			154	-	86	50	11	-	-	271	214	83	27	284	218
Chloride	mg/L	1			484	-	326	58	30	-	-	1010	717	297	361	911	828
Calcium	mg/L	1			183	-	130	48	9	-	-	168	126	119	73	170	141
Magnesium	mg/L	1			100	-	45	28	4	-	-	138	86	43	39	150	127
Sodium	mg/L	1			247	-	133	118	33	-	-	531	436	181	173	534	564
Potassium	mg/L	1			12	-	1	1	<1	-	-	<1	<1	6	1	2	3
Fluoride	mg/L	0.1			-	-	0.6	0.9	0.4	-	-	0.7	0.8	0.2	0.4	0.6	0.6
Total Anions	meq/L	0.01			-	-	16.8	9.65	2.23	-	-	44.5	33.8	18.2	15.4	42.8	39.7
Total Cations	meq/L	0.01			-	-	16	9.86	2.21	-	-	42.8	32.3	17.5	14.4	44.1	42.1
Ionic Balance	%	0.01			-	-	2.36	1.04		-	-	1.94	2.31	2.05	3.28	1.49	2.86
Nutrients																	
Ammonia as N	mg/L	0.01	0.9		0.07	-	0.02	0.02	0.01	-	-	<0.01	<0.01	3.22	0.09	0.03	0.02
Nitrite as N	mg/L	0.01			-	-	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	-	<0.01	<0.01	<0.01
Nitrate as N	mg/L	0.01			-	-	1.03	0.02	0.48	-	-	<0.01	<0.01	-	<0.01	0.01	0.02
Nitrite + Nitrate as N	mg/L	0.01			-	-	1.03	0.02	0.48	-	-	<0.01	<0.01	-	<0.01	0.01	0.02
Total Kjeldahl Nitrogen as N	mg/L	0.1			12.3 *	-	0.2	0.2	<0.1	-	-	<0.1	<0.1	2.4	0.1	1.9	0.3
Total Organic Carbon	mg/L	1			23 *	-	2	1	<1	-	-	2	1	16	<1	2	<1
Biochemical Oxygen Demand	mg/L	2			-	-	-	<2	<2	-	-	<2	<2	-	<2	5	5
Metals and Metalloids (dissolved) **																	
Aluminium	mg/L	0.01	0.055		0.01	-	0.01	0.02	0.06	-	-	<0.01	0.02	0.01	0.01	<0.01	<0.01
Arsenic	mg/L	0.001	-		<0.001	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	0.002	<0.001	<0.001	<0.001
Cadmium	mg/L	0.0001	0.0002		<0.0001	-	<0.0001	<0.0001	<0.0001	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	-		0.002	-	0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.0014		0.023	-	0.002	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	mg/L	0.001	0.0034		<0.001	-	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	0.003
Manganese	mg/L	0.001	1.9		0.096	-	0.061	0.389	0.041	-	-	0.726	0.026	4.17	0.656	<0.001	<0.001
Nickel	mg/L	0.001	0.011		0.03	-	0.002	0.001	<0.001	-	-	0.002	<0.001	0.01	<0.001	0.012	0.01
Zinc	mg/L	0.005	0.008		0.018	-	0.01	0.008	0.01	-	-	0.012	0.008	0.02	0.01	0.159	0.752
Iron	mg/L	0.05	-		<0.05	-	<0.05	<0.05	<0.05	-	-	0.07	<0.05	10.1	<0.05	<0.05	<0.05
Mercury	mg/L	0.0001	0.0006		<0.0001	-	<0.0001	<0.0001	<0.0001	-	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

* Values suspected of being anomalous or due to transcription error - to be reassessed during future works.
** All reported exceedances of the ANZECC (2000) criteria for copper, nickel and zinc were below the HMTVs calculated for each sample.

Notes:
NA = not applicable
- = not analysed

Prepared by: AB Date: 15/12/2011
Checked by: LJ Date: 06/01/2012

Table E1: Water Quality Results Summary Table
Whytes Gully New Landfill Cell
Project No. 117625003_070_R_Rev0

Analytes	Unit	LOR	ANZECC	Well ID	GABH01	GABH02	QC101	QC201	GABH03	GABH04	GABH05	GABH06S	GABH06D	QC100	BH6
				Sample Date	18/08/2011	19/08/2011	19/08/2011	19/08/2011	19/08/2011	19/08/2011	22/08/2011	17/08/2011	18/08/2011	18/08/2011	18/08/2011
				Type	Primary	Primary	Duplicate	Triplicate	Primary	Primary	Primary	Primary	Primary	Duplicate	Primary
				Primary Sample	NA	NA	GABH02	GABH02	NA	NA	NA	NA	NA	GABH06D	NA
				Lab Report No	ES1118241	ES1118241	ES1118241	60493	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241
				Lab Sample No	001	002	018	1	003	004	005	006	007	017	008
Field Parameters															
Static Water Level	mBTOC				2.905	4.725	4.725	4.725	0.18	0.94	5.72	1.89	1.37	1.37	1.34
Static Water Level	mBGL				2.33	4.195	4.195	4.195	-0.375	0.44	5.25	1.3	0.8	0.8	1.4
Static Water Level	mAHD				28.011	18.768	18.768	18.768	19.033	17.794	15.079	20.783	21.249	21.249	14.902
Field-pH	pH units				6.69	6.68	6.68	6.68	6.83	6.48	6.68	6.52	6.83	6.83	6.65
Field-temp	°C				17.4	17.2	17.2	17.2	17.0	17.3	17.9	17.8	18.7	18.7	18.8
Field-redox	mV				28	131	131	131	110	138	85	99	139	139	-6
Field-EC	µS/cm				2660	4940	4940	4940	5020	4990	4410	2870	3030	3030	4570
Field Dissolved oxygen	ppm				5.92	1.93	1.93	1.93	1.42	1.14	1.54	2.62	1.42	1.42	2.28
Major Ions															
Total Hardness as CaCO3	mg/L	1			830	1260	1260	1400	1560	1500	1260	411	575	583	808
Hydroxide Alkalinity as CaCO3	mg/L	1			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	mg/L	1			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	mg/L	1			604	834	844	910	607	458	574	376	319	319	656
Total Alkalinity as CaCO3	mg/L	1			604	834	844	910	607	458	574	376	319	319	656
Sulfate as SO4 - Turbidimetric	mg/L	1			208	157	156	160	214	287	242	220	220	221	293
Chloride	mg/L	1			596	1120	1120	1200	1300	1320	1080	605	745	740	1060
Calcium	mg/L	1			161	242	242	250	325	293	245	64	115	118	124
Magnesium	mg/L	1			104	159	159	180	183	188	158	61	70	70	121
Sodium	mg/L	1			364	596	592	580	512	520	495	475	453	451	747
Potassium	mg/L	1			2	3	3	3.6	2	1	<1	<1	<1	<1	<1
Fluoride	mg/L	0.1			0.5	0.6	0.6	0.52	0.6	0.6	0.6	1	0.5	0.6	1
Total Anions	meq/L	0.01			33.2	51.5	51.7	NA	53.2	52.4	47	29.2	32	31.8	49.1
Total Cations	meq/L	0.01			32.5	51.2	51	NA	53.6	52.7	46.8	28.9	31.2	31.3	48.6
Ionic Balance	%	0.01			1.12	0.36	0.7	-2.4	0.33	0.36	0.22	0.51	1.22	0.93	0.5
Nutrients															
Ammonia as N	mg/L	0.01	0.9		0.04	<0.01	<0.01	<0.005	0.04	0.01	0.02	<0.01	0.01	<0.01	0.04
Nitrite as N	mg/L	0.01			<0.01	<0.01	<0.01	NA	<0.01	-	<0.01	<0.01	<0.01	NA	<0.01
Nitrate as N	mg/L	0.01			0.02	0.05	<0.01	0.013	0.01	-	0.05	0.03	<0.01	NA	0.08
Nitrite + Nitrate as N	mg/L	0.01			0.02	0.05	<0.01	NA	0.01	-	0.05	0.03	<0.01	NA	0.08
Total Kjeldahl Nitrogen as N	mg/L	0.1			0.1	0.2	<0.1	0.2	<0.1	0.2	0.1	0.3	<0.1	<0.1	0.4
Total Organic Carbon	mg/L	1			3	5	4	5	3	2	2	<1	2	3	<1
Biochemical Oxygen Demand	mg/L	2			<2	<2	<2	<5	<2	-	<2	<2	<2	NA	<2
Metals and Metalloids (dissolved) **															
Aluminium	mg/L	0.01	0.055		<0.01	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	mg/L	0.001	-		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	mg/L	0.0001	0.0002		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002
Chromium	mg/L	0.001	-		<0.005	<0.005	<0.005	<0.001	<0.005	<0.001	0.002	<0.001	<0.001	<0.001	<0.005
Copper	mg/L	0.001	0.0014		<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Lead	mg/L	0.001	0.0034		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003
Manganese	mg/L	0.001	1.9		0.437	0.437	0.427	0.430	0.327	0.18	0.224	0.016	0.012	0.013	0.405
Nickel	mg/L	0.001	0.011		0.002	0.004	0.003	0.003	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.002
Zinc	mg/L	0.005	0.008		0.016	0.01	0.008	0.012	0.011	0.018	0.012	0.009	0.013	0.012	0.014
Iron	mg/L	0.05	-		0.97	0.08	<0.05	0.02	<0.05	<0.05	0.48	<0.05	<0.05	<0.05	<0.05
Mercury	mg/L	0.0001	0.0006		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

* Values suspected of being anomalous or due to transcription error - to be reassessed during
** All reported exceedances of the ANZECC (2000) criteria for copper, nickel and zinc were bel

Notes:
NA = not applicable
- = not analysed

Prepared by: AB Date: 15/12/2011
Checked by: LJ Date: 06/01/2012

Table E1: Water Quality Results Summary Table
Whytes Gully New Landfill Cell
Project No. 117625003_070_R_Rev0

Analytes	Unit	LOR	ANZECC	Well ID	GMW101	GMW102	GMW103	GMW104	GMW105	GMW106	GMW107	GMW108S	GMW108D	GMW109S	GMW109D	GMW110	GMW111
				Sample Date	17/08/2011	17/08/2011	18/08/2011	17/08/2011	17/08/2011	17/08/2011	17/08/2011	22/08/2011	22/08/2011	18/08/2011	22/08/2011	25/07/2011	25/07/2011
				Type	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary
				Primary Sample	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lab Report No	ES1118241	NA	ES1118241	ES1118241	ES1118241	NA	NA	ES1118241	ES1118241	ES1118241	ES1118241	ES1115894	ES1115894
				Lab Sample No	009	NA	010	011	012	NA	NA	013	014	015	016	001	002
Volatile Organic Compounds																	
Monocyclic Aromatic Hydrocarbons																	
Styrene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Isopropylbenzene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
n-Propylbenzene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.3.5-Trimethylbenzene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
sec-Butylbenzene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.2.4-Trimethylbenzene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
tert-Butylbenzene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
p-Isopropyltoluene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
n-Butylbenzene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Oxygenated Compounds																	
Vinyl Acetate	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
2-Butanone (MEK)	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
4-Methyl-2-pentanone (MIBK)	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
2-Hexanone (MBK)	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
Sulfonated Compounds																	
Carbon disulfide	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Fumigants																	
2.2-Dichloropropane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.2-Dichloropropane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
cis-1.3-Dichloropropylene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
trans-1.3-Dichloropropylene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.2-Dibromoethane (EDB)	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Halogenated Aliphatic Compounds																	
Dichlorodifluoromethane	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
Chloromethane	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
Vinyl chloride	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
Bromomethane	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
Chloroethane	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
Trichlorofluoromethane	µg/L	50			<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
1.1-Dichloroethene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Iodomethane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
trans-1.2-Dichloroethene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.1-Dichloroethane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
cis-1.2-Dichloroethene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.1.1-Trichloroethane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.1-Dichloropropylene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Carbon Tetrachloride	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.2-Dichloroethane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Trichloroethene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Dibromomethane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.1.2-Trichloroethane	µg/L	5	6500		<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.3-Dichloropropane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Tetrachloroethene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.1.1.2-Tetrachloroethane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
trans-1.4-Dichloro-2-butene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
cis-1.4-Dichloro-2-butene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.1.2.2-Tetrachloroethane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.2.3-Trichloropropane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Pentachloroethane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.2-Dibromo-3-chloropropane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Hexachlorobutadiene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Monocyclic Aromatic Hydrocarbons																	
Chlorobenzene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Bromobenzene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
2-Chlorotoluene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
4-Chlorotoluene	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.3-Dichlorobenzene	µg/L	5	260		<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.4-Dichlorobenzene	µg/L	5	60		<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.2-Dichlorobenzene	µg/L	5	160		<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.2.4-Trichlorobenzene	µg/L	5	170		<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
1.2.3-Trichlorobenzene	µg/L	5	10		<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Trihalomethanes																	
Chloroform	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Bromodichloromethane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Dibromochloromethane	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Bromoform	µg/L	5			<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5

Notes:
NA = not applicable
- = not analysed

Prepared by: AB Date: 15/12/2011
Checked by: LJ Date: 06/01/2012

Table E1: Water Quality Results Summary Table
Whytes Gully New Landfill Cell
Project No. 117625003_070_R_Rev0

Analytes	Unit	LOR	ANZECC	Well ID	GABH01	GABH02	QC101	QC201	GABH03	GABH04	GABH05	GABH06S	GABH06D	QC100	BH6
				Sample Date	18/08/2011	19/08/2011	19/08/2011	19/08/2011	19/08/2011	19/08/2011	22/08/2011	17/08/2011	18/08/2011	18/08/2011	18/08/2011
				Type	Primary	Primary	Duplicate	Triplicate	Primary	Primary	Primary	Primary	Primary	Duplicate	Primary
				Primary Sample	NA	NA	GABH02	GABH02	NA	NA	NA	NA	NA	GABH06D	NA
				Lab Report No	ES1118241	ES1118241	ES1118241	60493	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241
				Lab Sample No	001	002	018	1	003	004	005	006	007	017	008
Volatile Organic Compounds															
Monocyclic Aromatic Hydrocarbons															
Styrene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Isopropylbenzene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
n-Propylbenzene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.3.5-Trimethylbenzene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
sec-Butylbenzene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.2.4-Trimethylbenzene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
tert-Butylbenzene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
p-Isopropyltoluene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
n-Butylbenzene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Oxygenated Compounds															
Vinyl Acetate	µg/L	50			<50	<50	<50	NA	<50	<50	<50	<50	<50	<50	<50
2-Butanone (MEK)	µg/L	50			<50	<50	<50	NA	<50	<50	<50	<50	<50	<50	<50
4-Methyl-2-pentanone (MIBK)	µg/L	50			<50	<50	<50	NA	<50	<50	<50	<50	<50	<50	<50
2-Hexanone (MBK)	µg/L	50			<50	<50	<50	NA	<50	<50	<50	<50	<50	<50	<50
Sulfonated Compounds															
Carbon disulfide	µg/L	5			<5	<5	<5	NA	<5	<5	<5	<5	<5	<5	<5
Fumigants															
2.2-Dichloropropane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.2-Dichloropropane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
cis-1.3-Dichloropropylene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
trans-1.3-Dichloropropylene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.2-Dibromoethane (EDB)	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Halogenated Aliphatic Compounds															
Dichlorodifluoromethane	µg/L	50			<50	<50	<50	<10	<50	<50	<50	<50	<50	<50	<50
Chloromethane	µg/L	50			<50	<50	<50	<10	<50	<50	<50	<50	<50	<50	<50
Vinyl chloride	µg/L	50			<50	<50	<50	<10	<50	<50	<50	<50	<50	<50	<50
Bromomethane	µg/L	50			<50	<50	<50	<10	<50	<50	<50	<50	<50	<50	<50
Chloroethane	µg/L	50			<50	<50	<50	<10	<50	<50	<50	<50	<50	<50	<50
Trichlorofluoromethane	µg/L	50			<50	<50	<50	<10	<50	<50	<50	<50	<50	<50	<50
1.1-Dichloroethene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Iodomethane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
trans-1.2-Dichloroethene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.1-Dichloroethane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
cis-1.2-Dichloroethene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.1.1-Trichloroethane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.1-Dichloropropylene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Carbon Tetrachloride	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.2-Dichloroethane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Trichloroethene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Dibromomethane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.1.2-Trichloroethane	µg/L	5	6500		<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.3-Dichloropropane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Tetrachloroethene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.1.1.2-Tetrachloroethane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
trans-1.4-Dichloro-2-butene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
cis-1.4-Dichloro-2-butene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.1.2.2-Tetrachloroethane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.2.3-Trichloropropane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Pentachloroethane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.2-Dibromo-3-chloropropane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Hexachlorobutadiene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Monocyclic Aromatic Hydrocarbons															
Chlorobenzene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Bromobenzene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
2-Chlorotoluene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
4-Chlorotoluene	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.3-Dichlorobenzene	µg/L	5	260		<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.4-Dichlorobenzene	µg/L	5	60		<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.2-Dichlorobenzene	µg/L	5	160		<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.2.4-Trichlorobenzene	µg/L	5	170		<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
1.2.3-Trichlorobenzene	µg/L	5	10		<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Trihalomethanes															
Chloroform	µg/L	5			<5	<5	<5	3	<5	<5	<5	<5	<5	<5	<5
Bromodichloromethane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Dibromochloromethane	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Bromoform	µg/L	5			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5

Notes:
NA = not applicable
- = not analysed

Prepared by: AB Date: 15/12/2011
Checked by: LJ Date: 06/01/2012

Table E1: Water Quality Results Summary Table
Whytes Gully New Landfill Cell
Project No. 117625003_070_R_Rev0

Analytes	Unit	LOR	ANZECC	GMW101	GMW102	GMW103	GMW104	GMW105	GMW106	GMW107	GMW108S	GMW108D	GMW109S	GMW109D	GMW110	GMW111
Well ID				GMW101	GMW102	GMW103	GMW104	GMW105	GMW106	GMW107	GMW108S	GMW108D	GMW109S	GMW109D	GMW110	GMW111
Sample Date				17/08/2011	17/08/2011	18/08/2011	17/08/2011	17/08/2011	17/08/2011	17/08/2011	22/08/2011	22/08/2011	18/08/2011	22/08/2011	25/07/2011	25/07/2011
Type				Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary
Primary Sample				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lab Report No				ES1118241	NA	ES1118241	ES1118241	ES1118241	NA	NA	ES1118241	ES1118241	ES1118241	ES1118241	ES1115894	ES1115894
Lab Sample No				009	NA	010	011	012	NA	NA	013	014	015	016	001	002
Phenolic Compounds																
Phenol	µg/L	0.2	320	<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
2-Chlorophenol	µg/L	0.2	490	<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
2-Methylphenol	µg/L	0.2		<0.5	-	<0.5	0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
3- & 4-Methylphenol	µg/L	0.4		<1.0	-	<1.0	<0.9	<1.0	-	-	<1.0	<0.9	<1.0	<0.9	<2.0	<2.0
2-Nitrophenol	µg/L	0.2		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
2.4-Dimethylphenol	µg/L	0.2		<0.5	-	<0.5	0.7	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
2.4-Dichlorophenol	µg/L	0.2	160	<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
2.6-Dichlorophenol	µg/L	0.2		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
4-Chloro-3-Methylphenol	µg/L	0.2	10	<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
2.4.6-Trichlorophenol	µg/L	0.2	20	<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
2.4.5-Trichlorophenol	µg/L	0.2		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<1.0	<1.0
Pentachlorophenol	µg/L	0.4		<1.0	-	<1.0	<0.9	<1.0	-	-	<1.0	<0.9	<1.0	<0.9	<2.0	<2.0
Polynuclear Aromatic Hydrocarbons																
Naphthalene	µg/L	0.2	16	<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	0.4
Acenaphthylene	µg/L	0.2		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Acenaphthene	µg/L	0.2		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Fluorene	µg/L	0.2		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Phenanthrene	µg/L	0.2		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Anthracene	µg/L	0.2		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Fluoranthene	µg/L	0.2		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Pyrene	µg/L	0.2		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Benz(a)anthracene	µg/L	0.2		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Chrysene	µg/L	0.2		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Benzo(b)fluoranthene	µg/L	0.2		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Benzo(k)fluoranthene	µg/L	0.2		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Benzo(a)pyrene	µg/L	0.2		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Indeno(1.2.3.cd)pyrene	µg/L	0.2		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Dibenz(a.h)anthracene	µg/L	0.2		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Benzo(g.h.i)perylene	µg/L	0.2		<0.5	-	<0.5	<0.5	<0.5	-	-	<0.5	<0.5	<0.5	<0.5	<0.2	<0.2
Sum of polycyclic aromatic hydrocarbons	µg/L	0.5		-	-	-	-	-	-	-	-	-	-	-	-	0.4
BTEX																
Benzene	µg/L	1	950	<1	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
Toluene	µg/L	2		<5	-	<5	<5	<5	-	-	<5	<5	<5	<5	<5	<5
Ethylbenzene	µg/L	2		<2	-	<2	<2	<2	-	-	<2	<2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	200	<2	-	<2	<2	<2	-	-	<2	<2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	350	<2	-	<2	<2	<2	-	-	<2	<2	<2	<2	<2	<2
Total Xylenes	µg/L	2		<2	-	<2	<2	<2	-	-	<2	<2	<2	<2	<2	<2
Sum of BTEX	µg/L	1		<1	-	<1	<1	<1	-	-	<1	<1	<1	<1	<1	<1
Total Petroleum Hydrocarbons																
C6 - C9 Fraction	µg/L	20		<20	-	<20	<20	<20	-	-	<20	<20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50		<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100		<100	-	<100	<100	<100	-	-	<100	<100	<100	<100	430	1090
C29 - C36 Fraction	µg/L	50		<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	<50	770
C10 - C36 Fraction (sum)	µg/L	50		<50	-	<50	<50	<50	-	-	<50	<50	<50	<50	430	1860
Total Recoverable Hydrocarbons																
C6 - C10 Fraction	µg/L	20		<20	-	<20	<20	<20	-	-	<20	<20	<20	<20	<20	<20
C6 - C10 Fraction minus BTEX (F1)	µg/L	20		<20	-	<20	<20	<20	-	-	<20	<20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100		<100	-	<100	<100	<100	-	-	<100	<100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100		<100	-	<100	<100	<100	-	-	<100	<100	<100	<100	500	1640
>C34 - C40 Fraction	µg/L	100		<100	-	<100	<100	<100	-	-	<100	<100	<100	<100	<100	370
>C10 - C40 Fraction (sum)	µg/L	100		<100	-	<100	<100	<100	-	-	<100	<100	<100	<100	500	2010

Notes:
NA = not applicable
- = not analysed

Prepared by: AB Date: 15/12/2011
Checked by: LJ Date: 06/01/2012

Table E1: Water Quality Results Summary Table
Whytes Gully New Landfill Cell
Project No. 117625003_070_R_Rev0

Analytes	Unit	LOR	ANZECC	Well ID	GABH01	GABH02	QC101	QC201	GABH03	GABH04	GABH05	GABH06S	GABH06D	QC100	BH6
				Sample Date	18/08/2011	19/08/2011	19/08/2011	19/08/2011	19/08/2011	19/08/2011	22/08/2011	17/08/2011	18/08/2011	18/08/2011	18/08/2011
				Type	Primary	Primary	Duplicate	Triplicate	Primary	Primary	Primary	Primary	Primary	Duplicate	Primary
				Primary Sample	NA	NA	GABH02	GABH02	NA	NA	NA	NA	NA	GABH06D	NA
				Lab Report No	ES1118241	ES1118241	ES1118241	60493	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241
				Lab Sample No	001	002	018	1	003	004	005	006	007	017	008
Phenolic Compounds															
Phenol	µg/L	0.2	320		<0.5	<0.5	<0.5	<10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Chlorophenol	µg/L	0.2	490		<0.5	<0.5	<0.5	<10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Methylphenol	µg/L	0.2			<0.5	<0.5	<0.5	<10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
3- & 4-Methylphenol	µg/L	0.4			<0.9	<0.9	<0.9	<20	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
2-Nitrophenol	µg/L	0.2			<0.5	<0.5	<0.5	<10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2.4-Dimethylphenol	µg/L	0.2			<0.5	<0.5	<0.5	<10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2.4-Dichlorophenol	µg/L	0.2	160		<0.5	<0.5	<0.5	<10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2.6-Dichlorophenol	µg/L	0.2			<0.5	<0.5	<0.5	<10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4-Chloro-3-Methylphenol	µg/L	0.2	10		<0.5	<0.5	<0.5	NA	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2.4.6-Trichlorophenol	µg/L	0.2	20		<0.5	<0.5	<0.5	<10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2.4.5-Trichlorophenol	µg/L	0.2			<0.5	<0.5	<0.5	<10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Pentachlorophenol	µg/L	0.4			<0.9	<0.9	<0.9	<100	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
Polynuclear Aromatic Hydrocarbons															
Naphthalene	µg/L	0.2	16		<0.5	<0.5	<0.5	0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthylene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluorene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Phenanthrene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Anthracene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoranthene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Pyrene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benz(a)anthracene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chrysene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(b)fluoranthene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(k)fluoranthene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibenz(a.h)anthracene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(g.h.i)perylene	µg/L	0.2			<0.5	<0.5	<0.5	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sum of polycyclic aromatic hydrocarbons	µg/L	0.5			-	-	-	0.1	-	-	-	-	-	-	-
BTEX															
Benzene	µg/L	1	950		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	µg/L	2			<5	<5	<5	<1	<5	<5	<5	<5	<5	<5	<5
Ethylbenzene	µg/L	2			<2	<2	<2	<1	<2	<2	<2	<2	<2	<2	<2
meta- & para-Xylene	µg/L	2	200		<2	4	4	<2	<2	<2	<2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	350		<2	2	2	3	<2	<2	<2	<2	<2	<2	<2
Total Xylenes	µg/L	2			<2	6	6	3	<2	<2	<2	<2	<2	<2	<2
Sum of BTEX	µg/L	1			<1	6	6	3	<1	<1	<1	<1	<1	<1	<1
Total Petroleum Hydrocarbons															
C6 - C9 Fraction	µg/L	20			<20	30	30	<10	<20	<20	<20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50			<50	<50	<50	86	<50	<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100			<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50			<50	<50	<50	<100	<50	<50	<50	<50	<50	<50	<50
C10 - C36 Fraction (sum)	µg/L	50			<50	<50	<50	86	<50	<50	<50	<50	<50	<50	<50
Total Recoverable Hydrocarbons															
C6 - C10 Fraction	µg/L	20			<20	40	40	NA	<20	<20	<20	<20	<20	<20	<20
C6 - C10 Fraction minus BTEX (F1)	µg/L	20			<20	30	30	NA	<20	<20	<20	<20	<20	<20	<20
>C10 - C16 Fraction	µg/L	100			<100	<100	<100	NA	<100	<100	<100	<100	<100	<100	<100
>C16 - C34 Fraction	µg/L	100			<100	<100	<100	NA	<100	<100	<100	<100	<100	<100	<100
>C34 - C40 Fraction	µg/L	100			<100	<100	<100	NA	<100	<100	<100	<100	<100	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100			<100	<100	<100	NA	<100	<100	<100	<100	<100	<100	<100

Notes:
NA = not applicable
- = not analysed

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Checked by: LJ Date: 06/01/2012

Table E1: Water Quality Results Summary Table
Whytes Gully New Landfill Cell
Project No. 117625003_070_R_Rev0

	Well ID	GMW101	GMW102	GMW103	GMW104	GMW105	GMW106	GMW107	GMW108S	GMW108D	GMW109S	GMW109D	GMW110	GMW111
	Sample Date	17/08/2011	17/08/2011	18/08/2011	17/08/2011	17/08/2011	17/08/2011	17/08/2011	22/08/2011	22/08/2011	18/08/2011	22/08/2011	25/07/2011	25/07/2011
	Type	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary
	Primary Sample	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Lab Report No	ES1118241	NA	ES1118241	ES1118241	ES1118241	NA	NA	ES1118241	ES1118241	ES1118241	ES1118241	ES1115894	ES1115894
	Lab Sample No	009	NA	010	011	012	NA	NA	013	014	015	016	001	002
Analytes	**Unit**	**LOR**	**ANZECC**											
Organochlorine Pesticides														
Aldrin	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
alpha-BHC	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
beta-BHC	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
delta-BHC	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
4.4`-DDD	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
4.4`-DDE	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
4.4`-DDT	µg/L	0.010	0.01	<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Dieldrin	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
alpha-Endosulfan	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
beta-Endosulfan	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Endosulfan sulfate	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Endrin	µg/L	0.010	0.02	<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Endrin aldehyde	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Endosulfan (sum)	µg/L	0.010	0.2	<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Endrin ketone	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Heptachlor	µg/L	0.005	0.09	<0.005	-	<0.005	<0.005	<0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005
Heptachlor epoxide	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Hexachlorobenzene (HCB)	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
gamma-BHC	µg/L	0.010	0.2	<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Methoxychlor	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
cis-Chlordane	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
trans-Chlordane	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Total Chlordane (sum)	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Oxychlordane	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Sum of DDD + DDE + DDT	µg/L	0.010		<0.010	-	<0.010	<0.010	<0.010	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
Polychlorinated Biphenyls (as Aroclors)														
Total Polychlorinated biphenyls	µg/L	0.10		<0.10	-	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1016	µg/L	0.10		<0.10	-	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1221	µg/L	0.10		<0.10	-	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1232	µg/L	0.10		<0.10	-	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1242	µg/L	0.10	0.6	<0.10	-	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1248	µg/L	0.10		<0.10	-	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1254	µg/L	0.10		<0.10	-	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1260	µg/L	0.10		<0.10	-	<0.10	<0.10	<0.10	-	-	<0.10	<0.10	<0.10	<0.10	<0.10

Notes:
NA = not applicable
- = not analysed

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Checked by: LJ Date: 06/01/2012

Table E1: Water Quality Results Summary Table
Whytes Gully New Landfill Cell
Project No. 117625003_070_R_Rev0

Analytes	Unit	LOR	ANZECC	Well ID	GABH01	GABH02	QC101	QC201	GABH03	GABH04	GABH05	GABH06S	GABH06D	QC100	BH6
				Sample Date	18/08/2011	19/08/2011	19/08/2011	19/08/2011	19/08/2011	19/08/2011	22/08/2011	17/08/2011	18/08/2011	18/08/2011	18/08/2011
				Type	Primary	Primary	Duplicate	Triplicate	Primary	Primary	Primary	Primary	Primary	Duplicate	Primary
				Primary Sample	NA	NA	GABH02	GABH02	NA	NA	NA	NA	NA	GABH06D	NA
				Lab Report No	ES1118241	ES1118241	ES1118241	60493	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241	ES1118241
				Lab Sample No	001	002	018	1	003	004	005	006	007	017	008
Organochlorine Pesticides															
Aldrin	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
alpha-BHC	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
beta-BHC	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
delta-BHC	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
4.4`-DDD	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
4.4`-DDE	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
4.4`-DDT	µg/L	0.010	0.01		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Dieldrin	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
alpha-Endosulfan	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
beta-Endosulfan	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Endosulfan sulfate	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Endrin	µg/L	0.010	0.02		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Endrin aldehyde	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Endosulfan (sum)	µg/L	0.010	0.2		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Endrin ketone	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Heptachlor	µg/L	0.005	0.09		<0.005	<0.005	<0.005	<0.010	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Heptachlor epoxide	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Hexachlorobenzene (HCB)	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
gamma-BHC	µg/L	0.010	0.2		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Methoxychlor	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
cis-Chlordane	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
trans-Chlordane	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Total Chlordane (sum)	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Oxychlordane	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Sum of DDD + DDE + DDT	µg/L	0.010			<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Polychlorinated Biphenyls (as Aroclors)															
Total Polychlorinated biphenyls	µg/L	0.10			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1016	µg/L	0.10			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1221	µg/L	0.10			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1232	µg/L	0.10			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1242	µg/L	0.10	0.6		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1248	µg/L	0.10			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1254	µg/L	0.10			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1260	µg/L	0.10			<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

Notes:
NA = not applicable
- = not analysed

Prepared by: AB Date: 15/12/2011
Checked by: LJ Date: 06/01/2012

APPENDIX F

Data Validation Form

DATA VALIDATION SUMMARY SHEET (Sydney)

Project Name:	Whytes Gully New Cell	**Project Number:**	117625003
Primary Laboratory:	ALS	**Workorder Number:**	ES1118241
Secondary Laboratory:	ELS	**Workorder Number:**	60493
Date Sampled:	17/8/11-22/8/11	**Sample Medium:**	Water

Sample Information

Number of Primary Samples:	16	**Number of Triplicate Samples:**	0
Number of Duplicate Samples:	2	**Number of Other QAQC Samples:**	9

Documentation and Sample Handling Information

	Y/N	Comments
COC completed properly?	Y	
All requested analysis completed?	Y	
Samples received intact and chilled?	Y	
Samples analysed within appropiate holding times?	Y	
Sample volumes sufficient for QC analysis?	Y	
Are there non-NATA accredited methods used?	N	
Chromatograms supplied as appropriate?	N/A	
Laboratory reports signed by authorised personnel?	Y	

QAQC Sample Information (Method Blank - MB, Rinsate Blank - RB, Field Blank - FB, Trip Blank - TB)

Type	Sample ID	Comments
RB	QC300_17/8/11	All results are less than the LOR
RB	QC301_18/8/11	All Resuts are less than the LOR
RB	QC302_19/8/11	All results are less than the LOR
RB	QC303_22/8/11	All results are less than the LOR
TB	Trip Blank1	All results are less than the LOR
TB	Trip Balnk2	All results are less than the LOR
TB	Trip Blank3	All results are less than the LOR
MB	-	All MB results from this batch are less than the LOR

Trip Spike Information

Analyte	Spike Concentrations	Recovery Concentration	% Recovery	Comments
Benzene	20	17	85	All Trip spike recoveries from this batch are within acceptable limits
Toluene	20	18	90	
Ethylbenzene	20	18	90	
meta- & para-Xylene	20	18	90	
ortho-Xylene	20	19	95	
Benzene	20	16	80	
Toluene	20	18	90	
Ethylbenzene	20	17	85	
meta- & para-Xylene	20	18	90	
ortho-Xylene	20	18	90	

Laboratory Control Samples (LCS) Analyses

Analyte Group	Comments
Metals	LCS recovery of Lead (8.2%) is less than the lower control limit of 90%. LCS rercovery of Mercury (84.5%) is less than the lower control limits of 86%.
Phenolic compounds	LCS recovery of 2-chlorophenol (55.5%), 2-Methylphenol (54.3%), 2-Nitrophenol (50.5%) and 2.6-Dichlorophenol (61.8%) are less than the lower contol limits of 63.8%, 55.9%, 62.7% and 64.3% respectivley.

Matrix Spike (MS) Analyses

Analyte Group	Comments
Sulfate as SO42-	MS recovery in sample GABH1_18/8/11 was not determined due to background level being greater than or equal to 4x spike level.
Nitrate plus Nitrite as N	MS recovery in anonymous sample was not determined due to background level being greater than or equal to 4x spike level.
Phenolic compounds	MS recovery of 4-chloro-3-methylphenol of 68.5% is slighlty less than the lower data quality objective of 70%
BTEXN	Benzene MS recovery in anonymous sample was not determined due to background level being greater than or equal to 4x spike level.

Laboratory Duplicates (LD) Analyses

Analyte Group	Analyte(s)	Sample ID	Comments
All			All LD RPDs from this batch are within acceptable control limits

Field Duplicates (FD) Analyses

Analyte Group	Primary ID	Duplicate ID	Comments
	GABH6D_18/8/11	QC100	All FD RPDs are within acceptable control limits
	GABH2_19/8/11	QC101	All FD RPDs are within acceptable control limits

Field Triplicates (FT) Analyses

Analyte Group	Primary ID	Triplicate ID	Comments
	GABH2_19/8/11	QC201	All FT RPDs are within acceptable control limits

Surrogate Compound Monitoring Analyses

Analyte Group	Sample ID	Comments
All		All surrogate compound recoveries are within acceptable control limits.

Overall Comments

Low LCS recoveries for metals and Phenolics are not expected to affect the overall data quality as the recoveries are only slighlty less than the lower control limits.

Benzene MS recovery is not expected to affect the overall data quality as this analysis was performed on an anonymous sample and two other MS recoveries from this batch for Benzene are within acceptable limits

Low MS recovery for Phenolics are not expected to affect the overall data quality as the recoveries are only slightly less than the lower control limits.

ALS state that: Insufficient sample volume for Alkalinity and Fluoride analysis.
ALS state that: LCS recoveries for some elements fall outside ALS Dynamic control limit, however, they are within the acceptance criteria based on ALS DQO. No further action is required.

ALS state that: LOR for Chromium has been raised in particular sample(s) due to matrix interference(s).
ALS state that: LCS recovery for Mercury falls outside ALS Dynamic Control Limit. However, it is within the acceptance criteria based on ALS DQO. No further action is required.

ALS state that: Poor matrix spike recovery due to sample heterogeneity. Confirmed by re-extraction and re-analysis.

ALS state that: GABH2 19/8/11 sample results has been confirmed by reanalysis.

ALS state that: Level of reporting raised for toluene due to ambient background levels in the laboratory.

ALS state that: Sample TRIP SPIKE contains volatile compounds spiked into the sample containers prior to dispatch from the laboratory. BTEX compounds spiked at 20 ug/L. This batch is acceptable for environmental interpretative purposes.

Note: Data validation assesses each analyte in terms of all the data validation variables and only the exceedances and outliers are reported in this form.

*When concentrations are less than the LOR for both primary and duplicate/triplicate results, no RPDs are calculated

Performed By:	AM	**Reviewed By:**	**LBJ**
Date:	28/10/2011	**Date:**	23/01/2012

Whytes Gully New Cell
Duplicate Analysis RPDs
117625003

	Sample ID	GABH6D_18/8/11	QC100_18/8/11	-
	Sample Type	Primary	Field Duplicate	Field Triplicate
	Date Sampled	18/08/2011	18/08/2011	-

Analyte	Units	LOR				RPDs Primary vs Duplicate	RPDs Primary vs Inter Duplicate
Total Hardness as CaCO3	mg/L	1	575	583	-	1.4	#VALUE!
Hydroxide Alkalinity as CaCO3	mg/L	1	<1	<1	-	NA	NA
Carbonate Alkalinity as CaCO3	mg/L	1	<1	<1	-	NA	NA
Bicarbonate Alkalinity as CaCO3	mg/L	1	319	319	-	0.0	#VALUE!
Total Alkalinity as CaCO3	mg/L	1	319	319	-	0.0	#VALUE!
Sulfate as SO4 - Turbidimetric	mg/L	1	220	221	-	0.5	#VALUE!
Chloride	mg/L	1	745	740	-	0.7	#VALUE!
Calcium	mg/L	1	115	118	-	2.6	#VALUE!
Magnesium	mg/L	1	70	70	-	0.0	#VALUE!
Sodium	mg/L	1	453	451	-	0.4	#VALUE!
Potassium	mg/L	1	<1	<1	-	NA	NA
Aluminium	mg/L	0.01	<0.01	<0.01	-	NA	NA
Arsenic	mg/L	0.001	<0.001	<0.001	-	NA	NA
Cadmium	mg/L	0.0001	<0.0001	<0.0001	-	NA	NA
Chromium	mg/L	0.001	<0.001	<0.001	-	NA	NA
Copper	mg/L	0.001	<0.001	<0.001	-	NA	NA
Lead	mg/L	0.001	<0.001	<0.001	-	NA	NA
Manganese	mg/L	0.001	0.012	0.013	-	8.0	#VALUE!
Nickel	mg/L	0.001	<0.001	<0.001	-	NA	NA
Zinc	mg/L	0.005	0.013	0.012	-	8.0	#VALUE!
Iron	mg/L	0.05	<0.05	<0.05	-	NA	NA
Mercury	mg/L	0.0001	<0.0001	<0.0001	-	NA	NA
Fluoride	mg/L	0.1	0.5	0.6	-	18.2	#VALUE!
Ammonia as N	mg/L	0.01	0.01	<0.01	-	0.0	#VALUE!
Total Kjeldahl Nitrogen as N	mg/L	0.1	<0.1	<0.1	-	NA	NA
Total Anions	meq/L	0.01	32	31.8	-	0.6	#VALUE!
Total Cations	meq/L	0.01	31.2	31.3	-	0.3	#VALUE!
Total Organic Carbon	mg/L	1	2	3	-	40.0	#VALUE!
Styrene	µg/L	5	<5	<5	-	NA	NA
Isopropylbenzene	µg/L	5	<5	<5	-	NA	NA
n-Propylbenzene	µg/L	5	<5	<5	-	NA	NA
1.3.5-Trimethylbenzene	µg/L	5	<5	<5	-	NA	NA
sec-Butylbenzene	µg/L	5	<5	<5	-	NA	NA
1.2.4-Trimethylbenzene	µg/L	5	<5	<5	-	NA	NA
tert-Butylbenzene	µg/L	5	<5	<5	-	NA	NA
p-Isopropyltoluene	µg/L	5	<5	<5	-	NA	NA
n-Butylbenzene	µg/L	5	<5	<5	-	NA	NA
Vinyl Acetate	µg/L	50	<50	<50	-	NA	NA
2-Butanone (MEK)	µg/L	50	<50	<50	-	NA	NA
4-Methyl-2-pentanone (MIBK)	µg/L	50	<50	<50	-	NA	NA
2-Hexanone (MBK)	µg/L	50	<50	<50	-	NA	NA
Carbon disulfide	µg/L	5	<5	<5	-	NA	NA
2.2-Dichloropropane	µg/L	5	<5	<5	-	NA	NA
1.2-Dichloropropane	µg/L	5	<5	<5	-	NA	NA
cis-1.3-Dichloropropylene	µg/L	5	<5	<5	-	NA	NA
trans-1.3-Dichloropropylene	µg/L	5	<5	<5	-	NA	NA
1.2-Dibromoethane (EDB)	µg/L	5	<5	<5	-	NA	NA
Dichlorodifluoromethane	µg/L	50	<50	<50	-	NA	NA
Chloromethane	µg/L	50	<50	<50	-	NA	NA
Vinyl chloride	µg/L	50	<50	<50	-	NA	NA
Bromomethane	µg/L	50	<50	<50	-	NA	NA
Chloroethane	µg/L	50	<50	<50	-	NA	NA
Trichlorofluoromethane	µg/L	50	<50	<50	-	NA	NA
1.1-Dichloroethene	µg/L	5	<5	<5		NA	NA
Iodomethane	µg/L	5	<5	<5	-	NA	NA
trans-1.2-Dichloroethene	µg/L	5	<5	<5	-	NA	NA
1.1-Dichloroethane	µg/L	5	<5	<5	-	NA	NA
cis-1.2-Dichloroethene	µg/L	5	<5	<5	-	NA	NA
1.1.1-Trichloroethane	µg/L	5	<5	<5		NA	NA
1.1-Dichloropropylene	µg/L	5	<5	<5	-	NA	NA
Carbon Tetrachloride	µg/L	5	<5	<5	-	NA	NA
1.2-Dichloroethane	µg/L	5	<5	<5	-	NA	NA
Trichloroethene	µg/L	5	<5	<5	-	NA	NA
Dibromomethane	µg/L	5	<5	<5			NA
1.1.2-Trichloroethane	µg/L	5	<5	<5	-	NA	NA
1.3-Dichloropropane	µg/L	5	<5	<5	-	NA	NA
Tetrachloroethene	µg/L	5	<5	<5	-	NA	NA
1.1.1.2-Tetrachloroethane	µg/L	5	<5	<5	-	NA	NA
trans-1.4-Dichloro-2-butene	µg/L	5	<5	<5	-	NA	NA
cis-1.4-Dichloro-2-butene	µg/L	5	<5	<5	-	NA	NA
1.1.2.2-Tetrachloroethane	µg/L	5	<5	<5	-	NA	NA
1.2.3-Trichloropropane	µg/L	5	<5	<5	-	NA	NA
Pentachloroethane	µg/L	5	<5	<5	-	NA	NA
1.2-Dibromo-3-chloropropane	µg/L	5	<5	<5	-	NA	NA
Hexachlorobutadiene	µg/L	5	<5	<5	-	NA	NA
Chlorobenzene	µg/L	5	<5	<5	-	NA	NA
Bromobenzene	µg/L	5	<5	<5	-	NA	NA
2-Chlorotoluene	µg/L	5	<5	<5	-	NA	NA
4-Chlorotoluene	µg/L	5	<5	<5	-	NA	NA
1.3-Dichlorobenzene	µg/L	5	<5	<5	-	NA	NA
1.4-Dichlorobenzene	µg/L	5	<5	<5			NA
1.2-Dichlorobenzene	µg/L	5	<5	<5	-	NA	NA
1.2.4-Trichlorobenzene	µg/L	5	<5	<5	-	NA	NA
1.2.3-Trichlorobenzene	µg/L	5	<5	<5	-	NA	NA
Chloroform	µg/L	5	<5	<5	-	NA	NA
Bromodichloromethane	µg/L	5	<5	<5			NA
Dibromochloromethane	µg/L	5	<5	<5	-	NA	NA
Bromoform	µg/L	5	<5	<5	-	NA	NA
Phenol	µg/L	0.2	<0.5	<0.5	-	NA	NA
2-Chlorophenol	µg/L	0.2	<0.5	<0.5	-	NA	NA
2-Methylphenol	µg/L	0.2	<0.5	<0.5	-	NA	NA
3- & 4-Methylphenol	µg/L	0.4	<0.9	<0.9	-	NA	NA
2-Nitrophenol	µg/L	0.2	<0.5	<0.5	-	NA	NA
2.4-Dimethylphenol	µg/L	0.2	<0.5	<0.5	-	NA	NA
2.4-Dichlorophenol	µg/L	0.2	<0.5	<0.5	-	NA	NA
2.6-Dichlorophenol	µg/L	0.2	<0.5	<0.5	-	NA	NA
4-Chloro-3-Methylphenol	µg/L	0.2	<0.5	<0.5	-	NA	NA
2.4.6-Trichlorophenol	µg/L	0.2	<0.5	<0.5	-	NA	NA
2.4.5-Trichlorophenol	µg/L	0.2	<0.5	<0.5	-	NA	NA
Pentachlorophenol	µg/L	0.4	<0.9	<0.9	-	NA	NA
Naphthalene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Acenaphthylene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Acenaphthene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Fluorene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Phenanthrene	µg/L	0.2	<0.5	<0.5	-	NA	NA

Anthracene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Fluoranthene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Pyrene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Benz(a)anthracene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Chrysene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Benzo(b)fluoranthene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Benzo(k)fluoranthene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Benzo(a)pyrene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Indeno(1.2.3.cd)pyrene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Dibenz(a.h)anthracene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Benzo(g.h.i)perylene	µg/L	0.2	<0.5	<0.5	-	NA	NA
Sum of polycyclic aromatic hydrocarbon	µg/L	0.5			-	NA	NA
Benzene	µg/L	1	<1	<1	-	NA	NA
Toluene	µg/L	2	<5	<5	-	NA	NA
Ethylbenzene	µg/L	2	<2	<2	-	NA	NA
meta- & para-Xylene	µg/L	2	<2	<2	-	NA	NA
ortho-Xylene	µg/L	2	<2	<2	-	NA	NA
Total Xylenes	µg/L	2	<2	<2	-	NA	NA
Sum of BTEX	µg/L	1	<1	<1	-	NA	NA
Naphthalene	µg/L	5	<5	<5	-	NA	NA
C6 - C9 Fraction	µg/L	20	<20	<20	-	NA	NA
C10 - C14 Fraction	µg/L	50	<50	<50	-	NA	NA
C15 - C28 Fraction	µg/L	100	<100	<100	-	NA	NA
C29 - C36 Fraction	µg/L	50	<50	<50	-	NA	NA
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	-	NA	NA
C6 - C10 Fraction	µg/L	20	<20	<20	-	NA	NA
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	-	NA	NA
>C10 - C16 Fraction	µg/L	100	<100	<100	-	NA	NA
>C16 - C34 Fraction	µg/L	100	<100	<100	-	NA	NA
>C34 - C40 Fraction	µg/L	100	<100	<100	-	NA	NA
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	-	NA	NA
Aldrin	µg/L	0.01	<0.010	<0.010	-	NA	NA
alpha-BHC	µg/L	0.01	<0.010	<0.010	-	NA	NA
beta-BHC	µg/L	0.01	<0.010	<0.010	-	NA	NA
delta-BHC	µg/L	0.01	<0.010	<0.010	-	NA	NA
4.4`-DDD	µg/L	0.01	<0.010	<0.010	-	NA	NA
4.4`-DDE	µg/L	0.01	<0.010	<0.010	-	NA	NA
4.4`-DDT	µg/L	0.01	<0.010	<0.010	-	NA	NA
Dieldrin	µg/L	0.01	<0.010	<0.010	-	NA	NA
alpha-Endosulfan	µg/L	0.01	<0.010	<0.010	-	NA	NA
beta-Endosulfan	µg/L	0.01	<0.010	<0.010	-	NA	NA
Endosulfan sulfate	µg/L	0.01	<0.010	<0.010	-	NA	NA
Endrin	µg/L	0.01	<0.010	<0.010	-	NA	NA
Endrin aldehyde	µg/L	0.01	<0.010	<0.010	-	NA	NA
Endosulfan (sum)	µg/L	0.01	<0.010	<0.010	-	NA	NA
Endrin ketone	µg/L	0.01	<0.010	<0.010	-	NA	NA
Heptachlor	µg/L	0.005	<0.005	<0.005	-	NA	NA
Heptachlor epoxide	µg/L	0.01	<0.010	<0.010	-	NA	NA
Hexachlorobenzene (HCB)	µg/L	0.01	<0.010	<0.010	-	NA	NA
gamma-BHC	µg/L	0.01	<0.010	<0.010	-	NA	NA
Methoxychlor	µg/L	0.01	<0.010	<0.010	-	NA	NA
cis-Chlordane	µg/L	0.01	<0.010	<0.010	-	NA	NA
trans-Chlordane	µg/L	0.01	<0.010	<0.010	-	NA	NA
Total Chlordane (sum)	µg/L	0.01	<0.010	<0.010	-	NA	NA
Oxychlordane	µg/L	0.01	<0.010	<0.010	-	NA	NA
Sum of DDD + DDE + DDT	µg/L	0.01	<0.010	<0.010	-	NA	NA
Total Polychlorinated biphenyls	µg/L	0.1	<0.10	<0.10	-	NA	NA
Aroclor 1016	µg/L	0.1	<0.10	<0.10	-	NA	NA
Aroclor 1221	µg/L	0.1	<0.10	<0.10	-	NA	NA
Aroclor 1232	µg/L	0.1	<0.10	<0.10	-	NA	NA
Aroclor 1242	µg/L	0.1	<0.10	<0.10	-	NA	NA
Aroclor 1248	µg/L	0.1	<0.10	<0.10	-	NA	NA
Aroclor 1254	µg/L	0.1	<0.10	<0.10	-	NA	NA
Aroclor 1260	µg/L	0.1	<0.10	<0.10	-	NA	NA

Legend

ND = Not Detected (RPDs not calculated if both primary and duplicate results are below LOR)

- = Not analysed/calculated

Acceptable RPDs: RPD <= 30%

RPD > 30%, Analyis result < 10 times LOR

RPD <= 50%, Analysis result > 10 times LOR and < 20 times LOR

Whytes Gully New Cell
Duplicate Analysis RPDs
117625003

Sample ID	GABH2_19/8/11	QC101_19/8/11	QC201_19/8/11
Sample Type	Primary	Field Duplicate	Field Triplicate
Date Sampled	19/08/2011	19/08/2011	19/08/2011

Analyte	Units	LOR				RPDs Primary vs Duplicate	RPDs Primary vs Inter Duplicate
Total Hardness as CaCO3	mg/L	1	1260	1260	1400	0.0	10.5
Hydroxide Alkalinity as CaCO3	mg/L	1	<1	<1	<1	NA	NA
Carbonate Alkalinity as CaCO	mg/L	1	<1	<1	<1	NA	NA
Bicarbonate Alkalinity as CaC	mg/L	1	834	844	910	1.2	8.7
Total Alkalinity as CaCO3	mg/L	1	834	844	910	1.2	8.7
Sulfate as SO4 - Turbidimetric	mg/L	1	157	156	160	0.6	1.9
Chloride	mg/L	1	1120	1120	1200	0.0	6.9
Calcium	mg/L	1	242	242	250	0.0	3.3
Magnesium	mg/L	1	159	159	180	0.0	12.4
Sodium	mg/L	1	596	592	580	0.7	2.7
Potassium	mg/L	1	3	3	3.6	0.0	18.2
Aluminium	mg/L	0.01	<0.01	<0.01		NA	NA
Arsenic	mg/L	0.001	<0.001	<0.001	<0.001	NA	NA
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	NA	NA
Chromium	mg/L	0.001	<0.005	<0.005	<0.001	NA	NA
Copper	mg/L	0.001	0.001	<0.001	<0.001	0.0	0.0
Lead	mg/L	0.001	<0.001	<0.001	<0.001	NA	NA
Manganese	mg/L	0.001	0.437	0.427	0.43	2.3	1.6
Nickel	mg/L	0.001	0.004	0.003	0.003	28.6	28.6
Zinc	mg/L	0.005	0.01	0.008	0.012	22.2	18.2
Iron	mg/L	0.05	0.08	<0.05	0.02	46.2	120.0
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	NA	NA
Fluoride	mg/L	0.1	0.6	0.6	0.52	0.0	14.3
Ammonia as N	mg/L	0.01	<0.01	<0.01		NA	NA
Total Kjeldahl Nitrogen as N	mg/L	0.1	0.2	<0.1	0.2	66.7	0.0
Total Anions	meq/L	0.01	51.5	51.7	-	0.4	#VALUE!
Total Cations	meq/L	0.01	51.2	51	-	0.4	#VALUE!
Total Organic Carbon	mg/L	1	5	4	5	22.2	0.0
Styrene	µg/L	5	<5	<5	<1	NA	NA
Isopropylbenzene	µg/L	5	<5	<5	<1	NA	NA
n-Propylbenzene	µg/L	5	<5	<5	<1	NA	NA
1.3.5-Trimethylbenzene	µg/L	5	<5	<5	3	NA	50.0
sec-Butylbenzene	µg/L	5	<5	<5	<1	NA	NA
1.2.4-Trimethylbenzene	µg/L	5	<5	<5	<1	NA	NA
tert-Butylbenzene	µg/L	5	<5	<5	<1	NA	NA
p-Isopropyltoluene	µg/L	5	<5	<5	-	NA	NA
n-Butylbenzene	µg/L	5	<5	<5	<1	NA	NA
Vinyl Acetate	µg/L	50	<50	<50	<10	NA	NA
2-Butanone (MEK)	µg/L	50	<50	<50	-	NA	NA
4-Methyl-2-pentanone (MIBK)	µg/L	50	<50	<50	-	NA	NA
2-Hexanone (MBK)	µg/L	50	<50	<50	<1	NA	NA
Carbon disulfide	µg/L	5	<5	<5	-	NA	NA
2.2-Dichloropropane	µg/L	5	<5	<5	<1	NA	NA
1.2-Dichloropropane	µg/L	5	<5	<5	<1	NA	NA
cis-1.3-Dichloropropylene	µg/L	5	<5	<5	<1	NA	NA
trans-1.3-Dichloropropylene	µg/L	5	<5	<5	<1	NA	NA
1.2-Dibromoethane (EDB)	µg/L	5	<5	<5	<1	NA	NA
Dichlorodifluoromethane	µg/L	50	<50	<50	<10	NA	NA
Chloromethane	µg/L	50	<50	<50	<10	NA	NA
Vinyl chloride	µg/L	50	<50	<50	-	NA	NA
Bromomethane	µg/L	50	<50	<50	<10	NA	NA
Chloroethane	µg/L	50	<50	<50	<10	NA	NA
Trichlorofluoromethane	µg/L	50	<50	<50	<10	NA	NA
1.1-Dichloroethene	µg/L	5	<5	<5	<1	NA	NA
Iodomethane	µg/L	5	<5	<5	-	NA	NA
trans-1.2-Dichloroethene	µg/L	5	<5	<5	<1	NA	NA
1.1-Dichloroethane	µg/L	5	<5	<5	<1	NA	NA
cis-1.2-Dichloroethene	µg/L	5	<5	<5	<1	NA	NA
1.1.1-Trichloroethane	µg/L	5	<5	<5	<1	NA	NA
1.1-Dichloropropylene	µg/L	5	<5	<5	<1	NA	NA
Carbon Tetrachloride	µg/L	5	<5	<5	<1	NA	NA
1.2-Dichloroethane	µg/L	5	<5	<5	<1	NA	NA
Trichloroethene	µg/L	5	<5	<5	<1	NA	NA
Dibromomethane	µg/L	5	<5	<5	<1	NA	NA
1.1.2-Trichloroethane	µg/L	5	<5	<5	<1	NA	NA
1.3-Dichloropropane	µg/L	5	<5	<5	<1	NA	NA
Tetrachloroethene	µg/L	5	<5	<5	<1	NA	NA
1.1.1.2-Tetrachloroethane	µg/L	5	<5	<5	<1	NA	NA
trans-1.4-Dichloro-2-butene	µg/L	5	<5	<5	-	NA	NA
cis-1.4-Dichloro-2-butene	µg/L	5	<5	<5	-	NA	NA
1.1.2.2-Tetrachloroethane	µg/L	5	<5	<5	<1	NA	NA
1.2.3-Trichloropropane	µg/L	5	<5	<5	<1	NA	NA
Pentachloroethane	µg/L	5	<5	<5	-	NA	NA
1.2-Dibromo-3-chloropropane	µg/L	5	<5	<5	<1	NA	NA
Hexachlorobutadiene	µg/L	5	<5	<5	<1	NA	NA
Chlorobenzene	µg/L	5	<5	<5	<1	NA	NA
Bromobenzene	µg/L	5	<5	<5	<1	NA	NA
2-Chlorotoluene	µg/L	5	<5	<5	<1	NA	NA
4-Chlorotoluene	µg/L	5	<5	<5	-	NA	NA
1.3-Dichlorobenzene	µg/L	5	<5	<5	<1	NA	NA
1.4-Dichlorobenzene	µg/L	5	<5	<5	<1	NA	NA
1.2-Dichlorobenzene	µg/L	5	<5	<5	<1	NA	NA
1.2.4-Trichlorobenzene	µg/L	5	<5	<5	<1	NA	NA
1.2.3-Trichlorobenzene	µg/L	5	<5	<5	<1	NA	NA
Chloroform	µg/L	5	<5	<5	3.0	NA	50.0
Bromodichloromethane	µg/L	5	<5	<5	<1	NA	NA
Dibromochloromethane	µg/L	5	<5	<5	<1	NA	NA
Bromoform	µg/L	5	<5	<5	<1	NA	NA
Phenol	µg/L	0.2	<0.5	<0.5	<10	NA	NA
2-Chlorophenol	µg/L	0.2	<0.5	<0.5	<10	NA	NA
2-Methylphenol	µg/L	0.2	<0.5	<0.5	<10	NA	NA
3- & 4-Methylphenol	µg/L	0.4	<0.9	<1.0	<10	NA	NA
2-Nitrophenol	µg/L	0.2	<0.5	<0.5	<10	NA	NA
2.4-Dimethylphenol	µg/L	0.2	<0.5	<0.5	<10	NA	NA
2.4-Dichlorophenol	µg/L	0.2	<0.5	<0.5	<10	NA	NA
2.6-Dichlorophenol	µg/L	0.2	<0.5	<0.5	<10	NA	NA
4-Chloro-3-Methylphenol	µg/L	0.2	<0.5	<0.5	-	NA	NA
2.4.6-Trichlorophenol	µg/L	0.2	<0.5	<0.5	<10	NA	NA
2.4.5-Trichlorophenol	µg/L	0.2	<0.5	<0.5	<10	NA	NA
Pentachlorophenol	µg/L	0.4	<0.9	<1.0	<100	NA	NA
Naphthalene	µg/L	0.2	<0.5	<0.5	0.1	NA	133.3
Acenaphthylene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Acenaphthene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Fluorene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Phenanthrene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA

Anthracene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Fluoranthene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Pyrene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Benz(a)anthracene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Chrysene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Benzo(b)fluoranthene	µg/L	0.2	<0.5	<0.5	<0.2	NA	NA
Benzo(k)fluoranthene	µg/L	0.2	<0.5	<0.5		NA	NA
Benzo(a)pyrene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Indeno(1.2.3.cd)pyrene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Dibenz(a.h)anthracene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Benzo(g.h.i)perylene	µg/L	0.2	<0.5	<0.5	<0.1	NA	NA
Sum of polycyclic aromatic hyd	µg/L	0.5			-	NA	NA
Benzene	µg/L	1	<1	<1	<1	NA	NA
Toluene	µg/L	2	<5	<5	<1	NA	NA
Ethylbenzene	µg/L	2	<2	<2	<1	NA	NA
meta- & para-Xylene	µg/L	2	4	4	<2	0.0	66.7
ortho-Xylene	µg/L	2	2	2	3	0.0	40.0
Total Xylenes	µg/L	2	6	6	-	0.0	#VALUE!
Sum of BTEX	µg/L	1	6	6	-	0.0	#VALUE!
Naphthalene	µg/L	5	<5	<5	-	NA	NA
C6 - C9 Fraction	µg/L	20	30	30		0.0	#VALUE!
C10 - C14 Fraction	µg/L	50	<50	<50	86	NA	52.9
C15 - C28 Fraction	µg/L	100	<100	<100	<100	NA	NA
C29 - C36 Fraction	µg/L	50	<50	<50	<100	NA	NA
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	-	NA	NA
C6 - C10 Fraction	µg/L	20	40	40	<10	0.0	120.0
C6 - C10 Fraction minus BTEX	µg/L	20	30	30	-	0.0	#VALUE!
>C10 - C16 Fraction	µg/L	100	<100	<100	-	NA	NA
>C16 - C34 Fraction	µg/L	100	<100	<100	-	NA	NA
>C34 - C40 Fraction	µg/L	100	<100	<100	-	NA	NA
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	-	NA	NA
Aldrin	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
alpha-BHC	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
beta-BHC	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
delta-BHC	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
4.4`-DDD	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
4.4`-DDE	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
4.4`-DDT	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
Dieldrin	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
alpha-Endosulfan	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
beta-Endosulfan	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
Endosulfan sulfate	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
Endrin	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
Endrin aldehyde	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
Endosulfan (sum)	µg/L	0.01	<0.010	<0.010	-	NA	NA
Endrin ketone	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
Heptachlor	µg/L	0.005	<0.005	<0.005	<0.01	NA	NA
Heptachlor epoxide	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
Hexachlorobenzene (HCB)	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
gamma-BHC	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
Methoxychlor	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
cis-Chlordane	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
trans-Chlordane	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
Total Chlordane (sum)	µg/L	0.01	<0.010	<0.010	-	NA	NA
Oxychlordane	µg/L	0.01	<0.010	<0.010	<0.01	NA	NA
Sum of DDD + DDE + DDT	µg/L	0.01	<0.010	<0.010	-	NA	NA
Total Polychlorinated biphenyl	µg/L	0.1	<0.10	<0.10	<0.1	NA	NA
Aroclor 1016	µg/L	0.1	<0.10	<0.10	<0.1	NA	NA
Aroclor 1221	µg/L	0.1	<0.10	<0.10	<0.1	NA	NA
Aroclor 1232	µg/L	0.1	<0.10	<0.10	<0.1	NA	NA
Aroclor 1242	µg/L	0.1	<0.10	<0.10	<0.1	NA	NA
Aroclor 1248	µg/L	0.1	<0.10	<0.10	<0.1	NA	NA
Aroclor 1254	µg/L	0.1	<0.10	<0.10	<0.1	NA	NA
Aroclor 1260	µg/L	0.1	<0.10	<0.10	<0.1	NA	NA

Legend

ND = Not Detected (RPDs not calculated if both primary and duplicate results are below LOR)

- = Not analysed/calculated

Acceptable RPDs: RPD <= 30%

RPD > 30%, Analyis result < 10 times LOR

RPD <= 50%, Analysis result > 10 times LOR and < 20 times LOR

DATA VALIDATION SUMMARY SHEET (Sydney)

Project Name:	Whytes Gully New Cell	**Project Number:**	117625003
Primary Laboratory:	ALS	**Workorder Number:**	ES1118791
Secondary Laboratory:	-	**Workorder Number:**	-
Date Sampled:	29/08/2011	**Sample Medium:**	Water

Sample Information

Number of Primary Samples:	1	**Number of Triplicate Samples:**	0
Number of Duplicate Samples:	0	**Number of Other QAQC Samples:**	0

Documentation and Sample Handling Information

	Y/N	Comments
COC completed properly?	Y	
All requested analysis completed?	Y	
Samples received intact and chilled?	Y	
Samples analysed within appropiate holding times?	Y	
Sample volumes sufficient for QC analysis?	Y	
Are there non-NATA accredited methods used?	N	
Chromatograms supplied as appropriate?	N/A	
Laboratory reports signed by authorised personnel?	Y	

QAQC Sample Information (Method Blank - MB, Rinsate Blank - RB, Field Blank - FB, Trip Blank - TB)

Type	Sample ID	Comments
MB	-	All MB results from this batch are less than the LOR

Trip Spike Information

Analyte	Spike Concentrations	Recovery Concentration	% Recovery	Comments
				No Trip Spikes were analysed with this batch

Laboratory Control Samples (LCS) Analyses

Analyte Group	Comments
BOD	BOD LCS recovery is within acceptable control limits

Matrix Spike (MS) Analyses

Analyte Group	Comments
All	No MS results are required to be reported

Laboratory Duplicates (LD) Analyses

Analyte Group	Analyte(s)	Sample ID	Comments
All			All LD RPDs from this batch are within acceptable control limits

Field Duplicates (FD) Analyses

Analyte Group	Primary ID	Duplicate ID	Comments
			No FD were analysed with this batch

Field Triplicates (FT) Analyses

Analyte Group	Primary ID	Triplicate ID	Comments
			No FT were analysed with this batch

Surrogate Compound Monitoring Analyses

Analyte Group	Sample ID	Comments
All		No Surrogate results were reported with this batch

Overall Comments

This batch is acceptable for environmental interpretative purposes.

Note: Data validation assesses each analyte in terms of all the data validation variables and only the exceedances and outliers are reported in this form.

*When concentrations are less than the LOR for both primary and duplicate/triplicate results, no RPDs are calculated

Performed By: AM
Date: 28/10/2011

Reviewed By: LBJ
Date: 23/01/2012

DATA VALIDATION SUMMARY SHEET (Sydney)

Project Name:	Whytes Gully New Cell	**Project Number:**	117625003
Primary Laboratory:	ALS	**Workorder Number:**	EW1102582
Secondary Laboratory:	ELS	**Workorder Number:**	60727
Date Sampled:	25/08/2011	**Sample Medium:**	Water

Sample Information

Number of Primary Samples:	9	**Number of Triplicate Samples:**	1
Number of Duplicate Samples:	1	**Number of Other QAQC Samples:**	0

Documentation and Sample Handling Information

	Y/N	Comments
COC completed properly?	Y	
All requested analysis completed?	Y	
Samples received intact and chilled?	Y	
Samples analysed within appropiate holding times?	Y	
Sample volumes sufficient for QC analysis?	Y	
Are there non-NATA accredited methods used?	N	
Chromatograms supplied as appropriate?	N/A	
Laboratory reports signed by authorised personnel?	Y	

QAQC Sample Information (Method Blank - MB, Rinsate Blank - RB, Field Blank - FB, Trip Blank - TB)

Type	Sample ID	Comments
MB	-	All MB results from this batch are less than the LOR

Trip Spike Information

Analyte	Spike Concentrations	Recovery Concentration	% Recovery	Comments
				No Trip Spike was submitted with this batch

Laboratory Control Samples (LCS) Analyses

Analyte Group	Comments
All	All LCS recoveries are within acceptable contorl limits

Matrix Spike (MS) Analyses

Analyte Group	Comments
All	All MS recoveries are within acceptable control limits

Laboratory Duplicates (LD) Analyses

Analyte Group	Analyte(s)	Sample ID	Comments
All			All LD RPDs from this batch are within acceptable control limits

Field Duplicates (FD) Analyses

Analyte Group	Primary ID	Duplicate ID	Comments
	GABH2_25/8/11	QC104_25/8/11	All RPDs are within acceptable control limits

Field Triplicates (FT) Analyses

Analyte Group	Primary ID	Triplicate ID	Comments
	GABH2_25/8/11	QC204_25/8/11	Nitrate as N RPD exceeds acceptable LOR based control limits

Surrogate Compound Monitoring Analyses

Analyte Group	Sample ID	Comments
All		No Surrogate results were reported with this batch

Overall Comments

This batch is acceptable for environmental interpretative purposes.

Note: Data validation assesses each analyte in terms of all the data validation variables and only the exceedances and outliers are reported in this form.

*When concentrations are less than the LOR for both primary and duplicate/triplicate results, no RPDs are calculated

Performed By: AM
Date: 28/10/2011

Reviewed By: LBJ
Date: 23/01/2012

Whytes Gully New Cell
Duplicate Analysis RPDs
117625003

Sample ID	GABH2_25/08/11	QC104_25/08/11	QC204_25/08/11
Sample Type	Primary	Field Duplicate	Field Triplicate
Date Sampled	25/08/2011	25/08/2011	25/08/2011

Analyte	Units	LOR				RPDs Primary vs Duplicate	RPDs Primary vs Inter Duplicate
Nitrite as N	mg/L	0.01	<0.01	<0.01	-	NA	NA
Nitrate as N	mg/L	0.01	0.05	<0.01	0.13	133.3	88.9
Nitrite + Nitrate as N	mg/L	0.01	0.05	<0.01	-	133.3	#VALUE!
Biochemical Oxygen Demand	mg/L	2	<2	<2	<5	NA	NA

Legend
ND = Not Detected (RPDs not calculated if both primary and duplicate results are below LOR)
- = Not analysed/calculated
Acceptable RPDs: RPD <= 30%
RPD > 30%, Analyis result < 10 times LOR
RPD <= 50%, Analysis result > 10 times LOR and < 20 times LOR

DATA VALIDATION SUMMARY SHEET (Sydney)

Project Name:	Whytes Gully New Cell	**Project Number:**	117625003
Primary Laboratory:	ALS	**Workorder Number:**	ES1115894
Secondary Laboratory:	-	**Workorder Number:**	-
Date Sampled:	25/07/2011	**Sample Medium:**	Water

Sample Information

Number of Primary Samples:	2	**Number of Triplicate Samples:**	0
Number of Duplicate Samples:	0	**Number of Other QAQC Samples:**	0

Documentation and Sample Handling Information

	Y/N	Comments
COC completed properly?	Y	
All requested analysis completed?	Y	
Samples received intact and chilled?	Y	
Samples analysed within appropiate holding times?	N	TKN and Ammonia were extracted one day outside of the appropriate holding time. All other analysis were perfomed within appropriate holding time
Sample volumes sufficient for QC analysis?	Y	
Are there non-NATA accredited methods used?	N	
Chromatograms supplied as appropriate?	N/A	
Laboratory reports signed by authorised personnel?	Y	

QAQC Sample Information (Method Blank - MB, Rinsate Blank - RB, Field Blank - FB, Trip Blank - TB)

Type	Sample ID	Comments
MB	-	All MB results from this batch are less than the LOR

Trip Spike Information

Analyte	Spike Concentrations	Recovery Concentration	% Recovery	Comments

Laboratory Control Samples (LCS) Analyses

Analyte Group	Comments
Fumigants	LCS recovery of trans-1.3-Dichloropropylene of 79.1% is slightly less than the lower control limit of 79.3%.

Matrix Spike (MS) Analyses

Analyte Group	Comments
Sulfate as SO42-	MS recovery in anonymous sample was not determined due to background level being greater than or equal to 4x spike level.
Organochlorine Pesticides	MS recovery of beta-BHC of 42.9% in anonymous sample was less than the lower data quality objective of 43.8%.

Laboratory Duplicates (LD) Analyses

Analyte Group	Analyte(s)	Sample ID	Comments
All			All LD RPDs from this batch are within acceptable control limits

Field Duplicates (FD) Analyses

Analyte Group	Primary ID	Duplicate ID	Comments
			No FD were analysed with this batch

Field Triplicates (FT) Analyses

Analyte Group	Primary ID	Triplicate ID	Comments
			No FT were analysed with this batch

Surrogate Compound Monitoring Analyses

Analyte Group	Sample ID	Comments
All		All surrogate compound recoveries are within acceptable control limits.

Overall Comments

Inability to calculate sulfate MS recovery is not expeced to affect the overall data quality of this batch as this analysis was conducted on an anonymous sample

Low beta-BHC MS recovery is not expected to affect the overall data quality of this batch as the recovery wqas only slightly less than the lower control limit

As stated by ALS: Level of reporting raised for toluene due to ambient background levels in the laboratory.
This batch is acceptable for environmental interpretative purposes.

Note: Data validation assesses each analyte in terms of all the data validation variables and only the exceedances and outliers are reported in this form.

*When concentrations are less than the LOR for both primary and duplicate/triplicate results, no RPDs are calculated

Performed By:	AM	**Reviewed By:**	**LBJ**
Date:	28/10/2011	**Date:**	23/01/2012

DATA VALIDATION SUMMARY SHEET (Sydney)

Project Name:	Whytes Gully New Cell	**Project Number:**	117625003
Primary Laboratory:	ALS	**Workorder Number:**	ES1115248
Secondary Laboratory:	ELS	**Workorder Number:**	
Date Sampled:	17/8/11-22/8/11	**Sample Medium:**	Water

Sample Information

Number of Primary Samples:	6	**Number of Triplicate Samples:**	0
Number of Duplicate Samples:	1	**Number of Other QAQC Samples:**	0

Documentation and Sample Handling Information

	Y/N	Comments
COC completed properly?	Y	
All requested analysis completed?	Y	
Samples received intact and chilled?	Y	
Samples analysed within appropiate holding times?	N	pH analysis conducted within one day but ouside recomeneded six hour holding time. All other analysis coducted within appropriate holding times.
Sample volumes sufficient for QC analysis?	Y	
Are there non-NATA accredited methods used?	N	
Chromatograms supplied as appropriate?	N/A	
Laboratory reports signed by authorised personnel?	Y	

QAQC Sample Information (Method Blank - MB, Rinsate Blank - RB, Field Blank - FB, Trip Blank - TB)

Type	Sample ID	Comments
MB	-	All MB results from this batch are less than the LOR

Trip Spike Information

Analyte	Spike Concentrations	Recovery Concentration	% Recovery	Comments
				No Trip spikes were analysed with this batch.

Laboratory Control Samples (LCS) Analyses

Analyte Group	Comments
All	All LSC recoveries from this batch are within acceptable control limits
	.

Matrix Spike (MS) Analyses

Analyte Group	Comments
All	All MS recoveries from this batch are within acceptable control limits.

Laboratory Duplicates (LD) Analyses

Analyte Group	Analyte(s)	Sample ID	Comments
All			All LD RPDs from this batch are within acceptable control limits

Field Duplicates (FD) Analyses

Analyte Group	Primary ID	Duplicate ID	Comments
		GASW_FD01/ 180711	All FD RPDs from this batch are withi acceptable control limits

Field Triplicates (FT) Analyses

Analyte Group	Primary ID	Triplicate ID	Comments
			No FT were analysed with this batch

Surrogate Compound Monitoring Analyses

Analyte Group	Sample ID	Comments
All		All surrogate compound recoveries are within acceptable control limits.

Overall Comments

This batch is acceptable for environmental interpretative purposes.

Note: Data validation assesses each analyte in terms of all the data validation variables and only the exceedances and outliers are reported in this form.

*When concentrations are less than the LOR for both primary and duplicate/triplicate results, no RPDs are calculated

Performed By: AM
Date: 28/10/2011

Reviewed By: LBJ
Date: 23/01/2012

Whytes Gully New Cell
Duplicate Analysis RPDs
117625003

Sample ID	GASW06_180711/	GASW_FD01_180711/	-
Sample Type	Primary	Field Duplicate	Field Triplicate
Date Sampled	18/07/2011	18/07/2011	-

Analyte	Units	LOR				RPDs Primary vs Duplicate	RPDs Primary vs Inter Duplicate
pH Value	pH Unit	0.01	8.3	8.3	-	0.0	-
Electrical Conductivity @ 25°C	µS/cm	1	16300	16200	-	0.6	-
Salinity	g/kg	0.01	9.54	9.45	-	0.9	-
Turbidity	NTU	0.1	36.8	42.1	-	13.4	-
Copper	mg/L	0.001	0.04	0.042	-	4.9	-
Zinc	mg/L	0.005	0.172	0.185	-	7.3	-

Legend
ND = Not Detected (RPDs not calculated if both primary and duplicate results are below LOR)
- = Not analysed/calculated
Acceptable RPDs:
RPD > 30%, Analyis result < 10 times LOR
RPD <= 50%, Analysis result > 10 times LOR and < 20 times LOR

DATA VALIDATION SUMMARY SHEET (Sydney)

Project Name:	Whytes Gully New Cell	**Project Number:**	117625003
Primary Laboratory:	ALS	**Workorder Number:**	ES1117692
Secondary Laboratory:	ELS	**Workorder Number:**	
Date Sampled:	10/08/2011-11/08/2011	**Sample Medium:**	Soil

Sample Information

Number of Primary Samples:	2	**Number of Triplicate Samples:**	0
Number of Duplicate Samples:	0	**Number of Other QAQC Samples:**	0

Documentation and Sample Handling Information

	Y/N	Comments
COC completed properly?	Y	
All requested analysis completed?	Y	
Samples received intact and chilled?	Y	
Samples analysed within appropiate holding times?	N	Soil pH analysed outside of appropriate holding times
Sample volumes sufficient for QC analysis?	Y	
Are there non-NATA accredited methods used?	N	
Chromatograms supplied as appropriate?	N/A	
Laboratory reports signed by authorised personnel?	Y	

QAQC Sample Information (Method Blank - MB, Rinsate Blank - RB, Field Blank - FB, Trip Blank - TB)

Type	Sample ID	Comments
MB	-	All MB results from this batch are less than the LOR

Trip Spike Information

Analyte	Spike Concentrations	Recovery Concentration	% Recovery	Comments

Laboratory Control Samples (LCS) Analyses

Analyte Group	Comments
All	All LCS recoveries from this batch are within acceptable control limits.

Matrix Spike (MS) Analyses

Analyte Group	Comments
All	All MS recoveries from this batch are within acceptable conrtol limits.

Laboratory Duplicates (LD) Analyses

Analyte Group	Analyte(s)	Sample ID	Comments
All			All LD RPDs from this batch are within acceptable control limits

Field Duplicates (FD) Analyses

Analyte Group	Primary ID	Duplicate ID	Comments
			No FD were analysed with this batch

Field Triplicates (FT) Analyses

Analyte Group	Primary ID	Triplicate ID	Comments
			No FT were analysed with this batch

Surrogate Compound Monitoring Analyses

Analyte Group	Sample ID	Comments
All		All surrogate compound recoveries are within acceptable control limits.

Overall Comments

Analysis of soil pH 5 days outside of holding time may have affect the data quality of this analyte. This exceedance is not expected to affect the overall data quality of this batch.

This batch is acceptable for environmental interpretative purposes.

Note: Data validation assesses each analyte in terms of all the data validation variables and only the exceedances and outliers are reported in this form.

*When concentrations are less than the LOR for both primary and duplicate/triplicate results, no RPDs are calculated

Performed By: AM
Date: 28/10/2011

Reviewed By: LBJ
Date: 23/01/2012

DATA VALIDATION SUMMARY SHEET (Sydney)

Project Name:	Whytes Gully New Cell	**Project Number:**	117625003
Primary Laboratory:	ALS	**Workorder Number:**	ES1116709
Secondary Laboratory:	ELS	**Workorder Number:**	59331
Date Sampled:	26/07/2011-29/07/2011	**Sample Medium:**	Soil

Sample Information

Number of Primary Samples:	3	**Number of Triplicate Samples:**	0
Number of Duplicate Samples:	1	**Number of Other QAQC Samples:**	2

Documentation and Sample Handling Information

	Y/N	Comments
COC completed properly?	Y	
All requested analysis completed?	Y	
Samples received intact and chilled?	Y	
Samples analysed within appropiate holding times?	N	Soil pH analysis conducted 2 days outside of appropriate holding time. PCB, OCP, Phenolics and TPH risnate water analysis conducted ouside of appropriate holding time.
Sample volumes sufficient for QC analysis?	Y	
Are there non-NATA accredited methods used?	N	
Chromatograms supplied as appropriate?	N/A	
Laboratory reports signed by authorised personnel?	Y	

QAQC Sample Information (Method Blank - MB, Rinsate Blank - RB, Field Blank - FB, Trip Blank - TB)

Type	Sample ID	Comments
MB	-	All MB results from this batch are less than the LOR

Trip Spike Information

Analyte	Spike Concentrations	Recovery Concentration	% Recovery	Comments

Laboratory Control Samples (LCS) Analyses

Analyte Group	Comments
Soil - Metals	LCS recoveries for copper (118%) and Lead (117%) are greater than the upper conrtoll limits of 114% and 111% respectivley.
Soil - PCBs	LCS recovery for total PCBs (121%) exceeds the upper control limit of 117%.
Water - PCBs	LCS recovery for total PCBs (123%) exceeds the upper control limit of 107%.
Water - Phenolic Compounds	LCS recovery of Pentachlorophenol (100%) exceeds the upper control limit of 95.6%.
	All other LCS recoveries from this batch are within acceptabe control limits.

Matrix Spike (MS) Analyses

Analyte Group	Comments
All	All MS recoveries from this batch are within acceptable conrtol limits.

Laboratory Duplicates (LD) Analyses

Analyte Group	Analyte(s)	Sample ID	Comments
All			All LD RPDs from this batch are within acceptable control limits

Field Duplicates (FD) Analyses

Analyte Group	Primary ID	Duplicate ID	Comments
	GABH06_0.0-0.2_260711	GABHFD01_260711	All FD RPDs are within acceptable control limits

Field Triplicates (FT) Analyses

Analyte Group	Primary ID	Triplicate ID	Comments
	GABH06_0.0-0.2_260711	GABH_FT01_260711	All FT RPDs are within acceptable control limits

Surrogate Compound Monitoring Analyses

Analyte Group	Sample ID	Comments
All		All surrogate compound recoveries are within acceptable control limits.

Overall Comments

Soil LCS recovery exceedances for Metals and PCBs are nort expected to affect the overall data quality of this batch as the recoveries are only slightly outside of acceptable control limits.

Water LCS recovery exceedances are not expected to affect the overall data quality of this batch as they only affect the data quality of the water rinsate QC sample.

This batch is acceptable for environmental interpretative purposes.

Note: Data validation assesses each analyte in terms of all the data validation variables and only the exceedances and outliers are reported in this form.

*When concentrations are less than the LOR for both primary and duplicate/triplicate results, no RPDs are calculated

Performed By: AM
Date: 28/10/2011

Reviewed By: LBJ
Date: 23/01/2012

Whytes Gully New Cell
Duplicate Analysis RPDs
117625003

Sample ID	GABH06_0.0-0.2_260711	GABHFD01_260711/	GABH_FT01_260711
Sample Type	Primary	Field Duplicate	Field Triplicate
Date Sampled	26/07/2011	26/07/2011	26/07/2011

Analyte	Units	LOR				RPDs Primary vs Duplicate	RPDs Primary vs Inter Duplicate
Arsenic	mg/kg	5	<5	<5	<4	NA	NA
Cadmium	mg/kg	1	<1	<1	<0.5	NA	NA
Chromium	mg/kg	2	13	11	9	16.7	36.4
Copper	mg/kg	5	29	30	25	3.4	14.8
Lead	mg/kg	5	26	24	21	8.0	21.3
Nickel	mg/kg	2	5	5	5	0.0	0.0
Zinc	mg/kg	5	56	65	48	14.9	15.4
Mercury	mg/kg	0.1	<0.1	<0.1	<0.1	NA	NA
Total Polychlorinated biphenyls	mg/kg	0.1	<0.10	<0.10	ND	NA	NA
alpha-BHC	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Hexachlorobenzene (HCB)	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
beta-BHC	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
gamma-BHC	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
delta-BHC	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Heptachlor	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Aldrin	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Heptachlor epoxide	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
trans-Chlordane	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
alpha-Endosulfan	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
cis-Chlordane	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Dieldrin	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
4.4`-DDE	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Endrin	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
beta-Endosulfan	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
4.4`-DDD	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Endrin aldehyde	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Endosulfan sulfate	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
4.4`-DDT	mg/kg	0.2	<0.2	<0.2	<0.1	NA	NA
Endrin ketone	mg/kg	0.05	<0.05	<0.05	-	NA	NA
Methoxychlor	mg/kg	0.2	<0.2	<0.2	<0.1	NA	NA
Phenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2-Chlorophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2-Methylphenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
3- & 4-Methylphenol	mg/kg	1	<1.0	<1.0	<2	NA	NA
2-Nitrophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2.4-Dimethylphenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2.4-Dichlorophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2.6-Dichlorophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
4-Chloro-3-Methylphenol	mg/kg	0.5	<0.5	<0.5	-	NA	NA
2.4.6-Trichlorophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2.4.5-Trichlorophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
Pentachlorophenol	mg/kg	2	<2.0	<2.0	<10	NA	NA
Naphthalene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Acenaphthylene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Acenaphthene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Fluorene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Phenanthrene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Anthracene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Fluoranthene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Pyrene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Benz(a)anthracene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Chrysene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Benzo(b)fluoranthene	mg/kg	0.5	<0.5	<0.5		NA	NA
Benzo(k)fluoranthene	mg/kg	0.5	<0.5	<0.5	<0.2	NA	NA
Benzo(a)pyrene	mg/kg	0.5	<0.5	<0.5	<0.05	NA	NA
Indeno(1.2.3.cd)pyrene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Dibenz(a.h)anthracene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Benzo(g.h.i)perylene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Sum of polycyclic aromatic hydrocarbon	mg/kg	0.5	<0.5	<0.5	-	NA	NA
Benzene	mg/kg	0.2	<0.2	<0.2	<0.2	NA	NA
Toluene	mg/kg	0.5	<0.5	<0.5	<0.5	NA	NA
Ethylbenzene	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
meta- & para-Xylene	mg/kg	0.5	<0.5	<0.5	<2	NA	NA
ortho-Xylene	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
Sum of BTEX	mg/kg	0.2	<0.2	<0.2	-	NA	NA
Total Xylenes	mg/kg	0.5	<0.5	<0.5	-	NA	NA
Naphthalene	mg/kg	1	<1	<1	-	NA	NA
C6 - C9 Fraction	mg/kg	10	<10	<10	<25	NA	NA
C10 - C14 Fraction	mg/kg	50	<50	<50	<50	NA	NA
C15 - C28 Fraction	mg/kg	100	<100	<100	<100	NA	NA
C29 - C36 Fraction	mg/kg	100	<100	110	<100	9.5	NA
C10 - C36 Fraction (sum)	mg/kg	50	<50	110	-	75.0	NA
C6 - C10 Fraction	mg/kg	10	<10	<10	-	NA	NA
C6 - C10 Fraction minus BTEX (F1)	mg/kg	10	<10	<10	-	NA	NA
>C10 - C16 Fraction	mg/kg	50	<50	<50	-	NA	NA
>C16 - C34 Fraction	mg/kg	100	<100	150	-	40.0	NA
>C34 - C40 Fraction	mg/kg	100	<100	<100	-	NA	NA
>C10 - C40 Fraction (sum)	mg/kg	50	<50	150	-	100.0	NA

Legend
ND = Not Detected (RPDs not calculated if both primary and duplicate results are below LOR)
- = Not analysed/calculated
Acceptable RPDs:
RPD > 30%, Analyis result < 10 times LOR
RPD <= 50%, Analysis result > 10 times LOR and < 20 times LOR

DATA VALIDATION SUMMARY SHEET (Sydney)

Project Name:	Whytes Gully New Cell	**Project Number:**	117625003
Primary Laboratory:	ALS	**Workorder Number:**	ES1114651
Secondary Laboratory:	ELS	**Workorder Number:**	58255
Date Sampled:	05/07/2011-07/07/2011	**Sample Medium:**	Soil

Sample Information

Number of Primary Samples:	6	**Number of Triplicate Samples:**	1
Number of Duplicate Samples:	1	**Number of Other QAQC Samples:**	2

Documentation and Sample Handling Information

	Y/N	Comments
COC completed properly?	Y	
All requested analysis completed?	Y	
Samples received intact and chilled?	Y	
Samples analysed within appropiate holding times?	Y	
Sample volumes sufficient for QC analysis?	Y	
Are there non-NATA accredited methods used?	N	
Chromatograms supplied as appropriate?	N/A	
Laboratory reports signed by authorised personnel?	Y	

QAQC Sample Information (Method Blank - MB, Rinsate Blank - RB, Field Blank - FB, Trip Blank - TB)

Type	Sample ID	Comments
RB	GACS_RB01_05071	
TB	T.Blank	
MB	-	All MB results from this batch are less than the LOR

Trip Spike Information

Analyte	Spike Concentrations	Recovery Concentration	% Recovery	Comments
				No Trip Blanks were submitted with this batch

Laboratory Control Samples (LCS) Analyses

Analyte Group	Comments
Metals	LCS recovery for copper (87.6%) is less than the lower control limit of 89.2%.
	All other LCS analysis from this batch are within acceptable conrtol limits.

Matrix Spike (MS) Analyses

Analyte Group	Comments
	All MS recoveries from this batch are within acceptable control limits.

Laboratory Duplicates (LD) Analyses

Analyte Group	Analyte(s)	Sample ID	Comments
All			All LD RPDs from this batch are within acceptable control limits

Field Duplicates (FD) Analyses

Analyte Group	Primary ID	Duplicate ID	Comments
	GACS05_1.0-1.2M_050711	GACS_FD02_050711	All FD RPDs are within acceptable control limis

Field Triplicates (FT) Analyses

Analyte Group	Primary ID	Triplicate ID	Comments
	GACS05_1.0-1.2M_050711	GACS_FT02_050711	All FT RPDs are within acceptable control limits

Surrogate Compound Monitoring Analyses

Analyte Group	Sample ID	Comments
All		All surrogate compound recoveries are within acceptable control limits.

Overall Comments

Low LCS recovey for Copper is not expected to affect the overall data quality of this batch as the recovery is only slightly less than the lower control limit,
ALS state that: LCS recovery for Chromium falls outside ALS Dynamic Control Limit. However, they are within the acceptance criteria based on ALS DQO. No further action is required.

ALS state that: Level of reporting raised for toluene due to ambient background levels in the laboratory.
This batch is acceptable for environmental interpretative purposes.

Note: Data validation assesses each analyte in terms of all the data validation variables and only the exceedances and outliers are reported in this form.

*When concentrations are less than the LOR for both primary and duplicate/triplicate results, no RPDs are calculated

Performed By: AM
Date: 28/10/2011

Reviewed By: LBJ
Date: 23/01/2012

Whytes Gully New Cell
Duplicate Analysis RPDs
117625003

Sample ID	GACS05_1.0-1.2M_050711	GACS_FD02_050711	GACS_FT02_050711
Sample Type	Primary	Field Duplicate	Field Triplicate
Date Sampled	5/07/2011	5/07/2011	5/07/2011

Analyte	Units	LOR				RPDs Primary vs Duplicate	RPDs Primary vs Inter Duplicate
Arsenic	mg/kg	5	<5	<5	5	NA	0.0
Cadmium	mg/kg	1	<1	<1	0.6	NA	50.0
Chromium	mg/kg	2	8	10	10	22.2	22.2
Copper	mg/kg	5	26	27	14	3.8	60.0
Lead	mg/kg	5	18	24	24	28.6	28.6
Nickel	mg/kg	2	3	4	3	28.6	0.0
Zinc	mg/kg	5	46	45	25	2.2	59.2
Mercury	mg/kg	0.1	<0.1	<0.1	<0.1	NA	NA
Total Polychlorinated biphenyls	mg/kg	0.1	<0.10	<0.10	ND	NA	NA
alpha-BHC	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Hexachlorobenzene (HCB)	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
beta-BHC	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
gamma-BHC	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
delta-BHC	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Heptachlor	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Aldrin	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Heptachlor epoxide	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
trans-Chlordane	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
alpha-Endosulfan	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
cis-Chlordane	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Dieldrin	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
4.4`-DDE	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Endrin	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
beta-Endosulfan	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
4.4`-DDD	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Endrin aldehyde	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
Endosulfan sulfate	mg/kg	0.05	<0.05	<0.05	<0.1	NA	NA
4.4`-DDT	mg/kg	0.2	<0.2	<0.2	<0.1	NA	NA
Endrin ketone	mg/kg	0.05	<0.05	<0.05	-	NA	NA
Methoxychlor	mg/kg	0.2	<0.2	<0.2	<0.1	NA	NA
Phenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2-Chlorophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2-Methylphenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
3- & 4-Methylphenol	mg/kg	1	<1.0	<1.0	<2	NA	NA
2-Nitrophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2.4-Dimethylphenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2.4-Dichlorophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2.6-Dichlorophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
4-Chloro-3-Methylphenol	mg/kg	0.5	<0.5	<0.5	-	NA	NA
2.4.6-Trichlorophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
2.4.5-Trichlorophenol	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
Pentachlorophenol	mg/kg	2	<2.0	<2.0	<10	NA	NA
Naphthalene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Acenaphthylene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Acenaphthene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Fluorene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Phenanthrene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Anthracene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Fluoranthene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Pyrene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Benz(a)anthracene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Chrysene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Benzo(b)fluoranthene	mg/kg	0.5	<0.5	<0.5		NA	NA
Benzo(k)fluoranthene	mg/kg	0.5	<0.5	<0.5	<0.2	NA	NA
Benzo(a)pyrene	mg/kg	0.5	<0.5	<0.5	<0.05	NA	NA
Indeno(1.2.3.cd)pyrene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Dibenz(a.h)anthracene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Benzo(g.h.i)perylene	mg/kg	0.5	<0.5	<0.5	<0.1	NA	NA
Sum of polycyclic aromatic hydrocarbon	mg/kg	0.5	<0.5	<0.5	-	NA	NA
Benzene	mg/kg	0.2	<0.2	<0.2	<0.2	NA	NA
Toluene	mg/kg	0.5	<0.5	<0.5	<0.5	NA	NA
Ethylbenzene	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
meta- & para-Xylene	mg/kg	0.5	<0.5	<0.5	<2	NA	NA
ortho-Xylene	mg/kg	0.5	<0.5	<0.5	<1	NA	NA
Sum of BTEX	mg/kg	0.2	<0.2	<0.2	-	NA	NA
Total Xylenes	mg/kg	0.5	<0.5	<0.5	-	NA	NA
Naphthalene	mg/kg	1	<1	<1	-	NA	NA
C6 - C9 Fraction	mg/kg	10	<10	<10	<25	NA	NA
C10 - C14 Fraction	mg/kg	50	<50	<50	<50	NA	NA
C15 - C28 Fraction	mg/kg	100	<100	<100	<100	NA	NA
C29 - C36 Fraction	mg/kg	100	<100	<100	<100	NA	NA
C10 - C36 Fraction (sum)	mg/kg	50	<50	<50	-	NA	NA
C6 - C10 Fraction	mg/kg	10	<10	<10	-	NA	NA
C6 - C10 Fraction minus BTEX (F1)	mg/kg	10	<10	<10	-	NA	NA
>C10 - C16 Fraction	mg/kg	50	<50	<50	-	NA	NA
>C16 - C34 Fraction	mg/kg	100	<100	<100	-	NA	NA
>C34 - C40 Fraction	mg/kg	100	<100	<100	-	NA	NA
>C10 - C40 Fraction (sum)	mg/kg	50	<50	<50	-	NA	NA

Legend
ND = Not Detected (RPDs not calculated if both primary and duplicate results are below LOR)
- = Not analysed/calculated
Acceptable RPDs:
RPD > 30%, Analyis result < 10 times LOR
RPD <= 50%, Analysis result > 10 times LOR and < 20 times LOR

APPENDIX G

Laboratory Certificates of Analysis

Provided on DVD

ADDENDUM

TO Michael Herraman **DATE** March 2012

CC

FROM Lange Jorstad **PROJECT No.** 117625003-162-Rev0

INSTALLATION AND MONITORING OF ADDITIONAL GROUNDWATER MONITORING WELLS AT ALTERNATIVE WASTE TECHNOLOGY, NEW CELL FLOOR AND MIXED RECYCLING FACILITY AREAS, WHYTES GULLY RESOURCE RECOVERY PARK, KEMBLA GRANGE

1.0 INTRODUCTION

This addendum to the Hydrogeological Investigation Report (Golder ref. 117625003-070-R-Rev0, dated March 2012) (Golder 2012c) was prepared to document additional site investigation performed by Golder Associates Pty Ltd (Golder) on behalf of Wollongong City Council (Council) as part of the Whytes Gully New Landfill Cell project. The fieldwork was carried out in general accordance with our proposal Variation #4, Golder reference 117625003_L_054_Rev1, dated 4 November 2011. Authorisation to proceed was received via email from Council on 21 November 2011.

This addendum specifically addresses the installation, development and sampling of additional groundwater monitoring wells within the proposed New Cell Floor (NCF), Alternative Waste Technology (AWT) and Mixed Recycling Facility (MRF) areas (see Figure 1 attached). Other aspects of the work carried out as part of Variation #4 is presented in separate reports.

2.0 SCOPE OF WORK

The following scope of work was completed in conjunction with this investigation:

- Advanced one borehole (GABH201) to approximately 25 metres below ground level (mbgl) in the proposed AWT area. Installed one monitoring well in GABH201, including development and measurement of static water level;
- Advanced three boreholes (GABH202 to GABH204) to approximately 15 mbgl in the proposed MRF area. Installed one monitoring well in GABH202, including development and measurement of static water levels;
- Advanced three boreholes (GABH205 to GABH207) to refusal on bedrock in the proposed NCF area. Completed each borehole as a shallow monitoring well by backfilling with sand to 8 mbgl, and screening the wells from 8 mbgl to 1.5 mbgl to represent the shallow water table;
- All monitoring wells were developed prior to groundwater sampling;
- Groundwater sampling of each new monitoring well (NCF and MRF Area), including quality control samples, with groundwater samples dispatched to National Association of Testing Authorities (NATA) accredited laboratories for analysis; and
- Preparation of this report documenting the scope, methodology and results of the investigation program.

3.0 METHODOLOGY

3.1 Borehole Drilling

The drilling program was performed between 12 and 21 December 2011. All boreholes were drilled using a track-mounted drill rig (DrillCat) equipped with solid flight augers fitted with a tungsten-carbide (T-C) bit until refusal on bedrock was reached. Standard penetration tests (SPTs) were carried out at regular intervals to assess soil strength. The following additional drilling techniques were used in specific investigation areas:

- In the NCF area, both SPT *and* push tube samples (U75) were carried out at regular intervals to assess soil strength and collect soil samples for laboratory testing;
- HQ coring techniques were used beyond the auger refusal depth to achieve the intended investigation depth of 15 mbgl (MRF area) and 25 mbgl (AWT area); and
- A flocculent was used during rock coring in the AWT and MRF areas to improve core recovery and drilling water circulation. Drilling additives were not used in the NCF area.

3.2 Monitoring Well Installation and Development

The monitoring well installation was conducted in accordance with Golders' technical procedures, which are compliant with the *Minimum Construction Requirements for Water Bores in Australia (LWBC, 2003)*. Prior to construction of the monitoring wells in the AWT and MRF areas, the boreholes were flushed out with clean water to remove as much drilling mud as possible from the side walls and debris at the base of the borehole.

The following steps were undertaken during well installation:

- Lithological logs for each drilling location were reviewed to assess the interval to be targeted for monitoring by each well, such that well construction details could be modified on the basis of observed lithological conditions;
- The wells were constructed of 50 mm diameter PVC pipe, with factory slotted PVC screen (0.4 mm slots) and the remainder of the well constructed from blank PVC casing extending to approximately 1 m above ground level (magl);
- Washed and graded filter sand was poured into the annulus between the well screen and borehole wall, ensuring that the sand covered the entire screened level to a minimum of 0.5 m above the well screen;
- A layer of bentonite pellets were poured on top of the sand and hydrated to seal off the well screen from potential surface water inflows;
- The annular space above the bentonite seal was backfilled with cement grout to just below ground level;
- The surface completions comprised above ground lockable stainless steel monuments set in concrete; and
- The monitoring wells were installed in accordance with the NSW Office of Water (NOW) Monitoring Bore License number 10BL605033, and were registered with the NOW following installation via submission of a completed "Form A" for each well.

Following installation, the wells were developed by a Golder Engineer on 21 and 22 December 2011 to remove suspended fines from the drilling process, and to improve the hydraulic connection between the well and the surrounding formation. Well development consisted of purging of the wells to visual clarity and monitoring stabilisation of water quality parameters (pH and EC).

Well construction details are provided with the borehole reports (attached) and are summarised in Table 1 below.

Table 1: Summary of monitoring well details

Well No.	Well Installation Date	Drilling Details			Screened Depth (mbgl)	Geology Screened
		Top of Casing (magl)	Surface Elevation (mAHD)	Total Depth (mbgl)		
GABH201	21/12/2011	0.43	NA	25.00	8.0 – 20.0	Sandstone, medium to coarse grained, bedding dipping at 10-15°, orange brown to pale blue grey, moderately to highly weathered becoming slightly weathered with depth.
GABH202	12/12/2011	0.50	NA	12.00	2.0 – 12.0	Clayey sandy gravel, fine to coarse sub-angular to angular brown over clayey sand, medium to coarse grained becoming extremely weathered sandstone.
GABH205	16/12/2011	0.63	NA	7.90	1.5 – 7.9	Silty sandy clay, medium plasticity, dark brown becoming very stiff with depth over sandy clayey gravel, fine to coarse sub-angular to angular.
GABH206	16/12/2011	0.56	NA	8.00	2.0 – 8.0	Silty sandy clay, medium plasticity, brown to orange with some fine to medium sub-angular to angular gravel.
GABH207	15/12/2011	0.56	NA	8.00	2.0 – 8.0	Silty sandy clay, medium plasticity, brown to orange with some fine to medium sub-angular to angular gravel overlying sandy gravelly clay, low to medium plasticity, brown.

3.3 Groundwater Sampling

The newly installed monitoring wells were sampled by a Golder Engineer on 19 January 2012. Monitoring well BH201 was found to be dry at the time of sampling; hence no sample was collected from this location. All groundwater samples were collected using low flow sampling techniques, using a peristaltic pump with new disposable tubing. Sampling record sheets are provided in attachment D. Prior to groundwater sampling, the water levels within the groundwater wells were measured using a water level meter, then purged until the water quality parameters measured at the well head were observed to stabilise. During the purging process, indicator parameters (pH, temperature, electrical conductivity (EC), oxidation-reduction potential (ORP) and dissolved oxygen (DO)) were measured using a TPS 90FLMV water quality meter that was calibrated prior to use (calibration certificates and copies of field sampling forms are attached for reference).

Samples were placed directly into appropriately preserved bottles provided by the laboratory, with field filtering where required, and placed into an ice-filled chest for transport to the laboratory.

Primary and duplicate groundwater samples were analysed by ALS Laboratory Services, and the triplicate groundwater sample was analysed by Envirolab Services, both of which are National Association of Testing Authorities (NATA) accredited for the analyses performed.

3.3.1 Quality Assurance and Quality Control Samples

The following Quality Assurance and Quality Control (QA/QC) samples were collected in conjunction with the investigation program:

- The collection of one duplicate sample from well BH206 (QC100_19/1/12) was used to assess the precision of the laboratory results. The results of the duplicate analyses are included in the analytical results summary table and in the data validation report (attached);
- The collection of one triplicate sample from well BH206 (QC200_19/1/12) was used to assess the precision of the primary laboratory methodology. The results of the triplicate analyses are included in the analytical results summary table and in the data validation report (attached);
- One travel blank was submitted for analysis to assess the potential for cross-contamination associated with sample storage and handling procedures; and
- One rinsate blank (QC300_01/19/12) was collected to assess the efficacy of the equipment decontamination procedures.

3.3.2 Field and Laboratory Analytical Program

The primary and duplicate/triplicate samples were analysed for the following field and laboratory analytical suite:

- Field suite (temperature, pH, EC, ORP and DO);
- Cations and anions (calcium, magnesium, sodium, potassium, chloride, sulfate, fluoride, speciated alkalinity);
- Metals and metalloids (chromium, copper, iron, manganese, mercury, nickel, lead and zinc);
- Nitrate, ammonia, total Kjeldahl nitrogen (TKN) as N;
- Total petroleum hydrocarbons (TPH);
- Benzene, toluene, ethylbenzene, xylenes and naphthalene (BTEXN);
- Biochemical oxygen demand (BOD); and
- Total organic carbon (TOC).

The rinsate sample was analysed for metals, TPH and BTEX and the travel blank was analysed for volatile TPH (C_6-C_9 carbon range) and BTEX.

4.0 GROUNDWATER QUALITY ASSESSMENT CRITERIA

The Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (2000), "Australian and New Zealand Guidelines for Fresh and Marine Water Quality" (ANZECC 2000) were adopted as the groundwater quality assessment criteria for the site. In assigning levels of protection for aquatic ecosystems, the ANZECC (2000) guidelines recognise three types of ecosystems: high conservation value systems, slightly to moderately disturbed systems, and heavily disturbed systems. The guidelines describe slightly to moderately disturbed ecosystems as those in which aquatic biological diversity may have been adversely affected to a relatively small but measurable degree by human activity.

For the purposes of this assessment the ANZECC guideline values for a slightly to moderately disturbed ecosystem are considered to be appropriate considering the nature of the catchment, pertaining to a 95% level of species protection for a freshwater ecosystem. This is considered to be conservative given the land use (municipal landfill) and heavily modified nature of the site, but acknowledges the environmental values of the adjacent land.

Table 2 provides a summary of the adopted criteria for the analytical suite. Only analytes for which high or moderate reliability trigger values are available and that were detected above the laboratory limit of reporting (LOR) have been included. There are six metals for which hardness modified trigger values (HMTV) are available in the ANZECC (2000) guidelines (Cd, Cr, Cu, Pb, Ni, Zn; Table 3.4.3 of the ANZECC 2000 guidelines), which recognize the lower toxicity of these metals with increasing hardness. The hardness modification is calculated according to the specific hardness value for each individual sample, hence HMTV have not been included in Table 2 but are discussed in the results section.

Table 2: ANZECC Criteria for Groundwater Samples

Group	Analytes	95% Protection of Species Fresh Water (µg/L)
Metals & Metalloids [1]	Cadmium	0.2
	Chromium VI	1.0 [2]
	Copper	1.4
	Lead	3.4
	Mercury (inorganic)	0.6
	Nickel	11
	Silver	0.05
	Zinc	8.0 [2]
Non-Metallic Inorganics	Ammonia	900 [2,3]

[1] Trigger values for metals apply to bioavailable (soluble) fraction of total concentrations (filtered samples).

[2] Figure may not protect key test species from chronic toxicity (this refers to experimental chronic figures or geometric mean for species) – check Section 8.3.7 of ANZECC 2000 guidelines for spread of data and its significance.

[3] Ammonia trigger value corresponds to a water pH of 8.0, and must be adjusted when different pH values are recorded.

5.0 QUALITY ASSURANCE AND QUALITY CONTROL

The quality of the groundwater analytical data was assessed through a data validation program. The full data validation report is attached for reference, with the key points summarised below:

- The majority of calculated relative percent difference (RPD) values between primary and duplicate/triplicate groundwater samples were within acceptable tolerance limits. The one exception was the RPD value (60%) for dissolved iron between primary sample GABH02 (0.08 mg/L) and triplicate sample QC201 (0.02 mg/L). However, the reported concentrations are relatively low, and there is no ecological water quality criterion for iron, so the RPD exceedance is not considered to have affected the integrity of the data set;
- The BOD analysis for duplicate sample QC100 was analysed one day beyond the technical holding limit. Both the primary, duplicate and triplicate analytical results were below the LOR for this analyte, such that the holding limit non-conformance is considered unlikely to have materially affected the analytical result;
- Analyte concentrations in the travel blank and rinsate blank were below the laboratory LORs;
- Travel spike recovery values were within the acceptable tolerance ranges; and
- The majority of internal QA/QC checks routinely performed by the laboratories, including the assessment of spikes, blanks, duplicates and surrogates, were within acceptable tolerance limits. The few non-conformances identified were marginal, and are typically associated with internal “dynamic control limits” that are more conservative than the default tolerance limits adopted by Golder.

Based on the results of the data validation process, Golder is satisfied that the data is suitable for environmental interpretive use.

6.0 RESULTS

6.1 Water Level Measurements

The depths to groundwater and total well depths measured on 19 January 2012 are presented in Table 3. As indicated previously, monitoring well BH201 was dry during the sampling event.

The water depth to water in Table 3 is generally consistent with the observations reported in the Hydrogeological Investigation Report, notably including that the depth to water in the NCF area is generally between one and two mbgl.

Table 3: Water levels and total well depth - 19 January 2012

Well ID	Depth to Water		Total Well Depth (mbTOC)
	mbTOC [1]	mbgl	
BH201	Dry	Dry	20.40
BH202	4.15	3.65	12.33
BH205	1.62	0.99	8.50
BH206	1.89	1.33	8.56
BH207	2.84	2.28	8.51

6.2 Laboratory Analytical Results

Groundwater samples were collected from the newly installed monitoring wells (BH202, BH205, BH206 and BH207) and submitted to an analytical laboratory for analysis of a suite of general water quality parameters and potential leachate indicator parameters. The newly installed monitoring well BH201 was found to be dry at the time of sampling and no sample was collected from this location.

A summary of field and laboratory water quality results is presented in the analytical results summary table (Table A) and laboratory certificates of analysis ES1201335 (ALS) and 67851 (ELS), both attached for reference.

In general, the analytical results were similar to those reported in the Hydrogeological Investigation Report for wells in similar locations. The following observations are made regarding the results:

- The field water quality parameters, and particularly pH and EC values, were generally consistent with the results of previous monitoring at the site. EC values in the wells in the NCF area were higher than the value recorded for GABH06S, suggesting a potentially greater leachate influence slightly to the west of GABH06S in the shallow alluvial material;
- Alkalinity in wells BH205, BH206 and BH202 were generally consistent with previously reported values. The alkalinity value at BH207 was higher than the other shallow alluvial wells, and of a similar magnitude to GABH02, suggesting a greater leachate influence at this location;
- The TOC concentration at BH207 was elevated with respect to the rest of the groundwater monitoring network, suggesting a greater leachate influence at this location;
- Ammonia, nitrate, nitrite, TKN and BOD concentrations were generally close to or below the laboratory limits of reporting (LOR), and ammonia was below the ANZECC (2000) trigger value in all wells;
- Metals concentrations were either below the laboratory LOR, or below the ANZECC (2000) trigger values in all wells with the exception of marginal exceedances of the zinc assessment criterion in

BH202, BH205 and BH207. However, the results were below the hardness modified trigger values for zinc at these locations; and

- TPH/TRH and BTEX results were below the laboratory LOR for all wells.

7.0 CONCLUSIONS

The results of field screening and laboratory analysis of groundwater samples from the wells installed in December 2011 in the NCF, AWT and MRF areas (BH201, BH202, BH205, BH206, and BH207) are generally consistent with the groundwater quality identified within and the conclusions drawn in the previous Hydrogeological Investigation Report with the exception of the specific outliers identified above.

It is considered that the results of the assessment of the newly installed wells do not affect the conclusions and outcomes drawn previously from the Hydrogeological Investigation Report.

If you have any questions or would like to discuss further please do not hesitate to contact the undersigned on 02 9478 3900.





Adam Muller
Civil and Environmental Engineer

Lange Jorstad
Principal Hydrogeologist

AM/LJ/am

https://aupws.golder.com/117625003wollongongCityCouncilnewCellwhytesGully/Project Doc/201 b Hydrogeology (groundwater)/Variation 04 addendum/117625003 162 M Rev0.docx

FIGURES

298,000



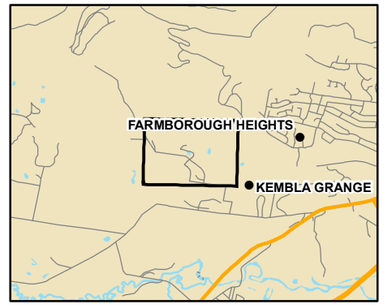
6,184,000

298,000

WHYTES GULLY NEW LANDFILL CELL ADDENDUM HYDROGEOLOGICAL REPORT

WOLLONGONG CITY COUNCIL

BOREHOLE LOCATIONS



LEGEND

- Borehole Location
- Site Boundary
- Approximate Extent Of Waste
- Extent of Landfill Works

NOTES

Aerial Ortho-Photograph provided by AAM Pty. Ltd. taken on 16 May 2011, Reference 18763A. Image Georeferenced.

0 12.5 25 50 75 100 125 150 metres

SCALE (at A3) 1:4,000

Coordinate System: GDA 1994 MGA Zone 56

PROJECT: **117625003**
DATE: **26/03/2012**
DRAWN: **FA**
CHECKED: **JMc**

FIGURE 1

Golder Associates

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File Location: J:\GIS\Jobs\117625003_Wollongong Council_New Landfill Cell_Whytes Gully\Workspaces\117625003_162_R_F0001_Boreholes.mxd

SUMMARY TABLES

Table A: Water Quality Results Summary Table
Whytes Gully New Landfill Cell
Project No. 117625003_162_R_Rev0

				Well ID	BH205	BH206	QC100	QC200	BH207	BH202
				Sample Date	19/01/2012	19/01/2012	19/01/2012	19/01/2012	19/01/2012	19/01/2012
				Type	Primary	Primary	Duplicate	Triplicate	Primary	Primary
				Primary Sample	N/A	N/A	BH206	BH206	N/A	N/A
				Laboratory	ALS	ALS	ALS	ELS	ALS	ALS
				Lab Report No	ES1201335	ES1201335	ES1201335	67851	ES1201335	ES1201335
				Lab Sample No	1	2	5	1	3	4
Analytes	**Unit**	**LOR**	**ANZECC**							
Field Parameters										
Static Water Level	mBTOC			1.62	1.89	NA	NA	2.84	4.15
Static Water Level	mBGL			0.99	1.33	NA	NA	2.28	3.65
Static Water Level	mAHD					NA	NA		
Field-pH	-log[H$^+$]			6.68	6.65	NA	NA	6.57	6.71
Field-temp	°C			17.7	16.9	NA	NA	17.1	18.8
Field-redox	mV			47.8	64.3	NA	NA	40.9	11.6
Field-EC	µS/cm			5295	4876	NA	NA	5047	2630
Field Dissolved oxygen	ppm			0.20	0.45	NA	NA	0.42	0.14
Major Ions									
Total Hardness as CaCO3	mg/L	1		1488	1371	1336	1165	1158	531
Hydroxide Alkalinity as CaCO3	mg/L	1		<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	mg/L	1		<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	mg/L	1		483	587	572	630	1120	575
Total Alkalinity as CaCO3	mg/L	1		483	587	572	630	1120	575
Sulfate as SO4 - Turbidimetric	mg/L	1		350	381	371	330	263	332
Chloride	mg/L	1		1740	1530	1530	1400	1450	564
Calcium	mg/L	1		212	188	192	170	124	79
Magnesium	mg/L	1		233	219	208	180	206	81
Sodium	mg/L	1		919	938	898	860	1070	514
Potassium	mg/L	1		<1	<1	<1	0.7	<1	2
Fluoride	mg/L	0.1		0.8	0.9	0.9	0.77	0.8	0.8
Total Anions	meq/L	0.01		66	62.8	62.3	-	68.8	34.3
Total Cations	meq/L	0.01		69.7	68.2	65.8	-	69.7	33
Ionic Balance	%	0.01		2.72	4.1	2.68	0.56	0.65	1.95
Nutrients									
Ammonia as N	mg/L	0.01	0.9	0.01	0.01	0.01	0.007	<0.01	0.02
Nitrite as N	mg/L	0.01		<0.01	<0.01	<0.01	<0.005	<0.01	0.03
Nitrate as N	mg/L	0.01		0.06	0.28	<0.01	0.009	<0.01	1.09
Nitrite + Nitrate as N	mg/L	0.01		0.06	0.28	<0.01	-	<0.01	1.12
Total Kjeldahl Nitrogen as N	mg/L	0.1		<0.1	0.2	<0.1	0.5	0.2	0.3
Total Organic Carbon	mg/L	1		<1	<1	<1	3	25	<1
Biochemical Oxygen Demand	mg/L	2		<2	<2	<2	<4	<2	<2
Metals and Metalloids (dissolved) **									
Chromium	mg/L	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.0014	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	mg/L	0.001	0.0034	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.001	1.9	0.242	0.049	0.053	0.066	0.108	0.054
Nickel	mg/L	0.001	0.011	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	mg/L	0.005	0.008	0.009	0.006	0.006	0.006	0.009	0.01
Iron	mg/L	0.05	-	<0.05	<0.05	0.06	<0.01	<0.05	<0.05
Mercury	mg/L	0.0001	0.0006	<0.0001	<0.0001	<0.0001	<0.00005	<0.0001	<0.0001

** All reported exceedances of the ANZECC (2000) criterion for zinc were below the HMTV calculated for each sample.

BTEX									
Benzene	µg/L	1	950	<1	<1	<1	<1	<1	<1
Toluene	µg/L	2		<5	<5	<5	<1	<5	<5
Ethylbenzene	µg/L	2		<2	<2	<2	<1	<2	<2
meta- & para-Xylene	µg/L	2	200	<2	<2	<2	<2	<2	<2
ortho-Xylene	µg/L	2	350	<2	<2	<2	<1	<2	<2
Total Xylenes	µg/L	2		<2	<2	<2	ND	<2	<2
Sum of BTEX	µg/L	1		<1	<1	<1	ND	<1	<1
Naphthalene	µg/L	5	16	<5	<5	<5	N/A	<5	<5
Total Petroleum Hydrocarbons									
C6 - C9 Fraction	µg/L	20		<20	<20	<20	<10	<20	<20
C10 - C14 Fraction	µg/L	50		<50	<50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100		<100	<100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50		<50	<50	<50	<100	<50	<50
C10 - C36 Fraction (sum)	µg/L	50		<50	<50	<50	ND	<50	<50
Total Recoverable Hydrocarbons									
C6 - C10 Fraction	µg/L	20		<20	<20	<20	-	<20	<20
C6 - C10 Fraction minus BTEX (F1)	µg/L	20		<20	<20	<20	-	<20	<20
>C10 - C16 Fraction	µg/L	100		<100	<100	<100	-	<100	<100
>C16 - C34 Fraction	µg/L	100		<100	<100	<100	-	<100	<100
>C34 - C40 Fraction	µg/L	100		<100	<100	<100	-	<100	<100
>C10 - C40 Fraction (sum)	µg/L	100		<100	<100	<100	-	<100	<100

Notes:
NA = not applicable
- = not analysed

Prepared by: AM Date: 02/02/2012
Checked by: Date:

DATA VALIDATION

DATA VALIDATION SUMMARY SHEET (Sydney)

Project Name:	Whytes Gully New Cell	**Project Number:**	117625003
Primary Laboratory:	ALS	**Workorder Number:**	ES1201335
Secondary Laboratory:	ELS	**Workorder Number:**	67851
Date Sampled:	19/01/2012	**Sample Medium:**	Water

Sample Information

Number of Primary Samples:	4	**Number of Triplicate Samples:**	1
Number of Duplicate Samples:	1	**Number of Other QAQC Samples:**	2

Documentation and Sample Handling Information

	Y/N	Comments
COC completed properly?	Y	
All requested analysis completed?	Y	
Samples received intact and chilled?	Y	ALS samples received at 3.2°c ELS samples received "cool"
Samples analysed within appropriate holding times?	N	Sample QC100 overdue for analysis by one day. All other analysis was conducted within appropriate holding time.
Sample volumes sufficient for QC analysis?	Y	
Are there non-NATA accredited methods used?	N	
Chromatograms supplied as appropriate?	N/A	
Laboratory reports signed by authorised personnel?	Y	

QAQC Sample Information (Method Blank - MB, Rinsate Blank - RB, Field Blank - FB, Trip Blank - TB)

Type	Sample ID	Comments
FB		All results less than LOR
MB		All MB less than LOR

Trip Spike Information

Analyte	Spike Concentrations	Recovery Concentration	% Recovery	Comments
				No trip spikes were submitted with this batch

Laboratory Control Samples (LCS) Analyses

Analyte Group	Comments
Metals	LCS recovery for Chromium (75.2%), Copper (86.6%), Nickel (82.6%), Zinc (81.3% and Iron (78.1%) are less than the lower control limits of 91%, 87%, 89%, 85% and 84% respectively.
	All other LCS recoveries are within acceptable control limits.

Matrix Spike (MS) Analyses

Analyte Group	Comments
	Sulfate as SO4- Turbidimetric MS recovery on anonymous sample could not be determined die to background level greater than or equal to 4x spike level.
	All other MS recoveries are within acceptable control limits

Laboratory Duplicates (LD) Analyses

Analyte Group	Analyte(s)	Sample ID	Comments
			All LD RPDs are within acceptable control limits.

Field Duplicates (FD) Analyses

Analyte Group	Primary ID	Duplicate ID	Comments
Nutrients	BH206	QC100	RPDs for Nitrite as N (186.2%) and Nitrite + Nitrate as N (186.2%) exceed LOR based acceptance criteria.
			All other FD RPDs are within LOR based acceptance criteria.

Field Triplicates (FT) Analyses

Analyte Group	Primary ID	Triplicate ID	Comments
	BH206	QC200	RPD for Nitrite as N (187.5%) exceeds LOR based acceptance criteria.
			All other FT RPDs are within LOR based acceptance criteria.

Surrogate Compound Monitoring Analyses

Analyte Group	Sample ID	Comments
		All surrogate recoveries are within acceptable control limits.

Overall Comments

As stated by ALS: LCS recoveries for some elements fall outside ALS Dynamic Control Limit. However, they are within the acceptance criteria based on ALS DQO. No further action is required.

As stated by ALS: Level of reporting raised for toluene due to ambient background levels in the laboratory.
Elevated RPDs for Nitrite is not expected to affect the overall quality of the data as the concentrations detected are significantly less than levels that would be a cause for concern. As a conservative measure the highest of the primary/duplicate/triplicate will be used for interpretation of the data.
This batch is considered acceptable for environmental interpretative purposes.

Note: Data validation assesses each analyte in terms of all the data validation variables and only the exceedances and outliers are reported in this form.

*When concentrations are less than the LOR for both primary and duplicate/triplicate results, no RPDs are calculated

Performed By: AM
Date: 2/02/2012

Checked By:
Date:

117625003
Whytes gully New Cell
RPD analysis

	Sample ID	BH206	QC100	QC200	
	Sample Type	Primary	Field Duplicate	Field Triplicate	
	Date Sampled	19/01/2012	19/01/2012	19/01/2012	

Analyte	Units	LOR				RPDs Primary vs Duplicate	RPDs Primary vs Inter Duplicate
Major Ions							
Hydroxide Alkalinity as CaCO3	mg/L	1	<1	<1	<1	NA	NA
Carbonate Alkalinity as CaCO3	mg/L	1	<1	<1	<1	NA	NA
Bicarbonate Alkalinity as CaCO3	mg/L	1	587	572	630	2.6	7.1
Total Alkalinity as CaCO3	mg/L	1	587	572	630	2.6	7.1
Sulfate as SO4 - Turbidimetric	mg/L	1	381	371	330	2.7	14.3
Chloride	mg/L	1	1530	1530	1400	0.0	8.9
Calcium	mg/L	1	188	192	170	2.1	
Magnesium	mg/L	1	219	208	180	5.2	19.5
Sodium	mg/L	1	938	898	860	4.4	8.7
Potassium	mg/L	1	<1	<1	0.7	NA	35.3
Fluoride	mg/L	0.1	0.9	0.9	0.77	0.0	15.6
Total Anions	meq/L	0.01	62.8	62.3	-	0.8	-
Total Cations	meq/L	0.01	68.2	65.8	-	3.6	-
Ionic Balance	%	0.01	4.1	2.68	0.56	-	-
Nutrients							
Ammonia as N	mg/L	0.01	0.01	0.01	0.007	0.0	35.3
Nitrite as N	mg/L	0.01	<0.01	<0.01	<0.005	NA	NA
Nitrate as N	mg/L	0.01	0.28	<0.01	0.009	186.2	187.5
Nitrite + Nitrate as N	mg/L	0.01	0.28	<0.01	-	186.2	-
Total Kjeldahl Nitrogen as N	mg/L	0.1	0.2	<0.1	0.5	66.7	85.7
Total Organic Carbon	mg/L	1	<1	<1	3	NA	100.0
Biochemical Oxygen Demand	mg/L	2	<2	<2	<4	NA	NA
Metals and Metalloids (dissolved)							
Chromium	mg/L	0.001	<0.001	<0.001	<0.001	NA	NA
Copper	mg/L	0.001	<0.001	<0.001	<0.001	NA	NA
Lead	mg/L	0.001	0.001	<0.001	<0.001	0.0	0.0
Manganese	mg/L	0.001	0.049	0.053	0.066	7.8	29.6
Nickel	mg/L	0.001	<0.001	<0.001	<0.001	NA	NA
Zinc	mg/L	0.005	0.006	0.006	0.006	0.0	0.0
Iron	mg/L	0.05	<0.05	0.06	<10	18.2	NA
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.05	NA	NA
BTEX							
Benzene	µg/L	1	<1	<1	<1	NA	NA
Toluene	µg/L	2	<5	<5	<1	NA	NA
Ethylbenzene	µg/L	2	<2	<2	<1	NA	NA
meta- & para-Xylene	µg/L	2	<2	<2	<2	NA	NA
ortho-Xylene	µg/L	2	<2	<2	<1	NA	NA
Total Xylenes	µg/L	2	<2	<2	ND	NA	-
Sum of BTEX	µg/L	1	<1	<1	ND	NA	-
Total Petroleum Hydrocarbons							NA
C6 - C9 Fraction	µg/L	20	<20	<20	<10	NA	NA
C10 - C14 Fraction	µg/L	50	<50	<50	<50	NA	NA
C15 - C28 Fraction	µg/L	100	<100	<100	<100	NA	NA
C29 - C36 Fraction	µg/L	50	<50	<50	<100	NA	NA
C10 - C36 Fraction (sum)	µg/L	50	<50	<50	ND	NA	-
Total Recoverable Hydrocarbons							
C6 - C10 Fraction	µg/L	20	<20	<20	-	NA	-
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	<20	<20	-	NA	-
>C10 - C16 Fraction	µg/L	100	<100	<100	-	NA	-
>C16 - C34 Fraction	µg/L	100	<100	<100	-	NA	-
>C34 - C40 Fraction	µg/L	100	<100	<100	-	NA	-
>C10 - C40 Fraction (sum)	µg/L	100	<100	<100	-	NA	-

Legend
ND = Not Detected (RPDs not calculated if both primary and duplicate results are below LOR)
- = Not analysed/calculated
Acceptable RPDs: RPD <= 30%
RPD > 30%, Analyis result < 10 times LOR
RPD <= 50%, Analysis result > 10 times LOR and < 20 times LOR

LABORATORY CERTIFICATES

Provided on DVD

SAMPLING RECORDS

GROUNDWATER SAMPLING RECORD FORM FOR LOW FLOW PURGING

Golder Associates

PROJECT INFORMATION

Project Number: 117625003
Client: EXCO
Site Location: Whynot's Gully

Date: 19/1/12
Sampled By: AM

GROUNDWATER WELL DATA

BORE ID: BH202

Information recorded on site

Diameter of standpipe (mm)	50
Standpipe stick up (m)	0.50m
Time	12:55
Depth to water (mbRP)	4.15m
Total depth of well (mbRP)	12.33m
Thickness of sediment on base of well (m)	~0.5m

Interface probe used?	(YES) / NO
Depth to product (mbRP)	Nil
Depth to water (mbRP)	4.15
Thickness of product (m)	Nil

Information from file

Surveyed reference point	
Depth of well (from log)	
Standard flow rate (L/min)	
Depth of pump intake (mbRP)	
Length of hose (m)	
Volume in hose (m)	

Note: Standard reference point is top of PVC standpipe
mbRP - metres below top of reference point
Hose volume - 0.1 L/m of 12mm diameter hose

PURGING RECORD

Depth to water after placement of pump (mbRP) 4.15

Time	Volume Purged (L)	Conductivity (mS or µS)	Temp (°C)	pH	Redox Potential (mV)	Dissolved Oxygen (mg/L)	Depth to Water (mbRP)	Appearance (colour, turbidity, odour, etc)
1300	3	2661	19.0	6.74	+37.5	0.12	4.32	clear, Lowt, No odour, Rusty
1305	6	2625	18.9	6.73	+27.8	0.16	4.34	"
1310	9	2632	18.8	6.72	+21.0	0.11	4.35	"
1315	12	2629	18.8	6.72	+14.5	0.12	4.36	"
13:20	15	2630	18.8	6.71	+11.4	0.13	4.36	"
13:25	18	2630	18.8	6.71	+11.6	0.14	4.36	"
Total vol. purged (L)	18			Flow Rate (L/min)		0.64/min		

Depth to water at end of purging (mbRP) 4.36
Purging and Sampling Equipment: New pump

SAMPLING RECORD

Time sampled: 13:30
Sample ID. BH202.19/1/12
Sample Appearance:
Colour Clear
Odour None
Samples filtered for metals?: (Yes) / No
Turbidity: (Low) / Medium / High
Hydrocarbon sheen? Nil
Duplicate sample taken? / Dup ID.: No Dups.

Sample Container and Preservation:
2x500mL Amber 1x125 Amber 1x500 plastic 1x250 plastic 1x Ammonia
1x TOC 2x VOA 1x filtered metals

OBSERVATIONS

Weather Conditions: Temperature: Hot
Precipitation: Nil

Notes:

GROUNDWATER SAMPLING RECORD FORM FOR LOW FLOW PURGING

Golder Associates

PROJECT INFORMATION

Project Number: 117625003
Client: WCC
Site Location: Chester Gully

Date: 19/1/12
Sampled By: AM

GROUNDWATER WELL DATA

BORE ID: BH205

Information recorded on site

Diameter of standpipe (mm)	50mm
Standpipe stick up (m)	0.63
Time	11.20am
Depth to water (mbRP)	1.61m
Total depth of well (mbRP)	8.50
Thickness of sediment on base of well (m)	Nil

Information from file

Surveyed reference point	
Depth of well (from log)	
Standard flow rate (L/min)	
Depth of pump intake (mbRP)	
Length of hose (m)	
Volume in hose (m)	

Interface probe used?	(YES) / NO
Depth to product (mbRP)	Nil
Depth to water (mbRP)	1.61m
Thickness of product (m)	Nil

Note: Standard reference point is top of PVC standpipe
mbRP - metres below top of reference point
Hose volume - 0.1 L/m of 12mm diameter hose

PURGING RECORD

Depth to water after placement of pump (mbRP) 1.61m

Time	Volume Purged (L)	Conductivity (mS or (µS))	Temp (°C)	pH	Redox Potential (mV)	Dissolved Oxygen (mg/L)	Depth to Water (mbRP)	Appearance (colour, turbidity, odour, etc)
11.35	3	5370	17.3	6.68	+115.5	0.17	2.34	light Brown, low T, No odour
11.40	6	5355	17.4	6.69	+91.7	0.22	2.56	clear, low T, No odour, No sheen
11.45	9	5364	17.5	6.68	+79.1	0.22	2.63	" " "
11.50	12	5334	17.5	6.68	+73.4	0.13	2.68	" " "
11.55	15	5350	17.6	6.68	+57.0	0.14	2.72	" " "
12:00	18	5302	17.5	6.69	+53.1	0.16	2.76	" " "
12'05	21	5295	17.7	6.68	+47.8	0.20	2.79	" " "
Total vol. purged (L)	21			Flow Rate (L/min)	0.6L/min			

Depth to water at end of purging (mbRP) 2.79mbtoc
Purging and Sampling Equipment: Geo pump

SAMPLING RECORD

Time sampled: 12:00
Sample ID. BH205.19/1/12
Sample Appearance:
Samples filtered for metals?: (Yes) / No
Colour clear
Turbidity: Low / Medium / High
Odour Nil
Hydrocarbon sheen? Nil
Sample Container and Preservation:
Duplicate sample taken? / Dup ID.: No Dup
2x500mL Amber, 1x125 Amber, 1x500mL Plastic 1x250 Plastic 1x Amonia
1x TOC 2x BTEX 1x filtered metals

OBSERVATIONS

Weather Conditions: Temperature: Warm
Precipitation: Nil
Notes: Logger pulled up 11:20am 1.61m

GROUNDWATER SAMPLING RECORD FORM FOR LOW FLOW PURGING

Golder Associates

PROJECT INFORMATION

Project Number: 117625003
Client: WCC
Site Location: Whytes Gully

Date: 19/1/12
Sampled By: AM

GROUNDWATER WELL DATA

BORE ID: BH206

Information recorded on site

Diameter of standpipe (mm)	50
Standpipe stick up (m)	0.56
Time	10:00
Depth to water (mbRP)	1.86mbtoc
Total depth of well (mbRP)	8.56m
Thickness of sediment on base of well (m)	Nil

Interface probe used?	YES / NO
Depth to product (mbRP)	Nil
Depth to water (mbRP)	1.86m
Thickness of product (m)	Nil

Information from file

Surveyed reference point	
Depth of well (from log)	
Standard flow rate (L/min)	
Depth of pump intake (mbRP)	
Length of hose (m)	
Volume in hose (m)	

Note: Standard reference point is top of PVC standpipe
mbRP - metres below top of reference point
Hose volume - 0.1 L/m of 12mm diameter hose

PURGING DATA

Depth to water at commencement of purge (mbRP) 1.86m

Time	Volume Purged (L)	Conductivity (mS or µS)	Temp (°C)	pH	Redox Potential (mV)	Dissolved Oxygen (mg/L)	Depth to Water (mbRP)	Appearance (colour, turbidity, odour, etc)
10:10	3	4952	16.9	6.60	87.7	0.23	2.20	clear, low T, Nil O, No sheen
10:15	6	4872	16.9	6.61	74.3	0.66	2.24	"
10:20	9	4801	17.0	6.64	72.2	0.21	2.25	"
10:25	12	4806	17.0	6.64	68.3	0.31	2.26	"
10:30	15	4801	17.0	6.65	66.0	0.47	2.28	"
10:35	18	4876	16.9	6.65	64.3	0.45	2.28	
Total vol. purged (L)	18			Flow Rate (L/min)		0.6L/min		

Depth to water at end of purging (mbRP) 2.28m
Purging and Sampling Equipment: Geo Pump

SAMPLING RECORD

Time sampled: 10:45am
Sample ID: BH206
Sample Appearance:
Colour: clear
Odour: Nil
Samples filtered for metals?: (Yes) / No
Turbidity: (Low) / Medium / High
Hydrocarbon sheen? Nil
Duplicate sample taken? / Dup ID: QC100-19/1/12 10:00 QC200-19/1/12
Sample Container and Preservation:
2x 500mL Amber 1x 125 amber 1x 500 Plastic 1x 250 plastic 1x Ammonia
1x TOC 1x BTEX 1x filtered metals

OBSERVATIONS

Weather Conditions: Temperature: Warm - Hot
Precipitation: Nil
Notes:

GROUNDWATER SAMPLING RECORD FORM
~~FOR THREE WELL VOLUME METHOD~~ Low flow Sampling

Golder Associates

PROJECT INFORMATION

Project Number: 117623003
Client: WCC
Site Location: Whyalla Cully

Date: 19/1/12
Sampled By: AM

GROUNDWATER WELL DATA

BORE ID BH207

Information from file

Surveyed reference point	
Depth of well (from log)	
Diameter of well (inc filter pack) (mm)	
Height of filter pack (m)	

Information recorded on site

Diameter of standpipe (mm)	50
Standpipe stick up (m)	0.56m btoc
Time	8:30am
Depth to water (mbRP)	2.82 mbtoc
Total depth of well (mbRP)	8.51m
Thickness of sediment on base of well (m)	N.M.
Height of water in standpipe (m)	
Well volume (L)	

Note:

Standard reference point is top of PVC standpipe
mbRP - metres below top of reference point

Interface probe used?	(YES) / NO
Depth to product (mbRP)	N/A
Depth to water (mbRP)	2.82m
Thickness of product (m)	Nil

Water column above filter pack, well volume wihtin 50mm standpipe is 2 litres/m

Estimation of Standing Well Volumes for 50 mm diameter standpipes, for height of water column within filter pack

Well diameter (standpipe plus filter pack)	100mm	115mm	120mm	125mm	150mm	200mm
Litres per lineal meter of water in bore	3.7	4.5	4.8	5.1	6.7	10.8

PURGING RECORD

Depth to water	Time	Volume Purged (L)	Conductivity (mS or µS)	Temp (°C)	pH	Redox Potential (mV)	Dissolved Oxygen (mg/L)	Appearance (colour, turbidity, odour, etc)
3.12m	9:00	3	5175	17.0	6.58	+75.3	0.09	L-M turb Brown, Nodo
3.16	9:05	6	5144	17.2	6.58	+72.4	0.14	"
3.20	9.10	9	5113	17.2	6.57	+70.3	0.25	"
3.22	9.15	12	5098	17.1	6.57	53.4	0.29	but L turb " clear
3.23	9:20	15	5075	17.1	6.57	45.9	0.39	"
3.23	9:25	18	5069	17.1	6.57	39.9	0.45	"
3.23	9:30	21	5067	17.1	6.57	40.9	0.42	"
	Total vol. purged (L)	21		~~No. bore vol. purged~~		Flow rate	Purging Time (minutes)	35

= 0.6 L/min

Depth to water at end of purging (mbRP) 3.23mbtoc
Purging Method: Low flow

SAMPLING RECORD

Sampling method: Low flow
Time sampled: 9:30am

Sample ID. BH207_19/1/12
Samples filtered for metals?: Yes / No

Sample Appearance:
Colour clear
Odour Nil

Turbidity Low / Medium / High
Hydrocarbon sheen? NO

Sample Container and Preservation:
Duplicate sample taken? / Dup ID.: No dup

2x500mL Amber 1x 125 amber 1x 500mL Plastic 1x 250mL Plastic 1x Ammonia
1x TOC 2x BTEX 1x filtered metals.

OBSERVATIONS

Weather Conditions: Temperature: cool - warm
Precipitation : Nil overcast

Notes:

CALIBRATION RECORD

Multi Parameter Water Meter

Instrument **YSI Quatro Pro Plus**
Serial No. **11K101268**

airmet
Air-Met Scientific Pty Ltd
1300 137 067

Item	Test	Pass	Comments
Battery	Charge Condition	✓	
	Fuses	✓	
	Capacity	✓	
Switch/keypad	Operation	✓	
Display	Intensity	✓	
	Operation (segments)	✓	
Grill Filter	Condition	✓	
	Seal	✓	
PCB	Condition	✓	
Connectors	Condition	✓	
Sensor	1. pH	✓	
	2. mV	✓	
	3. EC	✓	
	4. D.O	✓	
	5. Temp	✓	
Alarms	Beeper		
	Settings		
Software	Version		
Data logger	Operation		
Download	Operation		
Other tests:			

Certificate of Calibration

This is to certify that the above instrument has been calibrated to the following specifications:

Sensor	Serial no	Standard Solutions	Certified	Solution Bottle Number	Instrument Reading
1. pH 7.00		pH 7.00		IK2009	pH 7.02
2. pH 4.00		pH 4.00		IL1215	pH 4.04
3. mV		225.2mV		IK1658/JB1767	224.7mV
4. EC		2.76 mS		IK2011	2.73mS
6. D.O		0 ppm		212	0.04ppm
7. Temp		24.3°C		MultiTherm	24.4°C

Calibrated by: JA **Jacob Arnott**

Calibration date: **18/01/2012**

Next calibration due: **16/07/2012**

APPENDIX G4

Surface Water Report

March 2012

Surface Water Assessment

Submitted to:
Wollongong City Council

REPORT

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Golder Associates

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1.0 INTRODUCTION

This document describes the surface water assessment that has been undertaken to assess the long term surface water management requirements associated with the Whytes Gully New Landfill Cell Project. Located at the existing Whytes Gully Resource Recovery Park (the site), the Project would create approximately 6 million cubic metres of additional landfill capacity. The existing landfill is operated by Wollongong City Council (Council). The new landfill cell is proposed to be integrated with the existing landfill cells in a 'piggy back' formation.

The scope of this assessment includes:

- Review of existing surface water management system
- Sizing of Stormwater Management Infrastructure for the Project
- Assessment of Onsite Detention Requirements

Surface water management is an important part of the Project to ensure that the proposed activities do not adversely impact upon the surrounding land or drainage lines and waterways as a result of water quality or the quantity leaving the site.

This report outlines the existing surface water regime at the site and describes the proposed water management that would be implemented in conjunction with the activities proposed for the site.

2.0 EXISTING ENVIRONMENT

2.1 Location

The site is located on Reddalls Road, Kembla Grange NSW. The site is generally bounded by Reddalls Road to the south and west, rural residential lands to the north, north-east and north-west, and a water treatment plant to the south east. An industrial area lies to the south of Reddalls Road and Dapto Creek lies to the west. The residential suburb of Farmborough Heights is located approximately 360 m to the north east over a ridgeline.

2.2 Topography and Hydrology

The west-northwest and eastern extents of the landfill area are bounded by ridgelines, referred to as the western ridge and eastern ridge. A central north-south trending ridgeline, referred to as the central ridge, separates the two existing landfill areas, the Western Gully landfill and Eastern Gully landfill (refer Section 3.0). The site rises from RL 15 m at the south west to RL 100 m at the north east.

The current surface of the Western Gully landfill is generally sloped at approximately 5H:1V, with indistinct benches at 5m to 10m vertical intervals. The landfill surface above RL 80 m has gentler slopes, generally flatter than 10%.

The current surface of the Eastern Gully landfill has an upper platform portion where active landfilling is taking place, as well as a southwest-facing batter portion. The batter portion has an average slope of approximately 4H:1V and is terraced with benches at 2m to 3m vertical intervals, bench widths at 3m to 5m, and slope inclinations of 2H:1V to 3H:1V between benches.

The general surface water drainage direction on the site is from the north east towards the south west. The catchment area of the site is approximately 50 ha and extends from a ridge to the north of the site to Reddalls Road to the south. Run-on to the site is minimal due to the site being bounded by ridgelines.

Surface water runoff from covered areas of the Western and Eastern Gully landfills is captured by swales on the landfill surface. The swales divert the runoff towards drains around the perimeter of the landfills and to a central drain between the Eastern and Western Gully landfills. Runoff from the natural slope above the northern edge of the Eastern Gully landfill (rainforest area) is also directed to the central drain.

Surface water runoff reports to the surface water ponds at the southwest corner of the site before discharge to Dapto Creek.

A portion of surface water runoff from the Western ridge is diverted offsite to Dapto Creek via a culvert under Reddalls Road.

2.3 Geology and Soils

Based on the 1:100,000 geological map 'Wollongong-Port Hacking' (Department of Primary Industries, 1985) the site is on the boundary of two major geological formations. The southern part of the site is underlain by fluvial sands, silts and clays associated with Dapto Creek. Sandstone of the Budgong Sandstone formation underlies these alluvials. The Budgong Sandstone formation typically comprises red, brown and grey lithic sandstone. The northern portion of the site is underlain by interbedded lithic sandstone, coal, carbonaceous claystone, siltstone and claystone of the Pheasants Nest Formation. It appears that the Pheasants Nest formation is mainly encountered on the ridgelines.

The Environmental Impact Statement (EIS, 1982) indicates that prior to landfilling, volcanic sandstone covered most of the site with a transition to andesitic sandstone with coal seams, carbonaceous shale and mudrock in the higher section (above approximately RL 100 mAHD) and a zone of alluvium, gravels and sands in the lower sections (below approximately RL 30 mAHD). Bedrock is reported to appear at the surface in the upper sections of the site.

The Geotechnical Investigation Report prepared by Golder for the Project (ref: 117625003_077_Rev1. March 2012) summarises the conditions at the site.

2.4 Regional and Local Catchments

The site lies at the foot of Mt. Kembla and is located within the catchment of Dapto Creek which discharges to Lake Illawarra via the larger Mullet Creek. The site is approximately one kilometre upstream of Dapto Creek and five kilometres upstream of Lake Illawarra.

There is no major continuous watercourse flowing from the site. Both gullies feed into one minor ephemeral watercourse which discharges under Reddalls Road into Dapto Creek.

Dapto Creek discharges into the much larger Mullet Creek catchment which is approximately 74.5 km^2. Mullet Creek rises at the escarpment at an elevation of about 600m AHD and flows a distance of about 22 km before reaching the tidal Lake Illawarra. These steep catchment conditions provide for dynamic flooding and geomorphic conditions in the catchment.

The headwaters for the Mullet Creek catchment are mainly forested and much of its catchment is still used for rural activities. However Dapto, Horsley, Brownsville, Kembla Grange and Farmborough Heights represent significant urban use.

2.5 Water Use

The catchment for Dapto Creek is predominately made up of arable land. Other notable water catchments include the Whytes Gully Landfill site and the Grange golf course at the outfall into Mullet Creek.

A search of the NSW Office of Water data base and Council's internal data base indicates no known surface water extraction licences or other known uses of Dapto Creek downstream to the site.

2.6 Surface Water Quality

A Water Quality report prepared in 2004 by Council titled '*Monitoring of water quality in the West Dapto release area in conjunction with the Horsley release area"* (2004) presents the results of monitoring along Dapto Creek over the period July 2004 to July 2005. The results from the monitoring point downstream of Whytes Gully suggest that there are nine non compliance results, these include:

- Dissolved Oxygen
- Total Suspended Solids
- Total Phosphorus
- Total Nitrogen
- Oxidised Nitrogen
- Faecal Coliforms (Primary)
- Copper
- Chromium
- Aluminium

The monitoring point downstream of Whytes Gully was noted to have some impact and was possibly attributed to ground water seepage and runoff from Whytes Gully Waste Disposal Site within the report, however it is noted that management practices at the site have changed significantly since this time.

Surface water samples were collected by Council during December 2011 along Dapto Creek. The results of the surface water sampling from Dapto Creek, and from the leachate collection well, have been included in a Piper plot for reference in the Hydrogeological Investigation Report prepared by Golder for the Project (ref: 117625003_070_R_Rev0. Feb 2012). In general, the Piper plot indicates relatively similar water types between the upgradient, downgradient and Dapto creek water samples, and a leachate signature that is relatively distinct from the water samples. Hence, any leachate influence on groundwater or surface water quality is inferred to be limited.

Council are continuing to collect samples in Dapto Creek for baseline purposes in order to confirm surface water quality characteristics at the site and in Dapto Creek.

Site Surface Water Quality

The site operates under Environment Protection Licence (EPL) licence number 5862. With regards to surface water management the licence provides the following criteria:

- Monitoring annually and during over flow at the surface water ponds discharge point for
  - pH for a 100 percentile concentration limit is pH 6.5-8.5
  - Total Suspended Solids (TSS) for a 100 percentile concentration limit is 50 mg/l
- Drainage from areas not subject to waste disposal activities must be directed away from the existing leachate collection pond(s)
- Disturbed areas must be provided with separate water quality controls for the treatment of runoff containing suspended or turbid pollutants.

Surface water quality monitoring has been undertaken annually and during overflow at the discharge point from the surface water pond for pH, ammonia, TSS and temperature as a minimum.

The 2009 / 2010 Annual Environmental Monitoring Report (AEMR) (GHD 2010) covers the period from 29 May 2009 to 28 May 2010. Stormwater discharged from the site was reported to satisfy the EPL criteria but to have elevated concentrations of ions / anions.

The 2010/2011 AEMR was prepared by Council (Wollongong 2011) and covers the period from 01 June 2010 – 31 May 2011. The report indicates four surface water overflow events were monitored during the reporting period. The report further indicates compliance with surface water discharge criteria set out by the EPL for suspended solids, while one elevated value for ammonia of 3.86 mg/l was detected on 21 March 2011.

Council are continuing to monitor surface water at the site and the outflow in accordance with the EPL criteria.

2.7 Surface Water Flows

The NSW Office of Water and Council were consulted regarding streamflows along Dapto Creek and Mullet Creek but no information was available.

Environmental flows of Dapto and Mullet Creek are not expected to be impacted by the Project. There is no significant increase in the proposed area of impervious surfaces at the site (i.e. paving of limited road areas), rather vegetative cover and grassed drains would be implemented, which is a similar condition to the existing disturbed site. Therefore, watershed characteristics for the Project would be similar to the existing conditions.

2.8 Site Opportunities and Constraints

The location of the Site bordered by ridgelines reduces the surface water that can enter the site from external catchments. This feature of the site significantly simplifies the water management system and minimises the capacity of water conveyance and storage systems.

The opportunity to harvest water from the site is modest. The proposed surface water management system described subsequently would involve control of surface runoff from operational areas of the site as required in accordance with the NSW Department of Housing's Managing Urban Stormwater: Soils and Construction (2004) to be referred to as the "Blue Book' hereon. Water capture would be given priority for operational use for dust suppression and compaction.

It is noted that an additional volume of the "Blue Book" pertaining to landfill sites was issued in 2008 and is referred to as the "Landfill Blue Book' hereon.

2.9 Soils

General Characteristics

The southern part of the site is underlain by alluvial sands, silts and clays associated with Dapto Creek, the central part of the site is underlain by red, brown and grey lithic sandstone and the northern portion of the site is underlain by interbedded lithic sandstone, coal, carbonaceous claystone, siltstone and claystone.

Erodibility and Erosion Hazard

Soil loss is common when dealing with exposed sites such as a landfill sites and classifying the soil for its erosion potential is a first step to designing a relevant prevention and control measure. Based on the Wollongong-Port Hacking mapping the existing site falls under a soil class with the following criteria:

- Soil Sediment Type = Type D
- Soil Hydrological Group = C
- K Factor (Soil Erodibility Factor) = 0.022
- R Factor (Rainfall Erosive Factor) = 5400

- Erosion Hazard = low

The above soil criteria can be used to determine the erosion hazard at the site which in turn would help ascertain the type of erosion and sediment control required as part of the surface water management on site. The Revised Universal Soil Loss Equation (RUSLE) is a tool that can help determine this hazard. The following paragraphs explain these soil criteria and determine the potential erosion hazard.

Soil Sediment Type

The site soils have been classed under a Type D sediment type. Type D soil is fine (<0.005 mm) and dispersible and will not settle without the use of erosion and sediment controls.

Soil Hydrological Group

The hydrological group classifies a soil into its performance when dry and wet in terms of infiltration and surface water runoff. The site soil has been classified in group C which has a slow to moderate infiltration and a moderate to high run-off potential. This value is used to understand the velocities of surface water run-off. Generally the higher the potential run-off the more susceptible the soil is to erosion.

Soil Erodibility Factor

The soil erodibility factor (K) is a measure of the soils susceptibility for soil particles to detach and migrate through rainfall and runoff. The Wollongong –Port Hacking mapping has provided a K value of 0.022 for this region.

Rainfall Erosivity Factor

The Rainfall Erosivity Factor (R) is a measure of the ability of rainfall to cause erosion. The R factor can be derived using a simple equation based on the rainfall intensity for a 2 yr ARI, 6 hour rainfall event (S).

$$R = 164.74(1.1177)^{s} S^{0.6444}$$

The calculation of factor R is presented in Appendix B.

Erosion Hazard

On reviewing this with the effective slope of the rainfall catchment in Figure 4.6 found in the “Blue Book” for the assessment of potential erosion hazard, the existing site has been deemed to have a low erosion hazard.

3.0 EXISTING SITE STORMWATER MANAGEMENT AND INFRASTRUCTURE

Currently (2011), stormwater runoff from the landfill is generally directed along the eastern and western edges of both the Eastern Gully landfill and the Western Gully landfill through a series of swales and benches. Surface water runoff reports to the surface water ponds at the southwest corner of the site before discharge to Dapto Creek. The Surface Water Ponds comprise two surface water reed beds and a surface water polishing pond comprising an upper and lower level pond.

Run-on into the site is minimal due to the site being bounded by ridgelines. Runoff from the natural slope above the northern edge of the Eastern Gully landfill (rainforest area) is directed to the central drain and a portion of surface water runoff from the Western ridge is diverted offsite to Dapto Creek via a culvert under Reddalls Road.

The total capacity of the surface water treatment system is 40,000 cu.m. The depth of the two reed beds is approximately 2 m. The upper polishing pond is approximately 2 m deep and the lower pond approximately 3 m deep. The pond batter generally has a gradient of 1 in 4. The design of the ponds is detailed in design drawings prepared by Forbes Rigby within "Whytes Gully Waste Disposal Facility Leachate and Stormwater Ponds Civil Works, Reddalls Road, Kembla Grange for Wollongong City Council" (Forbes Rigby 2003).

The existing stormwater management system is operated and maintained to control erosion and sediment migration. A sensibility check was conducted by Rienco Consulting *'Whytes Gully Landfill Surface Water and Leachate Management Plan' (2008)* using the requirements set out by the "Blue Book" which confirmed that the existing surface water ponds volume of 40,000 m^3 is sufficient for the current 50 ha site run-off by calculating a required storage volume of 29,000 m^3 which was made up of 19,000 m^3 of settling volume and 10,000 m^3 of sediment storage.

A simple calculation was carried out to check the volume of the polishing pond. Appendix B presents these calculations based on the drawings provided by Forbes (2002) (Reference drawing 99095-5020, Sept 2003). An existing polishing pond volume of 27,059 m^3 was calculated made up of 23,805 m^3 for the upper pond and 3254 m^3 for the lower pond.

There is no indication within the Rienco 2008 report or the design of surface water ponds whether or not there is existing onsite stormwater detention (OSD) implemented on the site.

4.0 PROJECT STORMWATER MANAGEMENT AND INFRASTRUCTURE

The stormwater management philosophy for the proposed landfill work is to manage surface water runoff and control erosion and sediment migration to have a minimal effect on the water quality and hydrological regime of the downstream catchments. The proposed stormwater strategy for the site is set out of the following sections.

4.1 Staging of the Project

The Whytes Gully New Landfill Cell would be developed in 5 stages, Stages 1, 2A, 2B, 3 and 4 are summarised in the following Table 1:

Table 1: Whytes Gully New Landfill Cell Staging

	Proposed Liner Construction Period	Proposed Capping Construction Period (*)	Operation Period (Waste Filling)	
			(from year to year)	Length (years)
Stage 1	2013 - 2016	2016 - 2019	end 2013 - early 2018	4.4
Stage 2A	2017 - 2018	2020 - 2021	early 2018 - mid 2020	2.4
Stage 2B	2019 - 2031	2023 - 2036	mid 2020 - mid 2035	15.2
Stage 3	2035 - 2041	2038 - 2047	mid 2035 - end 2046	11.3
Stage 4	2046 - 2050	2048 - 2055	end 2046 - early 2054	7.2

4.2 Surface Water Management Principles

4.2.1 Water Types

Water at the site can be divided into three categories, Clean, Dirty and Leachate. These are defined in Table 2 along with their treatment requirements.

Table 2: Water Types

Name	Description	Treatment requirements
Clean	Runoff from: ■ undisturbed areas ■ disturbed areas after full revegetation ■ landfilled areas after final capping and full revegetation.	■ No treatment requirements ■ Discharge directly to creek ■ Note: “Landfill Blue Book” Page 28 - Sediment basins are usually only required for the first two years after the rehabilitation of disturbed areas.
Dirty	Runoff from: ■ disturbed areas (i.e. cleared or under construction) ■ landfilled areas with final capping prior to full revegetation ■ landfilled areas with temporary capping (i.e. interim cover 300 mm) .	■ Potentially sediment laden ■ Route to sedimentation ponds ■ Discharge to creek after sediment removal (will require periodic demonstration that water is not significantly impacted by landfill constituents).

Name	Description	Treatment requirements
Leachate	■ Water recovered from leachate collection systems. ■ Runoff that has come in direct contact with waste ■ Runoff from daily cover (i.e 150 mm cover) ■ Runoff that is otherwise known to be impacted	■ Collect , store, and treat to required sewer discharge standard

4.2.2 Key Stormwater Management Principles and Drainage Philosophy

The following key principles have been used as the basis for the design of the surface water management controls.

- Diversion of clean drainage directly into Dapto Creek. Runoff from areas that are unaffected by the development would be allowed to discharge directly from the site to Dapto Creek. Runoff from fully rehabilitated areas after two years of rehabilitation would also be allowed to discharge directly to Dapto Creek.
- Runoff from areas that are likely to generate sediment such as the new cell construction areas and stockpile areas would be directed into the Surface Water Ponds.
- Reduce the volume of runoff to Surface Water Ponds by reducing the contributing catchment area at any particular time.
- Keep sources of different water types separate from each other.
- Construction of a perimeter bund and drain around the entire active landfill area to prevent surface water from entering the landfill area;
- Construction of a diversion drain around the entire landfill area to collect all runoff from disturbed areas (but outside exposed/uncapped active waste cell area(s)) which would drain to the sedimentation basin to the north east of the landfill footprint.
- The existing Surface Water Ponds would be used for Stages 1 to 3 of the development.
- The Surface Water ponds would be downsized for Stage 4 onwards, as Stage 1 to 3 would be rehabilitated and runoff would be directed directly to Dapto Creek.
- Re-use ‘dirty’ water for dust suppression during construction and landfill operation.

4.2.3 Overview of Staging and Surface Water Management

The surface water management controls would be progressively developed as the landfilling areas are developed. Design Drawing D051 (Appendix A) presents the proposed surface water management throughout the Stages of the Project.

The site will be constructed over 5 stages between 2013 and 2050. The phasing of the landfill construction is to start landfilling from the east of the site and to finish in the west. A surface water drainage network will be constructed to suit each stage of landfilling with the final drainage network being located around the perimeter of the landfill to convey runoff to the surface water management ponds.

The following summarises the staged approach.

Stage 1 and Stage 2A:

The drainage philosophy up to the completion of Stage 2A is to discharge 50 ha of dirty and clean water runoff to the existing sediment pond. Rienco (2008) and Forbes Rigby (2002) reports suggest that there is sufficient capacity in the existing surface water management system for the whole 50 ha catchment.

Stage 2B:

After completion of Stage 2B the Eastern Gully would become fully capped and therefore surface runoff would become 'clean' runoff. At this stage a new 'clean' drain can be established to diverted clean water to bypass the sediment pond and discharge directly to Dapto Creek.

On completion of Stage 2B, approximately 24 ha will discharge direct to Dapto Creek and 26 ha to the existing sediment pond.

Stage 3:

On completion of Stage 3, approximately 30 ha of clean catchment will be discharged directly to Dapto Creek and 20 ha to the existing sediment pond.

Due to the extent of the Stage 4 works the existing leachate ponds will require relocating towards the end of Stage 3. At this stage it is proposed that the leachate pond is relocated to the footprint of the reed bed ponds and the existing surface water pond is downsized to within the footprint of the polishing pond. The downsizing of the surface water pond at this stage is possible due to approximately 60% of the original 50 ha catchment now discharging directly to the Dapto Creek outfall.

Stage 4:

For Stage 4, the remaining dirty 20 ha catchment would be directed to the downsized surface water pond and the clean 30 ha catchment will discharge unrestricted to Dapto Creek. The outflow from the pond to the Dapto Creek will be restricted to meet offsite constraints and the resultant attenuated runoff detained within the surface water pond. The surface water pond will be made up of two components,

- Sediment pond
- Onsite storm water detention pond.

The design for each component can be found in Appendix B. A summary for the overall design is compiled in the following sections.

4.3 Design Criteria

The surface water drainage will be designed in accordance with the Council's Development Control Plan (DCP), E14 Storm Water Management (2009) and the "Blue Book" and "Landfill Blue Book" design criteria outlined in the following sections.

A drainage philosophy has been devised based on the construction staging of the landfill cells and site discharge constraints off site in accordance with the DCP.

The structure of the design criteria is split into three sections, Surface Water Drains, Sedimentation Pond and Onsite Stormwater Detention (OSD).

4.3.1 Surface Water Drains

Surface water drains refers to the drainage channels that will convey surface water runoff away from the landfill construction (Dirty and Clean water runoff) to either the surface water ponds or Dapto Creek.

The design requirements for the surface water drains will be in accordance with Council's DCP. These are as follows:

- Drainage channels designed for 10yr Average Recurrence Interval (ARI), 2 hour duration for a **minor storm event**. Rainfall intensity: 47.2 mm/hr. Appendix B.
  - "For all land use types including rural residential, urban residential, commercial and industrial, the ARI must be 10 years"
- Drainage modelled for a 100yr ARI, 2 hour duration to ascertain a controlled flood path for a **major storm event**. Rainfall intensity: 73 mm/hr. Appendix B.
  - "The major system, which includes "escape routes" or overland flow routes for flows in excess of the piped system capacity must be designed and/or checked for a 100 year ARI event"
- Other design criteria/assumptions include:
  - Manning's roughness coefficient (n) value of 0.08 for catchment run-off, assuming the final stage vegetation cover is light brush and small trees (ARR 2007).
  - Manning's roughness coefficient (n) value of 0.033 for drains, assuming normal grass coverage (ARR 2007).

4.3.2 Sedimentation Pond

Sedimentation Pond refers to the storage required to treat and store sedimentation conveyed by the surface water runoff from the disturbed landfill catchments (i.e. dirty water runoff). It has been assumed that the existing sediment ponds will be used between stages 1 and 3. Refer to Section 4.2.3. A new sedimentation pond will be designed for the completion of Stage 4.

The design requirements for the sedimentation pond will be in accordance with the "Blue Book". These are as follows:

- Pond capacity will be designed for a Type D sediment soil
- 5 day, 90th%ile rainfall depth
- The storage capacity will be calculated for two storage zones, Settling Zone and Sediment Storage Zone. The volume of storage required (V) is therefore calculated using the following equation:

$$V = Settling\ Zone + Sediment\ Storage\ Zone$$

  - The Settling Zone will be calculated using the following equation based on Type D soils:

$$Settling\ Zone = 10 \times C_v \times A \times R_{(y\%ile.\ 5\ days)}$$

  - The Sediment Storage Zone has been sized based on 50% of the Settling Zone assuming a low erosion hazard based on good erosion and sediment control for the proposed landfill site. Refer to Section 2.9.
- 2 years after the completion of landfill capping, the sediment treatment is deemed to have been completed and therefore a sediment pond will no longer be required.

4.3.3 Onsite Stormwater Detention (OSD)

The OSD refers to the storage volume required to restrict flows to a Permissible Site Discharge (PSD) so as not to adversely affect the downstream catchment under a nominated ARI storm event.

The application of an OSD has been set out in the council's DCP whereby all commercial, industrial and special use developments and buildings require an OSD. It is noted that the site does not lie within the OSD concessions zone highlighted in Appendix A1 of the DCP.

To ascertain the OSD required for the site the DCP has been consulted regarding calculations for the result of PSD and Site Storage Requirements (SSR).

The PSD and SSR are based on a philosophy that the post-development site discharge will be restricted to that of the pre-development site discharge.

PSD

A PSD is a flow rate calculation that is required to ascertain the pre-development discharge off site. The flow rate is then used as a restriction for the post development discharge so the existing hydrological regime downstream to the site is unchanged.

The PSD has been calculated based on the following DCP equation for peak flow duration in a 5 yr ARI and 100 yr ARI:

$$PSD_{(5yr)} = F1_{(5yr)} \times F2 \times A \times I_{(50yr.60mins)} \times 2.67$$

$$PSD_{(100yr)} = F1_{(100yr)} \times F2 \times A \times I_{(50yr.60mins)} \times 4.67$$

- PSD_{5yr} calculated for a 5 yr ARI event, 2 hour duration peak flow to size onsite detention to the first stage control.
  - "The first stage is controlled by an orifice, the maximum diameter of which is to be sized using the value of PSD_{5yr} when under a head of SSR_{5yr} m^3 of stored water"
- PSD_{100yr} calculated for a 100 yr ARI event, 2hour duration peak flow to size onsite detention to the second stage control.
  - "A second stage outlet must also be provided either in the form of a pipe or weir which permits a maximum discharge equal to PSD_{100yr} when subject to a head of SSR_{100yr} m3 of stored water"

SSR

A SSR is a storage volume required upstream to the outfall to attenuate the PSD set at the outfall. This volume is the minimum storage requirement.

The SSR has been calculated based on the following DCP equation for PSDs associated with the peak flow duration in 5 yr ARI and 100 yr ARI:

$$SSR_{(5yr)} = F3 \times F4 \times 2.25 \times PSD_{5yr} / F2$$

$$SSR_{(100yr)} = F3 \times F4 \times 2.25 \times PSD_{100yr} / F2$$

Other design criteria/assumptions

- The aim is to combine the Sedimentation Pond storage and OSD storage in one overall Surface Water Management Pond.
- OSD designed to store water for the PSD 100 yr ARI event.
- It is understood that in a 100 yr ARI event the downstream Dapto Creek outfall would flood the south west section of the site (including the surface water pond). Refer to the Flood Impact Assessment in Appendix C.

4.3.4 Flood Impact Assessment

The Flood Impact Assessment has been prepared to understand the flood level impact associated with Dapto Creek catchment on the site. A Flood Impact Assessment has been prepared in Appendix C.

4.4 Surface Water Design

The Surface Water Design section will follow the structure of the design criteria section and will discuss the design detail under the headings, Surface Water Drains, Sedimentation Pond and Onsite Stormwater Detention.

4.4.1 Surface Water Drains

There are two different drains to be design as part of the site works. These are the drainage channels that convey surface water around the landfill cells to the outfall and the benching and drop structures that feed into this network.

4.4.1.1 Drainage Channels

Minor Storm Event

The drainage network has been designed in accordance with the DCP design requirements for a peak flow in a 10 yr ARI.

The drainage network has been designed and modelled as an open channel system using the hydrological modelling programme DRAINS by Watercom.

The networks have been sized and designed using the ILSAX Hydrological Method.

The drainage channels have been sized for the completed final stage in terms of catchment and final flows. The drainage channels have been separated into east and west drainage networks due to their different sized catchments and width restrictions. Table 3 summarises the design of the drainage channels.

Table 3: Drain Sizes

Network	Batter Slope (X:1)		Base Width (m)	Channel width (m)	Depth (m)	Cover Type	Manning (n)
	Left	Right					
East	4	1	0	5	1	Grass	0.033
West	2	2	1	5	1	Grass	0.033

The model results show that no spills were encountered in a 10 yr ARI thus satisfying DCP requirements (Appendix B).

Major Storm Event

The drainage network was also modelled in accordance with the DCP design requirements, for a peak flow in a 100 yr ARI. The performance of the drainage network and surface water flows is discussed in Section 4.4.6.

Other design considerations

The main drainage channels will be vegetated with grass to stabilise the form and shape of the open channel. A grassed channel would also increase the friction coefficient of the drain and therefore reduce the potential for scouring caused by high velocities surface runoff and sediment migration.

A velocity check was carried out as part of the drainage design to ascertain whether grass coverage would be sufficient as a means of erosion and sediment control and whether grass coverage would be able to withstand the channels resultant velocity. Appendix B presents the velocity calculations. It was noted that a normal cover of grass would be sufficient.

In areas of drainage where there is a change in direction, a more robust erosion control will be required to prevent drain deformities on the outer bend through erosion.

4.4.1.2 Drop Structures and Benches

As a means of reducing erosion and sediment migration a series of benches and drop structures have been designed in the final landform to control and reduce the velocity of overland flow down the surface of the landfill formation.

The benches will be 5 m wide with a cross fall of 5%. A 500 mm high bund will be constructed on the outer edge of the bench for vehicle safety, and this will also act as a channel for surface water runoff. The bench has been designed to convey up to a 100 yr ARI storm event in accordance with DCP requirements.

A series of drop structures will convey surface water runoff from the bench structures to the perimeter drainage at the foot of the landfill formation. These drop structures will be constructed using a geotextile-lined rock-filled Reno mattress to reduce water velocities and prevent riling. The drop structure will be trapezoidal in cross section with a 1m base width and a top width ranging between 2.7 m and 3.5 m. The depth of the structure will range between 300 mm to 400 mm. Like the bench construction the drop structure will be designed for up to a 100 yr ARI in accordance with DCP.

4.4.2 Sedimentation Pond

The drainage philosophy up until the completion of Stage 3 is to reuse the existing surface water ponds i.e. two reed beds and polishing pond.

For the proceeding stages it is proposed that all dirty water runoff (approximately 20 ha) is transferred to the existing polishing pond which would be reconfigured for the final stage works to act as both sediment pond and OSD, with the combined function pond referred to as the Surface Water Management Pond.

This pond has been designed in accordance with the “Blue Book” calculations found in Section 4.3.2 for the volume of Settlement Zone and Sediment Storage Zone. The results of this calculation have been summarised in Table 4. Full calculations can be found in Appendix B (Section 3.3).

Table 4: Sediment Dam Design Criteria

Final Stage Catchment Area (ha)	**20**
Soil sediment type	D
Rainfall	90th percentile 5 day rainfall event
Settlement Zone (m^3)	7660
Sediment storage (m^3)	3830
Total Storage (m^3)	**11490**

The Sediment Pond will be constructed as a wet basin with an overflow constructed at the top of the settlement zone. It is proposed that the Sediment Pond is constructed as part of the OSD to form an overall Surface Water Management Pond. Refer to the summary in Section 4.4.3.4.

4.4.3 Onsite Stormwater Detention

The purpose of the OSD is to store the attenuated flow associated with the PSD. This pond will therefore be constructed as a dry pond and will only be in use for the larger storm event.

The storage volume required for the OSD was calculated using the PSD and SSR constraints. The design of the OSD was carried out through modelling the drainage network discussed in Section 4.4.1 with PSD constraints on the outfall. The model was run for the 5 yr ARI and 100 yr ARI to correspond to the PSD requirements into Dapto Creek. The required storage volume for the network was then ascertained to support the requirements for PSD and accommodate the SSR.

4.4.3.1 PSD

The PSD equation has been noted in Section 4.3.3 with the full calculation noted in Appendix B.

A 20% impervious area has been used for the pre-development site when calculating PSD. The 20% has been based on a Public Recreation Area land use noted in the DCP. This is considered high and therefore the calculation is considered conservative.

A summary of PSD flows are summarised in Table 5 for the required 5 yr and 100 yr ARI events.

Table 5: Summary of PSD flows for a 5 yr and 100 yr ARI event

	ARI	
	5 yr – 2 hr duration	**100 yr – 2 hr duration**
Permissible Site Discharge (m^3/s)	8.01	13.62

A sensitivity calculation for the 20% existing impervious area was evaluated and presented in Appendix B. This was carried out for 15% and 25% impervious area and the results concluded that the difference was marginal.

4.4.3.2 SSR

The SSR equation has been noted in Section 4.33 with the full calculation presented in Appendix B.

A summary of the results from this calculation are in Table 6:

Table 6: Summary of SSR for a 5 yr and 100 yr ARI event

	ARI	
	5 yr – 2 hr duration	**100 yr – 2 hr duration**
Site Storage Requirement (m^3)	4876	8292

A sensitivity calculation for the 20% proposed impervious area was evaluated and presented in Appendix B. This was carried out for 15% and 25% impervious area and the results concluded that the difference was marginal.

4.4.3.3 OSD DRAINS Model

The DRAINS Hydrological model programme was used to ascertain the required detention basin volume required to meet the requirements for PSD and SSR.

The model was run with all the relevant drainage channels set out in the original DRAINS model to ensure that the time of concentrations were true to that of the proposed site.

The outputs from the DRAINS model are a series of graphs:

- Storage requirement graphs for the detention basin in a 5 yr ARI and 100 yr ARI to correspond with the PSD and SSR
- Flow hydrographs for the outfall channel into Dapto Creek which are to check that the design flows are in compliance with PSD requirements.

The results of the OSD DRAINS model are presented in Appendix B. A summary of the storage requirement graphs and outfall hydrographs is presented in Table 7.

Table 7: OSD DRAINS Model Summary

	ARI	
	5 yr – 2 hr duration	**100 yr – 2 hr duration**
Permissible Site Discharge (m^3/s)	8.01	13.62
Design Peak discharge at outfall (m^3/s)	7.23	11.71
Design OSD Volume (m^3)	7855	15452

The results show that the DRAINS model for a peak discharge into Dapto Creek is below the PSD for the relevant ARI event, therefore satisfying DCP requirements.

The results in Table 7 assume that the outfall into Dapto Creek is not surcharged. Refer to Section 4.4.5 for discussion.

4.4.3.4 Summary of the Surface Water Management Pond

The sediment and OSD ponds will be combined to form a Surface Water Management Pond. The ponds will be combined as there is sufficient capacity within the existing polishing pond for this to be efficiently accommodated.

The philosophy of the Surface Water Management Pond would be to construct the sediment ponds as a wet pond with a concrete culvert overflow to Dapto Creek. The invert level of the overflow would be set above the sediment pond level.

Above the sediment pond the onsite detention basin would be constructed which would be constructed to the level sufficient to contain up to a 100 yr ARI peak flow event.

Through modelling the drainage network design for the completion of Stage 4, the OSD storage volume was calculated to be greater than the SSR whilst satisfying PSD requirements at the Dapto Creek outfall, thus satisfying the Council's DCP design requirements for both PSD and SSR.

Table 8 summarises the total volume requirements for the pond.

Table 8: Surface Water Management Pond Summary

	ARI	
	5 yr – 2 hr duration	**100 yr – 2 hr duration**
Sediment pond volume (m^3)	11490	
OSD storage Volume (m^3)	7855	15452
Total Pond Volume (m^3)	19350	26950

The required storage of the Surface Water Management Pond of 26950 cum compares to an existing polishing pond volume of approximately 27000 m^3. Therefore there is adequate capacity in the existing surface water polishing pond for sediment and OSD requirements at the site from Stage 4 onwards.

A detailed survey of the existing ponds will be undertaken to ensure the available storage capacity in the polishing pond.

4.4.4 Flood Impact Assessment

A Flood Impact Assessment is presented in Appendix C which reports that Dapto Creek has a Flood Planning Level (FPL) for a 100 yr ARI of 17.14 mAHD including a freeboard of 500 mm for this area. At this FPL the extent of flooding would extend up to the bund that separates the two reed beds, therefore flooding the proposed extent of the new Surface Water Management Pond.

Through attenuating up to a 100 yr ARI flood level the Project does not exacerbate flooding into the Dapto Creek but it is understood, however, that the Dapto Creek flood water would fill the OSD capacity in a 100 yr ARI event.

It is understood that there are no OSD facilities on site as part of the existing surface water management and the Flood Plan Area currently encroaches on the south western portion of the site. However, the addition of a new OSD basin, designed to store up to the 100 yr ARI peak flow, is an improvement to the existing site performance and therefore it is thought that by constructing an OSD basin to store the 100 yr flow is sufficient to meet DCP criteria regardless of the 100 yr ARI FPL from the Dapto Creek flood plain.

4.4.5 Performance during a blocked outfall

As an additional check, the drainage design was run within the DRAINS model for a blocked outfall for a 10 yr ARI event. This check would ascertain what would happen if the outfall was blocked for 2 hours. The model was run so that the tailwater level was set at the soffit level of the outfall channel.

The storage volume and outfall hydrograph for a blocked outfall is presented in Appendix B.

Under these circumstances the drainage channels in the DRAINS model encountered no spills remain within the DCP guidelines.

4.4.6 Performance during a 100 yr ARI event

As part of the Council's DCP design requirements the peak flow for a 100 yr ARI event is to be modelled and checked for flow paths to ensure flood water does not impede on escape routes from the site or enter occupied buildings.

The topography of the final land formation suggests that all flood water will accumulate around the footprint of the surface water ponds in the south west corner of the site.

The flow path from the western drainage network is located within a low point between the new landfill formation and the western ridge line up to its final connection into the surface water pond. Therefore all flood water up to a 100 yr ARI will flow directly to the surface water pond and will not impede escape routes or reach occupied buildings.

The flow path from the eastern drainage network also lies within a low point between the landfill formation and the eastern ridge line up to the former SWERF building. Topographic levels show that the former SWERF building is located at a higher level than the surrounding road suggesting the 100 year ARI flood would flow along the access road north of the building bypassing the SWERF building and flow across the landscaped area at the centre of the site towards the surface water pond. Therefore all flood water up to a 100 Year ARI will not impede on escape routes and will bypass all occupied buildings.

It is thought at this stage with the combination of the eastern and western 100 yr flood water and 100 yr flood catchment of the downstream Dapto creek in a 100yr ARI event, the main entrance to the site would be flooded due to its location at the lower end of the landfill site. However the most occupied areas of the site (former SWERF building and Administration building) are located at a higher level with a secondary off-site access on to Reddalls Road. With this access off site, an escape route is still available for up to a 100 year ARI event.

4.4.7 Performance under the influence of Climate Change

A sensitivity analysis has been undertaken as part of the design when considering climate change impacts on sea level and flood producing rains. The Practical Consideration of Climate Change (DECC 2007) document recommends an examination of climate change effects and management options. The following criteria were modelled to ascertain climate change effects:

- 30% increase in peak rainfall and storm volume
- 0.91 m raised ocean level impacts

A model was run for up to a 10 yr ARI event for a peak flow plus an additional 30% increase to the rainfall intensity to include for climate change.

The proposed drainage channels and the existing polishing pond have sufficient capacity for the additional 30% for a 10 yr ARI. Events greater than the 10 yr ARI plus 30% climate change would flood the proposed 10 Year ARI system. This is equivalent to approximately a 40 yr ARI. The flood flow paths would be as per the 100 yr ARI event discussed in Section 4.4.6.

Storage requirements for a 10 yr ARI plus climate change have been shown in Appendix B.

The Mullet & Brooks Creek Flood Study (BMT WBM 2010) was consulted with regards to climate change and ocean impacts. There was no model ran in the BMT WBM study for the effects of climate change and it is unknown at this stage whether an increased ocean level would surcharge the Dapto Creek outfall. It is noted however that the Dapto Creek outfall is approximately 5 km west of the overall outfall into Lake Illawarra and is at a significant level above sea level (approximately 17 mAHD) suggesting that the tail water level would have minimal impact on the site.

4.4.8 Water Sensitive Urban Design

Water Sensitive Urban Drainage (WSUD) principles would be adopted in the design criteria for the control and treatment of drainage runoff. WSUD is a management approach for water cycles in an urban development to minimise environment degradation and improve the aesthetic appeal. Features of WSUD adopted at the site include:

- Minimal concrete or paved areas to mimic a more natural catchment hydrology
- Grassed drains for surface water treatment by impeding the conveyance of flows
- Vegetative areas for aesthetics
- Sedimentation Basin for surface water treatment
- Onsite Surface Water Detention for the restriction of flows to mimic that of the pre-development natural catchment so as not to disturb the downstream hydrological regime.

4.5 Erosion control

Erosion is most likely to occur during major rainfall events and heavy wind. There is the potential for erosion of soils during construction and operation, particularly upon removal of top soil and during the excavation works that would be required for the preparation for cell construction. Any erosion would potentially be accentuated via the movement of construction machinery, vehicles and personnel and would also be further exacerbated by rain. There is also the potential for aeolian (wind) erosion to occur from any unsecured stockpiles of materials or spoil, as well as any exposed ground during construction, and/or during operation.

The CEMP would contain a range of appropriate erosion and sediment control measures that would be required for implementation, monitoring and maintenance during the construction of the Project.

Construction

An Erosion and Sedimentation Control Plan would be developed as part of the CEMP in general accordance with the following erosion and sedimentation control principles:

- Construction of earth bunds and diversion drains upslope and around the perimeter of construction areas where surface disturbance occurs, to prevent clean surface water entering these areas.
- Erection of silt fences or straw bales at strategic locations (i.e. around stockpiles) to prevent the migration of fires.
- Construction of temporary sediment retention ponds.
- Installation of water recycling equipment for dust suppression as needed.
- Reducing the surface area disturbed by construction activities at any one time.
- Regular inspection and maintenance of sediment and erosion control structures.
- Protecting and retaining vegetation and surface cover where possible.
- Placement of an erosion protection barrier (e.g. grassing) at the completion of works.
- Using designated access roads and paths where possible.
- Removing soil adhering to the wheels and undercarriage of trucks (e.g. by wheel wash) prior to departure from the Project site.

- Limit both the size of any stockpile footprints and the time between excavation and removal off-site of materials.
- Do not place stockpiles within 30 m of any watercourse.
- Stabilise all disturbed areas as soon as practicable. Temporary vegetative destabilisation techniques must be applied to any disturbed soil to prevent areas remaining bare for more than 28 days.
- Stabilise all temporary and permanent drainage immediately.
- Maintain all sediments and erosion control measures in effective condition until the works are completed and the site is stabilised.
- Release “Dirty” Stormwater, captured and stored by sediment and erosion control measures or site works, after treatment and testing to confirm compliance with relevant criteria.

Operation

Proposed erosion and sediment control measures that would be applied during operation of the Project are outlined in the draft LEMP.

Erosion control works are required for all works where the possibility for soil erosion exists and are used to control and minimise erosion and sedimentation. Erosion control measures employed at the site incorporate the following:

- reducing the area of exposed soil including recently constructed sections of the landfill;
- retain existing vegetation onsite as long as possible;
- diverting clean run on away from disturbed areas;
- reducing the length and steepness of slopes;
- rehabilitating capped areas in the timely manner;
- applying sediment control measures to intercept and retain sediment on site (eg drains and sedimentation ponds).;
- an inspection maintenance and cleaning program for sediment control structures to maintain capacity and integrity;
- wheel wash facilities would be at site egress points, to prevent the tracking of mud or loose sediment off site;
- using designated access roads and paths where possible;
- Inspection monitoring and maintenance of sediment control structures (refer LEMP); and
- Surface water monitoring in the sedimentation ponds and Dapto Creek (refer LEMP).

REFERENCES:

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A guide to the use of grass in Hydraulic Engineering practice, E.Whitehead (1976)

Managing Urban Stormwater: Soils and Construction, Volume 2B Waste Landfills (2008) "Blue Book"

Wollongong Development Control Plan, Chapter E14 Storm Water Management (2009) "DCP"

Australian Rainfall & Runoff Volume, A Guide to Flood Estimation, Volume 1 &2 (2007) "AR&R"

Proposed Waste Disposal Depot at Reddall's Road West Dapto, Environmental Impact Statement, Scott and Furphy Engineers, February 1982

Mullet & Brooks Creeks Flood Study, Final Report, BMT WBM, February 2010.

Report Signature Page

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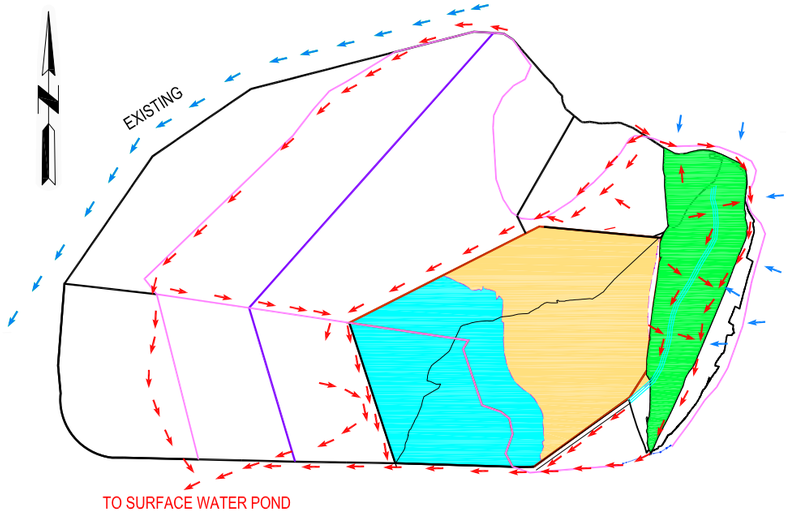
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http://aupws/117625003wollongongcitycouncilnewcellwhytesgully/project doc/209 surface water and leachate dam re-configuration/117625003_160_r_rev0.docx

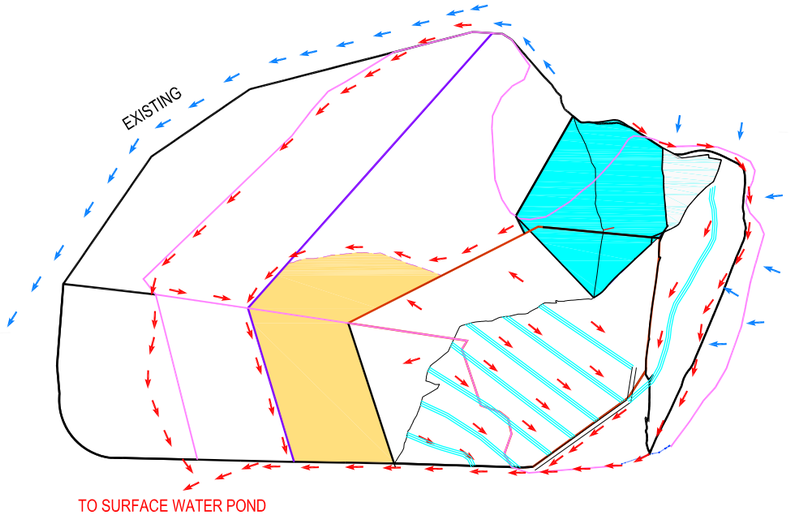
APPENDIX A

Drainage Staging and Concept Layout

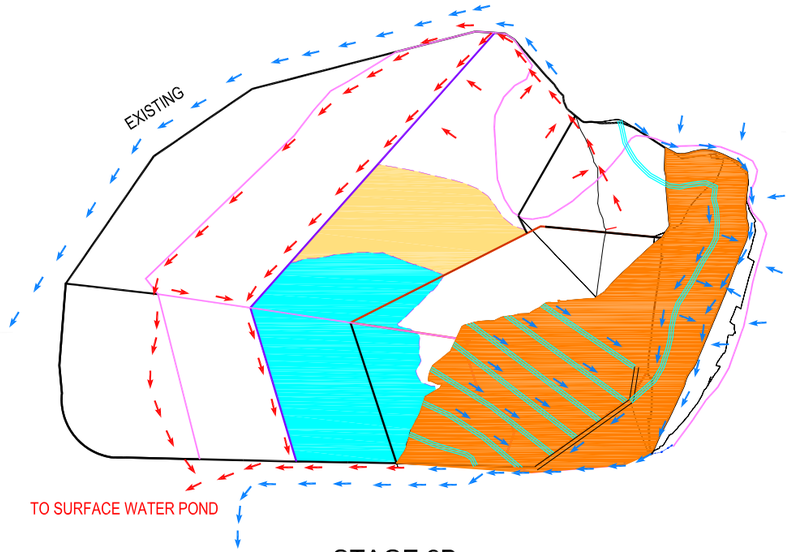
NOTE: DRAWINGS SHOW REPRESENTATIVE CONDITIONS AT AN INTERMEDIATE TIME DURING LINING AND FILLING OF EACH STAGE



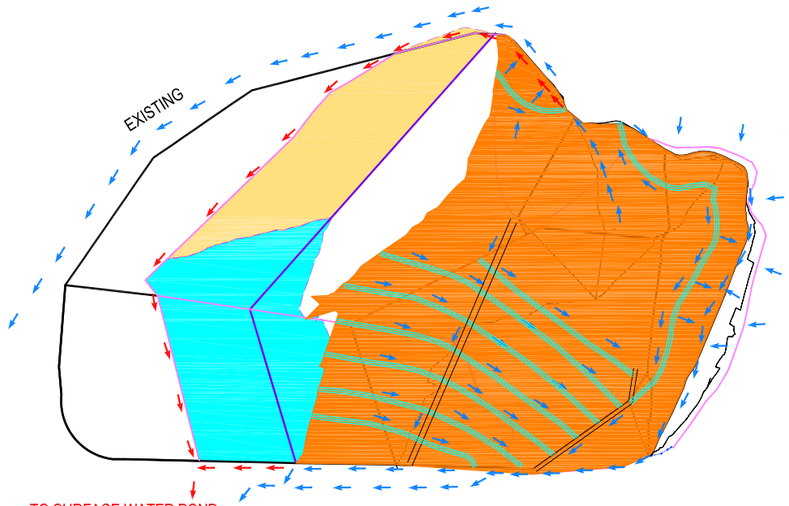
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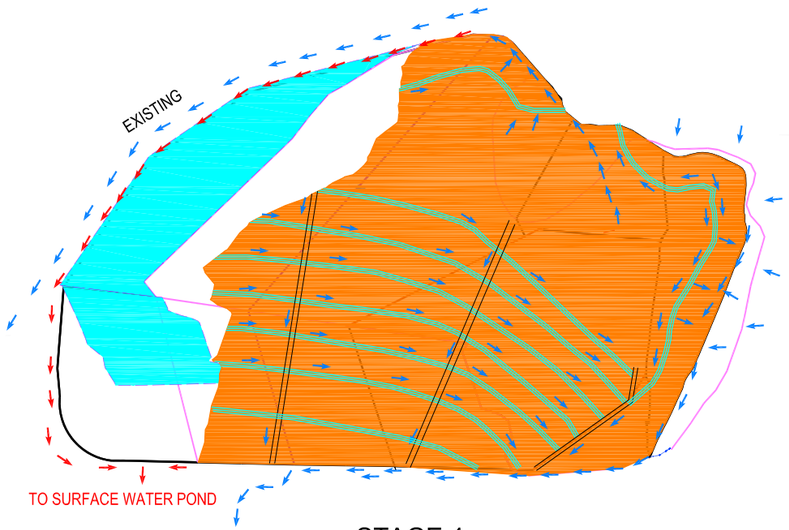
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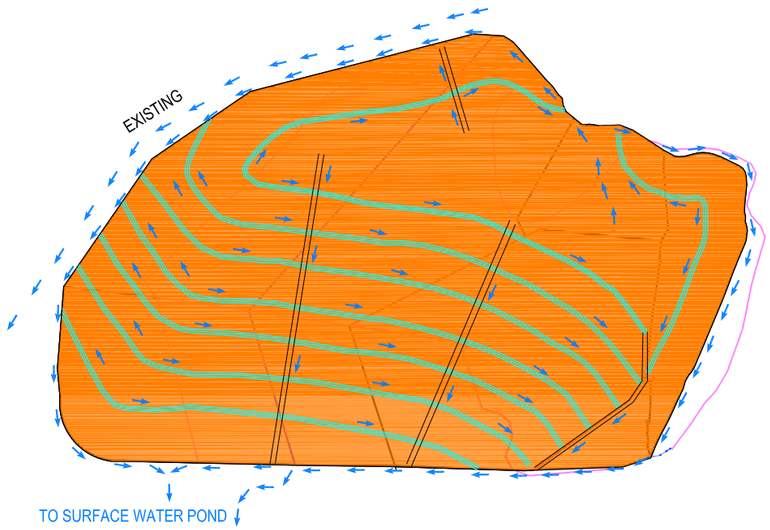
STAGE 2B
SCALE 1:7,500



STAGE 3
SCALE 1:7,500



STAGE 4
SCALE 1:7,500



STAGE FINAL
SCALE 1:7,500

LEGEND

- CLEAN WATER
- DIRTY WATER
- WASTE CUTBACK AREA
- ACTIVE FILLING AREA
- LINING AREA
- CAPPED AREA
- PROPOSED BENCHES
- PROPOSED DROP STRUCTURE

ISSUED FOR
PRELIMINARY
NOT FOR CONSTRUCTION

1:7,500 0 150 300 450m

REVISION	DESCRIPTION	DRAWN	DRAWN CHECK	DESIGN	DESIGN CHECK	AUTHORISED	DATE
	ISSUED FOR PRELIMINARY	E J JEET	R HUYNH	R HUYNH	G SCHMERTMANN	G SCHMERTMANN	
A	DRAFT - ISSUED FOR CLIENT REVIEW	C GIBCUS	R HUYNH	R HUYNH	G SCHMERTMANN	G SCHMERTMANN	23.01.2012

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LEAD PROJECT DRAFTER	PROJECT MANAGER	SCALE	SHEET SIZE
EJ JEET	J McMAHON	1:7,500	A3

CLIENT: WOLLONGONG CITY COUNCIL

PROJECT: WHYTES GULLY LANDFILL - NEW CELL DESIGN

DRAWING TITLE: SURFACE WATER MANAGEMENT SYSTEM CONCEPT PLAN

PROJECT No	DOC No	DOC TYPE	DRAWING No	REVISION
117625003	145	S	D051	B

Plot Date: 1 March 2012 Time:10:49:14 AM By: Jeet, Elvin Path: K:\Des\2011\117625003 WHYTES GULLY\DRAWINGS - File Name:117625003-145-S-D051-REVB.dwg
Xref: GAP_LOGO-A3.dwg; 117625003-XREF-STAGING - STAGE 1.dwg; 117625003-XREF-STAGING - STAGE 2A.dwg; 117625003-XREF-STAGING - STAGE 2B.dwg; 117625003-XREF-STAGING - STAGE 4.dwg; 117625003-XREF-STAGING - STAGE 3.dwg;

APPENDIX B

Drainage Design

1.0 SURFACE WATER BACKGROUND

1.1 Introduction

This section will identify the parameters required to design and check the rainfall and surface water characteristics of the site.

1.2 Rainfall Intensity Frequency Duration (IFD)

The Rainfall Intensity Frequency (IFD) is a rainfall statistic for a specific region where a rainfall station is located. IFD is measured in mm/hr.

To obtain the IFD for the site, the programme AusIFD version 2.0 was used with the following parameters with the results following thereafter.

Location: Wollongong, NSW.

Reference: 34.4333 South, 150.8833 East

Skewness, G: 0 F2 :4.28 F50: 15.81

Duration (mins)	ARI						
	1 Year ARI (mm/hr)	2 Year ARI (mm/hr)	5 Year ARI (mm/hr)	10 Year ARI (mm/hr)	20 Year ARI (mm/hr)	50 Year ARI (mm/hr)	100 Year ARI (mm/hr)
5	117	148	183	201	227	261	285
10	90	115	143	159	181	209	230
15	76	97	122	136	155	180	198
20	66	85	107	120	138	160	177
25	59	76	97	109	125	146	161
30	54	69	89	100	115	134	149
40	46.3	60	77	87	101	118	131
50	41	53	69	78	90	106	119
60	37	47.9	63	71	83	97	109
90	28.8	37.4	49.2	56	65	77	86
120	24	31.2	41.2	47.2	55	65	73
150	20.8	27.1	35.9	41.2	48.1	57	64
180	18.5	24.1	32.1	36.9	43.1	51	58
210	16.8	21.9	29.2	33.6	39.2	46.8	53
240	15.4	20.1	26.9	30.9	36.2	43.2	48.6
270	14.3	18.6	25	28.8	33.7	40.3	45.3
300	13.3	17.4	23.4	27	31.6	37.8	42.6
360	11.8	15.5	20.9	24.2	28.3	33.9	38.3
420	10.7	14.1	19	22	25.8	31	34.9
480	9.85	12.9	17.5	20.3	23.8	28.6	32.3
540	9.14	12	16.3	18.9	22.2	26.7	30.1
600	8.54	11.2	15.2	17.7	20.8	25.1	28.3
660	8.04	10.6	14.4	16.7	19.7	23.7	26.8
720	7.6	10	13.6	15.8	18.7	22.5	25.5
840	6.92	9.12	12.5	14.6	17.2	20.8	23.6
960	6.38	8.43	11.6	13.6	16.1	19.4	22.1
1080	5.94	7.85	10.8	12.7	15.1	18.3	20.8
1200	5.57	7.37	10.2	12	14.3	17.3	19.7
1320	5.25	6.96	9.68	11.4	13.5	16.5	18.8
1440	4.98	6.6	9.21	10.8	12.9	15.8	18
1800	4.33	5.76	8.09	9.57	11.4	14	16
2160	3.85	5.13	7.27	8.62	10.3	12.7	14.5
2520	3.48	4.65	6.62	7.88	9.47	11.7	13.4
2880	3.18	4.26	6.09	7.27	8.76	10.8	12.4
3240	2.93	3.93	5.65	6.76	8.17	10.1	11.6
3600	2.72	3.66	5.28	6.33	7.66	9.48	10.9
3960	2.54	3.42	4.95	5.95	7.21	8.95	10.3
4320	2.38	3.21	4.67	5.62	6.82	8.48	9.8

1.3 Rational Method

The Ration Method is a simple equation that expresses the relationship between catchment area and rainfall intensity in the form of an estimated peak discharge from a site. The limitation of this equation is that it assumes a steady and uniform rainfall which tends to underestimate a peak discharge for a much larger site where there are many variables. However the rational method equation is a good tool as a check for an understanding of the discharge flows and will be used as a check for model discharge outputs.

Peak flow is given by the rational formula:

$$\mathbf{Q_y = 0.00278 \times C_{10} \times F_y \times I_{y,tc} \times A}$$

Where:

$\mathbf{Q_y}$ = is the peak flow rate (m^3/s) of an Average Recurrence Interval (ARI) of 'Y' years

0.00278 = unit conversion factor

$\mathbf{C_{10}}$ = is the runoff coefficient for a 10year ARI.

$\mathbf{F_y}$ = is the frequency factor for 'y' years

$\mathbf{I_{y,tc}}$ = is the average Rainfall intensity (mm/hr) for an ARI 'y' years and a design duration of 't_c' (mins)

A = is the catchment area (ha)

Time of concentration (t_c) = $0.76 \times (A/100)^{0.38}$

Table B1: Peak flow calculation 1

Catchment	A(Ha)	t_c (mins)	Rainfall Intensity (mm/hr)							C_{10}
			$1_{y,tc}$	$2_{y,tc}$	$5_{y,tc}$	$10_{y,tc}$	$20_{y,tc}$	$50_{y,tc}$	$100_{y,tc}$	
Whole	50	35.04	52	67	87	98	113	134	149	0.8
East	30	28.86	52	67	87	98	113	134	149	0.8
West	20	24.74	57	73	73	107	123	145	161	0.8

Table B2: Peak flow calculation 2

ARI (yrs)	F_y	Peak Flow (cu.m/s)		
		Catchment Whole	Catchment East	Catchment West
1	0.62	3.59	2.15	1.57
2	0.74	5.51	3.31	2.40
5	0.88	8.51	5.11	2.86
10	1	10.90	6.54	4.76
20	1.12	14.07	8.44	6.13
50	1.31	19.48	11.69	8.43
100	1.29	21.33	12.80	9.22

2.0 SURFACE WATER DRAINAGE CONSTRAINTS

2.1 Introduction

It is proposed that all surface water run-off is conveyed to the Dapto Creek outfall to the south of the site as per the existing site. Under the Council's DCP, the post development surface water runoff from site is not exceeding that of the pre-development site.

The Council's have implemented this by creating a set of equations to calculate the restricted discharge off site known as a Permissible Site Discharge (PSD). Where the post development runoff from site is larger than the PSD an Onsite Stormwater Detention (OSD) basin will be required to store the additional run-off. An equation was also produced by the Council to calculate the Site Storage Requirement (SSR) to relate to this PSD.

The results for the calculation of the PSD and SSR are shown in the following sections.

2.2 Permissible Site Discharge

The equation established by the DCP to calculate the PSD is as follows:

$$PSD_{(5yr)} = F1_{(5yr)} \times F2 \times A \times I_{(50yr.60mins)} \times 2.67$$

$$PSD_{(100yr)} = F1_{(100yr)} \times F2 \times A \times I_{(50yr.60mins)} \times 4.67$$

Where:

$PSD_{(5yr)}$ = Peak Permissible Site Discharge in a 5 yr ARI event (L/s)

$PSD_{(100yr)}$ = Peak Permissible Site Discharge in a 100 yr ARI event (L/s)

$F1_{(5yr)}$ = 5 yr ARI factor for existing impervious area (Taken from AppA2 from WCC DCP)

$F1_{(100yr)}$ =100 yr ARI factor for existing impervious area (Taken from AppA2 from WCC DCP)

F2 = factor reflecting variations in area from a 1 ha base (Taken from AppA4 from WCC DCP)

A = Catchment area (ha)

$I_{(50yr.60mins)}$ = 1 hour 50 yr ARI rainfall Intensity (mm/hr) From AR&R Vol2

The results in Table B3 have been based on a pre-development impervious area of 20%.

Table B3: PSD criteria and results

	5 Year ARI	100 Year ARI
A (ha)	50	50
F1	1.07	1.05
F2	0.58	0.58
$I_{(50yr.60mins)}$ (mm/hr)	96.7	96.7
PSD (mm^3/s)	8010	13620

2.3 Site Storage Requirements

The equation established by the DCP to calculate the SSR is as follows:

$SSR_{(5yr)}$ = F3 x F4 x 2.25 x PSD_{5yr} /F2

$SSR_{(100yr)}$ = F3xF4 x 2.25 x PSD_{100yr} /F2

Where:

$SSR_{(5yr)}$ = Is the facility storage at a discharge of PSD_5

$SSR_{(100yr)}$ = Is the facility storage at a discharge of PSD_{100}

F3= is the factor reflecting post development impervious cover (Taken from AppA5 from WCC DCP)

F4 =is the factor reflecting variations in area from the 1Ha base (Taken from AppA6 from WCC DCP)

The results in Table B4 have been based on a post-development impervious area of 20%.

Table B4: PSD criteria and results

	5 Year ARI	100Year ARI
F3	0.059	0.059
F4	2.66	2.66
PSD_{Yyr} (mm^3/s)	8010	13620
F2	0.58	0.58
SSR (m^3)	4876	8292

2.4 Sensitivity Check

A sensitivity check was carried out on the assumed 20% impervious area of the pre-development site which was initialled based on the Council's DCP land use table 2 for a public recreational area. Therefore a check was conducted for a 5% difference to check limitations i.e. 15% and 25% for the PSD and SSR values.

Table B5: PSD sensitivity 15% existing impervious

	5 Year ARI	100Year ARI
A (ha)	50	50
F1	1.07	1.04
F2	0.565	0.565
$I_{(50yr.60mins)}$ (mm/hr)	96.7	96.7
PSD (mm^3/s)	7800	13270
F3	0.045	0.045
F4	2.66	2.66
SSR (m^3)	3718	6326

Table B6: PSD sensitivity 25% existing impervious

	5 Year ARI	100Year ARI
A (ha)	50	50
F1	1.09	1.07
F2	0.6	0.6
$I_{(50yr.60mins)}$ (mm/hr)	96.7	96.7
PSD (mm^3/s)	8440	14500
F3	0.072	0.072
F4	2.66	2.66
SSR (m^3)	6061	10414

3.0 SURFACE WATER DRAINAGE DESIGN

3.1 Introduction

This section looks at the design and model of the open channel drains located around the perimeter of the landfill site and its outfall into the Dapto Creek, the design of the sedimentation pond and the design model for the required OSD to meet PSD and SSR requirements.

3.2 DRAINS model for surface water drainage

3.2.1 Introduction

The drainage software DRAINS version 2010.06 by Watercom was used to model the Hydrology of the proposed drainage system. The model layout (Figure 1) represents Stage 4 onwards on drainage and staging concept plans that can be found in Appendix A. At this stage all existing drainage channels will be abandoned and all surface water runoff will discharge to the new perimeter drains.

The model will look to ensure that all DCP requirements are adhered to in the design of the channels as well as checking that the outfall discharges are in compliance with the PSD's.

3.2.2 Hydrological Model

The model was run as an ILSAX Hydrological model using the following criteria:

- Paved (Impermeable) area depression storage = 1mm
- Supplementary area depression storage = 1mm
- Grassed (permeable) area depression storage = 5mm
- Soil type 3

3.2.3 Model Inputs

The rainfall Intensity Frequency Duration Data (IFD) was taken from the AusIFD Version 2.0 based on the below reference:

Grid Reference: 34.4333 South 150.8833 East

The IFD data inputs required in the DRAINS model are found in Table B7.

Table B7: IFD Input

	2 yr ARI (mm/hr)	50yr ARI (mm/hr)
1 hr	47.94	97.5
12 hr	10	22.5
72 hr	3.21	8.48

Skew: 0.00 **F2: 4.28** **F50: 15.81**

3.2.4 Model Results

The DRAINS model was run for the following ARI's to comply with DCP criteria:

- 5yr ARI: To ascertain whether the system complies with the DCP's PSD
- 100yr ARI: To ascertain whether the system complies with the DCP's PSD and to check flood paths to ensure escape routes are not impeded.
- 10yr ARI: To ascertain whether the proposed system has been designed sufficiently to convey a peak flow in accordance with the DCP.
- Additional models were ran for climate change and scenarios where the outfall into Dapto Creek is surcharged:

- Climate Change - a model was ran for climate change to comply with DECC guidelines for a 30% increase in rainfall intensities. This was added to the minor storm 10 yr ARI, 2 hr duration to ascertain whether there was sufficient capacity in the designed system.
- Surcharged Outfall – a model was run for a surcharged outfall as a check where the outfall was given a tailwater level equal to the level at the top of the channel. This was added to the minor storm 10 yr ARI, 2 hr duration to ascertain whether there was sufficient capacity in the designed system.

On modelling the drainage layouts it was found that the duration that produced the peak discharge from site was the 2 hr. The Rainfall intensities for this duration and their associated ARI's have been recorded in Table B8.

Table B8: Rainfall Intensities for peak 2hr duration

Duration (Hrs)	**Design Rainfalls for Average Recurrence Intervals**						
	1 (mm/hr)	2 (mm/hr)	5 (mm/hr)	10 (mm/hr)	20 (mm/hr)	50 (mm/hr)	100 (mm/hr)
2hrs	24	31.2	41.2	47.2	55	65	73

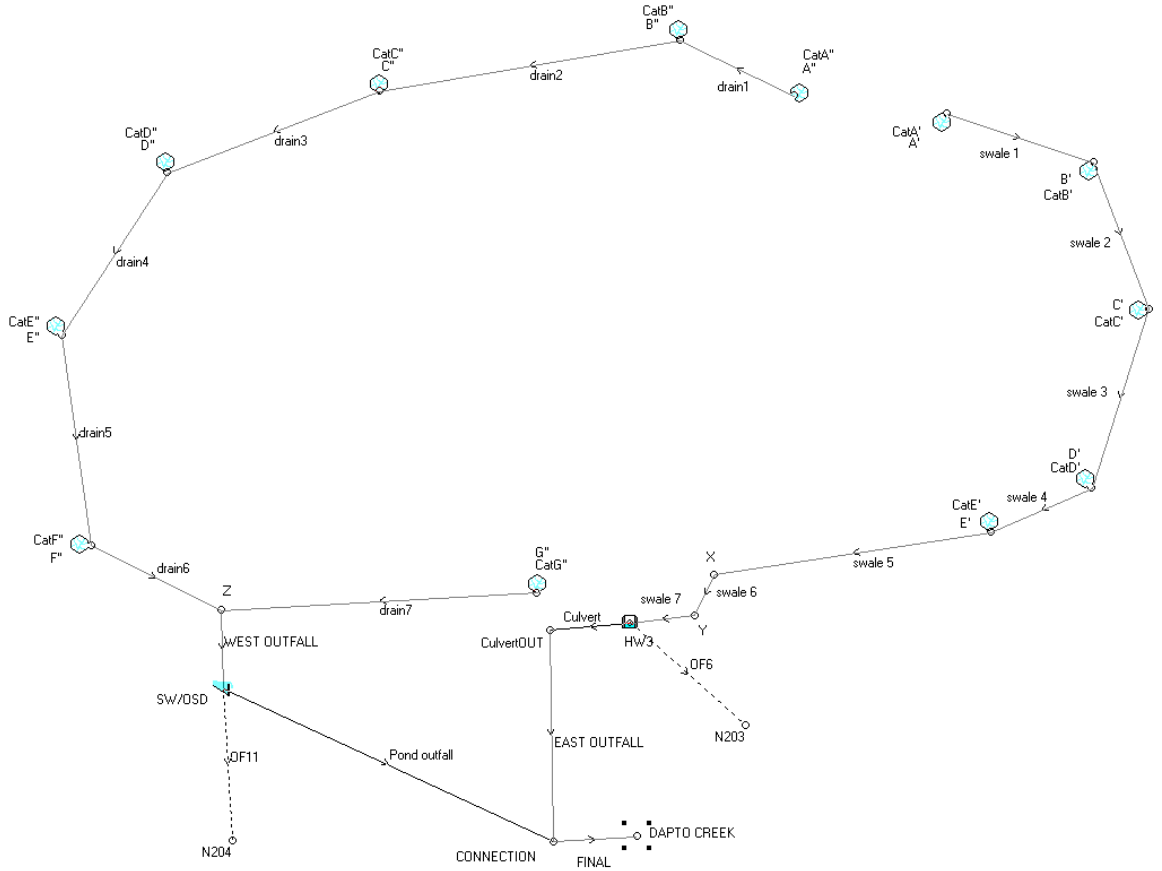


Figure 1: DRAINS model Drainage Layout

3.2.4.1 Hydrographs

5 yr ARI, 2 hour duration

Figure 2 shows the hydrograph at the Dapto Creek outfall for a 5 yr ARI, 2 hour duration. This model was ran to ensure compliance with the DCP $PSD_{5\ yr}$ of 8010 mm^3/s or 8.01 m^3/s. The peak discharge in this event is 5.94 m^3/s therefore satisfying DCP requirements.

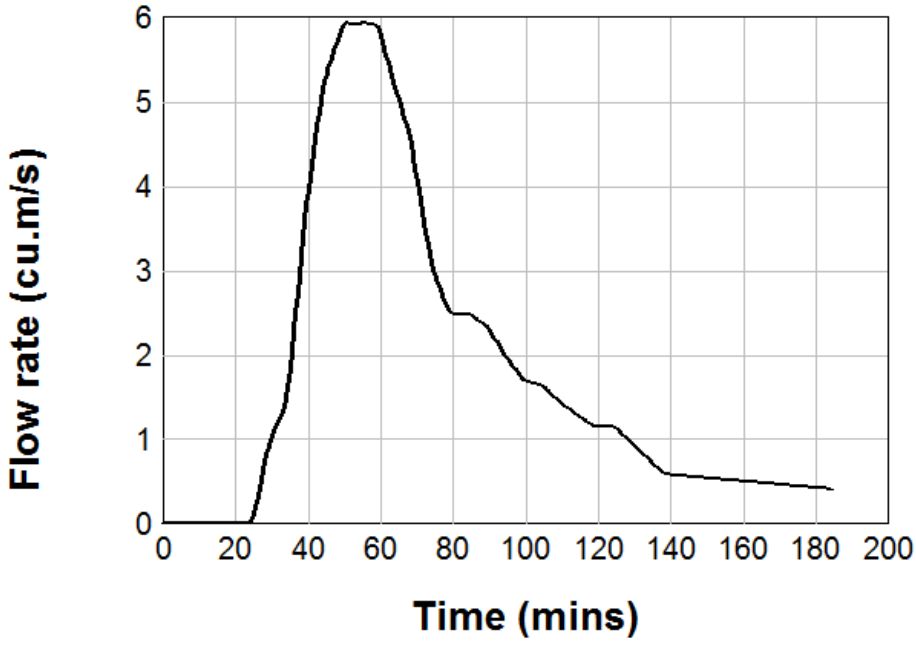


Figure 2: Flow hydrograph at the Dapto Creek outfall, 5 yr ARI, 2 hr Duration: 5.94 m^3/s

100 yr ARI, 2 hour duration

Figure 3 shows the hydrograph at the Dapto Creek outfall for a 100 yr ARI, 2 hour duration. This model was ran to ensure compliance with the DCP $PSD_{100\ yr}$ of 13620 mm^3/s or 13.62 m^3/s. The peak discharge in this event is 11.71 m^3/s therefore satisfying DCP requirements.

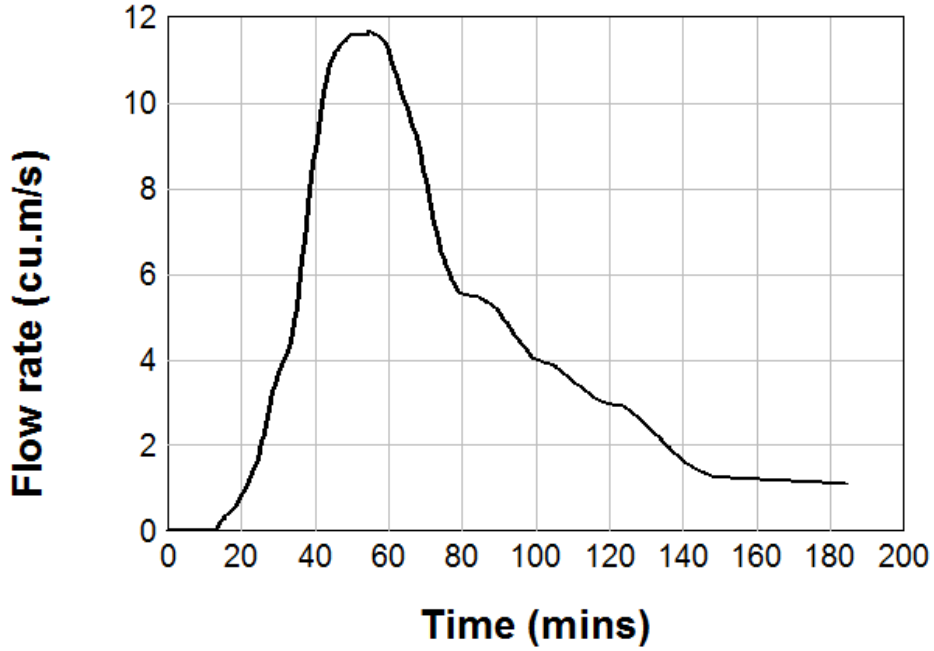


Figure 3: Flow hydrograph at the Dapto Creek outfall, 100 yr ARI, 2 hr Duration: 11.71 m^3/s

3.2.4.2 Critical drainage cross sections

10 yr ARI, 2 hour duration

Figure 4 shows a cross section of the most critical drainage section prior to the culvert under Reddals Road (annotated 'swale 7' in Figure 1) for a 10 yr ARI, 2 hour duration. This model was run to ensure the drainage capacity compliance with the DCP 10 yr ARI minor storm event. The critical flow depth is shown to be below that of the top of the channel, therefore satisfying DCP criteria.

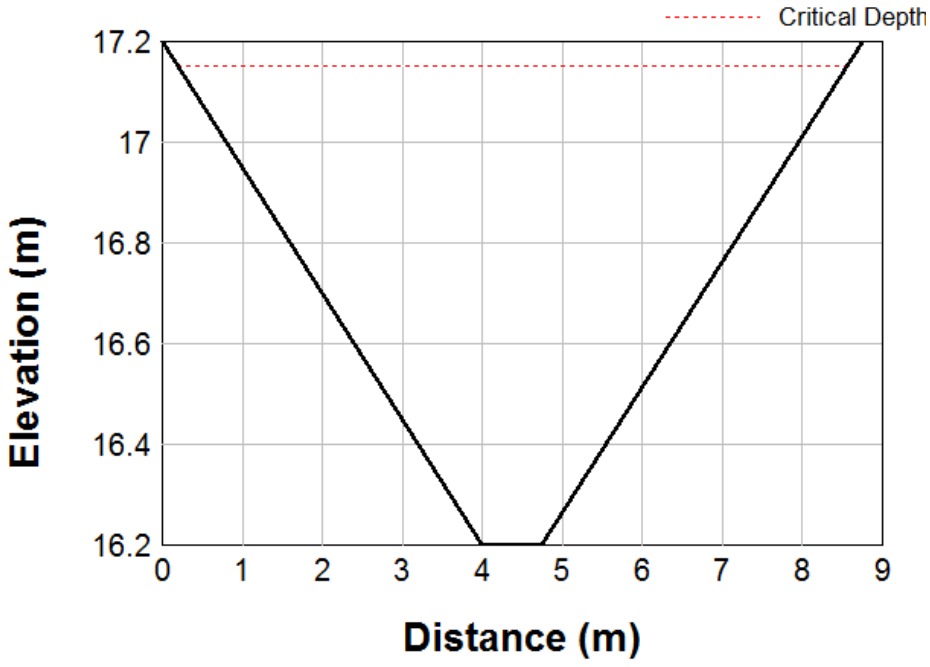


Figure 4: Drainage channel cross section for a critical flow depth, 10 yr ARI, 2 hr Duration

3.2.4.3 Climate Change

Figure 5 shows a cross section of the most critical drainage section prior to the culvert under Reddals Road (annotated 'swale 7' in Figure 1) for a 10 yr ARI, 2 hour duration plus a 30% increase to rainfall intensities to simulate climate change. This model was run to ensure the drainage capacity compliance with DECC guidelines and the DCP's requirement for no spill in 10 yr ARI minor storm event. The critical flow depth is shown to be below that of the top of the channel, therefore satisfying these criteria.

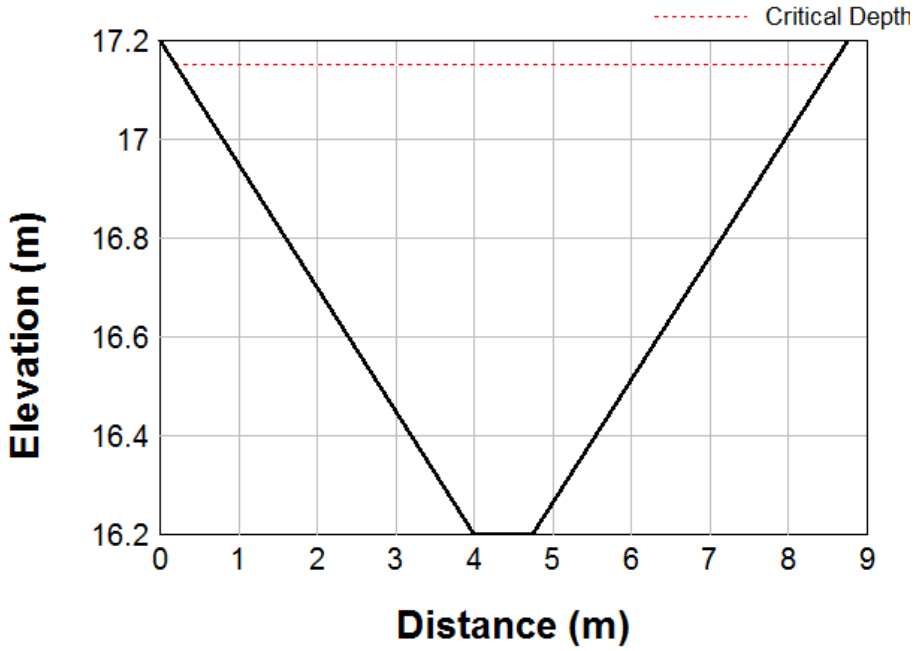


Figure 5: Drainage channel cross section for a critical flow depth, 10 yr ARI, 2 hr Duration +30% Climate Change.

3.2.4.4 Surcharged Outfall

Figure 7 shows the hydrograph at the Dapto Creek outfall for a 5 yr ARI, 2 hour duration plus a blocked outfall. This model was run as a check of the networks behaviour if such a scenario were to occur. The peak discharge in this event was 7.23 m^3/s, therefore satisfying the DCP's PSD.

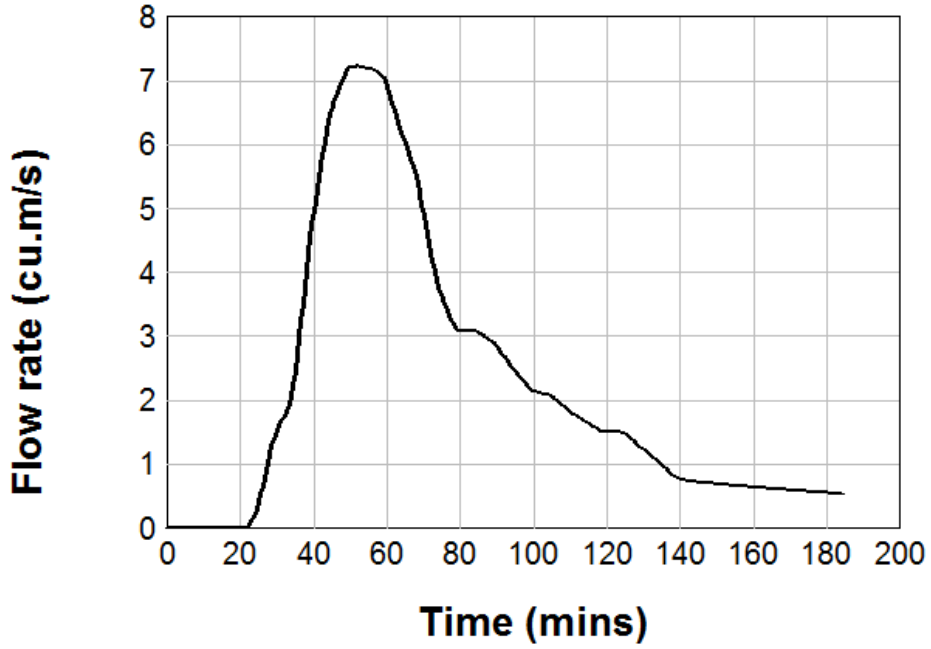


Figure 7: Flow hydrograph at the Dapto Creek outfall, 10 yr ARI, 2 hr for a blocked outfall: 7.23 m^3/s

Figure 8 the hydrograph at the Dapto Creek outfall for a 100 yr ARI, 2 hour duration plus a surcharged outfall. This model was run as a check of the networks behaviour if such a scenario were to occur. The peak discharge in this event was 11.6 m^3/s, therefore satisfying the DCP's PSD.

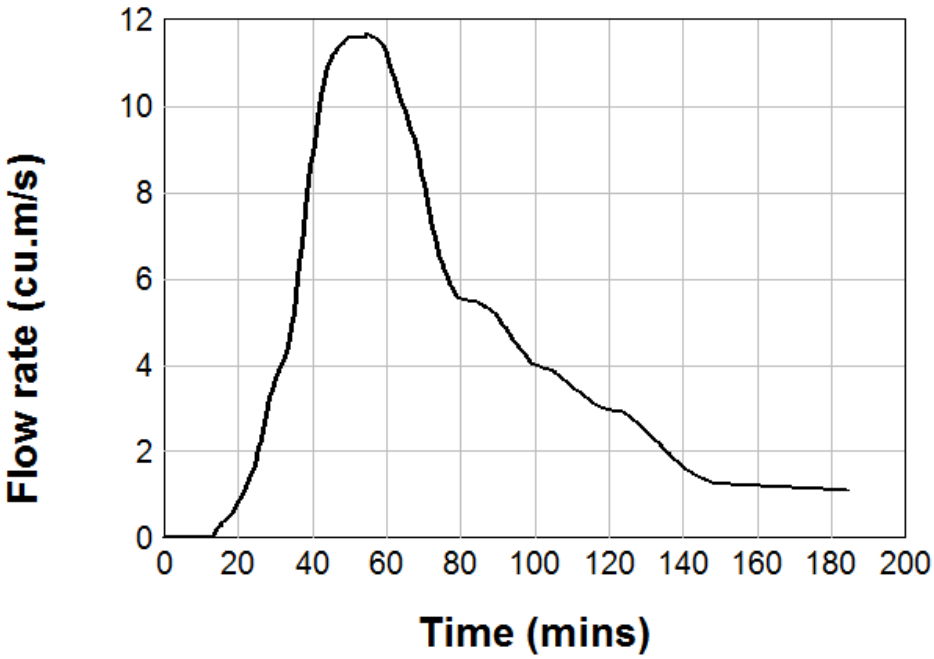


Figure 8: Flow hydrograph at the Dapto Creek outfall, 100 yr ARI, 2 hr with a blocked outfall: 11.60m^3/s

Figure 9 shows a cross section of the most critical drainage section prior to the culvert under Reddalls Road (annotated ‘swale 7’ in Figure 1) for a 10 yr ARI, 2 hour duration plus a blocked outfall. This model was run as a check of the networks behaviour if such a scenario were to occur. The critical flow depth is shown to be below that of the top of the channel, therefore satisfying these DCP criteria.

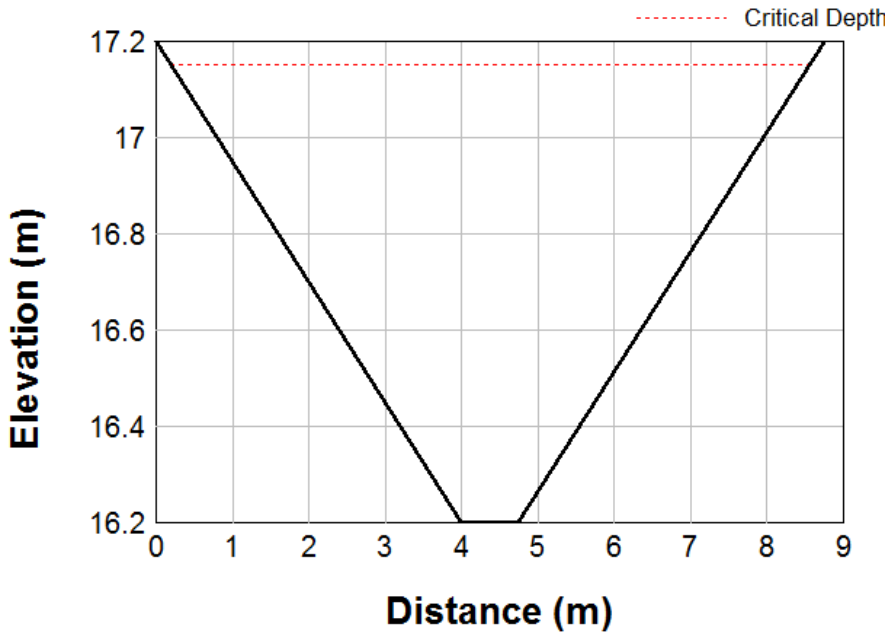


Figure 9: Drainage channel cross section for a critical flow depth, 10 yr ARI, 2 hr with a blocked outfall.

3.3 Sedimentation Pond Design

3.3.1 Introduction

This section looks to calculate the volume for the sediment pond in accordance with the “Blue Book”.

3.3.2 “Blue Book” Calculations

The Sediment pond is made up of two storage zones:

- Settling zone which is a storage volume to allow for treatment of sediment
- Sediment zone which is where sediment collects at the bottom of the pond

Therefore:

Sediment Pond Volume = Settling Zone volume + Sediment Storage Zone Volume

3.3.3 Settling Volume

The settling zone volume for type D soils is calculated to provide capacity to contain all runoff expected from up to the y-percentile rainfall event. The volume of the basin’s settling zone (V) can be determined as a function of the basin’s surface area and depth to allow for particles to settle and can be determined by the following equation:

V= 10 x Cv x A x R(y-%ile,x-day)

Where:

10 = a unit conversion factor
Cv = the volumetric runoff coefficient defined as that portion of rainfall that runs off as stormwater over the x-day period.
R = Is the x-day total rainfall depth (mm) that is not exceeded in the y percent of rainfall events.
A = total catchment area (ha)

3.3.4 Sediment Storage

In this calculation, the sediment storage zone is 50 % of the settling zone based on low erosion hazard lands. Additional calculation will be required at detailed design to confirm the effectiveness of the proposed erosion and sediment controls.

The low erosion hazard figure is a term derived out of the Revised Universal Soil Loss Equation (RUSLE) for a Rainfall Erosivity Factor and the effective slope of the exposed catchment.

Through comparing the Rainfall Erosivity Factor with the effective slope found on the graph in Figure 4.6 of the “Blue Book”, the potential erosion hazard can be assessed.

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3.3.4.1 Determining Potential Erosion Hazard

The calculation of the Rainfall Erosivity Factor (R) is derived from the RUSLE which states the following for the value of R:

$$R = 164.74(1.1177)^{S} S^{0.6444}$$

Where:

R = Rainfall Erosivity Factor

S = 2 year ARI, 6hour duration Rainfall Intensity (mm/hr) = 15.5mm/hr

Therefore, **R** = 5406

The value R was then compared to the effective slope for the proposed landfill catchment in Figure 4.6 of the "Blue Book". The effective slope has been noted to be shallower than 5% which therefore means the post development site fall under the Low Erosion Hazard category.

3.3.5 Summary

Through adding the settling zone and sediment zone volumes together the volume required for the sediment pond can be calculated, Table B9 summarises this.

Table B9: Sediment Pond Volume

Catchment	Cv	R(5day 90%ile)	Total Catchment Area (Ha)	Settling Zone Volume (m^3)	Sediment Storage Volume (m^3)	Total Basin Volume (m^3)
Dirty Catchment	0.63	60.8	20	7660.8	3830.4	11491.2

3.4 Onsite Stormwater Detention Pond

3.4.1 Introduction

This section looks to calculate the volume of storm water detention required to meet PSD values.

An SSR was calculated previously for the required OSD based on the Council's DCP. A detention basin or OSD was added to the DRAINS model already produced for the drainage channel design to check the storage volumes required in comparison to the SSR.

3.4.2 DRAINS model for Onsite Stormwater Detention

The drainage software DRAINS version 2010.06 by Watercom was used to model the Hydrology of the proposed OSD. The model layout (Figure 1) represents Stage 4 onwards on drainage and staging concept plans that can be found in Appendix A. At this stage the existing ponds will be transferred to the reconfigured polishing pond and what will be designed.

3.4.3 Model Results

The DRAINS model was run for the following ARI's to comply with DCP criteria:

- 5yr ARI: To ascertain whether the system complies with the DCP's PSD
- 100yr ARI: To ascertain whether the system complies with the DCP's PSD and to check flood paths to ensure escape routes are not impeded.
- Additional models were ran for climate change and scenarios where the outfall into Dapto Creek is surcharged:
  - Climate Change - a model was ran for climate change to comply with DECC guidelines for a 30% increase in rainfall intensities. This was added to the minor storm 10 yr ARI, 2 hr duration to ascertain whether there was sufficient capacity in the designed system.
  - Surcharged Outfall – a model was run for a surcharged outfall as a check whereby the outfall was given a tailwater level equal to the level at the top of the channel. This was added to the minor storm 10 yr ARI, 2 hr duration to ascertain whether there was sufficient capacity in the designed system.

3.4.3.1 Storage Graphs

5 yr ARI, 2 hour duration

Figure 10 shows a storage graph for a 5 yr ARI, 2 hour duration. This model was run to ensure compliance with the DCP $SSR_{5\ yr}$ for a $PSD_{5\ yr}$ of 8010 mm^3/s or 8.01 m^3/s. The required storage in the DRAINS model was 7855 m^3 with an SSR requirement of 3718 m^3. The model output is much greater than the DCP requirement therefore satisfied.

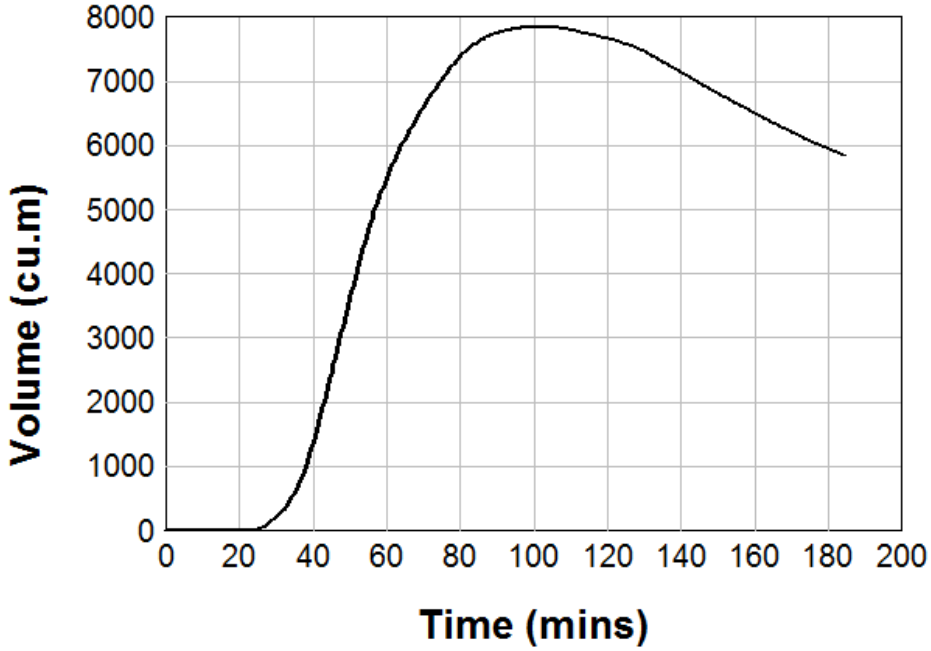


Figure 10: Storage graph for the OSD, 5 yr ARI, 2 hr Duration: 7855 m^3

100 yr ARI, 2 hour duration

Figure 11 shows a storage graph for a 100 yr ARI, 2 hour duration. This model was run to ensure compliance with the DCP $SSR_{100\ yr}$ for a $PSD_{100\ yr}$ of 13270 mm^3/s or 13.27 m^3/s. The required storage in the DRAINS model was 15452 m^3 with an SSR requirement of 6326 m^3. The model output is much greater than the DCP requirement therefore satisfied.

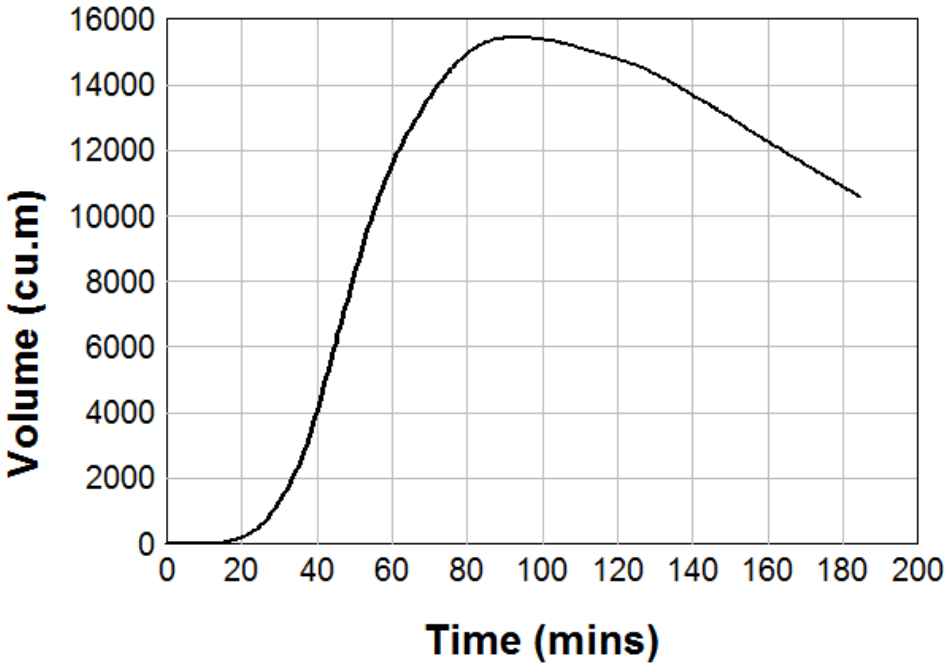


Figure 11: Storage graph for the OSD, 100 yr ARI, 2 hr Duration: 15452 m^3

3.4.3.2 Climate Change

Figure 12 shows a storage graph for a 10 yr ARI, 2 hour duration plus a 30% increase to rainfall intensities to simulate climate change. This model was run to ensure the OSD capacity compliance with the available storage in the existing polishing pond. The required storage in the DRAINS model is 13090 m^3 with an available storage for OSD of 155568 m^3 (existing volume minus volume required for the sedimentation pond). The model output is less than the existing therefore there is sufficient storage for the 10 yr ARI plus climate change.

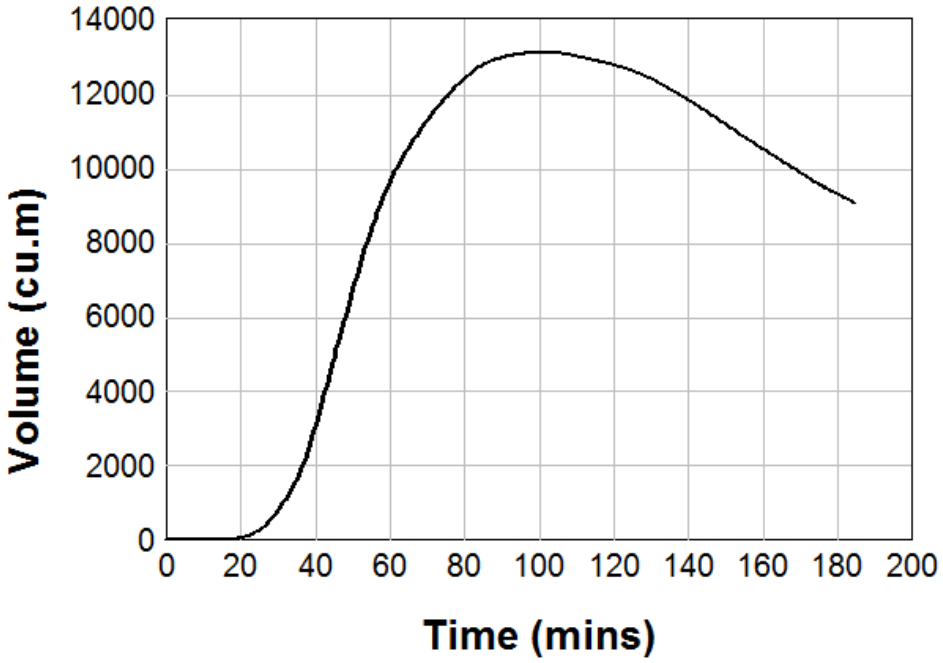


Figure 12: Storage graph for the OSD, 10 yr ARI, 2 hr Duration +30% Climate Change: 13090 m^3

3.4.3.3 Blocked Outfall

Figure 13 shows a storage graph for a 10 yr ARI, 2 hour duration plus a blocked outfall. This model was run as a check of the networks behaviour if such a scenario were to occur. The DRAINS model storage requirement in this event was 9401 m^3/s, below the available 155568 m^3 therefore there is sufficient storage in the event of surcharged outfall in a 10 yr ARI event.

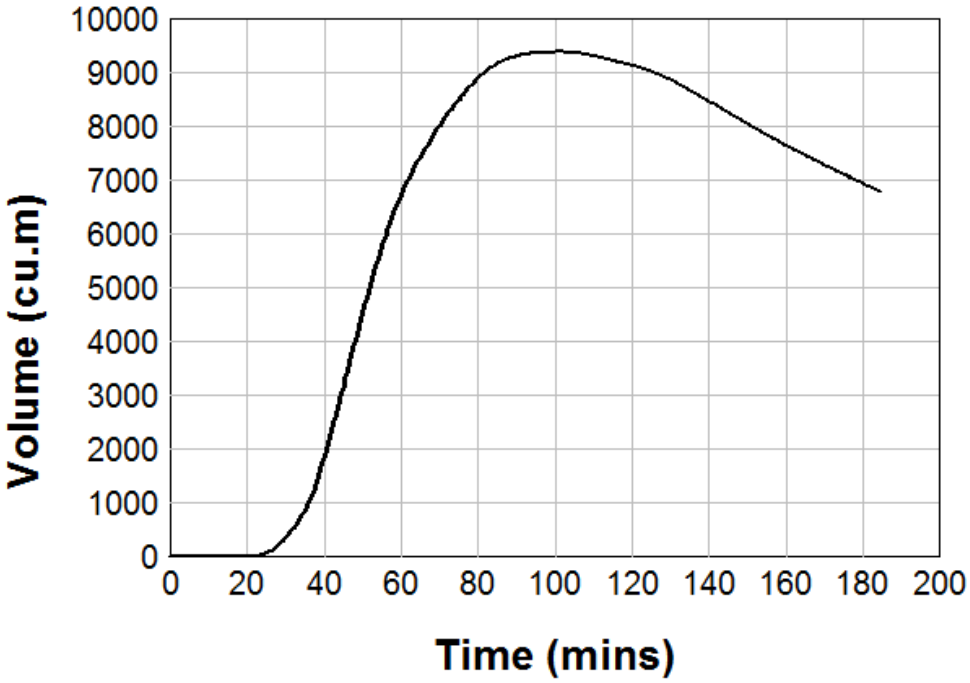


Figure 13: Storage graph for the OSD, 10 yr ARI, 2 hr with a blocked outfall: 9401 m^3

4.0 VOLUME OF EXISTING POND

The proposal is to use the existing polishing pond for the reduced 20Ha catchments for the duration of the stage 4 works and 2 years after the completion of the landfill works when sediment treatment has been fully completed.

Below is a simple volume check using the sum of side method on the records received from Forbes Rigby (99095-5020). Volumes were calculated for the existing polishing pond for both the upper and lower pond. It is however recommended that a full existing survey is completed prior to detailed design.

4.1 Upper pond

Upper Pond Foot Print ≈ 13689 m^2

Slope = 1 in 4

Depth = 2 m

Using sum of sides:

Assume footprint is square, therefore: √13689 = 117 m x 117 m = 13689 m^2 – (A)

Base area of basin with slopes 1 in 4 and depth 2m = 101 m x 101 m = 10201 m^2 – (B)

Sum of lengths multiplied by sum of widths = (117+101) x (117+101) = 47524 m^2 – (C)

Therefore,

A+B+C = 71414 m^2

((A+B+C) x Depth 2 m)/6 = <u>23805 m^3</u>

4.2 Lower pond

Lower Pond Foot Print ≈ 3721m^2

Slope = 1 in 4

Depth = 1m

Using sum of sides:

Assume footprint is square, therefore: √37221 = 61 m x 61 m = 3721 m^2 – (A)

Base area of basin with slopes 1 in 4 and depth 1m = 53m x 53m = 2809 m^2 – (B)

Sum of lengths multiplied by sum of widths = (61+53) x (61+53) = 12996m^2 – (C)

Therefore,

A+B+C = 19526 m^2

((A+B+C) x Depth 1m)/6 = <u>3254 m^3</u>

4.3 Total Polishing Pond Volume

<u>Lower pond + Upper pond = 27059m^3</u>

5.0 GRASS VELOCITIES

A check was carried out on the max velocities of each modelled drain for the minor storm design (10year ARI event, 2hour duration) to ascertain the effectiveness of grass as a means of preventing erosion of the open channel drain as surface water is conveyed towards the outfall.
A check was carried out by comparing the modelled velocities with the limiting velocities given by whitehead (1976) for the quality of grass cover. This has been summarised in Table B10.

Table B10: Whitehead (1976) Limiting velocities for erosion resistance of grasses

Flow duration (Hrs)	Velocities for Quality of Cover (m/s)		
	Good	Normal	Poor
2	5.0	3.8	2.8
4	3.7	2.9	2.1
6	3.3	2.5	1.8
9	3.0	2.3	1.6
12	2.8	2.1	1.5
18	2.7	2.0	1.3
24	2.6	1.9	1.2
48	2.5	1.7	1.0
72	2.4	1.6	0.9

At this stage of the design a check was carried out based on a 10yr ARI and 2 hour rainfall duration.

Tables B11-13 shows the velocities calculated from the DRAINS model for a 10yr ARI, 2 hour duration.

Assuming a normal grass cover, a limiting velocity of 3.8m/s was checked for erosion compliance with the resulting velocities.

Table B11: WEST 10yr, 2 hour duration. Channel Velocity Check

Reference	V max (m/s)	Grass cover comment
Drain 1	1.7	Grass cover Satisfactory to prevent scour
Drain 2	2.1	Grass cover Satisfactory to prevent scour
Drain 3	2.2	Grass cover Satisfactory to prevent scour
Drain 4	2.1	Grass cover Satisfactory to prevent scour
Drain 5	2.1	Grass cover Satisfactory to prevent scour
Drain 6	2.2	Grass cover Satisfactory to prevent scour
Drain 7	1.9	Grass cover Satisfactory to prevent scour
West Outfall	2.3	Grass cover Satisfactory to prevent scour
Pond Outfall	2.2	Concrete Pipe

Table B12: EAST 10yr, 2 hour duration. Channel Velocity Check

Reference	V max (m/s)	Required Drain Cover
Swale 1	1.5	Grass cover Satisfactory to prevent scour
Swale 2	1.7	Grass cover Satisfactory to prevent scour
Swale 3	1.7	Grass cover Satisfactory to prevent scour
Swale 4	1.8	Grass cover Satisfactory to prevent scour
Swale 5	2	Grass cover Satisfactory to prevent scour
Swale 6	2	Reinforced to prevent erosion at turns
Swale 7	2	Reinforced to prevent erosion at turns
Culvert	5.5	Concrete Pipe
East Outfall	1.8	Grass cover Satisfactory to prevent scour

Table B13: Outfall to Dapto Creek, 10yr, 2hour duration. Channel Velocity Check

Reference	V max (m/s)	Required Drain Cover
Final	2.1	Grass cover Satisfactory to prevent scour

APPENDIX C

Flood Assessment Report

1.1 Flood Impact Assessment

1.1.1 Description

The site is located to the north of the Mullet Creek floodplain. The location of the site in context to the Mullet Creek floodplain is presented in Figure 12.3 of the Environmental Assessment report. To the southwest of the site lies Dapto Creek.

The site consists of the following land parcels:

- Lot 2, DP 240557
- Lot 50, DP 1022266
- Lot 51, DP 1022266
- Lot 52, DP 1022266
- Lot 53, DP 1022266
- Lot 302, DP 776338

The Whytes Gully site lies upstream of the Mullet Creek floodplain and the majority of the site exists above the flood planning area, as defined in the Wollongong Local Environment Plan (LEP) – West Dapto (Wollongong City Council, 2010).

The Mullet Creek floodplain is broad and flat and is hydrodynamically influenced by the Illawarra Railway and Lake Illawarra. Dapto Creek is a minor tributary of the Mullet Creek floodplain of moderate slope, 10% below the escarpment, with a contributing catchment of only 280 ha.

The current flood study for Mullet Creek is presented in WBM BMT (2010). There is currently no flood study of Dapto Creek.

1.1.2 Relevant Legislation

The Site lies within the Wollongong Local Environment Plan – West Dapto 2010 (LEP – West Dapto 2010); therefore the flood planning areas as defined in the LEP provide guidance as to flood affectation of the site.

The 100 y Average Recurrence Interval (ARI) event is the basis of the Flood Planning Level (FPL) adopted by Wollongong City Council (Council). The FPL is determined by the addition of a freeboard to the 100 y ARI storm event. The freeboard, as defined in the Wollongong Development Control Plan 2009 (DCP 2009), E14 – Stormwater Management, is 0.7 m for the Lake Illawarra floodplain and is 0.5 m for all other floodplains.

The following is an extract from the LEP – West Dapto (current, 1 November 2011), which pertains to the Flood Planning Area:

7.2 Flood Planning Area

(1) The objectives of this clause are as follows:

(a) to maintain the existing flood regime and flow conveyance capacity,

(b) to enable the safe evacuation from land to which this clause applies,

(c) to avoid significant adverse impacts on flood behaviour,

(d) to avoid significant effects on the environment that would cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses,

(e) to limit uses to those compatible with flow conveyance function and flood hazard.

(2) This clause applies to land at or below the flood planning level, including land that is in a flood planning area.

(3) Development consent must not be granted for development on land to which this clause applies unless the consent authority is satisfied in relation to all of the following matters:

(a) all habitable floor levels of the development will be above the flood planning level,

(b) the development will not adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties,

(c) the development will not significantly alter flow distributions and velocities to the detriment of other properties or the environment of the floodplain,

(d) the development will not affect evacuation from the land,

(e) the development will not significantly detrimentally affect the floodplain environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses,

(f) the development will not result in unsustainable social and economic costs to the community as a consequence of flooding,

(g) if located in a floodway area—the development will not be incompatible with the flow conveyance function of, or increase a flood hazard in, the floodway area.

The development site will also be subject to stormwater management requirements as outlined in the DCP 2009. These include conduit blockage assumptions, minimum conduit sizes, on-site detention requirements (as defined site storage requirement (SSR) and permissible site discharge (PSD)). These aspects are addressed in the Surface Water Assessment report.

1.1.3 Current Flood Affectation

Figure 12.3 presents the flood planning area for Mullet Creek floodplain, as defined in the LEP – West Dapto 2010 (Reference No. 8450_URB_CL1_010_020_20100301.pdf) with respect to the relevant site boundaries and proposed development area. Council have also provided indicative 5 y and 100 y flood levels for Mullet Creek. A freeboard of 0.5 m has been added to these 100 y flood levels.

As outlined in Chapter 8 of the Environmental Assessment, the proposed development consists of a new landfill cell within Lot 2, DP 240557; Lot 50, DP 1022266 and Lot 53, DP 1022266.

From Figure 12.3 of the Environmental Assessment, the flood planning area ranges from 15.8 mAHD to 15.5 mAHD along the southwest boundary of the development site; however the FPL is less than the crown of Reddalls Road. There is a riparian zone defined to the west and southwest of Reddalls Road.

From Figure 12.3 of the Environmental Assessment, the southern portion of the Whytes Gully site is designated as being flood affected due to the culvert on the Reddalls Road being overtopped during the 100 y storm event. This is currently the main surface water discharge location. The affected lots due to this behaviour include:

- Lot 50, DP 1022266
- Lot 51, DP 1022266

Currently Lot 50, DP 1022266 is occupied by surface water ponds. The bund level (at minimum) of the Surface Water Polishing Pond is 15.8 mAHD. The bund level of the Surface Water Reed Ponds are 16.3 mAHD and 16.6 mAHD respectively. There are two leachate ponds in the north of the Lot 50. The bund level of the primary leachate pond is 20.6 mAHD (at minimum) and the bund level of the secondary leachate pond is 24.3 mAHD (at minimum).

The flood planning area is based on the Mullet and Brooks Creek Flood Study, however, a freeboard does not appear to have been added to this outline. The boundary of the flood model coincides with this location. It appears that the geometry of the model at that location is incomplete, specifically that the bunds of the surface water polishing pond does not appear to be clearly defined. This is likely due to the resolution of the model at that location being based on a 10 m grid. The FPL in that location, however, can be inferred, conservatively, based on the available results to be 17.14 mAHD (100 y flood level of 16.64 mAHD + 0.5 m freeboard). An interpreted extent of the flood planning area including freeboard is presented in Figure 12.3 of the Environmental Assesment.

Lot 51, DP 1022266 is currently occupied by the Materials Recycling Facility. The floor level of this building is approximately 19.5 mAHD, compared to the FPL in that area of 17.14 mAHD.

1.1.4 Impact Assessment

As presented in Section 1.1.3, the flood planning area intersects two land parcels; Lot 50, DP 1022266 and Lot 51, DP 1022266.

The proposed development will involve reconfiguration of the northern leachate ponds in Lot 50, DP 1022266 as well as reconfiguration of the surface water ponds in the south of Lot 50. The toe of the leachate ponds lie above the FPL, therefore reconfiguration will not affect flood level or flood behaviour. The footprint of the surface water ponds lie within the FPA (or the interpreted extent including freeboard); however, the proposed configuration will be such so as to maintain existing floodplain storage at this location. Accordingly the proposed development will not affect flood levels or flood behaviour. Stormwater management, however, is an integral part of the proposed development. These aspects are addressed in the Surface Water Assessment report.

It is noted that further assessment may be required in the vicinity of the surface water ponds to confirm this interpretation if there is a reduction in available flood storage area.

The proposed development does not include alteration to existing land-use with respect to Lot 51, DP 1022266, therefore the proposed development will not affect flood levels or flood behaviour with respect to this Lot. It is noted that the floor level of the MRF building that occupies Lot 51 is approximately 19.5 mAHD and is above the FPL.

1.1.5 References

BMT WBM, 2010. *Mullet and Brooks Creeks Flood Study – Final Report*. Reference No. R.B14142.001.05.Final.doc, dated March 2010.

Wollongong City Council, 2009. *Wollongong Development Control Plan – 2009*.

Wollongong City Council, 2010. *Wollongong Local Environment Plan (West Dapto) – 2010 (Reference No. 8450_URB_CL1_010_020_20100301.pdf)*.

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APPENDIX G5

Leachate Generation and Water Balance Modelling

June 2012
Report No. 117625003_159_R_Rev1

TECHNICAL MEMORANDUM

DATE March 2012 **REFERENCE No.** 117625003_151_M_Rev0

TO Michael Herraman
Wollongong City Council

CC

FROM Parnel Richards; Jacinta McMahon **EMAIL** prichards@golder.com.au; jmcmahon@golder.com.au

LEACHATE GENERATION AND WATER BALANCE MODELLING

1.0 INTRODUCTION

This memorandum describes the leachate generation and water balance modelling that has been undertaken to assess the long-term leachate storage requirements associated with the Whytes Gully New Landfill Cell Project. Located at the existing Whytes Gully Resource Recovery Park (the site), the Project would create approximately 6 million cubic metres of additional landfill capacity. The existing landfill is operated by Wollongong City Council (Council). The new landfill cell is proposed to be integrated with the existing landfill cells in a 'piggy back' formation.

The scope of this assessment includes:

- Review of existing leachate management and flows;
- Leachate generation modelling of existing and new landfill cells;
- Assessment of leachate pond capacity;
- Discussion of leachate management options.

2.0 EXISTING LEACHATE MANAGEMENT

The existing landfill comprises two cells located in the Western and Eastern Gullies. Filling of the Western Gully Landfill commenced in 1984 and finished in 1993, when filling of the Eastern Gully Landfill commenced. Filling of the Eastern Gully is projected to finish at the end of 2013. The development of the eastern and western gully landfills including existing leachate management at the site is summarised as follows.

2.1 Western Gully Landfill

Site Preparation - We understand that colluvium and residual soil were stripped from the natural slopes during preparation works prior to landfill being placed in the area. From discussions with Council staff involved in this stripping operation it appears that the natural slopes are likely to have been almost completely stripped to rockhead, but that colluvium and residual soil were not removed to full depth at the base of the natural slopes.

Lining - The Western Gully Landfill is unlined.

Leachate Collection –Collection of leachate was originally through a central 100 mm diameter perforated pipe located at the base of the landfill. From discussions with Council staff we understand that this pipe did not have filter protection and became non-functional early on during the filling process. These discussions also indicate that an alternate leachate collection system was constructed with the following features:

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a. leachate collection horizons were established successively at approximate 5m vertical intervals within the landfill mass; the first (lowest) horizon was at approximately RL 40 m and the last (highest) horizon was at approximately RL 60 m;
b. each horizon comprised a network of finger drains constructed of windrows of railway ballast-size gravel with no filter protection;
c. prior to constructing the finger drains at each horizon, the working landfill surface was prepared by placement and smooth rolling of a layer of silty coal washery rejects to create a fall toward a low point on the landfill batter (i.e., the southern batter);
d. at the low point on each horizon, flows in the finger drains enter a shallow 300 mm concrete or HDPE pipe and are conveyed to the base of the landfill batter; a pipe pit was installed at each horizon; and
e. at the toe of the landfill batter the shallow 300 mm pipe extends through the landfill bund wall to the current leachate collection pit near the landfill access road, from where it is transferred to the leachate collection ponds.

The effectiveness of the alternate leachate collection system is uncertain. Measurements of current water levels in abandoned gas wells and observation of high surface moisture conditions on portions of the landfill batter suggest that accumulated leachate may be present within the Western Gully waste mass below RL 40m and possibly in local perched layers at higher elevations. Management of any significant accumulated leachate in the Western Gully landfill will be needed to reduce ongoing groundwater impact risks and to improve surface conditions prior to piggy back liner construction. Such management measures are not within the scope of this leachate water balance report.

Irrigation of leachate is also understood to have historically been undertaken on the Western Gully Landfill but has not been practiced in recent years.

Volume - The Western Gully Landfill received approximately 980,000 cubic meters (cu.m.) of waste during its 9.5 year life from 1984 to 1993 (Forbes Rigby, 2001).

Filling - Landfilling commenced following the construction of a large soil bund wall at the toe of the landfill with a height of 5 m and a crest elevation of RL 35 m . The bund wall extends from one side of the Western Gully to the other. After site preparation, waste was subsequently placed in the gully behind the bund wall. Once waste was placed to the height of the bund wall, a second, smaller, bund wall was placed to a height of approximately 37.5 m AHD. Waste was then placed to the crest level of the second bund wall. This filling technique of bund construction followed by waste filling was continued throughout the life of the landfill with each bund wall being approximately 2.5 m high.

Bund wall and cover material was won from site preparation works prior to filling of each lift. The external bund wall surfaces were subsequently vegetated following completion of each lift.

Capping – the Western Gully Landfill is covered with a varying depth of cover materials comprising generally low to medium plasticity sandy clay ranging in thickness from 0.3 m to 2.5 m (Golder 2012).

Final Profile - The final profile of the landfill batter comprises an average surface slope of approximately 20% with indistinct benches at approximate 5 m to 10 m vertical intervals. The landfill surface above RL 80 m has gentler slopes, generally flatter than 10%.

2.2 Eastern Gully Landfill

Site Preparation - As with the Western Gully we understand that colluvium and residual soil were stripped from the natural slopes during preparation works prior to landfill being placed in the area. From discussions with Council Staff involved in this stripping operation it appears that the natural slopes are likely to have been almost completely stripped to rockhead, but that colluvium and residual soil were not removed to full depth at the base of the natural slopes.

Leachate Barrier - The Eastern Gully landfill was constructed as a lined landfill, with the barrier component of the lining system comprising a high density polyethylene (HDPE) geomembrane liner (2 mm thickness). The HDPE geomembrane liner has a textured surface in sloped areas to enhance landfill stability.

The HDPE geomembrane liner is underlain by a groundwater drainage layer comprising an approximate 500 mm thick fine gravel layer that is intended to collect any groundwater seepage from natural materials below the liner. This layer incorporates a 100 mm diameter collection pipe that drains by gravity to a surface

water pond at the toe of the landfill. Sampling shows that water collected in the groundwater system may be impacted by leachate. We understand that when high water levels develop in the surface water pond, it is generally pumped to the leachate management system.

Leachate Collection - The HDPE geomembrane liner is overlain by a blanket leachate drainage layer comprising an approximate 300 mm thick clean sand layer. This layer incorporates two 300 mm diameter leachate collection pipes that drain by gravity to the toe of the landfill – one pipe drains Stage 1 and the other pipe drains Stage 2 (refer below for stage description). Collected leachate is transferred to leachate ponds.

Filling - has been undertaken in four stages. Stage 1 commenced in 1993 and was located in the upper portion of the Eastern Gully. Stage 2, located on the lower section of the Eastern Gully commenced in 2001. Stages 1 and 2 together received approximately 1,250,000 cu.m. of waste to the year 2004. Stage 3 is located over the Stage 1 and Stage 2 filling area and had an estimated 610,000 cu.m. capacity over a five year period (2004 to 2009). Stage 4, located in the upper portion of the gully over Stage 3 and Stage 1 is currently underway and has an estimated 750,000 cu.m. capacity over a four year period (2009 to 2013) with completion of filling expected in 2013 (Forbes Rigby, 2001 and WCC Drawing No. 1475, 2004, Survey Drawings KFW dated December 2000, December 2001, June 2004 and December 2009 drawing numbers 2982, 3156, 3705, 4600 respectively).

Capping - Capping materials encountered had a variable composition of materials throughout the existing cap. The thickness of the capping observed by Golder (2012a) ranged from 0.1 m (GAHA04) to 0.6 m (GAHA01) across the Eastern Gully landfill.

Final Profile - The current landfill batter has an average slope of approximately 25% and is terraced with benches at 2m to 3m vertical intervals, bench widths at 3m to 5m, and slope inclinations of 2H:1V to 3H:1V between benches.

2.3 Leachate Storage

Leachate is collected from the Eastern Gully Landfill and Western Gully Landfill as described above and is piped to the Primary Leachate Pond. In the Primary Leachate Pond, the leachate is mixed and aerated and transferred to either the leachate treatment plant or, depending on plant capacity, to the Secondary Leachate Pond for storage.

The leachate ponds are lined with 1.5 mm HDPE geomembrane liner and have a capacity to store 18,000 cu.m. of leachate with a 300 mm freeboard. Both ponds contain surface aerators located on pontoons. The primary leachate pond also contains an axial mixer. The design of the ponds is detailed in design drawings prepared by Forbes Rigby provided for approval in 2003 (Forbes Rigby 2003).

The integrity of the existing leachate ponds and liner is monitored through regular visual inspection of the ponds and groundwater water monitoring. Groundwater monitoring bores are located downgradient of the leachate ponds and will continue to be monitored as part of the ongoing monitoring program for the site.

The Forbes Rigby report provided an assessment of leachate storage requirements in 2002 at the site and development of design criteria for the leachate ponds. This included site water balance modelling to determine the required capacity of the proposed leachate and surface water ponds at the site. The water balance modelling comprised a time series model in which staged capping of the cells including the Stage 3 landfill expansion was considered to obtain the maximum storage requirement during landfilling. The modelling also considered the local rainfall patterns, such as a series of small rainfall events, which can lead to pond overflows, despite each event being smaller than the design storm required in guidelines (25 year ARI, 24 hour event). These rainfall patterns had been observed to cause leachate pond overflows historically at the site.

Forbes Rigby (2002) calculated a minimum required leachate storage capacity of 18 000 cubic metres with an additional 300 mm freeboard, and identified that the proposed location for the ponds would encroach on the proposed landfill extension area. This location aw considered acceptable in order to provide the storage volume required. The currently existing ponds (Primary and Secondary Leachate Ponds) are understood to have been constructed in 2006 in general accordance with the Forbes Rigby (2002).

The RIENCO (2008) report provides the leachate and surface water management plan for the site at that time. The report characterises leachate flows at the site as continuous but variable, increasing during

periods of prolonged wet weather. The report flags a number of factors contributing the leachate generation at the site including high permeability of intermediate capping materials and cross connections between surface water and leachate management systems. Limited leachate discharge capacity, local rainfall patterns and available onsite leachate storage capacity are also important factors in leachate management at the site.

An analysis of leachate pond levels and rainfall events was undertaken, and the proportion of rainfall converted to leachate was estimated at 25% of incident rainfall. This rainfall infiltration was shown to affect leachate pond levels within days. It was identified that the short duration in which rainfall impacts on leachate levels was also due to the connections between the surface water and leachate systems, resulting in up to 40% of the total leachate collection. Rainfall on the leachate ponds contributes further leachate generation. RIENCO note that the total proportion of leachate generated from rainfall was generally comparable with that predicted in the Forbes Rigby model.

2.4 Leachate Treatment

Leachate is pre treated in the leachate ponds by aeration and mixing and then pumped to the on site leachate treatment plant (LTP). The LTP is a biological treatment process using sequencing batch reactor (SBR) technology. Construction of the leachate treatment plant was approved in 2003. The design of the leachate treatment plant is detailed in work as executed drawings prepared by URS Australia (URS, 2006). Key upgrades have been made to the leachate treatment process since construction (refer Golder 2012 Memorandum *Leachate Treatment Plant Operation Review* (ref: 117625003_158_M_Rev0, dated March 2012)) (Golder 2012j) the most recent being 30th June 2011.

The leachate treatment process currently begins with pre-treatment in the leachate ponds. From the leachate ponds the leachate is pumped to the LTP. The LTP has generally been operating on 4 cycles treating 200 kL/day since August 2011 and was recently upgraded to treat 250 kL/day. Treated leachate is discharged to sewer under the Trade Waste Agreement (TWA) with Sydney Water (TWA number 11205) or returned to the Secondary Leachate Pond.

Since the key upgrades to the leachate treatment process were completed in 2011, the levels in the leachate ponds have been monitored and managed on a daily basis with close control and coordination with the leachate treatment plant. There have been no leachate pond overflows during this period. Treated leachate discharge has been generally meeting Sydney Water Trade Waste Agreement discharge criteria.

2.5 Leachate Disposal

The disposal of leachate to sewer is currently (February 2012) limited to 250 kL/day. Although a sewer upgrade is expected due to the imminent West Dapto release, discussions between Sydney Water, Golder and Council have indicated that a design has not been determined and a greater discharge limit should not be designed for at this stage.

During the summer months, when there is low rainfall and ammonia levels within the leachate ponds are generally lower than discharge criteria, a higher rate of pumping to the LTP has been adopted, to reduce the volume of leachate in the ponds. This increases storage capacity for future storm events and/or when ammonia levels are high and a restricted pumping rate to the LTP would be required to achieve sufficient treatment. Similarly, leachate has been pumped from the ponds directly to the sewer, during periods of low ammonia levels.

2.6 Leachate Generation

Based on flow meter readings provided to Golder by Council for the period 30 September 2009 to 10 March 2011:

- the average existing leachate collection rate for the Eastern Gully Stage 1 was calculated to be 0.45 L/s.
- the surface water and leachate-impacted groundwater pumped from the pond at the toe of the Eastern Gully Landfill averages 0.15 L/s.

- the average existing leachate collection rate for the Eastern and Western Gullies (including surface water and groundwater from point 2 above) was calculated to be 2.44 L/s. Assuming 75% of the generated leachate is collected, and that average rainfall occurred during the period, this equates to an average infiltration rate of approximately 40%. With different assumptions an even higher average infiltration rate could be calculated. For example, 75% collection is expected to be a relatively optimistic assumption for the Western Gully considering that it is unlined and has an atypical leachate collection system - assuming a lower collection percentage would result in a higher calculated infiltration rate.

An Infiltration rate of 40% is considered extremely high given the Western Gully capping was clay and reportedly up to 2.5 m thick (although variable) and the Eastern Gully Capping is considered on average to be intermediate level capping around 300 mm thick.

Expected infiltration rates for intermediate capping are generally in the order of 20%. Expected infiltration rates for compacted clay capping systems are generally in the order of 5% or less. Actual infiltration rates will vary with site-specific capping details.

Golder understands the following may be contributing to the unusually high percentage infiltration:

- cross-connections between surface water and leachate collection systems allowing some surface water runoff to be collected as leachate;
- groundwater flow entering the waste mass and being collected as leachate;
- the existing profile of the Eastern Gully Landfill batter in particular (terraced benches) does not encourage surface water runoff, rather the existing profile encourages ponding of surface water and increased infiltration; and
- the existing active area and platform of the Eastern Gully landfill does not shed surface water.

3.0 PROPOSED LEACHATE MANAGEMENT

3.1 Key Principles

Leachate is deemed to include all water that has come into contact with waste. A range of appropriate measures would be implemented to minimise, contain, collect and dispose of leachate generated during landfilling at the site. All practicable measures would be undertaken to minimise the volume of leachate generated at the site, including:

- Diverting upstream, clean stormwater runoff around the landfilling operation, where able;
- Staging the landfilling operation to minimise the active footprint of the landfill;
- Minimising exposed areas within the active footprint of the landfill by regular covering of the landfilled waste;
- Grading filled areas to direct surface water runoff away from the active waste landfilling area;
- Applying intermediate cover on all areas of the landfill that are inactive for periods greater than 90 days; and
- Progressive capping and rehabilitation of completed landfill areas.

3.2 Infiltration Reduction at Existing Eastern and Western Gully Landfills

In addition to the measures reflected in the key principles above being adopted in the design and operation of the Whytes Gully New Landfill Cell, several improvements are planned for the existing Eastern and Western Gully surface profiles in order to reduce infiltration, these include:

- As part of finalising the existing active landfill area, the current Eastern Gully platform would be shaped to shed surface water and would be progressively covered and capped. This is expected to mark a significant reduction in the infiltration into the Eastern Gully Landfill.

- In preparation for the deployment of the Piggy Back Liner over the Eastern Gully Landfill, the terraced profile of the Eastern Gully would be shaped, smoothed and compacted. This is also expected to mark a significant reduction in the infiltration into the Eastern Gully Landfill. This exercise is expected to take place within the 1st year of the Project.
- Progressive piggy backing of the Eastern and Western Gully landfills would be undertaken over time including deployment of a composite piggy back liner, resulting in negligible infiltration in to the existing waste.

3.3 Leachate Generation, Storage and Treatment

The landfill will continue to generate leachate into the foreseeable future. The leachate from the existing landfill areas will continue to be collected in the existing leachate collection systems, piped to the leachate ponds, LTP and treated. The treated leachate will continue to be discharged to sewer under the TWA.

The Leachate Ponds will require relocation at towards the end of Stage 3 of the Project, prior to construction of the Stage 4 new cell liner. New ponds will, however, be constructed in the area north of and currently occupied by the Surface water Reed Bed 1. Sizing requirements for new ponds are estimated based on the peak flows obtained from leachate generation modelling.

4.0 LEACHATE GENERATION MODELLING

The leachate generation has been modelled using a Microsoft excel based site water balance model using monthly time steps (as required in *Director General Requirements for Whytes Gully Waste Disposal Facility – New Landfill Cells, Reddalls Road, Kembla Grange, Office of Environment and Water Director General Requirements*, dated 5 August 2011). The water balance has been conducted throughout the proposed development at the site considering existing and proposed design conditions. The modelling data input and assumptions are outlined below.

4.1 Staging Plan

The proposed landfill cells will allow for the disposal of waste to continue at the site until approximately 2054 (based on an annual filling rates of 140 000 m^3). The development strategy for the site will involve the construction of the new landfill cell in 5 Stages (Stages 1, 2A, 2B, 3 and 4), with each stage comprising staggered liner construction, waste filling, and final capping. Project Stage 1 is anticipated to be ready to accept waste by the end of 2013. The proposed staging timeline is presented below in Table 1 with months numbered sequentially from the start of liner construction in Stage 1.

Table 1: Proposed Staging Plan (to nearest 100 m^2 or m^3)

Stage	Area (m^2)	Area of final capping installed in stage by end of stage (m^2)	Area of final capping installed in stage by end of stage as a proportion of Stage area	Area of existing waste covered by PB liner (m^2)	Volume (m^3)	Liner Construction			Waste Filling			Final Capping		
						Start (month)	End (month)	Duration (months)	Start (month)	End (month)	Duration at current filling rates (months)	Start (month)	End (month)	Duration (months)
1	88 100	53 000	60%	62 400	912 400*	1	31	30	6	57	51	43	69	26
2A	20 800	12 000	58%	9 700	342 800	50	56	6	57	86	29	86	98	12
2B	83 000	42 900	52%	47 000	2 133 600	80	86	6	86	268	182	122	280	158
3	63 700	33 800	53%	38 800	1 588 700	262	336	74	268	404	136	304	416	112
4	62 100	62 100	100%	0	1 006 800	398	446	48	404	489	85	428	501	73
Total	317 700	-	-	158 000	5 984 200	-	-	-	-	-	-	-	-	-

Notes:

* Stage 1 volume includes 293 000 m^3 waste cut-back

4.2 Rainfall and Evaporation

The mean monthly rainfall records at Port Kembla Signal Station (Station No. 068053), sourced from the Bureau of Meteorology (BOM) were adopted in the base case leachate generation model. Port Kembla Signal Station, located approximately 8.5 km from the site, is the closest BOM station with rainfall data available. The rainfall records for Port Kembla Signal Station span from 1950 to 1977. The calculated monthly mean rainfall rates have been adopted. Calibration of the average records against the 5 years of available site data (provided by Council) has shown the Port Kembla Signal Station average values to be higher.

Based on the 27 years of rainfall records available for Port Kembla Signal Station, the statistical 90th percentile annual total rainfall is 1767 mm. The monthly 90th percentile rainfall has been synthesised as follows:

- Calculating the average distribution of rainfall throughout the wettest 5 years recorded for Port Kembla Signal Station (ie. calculating the average percentage of annual rainfall that falls in each month); and
- Apportioning the statistical 90th percentile annual total rainfall (1767 mm) across the months accordingly.

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The mean monthly evaporation rate records at Nowra RAN Air Station (Station No. 068076), sourced from the BOM and corrected using a Pan Evaporation Factor of 0.8 were also adopted in the leachate generation model. Nowra RAN Air Station, located approximately 58 km from the site, is the closest BOM station with evaporation data available.

The adopted rainfall and evaporation data are presented in Table 2 below.

Table 2: Rainfall and Evaporation Rates (to nearest mm)

Month	Mean Rainfall (mm)	Synthethised 90th Percentile Rainfall (mm)	Factored Mean Evaporation (mm)
January	116	88	94
February	158	263	74
March	184	379	67
April	93	131	77
May	89	93	102
June	140	150	115
July	63	90	139
August	88	119	144
September	55	43	169
October	108	169	154
November	94	171	137
December	90	72	114
Annual	1279	1767	1385

4.3 Modelling Assumptions

The following assumptions have been adopted in the leachate balance modelling:

Geometry and Landfilling Rate

- Landfill airspace is consumed at a rate of 140,000 m^3 per year for the operation life of the landfill.
- Approximately 293,000 m^3 of existing waste will be relocated during Stage 1 of the Project.
- Leachate generated from waste cut-back area has been conservatively included until the completion of the waste cut-back at the end of Stage 1.
- All existing waste will be covered by piggy back liner, with the exception of approximately 3.1 ha in Stage 1. The area of existing waste that is not covered by a piggy back liner is conservatively assumed to be covered by intermediate cover until the sixth year of the project (month 69) when the construction of the final Stage 1 cap has been completed.
- Area of active filling (daily cover) will be maintained at 10,000 m^2 throughout the operational life of the landfill.
- Intermediate cover is conservatively assumed to progressively cover the area of each proposed stage throughout the period of liner construction in each stage (assumes that the liner will progressively be covered with waste).
- Infiltrating rainwater is assumed to be collected as leachate in the same month as the rainfall occurs. This is equivalent to assuming that all waste is uniform and is at field capacity at the start of the simulation,
- Leachate generation does not include quantities associated with drainage of existing accumulated leachate in the Western Gully (refer Section 2.1 above).
- Leachate generation does not include quantities associated with leachate recirculation.

Leachate Ponds

- Existing leachate ponds (retained until the end of Stage 3) have a surface area of approximately 9,000 m^2 and a capacity of 18,000 m^3 plus freeboard.
- Proposed leachate pond (constructed during Stage 3 and operational during Stage 4) will have a surface area of approximately 9,000 m^2 (equal to that of the existing ponds).
- The leachate ponds were initially assumed to be empty.
- The discharge rate from the leachate ponds is assumed to be 250 kL/day.
- Under average rainfall conditions, direct rainfall into the leachate ponds is assumed to apply to the surface area of the ponds and evaporation is assumed to apply to the base area of the ponds as the ponds have been modelled to be largely empty under average rainfall conditions.
- Under 90th percentile rainfall conditions, direct rainfall and evaporation from the leachate ponds is assumed to apply to the surface area of the ponds as the ponds have been modelled to be near capacity under 90th percentile rainfall conditions.

Existing Leachate Collection System

- Prior to covering with piggy back liner, leachate collection in the existing system is conservatively assumed to correspond to the following rainfall infiltration rate:
  - Existing cover: 20% (Based on Western Gully having up to 2 m cover representing approximately half of the area and Eastern Gully terraced batters being re-profiled with intermediate cover and the

active area on the platform of the landfill being filled, covered and profiled to shed surface water representing approximately half of the area).

- During the construction of the piggy back liner in each stage, the leachate collection in the existing system is assumed to reduce as indicated in Table 4. The reduction is conservatively assumed to begin for each Stage of the project after 50% of the piggyback liner area has been installed in that Stage.

Table 3: Assumed Leachate Collection in Existing System after the Construction of 50% of the Piggy Back Liner

Years after installation of piggy back liner	Leachate collection as a percentage rate occurring prior to the construction of the piggy back liner
1	50%
2	25%
3	15%
4	10%
5 (and thereafter)	5%

The reduction reflects the anticipated effect of the piggyback liner to cut off rainfall infiltration and thereby gradually reduce leachate generation and collection from underlying existing waste. The assumed rate of leachate generation does not reach zero, but rather is assumed to persist at a small rate due to possible ongoing collection of groundwater and to squeezing out of leachate resident in existing waste due to consolidation in response to increased loading from new waste placement.

New Leachate Collection

- Leachate collection in the new system (i.e. piggy back liner and new cell liner) is assumed to correspond to the following rainfall infiltration rates:
  - Daily cover: 60%
  - Intermediate cover: 20%

Final Capping

- The rate of leachate collection resulting from rainfall infiltration after final capping is assumed to correspond to an infiltration rate of 1%. This rate is considered to be conservative for the proposed capping sytem which includes an LLDPE geomembrane layer.
- The final cap of each stage is assumed to be constructed progressively throughout the period of construction of the cap.

4.4 Modelling Results

The predicted monthly leachate collection volumes (based on average monthly rainfall) are summarised in Table 4 below.

Table 4: Modelled Volumes of Leachate Collection (Average Monthly Rainfall)

Stage	Leachate Collection (kL/month)		Leachate Requiring Storage (kL/month)*		Cumulative Leachate Storage Required (kL)	
	Minimum	Maximum	Minimum	Maximum	Maximum	At end of Stage
1-3	1 000	10 200	0	4100	6413	0
4	6 00	4 600	0	0	0	0

Notes:

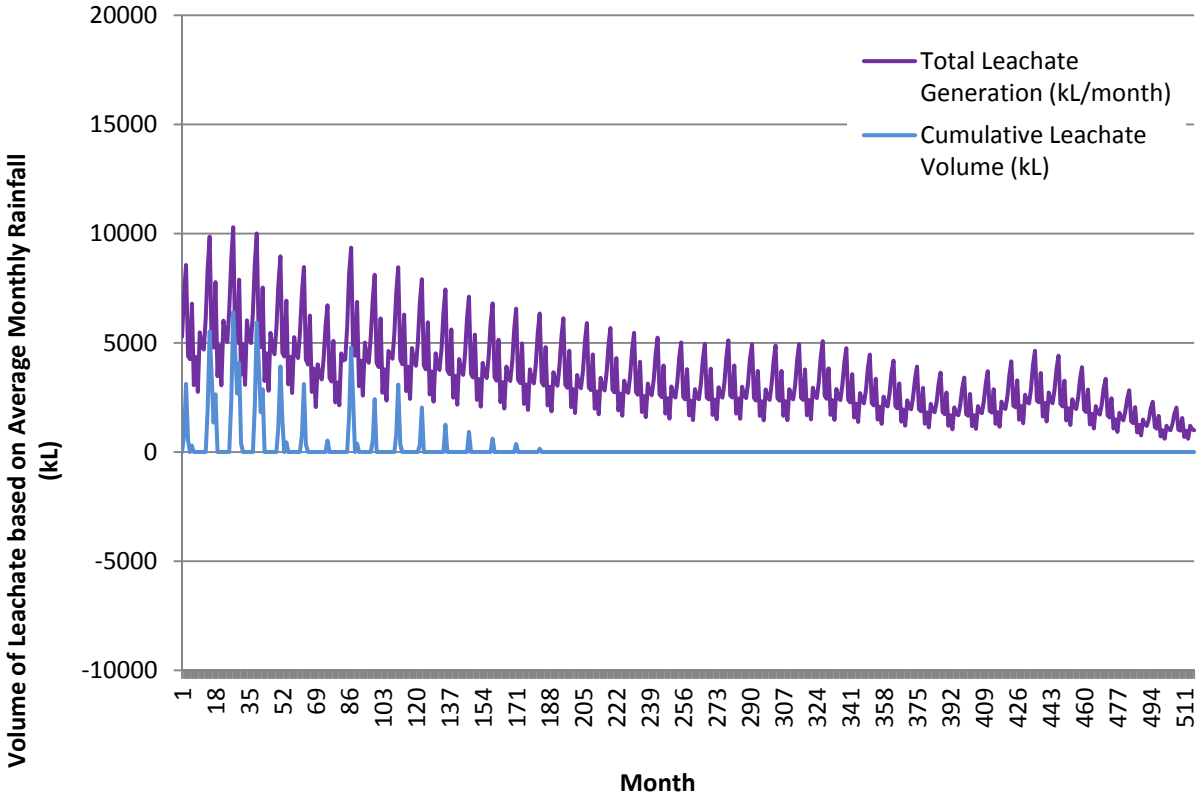
* After the consideration of rainfall, evaporation and discharge to sewer

The modelled leachate volumes (based on average monthly rainfall) indicate that throughout Stages 1-3, the maximum leachate requiring storage (4 100 kL/month) occurs during the second year of the project (month 24) and the maximum cumulative volume of leachate requiring storage (6 413 kL) occurs during the third year of the project (month 27). With a capacity of approximately 18 000 kL, the existing leachate ponds are therefore expected to have sufficient capacity to store leachate generated during Stages 1-3 under average rainfall conditions.

As discussed previously, due to the expansion of the landfill, a new leachate pond must be constructed by the beginning of Stage 4. The modelled leachate volumes (based on average monthly rainfall) indicate that the combined effect of discharge to sewer and evaporation is expected to exceed the volume of generated leachate such that the cumulative volume of leachate requiring storage at the end of Stage 4 is less than zero. A new leachate pond with nominally equivalent surface area and capacity as the existing ponds can thus be expected to provide ample storage for leachate generated during Stage 4 under average rainfall conditions.

A graph showing the monthly volume of generated leachate and cumulative leachate volume requiring storage under average rainfall conditions is included below as Figure 1**Error! Reference source not found.**.

Figure 1: Volume of Generated Leachate and Leachate Requiring Storage (based on average monthly rainfall)



4.5 Sensitivity Analyses

As recommended in EPA Victoria's *Best Practice Environmental Management – Siting, Design, Operation and Rehabilitation of Landfills* (Publication 788.1, dated September 2010) (BPEM), the 90th Percentile rainfall data is adopted for two consecutive years as a sensitivity analysis to ensure the system has sufficient capacity over the operational life of the landfill.

The predicted monthly leachate generation volumes (based on 90th percentile monthly rainfall) are summarised in Table 6 below. The first two years were selected for this analysis as this is the period which results in the highest volume of cumulative leachate storage required.

Table 5: Modelled Volumes of Leachate Collection (90th Percentile Rainfall)

Years	Leachate Collection (kL/month)		Volume of Leachate Requiring Storage (kL/month)*		Cumulative Leachate Storage Required (kL)	
	Minimum	Maximum	Minimum	Maximum	Maximum	At end of Stage
1	2100	17600	0	12500	18000	1500
2	2300	20300	0	15200	15000	4400

Notes:

* After the consideration of rainfall, evaporation and discharge to sewer

The modelled volumes (based on average monthly rainfall) indicate that throughout Stages 1-3, the maximum leachate requiring storage (15 200 kL) occurs during the second year of the project (month 15) and the maximum cumulative volume of leachate requiring storage (18 000 kL) occurs during the third month of the project (month 3). With a capacity of approximately 18 000 kL, the existing leachate ponds are therefore expected to have sufficient capacity to store leachate generated during two consecutive wet years.

4.6 Conclusion

The monthly leachate water balance using average rainfall shows the existing ponds are of adequate capacity for Stages 1-3 and ponds with a similar capacity and footprint would be adequate for Stage 4.

Sensitivity analyses indicate the ponds are of an adequate capacity for two consecutive years of 90th percentile rainfall.

5.0 RECOMMENDATIONS

Based on the results of this analysis it is proposed to:

- Continue to use the existing leachate treatment and disposal system with the current holistic leachate treatment philosophy.
- Review the resultant leachate generation volumes and rainfall amounts during 2014 and reassess the water balance model assumptions for infiltration rates (During the first year of the Project it is proposed there would be significant works undertaken at the Whytes Gully RRP site, including operational changes, that are expected to significantly impact and reduce the current leachate generation rates. These include capping the Eastern Gully landfill platform, reprofiling the existing Eastern Gully landfill batter (considered to be a significant source of infiltration and stormwater contribution to the leachate collected at the site), in addition to capping of the current landfilling area and commencement of the Piggy Back Liner).
- Continue to review the integrity of the leachate ponds through groundwater analysis and inspection.
- Continue to liaise with Sydney Water on timing for sewer capacity upgrade. Sydney Water may in this time develop firm upgrade plans for the sewer along Reddalls Road and consider an increased discharge limit to sewer for the Project site.
- Undertake treatment of accumulated leachate in the Western Gully prior to commencement of construction.

The following contingency actions for leachate storage and/or treatment are considered feasible, and could be implemented in a short period of time at the Project site if necessary:

- Discharge to sewer directly from the leachate storage ponds during periods of low ammonia concentrations to increase leachate storage capacity (this approach is known to be acceptabe to Sydney Water and has been implemented successsfuly in the past year).
- Leachate reinjection over short-term into new waste proposed for the new cell through surface application across the daily cover area (10 000 m^2);
- Trucking of leachate to sewage treatment plant for disposal;
- ‘Package’ plants: proprietary package treatment plants are available that can be mobilised to the Whytes Gully RRP site should increased leachate treatment capabilities be temporarily required;
- Until the end of Stage 1 store excess leachate in the former surface water pond at the toe of the Western Gully, or construct a new leachate overflow storage pond in the Cell 2 or Cell 3 area;
- Upgrade the existing leachate treatment plant to increase volume throughput and/or efficiency of treatment process/new technologies; and
- Construct a cover over the existing leachate ponds to reduce the effects of direct rainfall.

In addition prior to commencement of the Project Wollongong City Council would:

- ‘Drain’, treat and dispose of accumulated leachate from the Western Gully landfill via replacement of the existing shallow leachate drainage line in the Western Gully and construction of a proposed new leachate drainage line in the Western Gully.

6.0 REFERENCES

Attachment A: Director General Requirements for Whytes Gully Waste Disposal Facility – New Landfill Cells, Reddalls Road, Kembla Grange, Office of Environment and Water Director General Requirements, dated 5 August 2011).

EPA Victoria (September 2010) *Best Practice Environmental Management – Siting, Design, Operation and Rehabilitation of Landfills (Publication 788.1)*

Forbes Rigby Pty Ltd (2002), *Whytes Gully Landfill Leachate Management Study* (ref: 99095-03 Report 001 Rev0, dated August 2002)

Forbes Rigby Pty Ltd (2003), *Whytes Gully – Waste Disposal Facility, Leachate & Stormwater Ponds Civil Works, Reddalls Road, Kembla Grange for Wollongong City Council Landfill Leachate Management Study – Leachate Ponds Layout Plan* (ref: Project No. 99095, Com No. 5, Drawing No. 5010, dated 08/09/03)

Golder Associates (2012a), Whytes Gully New Landfill Cell, Geotechnical Investigation Report (ref: 117625003_077_R_Rev1, dated March 2012)

Golder Associates (2012j), Leachate Treatment Plant Operation Review (ref: 117625003_158_M_Rev0, dated March 2012)

RIENCO Consulting (2008), *Whytes Gully Landfill Surface Water and Leachate Management Plan 2008 DRAFT* (ref: 8015-1, Version P1, dated 05/12/2008)

Scott and Furphy Engineers (February 1982) *Proposed Waste Disposal Depot at Reddall's Road West Dapto, Environmental Impact Statement*

Report Signature Page

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http://aupws/117625003wollongongcitycouncilnewcellwhytesgully/project doc/202 leachate water balance/117625003-151-m-rev0-leachate generation and water balance modelling.docx

List of Attachments

Attachment 1: Extract from Leachate Water Balance Calculations

Attachment 2: Limitations

BASE CASE - AVERAGE MONTHLY RAINFALL

Key:

Input cells
Output cells

INPUT

Staging Plan

Stage	Stage area (m^2)	Area of final capping installed in stage by end of stage (m^2)	Area of final capping installed in stage by end of stage as a proportion of Stage area	Area of existing waste covered by PB liner (m^2)	Stage volume (m^3)	Liner Construction			Waste Filling			Final Capping		
						Start (month)	End (month)	Duration (months)	Start (month)	End (month)	Duration at current filling rates (months)	Start (month)	End (month)	Duration (months)
1	88130	53045	60%	62448	912428	1	31	30	6	57	51	43	69	26
2A	20780	12042	58%	9735	342754	50	56	6	57	86	29	86	98	12
2B	82960	42857	52%	47021	2133574	80	86	6	86	268	182	122	280	158
3	63690	33803	53%	38768	1588669	262	336	74	268	404	136	304	416	112
4	62100	62100	100%	0	1006799	398	446	48	404	489	85	428	501	73
Total	317660			157972	5984224									

Current filling rate	140000	m^3/yr
Stage 1 waste cut-back volume	293000	m^3
Area of Stage 1 Existing Waste not covered by PB liner	31341	m^2
Area of active filling area (daily cover only)	10000	m^2

Leachate Ponds

Existing pond area available for direct rainfall (Stages 1-3)	9000	m^2	surface area
Proposed pond area available for direct rainfall (Stage 4)	9000	m^2	
Existing pond area available for evaporation (Stages 1-3)	2200	m^2	base area (as ponds are generally near empty)
Proposed pond area available for evaporation (Stage 4)	2200	m^2	
Starting volume	0	kL	
Discharge rate to leachate treatment plant (Year 1)	250	kL/day	
	7604	kL/month	
Discharge rate to leachate treatment plant (Year 2 onwards)	250	kL/day	
	7604	kL/month	

Weather Data

	Rainfall (Port Kembla Signal Station 068053)		Pan Evaporation (Nowra RAN Air Station 068076)			Factored Mean Total Evaporation
	Mean Total		Mean Daily		Mean Total	
	mm	m	mm	m	m	m
January	116.1	0.1161	6.2	0.0062	0.186	0.1488
February	157.5	0.1575	5.7	0.0057	0.1767	0.14136
March	183.7	0.1837	4.6	0.0046	0.138	0.1104
April	92.9	0.0929	3.9	0.0039	0.1209	0.09672
May	89	0.089	3	0.003	0.093	0.0744
June	140.3	0.1403	2.8	0.0028	0.084	0.0672
July	62.6	0.0626	3.1	0.0031	0.0961	0.07688
August	87.7	0.0877	4.1	0.0041	0.123	0.0984
September	55	0.055	4.8	0.0048	0.1488	0.11904
October	108	0.108	5.6	0.0056	0.1736	0.13888
November	94.3	0.0943	6	0.006	0.18	0.144
December	90.4	0.0904	6.8	0.0068	0.2108	0.16864
Annual	1278.6	1.2786	4.7	0.0047	1.73	1.38

Pan Evaporation Factor	0.8

Capping Infiltration Rates

Capping	Future Waste			Existing Waste		
	Infiltration (% of rainfall)	ET (% of rainfall)	Runoff (% of rainfall)	Infiltration (% of rainfall)	ET (% of rainfall)	Runoff (% of rainfall)
Daily cover	60%	40%	0%	60%	40%	0%
Intermediate cover	20%	80%	0%	20%	80%	0%
Final capping	1%	80%	19%	1%	80%	19%

Existing Leachate Generation

	2.44	L/s	based on 2010 leachate meter volumes from WCC
Existing landfill leachate generation	6412	kL/month	
	76948	kL/yr	
Equivalent area	185314	m^2	assumes 100% intermediate cover, with 75% of leachate collected
Area of existing waste	185314	m^2	
Area covered by leachate collection	185314	m^2	
Equivalent Existing Infiltration	43%		calculated such that equivalent area = area of existing waste

Future Leachate Generation in Existing Waste

Years after piggy back liner is 50% installed	Leachate generation as a percentage of original generation prior to the construction of the piggy back liner
0	100%
1	50%
2	25%
3	15%
4	10%
5 (and thereafter)	5%

% Cover Over Future Waste at Key Events

Event					Month	Stage 1		Stage 2A		Stage 2B		Stage 3		Stage 4	
Stage 1	Stage 2A	Stage 2B	Stage 3	Stage 4		Final	Int.	Final	Int.	Final	Int.	Final	Int.	Final	Int.
Commence Liner					1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Complete Liner					31	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%
Commence Cap					43	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%
	Commence Liner				50	16%	84%	0%	0%	0%	0%	0%	0%	0%	0%
	Complete Liner				56	30%	70%	0%	100%	0%	0%	0%	0%	0%	0%
Complete Cap					69	60%	40%	0%	100%	0%	0%	0%	0%	0%	0%
		Commence Liner			80	60%	40%	0%	100%	0%	0%	0%	0%	0%	0%
	Commence Cap	Complete Liner			86	60%	40%	0%	100%	0%	100%	0%	0%	0%	0%
	Complete Cap				98	64%	36%	58%	42%	0%	100%	0%	0%	0%	0%
		Commence Cap			122	64%	36%	58%	42%	0%	100%	0%	0%	0%	0%
			Commence Liner		262	96%	4%	95%	5%	46%	54%	0%	0%	0%	0%
		Complete Cap			280	100%	0%	100%	0%	52%	48%	0%	24%	0%	0%
			Commence Cap		304	100%	0%	100%	0%	52%	48%	0%	57%	0%	0%
			Complete Liner		336	100%	0%	100%	0%	65%	35%	15%	85%	0%	0%
				Commence Liner	398	100%	0%	100%	0%	92%	8%	45%	55%	0%	0%
			Complete Cap		416	100%	0%	100%	0%	100%	0%	53%	47%	0%	38%
				Commence Cap	428	100%	0%	100%	0%	100%	0%	53%	47%	0%	63%
				Complete Liner	446	100%	0%	100%	0%	100%	0%	65%	35%	25%	75%
				Complete Cap	501	100%	0%	100%	0%	100%	0%	100%	0%	100%	0%

BASE CASE - AVERAGE MONTHLY RAINFALL

OUTPUT

Calculated Leachate Collection and Storage Requirements

Stage	Leachate Collection (kL/month)		Leachate Requiring Storage (kL/month)^		Cumulative Leachate Storage Required (kL)	
	Minimum	Maximum	Minimum	Maximum	Maximum	At end of Stage
1-3	1046	10291	-6325	4097	6413	0
4	609	4632	-6762	-1562	0	0

^After the consideration of rainfall, evaporation and discharge to sewer

SENSITIVITY ANALYSIS - 90TH PERCENTILE RAINFALL (YEARS 1 & 2)

Key:
Input cells
Output cells

INPUT

Staging Plan

Stage	Stage area (m^2)	Area of final capping installed in stage by end of stage (m^2)	Area of final capping installed in stage by end of stage as a proportion of Stage area	Area of existing waste covered by PB liner (m^2)	Stage volume (m^3)	Liner Construction			Waste Filling			Final Capping		
						Start (month)	End (month)	Duration (months)	Start (month)	End (month)	Duration at current filling rates (months)	Start (month)	End (month)	Duration (months)
1	88130	53045	60%	62448	912428	1	31	30	6	57	51	43	69	26
2A	20780	12042	58%	9735	342754	50	56	6	57	86	29	86	98	12
2B	82960	42857	52%	47021	2133574	80	86	6	86	268	182	122	280	158
3	63690	33803	53%	38768	1588669	262	336	74	268	404	136	304	416	112
4	62100	62100	100%	0	1006799	398	446	48	404	489	85	428	501	73
Total	317660			157972	5984224									

Current filling rate	140000	m^3/yr
Stage 1 waste cut-back volume	293000	m^3
Area of Stage 1 Existing Waste not covered by PB liner	31341	m^2
Area of active filling area (daily cover only)	10000	m^2

Leachate Ponds

Existing pond area available for direct rainfall (Stages 1-3)	9000	m^2	surface area
Proposed pond area available for direct rainfall (Stage 4)	9000	m^2	
Existing pond area available for evaporation (Stages 1-3)	9000	m^2	surface area (as ponds are generally full)
Proposed pond area available for evaporation (Stage 4)	9000	m^2	
Starting volume	0	kL	
Discharge rate to leachate treatment plant (Year 1)	250	kL/day	
	7604	kL/month	
Discharge rate to leachate treatment plant (Year 2 onwards)	250	kL/day	
	7604	kL/month	

Weather Data

	Rainfall (Port Kembla Signal Station 068053)				Pan Evaporation (Nowra RAN Air Station 068076)			Factored Mean Total Evaporation
	Mean		Synthetised 90th Percentile Year		Mean Daily		Mean Total	
	mm	m	mm	m	mm	m	m	m
January	116.1	0.1161	87.7	0.0877	6.2	0.0062	0.186	0.1488
February	157.5	0.1575	262.9	0.2629	5.7	0.0057	0.1767	0.14136
March	183.7	0.1837	379.0	0.3790	4.6	0.0046	0.138	0.1104
April	92.9	0.0929	130.5	0.1305	3.9	0.0039	0.1209	0.09672
May	89	0.089	93.3	0.0933	3	0.003	0.093	0.0744
June	140.3	0.1403	149.7	0.1497	2.8	0.0028	0.084	0.0672
July	62.6	0.0626	90.0	0.0900	3.1	0.0031	0.0961	0.07688
August	87.7	0.0877	119.4	0.1194	4.1	0.0041	0.123	0.0984
September	55	0.055	42.6	0.0426	4.8	0.0048	0.1488	0.11904
October	108	0.108	168.9	0.1689	5.6	0.0056	0.1736	0.13888
November	94.3	0.0943	170.8	0.1708	6	0.006	0.18	0.144
December	90.4	0.0904	72.2	0.0722	6.8	0.0068	0.2108	0.16864
Annual	1278.6	1.2786	1767.0	1.7670	4.7	0.0047	1.73	1.38

Pan Evaporation Factor	0.8	

Capping Infiltration Rates

Capping	Future Waste			Existing Waste		
	Infiltration (% of rainfall)	ET (% of rainfall)	Runoff (% of rainfall)	Infiltration (% of rainfall)	ET (% of rainfall)	Runoff (% of rainfall)
Daily cover	60%	40%	0%	60%	40%	0%
Intermediate cover	20%	80%	0%	20%	80%	0%
Final capping	1%	80%	19%	1%	80%	19%

Existing Leachate Generation

	2.44	L/s	based on 2010 leachate meter volumes from WCC
Existing landfill leachate generation	6412	kL/month	
	76948	kL/yr	
Equivalent area	185314	m^2	assumes 100% intermediate cover, with 75% of leachate collected
Area of existing waste	185314	m^2	
Area covered by leachate collection	185314	m^2	
Equivalent Existing Infiltration	43%		calculated such that equivalent area = area of existing waste

Future Leachate Generation in Existing Waste

Years after piggy back liner is 50% installed	Leachate generation as a percentage of original generation prior to the construction of the piggy back liner
0	100%
1	50%
2	25%
3	15%
4	10%
5 (and thereafter)	5%

% Cover Over Future Waste at Key Events

Event					Month	Stage 1		Stage 2A		Stage 2B		Stage 3		Stage 4	
Stage 1	Stage 2A	Stage 2B	Stage 3	Stage 4		Final	Int.	Final	Int.	Final	Int.	Final	Int.	Final	Int.
Commence Liner					1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Complete Liner					31	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%
Commence Cap					43	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%
	Commence Liner				50	16%	84%	0%	0%	0%	0%	0%	0%	0%	0%
	Complete Liner				56	30%	70%	0%	100%	0%	0%	0%	0%	0%	0%
Complete Cap					69	60%	40%	0%	100%	0%	0%	0%	0%	0%	0%
		Commence Liner			80	60%	40%	0%	100%	0%	0%	0%	0%	0%	0%
	Commence Cap	Complete Liner			86	60%	40%	0%	100%	0%	100%	0%	0%	0%	0%
	Complete Cap				98	64%	36%	58%	42%	0%	100%	0%	0%	0%	0%
		Commence Cap			122	64%	36%	58%	42%	0%	100%	0%	0%	0%	0%
			Commence Liner		262	96%	4%	95%	5%	46%	54%	0%	0%	0%	0%
		Complete Cap			280	100%	0%	100%	0%	52%	48%	0%	24%	0%	0%
			Commence Cap		304	100%	0%	100%	0%	52%	48%	0%	57%	0%	0%
			Complete Liner		336	100%	0%	100%	0%	65%	35%	15%	85%	0%	0%
				Commence Liner	398	100%	0%	100%	0%	92%	8%	45%	55%	0%	0%
			Complete Cap		416	100%	0%	100%	0%	100%	0%	53%	47%	0%	38%
				Commence Cap	428	100%	0%	100%	0%	100%	0%	53%	47%	0%	63%
				Complete Liner	446	100%	0%	100%	0%	100%	0%	65%	35%	25%	75%
				Complete Cap	501	100%	0%	100%	0%	100%	0%	100%	0%	100%	0%

SENSITIVITY ANALYSIS - 90TH PERCENTILE RAINFALL (YEARS 1 & 2)

OUTPUT

Calculated Leachate Collection and Storage Requirements

Year	Leachate Collection (kL/month)		Leachate Requiring Storage (kL/month)^		Cumulative Leachate Storage Required (kL)	
	Minimum	Maximum	Minimum	Maximum	Maximum	At end of Stage
1	2137	17661	-6155	12474	18063	1496
2	2371	20333	-5921	15146	15146	4469

^After the consideration of rainfall, evaporation and discharge to sewer

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