Report

Hydrological Investigations of Wetland

Tarrone Power Station

OCTOBER 2009

Prepared for

AGL Energy Limited

Level 22, 101 Miller Street
North Sydney
NSW 2060

43283491

URS

Project Manager:

……………………………
Joel Rodski
Environmental Planner

Project Director:

……………………………
Sean Myers
Senior Principal
Environmental Planner

Author:

……………………………
Rocco Vivarelli
Senior Water Engineer

Peer Review:

……………………………
David Fuller
Senior Principal

URS Australia Pty Ltd

Level 6, 1 Southbank Boulevard
Southbank VIC 3006
Australia
T: 61 3 8699 7500
F: 61 3 8699 7550

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Executive Summary

This report describes the development and testing of a water balance model for a wetland observed on AGL Energy Limited's proposed Tarrone Power Station Site in Western Victoria, Australia.

The catchment of the wetland was derived from detailed survey as 0.0431km^2 and drains to the west of the site whereas the remainder of the site tends to drain towards the south and Riordan's Road. Establishing infrastructure outside the catchment boundary would not contribute water to the wetland, though the generally low relief of the site suggests that appropriate storm water management controls may be required to ensure the wetland is isolated from any potentially contaminated runoff.

Water balance modelling indicates that the wetland is highly seasonal and likely to be mainly dry in the period December to June though December and June are more likely than other months in this range to have inundation. The period July to November is the most likely period for standing water in the wetland. Modelling suggests that water levels will be very shallow for much of this period with occasional excursions to a maximum depth of around 300mm. This maximum depth is controlled by a combination of Landers Lane roadway and a pipe culvert under the laneway. It appears highly likely that the construction of Landers Lane has contributed to the creation or enhancement of wetland conditions at this site. Survey of the well defined wetland extent supports this conclusion.

The wetland can be expected to fill in most, but not all years modelled. The full period of record of Hamilton Research station rainfall and evaporation record (1962 – 2000) has been used for modelling. Calibration of the model with the Moyne River stream gauge has been assumed to provide adequate assessment of local wetland runoff and independent water balance calculations suggest that the model is within acceptable tolerances given a lack of local wetland water level observations. It is noted that vegetation growth in the wetland and the adjacent spoon drain may have significant effects on flood inundation levels, but are less likely to affect general standing levels in the area.

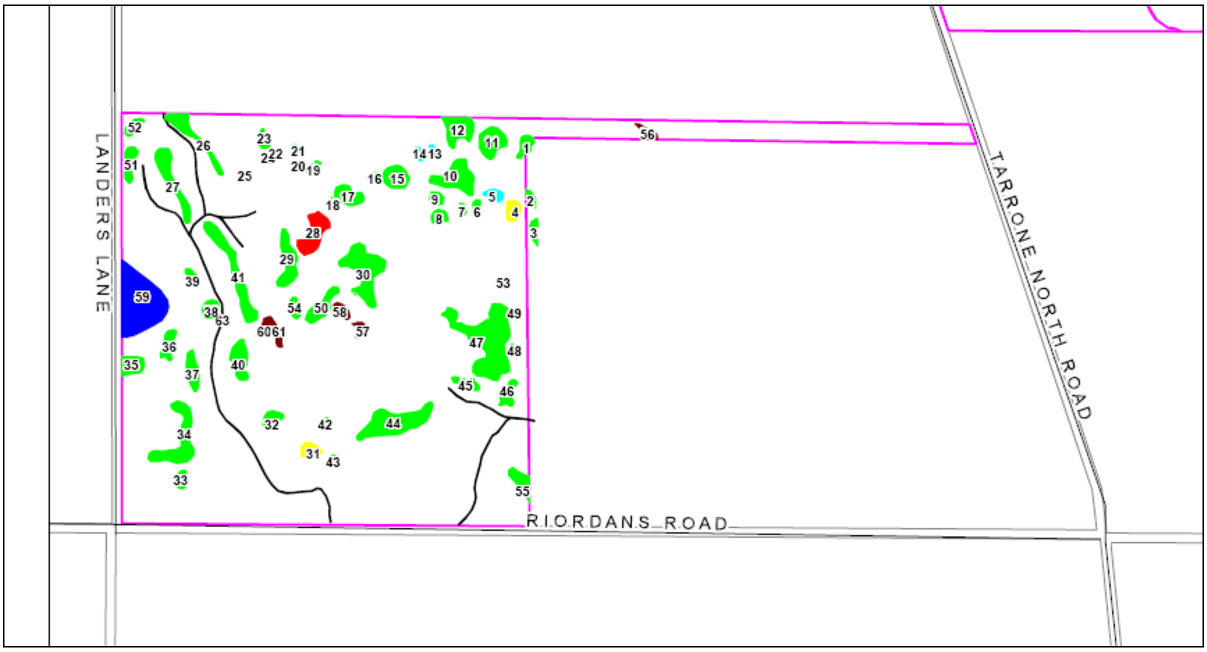
Introduction

1.1 Background

URA Australia Pty Ltd was engaged by AGL to investigate the hydrological regime of a wetland identified on a proposed power station site at Tarrone. The wetland has previously been identified as containing Wavy Swamp Wallaby-grass *Amphibromus sinuatus* a vegetation type that is of state conservation significance (Biosis, 2008).

The wetland area abuts Landers Lane an unsurfaced access road to the west of the power station site. The wetland area was identified as the blue area 59 on the map shown in Figure 1-1.

Figure 1-1 General Location of Wetland (after Biosis, 2008)



1.2 Objectives

The project objectives for the present study were to:

- Complete a comprehensive feature survey of the entire site for use in other projects;
- Survey remnant and native vegetation identified by Biosis (2008);
- Conduct additional field survey of vegetation in roadsides;
- Identify the catchment contributing to the wetland; and
- Develop a water balance of the wetland to assess frequencies and timing of inundation.

Methods

2.1 Field Survey

Professional surveyors (Alexander and Symonds) were engaged to undertake a feature survey in accordance with the following terms of reference. Diagrams of the contour survey and the feature survey are provided in Appendix B.

- Feature survey with at least 25m grid.
- General features should be identified as well as the following:
  - Drainage lines
  - Wet areas
  - Fence lines
  - Transmission pylons
  - Native vegetation of interest (as per Figure 1-1)
  - Trees
  - Rocky outcrops
  - Water troughs
  - Centre line of Landers Lane
  - Any other significant features
- Traverse along indistinct drainage line adjacent to Landers Lane from Riordans Road for approximately 2km north. Cross-sections between Landers Lane and fenceline at 250m intervals.
- Supply 3D digital terrain model (DTM) + 0.1m contours
- Additional feature survey of the roadsides and vegetation along Landers Lane and Riordan Road. Roadsides are defined as from the fence line to the centreline of the roads.
- Coordinate site visit with biologists to allow communication and flagging of vegetation as appropriate.

2.2 Roadside and Access Road Flora and Fauna Survey

Professional botanists and zoologists from Biosis Research were contracted to undertake:

- A roadside vegetation survey along Riordans Road and Landers Lane; and
- A vegetation survey of the access corridor into the site from Tarrone North Road.

The survey incorporated:

- Review of existing databases (Victorian Department of Sustainability and Environment's Flora Information System and Atlas of Victorian Wildlife databases, Birds Australia Atlas Database and the Commonwealth Department of Environment and Water Resources EPBC Act Protected Matters Search Tool);
- Field assessment of the study area, involving:
  - Identification of any ecological features of the study area such as areas of remnant native vegetation and large remnant trees;
  - Field analysis, including mapping any areas of ecological sensitivity, significant flora and fauna species and Ecological Vegetation Classes (EVCs);
  - Evaluation of the potential for the land to support threatened flora and fauna.
  - On-ground mapping and identification of areas of significant vegetation within the proposed power station site.

2.3 Other Biological Surveys

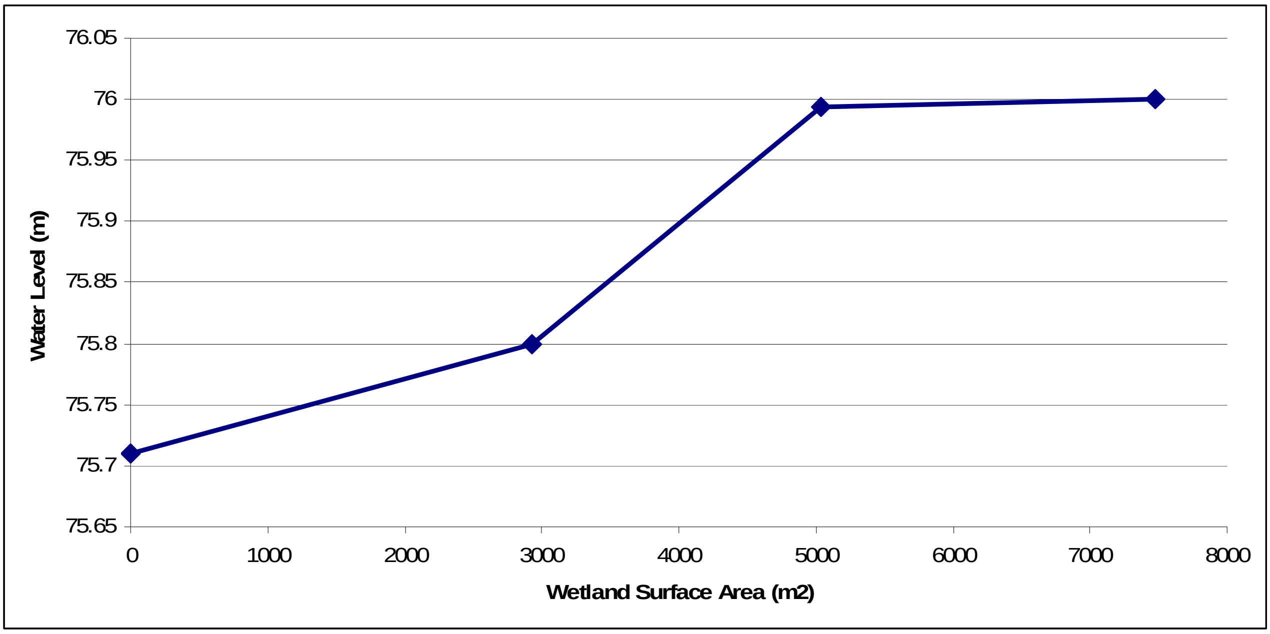
Biosis Research were also requested to undertake a Growling Grass Frog Survey of the wetland, an aquatic biota survey of the power station site and pipeline. The wetland and power station site were found to be dry so no at-site surveys were undertaken. Pipeline route surveys were also postponed awaiting access approvals.

2.4 Wetland Water Balance

The catchment area of the wetland was derived manually from survey points and survey contours in AutoCAD as 0.0431 km^2. Storage properties were derived from survey as shown in Figure 2-1 and Figure 2-2.

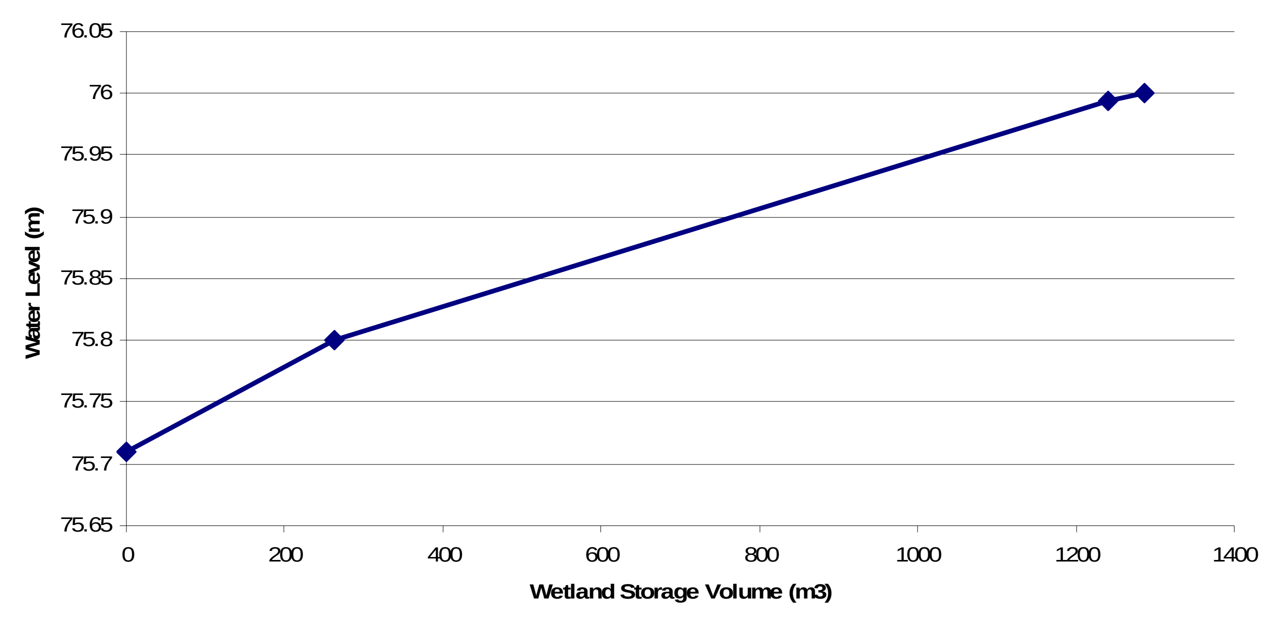
Two methods were used to estimate the hydrological behaviour of the wetland – a rainfall runoff then water balance method, and a direct water balance method with assumed runoff coefficients. The second method is more conservative but allows rapid confirmation of the order of magnitude of the rainfall runoff method. Each of these methods is described below.

Figure 2-1 Wetland Surface Area



2 Methods

Figure 2-2 Wetland Storage Volume



2.4.1 Rainfall Runoff Model Approach

A wetland water balance was developed in stages as follows:

- Climate data was sourced from the Bureau of Meteorology for the site with the longest continuous period of rainfall and evaporation record in the nearby vicinity (Site 90103 Hamilton Research Station). [It is noted that this station is likely to have a higher quality record than other nearby stations as it was manned at a professional facility.]
- A daily water balance model was developed for a nearby stream gauge record (Site 237208, Moyne River at Willatook, 1962 - 2000) using the Rainfall Runoff Library (CRC Catchment Hydrology) and the Australian Water Balance Model (AWBM).
- The AWBM parameters were used in a daily wetland catchment model to derive wetland inflows.
- An Excel daily water balance model was developed with catchment inflows as derived above and taking into account saturated infiltration based on basalt soils (I), precipitation (P) and evaporation (E) from the wetland. Potential evaporation was assumed to be equivalent to actual evaporation as the wetland surface is small and shallow. The wetland was assumed to be empty in January 1962 which appears to be a reasonable assumption based on recent site visits.
  - The basic water storage (S) equation was $S_{t+1} = S_t – I_t – E_t + P_t$ where t indicates time
- The Excel water balance model produced time series of height, surface area and storage volume.
  - The daily water balance model used linear interpolation to infer surface water area and water storage as required from (height, surface area) and (height, storage volume) data pairs derived from site survey.

Limitations of the method are:

- Assumption that the stream gauge is representative of the runoff characteristics of the wetland area;
- That the calibrated AWBM parameters are transferable across areal scales (i.e. stream gauge to wetland catchment);
- Very sensitive wetland storage vs height vs area data; and
- No direct account of runoff from the wetland surface.

2.4.2 Direct Water Balance Approach

This conservative approach was used to assess the sensitivity of the rainfall runoff modelling approach described above.

In this approach the following method was used:

- Direct rainfall was assumed to runoff the catchment into the wetland according to a nominated runoff coefficient. Assessment of the runoff coefficients between Hamilton Rainfall and Moyne River gauged flows indicates as little as 1% runoff during summer months and around 20% runoff during winter months. On an annual timestep the average runoff coefficient is ~10% with a 96% chance of lying in the interval 4% and 16% (+/- 2 standard errors).
- As per the rainfall runoff method the daily water balance was formed taking into account variations in surface area and storage in the wetland using linear interpolation between survey points.

Limitations of the method are:

- Lack of variability of runoff coefficient with incident rainfall or season;
- Assumption that the average annual runoff coefficient can be applied at a daily scale;
- Very sensitive wetland storage vs height vs area data; and

No direct account of runoff from the wetland surface.

Results

3.1 Feature Survey

The feature survey was completed and results are provided electronically in the accompanying disk.

3.2 Roadside and Access Road Flora and Fauna Survey

Flora surveys were completed and are reported in Biosis (2009). The wetland was dry at the time of sampling.

Biosis (2009) identify a swathe of sedges. Independent photos of the wetland area taken by Joel Rodski (URS) immediately following the survey suggests that these plants are located in the spoon drain immediately to the east of Landers Lane rather than in the main wetland itself. Photos from December 2009 also support this conclusion.

3.3 Wetland Water Balance

The catchment of the wetland is identified in Figure 3-1 overleaf. It is clear that the catchment area of the wetland is bounded by Landers Lane to the west and is small (0.0431 km^2) compared with the total surface area of the wetland itself (5040 m^2).

A typical cross-section of the wetland is also shown in Figure 3-1 the cross-section has been taken at the point at which the surface contours most closely approach the road drain.

The wetland has extremely low relief with a typical depth of 10 – 20 mm compared with the land surface immediately adjacent to the road drain to the west. Landers Lane road surface is approximately 300 mm above the lowest point in the wetland and is the main control on wetland water levels when large amounts of rainfall occur. The water in the wetland can therefore range from 0 mm (dry) to 300mm when full.

It is noted that there appears to be a drain pipe running underneath Landers Lane. The concrete pipe appears to be in a poor state of repair and may not effectively pass water under the lane.

The drainpipe was observed post survey; pictures are shown in Appendix A. No measurements were taken of the pipe. Estimates of the pipe diameter and invert level are based on visual assessment of the plates. The diameter is approximately 6 inches (152 mm) and the invert is approximately 2 pipe diameters below the road surface or around 75.8mAHD. Maximum flow rate under submerged conditions is estimated to be ~25 l/s. This is equivalent to 2160 m^3/day which is approximately 4 times the magnitude of the maximum estimated daily inflow. Hence for modelling including pipe flow it is assumed that the maximum depth in the wetland is equivalent to the 75.8mAHD.

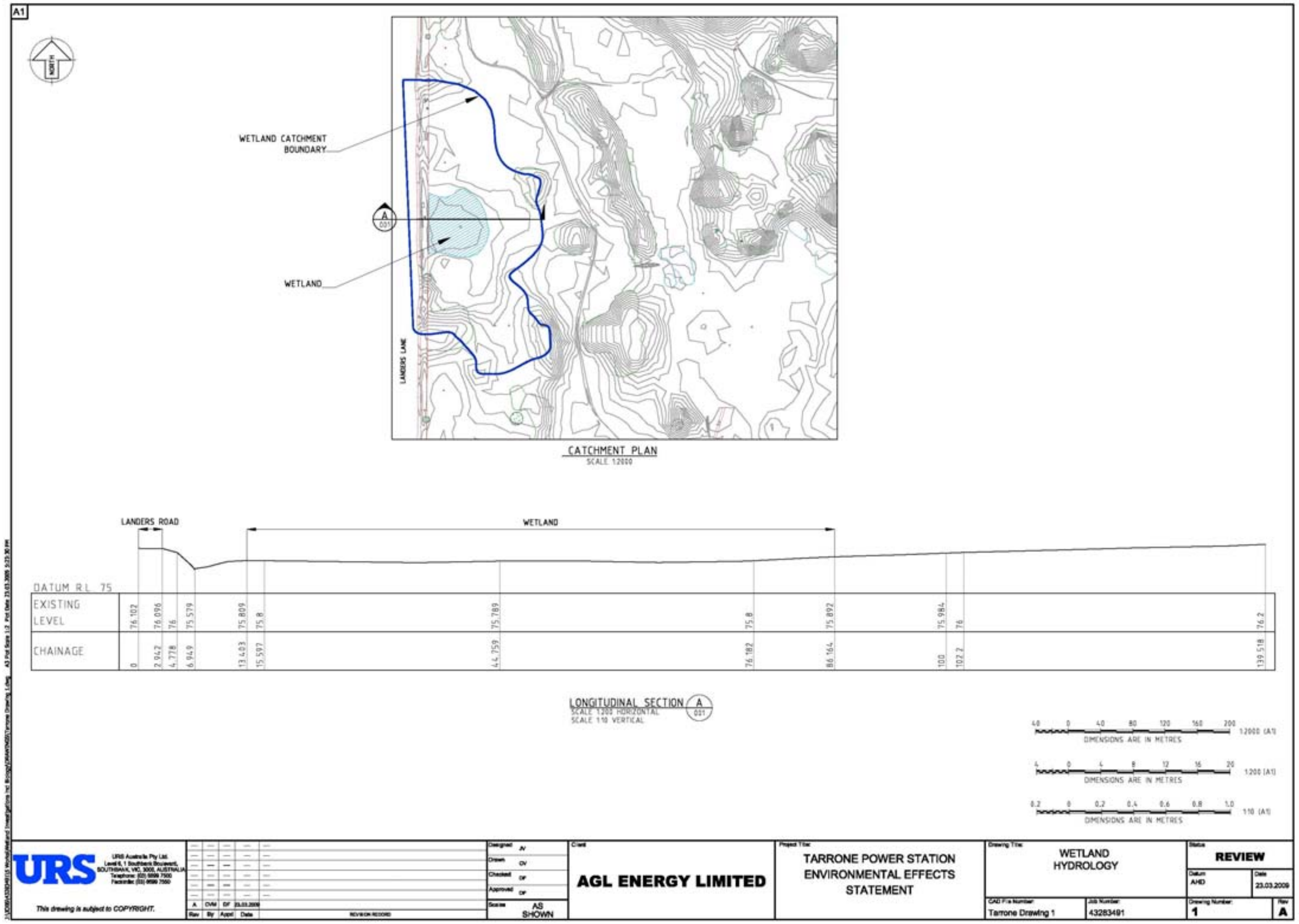
3.3.1 Results from Rainfall Runoff Approach:

The rainfall runoff model was run in two forms – firstly without the drainpipe flow then assuming the drainpipe is fully operational as described above.

Results from modelling <u>without drainpipe</u> show the wetland can be expected to fill most, but not all, years.

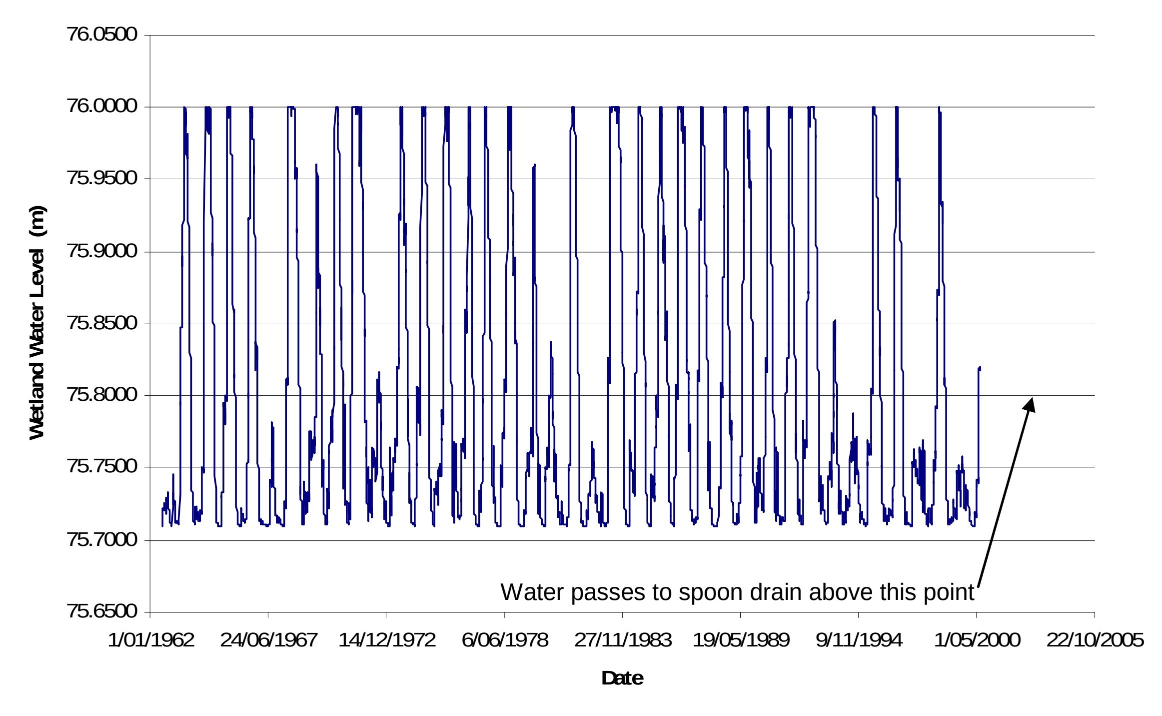
3 Results

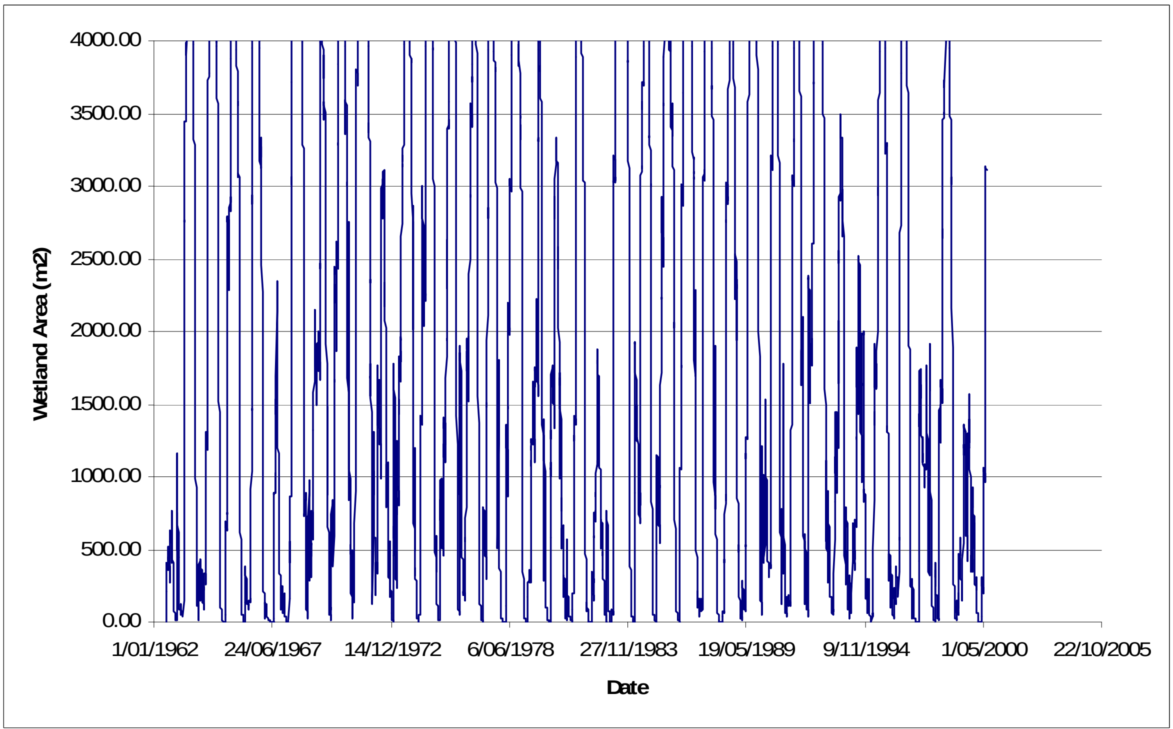
Figure 3-1 Wetland Catchment Area and Typical Cross-Section



3 Results

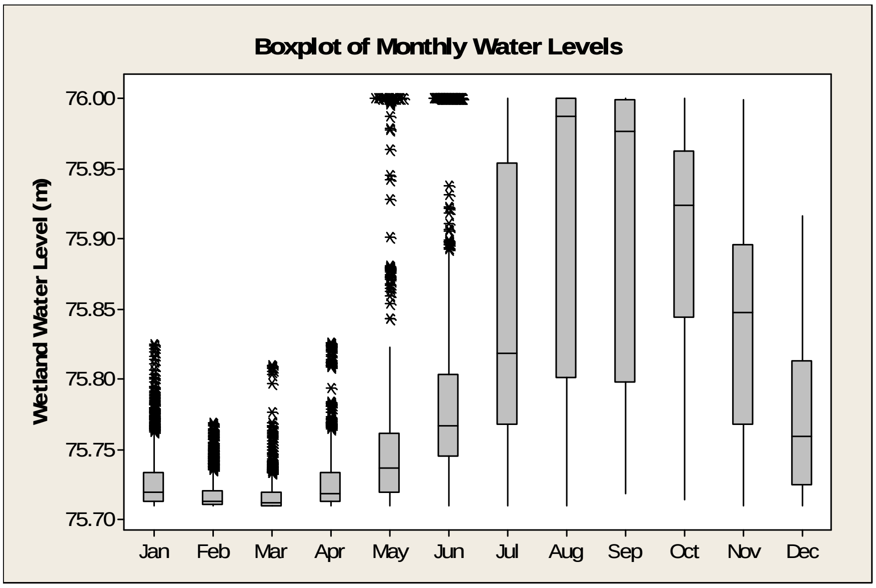
Figure 3-2 Modelled Wetland Water Level and Surface Area - No pip





3 Results

Figure 3-3 Frequency Distributions of Wetland Water Level by Month – No pipe Model



Modelling <u>with the drainpipe</u> did not reveal any discernable difference in wetland behaviour from that described above with the exception that the maximum level modelled was by default set equivalent to the invert of the drain.

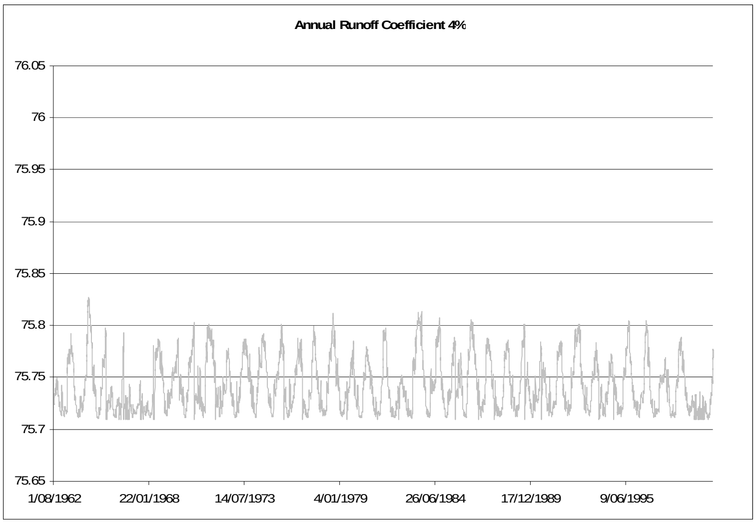
3.3.2 Results from Direct Water Balance Approach

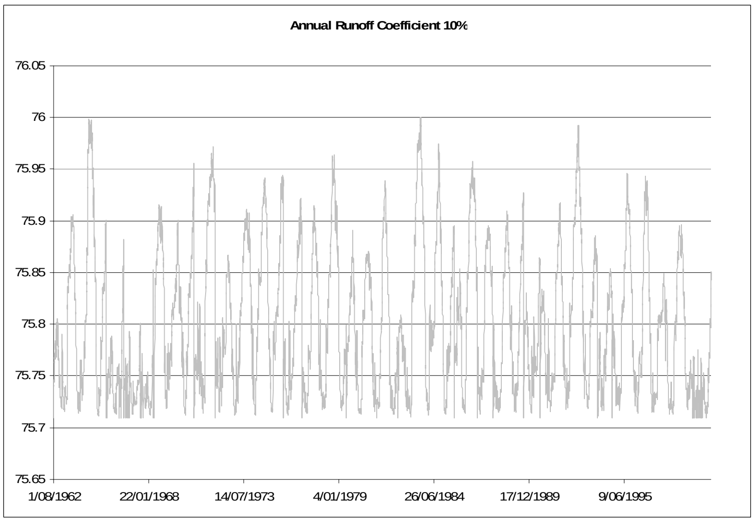
The direct water balance approach was used to apply rainfall and evaporation records from Hamilton Research to the wetland (Figure 3 4). Using the best estimate of mean annual runoff coefficient (10%) lead to a drier time sequence of wetland inundation behaviour than from the rainfall runoff model. Using a 4% runoff coefficient provides an even drier sequence of wetland behaviour, but a 16% runoff coefficient provides a relatively wet sequence of behaviour.

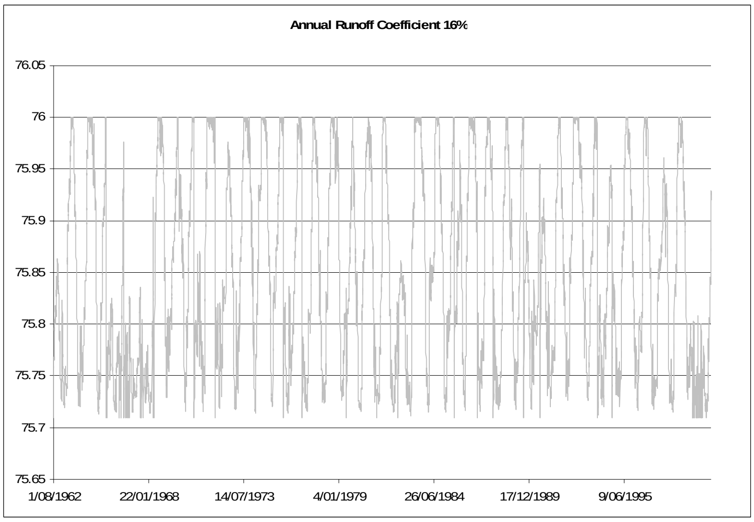
The frequency of inundation of the wetland by month is presented in Figure 3 5 for the 10% runoff coefficient, and in Figure 3-6 for the 16% runoff coefficient. Broadly the behaviour of the wetland as modelled using the rainfall runoff method described in Section 3.3.1 lies within the bounds of these behaviours.

3 Results

Figure 3-4 Direct Water Balance Calculations for Various Runoff Coefficients







3 Results

Figure 3-5 Monthly Wetland Inundation Frequencies - 10% Runoff Coefficient

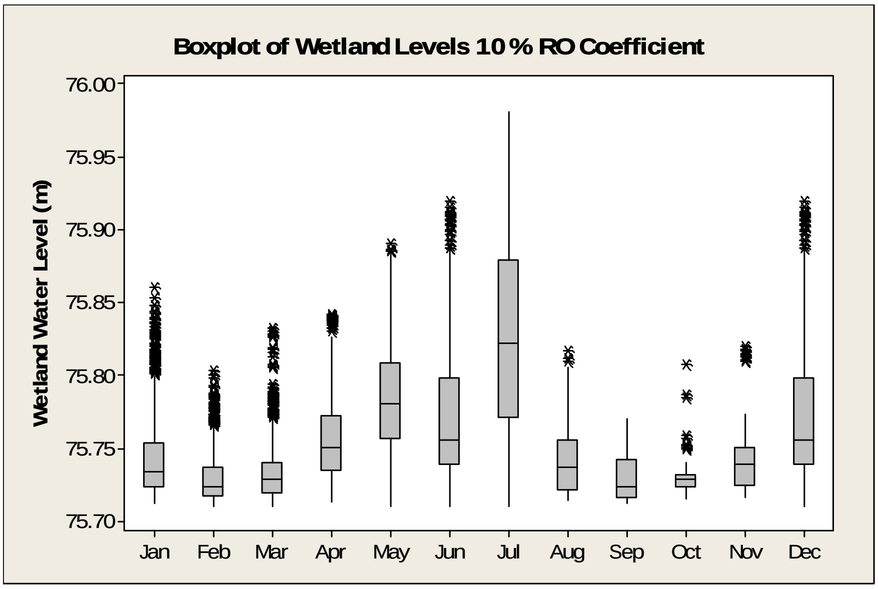
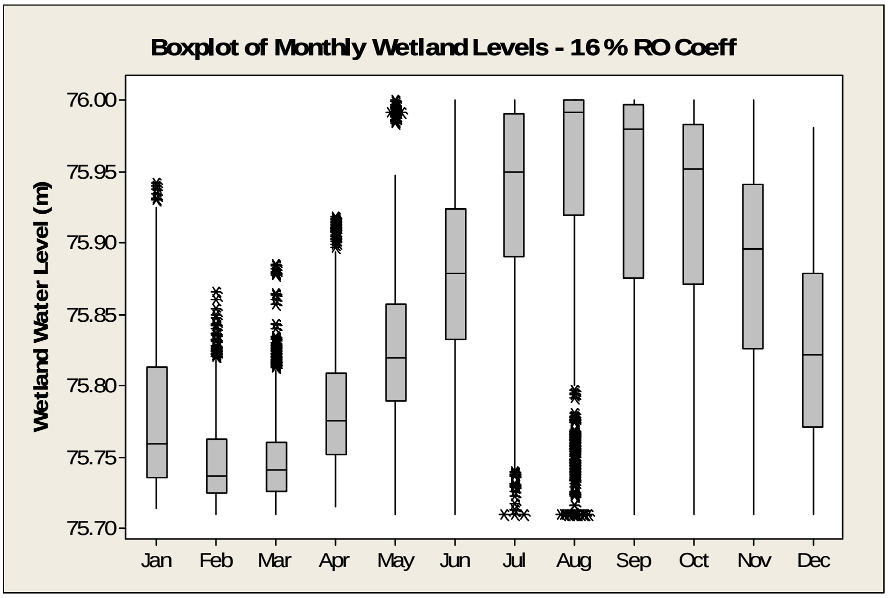


Figure 3-6 Monthly Wetland Inundation Frequencies - 16% Runoff Coefficient



4 Discussion and Conclusions

Water balance modelling of the wetland on the proposed Tarrone power station site is challenging due to the lack of local hydrological information and the very flat relief of the wetland itself.

Detailed survey has provided the facility to estimate storage height and surface area height relationships of the wetland. The survey has also allowed a delineation of the catchment (0.0431 km^2) of the wetland as shown in Figure 3 1. The catchment drains to the west away from the main power station site, with the remaining area draining mainly to the south via Riordan’s Road.

Water balance modelling using a rainfall runoff modelling approach is believed to reflect the general behaviour of the wetland. The modelled behaviours fall within broad assessments of wetland behaviour based on a more rudimentary and approximate runoff coefficient approach.

The rainfall runoff model is preferred as the best estimate of wetland behaviour at this time but suffers some limitations:

- The stream gauge catchment is assumed to be representative of the runoff characteristics of the wetland area;
- The calibrated AWBM parameters are assumed to be transferable across areal scales (i.e. stream gauge to wetland catchment);
- No direct account of has been taken of runoff from the wetland surface compared with catchment runoff;
- Changes in vegetation growth within the wetland and spoon drain have not been taken into account for the water balance model; and
- The wetland storage vs height vs area data is sensitive due to the flat relief and relative size of inflows compared with storage.

Due to the flat relief of the wetland, large surface area and small contributing catchment it appears that most flood flows will pass through the wetland within the day.

The maximum extent of the wetland is governed in part by Landers Lane and partly by the pipe culvert under the lane. While very shallow depressions are evident within the wetland itself, it is probable that the wetting regime and wetland extent has been significantly augmented by the construction of Landers Lane.

Better modelling of the extreme water levels (high and low) within the wetland is difficult without further observations at the site and these would best be performed the winter periods and targeted at flood flows.

However, the wetland area is well delineated and is clearly marked by changes in vegetation and damp soil as shown in Figure 3 1, Plate A-1 and Plate A-4.

The best evidence for the discharge levels in the wetland is the existing survey of the wetland boundary at ~75.99mAHD suggesting that Landers Lane road surface is the main hydraulic control on water levels. The amount of vegetation in the spoon drain will significantly reduce the efficiency of any pipe culvert drainage from the area, though apparent flood debris around the pipe orifice suggests that water may pond or flow through the pipe (Plate A-3).

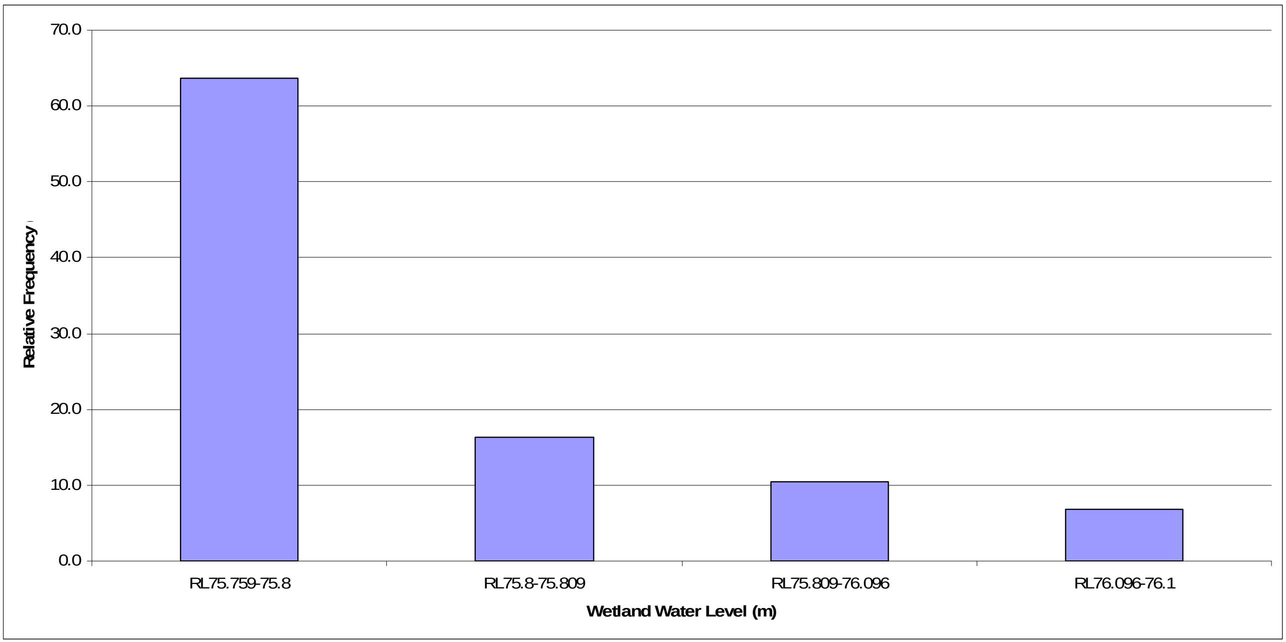
The existence of the sedges in the spoon drain (Plate A-1, Plate A-5 and Plate A-6) is consistent with the water balance modelling and other observations on site that suggest that water will linger in this drain even after the fenced wetland is dry. Cattle access to the fenced wetland area would also reduce the chances of sedges growing in this area.

4 Discussion and Conclusions

It is clear that the actual water levels and dynamics of this wetland will be governed by small scale influences that cannot be modelled in detail. Nevertheless, the water balance model produced in this report appears to provide a reasonable representation of wetland extent and inundation regimes given the data on hand.

The water balance model indicates that the wetland can be expected to fill in most years. An assessment of the frequency of inundation of relevant levels for the 38 year modelled sequence is presented in Figure 4 1.

Figure 4-1 Frequency of Wetland Inundation 1962 – 2000



For nearly 65% of the time water levels are at or below 75.8mAHD suggesting that water is in the spoon drain or absent from the site altogether. Fifteen percent of the time the wetland is likely to be "just wet" (i.e. >75.8mAHD) with water depths of around 1 cm; 10% of the time water in the wetland will be at or below 296 mm and approximately 6% of the time depths of around 300 mm can be expected.

Monthly analysis of frequencies of inundation (Figure 3-3) indicate that the wetland is likely to be dry (<75.8mAHD) for much of January to April. May, June and December can also be expected to be dry for much of the time. July through to November are the wettest periods for the wetland.

References

Biosis (2008), Flora and terrestrial fauna assessment of the proposed Tarrone Gas-fired Power Station and Associated Gas Pipeline, Victoria, Biosis Research, Draft report November 2008

Biosis (2009), Proposed Tarrone Gas-fired Power Station - Flora and fauna assessment of road reserves, Biosis Research, Draft report 19th March 2009

Limitations

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A

Appendix A Plates

Appendix A

Plate A-1 Wetland from Landers Lane, 28/2/2009

Plate A-2 Pipe culvert location Landers Lane in background, 28/2/2009

Appendix A

Plate A-3 Pipe culvert (note apparent flood debris), 28/2/2009

Plate A-4 Wetland extent, 4/12/2008

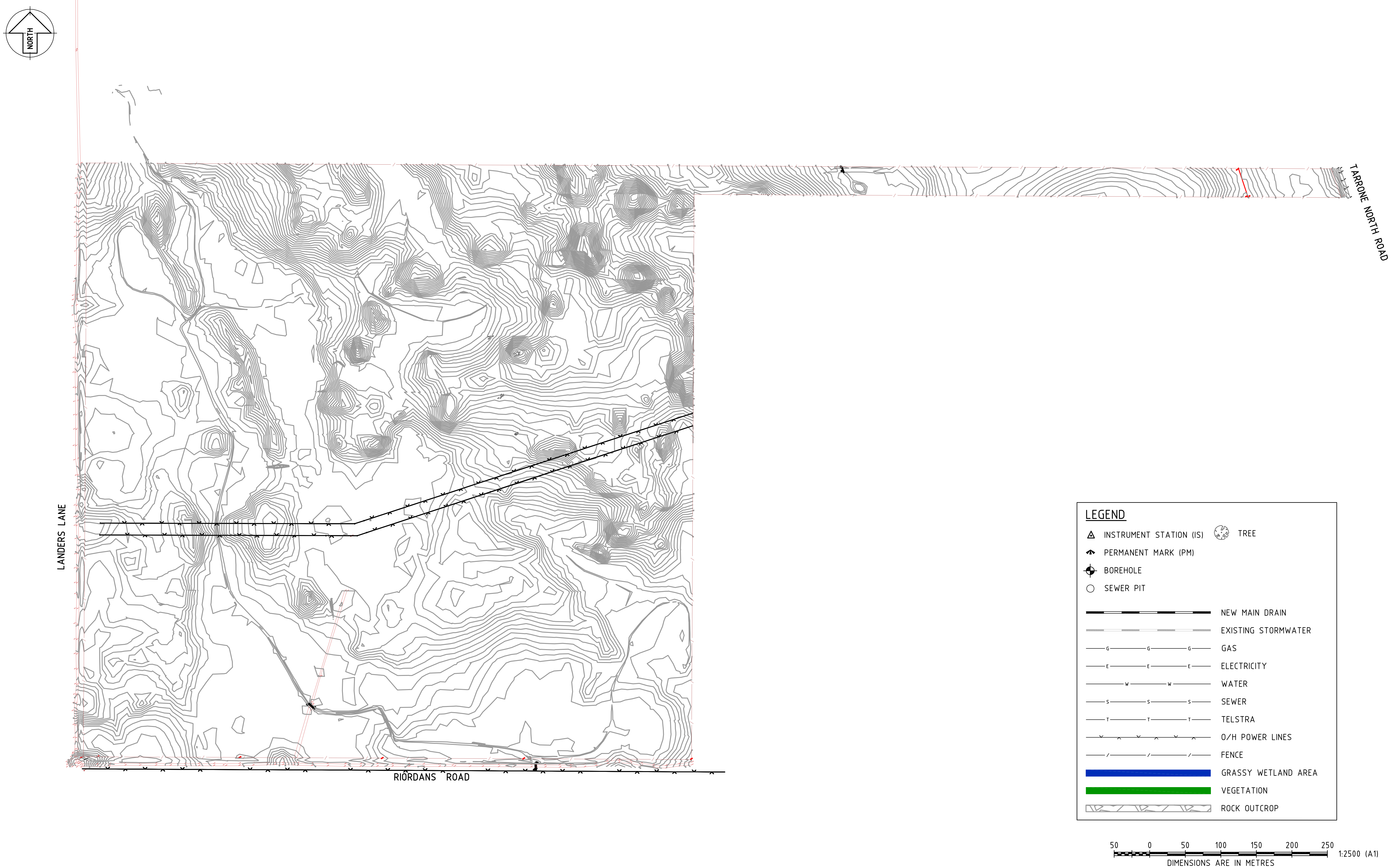
Appendix A

Plate A-5 Wetland drainage and sedges, 4/12/2008

Plate A-6 Wetland and spoon drain vegetation, 4/12/2008

Appendix B Survey of Proposed Power Station Site

A1



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URS

URS Australia Pty Ltd.
Level 6, 1 Southbank Boulevard,
SOUTHBANK, VIC, 3006, AUSTRALIA
Telephone: (03) 8699 7500
Facsimile: (03) 8699 7550

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A	CVM	DF	14.04.2009	SITE SURVEY BY ALEXANDER & SYMONDS (VIC) PTY LTD

Designed	
Drawn	CV
Checked	DF
Approved	DF
Scales	AS SHOWN

Client: **AGL ENERGY LIMITED**

Project Title: TARRONE POWER STATION ENVIRONMENTAL EFFECTS STATEMENT

Drawing Title: SITE SURVEY FOR PROPOSED POWER STATION CONTOURS

Status: **FINAL**

Datum: AHD

Date: 14.04.2009

CAD File Number: Site Survey 001

Job Number: 43283491

Drawing Number: **001**

Rev: **A**

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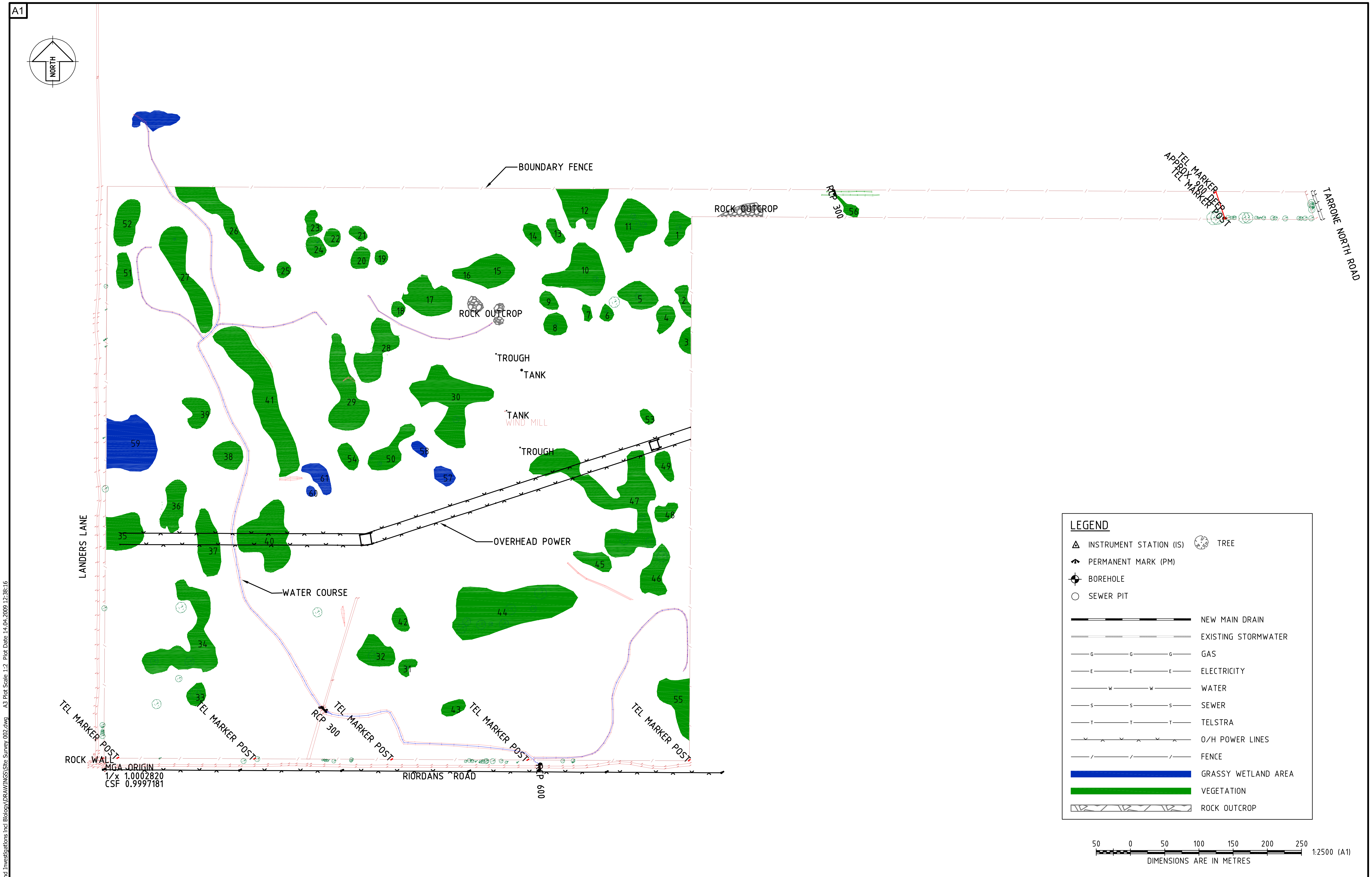

URS Australia Pty Ltd.
Level 6, 1 Southbank Boulevard,
SOUTHBANK, VIC, 3006, AUSTRALIA
Telephone: (03) 8699 7500
Facsimile: (03) 8699 7550

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Client
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Project Title:
TARRONE POWER STATION
ENVIRONMENTAL EFFECTS
STATEMENT

Drawing Title:
SITE SURVEY FOR
PROPOSED POWER STATION
SITE FEATURES

Status **FINAL**
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Date 14.04.2009
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Rev **A**

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URS Australia Pty Ltd
Level 6, 1 Southbank Boulevard
Southbank VIC 3006
Australia
T: 61 3 8699 7500
F: 61 3 8699 7550

www.ap.urscorp.com