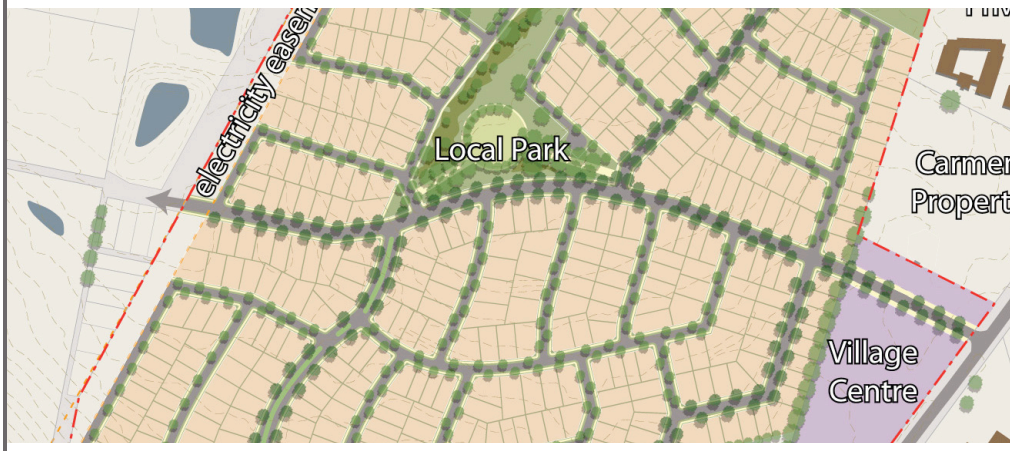


# Appendix 10
# Engineering Report

Cardno

Peter Andrews + Associates Pty Ltd
paa.design architecture planning urban design

Cardno
Shaping the Future

# South Orange DPI Land

## Engineering Report for Concept Plan Application

**Project Number 600229**

**Prepared for State Property Authority**

**May 2010**

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## Document Control

| Version | Date | Author | | Reviewer | |
|---|---|---|---|---|---|
| 1 | May 2010 | David Pitronaci | DDP | Andrew Reid | May 2010 |

# Table of Contents



## Annexes

# 1 Introduction

This report has been prepared to support the Concept Plan application for the development of the DPI land at South Orange. The report addresses items raised under the Director General's Requirements (Application No MP10_0021).

The report applies to the proposed development of Lots 7011, DP1000831 and Lots 143 and 145, DP750401 as detailed in the Concept Plan by Annand Alcock Urban Design (April 2010).

The report outlines engineering investigations undertaken in response to the Director General's requirements as follows:

DG Key Issues

1. *Rainwater Harvesting and Re-use* – Establish a strategy for water re-use.
2. *Energy Efficiency and Renewable Supply (Issue 7, dot-point 2)* –Advise on options for improving energy efficiency and renewable supply.
3. *Waste Recycling (Issue 7, dot-point 3)* –Advise on how waste can be minimised, particularly during construction.
4. *Site Water Balance - (Issue 9, dot-point 1)* – Undertake a water balance assessment of the site's water usage to help inform the water re-use strategy (refer point 1) .
5. *Consideration of Impacts on Groundwater (Issue 9, dot-point 3)* – Provide advice potential groundwater impacts.
6. *Plans of Proposed Drainage and Stormwater Infrastructure and WSUD Structures (Issue 9, dot-point 5)* - Prepare a schematic plan indicating drainage strategy in concept, including locations of WSUD devices, recycling / treatment and re-distribution of recycled water.
7. *Consideration of Potential Flooding (with consideration of climate change), Contamination and Salinity Impacts (Issue 9, dot-point 6)* – Review catchment data, undertake simplified calculations of likely flood flows through the site and their probable extents. Provide plan indicating likely flood extents through the site and the possible effects of climate change on these. Advise on how salinity and flooding issues would be addressed if encountered.
8. *Utilities and Services (Issue 13).*

    - Liaise with Council and request that it confirms details of the likely costs that would attributable to the transport, sewer and water infrastructure upgrades.
    - Liaise with service authorities to confirm currency of previous advice

- Provide a summary of the outcome of servicing investigations undertaken to date and how they would apply to the project
- Prepare a schematic plan indicating servicing upgrades

DG General Issues

1. *Concept Drawings Showing Proposed Earthworks, Roadworks and Infrastructure (Issue 4)* - Prepare a schematic plan incorporating road layout indicating approximate extents of cut and full across the site.
2. *Stormwater Concept Plan* – Prepare Stormwater Concept Plan – Refer Item 6 above.

# 2 Rainwater Harvesting and Re-Use

A key feature of the design is the use of topography to facilitate the discharge of collected stormwater into the existing dam at the northern end of the site. It is anticipated that the design will enable all runoff from the site to be directed to the dam. The dam has a storage volume of approximately 175ML and is currently used for irrigation of research orchards by the Department of Primary Industries. The Department has indicated that based on current rainfall, evaporation and usage requirements, the dam does not currently provide sufficient water supply for its own use.

Given the existing use of the dam for irrigation, the demand for more water by DPI, the topography of the site and the fact that the development will generate an increase in runoff volumes, it is considered that the most effective method of water re-use will be to capture the additional runoff within the dam for irrigation use by DPI. This will be implemented by draining roads and lot areas into a central channel, via water quality treatment systems consisting of bio-swales and bio-filtration systems, thence to the dam. Water will then be pumped out of the dam, through a filter to screen out coarse sediment and via a rising main to various locations within the site for use by DPI. The main would be located within an easement where it is routed through the development site.

The additional stormwater runoff generated from the development will become a valuable resource, its benefits being:

- Reduced demand on potable or other water supplies by the DPI for irrigation use
- Improved viability and therefore value of the research facilities
- Reduced ecological impact on the dam by the reduced frequency with which the dam is drawn down to very low levels

The proposed layout of the water harvesting and re-use system in detailed in Annex 5.

While not within the scope of this stage of the development of the site into residential allotments, it is anticipated that future dwellings would likely install rainwater tanks to help meet BASIX requirements. The implementation of the above scheme will not preclude the use of individual rainwater tanks by private dwellings within the development, but rather their use will simply reduce the amount of water available within the dam. A water balance has been carried out (see Section 3 below) which indicates that the use of rainwater tanks on all dwellings and connected to toilet flushing and outdoor use, would likely only utilise approximately 20% of the additional runoff generated from the development.

# 3 Site Water Balance

A water balance has been carried out to estimate the additional volume of water which will become available for harvesting (see Section 4 below). The following assumptions were made in development of the water balalnce:

- Catchment area contributing to the dam is about 267 Ha.
- Current catchments are 5% impervious with a volumetric runoff coefficient of 0.3 (i.e. 30% of total rainfall runs off the catchment). The remainder is lost to infiltration or evaporation.
- Post development of the DPI site, the developed catchment will have an imperviousness fraction of 55% and a volumetric runoff coefficient of 0.6.

Based on the above parameters and recorded rainfall data from Orange, it was estimated that the development of the DPI site would result in approximately 160ML of additional runoff into the dam per annum. Because the configuration of the dam will remain the same, evaporation and infiltration from the dam is not expected to increase significantly (except to the extent that additional water in the dam will result in a larger surface area over which evaporation and infiltration can occur). As such the majority of the additional 160ML per annum will be available for irrigation use.

Based on figures provided by DPI, current irrigation use is in the order of 500ML per annum, which is resulting in a gradual drawdown of the dam's storage, currently at around 15ML. The additional runoff generated from the development would therefore be expected to increase the water available for irrigation use by approximately 30%. Based on the amount of storage drawdown over the last 5 years (approximately 30ML per annum), the increase in flows could maintain dam levels and also increase irrigation supply by approximately 130 ML per annum (likely to be around a 25% increase in current usage). A full take-up of rainwater tanks within the development could result in approximately 32ML per annum of this storage being used for private purposes in lieu of irrigation by DPI, however the net result of reduced impact on the region's water resources will remain the same.

A summary of the water balance is attached in Annex 7.

# 4 Energy Efficiency and Renewable Supply

The concept design inherently provides a number of features which will directly or indirectly result in gains in energy efficiency when compared to other possible designs. Table 4.1 identifies these features and associated benefits.

**Table 4.1 Energy Efficiency and Renewable supply**

| Design Feature / Control Measure | Energy Efficiency benefit |
|---|---|
| Design of lot orientation | The sub-division has been designed to optimise the solar access to properties by giving consideration to the orientation of the lots. Accounting for solar gain in this manner at this stage of development maximises opportunity for heating and cooling demands to be minimised during building design. |
| A preference for natural drainage systems (e.g. swales) | Incorporation of natural drainage systems for main channels reduces the length of piped drainage required while supporting attractive and healthy riparian corridors. This will result in a number of energy efficiency benefits including:<br>1. Minimising the direct energy costs associated with pipe installation<br>2. Minimising the indirect energy costs associated with pipe manufacture<br>3. Collected stormwater will become available for irrigation purposes. Use of recycled stormwater is less energy intensive than the use of potable water (due to greater treatment effort) which may otherwise be used. |
| Design which minimises waste generation and maximises reuse of material on site | The re-use of material on site will considerably reduce the distance travelled on roads by vehicles carrying waste / materials. A key feature of the proposed design of the site is that the road and lot grading (as detailed in the earthworks design) aims to result in a balance of earthworks cut and fill, such that fill material will not need to be imported to, or exported from site. This results in a reduction of energy use in transport.<br>Subject to further analysis by geotechnical engineer, lime stabilisation of subgrade materials will be undertaken in order to minimise pavement thickness, reducing the amount of energy expended in transportation.<br>As far as practicable, crushed recycled concrete will be used for subbase materials, thereby facilitating recycling and minimising use of quarried product. |

With regard to supply of renewable energy, the utility connections to the site will facilitate the supply of power without discriminating between power from renewable or non-renewable sources. Determining where electricity for the development will be sourced is considered to be beyond the remit of the project.

# 5 Waste Recycling

The project design inherently provides a number of features which will directly or indirectly result in the minimization of waste generation and vehicle movements when compared to other possible designs. In addition, there are a number of considerations which may directly or indirectly promote the recycling of waste. Table 5.1 identifies these features and associated benefits.

**Table 5.1 Waste Recycling and Minimisation**

| Design Feature / Control Measure | ESD benefit |
|---|---|
| A preference for natural drainage systems (e.g. swales) | Use of natural drainage systems reduces the length of piped drainage required, minimising the amount of raw material required, and ultimately the amount of pipe requiring disposal at end of life. |
| Purchasing Policy | The Construction Environmental Management Plan will specify that wherever possible materials with a recycled content should be utilised, provided that they exhibit the same functional properties as materials which they replace. Examples of products which this may extend to include road pavements and plastic pipes.<br>The Construction Environmental Management Plan should also specify that material requirements will be carefully considered during the design and purchasing processes in order to match the amount of ordered material to site requirements, preventing over-ordering and minimizing the amount of excess materials on site. |
| Design which minimises waste generation and maximises reuse of material on site | A key feature of the proposed design of the site is that the road and lot grading (as detailed in the earthworks design) aims to result in a balance of earthworks cut and fill, such that fill material will not need to be imported to, or exported from site.<br>Subject to further analysis by geotechnical engineer, lime stabilisation of subgrade materials will be undertaken in order to minimise pavement thickness.<br>As far as practicable, crushed recycled concrete will be used for subbase materials, thereby facilitating recycling and minimising use of quarried product. |
| Diversion of material away from landfill | It is expected that the Construction Environmental Management Plan will include a requirement to separate different waste types where practical, and for these to be recycled wherever possible. |
| Beneficial use of cleared vegetation | Trees and other suitable vegetation cleared from the site will be preferentially chipped and reused beneficially on site in erosion protection structures. Fallen branches and other similar material which may provide fauna habitat on the ground will be relocated to undisturbed areas where practical. |
| Trip Containment during construction | All the options identified above can be expected to minimise the number of vehicle movements which will be required during development of the project as a direct result of minimizing the amount of raw material to be brought to the site, or waste to be collected from the site.<br>In addition, it can be expected that the construction environmental management plans will include measures to maximize the efficiency of transport through measures such as:<br>➢ Maximising loads on delivery or collection vehicles to minimise journey numbers;<br>➢ Vehicle route planning to link together destinations wherever possible, and to reduce vehicle travel distances / journey times within the constraints of the road network;<br>➢ Crushing / compaction / shredding of waste materials on site where practical to minmise the volume of material transported |

# 6 Impacts on Groundwater

Typical effects of residential development on the water cycle include an increase in runoff and a reduction in infiltration, as runoff is directed off impervious surfaces and into downstream waterways. While this development will also result in these effects, the impact on the overall water regime will be minimised due to the following:

- Where possible, water is being directed to swales, bio-filtration systems and a natural channel through the centre of the site. This will provide significant opportunity for infiltration.
- Natural drainage patterns (including catchments which originate from off-site) are generally being maintained, with runoff being directed to the existing dam, where infiltration will continue to occur over long periods.
- Most of the water directed to the dam will be recirculated back into the local groundwater system via irrigation.

As such, it is not anticipated that the development will result in significant impacts to the local groundwater system

# 7 Stormwater Concept

A central feature of the concept design layout is the maintenance of existing drainage patterns through the site by retaining existing gullies in riparian corridors central to the site, while also improving their habitat values by vegetating and rehabilitating the corridors. A stormwater concept design has been prepared and is included in Annex 4. Key features of the design are as follows:

- Water is collected via piped street drainage, inter-allotment drainage and bio-swales, then directed to trunk natural drainage channels.
- Bio-filtration systems located within pavement medians and trunk channels treat runoff to pre-development water quality levels prior to discharge off site.
- Existing catchments external to the site are maintained and directed through the site. Road crossings over the channels are maintained via culverts.
- Water discharged to the dam is then re-used for irrigation in the adjacent research facilities.

A stormwater quality model was set up using the software “MUSIC”. The following parameters were used:

- An imperviousness percentage of 55% was used for the post-developed DPI site.

- An imperviousness percentage of the existing catchment and of upstream rural catchments of 5% was used.
- A water quality goal of maintaining existing water quality post development (i.e. no net impact) was set.
- A series of catchment nodes was set up with bio-swales located in the upper reaches of the development catchment and bio-filtration areas within the central channels.

The MUSIC model calculated that a total area of bio-filtration of 4,000 sq.m and length of bio-swales of 500m would be required to meet the desired treatment outcome. These areas and lengths can be easily accommodated within the design and have been incorporated into the Stormwater Concept in Annex 4.

The area at the north east corner of the site (east of the existing dam) has been identified for possible future development. It is not known at this stage exactly what form the development would take, nor its density or layout, however the drainage and water quality treatment would be designed in a similar manner to the remainder of the site, with water quality treatment at the lower end of the site, discharging to the existing dam. An indicative location of water treatment facilities has been indicated on the concept plans.

Based on the current irrigation usage, evaporation rates and size of the existing basin, it is not anticipated that the peak runoff rates downstream of the existing dam will be significantly affected by the development, however should there be a change in the irrigation regime, of the land use in the upstream catchments or if detailed modelling indicates a need for stormwater detention, then significant attenuation would be able to be easily accommodated within the existing basin by a modification of the dam spillway / outlet structure.

# 8 Consideration of Potential Flooding (with Consideration of Climate Change), Contamination and Salinity Impacts

Flooding through the site was estimated using the hydrologic computer model “RAFTS” and the hydraulic modelling software “SOBEK”. The models used the following key parameters / assumptions:

- Upstream catchments were assumed to be fully developed (in order to represent a possible worst case future scenario).
- Post development imperviousness rations of 55% were used.
- Catchment information was obtained from LPMA contour data.
- Channel sizing and configuration was based on the concept drainage / earthworks design included in this report.

- Potential effects of climate change were modelled as an increase of peak 1 in 100 year average recurrence interval rainfall intensities of 30%, which translated to approximately a 25% increase in peak discharge rates.

The modelling indicated that 1 in 100 year flood flows (both currently and with the effects of climate change) could be accommodated within the proposed channels. These predicted flood extents have been mapped in Annex 3.

Based on available information, it is not known whether contamination or salinity will be encountered on the site, however we would recommend the following steps to identify and mitigate any effects of salinity or contamination:

- Engage a geotechnical / environmental consultant prior to detailed design to test for dry-land salinity and contamination and make recommendations
- If contamination found, develop site remediation strategy which includes identification, segregation, handling, remediation / off-site disposal and verification procedures.
- If salinity issues are identified, develop a salinity management plan, which is likely to include design and construction measures such as excavation in layers, the use of additional subsoil drainage, maintenance of topsoil cover over saline layers, lining of ponds, use of higher exposure classifications in concrete, use of salt tolerant plant species.
- Ensure that construction management plan includes appropriate procedures for the identification and treatment of both salinity and contamination.

# 9 Utilities and Services

Availability of utility services to the site have been investigated by review of available documentation and consultation with the relevant authorities.

Sewer, Water and Roads Infrastructure

An infrastructure assessment and servicing strategy for water, sewer and roadworks was undertaken for Orange City Council by Geolyse in December 2009. The key aims of the report were stated as being:

- Assess infrastructure
- Prepare a servicing strategy for the development of the DPI site and of the wider Southern Suburb Precinct to assist in future planning for major infrastructure
- Determine an economic means of providing infrastructure to the study area, with a focus on the servicing of the DPI land

The report investigated:

- Major road infrastructure
- Trunk water reticulation, pump stations, rising mains and reservoirs
- Trunk sewerage reticulation, pump stations and rising main through to the inlet of the sewerage treatment plant

The Infrastructure Assessment considered water supply, sewer infrastructure and road infrastructure in considerable detail, and with significant input from and consultation with Council. The assessment has generally considered all of the key aspects of the infrastructure investigated, including trunk mains, pumps, reservoirs, treatment plants, supply capacity, road conditions and widths and background data on traffic flows, sewage flows and water usage.

The findings of the Geolyse Report with respect to road infrastructure have been incorporated into an infrastructure contributions plan, which was adopted by Orange City Council in March 2010 and provide infrastructure contributions rates specifically for the DPI site.

The provision of sewer and water services to the site is currently funded under Development Servicing Plans prepared for Council by Worley Parsons in 2009.

It is anticipated that the developer of the site will pay contributions detailed in the above plans, subject to agreement with Council.

Electrical Supply

The State Significant Site Study of October 2008 by Peter Andrews and Associates states that sufficient electrical supply will be provided to the site via two proposed feeders being provided to the Bloomfield Hospital by Country Energy. We have confirmed with Country Energy that the two feeders have just been commissioned and that Country Energy still expects these to have sufficient capacity to service approximately 800 lots.

Gas services

Peter Andrews and Associates also consulted with Alinta as part of its State Signifcant Site Study, and Alinta advised that in order to supply gas to the site, supply will probably require upgrades. An agreement will need to be entered into between Alinta and the Developer under which Alinta agrees to supply gas to the site subject to financial viability and an appropriate level of funding by the Developer.

Telecommunications

Based on announcements made by Telstra and by the Federal Government in relation to the current National Broadband Network (NBN) policy on greenfields developments, it is anticipated that the provision of broadband “Fibre to the Premises” FTTP will attract development costs of between $1,500

and $3,500 per lot (estimated at an average of $2,500 per lot) depending on the location of the development.

# 10 Concept Drawings Showing Proposed Earthworks, Roadworks and Infrastructure

A concept road and earthworks design has been carried out. The key design criteria were to:

- Maintain longitudinal road grades of at least 1%
- Create positive surface drainage from all lots and roads to the central drainage channels and eliminate any trapped low points which could not be drained without pipes
- Ensure upstream catchments were accommodated
- Provide lot levels at least 500mm above predicted 1 in 100 year (plus climate change) flood levels in the drainage channels
- Maintain as far as practicable the existing topography and minimise depths of cut and fill
- Balance cut and fill such that a net import or export of fill material was avoided

A 3-dimensional earthworks model was created in the civil design package "12D" and manipulated in order to arrive at a design that met the above criteria. A balanced cut and fill scenario was achieved, with a total cut to fill volume of 100,000 cu.m estimated.

Annex 4 shows the proposed road and site grading via proposed contours. Annex 2 indicates approximate depths of cut and fill across the whole development site.

# 11 Conclusion

The above investigations demonstrate that the proposed concept design is able to satisfactorily address all of the civil engineering issues raised within the Director General's requirements. Concept designs for the various aspects of the development have been prepared which demonstrate practical solutions to the requirements. The concept designs are not intended to dictate the final design, but rather to demonstrate a feasible solution. The concepts would need to be further developed and tested as the detailed design for the site is developed.

# Annex 1

# Site Plan


NSW DEPARTMENT OF PRIMARY INDUSTRIES

STATE PROPERTY AUTHORITY

# Site Plan

SOUTH ORANGE - DPI LAND

**Legend**

- Site Boundary (Total Area = 165 ha)
- Watercourse (LPMA)
- 2m Contours (LPMA)
- Electricity Transmission Line (LPMA)
- Cadastre (LPMA)
- Crown Road (LPMA)
- Waterbodies (LPMA)
- Easement (DP 269835)
- Assumed Easement based on Title Search for Lot 145/750401

N W E S

**Scale 1:10,000 (at A3)**

Metres

0 100 200 300 400 500

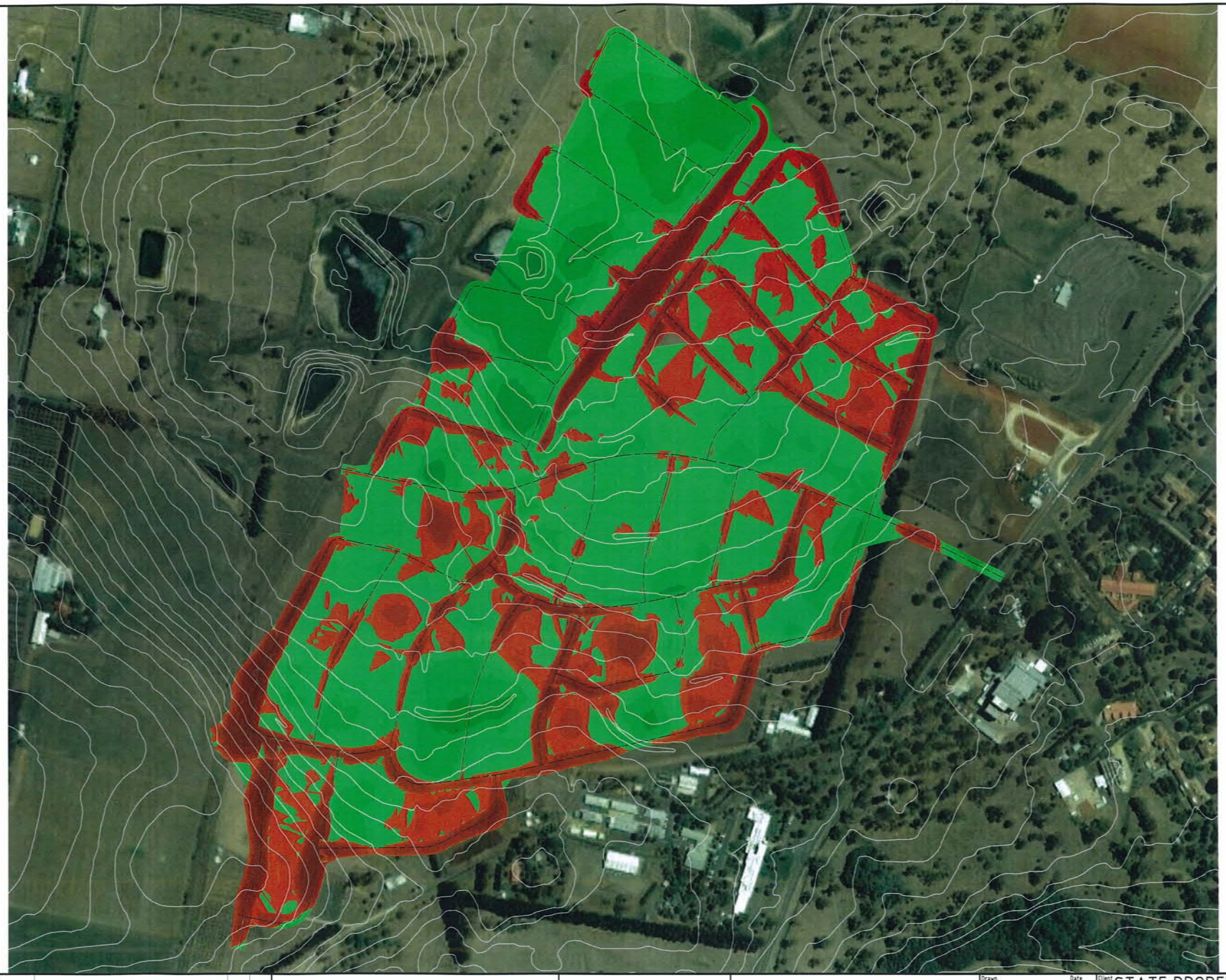
Cardno

Map Produced by Cardno Wollongong
Date: 08 February 2010
Coordinate System: Zone 55 MGA/GDA 94
GIS MAP REF: 210002-1-254_1801_SitePlan.mxd 07

Aerial imagery supplied by Google Earth Pro and associated third party suppliers
Imagery date - January 2003

# Annex 2

# Concept Earthworks Cut and Fill Plan



## LEGEND

PROPOSED DEPTH OF CUT AND FILL

CUT
- FROM -3.00 TO -2.00m
- FROM -2.00 TO -1.00m
- FROM -1.00 TO -0.50m
- FROM -0.5.0 TO -0.25m
- FROM -0.25 TO 0.00m

FILL
- FROM 0.00 TO 0.25m
- FROM 0.25 TO 0.50m
- FROM 0.50 TO 1.00m
- FROM 1.00 TO 2.00m

EXISTING SITE CONTOURS

## NOTES

1. AREAS OF CUT AND FILL ARE INDICATIVE ONLY
2. EXISTING SITE CONTOURS SHOWN
3. PLAN SHOWS EXISTING SURFACE TO DESIGN LEVELS
4. BULK EARTHWORKS VOLUMES:
   CUT = 100,703m3
   FILL = 106,050m3
   THEREFORE EARTHWORKS APPROXIMATELY BALANCED

50 30 10 0 50 100 150 200 250m

SCALE 1:2500

NOT CONSTRUCTION ISSUE

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|---|---|---|---|---|
| 1 | 7/05/2010 | ISSUED FOR CLIENT REVIEW | DPT | DDP |



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SOUTH ORANGE
DPI LAND

CONCEPT EARTHWORKS CUT & FILL PLAN

Status: NOT FOR CONSTRUCTION

| Date | Datum | Scale | Size |
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| 7/05/2010 | AHD | 1:2500 | A1 |

Drawing Number: 600261-001

Revision: 1

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DATE PLOTTED: 10 May 2010 1:37 PM BY : IAN C. MCKENZIE (SYDNEY)

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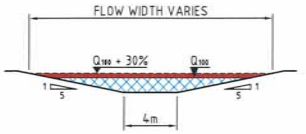
# Annex 3

# Flood Extent Plan


PRIMARY STORMWATER CHANNEL
TYPICAL DETAIL
NOT TO SCALE

LEGEND

$Q_{100}$ FLOOD EXTENTS

$Q_{100}$ + 30% - FLOOD EXTENTS WITH CLIMATE CHANGE EFFECTS

25 15 5 0 25 50 75 100 125m
SCALE 1:1250

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SOUTH ORANGE
DPI LAND

FLOOD EXTENT PLAN

Status: NOT FOR CONSTRUCTION

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| 7/05/2010 | AHD | 1:1250 | A1 |

Drawing Number: 600261-002
Revision: 1

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DATE PLOTTED: 10 May 2010 3:05 PM BY: IAN C. MCKENZIE (SYDNEY)

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# Annex 4

# Concept Road, Site Grading and Stormwater Plan


DATE PLOTTED: 10 May 2010 2:46 PM BY : IAN C. MCKENZIE (SYDNEY)

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SOUTH ORANGE
DPI LAND

CONCEPT ROAD, SITE GRADING & STORMWATER PLAN

Status: NOT FOR CONSTRUCTION

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Drawing Number: 600261-003
Revision: 1

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# Annex 5

# Concept Water Treatment / Re-use Plan


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Quality System
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SOUTH ORANGE
DPI LAND

CONCEPT WATER TREATMENT / RE-USE PLAN

Status: NOT FOR CONSTRUCTION

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Revision: 1

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CAD FILE: N:\Civil\6000 - 6999\600261 - Orange\3 Drafting\Drawings\600261-004(1).dwg

# Annex 6

# Concept Proposed Service Upgrade Plan


DATE PLOTTED: 18 May 2010 2:44 PM BY : IAN C. MCKENZIE (SYDNEY)

XREFs: X-GHP-A1-3Fl; X-STO-A1-Logo; X-Survey; X-Aerial; X-Utas Confs; X-Layout

CAD FILE: N:\Civil\6000 - 6999\60261 - Orange\3 Drafting\Drawings\60261-005(1).dwg

NOT CONSTRUCTION ISSUE

| Rev | Date | Description | Drawn | Appr. |
|---|---|---|---|---|
| 1 | 7/05/2010 | ISSUED FOR CLIENT REVIEW | DPT | DDP |



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| | | |
|---|---|---|
| Drawn | ICM | Date 7/05/2010 |
| Checked | DDP | Date 7/05/2010 |
| Designed | ICM | Date 7/05/2010 |
| Verified | | Date |
| Approved | | Date |

Client: STATE PROPERTY AUTHORITY

SOUTH ORANGE
DPI LAND

CONCEPT PROPOSED SERVICES UPGRADE PLAN

Status: NOT FOR CONSTRUCTION

| Date | Datum | Scale | Size |
|---|---|---|---|
| 7/05/2010 | AHD | 1:2500 | A1 |

Drawing Number: 600261-005 Revision: 1

0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150mm ON A1 ORIGINAL

# Annex 7

# Water Balance Summary

## Data received for the site dam and water usage by Orange Agricultural Institute

| Water usage at OAI from dam | | | | |
|---|---|---|---|---|
| | | | | |
| **Year of Usage** | **Drop in water level in ML** | **Yearly Rainfall** | **Yearly Evaporation** | **Yearly pumping hours** |
| Oct 2005 to Sept 2006 | 174 to 102 | 795 | 1556 | 710 |
| Oct 2006 to Sept 2007 | 102 to 34 | 659 | 1564 | 1178 |
| Oct 2007 to Sept 2008 | 41 to 22 | 860 | 1332 | 618 |
| Oct 2008 to Sept 2009 | 47 to 31 | 839 | 1376 | 692 |

## Water Balance

**EXISTING CATCHMENT -**

Catchment Area = 267ha, average imperviousness ~ 11%

| Period | Rainfall (mm) *1 | Runoff to Dam (ML) | Evaporation (ML) | Additional Drop in Water Level from OAI data (ML) | Estimated Usage by OAI (ML) *2 |
|---|---|---|---|---|---|
| Oct 2005 to Sept 2006 | 757 | 669 | 131 | 72 | 610 |
| Oct 2006 to Sept 2007 | 674 | 596 | 131 | 68 | 533 |
| Oct 2007 to Sept 2008 | 874 | 772 | 112 | 19 | 679 |
| Oct 2008 to Sept 2009 | 818 | 723 | 116 | 16 | 623 |

1. Rainfall from Bureau of Meteorology site 63254 Orange Agricultural Institute
2. This value is an estimate only and does not include other potential losses (eg infiltration at the dam)

**CATCHMENT WITH PROPOSED DEVELOPMENT -**

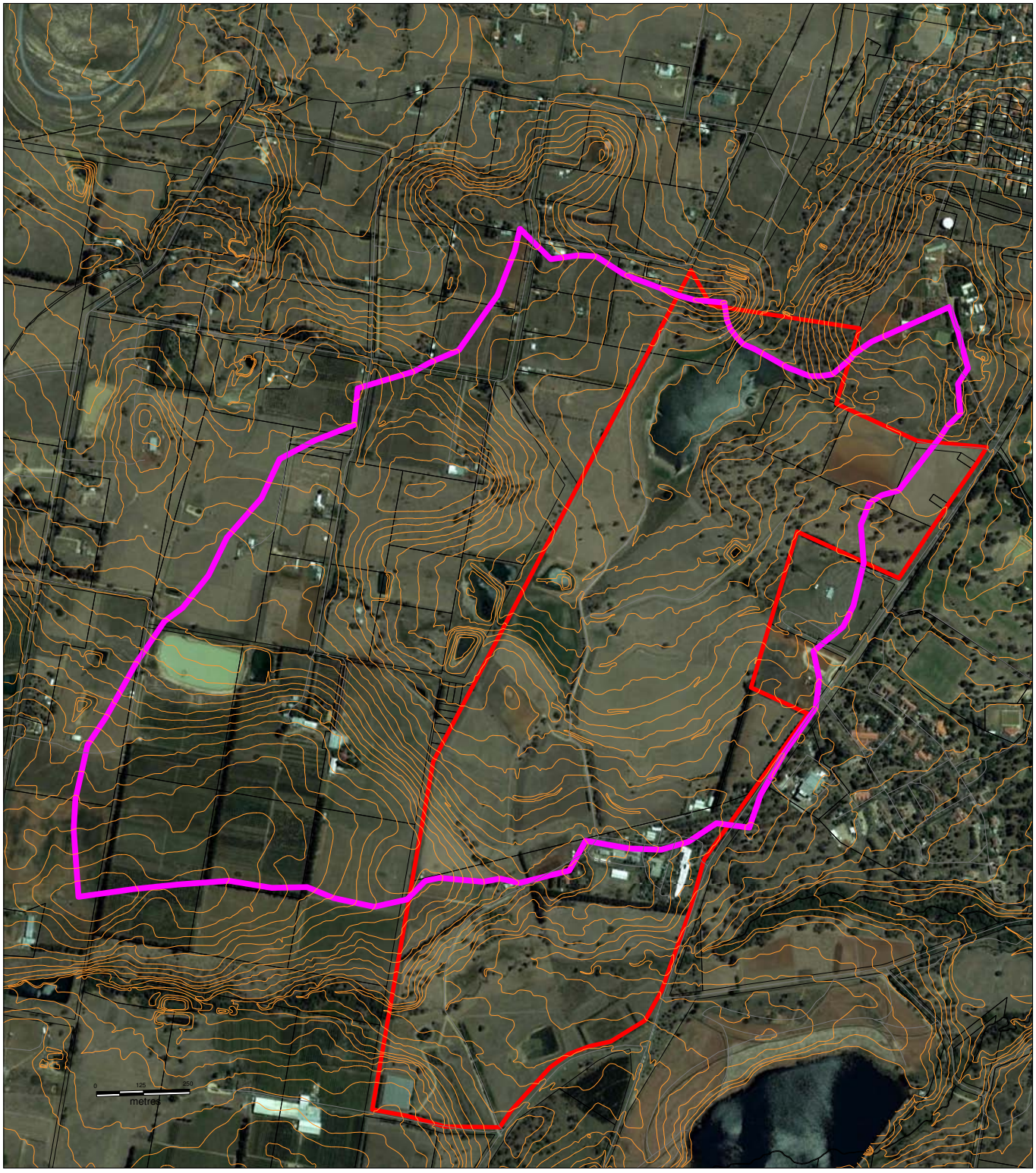
Catchment Area = 267ha, average imperviousness ~ 24%

Calculations using past 5 years of data

| Period | Rainfall (mm) | Runoff to Dam (ML) | Additional Runoff Post-Development (ML) | Additional Runoff Post-Development (%) |
|---|---|---|---|---|
| Oct 2005 to Sept 2006 | 757 | 844 | 175 | 29 |
| Oct 2006 to Sept 2007 | 674 | 751 | 155 | 33 |
| Oct 2007 to Sept 2008 | 874 | 974 | 202 | 30 |
| Oct 2008 to Sept 2009 | 818 | 912 | 189 | 30 |

# Annex 8

# Dam Catchment Boundary




DPI SITE BOUNDARY

CATCHMENT BOUNDARY FOR DAM

# SOUTH ORANGE
# DPI SITE -
# DAM CATCHMENT BOUNDARY

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**Project Reference: 600261**
**7/05/2010**