SEEC

Onsite Wastewater Site Assessment

for Castlereagh Christian Conference Centre Old Castlereagh Road, Castlereagh

Prepared by: Mark Passfield

SEEC Reference 15000102-WW-02

1st April 2016

Strategic Environmental & Engineering Consulting

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Document Certification

This report has been developed based on agreed requirements as understood by SEEC at the time of investigation. It applies only to a specific task on the nominated lands. Other interpretations should not be made, including changes in scale or application to other projects.
Any recommendations contained in this report are based on an honest appraisal of the opportunities and constraints that existed at the site at the time of investigation, subject to the limited scope and resources available. Within the confines of the above statements and to the best of my knowledge, this report does not contain any incomplete or misleading information.

Mark Passfield
Director
SEEC

1st April 2016

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Document Table

Version	Author	Reviewer	Date
FINAL	MP	CLIENT	01/04/2016

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1 INTRODUCTION

Strategic Environmental and Engineering Consulting (SEEC) Pty Ltd have been commissioned by the Castlereagh Christian Conference Centre to undertake this Onsite Wastewater Site Assessment. It is required to accompany an application to decommission an existing wastewater management system and install a new one. The replacement is required due to an imminent boundary adjustment.

Figure 1 - Site Locality (north is left)

2 SITE ASSESSMENT

2.1 Introduction

The following sections contain results of a detailed site investigation done by SEEC on 8th May 2015. The assessment was undertaken following Table 4 in the Environment and Health Protection Guidelines: Onsite Sewage Management for Single Households (Department of Local Government, 1998), which describes a rating system for onsite effluent management facilities. A range of possible site constraints are considered including, but not limited to:

- proximity to permanent and intermittent watercourses;
- landform, site gradient;
- drainage characteristics;
- aspect and exposure;
- extent of surface rock outcrop; and
- climate of the area

2.2 General Conditions

The Castlereagh Christian Conference Centre occupies flat land between Old Castlereagh Road and quarried lands to the east. The quarried lands hold water which now form part of the Sydney Regatta Centre. The water is 100 m east of a proposed new boundary.

The Centre comprises a chapel, offices, a clock tower, hall, cemetery and accommodation units. It is connected to reticulated water (provided by the Regatta Centre) and to rainwater tanks. It is not connected to reticulated sewer although it has an existing two-tank aerated wastewater treatment system (AWTS) which pumps treated water to a small pond from where the effluent is pumped to a series of subsurface irrigation fields. Some of those fields lie on land that is not owned by the Christian Centre and which are soon to be handed back to the NSW State Government by a boundary adjustment.

In the future it is proposed to extend the centre on lands in the north, although no new accommodation would be included. This means land available for effluent management is limited to two approximately equal, 600 m^2, areas where shown in Figure 2.

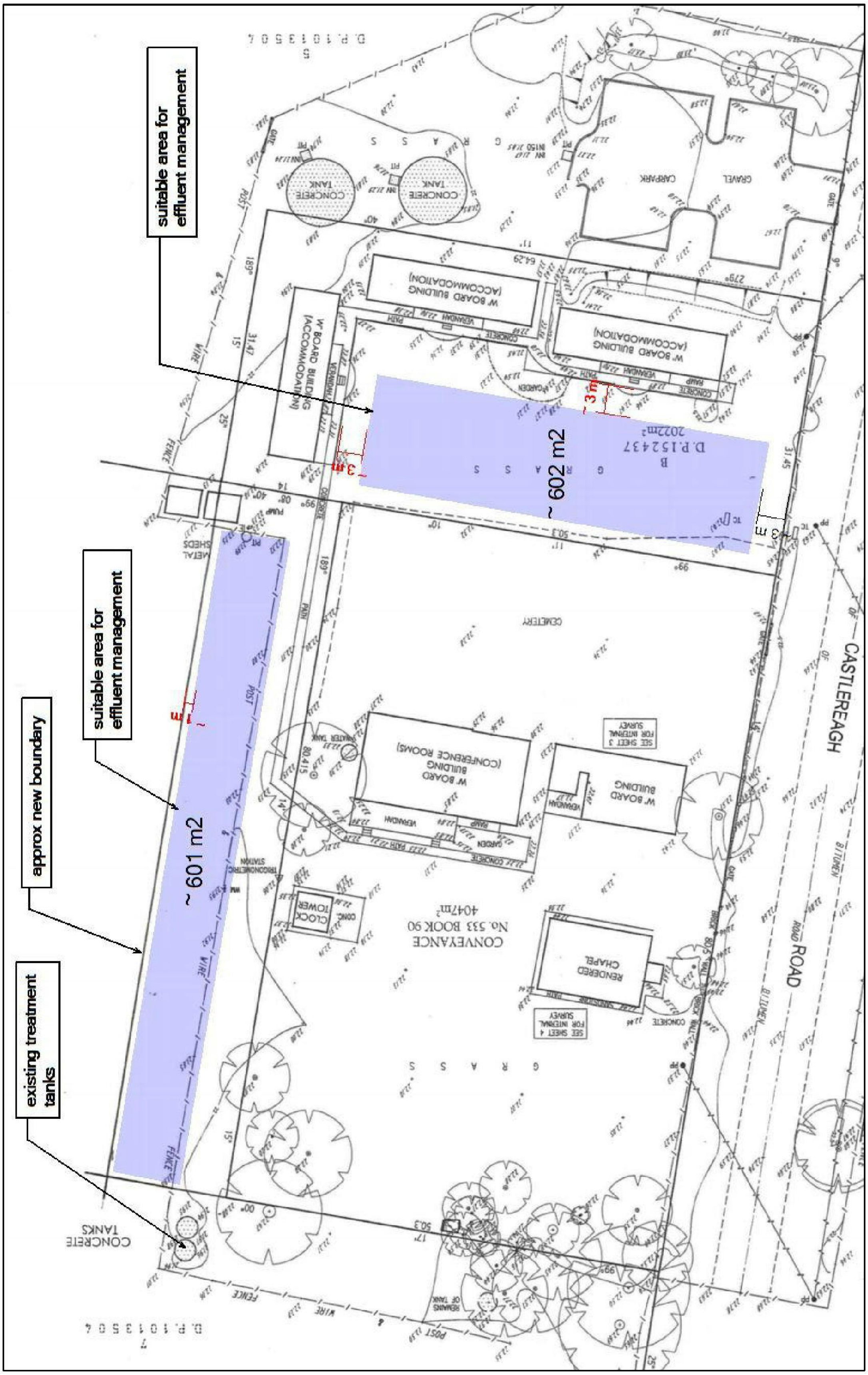

Figure 2 – Available land for effluent management after the boundary adjustment.

2.3 Climate

Climatic data is taken from the closest available rainfall and evaporation gauging stations. The Penrith area possesses a warm temperate climate with annual median rainfall of 831 mm [BOM Station number 067002 – Castlereagh] and mean annual pan evaporation of about 1,800 mm (Sydney Airport), temperatures occasionally fall below 15°C in winter. The climate of the area provides a minor limitation[1] to onsite effluent management.

2.4 Proximity to Surface Waters

The Sydney Regatta Centre lies to the east. This water is used by the public for competitive rowing but is more than 100 m from either of the possible effluent management areas and so meets buffer requirements. Minor limitation.

2.5 Flood Potential

Flood information prepared by Cardno for the Penrith Lakes Development Corporation has been supplied to us by the client (Appendix 2). The peak 100 year ARI flood levels are shown in Figure 2-1 of that report. The figure appears to show that the site is unaffected by the 100 year ARI flood.

2.5 Run-on and Seepage

There is little or no stormwater run-on to the proposed effluent management areas (EMAs). Roof water is collected and conveyed to two rainwater tanks, minor limitation.

2.6 Site Drainage

The site has good infiltration due to the sandy rich, lightly textured soils (**Section 3).** There is no evidence of possible periodic waterlogging in the subsoil (e.g. no light grey mottling in the soils); minor limitation.

2.7 Groundwater

Groundwater is known to be relatively deep as nearby graves have not shown signs of inundation. Most likely the groundwater level matches the level of water in the nearby Regatta Centre which is about 10m below the site's ground surface; minor limitation.

[1] Limitation classifications are those presented in DLG (1998)

2.8 Exposure

The proposed EMAs have a moderate exposure but there is some shading from nearby trees; minor limitation.

2.9 Slope

Slope gradient in the EMAs is zero; minor limitation.

2.10 Landform

The proposed EMAs are on a river terrace; minor limitation.

2.11 Erosion Potential

No significant erosion was noted on the site; minor limitation.

2.12 Fill

Minor ground disturbance has occurred over the site but the soils are essentially natural; minor limitation.

2.13 Surface Rock

There are no signs of exposed bedrock in the proposed EMAs; minor limitation.

2.14 Vegetation

The proposed EMAs have a very good covering of grass (Figure 1); minor limitation.

3 SOIL ASSESSMENT

3.1 Introduction

A soil survey was undertaken at the time of SEEC's site visit, the results of which are described below. The soil assessment was undertaken following Table 6 in Department of Local Government (1998), which describes a rating system for onsite effluent management facilities.

3.2 Geology and Soil Landscape

3.2.1 Mapping

The NSW Department of Environment and Heritage's website "eSPADE" indicates the site is on the Upper Castlereagh Soil Landscape. This is a fluvial soil landscape formed on terraces of the Nepean and Hawkesbury Rivers. It usually consists of loam topsoil over sandy clay loam to medium clay subsoil. Total soil depth is more than 1.5m.

3.2.2 Site Specific

Two test bores were drilled on site. They both revealed a similar and consistent profile of loamy topsoil over fine sandy loam grading to fine sandy clay loam. The soils are massive but appear well-drained. The two profiles were:

BH1

0–300	Dark grey loam
300-600	Brown loam, fine sandy
600-1100+	Orangey brown fine sandy clay loam, massive

BH2

0–100	Dark grey loam
100-500	Grey-brown loam, fine sandy
500-1100+	Orangey brown fine sandy clay loam, massive

3.3 Soil Depth

Depth to bedrock is greater than, 1.5 m; minor limitation.

3.4 Depth to Seasonal Waterlogging

No signs of seasonal waterlogging were noted; minor limitation.

3.5 Soil Permeability

Soil permeability was not directly measured but can be inferred from the soil texture, structure and depth, with reference to AS/NZS1547 (2012). The top 500 mm is comprised of loam having an indicative permeability between 0.5 and 1.5 m/day. The massive sandy clay loam subsoil has an indicative permeability of about 0.06-0.12 m per day, minor limitation.

3.6 Laboratory Testing

A sample of both topsoil and subsoil were sent to Scone Research Laboratory for a suite of effluent-disposal-related tests. The results of laboratory soil testing are contained in Table xx and are discussed below.

Table 1 – Laboratory Test Results

SOIL CONSERVATION SERVICE
Scone Research Centre

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Report No: SCO15/105R1
Client Reference: Kim Passfield
SEEC
PO Box 1098
Bowral NSW 2576

Lab No	Method	C1A/5	C2A/4	C2B/4	C5A/4 CEC & exchangeable cations (cmol (+)/ kg)						C8B/1	P9B/2	
	Sample Id	EC (dS/m)	pH	pH ($CaCl_2$)	CEC	Na	K	Ca	Mg	Al	P sorp (mg/kg)	EAT	Texture
1	15000102 BH1 10 cm	0.02	6.5	5.9	13.1	0.2	0.9	6.5	1.5	nt	190	5	Silty Loam
2	15000102 BH1 80 cm	<0.01	7.2	6.0	11.0	0.2	0.6	4.7	2.6	nt	210	3(1)	Sandy clay

nt=not tested

END OF TEST REPORT

3.6.1 pH

Soil pH is a measure of the acidity or alkalinity of a soil. It relates to the concentration of the hydrogen ions (H+) in the soil solution measured on a negative logarithmic scale of 1 to 14. The concentrations of hydrogen ions are equal to the hydroxyl ions (OH-) at pH 7, greater below pH 7 (acid) and fewer above (alkaline).

In the urban environment, the importance of pH is usually confined to its effect on the availability of elements in the soil and, therefore, possible deficiencies and/or toxicities. Whether these elements are available to plants depends on their solubilities, being available only when in soluble forms.

Soil pH was measured both with a 1:5 soil/water suspension and with Calcium Chloride. The former test reported soil pHs of 6.5 and 7.2 for the topsoil and subsoil respectively.

The latter test (which is more accurate) reported results of 5.9 and 6.0 respectively. These results show the soil is slightly acidic; moderate limitation.

3.6.2 Electrical Conductivity

The electrical conductivity (EC) of 1:5 soil/water suspensions are used to detect the presence of soluble salts and, from this, suggest the general salinity level. The main soluble salts likely to be present are sodium, calcium and magnesium, which might be chlorides, sulfates or carbonates. The standard unit of electrical conductivity in soil is deciseimens per metre (dS/m).

Electrical conductivity of the saturated extract (EC_e) was calculated by first measuring the electrical conductivity of a 1:5 soil in water suspension and using an appropriate multiplier factor to convert EC (1:5) to ECe. Calculated EC_e values are 0.2 (topsoil) and 0 for the subsoil decisiemens per metre and so the soils are non-saline; minor limitation.

3.6.3 Modified Emerson Aggregate Class

The Emerson Aggregate Test is a measure of soil dispersibility and susceptibility to erosion and structural degradation. It assesses the physical changes that occur in a single ped of soil when immersed in water, specifically whether the soil slakes and falls apart or disperses and clouds the water.

The Emerson Aggregate Test was performed on samples of both topsoil and subsoil. Soil samples recorded Emerson Aggregate Classes of 5 for the topsoil and 3(1) for the subsoil. Both these suggest the soils are not dispersive; minor limitation.

3.6.4 Cation Exchange Capacity

The cation exchange capacity (CEC) is the capacity of the soil to hold and exchange cations. It is a major controlling agent for soil structural stability, nutrient availability for plants and the soils' reaction to fertilisers and other ameliorants (Hazelton & Murphy, 2007).

Cation exchange capacity for topsoil was 13 while for the subsoil it was 11 (me/100g). These CEC values represent a moderate limitation to effluent management.

3.6.5 Exchangeable Sodium Percentage

The exchangeable sodium percentage (ESP) is calculated as [% Na / CEC] x 100. It is an indicator of sodicity – the tendency for soil dispersion and structural decline. Hazelton & Murphy (2007) suggests:

- ESP values less than 6 and are rated as non-sodic
- ESP values between 6 and 10 are rated as marginally sodic
- ESP values greater than 10 are rated as sodic

The ESP results are 1.5 and 1.8 for the topsoil and subsoil respectively; the soils are not sodic; minor limitation.

3.6.6 Phosphorus Sorption Capacity

Phosphorus is an important plant nutrient and its availability to plants depends heavily on soil pH, soil texture, organic matter content and clay mineralogy. Phosphorus is also an important environmental pollutant, particularly in waterways where it is responsible for promoting weed growth and algal blooms.

When assessing a site's suitability for wastewater application it is important to assess the soils' ability to fix (sorb) phosphorus, this being a significant mechanism for controlling phosphorus that is applied in wastewater. Phosphorus sorption tends to increase with increasing clay content, iron and aluminium concentration, and organic matter.

Phosphorus sorption capacity (PSC) and phosphorus sorption index (PRI) was measured and analysed with the assistance of the Scone Research Centre.

The PSC for the topsoil was 190 mg/kg and for the subsoil it was 210 mg/kg. These are moderate values and so the soils have a reasonable capacity to sorb phosphorus.

3.7 Soil Summary

The soils are well suited to effluent disposal as they have moderate CEC, are not saline and they are not dispersive. They have a moderate ability to sorb phosphorous and are currently supporting a good growth of grass.

4 WASTEWATER GENERATION

4.1 Wastewater Sources

Within the complex wastewater would be generated in:

- The accommodation units, which can house 48 people;
- The office, which is usually occupied by four staff and has toilets;
- The hall, which can hold about 60 people and uses the toilets described above;
- The kitchenette in the hall,
- A small laundry, although most laundry is done offsite.

All sources would generate wastewater essentially domestic in nature. Inflow due to stormwater infiltration could also occur; an allowance of at least 10% over and above the wastewater load is prudent.

4.2 Wastewater Volume

Management has provided details on the existing occupancy rates during several typical scenarios:

- The peak period which occurs in March
- A shoulder period which occurs in April
- A typical quiet period (July)

Given the peak period blends with a shoulder period that whole period is modelled below. Penrith City Council (2014) suggests the following daily allowances per person:

- Overnight visitor = 150 L/p/day
- Day visitor (e.g. to chapel or conference) = 15 L/day
- Office staff = 50 L/p/day.

Using these estimations, the design wastewater load is highly variable ranging from zero to a peak of about 7,400 L/day when the accommodation is full. A spreadsheet model of the peak period (March) merging into the shoulder period (April) and continuing into a quiet period has been done. Figure 3 shows the daily wastewater volumes produced over that period of about 90 days.

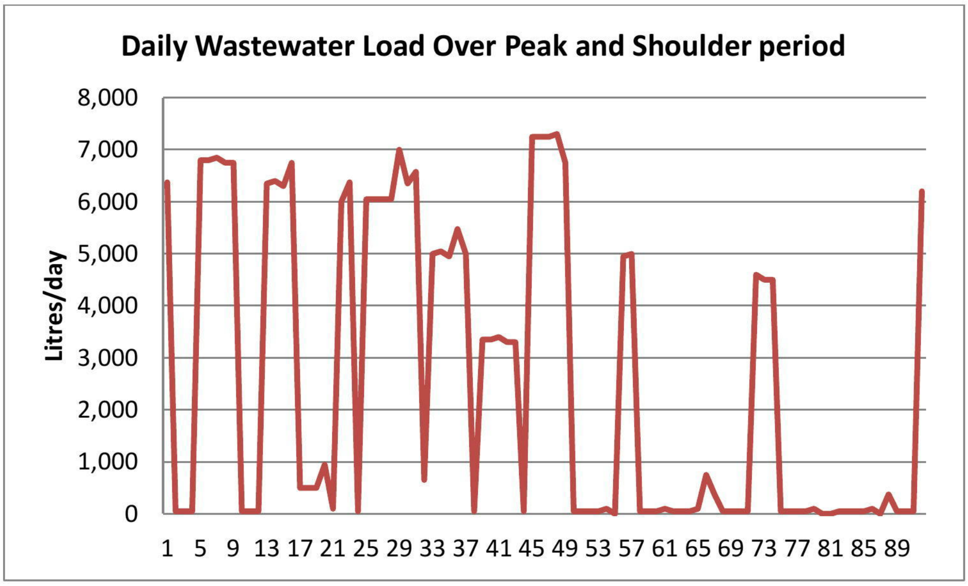

Figure 3 - Daily Wastewater Load Over Peak and Shoulder Period

There is a proposal to increase attendances to the chapel, up to about 60 persons on individual days. However, those persons would attend church services only and so would generate only about 180 L (NSW Health, 2001). The effect of that is not considered significant.

5 RECOMMENDATIONS

5.1 Treatment

5.1.1 Existing System

The existing treatment system consists of two tanks in series. The first is a septic tank which then delivers primary-treated wastewater to the (second) aeration tank. According to the maintenance manual prepared by Toby Fiander & Assoc. the system has a daily capacity of 3,500 L. This is not sufficient for the peak design load of 7,400 L/day and so it will be de-commissioned and replaced with a new system.

5.1.2 Septic Volume

The septic volume will be a minimum capacity of 9,000 L (being 7,400 L plus 1,550 L sludge allowance).

5.1.3 Treatment

A new treatment system will be installed capable of treating 4,500L/day (about the limit of disposal by irrigation, Section 5.2.2). If that were done, the septic volume and balancing volumes would be 9,000 L and 13,000 L plus a buffer respectively (Figure 5).

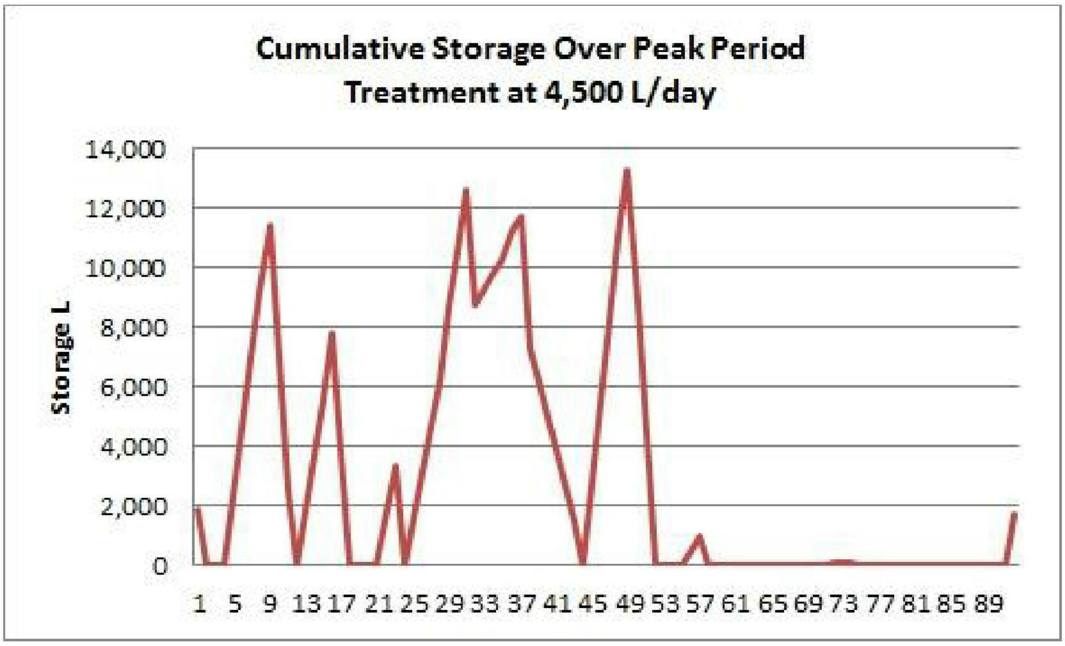

Figure 4

5.1.4 Secondary Treatment

Primary-treated wastewater from the balancing tank would be pumped to an aeration tank for secondary treatment. Disinfection would be required if irrigation is adopted as the disposal method.

5.1.5 *The Proposed System*

The proposed system is a Model CT40 system with appropriate balancing and storage tanks. It is manufactured by Ultra Clear Wastewater Treatment Systems and is presented diagrammatically in Appendix 1.

5.2 Effluent Disposal

5.2.1 *Available Land*

Figure 2 shows there are two available effluent management areas. They are both about 600 m^2 and so there is about 1,200 m^2 of land available.

5.2.2 *Irrigation Option*

The design irrigation rate (DIR) is 4mm/day (loam soil, AS/NZS 1547:2012). Therefore, a peak disposal rate of 4,800 L/day is permissible by irrigation. Based on an output of 4,500 L/day the required irrigation area would be 1,125 m^2. This would be divided into four fields of subsurface irrigation sequentially dosed by using an index valve.

5.3 Mitigation

There are a number of mitigations that should be done to reduce wastewater load and improve the performance of the treatment system and disposal area:

- Low-flow shower heads (min. three-star) and/or timers should be installed in all units.
- Toilet cisterns should be at least three-star rated.
- If the emergency overflow alarm is activated, investigate why the wastewater load has been so high; perhaps there is leakage in the building.

5.4 Contingencies

The following contingences should be adopted:

- High water alarms must be fitted to all tanks to indicate if there has been a pump failure.
- Check fittings daily to ensure no leakage.
- The system should be regularly inspected and maintained; we recommend three-monthly inspections by a qualified wastewater contractor familiar with irrigation.

6 SUMMARY AND CONCLUSION

The existing wastewater system at the Castlereagh Christian Conference Centre has to be removed and replaced so that it will be wholly contained within newly-proposed site boundaries. The existing system is quoted to have a design loading of 3,500 L/day which is insufficient for the peak daily design load of 7,500 L/day. Therefore, a new treatment system manufactured by Ultra Clear Wastewater Treatment Systems will be installed.

It will have an increased septic volume of 9,000 L to provide adequate primary treatment. Primary-treated effluent would then be balanced in two 8,500 L tanks before being sent to two 5,000 L aeration tanks for treatment and disinfection. The proposed system is shown diagrammatically in Appendix 1.

Disposal of 4,500 L/d requires a total irrigation area of 1,125 m^2, divided into four equal fields sequentially dosed by an index valve. The irrigation fields will be installed in the permissible effluent management areas shown in Figure 2.

7 REFERENCES

AS/NZS 1547:2012. *On-site Domestic Wastewater Management*. Australian and New Zealand Standard. Standards Australia Limited/Standards New Zealand.

Department of Local Government (DLG) (1998). *Onsite Sewage Management for Single Households.*

Hazelton and Murphy (2007). *Interpreting Soil Test Results: What do all the Numbers Mean?* CSIRO Publishing, Collingwood, Victoria.

NSW Health (2001) *Septic tank and collection well accreditation guideline.*

Penrith City Council (2014) *Onsite Sewage Management and Greywater Reuse Policy*.

8 APPENDICES

8.1 Appendix 1 – The Proposed Wastewater Treatment System

over-page (two pages)

MODEL CT40 WITH BALANCE TANKS SITE SPECIFIC DESIGN

AERATED WASTEWATER TREATMENT SYSTEM **Castlereagh Christian Conference Centre**

SUITABLE TO DEAL WITH WC'S AND ALL WASTE UP TO 6,000 LITRES PER DAY

Ultra Clear Wastewater Treatment Systems ABN 93 090 907 725

PO BOX 1158, MITTAGONG NSW 2575 Phone: 02 4871 2156 Fax: 02 4872 4109

www.ultraclear.com.au

All internal and sundries supplied and installed by

Ultra Clear Wastewater Treatment Systems

5 x 10,000 litre collection wells approved by NSW Health

COLLECTION WELLS manufactured by **Highland Concrete Tanks.**

All Septic Tanks & Collection Wells are manufactured to comply with Australian Standards AS/NZS 1546.1:2008 Licence No. SMKB20582

www.highlandtanks.com.au

FACTORY: 16 Gantry Place, BRAEMAR NSW 2575

Phone: 02 4871 2156 Fax: 02 4842 4109

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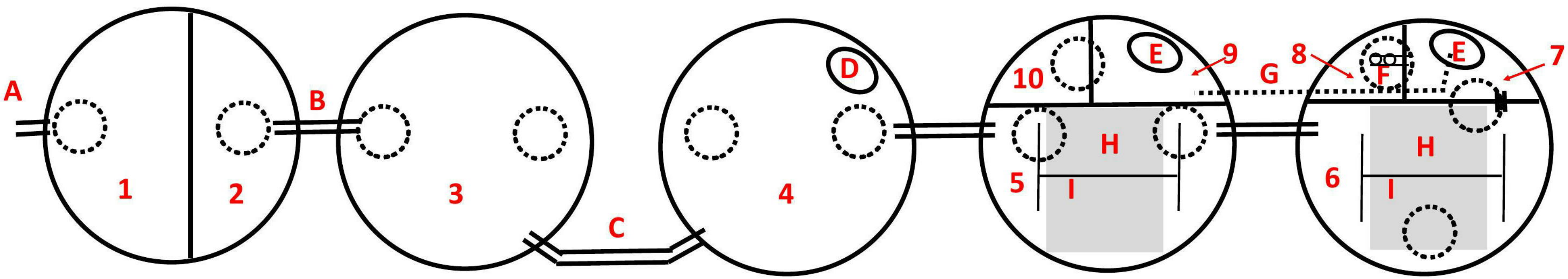


No.	*Capacity*	*Description Chamber*
1	6,000 litres	Primary Chamber 1
2	3,000 litres	Primary Chamber 2
3	8,500 litres	Balance Tank 1
4	8,500 litres	Balance Tank 2
5	5,000 litres	Aeration Chamber 1
6	5,000 litres	Aeration Chamber 2
7	1,500 litres	Settling Chamber
8	900 litres	Disinfection Pump Chamber
9	1,500 litres	Humus Waste Chamber 1
10	900 litres	Humus Waste Chamber 2

No.	*Description Parts*	*No.*	*Description Parts*
A	Inlet	F	Chlorinator
B	Flow Pipe	G	Sludge Return Pipe
C	100mm Balance Pipe at Base of Tanks	H	Media Pack
D	Balance Pump cover with Timer	I	Air Diffuser Line
E	Blower & Electrical Cover Box		

MODEL CT40 WITH BALANCE TANKS SITE SPECIFIC DESIGN

AERATED WASTEWATER TREATMENT SYSTEM   **Castlereagh Christian Conference Centre**

SUITABLE TO DEAL WITH WC'S AND ALL WASTE UP TO 6,000 LITRES PER DAY

Ultra Clear Wastewater Treatment Systems   ABN 93 090 907 725

PO BOX 1158, MITTAGONG NSW 2575   Phone: 02 4871 2156   Fax: 02 4872 4109

www.ultraclear.com.au

All internal and sundries supplied and installed by

Ultra Clear Wastewater Treatment Systems

EXPECTED EFFLUENT QUALITY OUTPUT

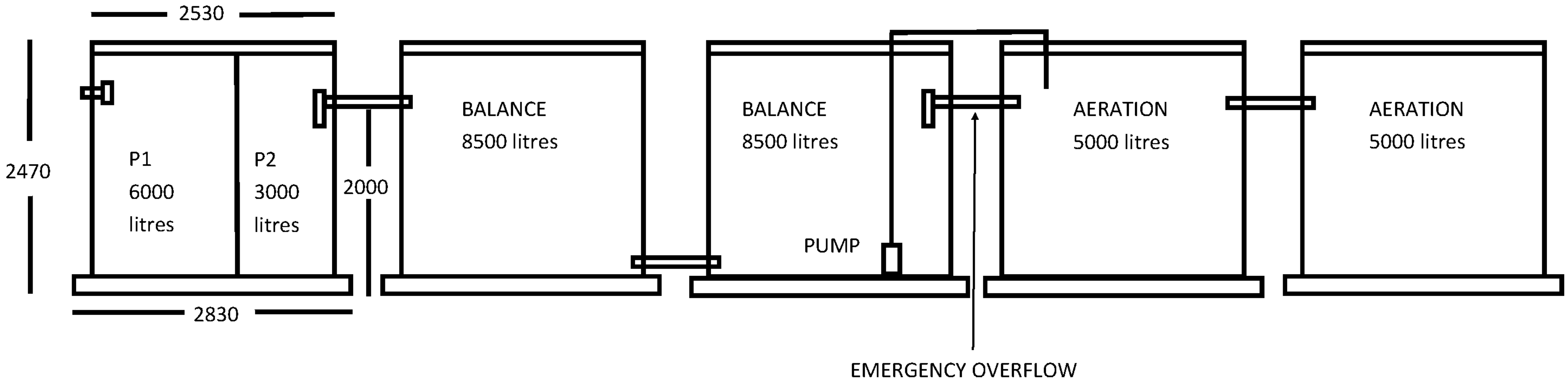
BOD 5	<20
SS	<30
FREE CHLORINE	.5 - 2 mg/lt
TN	<25
TP	<12

VISUAL ALARM

for balance tank pump mounted on control box on tank

ALL TANKS HAVE INTEGRATED ANTI-FLOATATION COLLARS

Drawing ID: UCSCT40SSCCCCM 199 20/03/2016 Page 2



8.2 Appendix 2 – Flood Report (Cardno)

(over-page)

Our Ref W4856-L27 :lre/rst

Contact Rhys Thomson / Dr Brett C Phillips

10th February 2014

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Penrith Lakes Development Corporation
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CRANEBROOK NSW 2749

Attention: Mr Mick O'Brien

Dear Mick,

FUTURE URBAN DEVELOPMENT AREAS – FLOOD AFFECTATION

Cardno have been advised by Penrith Lakes Development Corporation (PLDC) of their proposal to submit development applications for future development of land marked 'Future Urban Areas' on the structure plan, as shown in the image attached at the end of this letter.

Cardno have been asked by PLDC to provide advice on:

- The 100yr ARI flood level within the lakes scheme as a results of the Water Management Plan 2012 (WMP 2012) scheme;
- The impact on peak flood levels in areas adjacent to the PLDC scheme; and,
- Compliance with the Penrith Development Control Plan 2010.

For the purpose of the assessment, we have assumed that the future urban development area terrain is consistent with the 2012 study.

1. BACKGROUND

A SOBEK model was constructed for the PLDC Lakes Scheme (the Scheme) in 2008 to replace the physical model and allow for the rapid assessment of various scheme layouts. The SOBEK model was calibrated and validated to historical floods which occurred in 1978, 1986 and 1990, a 2006 scanned version of the physical model (referred to as the Alignment model) and other numerical models, as detailed in *Penrith Lakes Flood Model: Calibration & Verification* (Cardno, 2010).

PLDC commissioned a peer review of the hydraulic modelling, with a particular focus on the integrity of the hydraulic modelling, which was completed by WMAwater in August 2010, and a draft report was prepared.

The outcome of the calibration and validation process was a numerical model that can be used with confidence to assess the flooding performance of the works associated with the Penrith Lakes Scheme. This conclusion was supported by the peer review and accepted by the Department of Planning and Infrastructure when it granted approval to WMP2012 of 5 November 2013.

The model has subsequently been used to assess the flooding behaviour of the PLDC site and surrounding area as a result of the WMP 2012 scenario.

2. FLOOD LEVELS FOR FUTURE URBAN AREAS UNDER THE WMP 2012 SCENARIO

Under the current PLDC structure plan, regions of land surrounding the Main Lakes are marked as 'Future Urban Areas'.

Under the WMP 2012 scenario, the peak 100 year ARI level in Main Lake A and Main Lake B is 21.72 mAHD. The peak Main Lake levels, as well as the peak levels in the adjacent lakes and Nepean River, are shown in **Figure 2-1** below.

Further details of peak levels and the flood behaviour of the lakes scheme are provided in the *Penrith Lakes Scheme: Flood Infrastructure Concept Design 2012* report prepared by Cardno (Cardno, 2012).

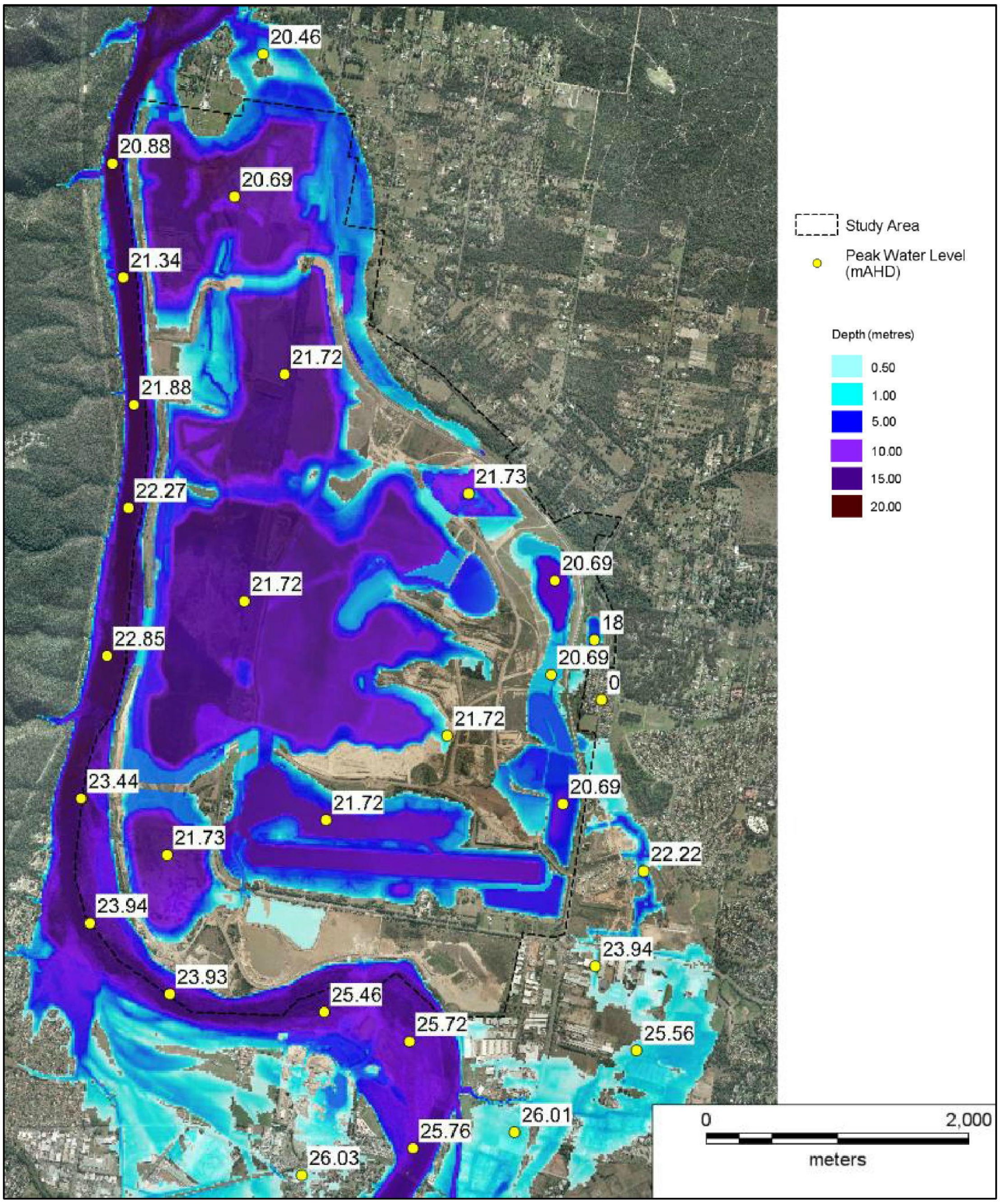

Figure 2-1: Peak 100yr ARI Flood Levels

3. FLOOD IMPACTS OF THE WMP 2012 SCHEME

The 2012 scheme results in significant reductions in peak water levels (relative to the pre-quarry condition) in the 100 year ARI and minor reductions in the 200 year ARI within the Emu Plains and Penrith areas. Reductions in the order of 0.3 – 0.6m are observed in the 100 year ARI levels along the Nepean River. This results in a significant benefit to a large number of properties in this area.

The 2012 Scheme provides the Cranebrook Village area with significant flooding improvements in the 100yr ARI with a reduction in flood extents, resulting in only 2 properties remaining flood affected in the 100yr ARI event, where 34 were previously flood affected under pre-quarry conditions.

Waterside Green is a new development located to the east of the Penrith Lakes Scheme. An assessment of the flood levels in this location for both the 100 year and 200 year ARIs show that the 2012 Scheme would result in lower flood levels in this area compared to the flood levels adopted during the design and construction of Waterside Green.

A full discussion on the flooding behaviour of the scheme is provided in the *Penrith Lakes Scheme: Flood Infrastructure Concept Design 2012* report prepared by Cardno (Cardno, 2012).

4. PENRITH DCP-2010

Consolidation and subdivision of Scheme land is proposed by PLDC to implement the vision of the Scheme. The lakes are designed to accommodate flooding and the land identified for future urban areas is either naturally above the 100 year ARI level or designed to be filled above the flood level under existing quarry extraction approvals and approved two year plans.

The design for rehabilitation of land does not adversely affect any flood levels, flows or velocities, as identified in *Penrith Lakes Scheme: Flood Infrastructure Concept Design* (Cardno, 2013). Local drainage issues would be appropriately incorporated as part of the stormwater design during detailed phases.

The requirements of Penrith City Council's DCP-2010, and details of how the Scheme addresses these requirements are presented in **Table 4-1** on the following page.

5. DEVELOPMENT OF 'FUTURE URBAN AREAS'

We understand that the development of the land marked 'Future Urban Area' (refer attached image) will require the import of virgin excavated natural material (VENM) into the scheme in order to complete the final landforms as there is insufficient material remaining within the PLDC site to construct these landforms. The shortfall is estimated to require the importing of 1 million tonnes of VENM each year for three years.

As previously discussed (in advice provided 6 November 2012, Letter L09) as this fill is to be used to complete the landforms currently represented in the flood model, the provision of this material is not expected to adversely affect the flood behaviour of the scheme.

Furthermore, as the future development of these areas will take place above the 100yr ARI flood level, it is not expected that this future development would result in adverse effects on the 100yr ARI flood behaviour.

Table 4-1: DCP-2010 Requirements

Clause	Requirements	Scheme Suitability
C3 1. a)	Where relevant, a comprehensive flood study, incorporating: i) a survey of the main watercourse; ii) a survey of the site; and iii) a detailed flood and drainage investigation which establishes the estimated 1:100 ARI flood level; is to be submitted with any development application on land identified as fully or partially flood affected. The levels on the survey are required to be verified during construction by a survey certificate.	A comprehensive flood study was undertaken and documented in the *Penrith Lakes Scheme: Flood Infrastructure Report* (Cardno, 2012). The study determined the 100yr ARI flood levels and extent for the PLDC Scheme. The results are shown in Figure 1.
C3 1. b)	The applicant shall be required to demonstrate to the satisfaction of Council (on the basis of a qualified consultant report) that: i) The development will not increase the flood hazard or risk to other properties	This has been demonstrated in the *Penrith Lakes Scheme: Flood Infrastructure Report* (Cardno, 2012), which shows that that the development does not increase flood hazard or risk for other properties.
C3 2. a)	Council will consider development on flood liable land but will not grant consent to development in floodways or in high hazard areas.	The future urban areas are out of the 100yr ARI flood extent, and thus not within floodways or high hazard areas.
C3 3. a)	Floor levels of habitable rooms shall be at least 0.5m above the 1:100 ARI flood; i.e. the flood planning level.	The terrain for the future urban areas is above the FPL; thus properties constructed will be able the FPL.
C11 5. b)	Council will not approve any subdivision of lots where it is evident that a flood free building envelope and safe internal access from/to the public road cannot be provided. The building envelope for any dwelling should be flood free in a 1:100 Average Recurrence Interval (ARI) flood. Evidence of this must be provided as part of any application.	The land proposed for the future urban areas is above the 100yr ARI flood level, as shown in Figure 1.
C11 5. c)	Council will not support the subdivision of any land located in a floodway or areas of high flood hazard.	The land proposed for the future urban areas is above the 100yr ARI flood level, and thus is not located in a floodway or high hazard region.

6. CONCLUSION

Based on the above, it is not expected that the future development of land marked 'Future Urban Areas' on the Structure Plan, including the addition of imported VENM to make up levels to the proposed WMP 2012 terrain, will adversely affect the flood behaviour of the scheme. Neither will it adversely affect Nepean River geomorphology or the peak flood levels of surrounding regions in events up to the 100yr ARI design event.

We trust that the above answers your queries. If you have any questions, please do not hesitate to contact me on 9496 7700.

Yours sincerely

Rhys Thomson
Senior Engineer / Economist
for **Cardno (NSW/ACT) Pty Ltd**

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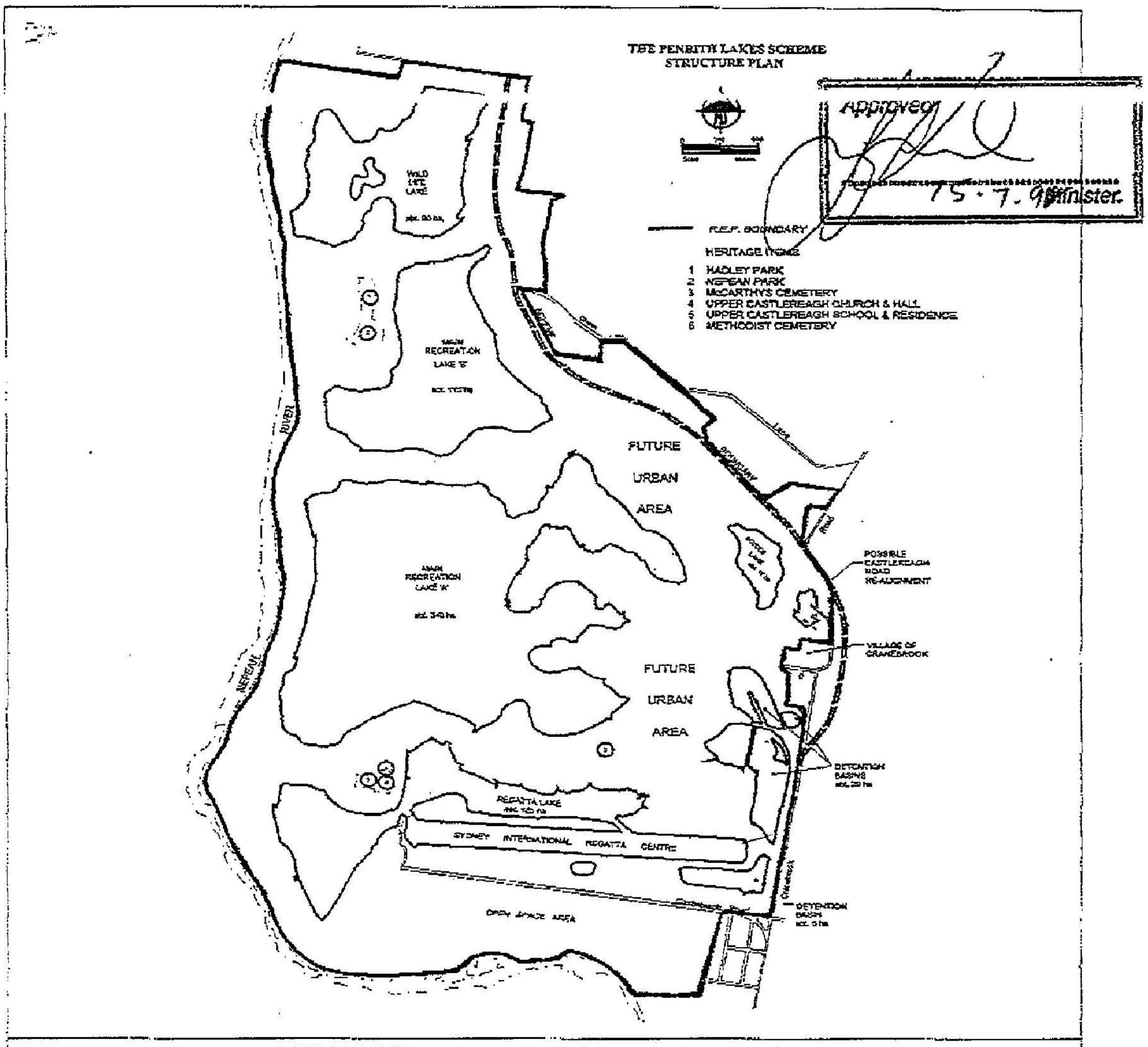

DEPARTMENT OF URBAN AFFAIRS AND PLANNING
ENVIRONMENTAL PLANNING & ASSESSMENT ACT, 1979
SYDNEY REGIONAL ENVIRONMENTAL PLAN No. 11
(PENRITH LAKES)
AMENDMENT No. 4

L.G.A. PENRITH
PARISH OF CASTLEREAGH
LOCALITY CASTLEREAGH
COUNTY OF CUMBERLAND
DRAWN BY S. MANTELLA-GALLI DATE 8 JULY 1998
CHECKED BY MANAGER CARTOGRAPHIC
PLANNING OFFICER
NOTATIONS
Amendment No. 4
This map is a reduced scale interpretation of the map referred to in the S.R.E.P. No.11 (Penrith Lakes)
DEPARTMENT FILE No. P97/00236 Pt.1
GOVERNMENT GAZETTE OF
CATALOGUE No. 0 5 0 9 9 9 8 4 2 4 2