Our Ref W4856-L27 :lre/rst

Contact Rhys Thomson / Dr Brett C Phillips

10th February 2014

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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).

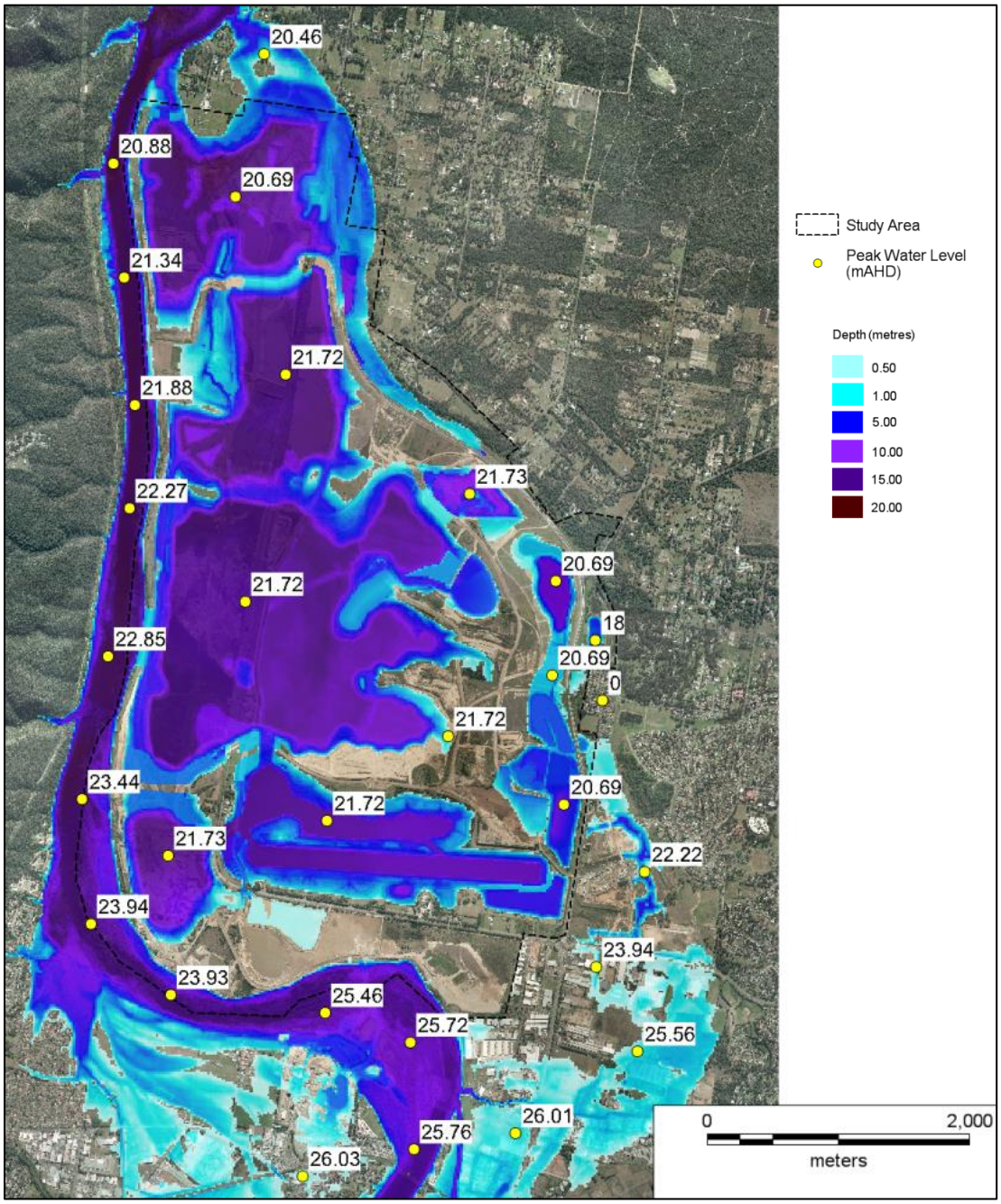


Figure 2-1: Peak 100yr ARI Flood Levels

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**

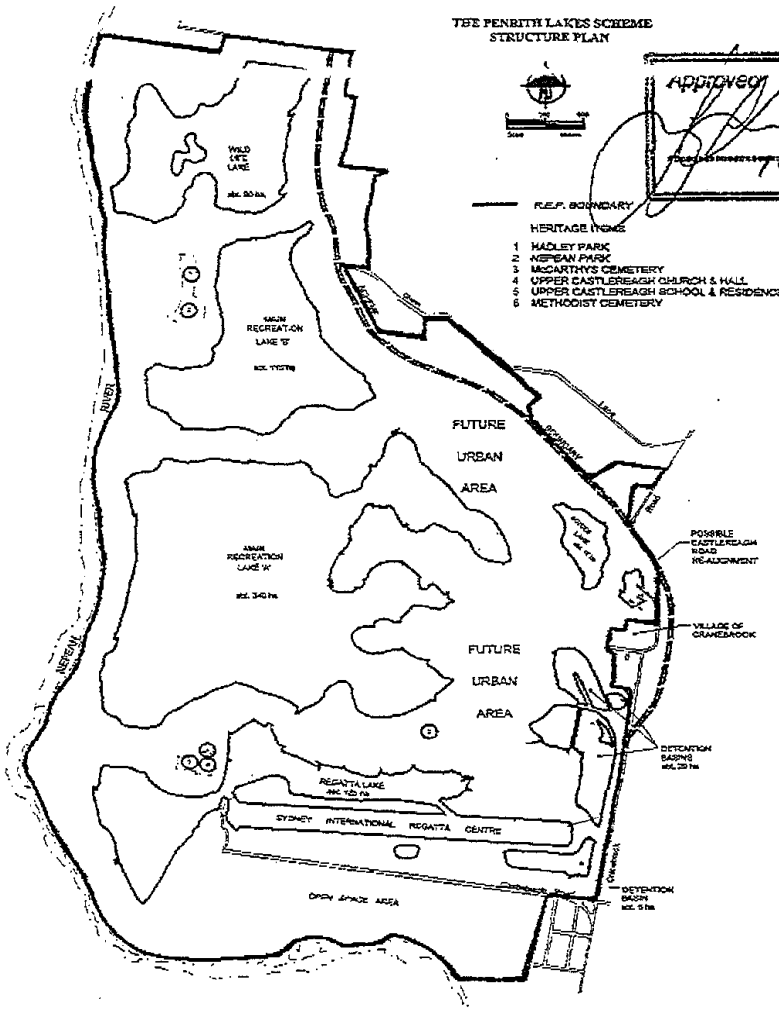
26-MAY-1999 11:47 FROM URBAN AFFAIRS & PLAN PTTA TO 047301462 P.04

THE PENRITH LAKES SCHEME
STRUCTURE PLAN

Approved
15.7.99 Minister.

R.E.P. BOUNDARY

HERITAGE ITEMS
1 HADLEY PARK
2 NEPEAN PARK
3 McCARTHYS CEMETERY
4 UPPER CASTLEREAGH CHURCH & HALL
5 UPPER CASTLEREAGH SCHOOL & RESIDENCE
6 METHODIST CEMETERY



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. PARISH OF	PENRITH CASTLEREAGH	LOCALITY COUNTY OF	CASTLEREAGH CUMBERLAND
DRAWN BY	S. MANTELLA-GALLI DATE 8 JULY 1998	NOTATIONS	
CHECKED BY	MANAGER CARTOGRAPHIC	Amendment No. 4	
	PLANNING OFFICER	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 8 4 2 4 2