Appendix F Cardno Lawson Treloar Flood Report

Our Ref J5470/LM2180 :GAS

Contact Melanie Dalton

4 April 2006

Mr Colin Kalms
City of Greater Shepparton
Locked Bag 1000
SHEPPARTON VIC 3632

169 Burwood Road
Hawthorn
Victoria 3122 Australia
Telephone: 03 9818 3910
Facsimile: 03 9818 7033
International: +61 3 9818 3910
Email: cltvic@cardno.com.au
Web: www.cardno.com.au

Dear Sir

RE – MOOROOPNA OUTLINE DEVELOPMENT PLAN (ODP) FLOODING

Thank you for the opportunity to work with you on this project. We are pleased to present the results of our investigation in this letter. This report contains some background on the study area and flood modelling in the area, details of the hydraulic modelling that has been undertaken, and recommendations for the ODP area with regard to flooding.

BACKGROUND

The city of Shepparton is situated in Northern Victoria, approximately 180 km directly north of Melbourne. It is at the centre of the Goulburn Valley, at the confluence of three major watercourses, the Goulburn River, Broken River and Seven Creeks. The area is extremely flat and consequently, when flooding occurs, large areas of the floodplain are inundated.

The townships of Shepparton and Mooroopna have been subject to numerous floods since European development, with the largest floods on record occurring in 1916, 1939, 1974 and 1993. Following the 1993 floods, Cardno Lawson Treloar (previously Lawson and Treloar) were commissioned to create a hydraulic model of the Shepparton area, to investigate the effect of flooding on the area. This resulted in the Shepparton-Mooroopna Flood Study (SKM, 2002).

The Mooroopna Outline Development Plan (ODP) covers a large area to the north west of Mooroopna, as shown in figure 1. In 2005 CoGS (City of Greater Shepparton) commissioned Cardno Lawson Treloar to undertake hydraulic modelling to assess the impact of developing the ODP area on flood flows and levels on adjacent properties. This report presents the results of this investigation.

HYDRAULIC MODELLING

In 2005 the hydraulic model used for the Shepparton Flood Study, was updated to the SOBEK modelling system, and the topography updated to include all current developments. Figure 2 shows the location of recent developments included in the model. These were identified by comparing the September 2005 cadastre (provided by CoGS) with the 1999 cadastre used for the original flood study. Any areas showing a difference were discussed with council and finished surface levels requested for the selected developments.

The survey obtained for these locations was included in the updated model topography. Figure 3 shows the 2005 base case model topography.

The model roughness used is shown in figure 4. This roughness map has been updated to include the new developments.

Cardno Lawson Treloar Pty Ltd ABN 55 001 882 87

Figures 5 and 6 show the maximum predicted water surface elevation and depth for the 100 year ARI Goulburn dominant event respectively from the SOBEK model with 2005 topography.

PROPOSED DEVELOPMENT

To represent the development area in the hydraulic model, the grid cells within the ODP area shown in Figure 1 were raised above the 100 year ARI flood level.

The resulting maximum water-surface elevations for the 100-year ARI event were compared to that produced for the existing conditions. This showed that by developing the ODP area, water levels on properties to the east of the ODP would increase. As this effect is unacceptable, mitigation options were investigated to minimise the impact the ODP would have on flood flows and levels in the surrounding areas.

These mitigation options consisted of a series of floodways through the development. Some of these floodways could be roads, with others being designated floodways.

The following features have been modified in the area. Figure 7 shows the location of these.

- The channel to the west of the development has been deepened by up to 1.6 metres over a width of approximately 25 metres along the centre of the channel.
- The channel that runs through the centre of the development has been deepened up to 3.1 metres. This channel was also widened by approximately 50 metres.
- A series of roads (labelled A-H on Figure 7) has been used to convey floodwater through the development from east to west, with the water ultimately flowing into the west channel.
- The north-south road running through the centre of the development.
- A floodway to the east of the development (North-South floodway).
- Removal of an existing house block (labelled 1) to assist with moving flood water through the ODP site.
- Five additional floodways (labelled 2-6) to allow flow through to the roads and the North-South floodway.

MODELLING RESULTS

The maximum water depths and maximum water surface elevations from the developed conditions model are shown in figures 8 and 9 respectively. The road and channel alterations proposed for the Mooroopna development have successfully prevented inundation of most properties around the development as shown in Figure 10. There is some increase in water levels shown in the existing areas, but this is mostly limited to the road reserves.

The maximum flow and velocities for the roads and channels extracted from the hydraulic model are shown in Table 1.

Topographical Feature	Velocity (m/s)	Flow (m^3/s)
Road A	0.18	1.03
Road B	0.09	0.08
Road C	0.18	0.74
Road D	0.25	1.40
Road E	0.25	1.38
Road F	0.36	2.00
Road G	0.31	2.83
Road H	0.37	4.76
Channel - West	0.63	70.36
Channel - Centre	0.62	72.86
North-South Road	0.23	3.37
North-South Floodway	0.65	18.1
Floodway 1	0.05	2.9
Floodway 2	0.07	2.39
Floodway 3	0.11	1.48
Floodway 4	0.06	1.1
Floodway 5	0.04	0.5
Floodway 6	0.03	0.3

Table 1: *Results from the Hydraulic Model*

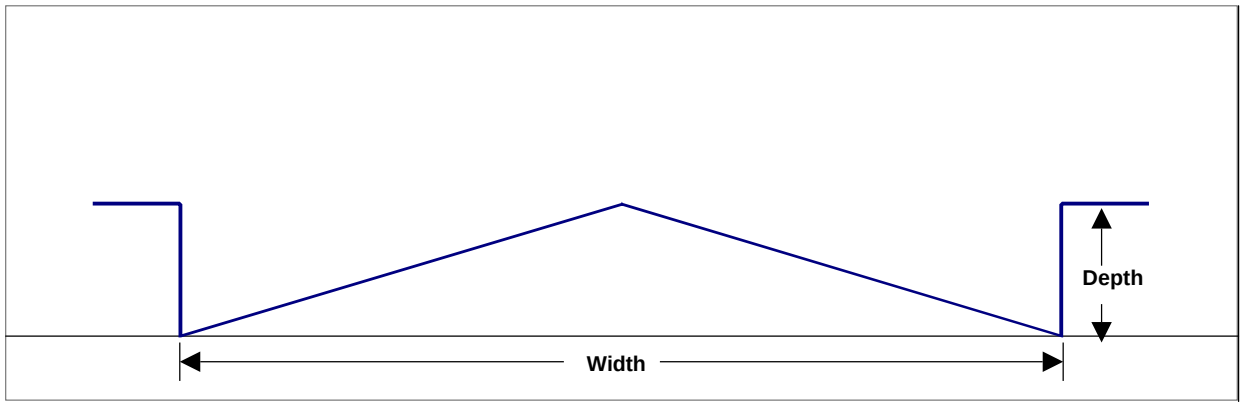
To ensure that the floodwater is confined to the roadways, the required area of the roadway cross-section needs to be calculated. This information can be obtained by utilising the resultant flows and velocities from table 1.

	Depth	Width
Road A	0.50	22.94
Road B	0.11	15.31
Road C	0.30	26.88
Road D	0.50	22.50
Road E	0.47	23.45
Road F	0.50	22.28
Road G	0.50	36.31
Road H	0.50	51.71

Table 2: *Roadway Design Details*

Figure 11 below shows a typical road cross-section.

Figure 11: Typical Road Cross-Section



Given that the discharges through the floodways (labeled 1 – 6 on figure 7) are relatively small, several options are available including, pipes or overland floodways. There is a requirement for offsite works (locations 1-6) in order to get the development to work. The actual configuration of these will need to be determined in consultation with local land owners.

CONCLUSIONS & RECOMMENDATIONS

The information in this letter report will be provided to Maunsell Australia to assist in the preparation of the full ODP investigation.

The design presented in this report is conceptual only. It is recommended that the final design be tested within the hydraulic model to ensure that the impacts on surrounding properties are as predicted.

If you have any queries or require additional information please contact us.

Yours faithfully

Melanie Dalton
Project Manager
for **Cardno Lawson Treloar**

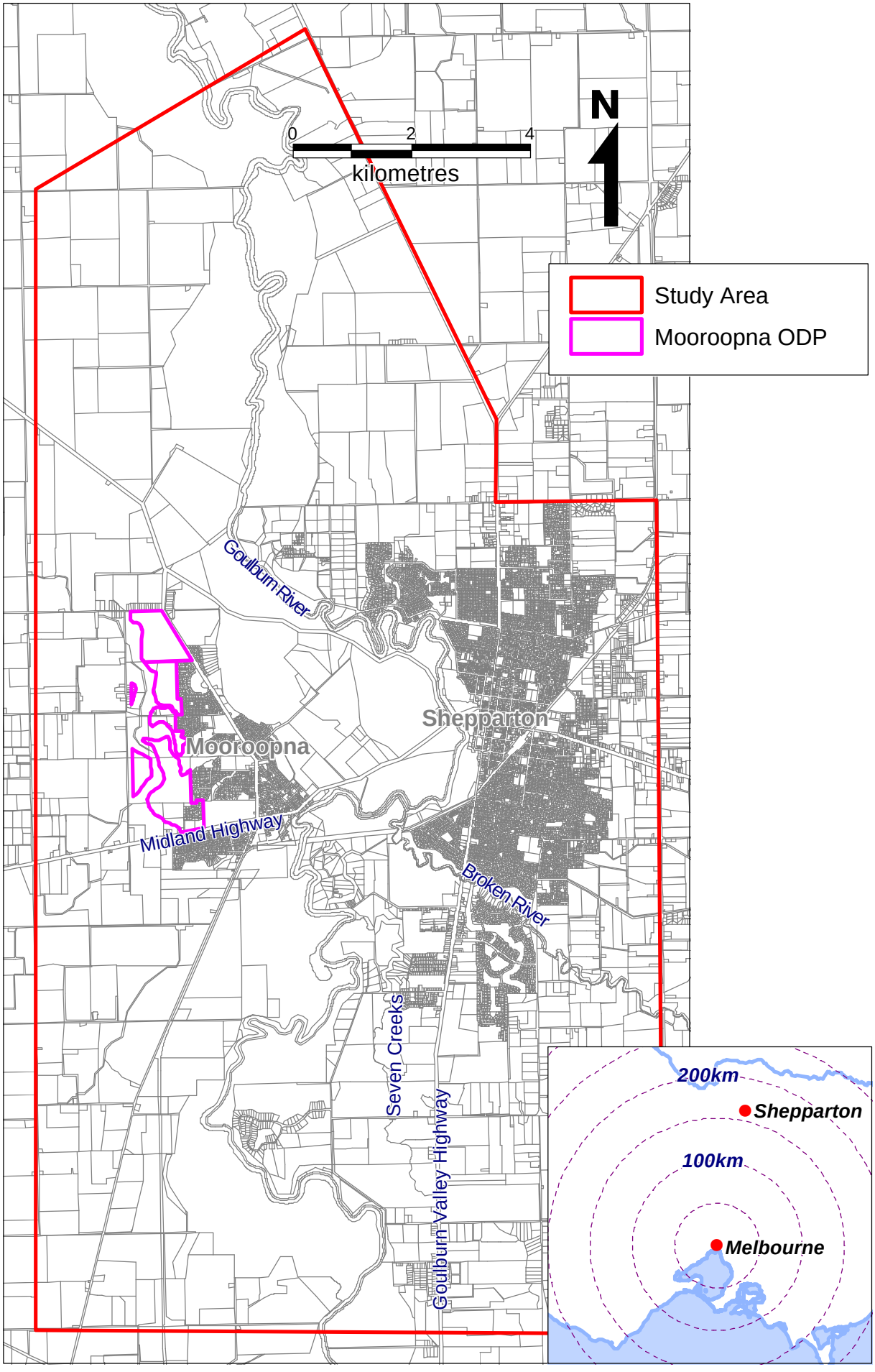


Figure 1 - Study Area and Mooroopna ODP

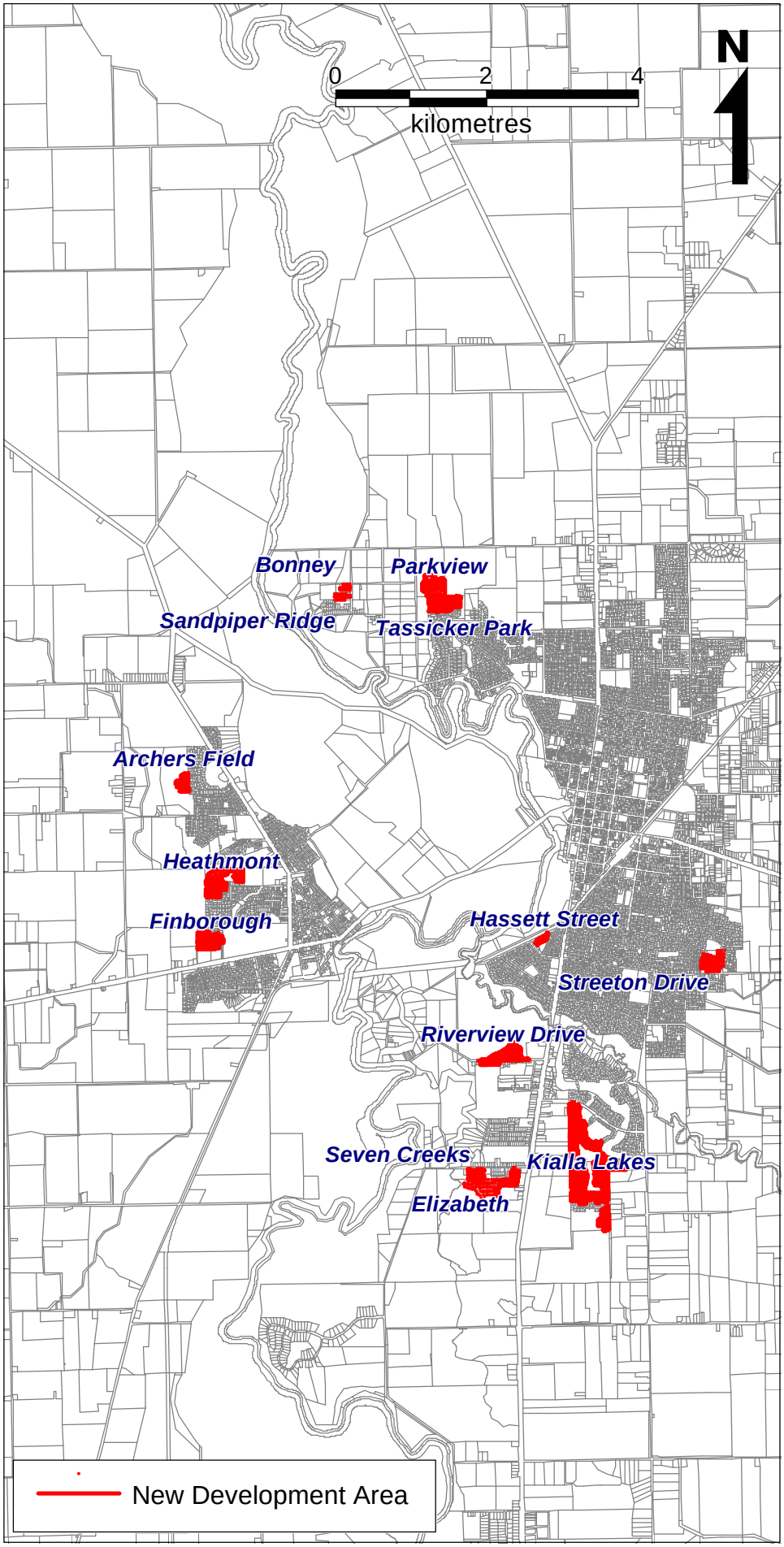


Figure 2 - Location of New Developments (2005 - 1999 Survey)

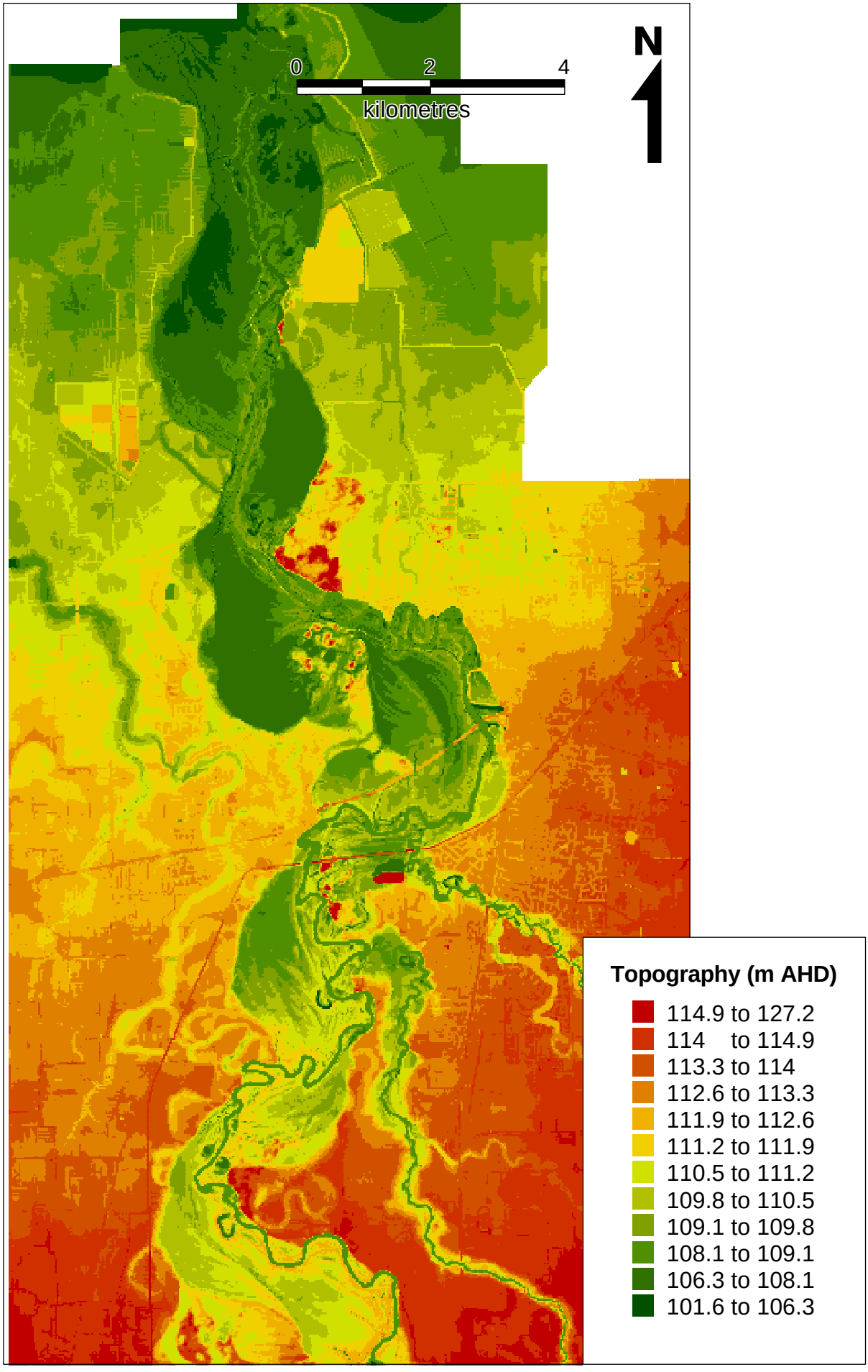


Figure 3 - Topography, 2005 Existing Conditions