Appendix C

Flood Assessment

Our Ref: 59914059-L02:BCP/bcp
Contact: Dr Brett C. Phillips

27th August 2014

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The Project Director
Health Infrastructure
c/- APP Corporation Pty Ltd
PO Box 2195
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Attention: Mr Peter Allen
Email: Peter.Allen@app.com.au

Dear Peter,

ADDITIONAL FLOODING ADVICE FOR PROPOSED ADDITIONAL ON-GRADE CAR PARK AT COFFS HARBOUR HEALTH CAMPUS

On 19 December 2013, Cardno prepared a preliminary assessment of the flooding impact of the concept on-grade car park for the Coffs Harbour Health Campus.

Health Infrastructure decided subsequently to proceed with the design to finalise the Scheme and prepare suitable DA documentation.

As part of this process an assessment of the flood impacts on the proposal including work on the proposed upgraded access between Phil Hawthorne Drive and the campus was commissioned. The upgraded access track was to be assessed in terms of flood safety and impacts on flood behaviour. i.e. that the proposal:

a) is compatible with the flood hazard of the land, and
b) is not likely to significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties, and
c) incorporates appropriate measures to manage risk to life from flood, and
d) is not likely to significantly adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses,
e) is not likely to result in unsustainable social and economic costs to the community as a consequence of flooding.

1. PREVIOUS ASSESSMENT

An assessment of the flooding impact of a concept on-grade car park for the Coffs Harbour Health Campus was detailed in our letter report dated 19 December 2014.

It was concluded from a comparison of the Existing and Future Conditions results that the planned car park development has:

- Nil adverse impact on 20 yr ARI flood levels on the floodplain;
- A small local impact of up to 0.02 m and nil impact elsewhere on the floodplain in the 100 yr ARI event.
- Negligible impact on 20 yr ARI flood depths, velocities, velocity x depth and provisional flood hazard elsewhere on the floodplain;
- Locally increases the velocity in the drainage line along the western boundary of the proposed car park and negligible impacts elsewhere on the floodplain; and
- Negligible impact on the velocity x depth and provisional flood hazard elsewhere on the floodplain.

2. COUNCIL ADVICE

In response to a request for clarification of Council's flooding requirements for the proposed works, Council provided the following comments on 1 May 2014:

> *Councils guidelines for car parking are not particularly well defined. In councils 'Floodplain Development and Management Policy' it has guidelines for structures which is defined as buildings and 'Activity other than building' which covers car parks. The policy also references the 'Coffs Creek Floodplain Risk Management Study and Plan' that has a more detailed set of flood planning controls. Car parking is discussed here and it has car park level at the 1% AEP. This has proved problematic to achieve in already developed areas particularly where council does not want to encourage additional filling on the floodplain.*
>
> *The fairly recently developed medical centre adjacent to the hospital had the following in its DA approval 'Open car park have finished levels no lower than the predicted 20 year ARI flood level minus 300mm'.*
>
> *Council needs to review and clarify controls around car parking balancing impacts on flooding, normally associated with filling on the floodplain, and providing an appropriate level of flood protection. In completely green field sites council would be looking for car parking to be at the 1% AEP flood level.*
>
> *While the hospital car park is on a green field site it is for an existing development. Considering the car park as an extension of an existing development council would assess the car park flooding issues on merit. The closer the car park can get to the 1% AEP flood level the better while possible impacts to adjoining development needing to be minimised.*
>
> *Also there is an existing overland flow path between the main hospital block development and the School of Rural health and Radiology? Building that needs to be maintained that comes out near the NW corner of the car park site.*
>
> *So in response to your questions definitely need to assess the 100yr and 20yr flood events and provide some general overview comments on climate change and SLR – no modelling required. If there are significant impacts on adjoining developments in the 20 yr event smaller events may require modelling.*

I believe the car park is to extend nearly all the way to the existing channel to achieve a balance between risk and flood impacts the car park may need to be constructed at different levels say the northern portion might be at the 1% AEP flood level while the most southern portion might be at the 20% AEP flood level to minimise flood impacts. As stated above council will be assessing on merit.

3. OBJECTIVE

The objective of the study was to provide flooding advice for the proposed additional on-grade car park for Coffs Harbour Health Campus in accordance with the requirements identified by Council on 1 May 2014.

4. HYDRAULICS

The benchmark floodplain model assembled for the flood impact assessment reported on 19 December 2014 was updated to include existing drainage infrastructure that was surveyed prior to the design of upgraded access between Phil Hawthorne Drive and the campus.

4.1 Updated Benchmark Conditions

The estimated peak flood level contours for the 20 yr ARI 9 hour storm burst and 100 yr ARI 9 hour storm burst are given in **Figures 28** and **31** respectively.

4.2 Future Conditions

The Future Conditions were based on the proposed layout Stages 1 and 2 of Car Park supplied in May 2014 as identified in **Figure 27**.

The estimated peak flood level contours for the 20 yr ARI 9 hour storm burst and 100 yr ARI 9 hour storm burst are given in **Figures 29** and **32** respectively.

4.3 Climate Change

In October 2007 the then NSW Department of Environment and Climate Change (DECC) released a guideline titled “Practical Consideration of Climate Change”. As discussed in the guideline, climate change is expected to have adverse impacts upon sea levels and rainfall intensities, both of which may have significant influence on flood behaviour at specific locations.

Combining the relevant global and local information indicates that sea level rise on the NSW coast is expected to be in the range of 0.18 m to 0.91 m by between 2090 and 2100.

The site survey and the flood levels assessed in 2011 WMAwater Flood Study disclose that the site is sufficiently elevated such that flood of the site is not influenced by sea level rise.

DECC, 2007 recommends in part that the following sensitivity analyses are undertaken:

- Rainfall intensities. Increases of:
  - 10% in peak rainfall and storm volume
  - 20% in peak rainfall and storm volume
  - 30% in peak rainfall and storm volume

Previous hydrological and hydraulic assessments have identified the 9 hour storm burst as the critical storm burst for flooding in the vicinity of the site. Consequently an analysis of 9 hour rainfall intensity was undertaken to assess the indicative equivalent ARI of a 10%, 20% or 30% increase in the 100 yr ARI rainfall intensity under current conditions. It was estimated that a 10%, 20% or 30% increase in the 100 yr ARI rainfall intensity under current conditions is broadly equivalent to a 180 yr ARI, 340 yr ARI and 500 yr ARI event respectively.

The indicative impact on 100 yr ARI flood levels in the east end of Main Hospital Building would be 0.08 m, 0.16 m or 0.2 m for 10%, 20% or 30% increases in the 100 yr ARI 9 hour rainfall intensity respectively. In comparison the increases in the vicinity of the car park for 30% increases in rainfall would be < 0.1 m.

5. FLOOD IMPACT ASSESSMENT

The impacts of the proposed car park development on the flood levels in the 20 yr ARI 9 hour storm burst and 100 yr ARI 9 hour storm burst are given in **Figures 30** and **33** respectively.

It will be noted that the May 2014 design creates a new flowpath between the existing car park and proposed car park with high impacts on 20 yr ARI and 100 yr ARI flood levels (see below for cause of this feature).

Elsewhere these proposed works have minimal impact on 20 yr ARI and 100 yr ARI flood levels.

Figures 34 and **35** provide a comparison of the existing terrain and proposed future (May 2014) terrain at Section X1. This comparison discloses that a new flowpath between the existing car park and proposed car park with high impacts on flood levels is caused by the access road which partially fills the current drain.

Subsequently the designers considered options to avoid these local adverse impacts and formulated an amended design which is given in **Figure 36.**

The significant filling in the north-west corner of the car park which caused the adverse local impacts is disclosed in **Figure 37**.

The comparison of the amended design and the existing terrain given in **Figure 38** discloses that the July 2014 layout eliminates the impact of adverse local impact.

Figure 39 discloses where major changes in level have occurred.

It is concluded that the July 2015 configuration overcomes the adverse local impacts of the May 2014 layout and that overall the proposed design will have a minimal impact on 20 yr ARI and 100 yr ARI flood levels.

Yours faithfully

Brett C. Phillips

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Dr Brett C. Phillips
Director, Water Engineering
for **Cardno**

Figure 27 Layout of Car Park Stage 1 and Stage 2 (May 2014)

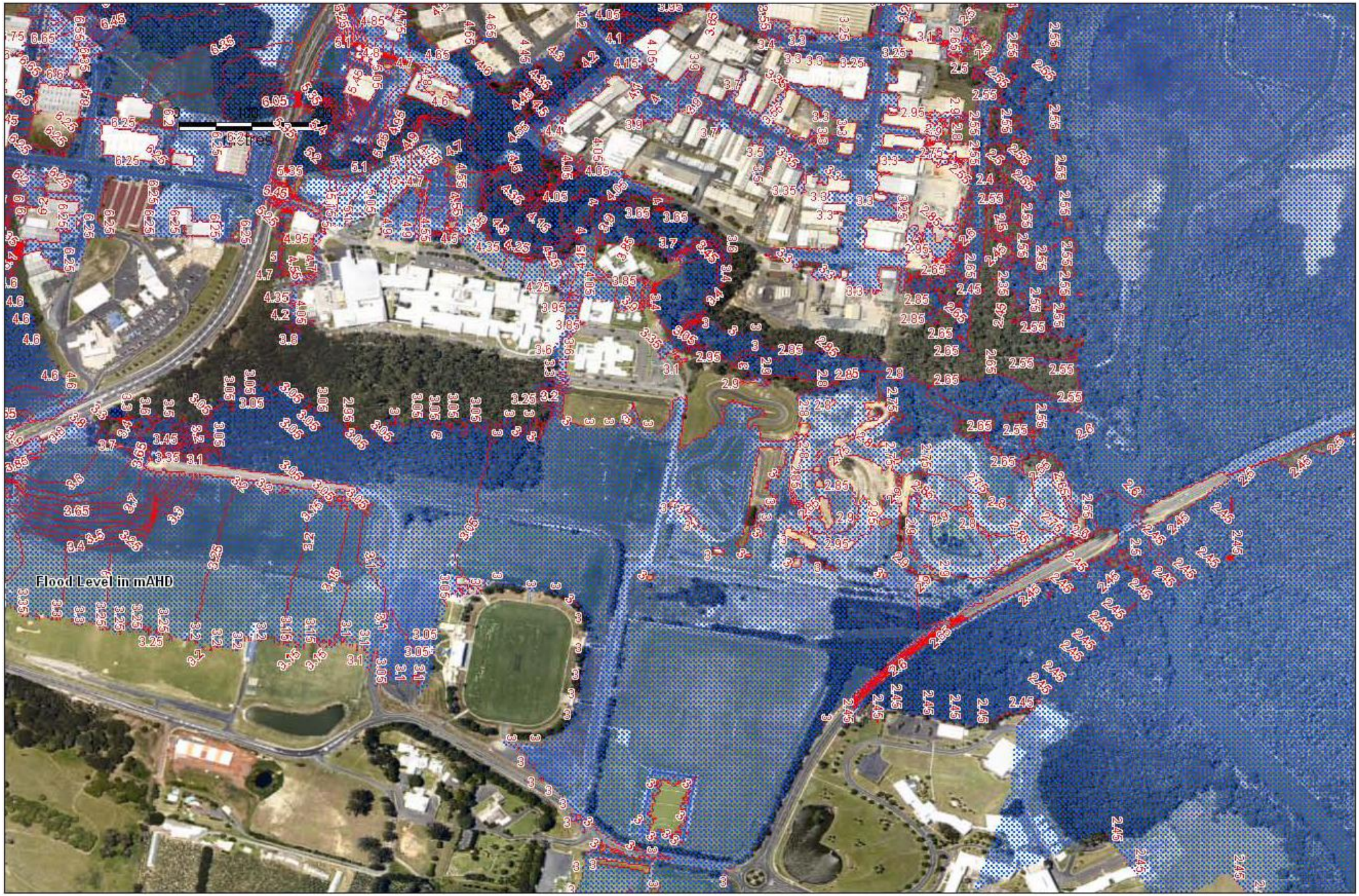

Figure 28 20 yr ARI Flood Level Contours – Existing Conditions with Phil Hawthorne Road Drainage

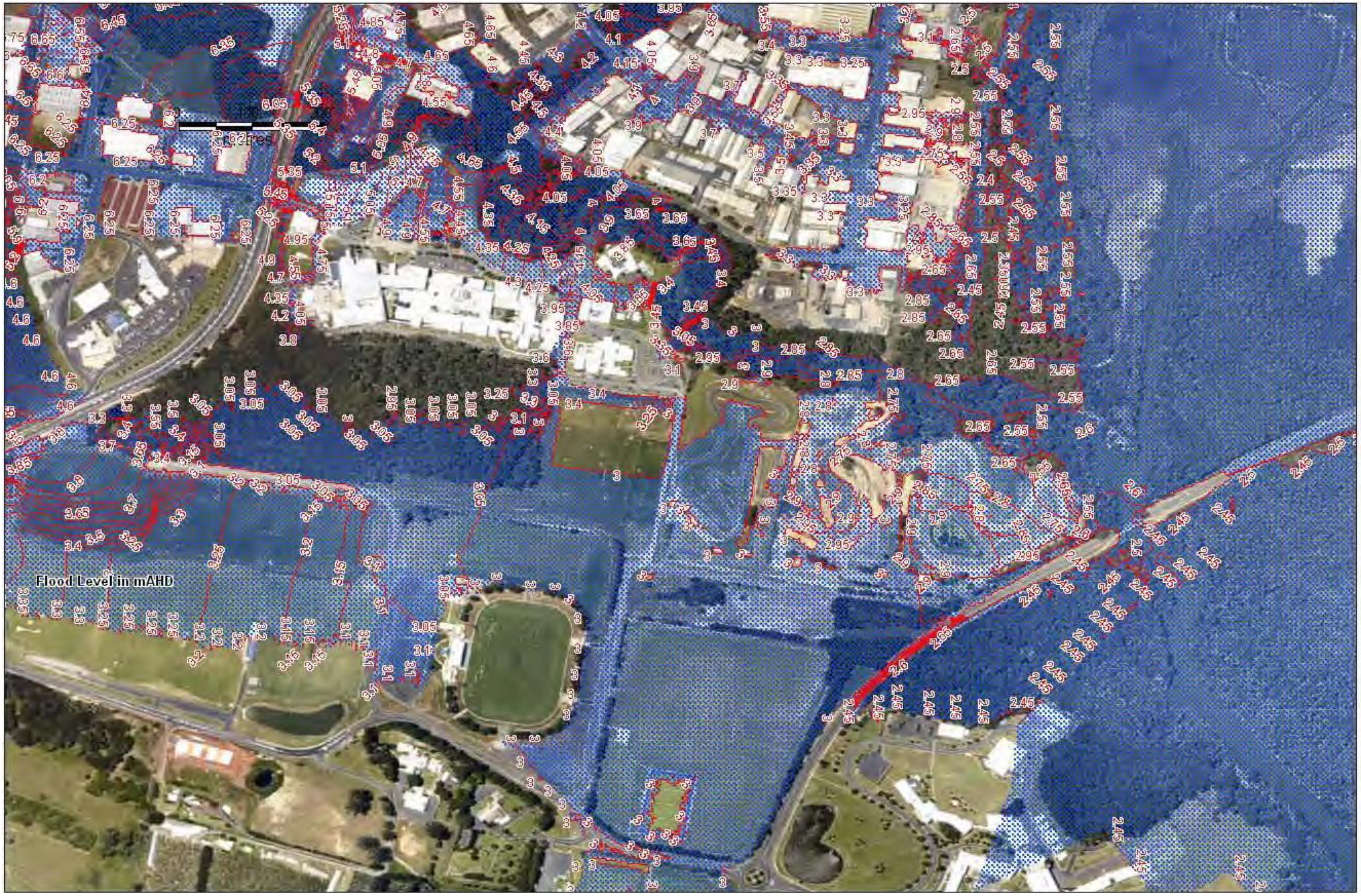

Figure 29 20 yr ARI Flood Level Contours – Future Conditions

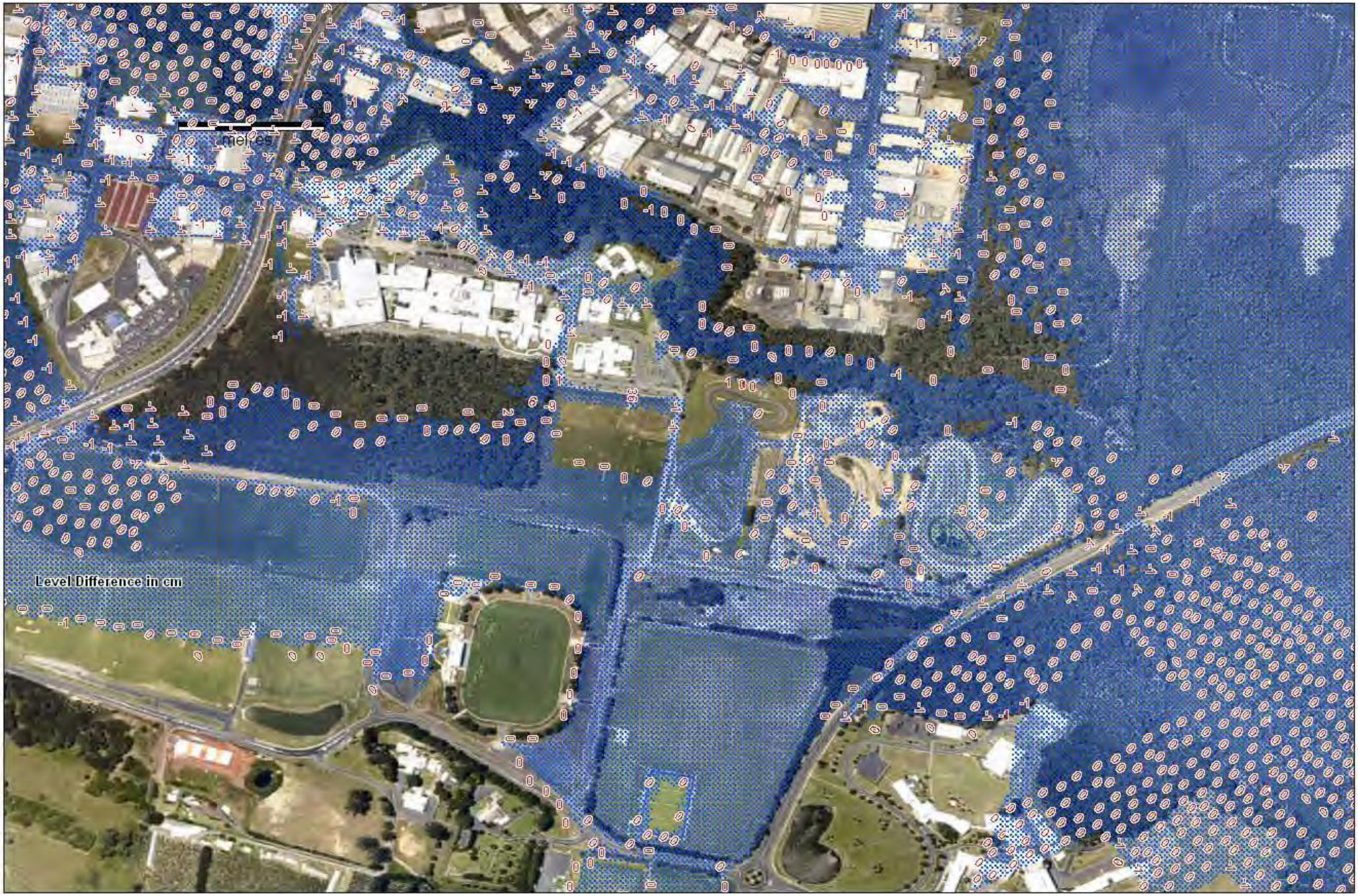

Figure 30 20 yr ARI Flood Level Differences - Future less Existing Conditions

Figure 31 1000 yr ARI Flood Level Contours – Existing Conditions with Phil Hawthorne Road Drainage

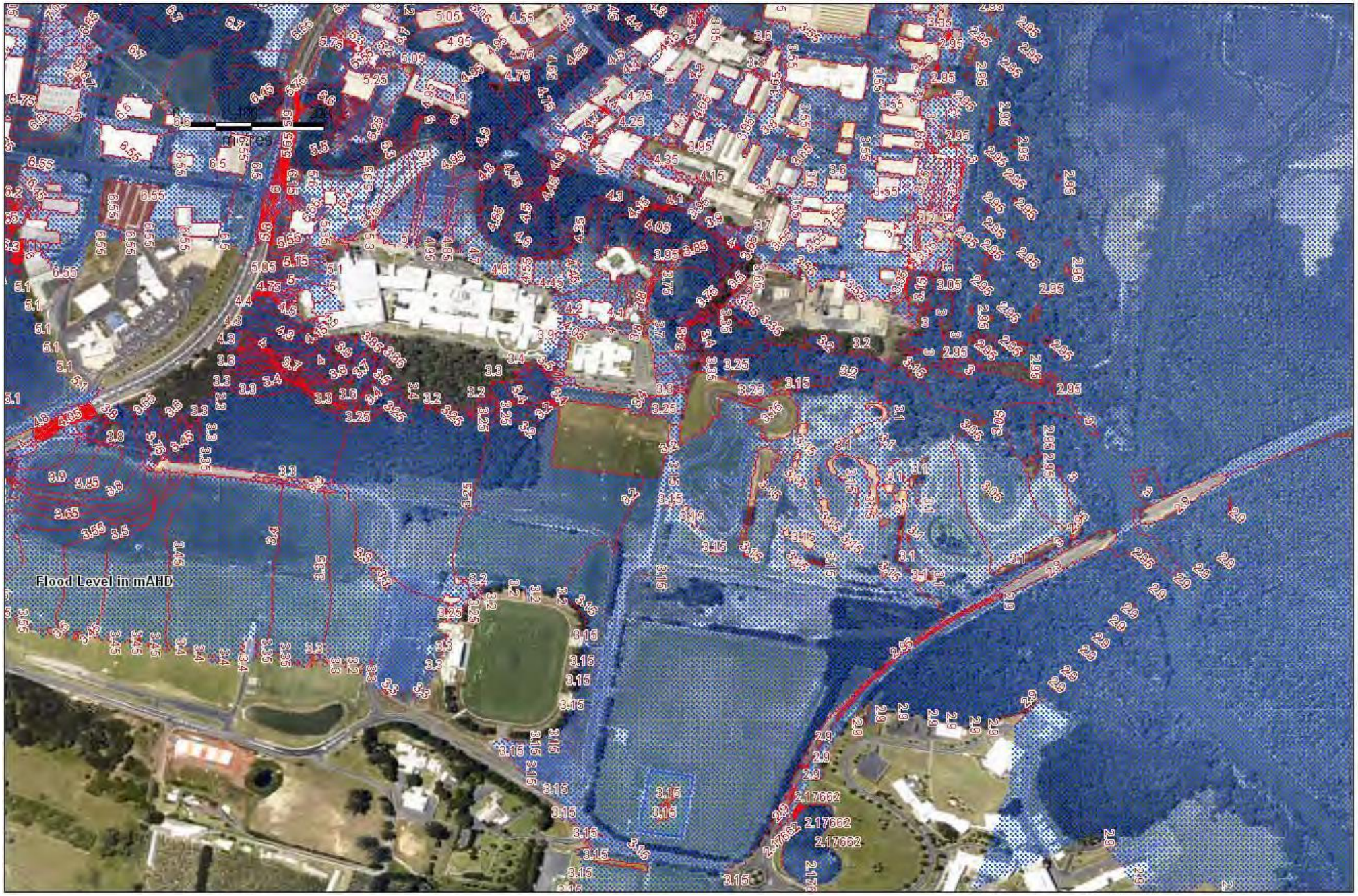

Figure 32 100 yr ARI Flood Level Contours – Future Conditions

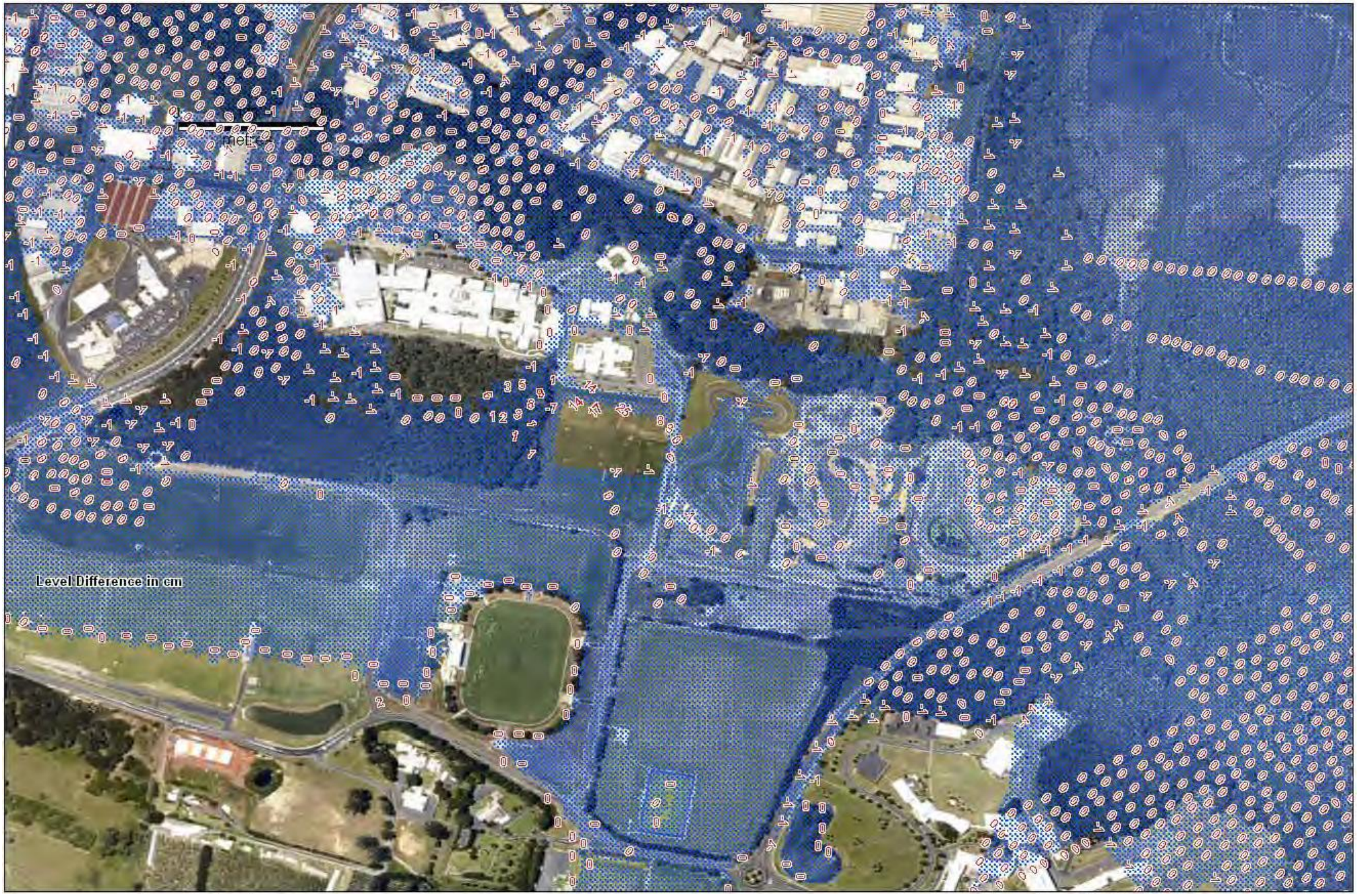

Figure 33 100 yr ARI Flood Level Differences - Future less Existing Conditions

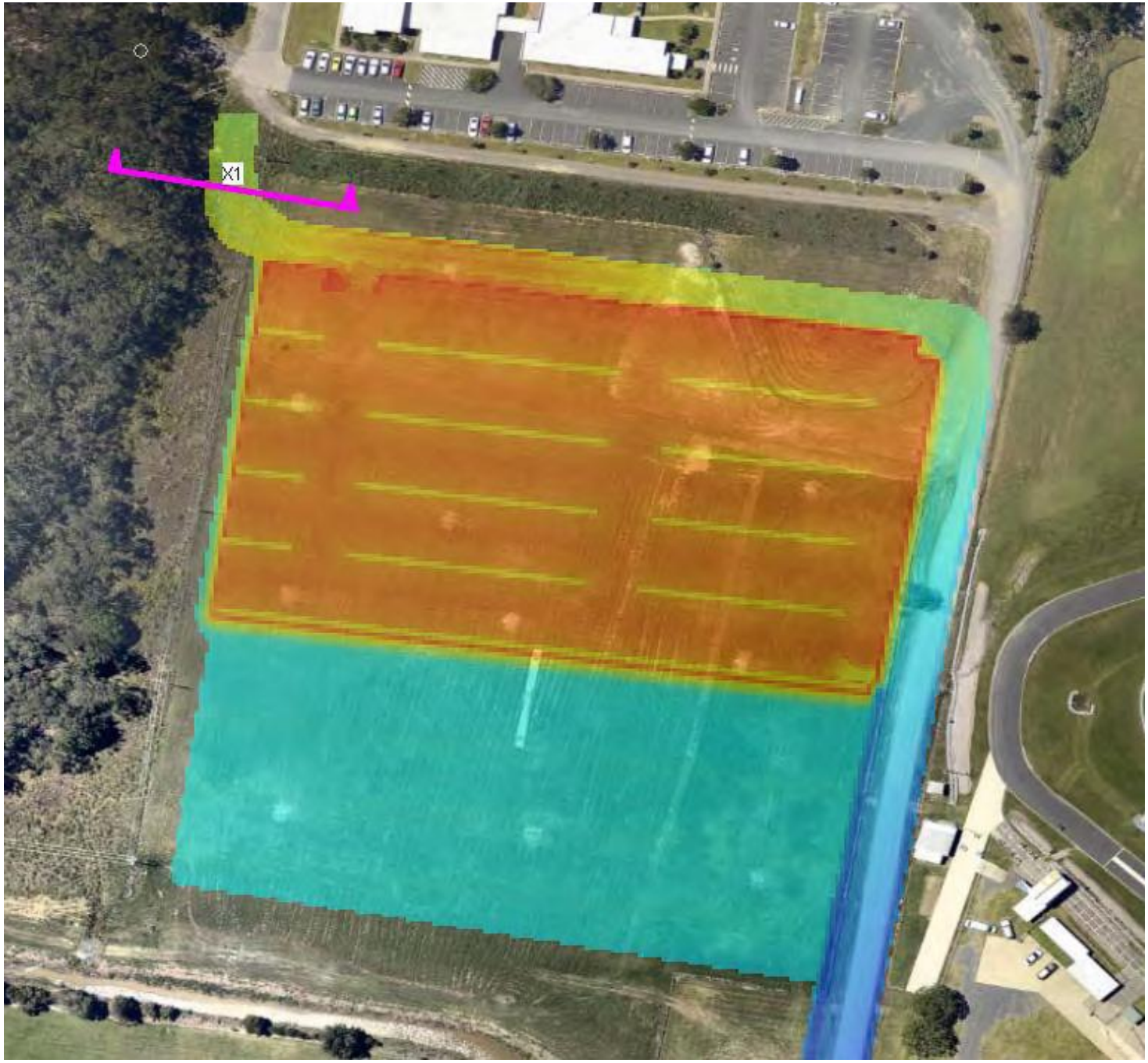

Figure 34 Location of Reference Section

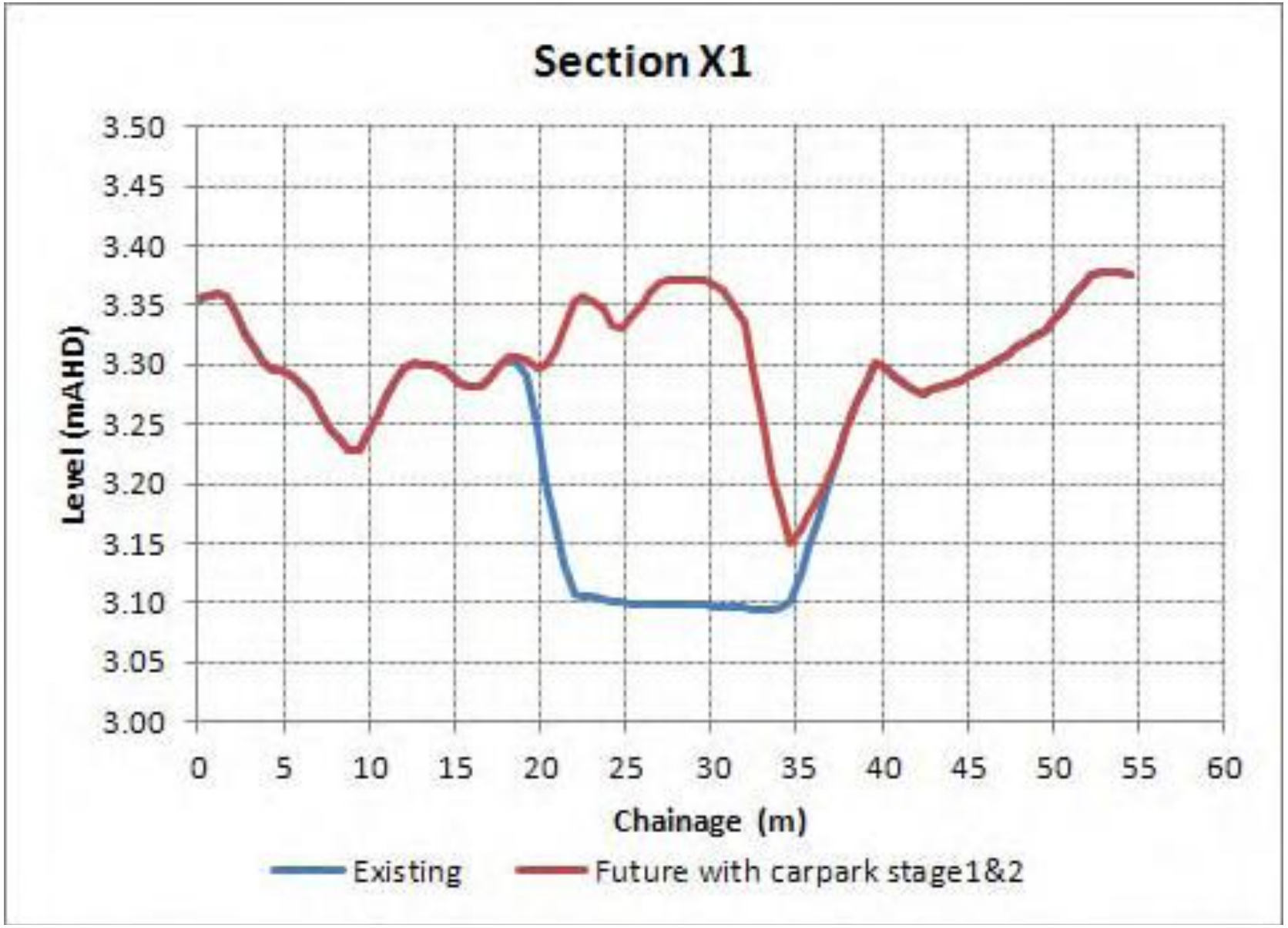

Figure 35 Comparison of Existing and Future Ground Level along Section X1

Figure 26 Layout of Car Park Stage 1 and Stage 2 (July 2014)

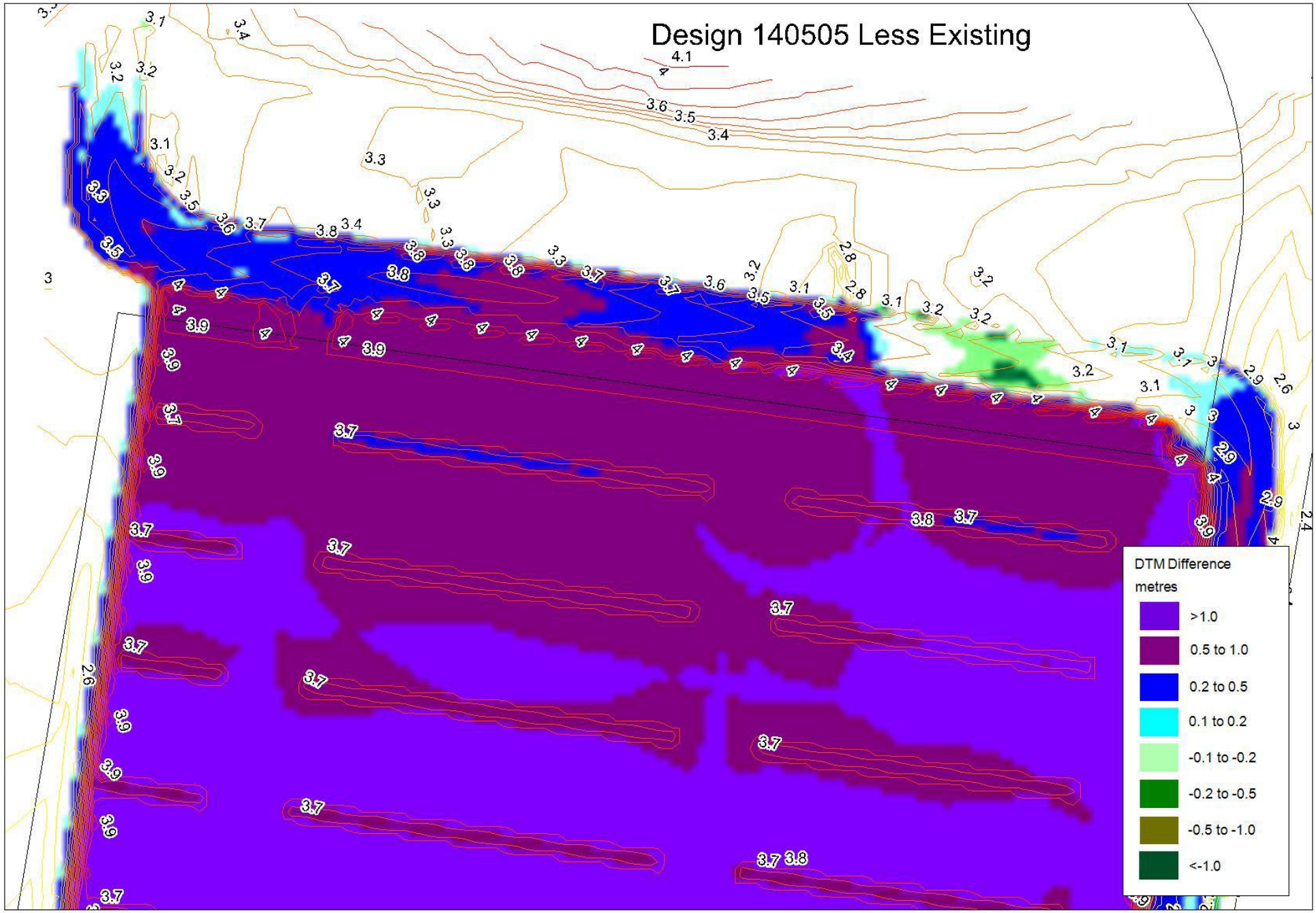

Figure 37 Ground Level Differences – Future (May) less Existing Conditions

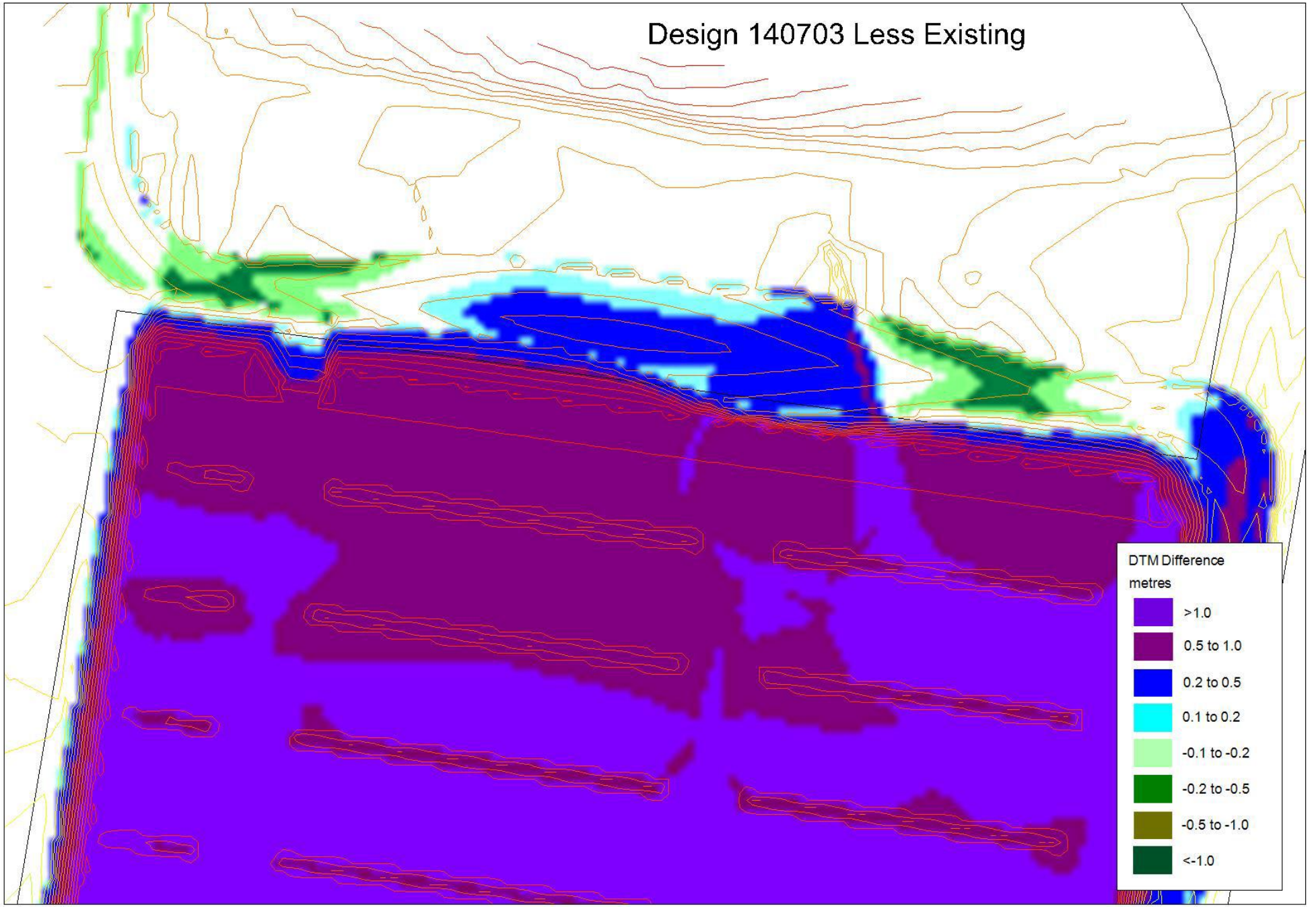

Figure 38 Ground Level Differences – Future (July) less Existing Conditions

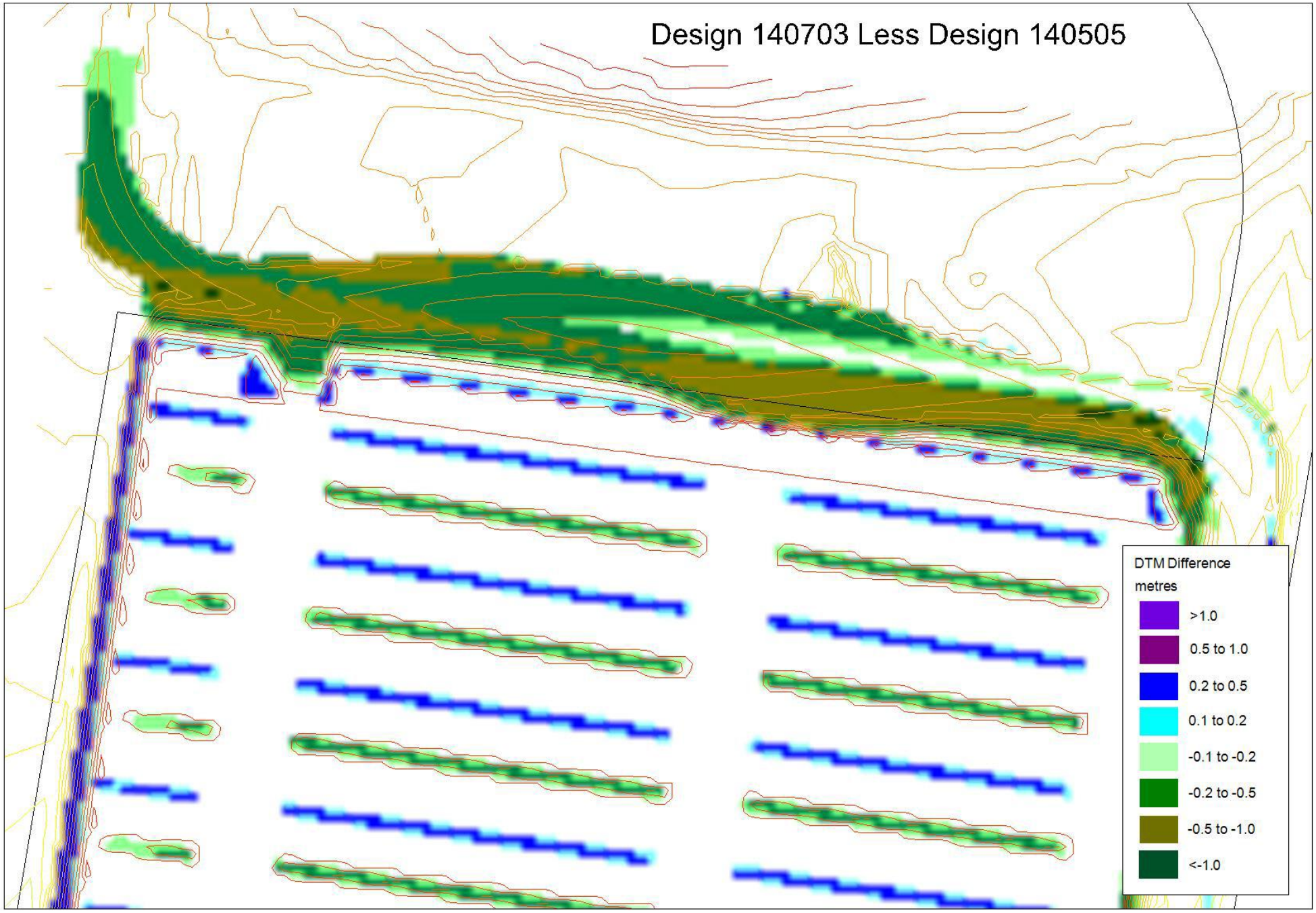

Figure 39 Ground Level Differences – Future (July) less Future (May)