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RE: Further Details (as requested) of POST DEVELOPMENT Flood Level Assessment Lot 100 & Lot1 Wyalla Rd Jamberoo

OVERVIEW:

As mentioned in the Addendum Report dated 28/05/2012 there were several terrain changes requested to be modelled to assess the impact on the interaction of the flood from the proposed development.

The details were not provided in the form of detailed design drawings with finished surface level contours. Instead the focus was on the impact on flood behaviour on the site and upstream and downstream of the site. Hence the cross sections are not final design cross sections but rather cross sections that would clearly identify the interaction of flooding on the development site. (Final post developed levels will be established at the DA design stage.)

In order to facilitate discussion about the changes and impacts of proposed terrain changes associated with the proposed development the following diagram is provided that shows a stream reference line with cross sections at 100m spacings.

This addendum report provides a further 46 figures with explanations to provide details of the flood behaviour pre and post development.

The end results shows that looking at various options incorporating terrain changes onsite the development site can be made flood free in both the 100 year and PMF events without adversely impacting adjoining properties upstream or down stream. Further this can be accomplished without impacting adjoining properties local flow or drainage flow paths.

It should be noted that this document is not a Subdivision DESIGN report its aim is to report on the FLOOD impact of undertaking certain works on site to make the site

flood free. The final DESIGN of the subdivision layout and earthworks are yet to be completed.

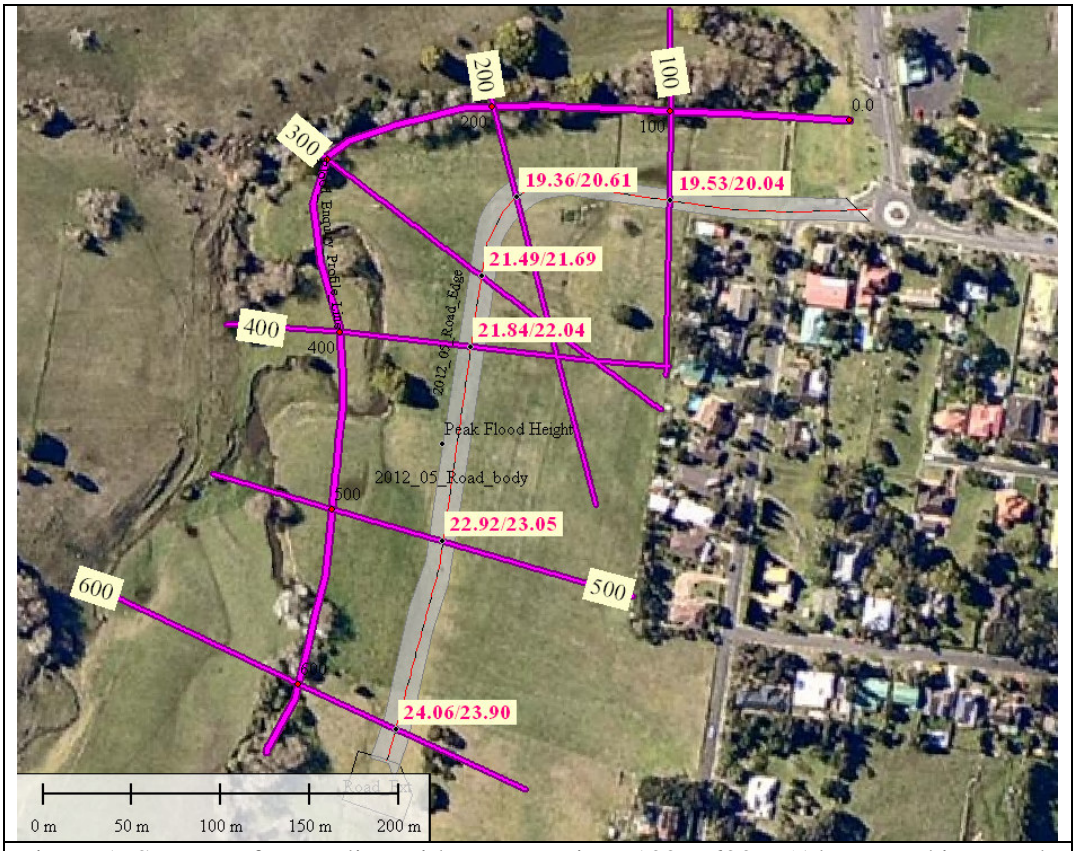


Figure 1. Stream reference line with cross sections 100 – 600m (Also note thin re and black line, being the centre line of the proposed roadway) (Showing existing/proposed levels in Pink, eg: 19.36/20.61 shows a 1.26m change in terrain level).

In order to compare flood impacts the first issue to establish is the existing flood levels.

That is the flood levels that exist on the site prior to any terrain changes.

EXISTING Q100 FLOOD LEVELS: (Without any development or terrain changes)

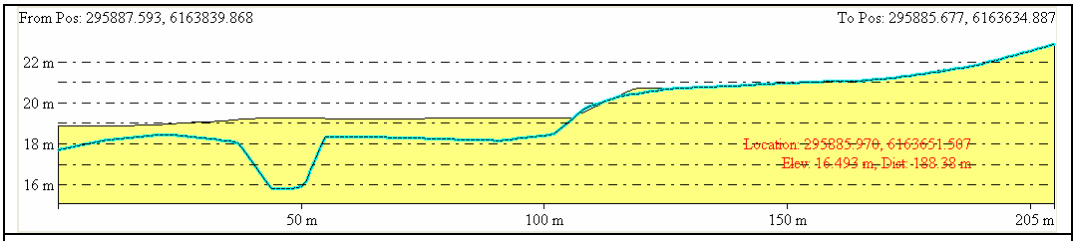


Figure 2. CROSS SECTION 100 Existing Q100 Flood level

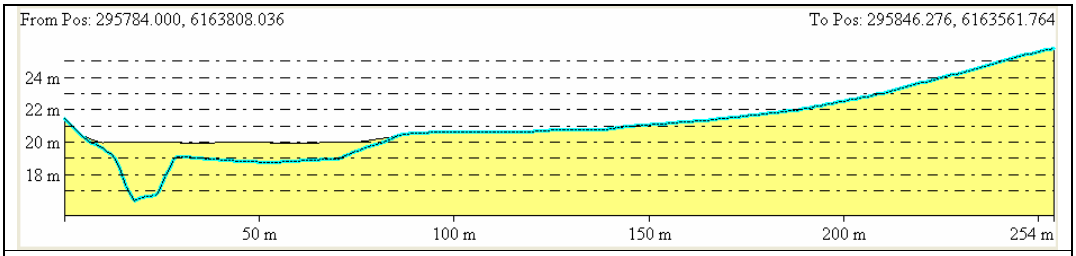


Figure 3. CROSS SECTION 200 Existing Q100 Flood level

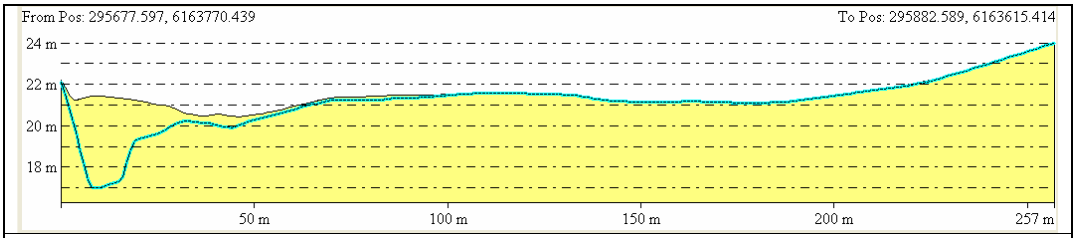


Figure 4. CROSS SECTION 300 Existing Q100 Flood level

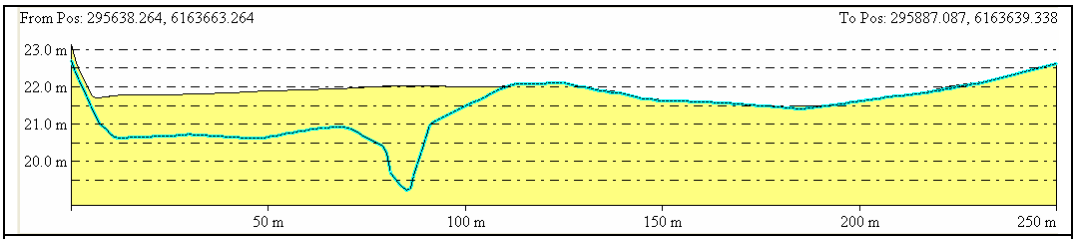


Figure 5. CROSS SECTION 400 Existing Q100 Flood level

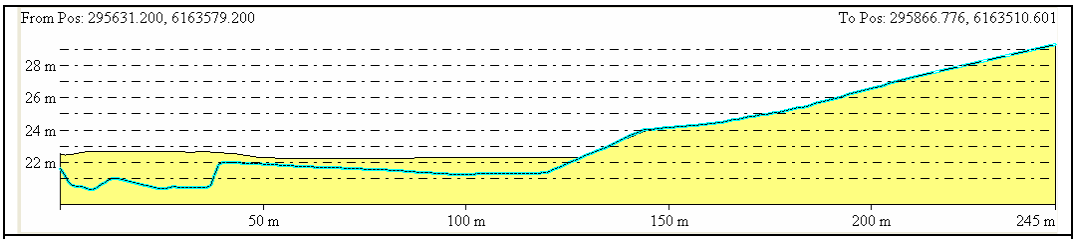


Figure 6. CROSS SECTION 500 Existing Q100 Flood level

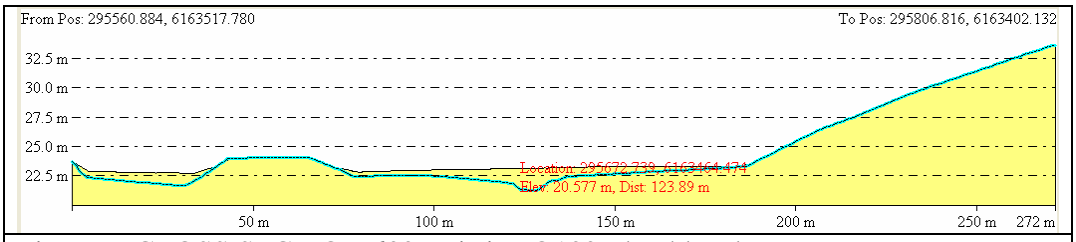


Figure 7. CROSS SECTION 600 Existing Q100 Flood level

EXISTING QPMF FLOOD LEVELS (Without any development or terrain changes)

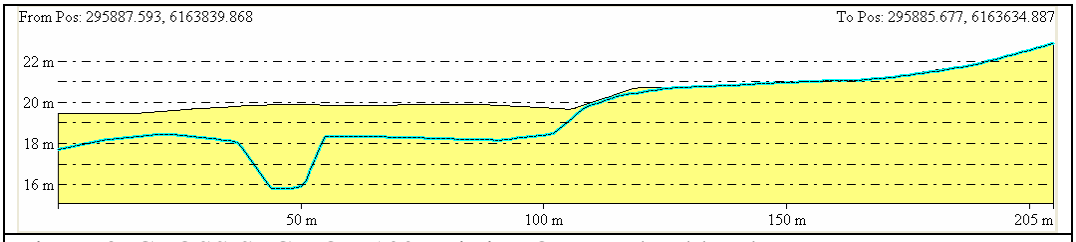


Figure 8. CROSS SECTION 100 Existing QPMF Flood level

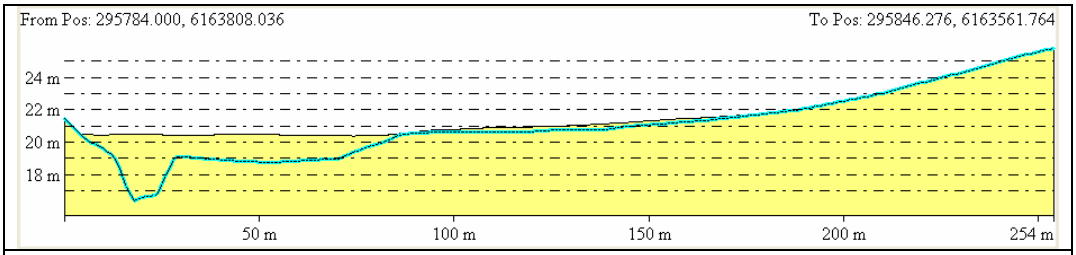


Figure 9. CROSS SECTION 200 Existing QPMF Flood level

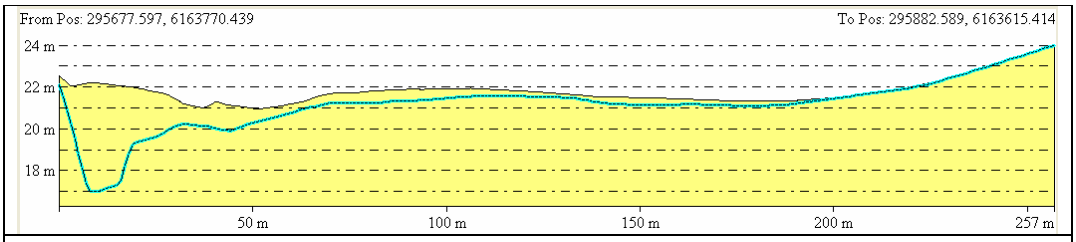


Figure 10. CROSS SECTION 300 Existing QPMF Flood level

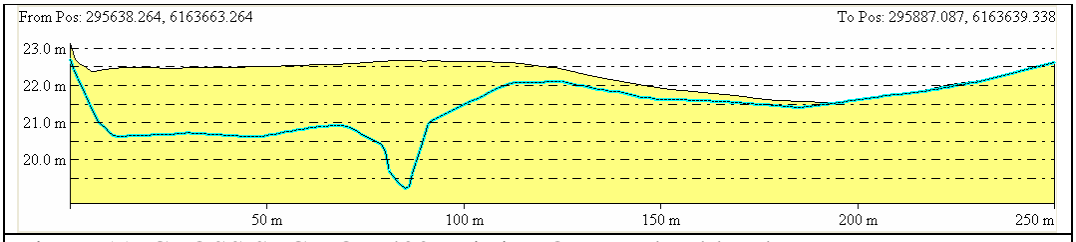


Figure 11. CROSS SECTION 400 Existing QPMF Flood level

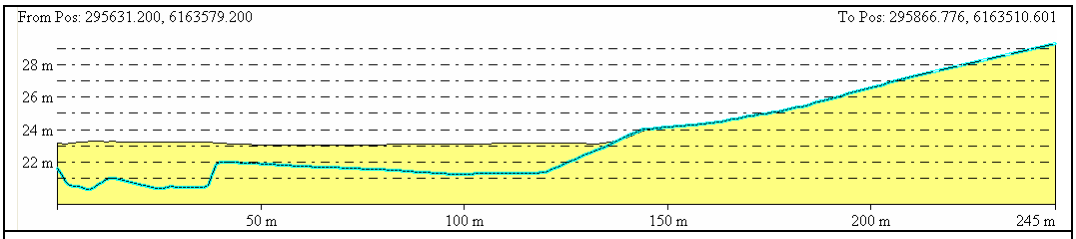


Figure 12. CROSS SECTION 500 Existing QPMF Flood level

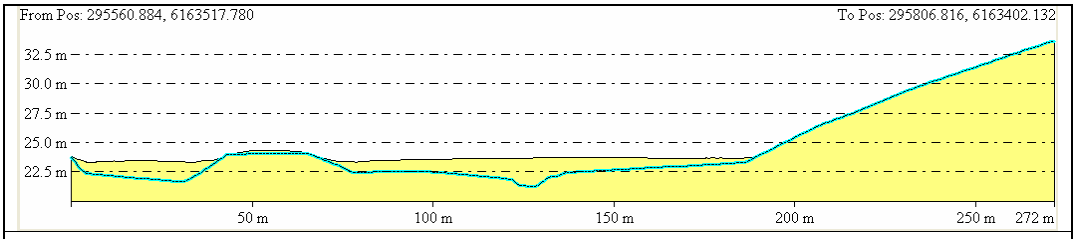


Figure 13. CROSS SECTION 600 Existing QPMF Flood level

TERRAIN CHANGE 1:

The first terrain change provided the roadway vertical alignment, and minor filling of low spots on lots, such as in remnant gullies.
The extent of cut and fill is shown:

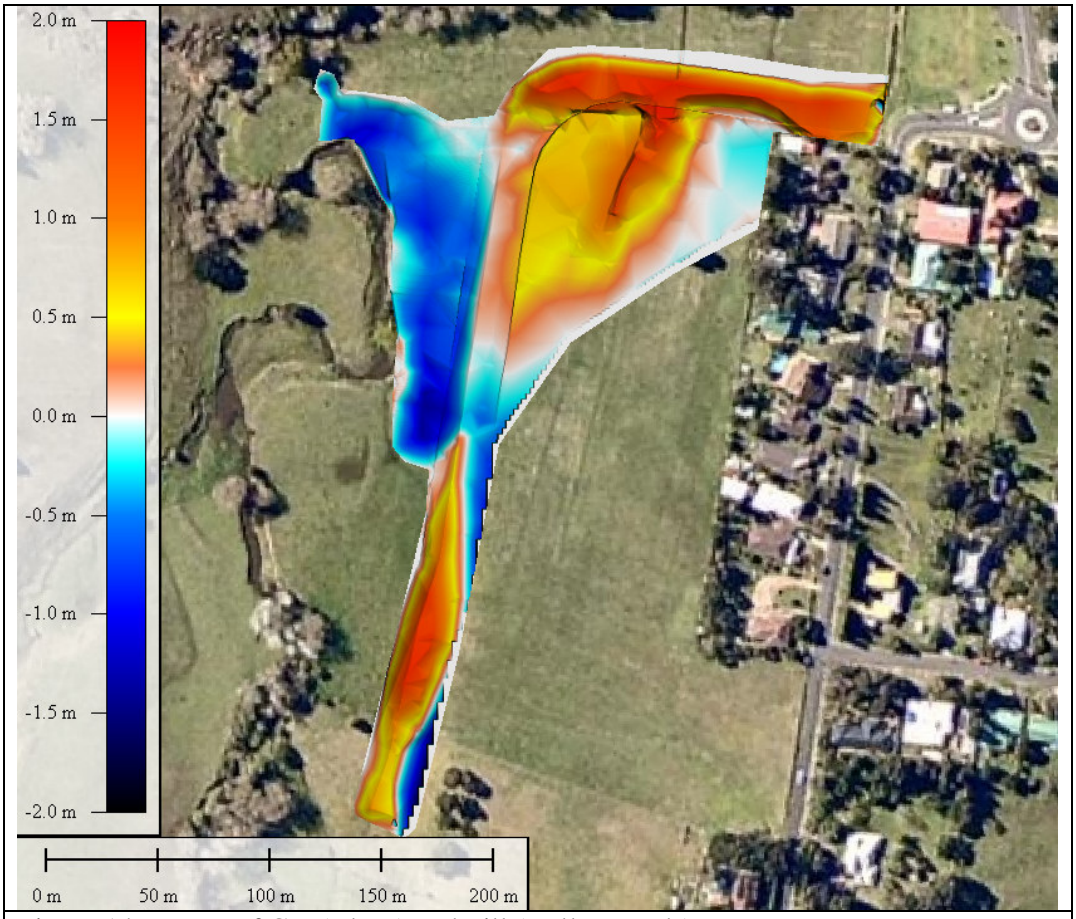


Figure 14. Extent of Cut (Blues) and Fill (Yellow-Reds)

Most of the fill areas on future proposed lots are around 0.5-0.6m except for a small remnant gully which has fill depths to a maximum of 1.7m. The cut areas are generally west of the roadway and are on average around 0.5m with localised humps and bumps being removed to a maximum of 1.1m. Filling (and minor cut) along the roadway centreline is shown in the following figure. Note there are two areas of fill along the roadway (in the north and south).

The following shows the existing terrain and proposed roadway centreline levels.

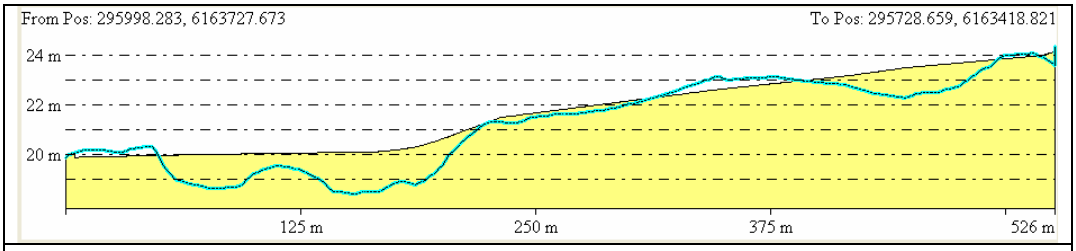


Figure 15. Changes to terrain to create roadway levels along proposed roadway centreline (Existing=Blue, Proposed = Yellow)

Position of roadway centreline is as shown below:

Figure 16. Proposed Roadway Centreline

The impact of this terrain change at (Stream) cross sections is shown as follows: Where the existing terrain is blue and proposed is yellow.

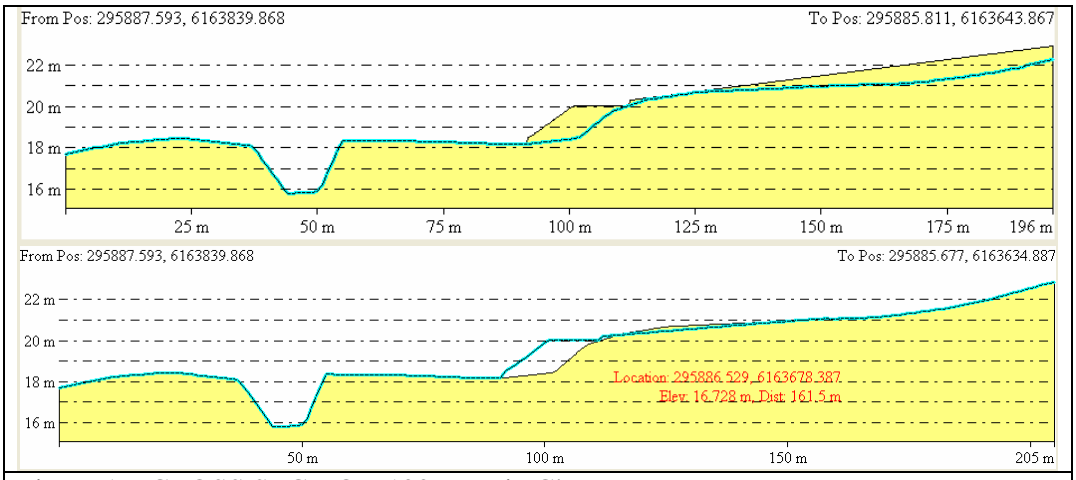


Figure 17. CROSS SECTION 100 Terrain Change

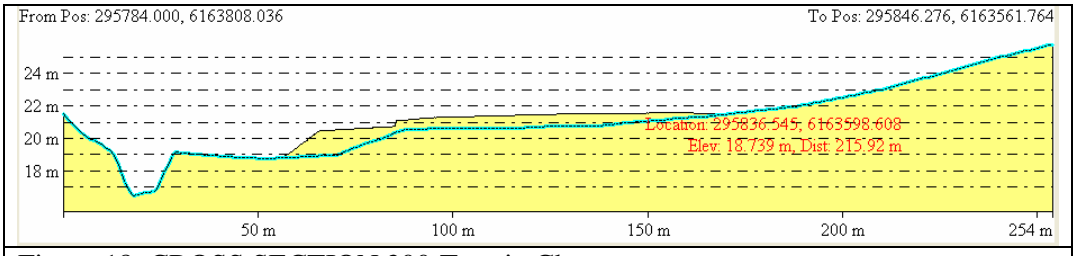


Figure 18. CROSS SECTION 200 Terrain Change

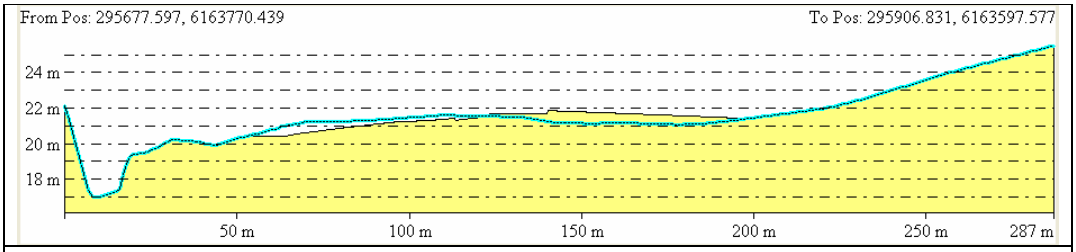


Figure 19. CROSS SECTION 300 Terrain Change

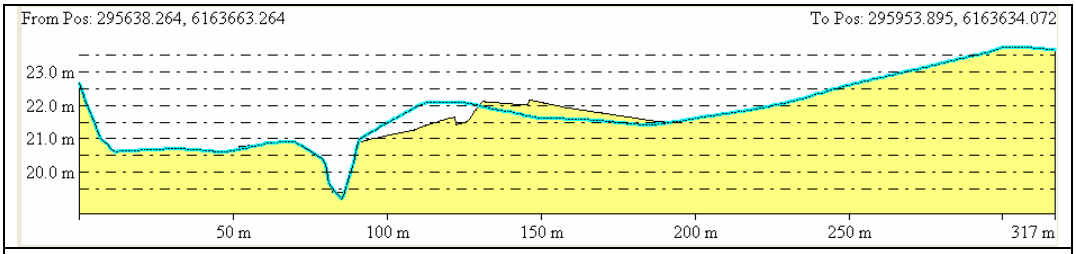


Figure 20. CROSS SECTION 400 Terrain Change

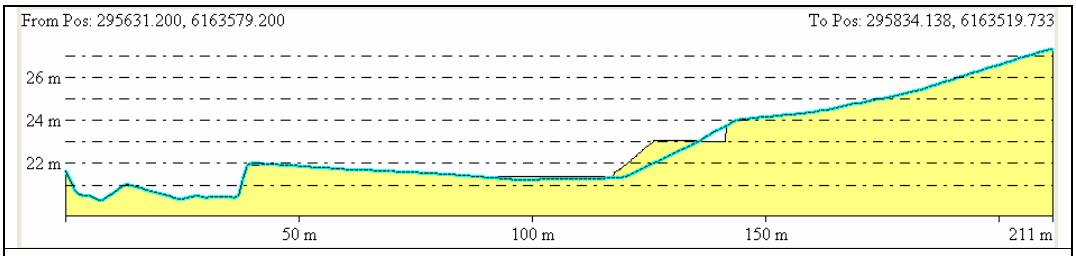


Figure 21. CROSS SECTION 500 Terrain Change

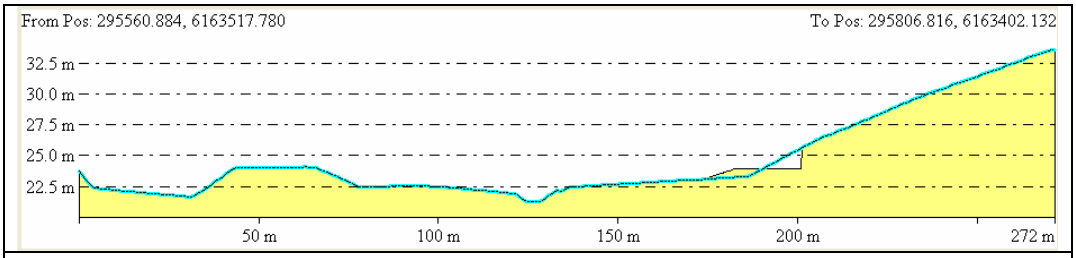


Figure 22. CROSS SECTION 600 Terrain Change

TERRAIN CHANGE 1:- IMPACT ON FLOODING.
Adjusting the terrain and re-running the flood model allows for a comparison of flood levels. In comparing the existing flooding (blue lines below) to the flood level resulting from terrain changes (yellow filled area) it is clear the only perceivable impacts are a general lowering of flood levels locally within the site.
There are no impacts up stream or downstream of the site.

Q100:

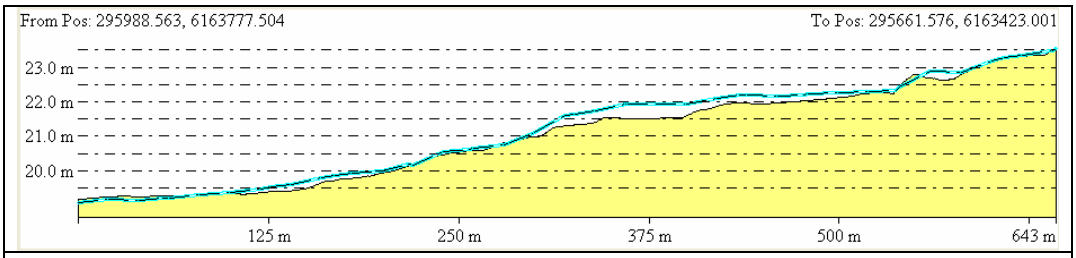


Figure 23. Q100 Existing and Terrain Change Flood Profile

Looking at each cross section with the changed terrain shown (blue lines) and the resulting Q100 flood levels (filled yellow), it is clear that the Q100 does not impact the proposed development.

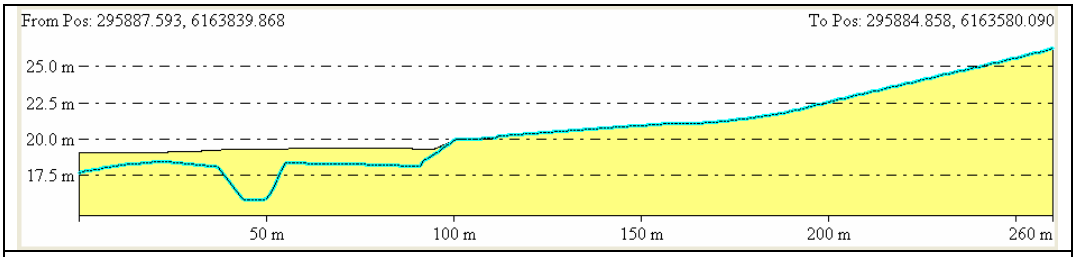


Figure 24. CROSS SECTION 100 Terrain Change Q100 Flood Level

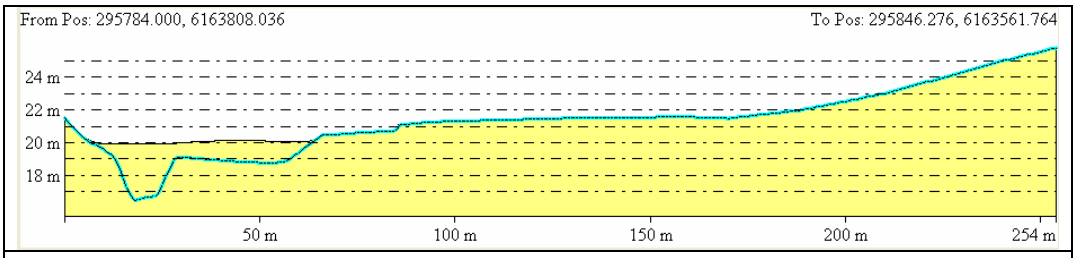


Figure 25. CROSS SECTION 200 Terrain Change Q100 Flood Level

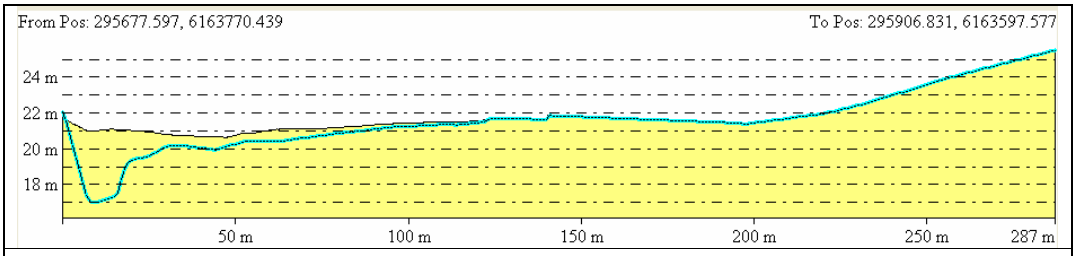


Figure 26. CROSS SECTION 300 Terrain Change Q100 Flood Level

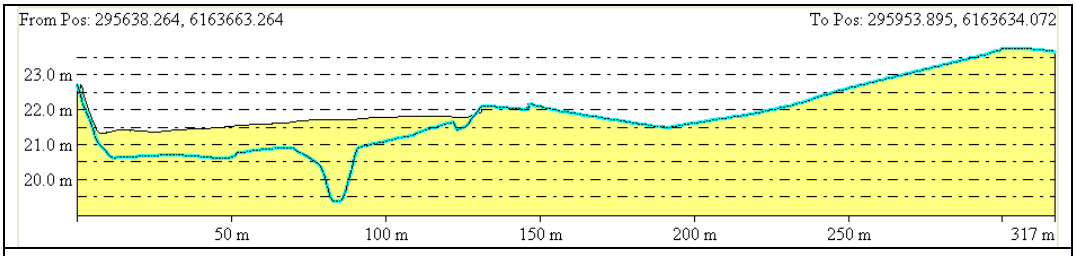


Figure 26. CROSS SECTION 400 Terrain Change Q100 Flood Level

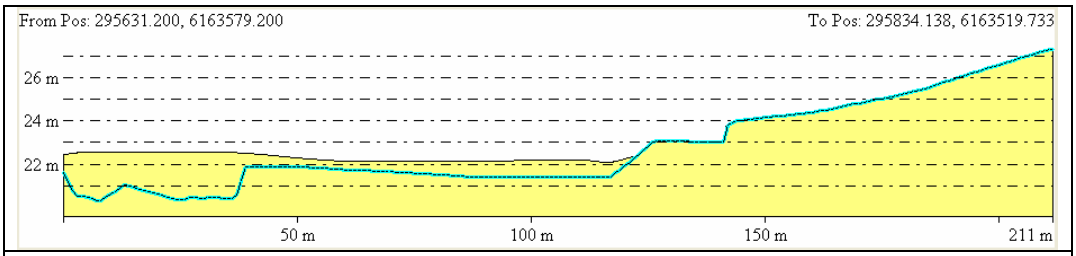


Figure 27. CROSS SECTION 500 Terrain Change Q100 Flood Level

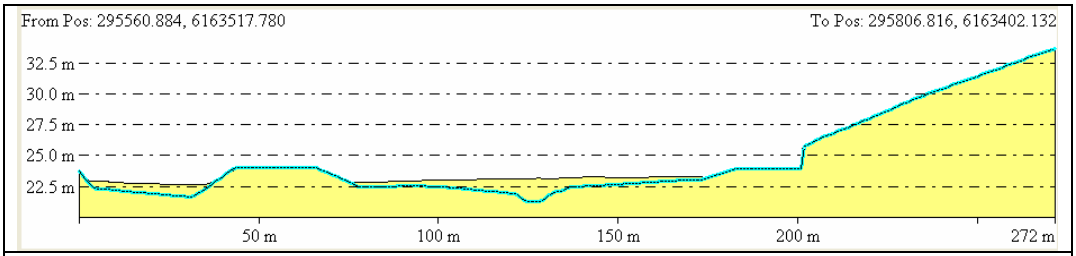


Figure 28. CROSS SECTION 600 Terrain Change Q100 Flood Level

TERRAIN CHANGE 1 IMPACT ON FLOODING:
QPMF:
The PMF flood profile results in a localised increase and a larger localised decrease along the stream. Once again both up stream and down stream there is no impact.

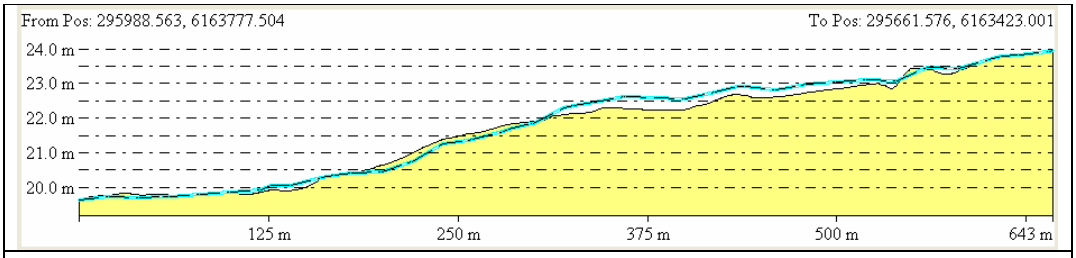


Figure 29. PMF Existing and Terrain Change Flood Profile

As shown in the Report, although the Q100 is contained without impacting the development, the same is not true for the PMF event.

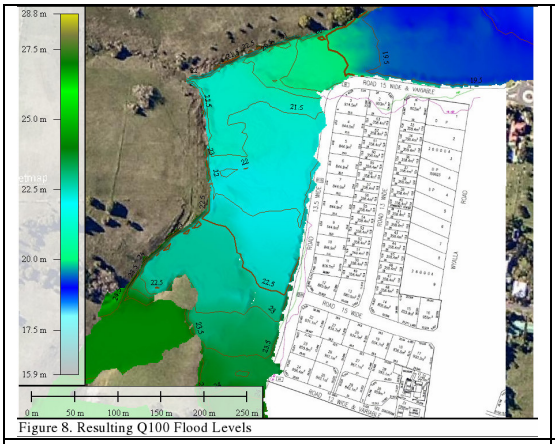


Figure 30. Q100 after Terrain Change 1

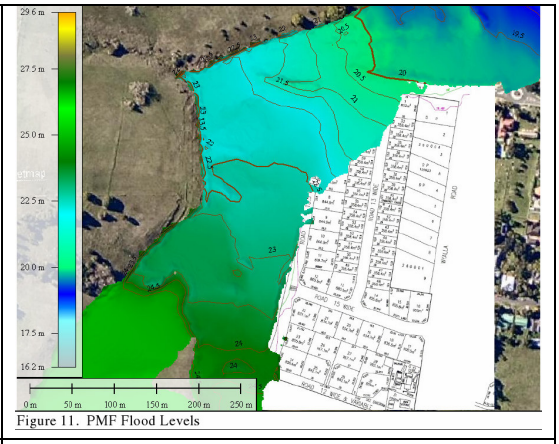


Figure 31. QPMF after terrain change 1

It was requested (by the proponents) to raise the terrain levels (on the lots) to ensure the PMF event did not impact those lots shown impacted. Hence an arbitrary terrain increase was applied to the lots only. The roadway remained as designed as the focus is to remove the PMF from the lots. The roadway is already flood free in the Q100. Inundation of the roadway during a PMF is not seen as a significant issue.

TERRAIN CHANGE 2:

The change to the terrain was not a rigorous design resulting in final design surface but rather a way of determining whether or not filling the lots would adversely impact flow behaviour.

A comparison of the initial terrain change to the additional arbitrary change is shown below: (Note that no additional filling has occurred on the roadway, it is only an arbitrary amount of fill to force the PMF off the lots, so as to assess the impact on flow behaviour.)

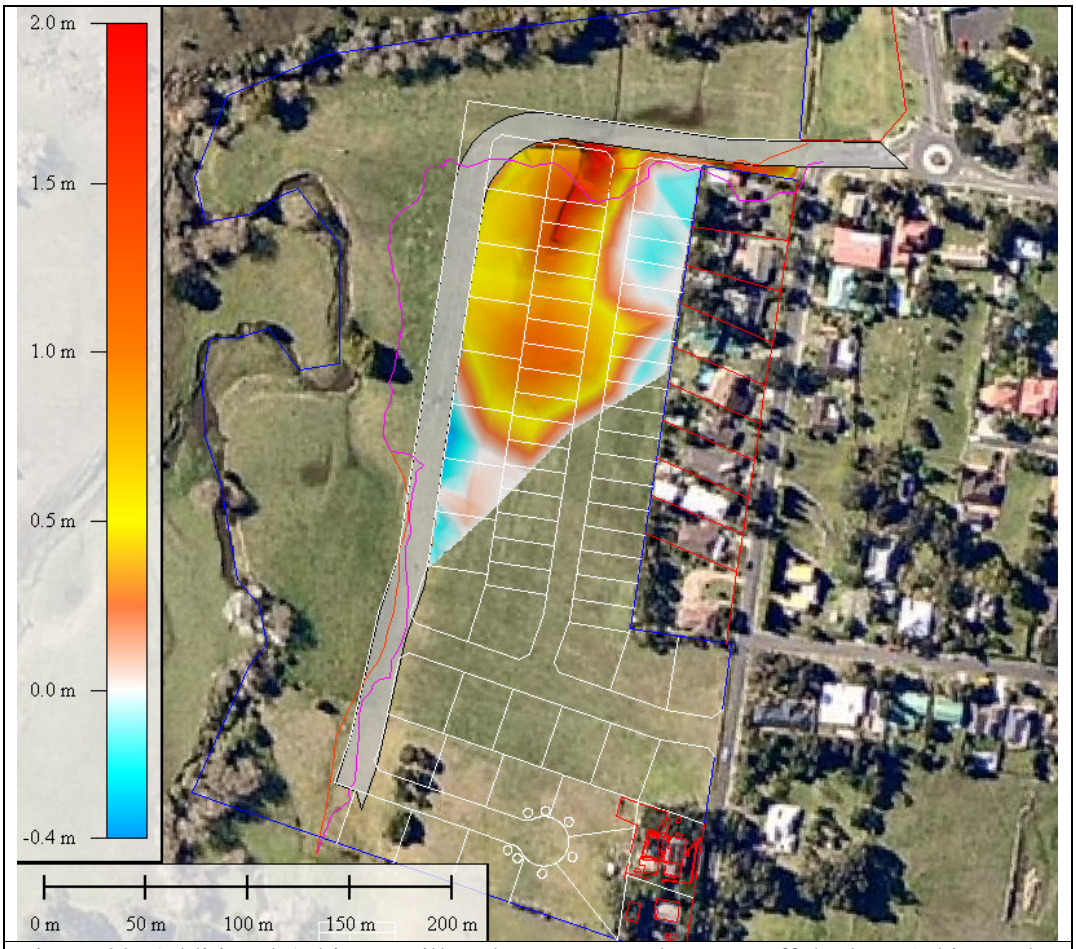


Figure 32. Additional Arbitrary Fill on lots to Force the PMF off the lots. (This need to be design in detail …)

Once again comparing the terrain with the influence of the additional filling on the cross sections:-

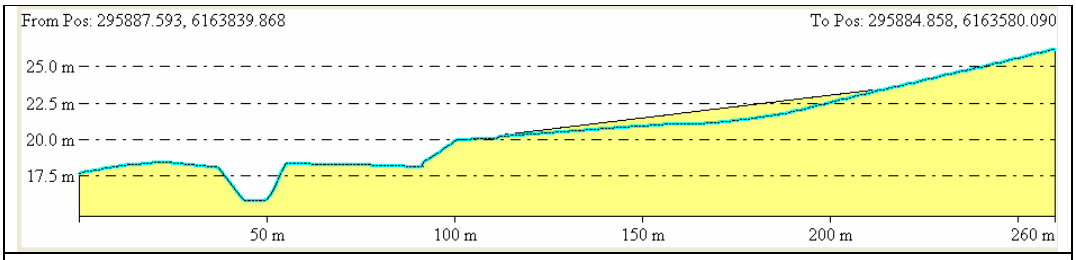


Figure 33. CROSS SECTION 100

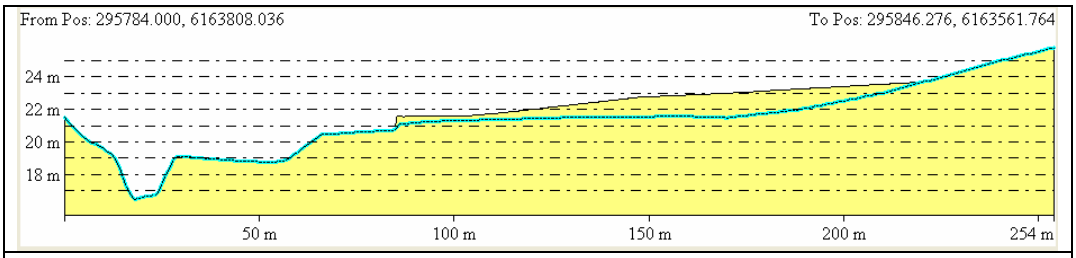


Figure 34. CROSS SECTION 200

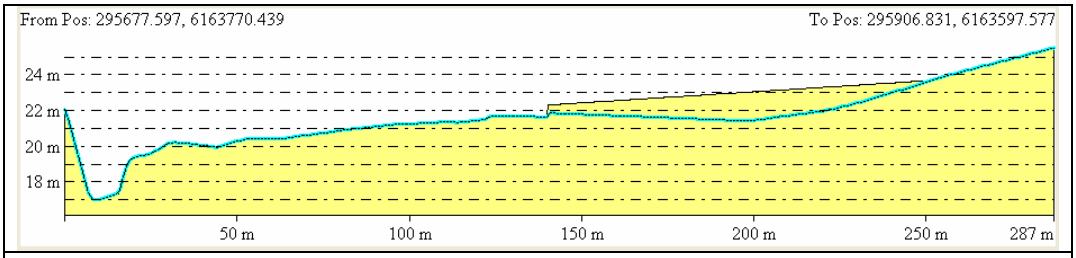


Figure 35. CROSS SECTION 300

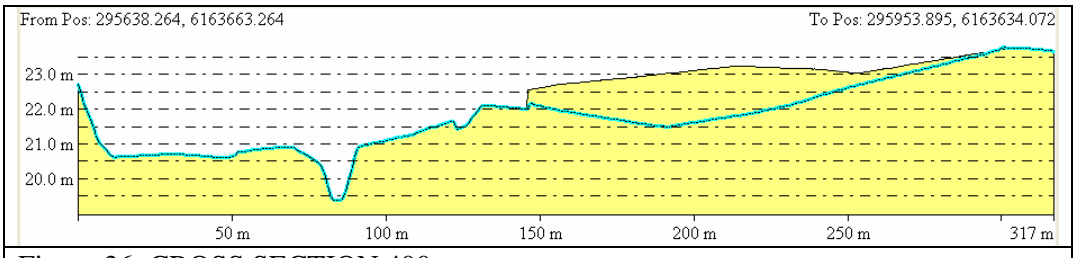


Figure 36. CROSS SECTION 400

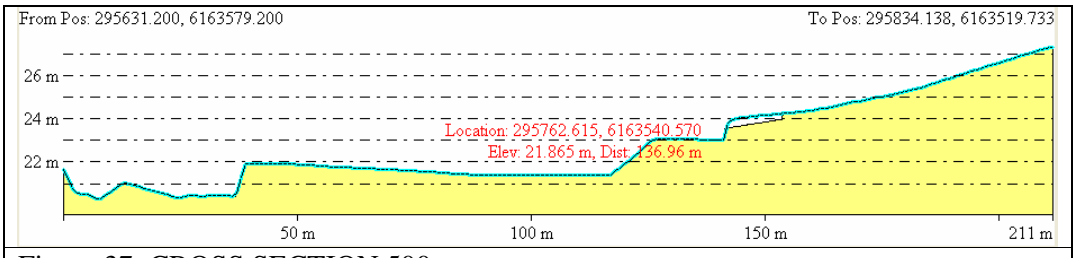


Figure 37. CROSS SECTION 500

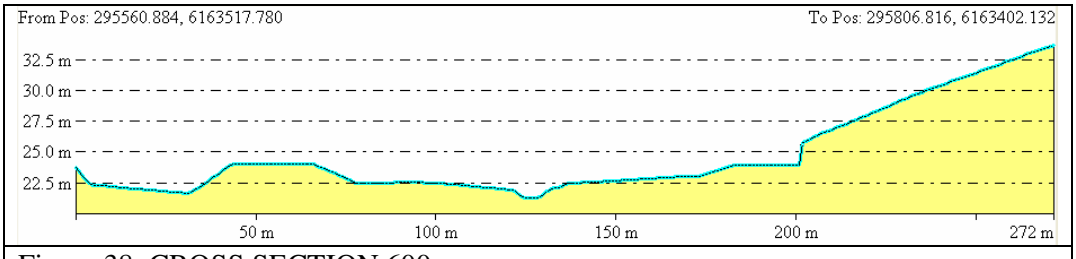


Figure 38. CROSS SECTION 600

The change would have no impact on the Q100 as it was already above the Q100.

The overall impact of this level change on the PMF flood profile is shown below, which compares the previous PMF flood profile along the stream reference line to the PMF profile resulting from the additional fill.

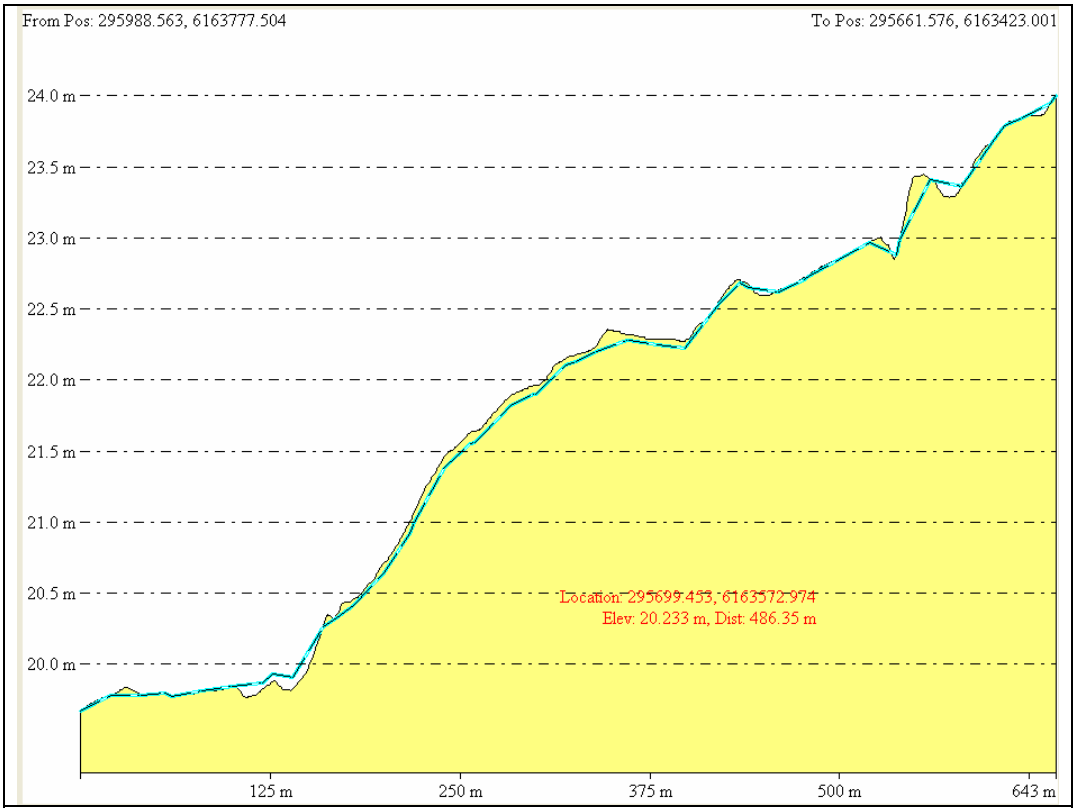
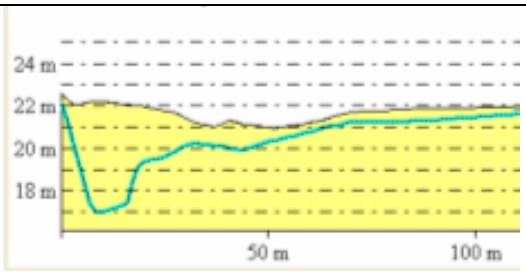


Figure 39. Impact of Terrain Change 2 on the PMF profile along the stream Line shown in figure 1. {With exaggerated vertical scale) (Blue=Terrain 1, Yellow Terrain 2)

It is clear that the impact is a minimal localised increase with no impact upstream or down stream.



Flood profile Cross Section 300.

(Note 0.5m variation in water surface)

Unlike older methods of flood analysis where there is an implicit assumption that the flowing water at each cross section is flat (horizontal), new methods using 2D models with shock capturing capability are able to provide insight into the extremely dynamic behaviour of flooding. A very clear example of this is the superelevation of the water surface around the sharp bend at cross section 300.

Figure 40. The Benefit of Detailed 2D flood modelling

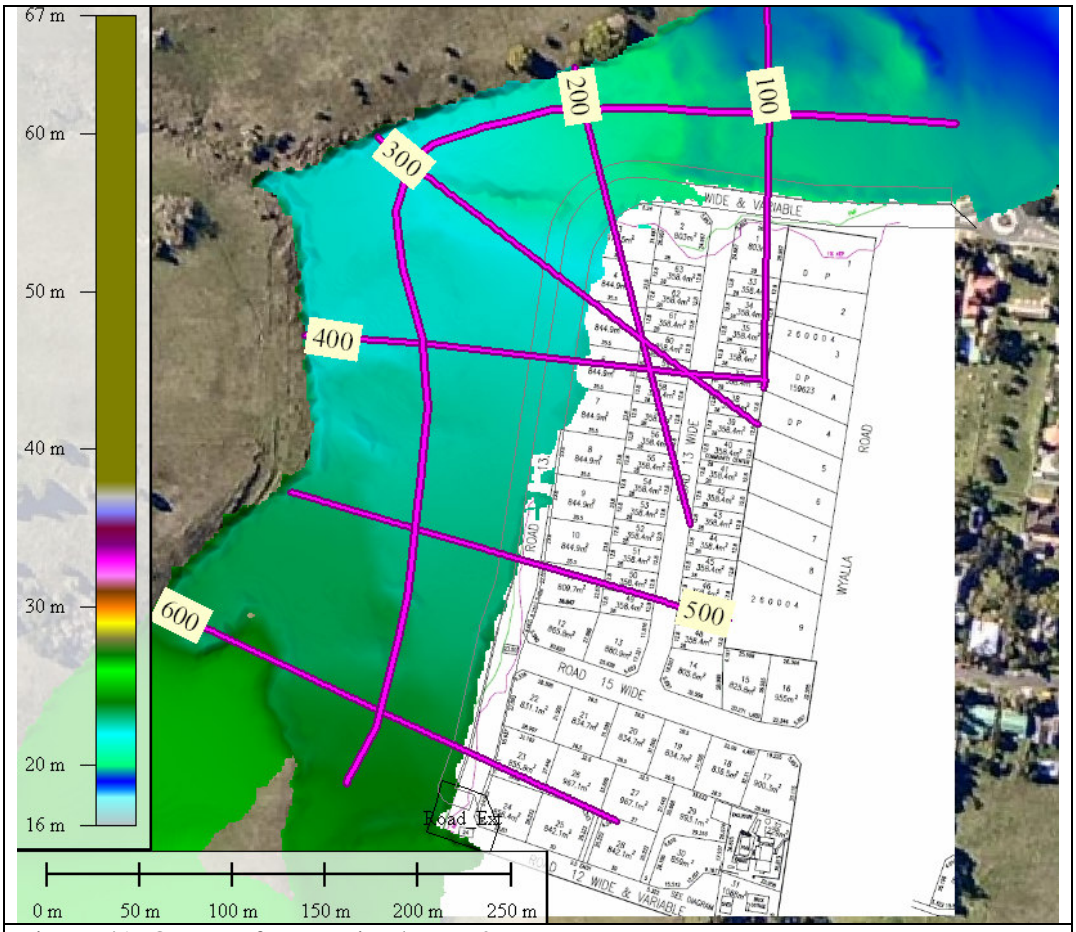


Figure 41. QPMF after terrain change 2

In order to provide a quick method of comparison the average water level at cross sections Pre-Development and Post Development are listed and compared:

Reference Line Chainages	Q100 Flood Levels		PMF Flood Levels	
	Exist	Proposed	Exist	Proposed
100	19.4	19.35	19.9	19.89
200	19.95	20.0 (+50mm)	20.5	20.8 (+300mm)
300	21.0	21.1(+100mm)	21.5	21.9 (+400mm)
400	21.8	21.7	22.5	22.5
500	22.4	22.4	23.1	23.1
600	23.3	23.3	23.7	23.7

The table confirms the findings that the terrain changes on the site associated with the proposal results in a localised increase in flood level that is contained within the site extent. Considering the steep northern and north western bank the localised increase is not considered to have a significant impact on that adjoining land.

The upstream and downstream flood levels are not affected by the proposed development. Furthermore the proposed on site terrain changes (cut and fill) ensure that lots can be made flood free up to and including the PMF event. The proposed roadway remains flood free during a 100 year event and is passable by truck or 4x4 during a PMF event. The eastern footpath is passable by pedestrians.

Further on going discussion with the proponent has resulted in a request to investigate the impact of raising the roadway identified as flood prone during a PMF event above those levels. This will ensure the entire development and roadway is flood free for all events up to and including the PMF.

As a result the following section has been added to this addendum.

TERRAIN CHANGE 2 (b):

The following image indicates the roadway level as design (above) in yellow and the PMF flood level in blue.

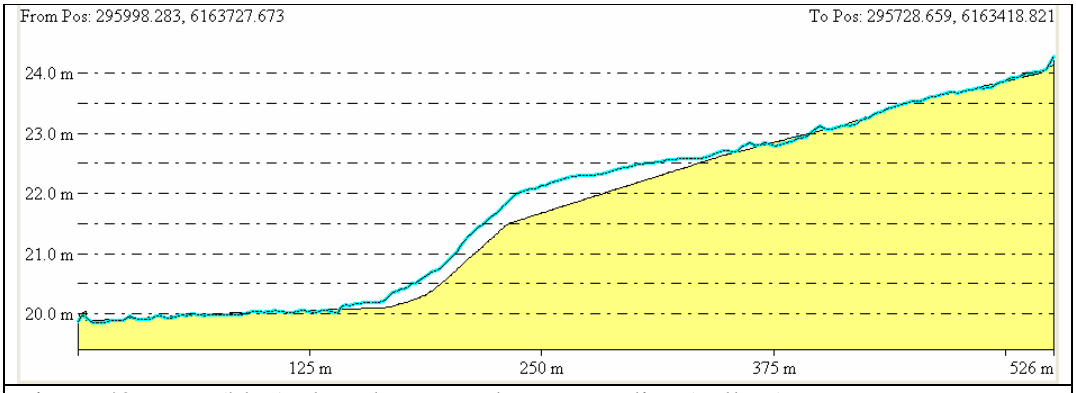


Figure 42. PMF (blue) plotted over roadway centreline (yellow)

As can be seen the section between 140m and around 340m (some 200m in length) is impacted by the PMF event.

The terrain model has been adjusted to raise the roadway as required to ensure the PMF flood does not impact the roadway. In addition, as it is anticipated that the roadway raising may marginally impact local flood levels, to limit the impact an amount of cut (lowering of ground level) on the adjoining terrain has been included.

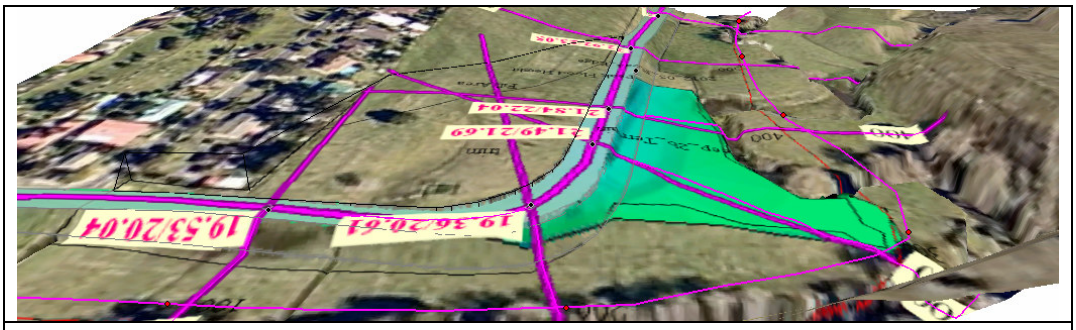


Figure 43. Overview of terrain changes to roadway and adjoining western portion

The ANUGA model was re-run using the adjusted terrain described.

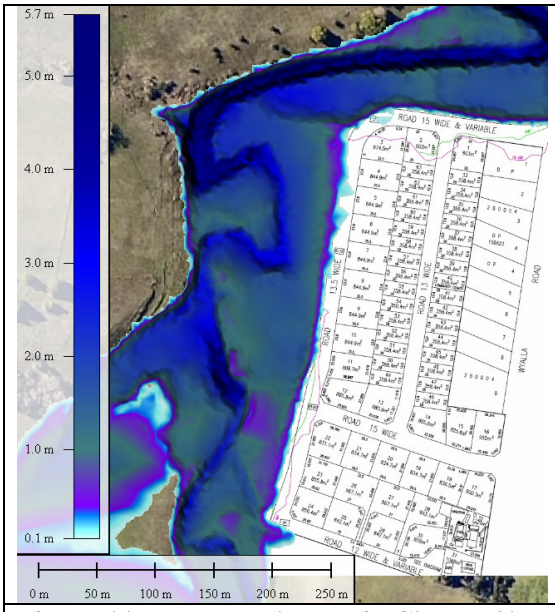


Figure 44. PMF Depth Terrain Change 2b

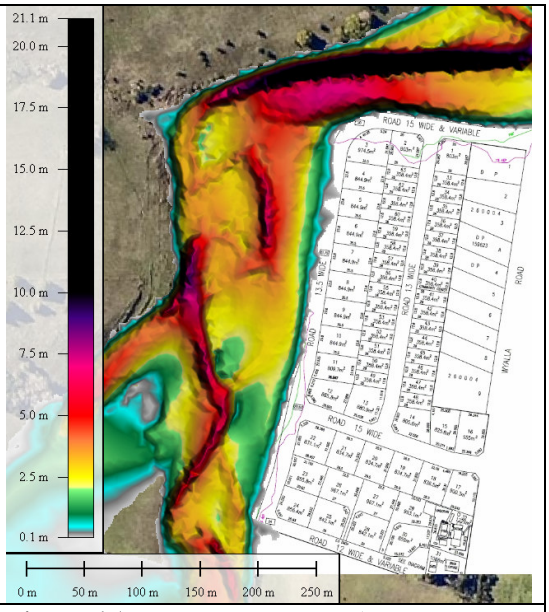


Figure 45. PMF Momentum (Prov. HAZARD VxD) Terrain Change 2b

Once again updating figures 31 and 41 the following plots the PMF flood levels over the proposed development are as follows:

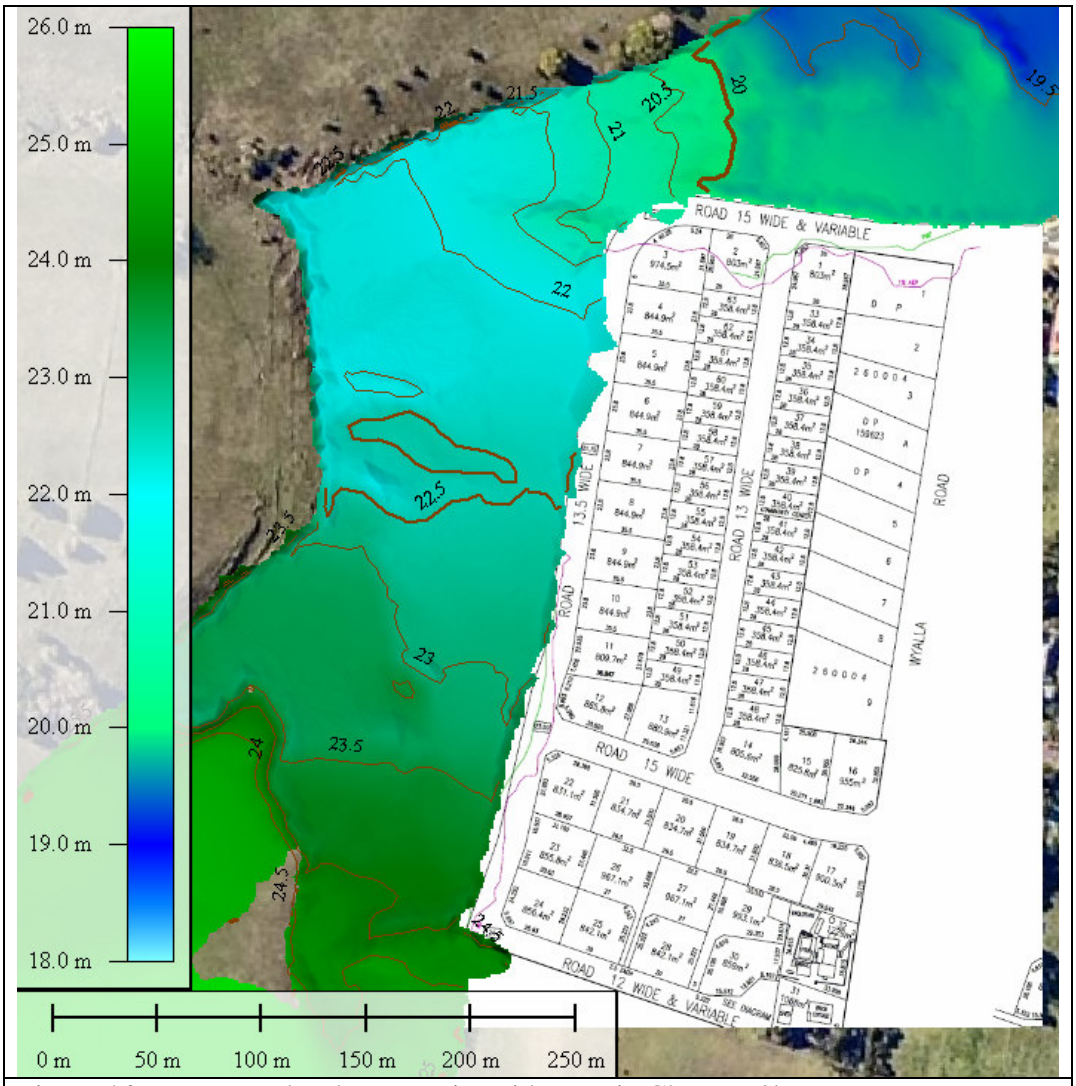


Figure 46. PMF over development site with Terrain Changes 2b

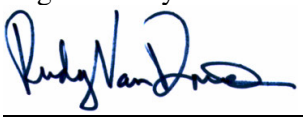
SUMMARY AND CONCLUSION:

The results show that it is feasible to undertake the development as indicated incorporating some relatively minor terrain changes making the development flood free in a 1:100 year event. Further that with additional terrain changes including raising the roadway and associated reshaping it is plausible to make the development including the roadway flood free in all events up to and including the PMF event.

This report is not a Subdivision design report but rather a Subdivision Design Guideline Report. The final roadway layout, earthworks and final levels are yet to be deigned. However in referring to this report the design can be undertaken in such a way as to ensure the development is constructed in a manner that results in a flood free development site for all events up to and including the PMF.

If any one has any further questions regarding any thing stated in this report please do not hesitate to contact me.

Regards Rudy Van Drie



20/09/2012