Water Solutions
Certainty in Water

Report to

Grantham Floods Commission of Inquiry

on

Expert Hydrology Report 10 January 2011 Flood

Circumstances and Contributing Factors

Supplementary Material No. 2

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Water Solutions
Certainty in Water

Grantham Floods Commission of Inquiry
Expert Hydrology Report 10 January 2011 Flood Circumstances & Contributing Factors (Supplementary Material No 2)

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1 Scope of Additional Material

1.1 Introduction

1. This document should be read as an addendum to my main report, Document Number WS150262 Rev 0, dated 11 August 2015. It contains:

- amended simulation outputs from the GFCOI model; and
- further material I have considered since the conduct of the GFCOI hearing.

2. In conjunction with this report I have provided separately, movie files that present animations of complete simulation outputs for:

- the extent of inundation;
- flow intensity;
- velocity direction; and
- velocity magnitude.

3. These simulation sequences cover:

- 2011 Flood: the period 12pm to 8 pm on the 10th January 2011 (8 hours).

4. The movie files have been produced with a time-step of 1 minute. The file names and descriptions are listed in Table 1.1 below.

Table 1.1 – Simulation Movie Files

File Name	Contents
GFCOI_Most_Likely_Jan_2011_Rev1.avi	Most Likely Case - includes features for Anzac Av and Lawlers Rd
GFCOI_No_Quarry_No_Plant_Jan_2011.avi	No Grantham Quarry and No Batching Plant
GFCOI_No_Rail_Extended_Jan_2011.avi	No Railway Embankment - throughout entire GFCOI model area

1.2 Reference Locations

5. I have established the likely effects on flooding in Grantham using two indicator methods:

- comparison of time-series of simulated flood flow rates, at the downstream locations marked in Figure 1.1; and
- comparison of depth and flow intensity hydrographs, at the locations marked in Figure 1.2.

6. Please note that, for the purposes of this report, I have shifted the Besley Location by a distance of approximately 20m north-north-east. This was necessary because when I prepared a simulation case that removed the batching plant I observed that the original Besley reference location was affected by the change in topography. If I had not shifted the reference point then plotted simulation outcomes at this location would have been unsuitable for comparison.

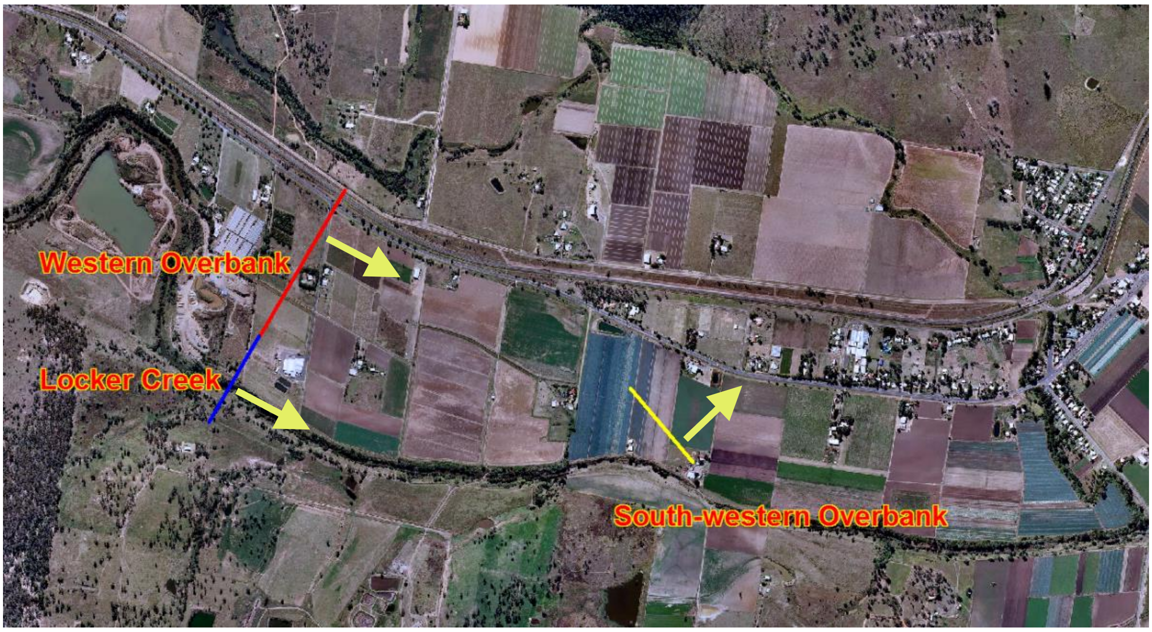


Figure 1.1 – Downstream Reporting Locations

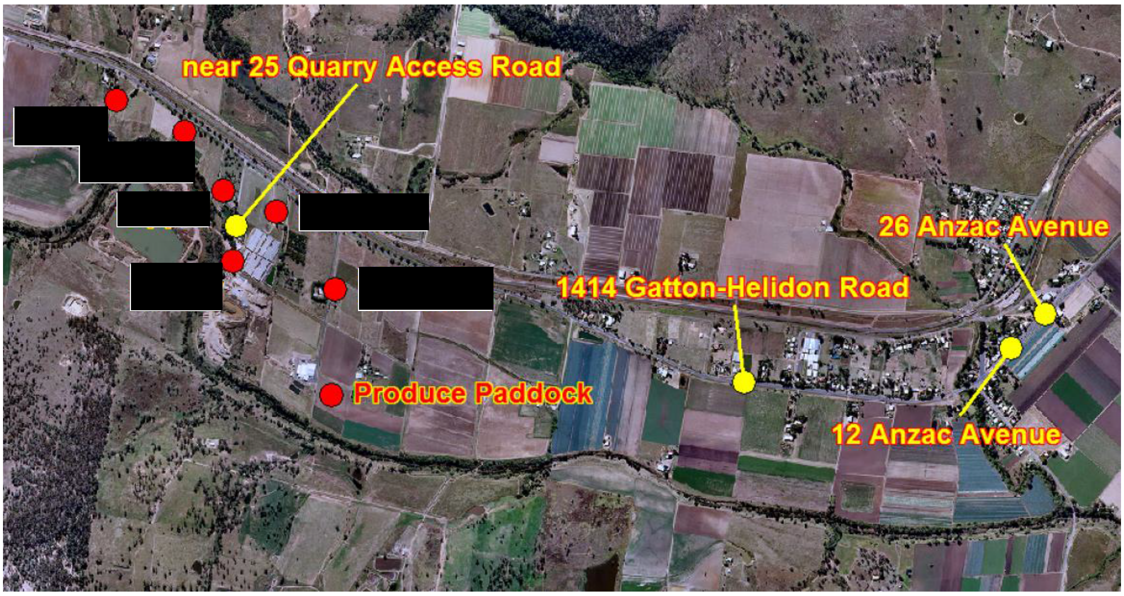


Figure 1.2 – Flow Depth and Intensity Hydrograph Locations

7. I have selected the downstream reporting locations marked in Figure 1.1 for the same reasons I gave in my main report.

8. I have selected the flow hydrograph reporting locations indicated in Figure 1.2 because they give representative coverage of depth and flow intensity measurements within and around the Grantham Quarry. Depth and flow intensity measurements are good indicators for the quantification of flood hazard.

1.3 Structure of Report

9. I have structured the material presented in my report as follows:

- Section 2: Amendment of certain plots in my main report of flow depth and intensity;
- Section 3: Consideration of an additional GFCOI model scenario for the case of pre-quarry conditions, with no development of the Batching Plant area;
- Section 4: Consideration of an additional GFCOI model scenario for the case of no railway embankment conditions (throughout the entire model area);
- Section 5: Consideration of flood flows through Grantham;
- Section 6: Consideration of flood flows at Lawlers Road;
- Section 7: Consideration of peak flood depths in the vicinity of Kluck and Castle properties;
- Section 8: Consideration of material provided by Mr Bower, One Nation Candidate dated 20 August 2015;
- Section 9: Consideration of statements provided by Dr Galletly;
- Section 10: Consideration of evidence provided by Mr and Mrs Arndt during the hearing;
- Section 11: Consideration of additional evidence by Mr Gillespie; and
- Section 12: Consideration of material provided by Ms Gearing, dated 24 August 2015.

2 Amended Flow Depth and Intensity Plots

10. I have amended a number of plots that are presented in my main report showing flow depth and intensity at the locations of near 25 Quarry Access Road, 1414 Gatton-Helidon Road, 12 Anzac Avenue and 28 Anzac Avenue, as indicated on Figure 1.2, above.

11. These amended plots now correctly present GFCOI model simulation outputs at these locations.

12. The reason for the amendments is on account of:

- the inclusion of a small surface drainage feature in the GFCOI model to represent the road gutter on the northern side of Anzac Avenue, to the east of Sandy Creek road bridge;
- small changes to the Besley reporting location as indicated in Section 1.2 above;
- the inclusion of a surface drainage feature in the GFCOI model to represent the table drains along Lawlers Road over the crest of the hill to the east of the railway underpass at Dinner Corner on Gatton-Helidon Road; and
- for the Worst Case scenario outputs only, presentation of simulation outcomes for the GFCOI model with the calibration adjustment (as discussed in Section 8.13 of my main report) in place of outcomes from the GFCOI model without calibration adjustment that I mistakenly used to prepare the original plots in my main report. I note that this plotting error was only for the Worst Case results.

13. I have included the main report figure numbers in the figure titles for the amended plots for clarity and ease of cross-reference.

14. I consider that the following amendments are for completeness only. They do not amount to any material change of my assessment of the Grantham Flood or my conclusions drawn in my previous reports.

2.1 No Quarry Scenario

(a) Quarry Access Road

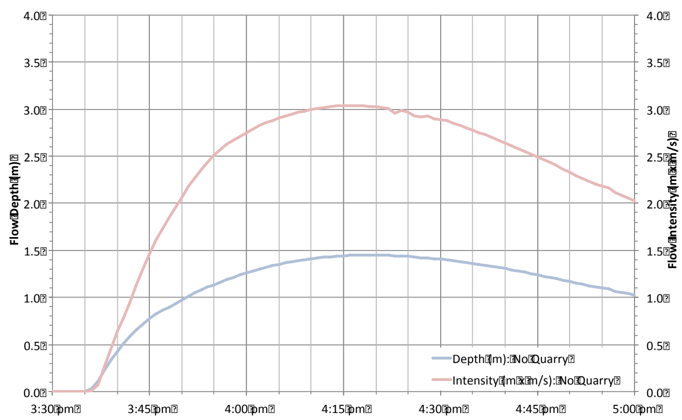


Figure 2.1 – No Quarry Reference Flow Depth and Intensity Location (Amended Figure 10.8)

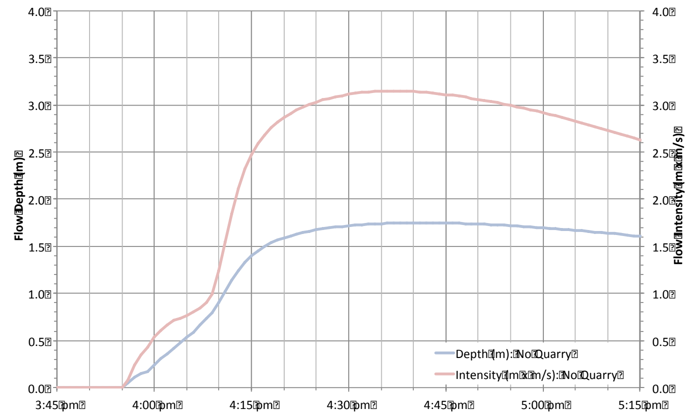
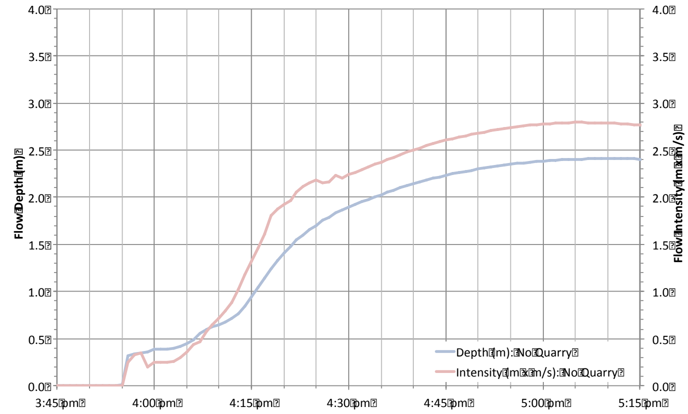
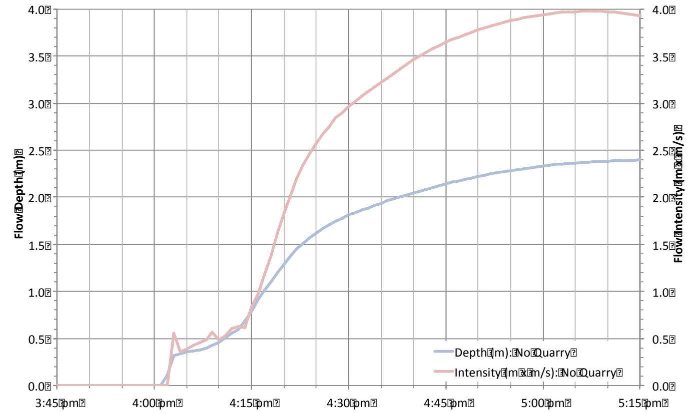
(b) 1414 Gatton-Helidon Road	
(c) 12 Anzac Avenue	
(d) 26 Anzac Avenue	

Figure 2.1 (continued) – No Quarry Reference Flow Depth and Intensity Location (Amended Figure 10.8)

2.2 Most Likely Scenario

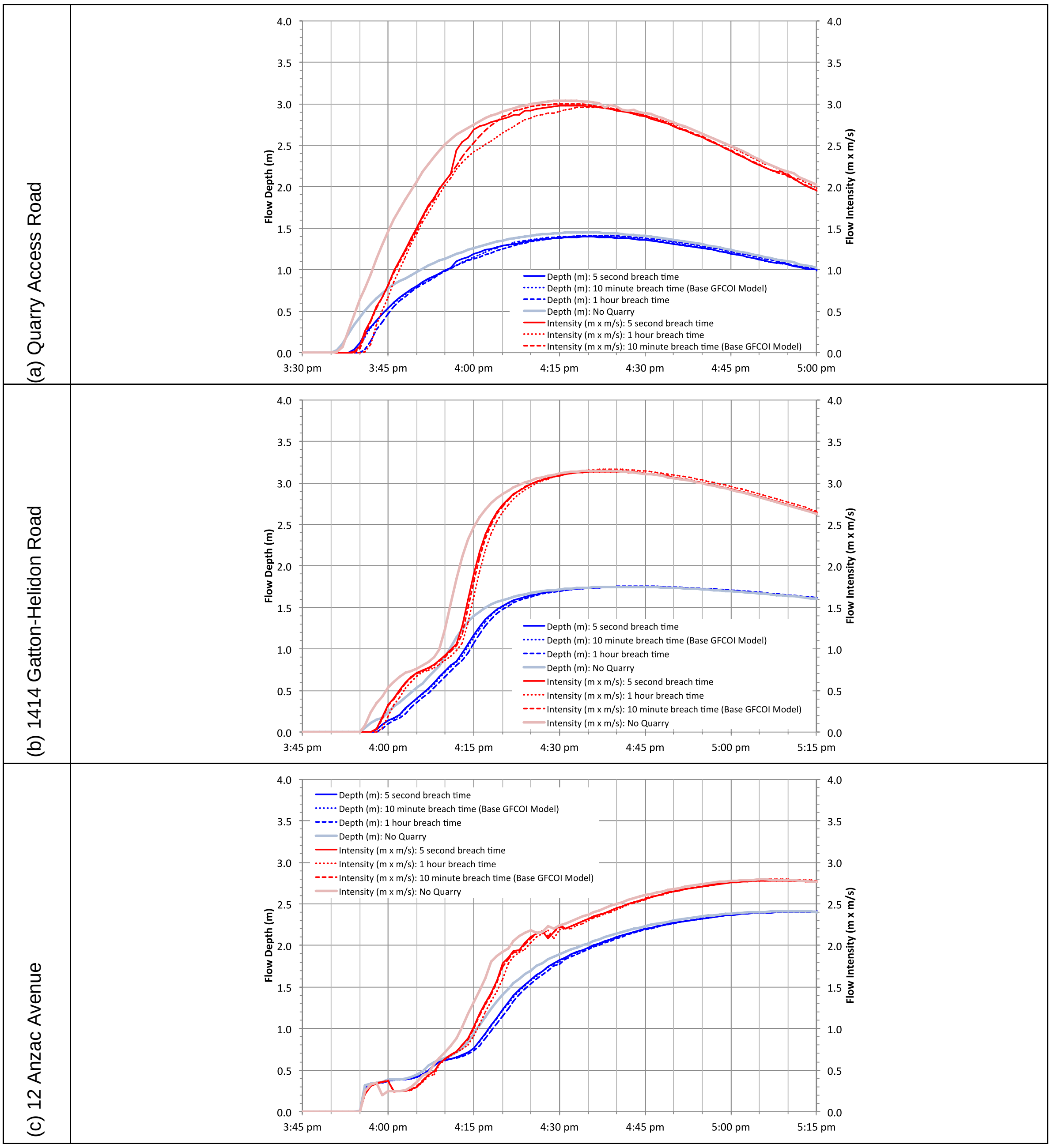


Figure 2.2 – Effect of Most Likely Quarry Levee Failure on Flow Depth and Intensity (Amended Figure 10.11)

(d) 26 Anzac Avenue

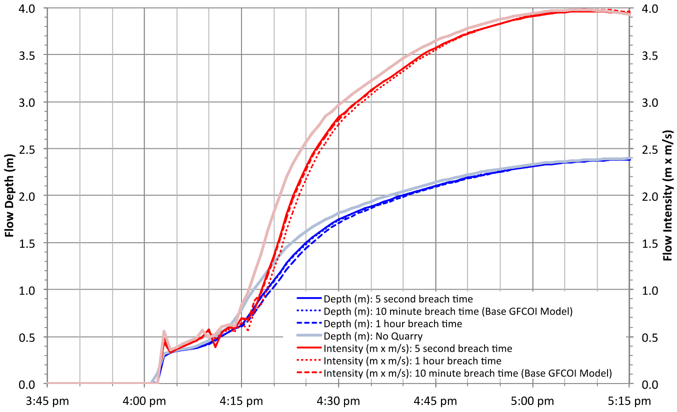


Figure 2.2 (continued) – Effect of Most Likely Quarry Levee Failure on Flow Depth and Intensity (Amended Figure 10.11)

2.3 Worst Case Scenario

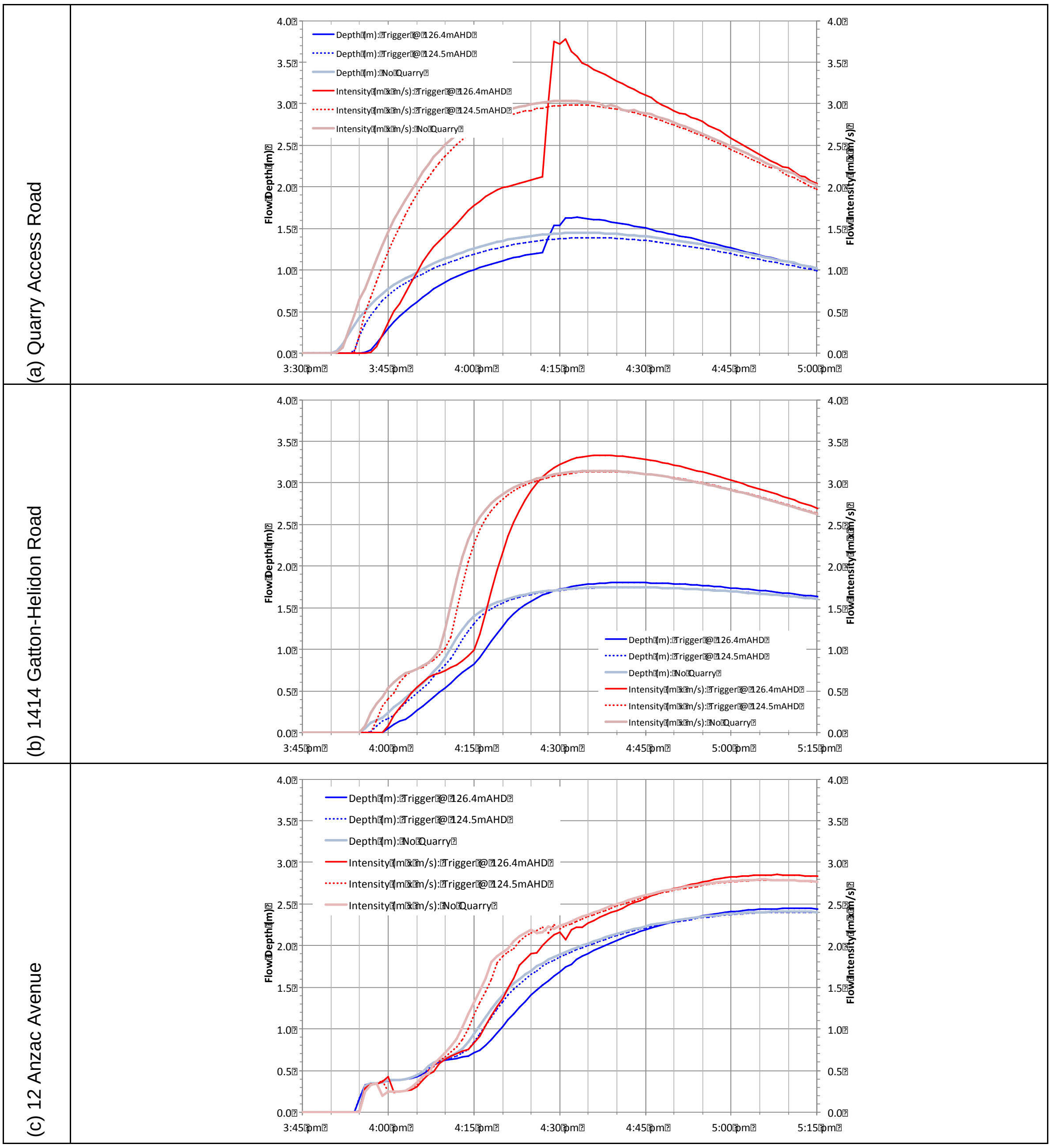


Figure 2.3 – Effect of Worst Case Quarry Levee Failure on Flow Depth and Intensity (Amended Figure 10.18)

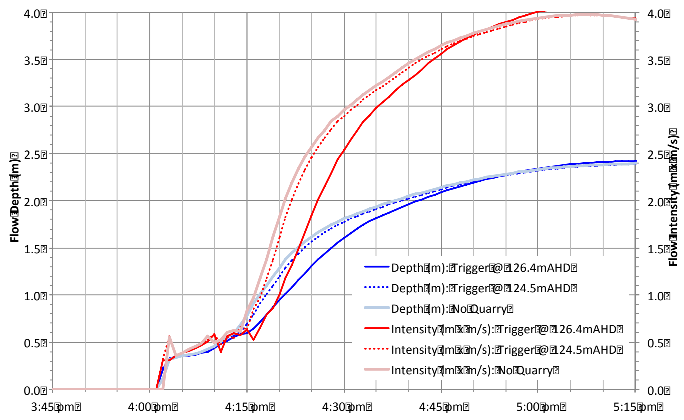
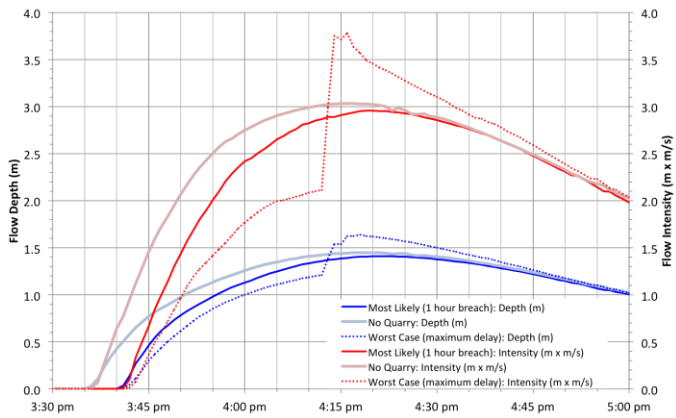
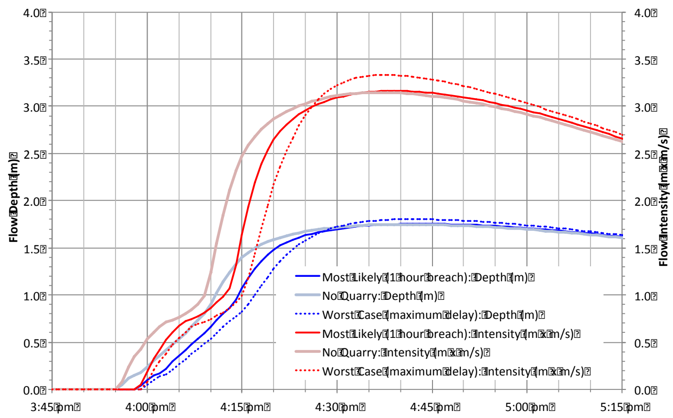
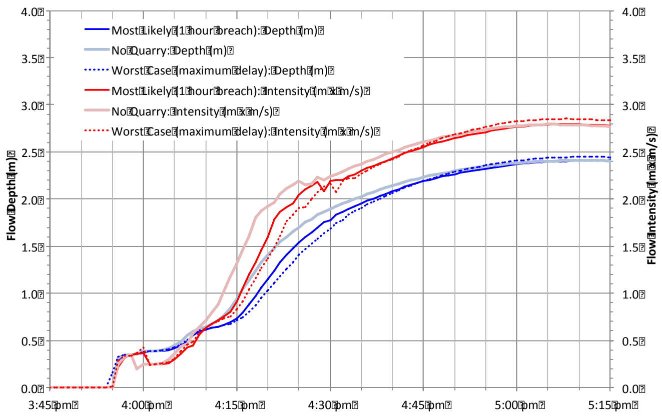
(d) 26 Anzac Avenue	

Figure 2.3 (continued) – Effect of Worst Case Quarry Levee Failure on Flow Depth and Intensity (Amended Figure 10.18)

2.4 Scenario Comparisons

(a) Quarry Access Road	
(b) 1414 Gatton-Helidon Road	

(c) 12 Anzac Avenue



(d) 26 Anzac Avenue

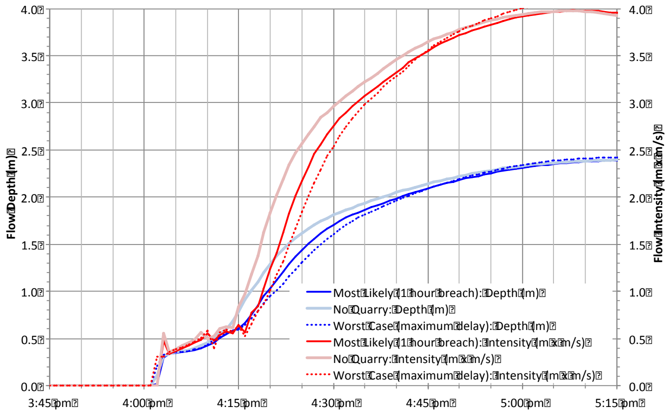


Figure 2.4 (continued) – Effect of Worst Case Quarry Levee Failure on Flow Depth and Intensity (Amended Figure 10.20)

2.5 Initial Lake Level

(a) Quarry Access Road

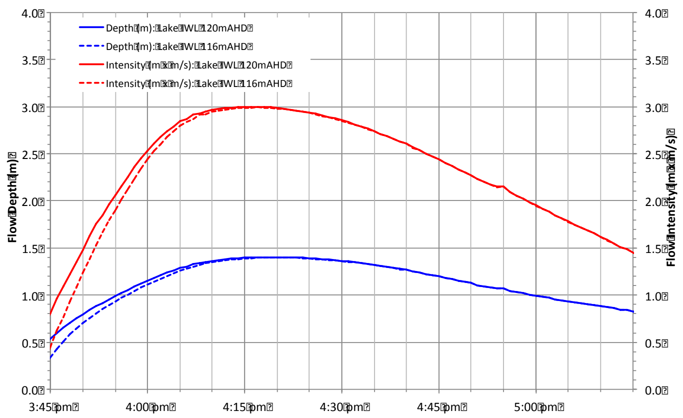
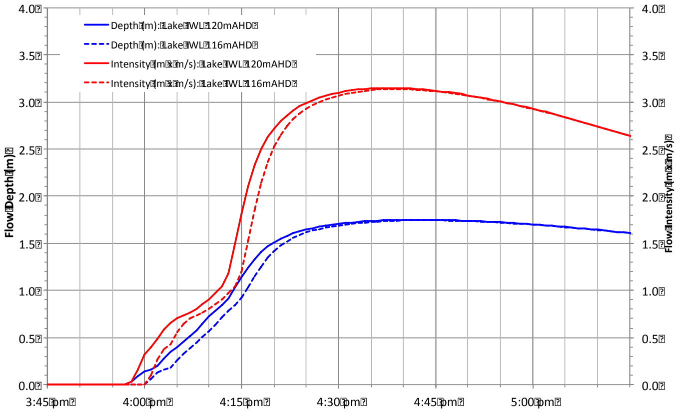
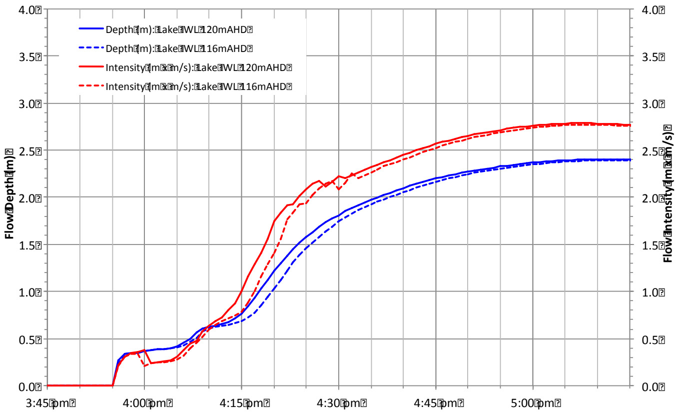


Figure 2.5 – Effect of Initial Lake Level on Flow Depth and Intensity (Amended Figure 12.7)

(b) 1414 Gatton-Helidon Road



(c) 12 Anzac Avenue



(d) 26 Anzac Avenue

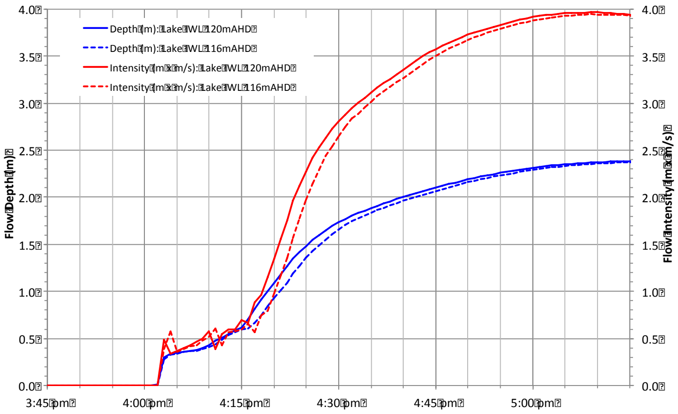


Figure 2.5 (continued) – Effect of Initial Lake Level on Flow Depth and Intensity (Amended Figure 12.7)

3 GFCOI Model Simulation – No Quarry Operations

15. In my main report, I presented details of a scenario depicting topographic conditions had the Grantham Quarry not been constructed. That is, the land as it was before quarrying operations commenced. Under these conditions there would have been no pits, bunds or piles of spoil / quarried material. I relied on the work of Mr Starr (Geotechnical Expert) for the definition of the pre-quarry topography.

16. I have considered an extension to my previous definition of pre-quarry topographic conditions to remove those topographic features associated with the materials processing, storage and batching plant (Plant Area).

17. This Plant Area is located on the eastern side of Lockyer Creek to the south-east of the quarry pit.

18. I have prepared an aerial image of the Plant Area depicting my assessment of the most likely topography immediately before the 10th January 2011 flood. This is shown in Figure 3.1.

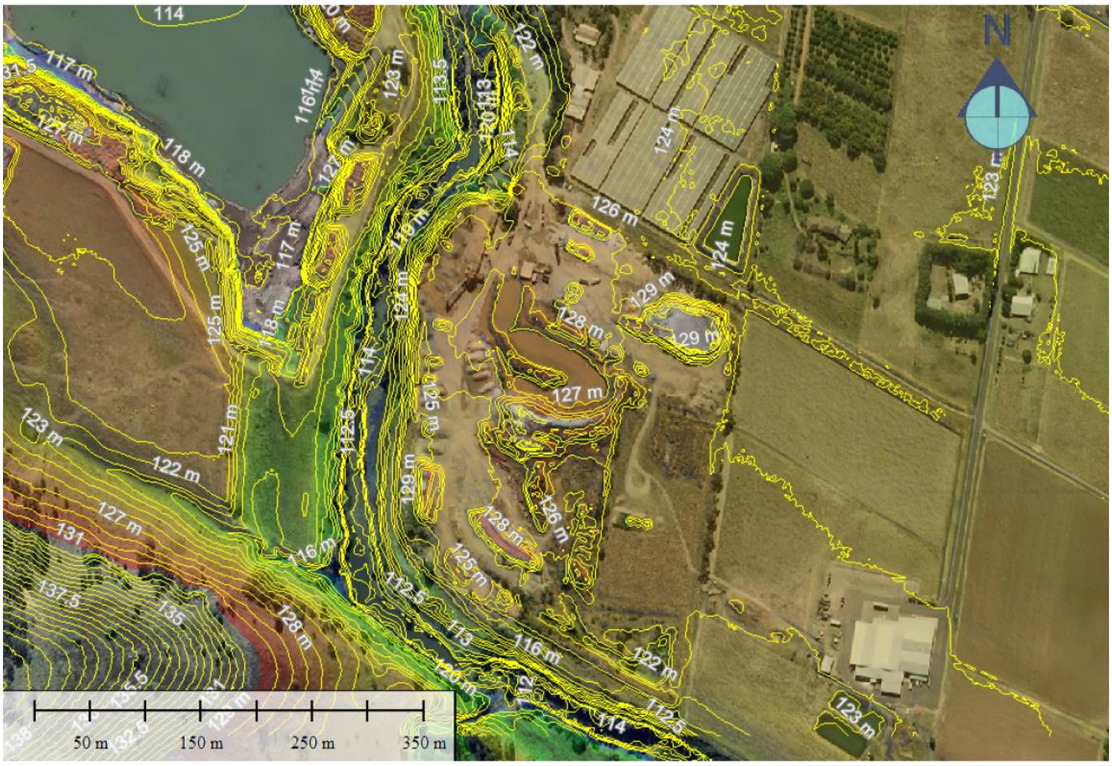


Figure 3.1 – Surface Topography at the Grantham Quarry Plant Area August 2010

19. Mr Starr has advised that he inspected aerial photographs using stenographic viewing to establish key topographic features defining the pre-plant surface. His interpretation was that the plant earthworks were built on flat agricultural land. In his opinion, the top of the riverbank was about 124.0mAHD and the ground was then essentially a flat flood plain (similar to land immediately east of Western Levee pre-flood). Mr Starr also noted that there could have been some areas up to 124.5mAHD. On the riverbank, he noted that there was one intermediate terrace at about AHD 120.0mAHD.

20. Based on Mr Starr's advice I have prepared an aerial image of the Plant Area depicting the most likely topography as shown in Figure 3.2 below.

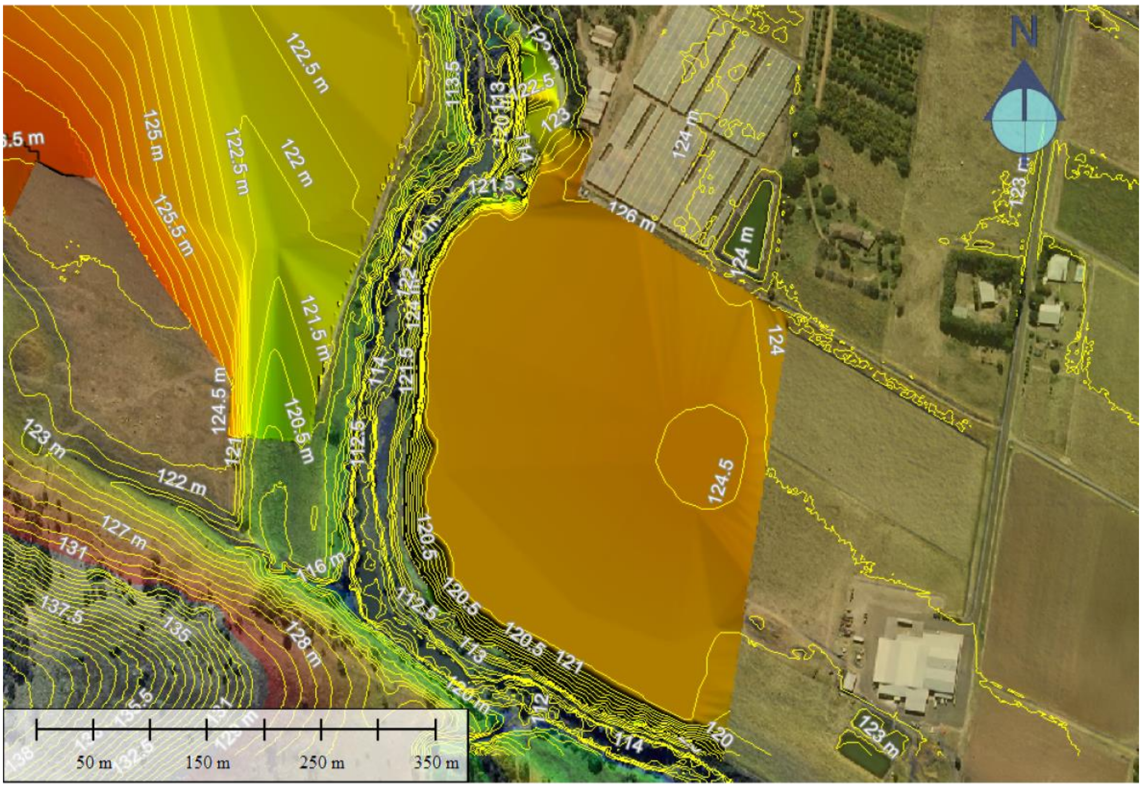


Figure 3.2 – Surface Topography at the Grantham Quarry Plant Area Before Development (Circa 1982)

21. I refer to topographical conditions before development of the Plant Area as No Plant conditions, and conditions for No Quarry and No Plant as No Quarry Operations.

22. I have considered the effect of the topographical features on the Plant Area on Grantham flooding by using the GFCOI model to simulate the 10th January 2011 flood with No Quarry Operations topography. I have used simulation outcomes to produce hydrographs at the locations shown in Figure 1.1 and flow depth and intensity at the 4 locations marked as yellow dots in Figure 1.2 above. Those hydrographs are shown in Figure 3.3 and Figure 3.4 below.

23. For comparison, I have also shown in Figure 3.3 and Figure 3.4 the outcomes for the original No Quarry Scenario and the Most Likely Scenario.

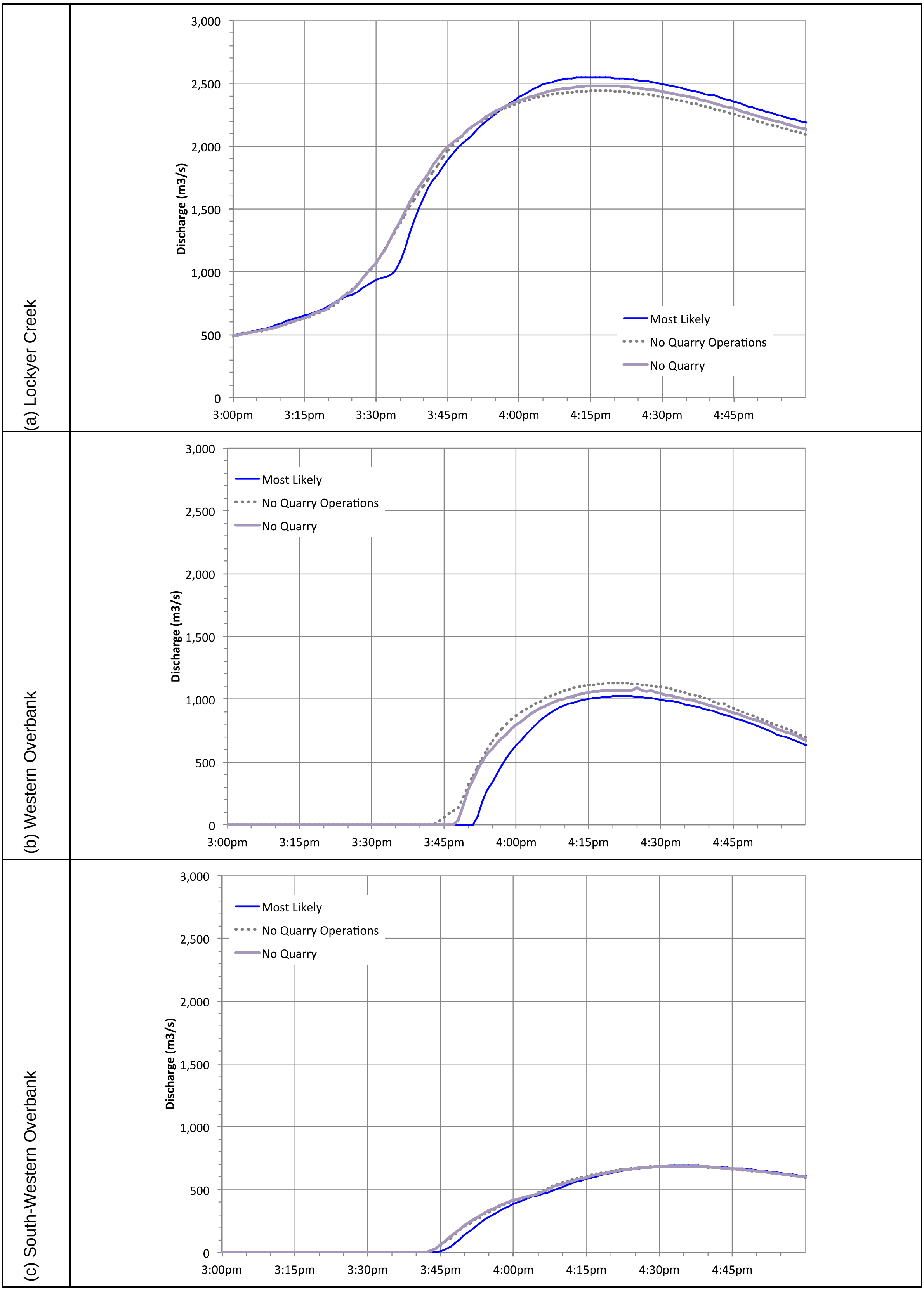


Figure 3.3 – Effect of No Quarry Operations on Downstream Flow

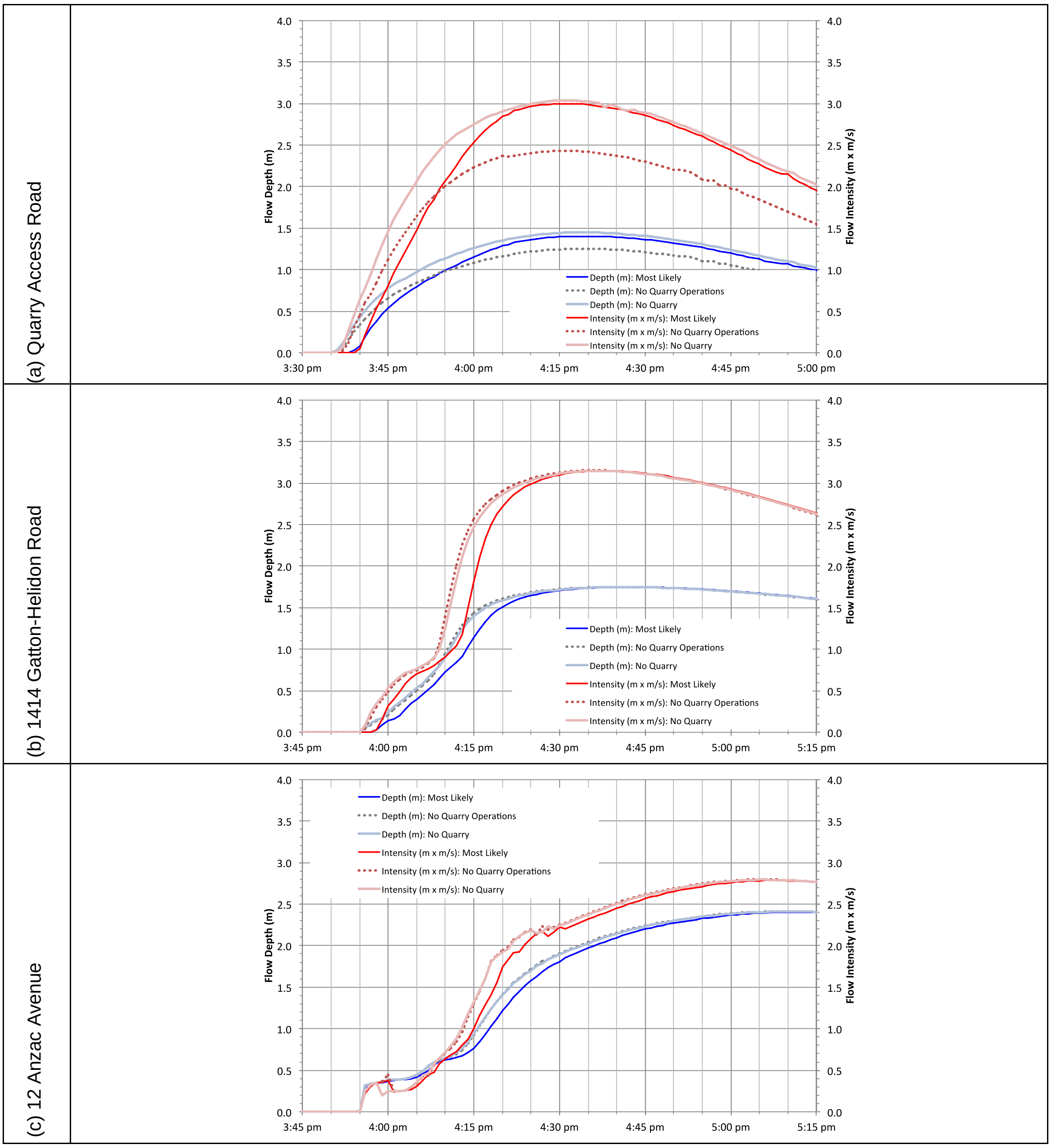


Figure 3.4 – Effect of Quarry Operations on Flow Depth and Intensity

(d) 26 Anzac Avenue

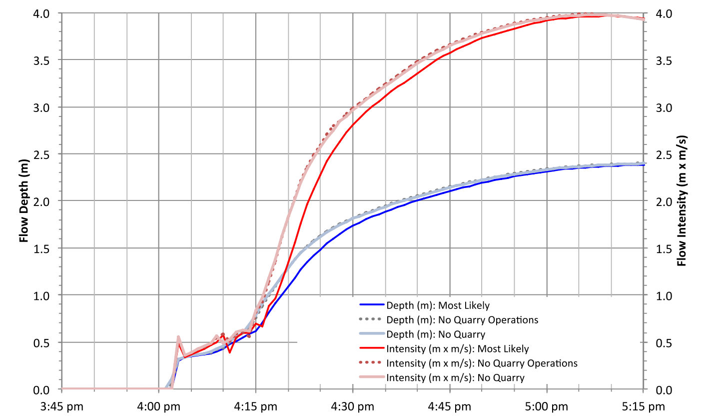


Figure 3.4 (continued) – Effect of Quarry Operations on Flow Depth and Intensity

24. I have interpreted these hydrographs by comparing the No Quarry Operations scenario against the results of the No Quarry scenario as set out in my previous reports. My views are summarized as follows:

- no change to delay times to the Most Likely scenario case;
- a slight reduction in the peak flow rate in Lockyer Creek of about 60m^3/s (2%);
- a small increase in the peak flow rate in the Western Overbank of about 110m^3/s (10%);
- no apparent change in the peak flow rate in the South Western Overbank;
- a reduction in peak flow depth and flow intensity at near 25 Quarry Access Road of about 0.2m (15%) and 0.6m^2/s (20%) respectively, compared to the No Quarry case;
- no apparent change to depth or flow intensity at the other reference locations.

25. As indicated above, I consider that the removal of the surface features associated with quarrying operations in the Plant area with the No Quarry Operations scenario resulted in the direction of slightly more overbank flow into the Western Overbank in preference to Lockyer Creek compared with both the No Quarry and Most Likely scenarios. This had an impact in the No Quarry Operations scenario at near 25 Quarry Access Road because the flow path at this location is wider than simulated under No Quarry scenario conditions. In my opinion the wider flow path resulted in a reduction in flow depth and intensity at this location as indicated in Figure 3.4(a).

26. The observed reduction in flow depth and intensity at near 25 Quarry Access Road is the largest change across the reporting locations. This location is closest to the Grantham Quarry and I therefore considered it necessary to review the effect of the No Quarry Operations scenario at the 7 additional reference points (shown as red dots in Figure 1.2). I have produced plots of flow depth and intensity at these locations for the cases of No Quarry, No Quarry Operations and Most Likely for comparison, Figures 3.5 to 3.11.

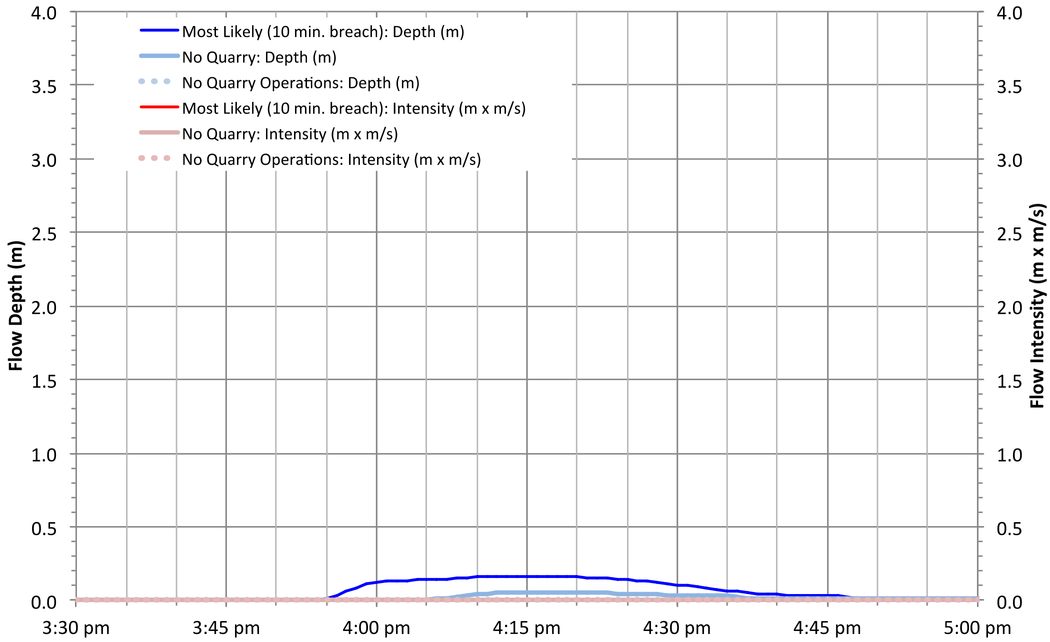


Figure 3.5 –Comparison of Flow Depth and Intensity at Ryman

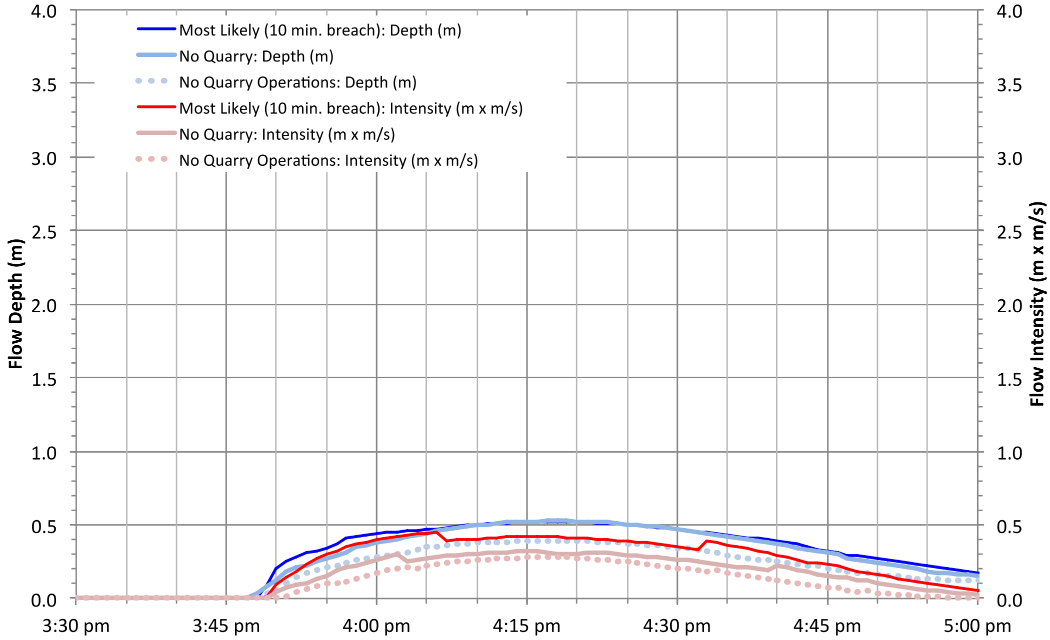


Figure 3.6 –Comparison of Flow Depth and Intensity at Mallon

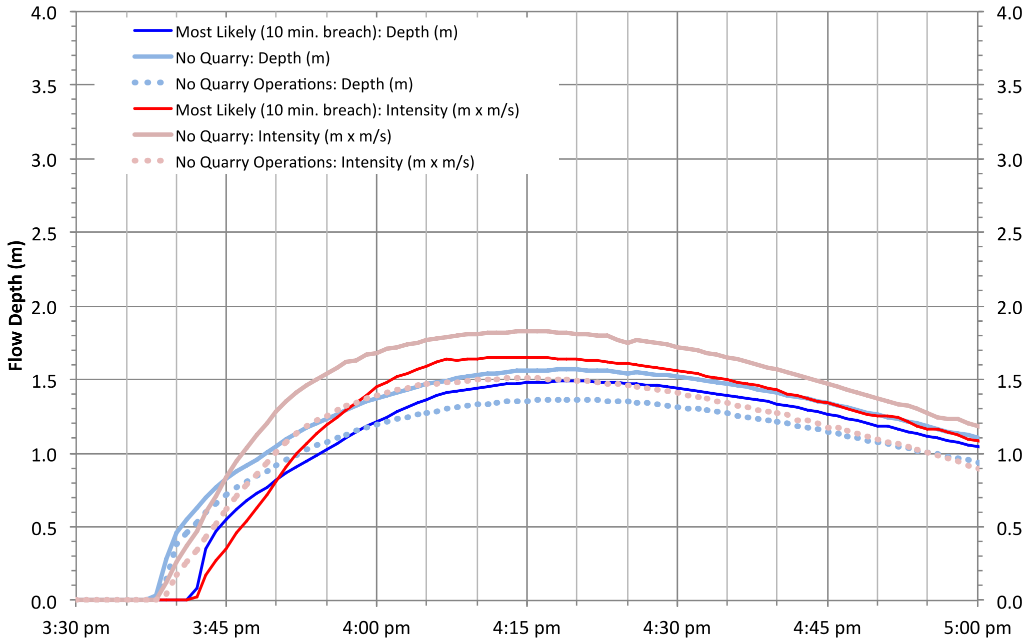


Figure 3.7 –Comparison of Flow Depth and Intensity at Sippel

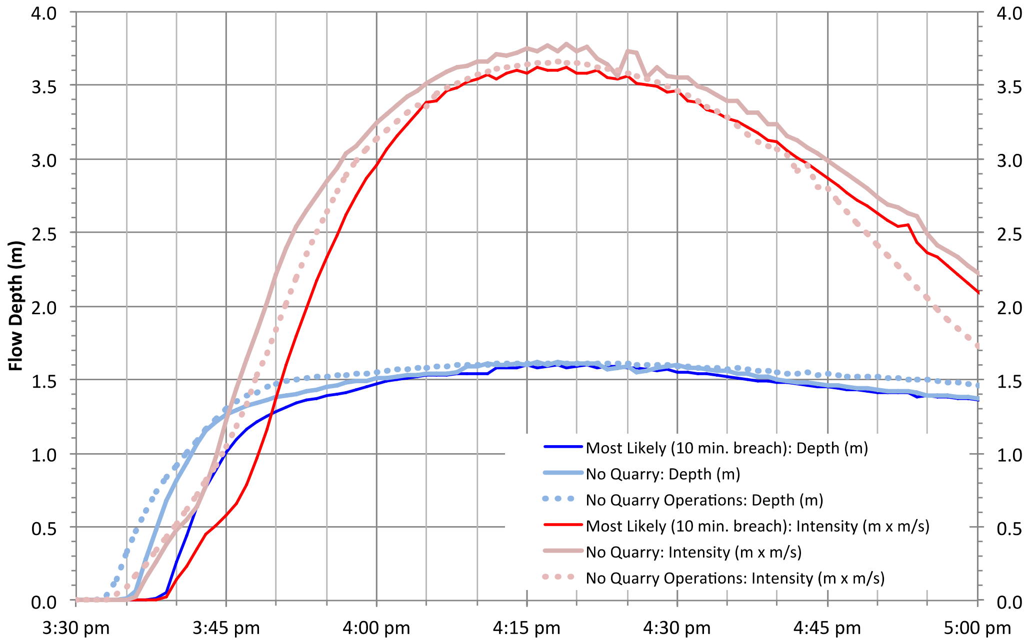


Figure 3.8 –Comparison of Flow Depth and Intensity at Besley

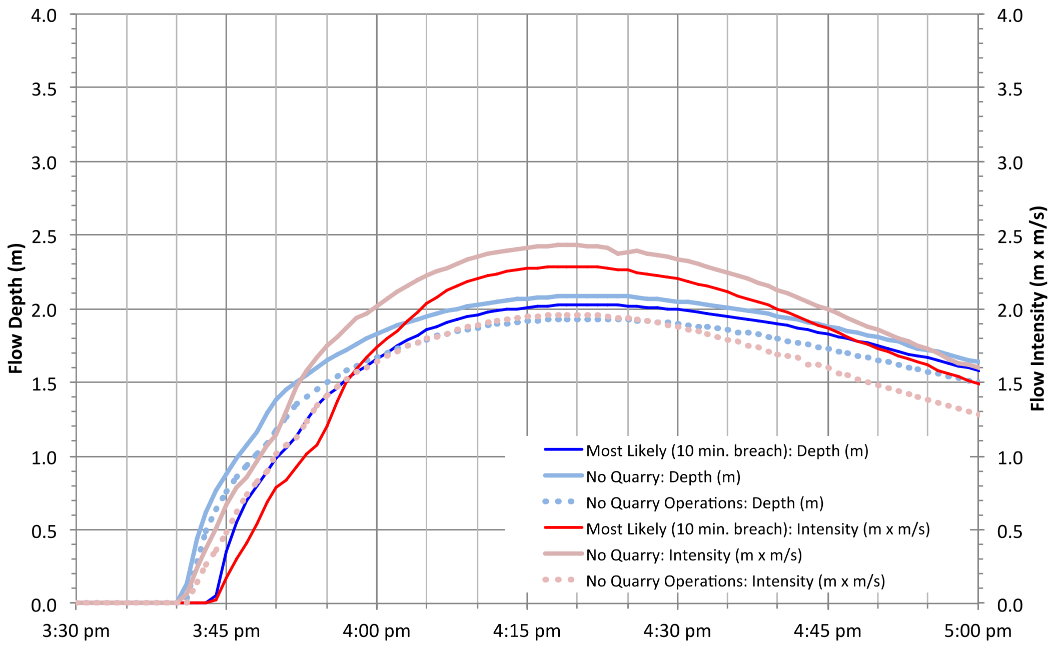


Figure 3.9 –Comparison of Flow Depth and Intensity at Gillespie

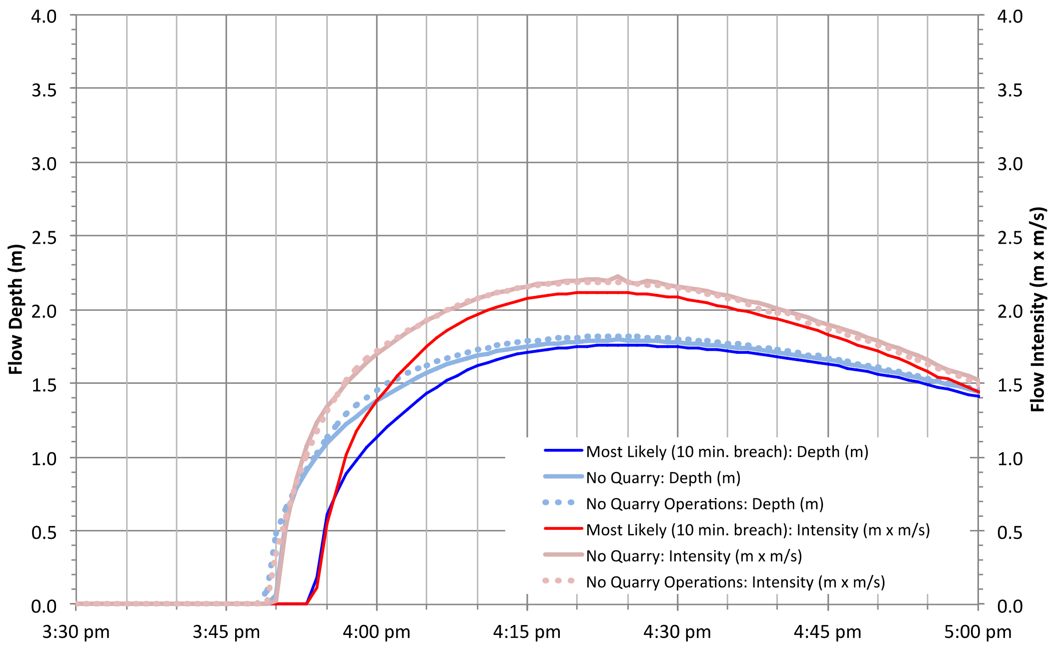


Figure 3.10 –Comparison of Flow Depth and Intensity at Gallagher

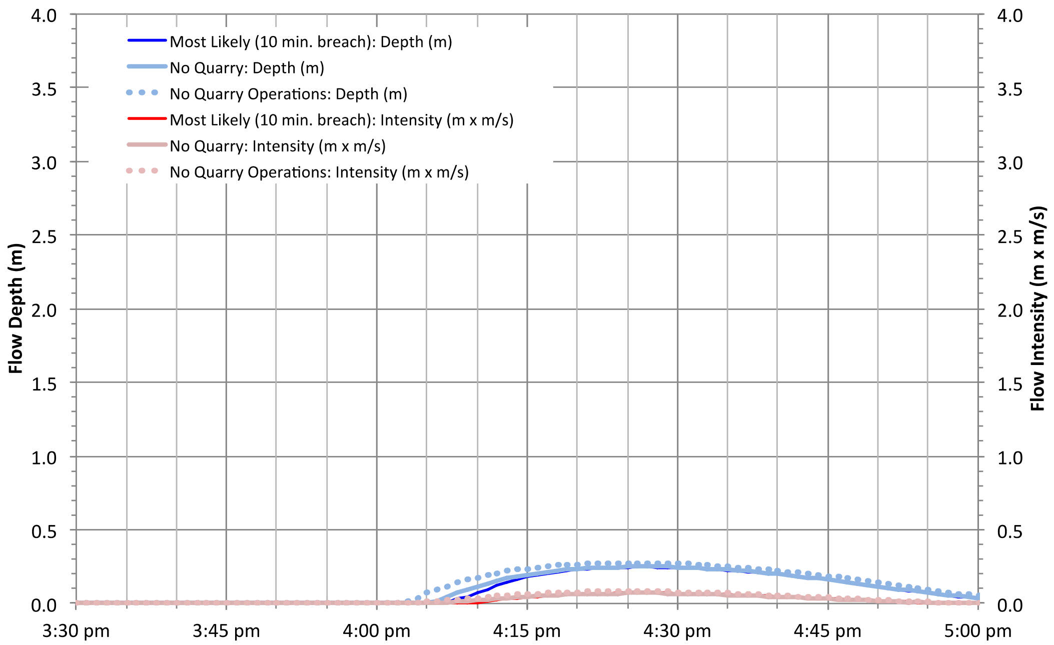


Figure 3.11 –Comparison of Flow Depth and Intensity at Produce Paddock

27. I have interpreted the information presented in the above plots by making comparison between No Quarry and No Quarry Operations scenarios. My views are summarized as follows:

- there is no apparent change to flow depth and intensity at the locations of Ryman, Gallagher and Produce Paddock;
- at the Mallon reporting location, there is a reduction in depth of less than about 0.1m and a reduction in intensity of less than about $0.1m^2/s$;
- at the Sippel reporting location, there is a reduction in depth of less than about 0.2m and a reduction in intensity of less than about $0.2m^2/s$;
- at the Besley reporting location, there is a reduction in depth of up to about 0.3m and a reduction in intensity of up to about $0.3m^2/s$, with the greatest reduction being on the rising limb of the hydrographs; and
- at the Gillespie reporting location, there is a reduction in depth of less than about 0.2m and a reduction in intensity of less than about $0.5m^2/s$;

4 GFCOI Model Simulation – Extended No Railway Embankment

28. In my main report, I presented details of a scenario depicting topographic conditions had a section of the railway embankment at Grantham not been constructed. Under these conditions there would have been no railway embankment immediately to the north of Western and Central Grantham. Elsewhere the embankment remained unchanged.

29. I have considered an extension to my previous definition of the No Railway topographic conditions to include removal of the entire railway embankment throughout the GFCOI model area. I refer to these conditions as No Extended Railway Embankment and the conditions in my main report as No Railway Embankment.

30. I have used the same technique described in Appendix B.8 in my main report for removal of the entire railway embankment. That is, I have removed the entire railway embankment by determining the natural ground levels across the width of the railway corridor.

31. I have prepared a locality map showing the extent of the removed railway embankment under my No Extended Railway Embankment conditions as indicated on Figure 4.1.

Figure 4.1 – Extended Railway Embankment Locality

32. I have considered the effect of the entire railway embankment on Grantham flooding by using the GFCOI model to simulate the 10th January 2011 flood with No Extended Railway Embankment topography. I have considered the following simulation outputs covering the regions of Western Grantham, Central Grantham and Eastern Grantham in my assessment:

- maximum flow intensity, Figure 4.2;
- maximum flood depth, Figure 4.5; and
- maximum flood velocity, Figure 4.8.

33. For comparison, I have also included simulation outputs for the Most Likely scenario case (Figures 4.3, 4.6 and 4.9 for intensity, depth and velocity respectively) as well as the change between Most Likely and No Railway Extended simulation outcomes (Figures 4.4, 4.7 and 4.10 for intensity, depth and velocity respectively).

34. Further, I have produced a movie file of the GFCOI model simulation, as described in Section 1.1, that depicts the extent of inundation and flow intensity over the simulation period.

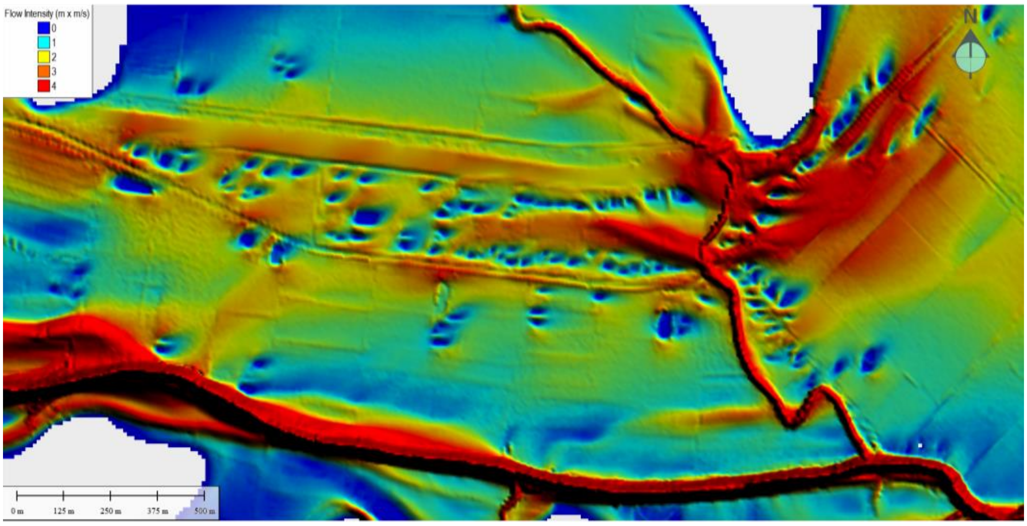


Figure 4.2 – Maximum Event Flow Intensity without Extended Railway Embankment

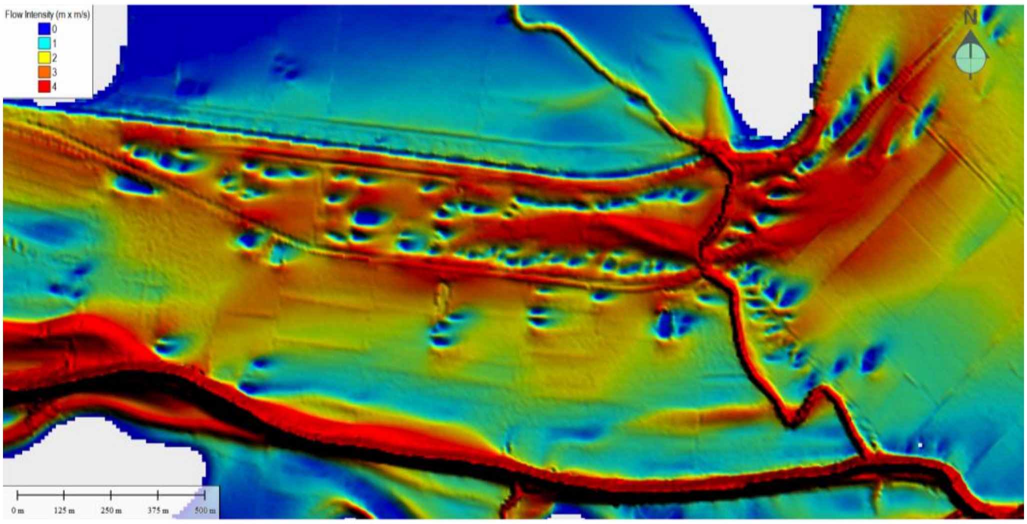


Figure 4.3 – Maximum Event Flow Intensity with Railway Embankment

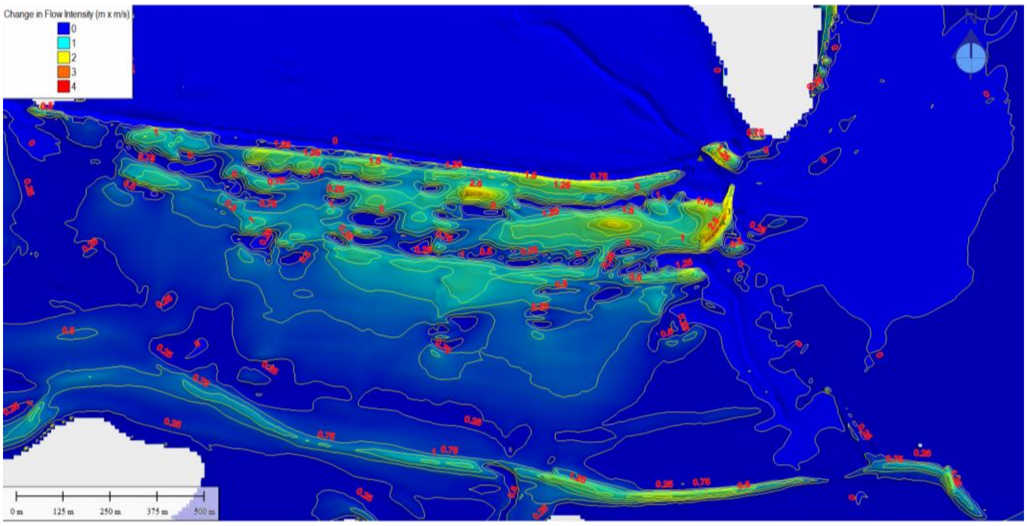


Figure 4.4 – Increase in Event Flow Intensity due to Extended Railway Embankment

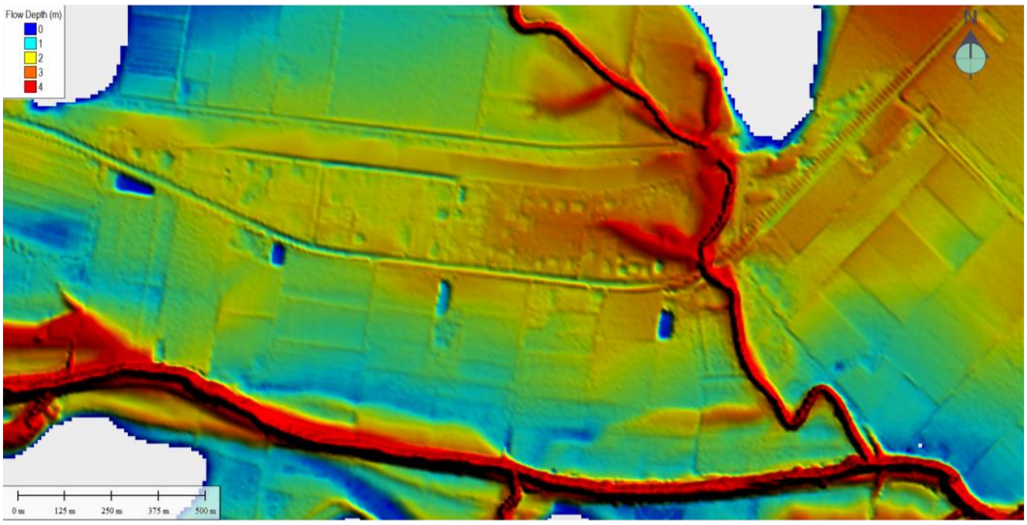


Figure 4.5 – Maximum Event Flow Depth without Extended Railway Embankment

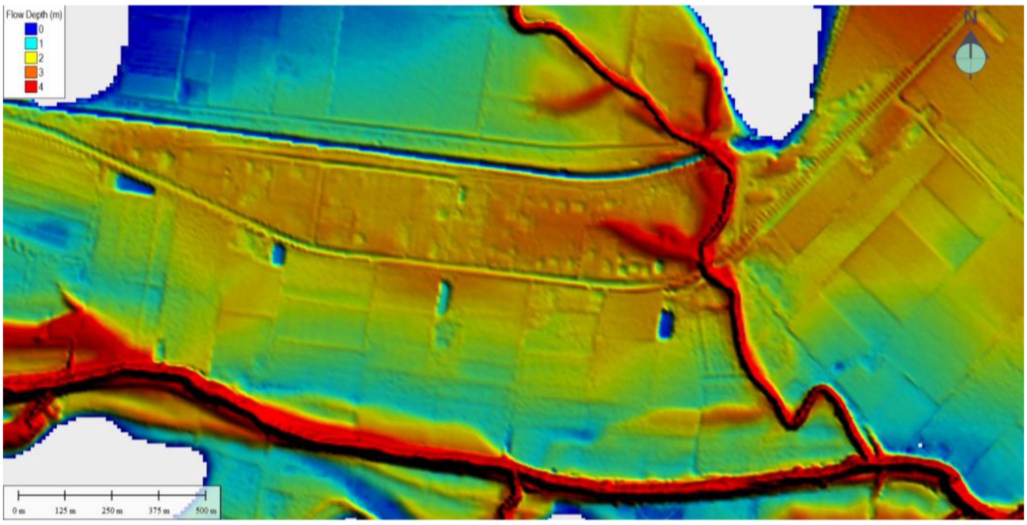


Figure 4.6 – Maximum Event Flow Depth with Railway Embankment

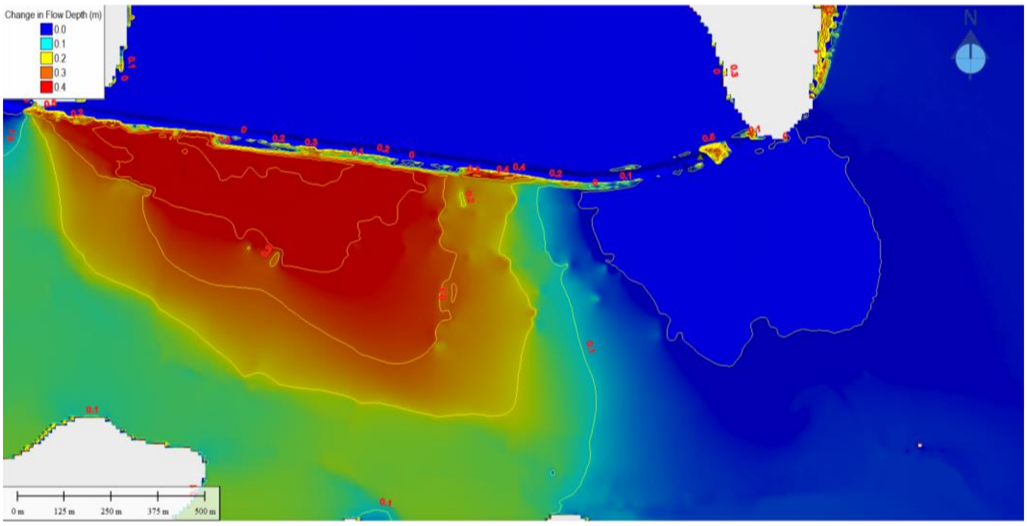


Figure 4.7 – Increase in Event Flow Depth due to Extended Railway Embankment

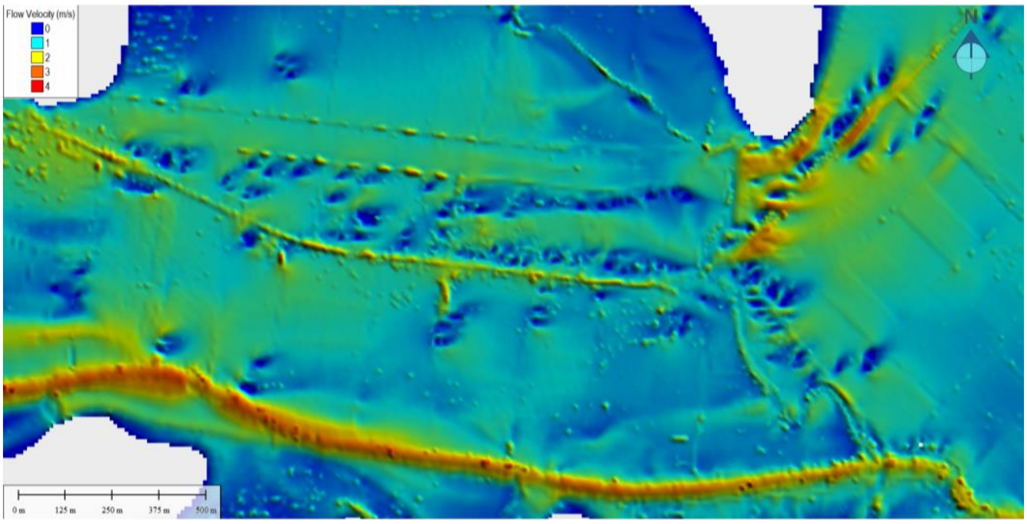


Figure 4.8 – Maximum Event Flow Velocity without Extended Railway Embankment

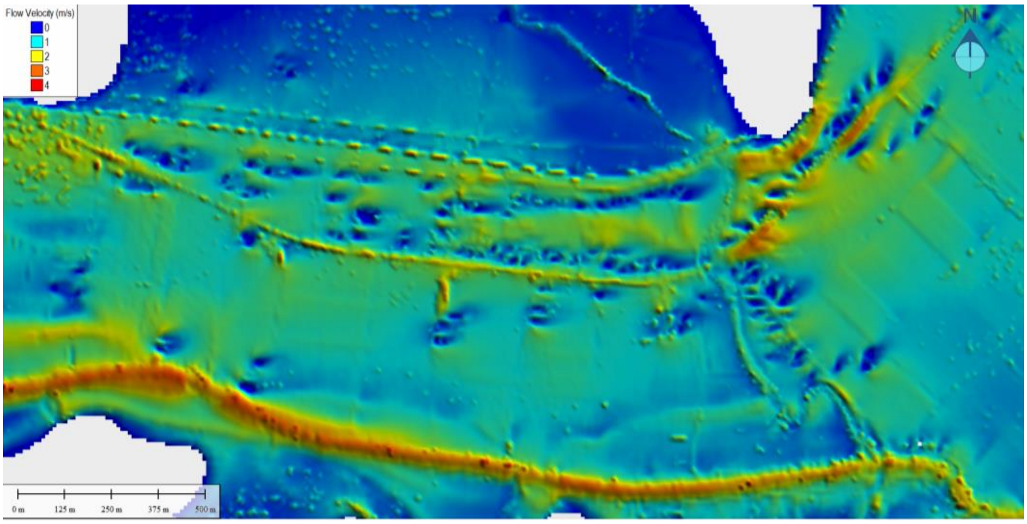


Figure 4.9 – Maximum Event Flow Velocity with Railway Embankment

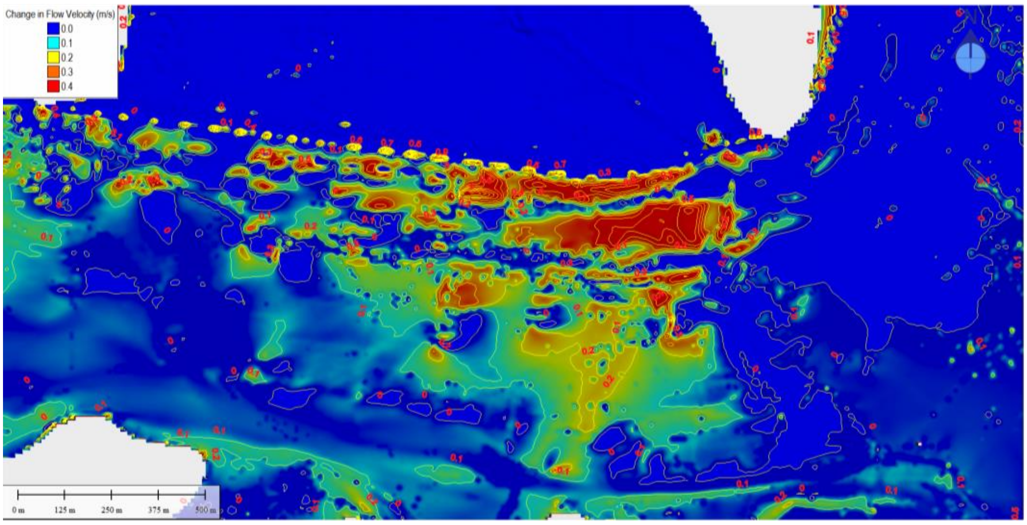


Figure 4.10 – Increase in Event Flow Velocity due to Extended Railway Embankment

35. Based on my comparison between the Extended Railway Scenario and the Most Likely scenario, as shown in the above Figures 4.2 to 4.10, I consider that the effect of the Extended Railway Embankment is the same as the No Railway Embankment scenario as described in paragraph 409 of my main report.

36. I have listed the average of the plotted flow parameters through Western Grantham and Central Grantham to the West of Sandy Creek in Table 4.1. For ease of reference I have also included parameters for the No Railway Embankment case presented in my main report.

Table 4.1 – Flow Parameters and Change due to Railway Embankment

Item	With Railway	No Railway Embankment		No Extended Railway Embankment	
	Maximum	Maximum	Change	Maximum	Change
Average Intensity (m x m/s)	2.8	2.3	-0.5	2.2	-0.6
Average Depth (m)	2.6	2.4	-0.2	2.3	-0.3
Average Velocity (m/s)	1.2	1.1	-0.1	1.1	-0.1

37. I have considered the outcomes listed in Table 4.1 and conclude that the presence of the entire railway embankment has resulted in increased maximum flood depths, velocities and flow intensity within Western Grantham and Central Grantham. I have also concluded that the Extended Railway Embankment case produces an additional increase of $0.1m^2/s$ in average intensity and 0.1m/s in average velocity, but no significant increase in average depth, compared to the No Railway scenario.

38. I further consider that the underlying flood hazard (as depicted by the average intensity parameter) remains relatively high under both no embankment cases considered.

39. Finally, during the course of the hearing I gave evidence concerning my assessment of the likely flow depth and intensity hydrographs at the property of Mr Marshall at 1420 Gatton-Helidon Road. I provided this information at three locations:

- in the centre of Mr Marshall's house (depth only);
- outside and a short distance immediately to the north of the house; and
- outside and a short distance immediately to the south of the house;

I provided this information for the simulation cases of the Most Likely and No Railway cases.

40. I have extracted additional flow depth hydrograph simulation outcomes from the GFCOI model for the No Extended Railway Embankment case and overlaid the additional case on the original graphs, as I show in Figure 4.11.

41. I have observed from the information plotted in Figure 4.11 that the Extended Railway Embankment case produces a small lowering in flow depth and intensity compared to the No Railway Embankment case. This is consistent with the simulation outcomes presented in Figures 4.4 and 4.7 above.

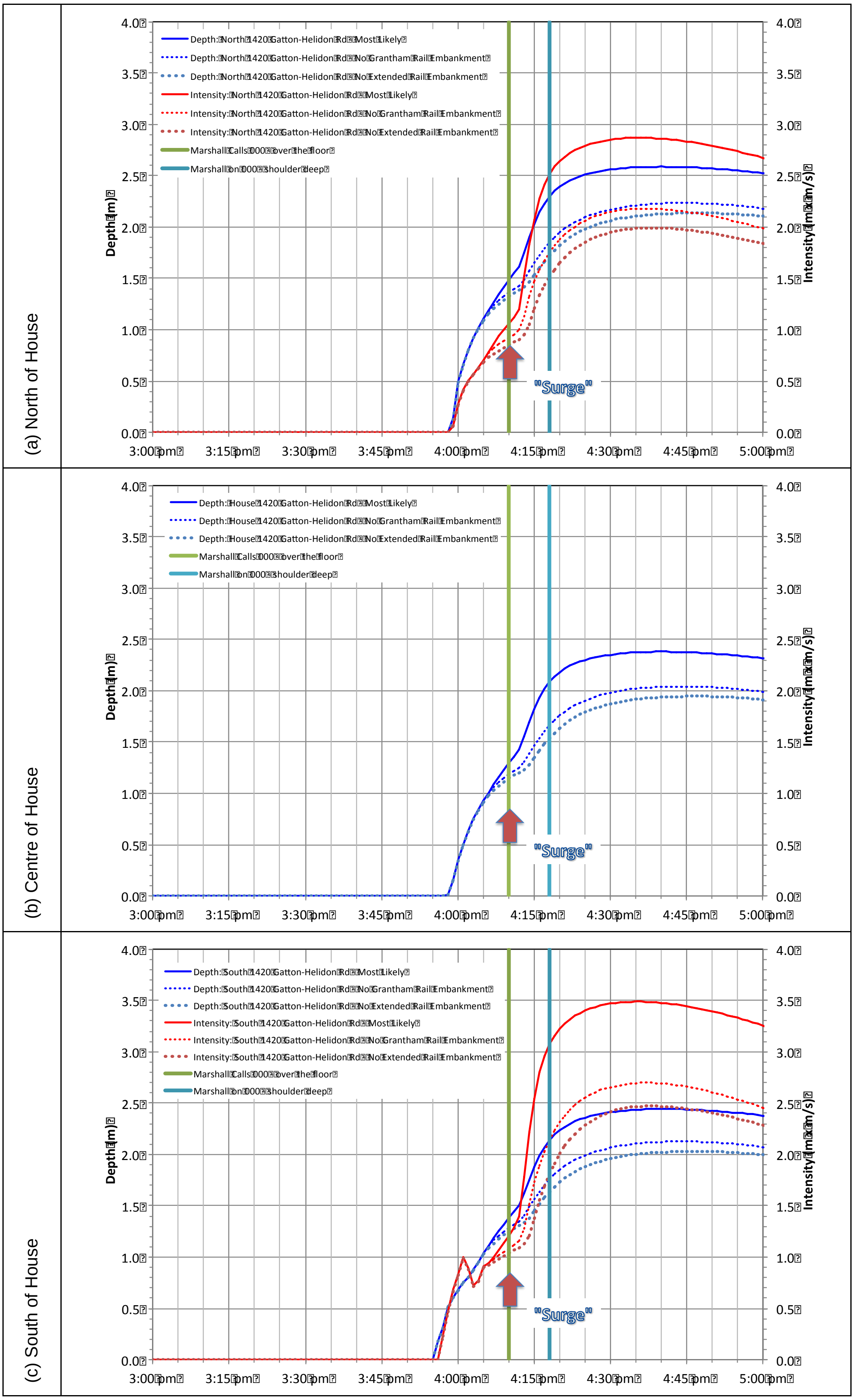


Figure 4.11 – Flow Depth and Intensity at the Location of 1420 Gatton-Helidon Road

5 Consideration of Volume of Flood Water Through Grantham

42. I have been asked to provide an estimate of:

- (i) the total volume of water that passed through the system and passed through Grantham within the relevant period during which the destruction took place; and
- (ii) the ordinary volume of water when the creek wasn't flowing in flood so that it can be subtracted from (i)

43. Item (i) above applies to the 10th January 2011 flood. I have selected the May 1996 flood event as being representative of an ordinary flood for the purposes of my addressing Item (ii).

44. I have extracted flow hydrograph information for both flood events and have plotted these in Figures 5.5 and 5.6 for the 2011 and 1996 flood events respectively.

45. I note that in Figure 5.5 the blue lines represent the total waterway flow and the red coloured lines represent that portion of the flow that was simulated as passing west to east through Western Grantham.

46. Furthermore, although some of the 1996 flood hydrograph shown in Figure 5.6 entered Grantham, I consider that the proportion was relatively small. I consider that the 1996 flood event is a reasonable representation of flow for the purposes of item (ii) above.

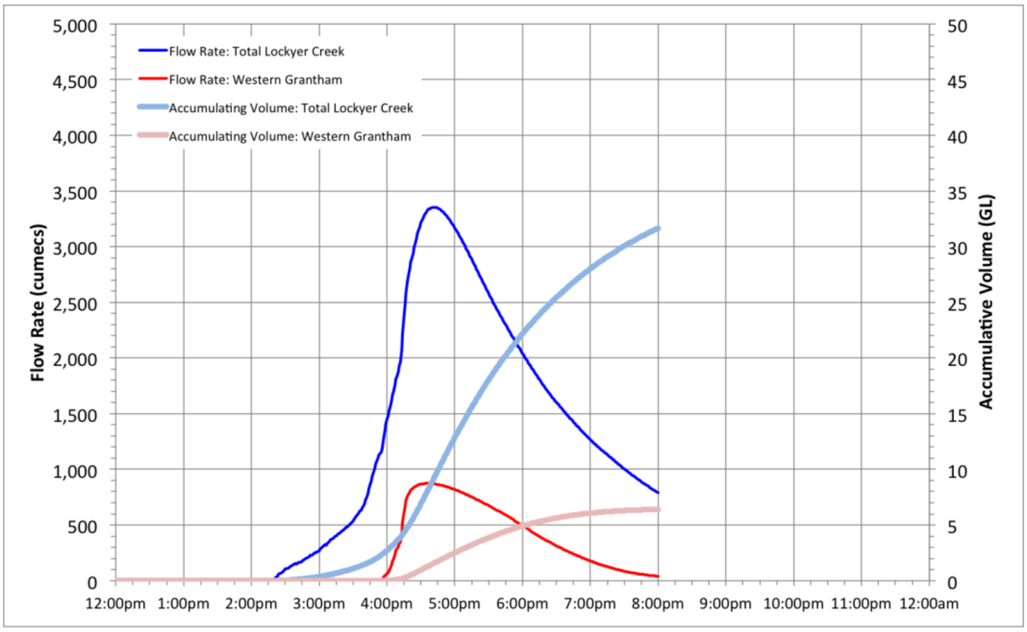


Figure 5.5 – 2011 Lockyer Creek and Overbank Flow Hydrograph and Volume at Near Grantham

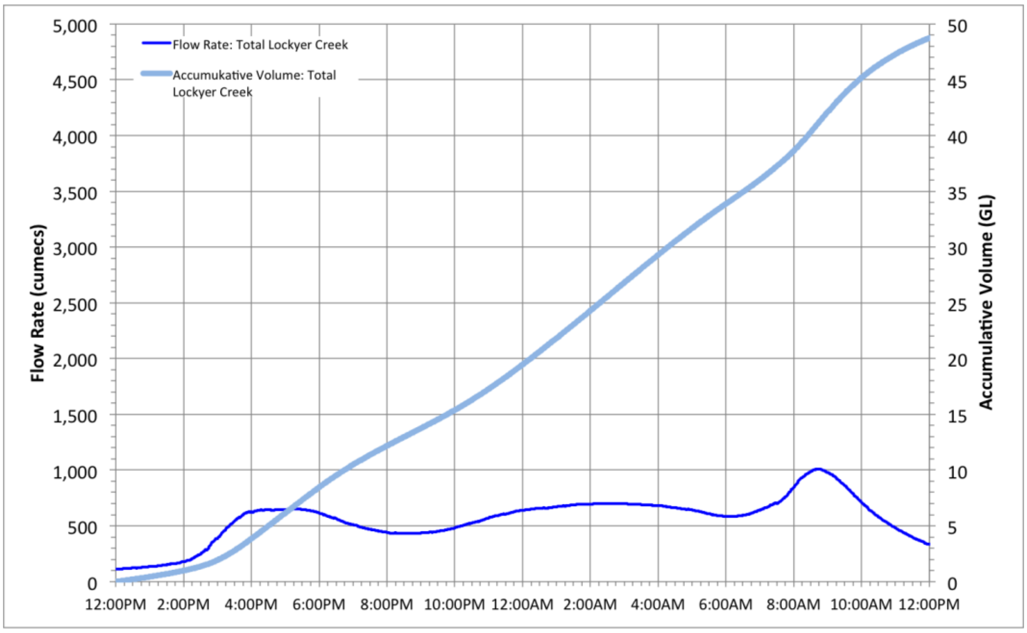


Figure 5.6 – 1996 Lockyer Creek Hydrograph and Volume at Near Grantham

47. I observe from Figure 5.5 that the data for the 2011 event is truncated at 8:00pm. This is because the GFCOI model that I used to produce this flow estimate was set to stop the simulation at this time.

48. I also observe that the total volume of flow that passed by Grantham in the Lockyer Creek and overbank areas amounted to approximately 32GL by 8:00pm. Further, the flow volume that passed through Western Grantham over this same period was about 6GL, or about 20% of the total flood volume to 8:00pm. This outcome addresses Item (i).

49. I observe in Figure 5.6 that the rate of increase in accumulating flow volume for the 1996 flood event appears relatively linear at approximately 50GL over a period of 24 hours, or about 2GL/hr. Therefore, over a 6 hour period 12GL would typically have flown past Grantham under these conditions. I consider that this outcome satisfactorily addresses Item (ii).

6 Lawlers Road Flood Flows

50. I have considered Mr Sippel's evidence at page 138 at lines 5 and following (21 July transcript) wherein Mr Sippel described seeing the running of water down the northern side of the railway line from Dinner Corner towards Sandy Creek.

51. I have reviewed my Most Likely case simulation along Lawlers road. Based on that review I observe that the simulation failed to show water flowing eastwards along Lawlers Road from floodwater that had accumulated around the railway underpass at Dinner Corner on Gatton-Helidon Road.

52. The reason for this was that the spatial resolution of the GFCOI model was not sufficiently fine to properly delineate the Lawlers Road table drains. I have amended the GFCOI model to specifically include the drainage feature of the Lawlers Road table drain as it runs east from Dinner Corner railway underpass.

53. I refer to the updated movie file for the Most Likely simulation listed in Table 1.1. Mr Sippel's observations now corroborate the GFCOI model in this respect.

54. Further, I note that the flow rate of floodwater along Lawlers Road is simulated as being very small. Its inclusion has a minimal effect on simulation outcomes.

7 Flood Depths in the Vicinity of the Kluck and Castle Properties

55. I have been provided with three statements that contain additional accounts of flood inundation in the vicinity of the Kluck and Castle properties:

- a statement by Mr McIntosh dated 20 August 2015; and
- two statements from Mr Castle, one dated 29th January 2011 and the other dated 26th August 2015.

Statement by Mr McIntosh

56. In his statement Mr McIntosh has provided information associated with the 10th January 2011 flood at a number of locations, including Mr Kluck's residence.

57. I have addressed the issues raised by Mr McIntosh concerning Mr Kluck's residence in the following paragraphs.

58. Mr McIntosh has stated that the property located at [redacted] was not inundated during the course of the 10th January 2011 flood.

59. I have prepared a contour plan that has a house on this property circled in red, Figure 6.1. A yellow line is also marked horizontally which crosses through the circle depicting the line of a cross-section that is shown plotted in Figure 6.2.

Figure 6.1 – House on the Property of [redacted]

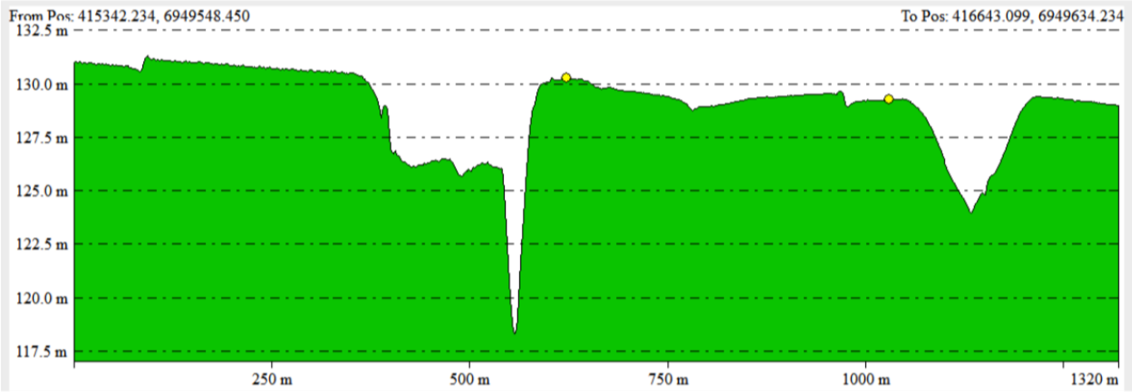


Figure 6.2 – Cross-section through House on the Property of [redacted]

60. I observe that the house sits on a ridge line running east-west between two drainage paths and about 2m higher than the edges of the fields immediately to the north and south. The ground level at the location of the house is shown at around 130.0mAHD.

61. Simulation outcomes from the GFCOI model for the 10th January 2011 flood produce a maximum flood level at the location of the house of about 130.4mAHD, or 0.4m above ground level.

62. I have extracted aerial images of the area around [redacted] from the August 2010 and January 2011 aerial survey data provide to me by LVRC. These are shown on Figures 6.3 and 6.4 respectively.

Figure 6.3 – Aerial Image of [redacted], Pre Flood August 2010

Figure 6.4 – Aerial Image of [redacted], Post Flood January 2011

63. On the basis of my comparison of these two images I observe that portions of 67 Carpendale Road were inundated by the flood as indicated by flood flow marks and sediment deposits covering previously ploughed fields.

64. I am unable to discern from the aerial image if floodwaters (simulated to be around 0.4m deep, as I have noted above) covered the area of land on which the house is located.

65. Further, I refer to peak flood height data provided to me by LVRC as I have discussed in Section 12.4 of my main report. In Figure 12.8b of that report I have presented a comparison between simulated peak flood heights for the 10th January 2011 flood and those peak heights provided to me by LVRC. I observe from this figure that the simulated level at [redacted] is 0.9m higher than the peak height provided to me by LVRC.

Statements by Mr Castle

66. In his statements Mr Castle has provided information associated with the 10th January 2011 flood he observed. Mr Castle has also provided photographs of Lockyer Creek viewed in south-westerly, southerly, and south-easterly directions from a location on the southern side of his residence. I have extracted a locality map from Mr Castle's 2015 statement that shows his residence and have reproduced this on Figure 6.5 below.

67. I note that Mr Castle has stated that the photograph time-stamps show times 2 hours and 50 minutes ahead of the correct time, according to his calculation. That is for example, Mr Castle's photograph P2060259, which has a metadata time-stamp of 4:55pm 6th February 2011, was taken 2 hours and 50 minutes prior, or at 2:05pm on 6th February 2011. I consider it obvious that the photograph was not taken on 6th February 2011 and accept that Mr Castle's calculation for the adjustment of the metadata time-stamp within all his submitted photographs includes an implied date change from 6th February 2011 to 10th January 2011.

68. I have reproduced a cropped enlargement from photograph P2060259 shown on Figure 6.6 (below). I note Mr McIntosh's residence in centre-field background that I have identified with a red dashed line oval shape.

Figure 6.5 – Locality Map from Mr Castle's Statement

Figure 6.6 – Photograph P2060259 by Mr Castle (cropped enlargement)

69. I observe from Figure 6.6 that floodwater had broken the northern bank of Lockyer Creek at Mr Castle's location, and is just on the brink of a full breakout adjacent to Mr McIntosh. I have indicated (with the overlaid red dotted oval shape) the paddock area on Figure 6.6 that separates Mr McIntosh's residence from Lockyer Creek. I also observe within this paddock an area of backwater within a depressed local drainage path that lies between Mr McIntosh's residence and the creek.

70. I also observe a photograph labelled IMG_0229.jpg contained in material provided by Mr McIntosh taken at 3:15pm on 10th January 2011 that contains the same vista shown in Mr Castle's image (Figure 6.6), but from the location of Mr McIntosh. I have reproduced a cropped enlargement from Mr McIntosh's photograph shown on Figure 6.7.

71. I further note that photograph IMG_0229.jpg was made on an iPhone with reliable time-stamp.

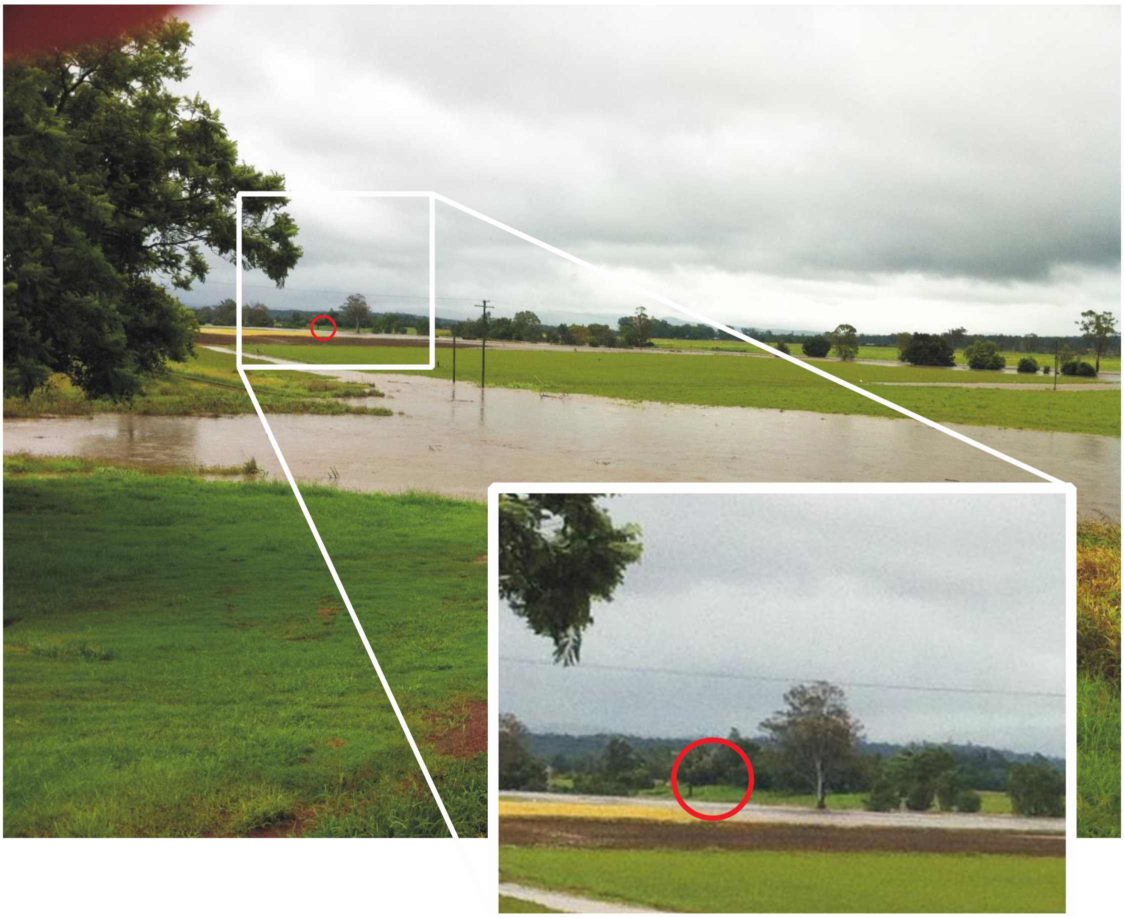


Figure 6.7 – Photograph IMG_0229 by Mr McIntosh (cropped enlargement)

72. I observe from Figure 6.7 that flooding conditions at the location adjacent to Mr McIntosh's residence appears similar to those shown in Figure 6.6. That is, Lockyer Creek is just starting to break its banks, and the existence of backwater inundation of a drainage path in the middle-ground of the figure.

73. In view of the above I consider it likely that the image shown in Figure 6.6 (Mr Castle's) is more consistent with a time of 3:15pm rather than the time estimated by Mr Castle.

74. I note that outcomes from my simulation modelling of the Most Likely scenario case show breakout timing consistent with Mr Castle's observations, if I take into consideration the likely time of Mr Castle's photograph, as discussed above.

75. I also note Mr Castle's observation that water did not enter his residence and remained at a distance of about 120m from it. As I have indicated above, the photographs taken by Mr Castle on 10th January 2011 were taken from a location on the southern side of his residence.

76. I have reproduced a copy of Mr Castle's photograph P2060273 that I observe was taken at a time close to the peak of the flood. This photograph is Figure 6.8 below.

Figure 6.8 – View South-West Over Lockyer Creek from the Southern Side of Mr Castle's Residence (Photograph P2060273)

77. From the location of objects shown on Figure 6.8 it is my view that this image was taken at a location approximately 20m directly south of Mr Castle's residence. I observe that the extent of flood inundation shown in this image is well within a distance of 120m from Mr Castle's residence.

78. In consideration of the above, it is my view that although Mr Castle did not indicate any particular direction when he referred to the closest proximity of flood inundation to his residence, he clearly could not have meant it to apply to the south of his residence.

79. I have produced an aerial image, Figure 6.9, showing the region surrounding Mr Castle's residence and plotted on contours of peak flood depth from the Most Likely scenario simulation outcomes. I have further drawn a white circle with a radius of 120m from Mr Castle's residence.

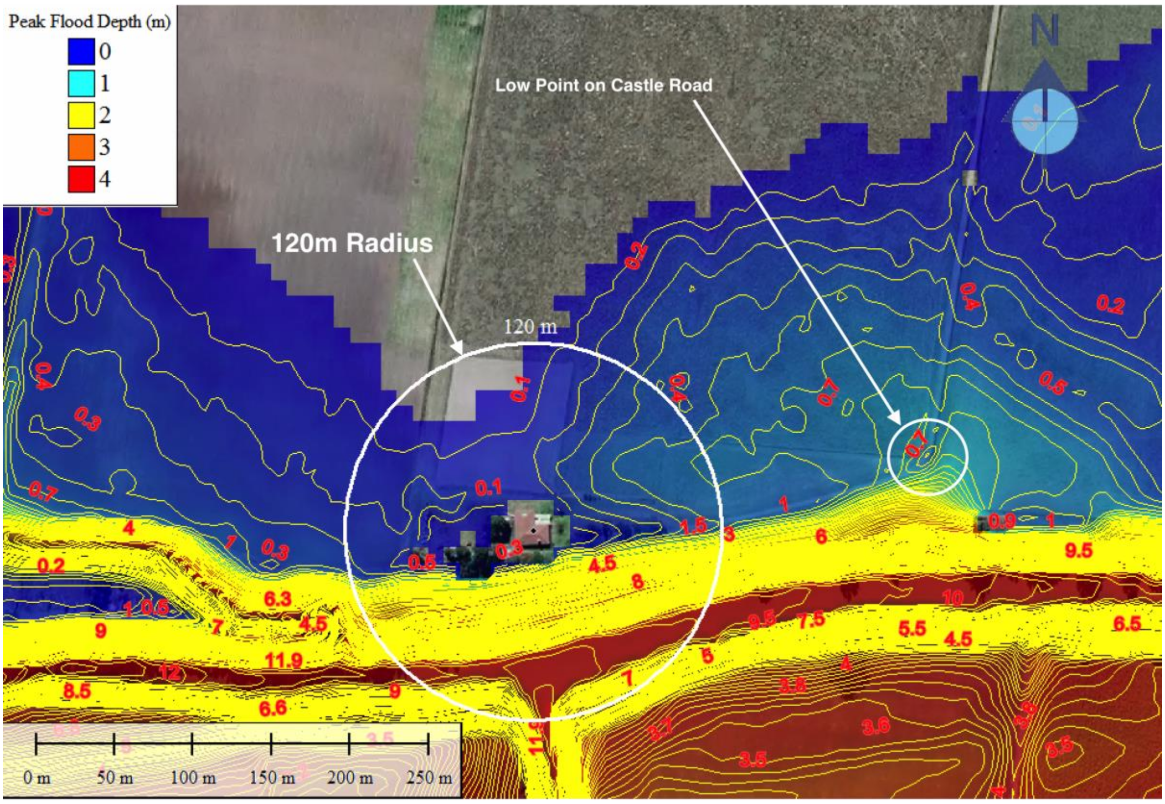


Figure 6.9 – Peak Flood Depth Around the Castle Residence, Most Likely Scenario

80. I observe from Figure 6.9 that within 120m from Mr Castle's residence, the maximum simulated flood depth:

- to the north, is about 0.1m;
- on the creek bank to the west, increases up to about 0.2m;
- on the creek bank to the east increases up to about 0.5m; and
- to the south is Lockyer Creek and is very deep.

81. I further observe from the information presented in Figure 6.9 that Mr Castle's residence remained flood free.

82. Given the above, I observe that the simulated peak depths to the north, west and east of Mr Castle's residence ranges from about 0.1m to about 0.5m. I consider these depths to be shallow. I further consider the depth to the north to be within the calibration accuracy of the GFCOI model as indicated in Section 12.4 of my main report. On this basis I consider that the GFCOI model is consistent with Mr Castle's observations and photographs, but only for the immediate vicinity of the house, and to its north.

83. Finally, Mr Castle made further reference to the peak flood depth along Castle Road being no more than wheel height. I consider that a utility vehicle (e.g. Toyota Hilux) would have a wheel diameter between 0.7m and 0.8m. I observe on Figure 6.9 that the low point on Castle Road occurs close to the creek bank, at the bend in the road (also indicated by a white circle). I further observe that the peak simulated flood depth at this location is 0.7m to 0.8m. I consider that simulation outcomes from the GFCOI model are consistent with Mr Castle's observation at this location.

Consideration of Simulated Peak Levels

84. I have considered the information provided in the statements by Mr McIntosh dated 20th August 2015 and Mr Castle dated 29th January 2011 and 26th August 2015.

85. I observe that Mr McIntosh's statement contains information on peak flood levels at the location of Mr Kluck's residence at 67 Carpendale Road, and that Mr Castle's statements provide information on peak flood levels at his residence and over the length of Castle Road. I further observe that Mr Castle's property lies directly across Lockyer Creek from Mr Kluck's residence.

86. In my view the peak flood height information at Mr Kluck's residence indicates a discrepancy with those simulated by the GFCOI model.

87. However, it is also my view that peak flood height information at Mr Castle's residence and along Castle Road is consistent with GFCOI model simulation outcomes.

88. I consider that the noted discrepancy at the location of Mr Kluck's residence is of no consequence to my investigations and outcomes because:

- the area around Mr Kluck's residence is too far removed from Grantham and the Grantham Quarry for there to be any effect on my assessment of the Grantham Flood;
- the GFCOI model has demonstrated good calibration to peak flood heights throughout Grantham, about Grantham Quarry, and upstream of the quarry to Klucks Road; and
- the GCFOI model has demonstrated good corroboration with eye-witness observations ranging throughout Grantham, about Grantham Quarry, and upstream of the quarry to Mr Castle's property.

89. I have considered the likely reasons for the discrepancy at Mr Kluck's residence and in my opinion it is most likely to be because of:

- survey error of peak flood height; and / or
- error in the interpretation or datum adjustment of LIDAR data in the near vicinity.

8 Consideration of Material Provided by Mr Bower

90. I have reviewed material provided by Mr Bower, One Nation Candidate for Beaudesert. The material makes reference to observations and statements relayed to Mr Bower from Mr Sippel and Mr Warburton.

91. In summary, the material concerns:

- the flow of floodwater through and around the Grantham Quarry;
- the presence of the Batching Plant and other works associated with the Grantham Quarry; and
- Mr Warburton's Workplace Health and Safety issues.

92. I consider that all the material raised in connection with the flow of floodwater about the Grantham Quarry, including the presence of the Batching Plant, have been adequately accounted for in my investigation and reports produced to-date. Further, I consider additional material provided by me in this supplementary report is of relevance in this regard.

93. Mr Bower's additional material has not altered my opinion and findings in connection with the Grantham Flood.

94. I note that issues associated with Workplace Health and Safety are beyond the scope of my investigation and advice.

9 Consideration of Statements Provided by Dr Galletly

95. I have been provided with a number of statements from Dr Galletly that concern the Grantham flood:

- GFC-02: The Grantham Flood, 10 January 2011 – an analysis;
- GFC-07b: The second Flood Grantham Flood Inquiry, Part 1: Science and Hydrology;
- GFC-11: The second Flood Grantham Flood Inquiry, Part II: Flood estimation in the Grantham catchment;
- GFC-10: The second Flood Grantham Flood Inquiry, Civil engineering metaphysics and hydrology; and
- GFC-14: The Grantham Flood Commission of Inquiry – August 2015, Explaining the sudden surge of water into Grantham on 10 January 2011.

96. I have reviewed these statements and observe that the content is broad and includes matters that I consider lie outside the scope of my investigations. I have therefore limited my consideration to those matters that I consider to be of relevance to my investigations.

<u>GFC-02: The Grantham Flood, 10 January 2011 – an analysis</u>

97. This statement provides Dr Galletly's assessment of the Grantham Flood. The scope of his assessment is similar in many respects to that which I have covered in my investigations.

98. I observe that two key components covered by Dr Galletly relate to:

- flood hydrology; and
- flood hydraulics.

99. I consider that the information presented under the hydrology section is not of direct relevance to the investigations that I have undertaken. I have this view because the flood hydrology of the 10th January 2011 flood has been substantially defined by records of Lockyer Creek flow at Helidon. Furthermore, BOM records indicate little rainfall in the vicinity of Grantham on the 10th January 2011, which meant that local catchment hydrology (i.e. rainfall runoff) was not an item of great significance for the Grantham Flood.

100. I further consider that the hydraulic assessment provided by Dr Galletly has over-simplified the situation to such an extent that his schematisation does not bear resemblance to what occurred during the flood. In this regard, I specifically make mention of Dr Galletly's portrayal of the *M3* water surface profile and associated *hydraulic jump* which, in my opinion is only applicable to within the confines of the quarry pit, and no further downstream.

101. In summary, the contents of this paper has not contributed to or changed my opinions or conclusions in relation to the Grantham Flood as I have previously presented.

<u>GFC-07b: The second Flood Grantham Flood Inquiry, Part 1: Science and Hydrology</u>

102. I consider this statement to be largely philosophical in content. In my view it is not of direct relevance to my investigations.

GFC-11: The second Flood Grantham Flood Inquiry, Part II: Flood estimation in the Grantham catchment

103. I observe that this statement largely concerns the topic of hydrology and elaborates further on statement GFC-02. For the reasons I have stated above, I do not consider that the content of this statement is of direct relevance to my investigations.

GFC-10: The second Flood Grantham Flood Inquiry, Civil engineering metaphysics and hydrology

104. I observe that this statement largely presents philosophical considerations associated with catchment hydrology. For the reasons I have stated above, I do not consider that the content of this statement is of direct relevance to my investigations.

GFC-14: The Grantham Flood Commission of Inquiry – August 2015, Explaining the sudden surge of water into Grantham on 10 January 2011

105. I observe that in this statement Dr Galletly states his disagreement with the substance and outcomes of my investigations. The basis of his disagreement appears to be largely on philosophical grounds and the presumption that my experience and technical capability is not sufficient for the tasks I have undertaken.

106. I disagree with Dr Galletly's views.

10 Additional Evidence by Mr and Mrs Arndt

107. I refer to evidence given by Mr and Mrs Arndt during the course of the hearing:

- (a) Mrs Arndt's evidence at p. 95 lines 39 - 50 on 21 July 2015 (see: http://granthaminquiry.qld.gov.au.s3-ap-southeast-2.amazonaws.com/Transcripts/21-July-2015-Transcript.pdf); and
- (b) Mr Arndt's evidence at p.325 lines 9-16 on 23 July 2015 (see: http://granthaminquiry.qld.gov.au.s3-ap-southeast-2.amazonaws.com/Transcripts/23-July-2015-Transcript.pdf).

108. I observe from this evidence that:

- while Mrs Arndt and Mr Arndt were clinging to the branches in a tree, the flood water level rose to their necks; and
- Mrs and Mr Arndt went back to the tree and by measuring from the ground up to the point they were in the trees and that based on this measurement, they both considered the water reached 15 feet in height at that location.

109. I have identified the location of the tree that I understand Mr and Mrs Arndt refer to as indicated by a yellow rectangle in an aerial photograph contained in Mrs Adndt's statement dated 1st July 2015. I have reproduced a copy of this image in Figure 10.1.

Figure 10.1 – Arndt's Vehicle Location

110. I have produced a flood depth hydrograph from simulation output from the GFCOI model for the Most Likely case and show this in Figure 10.2.

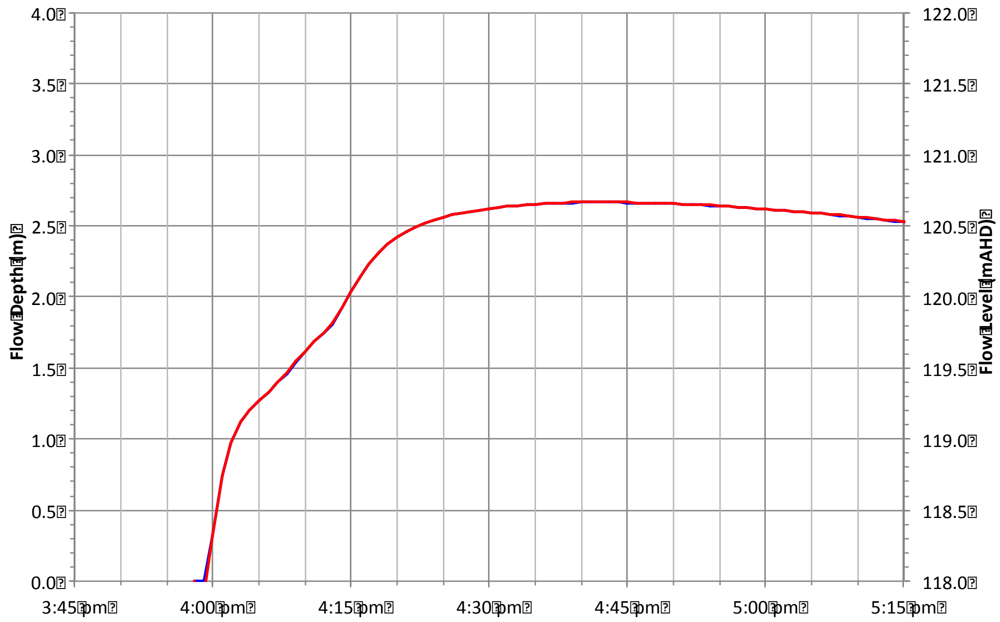


Figure 10.1 – Simulated Flood Depth and Level Hydrograph at the Arndt Tree

111. I observe from Figure 10.1 that the ground level at the tree is close to 118.0mAHD.

112. This level is approximately 0.5m lower than the level of the adjacent Gatton-Helidon Road that is close to 118.5mAHD, from the August 2010 LIDAR aerial survey.

113. Further, I refer to LVRC flood height survey data for this same location as indicated in Figure 12.8a of my main report:

- ID 3084_L4: Peak Height 120.75mAHD

114. In my opinion the surveyed peak height provided by LVRC is reliable and the peak flood depth at the tree was about 2.8m.

115. I observe from Figure 10.1 that the simulated peak flood level at this location is about 120.7mAHD, or within 0.1m of the surveyed level.

116. I note that there is a discrepancy with the observations of Mr and Mrs Arndt as to the peak flood level at the tree compared with the surveyed peak and the simulated peak. I can offer no technical reason of explanation.

11 Additional Evidence by Mr Gillespie

117. I have been provided with the following additional material concerning a crane located on Mr Gillespie's property:

- a statutory declaration from Mr Gillespie dated 31st August 2015;
- submission by Mr Gillespie to the GFCOI;
- statement from Mr Gillespie dated 17th February 2011;
- transcript of evidence given to the GFCOI on 28th July 2015 at pages 537 to 539; and
- technical specifications for the crane provided by Maddens.

118. I have reviewed this material and noted Mr Gillespie's observation that the crane was moved during the course of the 10th January 2011 flood. Mr Gillespie has provided different observations to the extend of this movement:

- in his 2011 statement Mr Gillespie estimated the crane moved approximately 15m from its original position (paragraph 29);
- in his submission to the GFCOI Mr Gillespie estimated the crane moved approximately 30m to 40m from its original position (page 2);
- in the transcript of evidence before the GFCOI at page 537 Mr Gillespie estimated the crane moved approximately 20m to 30m from its original position; and
- in his statutory declaration Mr Gillespie provided a scale map which appeared to show the crane moved between 30m and 40m from its original position;

119. I have also noted from Mr Gillespie's statutory declaration that:

- the location of the crane before the flood placed it in the vicinity of very high intensity flow (about $3m^2/s$); and
- the photographs SG-2 indicate considerable debris was conveyed by the flood flows onto and past the crane.

120. I have considered Mr Gillespie's observations, together with the other material that I have mentioned above, to determine whether I can confirm whether or not the flow characteristics simulated by the GFCOI model is consistent with the movement of the crane described by Mr Gillespie. In this regard, I am of the opinion that:

- it is likely that debris accumulation on the crane during the course of the flood would have fully blanketed the crane thereby creating a significant area for flow to press against. Furthermore, I note that the debris appears to contain the remnants of building structures (e.g. plastic sheeting and framework) and I am further of the view that it is likely that cohesive bodies of debris would have snagged onto the crane during the course of the flood;
- the extent of the debris accumulation on the crane would have impacted the flood loading and this would have had a bearing on the crane's movement;
- I have not been given sufficient data on the extent of debris accumulation on the crane during the course of the flood to allow me to definitively make calculation of the extent of that flood

loading. Consequently I cannot definitively say whether or not simulated flow characteristics from the GFCOI model confirm Mr Gillespie's description of the crane movement; and

- in any event, I note that at the initial location of the crane, GFCOI model simulation outcomes showed the presence of high intensity flow. The occurrence of this high intensity flow, in conjunction with potential for debris accumulation and debris snagging on the crane would have created a flood loading situation entirely consistent with the described movement of the crane.

12 Addendum Statement by Ms Gearing

121. I have been provided with an addendum statement by Ms Gearing dated 24 August 2015.

122. The statement contains 13 sections. Of these, Section 12 Hydrology, is directly associated with the scope of my investigations. Within Section 12 Ms Gearing discusses:

- the level of flood water at the location of Kapernicks Bridge;
- flooding on 11th January 2011;
- the events relating to Teddy Perry; and
- flood levels about Mr Gillespie's residence.

<u>Kapernick's Bridge</u>

123. I consider that eye-witness observations of flow characteristics and water level differentials at Kapernick's Bridge are local to the vicinity of the bridge. Furthermore, in my opinion, none of these observations are in any way connected with the presence of the Grantham Quarry. I considered that these observations are on account of the local waterway geometry, flood levels immediately downstream from the bridge, the geometry of the bridge, the flood flow rates, and debris; all of which, in my opinion, are unaffected by the presence of the Grantham Quarry.

124. Further, I consider that the information provided by me to the GFCOI sufficiently addresses the basis of my opinion, and in particular Section 12.5 of my main report.

<u>11th January 2011 Flood</u>

125. DNRM gauging station records from Helidon show that flows in Lockyer Creek on 11thJanuary 2011 at Helidon were substantially smaller than those of 10th January 2011. Also, eye-witness statements have confirmed that flooding at Grantham on 11th January 2011 was considerably less than that of the 10th January 2011.

126. For these reasons, I consider that the 11th January 2011 flood event was not of relevance to the scope of my investigations.

<u>Teddy Perry</u>

127. I note that there is very little information that records the track of the Perrys in the Lockyer Creek floodwaters. However based on the limited information that I do have, I consider that the information I have provided to date is sufficient to demonstrate that the GFCOI model simulation outcomes are consistent with the movement of Teddy Perry from the Helidon Bridge to Mr Gallagher's property.

<u>Mr Gillespie's Residence</u>

128. Figure 12.8b of my main report presents the difference between simulated and surveyed peak flood heights in the vicinity of the Gillespie's residence. The figure shows a comparison point at the location of Mr Gillespie's residence that indicates the simulated peak height being 0.1m below the recorded peak.

129. I observe from Figure 3.9 above that under Most Likely case conditions the simulated peak flow depth at the Gillespie location was about 2.0m.

130. In Ms Gearing's statement, she suggests that the peak flood level at the Gillespie property was of the order of 4m to 5m in depth. That is, over about twice the recorded (and simulated) flood depth.

131. Ms Gearing has provided a number of suggestions as too what may have been responsible for this difference. I have considered these suggestions, amongst others as contained in my main report, and have concluded that the presence of mud on the top of the roof ridge at the Gillespie property is most likely to be on account of another non-flood related reason.

J.C. Macintosh

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