DTMR M1 UPGRADE

FLOOD EVENTS OF FEBRUARY AND MARCH 2022
ADDITIONAL FLOODING ANALYSES BASED ON NEW DATA

Prepared for:

[redacted]

SLR Ref: 620.31045-R03
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PREPARED BY

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with [redacted] (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
620.31045-R03-v0.1	5 April 2023	[redacted]	[redacted]	

CONTENTS

FIGURES

1 INTRODUCTION

1 I refer to the [redacted] letter of instruction of 23 June 2022 in relation to this matter, and subsequent detailed discussions with [redacted] and Department of Transport and Main Roads (DTMR) personnel. SLR Consulting under my direction has prepared a number of previous reports related to this matter in accordance with instructions. In particular, I refer to the report of 7 October 2022 (620.31045-R01-v0.1) which analysed flooding behaviour in the Tallebudgera Creek catchment during the major storm event of late February and early March 2022, and the report of 19 January 2023 (620.13045-R02-v0.1) which considered the potential impact of this flooding on residential properties in Elanora and Tallebudgera. The principal aim of this work was to quantify the impact, if any, of the temporary construction works in Tallebudgera Creek for the M1 upgrade on flood levels in the catchment.

2 Significant additional flooding information has now been provided to SLR Consulting from a number of sources, including [redacted]. This information has been used to recalibrate the TUFLOW hydraulic model used in the analysis, and is considered to have significantly increased the accuracy of the assessments undertaken.

3 For completeness sake, I note that DTMR is currently constructing the M1 Pacific Motorway upgrade for the Varsity Lakes to Tugun (VL2T) project. The project comprises three packages, being Package A (VL2B), Package B (B2PB) and Package C (VL2T) as per the coloured sections on the plan on the next page. The bridge construction work underway at Tallebudgera Creek involved the installation of temporary constructions works in the creek channel. These works were in place at the time of the February 2022 flooding.

2 RAINFALL INTENSITY ANALYSIS

4 Based on available rainfall pluviograph and ALERT rainfall station data in the Tallebudgera Creek catchment, it was determined that the February 2022 storm event had an Average Exceedance Probability (AEP) of between 2% and 5%, and probably closer to the 2% case which is equivalent to the 50 year Average Recurrence Interval (ARI) event.

5 In comparison, the March 2022 storm event had an AEP of 20%, equivalent to the 5 year ARI event, and was considerably less severe than the February storm.

3 REVISED FLOOD MODELLING

3.1 General

6 The previous flooding analyses carried out for this project were based on a WBNM hydrological model (to predict the flow hydrographs for the February 2022 event) and a TUFLOW hydrodynamic model (to predict flood levels and flow velocities throughout the area of interest).

7 The hydrological modelling remains unchanged from the previous reporting, and is considered to replicate monitored information very accurately. However, the hydraulic model has been significantly revised, primarily on the basis of additional flood level information which is now available. Since the completion of the previous reporting, DTMR has been able to supply SLR Consulting with additional flood level information from the central part of the catchment. [redacted] was able to provide relevant information to DTMR in relation to peak water levels in Larch and Daffodil Streets, and Kentia Court. In addition, a number of videos and photographs have been provided by members of the public which show allotment and over-floor flooding in a number of urban locations in the vicinity of 19th Avenue. While this information shows a degree of scatter in specific locations, the averaged information has been invaluable in verifying the calibration adopted for the flood model.

8 The [redacted] information and the video data has not been listed in detail in this report to maintain the privacy of the data. However, all relevant and acceptable level information has been used in the verification process, resulting in increased level degree of reliability for the flood modelling.

9 The TUFLOW model has been extended westwards to now include the Coplicks Bridge flood gauging station, and the model has been recalibrated on the basis of that additional level information and then verified against the other available flood level data from the catchment.

10 The net result is that predicted flood levels have increased by up to 480 mm in the catchment in comparison to the previous estimated levels. This means that many more properties in the catchment are likely to have been affected by flooding than was estimated in the previous reporting, However, the modelling also shows that the extent of flooding was less affected by the temporary construction works than had been previously estimated,

11 The revised TUFLOW model was used to determine peak flood depths, maximum flood levels and maximum flow velocities for the February 2022 event, as well as design flood events with AEPs of 1%, 2% and 5%. These latter analyses are provided solely for comparative purposes in order to demonstrate that the February flood is generally consistent with a 2% to 5% AEP design event. In general, the results indicate that the February flood event had an AEP of slightly more than 2%, corresponding to a Recurrence Interval of somewhat less than 50 years. This finding is entirely consistent with the hydrological assessment based on the recorded rainfall intensities. The attached Figures 1 to 14 provide the relevant peak flood level information in a graphical form.

12 Those Figures provide the following information:

- Figures 1 to 3 Pre-development peak flood levels for the 1%, 2% and 5% AEP events
- Figures 4 to 6 Pre-development peak flood depths for the 1%, 2% and 5% AEP events
- Figure 7 to 9 Pre-development peak velocities for the 1%, 2% and 5% AEP events
- Figures 10 and 11 Pre-development and construction phase peak flood levels for the February 2022 event
- Figure 12 and 13 Pre-development and construction phase peak flood depths for the February 2022 event
- Figure 14 Peak flood level afflux for the February 2022 event

13 A comparison of Figures 1 (5% AEP), 2 (2% AEP) and 10 (February 2022 event for pre-construction conditions) shows that the flood event which occurred in late February 2022, in the absence of any construction works, would have fitted comfortably between a 2% and 5% AEP event. This is entirely consistent with the rainfall and hydrologic analysis reported on above. That is, if the construction works has not been underway, the flood levels experienced throughout the catchment would have been lower than those for a 2% AEP event, but higher than those for a 5% event.

14 The flood modelling demonstrates that the M1 construction works at the Tallebudgera Creek crossing have increased flood levels in the catchment from the M1 bridge crossing location upstream to Coplicks Bridge. Figure 14 presents the peak flood afflux for the February 2022 flood event, ie the increase in peak flood level resulting from the construction works.

15 More detailed review of the results for the peak afflux case provides the following conclusions:

- Increase of up to 300 mm immediately upstream of the M1 Tallebudgera Creek bridge crossing
- Increase of 140 mm at the [redacted] located at [redacted] Tallebudgera Creek Road
- Increase of 70 mm on eastern side of Heather Street
- Increase of 60 mm upstream of the overflow culverts and around Woolworths
- Increase of 25 mm at Kentia Court
- Increase of 25 mm at Daffodil Street
- Increase of 20 mm at Larch Street
- No increases in flood level downstream of the M1

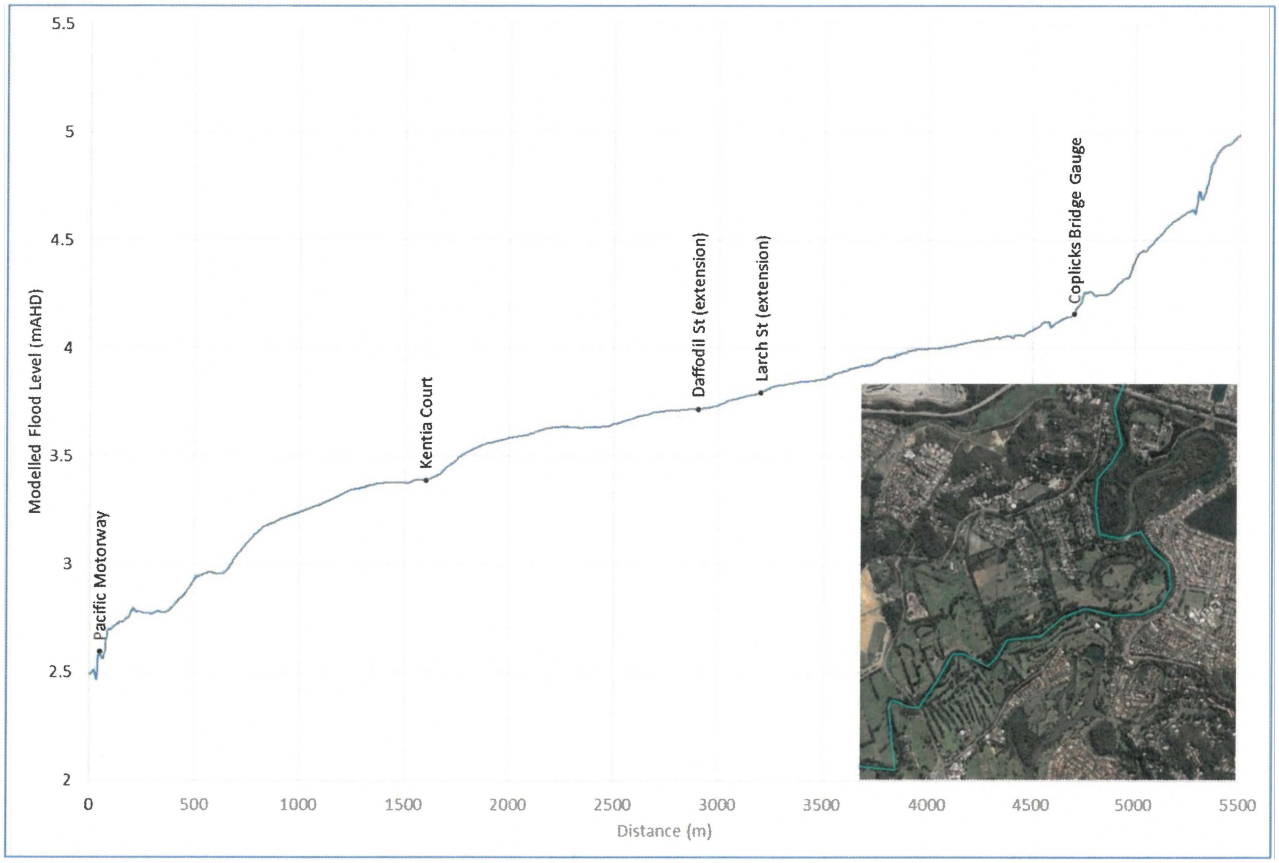
3.2 Comparison Between Recorded and Modelled Flood Levels

16 DTMR has supplied a number of surveyed flood levels for the February 2022 event based on debris marks upstream and downstream of the M1 as well as recorded flood levels at a gauging station downstream of the M1. This information is presented in the following table together with relevant model results:

Location	Recorded Level (m AHD)	Calculated Level (m AHD)	Difference (m)
Oyster Creek gauge (downstream of M1)	2.59	2.65	+0.06
Martin Shiels Park (downstream of M1)	2.45 to 2.52 (average = 2.49)	2.49	+0.00
Site Office (upstream of M1)	2.88	2.80	-0.08
Upstream of M1 Overflow Culverts	3.1 to 3.2 (average = 3.15)	3.25	+0.10
Larch St ([redacted])	3.6 to 4.2 (Average = 3.9)	3.8	-0.10
Daffodil St ([redacted])	3.5 to 4.0 (Average = 3.75)	3.7	-0.05
Coplicks Bridge gauge	4.27	4.25	-0.02

17 As noted above and included in this table, the model verification process also used data provided by [redacted].

18 This comparison demonstrates good consistency between measured and calculated flood levels. The TUFLOW model is considered to accurately replicate actual catchment behaviour which validates the hydraulic modelling. It is noted that the inclusion of the flood level information upstream of Kentia Court has resulted in increased predicted flood levels which are consistent with recorded data. The change in flood level with increasing upstream distance is illustrated in the figure on the next page.


5.5
5
4.5
4
3.5
3
2.5
2
Modelled Flood Level (mAHD)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
Distance (m)
Pacific Motorway
Kentia Court
Daffodil St (extension)
Larch St (extension)
Coplicks Bridge Gauge

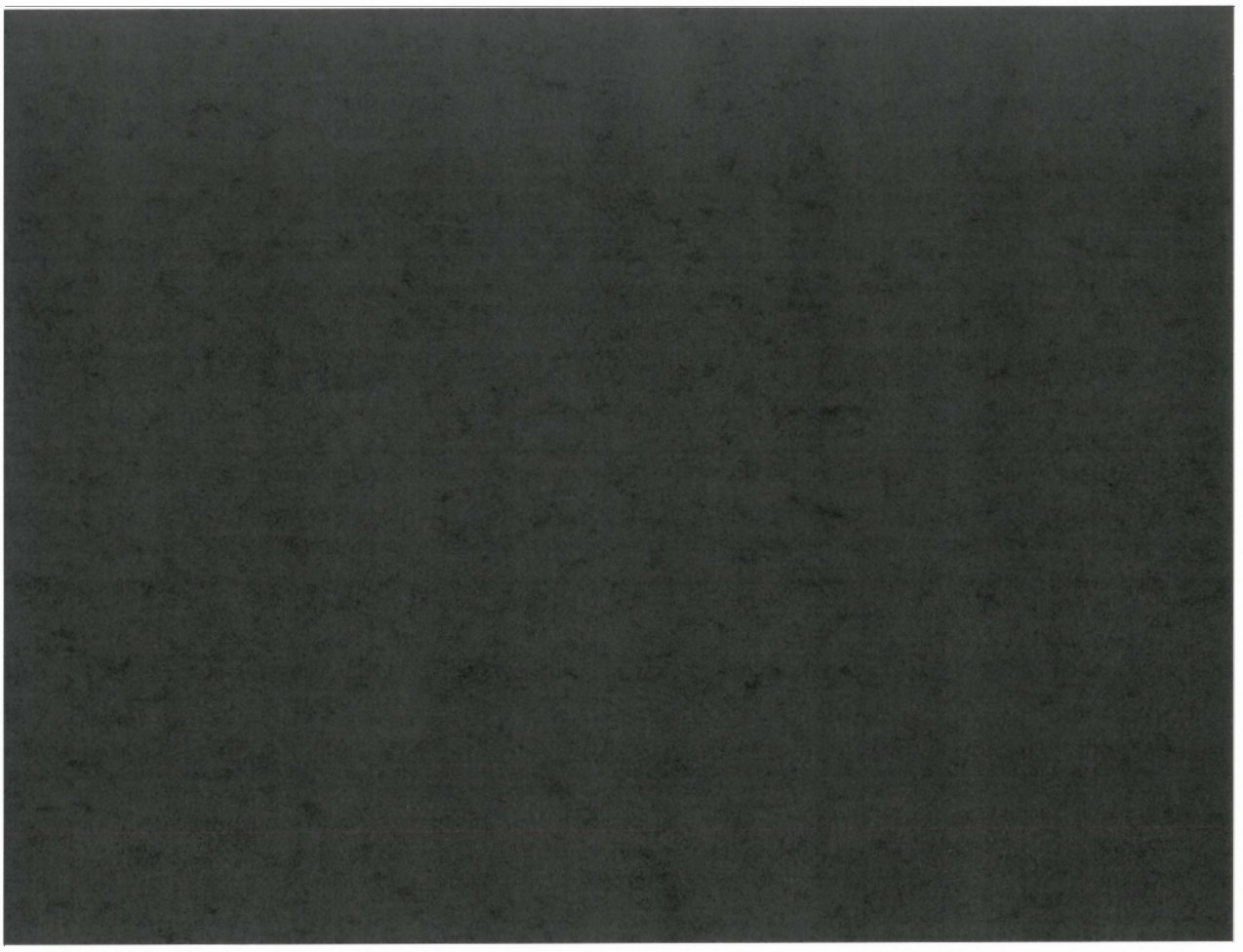
4 POTENTIAL IMPACTS OF CONSTRUCTION PHASE AFFLUX ON EXISTING DEVELOPMENT

19 Figure 14 shows widespread low-level impacts (increases in peak flood level of between 10 and 100 mm) generally in the urbanised catchment areas upstream of the M1, and extending to the upstream extent of the model at Coplicks Bridge. In a substantial change from the previous reporting (v0.1 dated 7 October 2022), the revised flood mapping now shows extensive allotment inundation in many locations throughout the area of interest, particularly in the vicinity of Larch and Daffodil Streets. While the previous mapping also showed extensive allotment inundation, it did not indicate that significant over-floor flooding was likely to have occurred.

20 However, it needs to be recognised that the level information contained in the flood model has been derived almost entirely from Lidar (aerial laser survey) data obtained from aerial photography. The Lidar data does not detect floor levels in buildings.

21 Normally, house floor levels would be set at least 225 mm above the allotment ground level. Inundation of an area in the flood model (and in the mapping) therefore does not necessarily indicate that habitable floors have been flooded, although that is likely to have occurred in many locations. For example, the depth of flooding on allotments in Kentia Court (Figure 13) is generally less than 250 mm, which may indicate that over-floor flooding was not prevalent in this areas. Conversely, a number of allotments in Daffodil Street show inundation depths in excess of 500 mm, which probably means that most houses were flooded. Given the more extensive inundation indicated by the revised flood modelling, conclusions in this regard are difficult without accurate knowledge of actual habitable floor levels. The best which can be stated is that extensive road and allotment flooding occurred throughout the area of interest, with the likelihood that over-floor flooding probably occurred in many locations.

22 DTMR has provided the following aerial photograph to SLR Consulting, showing the location of flooding complaints received after the February 2022 flood event.



23 A comparison of this photograph with Figure 14 allows the following conclusions to be drawn:

- Flood level increases in the order of 25 to 30 mm occurred in the Larch Street, Daffodil Street and Elm Court vicinities. Given the reduced magnitude of the afflux, and the average inundation depths indicated on Figure 13, two scenarios are most likely. Either houses were flooded, but would have been flooded anyway, or houses were not flooded. In order for a property to have been adversely affected by the construction works, it would need to sit in a very narrow level band, where the pre-construction flood level was below the floor level and the construction flood level was above the floor. A knowledge of simple statistics would dictate that the number of affected houses is likely to be minimal. However, the actual impact can only be assessed when accurate floor levels are available.
- Similar increases occurred in the vicinity of Kentia Court. Again, the number of adversely affected properties is likely to be low, but detailed site survey of existing floor levels would be required to further quantify the outcome.

- Flood level increases of 60 to 70 mm occurred in the vicinity of Heather Street, and around the Woolworths shopping centre. Because of the increased afflux, it is more likely that residences and retail businesses in these locations may have suffered adverse impacts as a result of construction activity. Again, this finding would be dependent on the results of site survey of existing floor levels.
- No increases beyond the nominal 10 mm were generally indicated in residential locations downstream of the M1 embankment. While there are minor flood level increases in the order of 25 to 50 mm immediately downstream of the embankment, these affluxes do not appear to have extended more than twenty metres downstream and seemingly did not impact on any existing residences.
- The model results and hydraulic theory do not support a finding that the construction works had any impact on buildings or residences in Township Drive, Japonica Drive or Colvillea Court

5 HOUSE AND PROPERTY FLOODING ASSESSMENT

24 The following table presents a detailed summary of the habitable floor, garage floor and front yard levels adopted in our analyses, as well as comments on likely flooding impacts throughout the areas of interest, based on the revised flood modelling referred to above. Levels were recorded on 133 allotments in the area upstream of the M1 by the road survey process.

25 A statement of Direct in the Method column means that the actual habitable floor level was directly measured during the data collection phase. Garage in the Method column indicates that the actual garage floor level was similarly measured directly by LIDAR for the lot in question. Consequently, the value given in the Floor Level column is either the actual measured habitable floor level, the actual measured garage level, or the estimated habitable floor level based on adding 225 mm to the front yard level when either of the other two levels were not available.

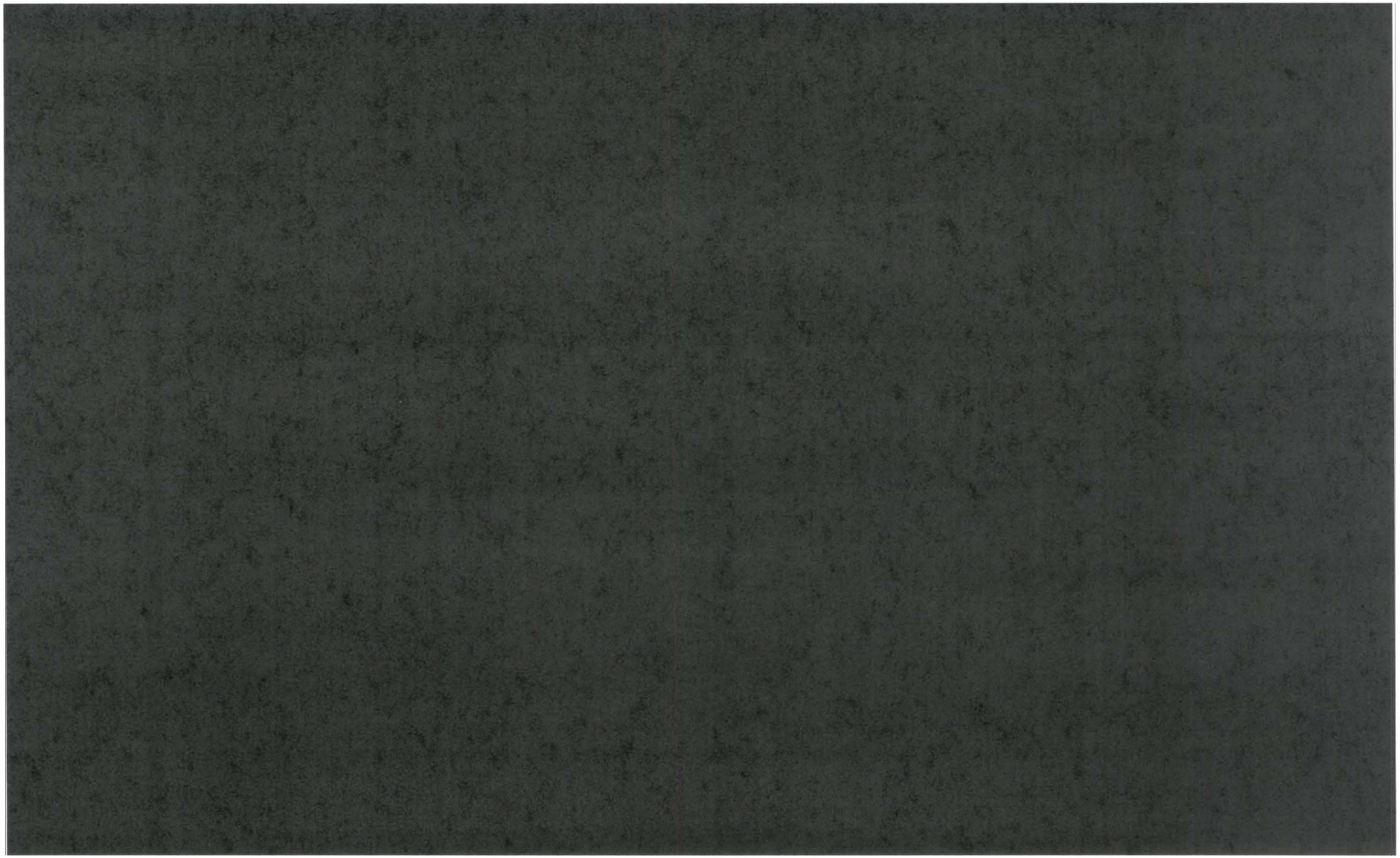
26 Of the 132 houses and 1 church surveyed, direct floor level measurement was achieved in only 32 cases. Therefore, we can determine with an acceptable level of accuracy that these buildings either flooded or did not flood in February 2022. Similarly, the available level information in the majority of the remaining cases was also considered sufficient to allow an accurate conclusion to be drawn as to whether the property was inundated or not during the flood event. However, there remain a number of allotments where the predicted floor level was within 100 mm (either above or below) the calculated flood level, and the floor level was not directly measured. While each of these residences have been classified as either inundated or not in the table, I have used the word "likely" in the description to denote that the finding is less certain than for the other categories. Of the 133 allotments considered, 20 fall into this category where further investigation might be necessary.

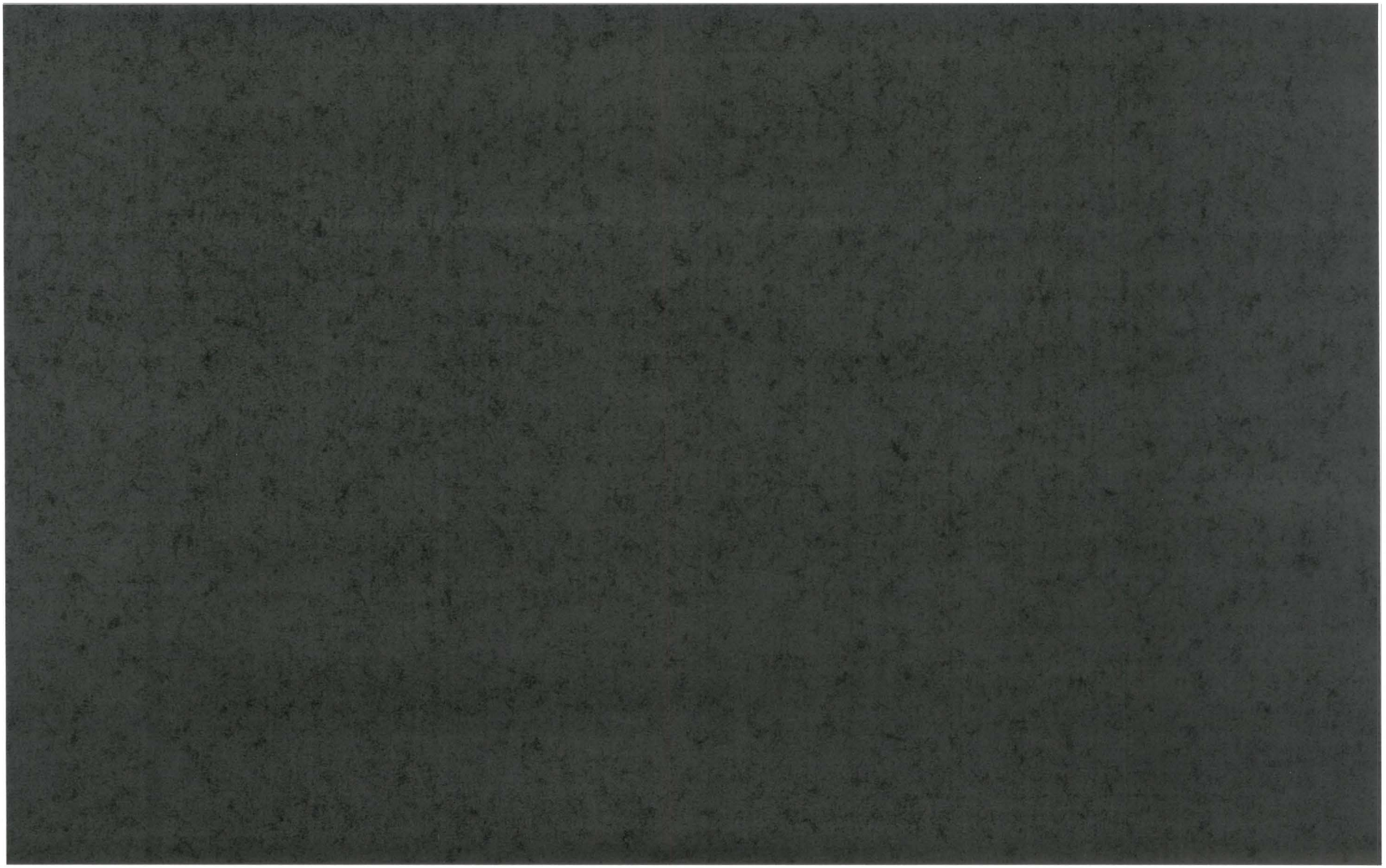
27 The table shows that a significant number of the houses considered in the assessment were likely to have had habitable floors inundated during the February 2022 event. However, the data also shows that, in all cases, those houses would have also flooded even if the construction works had not been in place. The quantum of increase in most cases (20 to 30 mm) is also sufficiently small that it is unlikely that the additional incremental damage caused by the afflux would be significant, or indeed measurable. However, this could correctly only be assessed by individual house inspections and analysis.

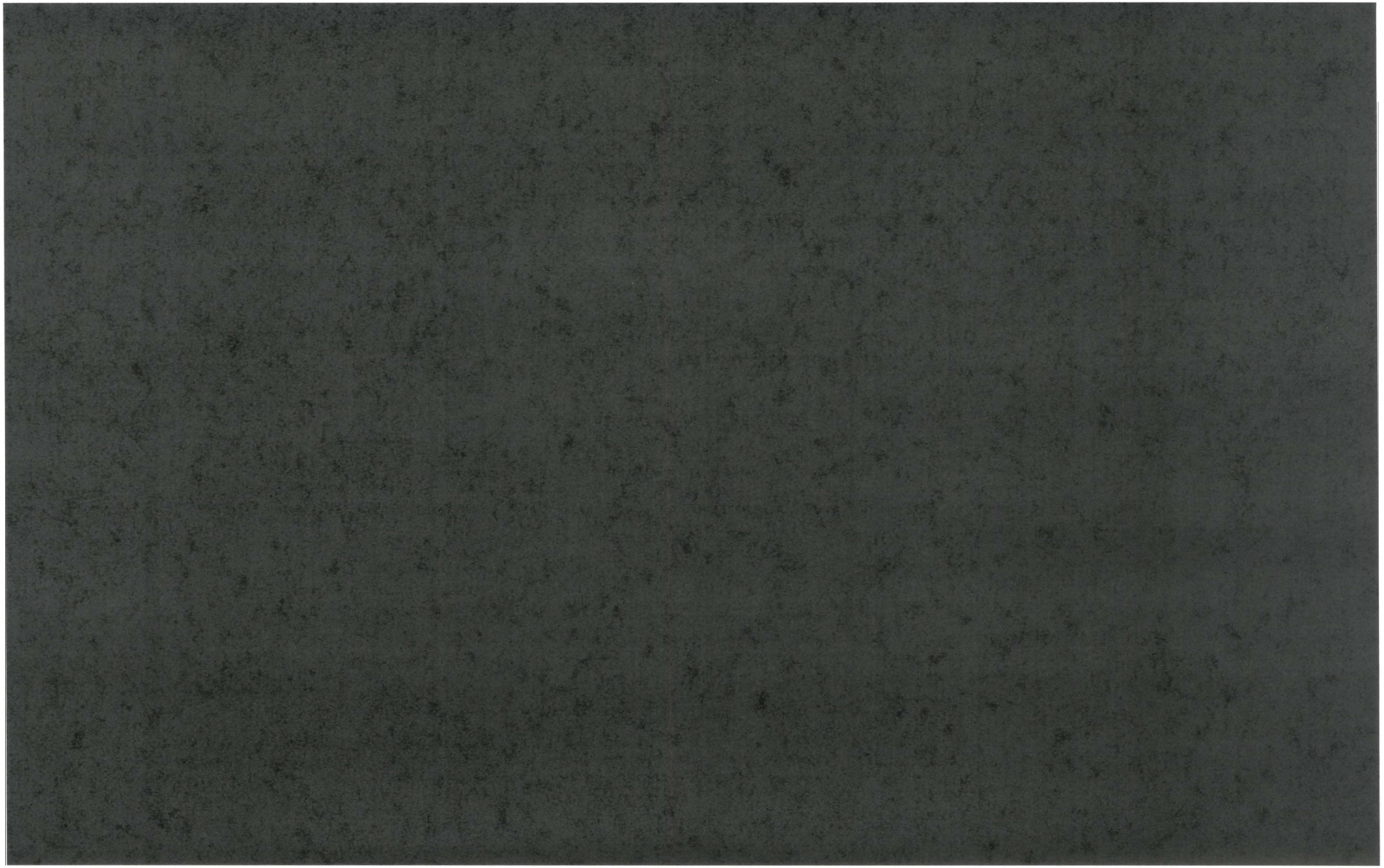
28 To summarise then, our analysis of the results indicates that no houses were likely to have been adversely affected during the February 2022 event. While many of the surveyed houses appear to have sustained over-floor flooding, over-floor flooding would still have occurred if the DTMR construction works were not in place. Flood levels increased as a consequence of these works, but the quantum of increase was generally low at between 20 and 30 mm for the vast majority of cases.

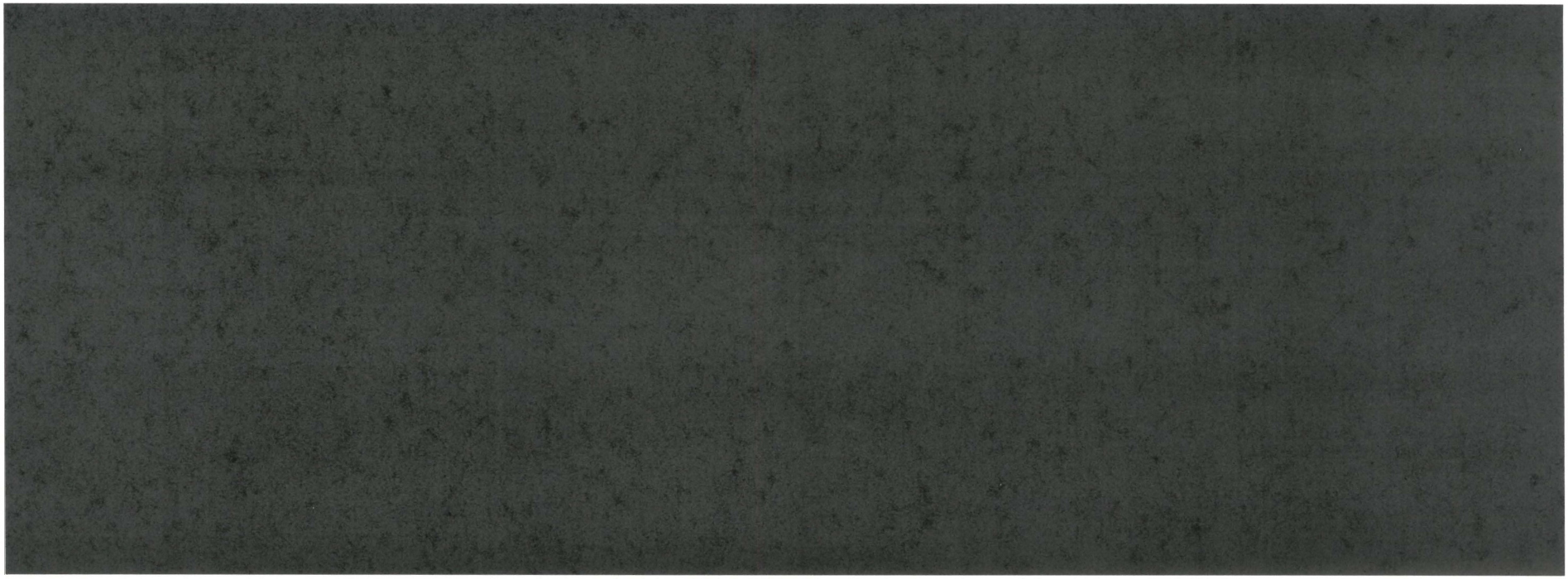
29 While I note that caution should be applied when drawing conclusions from this information because of measurement and computational uncertainty, I believe that the findings provide a reasonable assessment of the quantum of impact resulting from the temporary construction works.

30 Further assessment can be made of this information if required. For example, locations where yards were notionally flooded could be determined. The focus to date has been on identifying properties which may have suffered damage during the flood event. In that regard, the next step in this process should probably involve further measurement of actual habitable floor levels, and interviews with residents who consider that their properties suffered damage or adverse impact during the flooding event.









6 CONCLUSIONS

31 A detailed hydraulic assessment of the impact of M1 construction works on flood levels in the Tallebudgera Creek catchment during the flood of February/March 2022 has been undertaken. It has been determined that the flood had an Annual Exceedance Probability (AEP) of slightly more (ie less severe) than 2% (a 2% AEP is equivalent to a 50 year Average Recurrence Interval).

32 The flood modelling used for this analysis achieved good correlation with observed and monitored flow rates and flood levels throughout the lower part of the catchment upstream and downstream of the M1 crossing of Tallebudgera Creek.

33 The model showed the following:

- Flood level increases in the order of 20 to 25 mm occurred in the Larch Street, Daffodil Street and Elm Court vicinities. A similar result was indicated for Kentia Court.
- Flood level increases in the order of 60 to 70 mm occurred in the vicinity of Heather Street and around the Woolworths shopping centre.
- No increases beyond the nominal 10 mm were generally indicated in residential locations downstream of the M1 embankment.

34 Further assessment of the impact of these increases on existing residences and businesses has been undertaken using allotment and floor level information provided by DTMR. It has been determined that, while the temporary bridge works in Tallebudgera Creek did increase flood levels upstream of the M1, it was unlikely that the works caused any property to suffer additional flood damages. That is, the properties which were affected by flooding in the February 2022 storm event would have suffered over-floor flooding even if no construction works had been underway. While the depth of inundation was increased marginally by the works (generally by between 20 and 30 mm), it is unlikely that the increased caused significant further incremental damage.

35 It is noted that in many instances, these conclusions are based on estimated, and not surveyed, floor levels. The collection of further accurate floor level information through areas affected by flooding, as well as further flood level information provided by residents, would significantly improve the reliability of the forecasting relied upon in this report. It is still possible, although statistically unlikely, that this further assessment could disclose properties where the flood level increase was just sufficient to cause over-floor flooding where none had previously occurred. However, at this stage, we have not identified any properties which are in this position.

[redacted]

[redacted]

Figures

Appendix A contents here

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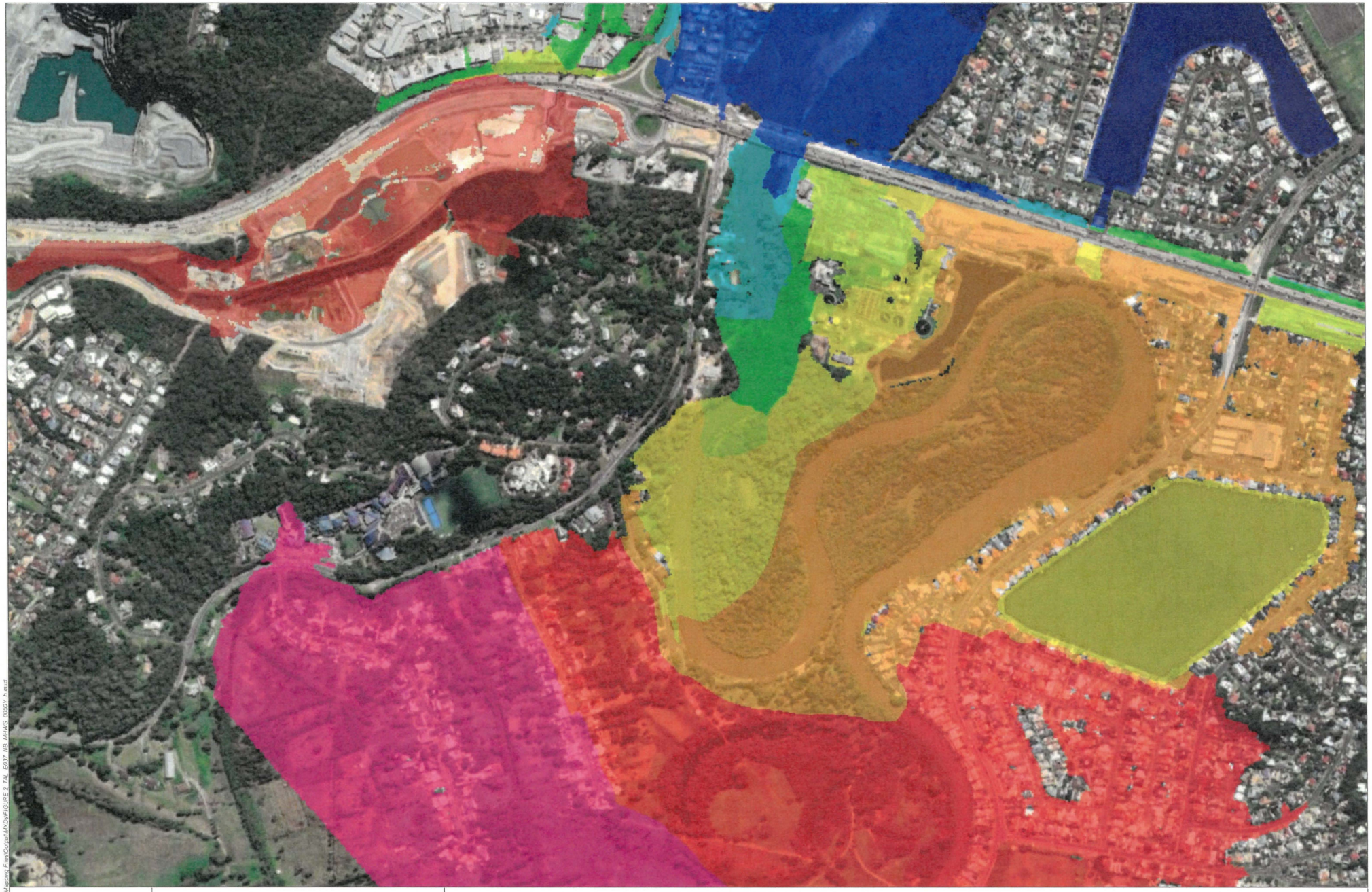
M1 B2PB - Tallebudgera Creek
Construction Flood Impact Assessment

Pre-Construction Conditions (E037)
Peak Flood Levels - 5% AEP

FIGURE 1



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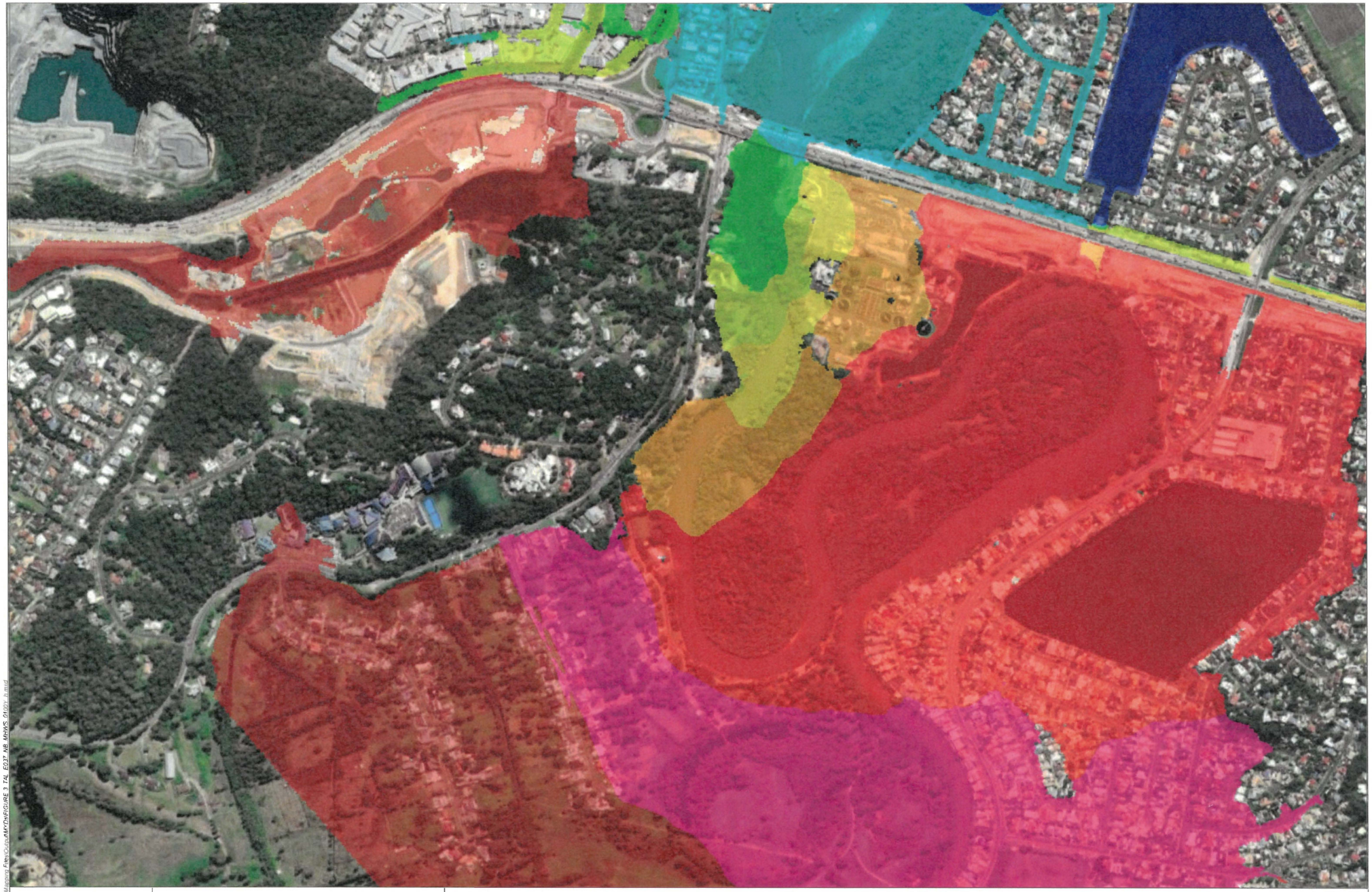
M1 B2PB - Tallebudgera Creek
Construction Flood Impact Assessment

Pre-Construction Conditions (E037)
Peak Flood Levels - 2% AEP

FIGURE 2



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0 180 360 540 Meters

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Legend

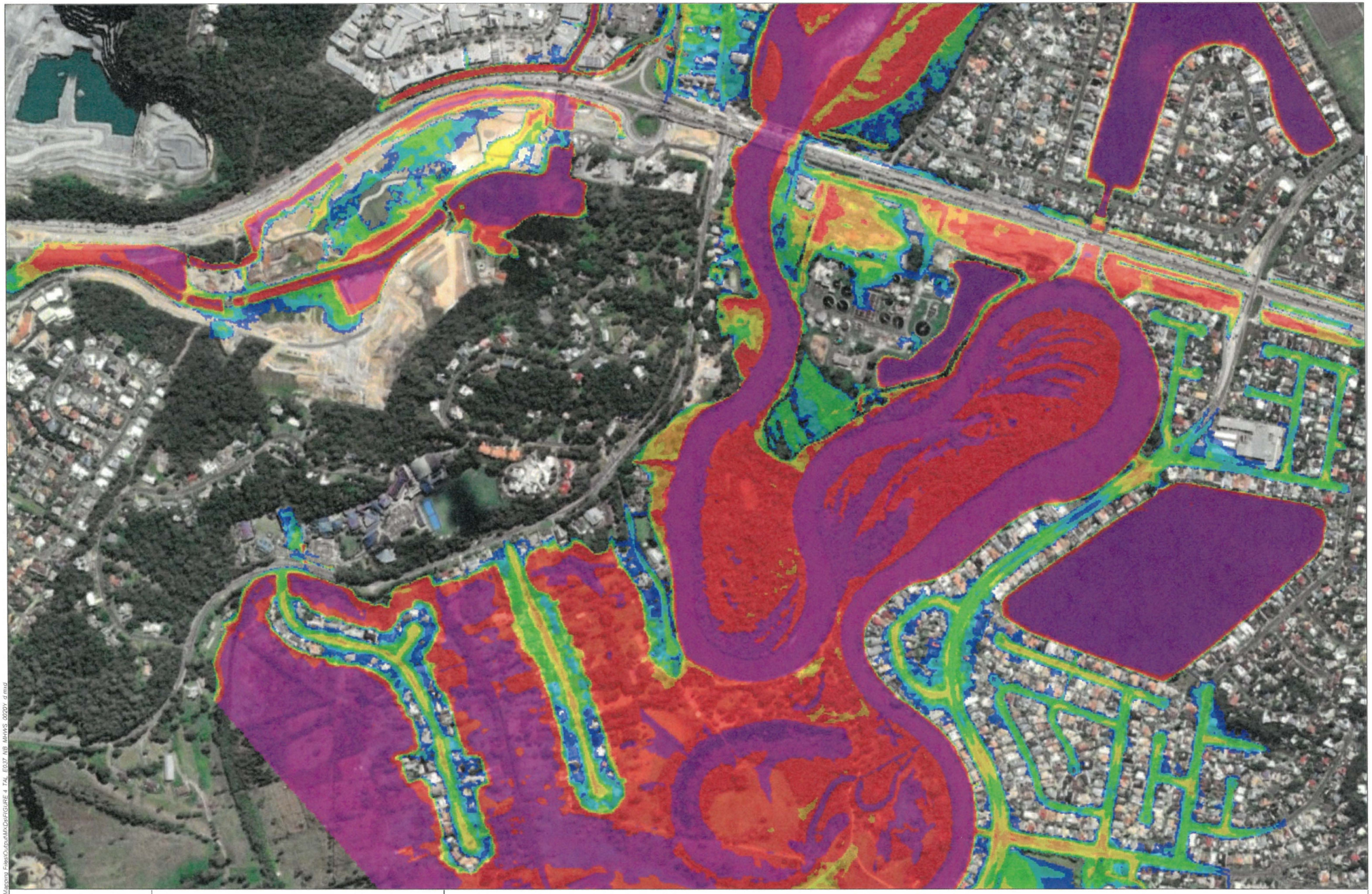
Level (m AHD)

< 2.4	3.0 - 3.2	3.8 - 4.0
2.4 - 2.6	3.2 3.4	> 4.0
2.6 - 2.8	3.4 - 3.6	
2.8 - 3.0	3.6 - 3.8	

M1 B2PB - Tallebudgera Creek
Construction Flood Impact Assessment

Pre-Construction Conditions (E037)
Peak Flood Levels - 1% AEP

FIGURE 3



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Legend

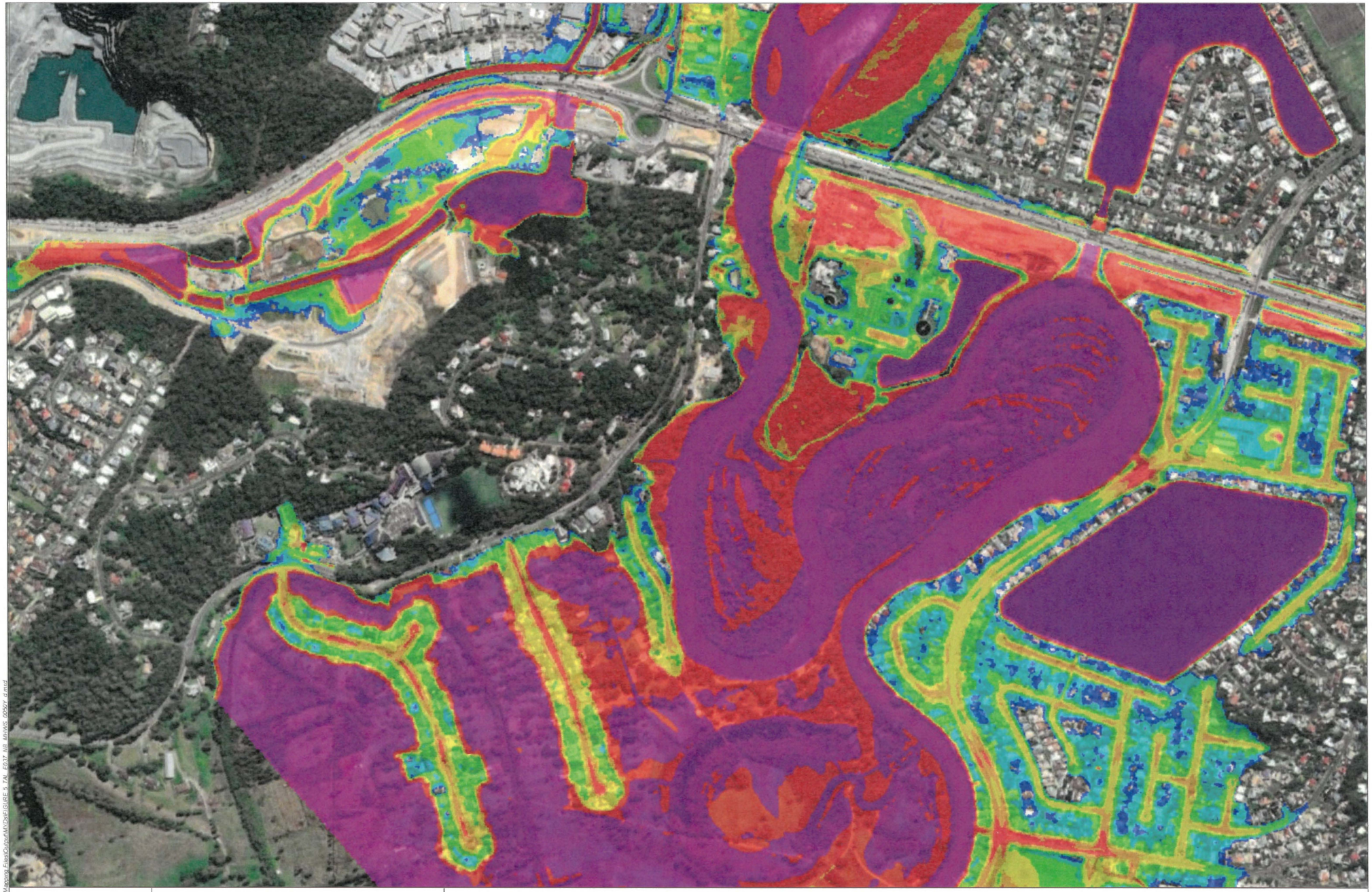
Depth (m)

< 0.1	0.75 - 1
0.1 - 0.25	1 - 2
0.25 - 0.5	> 2
0.5 - 0.75	

M1 B2PB - Tallebudgera Creek
Construction Flood Impact Assessment

Pre-Construction Conditions (E037)
Peak Flood Depths - 5% AEP

FIGURE 4



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Legend

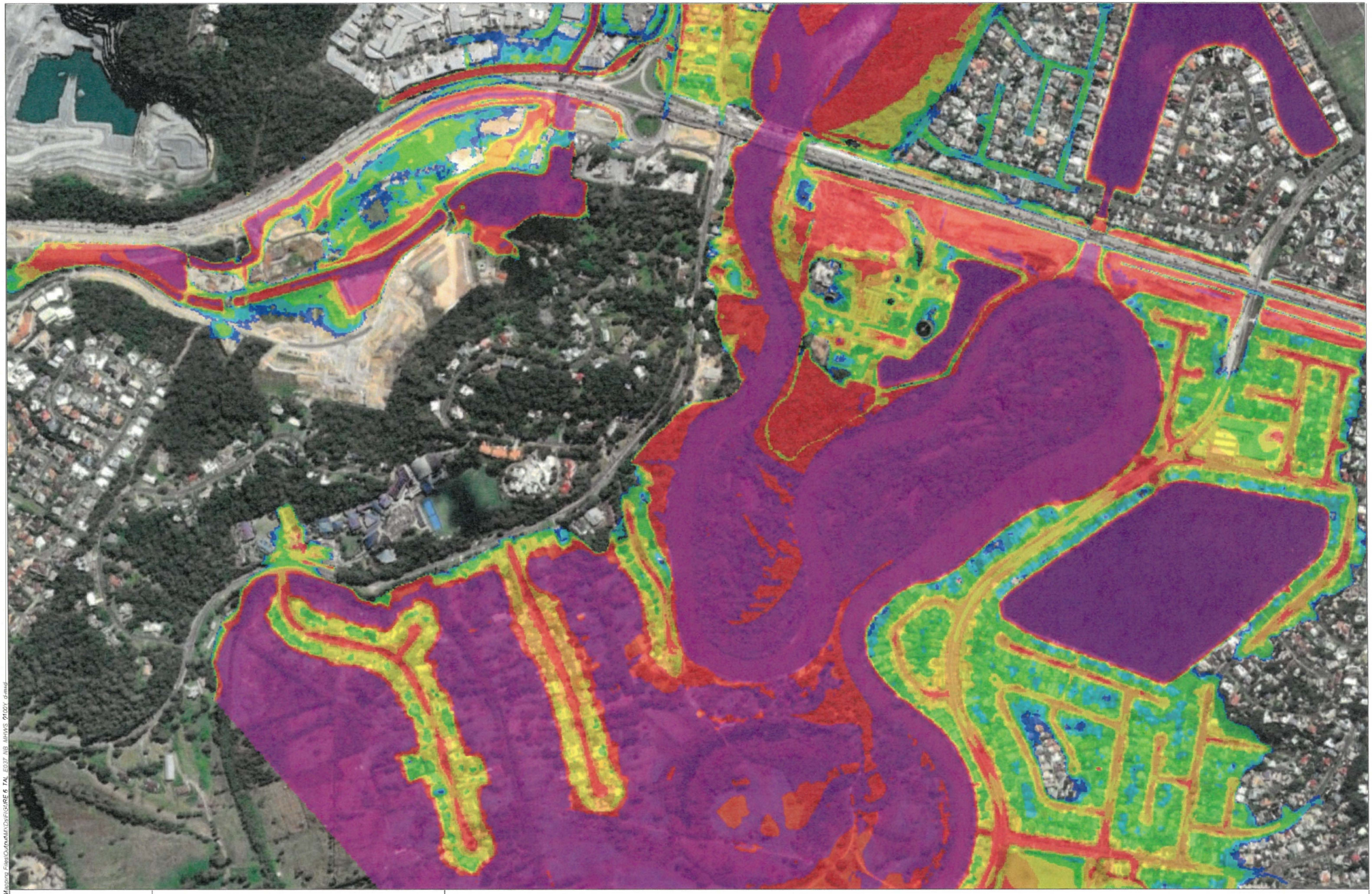
Depth (m)

< 0.1	0.75 - 1
0.1 - 0.25	1 - 2
0.25 - 0.5	> 2
0.5 - 0.75	

M1 B2PB - Tallebudgera Creek
Construction Flood Impact Assessment

Pre-Construction Conditions (E037)
Peak Flood Depths - 2% AEP

FIGURE 5



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Legend

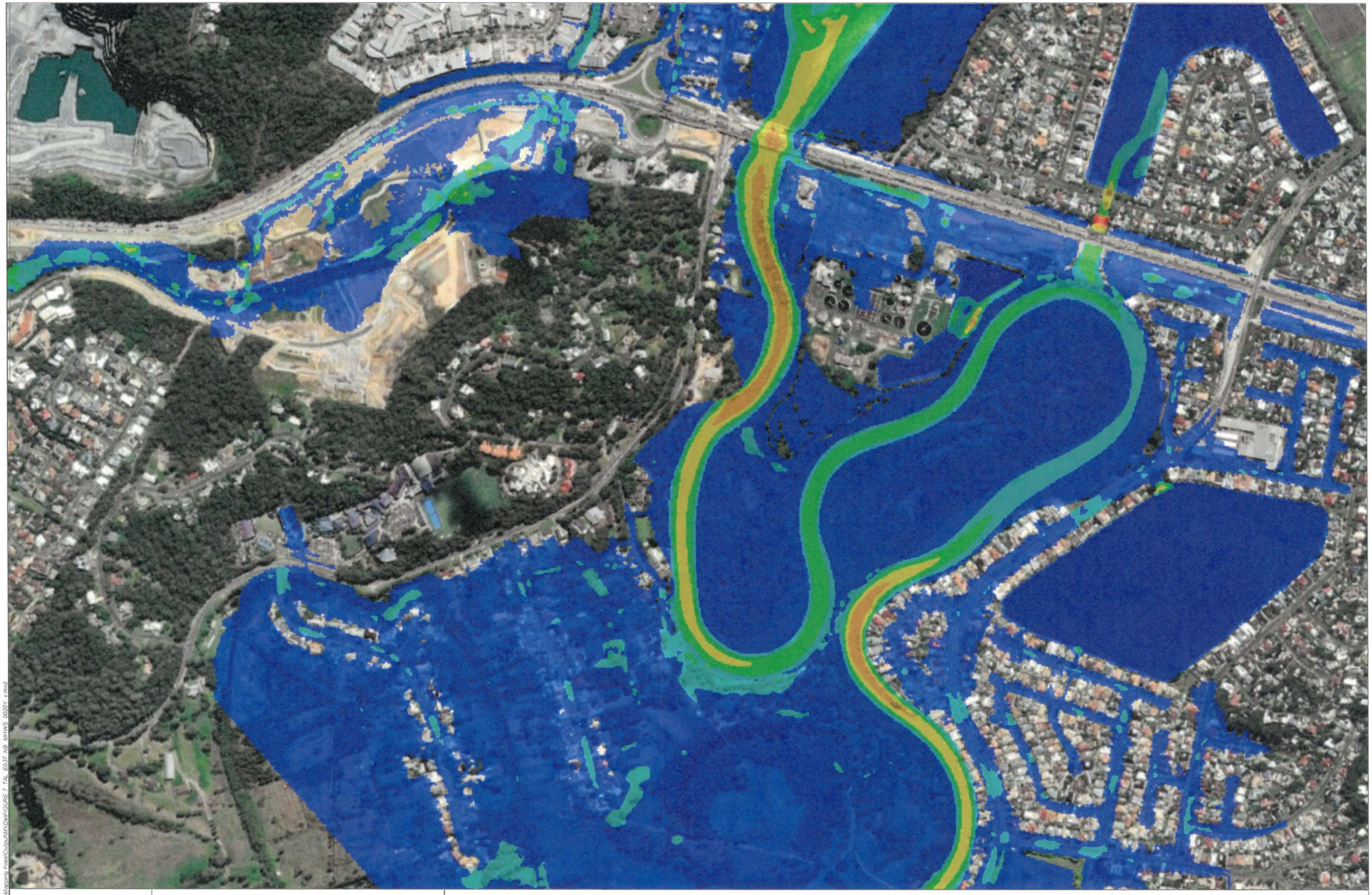
Depth (m)

< 0.1	0.75 - 1
0.1 - 0.25	1 - 2
0.25 - 0.5	> 2
0.5 - 0.75	

M1 B2PB - Tallebudgera Creek
Construction Flood Impact Assessment

Pre-Construction Conditions (E037)
Peak Flood Depths - 1% AEP

FIGURE 6



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Legend

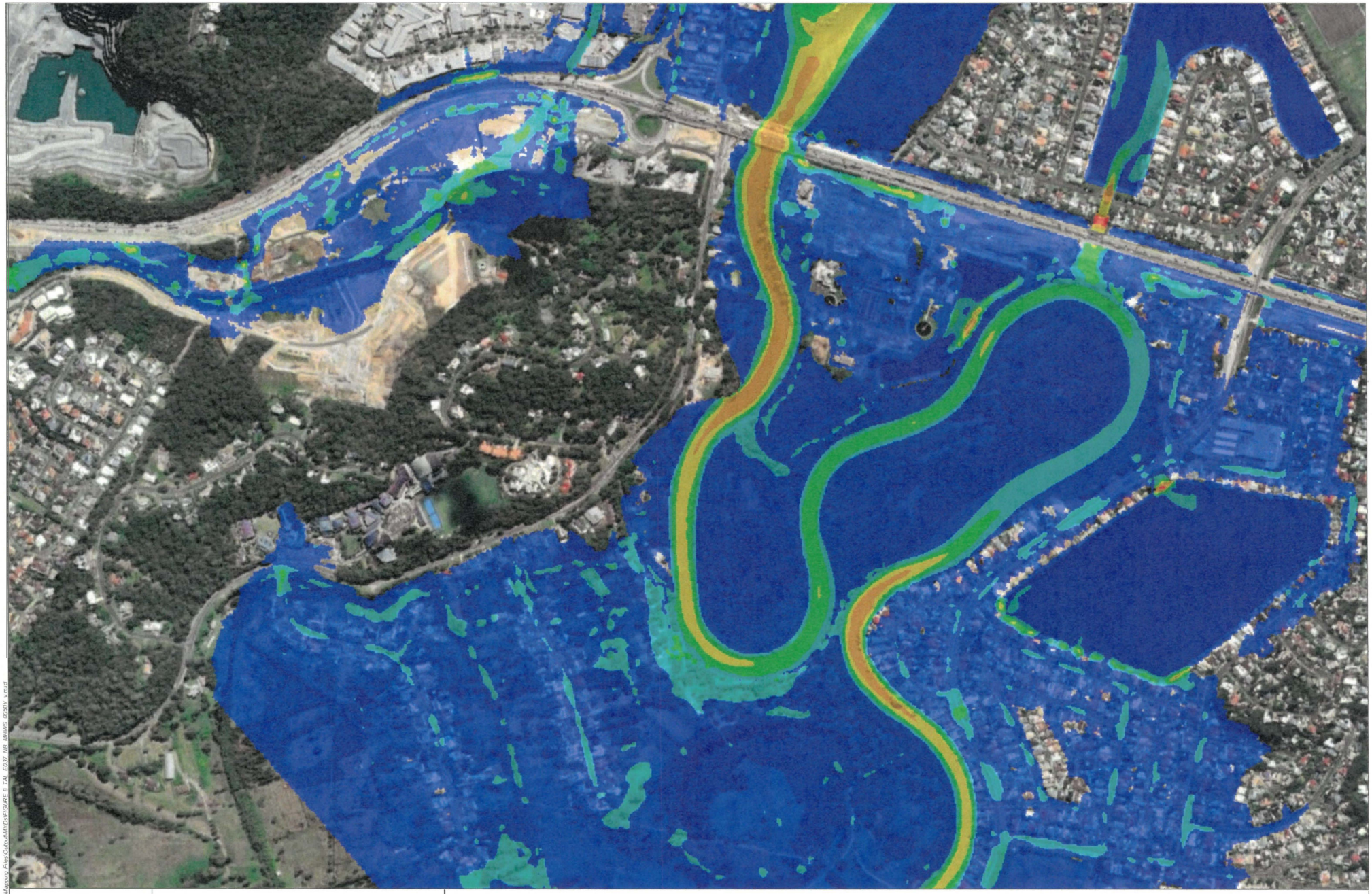
Velocity (m/s)

- < 0.5
- 0.5 - 1
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- > 3.0

M1 B2PB - Tallebudgera Creek
Construction Flood Impact Assessment

Pre-Construction Conditions (E037)
Peak Flood Velocities - 5% AEP

FIGURE 7



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0 180 360 540 Meters

04-Apr-2023 Scale: 1:7,500

Sheet Size : A3 GDA 1994 MGA Zone 56

Legend

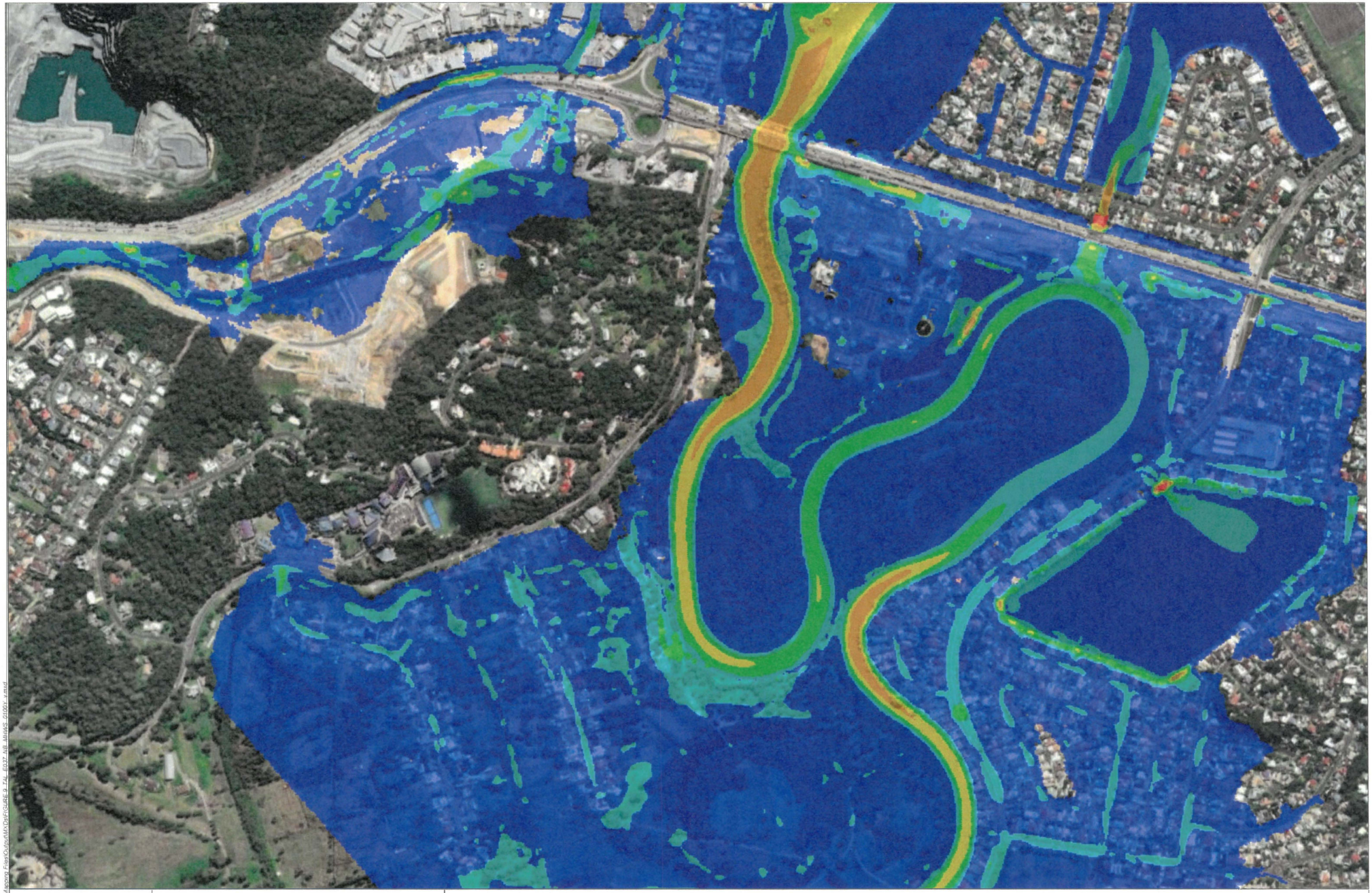
Velocity (m/s)

- < 0.5
- 0.5 - 1
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- > 3.0

M1 B2PB - Tallebudgera Creek
Construction Flood Impact Assessment

Pre-Construction Conditions (E037)
Peak Flood Velocities - 2% AEP

FIGURE 8



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0 180 360 540 Meters

04-Apr-2023 Scale: 1:7,500

Sheet Size : A3 GDA 1994 MGA Zone 56

Legend

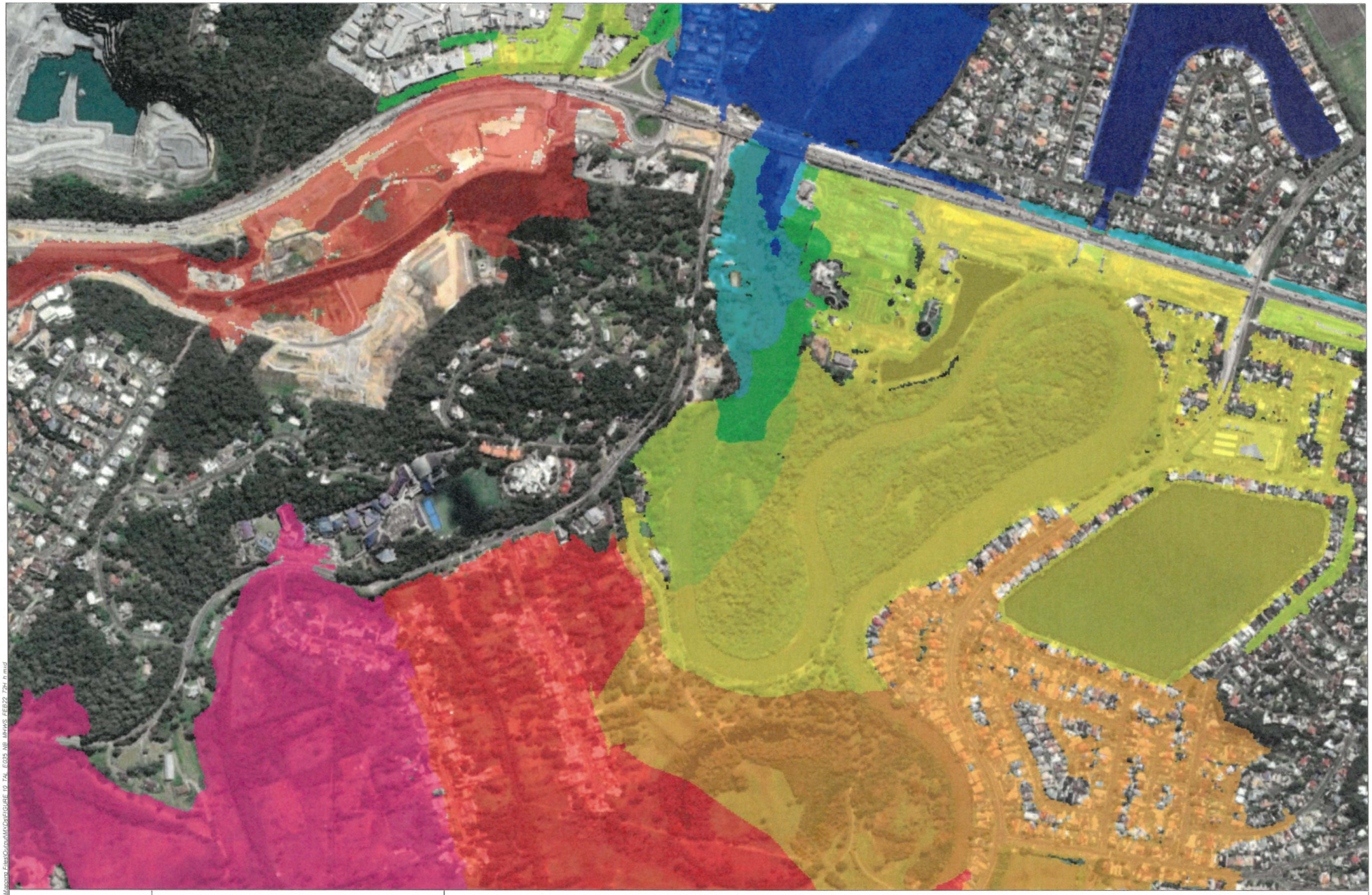
Velocity (m/s)

- < 0.5
- 0.5 - 1
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- > 3.0

M1 B2PB - Tallebudgera Creek
Construction Flood Impact Assessment

Pre-Construction Conditions (E037)
Peak Flood Velocities - 1% AEP

FIGURE 9



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0 180 360 540 Meters

04-Apr-2023 Scale: 1:7,500

Sheet Size : A3 GDA 1994 MGA Zone 56

Legend

Level (m AHD)

< 2.4	3.0 - 3.2	3.8 - 4.0
2.4 - 2.6	3.2 3.4	> 4.0
2.6 - 2.8	3.4 - 3.6	
2.8 - 3.		

M1 B2PB - Tallebudgera Creek
Construction Flood Impact Assessment

Pre-Construction Conditions (E035)
Peak Flood Levels - February 2022 Event

FIGURE 10

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0 180 360 540 Meters

04-Apr-2023 Scale: 1:7,500

Sheet Size : A3 GDA 1994 MGA Zone 56

Legend

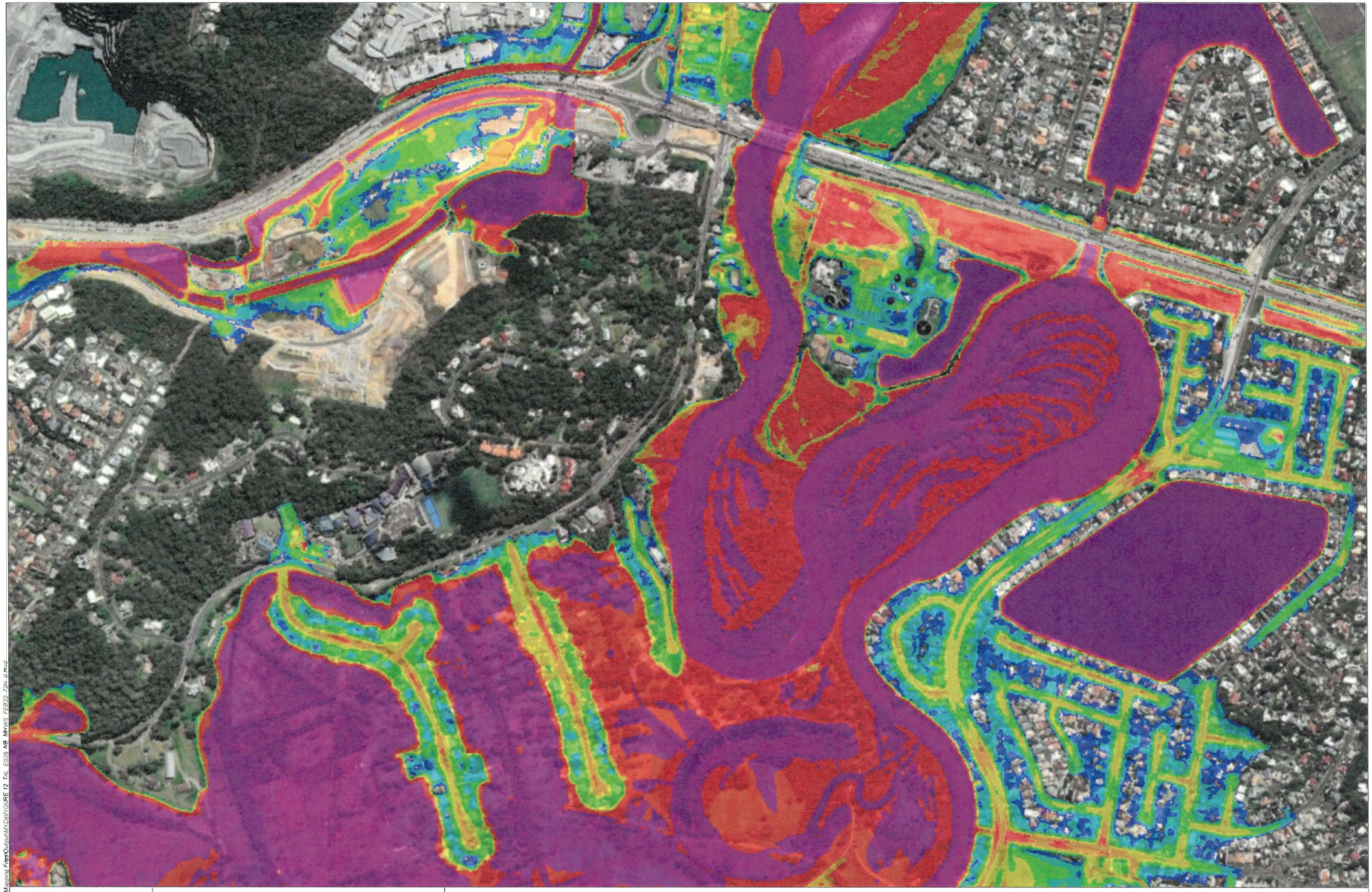
Level (m AHD)

< 2.4	3.0 - 3.2	3.8 - 4.0
2.4 - 2.6	3.2 3.4	> 4.0
2.6 - 2.8	3.4 - 3.6	
2.8 - 3.		

M1 B2PB - Tallebudgera Creek
Construction Flood Impact Assessment

February 2022 Construction Conditions (C014)
Peak Flood Levels - February 2022 Event

FIGURE 11



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0 180 360 540 Meters

04-Apr-2023 Scale: 1:7,500

Sheet Size : A3 GDA 1994 MGA Zone 56

Legend

Depth (m)

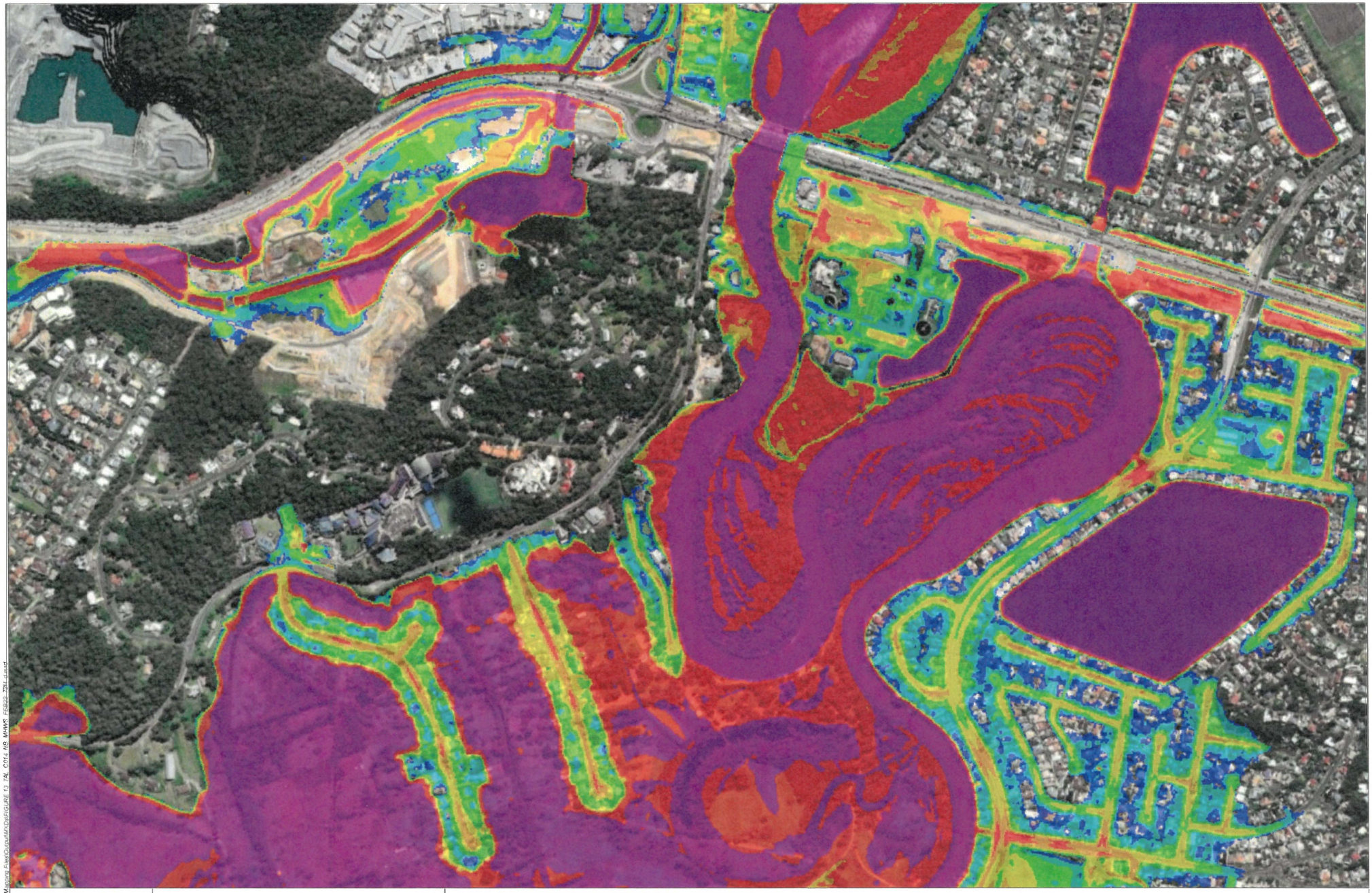
< 0.1	0.75 - 1
0.1 - 0.25	1 - 2
0.25 - 0.5	> 2
0.5 - 0.75	

M1 B2PB - Tallebudgera Creek
Construction Flood Impact Assessment

Pre-Construction Conditions (E035)
Peak Flood Depths - February 2022 Event

FIGURE 12

C:\Jobs\Projects\Tallebudgera\ArcGIS\Mapping Files\QuickMaps\FIGURE 12_TAL_E035_NR_MHWS_FEB22_72H_v1.mxd



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0 180 360 540 Meters

04-Apr-2023 Scale: 1:7,500

Sheet Size : A3 GDA 1994 MGA Zone 56

Legend

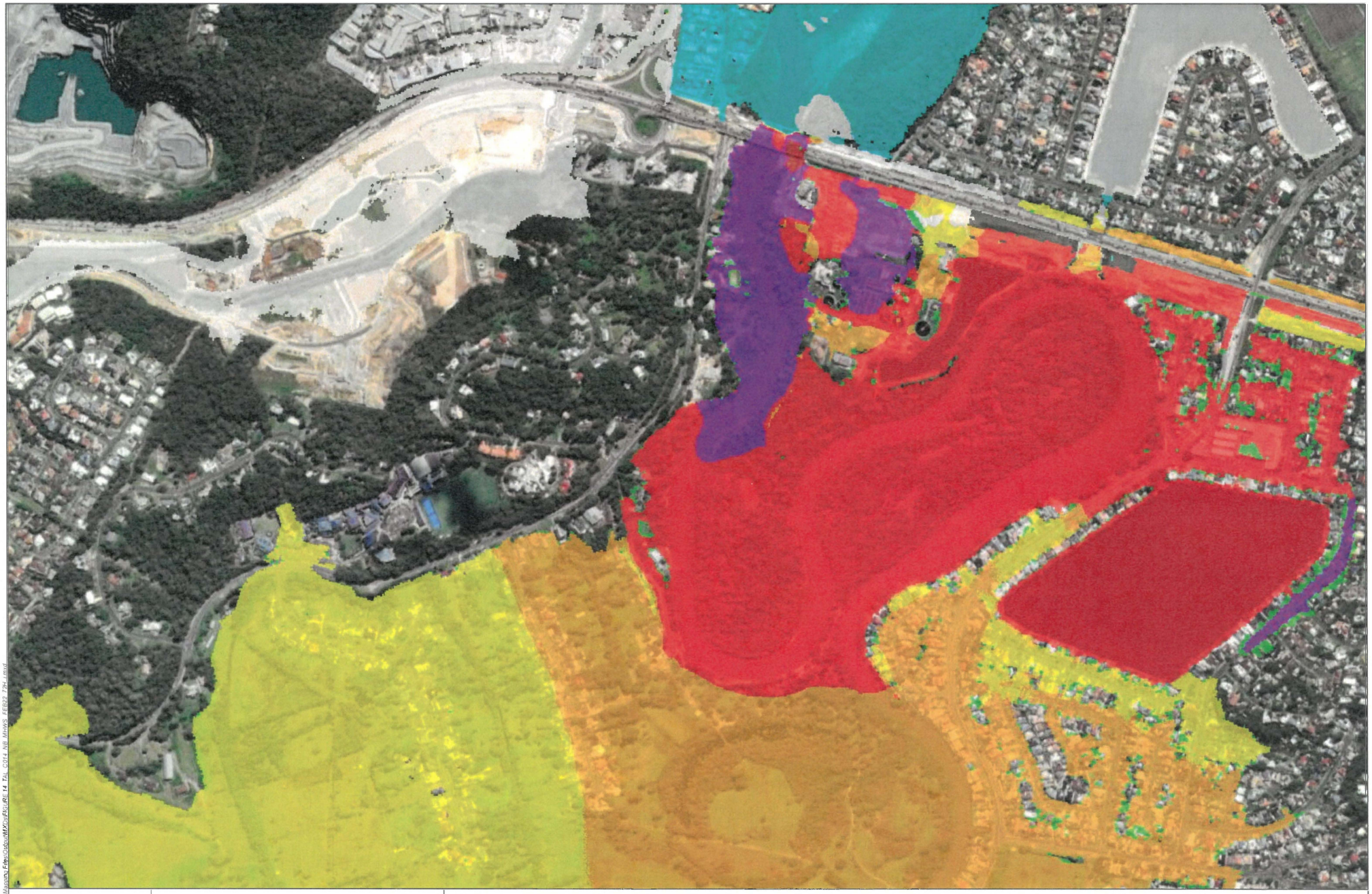
Depth (m)

- < 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 2
- > 2

M1 B2PB - Tallebudgera Creek
Construction Flood Impact Assessment

February 2022 Construction Conditions (C014)
Peak Flood Depths - February 2022 Event

FIGURE 13



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Sheet Size : A3 GDA 1994 MGA Zone 56

M1 B2PB - Tallebudgera Creek
Construction Flood Impact Assessment

February 2022 Construction Conditions (C014)
Peak Flood Afflux - February 2022 Event

FIGURE 14