9. Operation impact assessment

9.1 Flooding

This impact assessment has investigated the potential for the operation of North East Link to increase flood levels affecting private property and infrastructure (risk SW09), or result in flooding of the tunnel portals (risk SW17). The risks identified in this assessment are possible during the operation of a project of this type where there are significant interactions with surface water. Subsequently the EPRs that have been developed for the project are standard controls for a project of this type. These risks and the recommended EPRs are described in the following sections for each specific waterway.

A key issue for the project as described in the scoping requirements (see Section 2) is to include an assessment for future climate change scenarios with respect to flooding.

A number of assessments using increased rainfall intensities have been considered with respect to the assessment of flooding impacts. This has included the assessment of relative changes in flood level under climate change conditions between existing and proposed conditions which as indicated by the results in Appendix D is generally not significant. The few observed exceptions are discussed in the specific waterway discussions below. Of more significance is the need to provide increased certainty with respect to performance requirements which depend strongly on absolute levels such as the threshold to the portal entrances. In these cases, the design levels have included an allowance for climate change in accordance with current practice.

While a performance requirement for the flood immunity of above ground roads has not been directly specified, any increase in flooding as a result of the works could cause a public safety risk. The EES has considered the potential for such outcomes and recommended performance requirements to maintain public safety. The flood immunity of shared use paths are specified by project requirements to be in accordance with current guidelines providing flood immunity to a 10% AEP standard.

The EES has not considered in detail the longitudinal road drainage which would be required to drain the surface of the roads beyond consideration of outlet locations and the need for and potential to provide sufficient attenuation and water quality treatment for flows discharging to receiving drains and waterways (refer Section 9.2.1).

Drainage systems to remove surface water on new roads resulting from rainfall would need to be designed to Austroads Standards (see Section 4.4.1). If road drainage is designed with insufficient capacity to accommodate increased rainfall intensities from climate change this could result in the potential for reduced safety during floods (risk SW19). To reduce this risk the project must consider the potential effects of climate change with and without the project for both historic climate and projected future climate change conditions (EPR SW13). Projected future climate change conditions adopted for this assessment were an increased rainfall intensity of 19 per cent based on initial advice from Melbourne Water which interpreted guidance from ARR 2016 using representative concentration pathway (RCP) 8.5 projections for the Southern Slopes from CSIRO. Based on the likely asset life a higher increase in intensity could potentially be considered for design purposes however for the purposes of the EES, the initially adopted increase of 19 per cent is suitable to investigate the potential impacts of the project. Consideration of potential sea level rise is not significant at this elevation and distance from the coast.

The following sub sections describe the potential operational flooding impacts. Impacts are assessed in terms of change in peak flood depth, level and velocity for a 1% AEP design event with existing and reference project infrastructure scenarios. Both flood depth and flood level have been provided to facilitate interpretation of the modelling results in areas where the terrain has been modified. Changes in velocity provide an indication of changes which may affect scour and or safety. The changes in these values are known as afflux or difference and plotted as a continuous colour range from red indicating an increase in value (positive afflux or difference) through yellow values which are close to zero indicating no significant change, through to green which indicates a reduction in value (negative afflux or difference). Green or yellow colouring generally indicates a good outcome, red colours indicate an increase in value. Red areas indicate that for the current reference project there is an increase in that particular parameter which is generally but not always undesirable. Examples of when an increase is an expected and potentially acceptable outcome include:

- An increase in depth where, for example there has been an excavation to provide a storage, wetland or channel and any changes in flood level do not significantly reduce the capacity of the upstream drainage system.
- An increase in flood level where for instance a road surface has been raised and depths and velocities have not significantly increased.

At locations where undesirable afflux or difference has been identified in the current reference project, future design changes and refinements would seek to reduce these impacts further.

9.1.1 Yando Street Main Drain

This assessment has investigated the potential for the operation of North East Link to increase flood frequency and levels at receptors within or around the existing Yando Street Main Drain floodplain due to the project displacing flood water (risk SW09).

North East Link proposes the widening of Greensborough Bypass over Yando Street Main Drain to accommodate additional road lanes and ramps. This would include widening of the existing road by approximately 44 metres to the west and 32 metres to the east of the existing freeway to support additional lanes in both directions on the main carriageway and on and off ramps for the M80 Ring Road interchange. North East Link proposes new shared use paths potentially with earth filled abutments within the floodplain on the eastern and western sides of North East Link. A plan of the proposed works is shown in Figure 9-1.

These works would extend the fill over the drain and floodplain and require modifications to the existing underground drainage system including the replacement of surface connections to capture overland flow and the extension of the existing shared use path underpass. These proposed works would reduce floodplain storage.

Modelling of the reference project has been undertaken to quantify the potential impacts on flood risk. Figure 9-2, Figure 9-3 and Figure 9-4 show the difference in peak 1% AEP flood depth, flood level and flood velocity respectively along the Yando Street Main Drain. Further results at select locations for a range of events are provided in Appendix D1. The reference project results in the following flood impacts for the events ranging from a 20% AEP through to a 1% AEP with climate change:

- No significant change to existing flooding of private property on Sellars Street.
- Localised afflux within the floodplain adjacent to proposed infrastructure upstream of Greensborough Bypass of up to 100 millimetres and decreasing upstream

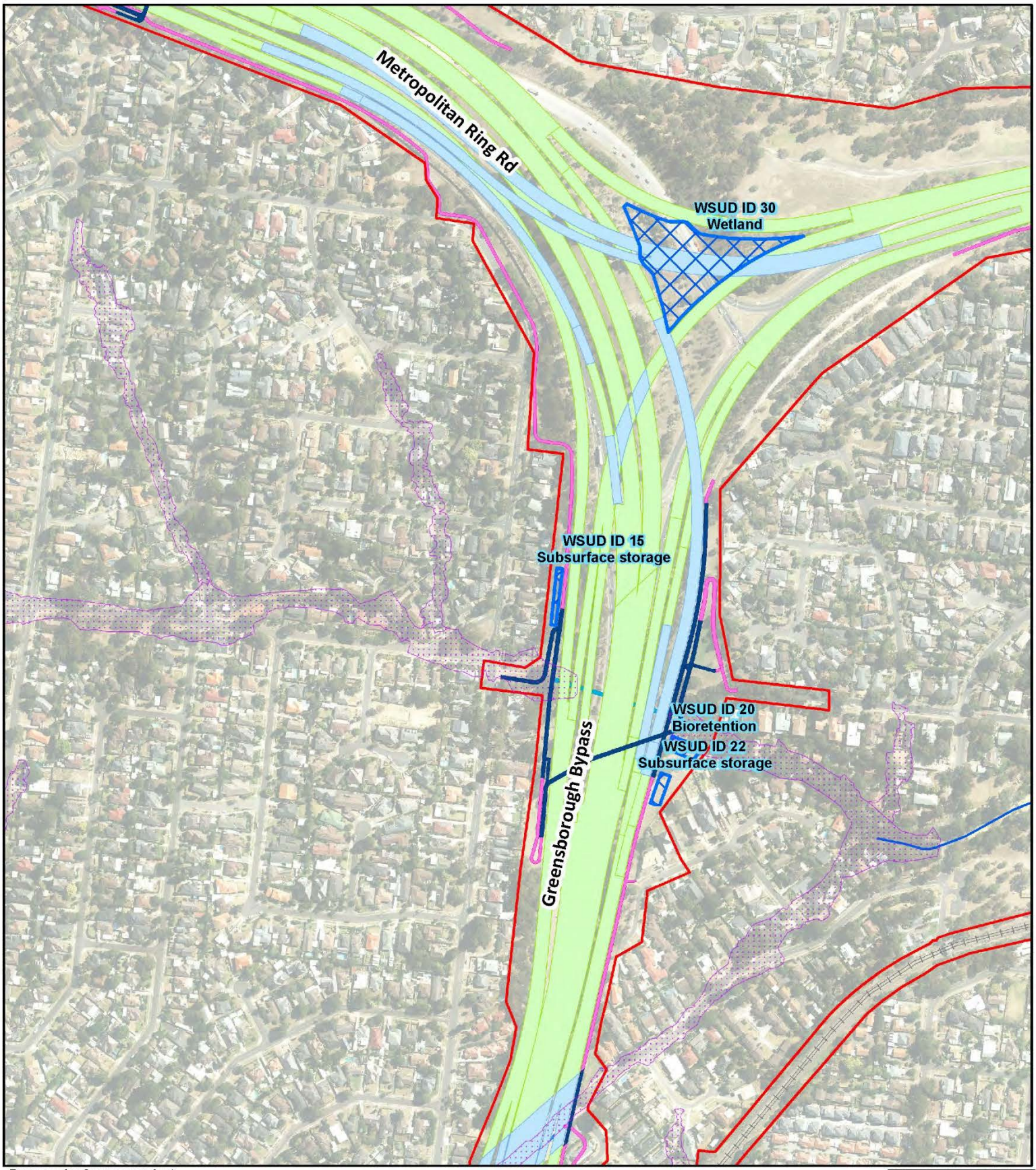
- Localised afflux within the floodplain adjacent to proposed infrastructure downstream of Greensborough Bypass of up to 80 millimetres and decreasing downstream
- No significant change to existing flooding of private properties further downstream.

Further modelling of the final design to confirm that the adopted mitigation measures adequately offset the impacts on flood levels would need to be undertaken to meet Melbourne Water requirements (EPR SW6). Mitigation may potentially involve land modifications to increase the floodplain storage both upstream and downstream of Greensborough Bypass. Consultation with Melbourne Water would occur through the concept and detailed design process.

ARR 2016 sensitivity analysis

As for the existing conditions sensitivity analysis (refer Section 6.1.2), the ARR 2016 flood levels for the 1% AEP flood event during operation are slightly higher than predicted using ARR 1987.

In terms of estimated impacts, there is no significant trend or difference between the ARR 2016 and the ARR 1987 estimates for this location. Observed differences are all less than 35 millimetres and mostly considerably less as shown in Appendix F. At the identified locations ARR 1987 indicated a maximum increase of 30 millimetres as a result of the reference project whereas ARR 2016 indicated a maximum increase of 2.2 millimetres.



Proposed reference project

- LSIO
- SBO
- Area required for CFSL
- Area required for WSUD
- Project boundary-sub surface
- Project boundary-surface
- Ventilation System
- Area for substation
- Shared use path overpass
- Shared use path
- Shared use path underpass
- Multi-deck car park
- Public transport infrastructure upgrade
- Elevated road, ramp or structure
- Surface road
- Road in trench
- Rail tunnel
- Underground tunnel
- River
- Stream
- Channel
- Drain

Paper Size A4

0 30 60 120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link
North East Link Project

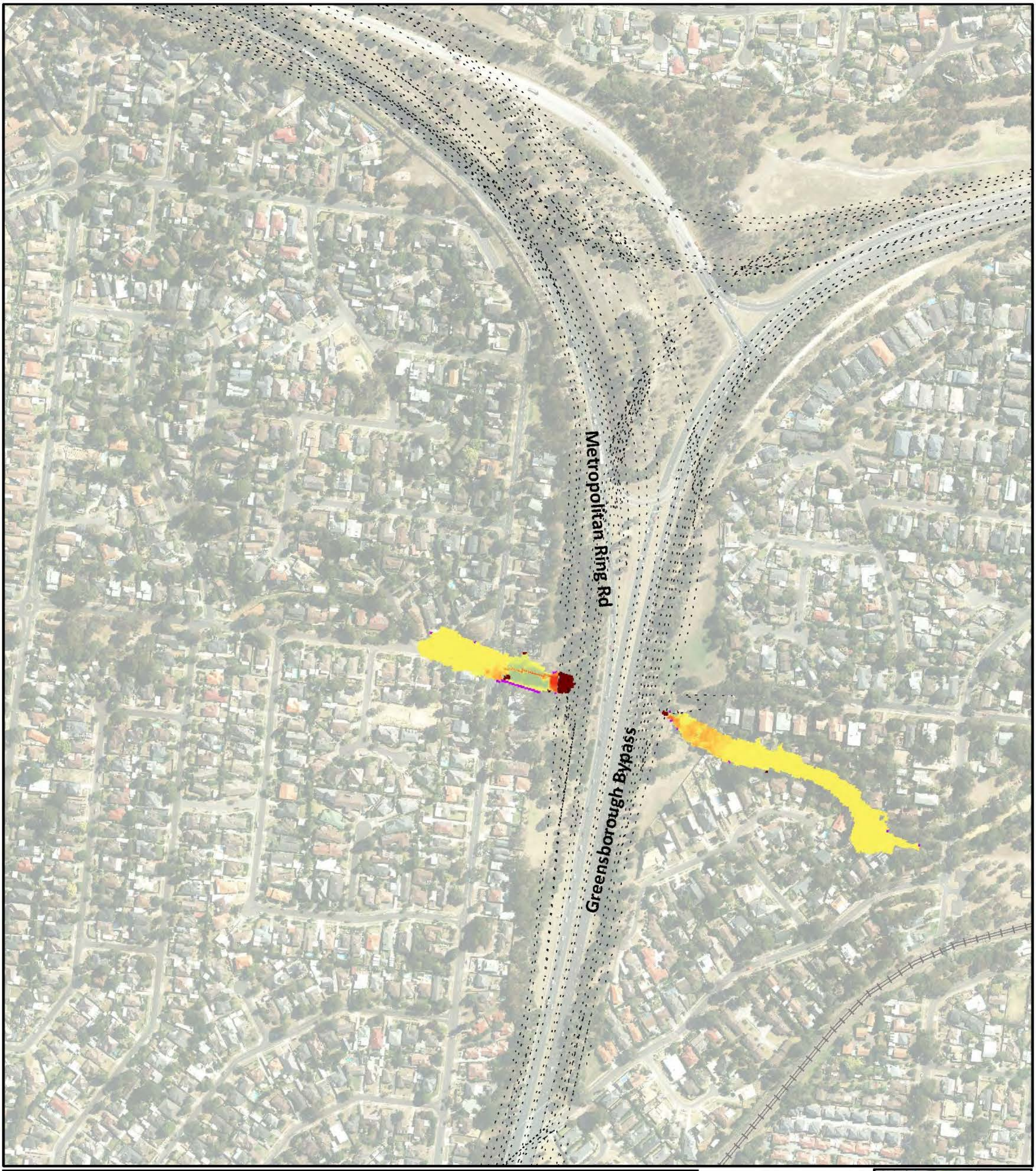
Job Number 31-35006
Revision C
Date 23/01/2019

Project overview
Yando Street Main Drain

Figure 9-1

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_HydraulicsBM_44.mxd GHD 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Depth Afflux (m)

- Was Wet Now Dry
- <-0.500
- -0.499 - -0.300
- -0.299 - -0.200
- -0.199 - -0.150
- -0.149 - -0.100
- -0.099 - -0.050
- -0.049 - -0.030
- -0.029 - -0.020
- -0.019 - -0.010
- -0.009 - 0.000
- 0.001 - 0.010
- 0.011 - 0.020
- 0.021 - 0.030
- 0.031 - 0.050
- 0.051 - 0.100
- 0.101 - 0.150
- 0.151 - 0.200
- 0.201 - 0.300
- 0.301 - 0.500
- > 0.500
- Was Dry Now Wet

Paper Size A4

0 30 60 120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

North East Link
North East Link Project

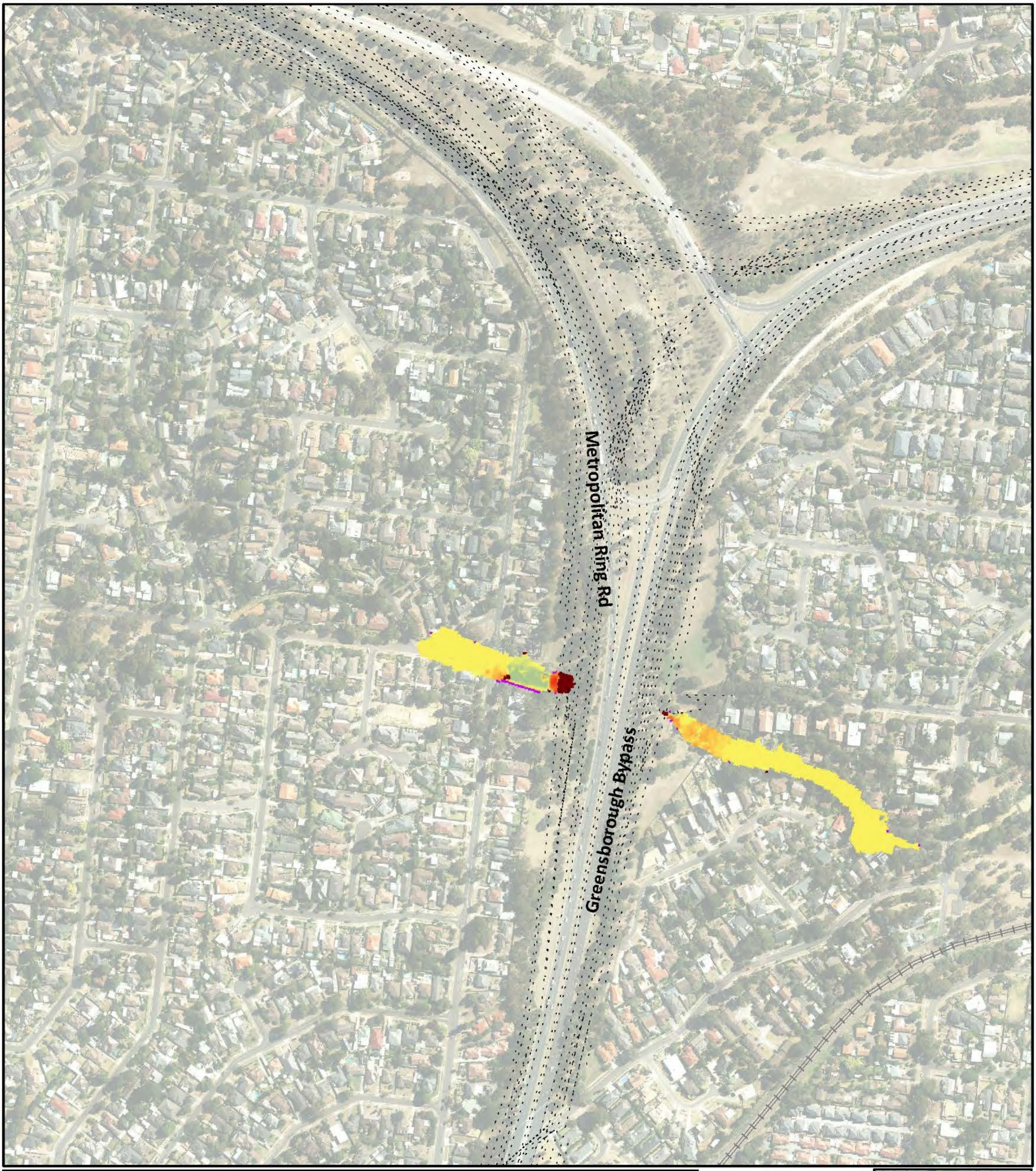
Job Number | 31-35006
Revision | B
Date | 08/10/2018

1% AEP peak flood depth afflux
Yando Street Main Drain

Figure 9-2

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_Hydraulics_[illegible] 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Level Afflux (m)

Was Wet Now Dry	-0.199 - -0.150	-0.019 - -0.010	0.031 - 0.050	0.301 - 0.500
<-0.500	-0.149 - -0.100	-0.009 - 0.000	0.051 - 0.100	> 0.500
-0.499 - -0.300	-0.099 - -0.050	0.001 - 0.010	0.101 - 0.150	Was Dry Now Wet
-0.299 - -0.200	-0.049 - -0.030	0.011 - 0.020	0.151 - 0.200	
	-0.029 - -0.020	0.021 - 0.030	0.201 - 0.300	

Paper Size A4

0 30 60 120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

North East Link
North East Link Project

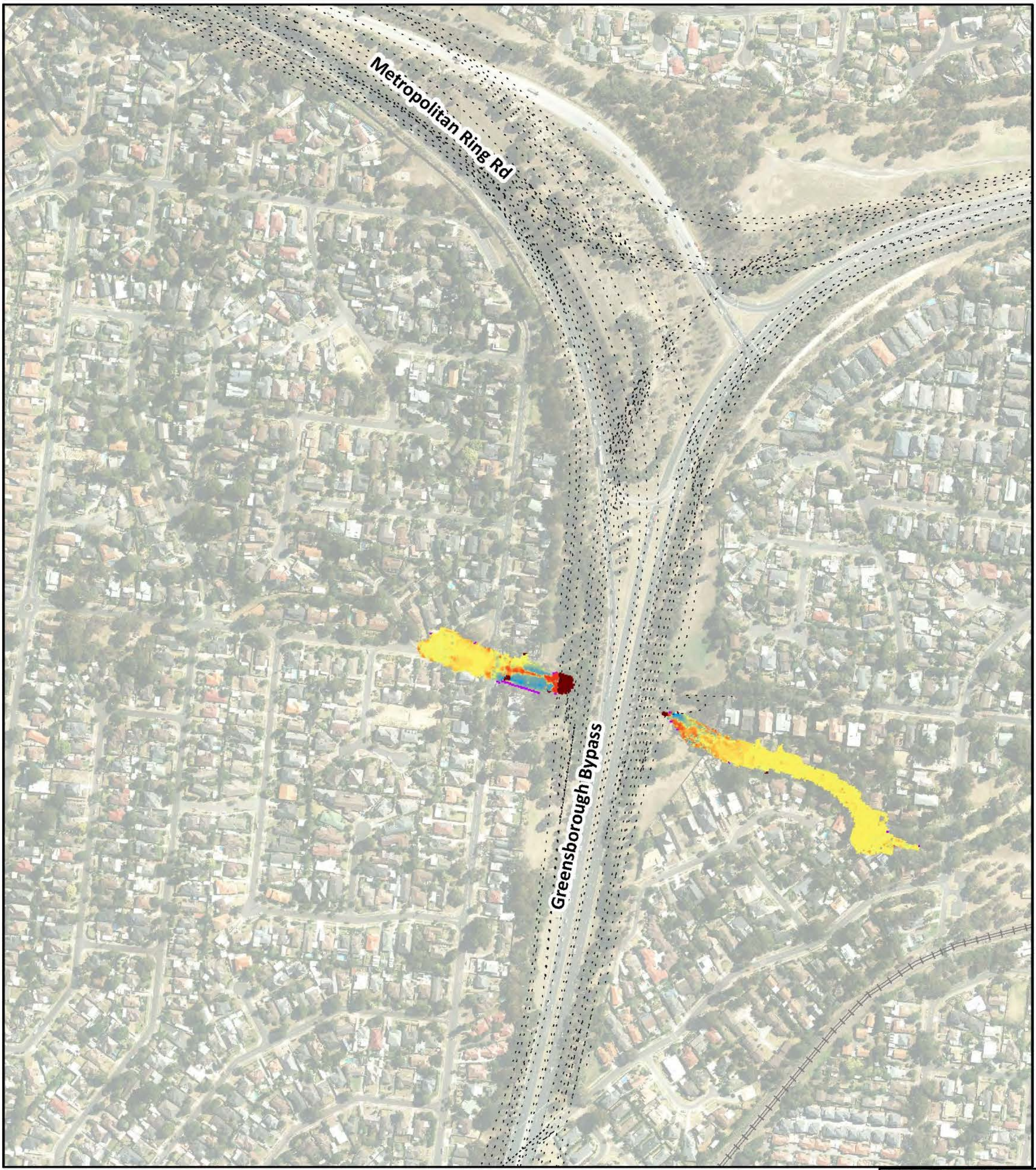
Job Number 31-35006
Revision B
Date 08/10/2018

1% AEP peak flood level afflux
Yando Street Main Drain

Figure 9-3

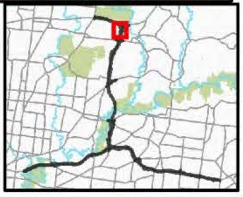
G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_Hydraulics_XBM_Master.mxd 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Velocity difference (m/s)

Was Wet Now Dry	-0.199 - -0.150	-0.019 - -0.010	0.031 - 0.050	0.301 - 0.500
<-0.500	-0.149 - -0.100	-0.009 - 0.000	0.051 - 0.100	> 0.500
-0.499 - -0.300	-0.099 - -0.050	0.001 - 0.010	0.101 - 0.150	Was Dry Now Wet
-0.299 - -0.200	-0.049 - -0.030	0.011 - 0.020	0.151 - 0.200	
	-0.029 - -0.020	0.021 - 0.030	0.201 - 0.300	



Paper Size A4

0 30 60 120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link
North East Link Project

Job Number 31-35006
Revision C
Date 03/12/2018

1% AEP peak flood velocity difference
Yando Street Main Drain

Figure 9-4

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_Hydraulics_KBM_... 180 Lonsdale Street Melbourne VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com **W** www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

9.1.2 Kempston Street Main Drain

This assessment has investigated the potential for the operation of North East Link to increase flood frequency and levels at receptors within or around the existing Kempston Street Main Drain floodplain due to the project displacing flood water (risk SW09).

The reference project details are provided in Figure 9-5.

A new shared use path underpass beneath Grimshaw Street would be part of North East Link's works. This underpass would need to be isolated from the retarding basin using a floodwall to prevent it from becoming an uncontrolled outlet. Without appropriate mitigation, this floodwall to protect the underpass would reduce the storage within the retarding basin which could result in more frequent overtopping of Grimshaw Street and increased downstream flood flows, levels and flooding frequency.

The current retarding basin has mowable grass batters which could potentially be steepened with terraces and retaining walls to increase the available storage. A wetland or other permanent water feature could be used to provide both a water quality benefit and provide a maintainable flat base. Modelling to determine the effectiveness of potential mitigation measures to offset the impacts on floodplain storage indicates that with further refinement, the reduction in storage associated with the floodwall protecting the shared use path can be mitigated to comply with local council and Melbourne Water requirements (EPR SW6).

Modelling of the reference project has been undertaken to quantify the potential impacts on flood risk. Figure 9-6, Figure 9-7 and Figure 9-8 show the difference in peak 1% AEP flood depth, flood level and flood velocity respectively along the Kempston Street Main Drain. Further results at select locations for a range of events are provided in Appendix D2.

Modelling indicates that for the design storms investigated, most locations experience very little change in flood level as a result of the reference project. Locations where impacts are shown would require further refinement and are described below:

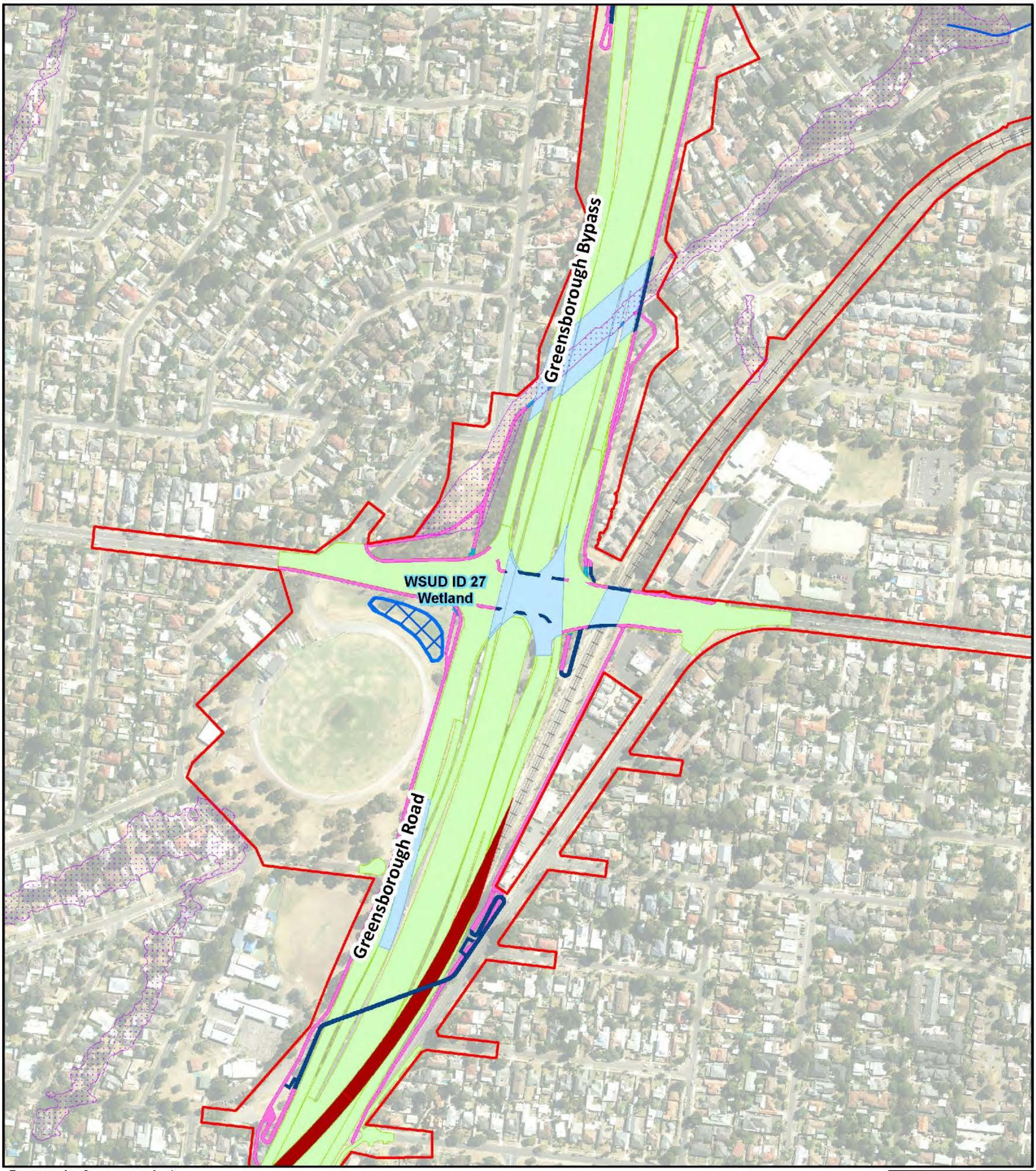
- Flood levels in the AK Lines Retarding Basin and the depth of flow overtopping Grimshaw Street increase by up to 40 millimetres in the 1% AEP event
- At the corner of Trist Street and Sellars Street immediately upstream of the top of Kempston Street there is an increase in flood depth of around 220 millimetres for many events as the result of a constriction in the overland flow path due to the current alignment of the new shared use path.

While neither of these locations directly affect private property they would need to be addressed to maintain public safety. Further improvements to the design of the retarding basin and bike path integration combined with moving the shared use path further to the east to reduce the obstruction currently modelled would improve the currently reported outcomes.

ARR 2016 sensitivity analysis

As for the existing conditions sensitivity analysis (refer Section 6.2.2), the ARR 2016 flood levels for the 1% AEP flood event during operation are generally slightly higher than predicted using ARR 1987. The larger increases in the retarding basin and at Grimshaw Street are slightly less pronounced when analysed with the reference project.

At most locations the ARR 2016 and ARR 1987 based impact estimates are very similar, refer to tabulated values in Appendix F. The two methods predict different impacts for Grimshaw Street and in the AK Lines retarding basin. In both cases the ARR 2016 predicts a smaller increase in flood levels (in fact, ARR 2016 predicts a reduction in flood level for Grimshaw Street). Observed differences are all less than 35 millimetres and mostly considerably less as shown in Appendix F. At the identified locations ARR 1987 indicated a maximum increase of 30 millimetres as a result of the reference project whereas ARR 2016 indicated a maximum increase of 2.2 millimetres.



Proposed reference project

- LSIO
- SBO
- Area required for CFSL
- Area required for WSUD
- Project boundary-sub surface
- Project boundary-surface
- Ventilation System
- Area for substation
- Shared use path overpass
- Shared use path
- Shared use path underpass
- Multi-deck car park
- Public transport infrastructure upgrade
- Elevated road, ramp or structure
- Surface road
- Road in trench
- Rail tunnel
- Underground tunnel
- River
- Stream
- Channel
- Drain

Paper Size A4

0 30 60 120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link
North East Link Project

Job Number 31-35006
Revision C
Date 23/01/2019

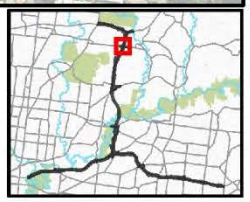
Project overview
Kempston Street Main Drain Figure 9-5

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_Hydraulics_KempstonStreet 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

Flood Depth Afflux (m)

- Was Wet Now Dry
- <-0.500
- -0.499 - -0.300
- -0.299 - -0.200
- -0.199 - -0.150
- -0.149 - -0.100
- -0.099 - -0.050
- -0.049 - -0.030
- -0.029 - -0.020
- -0.019 - -0.010
- -0.009 - 0.000
- 0.001 - 0.010
- 0.011 - 0.020
- 0.021 - 0.030
- 0.031 - 0.050
- 0.051 - 0.100
- 0.101 - 0.150
- 0.151 - 0.200
- 0.201 - 0.300
- 0.301 - 0.500
- > 0.500
- Was Dry Now Wet



Paper Size A4

0 30 60 120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link
North East Link Project

Job Number 31-35006
Revision B
Date 08/10/2018

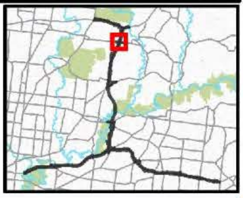
1% AEP peak flood depth afflux
Kempston Street Main Drain Figure 9-6

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_HydraulicsFigs_44.mxd 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

Flood Level Afflux (m)

- Was Wet Now Dry
- <-0.500
- -0.499 - -0.300
- -0.299 - -0.200
- -0.199 - -0.150
- -0.149 - -0.100
- -0.099 - -0.050
- -0.049 - -0.030
- -0.029 - -0.020
- -0.019 - -0.010
- -0.009 - 0.000
- 0.001 - 0.010
- 0.011 - 0.020
- 0.021 - 0.030
- 0.031 - 0.050
- 0.051 - 0.100
- 0.101 - 0.150
- 0.151 - 0.200
- 0.201 - 0.300
- 0.301 - 0.500
- > 0.500
- Was Dry Now Wet



Paper Size A4

0 30 60 120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link
North East Link Project

Job Number 31-35006
Revision B
Date 08/10/2018

1% AEP peak flood level afflux
Kempston Street Main Drain Figure 9-7

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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

Flood Velocity difference (m/s)

- Was Wet Now Dry
- <-0.500
- -0.499 - -0.300
- -0.299 - -0.200
- -0.199 - -0.150
- -0.149 - -0.100
- -0.099 - -0.050
- -0.049 - -0.030
- -0.029 - -0.020
- -0.019 - -0.010
- -0.009 - 0.000
- 0.001 - 0.010
- 0.011 - 0.020
- 0.021 - 0.030
- 0.031 - 0.050
- 0.051 - 0.100
- 0.101 - 0.150
- 0.151 - 0.200
- 0.201 - 0.300
- 0.301 - 0.500
- > 0.500
- Was Dry Now Wet

Paper Size A4

0 30 60 120

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link
North East Link Project

Job Number	31-35006
Revision	C
Date	03/12/2018

1% AEP peak flood velocity difference

Kempston Street Main Drain **Figure 9-8**

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_Hydraulics_KEM_... 180 Lonsdale Street Melbourne VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com **W** www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

9.1.3 Watsonia Station drain

This assessment has investigated the potential for the operation of North East Link to increase flood frequency and levels at receptors along an unnamed council drainage system referred to as the Watsonia Station drain in this report (which runs east from Watsonia railway station towards Melbourne Water's Watsonia Drain). This has the potential to occur due to the proposed open cut section of North East Link obstructing the existing overland flow path, potentially increasing upstream ponding levels and diverting any remaining overland flow across a land bridge to the south of its current alignment. The project is also expected to requiring the decommissioning of the existing underground drain and replacement with a new drain along a new alignment to provide sufficient cover beneath the lowered road surface.

The reference project details are provided in Figure 9-9.

Modelling of the reference project has been undertaken to quantify the potential impacts on flood risk. Figure 9-9 Figure 9-10, Figure 9-11 and Figure 9-12 show the difference in peak 1% AEP flood depth, flood level and flood velocity respectively along the drainage alignment. Further results at select locations for a range of events are provided in Appendix D3.

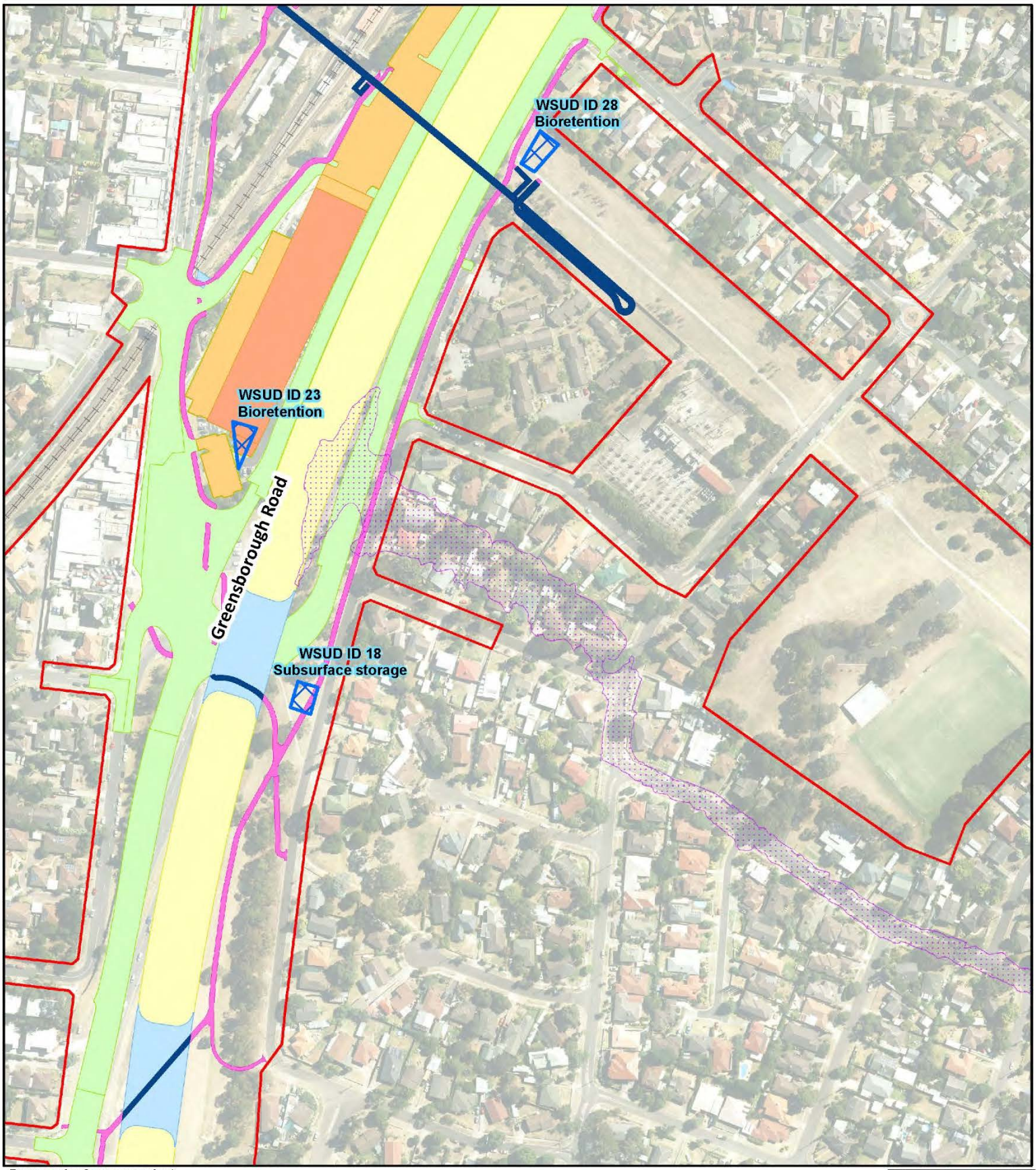
The anticipated increase in flood level upstream to the west of the alignment has the potential to affect roadways, shared use paths and parking areas. Modelling indicates that while flood levels in these areas are increased, the depth of flooding on each of these features could generally be maintained by also increasing the ground surface. It is important that existing storage capacity upstream of the main carriageway (to the west of the existing Greensborough Bypass) is not reduced by this filling which would have the potential to reduce the existing levels of attenuation and increase downstream flooding to the east of the main carriageway. The reference project provides storage in swales between these features and actually results in a small reduction in downstream flooding for larger events (to the east of the main carriageway). However, for smaller floods the current configuration appears to provide less attenuation than under existing conditions and would need to be refined

Modelling of the reference project indicates the following flood impacts for modelled design events ranging from a 20% AEP through to a 1% AEP with climate change:

- An increase in flood depth of up to 100 millimetres for the larger events on Watsonia Road upstream (west) of the North East Link alignment
- Flooding depths in the upstream service road of up to 600 millimetres in the larger events although fairly dry for events up to and including the 10% AEP
- Flooding depths in the downstream service road currently increase in the more frequent events by less than 200 millimetres and are generally reduced for the modelled 1% AEP and larger events
- Flooding through the rear of properties fronting Rasheda Street is increased by around 100 millimetres in more frequent events although modest reductions of less than 100 millimetres are achieved in the larger events modelled
- Levels in Rasheda Street and Frensham Road are not significantly changed.

It should be noted the currently indicated flooding impacts have demonstrated the need for further investigation of potential design changes and mitigation works in this location. The estimated impacts on private property for the smaller flood events described above and in Appendix D are not evident in the following afflux plots which show results for the 1% AEP event. Adjustments to the current concept in conjunction with mitigation works are being investigated to help to resolve this issue.

Further modelling of the final design to confirm that adopted mitigation measures adequately offset the impacts on flood levels would need to be undertaken to meet the City of Banyule and Melbourne Water requirements (EPR SW6). Mitigation may potentially involve land modifications to increase the floodplain storage both upstream and downstream of Greensborough Bypass. Consultation with the City of Banyule and other stakeholders would occur through the concept and detailed design process.



Proposed reference project

- LSIO
- SBO
- Area required for CFSL
- Area required for WSUD
- Project boundary-sub surface
- Project boundary-surface
- Ventilation System
- Area for substation
- Shared use path overpass
- Shared use path
- Shared use path underpass
- Multi-deck car park
- Public transport infrastructure upgrade
- Elevated road, ramp or structure
- Surface road
- Road in trench
- Rail tunnel
- Underground tunnel
- River
- Stream
- Channel
- Drain

Paper Size A4

0 20 40 80

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link
North East Link Project

Job Number 31-35006
Revision C
Date 23/01/2019

Project overview
Watsonia Station drain

Figure 9-9

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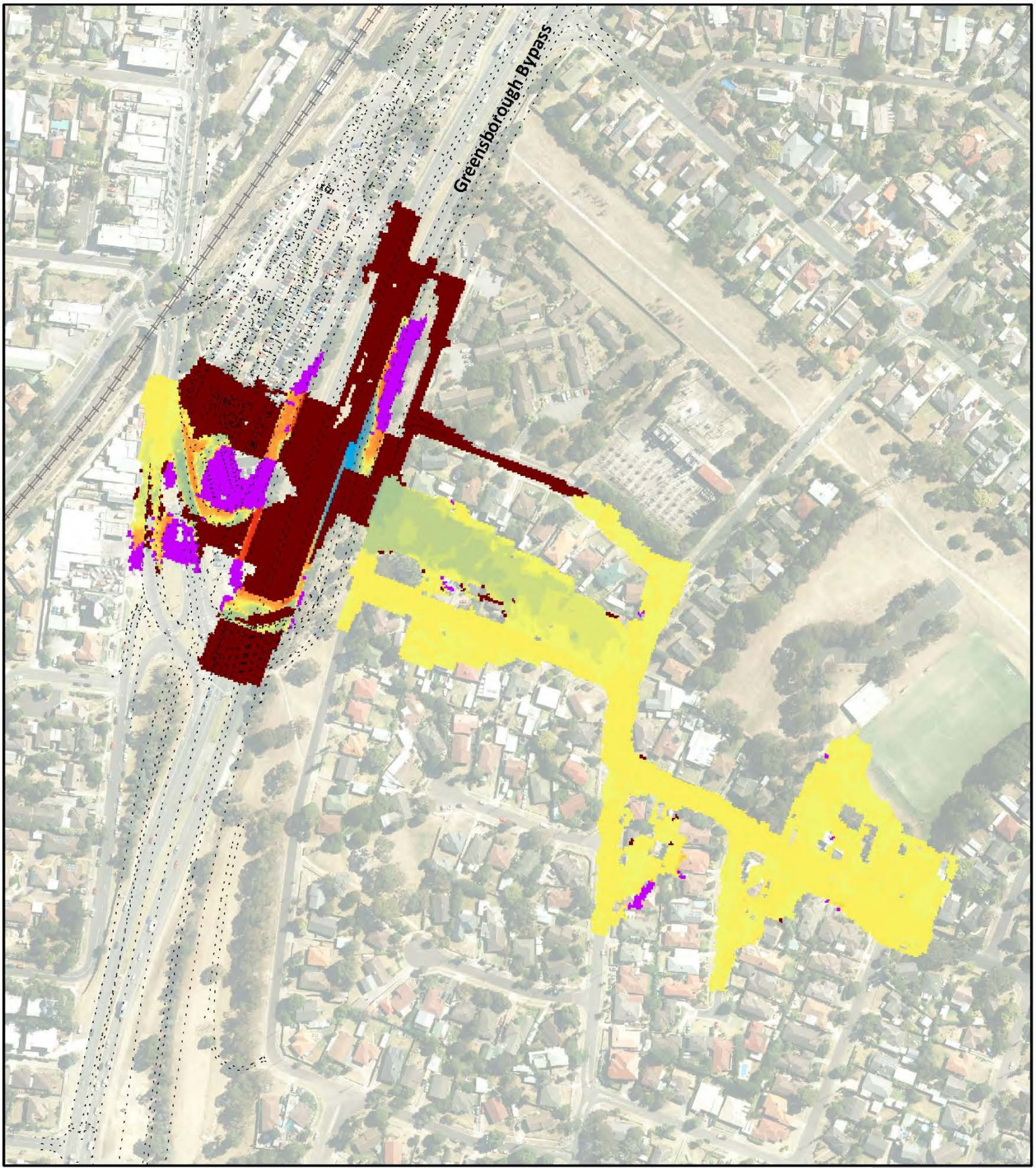
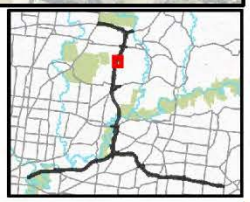
Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Depth Afflux (m)	-0.199 - -0.150	-0.019 - -0.010	0.031 - 0.050	0.301 - 0.500
Was Wet Now Dry	-0.149 - -0.100	-0.009 - 0.000	0.051 - 0.100	> 0.500
<-0.500	-0.099 - -0.050	0.001 - 0.010	0.101 - 0.150	Was Dry Now Wet
-0.499 - -0.300	-0.049 - -0.030	0.011 - 0.020	0.151 - 0.200	
-0.299 - -0.200	-0.029 - -0.020	0.021 - 0.030	0.201 - 0.300	



Paper Size A4

0 20 40 80

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link
North East Link Project

Job Number 31-35006
Revision B
Date 08/10/2018

1% AEP peak flood depth afflux Watsonia Station drain

Figure 9-10

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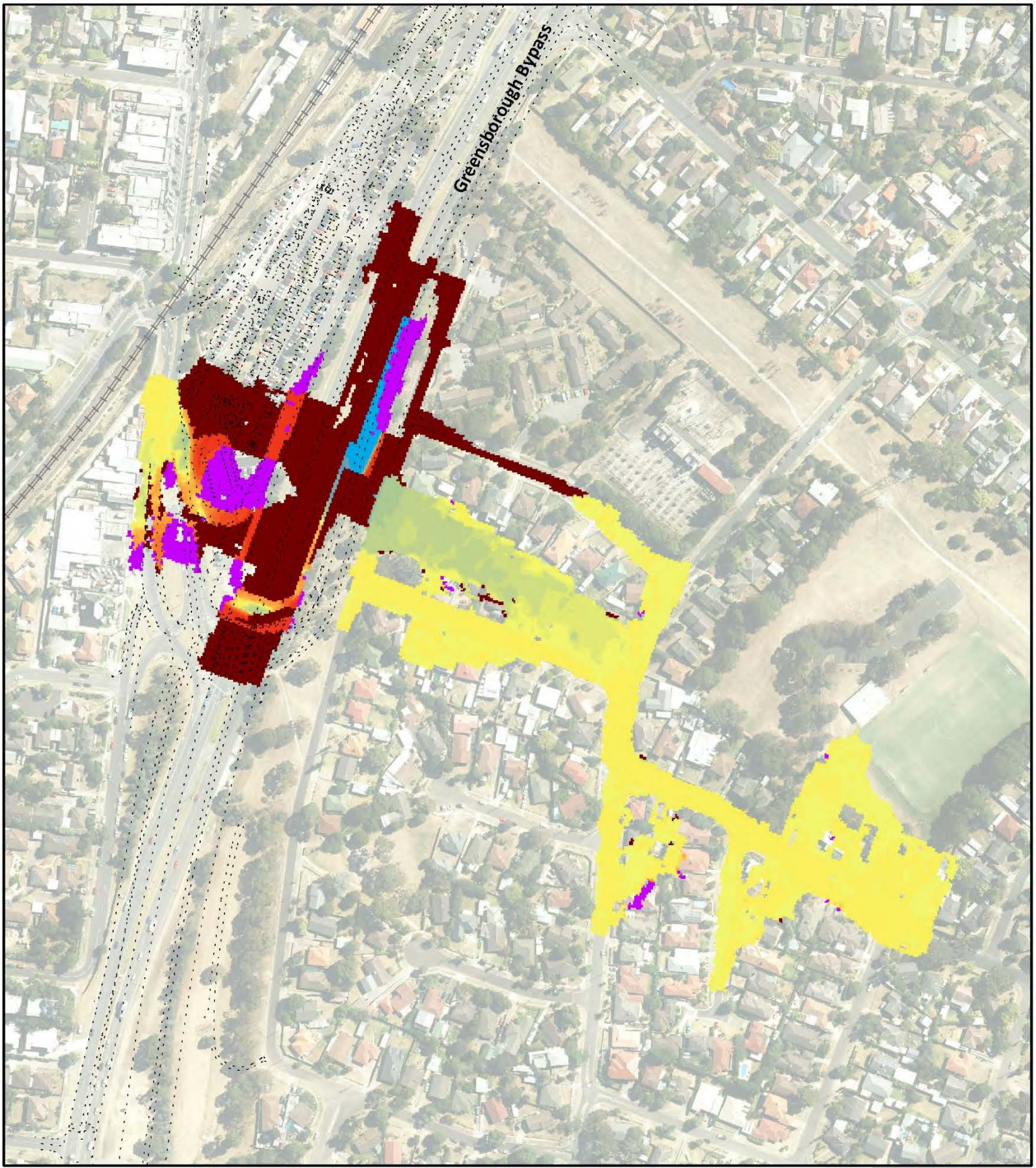
Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Level Afflux (m)	-0.199 - -0.150	-0.019 - -0.010	0.031 - 0.050	0.301 - 0.500
Was Wet Now Dry	-0.149 - -0.100	-0.009 - 0.000	0.051 - 0.100	> 0.500
<-0.500	-0.099 - -0.050	0.001 - 0.010	0.101 - 0.150	Was Dry Now Wet
-0.499 - -0.300	-0.049 - -0.030	0.011 - 0.020	0.151 - 0.200	
-0.299 - -0.200	-0.029 - -0.020	0.021 - 0.030	0.201 - 0.300	

Paper Size A4

0 20 40 80

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link
North East Link Project

Job Number 31-35006
Revision B
Date 08/10/2018

1% AEP peak flood level afflux Watsonia Station drain

Figure 9-11

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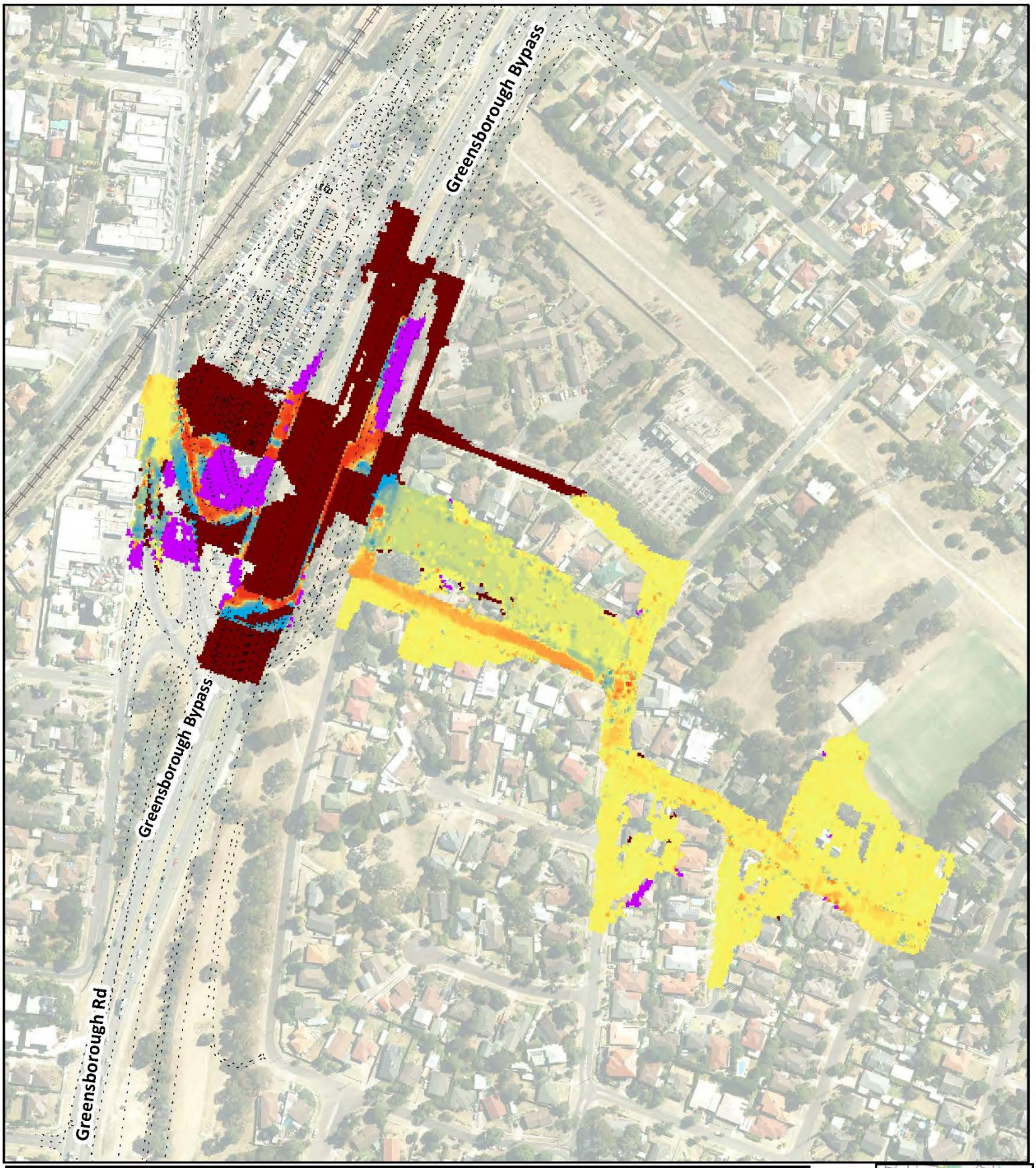
Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Velocity difference (m/s)				
Was Wet Now Dry	-0.199 - -0.150	-0.019 - -0.010	0.031 - 0.050	0.301 - 0.500
<-0.500	-0.149 - -0.100	-0.009 - 0.000	0.051 - 0.100	> 0.500
-0.499 - -0.300	-0.099 - -0.050	0.001 - 0.010	0.101 - 0.150	Was Dry Now Wet
-0.299 - -0.200	-0.049 - -0.030	0.011 - 0.020	0.151 - 0.200	
	-0.029 - -0.020	0.021 - 0.030	0.201 - 0.300	

Paper Size A4

0 20 40 80

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link
North East Link Project

Job Number 31-35006
Revision C
Date 03/12/2018

1% AEP peak flood velocity difference
Watsonia Station drain

Figure 9-12

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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

9.1.4 Banyule Creek

This assessment has investigated the potential for the operation of North East Link to increase flood frequency and levels at receptors around the existing Banyule Creek floodplain due to project assets displacing flood water (risk SW09). North East Link would include a cut and cover roadway as well as tunnel portal and ventilation structures located within the existing Banyule Creek floodplain and would displace floodwater in a 1% AEP flood event. In addition, the project would result in Banyule Creek being diverted into a drainage system to either side of the North East Link roadway, between Simpson Barracks and Lower Plenty Road. As a result, the existing flood regime would be significantly altered.

The reference project details are provided in Figure 9-13.

The reference project has been modelled to assess the potential change to flood impacts on surrounding property and assets in comparison to the existing scenario, due to the addition of assets within the floodplain and changes to drainage system.

Modelling of the reference project has been undertaken to quantify the potential impacts on flood risk. Figure 9-14 Figure 9-15 and Figure 9-16 show the difference in peak 1% AEP flood depth, flood level and flood velocity respectively along the drainage alignment. Further results at select locations for a range of events are provided in Appendix D4.

No significant increase in flood depths are anticipated for any of the events or locations summarised. There are expected increases in flood depths within designed storages and channels as evident in Figure 9-14 but with no adverse effect on private property.

Hydraulic modelling indicates the reference project provides sufficient attenuation to offset the loss of existing floodplain storage and avoid changes to downstream flooding with the potential to affect waterway stability or private property.

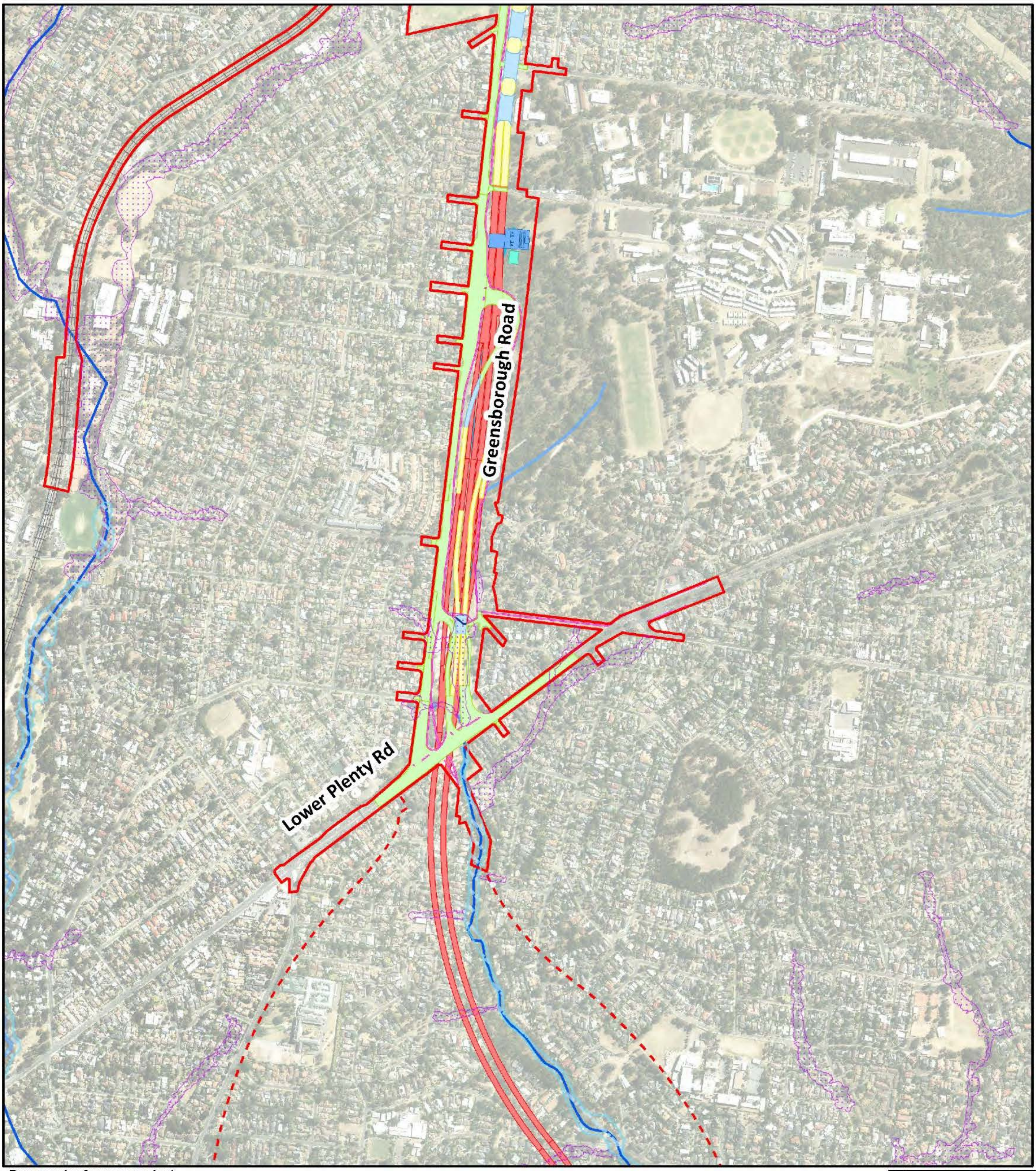
The drainage diversion system, particularly if piped, would require effective inlet capacity which would need careful integration with the surrounding assets. The potential for and consequence of bypass of these inlets has not been modelled as part of the EES but would require consideration as part of the risk assessment required by EPR SW6.

It is recognised that alternative solutions to the reference project may evolve and these would be required to demonstrate through modelling that the design of permanent infrastructure meets the flood level, flow and velocity requirements with consideration for climate change (EPR SW6 and EPR SW13).

This assessment has also investigated the potential for flooding to inundate the tunnels and cause a public safety risk (risk SW17). The reference project locates the northern tunnel portal within a flood-prone area of Banyule Creek which may be subject to flash flooding. Due to the short reach lengths and steep nature of the catchment, flash flooding typically occurs within one to two hours of rain starting. Therefore, there would be limited time available to evacuate the tunnels in the case of a flood event.

Despite the relatively small catchment and subsequently relatively small runoff volumes, the lack of warning time influenced a risk based assessment to design the tunnel entrances at the northern portal and Lower Plenty Road interchange to cope with a probable maximum flood estimated by applying the worst conceivable rainfall event (the probable maximum precipitation) to a catchment with conditions conducive to generating floods.

Hydraulic modelling indicates the safety risk associated with flooding of the northern portal could be physically managed with a combination of adequate diversion capacity, road grading and floodwalls to protect the threshold. Further protection would be afforded by the implementation of suitable operation and emergency management plans (EPR SW7).



Proposed reference project

- LSIO
- SBO
- Area required for CFSL
- Area required for WSUD
- Project boundary-sub surface
- Project boundary-surface
- Ventilation System
- Area for substation
- Shared use path overpass
- Shared use path
- Shared use path underpass
- Multi-deck car park
- Public transport infrastructure upgrade
- Elevated road, ramp or structure
- Surface road
- Road in trench
- Rail tunnel
- Underground tunnel
- River
- Stream
- Channel
- Drain

Paper Size A4

0 85 170 340

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

North East Link
North East Link Project

Job Number	31-35006
Revision	C
Date	23/01/2019

Project overview
Banyule Creek

Figure 9-13

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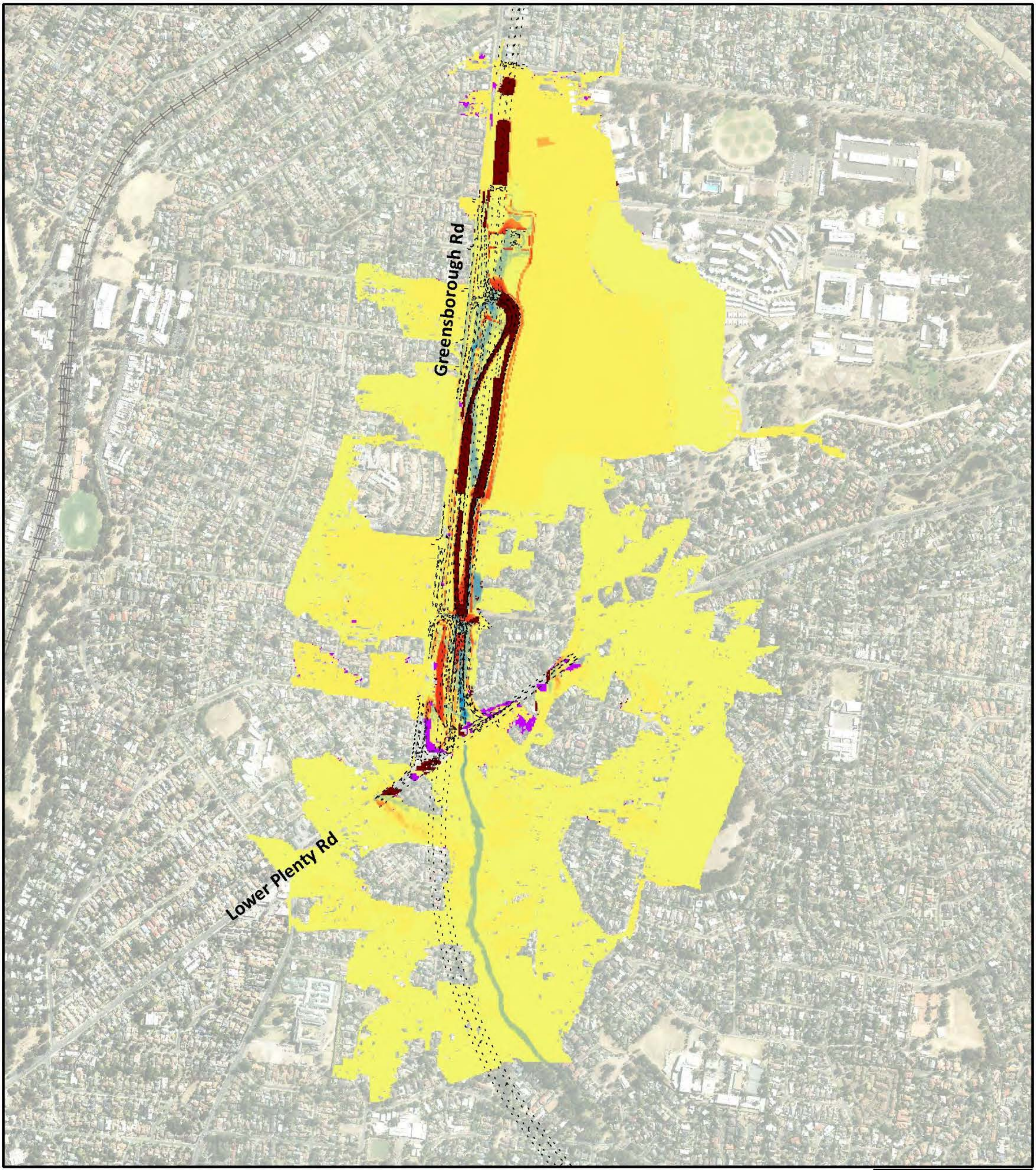
Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Depth Afflux (m)

Was Wet Now Dry	-0.199 - -0.150	-0.019 - -0.010	0.031 - 0.050	0.301 - 0.500
<-0.500	-0.149 - -0.100	-0.009 - 0.000	0.051 - 0.100	> 0.500
-0.499 - -0.300	-0.099 - -0.050	0.001 - 0.010	0.101 - 0.150	Was Dry Now Wet
-0.299 - -0.200	-0.049 - -0.030	0.011 - 0.020	0.151 - 0.200	
	-0.029 - -0.020	0.021 - 0.030	0.201 - 0.300	

Paper Size A4

0 85 170 340

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

NORTH EAST LINK PROJECT

North East Link
North East Link Project

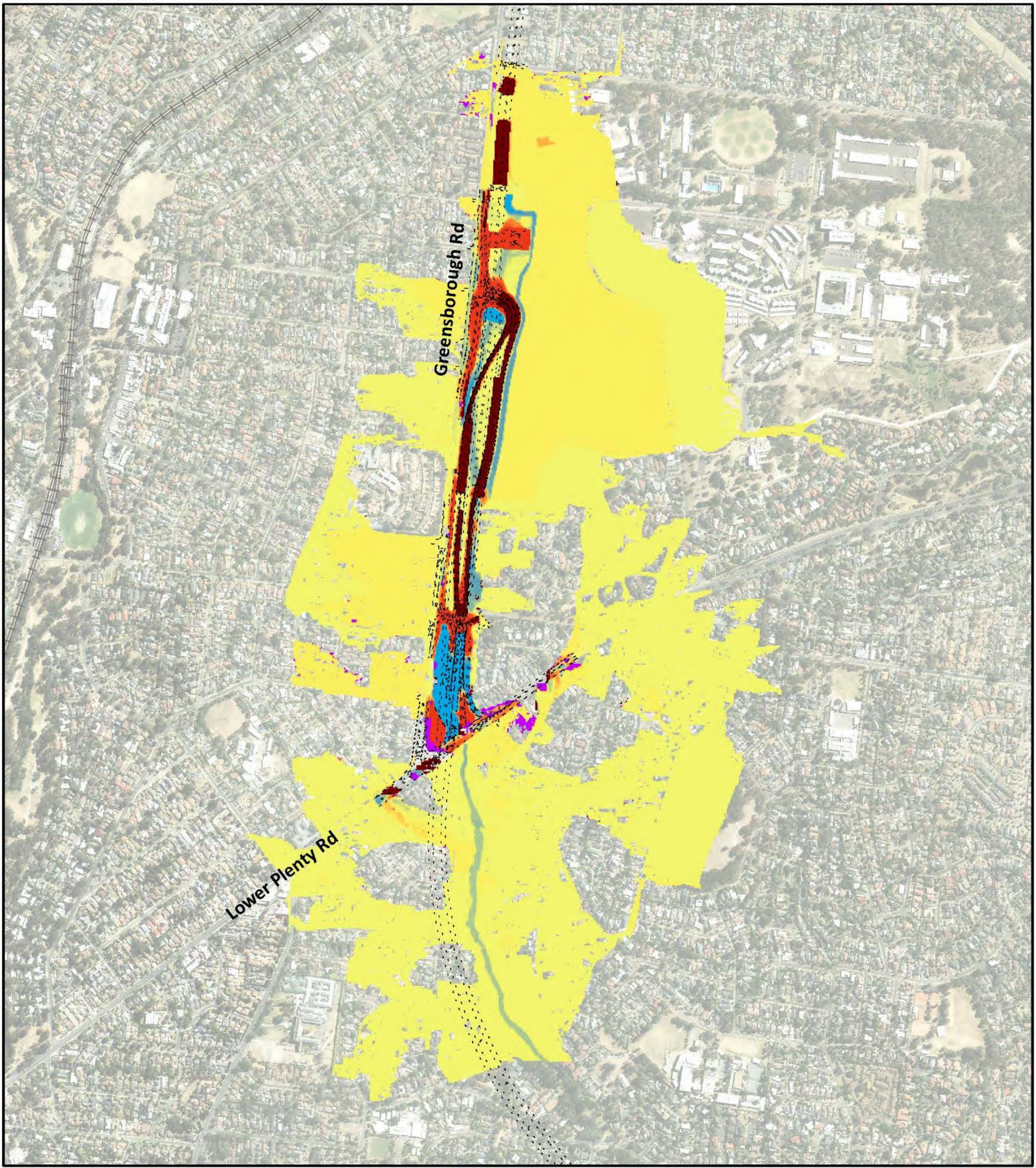
Job Number 31-35006
Revision B
Date 08/10/2018

1% AEP peak flood depth afflux
Banyule Creek

Figure 9-14

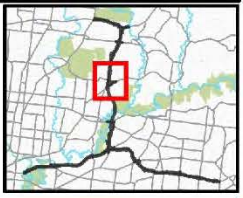
G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_Hydraulics_KBM_... 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Level Afflux (m)

Was Wet Now Dry	-0.199 - -0.150	-0.019 - -0.010	0.031 - 0.050	0.301 - 0.500
<-0.500	-0.149 - -0.100	-0.009 - 0.000	0.051 - 0.100	> 0.500
-0.499 - -0.300	-0.099 - -0.050	0.001 - 0.010	0.101 - 0.150	Was Dry Now Wet
-0.299 - -0.200	-0.049 - -0.030	0.011 - 0.020	0.151 - 0.200	
	-0.029 - -0.020	0.021 - 0.030	0.201 - 0.300	



Paper Size A4

0 85 170 340

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

North East Link
North East Link Project

Job Number 31-35006
Revision B
Date 08/10/2018

1% AEP peak flood level afflux
Banyule Creek

Figure 9-15

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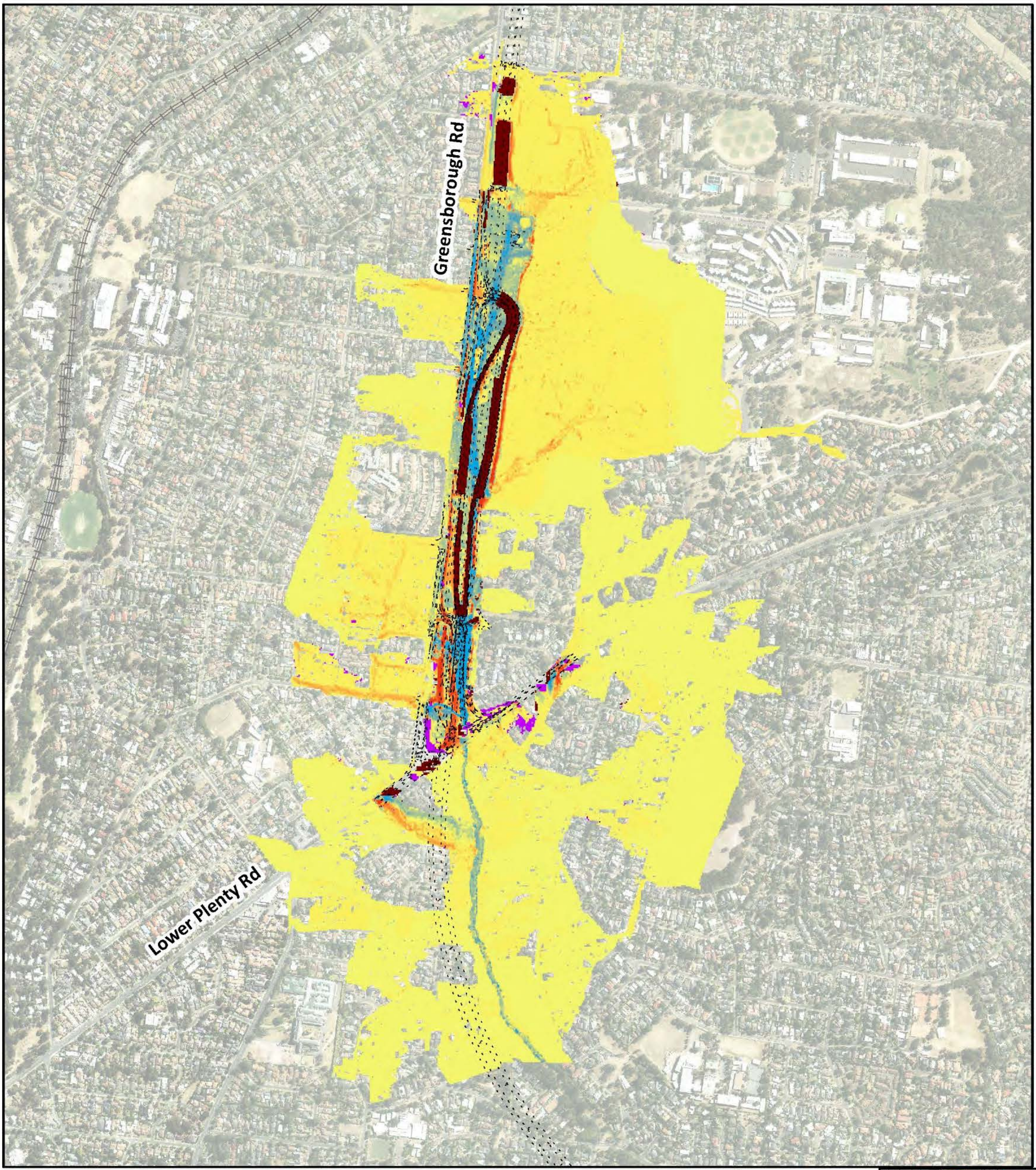
Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Velocity difference (m/s)

- Was Wet Now Dry
- <-0.500
- -0.499 - -0.300
- -0.299 - -0.200
- -0.199 - -0.150
- -0.149 - -0.100
- -0.099 - -0.050
- -0.049 - -0.030
- -0.029 - -0.020
- -0.019 - -0.010
- -0.009 - 0.000
- 0.001 - 0.010
- 0.011 - 0.020
- 0.021 - 0.030
- 0.031 - 0.050
- 0.051 - 0.100
- 0.101 - 0.150
- 0.151 - 0.200
- 0.201 - 0.300
- 0.301 - 0.500
- > 0.500
- Was Dry Now Wet

Paper Size A4

0 85 170 340

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link
North East Link Project

Job Number 31-35006
Revision C
Date 03/12/2018

1% AEP peak flood velocity difference
Banyule Creek

Figure 9-16

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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

9.1.5 Yarra River

This assessment has investigated the potential for the operation of North East Link to increase flood frequency and levels at receptors within and around the existing Yarra River floodplain due to the project displacing flood water (risk SW09). The project proposes a new interchange at Manningham Road, a tunnel portal and associated ventilation facility located south of the Veneto Club and further to the south surface road and elevated ramps connecting to the Eastern Freeway via a new interchange. These would be located with the existing Yarra River floodplain and would displace floodwater in a 1% AEP flood event.

The reference project details are provided in Figure 9-17 to Figure 9-19

Modelling of the reference project has been undertaken to quantify the potential impacts on flood risk Figure 9-20 to Figure 9-22, Figure 9-23 to Figure 9-25 and Figure 9-26 to Figure 9-28 show the difference in peak 1% AEP flood depth, flood level and flood velocity respectively along the drainage alignment. Further results at select locations for a range of events are provided in Appendix D5.

The reference project has been modelled to assess the potential change to flood impacts on surrounding property and assets in comparison with the existing scenario, due to the addition of assets within the floodplain. Modelling of the reference project has demonstrated that loss of flood plain storage would have little impact on flood levels. The modelling indicates that some localised increases in flood levels (less than 25 millimetres) may occur upstream of Manningham Road. While this is a small increase, it continues a significant distance upstream before being fully dissipated. As there is some residual afflux at the upstream end of the TUFLOW model, the MW HecRAS model was used to continue the assessment further upstream. Smaller increases are shown along the Eastern Freeway near Burke Road due to a slight lowering of the Eastern Freeway and to the east of Bulleen Road from Koonung Creek. Although these small increases may be further mitigated, a preliminary assessment of the number of properties potentially affected was undertaken and is summarised in Table 9-1. Buildings within the flood extent do not necessarily experience above floor flooding.

Table 9-1 Estimated impact during a 1% AEP Yarra River flood

Location	Maximum afflux (m)	Additional properties affected by flooding	Flooded properties exposed to an increase in flood level	Main buildings within flood extent exposed to an increase in flood level
Eastern Freeway (near Burke Road)	0.015	0	1	1
Koonung Creek (east of Bulleen Road)	0.016	0	2	0
Manningham Road (within TUFLOW model)	0.022	0	123	46
Upstream of TUFLOW model (based on HecRAS assessment)	0.01	0	122	33
TOTAL	**N/A**	**0**	**248**	**80**

Residual issues of the afflux levels would be required to be resolved as part of the detailed design to demonstrate that the design of permanent infrastructure meets the flood level, flow and velocity requirements with consideration for climate change (EPR SW6 and EPR SW13).

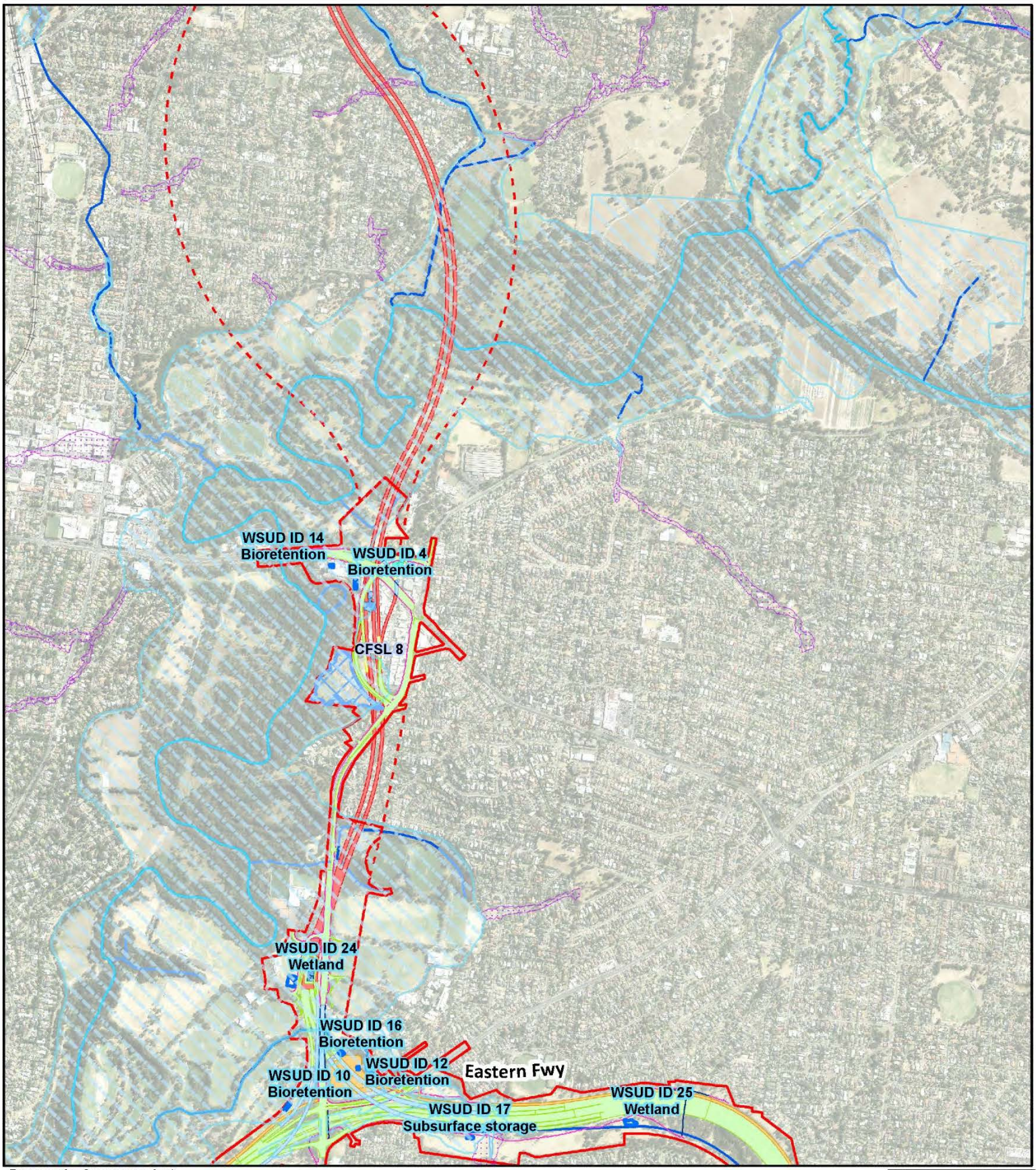
Downstream of the main Yarra River TUFLOW model, there are proposed strengthening works to the existing Eastern Freeway bridge at Yarra Bend and a new shared use path bridge immediately upstream. Preliminary modelling using HECRAS has indicated that provided the piers and soffit of the new bridge are aligned with the existing structure and any modifications to the existing piers are fairly streamlined and not excessive, there would be minimal increase in upstream flood level. The final design of these structures would need to be assessed to confirm that effects of any afflux are acceptable in accordance with the EPRs, particularly EPR SW1 EPR SW6, EPR SW8, and EPR SW9 and EPR SW10.

This assessment has also investigated the potential for flooding to inundate the tunnels and cause a public safety risk (risk SW17). The reference project locates the Manningham Road interchange and southern tunnel portals within a flood-prone area of Yarra River. To manage the risk of flooding of the tunnels, the project includes floodwalls, and has carefully considered the road geometry to provide passive protection for large flood events.

Given the large size of the Yarra River floodplain, peak flows for large floods typically occur several days following the rain falling in the upper catchment. The substantial lead time for large flooding events provides the opportunity to remove people from the tunnel in the case of an extreme flood event. Consequently the tunnel entrances at the southern portal and Manningham Road interchange have been designed with an understanding that a combination of active and passive measures (examples of each being flood gates and floodwalls respectively) to manage the potential for flooding. Operation, maintenance and emergency management plans would be implemented, detailing the evacuation process in the case of an oncoming flood (EPR SW7). Modelling has demonstrated that with the floodwalls, and the implementation of operation management plans and procedures, tunnel users and tunnel infrastructure can be adequately protected.

Although North East Link is a large project, the proposed footprint of the works relative to the local extent of the Yarra River floodplain (Chandler Basin) is relatively small, not more than a few percent by area. Given the current land use and zonings, the potential for additional development within the floodplain to have a measurable impact on flood storage is limited. Hence the potential for significant cumulative floodplain impacts due to the incremental loss of flood plain storage is effectively constrained. Given there is limited potential for the incremental loss of flood plain storage and that modelling confirms the loss of storage due to the project would have little impact on flood levels (EPR SW06), the need for and benefit of mitigation is limited in this instance. Indeed, if needed, alternative forms of compensation may be more beneficial in reducing flood risk.

Flooding and groundwater have an important role in maintaining the normal variations of water level in many flood plain features including the Bolin Bolin Billabong. No significant change to the relevant flooding regime in terms of frequency, quantity or quality are anticipated as a result the project. Further information regarding the ecological values and potential changes to groundwater levels are contained in the ecological and groundwater technical reports respectively.



Proposed reference project

- LSIO
- SBO
- Area required for CFSL
- Area required for WSUD
- Project boundary-sub surface
- Project boundary-surface
- Ventilation System
- Area for substation
- Shared use path overpass
- Shared use path
- Shared use path underpass
- Multi-deck car park
- Public transport infrastructure upgrade
- Elevated road, ramp or structure
- Surface road
- Road in trench
- Rail tunnel
- Underground tunnel
- River
- Stream
- Channel
- Drain

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

North East Link
North East Link Project

Job Number 31-35006
Revision D
Date 23/01/2019

Project overview
Yarra River 1 of 3

Figure 9-17

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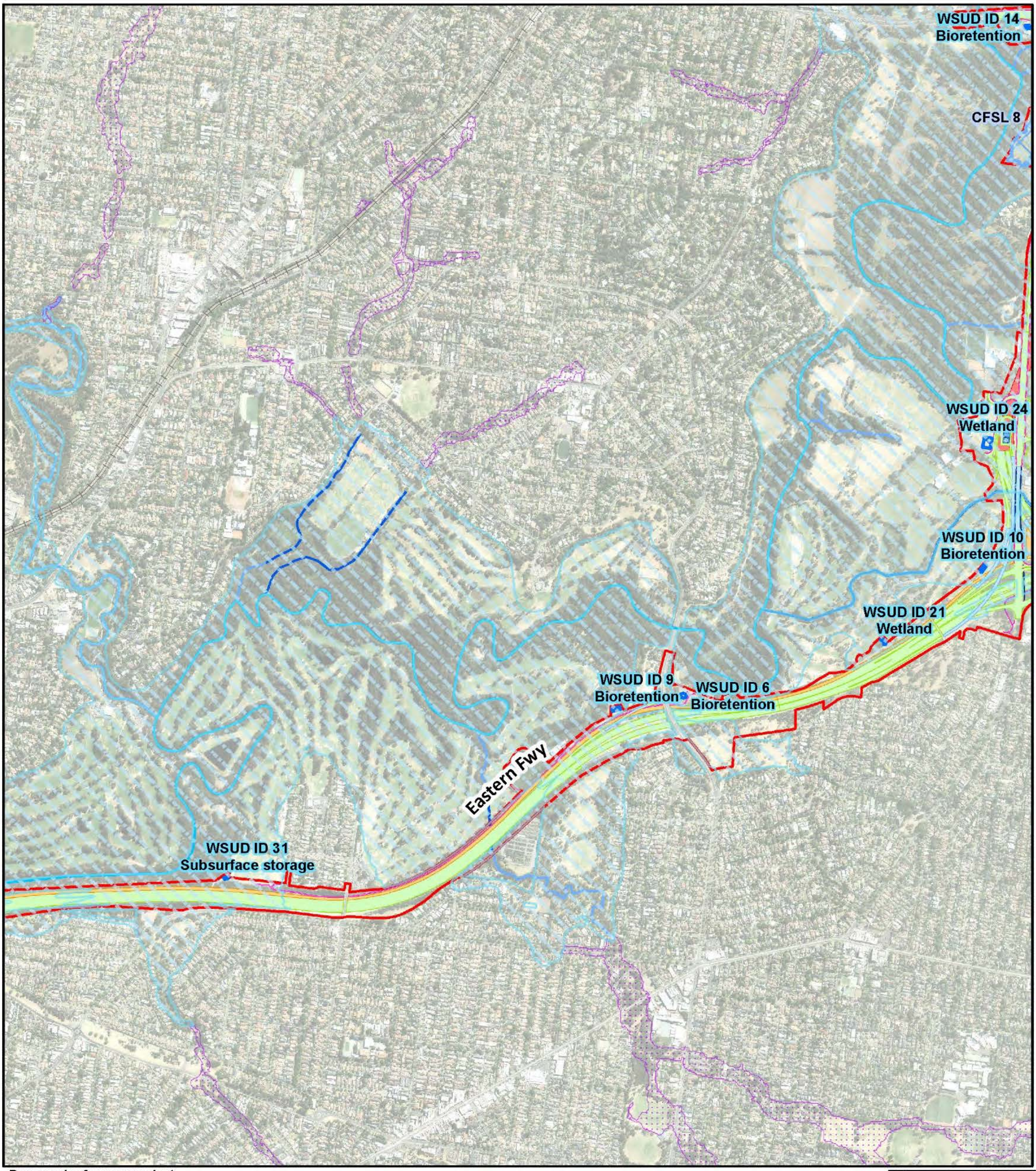
Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Proposed reference project

LSIO	Project boundary-surface	Shared use path underpass	Road in trench	Channel
SBO	Ventilation System	Multi-deck car park	Rail tunnel	Drain
Area required for CFSL	Area for substation	Public transport infrastructure upgrade	Underground tunnel	
Area required for WSUD	Shared use path overpass	Elevated road, ramp or structure	River	
Project boundary-sub surface	Shared use path	Surface road	Stream	

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

North East Link
North East Link Project

Job Number 31-35006
Revision C
Date 23/01/2019

Project overview
Yarra River 2 of 3

Figure 9-18

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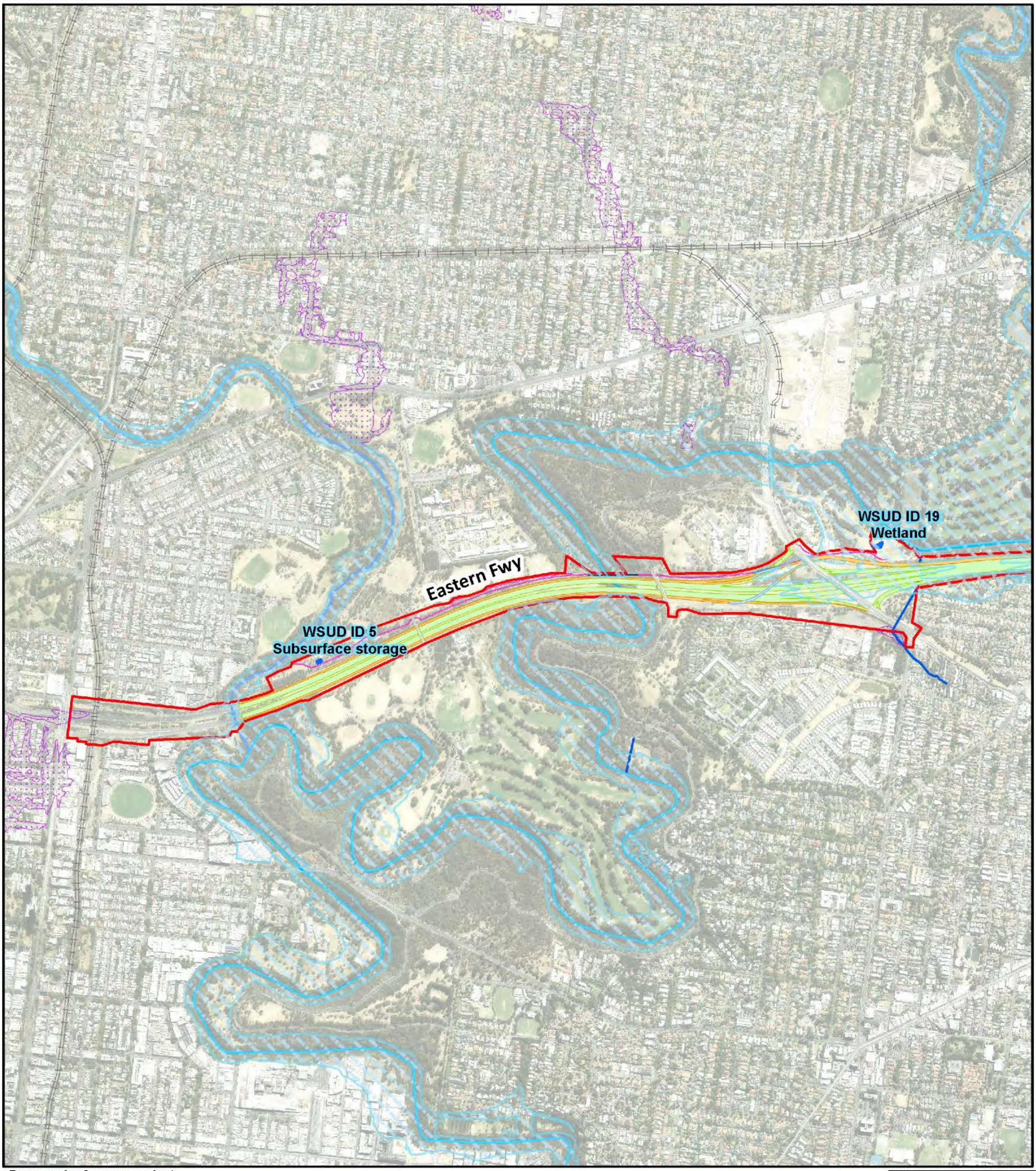

Proposed reference project

LSIO	Project boundary-surface	Shared use path underpass	Road in trench	Channel
SBO	Ventilation System	Multi-deck car park	Rail tunnel	Drain
Area required for CFSL	Area for substation	Public transport infrastructure upgrade	Underground tunnel	
Area required for WSUD	Shared use path overpass	Elevated road, ramp or structure	River	
Project boundary-sub surface	Shared use path	Surface road	Stream	

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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NORTH EAST LINK PROJECT

North East Link
North East Link Project

Job Number | 31-35006
Revision | C
Date | 23/01/2019

Project overview
Yarra River 3 of 3

Figure 9-19

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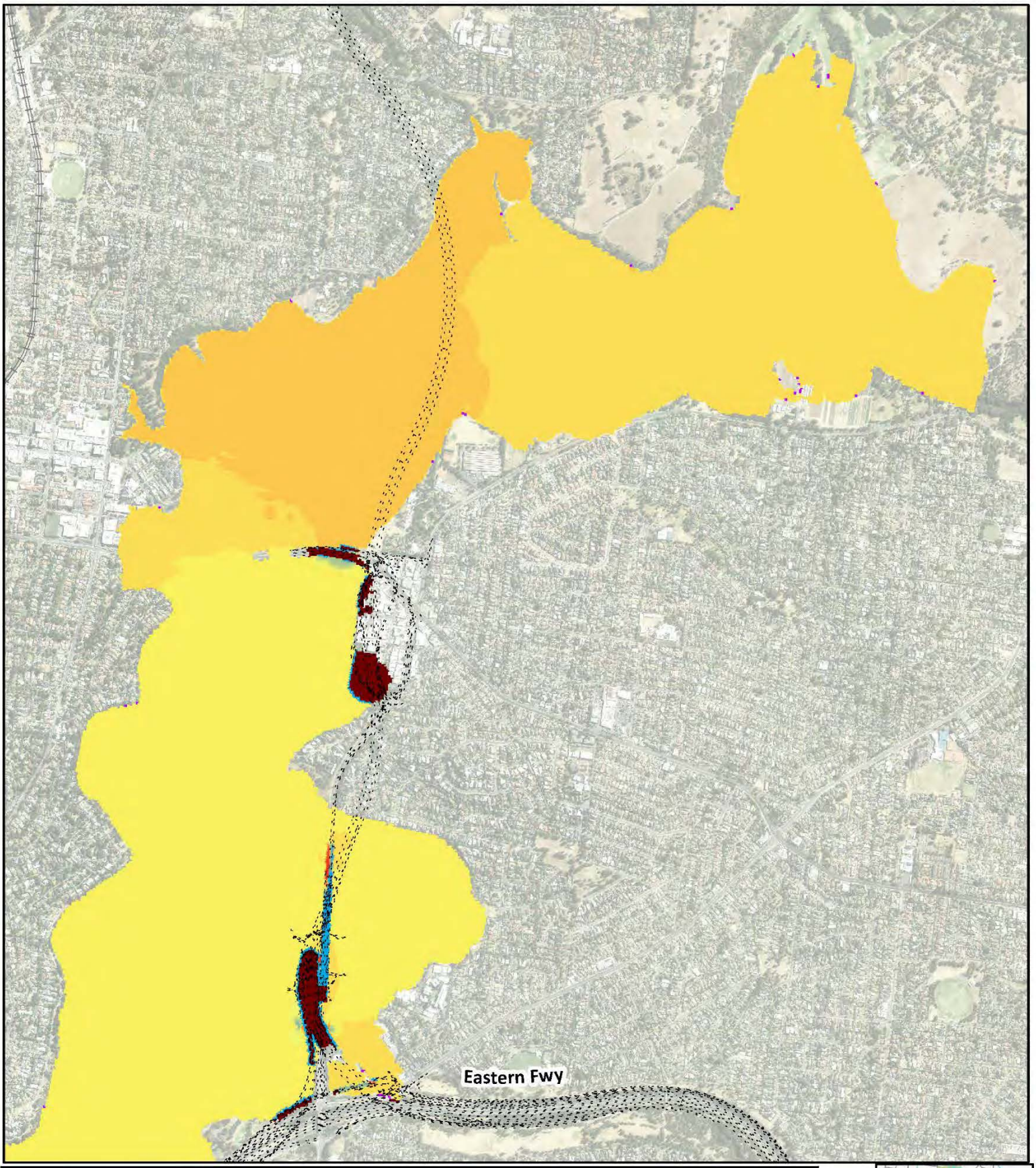


Flood Depth Afflux (m)	-0.199 - -0.150	-0.019 - -0.010	0.031 - 0.050	0.301 - 0.500
Was Wet Now Dry	-0.149 - -0.100	-0.009 - 0.000	0.051 - 0.100	> 0.500
<-0.500	-0.099 - -0.050	0.001 - 0.010	0.101 - 0.150	Was Dry Now Wet
-0.499 - -0.300	-0.049 - -0.030	0.011 - 0.020	0.151 - 0.200	
-0.299 - -0.200	-0.029 - -0.020	0.021 - 0.030	0.201 - 0.300	

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link
North East Link Project

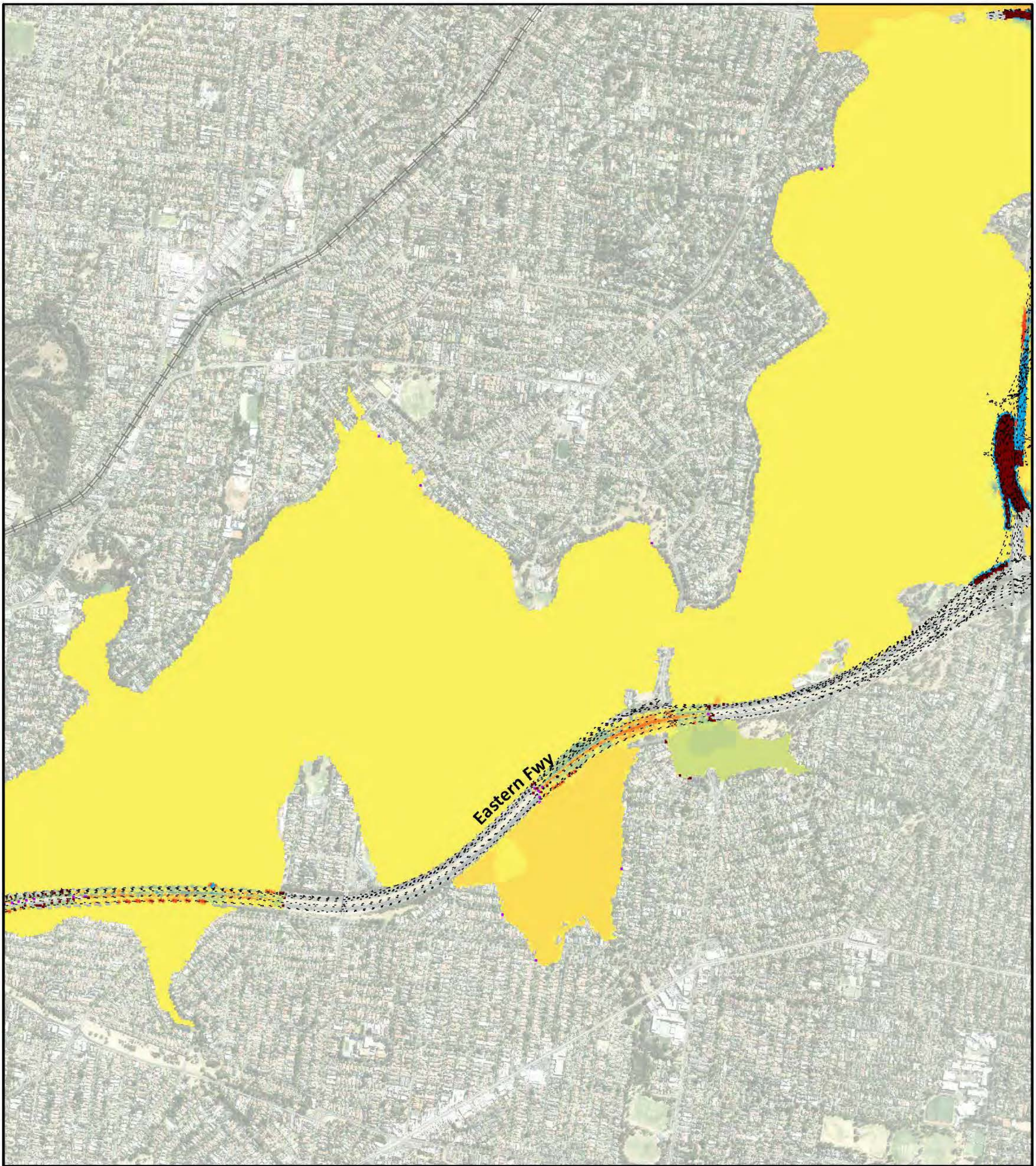
Job Number 31-35006
Revision C
Date 26/10/2018

1% AEP peak flood depth afflux
Yarra River 1 of 3

Figure 9-20

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_HydraulicsBM_44.mxd Level 8, 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Depth Afflux (m)				
Was Wet Now Dry	-0.199 - -0.150	-0.019 - -0.010	0.031 - 0.050	0.301 - 0.500
<-0.500	-0.149 - -0.100	-0.009 - 0.000	0.051 - 0.100	> 0.500
-0.499 - -0.300	-0.099 - -0.050	0.001 - 0.010	0.101 - 0.150	Was Dry Now Wet
-0.299 - -0.200	-0.049 - -0.030	0.011 - 0.020	0.151 - 0.200	
	-0.029 - -0.020	0.021 - 0.030	0.201 - 0.300	

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

North East Link
North East Link Project

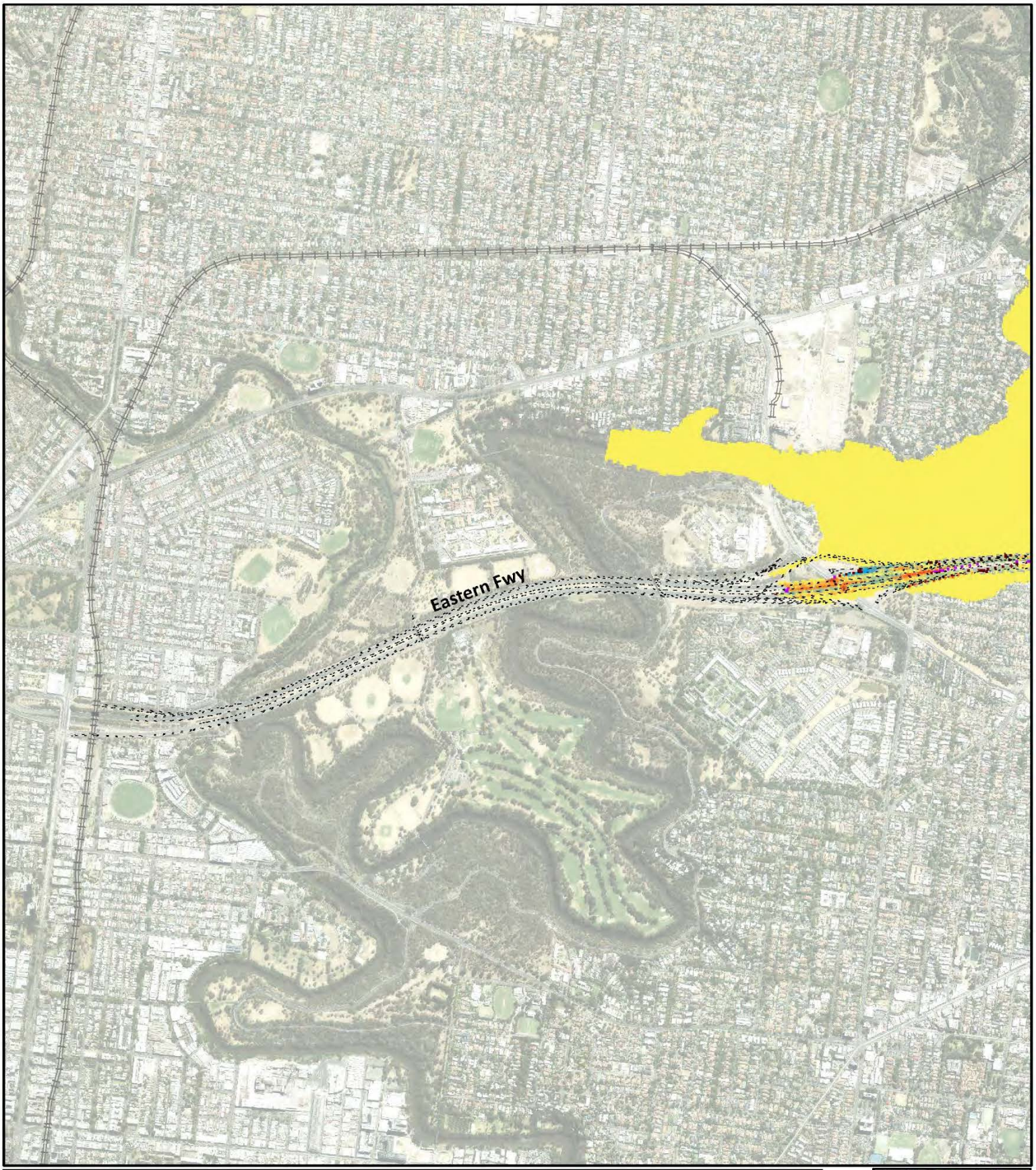
Job Number 31-35006
Revision B
Date 08/10/2018

1% AEP peak flood depth afflux
Yarra River 2 of 3

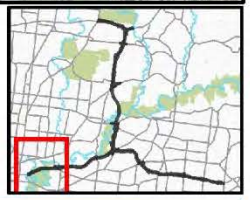
Figure 9-21

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_Hydraulics_KBM_Afflux.mxd 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Depth Afflux (m)	-0.199 - -0.150	-0.019 - -0.010	0.031 - 0.050	0.301 - 0.500
Was Wet Now Dry	-0.149 - -0.100	-0.009 - 0.000	0.051 - 0.100	> 0.500
<-0.500	-0.099 - -0.050	0.001 - 0.010	0.101 - 0.150	Was Dry Now Wet
-0.499 - -0.300	-0.049 - -0.030	0.011 - 0.020	0.151 - 0.200	
-0.299 - -0.200	-0.029 - -0.020	0.021 - 0.030	0.201 - 0.300	



Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

North East Link
North East Link Project

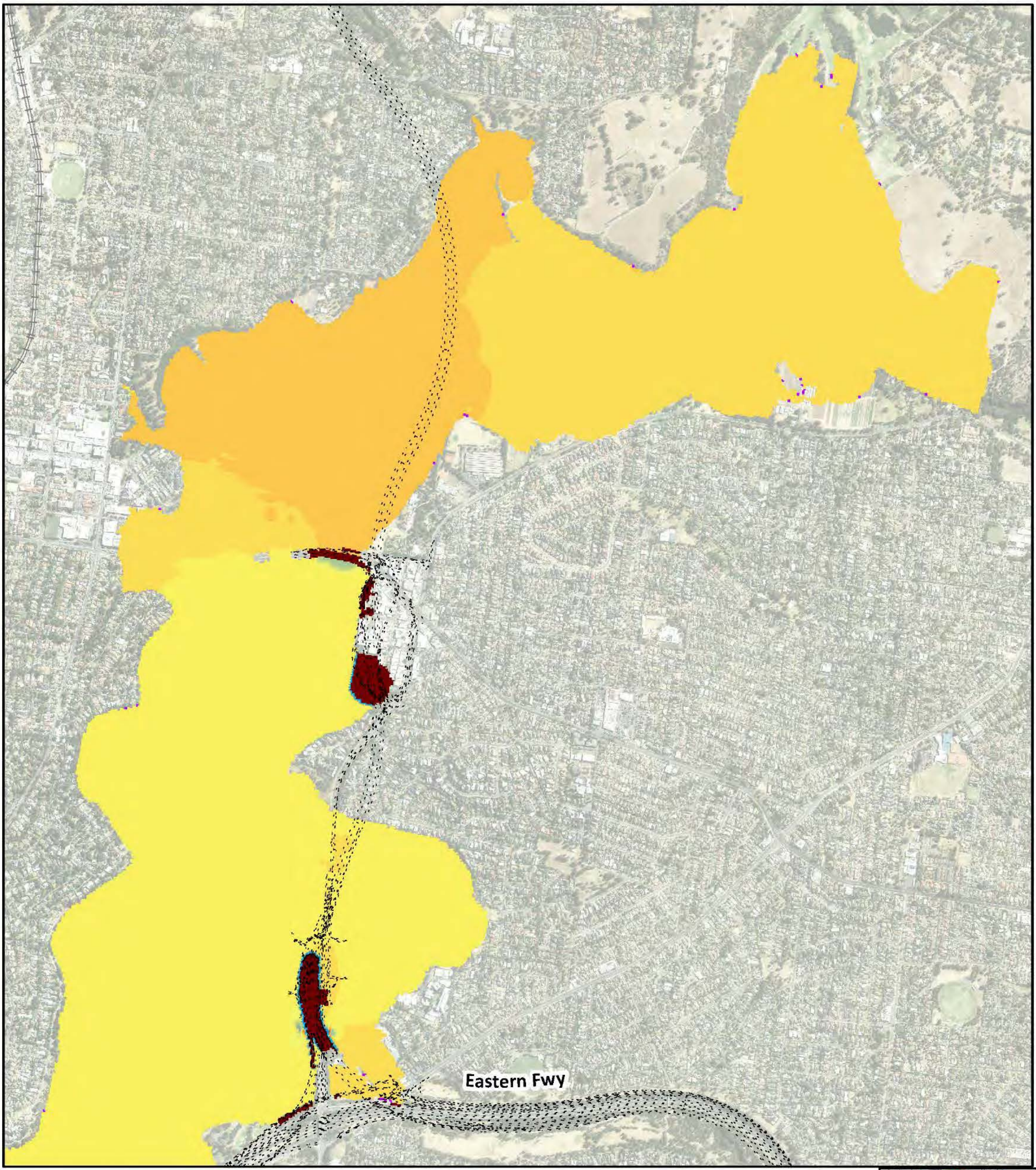
Job Number 31-35006
Revision B
Date 08/10/2018

1% AEP peak flood depth afflux
Yarra River 3 of 3

Figure 9-22

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_HydraulicsBM_44.mxd GHD 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Level Afflux (m)

Was Wet Now Dry	-0.199 - -0.150	-0.019 - -0.010	0.031 - 0.050	0.301 - 0.500
<-0.500	-0.149 - -0.100	-0.009 - 0.000	0.051 - 0.100	> 0.500
-0.499 - -0.300	-0.099 - -0.050	0.001 - 0.010	0.101 - 0.150	Was Dry Now Wet
-0.299 - -0.200	-0.049 - -0.030	0.011 - 0.020	0.151 - 0.200	
	-0.029 - -0.020	0.021 - 0.030	0.201 - 0.300	

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

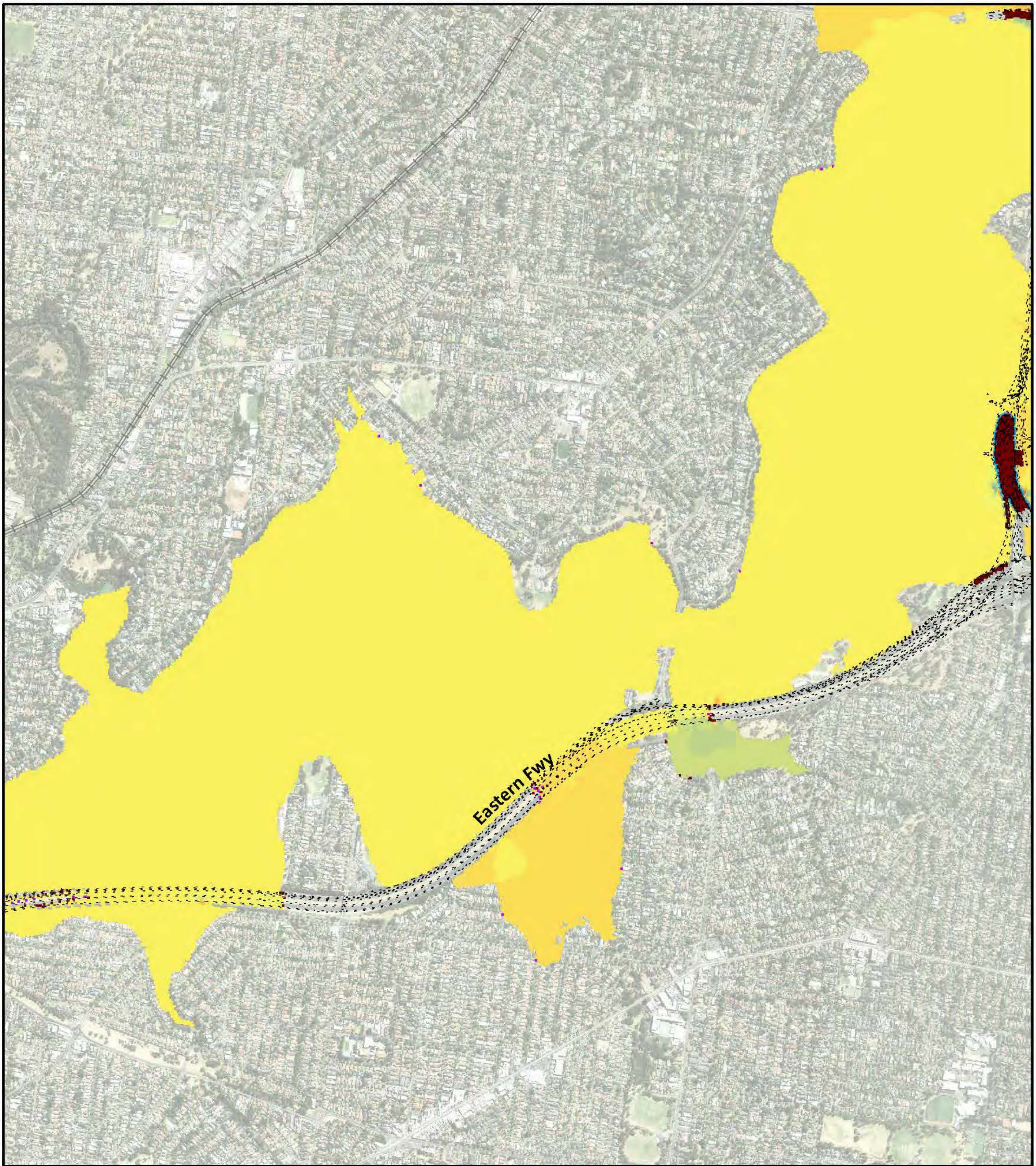
North East Link
North East Link Project

Job Number 31-35006
Revision C
Date 26/10/2018

1% AEP peak flood level afflux
Yarra River 1 of 3 **Figure 9-23**

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_Hydraulics_KBM 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Level Afflux (m)				
Was Wet Now Dry	-0.199 - -0.150	-0.019 - -0.010	0.031 - 0.050	0.301 - 0.500
<-0.500	-0.149 - -0.100	-0.009 - 0.000	0.051 - 0.100	> 0.500
-0.499 - -0.300	-0.099 - -0.050	0.001 - 0.010	0.101 - 0.150	Was Dry Now Wet
-0.299 - -0.200	-0.049 - -0.030	0.011 - 0.020	0.151 - 0.200	
	-0.029 - -0.020	0.021 - 0.030	0.201 - 0.300	

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

North East Link
North East Link Project

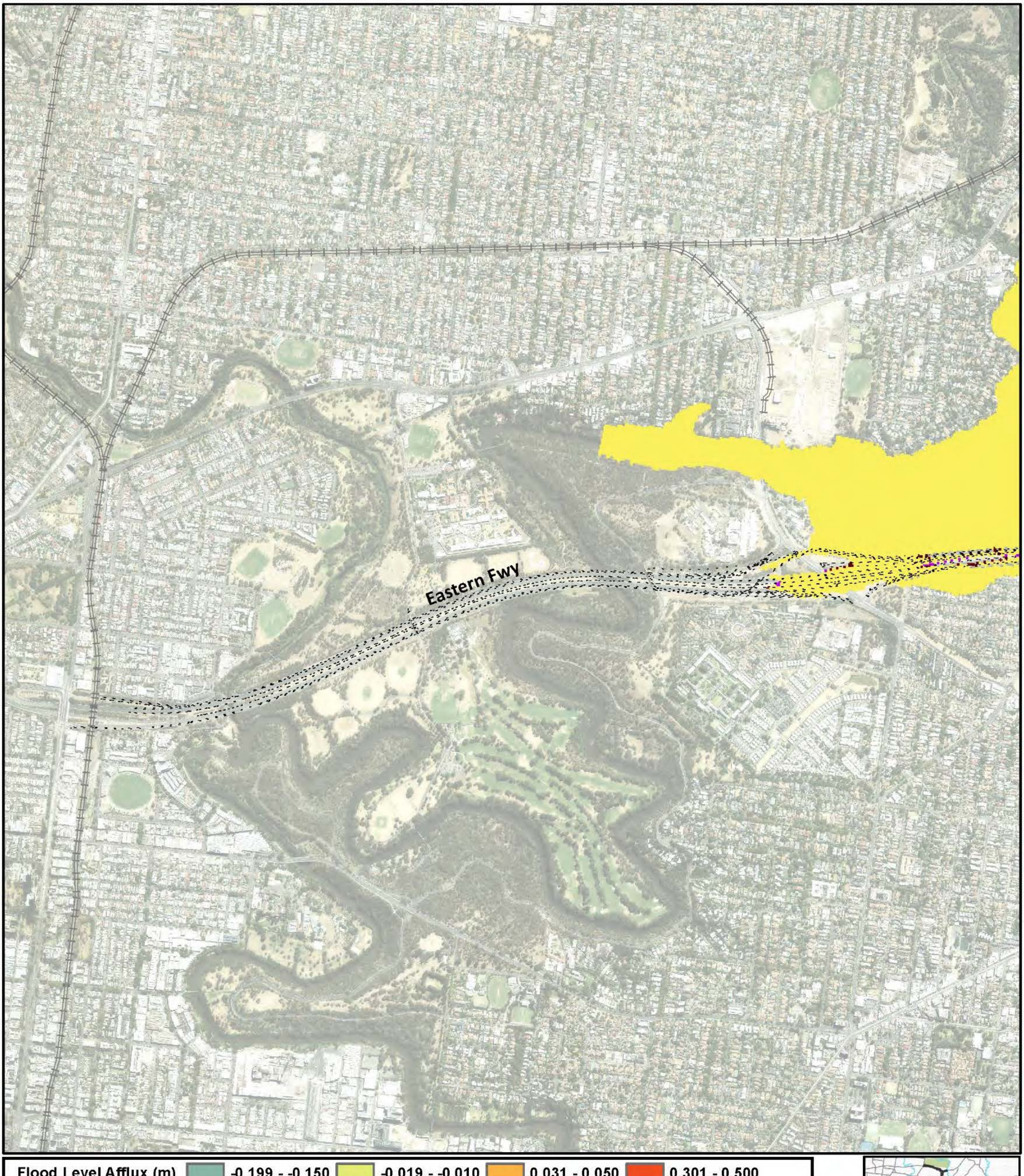
Job Number 31-35006
Revision B
Date 08/10/2018

1% AEP peak flood level afflux
Yarra River 2 of 3

Figure 9-24

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_Hydraulic 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Level Afflux (m)

Was Wet Now Dry	-0.019 - -0.010
<-0.500	-0.009 - 0.000
-0.499 - -0.300	0.001 - 0.010
-0.299 - -0.200	0.011 - 0.020
-0.199 - -0.150	0.021 - 0.030
-0.149 - -0.100	0.031 - 0.050
-0.099 - -0.050	0.051 - 0.100
-0.049 - -0.030	0.101 - 0.150
-0.029 - -0.020	0.151 - 0.200
0.201 - 0.300	0.301 - 0.500
> 0.500	Was Dry Now Wet

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

North East Link
North East Link Project

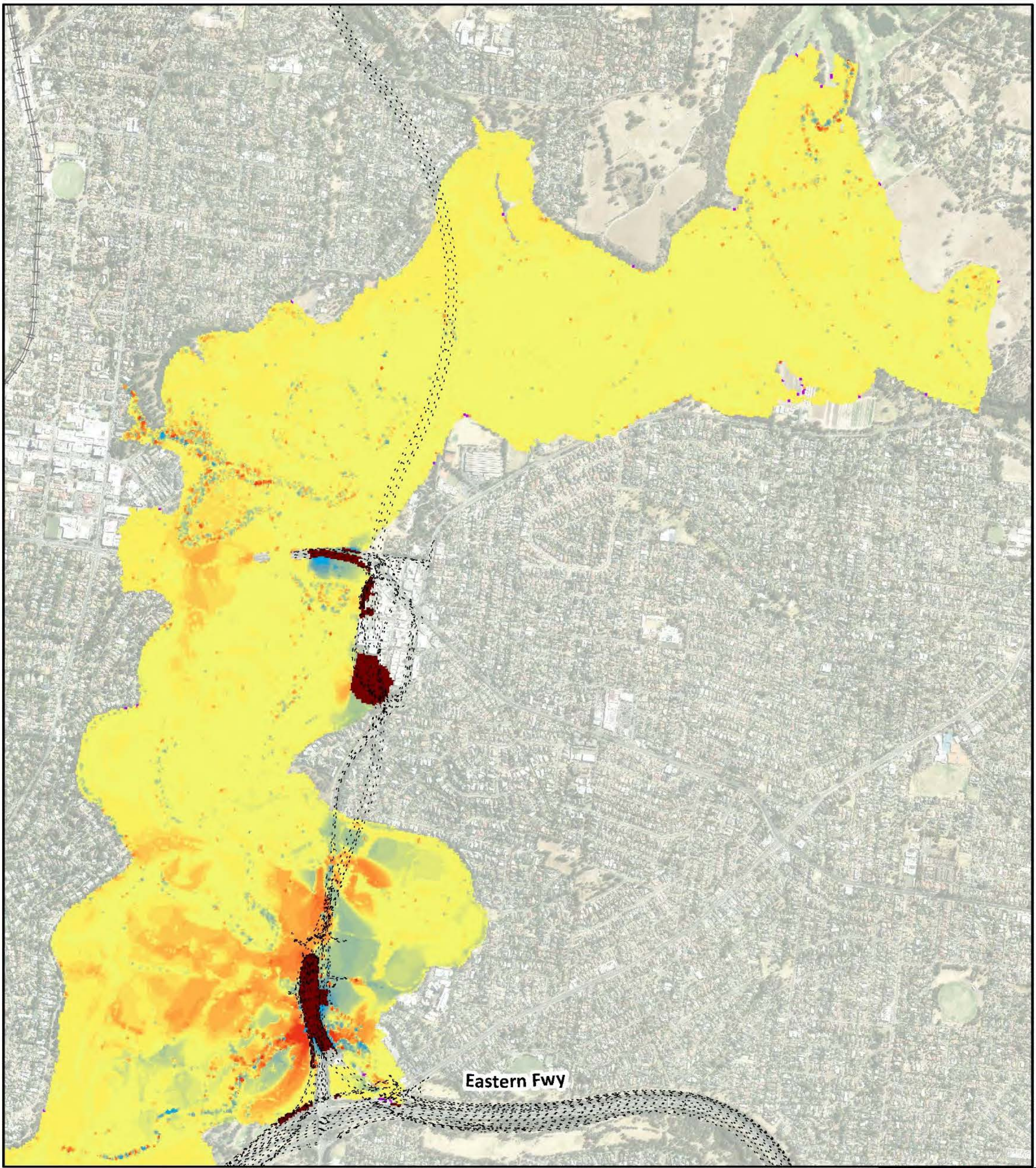
Job Number 31-35006
Revision B
Date 08/10/2018

1% AEP peak flood level afflux
Yarra River 3 of 3

Figure 9-25

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_Hydraulics_XLM_... 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Velocity difference (m/s)				
Was Wet Now Dry	-0.199 - -0.150	-0.019 - -0.010	0.031 - 0.050	0.301 - 0.500
<-0.500	-0.149 - -0.100	-0.009 - 0.000	0.051 - 0.100	> 0.500
-0.499 - -0.300	-0.099 - -0.050	0.001 - 0.010	0.101 - 0.150	Was Dry Now Wet
-0.299 - -0.200	-0.049 - -0.030	0.011 - 0.020	0.151 - 0.200	
	-0.029 - -0.020	0.021 - 0.030	0.201 - 0.300	

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

North East Link
North East Link Project

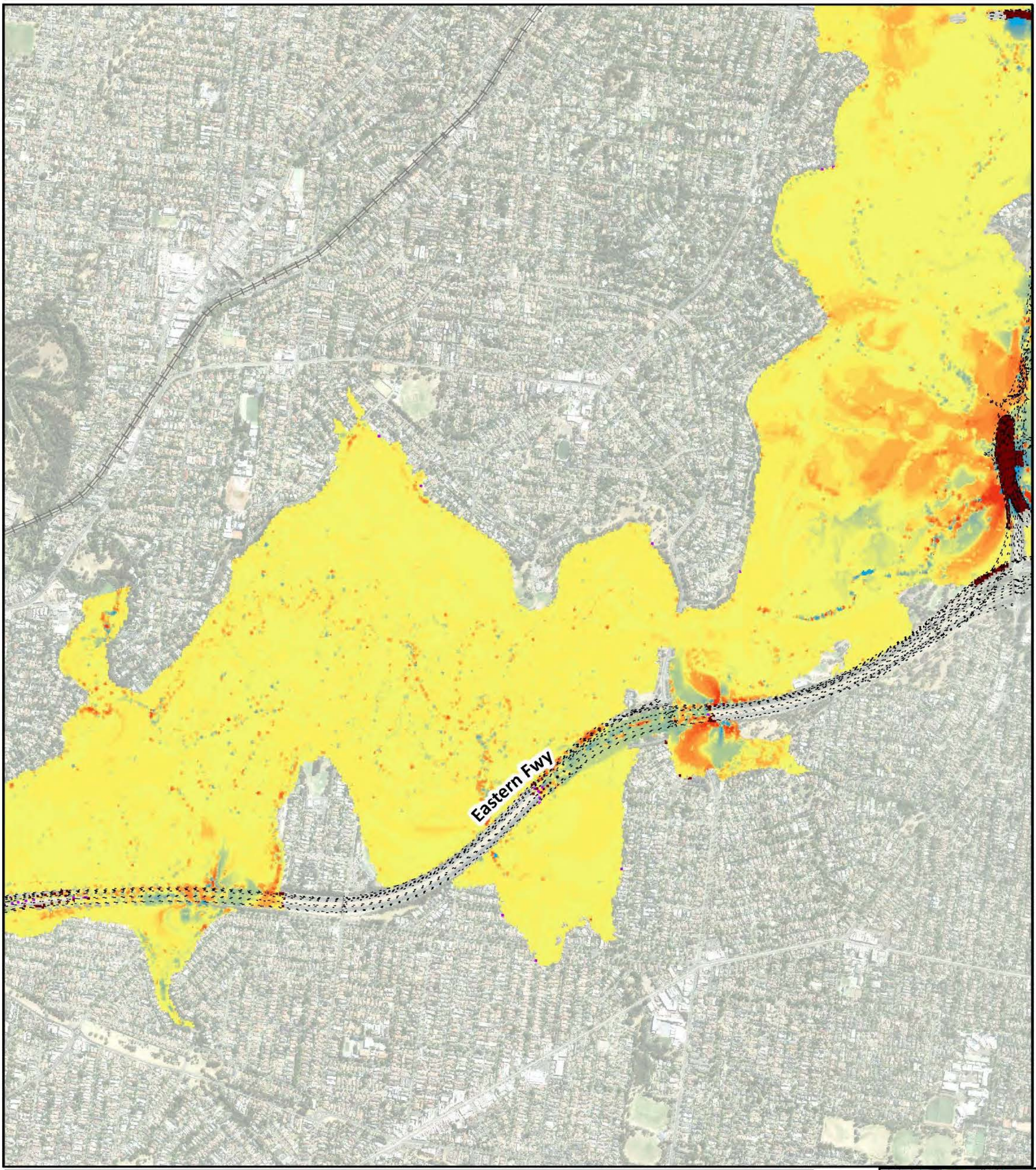
Job Number 31-35006
Revision D
Date 03/12/2018

1% AEP peak flood velocity difference
Yarra River 1 of 3

Figure 9-26

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_Hydraulic_KBm_s_Exb.mxd 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Velocity difference (m/s)

- Was Wet Now Dry
- <-0.500
- -0.499 - -0.300
- -0.299 - -0.200
- -0.199 - -0.150
- -0.149 - -0.100
- -0.099 - -0.050
- -0.049 - -0.030
- -0.029 - -0.020
- -0.019 - -0.010
- -0.009 - 0.000
- 0.001 - 0.010
- 0.011 - 0.020
- 0.021 - 0.030
- 0.031 - 0.050
- 0.051 - 0.100
- 0.101 - 0.150
- 0.151 - 0.200
- 0.201 - 0.300
- 0.301 - 0.500
- > 0.500
- Was Dry Now Wet

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

North East Link
North East Link Project

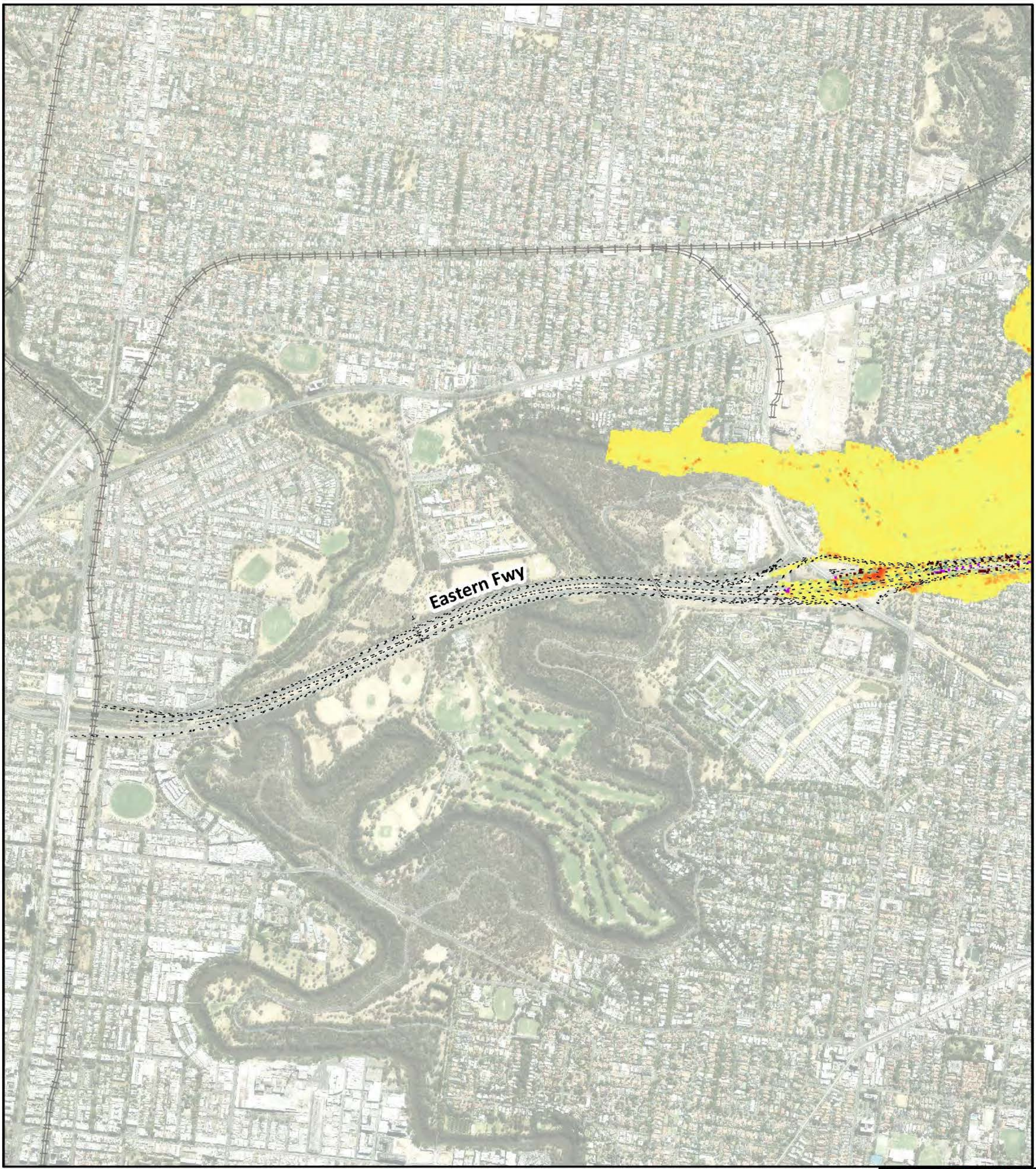
Job Number 31-35006
Revision C
Date 03/12/2018

1% AEP peak flood velocity difference
Yarra River 2 of 3

Figure 9-27

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_Hydraulics_XBM_NEL.mxd 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Velocity difference (m/s)

- Was Wet Now Dry
- <-0.500
- -0.499 - -0.300
- -0.299 - -0.200
- -0.199 - -0.150
- -0.149 - -0.100
- -0.099 - -0.050
- -0.049 - -0.030
- -0.029 - -0.020
- -0.019 - -0.010
- -0.009 - 0.000
- 0.001 - 0.010
- 0.011 - 0.020
- 0.021 - 0.030
- 0.031 - 0.050
- 0.051 - 0.100
- 0.101 - 0.150
- 0.151 - 0.200
- 0.201 - 0.300
- 0.301 - 0.500
- > 0.500
- Was Dry Now Wet

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link
North East Link Project

Job Number	31-35006
Revision	C
Date	03/12/2018

1% AEP peak flood velocity difference
Yarra River 3 of 3

Figure 9-28

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_Hydraulic… 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

9.1.6 Koonung Creek

This assessment has investigated the potential for the operation of North East Link to increase flood frequency and levels at receptors within and around the existing Koonung Creek floodplain due to the project displacing flood water (risk SW09). North East Link would include widening the Eastern Freeway with new lanes located with the existing Koonung Creek floodplain, which would displace floodwater in a flood event. In addition, North East Link proposes the diversion and undergrounding of some sections of the existing open channel for Koonung Creek.

The reference project details are provided in Figure 9-29 to Figure 9-31.

Modelling of the reference project has been undertaken to quantify the potential impacts on flood risk. Figure 9-32 to Figure 9-34, Figure 9-35 to Figure 9-37 and Figure 9-38 to Figure 9-40 show the difference in peak 1% AEP flood depth, flood level and flood velocity respectively along the drainage alignment. Further results at select locations for a range of events are provided in Appendix D6.

The following describes the expected impact on a 1% AEP flood event at a number of locations of interest for the reference project. Further design modification and modelling would address many of the impacts currently identified and provide results for a wider range of events:

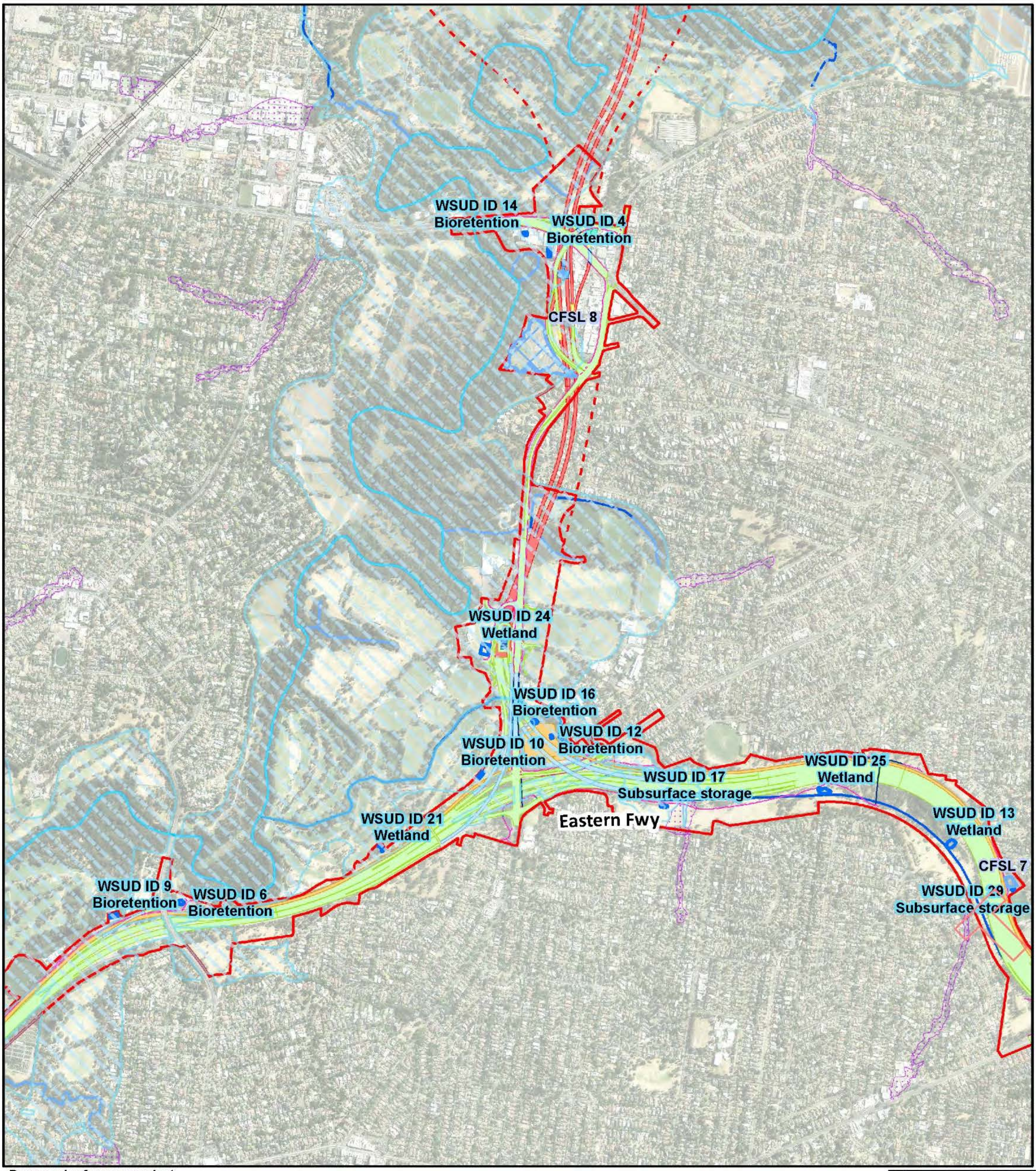
- Downstream of Thompson Road, the reference project indicates reduced flood levels on the upstream (east) side of Bulleen Road with a slight increase in the downstream (west) side of Bulleen Road (<100 millimetres). Subject to consideration of afflux in other events, and checking for potential impacts with respect to Yarra River flooding, a small reduction in the capacity of the new cross culverts is expected to improve this outcome further.
- The shared use path underpass under the inbound Bulleen Road on-ramp needs to be protected by a flood barrier so the local catchment doesn't drain through the underpass onto the Eastern Freeway. The current modelling doesn't have any flood barrier in place and subsequently shows increased flooding in the freeway, especially in the more frequent events.
- The removal of existing surface flooding along the southern edge of the Eastern Freeway from Wilburton Parade to Mountain View Road also removes a location which would currently inundate the freeway in significant events near Mountain View Road (towards Bullen Road). As a result, flooding on the freeway is reduced although ponding in the reserve increases with afflux increasing with event size and in larger events extending across Carron Street into private property. The 1% AEP levels in Carron Street are expected to increase by approximately 400 millimetres. This may potentially be reduced by providing a high-level outlet from this area and or additional storage in the parkland.
- There are local increases in flood levels on the northern side of the Eastern Freeway at a number of discreet locations between Bulleen Road and Doncaster Road. This is due to a faster response in Koonung Creek which increases tailwater levels at these inlets, and a reduction in local flood storage as a result of the freeway widening. These issues are being investigated individually and would benefit from local terrain modifications and refinement of upstream storages to slow the response of Koonung Creek.
- There is no significant change to flooding along Gardenia Road.

- Between Doncaster and Elgar Roads, there is a mix of small reduction in flood levels (~12 millimetres) and no significant change to existing flooding of residential properties along Valda Avenue. Some localised increases in flooding in this area are limited to parklands with no impact to private properties. Flood extents are generally reduced.
- Between Elgar and Tram Roads, there is slight reduction of flood levels and extents.
- Between Tram Road and Middleborough Road, there is widespread reduction in flood levels to the north of the Eastern Freeway which reduces flood levels on some private properties, such as by 150 millimetres in properties fronting Grange Park Avenue. However on the south side of the freeway, the properties along Eram Road (near Heathfield Rise) experience a flood level increase of up to 90 millimetres in short duration (smaller volume high intensity) events due to a loss of existing local flood storage. The reductions in flood levels on the north of the freeway increase the outlet capacity from this area sufficiently that in longer duration (lower intensity) events flood levels reduce by up to 250 millimetres.
- East of Middleborough Road there are no changes to flood levels as the works would not impact the flood-prone areas or the capacity of drainage assets.

To minimise the potential flood risks, a number of concepts that include diversions, storages and undergrounding sections of creek have been considered and modelled to assess their performance. Current investigations indicate these concepts have the potential to be refined to further reduce flood impacts on surrounding property and assets although detailed fine tuning of the concepts would be left for detailed design.

Further sensitivity testing for larger events is planned to inform understanding of potential options for mitigation such as designated overtopping locations to preferentially flood sections of the Eastern Freeway in a controlled manner and provide improved protection to property in and adjacent to the floodplain.

Any residual issues would be resolved as part of the detailed design process which would need to demonstrate through modelling that the design of permanent infrastructure meets the flood level, flow and velocity requirements with consideration for climate change (EPR SW6 and EPR SW13).



Proposed reference project

- LSIO
- SBO
- Area required for CFSL
- Area required for WSUD
- Project boundary-sub surface
- Project boundary-surface
- Ventilation System
- Area for substation
- Shared use path overpass
- Shared use path
- Shared use path underpass
- Multi-deck car park
- Public transport infrastructure upgrade
- Elevated road, ramp or structure
- Surface road
- Road in trench
- Rail tunnel
- Underground tunnel
- River
- Stream
- Channel
- Drain

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link
North East Link Project

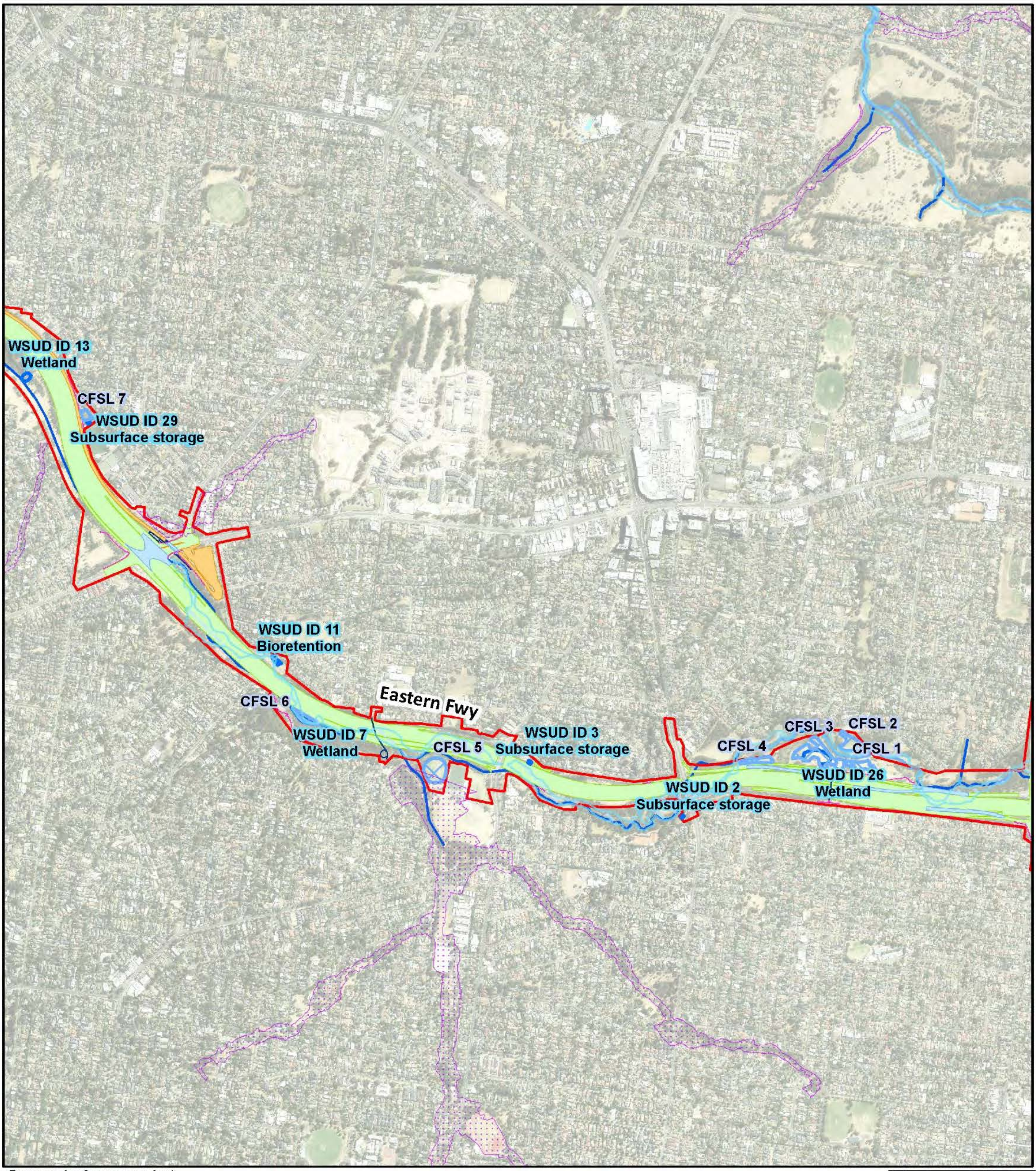
Job Number | 31-35006
Revision | C
Date | 23/01/2019

Project overview
Koonung Creek 1 of 3

Figure 9-29

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_Hydraulics_KCM_... 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Proposed reference project

LSIO	Project boundary-surface	Shared use path underpass	Road in trench
SBO	Ventilation System	Multi-deck car park	Rail tunnel
Area required for CFSL	Area for substation	Public transport infrastructure upgrade	Underground tunnel
Area required for WSUD	Shared use path overpass	Elevated road, ramp or structure	River
Project boundary-sub surface	Shared use path	Surface road	Stream

Channel
Drain

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

North East Link
North East Link Project

Job Number 31-35006
Revision C
Date 23/01/2019

Project overview
Koonung Creek 2 of 3

Figure 9-30

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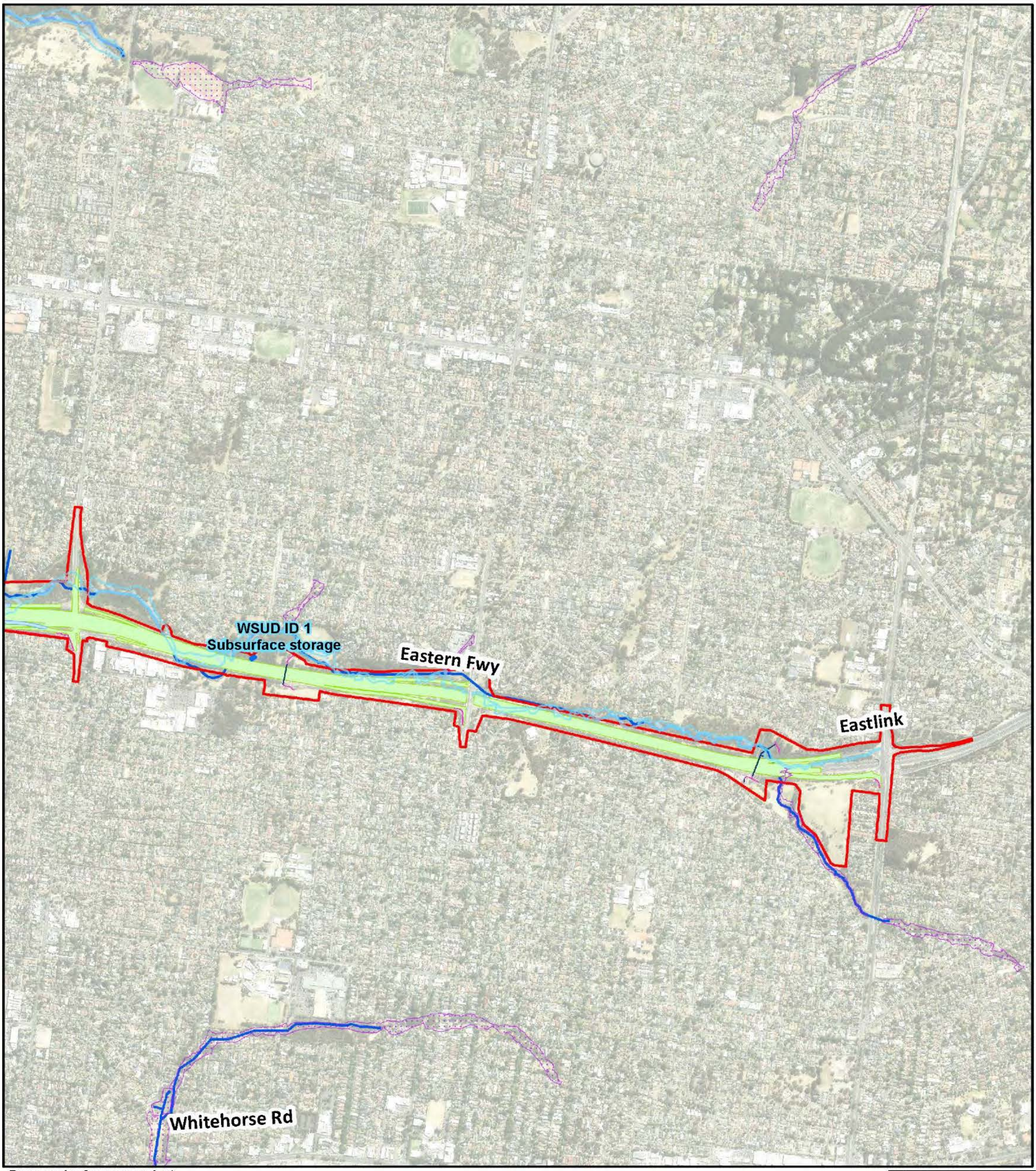
Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Proposed reference project

LSIO	Project boundary-surface	Shared use path underpass	Road in trench	Channel
SBO	Ventilation System	Multi-deck car park	Rail tunnel	Drain
Area required for CFSL	Area for substation	Public transport infrastructure upgrade	Underground tunnel	
Area required for WSUD	Shared use path overpass	Elevated road, ramp or structure	River	
Project boundary-sub surface	Shared use path	Surface road	Stream	

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link
North East Link Project

Job Number 31-35006
Revision C
Date 23/01/2019

Project overview
Koonung Creek 3 of 3

Figure 9-31

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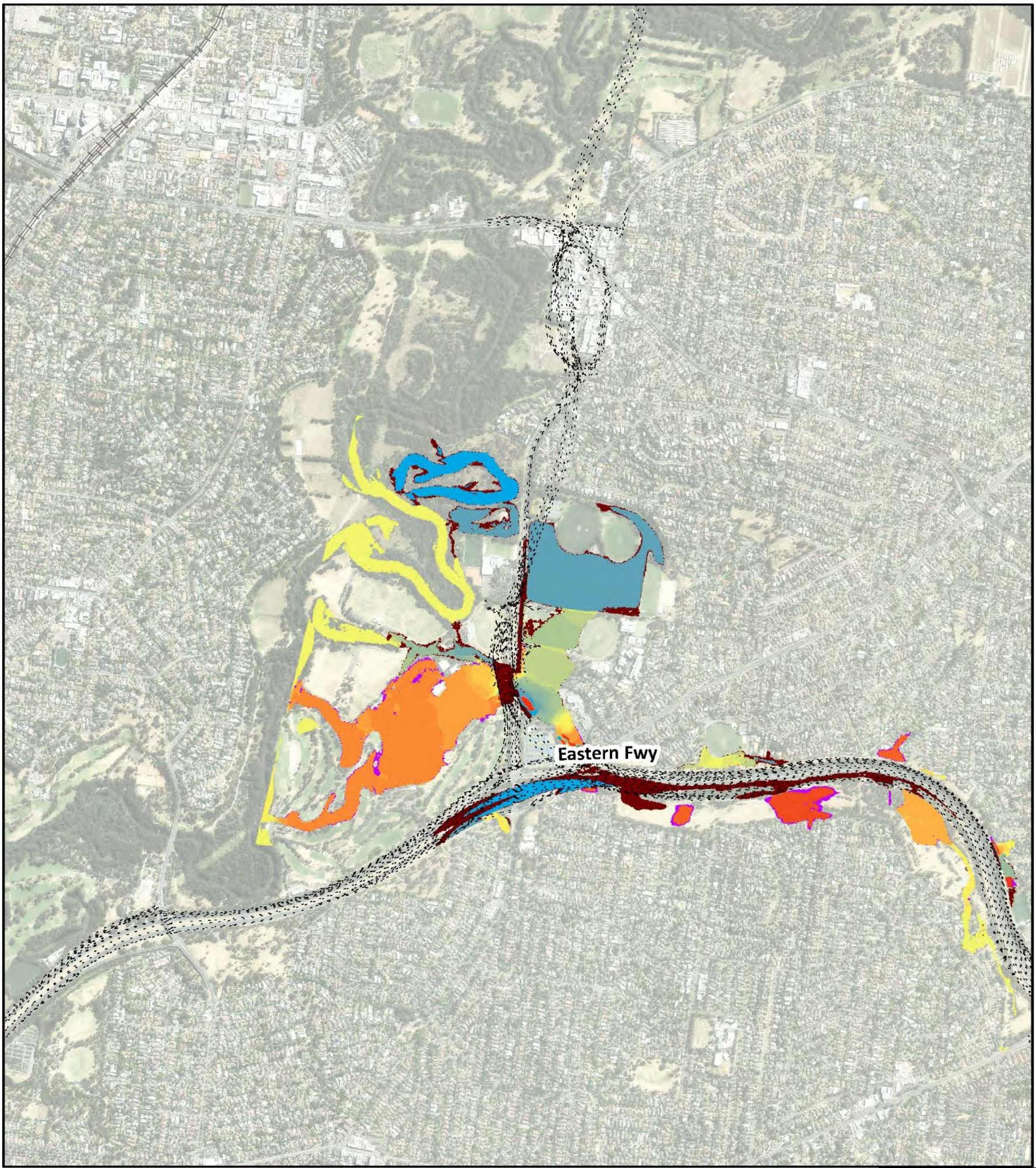
Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Depth Afflux (m)

Was Wet Now Dry	-0.199 - -0.150	-0.019 - -0.010	0.031 - 0.050	0.301 - 0.500
<-0.500	-0.149 - -0.100	-0.009 - 0.000	0.051 - 0.100	> 0.500
-0.499 - -0.300	-0.099 - -0.050	0.001 - 0.010	0.101 - 0.150	Was Dry Now Wet
-0.299 - -0.200	-0.049 - -0.030	0.011 - 0.020	0.151 - 0.200	
	-0.029 - -0.020	0.021 - 0.030	0.201 - 0.300	

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

North East Link
North East Link Project

Job Number 31-35006
Revision D
Date 26/10/2018

1% AEP peak flood depth afflux
Koonung Creek 1 of 3 Figure 9-32

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_Hydraulic... 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

Flood Depth Afflux (m)

Was Wet Now Dry	-0.199 - -0.150	-0.019 - -0.010	0.031 - 0.050	0.301 - 0.500
<-0.500	-0.149 - -0.100	-0.009 - 0.000	0.051 - 0.100	> 0.500
-0.499 - -0.300	-0.099 - -0.050	0.001 - 0.010	0.101 - 0.150	Was Dry Now Wet
-0.299 - -0.200	-0.049 - -0.030	0.011 - 0.020	0.151 - 0.200	
	-0.029 - -0.020	0.021 - 0.030	0.201 - 0.300	

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link
North East Link Project

Job Number | 31-35006
Revision | D
Date | 26/10/2018

1% AEP peak flood depth afflux
Koonung Creek 2 of 3 Figure 9-33

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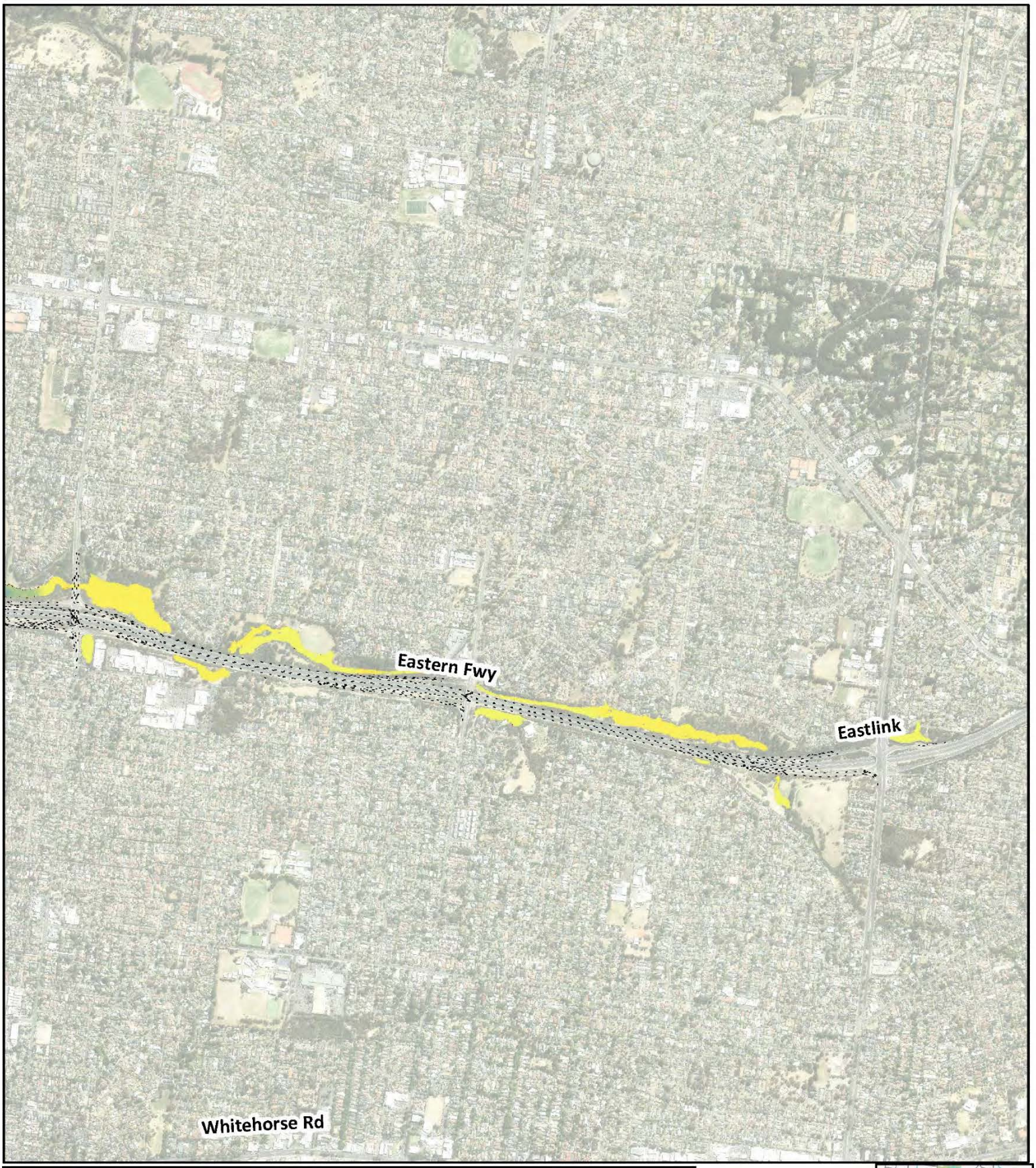
Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Depth Afflux (m)				
Was Wet Now Dry	-0.199 - -0.150	-0.019 - -0.010	0.031 - 0.050	0.301 - 0.500
<-0.500	-0.149 - -0.100	-0.009 - 0.000	0.051 - 0.100	> 0.500
-0.499 - -0.300	-0.099 - -0.050	0.001 - 0.010	0.101 - 0.150	Was Dry Now Wet
-0.299 - -0.200	-0.049 - -0.030	0.011 - 0.020	0.151 - 0.200	
	-0.029 - -0.020	0.021 - 0.030	0.201 - 0.300	

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link
North East Link Project

Job Number 31-35006
Revision D
Date 26/10/2018

1% AEP peak flood depth afflux Koonung Creek 3 of 3

Figure 9-34

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_HydraulicsFigs_44.mxd 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

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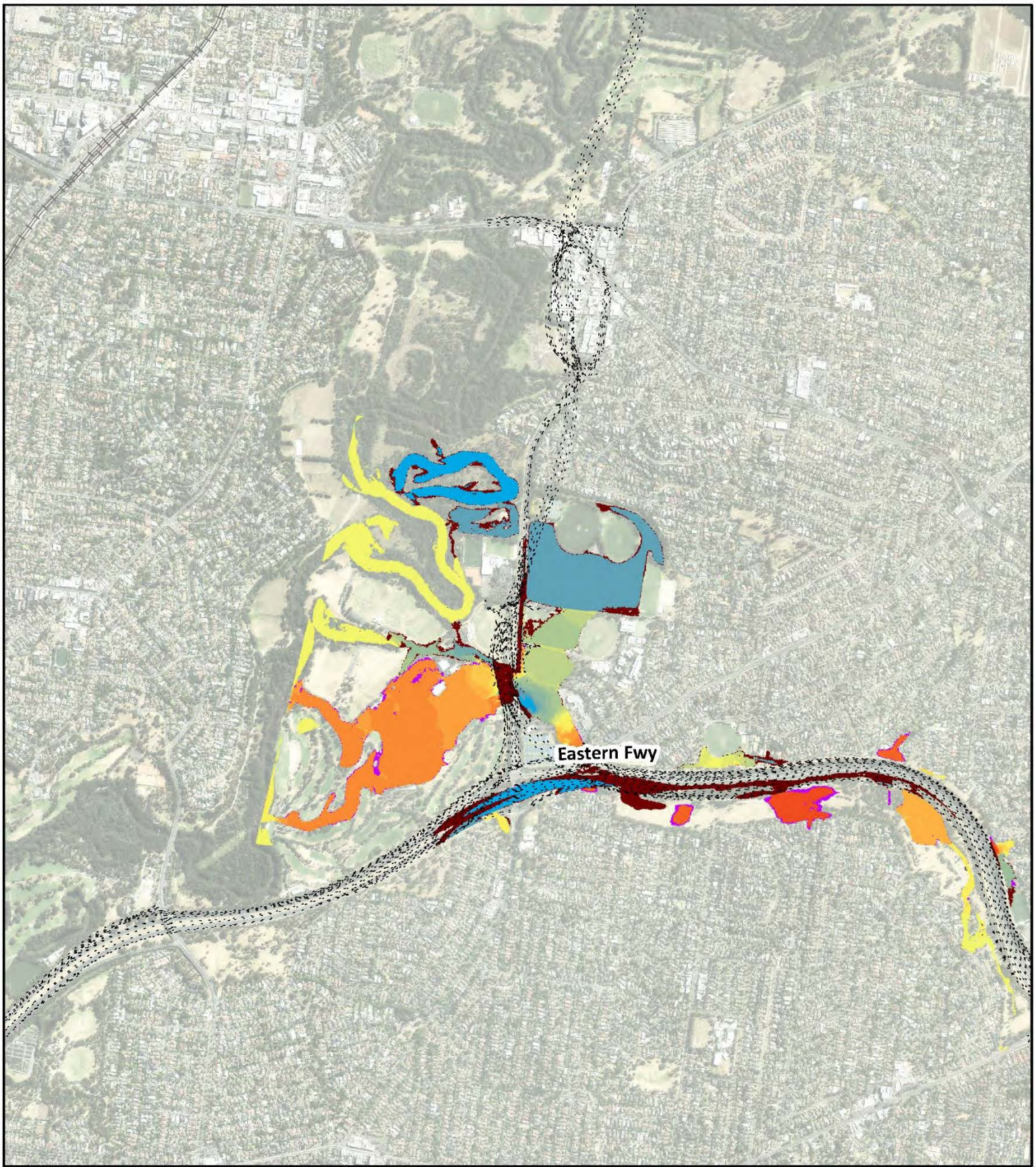

Flood Level Afflux (m)

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<-0.500	-0.149 - -0.100	-0.009 - 0.000	0.051 - 0.100	> 0.500
-0.499 - -0.300	-0.099 - -0.050	0.001 - 0.010	0.101 - 0.150	Was Dry Now Wet
-0.299 - -0.200	-0.049 - -0.030	0.011 - 0.020	0.151 - 0.200	
	-0.029 - -0.020	0.021 - 0.030	0.201 - 0.300	

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

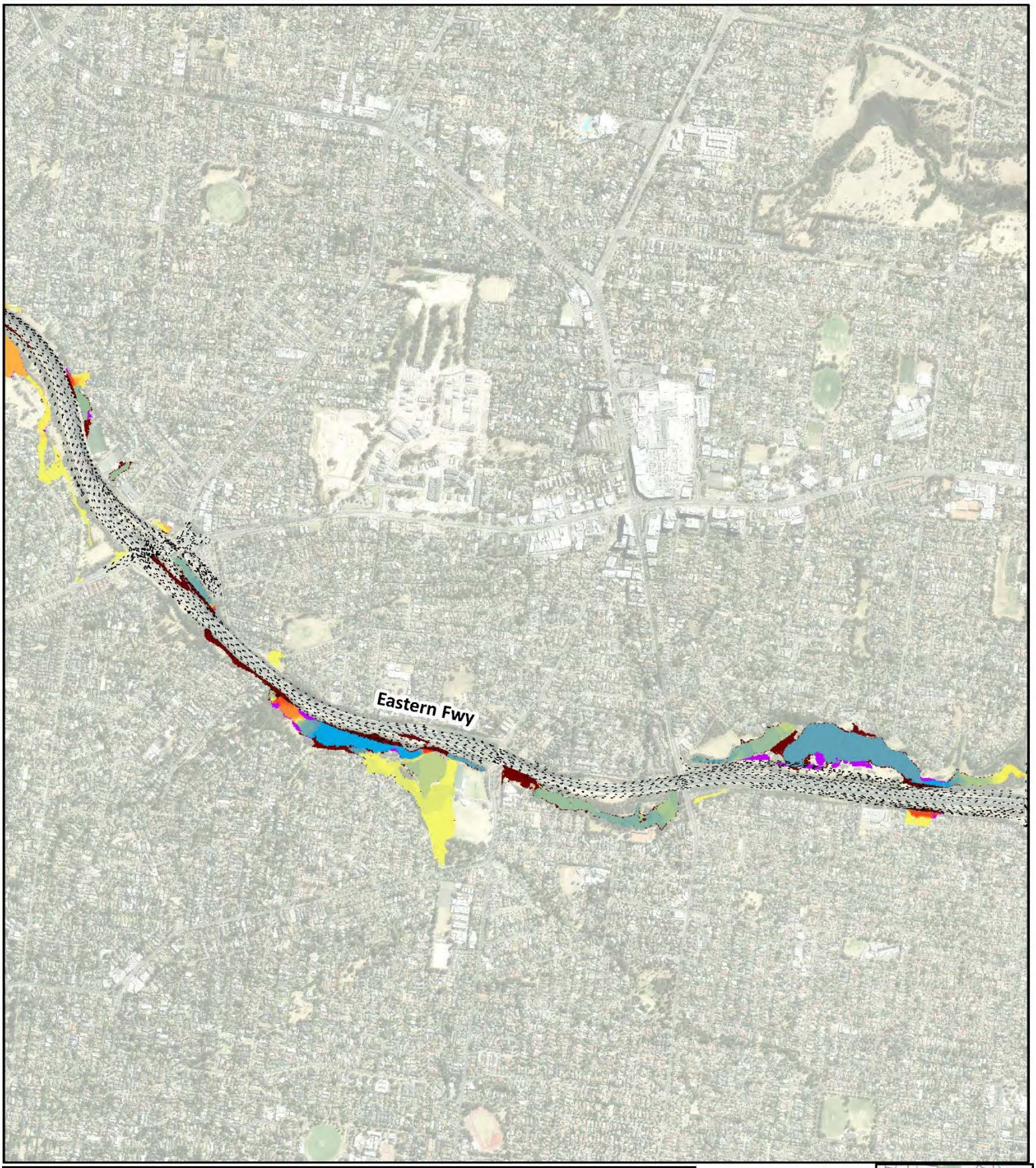
North East Link
North East Link Project

Job Number 31-35006
Revision D
Date 26/10/2018

1% AEP peak flood level afflux
Koonung Creek 1 of 3 Figure 9-35

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_HydraulicsFigs_44.mxd 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Level Afflux (m)				
Was Wet Now Dry	-0.199 - -0.150	-0.019 - -0.010	0.031 - 0.050	0.301 - 0.500
<-0.500	-0.149 - -0.100	-0.009 - 0.000	0.051 - 0.100	> 0.500
-0.499 - -0.300	-0.099 - -0.050	0.001 - 0.010	0.101 - 0.150	Was Dry Now Wet
-0.299 - -0.200	-0.049 - -0.030	0.011 - 0.020	0.151 - 0.200	
	-0.029 - -0.020	0.021 - 0.030	0.201 - 0.300	

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

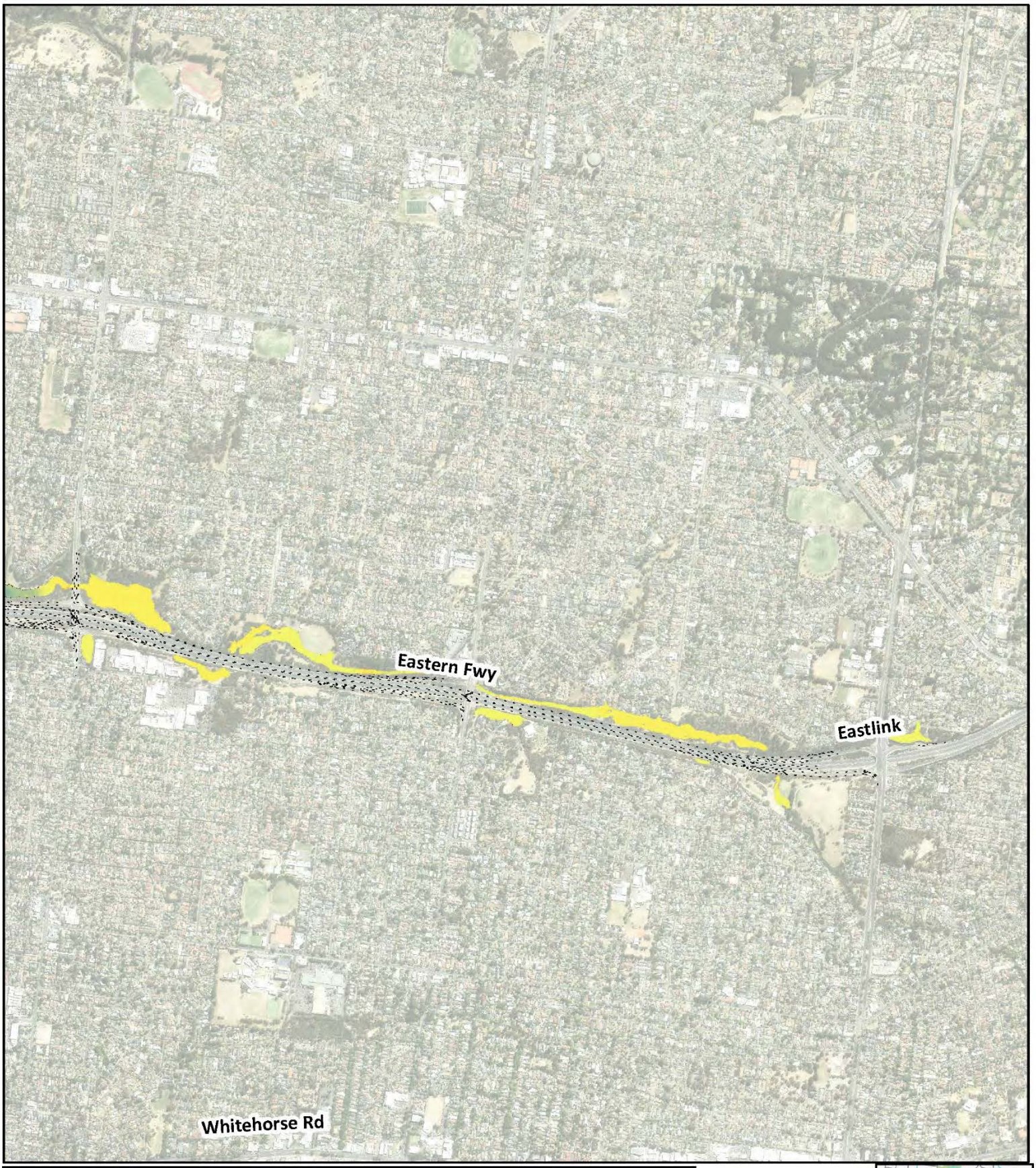
North East Link
North East Link Project

Job Number 31-35006
Revision D
Date 26/10/2018

1% AEP peak flood level afflux
Koonung Creek 2 of 3 Figure 9-36

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_HydraulicsFigs_44.mxd 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Level Afflux (m)				
Was Wet Now Dry	-0.199 - -0.150	-0.019 - -0.010	0.031 - 0.050	0.301 - 0.500
<-0.500	-0.149 - -0.100	-0.009 - 0.000	0.051 - 0.100	> 0.500
-0.499 - -0.300	-0.099 - -0.050	0.001 - 0.010	0.101 - 0.150	Was Dry Now Wet
-0.299 - -0.200	-0.049 - -0.030	0.011 - 0.020	0.151 - 0.200	
	-0.029 - -0.020	0.021 - 0.030	0.201 - 0.300	

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

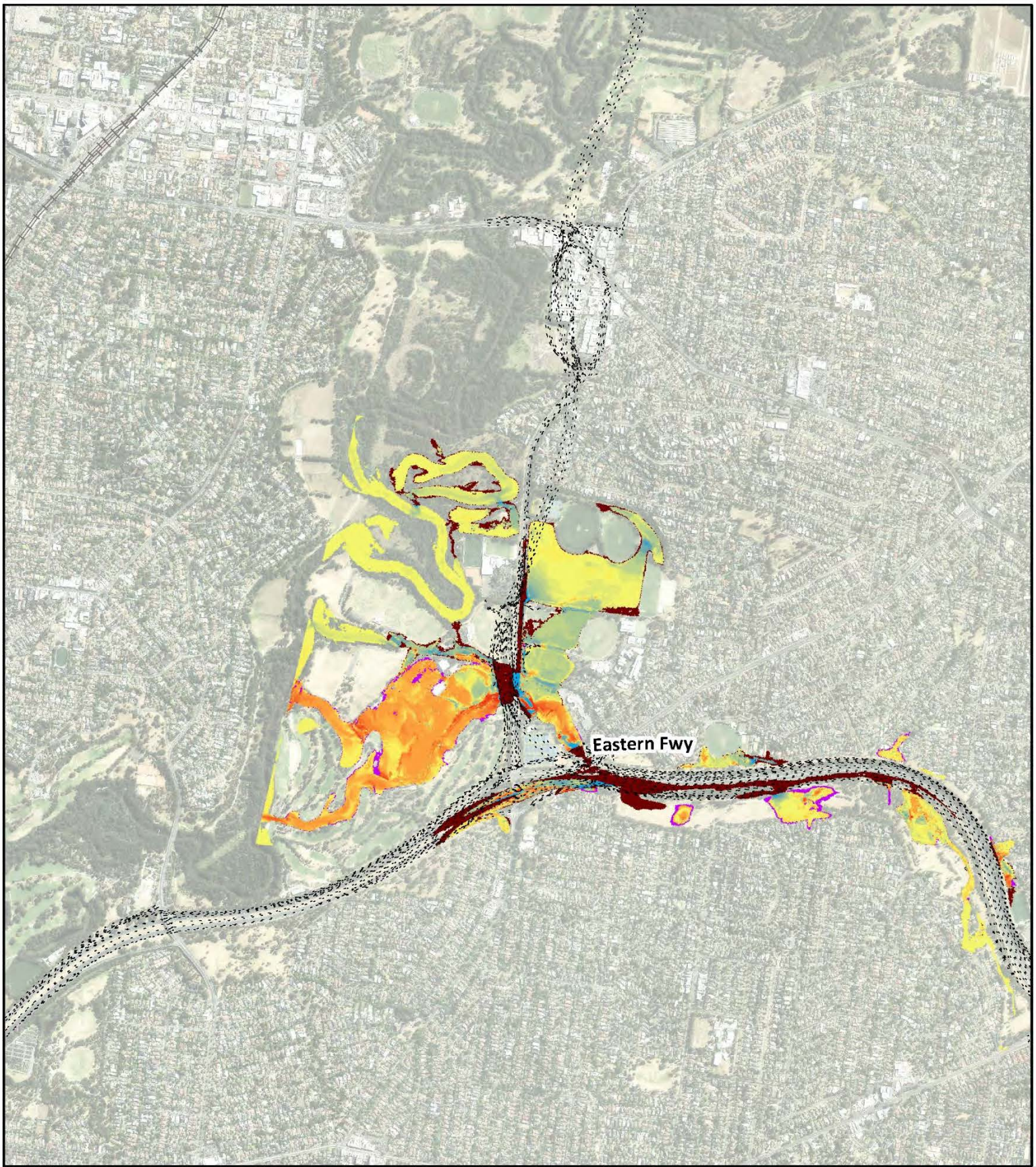
North East Link
North East Link Project

Job Number 31-35006
Revision D
Date 26/10/2018

1% AEP peak flood level afflux
Koonung Creek 3 of 3 Figure 9-37

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_HydraulicsBM_44.mxd 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Velocity difference (m/s)

Was Wet Now Dry	-0.199 - -0.150	-0.019 - -0.010	0.031 - 0.050	0.301 - 0.500
<-0.500	-0.149 - -0.100	-0.009 - 0.000	0.051 - 0.100	> 0.500
-0.499 - -0.300	-0.099 - -0.050	0.001 - 0.010	0.101 - 0.150	Was Dry Now Wet
-0.299 - -0.200	-0.049 - -0.030	0.011 - 0.020	0.151 - 0.200	
	-0.029 - -0.020	0.021 - 0.030	0.201 - 0.300	

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

NORTH EAST LINK PROJECT

North East Link
North East Link Project

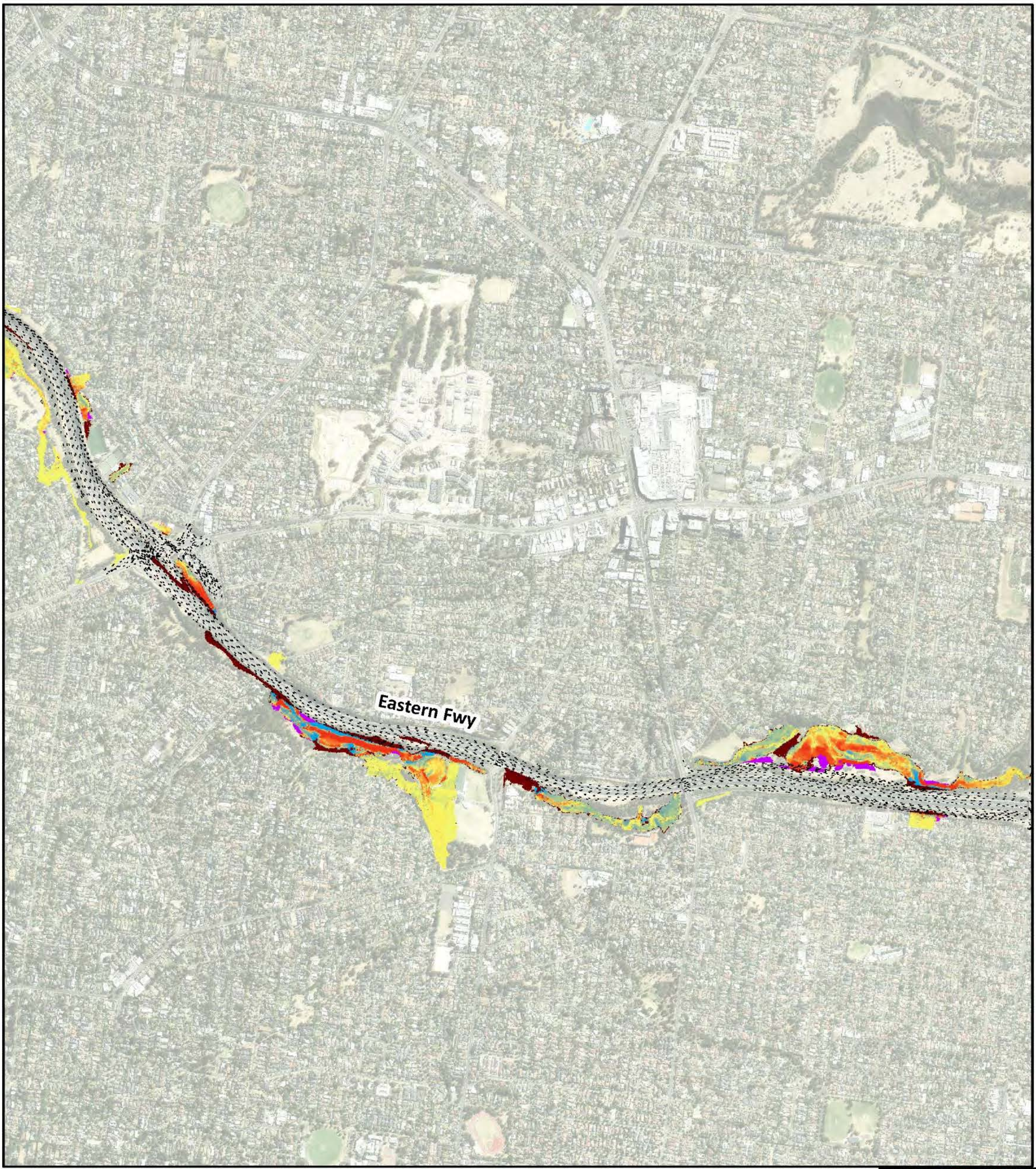
Job Number 31-35006
Revision D
Date 03/12/2018

1% AEP peak flood velocity difference
Koonung Creek 1 of 3

Figure 9-38

G:\31\35006\GIS\Maps\Working\Specialist Submission\EES\Groundwater and Hydrology\Surface_Water\35006_HydraulicsBM_44.mxd 180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari



Flood Velocity difference (m/s)

- Was Wet Now Dry
- <-0.500
- -0.499 - -0.300
- -0.299 - -0.200
- -0.199 - -0.150
- -0.149 - -0.100
- -0.099 - -0.050
- -0.049 - -0.030
- -0.029 - -0.020
- -0.019 - -0.010
- -0.009 - 0.000
- 0.001 - 0.010
- 0.011 - 0.020
- 0.021 - 0.030
- 0.031 - 0.050
- 0.051 - 0.100
- 0.101 - 0.150
- 0.151 - 0.200
- 0.201 - 0.300
- 0.301 - 0.500
- > 0.500
- Was Dry Now Wet

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

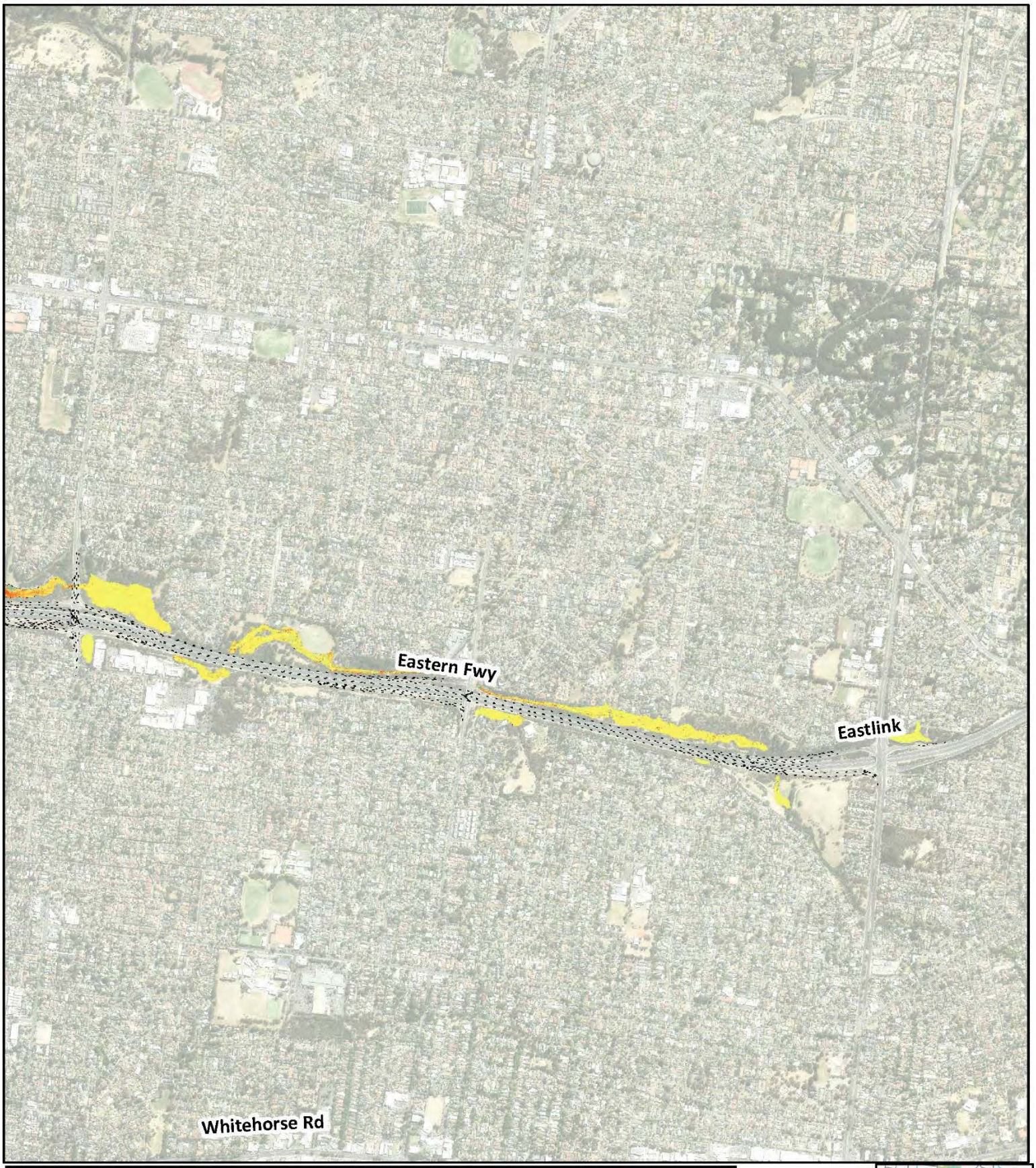
NORTH EAST LINK PROJECT

North East Link
North East Link Project

Job Number	31-35006
Revision	D
Date	03/12/2018

1% AEP peak flood velocity difference
Koonung Creek 2 of 3

Figure 9-39



Flood Velocity difference (m/s)				
Was Wet Now Dry	-0.199 - -0.150	-0.019 - -0.010	0.031 - 0.050	0.301 - 0.500
<-0.500	-0.149 - -0.100	-0.009 - 0.000	0.051 - 0.100	> 0.500
-0.499 - -0.300	-0.099 - -0.050	0.001 - 0.010	0.101 - 0.150	Was Dry Now Wet
-0.299 - -0.200	-0.049 - -0.030	0.011 - 0.020	0.151 - 0.200	
	-0.029 - -0.020	0.021 - 0.030	0.201 - 0.300	

Paper Size A4

0 135 270 540

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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North East Link
North East Link Project

Job Number 31-35006
Revision D
Date 03/12/2018

1% AEP peak flood velocity difference
Koonung Creek 3 of 3

Figure 9-40

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Data source: Google Earth Pro Imagery, Vicmap, DELWP, 2018. Created by: rhasanzadehnafari

9.2 Water quality

In recognition that North East Link's potential impacts on water quality are generally more to do with the type of works than the location of the works, the water quality section of the report is structured around surface roads, tunnels and diversions, rather than the waterway-based structure adopted for the remainder of the report.

9.2.1 Surface roads

The operation of North East Link has the potential to impact the waterway health and water quality though contamination of stormwater runoff from surface roads.

There are two main ways that surface water has the potential to be contaminated:

- By contaminated runoff from additional impervious area flowing into waterways (risk SW16)
- By spills or accidents occurring on North East Link flowing into waterways (risk SW15).

North East Link includes the construction of approximately 700,000 square metres of additional pavement. This impact assessment has investigated the potential for the increase in impervious area to lead to an increase in contaminants being released into waterways (risk SW16). Stormwater runoff from road surfaces can contain oils, greases and sediment that has the potential to lead to reduced water quality if discharged to the stormwater drainage system, and subsequently the waterways, without treatment.

To minimise the potential for pollutants to end up in the waterways, the reference project has included a number of water treatment features along the alignment that would filter and treat the stormwater captured by the new road surfaces. These water sensitive urban design (WSUD) features include wetlands, bioretention ponds and storage dams which range from approximately 45 m^2 to 3,000 m^2 in size. For example, a large 3,000 m^2 wetland area is proposed at the M80 Ring Road and Greensborough Road interchange, beneath the North East Link elevated roads. This would collect and treat additional runoff from the new roads and ramps in the vicinity.

To assess the effectiveness of the WSUD features included in the reference project, water quality modelling using MUSIC has been undertaken in accordance with Melbourne Water guidelines to calculate the pollutant loads due to the increased pavement at the points of discharge. This modelling has shown that the pollutant reduction requirements of Best Practice Environmental Management Guidelines (BPEMG) can be achieved using a subset of the potentially available sites. As the details of the reference project are subject to change, the detailed arrangements for ownership, maintenance and operation of these sites would be resolved on a case-by-case basis during the detailed design stage.

Complying with the BPEMG in operation would assist in meeting the SEPP (Waters) over the long term for pollutant concentrations in receiving waters (EPR SW1).

The initial locations of the WSUD features were selected with consideration of topography (located within natural depression) and existing land uses with a preference for locations within the road reserve. In the event that insufficient space is available within the road reserve, options on land outside the road reserve have been considered. Where the proposed WSUD features have unacceptable effects from a planning or environment perspective, options for retention along the wider project corridor were also considered.

The precise location and design of the final WSUD features needs to be further explored at the detailed design stage in consultation with stakeholders, including local councils and land owners. This would include exploration of opportunities to reuse the additional stormwater, potentially providing benefits to other water users.

This impact assessment has also investigated the potential for spills of hazardous materials during project operation to pollute waterways (risk SW15). To manage the potential of spilled liquids ending up in waterways, the project would include the provision of spill containment for all freeway pavements (including ramps) to meet Austroads requirements. Procedures would be developed for existing and proposed roads and ramps, to be implemented in response to hazardous spills (EPR SW2).

9.2.2 Tunnels

During the operation of North East Link, the tunnel drainage system would collect water from the following sources;

- Groundwater seepage (refer to Technical report N – Groundwater)
- Deluge of firefighting substances from testing and accidents
- Rain water from vehicles
- Direct runoff from the approach ramps at the tunnel portals.

This impact assessment has investigated the potential for the discharge of these water sources to lead to an increase in contaminants being released into waterways (risk SW18). Water collected from these sources can contain oils, greases and sediment that has the potential to lead to reduced water quality if discharged to the stormwater drainage system, and subsequently the waterways, without treatment.

To reduce the potential for pollutants to end up in the waterways, the project would require a water quality treatment plant to manage and potentially treat the water collected in the tunnels before discharge. Subject to the characteristics of the collected water, the discharge may be to sewer, stormwater, reuse or off-site subject to approval. If discharged to stormwater, the water would be required to be treated to meet SEPP (Waters) (EPR SW1) and have approval from relevant authority before discharge (EPR SW3). With the implementation of the recommended EPRs (EPR SW1 and EPR SW3) impacts to water quality would be unlikely.

9.2.3 Diversion of waterways

There is the possibility the diversion of existing flow paths including piped flow could cause a change in flow to downstream water quality assets which could adversely impact the performance of the asset (risk SW10). This risk could be mitigated through careful design responding to the hydraulic modelling of flood levels, flows and velocities, the integration of water sensitive urban design, measures for storage and reuse and considering the effects of climate change. With implementation of the recommended EPRs (EPR SW6, EPR SW11, EPR SW12 and EPR SW13) the residual risk would be low.

The project assets may directly impact the performance of an existing water quality asset such as the wetlands south of the Eastern Freeway adjacent to Koonung Creek. This could adversely affect the beneficial uses of the receiving waterway (risk SW21). Retaining or replacing the existing water quality assets would be required to address any direct impact (EPR SW14).

9.3 Geomorphology

Geomorphology relates to the study of landforms, their origin and evolution. For North East Link, the key geomorphologic characteristics are associated with the banks and beds of waterways. The project's numerous new roads and ramps, carparks and shared use paths would increase the paved surface area. Connectivity of stormwater runoff from roads to the drains and waterways would increase, along with the risk of increasing peak inflows to drains and waterways, which has the potential to affect the geomorphic condition of receiving waterways.

9.3.1 Banyule Creek

Upstream of Lower Plenty Road, North East Link works within the Banyule Creek catchment would increase the impervious area (paved surfaces) and reduce attenuation (piped diversion of existing waterways). Without mitigation the resultant increase in flows to drains and waterways may lead to bed or bank erosion, affecting assets adjacent to Banyule Creek or the beneficial uses of the receiving waterway (risk SW11 and risk SW12). With appropriate mitigation, changes in the downstream flow regime would be insignificant with no significant impacts on the downstream waterway.

The flow regime would be controlled by a retarding basin with an outlet designed to maintain the existing flow conditions downstream of Lower Plenty Road. The potential for subsidence due to the tunnelling is discussed in Technical report M – Ground movement, and is understood to be insignificant with respect to the function and stability of Banyule Creek. The function of all local drainage currently discharging to Banyule Creek upstream of Lower Plenty Road would need to be maintained during operation.

With the implementation of the recommended EPRs (EPR SW1, EPR SW6, EPR SW9 and EPR SW11) the residual risk of geomorphic changes from changed flow velocities and or flow regimes would be low. With the addition of the proposed storages and designed waterways upstream of Lower Plenty Road it is probable that erosion and sediment loads would reduce. While reduced sediment loads may benefit the downstream creek, they would not affect the existing bank erosion issues evident downstream of Lower Plenty Road.

New drainage discharge locations associated with the new roads for North East Link could concentrate the flow, leading to bed or bank erosion causing instability of assets adjacent to the waterway (risk SW13) and increasing sediment loads, which may impact on the beneficial uses of the receiving waterway (risk SW14). The new drainage discharge locations upstream of Lower Plenty Road would be designed with appropriate scour protection and might be expected to reduce erosion rates relative to existing conditions. There are no new outlets proposed downstream of Lower Plenty Road with the existing outlet to be maintained. With the implementation of the recommended EPRs (EPR SW1, EPR SW6, EPR SW8, EPR SW9 and EPR SW11) the operation of the project would be unlikely to have any significant effect on the geomorphic conditions of Banyule Creek downstream of Lower Plenty Road.

9.3.2 Yarra River

With the exception of the tunnel portals and the associated interchanges, substations and ventilation structures, North East Link would pass beneath the Yarra River floodplain in a tunnel with little direct impact on surface water. The minor increases in runoff associated with the tunnel portals and associated infrastructure are both small relative to the size of the catchment, and likely to be fully offset by the additional storage associated with the sump and pump systems associated with the tunnel drainage. Risk SW11 and risk SW12 are therefore not significant for the Yarra River.

The structures and embankments associated with the new tunnel portals and the associated interchanges, substations and ventilation structures have the potential to alter discharge locations and result in the concentration of flow leading to bed or bank erosion causing instability of assets adjacent to the waterway (risk SW13) and resulting in increased sediment loads, which may impact on the beneficial uses of the receiving waterway (risk SW14). Permanent works must not have any adverse impacts on flow velocities, and any change to the flow regime must satisfy Melbourne Water and adhere to its requirements. The proposed structures and embankments are generally not within active parts of the floodplain and are unlikely to be significantly affected, although local erosion protection works would be provided if needed. With the implementation of the recommended EPRs (EPR SW1, EPR SW6, EPR SW8, EPR SW9, and EPR SW11) the operation of the project would be unlikely to have any significant effect on the geomorphic conditions of the Yarra River.

The potential for subsidence over the tunnels is discussed in Technical report M – Ground movement, and is understood to be insignificant with respect to the function and stability of the Yarra River.

9.3.3 Koonung Creek

North East Link would increase the amount of paved surface area within the Koonung Creek catchment. The connectivity of stormwater runoff from roads to the drains and waterways would also increase. Without mitigation the increased impervious pavement area and reduced attenuation would lead to increased flows to drains and waterways which may lead to bed or bank erosion affecting assets adjacent to Koonung Creek or the beneficial uses of receiving waterway (risk SW11 and risk SW12). With the implementation of the recommended EPRs (EPR SW1, EPR SW6, EPR SW9 and EPR SW11) the operation of the project would be unlikely to have any significant adverse effect on the stability of Koonung Creek.

Widening of the Eastern Freeway would encroach on Koonung Creek and require 1,500 metres of the creek to be diverted in a pipe or realigned. Culverts can initiate upstream bed erosion if they are inappropriately recessed into the bed of the waterway, and the replacement of a waterway with a hydraulically smooth conduit can cause high flow velocities that result in new erosion problems (risk SW13 and risk SW14).

Before the realignment of Koonung Creek as part of North East Link's construction, some sections of the creek would receive more shading from the new freeway noise walls than it does in the existing conditions. Shading of a creek can cause the loss of essential ground cover vegetation resulting in bed and bank erosion (risk SW13 and risk SW14).

Controls to mitigate these risks include compliance with the flow objectives of VicRoads and Melbourne Water for the retardation of increased flows. The stormwater treatment system would be integrated into the design in accordance with the EPA Victoria *Best Practice Environmental Management Guidelines for Urban Stormwater* (2006). New Eastern Freeway noise walls would be designed to limit shading. Permanent waterway diversion works including piped networks and open channels must not have any adverse impacts on flow velocities, and any change to the flow regime must satisfy Melbourne Water and adhere to its requirements. With the implementation of the recommended EPRs (EPR SW1, EPR SW6, EPR SW8 and EPR SW9) the operation of the project would be unlikely to have any significant effect on the already altered conditions of Koonung Creek, which would remain stable and broadly comparable with existing values and characteristics.

New drainage discharge locations associated with the new roads for North East Link could concentrate the flow, leading to bed or bank erosion that causes instability of assets adjacent to the waterway (risk SW13) and result in increased sediment loads which may impact beneficial uses of the receiving waterway (risk SW14). The new drainage assets would be designed with appropriate scour protection and located to minimise the potential for erosion. With the implementation of the recommended EPRs (EPR SW1, EPR SW6, EPR SW8, EPR SW9 and EPR SW11) the new outlets would help maintain the stability of the waterway.

9.4 Water supply

The private dam on the Trinity Grammar School Sporting Complex would be impacted by the construction of the cut and cover tunnel at Bulleen Road. If this functionality was not appropriately reinstated, North East Link may impact on the stormwater storage for irrigation purposes of Trinity Grammar School Sporting Complex and also Marcellin College (risk SW20). The existing stormwater supply would need to be maintained to meet the currently supplied irrigation demand of the Trinity Grammar School Sporting Complex and Marcellin College (EPR SW12). This is expected to be achieved through the construction of a new storage dam, or alternative water supply arrangements. Other secondary functions of this system such as local drainage and flood mitigation would also need to be adequately maintained by the proposed works (EPR SW6).

A suitable supply to the newly constructed Bolin Bolin Integrated Water Management Project would also need to be reinstated to comply with EPR SW12 and avoid any long-term adverse impacts to the water management project. Likely solutions include reconnecting to the existing catchment or providing an alternative water source.

10. Alternative design options

Although the North East Link reference project has largely been finalised, there are two design options being considered for the arrangement of the Manningham Road interchange, and two locations for the launch of the tunnel boring machine (TBM) being considered. For information on these design options, refer to EES Chapter 8 – Project description.

This section explains how the potential impacts associated with the alternative design options would differ from the impacts associated with the reference project for the interchange assessed in Section 8 and Section 9.

10.1 Manningham interchange alternative

The potential surface water impacts of the alternative design for the Manningham Road interchange have been reviewed. This alternative design would result in minor changes to the location of the floodwalls but would not result in any significant changes to the surface water risks or require any amendment of the EPRs. The alternative design extends further to the west into a lower section of the floodplain at its southern end and may result in a greater loss of flood plain storage. The differences between the reference project and the alternative design with respect to surface water are marginal and the merits of the alternative design are expected to be dominated by other considerations.

10.2 Northern tunnel boring machine (TBM) launch

The potential surface water impacts of the alternative TBM launch site have been reviewed. While no long-term operational impacts are anticipated, there is potential for this alternative launch site to result in impacts during construction, particularly with respect to flood flows along Banyule Creek to the north of Lower Plenty Road.

To minimise potential flood impacts, the Surface Water Management Plan would include requirements to maintain flow characteristics to prevent flood impacts (EPR SW5). Modelling the proposed layout of compounds before construction (EPR SW6) would allow for identification of issues and associated contingency measures to satisfy the requirements of the relevant drainage authority. Furthermore, waterway modifications would need to be designed to mitigate the effects of changes to flow (EPR SW8).

The limited footprint at this location and operation within an ephemeral flood plain would need to be carefully considered, planned and implemented to comply with the EPRs and manage the potential construction risks. Consideration of the modelling results and a range of design concepts indicates there is a feasible surface water solution for the northern TBM launch alternative although it would require careful planning, analysis, detailing and implementation to maintain an acceptable surface water outcome throughout the project's construction and may result in more severe constraints on stockpile configurations.

Some modelling of a potential construction stage footprint has been undertaken and is reported on in Appendix E. These results indicate that although it may be feasible to construct diversion pipes of sufficient capacity, it would be challenging to effectively capture flows into these pipes and to adequately attenuate these flows. Although both these challenges can be addressed, space would be very limited at this location and the viability of a solution would rely on a very tight integration of the drainage and other civil requirements. Further development and integration of the design solution in consultation with the relevant drainage authority would be required during detailed design.

11. Cumulative impacts

There is the potential for surface water-related cumulative impacts associated with North East Link, where potential impacts within individual sub-catchments could be cumulative in the wider catchment or in association with other future works. This particularly relates to flood risk and water quality effects associated with stormwater runoff from additional pavement areas.

The potential effects of increased stormwater runoff on flooding risk have been assessed. Based on the assessment undertaken and the proposed EPRs, it is expected that flooding risk could be managed at the sub-catchment level in accordance with drainage authority requirements. Accordingly cumulative impacts on flooding risk are unlikely.

With respect to water quality, water sensitive urban design measures are proposed as part of the project design to manage water quality. Wherever possible, this would be undertaken at a sub-catchment level, but in certain locations it would be done in the wider catchment or in some instances through compensatory works in a different catchment. Overall no adverse cumulative impacts on water quality are expected.

With respect to floodplain storage, North East Link would reduce the current floodplain storage in relation to Yando Street Main Drain, Kempston Street Main Drain, Banyule Creek, the Yarra River and Koonung Creek. At Yando Street Main Drain and on Banyule Creek, modelling indicates that local treatment measures would provide adequate mitigation so that downstream environments were not adversely affected. Only small impacts are expected on the Yarra River which would likely be insignificant in themselves. However, mitigation works may be required to address the potential for cumulative impacts from numerous projects over time to prevent the incremental reduction in performance of the overall system from lots of small independently insignificant changes. If needed, this mitigation would be designed in consultation with Melbourne Water. The effects and potential mitigation mechanism are still being refined for Kempston Street Main Drain and for Koonung Creek, with the expectation that design development and modelling would verify that downstream impacts can be mitigated.

There is also the potential for cumulative impacts due to the combined effects of North East Link and other separate upgrades to the M80 Ring Road planned by VicRoads in the immediate vicinity and with respect to the upgrade of the Chandler Highway bridge across the Yarra River. However, no cumulative impacts have been identified because the construction periods of these projects would not overlap and each project would be designed to meet the relevant flooding and water quality requirements during their operation.

12. Environmental Performance Requirements

Table 12-1 lists the currently recommended Environmental Performance Requirements (EPRs) relevant to the surface water assessment. These are currently draft requirements which are subject to further revision and refinement.

Table 12-1 Environmental Performance Requirements

EPR Code	Environmental performance requirements
EPR SW1	**Discharges and runoff to meet State Environment Protection Policy (Waters)** Meet the State Environment Protection Policy (Waters)) requirements for discharge and run-off from the project, including by complying with the Victorian Stormwater Committee's Best Practice Environmental Management Guidelines for Urban Stormwater (as published by CSIRO in 1999 with assistance from EPA Victoria and others).
EPR SW2	**Design to include spill containment** Design and construct the spill containment capacity of the stormwater drainage system for all freeway pavements (including ramps) to manage the risk of hazardous spills from traffic accidents at or prior to every stormwater outlet, to meet AustRoads requirements. The design and location of spill containment must consider the risk and potential impact of a spill, as well as the effectiveness in reducing the risks associated with a spill on the environment. Develop procedures for freeway roads and ramps to be implemented in response to a hazardous spill.
EPR SW3	**Wastewater discharges to be minimised and approved** The Surface Water Management Plan (refer EPR SW5) and OEMP must include requirements and methods for minimising, handling, classifying, treating, disposing and otherwise managing waste water. Any proposed discharge of waste water from the site must be approved by the relevant authority prior to discharges occurring and meet the State Environment Protection Policy (Waters) requirements.
EPR SW4	**Monitor water quality** Develop and implement a surface water monitoring program prior to commencement of and during construction to assess surface water quality a suitable distance upstream and downstream of works to establish baseline conditions and enable assessment of construction impacts on receiving waters. This monitoring program must be developed in consultation with EPA Victoria and the asset owner/manager and as appropriate with reference to EPA Victoria Publication 596 Point source discharges to streams: protocol for in-stream monitoring and assessment and Industrial Waste Resource Guideline 701 Sampling and analysis of waters, wastewaters, soils and wastes. The surface water monitoring program is to be used to inform the development and refinement of the Surface Water Management Plan (EPR SW5).

EPR Code	Environmental performance requirements
EPR SW5	**Implement a Surface Water Management plan during construction** Develop and implement a Surface Water Management Plan for construction that sets out requirements and methods for: • Best practice sediment and erosion control and monitoring, in general accordance with EPA Victoria publications 275 Construction techniques for sediment pollution control, 347.1 Bunding Guidelines, 480 Best Practice Environmental Management Environmental Guidelines for Major Construction Sites, 960 Temporary Environmental Protection Measures for Subdivision Construction Sites, and Industrial Waste Resource Guideline 701 Sampling and analysis of waters, wastewaters, soils and wastes • Maintaining the key hydrologic and hydraulic functionality and reliability of existing flow paths, drainage lines and floodplain storage • Retain existing flow characteristics to maintain waterway stability downstream of construction • Location and bunding of any contaminated material (including tunnel spoil and stockpiled soil) to the 1% AEP flood level and to the requirements of EPA Victoria and the relevant drainage authority • Works scheduling to reduce flood related risks. • Bunding of significant excavations including tunnel portals and interchanges to an appropriate level during the construction phase. • Protecting against the risk of contaminated discharge to waterways when working in close proximity to potential pollutant sources (eg landfill or sewer infrastructure) • Documenting the existing condition of all drainage assets potentially affected by the works (including their immediate surrounds) to enable baseline conditions to be established and potential construction impacts on these assets to be assessed and managed.
EPR SW6	**Minimise risk from changes to flood levels, flows and velocities** Permanent works and associated temporary construction works must not increase overall flood risk or modify the flow regime of waterways without the acceptance of the relevant drainage authority or asset owner (typically Melbourne Water) and in consultation with other relevant authorities (eg Council, VicRoads, Parks Victoria, SES, emergency services). To assess overall flood risk, undertake modelling of the design of permanent and temporary works to demonstrate the resultant flood levels and risk profile. This modelling analysis is to include sufficient events (at least up to and including the 1% AEP event) and scenarios (eg with and without blockage) to support the estimation of tangible (eg average annual damages) and intangible flood damages. If significant increases in flood risk are predicted for any events analysed, an assessment of overall flood risk considering tangible and intangible flood damages must be prepared and presented with appropriate mitigation measures for the acceptance of the relevant drainage authority or asset owner.
EPR SW7	**Develop flood emergency management plans** Develop and implement flood emergency management plans for each of construction and operation. Flood emergency management plans are to include but not be limited to measures to manage flood risk to construction sites (including consideration of scheduling works), the tunnels and tunnel portals including interchanges and substations, and operation, maintenance and emergency management procedures for flood protection works.
EPR SW8	**Minimise impacts from waterway modifications** Where waterway or flow regime modification is necessary, modifications will be designed and undertaken in a way that mitigates to the extent practicable the effects of changes to flow and minimises, to the extent practicable, the potential for erosion, sediment plumes, impacts on bed or bank stability and exposure or mobilisation of contaminated material during construction and operation to the requirements of Melbourne Water or the relevant drainage authority. Waterway modifications are to be designed and undertaken in a way that maximises the visual and aesthetic amenity and environmental conditions (including habitat, connectivity, refuge and hydraulic conditions) to support aquatic ecosystems of the waterways having regard to relevant strategies, policies and plans for that waterway and in consultation with Melbourne Water or the relevant drainage authority.

EPR Code	Environmental performance requirements
EPR SW9	**Maintain bank stability** Develop and implement appropriate measures to minimise erosion and protect bank stability of waterways affected by construction or operation activities both directly or indirectly (for example as a result of site access), to the requirements of Melbourne Water or the relevant drainage authority.
EPR SW10	**Provide access to Melbourne Water and other drainage assets** Provide adequate clearances and access for ongoing maintenance of Melbourne Water and other drainage authority assets to the requirements of the relevant drainage authority.
EPR SW11	**Adopt Water Sensitive Urban and Road Design** Adopt and implement water sensitive urban design and integrated water management principles in the stormwater treatment design, in general accordance with the Urban Design Strategy, the specifications of the relevant local council as applicable, and VicRoads Integrated Water Management Guidelines (June 2013), the Victorian Stormwater Committee's Victoria Best Practice Environmental Management Guidelines for Urban Stormwater (as published by CSIRO in 1999 with assistance from EPA Victoria and others) and the DELWP Integrated Water Management Framework for Victoria (September 2017).
EPR SW12	**Minimise impacts on irrigation of sporting fields** Maintain existing storage and available water supply for the irrigation of sporting fields impacted by the project as necessary in consultation with the impacted stakeholders.
EPR SW13	**Consider climate change effects** The flood risk assessment (as required by EPR SW6) must consider current climate conditions as well as the potential effects of climate change on pre and post work scenarios for future climate conditions (ie increased rainfall intensity and sea-level rise) as predicted at the end of the asset's design life using RCP8.5 projections from CSIRO to the requirements of Melbourne Water or the relevant drainage authority.
EPR SW14	**Meet existing water quality treatment performance** Retain or replace existing water quality treatment assets to meet or exceed existing water quality treatment performance. Consider climate change effects where practicable.
EPR B3.[1]	**Minimise and remedy damage or impacts on third party property and infrastructure** Through detailed design and construction, and in consultation with relevant land owners and parties as necessary, design and construct the works to minimise, to the extent practicable, impacts to, and interference with, third party property and infrastructure and to ensure that infrastructure and property is protected during construction and operation. Any damage caused to property or infrastructure as a result of North East Link must be appropriately remedied in consultation with the property or asset owner.

[1] This EPR is important to minimise damage to drainage assets and to clarify reinstatement requirements so that surface water performance is not adversely affected.

EPR Code	Environmental performance requirements
EPR CL5	**Manage chemicals, fuels and hazardous materials** The CEMP and OEMP must include requirements for management of chemicals, fuels and hazardous materials including: • Minimise chemical and fuel storage on site and store hazardous materials and dangerous goods in accordance with the relevant guidelines and requirements. • Comply with the Victorian WorkCover Authority and Australian Standard AS1940 Storage Handling of Flammable and Combustible Liquids and EPA Victoria publications 480 Environmental Guidelines for Major Construction Sites and 347 Bunding Guidelines • Develop and implement management measures for hazardous materials and dangerous substances, including: – Creating and maintaining a dangerous goods register – Disposing of any hazardous materials, including asbestos, in accordance with Industrial Waste Management Policies, regulations and relevant guidelines – Implementing requirements for the installation of bunds and precautions to reduce the risk of spills. • Contingency and emergency response procedures to handle fuel and chemical spills, including availability of on-site hydrocarbon spill kits.

13. Conclusion

The purpose of this report is to provide surface water impact assessments to inform the preparation of the EES and EPBC Act assessments required for the project.

13.1 Relevant EES evaluation objectives

The scoping requirements for the EES specify the draft evaluation objectives. Two objectives are relevant to surface water:

- **Land Stability** – To avoid or minimise adverse effects on land stability from project activities, including tunnel construction and river and creek crossings
- **Catchment Values** – To avoid or minimise adverse effects on surface water, groundwater and floodplain environments.

This report identifies the key risk areas, particularly in relation to floodplain function, where risk ratings are elevated. Through the incorporation of EPRs and specific mitigation works, adverse effects on surface water can be reduced.

Environmental controls are specified for the project to require that best practice water quality treatment is undertaken, or integrated water solutions are provided, which reduce the potential adverse effects of the project on water quality.

The risk of erosion has been assessed and mitigation measures and EPRs recommended to reduce the potential for adverse impacts on land stability.

13.2 Impact assessment summary

Construction of North East Link has the potential to impact a number of waterways including Banyule Creek, Koonung Creek and the Yarra River as well as the Yando Street Main Drain and Kempston Street Main Drain. The impact assessment has considered the risk of construction and operation of the project, adversely impacting water quality and geomorphic conditions of the above waterways or the flooding of their associated floodplains and tributaries. All surface water impacts relating to an elevated risk identified in this study have been considered and environmental performance controls that either reduce or mitigate the impact proposed.

The initial EPRs were reasonably effective in managing risks although with additional refinement and strengthening the final EPRs have been effective in further reducing risk. The EPRs that have been developed for the project provide robust requirements for the reduction or elimination of the incremental surface water risks associated with the project. As discussed in this report, this would be achieved through a number of different mechanisms including but not limited to: meeting authority requirements in relation to flood risk; requiring appropriate investigation, modelling and management; water sampling and analysis to determine risks of contamination; and the implementation of suitable Surface Water Management Plan and OEMP.

With the developed EPRs in place there are no remaining high risks and a small number of risks that have a medium residual risk rating. These are summarised below.

13.2.1 Construction

Medium residual risk ratings remain for the following risks:

- Planned construction activities causing increase in flooding frequency or levels which affect users or assets within the floodplain (risk SW01).
- Construction activities causing unintended damage to drainage assets resulting in an unacceptable increase in flooding risk (risk SW03).
- Construction activities resulting in bed or bank erosion causing instability of assets adjacent to the waterway (risk SW04) or impacting on the beneficial uses of the receiving water (risk SW05).
- Hazardous materials or construction activities causing contaminants to be released into the waterways resulting in adverse impacts on the beneficial uses of the receiving water (risk SW06 and risk SW07).

13.2.2 Operation

Medium residual risk ratings remain for the following risks:

- Project assets increase the flooding frequency or levels which affect users or assets within the floodplain (risk SW09).
- Change in drainage alignment or discharge location concentrating flow and leading to bed or bank erosion causing instability of assets adjacent to the waterway (risk SW13) or increased sediment loads impacting on the beneficial uses of the receiving water (risk SW14).
- Spills from traffic during operation of the project, or the increase in impervious area leading to an increase in contaminants being released into the waterways resulting in adverse impacts on the beneficial uses of the receiving water (risk SW15, SW16).
- Flood water inundating the project's tunnels during operation of the project and causing a public safety risk (risk SW17).
- Discharge from the tunnel drainage system adversely impacting the beneficial uses of the receiving water (risk SW18).
- Insufficient capacity of road drainage design due to increased rainfall intensities from climate change that would cause a public safety risk (risk SW19).
- Project assets reducing the effectiveness of water quality treatment resulting in adverse impacts on the beneficial uses of the receiving water (risk SW21).

While each of these impacts poses a risk to the environment, the EPRs would effectively manage these risks.

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