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M12 Motorway

Amendment Report - Appendix H

Flooding supplementary technical memorandum

October 2020

Memorandum

Issued by	Laura Baxter, Vincent Chu
Subject	M12 Motorway amendment report – Flooding supplementary technical memorandum
Client	Transport for NSW
Project	M12 Motorway
Date	October 2020

1. Introduction and background

1.1 Overview

Transport for New South Wales (TfNSW; formerly Roads and Maritime Services) proposes to build the M12 Motorway between the M7 Motorway at Cecil Hills and The Northern Road at Luddenham (the project), over a distance of about 16 kilometres. The project would provide the main access from the Western Sydney International Airport at Badgerys Creek to Sydney's motorway network and is expected to be opened to traffic before the opening of the Western Sydney International Airport.

TfNSW is seeking approval under Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to construct and operate the project. An environmental impact statement (EIS) was prepared to assess the potential impacts of the project and recommend management measures to appropriately address those impacts. The key features of the project as described in the EIS is provided in Section 1.1 of the amendment report. This EIS was placed on public exhibition from 16 October to 18 November 2019.

TfNSW proposes to amend the project following further design development since the exhibition of the EIS. The proposed changes include design changes and construction updates. These provide functional improvements to the design and improved integration with surrounding major transport infrastructure projects and potential future development. They also respond to issues raised in community and stakeholder submissions, and, in some instances, further reduce the potential impacts of the project as described in the EIS.

The proposed changes are described in **Section 1.2**.

1.2 Proposed changes

The proposed changes to the project as described in the EIS are summarised below and are described in detail in Chapter 3 and Chapter 4 of the amendment report:

- Amendments to the motorway-to-motorway interchange at the M7 Motorway, including:
  - Changes to Elizabeth Drive and Cecil Road intersections, proposed exit ramps, the Wallgrove Road connection to Elizabeth Drive and proposed shared user path realignments
  - The widening of Elizabeth Drive under the M7 Motorway and approaches
- An option to provide a new connection between the M12 Motorway and Elizabeth Drive near the M7 Motorway interchange
- Two new signalised intersections into the Western Sydney International Airport, with provisions for future connection to potential developments north of the Western Sydney International Airport
- Additional ancillary facilities to support the delivery of the project.

Refinements have also been made as part of the ongoing development of the project since the EIS was exhibited. Refinements are changes that are consistent with the parameters of the project description as outlined in the EIS. For completeness, however, these refinements have been factored into the amended construction and operational footprint and included in the impact assessment described in this supplementary technical memorandum. The refinements are described in Section 3.3 and Section 4.2 of the amendment report and include:

- Lowering the height of the M12 Motorway in and around the Western Sydney International Airport interchange
- Reduction in the scope of work associated with the M12 Motorway and The Northern Road intersection
  - This intersection would still be constructed, but the main infrastructure work would be delivered as part of The Northern Road upgrade project
- Relocation of utilities
- Changes to property access and acquisition
- Changes to drainage
- Adjustments to construction access, hours, haulage, timing and material quantities.

The project with all proposed changes is referred to as the amended project.

1.3 Amended project

1.3.1 Overview

The amended project would continue to provide the main access from the Western Sydney International Airport at Badgerys Creek to Sydney's motorway network and be located between The Northern Road in the west and the M7 Motorway in the east. The amended project includes an option for a direct connection between the M12 Motorway and Elizabeth Drive at the eastern extent of the project. This option would include some realignment of Wallgrove Road and widening of Elizabeth Drive at the motorway-to-motorway interchange at the M7 Motorway to facilitate the connection. Therefore, two options are being proposed for the amended project at the interchange with the M7 Motorway.

The two options for the amended project would be consistent from The Northern Road in the west until Duff Road in the east. At the motorway-to-motorway interchange with the M7 Motorway, the project is proposed to be either:

- Option 1 – Without Elizabeth Drive connection
  - Interchange provides entry and exit ramps between the M12 Motorway and the M7 Motorway; in addition, it would maintain the existing connection of the M7 Motorway to Elizabeth Drive with new entry and exit ramps
- Option 2 – With Elizabeth Drive connection
  - Interchange as per option 1 and also provides entry and exit ramps between the M12 Motorway and Elizabeth Drive, Cecil Road and Wallgrove Road.

This section of the amended project is shown in **Figure 1-1,** with the Elizabeth Drive connection associated with option 2 shown in a different colour and detailed in inset A. The decision on which option would be built is dependent on funding being available to include the Elizabeth Drive connection. This will be determined during the detailed design and construction phase of the project. The key features of each option are described in the following sections.

The proposed changes (see **Section 1.2**) would result in an amended construction footprint (**Figure 1-2**) and an amended operational footprint (**Figure 1-3**). The footprints would be the same for both options, with each footprint assuming the worst case scenario (ie option 2).

The assessment of potential impacts described in **Section 4** relates to the worst case scenario and covers both options, unless stated otherwise.

The key features of the amended project are listed in **Section 1.3.2** and include both options.

1.3.2 Key features of the amended project

The key features of the amended project are listed below. Where the description of the proposed amended project key features differs from the description listed in the EIS (see Section 1.1 of the amendment report), those changes are shown in **bold** text:

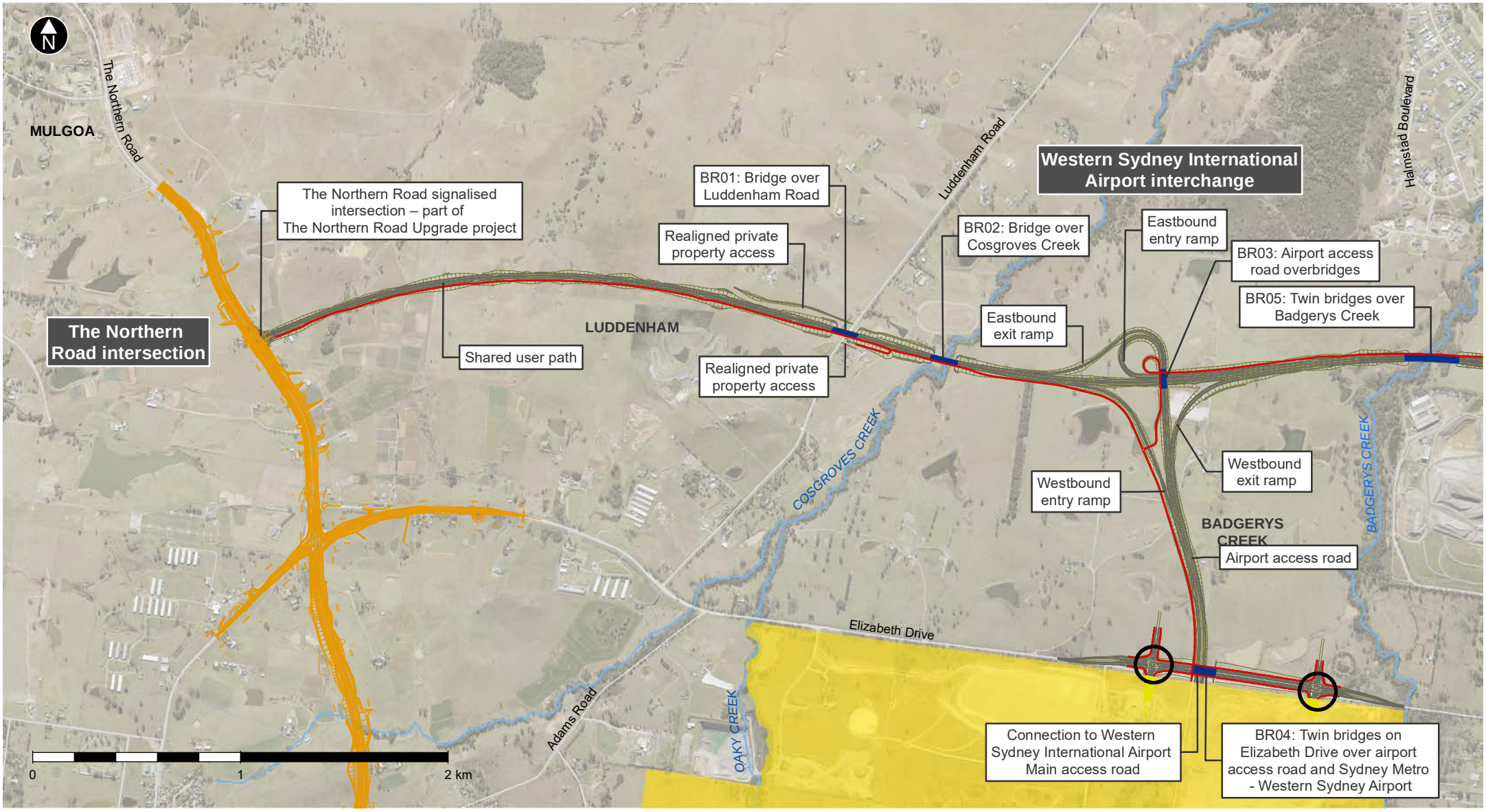
- A new dual-carriageway motorway between the M7 Motorway and The Northern Road with two lanes in each direction with a central median allowing future expansion to six lanes
- Motorway access via three interchanges/intersections:
  - A motorway-to-motorway interchange at the M7 Motorway and associated works (extending about four kilometres within the existing M7 Motorway corridor) **with the following options:**
    - **Option 1 – without connection between the M12 Motorway and Elizabeth Drive**
    - **Option 2 – with connection between the M12 Motorway and Elizabeth Drive**
  - A grade-separated interchange referred to as the Western Sydney International Airport interchange, including a dual-carriageway four-lane airport access road (two lanes in each direction for about 1.5 kilometres) connecting with the Western Sydney International Airport Main Access Road
  - A signalised intersection at The Northern Road with provision for grade separation in the future
- Bridge structures across Ropes Creek, Kemps Creek, South Creek, Badgerys Creek and Cosgroves Creek
- A bridge structure across the M12 Motorway into the Western Sydney Parklands to maintain access to utilities, including the existing water tower and mobile telephone/other service towers on the ridgeline in the vicinity of Cecil Hills, to the west of the M7 Motorway
- Bridge structures at interchanges and at Clifton Avenue, Elizabeth Drive, Luddenham Road and other local roads to maintain local access and connectivity
- Inclusion of active transport (pedestrian and cyclist) facilities through provision of pedestrian bridges and an off-road shared user path, including connections to existing and future shared user path networks
- Modifications to the local road network, as required, to facilitate connections across and around the M12 Motorway including:
  - Realignment of Elizabeth Drive at the Western Sydney International Airport, with Elizabeth Drive overpassing the airport access road and rail infrastructure
  - **Two new signalised intersections from Elizabeth Drive into the Western Sydney International Airport, with provisions for future connection to potential developments to the north**
  - **Widening of Elizabeth Drive under the M7 Motorway and approaches**
  - Realignment of Clifton Avenue over the M12 Motorway, with associated adjustments to nearby property access
  - Relocation of the Salisbury Avenue cul-de-sac, on the southern side of the M12 Motorway
  - **Realignment of Wallgrove Road to connect to Cecil Road, including a connection between Elizabeth Drive and Wallgrove Road via Cecil Road with a signalised intersection with Elizabeth Drive**

- Adjustment, protection or relocation of existing utilities
- Ancillary facilities to support motorway operations, smart motorways operation in the future and the existing M7 Motorway operation, including gantries, electronic signage and ramp metering
- Other roadside furniture, including safety barriers, signage and street lighting
- Adjustments of waterways, where required, including Kemps Creek, South Creek and Badgerys Creek
- Permanent water quality management measures including swales and basin
- Establishment and use of temporary ancillary facilities, temporary construction sedimentation basins, access tracks and haul roads during construction
- Permanent and temporary property adjustments and property access refinements as required.

An overview of the amended project is shown in **Figure 1-1**.

1.4 Purpose of document

This supplementary technical memo has been prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) issued on the 30 October 2018 to support the EIS. The purpose of this memo is to identify and assess the potential construction, operation and cumulative flooding impacts of the amended project, including an assessment of the proposed changes against the impacts documented in the EIS. Where required, this document recommends changes or feasible and reasonable additions to the management measures described in the EIS.



The amended project

Part of The Northern Road upgrade project

Shared user path

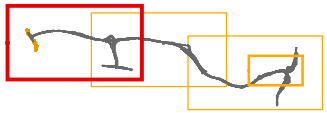
Bridges

Existing roads

Waterways

Western Sydney International Airport

Signalised intersections into the Western Sydney International Airport
Note: Indicative, subject to detailed design



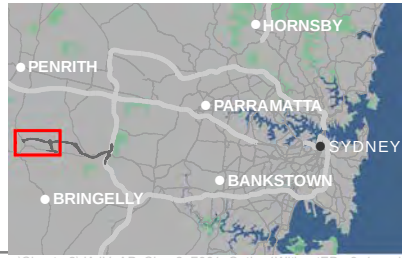


Figure 1-1 Key features of the amended project

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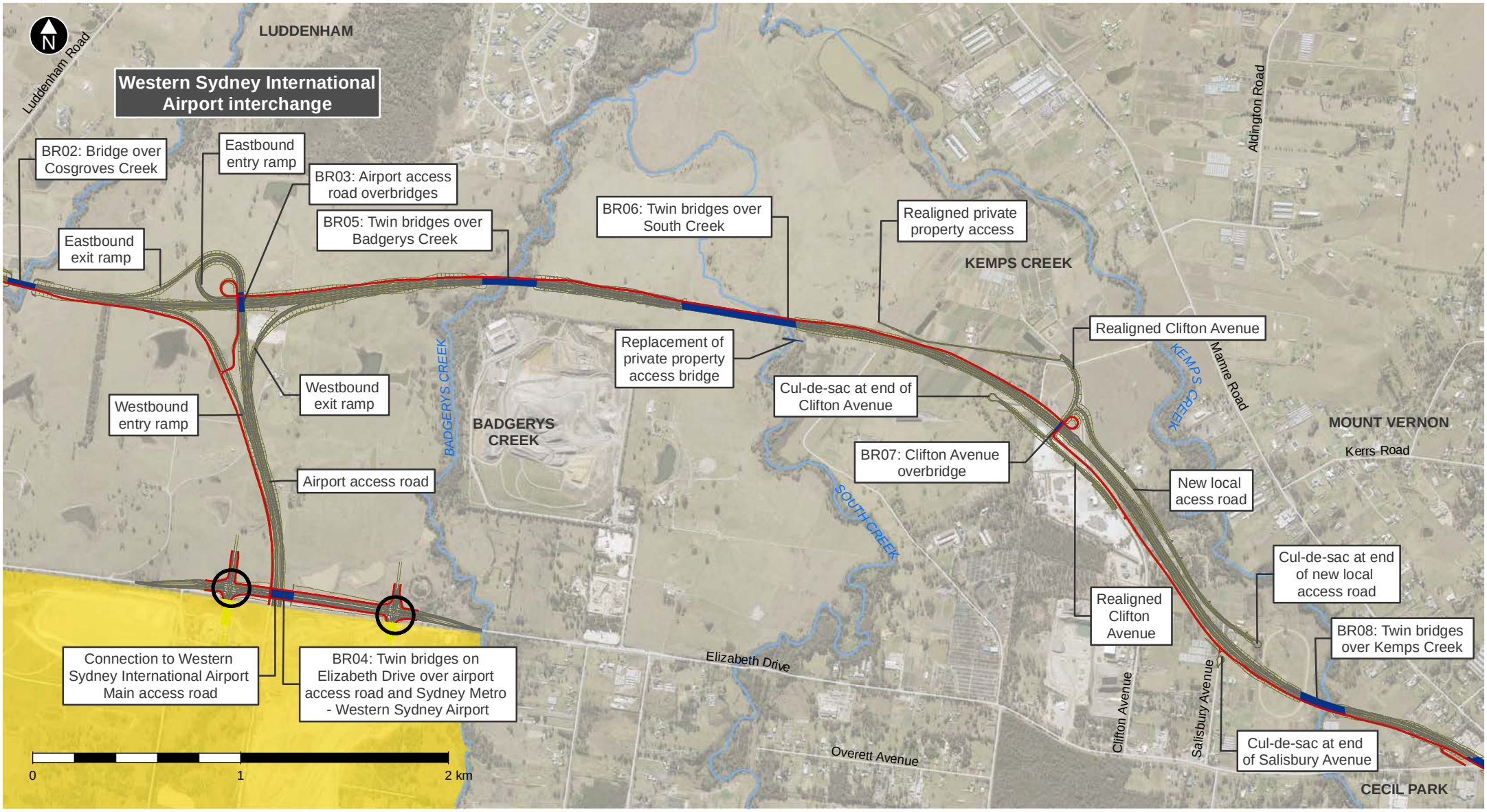
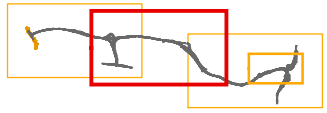


The amended project
Shared user path
Bridges
Existing roads
Waterways
Western Sydney International Airport
Signalised intersections into the Western Sydney International Airport
Note: Indicative, subject to detailed design



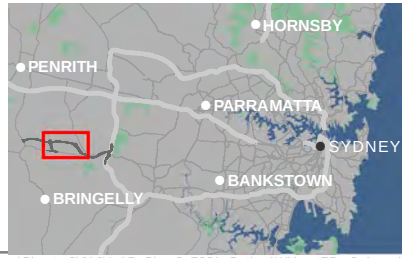


Figure 1-1 Key features of the amended project

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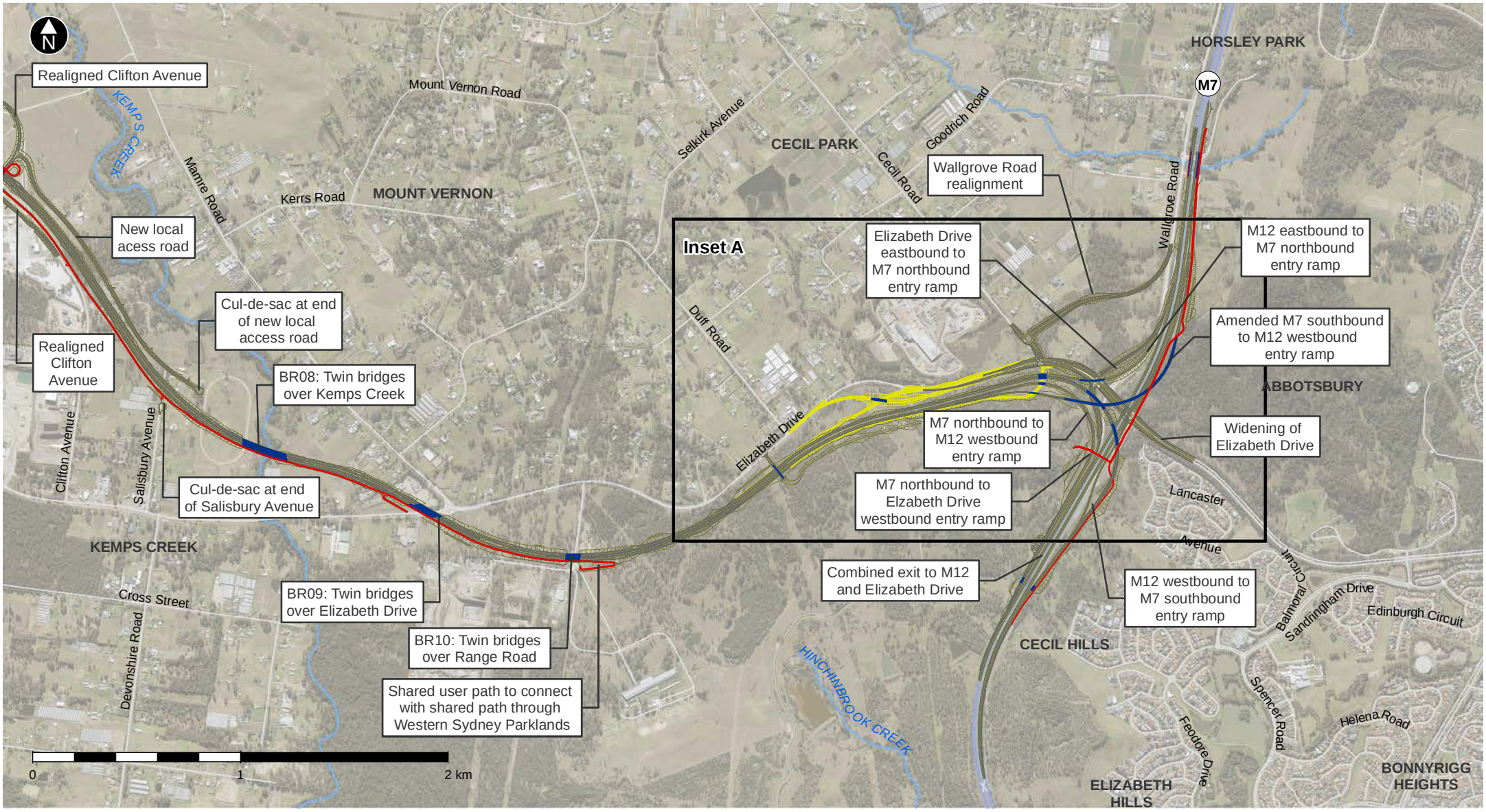


The amended project

The amended project (Elizabeth Drive connection)

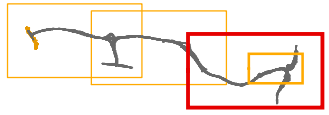
Shared user path

Bridges

Motorway

Existing roads

Waterways



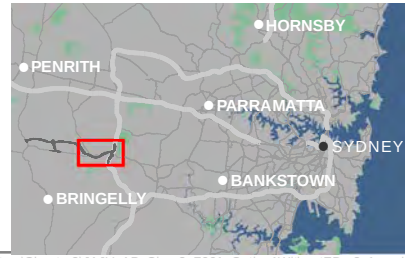


Figure 1-1 Key features of the amended project

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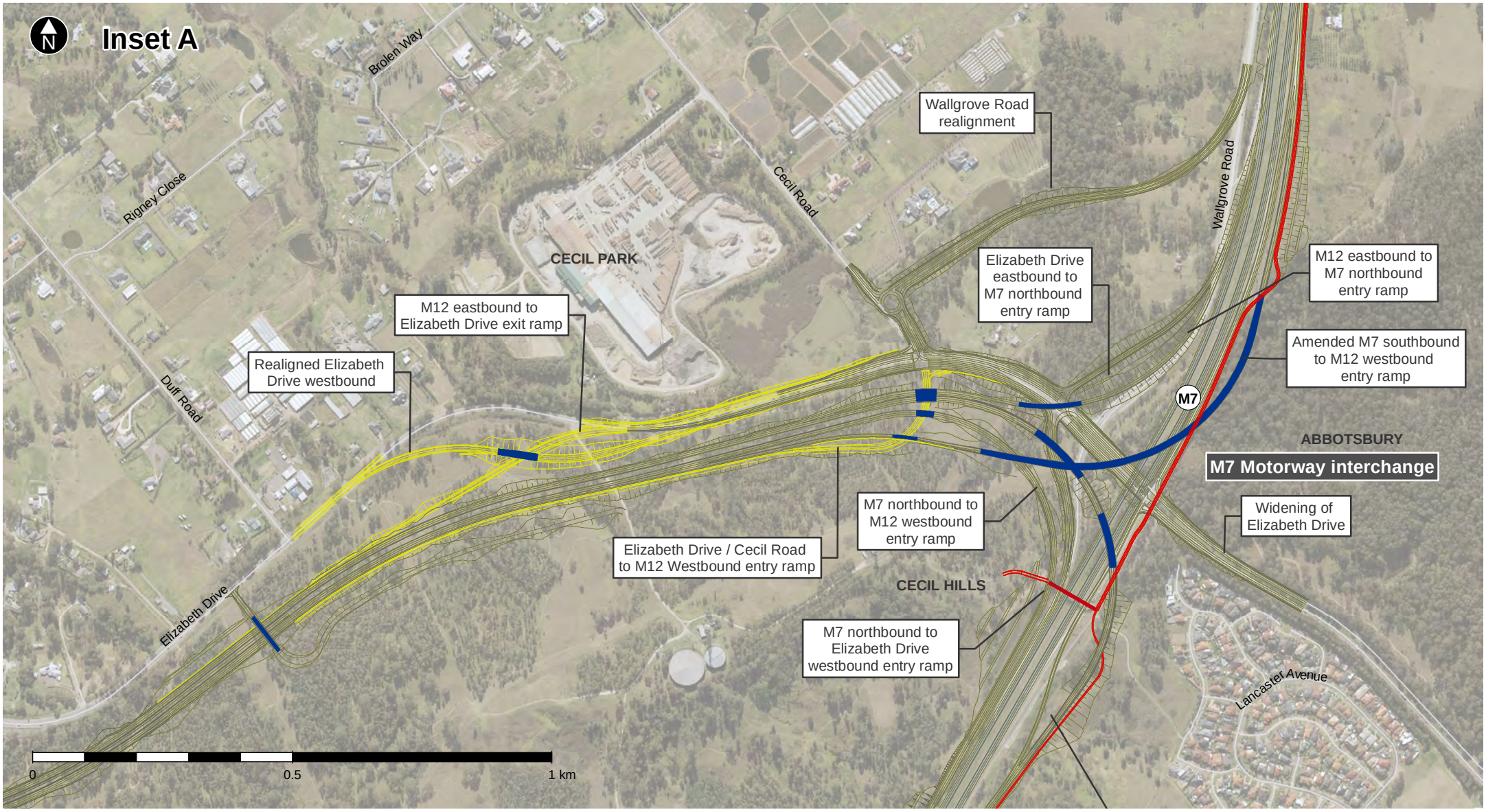
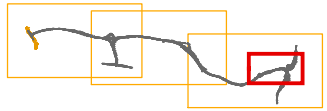


- The amended project
- The amended project with Elizabeth Drive connection
- Shared user path
- Bridges
- Motorway
- Existing roads



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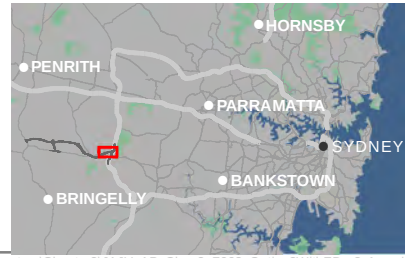

Figure 1-1 Key features of the amended project

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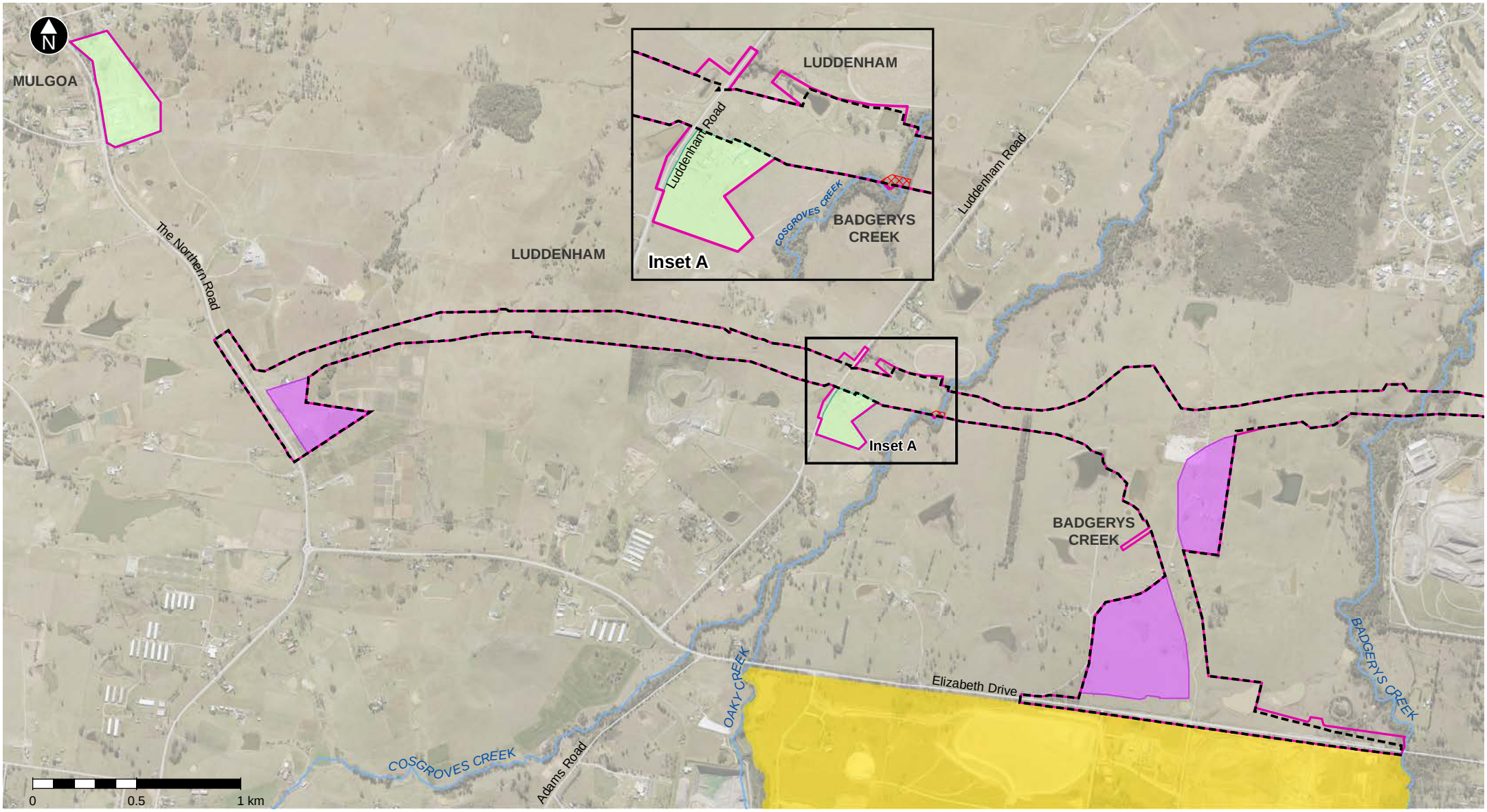

Figure 1-2 Construction footprints of the amended project and the project as described in the EIS

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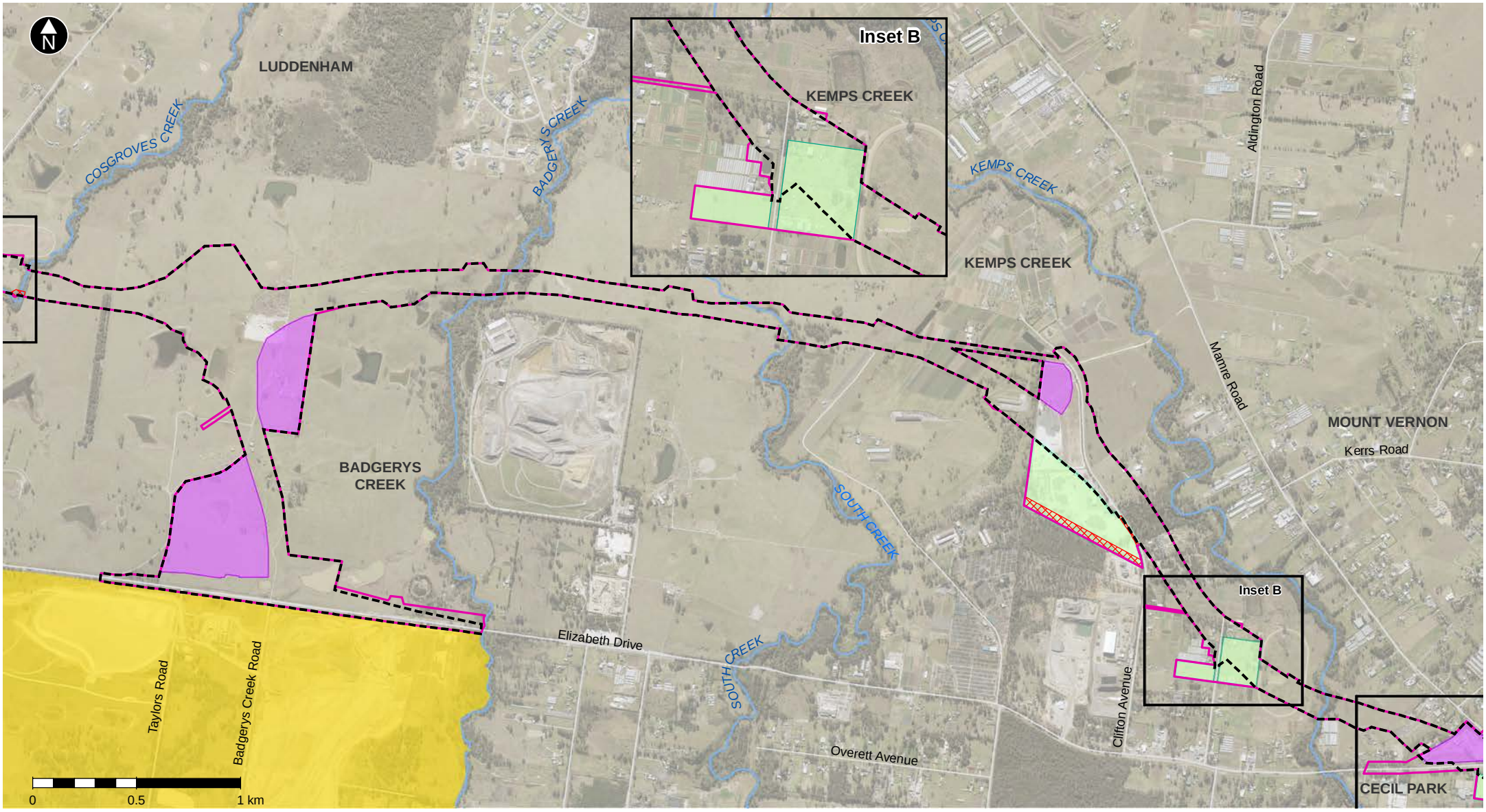


The project construction footprint as per the EIS

The amended project construction footprint

The amended project exclusion zones

Ancillary facilities as per the EIS

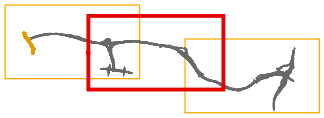
Additional ancillary facilities

Western Sydney International Airport

Waterways

Motorway

Existing roads



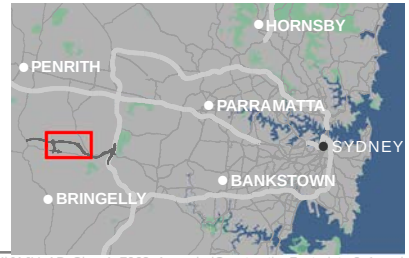


Figure 1-2 Construction footprints of the amended project and the project as described in the EIS

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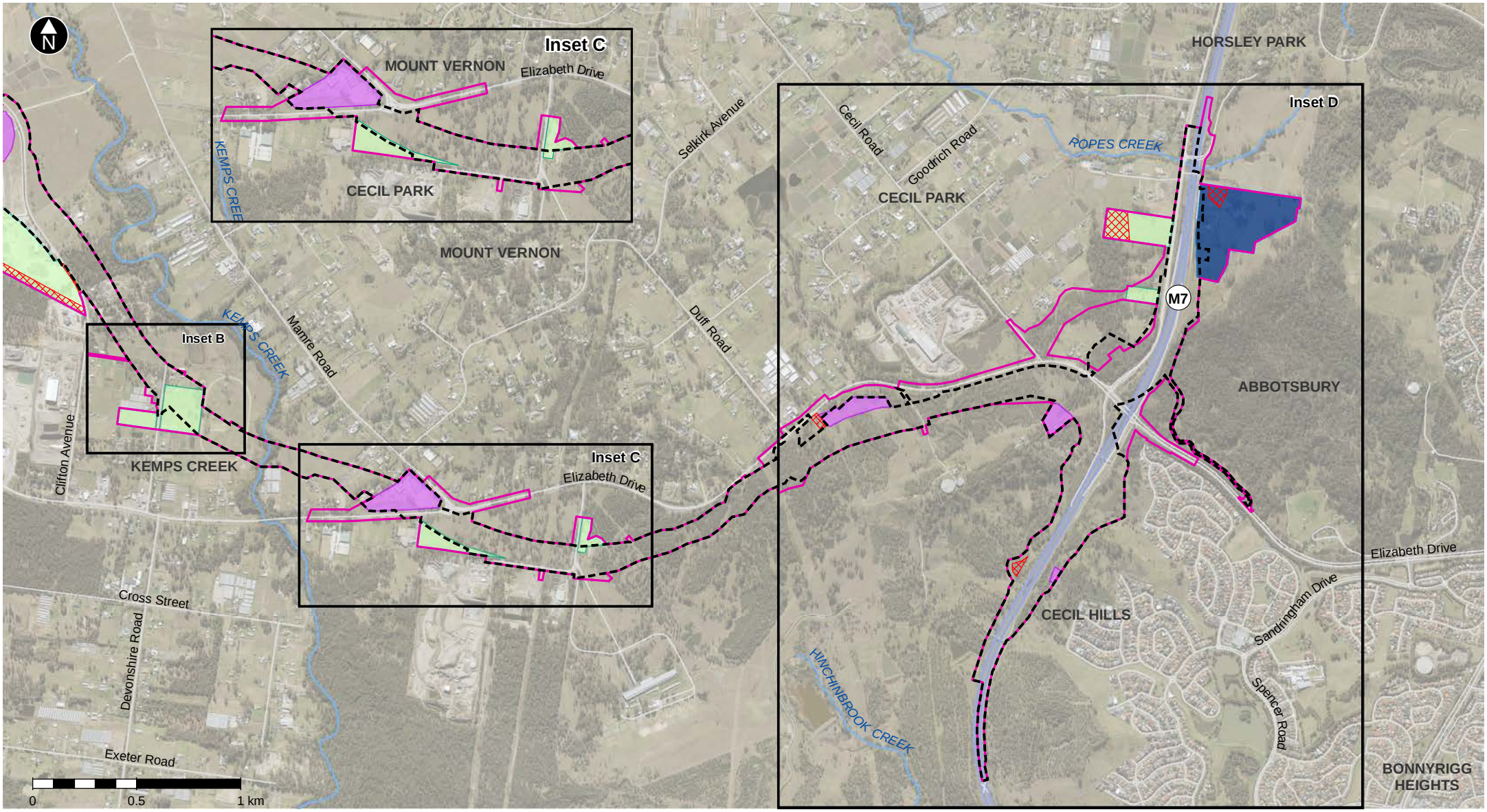


The project construction footprint as per the EIS

The amended project construction footprint

The amended project exclusion zones

Ancillary facilities as per the EIS

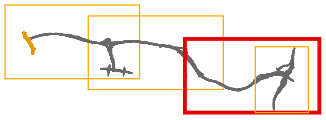
Additional ancillary facilities

Amended ancillary facilities

Waterways

Motorway

Existing roads



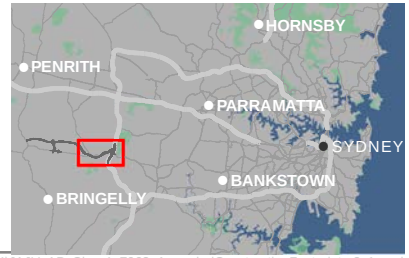


Figure 1-2 Construction footprints of the amended project and the project as described in the EIS

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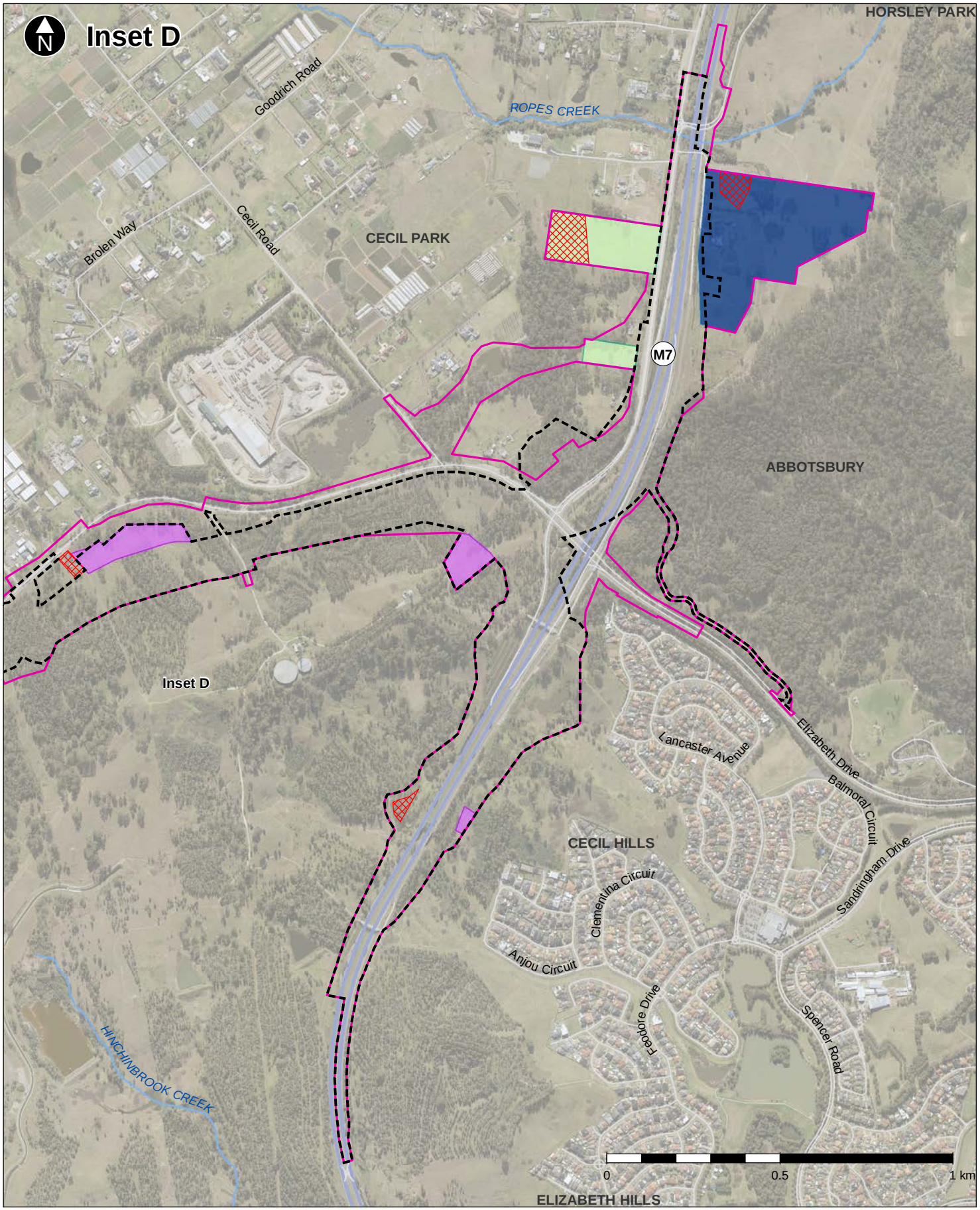


The project construction footprint as per the EIS

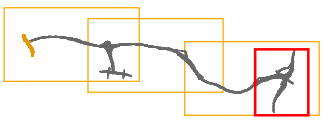
The amended project construction footprint

The amended project exclusion zones

Ancillary facilities as per the EIS

Additional ancillary facilities

Amended ancillary facilities



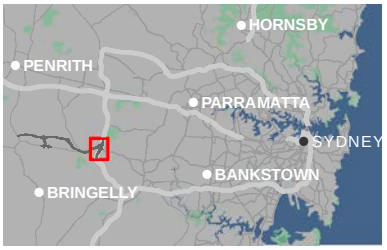


Figure 1-2 Construction footprints of the amended project and the project as described in the EIS

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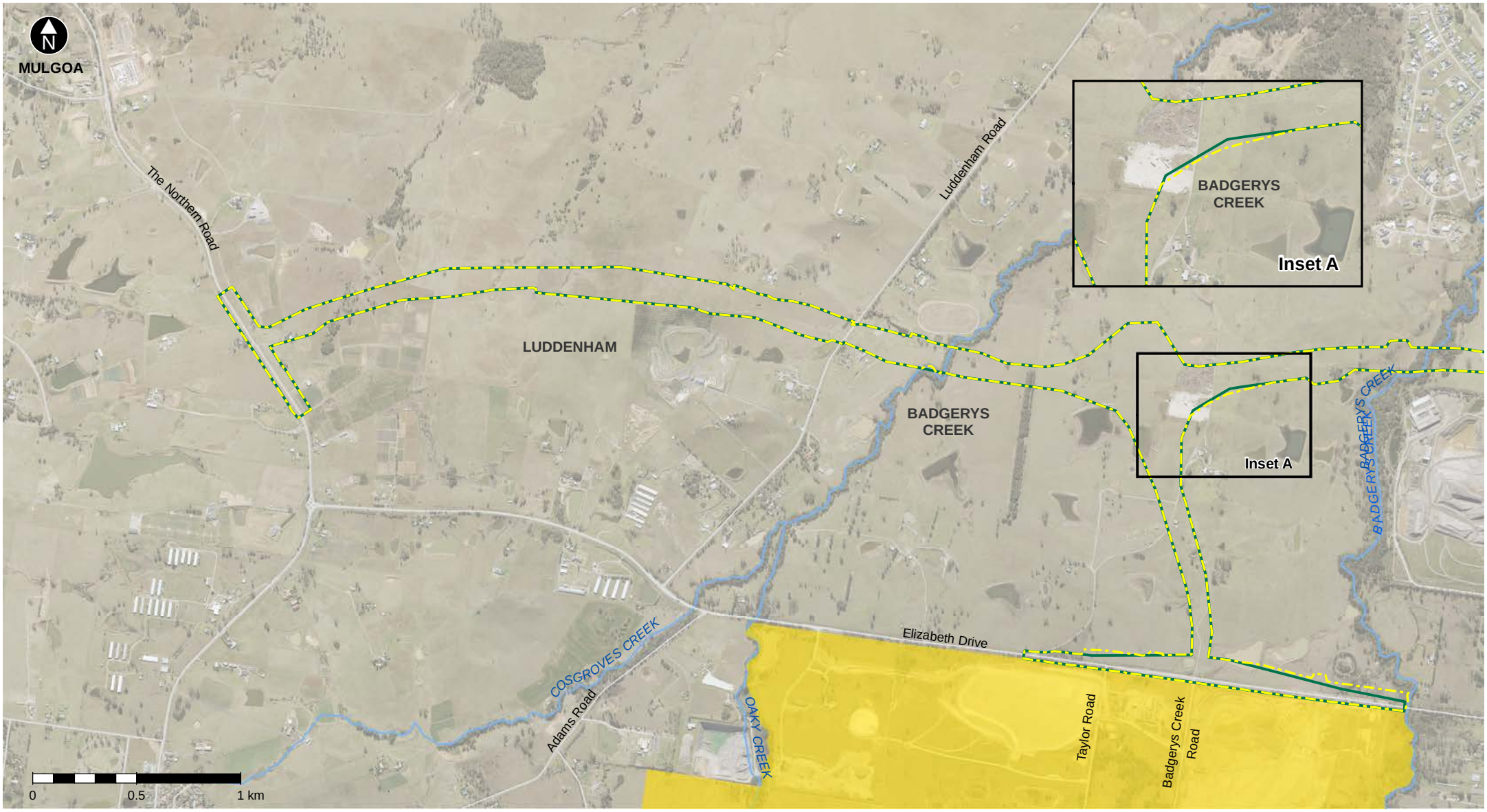


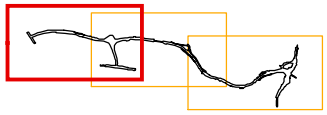
The project operational footprint as per the EIS

The amended project operational footprint

Waterways

Western Sydney International Airport

Existing roads



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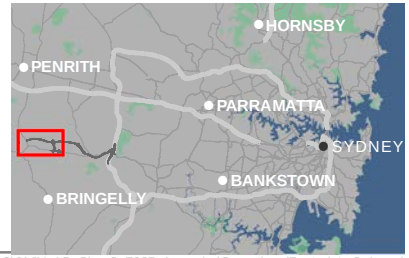

Figure 1-3 Operational footprints of the amended project and the project as described in the EIS

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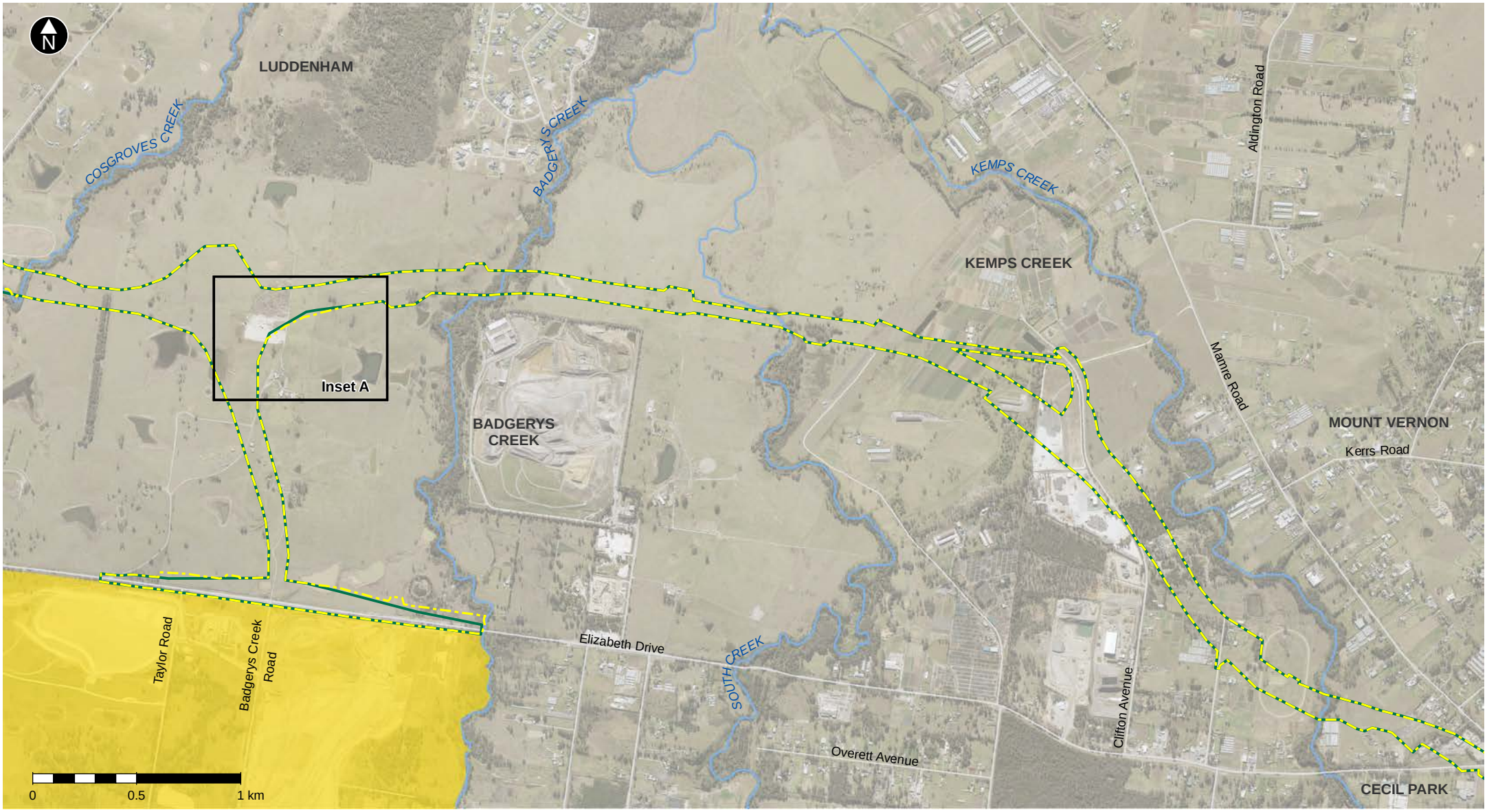

Figure 1-3 Operational footprints of the amended project and the project as described in the EIS

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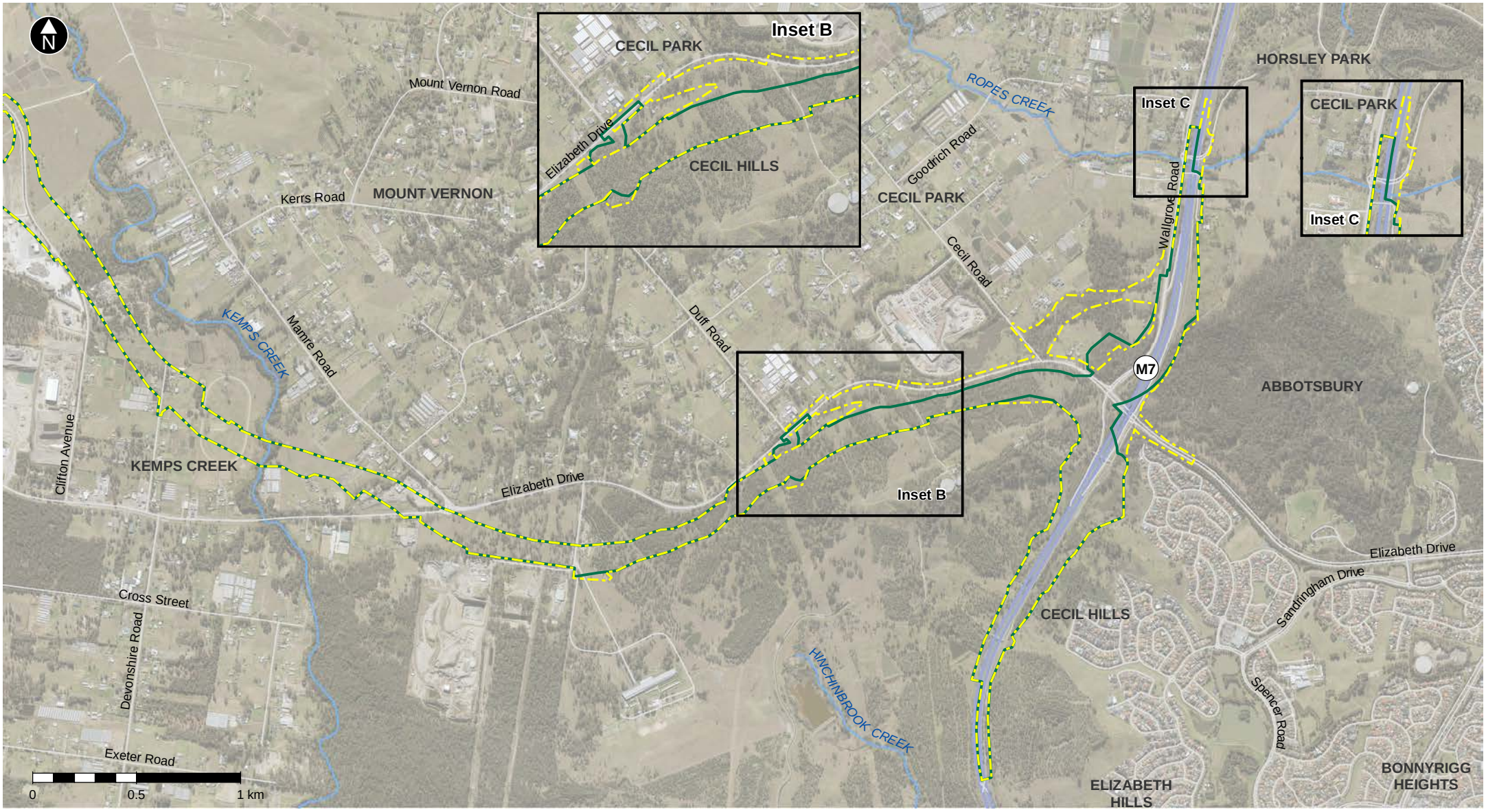


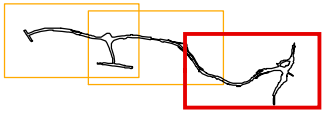
The project operational footprint as per the EIS

The amended project operational footprint

Waterways

Motorway

Existing roads



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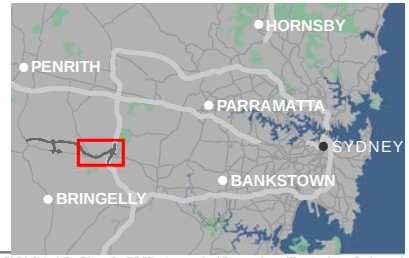

Figure 1-3 Operational footprints of the amended project and the project as described in the EIS

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2. Assessment methodology

2.1 Overview

The methodology for the flooding assessment was prepared in accordance with the policy and planning setting detailed in Section 7.8.1 of the EIS. The supplementary flooding assessment involved the following:

- Review of flooding assessment carried out as part of the EIS against the amended project
  - Confirm qualitatively the likely impact to the flooding conditions from the geometric design changes
- TUFLOW flood modelling of the amended project
  - With project conditions under 5 year, 20 year, 50 year and 100 year average recurrence interval (ARI) events and probable maximum flood (PMF) for the study area where change of impact is likely to occur (refer to first dot point above)
- Update of flood immunity and hydraulic impact predictions for the amended project
- Identification of changes to the impacts documented in the EIS
- Identification of any updates to existing management measures presented in the EIS, or additional management measures required to address impacts resulting from the amended project.

2.2 Study area

The study area as described in the EIS (see Section 7.8.2 of the EIS) covered five key areas where the project would influence, or be influenced by, flooding including:

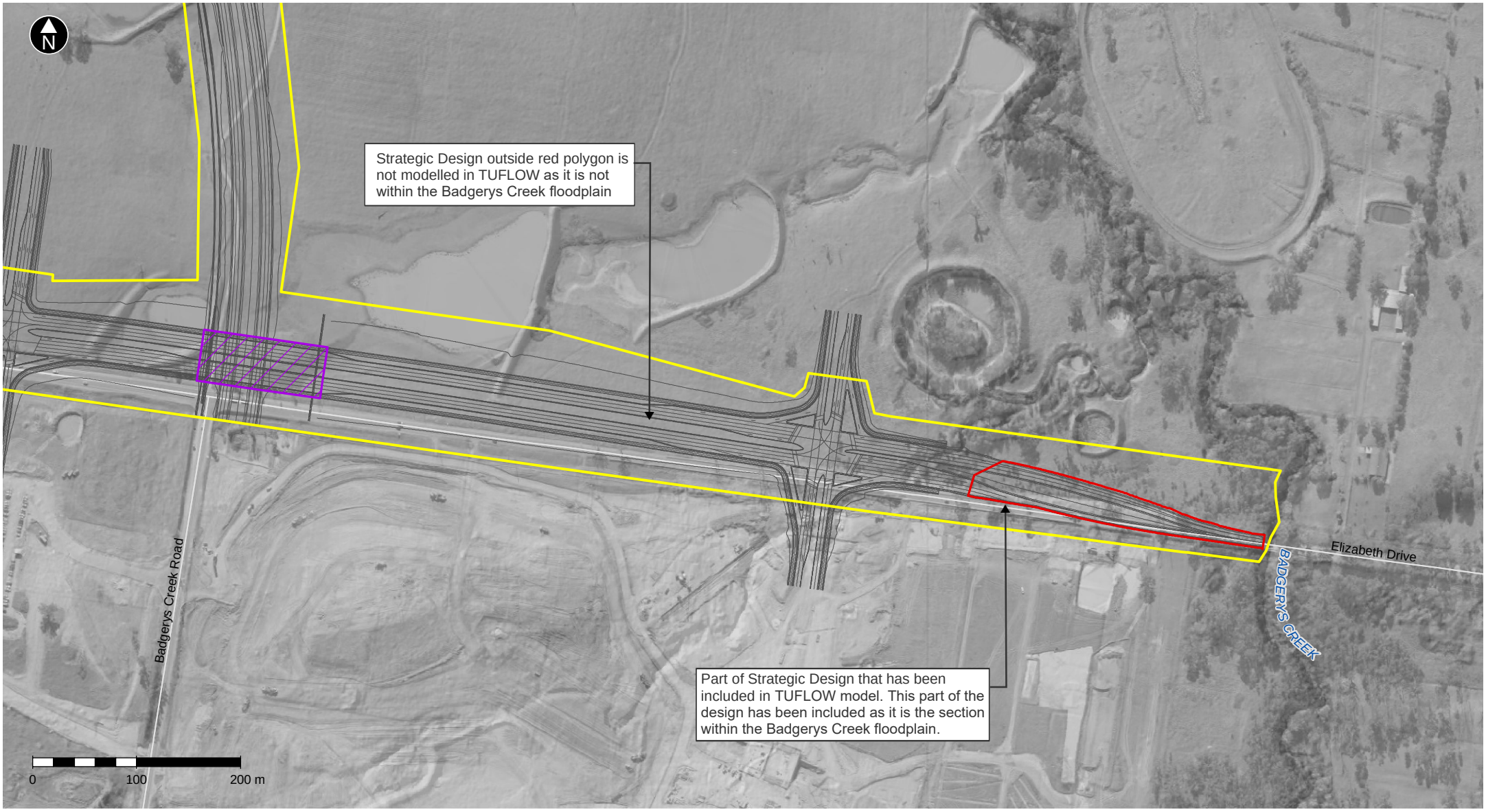
- Cosgroves Creek
- Badgerys Creek
  - The EIS flood model only included the area where the M12 Motorway would intersect the creek
  - The area where Elizabeth Drive crosses Badgerys Creek was not included the EIS flood model
- South Creek
- Kemps Creek
- The minor waterway next to Luddenham Road that would be bridged by the project.

The amended project would extend further into the Badgerys Creek floodplain than the project as described in the EIS. The study area has therefore been extended into the Badgerys Creek floodplain in the vicinity of Elizabeth Drive to assess any potential flood impact as a result of the amended project (**Figure 2-1**).

2.3 Modelling

The flood modelling process comprised of hydraulic modelling. Hydrologic modelling was not required for this assessment, as the hydrological characteristics of the catchments surrounding the amended project are presented throughout Section 7.8 of the EIS and are not proposed to change as a result of the amended project.

Therefore, this supplementary assessment focuses on the hydraulic analysis for the amended project using the TUFLOW modelling developed for the EIS. The approach as described in the EIS (eg grid size, model boundary and boundary conditions etc) was adopted to undertake the current flood supplementary assessment (see Section 7.8.2 of the EIS).



The amended project

The amended project operational footprint

Bridge

Extent of the amended project modelled in TUFLOW

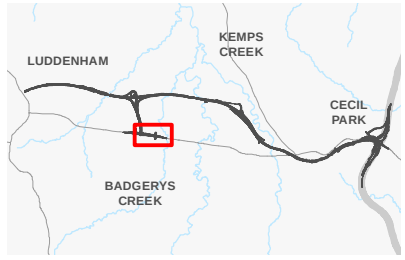


Figure 2-1 Amended study area (TUFLOW Modelling Area)

The outputs from the EIS flood model and the amended project flood model were compared to identify any additional impacts. The comparison of hydraulic assessment outputs included flood levels, flood depths, flood velocities and afflux.

The review identified one area where the amended project would result in a noticeable change to the flooding results for the project as described in the EIS. This was at Badgerys Creek in the area of Elizabeth Drive to the north of the Western Sydney International Airport. The other changes were found to be minimal and/or contained within the amended project construction and operational footprints. The flooding impacts from the amended design were considered consistent to those shown in EIS and are not repeated in this report.

In updating the flood model to incorporate the amended project, the following should be noted:

- The design of the amended project was provided as a surface model and only a portion of the Elizabeth Drive upgrade area was incorporated into the flood model
- In areas outside the TUFLOW modelling area, the amended project design was not included and the model terrain was left as existing
- The flooding impact at Badgerys Creek in the vicinity of Elizabeth Drive extends beyond the boundary of the current flood model.

2.3.1 Criteria

The criteria and objectives used are consistent with those described in Section 7.8.2 of the EIS.

2.3.2 Key assumptions

This supplementary assessment provides an indication of the potential flooding impacts as a result of the amended project. Assumptions were adopted for this assessment and are described below. During detailed design, the flood modelling for the project would be updated and these assumptions would be clarified and refined.

Existing Hydraulic Structures

It was assumed that both existing and proposed culverts at the unnamed tributary associated with Badgerys Creek, and the existing bridge at Elizabeth Drive crossing Badgerys Creek would have sufficient capacity, up to the 100 year ARI, and do not influence the flooding condition at the tributary. The culverts were excluded from the flood model under existing and proposed scenarios.

The existing case flood model as per the EIS was used for this supplementary assessment. The existing Elizabeth Drive bridge over Badgerys Creek and tributary culverts were not represented as hydraulic structures in the EIS flood model; they are open gaps in the model DEM to allow the channel flows to pass unimpeded. Incorporating the existing structures into the flood model during the detailed design phase would allow for the results to be refined.

Western Sydney International Airport

It is assumed that the Western Sydney International Airport would have adequate onsite measures to retain water within the Airport site. An example of an onsite measure is the provision of detention basins to mitigate any flooding impacts outside the boundary of the Airport.

3. Existing flooding conditions

Section 7.8.3 of the EIS provides a detailed description of the existing flooding conditions of the project study area, which are shown in **Annexure A** of this memorandum. As outlined in **Section 2.3,** the amended project would extend further into the Badgerys Creek floodplain than the project as described in the EIS. This area is referred to as Badgerys Creek in the area of Elizabeth Drive, to the north of the Western Sydney International Airport in this report.

At this area, Elizabeth Drive bridges over Badgerys Creek. The creek flows south-to-north under Elizabeth Drive and then passes under the main M12 carriageway at BR05 (see Figure 3-2 in the amendment report) further north before joining South Creek. West of the Elizabeth Drive bridge over Badgerys Creek, there is a tributary to Badgerys Creek that crosses Elizabeth Drive via a box culvert.

Upstream of Elizabeth Drive (south of the road) the combined Badgerys Creek and tributary floodplains flow overland towards Elizabeth Drive. Under existing conditions, Elizabeth Drive is shown to be inundated in events smaller than the 20 year ARI flood event. The floodwaters in the floodplain of the tributary and Badgerys Creek overtop a low point in the road.

The draft for public exhibition Floodplain Risk Management Study and Plan for South Creek (Penrith City Council, September 2019), also indicates overtopping of the road in the five per cent AEP flood (equivalent to the 20 year ARI flood event).

4. Assessment of potential impacts

This section provides an assessment of the potential flooding impacts that may result due to the construction and operation of the amended project. These impacts are discussed in relation to the flooding impacts of the project as described in the EIS. The assessment of potential impacts described in this section relates to both options unless stated otherwise.

4.1 Construction impacts

The amended project has considered the requirement to minimise impact on existing traffic, enable safe construction access and egress, and minimise the duration of construction. The amended project also considered the potential flood impacts associated with the construction activities.

The following construction activities have the potential to affect the existing flood conditions:

- Earthworks – The fill associated with the construction of the amended project would be 3,322,000 cubic metres. This is a decrease of 267,000 cubic metres from the 3,589,000 cubic metres that would be required for the project as described in the EIS. Flow constriction and loss of storage would be similar to the effects described in the EIS.
- Stockpile and ancillary facilities – To support the construction of the amended project, nine additional construction ancillary facilities (AF 10 to AF 18) and an expanded AF 9 would be required. Six of the additional proposed ancillary facilities (AF 11 to AF 16) would be located outside of the major floodplains to avoid or minimise impacts from project earthworks on flow behaviour in the floodplains. Three of the additional proposed ancillary facilities (AF 10, AF 17 and AF 18) and expanded AF 9 are located near the Northern Road and Ropes Creek Catchment. Potential flood impacts of these ancillary facilities are as follows:
  - A small portion of expanded AF 9 would be located within the medium risk flood precinct which is below the 100 year flood but is not subject to a high hydraulic hazard as per the Ropes Creek Flood Planning Map (Fairfield City Council, 2014). The impact from the expanded AF 9 on the 100 year flood conditions is likely to be minimal.
  - AF 17 and AF 18 would be located within the low flood risk precinct which is within the PMF extent but above the 100 year flood as per Fairfield City Council (2014). This will not be impacted by a 100 year flood.
  - AF 10 is located about 1,500 metres from Blaxland Creek, the closest significant waterway. As a result, negligible impact on the main creek floodplains is expected.

- Temporary creek crossings – Temporary creek crossings would not change from those described in the EIS. As a result, no change to flood conditions is anticipated as a result of temporary creek crossings.

Other than the above, the magnitude of construction impacts on existing flood conditions would not be different from those described in the EIS (see Section 7.8.4 of the EIS).

Construction impacts would be managed through the environmental management measures set out in Section 7.8.6 of the EIS.

4.2 Operational impacts

Operational impacts would not change from that described in Section 7.8.4 of the EIS as a result of the amended project with the exception of the area of Badgerys Creek at Elizabeth Drive north of the Western Sydney International Airport.

Operational impacts associated with increases in flood affectation, changes to peak stormwater flows, downstream velocity and scour potential, and flood hazards would change as a result of the amended project at Badgerys Creek at Elizabeth Drive north of the Western Sydney International Airport. These are discussed in the sections below.

Consistent with the reporting in the EIS, the following aspects of flooding impacts have been investigated at Badgerys Creek at Elizabeth Drive north of the Western Sydney International Airport.

- Increases in flood affectation – other properties, assets and infrastructure (see **Section 4.2.1**)
- Changes to peak stormwater flows, downstream velocity and scour potential (see **Section 4.2.2**)
- Flood hazards (see **Section 4.2.3**)
- Climate change (see **Section 4.2.4**).

Annexure B presents the flood mapping of the amended project for the area around Badgerys Creek at Elizabeth Drive north of the Western Sydney International Airport for the 5, 20, 50, 100 Year ARI and PMF.

The proposed changes described in **Section 1.2** would not significantly alter the following operational flooding impacts, as the amended project is not anticipated to have any design features that would result in increased flooding impacts as compared to the EIS design:

- Land use impact
- Impacts on buildings and inundation durations
- Changes in surrounding catchments
- Farm dams
- Hydraulic functions of flow conveyance
- Adverse effects to beneficial floodplain inundation
- Emergency management, evacuation and access
- Social and economic costs.

As a result, these operational flooding impacts would not change from those described in Section 7.8.4 of the EIS and have not been assessed further in this memorandum.

4.2.1 Increases in flood affectation

Elizabeth Drive would be raised from the existing road surface level and the road widened as part of the amended project. Floodwaters would build up upstream of the road (to the south) before the road is overtopped. This would cause an increase in flood levels on the upstream side of the road of about 50 millimetres in the floodplain area in the 100 year ARI event.

The maximum predicted flood level in Badgerys Creek channel upstream of the existing bridge would increase by about 75 millimetres. Downstream of Elizabeth Drive (to the north) a decrease in flood levels of up to 25 millimetres is predicted due to the reduced overtopping of the road.

The area in the vicinity of the amended project at Elizabeth Drive is currently agricultural land use. A 250 millimetre threshold was adopted in the EIS as a flood impact objective for this land use type. The predicted afflux from the assessment of the amended project is within the flood impact objective in the 100 year ARI flood event. During the detailed design phase, TfNSW will seek to refine the design of the works at Elizabeth Drive near Badgerys Creek to minimise flood affectation. Mitigation measures may include adjustment of road levels and/or flood relief culverts through the road.

Table 4-1 describes the increases in flood affectation for the amended project as compared to the project as described in the EIS.

Table 4-1 Elizabeth Drive increases in flood affectation and flood immunity

Flood affectation	Existing conditions	Amended Project
Flood level upstream of existing bridge (100 year ARI)	46.55 m AHD	46.63 m AHD
Flood level in floodplain (100 year ARI)	46.82 m AHD	46.87 m AHD
Afflux – Badgerys Creek (100 year ARI)	N/A	+ 75 mm
Afflux – floodplain (100 year ARI)	N/A	+ 50 mm
Afflux – downstream of Elizabeth Drive (100 year ARI)	N/A	- 25 mm
Flood immunity at area of Badgerys Creek at Elizabeth Drive north of the Western Sydney International Airport	5 year ARI flood immunity Overtopped in the 20 year ARI event by about 295 mm over road crown.	5 year ARI flood immunity Overtopped in the 20 year ARI event by about 160 mm over road crown and depths of up to 350 mm on the west-bound carriageway.

4.2.2 Changes to peak stormwater flows, downstream velocity and scour potential

The amended project would not change the existing peak flows in the creek downstream and upstream of Elizabeth Drive would remain unchanged from the existing conditions.

Under the amended project velocities in the creek channel would remain in the order of 1.5 to 2.3 metres per second and increase by a maximum of 0.1 metres per second in the 100 year ARI flood event compared to the existing conditions. In the floodplain, velocities would remain in the order of 0.1 to 0.8 metres per second and increase by a maximum of 0.1 metres per second in the 100 year ARI flood event. **Table 4-2** described the changes to velocity for the amended project as compared to the project as described in the EIS.

The design of any proposed culverts for the amended project will minimise scour by adopting the same principle as described in the EIS, ie minimising the outlet velocities, and providing scour protection measures at culvert inlets and outlets.

Given the change in peak flows and velocity is negligible, there would no expected increase in scour potential.

Table 4-2 Elizabeth Drive changes to velocity

Flood affectation	Existing conditions (metres per second)	Amended Project (metres per second)
Velocity at existing bridge (100 year ARI)	2.2	2.3
Velocity in upstream floodplain (adjacent to road embankment) (100 year ARI)	0.7	0.8

4.2.3 Flood hazards

The existing Badgerys Creek at Elizabeth Drive north of the Western Sydney International Airport has a flood immunity up to and including the 5 year ARI flood event. It is overtopped on the 20 year ARI event under the existing scenario with 295 millimetres of flood depth above the crown of the road.

During operation of the amended project, Elizabeth Drive would have a flood immunity up to and including the 5 year ARI flood event. It would be overtopped in the 20 year ARI event with a flood depth of about 160 millimetres above the crown of the road and depths of up to 350 millimetres on the west-bound carriageway.

There would be no substantial change to the flood immunity at Elizabeth Drive north of the Western Sydney International Airport.

There is an opportunity to improve the flood immunity of Elizabeth Drive through further raising of the road, although it is noted that there are other flood prone locations along the road outside of the project area. (The Penrith City Council Public Exhibition Draft South Creek Floodplain Risk Management Plan identifies Elizabeth Drive as overtopping at Badgerys Creek, South Creek and Kemps Creek in as little as the 20 year ARI event).

4.2.4 Climate change

The project as described in the EIS would be well above the 0.05 per cent AEP (equivalent to 2000 year ARI) flood levels and the impacts of climate change will have minimal impact on flooding due to the project (see Section 7.2.8 of Appendix L of the EIS). A similar conservative climate change assessment was carried out for the amended project by analysing the 2000 year ARI flow rates[1]. Despite this conservative approach, the vertical alignment of the amended project, along the M12 Motorway main carriageway, would still be well above the 2000 year ARI flood levels and the future climate change will have minimal impact on flooding due to the amended project.

The section of the amended project along Elizabeth Drive around the Western Sydney International Airport, however, would be overtopped during both the 100 year ARI and the 2000 year ARI flood events (see Annexure B). The depth of overtopping would increase by about 220 millimetres in a 2000 year ARI event compare to the 100 year ARI event. Elizabeth Drive would be overtopped both for existing conditions and if the amended project is approved and constructed in smaller floods than the 20 year ARI flood.

[1] The 2000 year ARI flow rates are far in excess of the 100 year ARI flow rates with the standard climate change factors of between 10 and 30 per cent applied.

The impacts of climate change may result in an increased frequency of flooding events and the overtopping of Elizabeth Drive. As such, the road may become overtopped in smaller magnitude flood events or inundated for longer periods of time. However, the impact of climate change is not likely to significantly alter the trafficability conditions of the road compared to the existing conditions when in flood, given the flood modelling undertaken for the amended project (see Annexure A).

4.3 Cumulative impacts

The cumulative flooding impacts would likely remain unchanged from the qualitative assessment undertaken as part of the EIS and presented in Section 7.8.5 of the EIS.

For Badgerys Creek at Elizabeth Drive north of the Western Sydney International Airport an assumption has been made that the Western Sydney International Airport would have adequate on-site measures, for example detention basins, to mitigate any impacts outside the Airport site boundary. Ongoing consultation will be carried out with Western Sydney International Airport and as further details of their flood management and earthworks are developed, these will be incorporated into an updated M12 Motorway flood model for the detailed design phase of the project.

5. Revised environmental management measures

Flooding impacts associated with the amended project are generally consistent with impacts described in the EIS and would therefore be managed through the implementation of the proposed management measures described in Section 7.8.6 of the EIS.

Further flood investigations and hydrological and hydraulic modelling will be required to be undertaken during detailed design stage to ensure the flood impact criteria for the project are met. This is addressed in the existing environmental management measure F01. The refined modelling will be adopted to define the nature of Badgerys Creek mainstream flooding and tributary flooding at the area where Elizabeth Drive crosses the Badgerys Creek floodplain.

Revised environmental management measures for potential flooding impacts are outlined in **Table 5-1**, with additional text (to that presented in the EIS) shown in bold and deleted text shown as strikethrough text. Where there is no change to an environmental management measure, it is not repeated in **Table 5-1**.

Table 5-1 Supplementary environmental management measures (flooding)

Impact	Reference	Environmental management measure	Responsibility	Timing
Consultation regarding flooding impacts	**F09**	**Ongoing consultation will be carried out with Western Sydney International Airport and as further details of their flood management and earthworks are developed, these will be incorporated into an updated M12 Motorway flood model for the detailed design phase of the project.**	**TfNSW / Contractor**	**Prior to and during construction**
Flooding impacts of bridges and culverts	**F10**	**During the detailed design phase, TfNSW will seek to refine the design of the works at Elizabeth Drive near Badgerys Creek to minimise flood affectation. Mitigation measures may include adjustment of road levels and/or flood relief culverts through the road.**	**TfNSW / Contractor**	**Detailed design**

6. Conclusion

The flood modelling assessment carried out was for the purpose of comparing the inputs of the amended project to the assessment carried out as part of the EIS. It has been concluded that the amended project would not lead to unacceptable flooding impacts. This conclusion is based on the determination of potential impacts on flooding during both construction and operational stages, including potential cumulative impacts.

Further flood modelling assessment will be carried out in the detailed design phase to refine the design. During the detailed design phase TfNSW, will seek to refine amended project design at Badgerys Creek at Elizabeth Drive north of the Western Sydney International Airport to minimise the flood affectation detailed in this report. Refinements may include adjustment of road levels and/or flood relief culverts through the road.

The measures adopted during the construction of the amended project at Elizabeth Drive around Western Sydney International Airport would be similar to that of the overall project in other floodplains as described in the EIS.

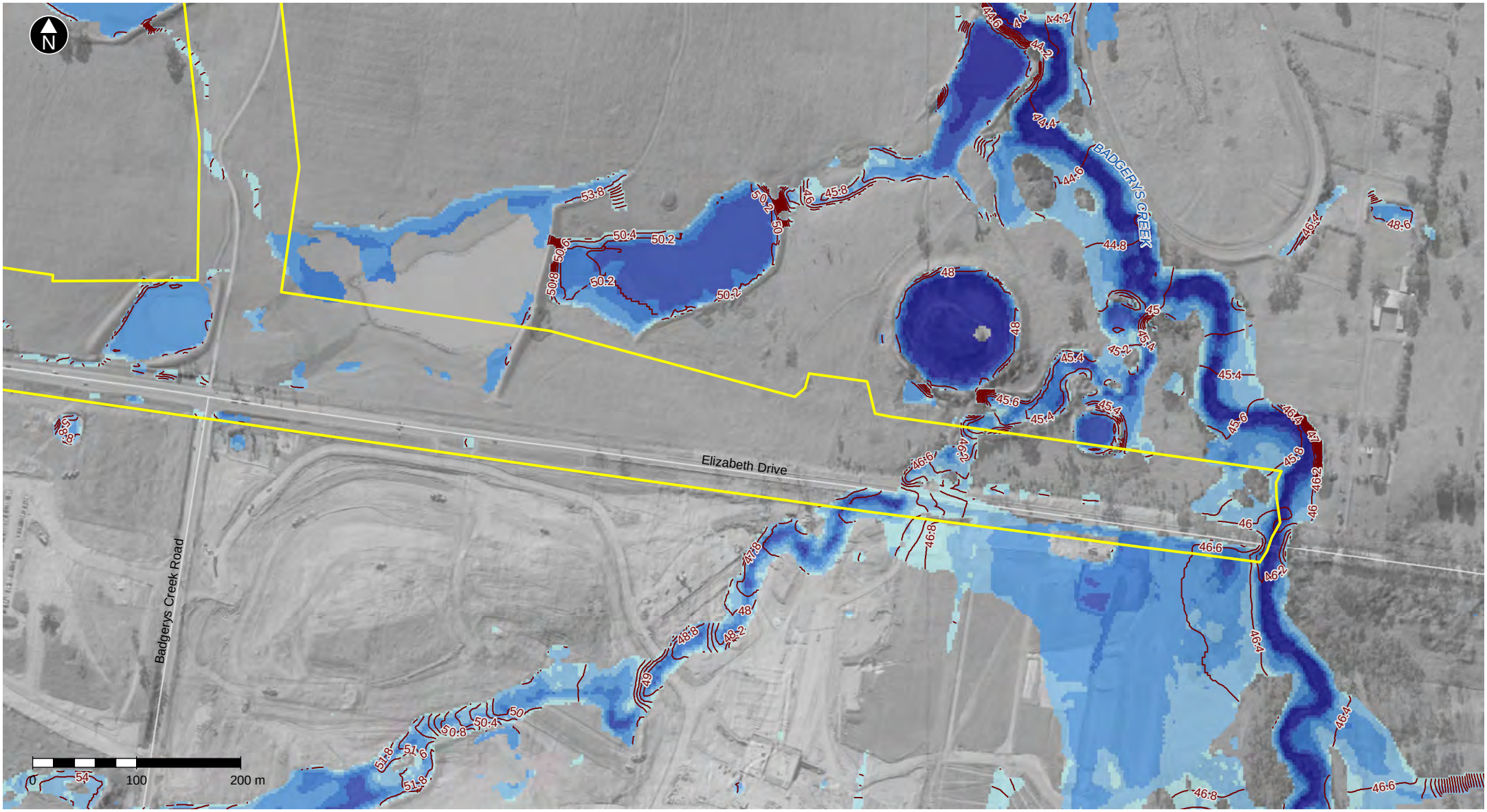
Subject to further assessment, with the application of the appropriate safeguards it is anticipated that flooding impacts from the project would be minimal.

7. References

Fairfield City Council (2014) Ropes Creek – Flood Planning Map. 20 August 2014.Available at http://www.fairfieldcity.nsw.gov.au/downloads/download/68/flood_maps_and_studies

Penrith City Council (2019). South Creek Floodplain Risk, Revision B, Public Exhibition Draft Management Plan. Prepared by Advisian. 13 September 2019

Annexure A Flood mapping at Elizabeth Drive at Badgerys Creek around Western Sydney International Airport – Existing conditions



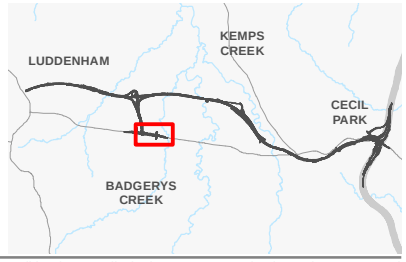
The amended project operational footprint

0.2m Flood Height Contour (m AHD)

Flood Depth (m)

- < 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- > 2.0

**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



5 Year ARI Flood Level & Depth - Existing Conditions - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

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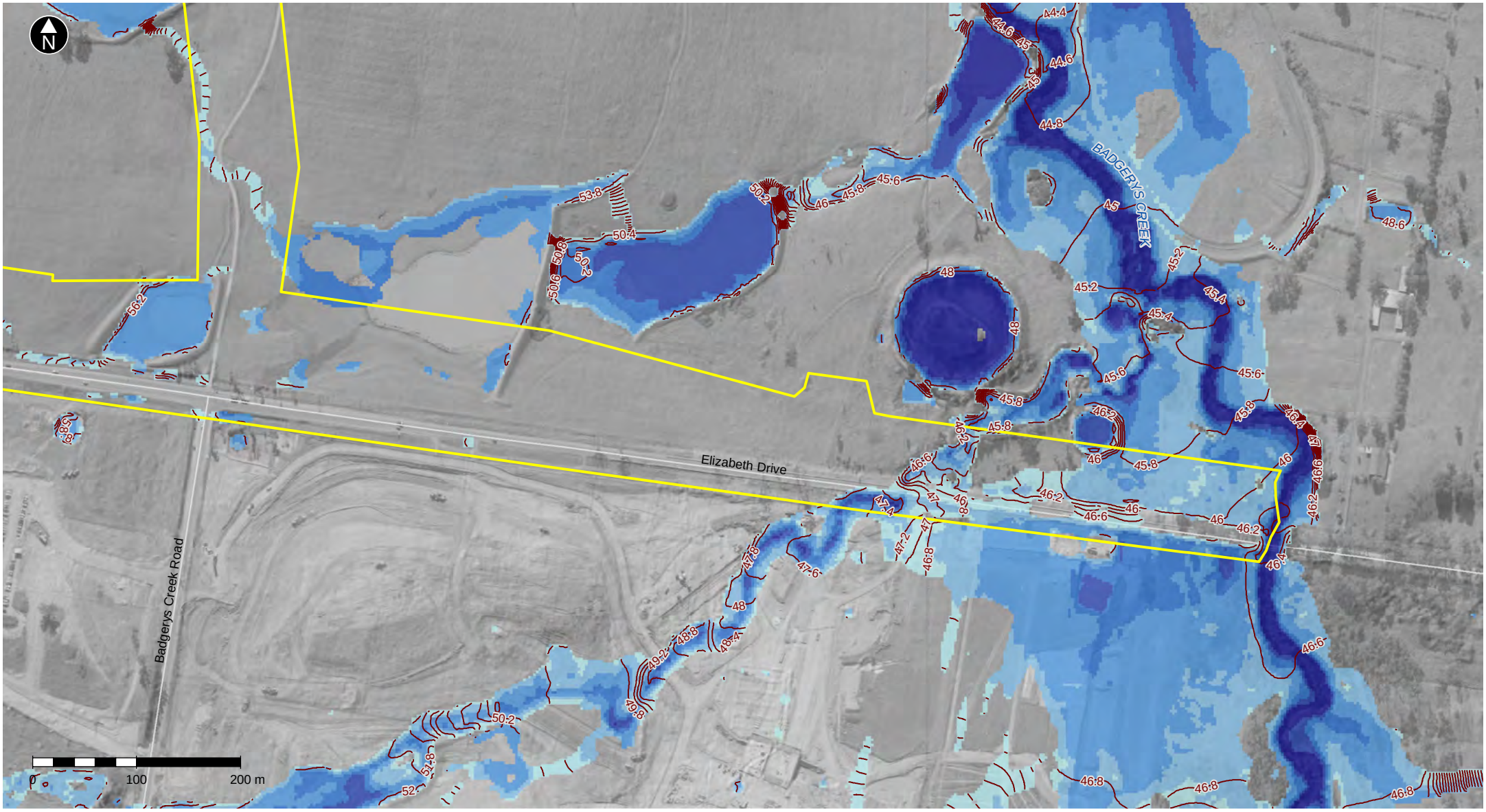


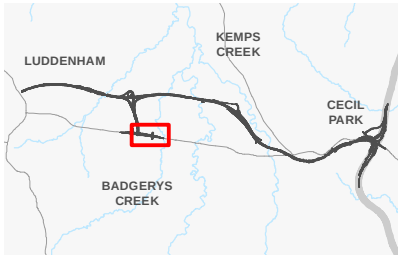
The amended project operational footprint

0.2m Flood Height Contour (m AHD)

Flood Depth (m)

- < 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- > 2.0

**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



20 Year ARI Flood Level & Depth - Existing Conditions - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

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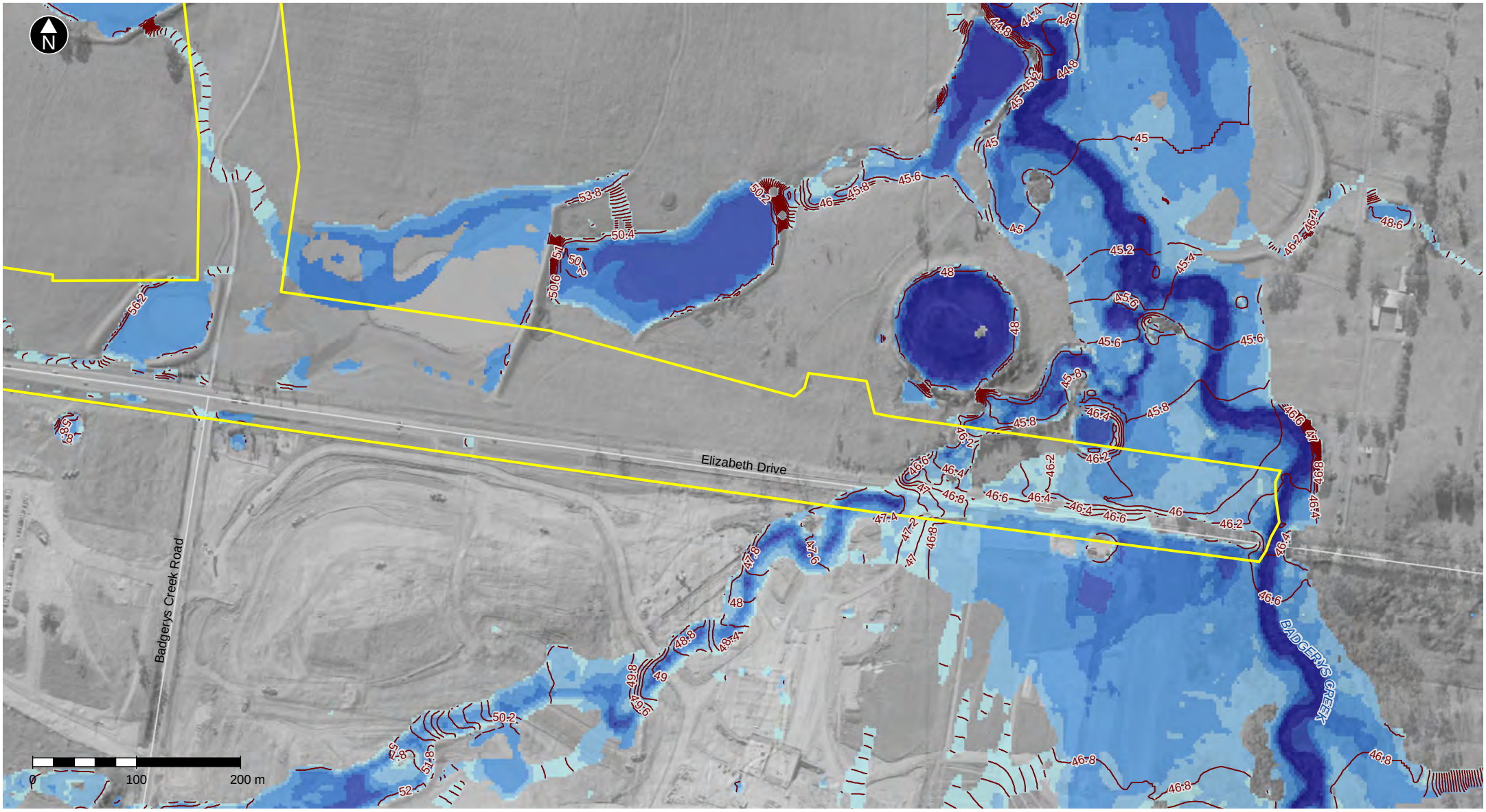


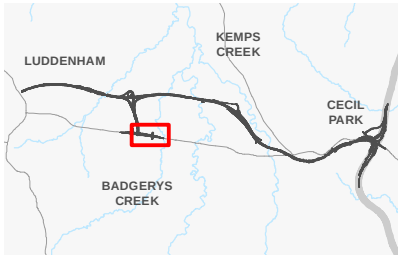
The amended project operational footprint

0.2m Flood Height Contour (m AHD)

Flood Depth (m)

- < 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- > 2.0

**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



50 Year ARI Flood Level & Depth - Existing Conditions - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

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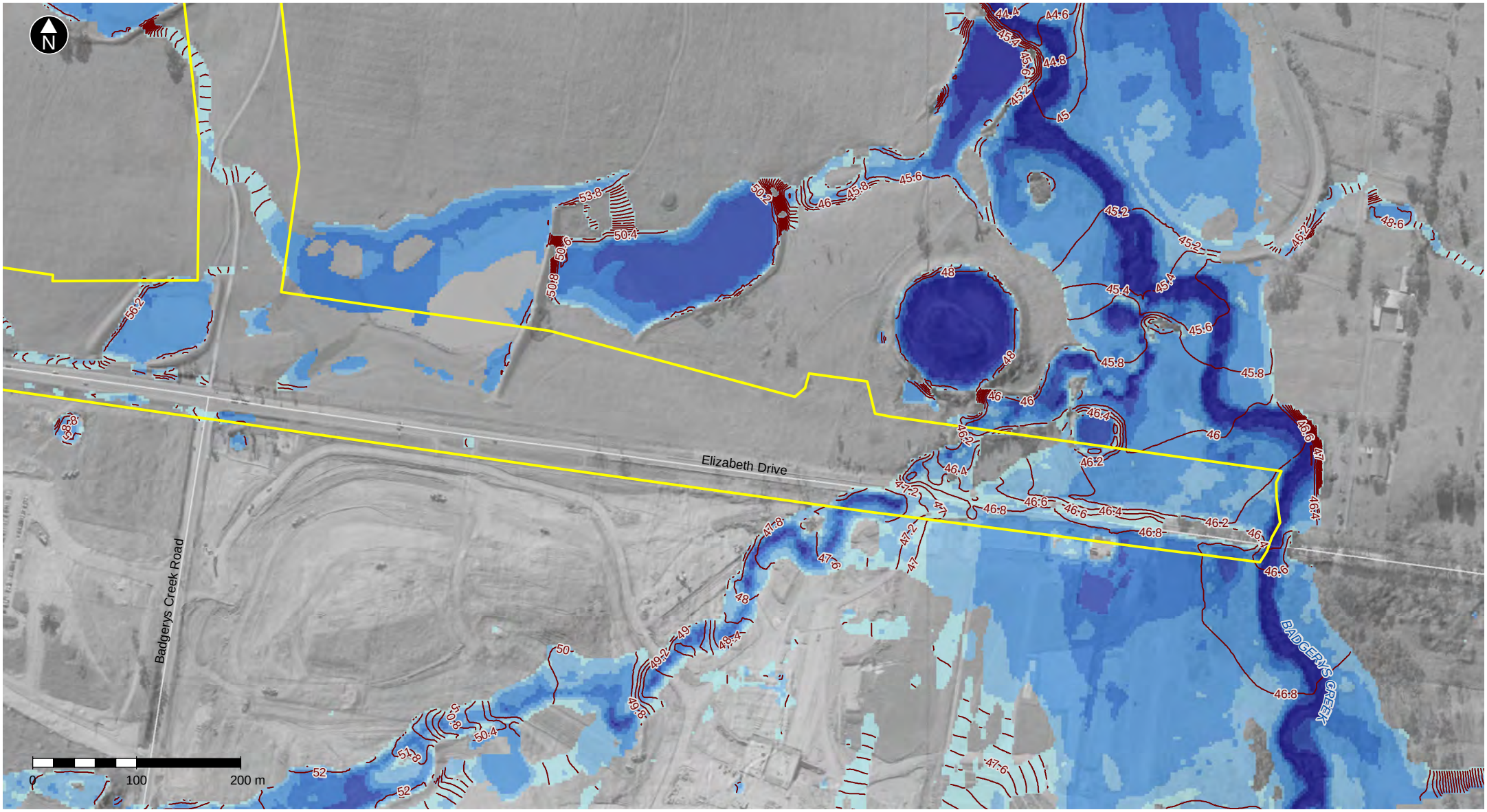


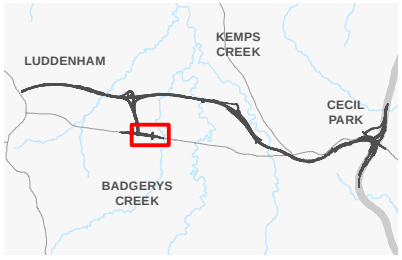
The amended project operational footprint

0.2m Flood Height Contour (m AHD)

Flood Depth (m)

- < 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- > 2.0

**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



100 Year ARI Flood Level & Depth - Existing Conditions - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

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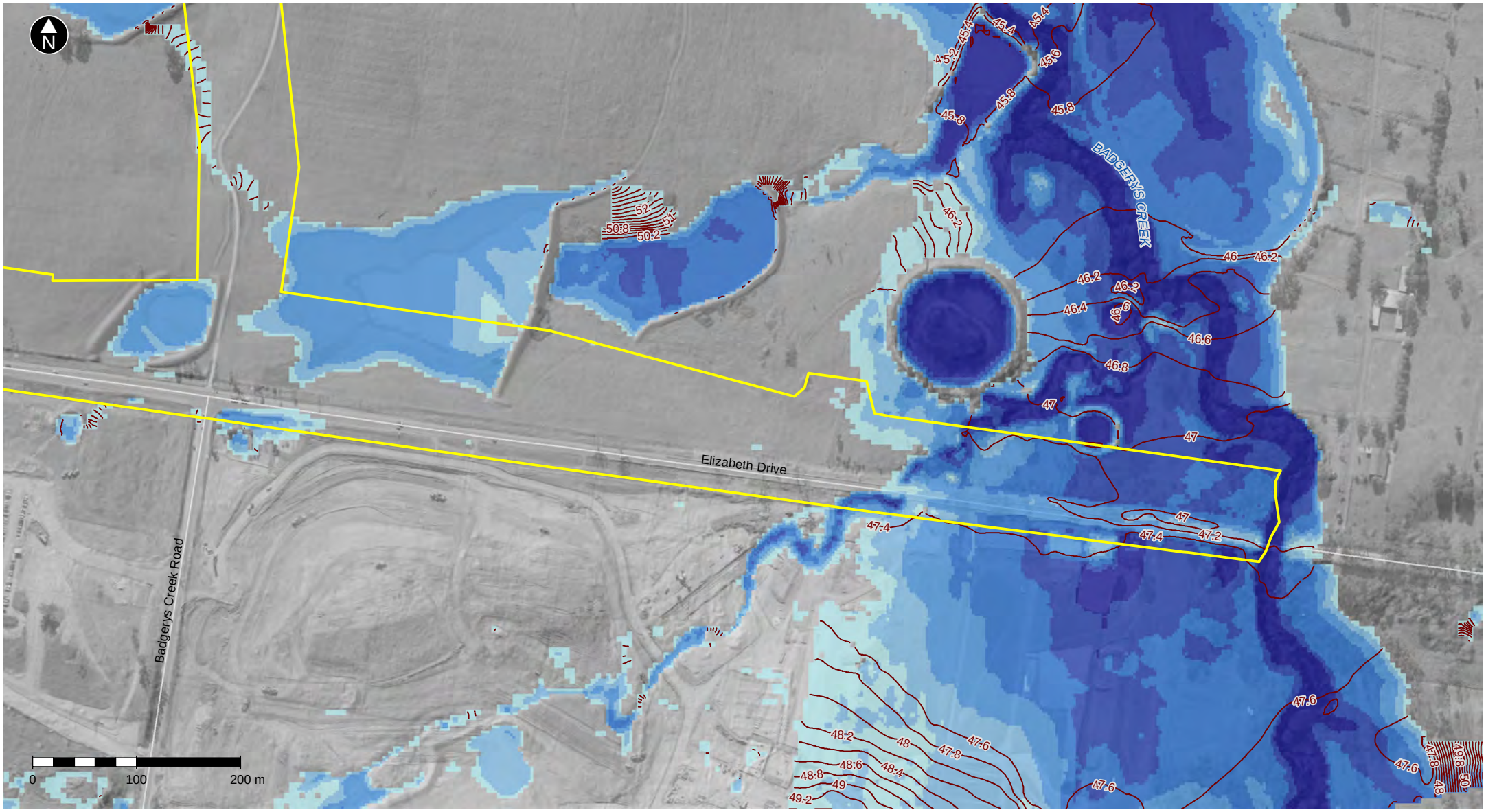


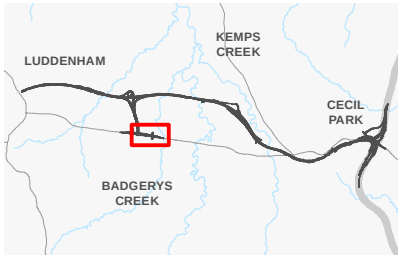
The amended project operational footprint

0.2m Flood Height Contour (m AHD)

Flood Depth (m)

- < 0.2
- 0.2 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- > 2.0

**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



PMF Flood Level & Depth - Existing Conditions - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

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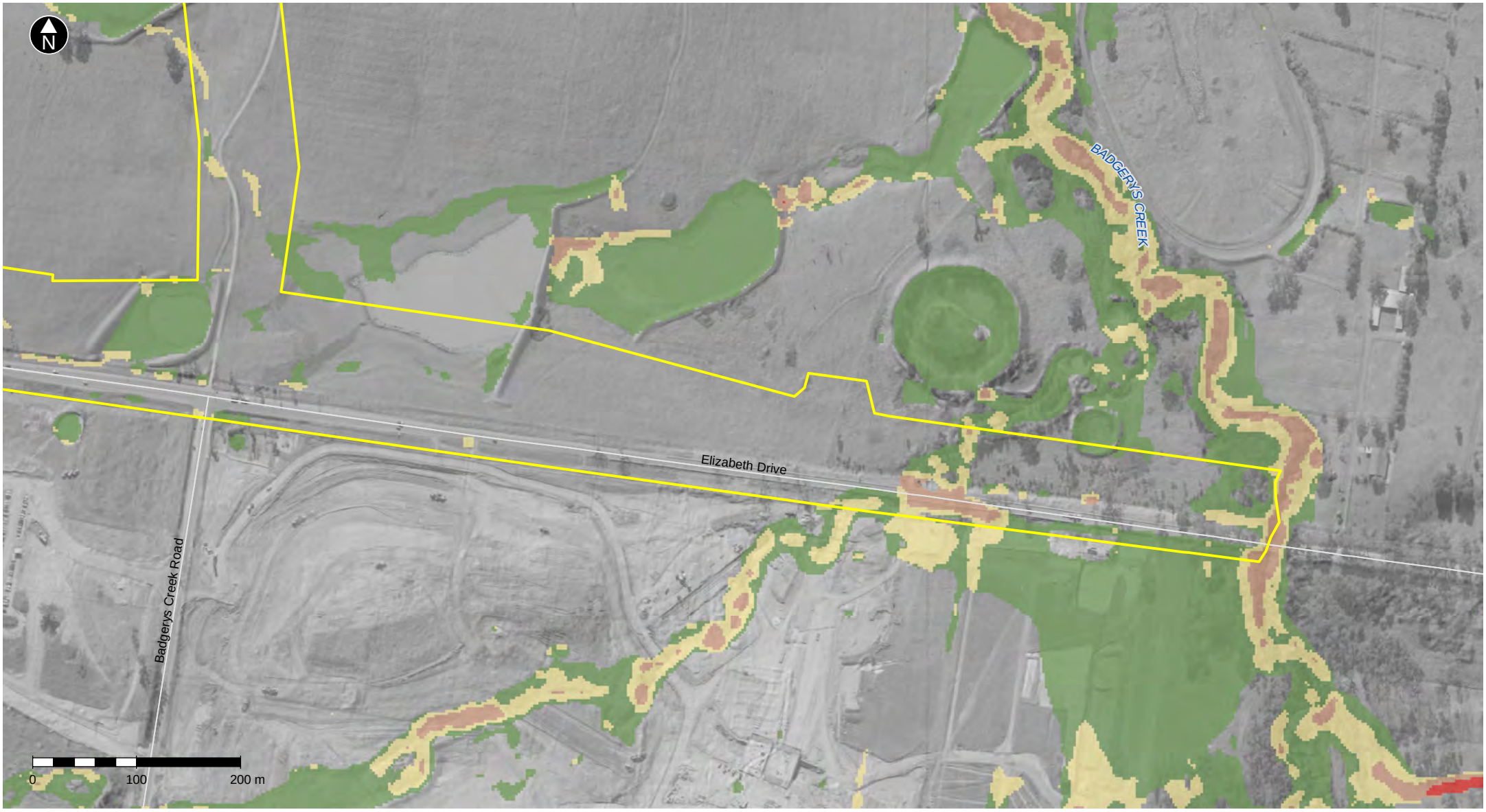
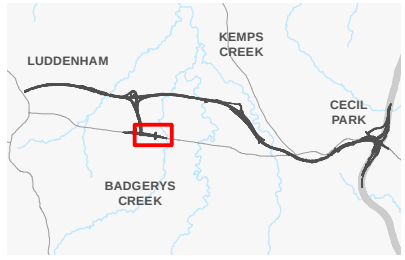


The amended project operational footprint

Flood Velocity (ms^{-1})

- < 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- > 2.0

**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



5 Year ARI Flood Velocity - Existing Conditions - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

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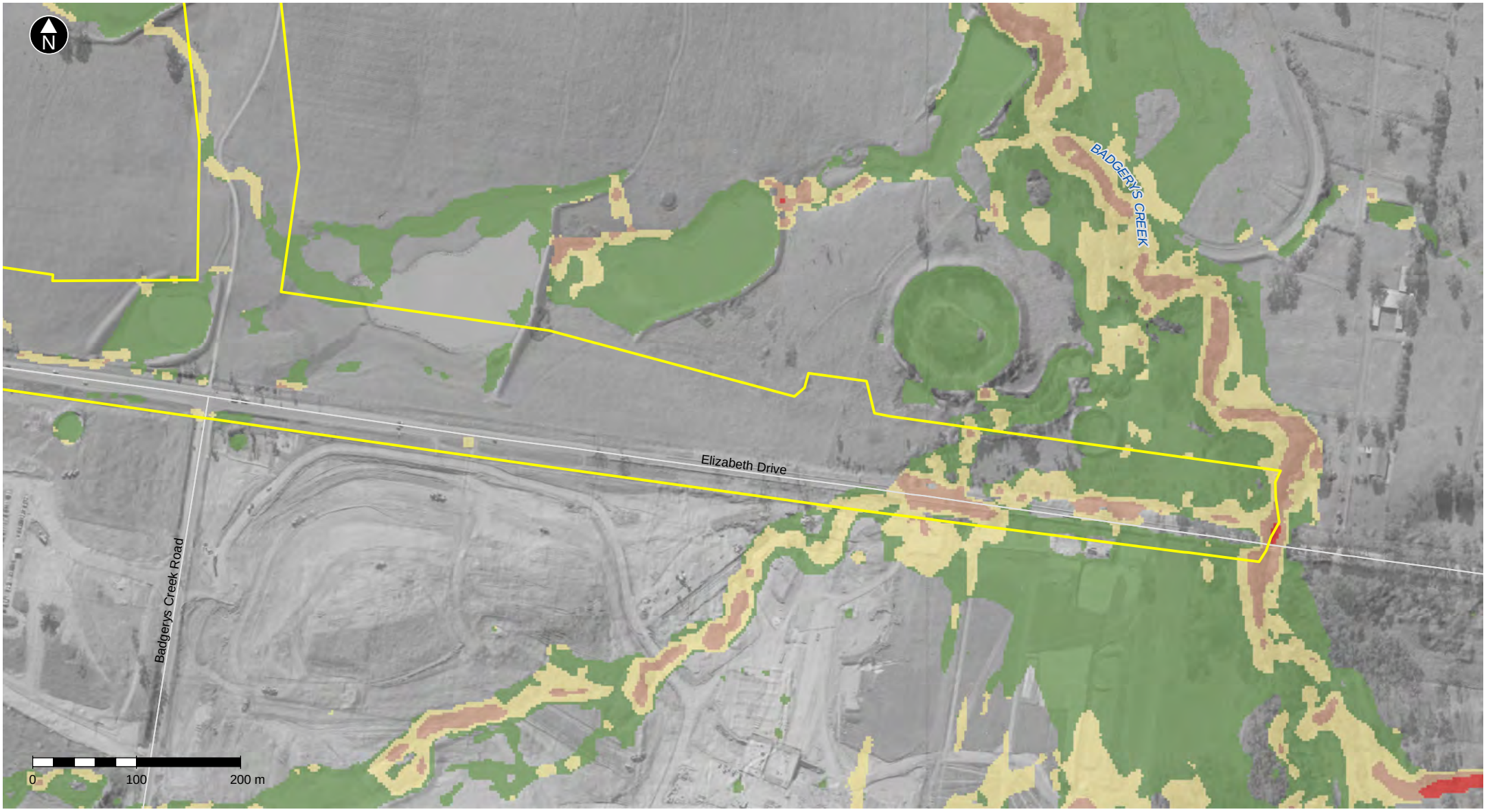
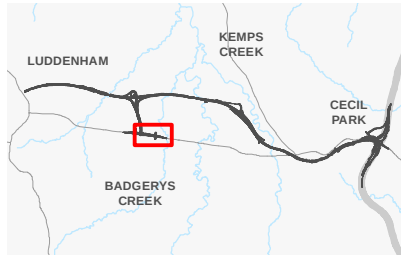


The amended project operational footprint

Flood Velocity (ms^{-1})

- < 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- > 2.0

**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



20 Year ARI Flood Velocity - Existing Conditions - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

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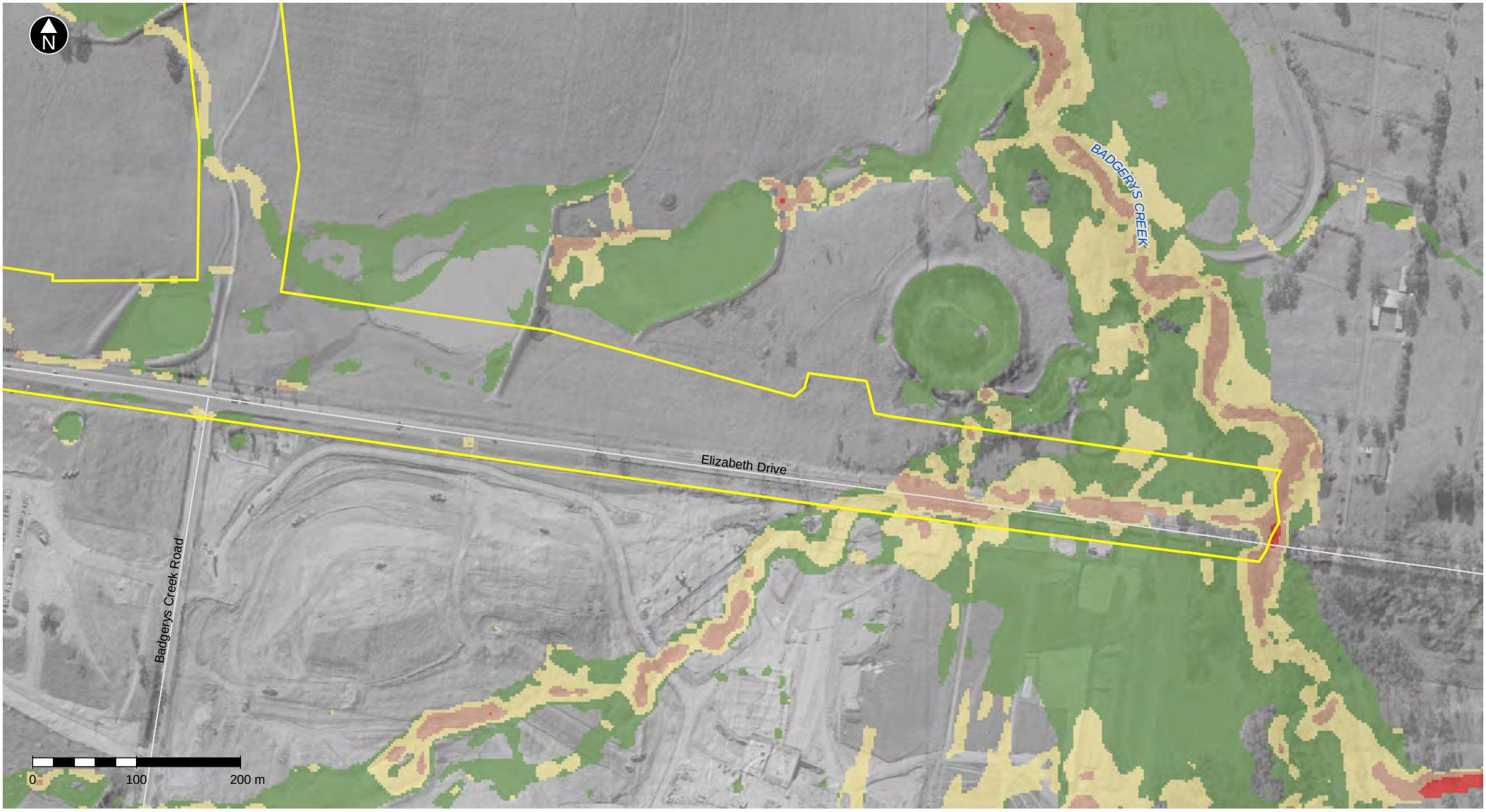
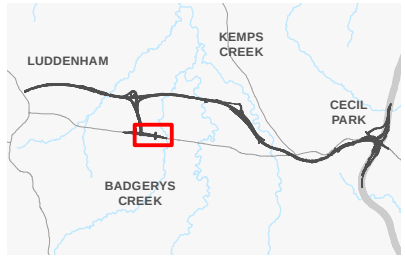


The amended project operational footprint

Flood Velocity (ms^{-1})

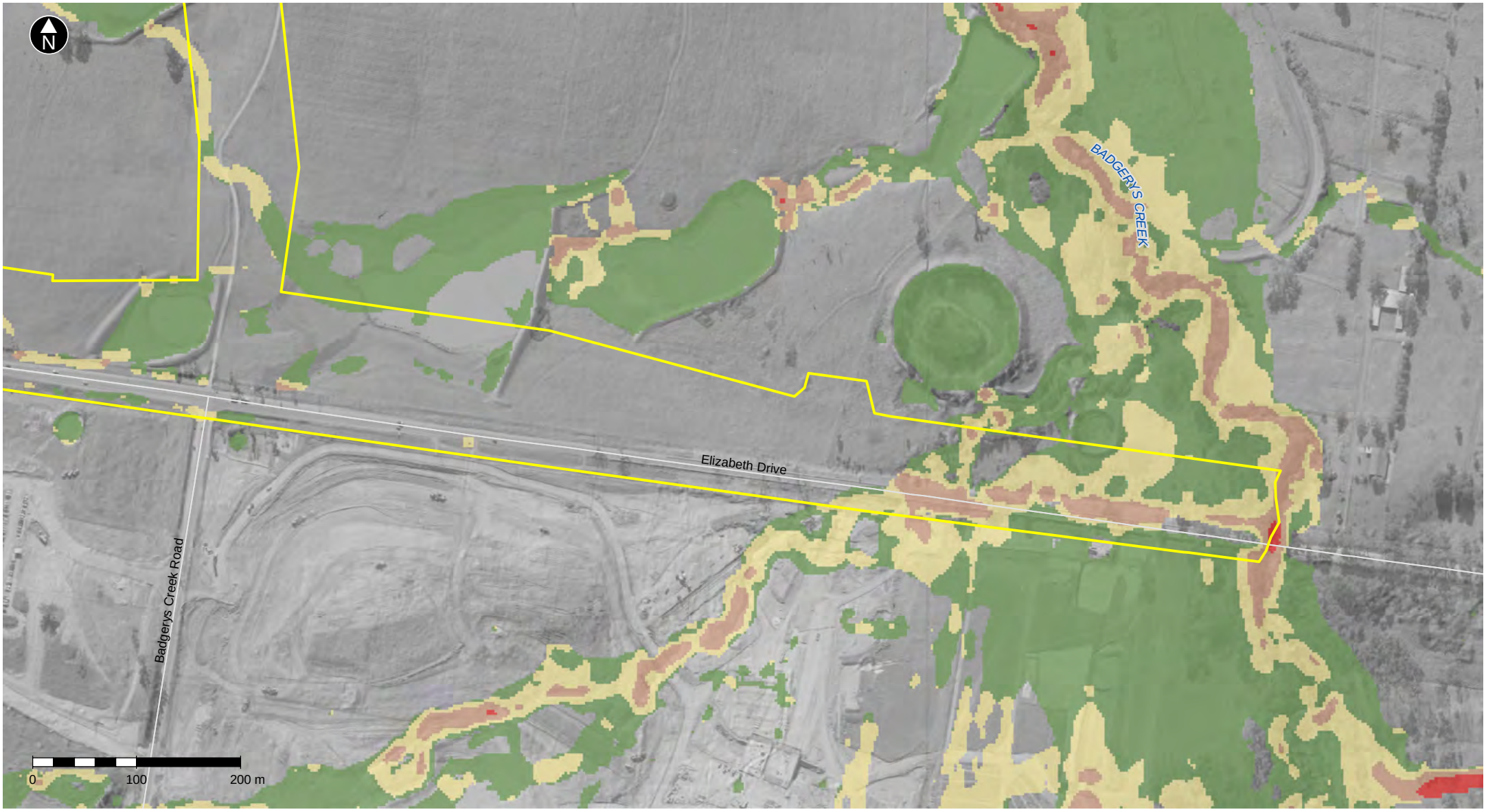
- < 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- > 2.0

**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



50 Year ARI Flood Velocity - Existing Conditions - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

Date: 17/04/2020 Path: M:\GIS\MXDs\Figures\Technical_reports\Flood_80pcDesign\ElizabethDrive\ExistingConditions\JAJV_ElizabethDr_008_Ex50yrFloodVelocity_A4L_v1.mxd
Created by : EM | QA by : RB

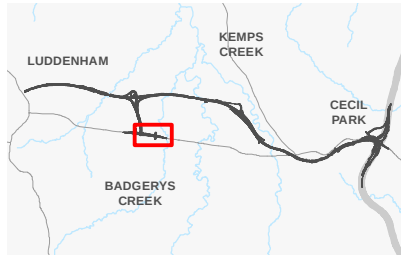


The amended project operational footprint

Flood Velocity (ms^{-1})

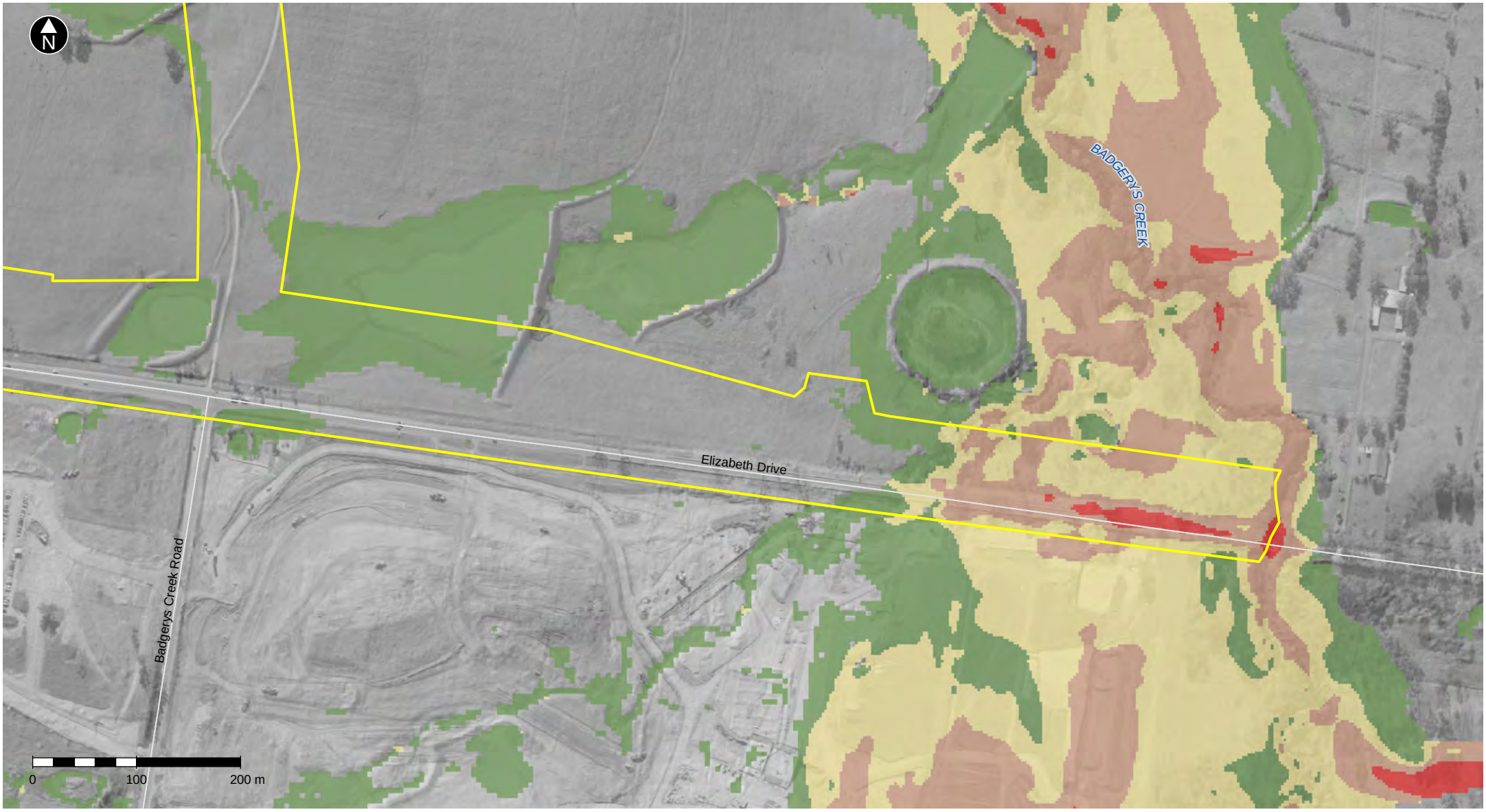
- < 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- > 2.0

**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



100 Year ARI Flood Velocity - Existing Conditions - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

Date: 17/04/2020 Path: M:\GIS\MXDs\Figures\Technical_reports\Flood_80pcDesign\ElizabethDrive\ExistingConditions\JAJV_ElizabethDr_009_Ex100yrFloodVelocity_A4L_v1.mxd
Created by : EM | QA by : RB

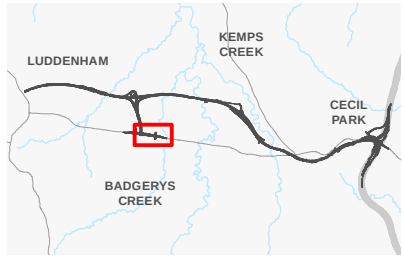


The amended project operational footprint

Flood Velocity (ms^{-1})

- < 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- > 2.0

**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*

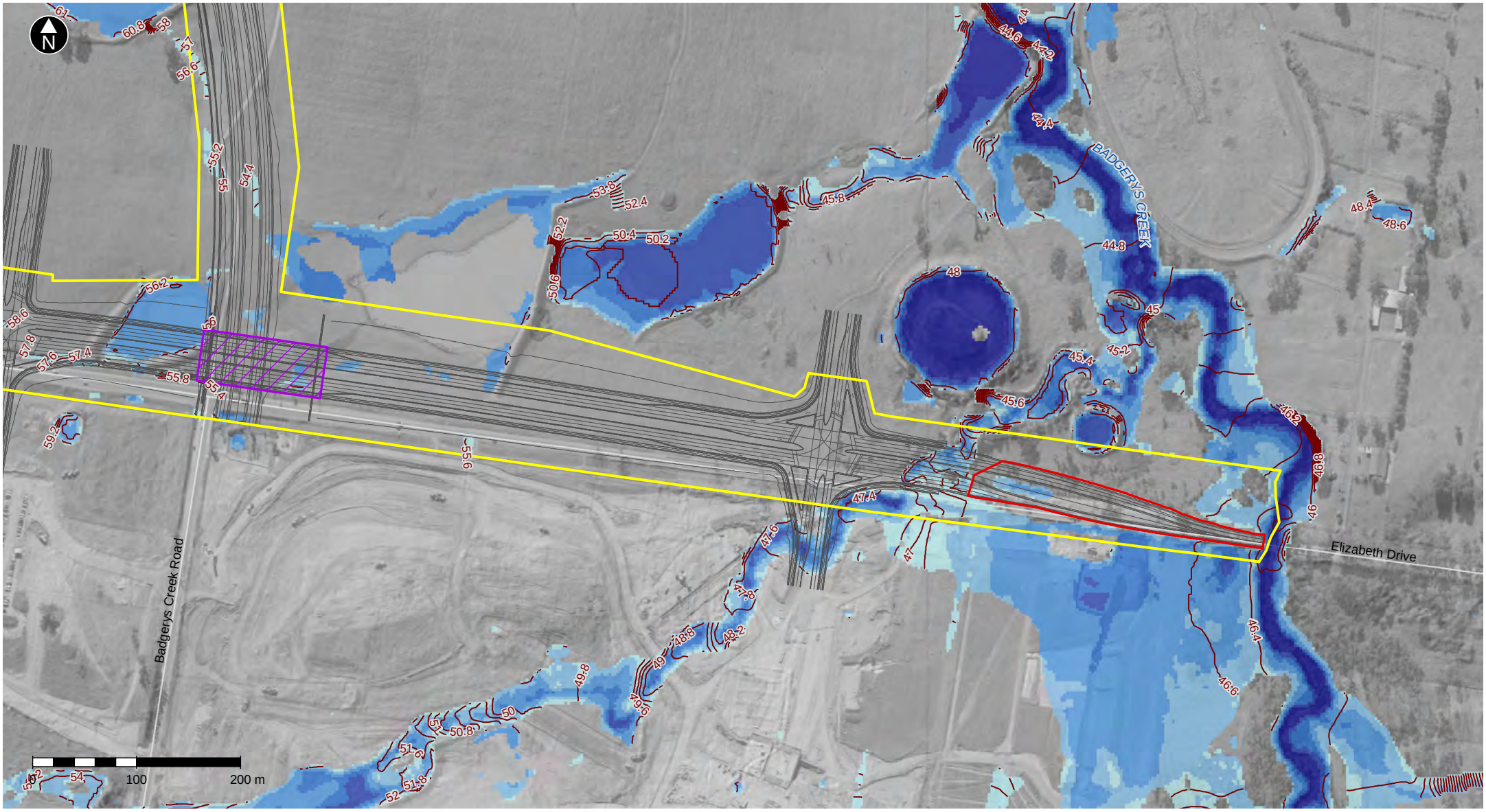


PMF Flood Velocity - Existing Conditions - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

Date: 17/04/2020 Path: M:\GIS\MXDs\Figures\Technical_reports\Flood_80pcDesign\ElizabethDrive\ExistingConditions\JAJV_ElizabethDr_010_ExPMF_FloodVelocity_A4L_v1.mxd

Created by : EM | QA by : RB

Annexure B Flood mapping at Elizabeth Drive at Badgerys Creek around Western Sydney International Airport – Amended project



The amended project

The amended project operational footprint

Bridge

0.2m Flood Height Contour (m AHD)

Flood Depth (m)

< 0.2

0.2 - 0.5

0.5 - 1.0

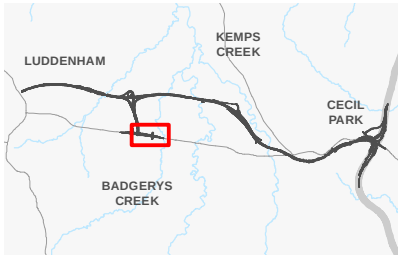
1.0 - 1.5

1.5 - 2.0

> 2.0

Extent of the amended project modelled in TUFLOW

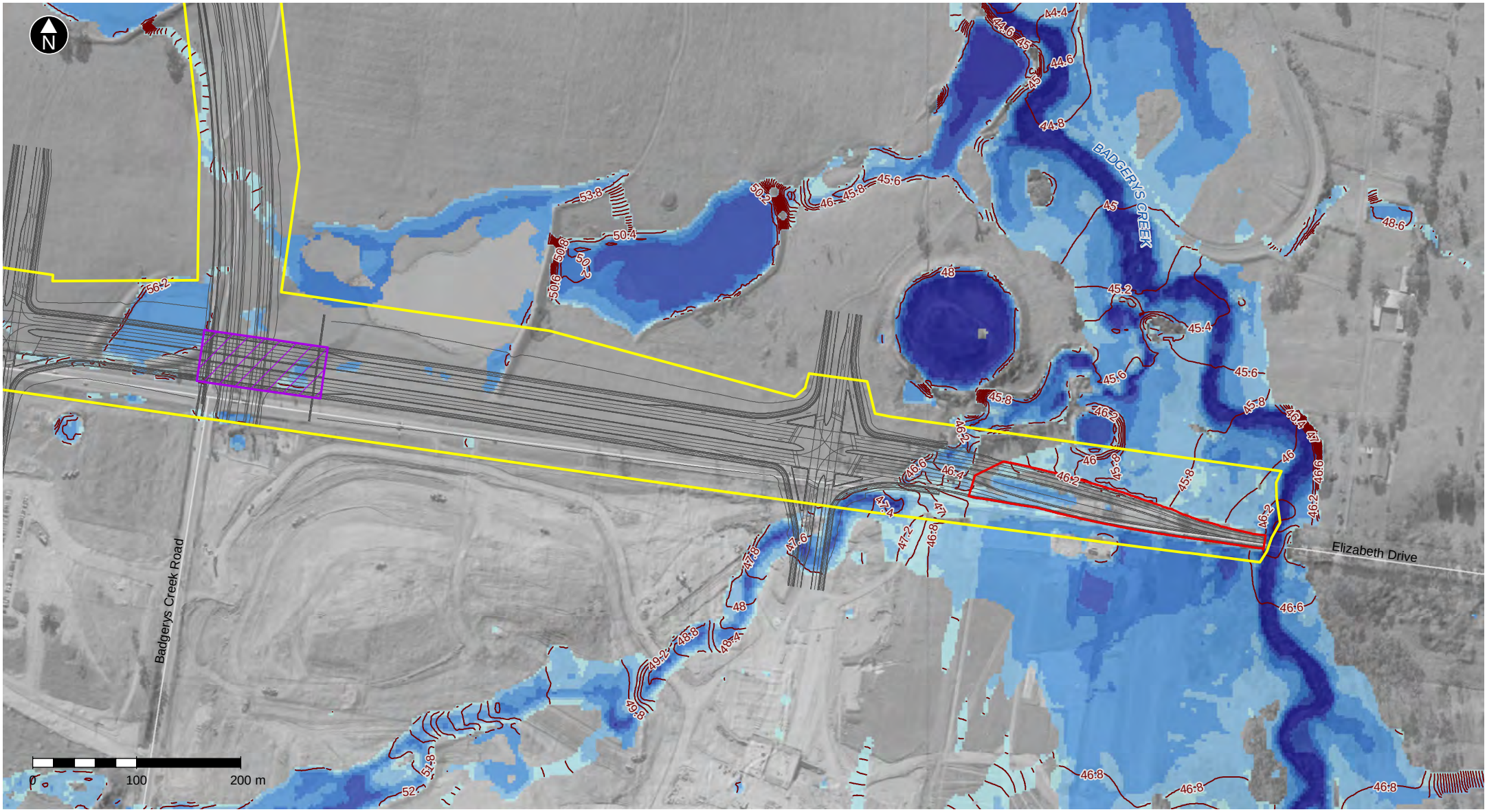
**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



5 Year ARI Flood Level & Depth - Amended project - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

Date: 17/04/2020 Path: M:\GIS\MXDs\Figures\Technical_reports\Flood_80pcDesign\ElizabethDrive\Developed Conditions\JAJV_ElizabethDr_001_5yrFloodLDepth_A4L_v2.mxd

Created by : EM | QA by : RB



The amended project

The amended project operational footprint

Bridge

0.2m Flood Height Contour (m AHD)

Flood Depth (m)

< 0.2

0.2 - 0.5

0.5 - 1.0

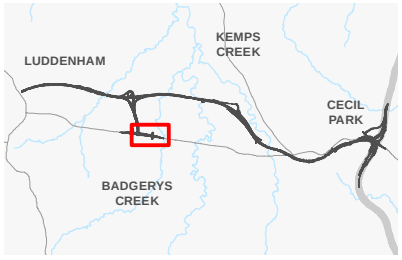
1.0 - 1.5

1.5 - 2.0

> 2.0

Extent of the amended project modelled in TUFLOW

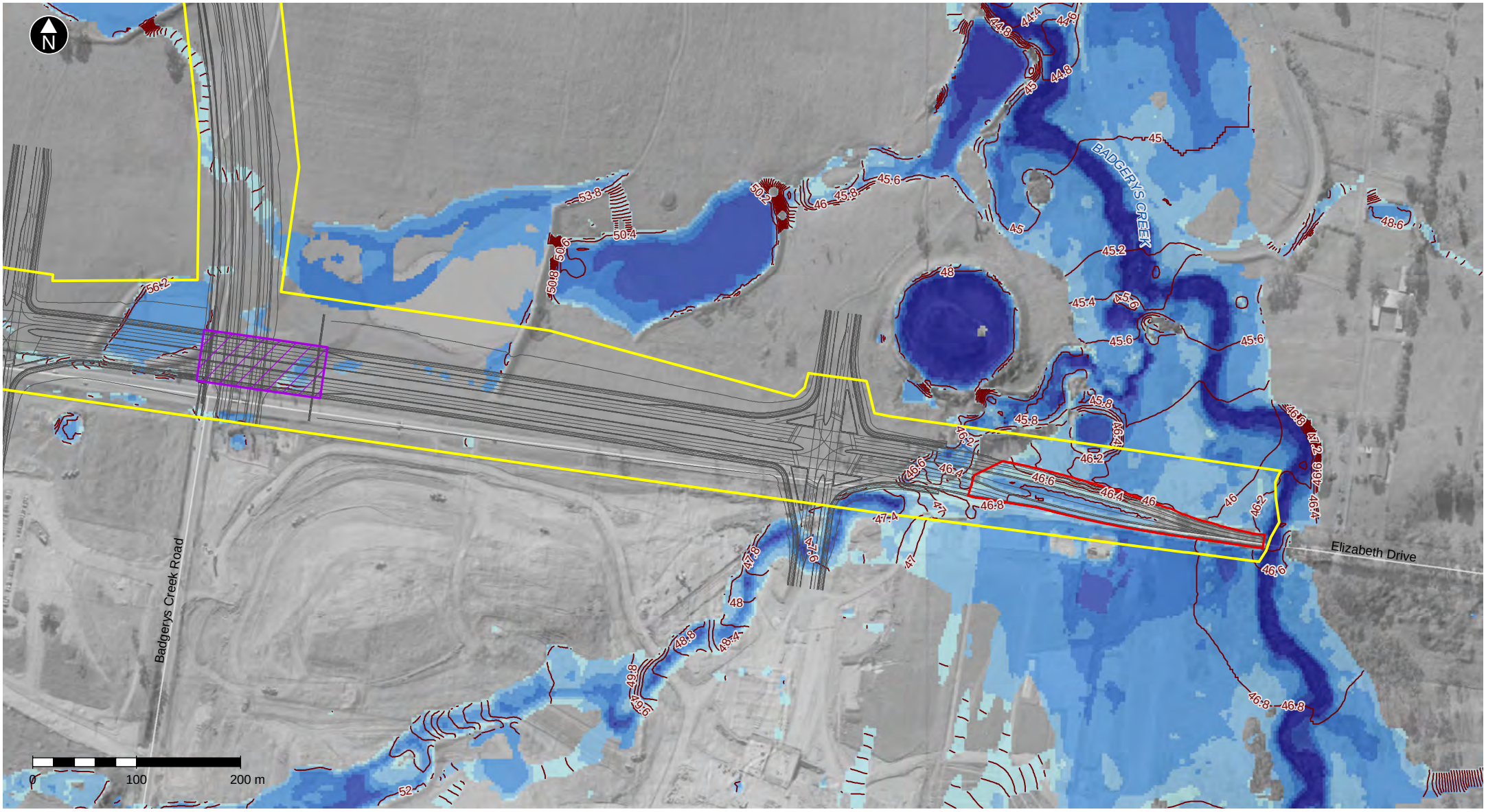
**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



20 Year ARI Flood Level & Depth - Amended project - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

Date: 17/04/2020 Path: M:\GIS\MXDs\Figures\Technical_reports\Flood_80pcDesign\ElizabethDrive\Developed Conditions\JAJV_ElizabethDr_002_20yrFloodLDepth_A4L_v2.mxd

Created by : EM | QA by : RB



The amended project

The amended project operational footprint

Bridge

0.2m Flood Height Contour (m AHD)

Flood Depth (m)

< 0.2

0.2 - 0.5

0.5 - 1.0

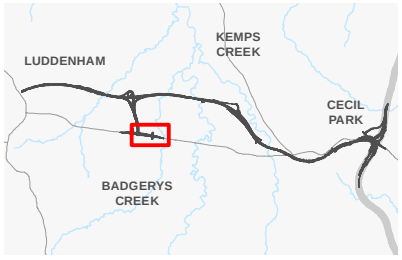
1.0 - 1.5

1.5 - 2.0

> 2.0

Extent of the amended project modelled in TUFLOW

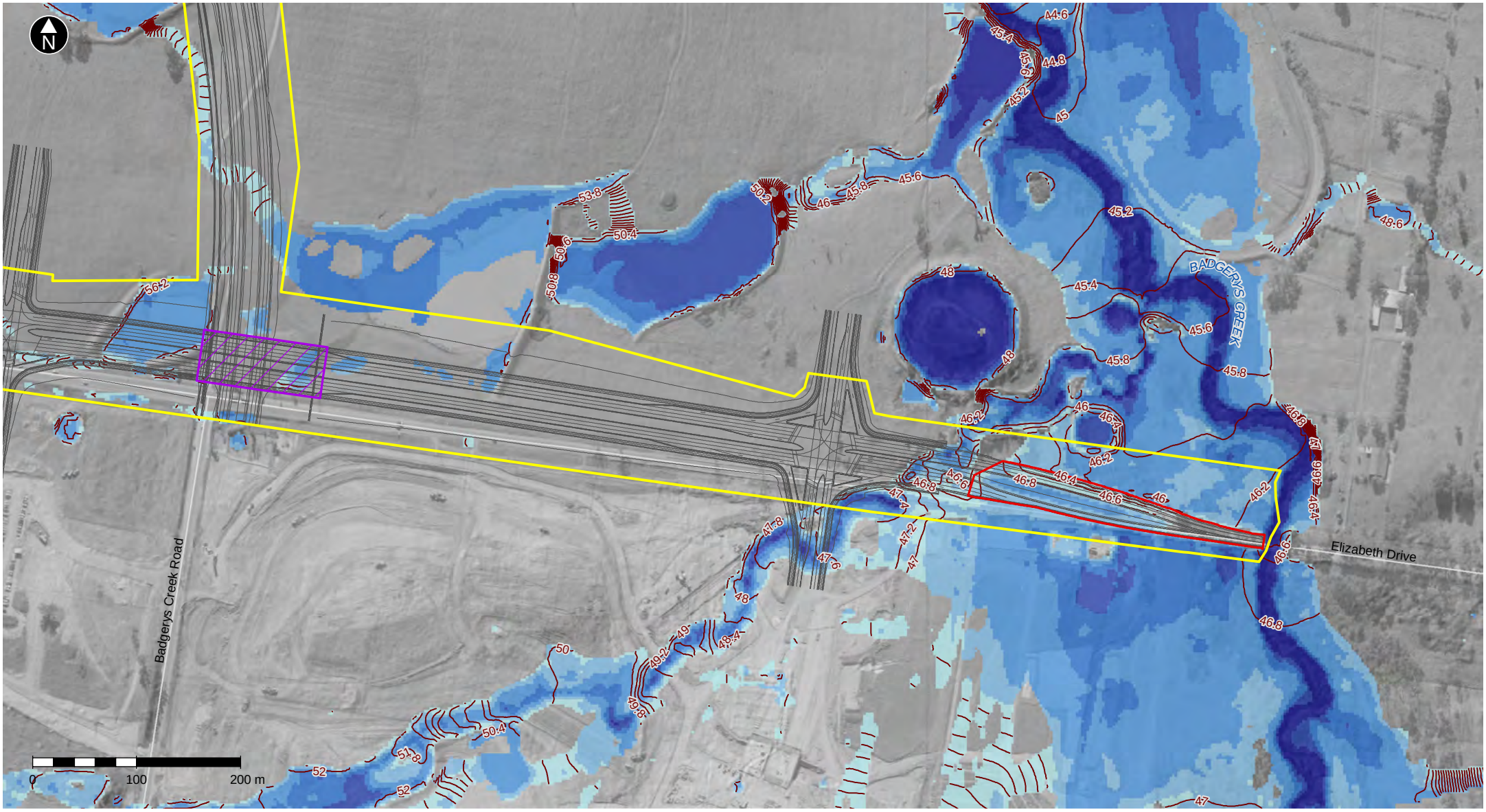
**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



50 Year ARI Flood Level & Depth - Amended project - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

Date: 17/04/2020 Path: M:\GIS\MXDs\Figures\Technical_reports\Flood_80pcDesign\ElizabethDrive\Developed Conditions\JAJV_ElizabethDr_003_50yrFloodLDepth_A4L_v2.mxd

Created by : EM | QA by : RB



The amended project

The amended project operational footprint

Bridge

0.2m Flood Height Contour (m AHD)

Flood Depth (m)

< 0.2

0.2 - 0.5

0.5 - 1.0

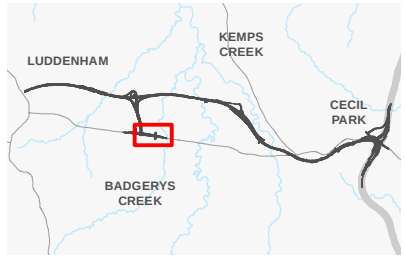
1.0 - 1.5

1.5 - 2.0

> 2.0

Extent of the amended project modelled in TUFLOW

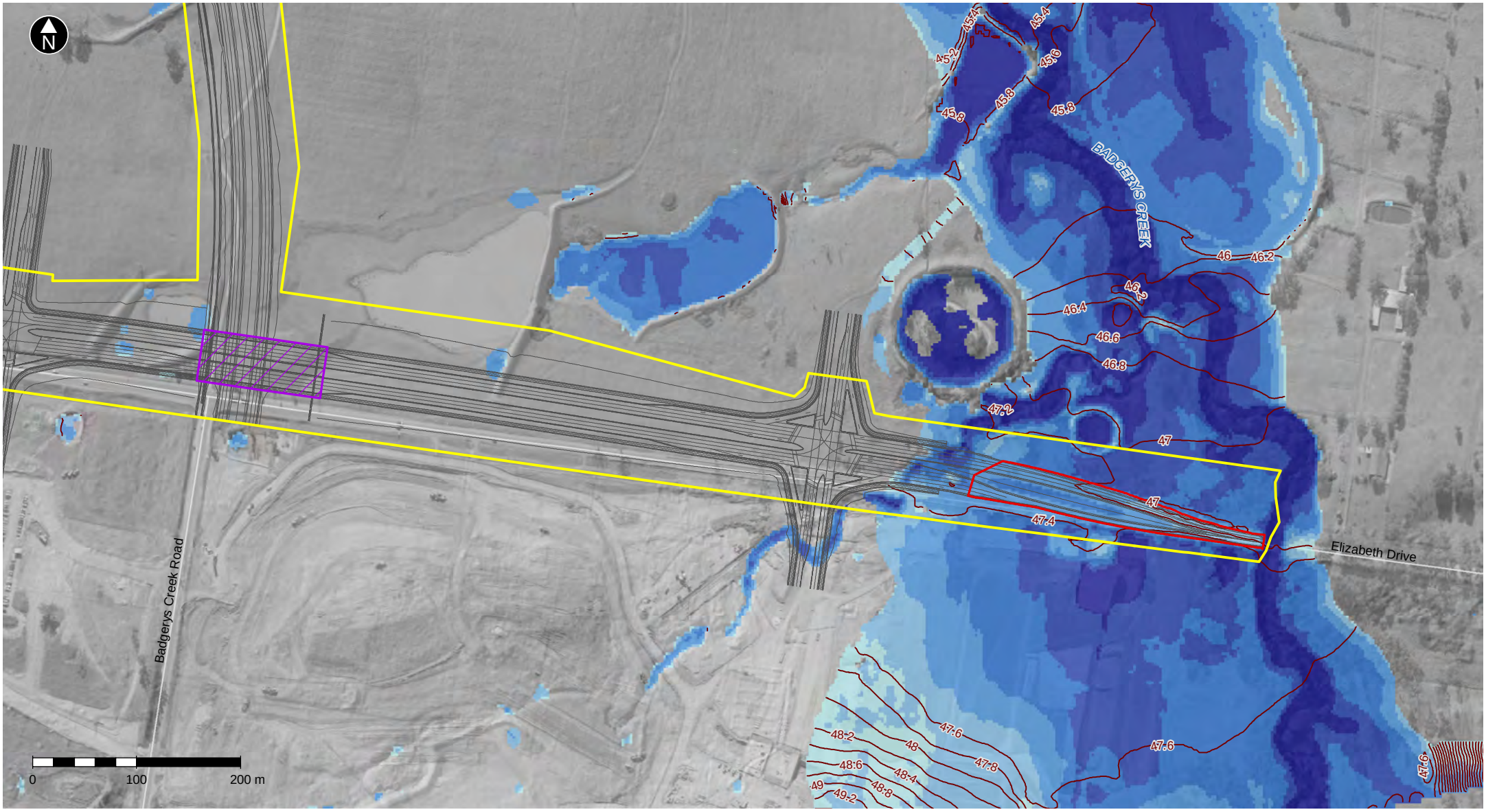
**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



100 Year ARI Flood Level & Depth - Amended project - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

Date: 17/04/2020 Path: M:\GIS\MXDs\Figures\Technical_reports\Flood_80pcDesign\ElizabethDrive\Developed Conditions\JAJV_ElizabethDr_004_100yrFloodLDepth_A4L_v2.mxd

Created by : EM | QA by : RB



The amended project

The amended project operational footprint

Bridge

0.2m Flood Height Contour (m AHD)

Flood Depth (m)

< 0.2

0.2 - 0.5

0.5 - 1.0

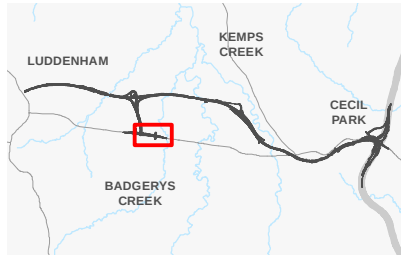
1.0 - 1.5

1.5 - 2.0

> 2.0

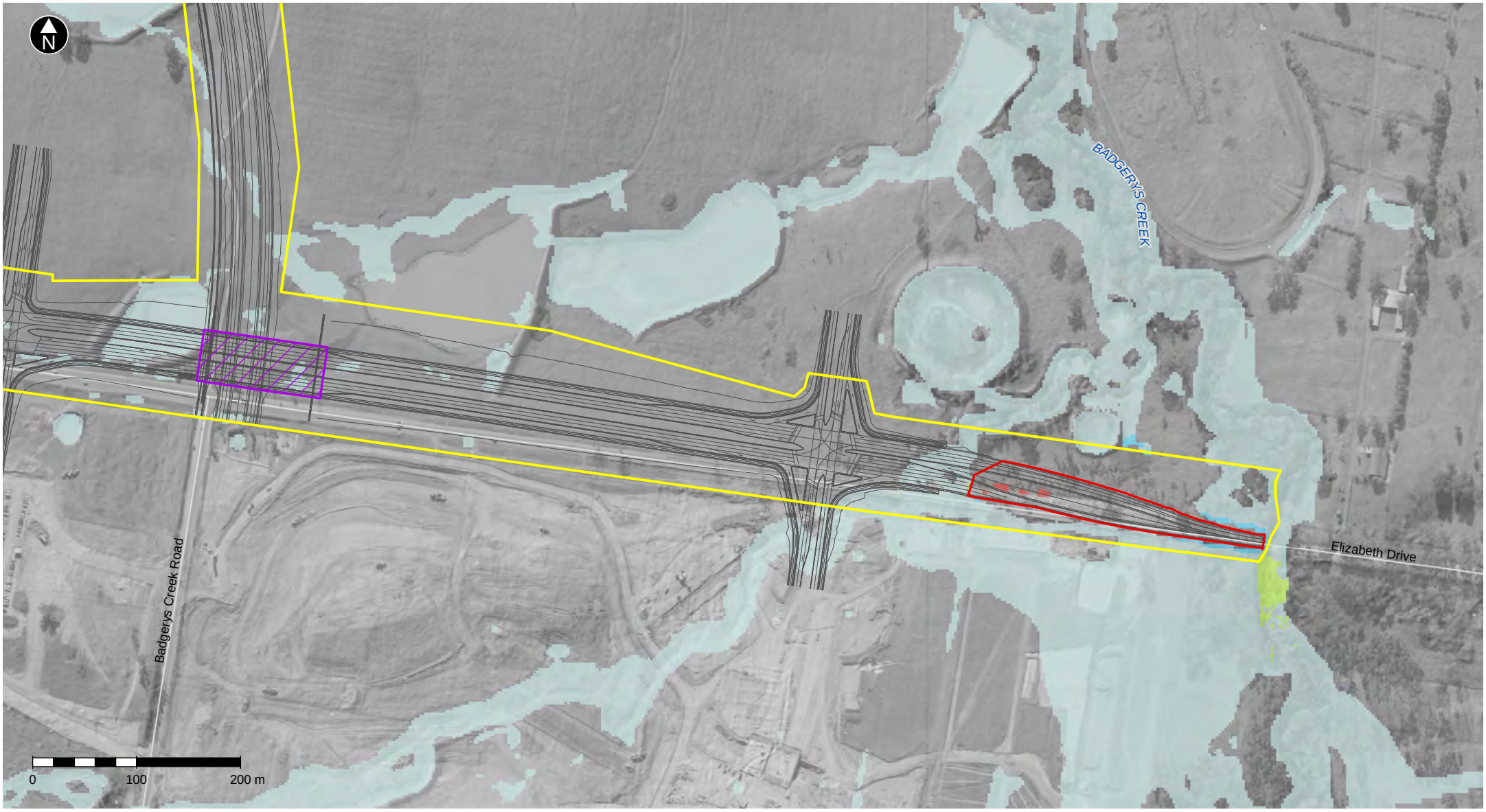
Extent of the amended project modelled in TUFLOW

**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



PMF Flood Level & Depth - Amended project - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

Date: 17/04/2020 Path: M:\GIS\MXDs\Figures\Technical_reports\Flood_80pcDesign\ElizabethDrive\Developed Conditions\JAJV_ElizabethDr_005_PMF_FloodLDepth_A4L_v2.mxd
Created by : EM | QA by : RB



The amended project

The amended project operational footprint

Bridge

Extent of the amended project modelled in TUFLOW

Peak flood afflux (mm)

< -20

-20 to 20

20 to 40

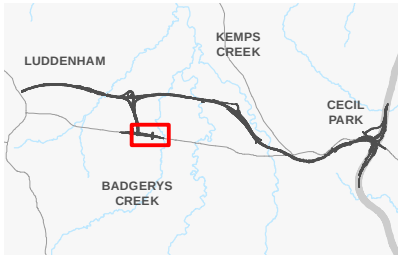
40 to 60

60 to 80

80 to 100

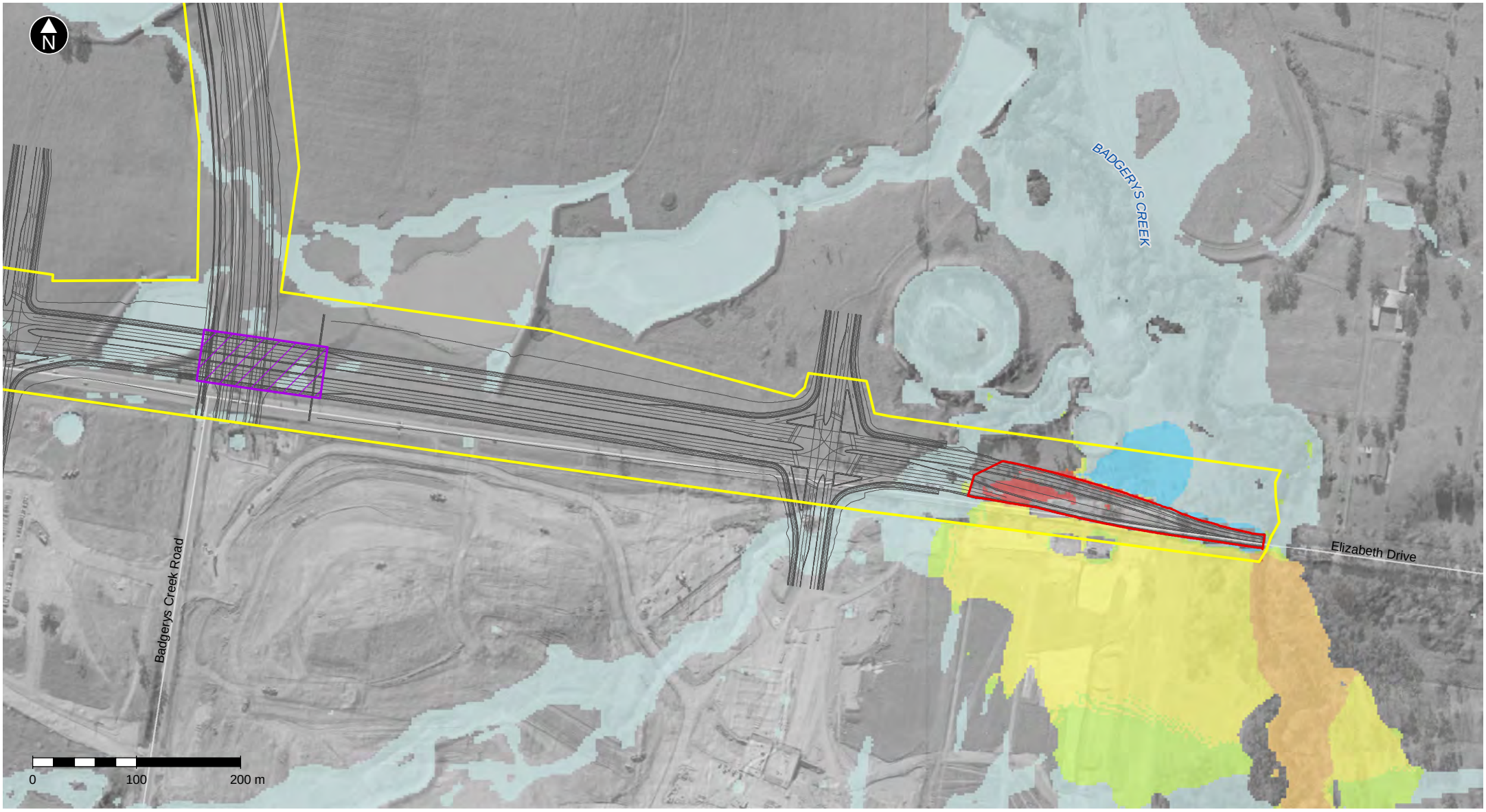
100 >

**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



5 Year ARI Afflux - Amended project - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

Date: 17/04/2020 Path: M:\GIS\MXDs\Figures\Technical_reports\Flood_80pcDesign\ElizabethDrive\Developed Conditions\JAJV_ElizabethDr_006_5yrAfflux_A4L_v2.mxd
Created by : EM | QA by : RB



The amended project

The amended project operational footprint

Bridge

Extent of the amended project modelled in TUFLOW

Peak flood afflux (mm)

< -20

-20 to 20

20 to 40

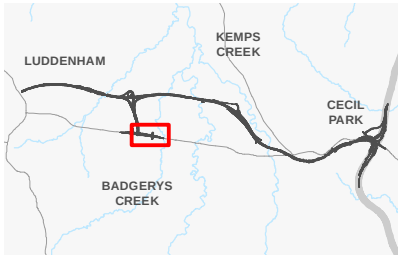
40 to 60

60 to 80

80 to 100

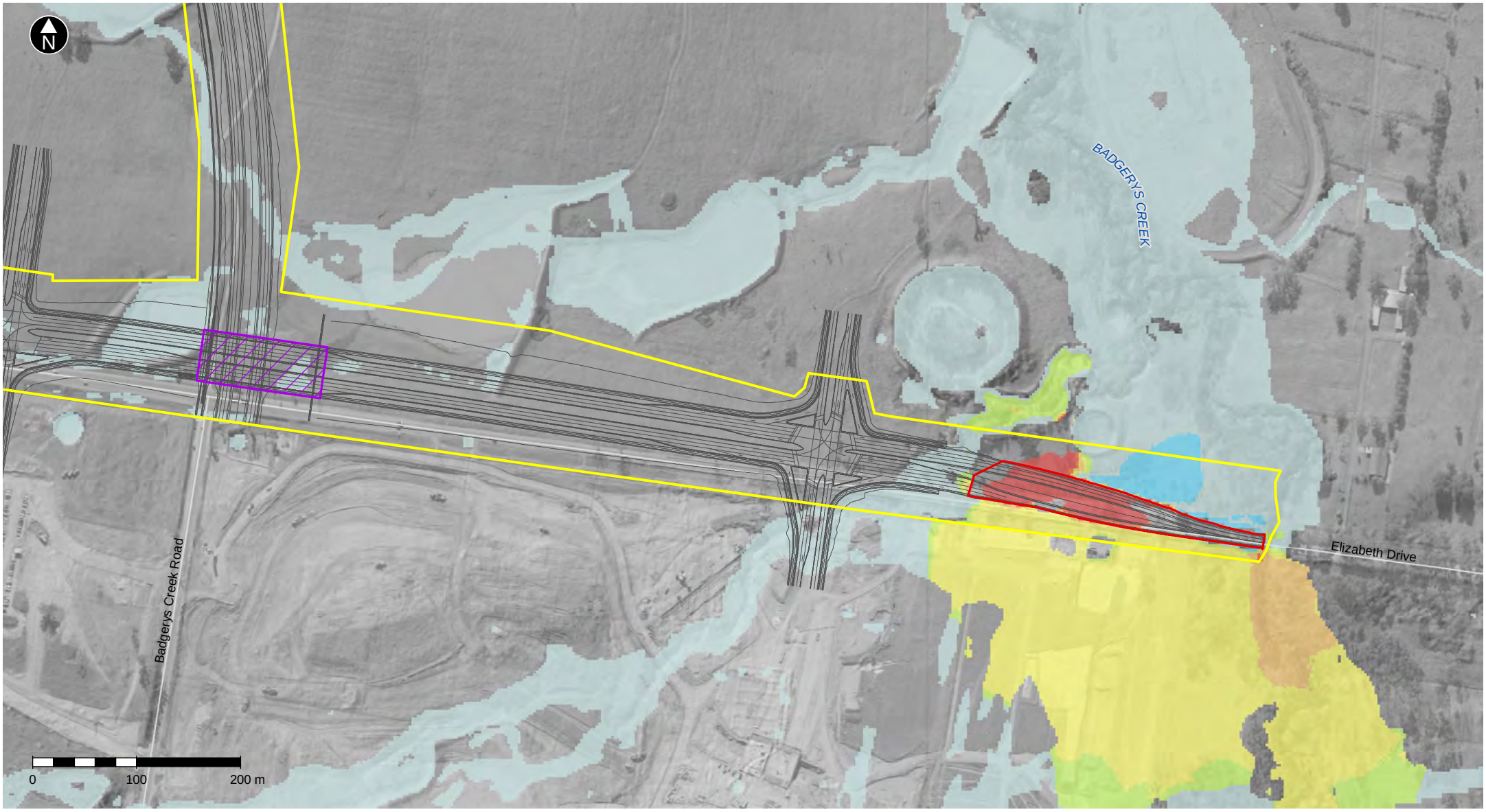
100 >

**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



20 Year ARI Afflux - Amended project - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

Date: 17/04/2020 Path: M:\GIS\MXDs\Figures\Technical_reports\Flood_80pcDesign\ElizabethDrive\Developed Conditions\JAJV_ElizabethDr_007_20yrAfflux_A4L_v2.mxd
Created by : EM | QA by : RB



The amended project

The amended project operational footprint

Bridge

Extent of the amended project modelled in TUFLOW

Peak flood afflux (mm)

< -20

-20 to 20

20 to 40

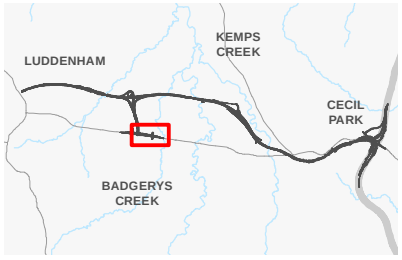
40 to 60

60 to 80

80 to 100

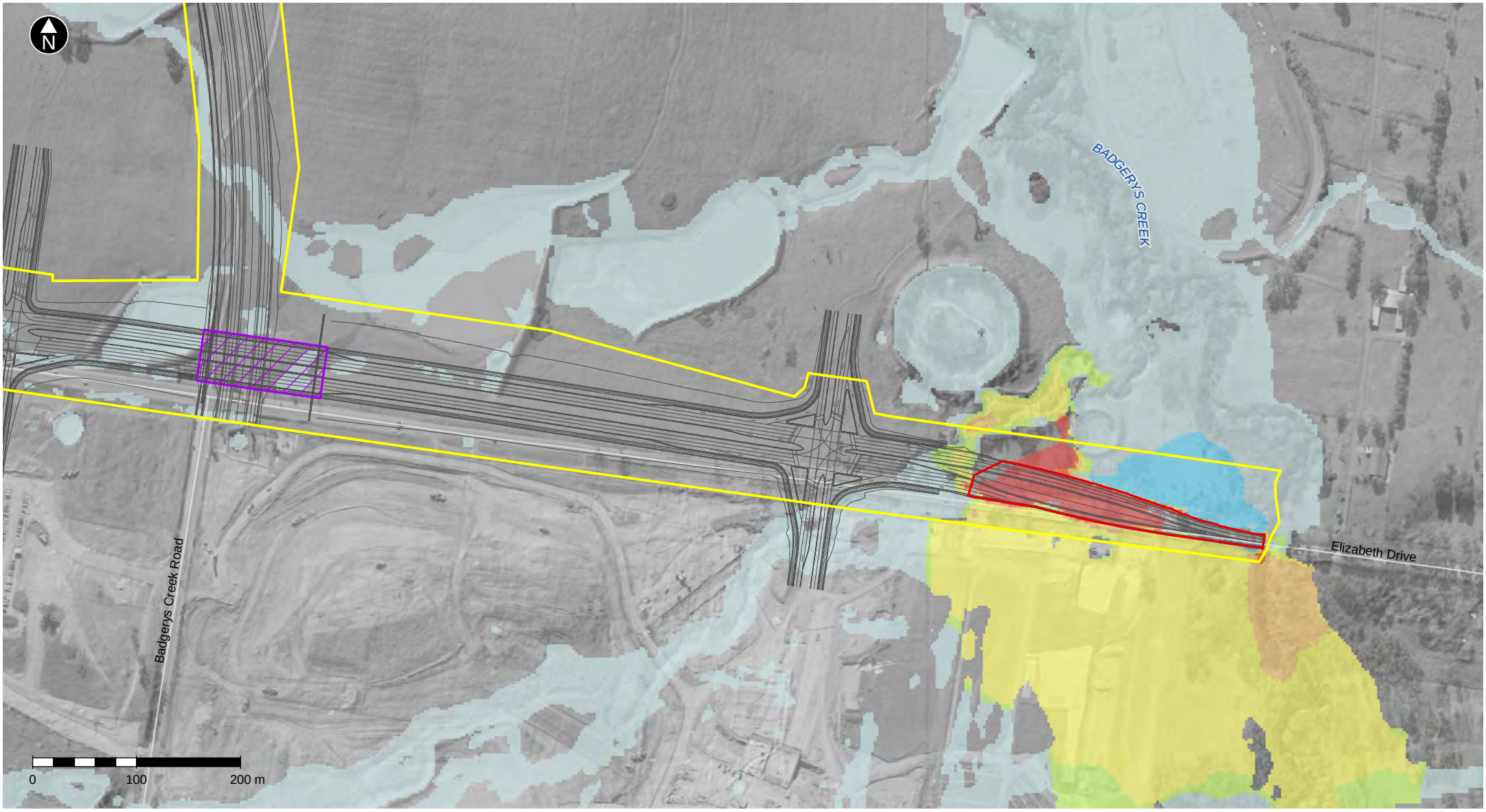
100 >

**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



50 Year ARI Afflux - Amended project - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

Date: 17/04/2020 Path: M:\GIS\MXDs\Figures\Technical_reports\Flood_80pcDesign\ElizabethDrive\Developed Conditions\JAJV_ElizabethDr_008_50yrAfflux_A4L_v2.mxd
Created by : EM | QA by : RB



The amended project

The amended project operational footprint

Bridge

Extent of the amended project modelled in TUFLOW

Peak flood afflux (mm)

< -20

-20 to 20

20 to 40

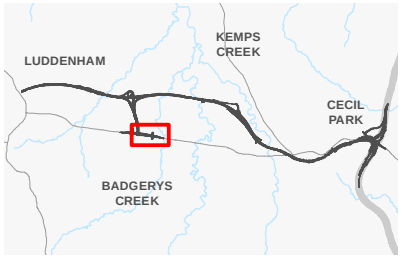
40 to 60

60 to 80

80 to 100

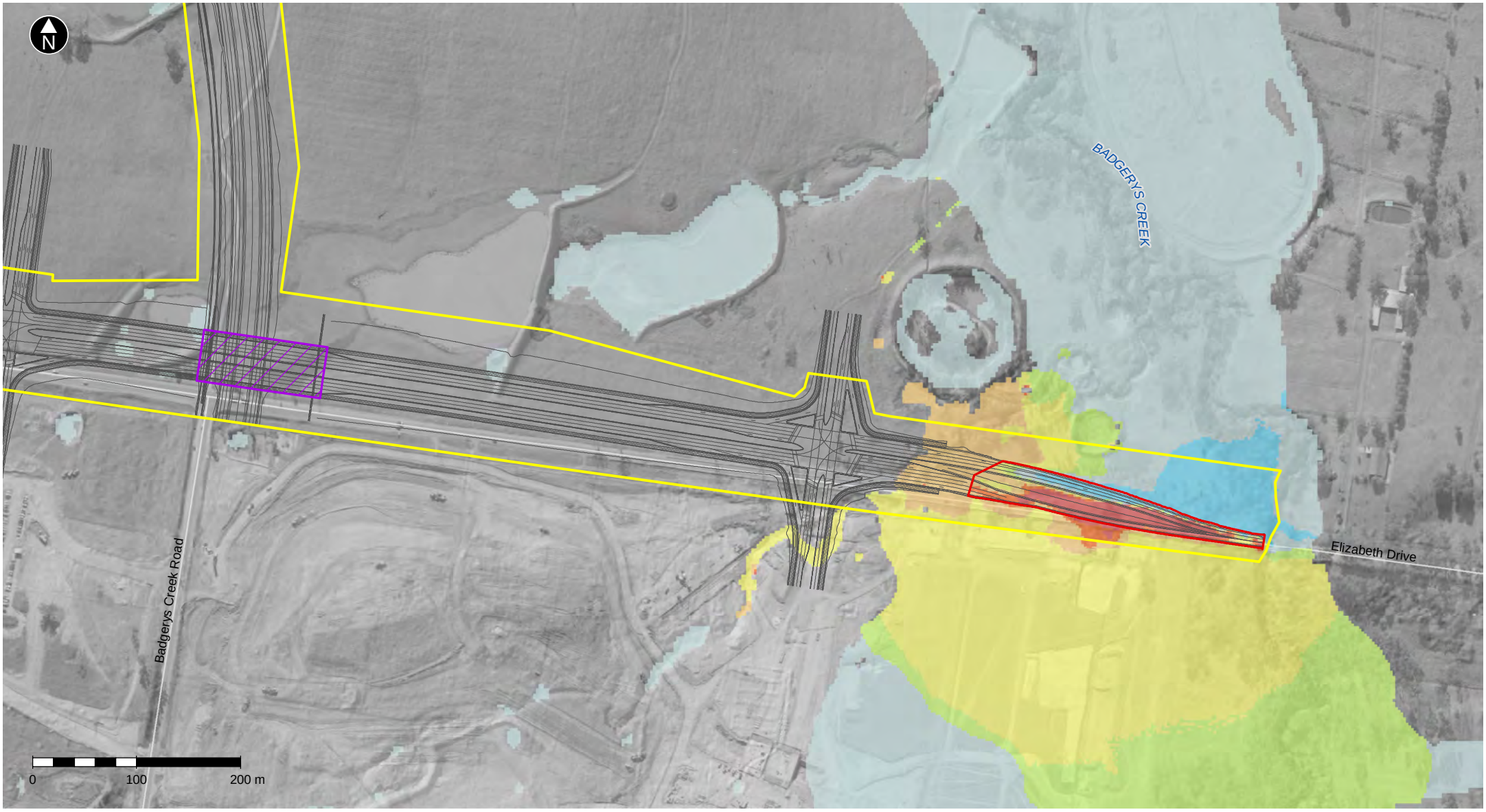
100 >

**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



100 Year ARI Afflux - Amended project - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

Date: 17/04/2020 Path: M:\GIS\MXDs\Figures\Technical_reports\Flood_80pcDesign\ElizabethDrive\Developed Conditions\JAJV_ElizabethDr_009_100yrAfflux_A4L_v2.mxd
Created by : EM | QA by : RB



The amended project

The amended project operational footprint

Bridge

Extent of the amended project modelled in TUFLOW

Peak flood afflux (mm)

< -20

-20 to 20

20 to 40

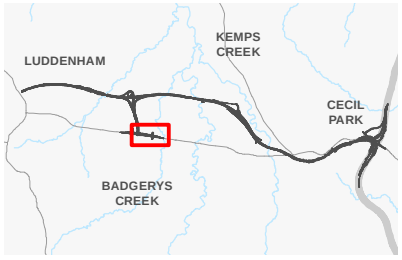
40 to 60

60 to 80

80 to 100

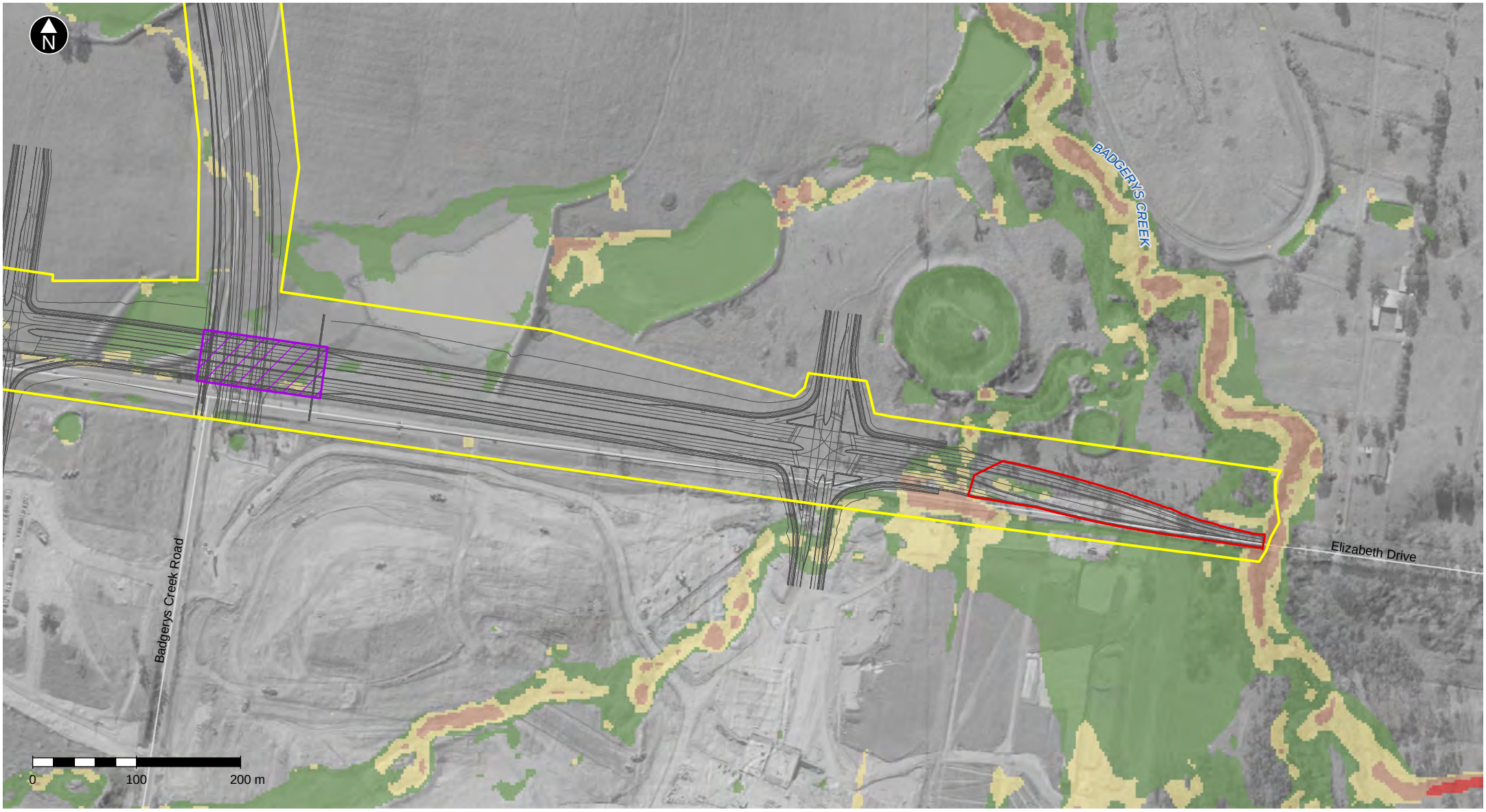
100 >

**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



PMF Afflux - Amended project - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

Date: 17/04/2020 Path: M:\GIS\MXDs\Figures\Technical_reports\Flood_80pcDesign\ElizabethDrive\Developed Conditions\JAJV_ElizabethDr_010_PMF_Afflux_A4L_v2.mxd
Created by : EM | QA by : RB



The amended project

The amended project operational footprint

Bridge

Extent of the amended project modelled in TUFLOW

Flood Velocity (ms^{-1})

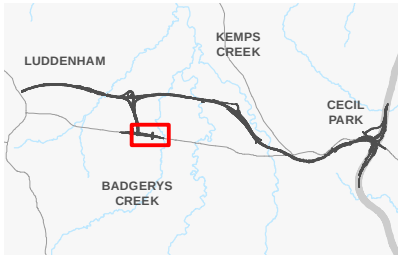
< 0.5

0.5 - 1.0

1.0 - 2.0

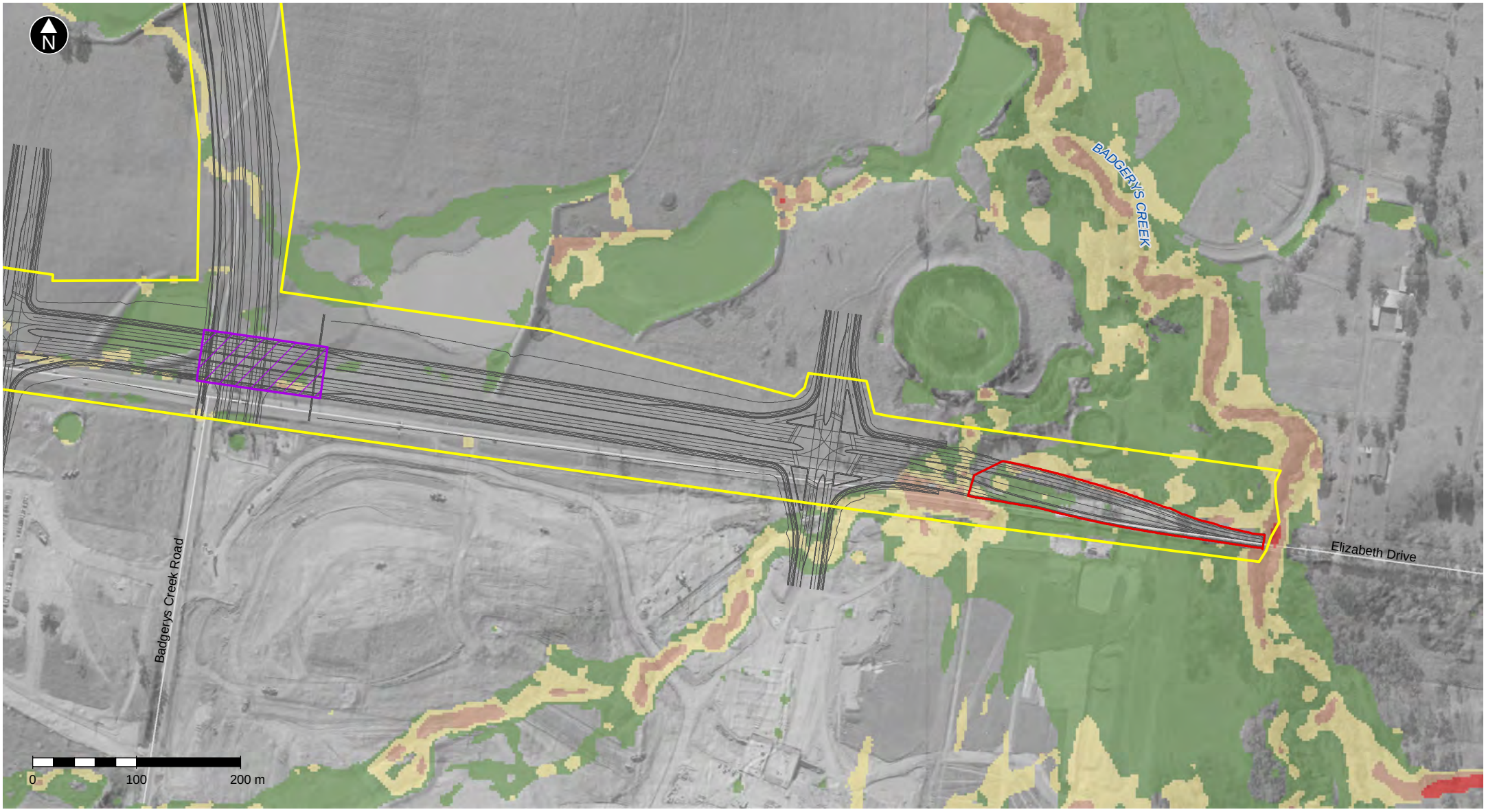
> 2.0

**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



5 Year ARI Flood Velocity - Amended project - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

Date: 17/04/2020 Path: M:\GIS\MXDs\Figures\Technical_reports\Flood_80pcDesign\ElizabethDrive\Developed Conditions\JAJV_ElizabethDr_011_5yrVelocity_A4L_v2.mxd
Created by : EM | QA by : RB



The amended project

The amended project operational footprint

Bridge

Extent of the amended project modelled in TUFLOW

Flood Velocity (ms^{-1})

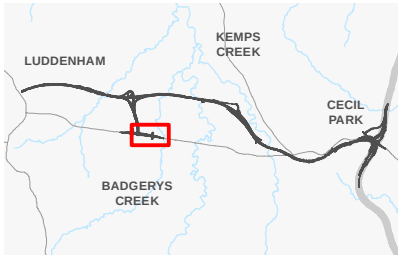
< 0.5

0.5 - 1.0

1.0 - 2.0

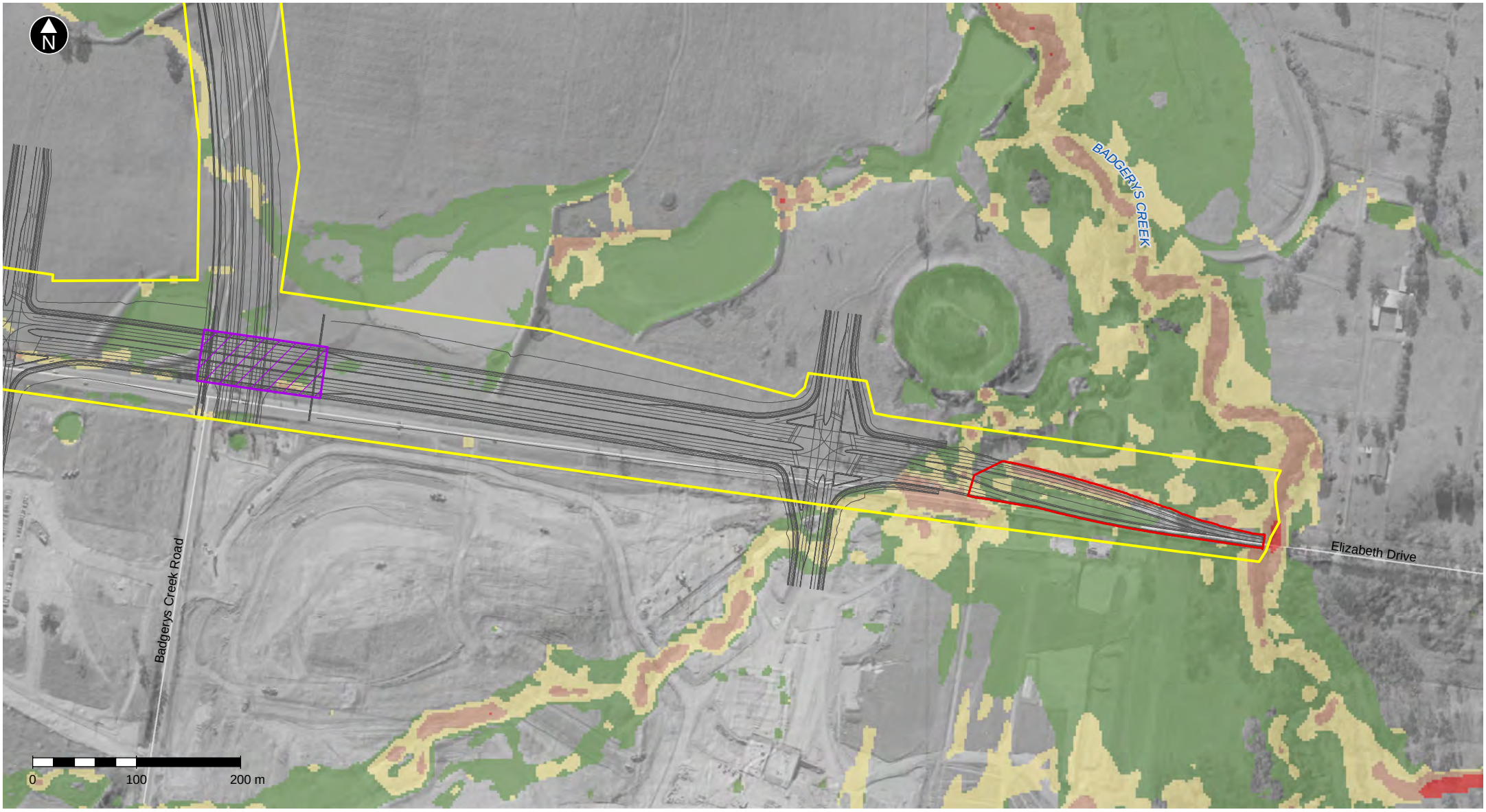
> 2.0

**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



20 Year ARI Flood Velocity - Amended project - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

Date: 17/04/2020 Path: M:\GIS\MXDs\Figures\Technical_reports\Flood_80pcDesign\ElizabethDrive\Developed Conditions\JAJV_ElizabethDr_012_20yrVelocity_A4L_v2.mxd
Created by : EM | QA by : RB



The amended project

The amended project operational footprint

Bridge

Extent of the amended project modelled in TUFLOW

Flood Velocity (ms^{-1})

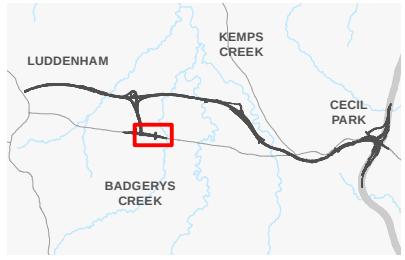
< 0.5

0.5 - 1.0

1.0 - 2.0

> 2.0

**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



50 Year ARI Flood Velocity - Amended project - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

Date: 17/04/2020 Path: M:\GIS\MXDs\Figures\Technical_reports\Flood_80pcDesign\ElizabethDrive\Developed Conditions\JAJV_ElizabethDr_013_50yrVelocity_A4L_v2.mxd
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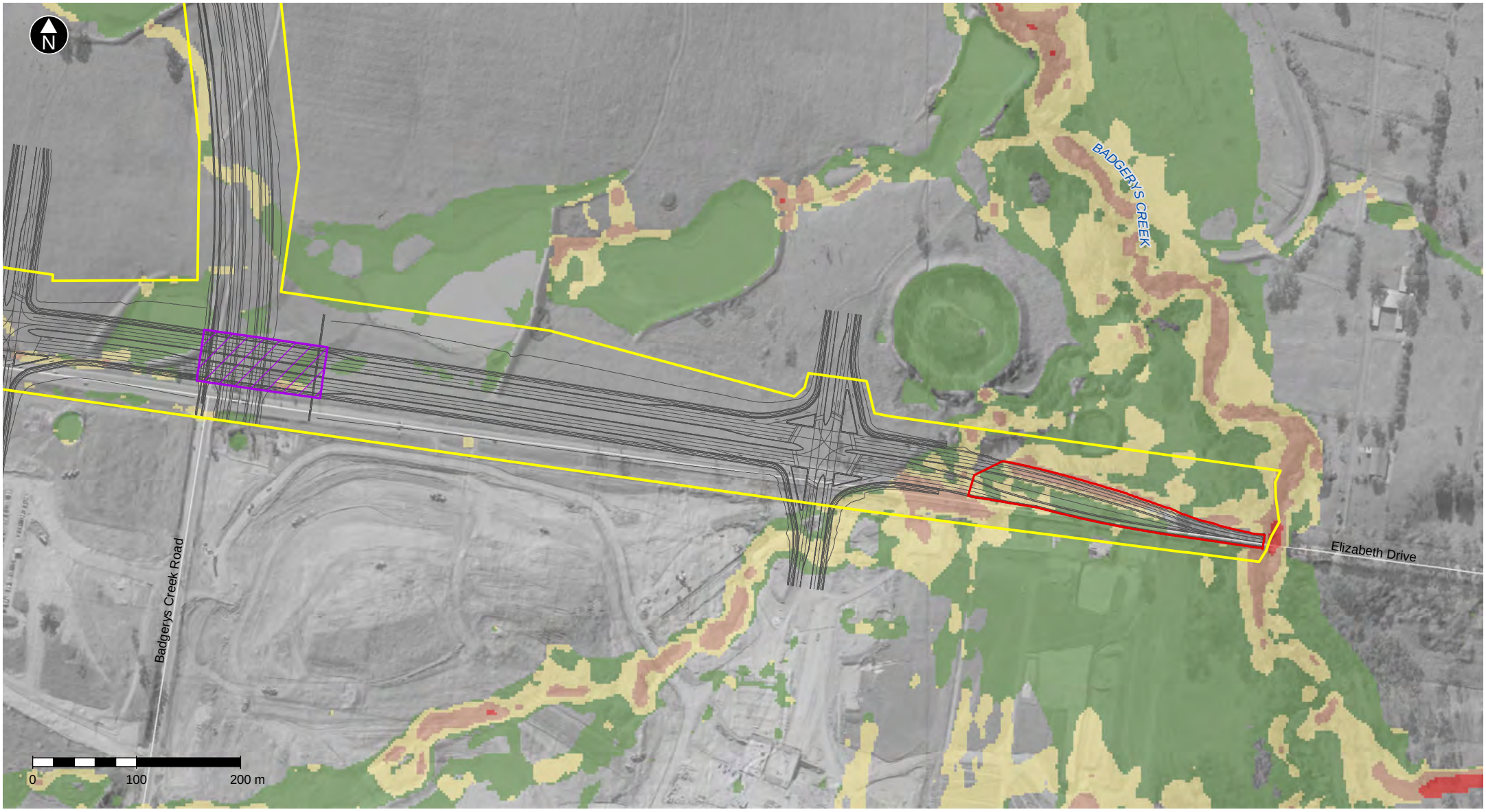


The amended project

The amended project operational footprint

Bridge

Extent of the amended project modelled in TUFLOW

Flood Velocity (ms^{-1})

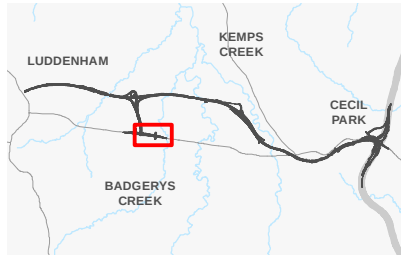
< 0.5

0.5 - 1.0

1.0 - 2.0

> 2.0

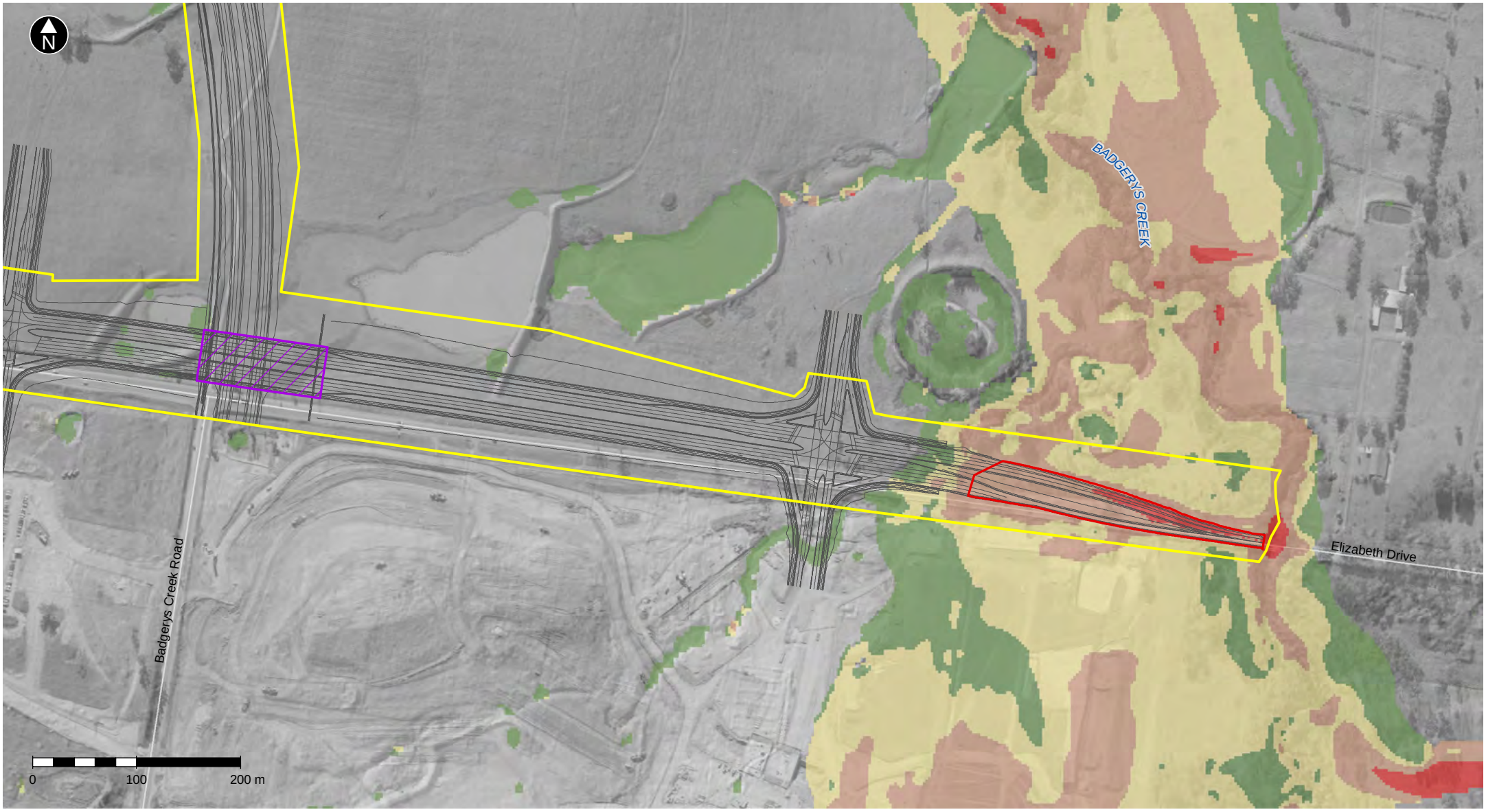
**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



100 Year ARI Flood Velocity - Amended project - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

Date: 17/04/2020 Path: M:\GIS\MXDs\Figures\Technical_reports\Flood_80pcDesign\ElizabethDrive\Developed Conditions\JAJV_ElizabethDr_014_100yrVelocity_A4L_v2.mxd

Created by : EM | QA by : RB



The amended project

The amended project operational footprint

Bridge

Extent of the amended project modelled in TUFLOW

Flood Velocity (ms^{-1})

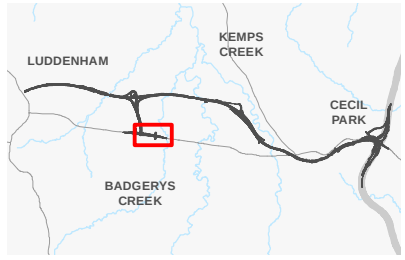
< 0.5

0.5 - 1.0

1.0 - 2.0

> 2.0

**Flood conditions of carriageway of proposed motorway M12 and Elizabeth Drive are not shown as assumed to be considered in longitudinal drainage design*



PMF Flood Velocity - Amended project - Elizabeth Drive at Badgerys Creek around Western Sydney Airport

Date: 17/04/2020 Path: M:\GIS\MXDs\Figures\Technical_reports\Flood_80pcDesign\ElizabethDrive\Developed Conditions\JAJV_ElizabethDr_015_PMF_Velocity_A4L_v2.mxd

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