



Cumberland Plain Conservation Plan Functional Koala Corridors

FINAL REPORT

Prepared for Department of Planning Industry and Environment

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1 Introduction

1.1 Purpose

This report documents the method used to apply the Office of the NSW Chief Scientist and Engineer's advice in relation to koala habitat corridors in the Wilton and Greater Macarthur Growth Areas. The mapped outputs from this work support the delivery of the Cumberland Plain Conservation Plan (CPCP).

1.2 Project background

In April 2021, the Minister for Planning and Public Spaces and the Minister for Energy and Environment requested the Office of the NSW Chief Scientist & Engineer (OCSE) provide advice on the adequacy of koala specific measures in the Wilton Growth Area (WGA) and Greater Macarthur Growth Area (GMGA) proposed as part of the CPCP (OCSE 2021b). Specifically, the draft Terms of Reference (ToR) sought advice *regarding the adequacy of the CPCP's koala specific measures in supporting a long-term strategic landscape-scale outcome for koalas across Wilton and the Greater Macarthur Growth Areas*. The ToR listed a number of factors to be considered, including:

- a) *existing development and infrastructure*
- b) *physical constraints such as the Sydney Water Canal and necessary major infrastructure such as the OSO2 Transport Corridor*
- c) *increased corridor width into cleared land currently proposed for development which may result in trade-offs that lead to vegetation degradation or loss in other areas*
- d) *loss of upfront conservation land through the negotiations underway with Walker Corporation for a Voluntary Planning Agreement if changes required to urban capable footprint.*

The OCSE provided the advice to the Minister for Planning and Public Spaces and the Minister for Energy and Environment on 14 May 2021. This advice builds on previous advice prepared by the OCSE, being 'Advice on the protection of the Campbelltown Koala population' (OCSE 2020) and additional advice provided to the Department of Planning, Industry and Environment (DPIE) in February 2021 (OCSE 2021a).

The OCSE advice prepared (OCSE 2021b) identifies 31 principles relevant to the protection of Koalas in the GMGA and WGA and surrounds. Principle 5 relates to determining adequate Koala corridor widths and states:

corridors should be widened where feasible through revegetation to an average minimum width of 390 - 425 m, include a buffer on either side (30 m wide where fenced and wider to ~ 60 m where fencing is infeasible), and trees should 3 m from the fence (to prevent tree branch damage to fence).

Diagrams to demonstrate possible Koala corridor configuration were also provided and are reproduced in Figure 1 below.

In addition to the OCSE advice identifying an average minimum Koala corridor width of 390 - 425 metres, measured along the corridors length. The advice also considers the functionality of Koala corridors and whether all Koala corridors and habitat is 'functional' (or preferred) for Koala movement. In particular, the advice states that 'corridor measurements should reflect their functionality for koalas' (OCSE 2021b) and a diagram is provided on the type of habitat that may be considered 'functional' (Figure 2). The diagram demonstrates the functional area of a Koala corridor compared to areas that are likely to be less accessible, and therefore less functional, when considering Koala movement through the landscape.

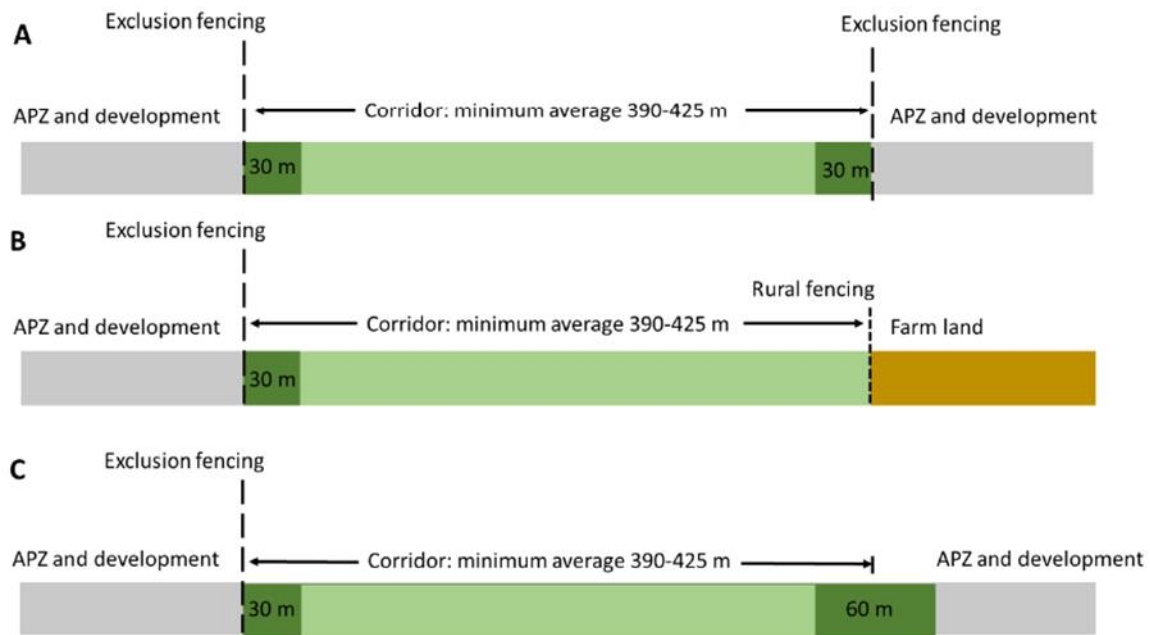


Figure 1 Recommendations for corridors. A) Development either side of the corridor, B) Development on one side and farmland on the other, C) Development on both sides, but with one side unable to be fenced. OCSE 2021a, 2021b

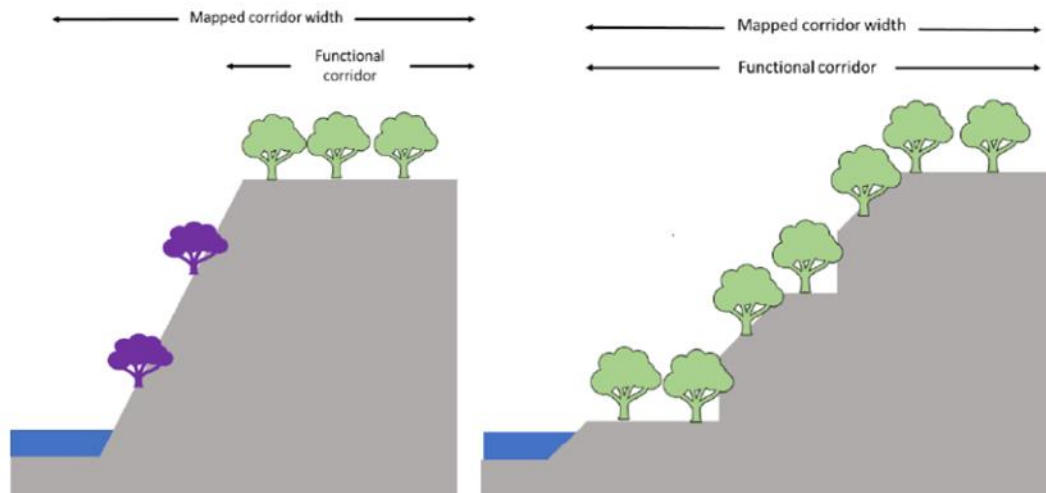


Figure 2 Corridors in riverine areas (the 'green' trees are those in the functional area of the corridor, the 'purple' trees are less likely to be easily accessible). OCSE 2021b

The OCSE also restates previous advice (OCSE 2021a) that some riverine corridors, including the Nepean River, provide separate habitat on each side and therefore effectively function as two separate corridors for Koala movement (OCSE 2021a, 2021b). In particular, the 2021a advice states 'the Nepean River would effectively act as a barrier and therefore encourage koala movement separately along each side' and the

corridors should be 'treated as separate corridors that provide a symbiotic-like protection to the adjacent riverbank'.

The following method was used to map 'functional' Koala corridors in line with the OCSE advice under the CPCP. The method is based on the following three key steps:

- Step 1 – desktop assessment of functional Koala corridor location and width
- Step 2 – field validation and assessment of functional Koala corridor width
- Step 3 – functional Koala corridor width measurements and refinement of development and avoidance areas under the CPCP.

Each step of the method, and the results of the mapping, are described below.

2 Methods

2.1 Step 1 – desktop assessment of functional Koala corridor location and width

An assessment of functional Koala corridor width was conducted for a number of corridors located within GMGA and WGA. The method assesses relevant sections of the Nepean River, Georges River, Cataract River, Allens Creek and Ousedale Creek corridors that lie within the WGA and GMGA (Figure 3). These corridors were assessed as they have been identified as primary koala habitat, or important east/west links between the Nepean River and the Georges River (OEH 2019), and are the focus of restoration and protection efforts under the Plan. The Nepean River corridor in the Gilead area has been included in the assessment to ensure the full extent of the corridor within the GMGA was assessed, however the mapping for Gilead is indicative only. It is anticipated that the mapping for the final Koala corridor for Gilead will be finalised through a future rezoning process, such as a planning proposal through Campbelltown City Council or a State led rezoning, however will remain consistent with the OCSE advice. Other potential Koala corridors, such as Malatty Creek, were not assessed as Koalas are to be excluded from these areas under the CPCP in line with the advice related to minimum average widths from the OCSE.

As per the OCSE advice, for major waterways where steep topography and barriers (such as deep water) are present, functional Koala corridors were mapped so that each side of the waterway was treated as a separate corridor and the steeper areas were excluded from the measurements of functional Koala corridor width. This included the Nepean River, Georges River and Cataract River. For more minor waterways where topography and other barriers are not as significant, measurements were made across the watercourse. These corridors were considered to completely contain functional habitat and include Ousedale Creek and Allens Creek (Figure 3).

In order to measure the width of each functional Koala corridor the location where the functional corridor commenced (i.e. the edge of the cliffs and steeper topography) was determined for those major waterways listed above, being the Nepean River, Georges River and Cataract River. The desktop identification of the location of the functional habitat aimed to exclude from the Koala corridor width calculations areas of steep topography and cliff lines that are less likely to be traversed by Koalas, and was based on:

- Aerial Photo Interpretation (API) and contour/slope data – high resolution aerial photos, contour data and a 1 m Digital Elevation Model (source: <https://elevation.fsd.org.au/>) was used to exclude areas of obvious cliffs or steep and rugged terrain.
- Koala Habitat Suitability Model v1.0 (DPIE 2019) – The model was used to help determine more suitable habitat from less suitable habitat. As a broad indicator a value of 0.45 was used to assist in the identification of the functional Koala corridor. Analysis of Koala records within the CPCP area indicates that 95% of Koala records occur in areas with a suitability index of greater than, or equal to, a habitat suitability value of 0.45.

Once the location of the start of functional Koala habitat was determined a series of measurements were made using 'matchstick' mapping. For each corridor being assessed a virtual matchstick was created, measuring 390 to 425 metres. The matchsticks were placed along the corridors to enable a visual representation of potential functional corridor width within GMGA and WGA for each corridor. For corridors where matchsticks were mapped so that each side of the waterway was treated a separate Koala corridor (Nepean River, Georges River and Cataract River) the waterway side (or start point) of the corridor was defined at the edge of the 'functional' Koala corridor. This approach allowed the matchsticks to measure functional habitat only, and excluded from measurement steeper, less functional habitat closer to the rivers. For the other waterways (Ousedale Creek and Allens Creek) the matchsticks were placed across the watercourse, with all habitat considered functional.

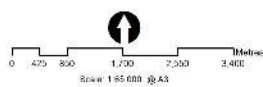


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Legend

- ▭ Nominated areas
- Indicative 425 m functional corridor width**
- Nepean River and Cataract River (GMCA) and Nepean River – South (WGA) (Mt Gilead indicative mapping)
- Nepean River and Cataract River (GMGA) and Nepean River – South (WGA)
- Georges River (GMCA)
- Nepean River - North (WGA)
- Cusedale Creek (GMGA)
- Allens Creek (WGA and outside)

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Cumberland Plain Conservation Plan
 Functional Koala corridors
 assessed - WGA and GMGA



Figure 3 Functional Koala corridors assessed

Matchstick measurements were placed at approximately 200 metre intervals as described by Biolink (Biolink 2020) and as referenced in the OCSE advice 2021a, with the measurements generally placed perpendicular to the waterway. Exceptions to this occur when a waterway bends significantly, where matchstick angles were adjusted to ensure measurements did not cross. This approach avoided double counting habitat with multiple overlapping matchstick measurements (Figure 4).



Figure 4 Examples of matchstick placement with bends in waterways/corridors evident - (a) Wilton Growth Area (b) Greater Macarthur Growth Area

2.2 Step 2 – field validation and assessment of functional Koala corridor width

The Koala corridor functional width measurements were the subject of ground truthing to verify that the area included within each matchstick measurement would function as intended. Senior Ecologist – Technical Lead Zoology of Biosis undertook the assessment of the proposed Koala corridors that were identified by OCSE (2021b) as potentially containing significant impediments to Koala movement or use. The survey of the major waterways was undertaken to collect spatial point data on where the river side of the functional Koala corridor commenced. Factors considered during ground truthing included:

- Vegetation type i.e. containing koala feed and/or use trees in meaningful densities.
- Distinction of terracing versus steep rocky gorges.
- “Ruggedness” of terrain in regards to presence of boulders and outcrops.
- “Ruggedness” of ground and midstorey vegetation in regards to dense weed infestations and predator avoidance.

Ground truthing of matchstick measurements was undertaken by boat along the Nepean River and Cataract River where the waterways were navigable. The location of the boat was recorded via ArcGIS field maps and a rangefinder recorded the distance of the boat from the observed, landward, starting point of a functional Koala corridor. A total of 36 points were assessed for functionality as a Koala corridor, with the remainder of the GMGA and northern section of Wilton undertaken by aerial imagery and digital elevation model (DEM) analysis. Each location aligned with the matchstick measurement mapping.

In most instances the landward starting point of a functional Koala corridor aligned with the cliff lines parallel to the Nepean River, Ousedale Creek and Cataract River (Photo 1 and Photo 2). The terrain and vegetation between the cliff lines and the wetted edge of the waterways was between 30 to 80 metres and was excluded as being part of a functional corridor (Photo 3). These sections of the riparian corridor were generally considered unsuitable for use by Koala even though, in many sections, Koala feed trees and navigable terrain

was observed. These areas were considered inaccessible to Koalas due to vertical rock faces, large boulders or dense vegetation.

Dense vegetation included swathes of both species of Privett *Ligistrum* spp. (Photo 3) and patches of Dry Myrtle Rainforest contained dense Grey Myrtle *Backhousia myrtifolia*. The multi stemmed habits of this vegetation would present a substantial barrier to the movement of Koala on the ground and provide no opportunity for arboreal movement.

The OSCE advice (2021 b) indicates that terracing of the gorge could still facilitate the movement of Koalas in the region, however, the terracing observed was considered unsuitable. The terracing observed had the same limitations to Koala movement as did the larger cliff lines (Photo 4).

Two significant adjustments were required in two instances where steep gullies with distinct cliff lines occurred perpendicular to the Nepean River and Cataract River (Photo 5). In these areas the gullies included up to 80 % of the proposed corridor, and therefore reduced the functional corridor width accordingly. The starting point of the matchstick measurements were shifted landward to provide for a functional corridor and to reduce the effect of cliff lines as a "hard" barrier to koala movement.

The Ousedale Creek section of the Koala corridor was mapped to cross the creekline for the length of the waterway. During ground truthing it was identified that the Ousedale corridor, near the confluence with the Nepean River, contained significant cliff lines, and vegetation within the gully was predominantly Dry Myrtle Rainforest. As such, this section of the Ousedale corridor was considered unable to be navigated by Koalas, unless individuals were forced to seek refuge in the case of wildfire. Due to the close proximity to the Nepean River corridor the matchstick measurements for the Nepean River were adjusted to reflect the functional Koala corridor in this location.

The section of proposed Koala corridor along Allens Creek, that forms the eastern boundary of the Wilton Growth Area, was ground truthed to determine suitability of corridor being measured across both banks. Allens Creek did not contain extensive areas of distinct cliff line, and the waterway did not present a limitation to Koala movement (Photo 6). Therefore, the proposed matchstick measurements at Allens Creek were considered suitable as a functional Koala corridor.

Appendix 1 includes images at key locations, taken during the ground truthing of the functional Koala corridor.

2.3 Step 3 – functional Koala corridor width measurements and refinement of development and avoidance areas under the CPCP

The results of the field validation and assessment were incorporated into the functional Koala corridor width mapping. In some cases the start point of functional corridors were adjusted based on the results, with matchsticks moved either closer to the mapped waterway, or further from the mapped waterway, based on the field observations and extrapolated data (Step 2) (Figure 5).

Following this the width of the functional Koala corridor at each matchstick was measured. The width measurements were based on an equitable rule-based approach where each matchstick was reduced or extended taking into consideration avoided land, which includes existing Koala habitat under the CPCP, current land use or known future major infrastructure (Table 1).

Where possible the avoided lands under the CPCP were extended to allow the minimum average functional corridor with of 390 metres to be achieved. The rules below were applied in turn, with rule 1 applied first, followed by rule 2 and rule 3. In summary the rules include:

- Rule 1 – functional Koala corridor width measured to the edge of existing infrastructure, future major infrastructure corridors or privately owned urban zoned land
- Rule 2 - functional Koala corridor width measured to the edge of avoided lands under the CPCP, which includes the majority of existing vegetation and Koala habitat within the Nominated areas
- Rule 3 – where areas are not affected by Rule 1, or where existing avoided land is <390 m, extend avoided lands under the CPCP to enable the minimum 390 m width recommended by the OCSE to be met or, where it cannot be met, extend the avoided lands under the CPCP to a maximum functional Koala corridor width of 390 m.

Table 1 Rules for measuring functional Koala corridor width for each matchstick measurement

Rule No.	Rule category	Rule description
1a	Current land use or future major infrastructure corridor	Functional Koala corridor measured to the edge of existing infrastructure including the western edge of the Sydney Water Upper Canal in GMGA, the edge of the Main Southern Railway in WGA, the edge of Wilton Park Road in WGA and the edge of the Maldon-Dombarton rail corridor in WGA.
1b		Functional Koala corridor measured to the western edge of the proposed Outer Sydney Orbital (OSO) 2 route. Where OSO2 crosses Elladale Creek Transport for NSW has committed to designing the structure to allow for Koala movement.
1c		Functional Koala corridor measured to the edge of existing industrial zones in Maldon and proposed future development areas in Bingara Gorge.
2	Existing vegetation and avoided lands under the CPCP	Functional Koala corridor measured to the edge of avoided lands under the CPCP, which contain large areas of existing vegetation. Where cleared land is included within these avoided lands it is assumed that the land will be revegetated to provide future Koala habitat.
3	Extend functional Koala corridor width (and avoided land under the CPCP)	Average functional Koala corridor width is measured, and avoided lands under the CPCP are extended, to meet the minimum 390 m average for lands not affected by rule 1. Where avoided lands are already >390 m in width avoided lands are not increased. For corridors that cannot meet the average minimum width due to the application of rule 1, the avoided lands under the CPCP are extended to a maximum width of 390 m. Where cleared land is included it is assumed that the land will be revegetated to provide future Koala habitat.

In some cases avoided lands under the CPCP have resulted in corridor width measurements that exceed the 390 – 425 m average width recommended by the OCSE. In other cases existing land uses, or known future major infrastructure corridors, mean that corridor width is restricted to less than the recommended width. The application of the ruleset above results in:

- The extension of avoided lands for the Nepean River and Cataract River (GMGA) and Nepean River – South (WGA) corridor to 340 m under rule 3. This extension results in an overall average functional Koala corridor width of > 390 m.

- The extension of avoided lands for the Nepean River – North (WGA) to 390 m under rule 3. Due to the application of rules 1 and 2, and the short distance of this corridor, the resulting average corridor width remains < 390 m.
- No change for all other corridors as the average functional Koala corridor width for these corridors is greater than the minimum 390 m recommended by the OCSE.

In one case in WGA, where the extension of avoided lands to 390 m for the Nepean River – North (WGA) corridor resulted in a small sliver of developable lands of 20 m adjacent to the Main Southern Railway, the decision was made to extend the avoided lands to the edge of the railway, increasing the width of the corridor slightly at this location.

All corridor measurements were mapped completely within the boundaries of the Growth Areas, except for the Allens Creek corridor. As Allens Creek forms the eastern boundary of the WGA the measurements for this corridor extended outside of the WGA.

It is noted that where a separate corridor or adjacent habitat extends perpendicular to the corridor being mapped the measurement taken was mapped to the boundary of a natural feature (such as a minor drainage line) or to a distance of 500 m. This approach was adopted so corridor width was not artificially inflated by adjacent habitat or perpendicular corridors.

3 Results

Corridor width statistics were generated on the average width for each corridor based on the measurements taken. The Nepean River and Cataract River (GMGA) and Nepean River – South (WGA) is the longest Koala habitat corridor under the CPCP, running to an approximate length of 31,200 metres within the WGA and GMGA. As described above this includes the corridor in the Gilead area, where mapping is indicative and will be finalised during a future rezoning process. This corridor also interfaces with the most development area. For the purposes of generating average corridor widths the following corridors were considered:

1. Georges River (GMGA)
2. Nepean River and Cataract River (GMGA) and Nepean River – South (WGA)
3. Nepean River – North (WGA)
4. Ousedale Creek (GMGA)
5. Allens Creek (WGA and outside)

To generate the average width of each functional Koala corridor the total distance of each measurement was tallied, and then divided by the number of measurements made. The final mapping is provided in Figure 6 and Figure 7, with the averages calculated in Table 2.

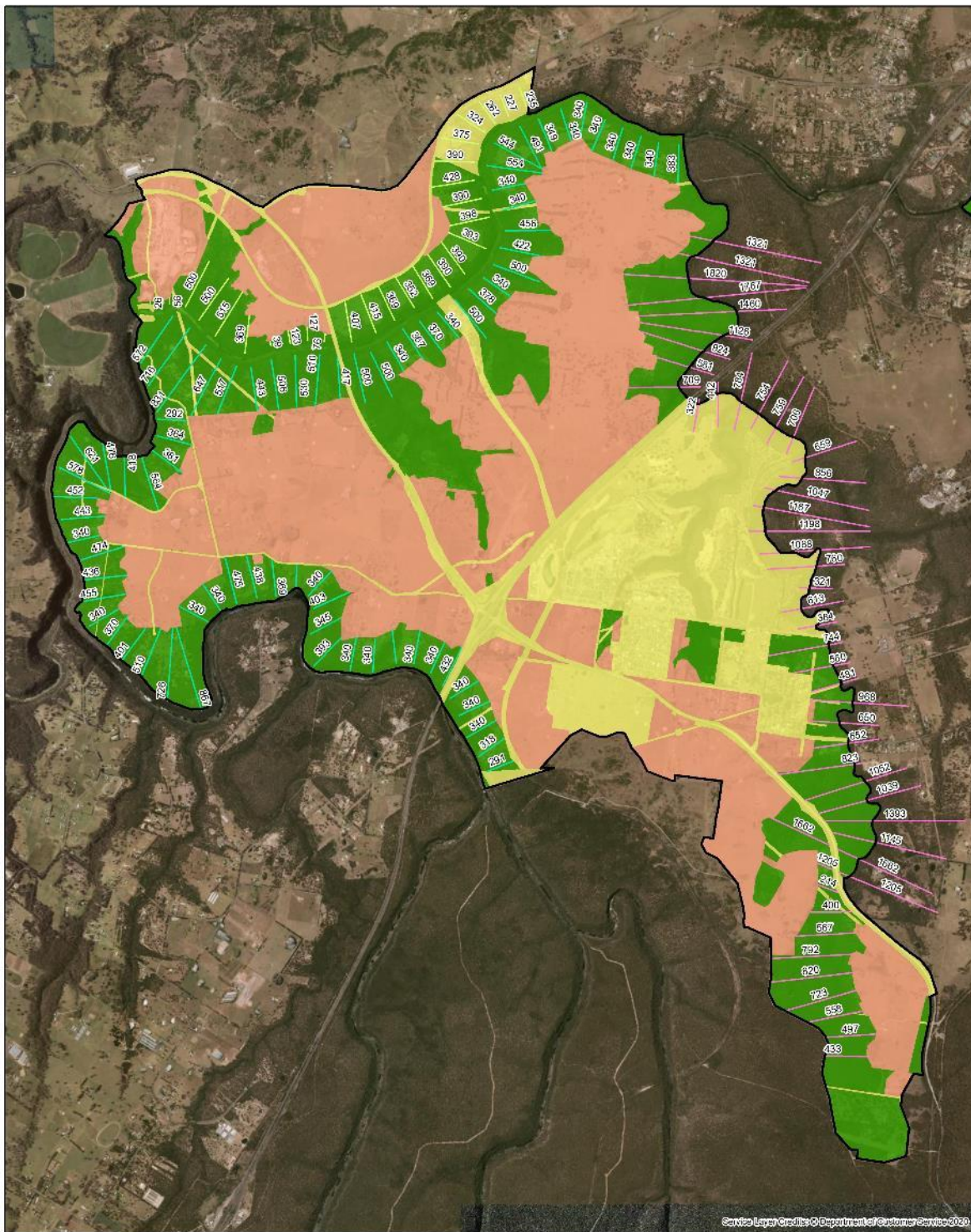
Table 2 Functional Koala corridor average width

Corridor name	Approximate corridor length (m)	Measurement type	Number of measurements	Functional corridor width (average) (m)
Nepean River and Cataract River (GMGA) and Nepean River – South (WGA)*	31,200	One side	148	393
Allens Creek (WGA and outside)	10,500	Across	47	857
Georges River (GMGA)	8,700	One side	44	672
Nepean River – North (WGA)	5,700	One side	27	313
Ousedale Creek (GMGA)	3,900	Across	19	598

* Includes indicative measurements in Gilead that will be refined during a future rezoning process

As described above the Allens Creek (WGA and outside), Ousedale Creek (GMGA) and Georges River (GMGA) corridors met the minimum functional Koala corridor width of 390 – 425 metres without the application of rule 3 (i.e. no extension of avoided lands). For the Nepean River and Cataract River (GMGA) and Nepean River – South (WGA) an extension of avoided lands to 340 m was required for areas within the corridor that were not affected by rule 1. The average corridor achieved after the application of the extended avoided lands was 393 metres.

The Nepean River – North (WGA) average functional Koala corridor width is 313 metres. The avoided lands were extended to 390 metres for this corridor in areas not affected by rule 1, however due to the short length of the corridor, and the existing infrastructure and land zoning in place, the minimum recommended functional Koala corridor width was not able to be achieved for this corridor.



Legend

- Nominated areas
- Functional Koala corridor measurements
 - Nepean River and Cataract River (CMGA) and Nepean River - South (WGA)
 - Nepean River - North (WGA)
 - Allens Creek (WGA and outside)
- Land categories
 - Certified - Urban Capable
 - Excluded
 - Non certified - Avoided land

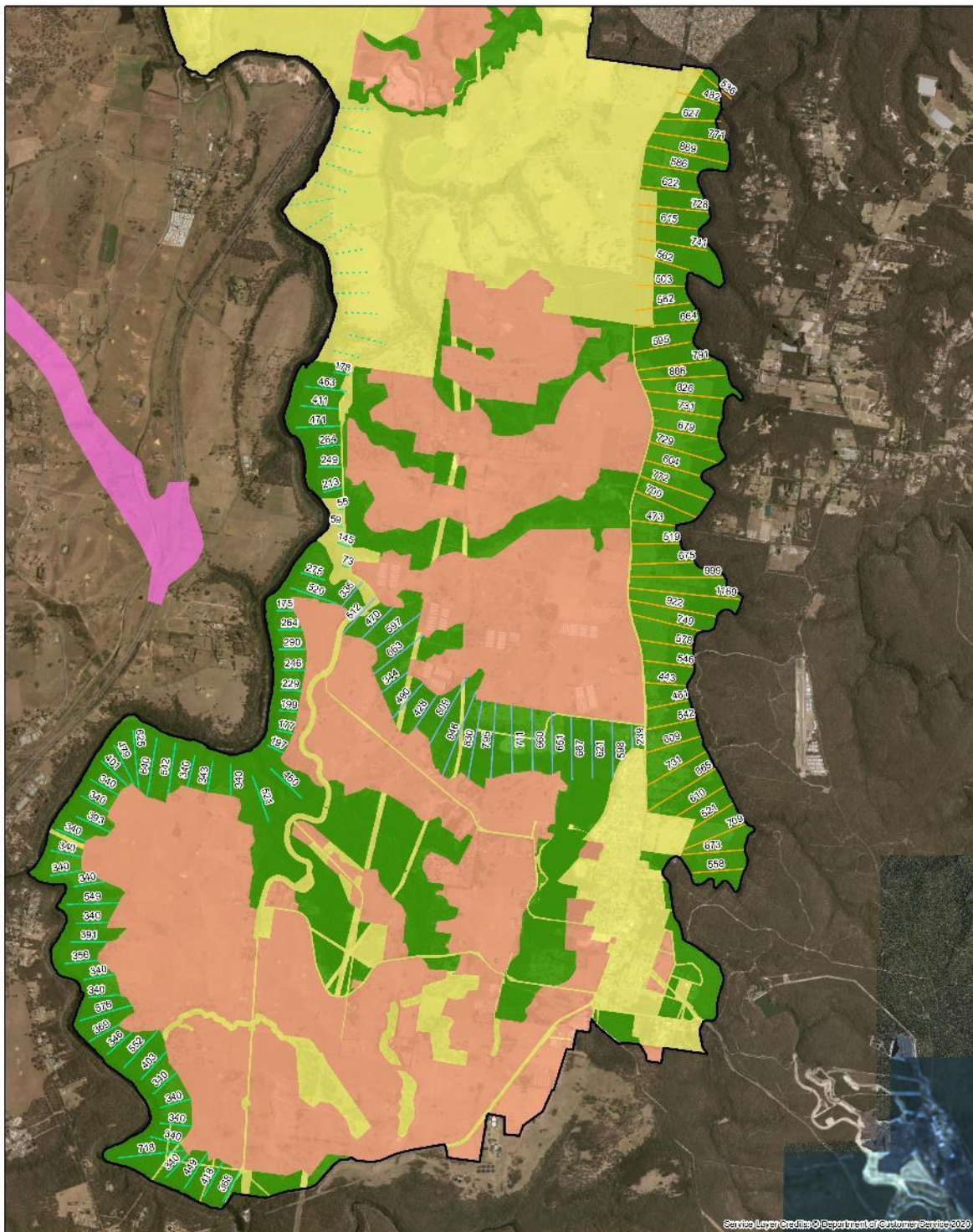
Cumberland Plain Conservation Plan
Functional Koala corridor width mapping - WGA

Scale: 1:35,000 @ 8.43

NSW Planning, Industry & Environment

Prepared for: The Council of the City of Parramatta
Date: 10/11/2021

Figure 6 Functional Koala corridor width mapping - WGA



Legend

Nominated areas

Functional Koala corridor measurements

- Nepean River and Cataract River (GMCA) and Nepean River – South (WGA) (Mt Gibraltar indicative mapping)
- Nepean River and Cataract River (GMGA) and Nepean River – South (WGA)
- Georges River (GMCA)
- Nepean River – North (WGA)
- Ousedale Creek (GMGA)
- Allens Creek (WGA and outside)

Land categories

- Certified - Urban Capable
- Excluded
- Non-certified - Avoided land
- Non-certified - Major Transport Corridor (Strategically Assessed Only)

Scale: 1:37,500 @ 8.43

0 250 500 1000 1500 2000 metres

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Cumberland Plain Conservation Plan
Functional Koala corridor with mapping - GMGA



Figure 7 Functional Koala corridor width mapping - GMGA

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Appendix 1 - Field observations



Photo 1 General terrain and vegetation within the riparian corridor of the Nepean River



Photo 2 Cliffline example of eastern bank of Nepean River between Elladale Creek and Ousedale Creek



Photo 3 Dense vegetation and cliff lines, with top of cliffline indicating start of functional Koala corridor



Photo 4 Terracing of cliff lines unsuitable for Koala movement



Photo 5 Facing upstream of Cataract River



Photo 6 Facing upstream of Allens Creek