
Appendix B

Feasibility study



Upper Canal Ousedale Creek Koala Crossing Feasibility Study

Prepared for Department of Planning and Environment
May 2022





Servicing projects throughout Australia and internationally

SYDNEY

Ground Floor, 20 Chandos Street
St Leonards NSW 2065
T 02 9493 9500

NEWCASTLE

Level 3, 175 Scott Street
Newcastle NSW 2300
T 02 4907 4800

BRISBANE

Level 1, 87 Wickham Terrace
Spring Hill QLD 4000
T 07 3648 1200

ADELAIDE

Level 4, 74 Pirie Street
Adelaide SA 5000
T 08 8232 2253

MELBOURNE

Ground Floor, 188 Normanby Road
Southbank VIC 3006
T 03 9993 1905

PERTH

Suite 9.02, Level 9, 109 St Georges Terrace
Perth WA 6000
T 02 9339 3184

CANBERRA

Level 2, Suite 2.04, 15 London Circuit
Canberra City ACT 2601

Upper Canal Ousedale Creek Koala Crossing

Feasibility Study

Report Number

E210950 RP#3

Client

Department of Planning and Environment

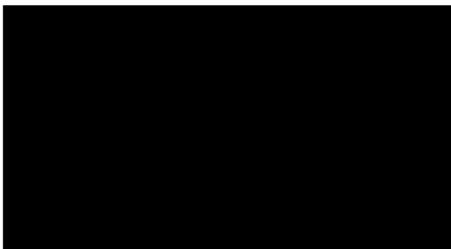
Date

2 May 2022

Version

v2 Final

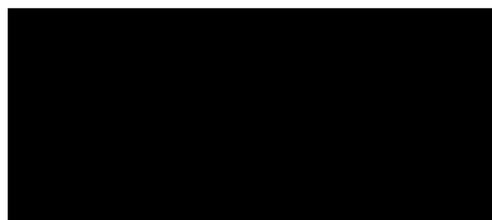
Prepared by



Ecologist

2 May 2022

Approved by



Associate Ecologist

2 May 2022

This report has been prepared in accordance with the brief provided by the client and has relied upon the information collected at the time and under the conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of the client and no responsibility will be taken for its use by other parties. The client may, at its discretion, use the report to inform regulators and the public.

© Reproduction of this report for educational or other non-commercial purposes is authorised without prior written permission from EMM provided the source is fully acknowledged. Reproduction of this report for resale or other commercial purposes is prohibited without EMM's prior written permission.

Executive Summary

ES1 Introduction

The Draft Cumberland Plain Conservation Plan (CPCP) has been set up to protect biodiversity values in response to planned urban development in Western Sydney (DPIE 2020a). Koalas are one of the key biodiversity values to be protected under the CPCP, with a suite of management and mitigation measures proposed in *Sub-Plan B: Koalas* (DPIE 2020b). One of the commitments of the CPCP is to secure habitat connectivity in at least one east-west Koala movement corridor, linking the primary Koala corridors of the Nepean and Georges River. The Ousedale Creek corridor has been identified as the most suitable corridor for this purpose (CSE 2020), so as development progresses, it is important that Koalas are able to move freely through this corridor.

ES2 Koala population

Southern Sydney, consisting of the Campbelltown Local Government Area (LGA) and the eastern section of the Wollondilly LGA and to the Southern Highlands, is home to an estimated Koala population of between 600 and 1000 individuals (DPIE 2020b). The Campbelltown LGA Koala population is the largest Chlamydia-free populations in NSW. Koalas prefer woodland or forest habitat on fertile shale soils but will also utilise and breed in vegetation located on less fertile soils, such as sandstone (Ward 2002). Due to land clearing on the Cumberland Plain, where the preferred more fertile shale soils occur, available Koala habitat in the area is frequently restricted to narrow corridors, usually following water courses.

Two primary Koala habitat corridors have been identified along the Nepean River in the west and the Georges River in the east (DPIE 2020b). Koala movement between these areas is crucial for the persistence of Koalas in the area. There are six secondary east-west corridors that connect the areas, the widest of which runs along Ousedale Creek. The Ousedale Creek corridor has been proposed as the most suitable corridor to provide connectivity between the Nepean and Georges River, and the Cumberland Plain Conservation Plan aims to ensure free Koala movement through the corridor.

ES3 Upper Canal

The Upper Canal is a heritage-listed open channel water supply, connecting the upper Nepean Dams to Prospect Reservoir. The canal intersects the Ousedale Creek corridor and has been identified as a barrier to Koala movement.

Where the canal crosses Ousedale Creek, the open canal flows into a large steel pipeline that is supported across the creek line by sandstone pillars. The creek itself has steep cliff edges. The canal walls, the pipeline and the steep banks are currently all expected to be impassable to Koalas, however there is some evidence of fauna movement under the pipeline in areas with sufficient clearance.

Running parallel to the canal infrastructure is a vehicular track and fence line. The recently installed wire mesh fence line is also predicted to be impassable to Koalas, however there are some holes dug under the fence that have been created by fauna species that are used for movement.

ES4 Koala crossing design options

After consultation with stakeholders on initial design options, four design solutions are being proposed that will enable Koalas to cross the existing infrastructure at the site:

- **Solution A: Log Climb Crossing.** A log climb crossing design that will enable Koalas to traverse the steep rocky banks of Ousedale Creek and excavated sandstone rock and move between habitat on the upper bank and the creek line in order to cross the pipeline area.
- **Solution B: Under Fence Crossing.** Providing reinforced access spaces under the fence line that will allow Koalas to pass underneath, without harm to themselves or further damage to the fence.
- **Solution C: Pipeline Climb Crossing.** A crossing over the top of the pipeline, where the pipe is embedded in the ground, providing an easy movement pathway for Koalas along the upper banks of Ousedale Creek.
- **Solution D: Under Pipe Crossing.** Modification of the sandstone banks, allowing Koalas access to cross underneath the pipe in places where there is sufficient clearance.

Given that the proposed design solutions address different site access challenges and varied components of the infrastructure on the site, it is recommended that all designs are pursued, to minimise barriers to Koala movement in the corridor.

ES5 Impact assessments required

It is anticipated that the Koala crossing design solutions, if carried out by, or on behalf of, a public authority, that they would be works permitted without consent under Part 5 of the *Environmental Planning and Assessment Act 1979* ('the EP&A Act'). Thus, approval could likely be granted via the preparation and consideration of a Review of Environmental Factors (REF) pursuant to clause 171 of the Environmental Planning and Assessment Regulation 2021.

To support the Review of Environmental Factors (REF), a heritage assessment and statement of heritage impact will be required. Solutions C and D would require some new works comprising independent footings in proximity to the Upper Canal pipeline across Ousedale Creek. The proposed designs would be independent and not interfere with the canal fabric, fixtures or footings.

Environmental impacts are expected to be low, with little to no vegetation clearing anticipated, which could be addressed under a Flora and Fauna Assessment. Other impacts such as visual or noise are also considered likely to be minimal and could likely be addressed within the Review of Environmental Factors itself.

The full list of assessment requirements will be determined in Stage 2 of the project, once designs progress to Detailed Concepts, suitable for assessment purposes. Once the Detailed Concepts are approved, Detailed Designs and Specifications would need to be prepared for tender and construction purposes.

Table of Contents

Executive Summary	ES.1
1 Background	1
2 Koala movement	5
3 Canal stability, access, and safety	16
4 Koala crossing options	18
5 Camera Monitoring	25
6 Impact assessments required	27
7 Conclusion	31
References	32

Appendices

Appendix A	Survey plans
Appendix B	TBLD site plans and initial design options
Appendix C	Stakeholder input on initial designs
Appendix D	Koala camera monitoring results

Tables

Table 1.1	Project study team	4
Table 4.1	Summary of Design Solutions for Koala crossing interventions at Ousedale Creek	20

Figures

Figure 1.1	Local government area boundary (green line) relative to site (red circle)	3
Figure 2.1	Koala records around the Ousedale Creek Corridor	8
Figure 2.2	Planned urban development in the Greater Macarthur Growth Area	9
Figure 2.3	Koala movement corridors in the Greater Macarthur Growth Area	10
Figure 2.4	Fauna movement at Ousedale Creek	11
Figure 4.1	Design Solution A	21
Figure 4.2	Design Solution B	22
Figure 4.3	Design Solution C	23
Figure 4.4	Design Solution D	24

Photographs

Photograph 2.1	Two current WaterNSW crossing structures over the Upper Canal, located to the south of Ousedale Creek. In the foreground is a bridge with a wood base, and in the rear is a bridge with a metal grid base	12
Photograph 2.2	WaterNSW vehicular access structures over the Upper Canal, located to the north of Ousedale Creek, with the base constructed of concrete	12
Photograph 2.3	WaterNSW Upper Canal pipeline to the north of Ousedale Creek, close to the transition to the open canal (the edge of which can be seen in the far right of the photograph). In this location the pipeline is embedded into the ground	13
Photograph 2.4	WaterNSW Upper Canal pipeline to the south of Ousedale Creek. In this location the pipeline located is embedded into the ground, and a potential fauna movement path is present, with a fauna monitoring camera installed on a star picket (Section 5, camera 9)	13
Photograph 2.5	Vertical cliff on the northern bank of Ousedale Creek adjacent to the WaterNSW access road. The southern bank is very steeply sloped, but can be traversed in locations	14
Photograph 2.6	Bottom of Ousedale Creek in proximity to the WaterNSW Upper Canal. The sandstone base of the creek is visible, along with pools of water	14
Photograph 2.7	Example of barbed wire fencing along the WaterNSW Upper Canal land at Ousedale, located to the north of Ousedale Creek looking towards the access road creek crossing	15

1 Background

NSW Department of Planning and Environment (DPE) is investigating the need for, and the options for a Koala crossing where the Water NSW Upper Canal System intersects Ousedale Creek north-west of the suburb of Appin.

1.1 About the Draft Cumberland Plain Conservation Plan

The Draft Cumberland Plain Conservation Plan (CPCP) is one of the largest strategic conservation plans to be undertaken in Australia, covering 200,000 hectares of Western Sydney, from Wilton in the South to Windsor and Kurrajong in the north, and including the Wilton and Greater Macarthur Growth Areas (DPIE 2020a). It was developed in response to the projected population growth in Western Sydney while protecting biodiversity values, such as threatened plants and animals.

The Koala (*Phascolarctos cinereus*) population in the south-western Sydney region is one of the biodiversity values to be protected under the CPCP. The CPCP *Sub-Plan B: Koalas* identifies the proposed management and mitigation measures proposed for Koala management, including maintaining and restoring connectivity of Koala habitat (DPIE 2020b). One of the commitments in *Sub-Plan B* is to secure at least one east-west Koala movement corridor between Koala habitat on the Georges River and Nepean River. The Ousedale Creek corridor has been identified as the most suitable corridor for this purpose, due to the condition and width of the existing vegetation (CSE 2020).

DPE proposes to facilitate Koala movement/support koala distribution along the Ousedale east to west corridor by constructing a koala crossing at Appin Road (connecting the proposed reserve through to Ousedale Creek corridor), and a Koala passage under Kings Falls Bridge, where Appin Road crosses the Georges River, to support north-south koala connectivity from the proposed Georges River Koala Reserve to the southern koala habitat. Here is some more information about both these crossings:

- Kings Falls Bridge Fauna Crossing at Appin Road
 - This project is being funded by the Department of Planning and Environment (DPE) and delivered in partnership with TfNSW.
 - Underpass construction will involve augmenting the existing Kings Falls Bridge by constructing a bench adjacent to the bridge abutments that will allow dry passage for Koalas (and other fauna) under both sides of the bridge, to increase the duration of safe access under Appin Road.
 - Koala fencing along Appin Road for around 1 km adjacent to the crossing to help redirect Koalas and other animals away from Appin Road to the underpass to facilitate safer fauna crossing.
 - Transport for NSW (TfNSW) is currently in the planning phase of the fauna crossing, with construction anticipated to commence mid-year of 2022, with construction to approximately 6–8 weeks. TfNSW will become the asset owner of the koala fence and underpass following completion of construction in 2022.
- Ousedale Fauna Underpass at Appin Road
 - DPE has also partnered with TfNSW to develop a fauna crossing to facilitate safe south-west movement of koalas under Appin Road (near Brian Road) to provide safer Koala (and other fauna) access to the Ousedale Creek corridor.
 - The crossing is part of a package of works, which also includes road safety upgrades at the intersection of Appin Road and Brian Road (roundabout). TfNSW have advised that to progress the underpass

works, it must progress concurrently with the nearby roundabout. This is because the works for both road elements have physical crossover and construction will impact road traffic and nearby properties.

- In April 2021, TfNSW completed a feasibility study of engineering solutions for the Ousedale underpass. This location was determined the most suitable site for fauna connectivity due to a good level of vegetation on either side of the underpass.
- TfNSW is currently preparing detailed design for the underpass structure, fauna fencing in the immediate project area, as well as environmental and planning assessments for the project. These are anticipated to be completed by November 2022. As design and assessment progress, TfNSW will consult with Wollondilly Council, including in relation to impacts to and works within Brian Road (which is a local road). TfNSW has advised it is likely they will undertake a public exhibition of the REF.
- Construction of the underpass and roundabout is anticipated to commence in 2024.

1.2 Upper Canal site at Ousedale Creek

Advice from the NSW Office of the Chief Scientist and Engineer (CSE 2021), indicates that the Upper Canal may potentially be an impediment to the movement of Koalas through the Ousedale Creek corridor. The Upper Canal site at Ousedale Creek site includes the canal itself, a pipeline over Ousedale Creek, a road, and fencing.

The Upper Canal is listed on the NSW State Heritage Register and protected by the NSW *Heritage Act 1997*. The Upper Canal is critical water supply infrastructure, and is also considered a controlled area under the *Water NSW Act 2014*.

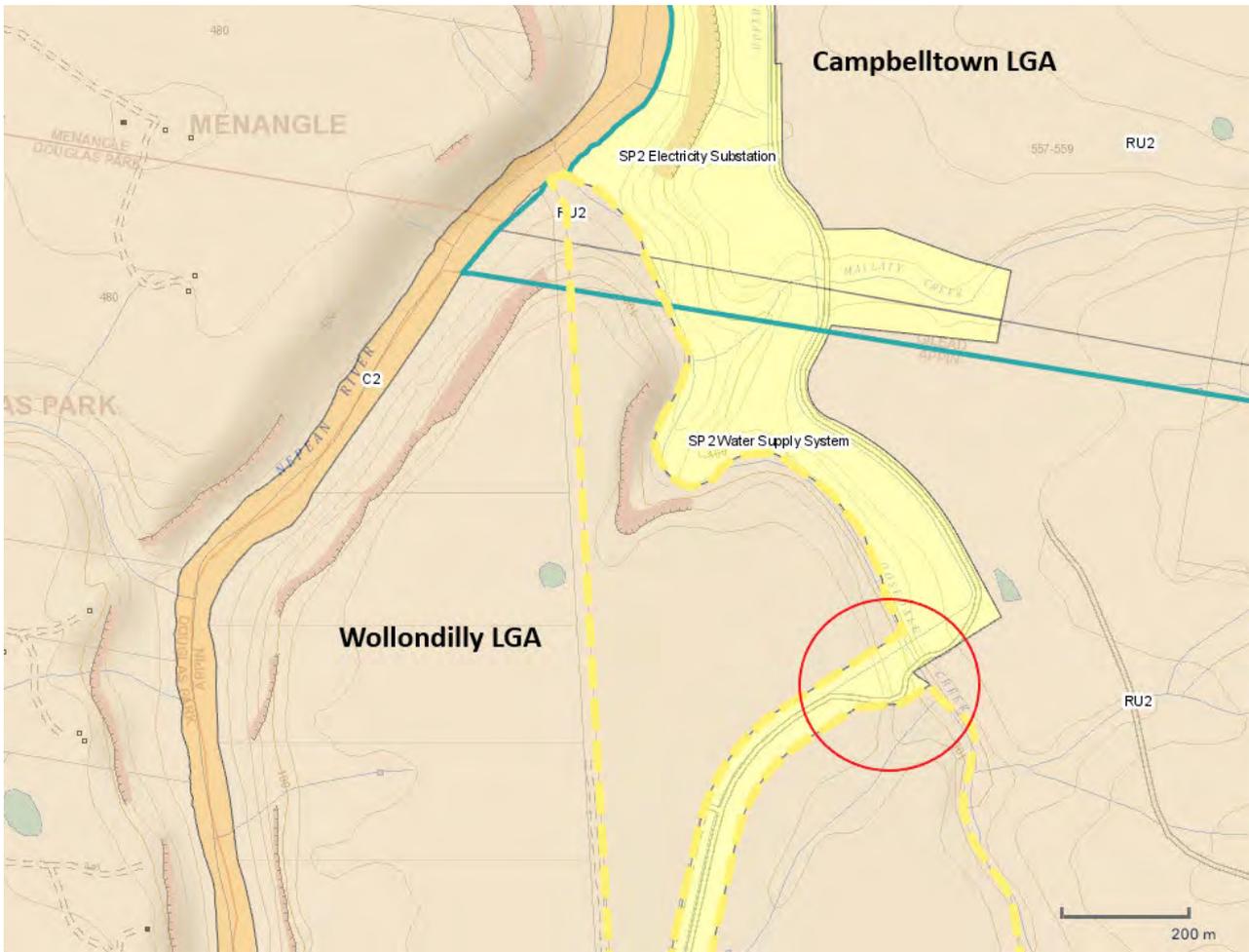
This feasibility report investigates the ability of Koalas to cross the Upper Canal and associated infrastructure and outlines potential design options to facilitate Koala movement through the Ousedale Creek corridor.

For reference, the area investigated is at the junction of a number of lots. The legal descriptions are:

- Lot 1 DP 816861;
- Lot 1 DP625921;
- Lot 2 DP 625921; and
- Lot 105 DP1188670.

A Survey Plan prepared by C.M.S. Surveyors is provided at Appendix A.

The investigation area falls within Wollondilly local government area (LGA) although the site is close to the boundary with Campbelltown LGA, and Ousedale Creek is situated in both LGAs (refer to Figure 1.1).



Source: NSW Planning Portal

Figure 1.1 Local government area boundary (green line) relative to site (red circle)

1.3 Study team

The study team for the project is summarised in Table 1.1. The project was a joint works between EMM Consulting Pty Limited (EMM; lead consultant), and Thompson Berrill Landscape Design (TBLD). EMM provided input on Koala ecology and movement, and approval requirements, and TBLD undertook the development of design solutions to facilitate Koala movement.

Table 1.1 Project study team

Staff member name	Company	Position	Role in project
██████████	EMM	National Technical Leader, Urban & Regional Planning	Project Director, Planning advice
██████████	EMM	Associate Ecologist/Biodiversity Offsets Lead	Project Manager, Koala advice (PhD in Koala ecology)
██████████	EMM	Ecologist	Project Coordinator, delivery of fieldwork components and reporting
██████████	EMM	Associate, National Technical Lead – Historical Heritage	Heritage advice
██████████	TBLD	Director	TBLD Project Lead, Koala crossing design and reporting
██████████	TBLD	Associate	TBLD Project Manager, Koala crossing design and reporting
██████████	TBLD	Landscape Architect	TBLD Support

2 Koala movement

2.1 Southern Sydney Koala population

The Koala population in southern Sydney is estimated to contain between 600 to 1,000 Koalas, and is showing signs of population recovery, partly because young male animals have been able to move through the landscape to new habitat (DPIE 2020b). The area contains the largest Chlamydia-free population of Koalas in NSW.

Koalas prefer habitat located on shale and shale-sandstone transition soils (Ward 2002) and require large areas of habitat to support feeding and breeding. Koalas once inhabited forests and woodlands of the fertile shale soils across the Cumberland subregion (DPIE 2020b), but due to the limited and fragmented nature of the remaining shale forest, the habitat that remains is crucial for Koalas to persist in the region (DPIE 2019).

There are large patches of Koala habitat on the eastern edge of the Cumberland Plain, largely surrounding the Nepean and Georges Rivers, and in corridors of vegetation along smaller watercourses in between. Koalas have been recorded throughout the area, with records concentrated in areas of highest interaction with humans (Figure 2.1). Care must be taken in interpreting that the areas with the highest concentration of sightings are where the greatest number of Koalas are, as the majority of Koala sightings come from public reports, and consequently the greatest number of sightings come from where the public can most easily come into contact with Koalas (Ward 2002). Koalas may be present on private lands, but they may not be reported (or reported less often) from these lands.

Habitat loss and fragmentation is a key threat to Koalas and to the south Sydney population. Fragmentation creates remnant patches of habitat where Koalas can become isolated, and limits dispersal for breeding and maintenance of genetic diversity. The increasing urbanisation of the Cumberland Plain will increase the importance of habitat corridors (CSE 2021). Figure 2.2 shows the areas of planned urban development in the Greater Macarthur Growth Area.

Connectivity between the Georges River and Nepean River is important for the resilience of the Southern Sydney Koala population. The Nepean and Georges River are classified as primary corridors because they are contiguous and are greater than 380 ha in size (DPIE 2019). There are six secondary corridors that run between the two areas, which are smaller and more fragmented (DPIE 2019, CSE 2020), but nonetheless important in supporting Koala movement through the landscape (Figure 2.3).

2.2 Ousedale Creek Corridor

The Ousedale Creek corridor runs from the Nepean River in the west, to Appin North in the east. It is within the Greater Macarthur Growth Area, in the Wollondilly Local Government Area. The bushland in the Ousedale Creek corridor constitutes part of the strategic conservation area under the CPCP and is considered critical habitat to the long-term viability of Koalas (DPIE 2020a, 2020b). In combination with the adjoining Mallaty Creek corridor to the north, the corridor contains 390 ha of high quality Koala habitat and is expected to support an estimated 20 Koalas (DPIE 2019) (Figure 2.3). The Ousedale Creek corridor is not classified as a primary corridor due to some fragmentation.

As per Commitment 12 of the CPCP (DPIE 2020a), the department will facilitate Koala movement in one east-west corridor in the region. The Ousedale Creek corridor contains the most habitat and is the preferred option of the six secondary corridors (CSE 2020).

As well as habitat protection, restoration of the corridor will also likely involve the construction of Koala crossings at Appin Road, measures to separate Koalas from urban areas and threats (exclusion fencing and buffer zones), and active management of Koalas such as through breeding and relocation (CSE 2020).

The current level of use of the Ousedale Creek corridor by Koalas is not known but will be investigated as part of this feasibility study through the deployment of motion sensor cameras (see Section 5).

The Upper Canal has been identified as a potential barrier to Koala movement within the Ousedale Creek corridor (CSE 2020, DPIE 2020b). Other potential barriers include:

- Appin Road, noting that DPE is working with TfNSW on development of the Ousedale Fauna Underpass at Appin Road;
- the narrow width of the vegetated area in proximity to the Appin Greyhound Track, and on private properties to the east of the Brian Road and Appin Road intersection, and to the south of the Macarthur Motorcycle Club;
- other infrastructure easements that cross the Ousedale Creek corridor; and
- fencing that may potentially be present, noting that the length of the corridor has not been inspected so it is unknown if fencing may be present that is a potential barrier to Koala movements.

2.3 Koala movement across the Upper Canal

The Upper Canal connects the Upper Nepean dams to Prospect Reservoir over 54 kilometres (km), supplying on average 20% of Sydney's water. It was constructed in the 1880s and is now heritage listed. The canal contains sections of open canal, tunnels to allow it to pass under hills, and pipelines to cross creeks and gullies.

Where the canal crosses Ousedale Creek, the creek line has steep sandstone cliffs to both sides. The open canal runs into a steel pipeline with a diameter of approximately 2.3 metres (m). On the upper banks of the creek line, the pipeline is semi-embedded in the ground, and as the banks drop away the pipeline runs across the valley, supported by sandstone pillars (Figure 2.4).

Along the sections of open canal, the vertical sandstone canal walls (up to 1.5–2 m in height) do not allow Koalas (or other fauna species) to cross, unless there is infrastructure such as access roads, stormwater drain chutes or bridge gantries across the canal. Where the pipeline is embedded in the ground, there is only a small gap between the cutting in the rock and the wall of the pipeline, with a drop of up to 2 m. In most places, Koalas would not be able to get through between the pipeline and the ground. The canal also presents a high risk of drowning if they attempt to swim across, or fall in, as they are unable climb out.

The large diameter and hard surface of the steel pipeline is very smooth presenting no grip and therefore not climbable for Koalas. Where the ground drops away, there are some sections where there is space for Koalas to cross underneath the pipeline, but the ground is very steep, and transitions into vertical cliffs that are impassable to Koalas.

As well as the canal infrastructure, there is a former vehicle track and fence line running parallel on the southern side of the canal and pipeline. The fence line presents a physical barrier to Koala movement.

Most infrastructure at the site is expected to be a barrier to Koala movement. A detailed physical description of the site is provided in Section 3.2. Further investigation into which animals can currently cross the canal and pipeline will be undertaken using motion sensor cameras (Section 5).

2.4 Opportunities for Koala crossings at the canal

Koalas have been found to generally move at ground level and may potentially move a significant distance during a 24-hour period. It is possible for Koalas to move between trees where the canopies interlock, but this is uncommon. Radiotracked Koalas in the local (Campbelltown) area have been observed to occasionally utilise steep sandstone gullies, and thus the Koala is known to be capable of crossing steep slopes and have been observed to be very agile at ground level. However, it is considered that the Koala would not be able to cross very steep or near vertical cliff-faces. To inform how Koalas currently move through the site, monitoring of current potential crossing points will occur with automated cameras (Section 5), and it is anticipated that this will assist to inform the Stage 2 design process and crossing solutions location refinement.

Some evidence of fauna movement across the canal alignment was observed during site inspections and crossing designs should aim to enhance the pathways that are already in use (Figure 2.4). Identified movement paths were mostly found passing underneath the pipeline where the banks are not too steep.

On the western bank of Ousedale Creek, it seems that some fauna species are able to pass under the embedded pipeline, where there is a slightly larger gap, as well as under the elevated pipeline at the top of the steep bank. There is a footbridge across the open canal to the west that could provide a potential crossing for Koalas, but it is currently considered that this is unlikely to be used.

On the eastern side of the creek, the banks are steeper. Two movement paths were visible. A narrow path under the pipeline was observed at the upper eastern edge of Ousedale Creek. The second path potential path leads to a vehicular bridge across the open canal (Figure 2.4).

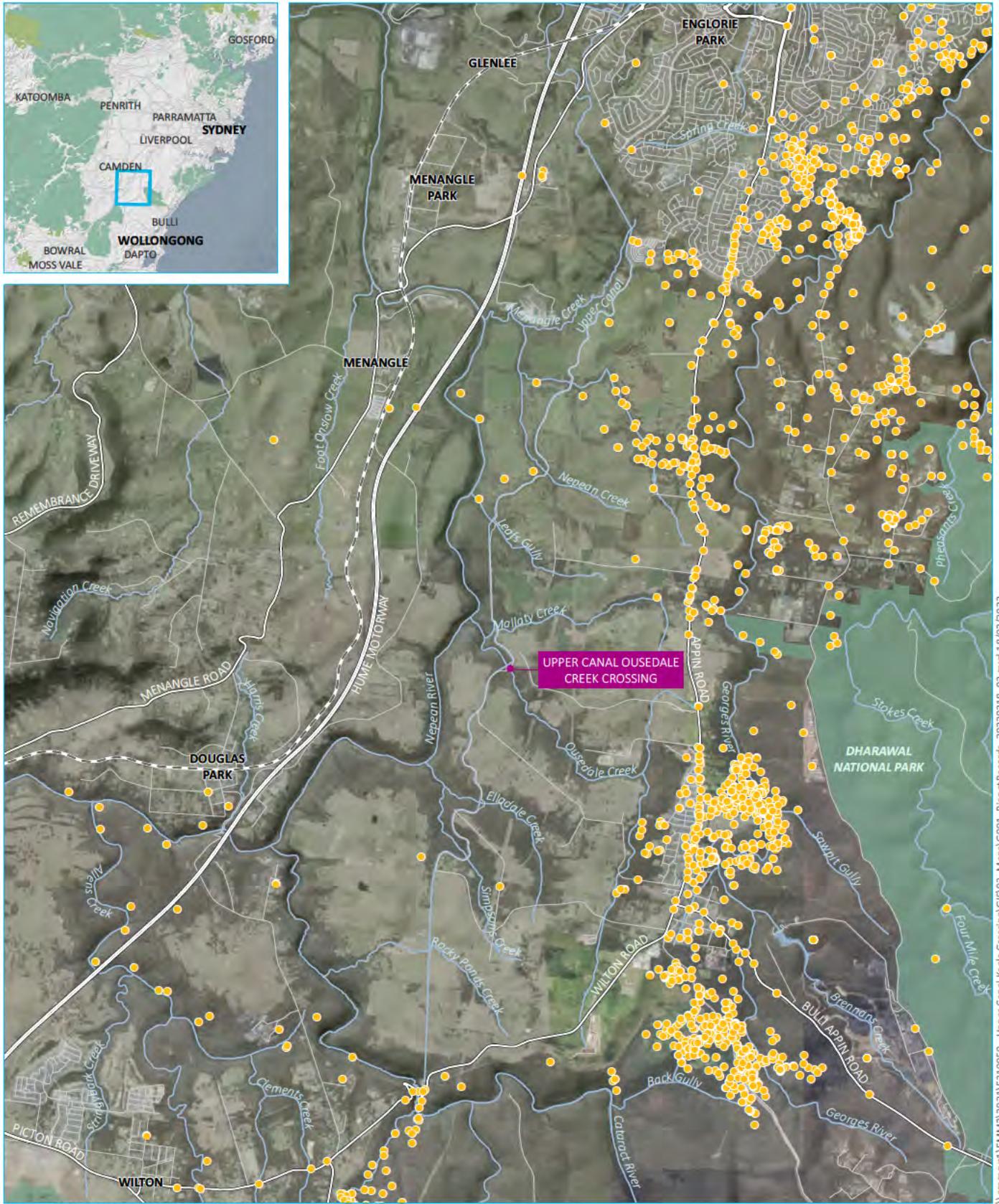
Where the fauna movement paths cross the boundary fencing, access holes have been pushed through and under the existing wire mesh fence by fauna, most likely by wombats.

There is also potential that Koalas may utilise the bottom of the Ousedale Creek for movement. Koalas can swim, but they may be discouraged from utilising this route by the presence of water at the bottom of Ousedale Creek, and flash flooding, as they will often prefer to stay dry where possible.

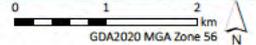
To assist Koalas in crossing the above structures and minimising impediments to access, the following crossing options could be considered:

- across the open canal (facilitating use of current structures where they exist, Photograph 2.1 and Photograph 2.2);
- over the embedded pipeline and across the access (Photograph 2.3);
- under the elevated pipeline and access road (Photograph 2.4);
- down the steep rocky banks road (Photograph 2.5) so Koalas can use the valley (Photograph 2.6) to cross the pipeline and access road; and
- under the fence line (Photograph 2.7).

Based on the current barriers, the above crossing options would facilitate the movement of Koalas as well as other fauna species across the canal infrastructure. Future developments such as new fencing without gaps may present new barriers to Koala movements (Section 3.3).



Source: EMM (2022); DFSI (2020, 2021); GA (2011); MetroMap (2022); DPE (2022)



KEY

- Bionet record - Koala (*Phascolarctos cinereus*)
- Rail line
- == Major road
- Minor road
- Named watercourse
- NPWS reserve

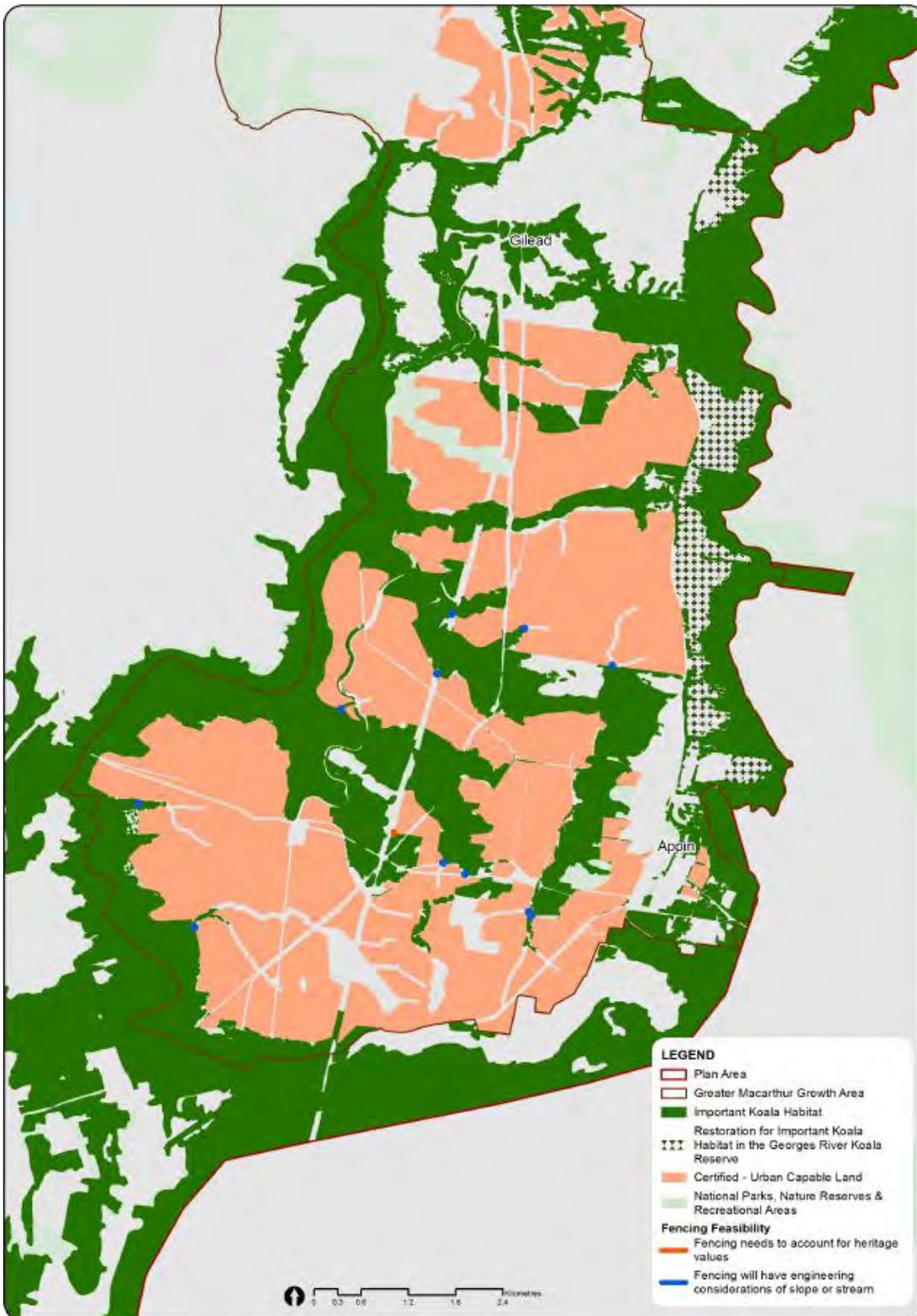
- INSET KEY**
- Major road
 - State forest

Koala records around Ousedale Creek Corridor

Ousedale Creek Corridor Feasibility Report
Figure 2.1

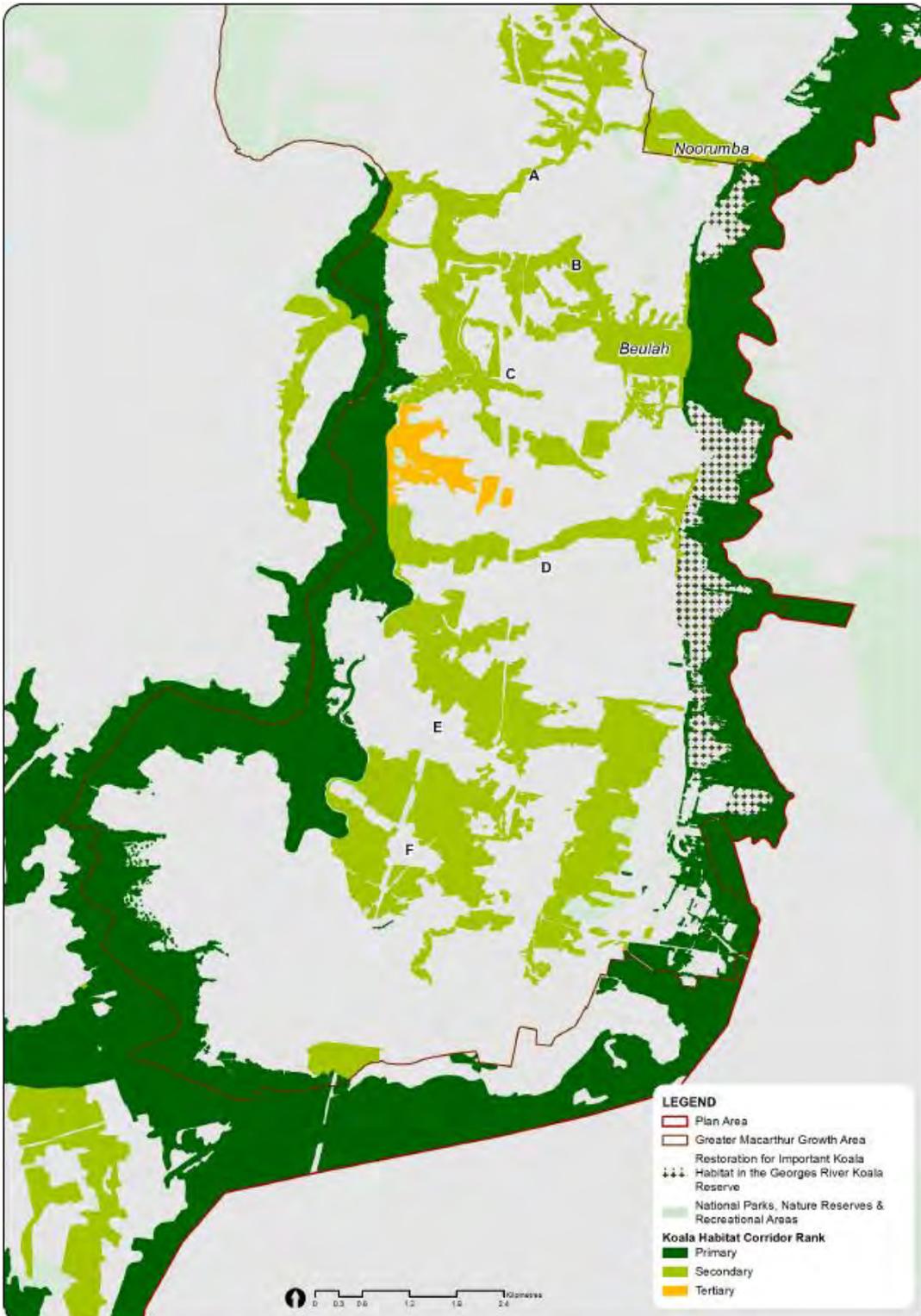


\\emmsvr1\EMM\3\2021\E210950 - Upper Canal Koala Crossing\GIS\02_Maps\G001_BionetRecords_20220318_02.mxd 18/03/2022



Source: DPIE 2020b

Figure 2.2 Planned urban development in the Greater Macarthur Growth Area



East-west corridors connecting Nepean River to Georges River A) Menangle Creek to Noorumba B) Woodhouse Creek to Beulah C) Nepean Creek to Beulah D) Mallaty Creek to Georges River E) Ousedale Creek to Appin North F) Elladale Creek and Simpson Creek to colliery. Source: DPIE 2020b

Figure 2.3 Koala movement corridors in the Greater Macarthur Growth Area

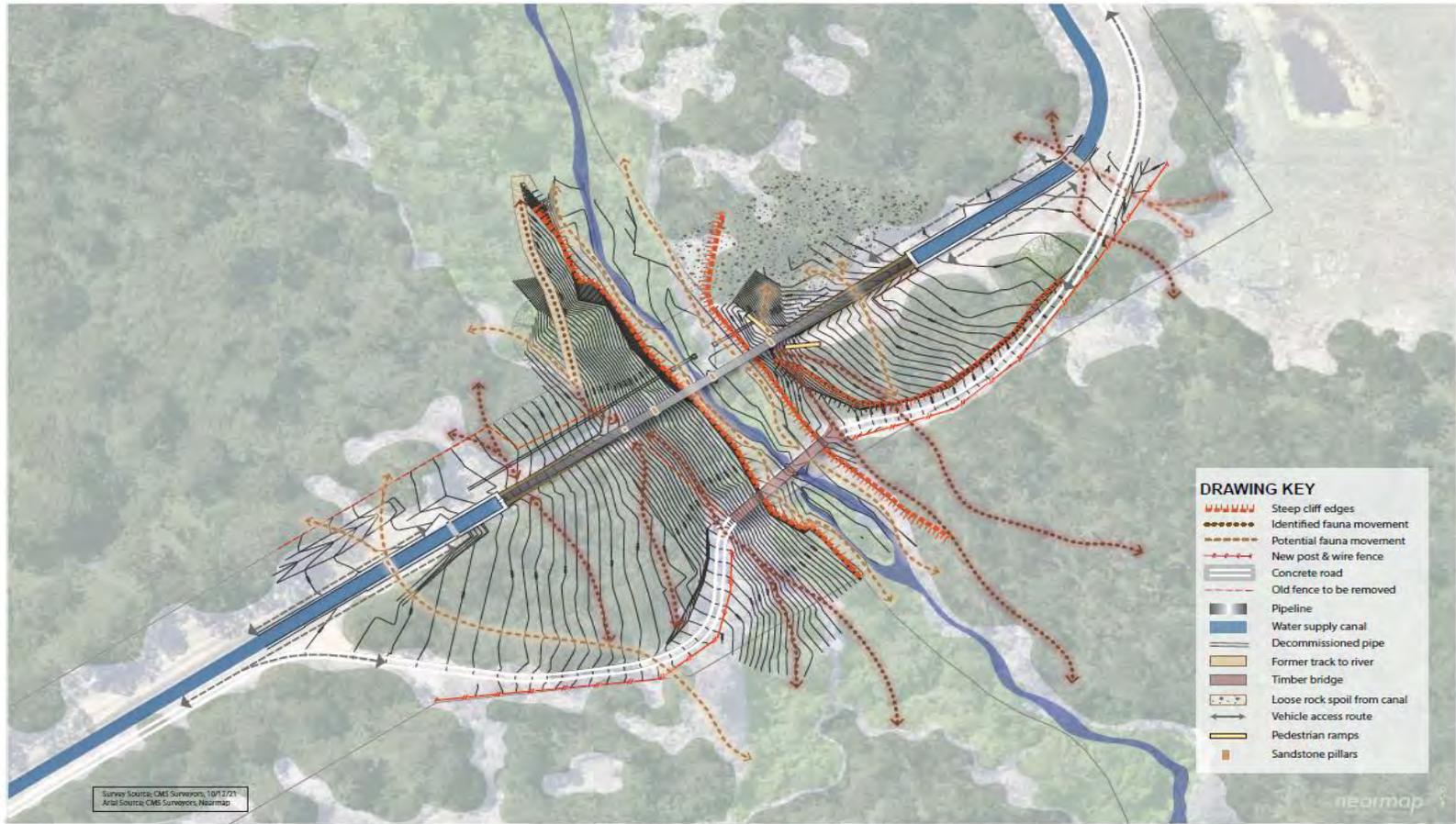


Figure 2.4 Fauna movement at Ousedale Creek



Photograph 2.1 Two current WaterNSW crossing structures over the Upper Canal, located to the south of Ousedale Creek. In the foreground is a bridge with a wood base, and in the rear is a bridge with a metal grid base



Photograph 2.2 WaterNSW vehicular access structures over the Upper Canal, located to the north of Ousedale Creek, with the base constructed of concrete



Photograph 2.3 WaterNSW Upper Canal pipeline to the north of Ousedale Creek, close to the transition to the open canal (the edge of which can be seen in the far right of the photograph). In this location the pipeline is embedded into the ground



Photograph 2.4 WaterNSW Upper Canal pipeline to the south of Ousedale Creek. In this location the pipeline located is embedded into the ground, and a potential fauna movement path is present, with a fauna monitoring camera installed on a star picket (Section 5, camera 9)



Photograph 2.5 Vertical cliff on the northern bank of Ousedale Creek adjacent to the WaterNSW access road. The southern bank is very steeply sloped, but can be traversed in locations



Photograph 2.6 Bottom of Ousedale Creek in proximity to the WaterNSW Upper Canal. The sandstone base of the creek is visible, along with pools of water



Photograph 2.7 Example of barbed wire fencing along the WaterNSW Upper Canal land at Ousedale, located to the north of Ousedale Creek looking towards the access road creek crossing

3 Canal stability, access, and safety

3.1 Site survey

To understand the existing site conditions, challenges and opportunities, the project team visited the Ousedale Creek study area on Monday 6 December 2021. Following the team inspection, TBLD visited the study area for a further detailed site investigation to develop potential Koala crossing options on Thursday 9 December 2021. As part of the project works, a feature level survey was prepared for the Ousedale Creek Koala Crossing study areas by CMS Surveyors.

The feature survey works covered the maintenance track, upper canal, elevated pipe, support pillars, abutments, embankments, adjacent infrastructure (stairs, fencing, etc), valley floor and creek.

The information, contours and features mapped during the survey allowed for the feasibility of potential crossing options to be fully explored and accurately illustrated. The full feature level survey plans provided by CMS Surveyors are included in Appendix A.

From the site inspection it was concluded that there is potential that the Koala may currently move through the Ousedale Creek corridor, especially as fauna movement trails were observed within the site (Figure 2.4).

3.2 Existing Conditions

The study area is focussed on land at the Upper Canal near Ousedale Creek, which is a vegetated creek in a deep gully. Surrounding the valley to the east and west are rural properties with pasture grasses, various stock, and farm fencing.

The eastern side of the gully is steep, with sheer sandstone cliff faces. The western side of the gully has a shorter sheer cliff but in general is steeply sloping, with a former access track cut diagonally down the western bank face to the north of the pipeline.

The Upper Creek Canal is a heritage-listed open channel water supply constructed from sandstone blocks, flowing from south-west towards the north-east, supplying raw bulk potable water supply to Sydney via Prospect Reservoir and water filtration plant. The deep flowing canal presents a significant physical barrier within the landscape, preventing the natural movement along the waterway corridor of Koalas and other native fauna species, except potentially via elevated crossings over creek lines or potentially via WaterNSW infrastructure over the canal (access roads, elevated stormwater drains, maintenance infrastructure). The open canal transitions into an elevated hot riveted steel heritage pipeline as it crosses the valley, supported on high sandstone pillars that are founded on the valley floor. The sandstone canal, the steel pipeline and sandstone pillars are recognised to have heritage significance and have been carefully considered in the Koala crossing solutions.

Appendix B.1 includes plans prepared by TBLD to illustrate the complex site features, values and functions of the wider site. These plans have been carefully considered during the preparation of design options, solutions and refinements.

3.3 Future development

During the design process, a range of future potential development proposals were identified and discussed. The key potential future developments that could have an impact on the movement of Koalas are outlined below:

- Adjacent Land Use – the private land adjacent to the study area is currently rural. This will change to low or medium density residential land use in the future, which would bring significantly higher vehicular and pedestrian activity to the area, reduce mature tree cover in the adjacent areas and increase the “hardened” stormwater catchment entering the Ousedale Creek catchment.
- Fencing – future fencing to the eastern side of the maintenance access road likely to be a standard WaterNSW 2.4 m chain link mesh fence, with triple strands of barbed wire to the top, to effectively prevent pedestrian access into the study area for safety and security purpose. The time frame for this higher fencing is dependent on adjacent development timing.
- WaterNSW development standards – any proposed works are not to limit the ability of WaterNSW to maintain access along Upper Canal.
- WaterNSW future works – any proposed works are not to limit the future ability of WaterNSW to augment supply and install additional water supply infrastructure, which could include a duplicate pipeline.

The above items are noted for context, however, the design approaches presented in this report deal with the current condition of the site. Future development should consider fauna movement paths through the Ousedale Creek corridor and seek to facilitate these opportunities. Consideration of the above potential future developments has influenced the design solution approaches towards flexible and (where possible) moveable designs.

4 Koala crossing options

4.1 Initial design options

Three 'design options' were prepared by TBLD in collaboration with EMM to explore early approaches to improving opportunities for Koala crossings. The three options were as follows (further details provided in Appendix B.2):

- Option 1: explored potential for improvements to existing Koala crossing movement patterns with lower impact interventions such as improving crossings under or over fences, or utilising existing bridges over the canal, and how they could be integrated into existing assets;
- Option 2: development of a new crossing over the pipeline, with exploration of where that could be ideally located and what form it could take, and understanding the implications for the canal assets; and
- Options 3: exploration of how crossings could utilise existing site conditions adjacent to the canal such as broken sandstone walls and innovative ways to solve the challenges faced in order to facilitate access over very large piles of loose rock scree and up very steep rock slopes.

4.2 Stakeholder input on design approaches

The three design options were presented to a stakeholder and client forum to gather feedback, understand potential issues and to guide refinements of design solutions. Minutes from the consultation are included in Appendix C.1.

Support was indicated for simple and low maintenance design options, which do not impact on WaterNSW activities or assets along the canal, with the following preferred as design solutions for koala access:

- crossings underneath existing mesh farm fences are preferred to climbing-based overhead structures, to allow use by other fauna;
- the low-level crossing over the top of the embedded pipeline was supported due to its simplicity and ability to be utilised by other fauna species; and
- both the log climbing structure over steep rocky areas and the excavation to allow movement underneath the steel pipeline were supported for their low maintenance, and low impact on WaterNSW assets.

WaterNSW also noted a preference for both the log climbing structure over steep rocky areas and excavation to allow movement underneath the steel pipeline, to structures which cross 'over' Upper Canal infrastructure.

4.2.1 Maintenance

The agency to be responsible for ongoing maintenance was raised by WaterNSW. This will be the subject of discussions between DPE and WaterNSW to determine interim and future long term asset owners and responsibility for maintenance. These discussions are to commence once DPE has made a decision on whether to proceed with a crossing at the location (decision to progress to Stage 2 for refined design, and then onto construction).

4.3 Refined design solutions

The following four design solutions are designed to respond to the current site conditions at Ousedale Creek but may also be applicable in other similar pipeline locations, with suitable modifications and adaptations to suit local conditions.

To improve fauna access and facilitate and encourage potential Koala movements along the Ousedale Creek corridor, four 'design solutions' were developed through workshops between TBLD and EMM. TBLD then prepared detailed graphical diagrams to represent the design solutions with explanatory text, site location plan and a 3D sketch visualisation in the actual site conditions.

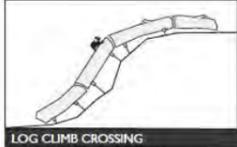
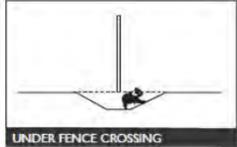
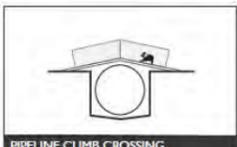
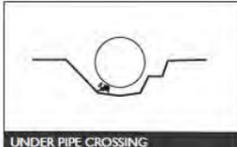
The four design solutions are as follows:

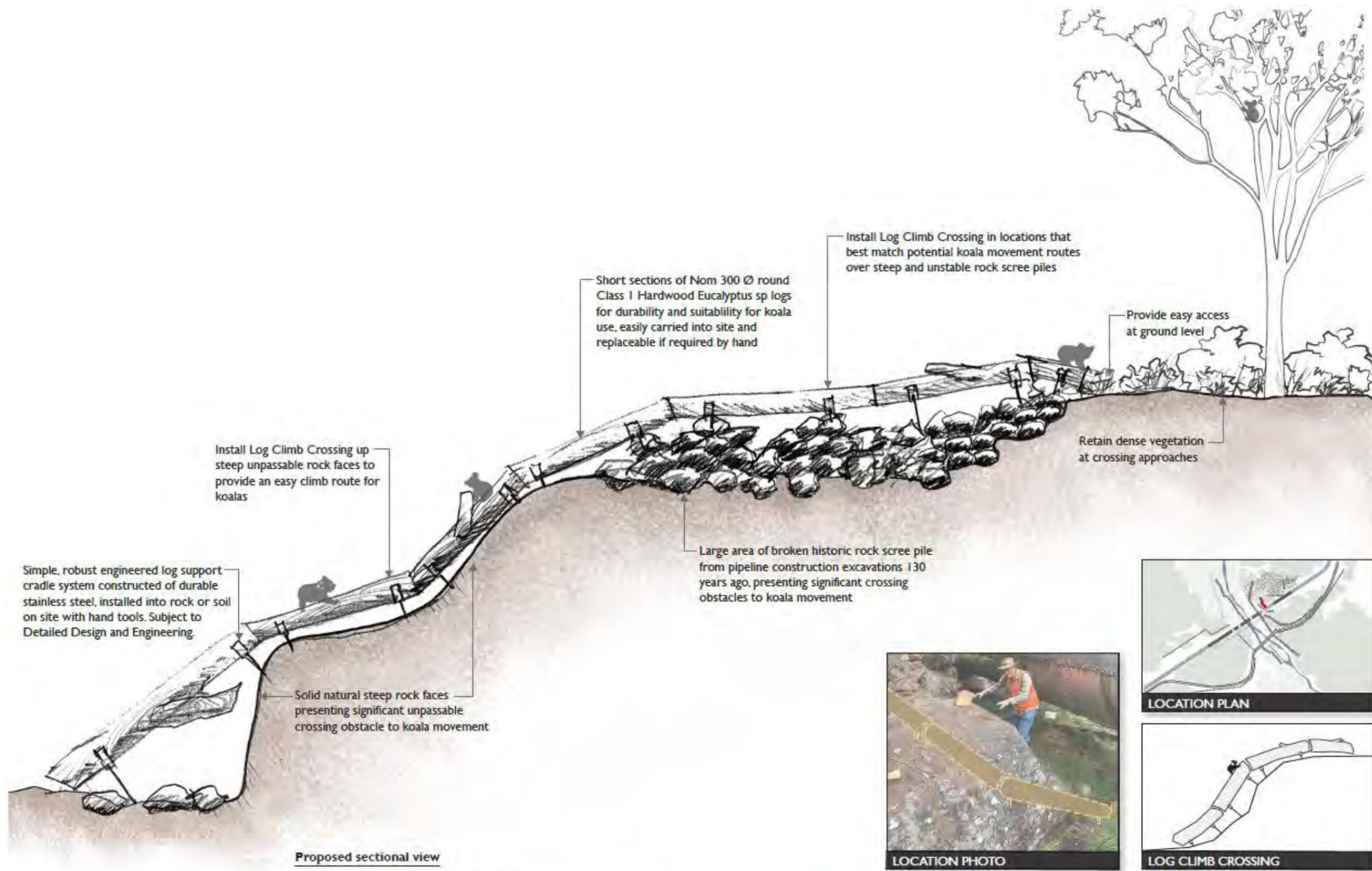
- **Solution A: Log Climb Crossing** comprising an angled log climb design solution that would provide Koalas with an accessible, familiar and easy to use solution for them to be able to climb up steep rock faces (which currently cannot be climbed) or traverse over large areas of scree rock (which current cannot easily be traversed). The solution uses natural selected hardwood log materials, supported on durable steel supports, with a design that is flexible and applicable to accommodate highly variable terrain, allowing for ease of on-site construction and maintenance. See Figure 4.1.
- **Solution B: Under Fence Crossing** comprising a low-tech constructed solution for under fence crossings, where wombats have currently forced or dug their way under fences. The solution comprised a structural hardening of the tunnel access, to prevent further enlargement or damage to the fence, using recycled and natural materials with integration into existing wombat tunnels providing a known and familiar crossing solution, in a low profile and easy to use design, hidden within native grasses. See Figure 4.2.
- **Solution C: Pipeline Climb Crossing** comprising a constructed low profile, light weight fauna crossing, that would provide Koalas with an accessible, non-threatening and easy to use solution for them to be able to use that would allow Koalas to easily cross over the pipeline at points where the large steel pipe is virtually embedded in the sandstone banks and impassable. The low-level crossing would comprise light weight metal frames panels, with side panels, with a bespoke, durable and simple locking and lifting mechanism to enable fast and easy removal for pipeline servicing. The crossing would provide safe access for both fauna and maintenance staff if required. See Figure 4.3.
- **Solution D: Under Pipe Crossing** comprising an access crossing excavated into the sandstone banks providing lower gradient approach banks to access the existing clearance under the pipeline that would provide Koalas with an accessible, non-threatening option to cross under the pipeline at this specific point where the sandstone banks are partially lowered, and fauna appear to currently use the route. The crossing would require excavation and removal of sections of the sandstone banks to both sides with suitable handheld power saw and hammer machinery and roughening of the surfaces with a scabbling tool for grip. See Figure 4.4.

Table 4.1 provides a summary of each option and Figure 4.1 to Figure 4.4 provide the location, technical and conceptual approach for each design solution.

Table 4.1 Summary of Design Solutions for Koala crossing interventions at Ousedale Creek

Indicative Cost Range: \$ (low) to \$\$\$\$ (high)
 \$ is indicatively \$5K - \$15K cost; \$\$ is \$15K - 50K cost; \$\$\$ is \$50K-100K cost; \$\$\$\$ is \$100K - \$150K cost.
 The cost codes (\$, \$\$, \$\$\$ and \$\$\$\$) shown below indicate the variable cost range at sketch design, which would be updated to reflect subsequent refinement of each design solution and will vary according to the scale of actual site works. Cost estimates will be refined in Stage 2 Detailed Concept and again in the subsequent Detailed Engineering Design works.

Design Solution Number	Brief description of the design solution <i>Note: designs are subject to detailed concept development and engineering design.</i>	Likely performance from a Koala perspective	Implications for canal or pipe integrity and construction methods	Ability of Water NSW to access, maintain, and operate their infrastructure	Historic heritage impact to canal and pipeline	Flood risk to design solutions	Unauthorised human access risk to design solutions	Bushfire risk to design solutions	Indicative cost (excluding approvals)
A 	Install durable hardwood Eucalyptus sp. Logs (easily movable and can be installed on site with hand tools) to create a log climb structure in locations that best match potential Koala movement routes over unstable rock scree piles. Potential location near the end of decommissioned pipeline towards the eastern side over large, exposed rock faces and rock spoil areas.	Construction from selected Eucalyptus logs will make the structure appealing for Koala use. Log climbing is a common movement for Koalas.	Located in proximity to pipeline but not connected structurally in any way. Construction would require material movement into site by hand, and construction with hand tools and portable power generator.	Log Climb Crossing will not adversely impact Water NSW access to their infrastructure.	Log Climb Crossing would be naturalistic in form and materials, with discreet structural supports presenting minimal impact on the pipeline and sandstone channel heritage curtilage.	Solution not impacted by flood.	Log Climb Crossing would utilise round smooth logs to deter climbing access. It would present low risk.	The design solution would utilise fire resistant Eucalyptus species to withstand grassfires. The design would allow for easy replacements of section(s) should fire cause damage.	\$\$\$
B 	Install along existing fauna movement lines, along the waterway corridor sides. The design provides functional Koala access via formalised holes under fence dug by wombats. The holes would be lined with WPC (Wood Plastic Composite) profile to deter additional digging, with ag drain to drain away surface water to grass areas downslope. The crossing would be hidden within retained grassy vegetation.	Crossing should be easy for Koalas to use, given its short distance, placement along existing access pathways, and in proximity to ground level.	Not located in proximity to canal or pipeline assets. Construction would not damage existing fence. Construction would require material movement into site by hand with hand tools and portable power generator.	Under Fence Crossing will not adversely impact Water NSW access to their infrastructure.	Under Fence Crossing will have no impact on historic heritage values or pipeline and sandstone channel heritage curtilage.	May temporarily be impacted then will freely drain.	Under fence crossing is suited for small animals but is a deterrent for humans due to the access shape and small clearance. It is also visually disguised by planting. It would present low risk.	Under Fence Crossing would be constructed of fireproof WPC (Wood Plastic Composite) material.	\$
C 	Installing, low profile and lightweight ramp panel structure, which can be easily installed, lifted or hinged out of the tunnel area by one person, for ease of crossing or pipeline maintenance access. The crossing would have transparent steel mesh infill to stop fauna falling onto pipeline. The ramp extends from the two banks of the sandstone channel, secured in the middle, with non-invasive supports to sides. Installed at the location where pipeline embedment is deepest in the ground, to minimise ramp height, and to encourage fauna to cross over across the pipeline. The structure would be designed to take maintenance staff loading.	Structure should be easy for Koalas to cross, given that it connects at ground level. Surfaces will be developed to provide a comfortable crossing environment for koalas. Effectiveness can be enhanced with low vegetation cover on both sides of the crossing.	Located directly over pipeline and designed so as to be self-supported and not connected to, or inhibiting access to, pipeline for maintenance access. Structurally connected to earthen banks outside the walls, but not connected to sandstone walls. Independently supported with earth anchors that are fully reversible if the ramp is removed or relocated.	Can be removed and relocated if required for access to another site by hand.	Pipeline Crossing would be lightweight (aluminium) and painted with neutral colours, with independent supports that are not attached to the pipeline or sandstone canal walls. The structure would be completely reversible without impact on the tunnel and sandstone wall curtilage.	Pipeline crossing would not be impacted by flood as it is in an elevated location.	The design includes side infill and top rail to provide safe maintenance access without risk of falling onto pipeline. It would present low risk.	The Pipe Crossing would be constructed of fireproof material such as aluminium and light woven steel mesh and fireproof WPC (Wood Plastic Composite) supports.	\$\$\$\$
D 	Excavation of the currently fractured rock faces on both sides of pipeline at this identified location on an existing fauna movement line. The rock slope would be widened, the angle of slope lowered and the surface heavily scabbled to improve grip. It would provide Koala and fauna movement to easily climb down, pass under the pipeline supports, and back up without disturbing the pipeline structure.	The gentle slope of the approach and natural surface of the crossing should make this an effective solution for Koalas to cross.	Under Pipe Crossing is directly adjacent to and under the pipeline. Works would require careful removal of sandstone rock to the sides of canal banks to create desired crossing incline. This would require sandstone saw cuts, light hydraulic hammer and chisel works.	Under Pipe Crossing would provide enhanced access to the underside of pipeline for inspection. Maintenance pedestrian access would be retained along the top of the bank with minimal clearing of vegetation.	Located in a site where there is already natural fractures and deformation of the canal bank wall. Works would maintain rough naturalistic character of a weathered rock and not exhibit period cut stone masonry techniques, without impact on the tunnel and sandstone wall curtilage.	Could temporarily be impacted then freely drain.	The face would be steep to deter human access and minimal clearance under pipeline would prohibit human access. It would present low risk.	No fire risk for Under Pipe Crossing.	\$\$



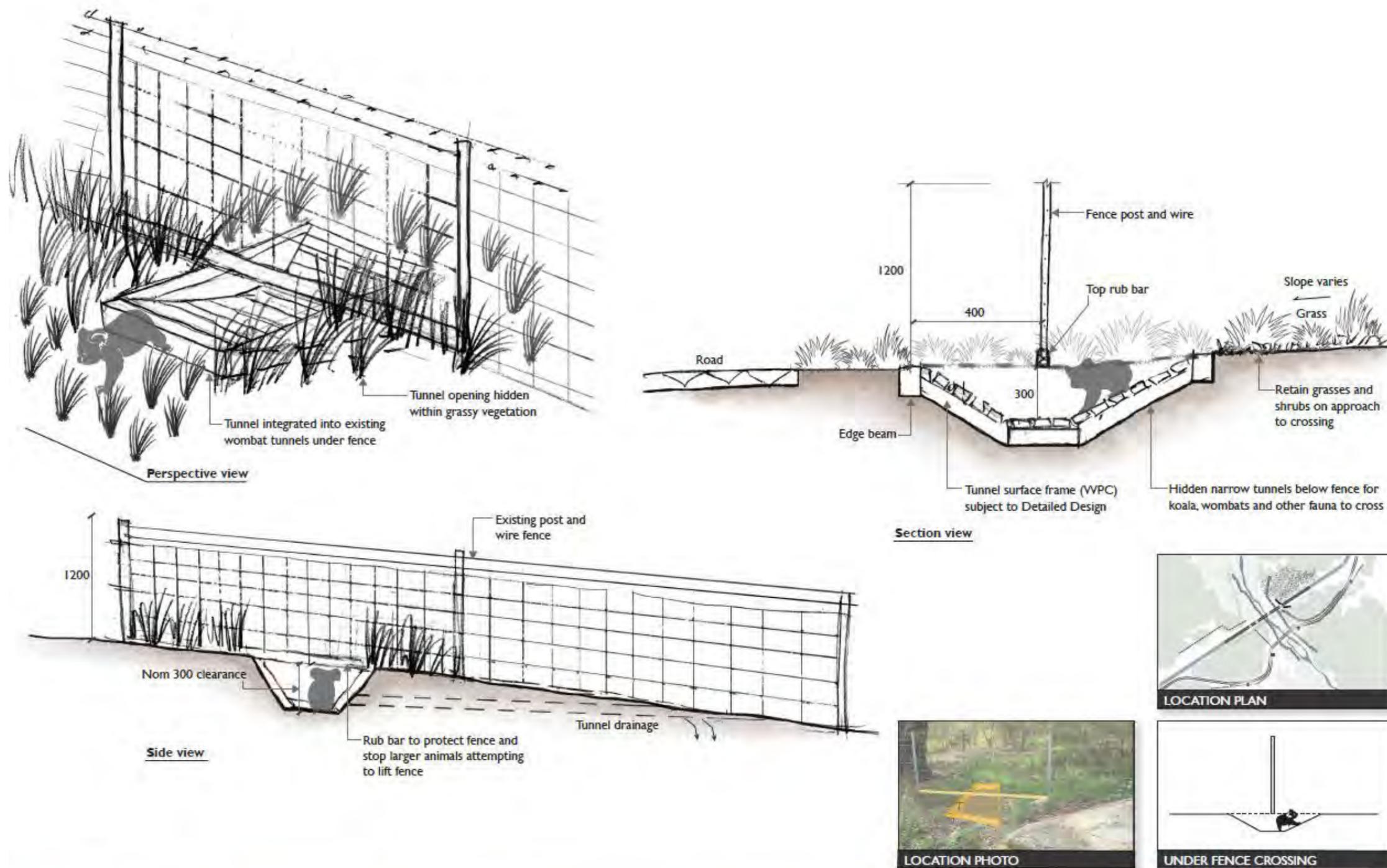





DESIGN SOLUTION A : LOG CLIMB CROSSING
Koala Crossing - Upper Canal

02 MAR 2022
 DWG No. KC_C8 **C8**

Figure 4.1 Design Solution A



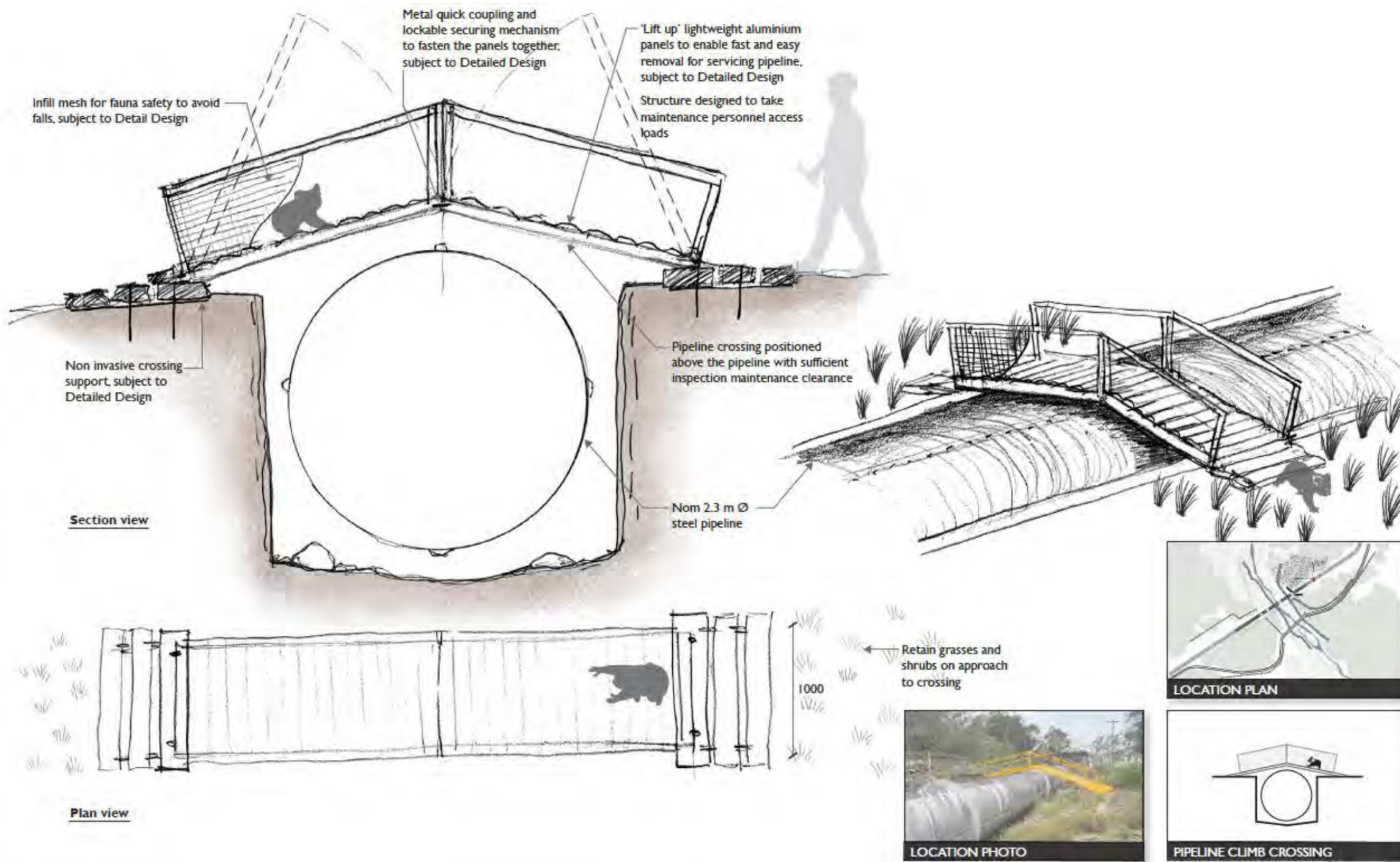





DESIGN SOLUTION B : UNDER FENCE CROSSING
Koala Crossing - Upper Canal

02 MAR 2022
 DWG No. KC_C9 **C9**

Figure 4.2 Design Solution B








DESIGN SOLUTION C : PIPELINE CLIMB CROSSING
Koala Crossing - Upper Canal

02 MAR 2022
 DWG No. KC_C10 **C10**

Figure 4.3 Design Solution C

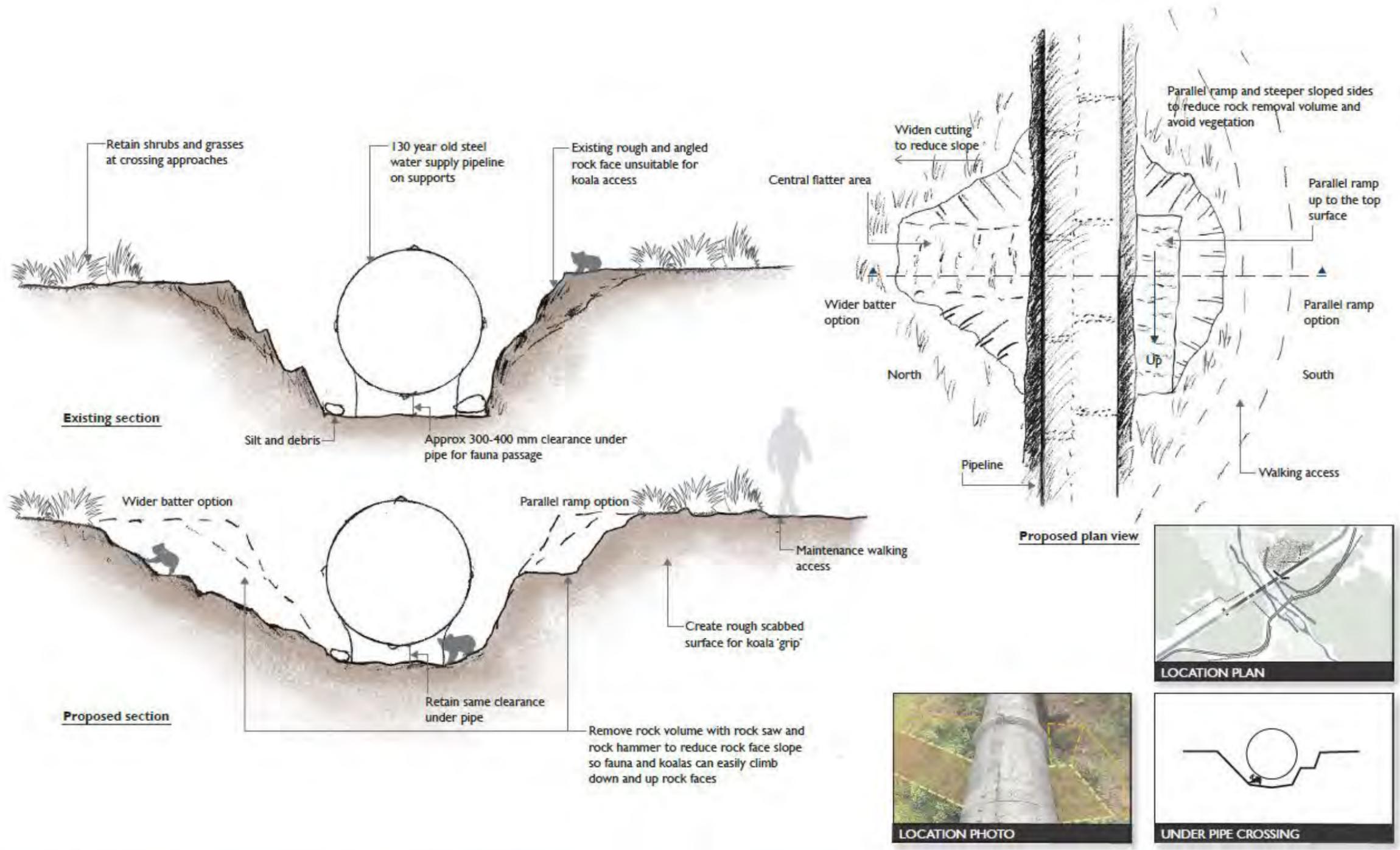


Figure 4.4 Design Solution D

5 Camera Monitoring

5.1 Purpose

EMM will be installing motion sensor cameras at 10 key locations in the crossing area, targeting fauna paths and potential crossing points. The images from the cameras will provide information on which species are present in the area, the locations they are currently able to cross, and whether Koalas are currently crossing the canal and pipeline.

5.2 Camera monitoring methods

Ten cameras will be deployed at the locations shown in Figure 5.1, targeting existing fauna movement paths and potential crossing locations. It is noted that, as per the works approved by DPE, whilst ten cameras will be utilised, one camera is of a lower specification and may not be reliable. EMM will place this in a location considered to be a lower priority.

Camera batteries will be changed, and images downloaded each month, for a period of 3 months. Images will be analysed by EMM and any fauna species detected at each camera location will be identified where possible.

5.3 Results and implications

The camera monitoring study commenced on Wednesday 27 April. Results will be provided in Appendix D when they are available.

Results from camera monitoring will reveal whether Koalas (and other fauna species) are currently able to cross the Upper Canal and pipeline infrastructure. It will inform the placement of potential crossings by revealing preferred pathways of fauna species moving through the area.

If no Koalas are recorded in the images, the ability of other fauna species (their size and climbing ability) can be used to inform crossing options for Koalas. As for the results, brief discussion of the implications for the crossing designs will be presented in Appendix D.

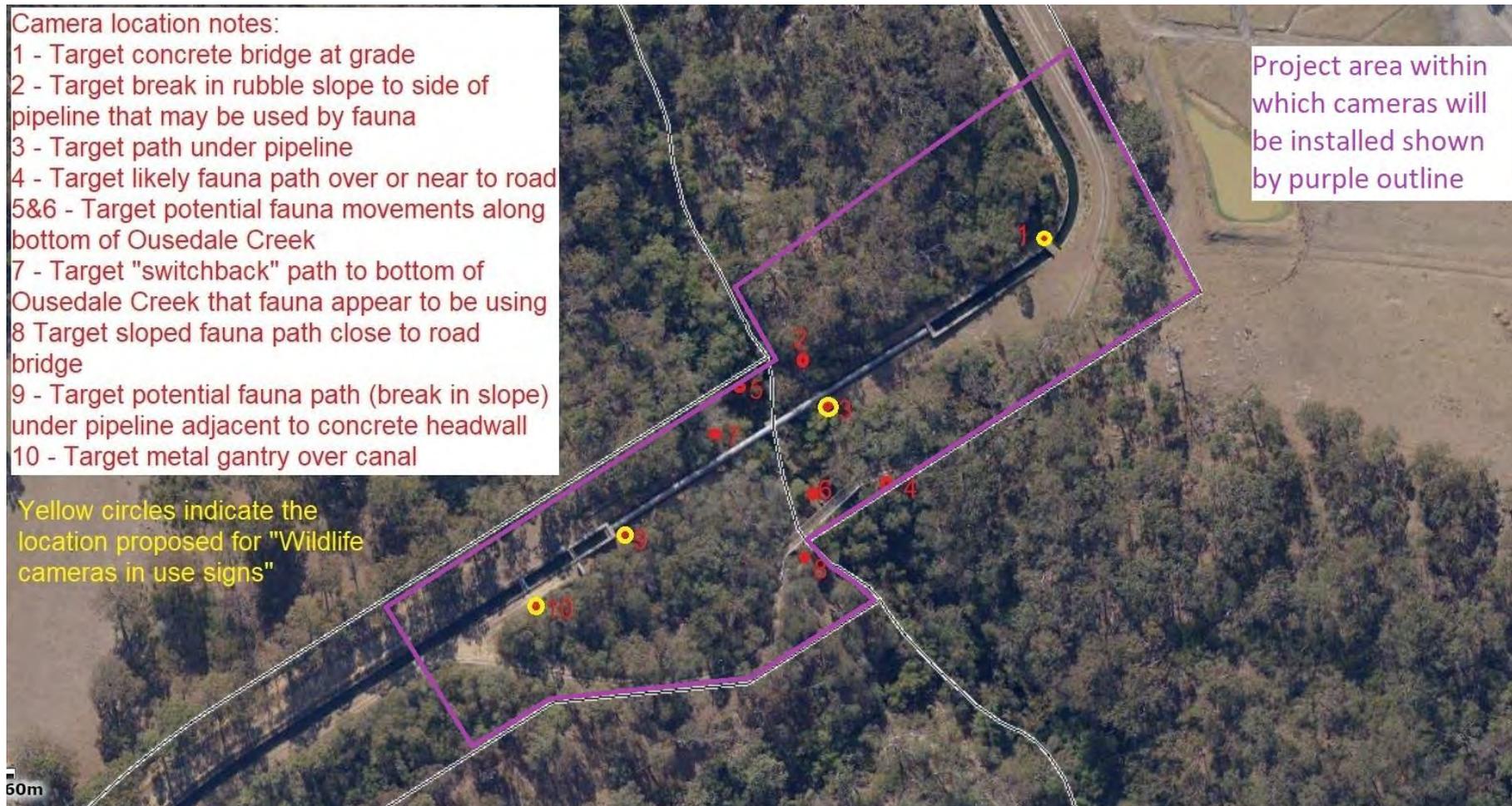


Figure 5.1 Camera monitoring locations

6 Impact assessments required

6.1 Initial planning insights

The approvals pathway for the project will depend on which design solutions are proposed. The impact assessments and reporting requirements will also depend on the final design choices. Once the full suite of activities is determined, the approvals pathway will be confirmed as either a Development Assessment (Part 4) or Environmental Assessment (Part 5) under the *Environmental Planning and Assessment Act 1979* (EP&A Act).

6.1.1 State Environmental Planning Policy (Exempt and Complying Development Codes) 2008

i Exempt development provisions

State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 ('the Codes SEPP') sets out some general provisions at section 1.16 which all exempt and complying development must meet.

Pursuant to subsection 1.16(1)(c):

To be exempt development for the purposes of this Policy, the development ... must not be carried out on land that is, or on which there is, an item that is listed on the State Heritage Register under the *Heritage Act 1977*, or that is subject to an interim heritage order under that Act.

Despite the provisions of subsection 1.16(1)(c), subsection 1.16(1A) provides that the development may nevertheless be classified as exempt if it meets the requirements and standards specified in the Codes SEPP and if the development:

- (a) has been granted an exemption under section 57(2) of the *Heritage Act 1977*, or
- (b) is subject to an exemption under section 57(1A) or (3) of that Act.

There is no specific provision within the Codes SEPP for structures to facilitate animal movement. There is a provision at Subdivision 24 for *landscaping structures* to be exempt development but the specified development states that it "must not constructed or installed on or in a heritage item or a draft heritage item" (section 2.47).

6.1.2 State Environmental Planning Policy (Transport and Infrastructure) 2021

i Exempt development provisions

State Environmental Planning Policy (Transport and Infrastructure) 2021 ('the Transport and Infrastructure SEPP') also includes certain provisions at Schedule 1 which identify development which can be classified as exempt development if undertaken by a public authority.

There is a type of development described as 'investigations' which may be available for some of the activities. The description of 'investigations' is:

Investigations (including geotechnical and other testing, surveying and the placement of survey marks, and sampling) relating to proposed development or for the purposes of system development or determining the safety or condition of infrastructure

The relevant development controls for investigations are:

- Must not involve any greater disturbance of the ground or vegetation than is necessary.
- Must not result in an increase in stormwater drainage or run-off from the site concerned

Section 5.24 of the Transport and Infrastructure SEPP notes however that to be exempt development, the development

if it is likely to affect a State heritage item or a heritage item or heritage conservation area specified in an environmental planning instrument, must involve no more than minimal impact on the heritage significance of the item or area

ii Environmental management works

There is a category of development called environmental management works which is defined as follows:

environmental management works means—

- (a) works for the purpose of avoiding, reducing, minimising or managing the environmental effects of development (including effects on water, soil, air, biodiversity, traffic or amenity), and
- (b) environmental protection works.

Broadly, there are provisions for environmental management works to be carried out without consent, however those provisions are not general but rather are limited to the purpose described in the relevant Division. For example, it is possible to undertake environmental management works for the purpose of *water supply systems* (as defined).

It is also possible to undertake environmental management works for the purpose of *parks and reserves* (as defined).

Section 2.158 of the Transport and Infrastructure SEPP identifies development permitted without consent and states (underlining added):

2.158 Development permitted without consent

(1) Development for the purpose of water reticulation systems may be carried out by or on behalf of a public authority without consent on any land.

(2) Development for the purpose of water storage facilities may be carried out without consent if it is carried out by or on behalf of—

(a) any public authority on land in Zone RU1 Primary Production, Zone RU2 Rural Landscape, Zone SP1 Special Activities, Zone SP2 Infrastructure or an equivalent land use zone, or

(b) Water NSW on land within the Sydney catchment area within the meaning of the *Water NSW Act 2014*.

(3) A reference in subsection (2) to development for the purpose of water storage facilities, includes a reference to development for any of the following purposes—

(a) catchment management works,

(b) recreation areas associated with a water storage facility.

(4) Development for the purpose of water treatment facilities may be carried out by or on behalf of a public authority without consent on land in a prescribed zone.

(5) Development for the purpose of a water supply system may be carried out on land reserved under the *National Parks and Wildlife Act 1974* only if it is authorised by or under that Act.

(6) In this Division, a reference to development for the purpose of a water supply system of any kind includes a reference to development for any of the following purposes if the development is in connection with the water supply system—

- (a) dams, reservoirs, weirs, levees, spillways and fishways,
- (b) catchment management works,
- (c) groundwater investigation works, groundwater bore stations, borefields, minewater works and the like,
- (d) access ways,
- (e) water intakes, pumping stations, pipelines, channels, tunnels, canals and aqueducts,
- (f) gauging and monitoring equipment,
- (g) power supply to the water supply system,
- (h) hydro-electric power generation equipment and associated connections to the electricity network,
- (i) construction works,
- (j) emergency works and routine maintenance works,
- (k) environmental management works,
- (l) schemes for the reuse of water treatment residuals,
- (m) maintenance depots.

(7) Development for any of the following purposes may be carried out by or on behalf of Water NSW without consent on any land—

- (a) investigations into the availability of groundwater (including mine water), extraction of groundwater or mine water, and associated water reticulation systems,
- (b) development to enable access to deep water extraction in dams within the Sydney catchment area within the meaning of the *Water NSW Act 2014*, including investigations, associated works or equipment and construction works and other water supply infrastructure, such as the Megarrity's Creek Water Pumping Station and other Warragamba Emergency Scheme works.

Section 2.157 refers to definitions provided in the Standard Instrument – Principal Local Environmental Plan ('the Standard Instrument'). The relevant definitions are shown below:

water supply system means any of the following—

- (a) a water reticulation system,
- (b) a water storage facility,
- (c) a water treatment facility,
- (d) a building or place that is a combination of any of the things referred to in paragraphs (a)–(c).

water reticulation system means a building or place used for the transport of water, including pipes, tunnels, canals, pumping stations, related electricity infrastructure and dosing facilities.

Noting therefore that the definition of environmental management works includes “works for the purpose of avoiding, reducing, minimising or managing the environmental effects of development (including effects on water, soil, air, biodiversity, traffic or amenity”, it could be reasonable to form a view that the development options for Koala crossings at Ousedale Creek are for the purpose of managing the environmental effects of the Upper Canal on biodiversity.

If that characterisation is supported, then subsections 2.158(1) and 2.158(6)(k) identify that the works are permitted without consent. This assumes that the works are to be carried out by, or on behalf of, a public authority.

6.1.3 Environmental Planning and Assessment Act 1979

Part 5 of the *Environmental Planning and Assessment Act 1979* (‘the EP&A Act’) addresses the need for environmental impact assessment.

Again, assuming that the proponent is a public authority, there is an obligation placed on that public authority (and potentially other public authorities which need to grant an approval) pursuant to subsection 5.5(1) to “examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity”.

This requires the preparation and consideration of a Review of Environmental Factors (REF) pursuant to clause 171 of the Environmental Planning and Assessment Regulation 2021.

6.2 Environmental assessments

Environmental impacts are expected to be low, with little to no vegetation clearing anticipated as part of these designs. If the development proceeds under the anticipated Review of Environmental Factors (Part 5) approval pathway, a Flora and Fauna Assessment will be required, and it is considered highly unlikely that impacts would to biodiversity values would be significant, due to the very low impact of the refined designs.

The area is heritage listed and considered a controlled area under the *Water NSW Act 2014*. A heritage assessment and statement of heritage impact will be required for any plans going forward. The report will have to assess impacts to the state significant values of the item.

Works may also have to be assessed for other impacts such as visual or noise. If assessed via a Review of Environmental Factors approval pathway these impacts could likely be assessed within the Review of Environmental Factors itself, rather than engaging standalone specialist reports.

The full list of assessment requirements will be determined in Stage 2 of the project, once designs are updated for assessment purposes. Once approved, detailed designs would need to be prepared for construction purposes.

7 Conclusion

As urban development progresses in the Cumberland Plain, it is important to protect biodiversity values of the area, as outlined in the CPCP. Maintaining habitat connectivity is crucial in supporting the Koala population in the region. In particular, the primary habitat corridors of the Nepean and Georges River need to be connected through an east-west movement corridor. The Ousedale Creek corridor has been identified as the most suitable option for supporting Koala movement in the area (CSE 2020, DPIE 2021).

The Upper Canal and associated infrastructure currently present challenges to Koala movement through the Ousedale Creek corridor. Based on the site inspection it is considered that there is potential that the Koala may currently move through the Ousedale Creek corridor at the Upper Canal site, due to the fauna paths observed within the site. However, currently Koalas would face difficulty and challenges when attempting to cross the open canal, the fence lines, the pipeline and the steep rocky slopes along the creek line. To better understand whether, or how, the Koala currently moves through the site, fauna camera monitoring will be conducted. Results from this monitoring are not yet available, but do not preclude development of concept solutions to be pursued to deliver improvement of Koala connectivity at the site. The camera monitoring results may assist in spatial location and installation of crossing design solutions.

The designs outlined in this report are intended to facilitate Koala movement at the site. A total of four design solutions have been prepared. Importantly, it is noted that these access solutions are complementary and provide enhanced access solutions to separate movement challenges identified at the site. That is, all solutions have the potential to improve Koala movement through the Ousedale Creek corridor and connection between the primary habitat corridors of Nepean and Georges Rivers.

It is recommended that all proposed design options are pursued, in order to minimise barriers to Koala movement. Each design approach is unique and offers a potential solution to the varied challenges presented by the canal and pipeline infrastructure and the immediate site conditions. The proposed design solutions have the potential to be applied in other areas where fauna crossings are required over similar infrastructure, with modifications to accommodate inherent site conditions.

References

CSE 2020, *Advice on the protection of the Campbelltown Koala population: Koala Independent Expert Panel*, NSW Chief Scientists and Engineer.

CSE 2021, *Advice regarding the protection of Koala populations associated with the Cumberland Plain Conservation Plan*, NSW Chief Scientists and Engineer.

DPIE 2019, *Conserving Koalas in the Wollondilly and Campbelltown Local Government Areas*, Department of Planning, Industry and Environment.

DPIE 2020a, *The Draft Cumberland Plain Conservation Plan: A conservation plan for Western Sydney to 2056*, Department of Planning, Industry and Environment.

DPIE 2020b, *Sub-Plan B: Koalas: Draft Cumberland Plain Conservation Plan*, Department of Planning, Industry and Environment.

DPIE 2021, *Response to advice from the Office of the NSW Chief Scientist & Engineer 2021: Protection of Koala populations associated with the Cumberland Plain Conservation Plan*, Department of Planning, Industry and Environment.

Ward S 2002, *Koalas and the community: a study of low density populations in southern Sydney utilising community reports, opportunistic captures and radio-tracking techniques*. Ph.D. thesis, University of Western Sydney, Campbelltown.

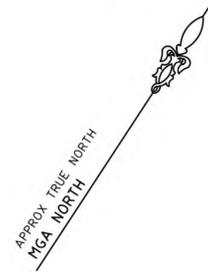
WaterNSW 2018, *Guidelines for development adjacent to the Upper Canal and Warragamba pipelines*, WaterNSW



Appendix A

Survey plans





1
D.P.816861

SEE SHEET 2

2
D.P.625921

SEE SHEET 3

1
D.P.625921

SEE SHEET 4

1
D.P.816861

OUSEDALE

CREEK

105
D.P.1188670



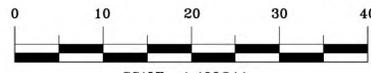
Note:
FOR THE PURPOSE OF THIS SURVEY, ALL TITLE PARTICULARS INCLUDING EASEMENTS, COVENANTS RESTRICTIONS, RIGHTS, AND RIGHTS OF CARRIAGEWAY HAVE NOT BEEN INVESTIGATED OR DETERMINED AS PART OF THIS SURVEY.

Notes:

- BOUNDARIES SHOWN ARE FROM DIGITAL CADASTRAL DATABASE (DCDB) PLOT. NO RESPONSIBILITY IS TAKEN BY CMS SURVEYORS AS TO THE LOCATION OR INTEGRITY OF THESE BOUNDARIES. THE LOCATION OF THESE BOUNDARIES MUST BE TAKEN AS INDICATIVE ONLY AND IS SUBJECT TO SURVEY. NO TITLE INVESTIGATION HAS BEEN UNDERTAKEN
- IF ACCURATE BOUNDARIES ARE REQUIRED LPI SEARCH & GROUND SURVEY WOULD BE REQUIRED.
- TREE SIZES ARE ESTIMATES ONLY.
- THIS PLAN HAS BEEN PREPARED FOR THE EXCLUSIVE USE OF THOMPSON BERRILL LANDSCAPE DESIGN.
- RELATIONSHIP OF IMPROVEMENTS TO BOUNDARIES IS DIAGRAMMATIC ONLY. WHERE OFFSETS ARE CRITICAL THEY SHOULD BE CONFIRMED BY FURTHER SURVEY.
- EXCEPT WHERE SHOWN BY DIMENSION LOCATION OF DETAIL WITH RESPECT TO BOUNDARIES IS INDICATIVE ONLY.
- ONLY VISIBLE SERVICES HAVE BEEN LOCATED. UNDERGROUND SERVICES HAVE NOT BEEN LOCATED. DIAL BEFORE YOU DIG SERVICES (BY 1100) SHOULD BE USED AND A FULL UTILITY INVESTIGATION INCLUDING A UTILITY LOCATION SURVEY, SHOULD BE UNDERTAKEN BEFORE CARRYING OUT ANY CONSTRUCTION ACTIVITY IN OR NEAR THE SURVEYED AREA.
- CRITICAL SPOT LEVELS SHOULD BE CONFIRMED WITH SURVEYOR.

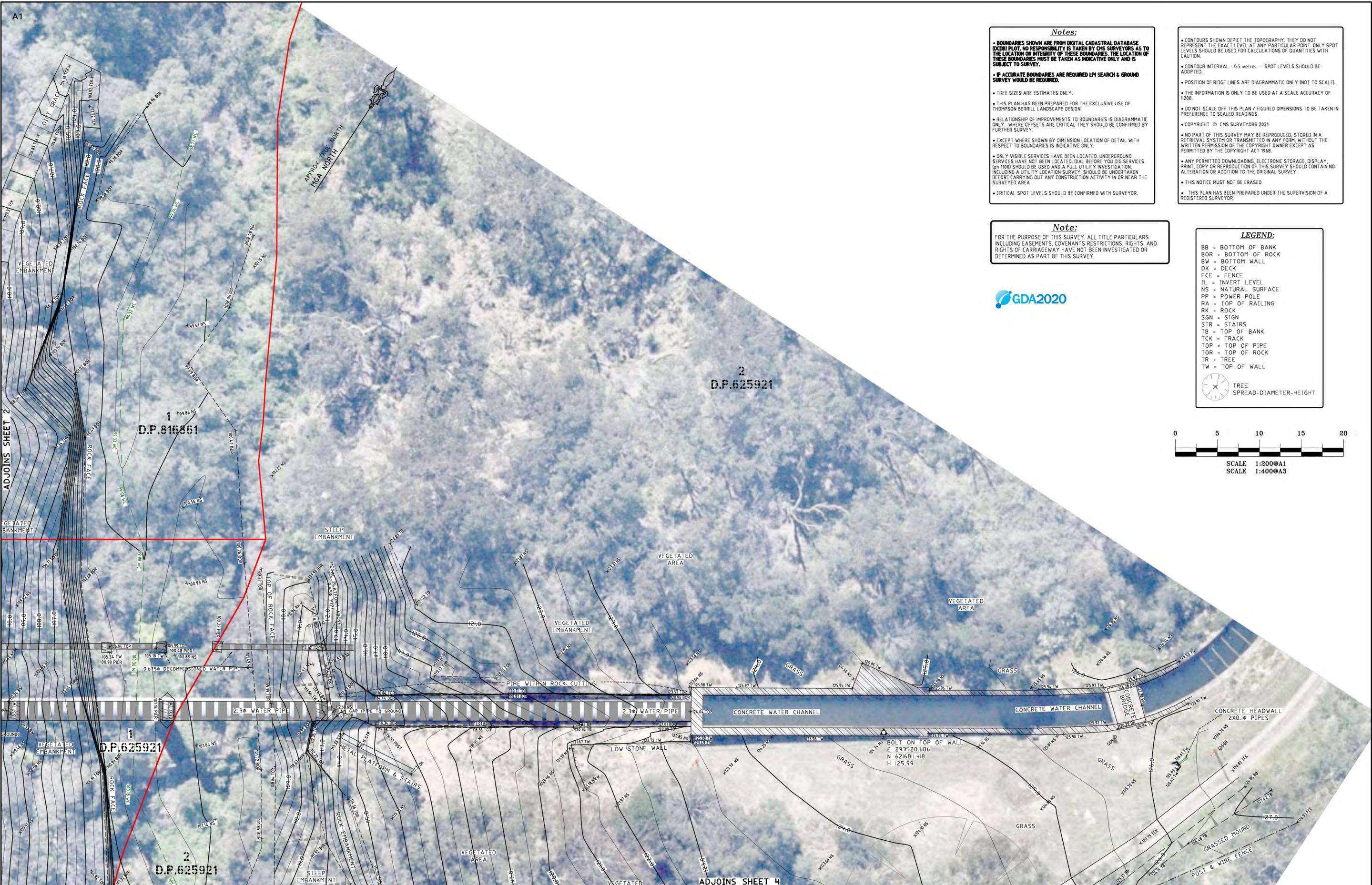
Notes:

- CONTOURS SHOWN DEPICT THE TOPOGRAPHY. THEY DO NOT REPRESENT THE EXACT LEVEL AT ANY PARTICULAR POINT. ONLY SPOT LEVELS SHOULD BE USED FOR CALCULATIONS OF QUANTITIES WITH CAUTION.
- CONTOUR INTERVAL - 0.5 metre. - SPOT LEVELS SHOULD BE ADOPTED.
- THE INFORMATION IS ONLY TO BE USED AT A SCALE ACCURACY OF 1:400.
- DO NOT SCALE OFF THIS PLAN / FIGURED DIMENSIONS TO BE TAKEN IN PREFERENCE TO SCALED READINGS.
- COPYRIGHT © CMS SURVEYORS 2021.
- NO PART OF THIS SURVEY MAY BE REPRODUCED, STORED IN A RETRIEVAL SYSTEM OR TRANSMITTED IN ANY FORM, WITHOUT THE WRITTEN PERMISSION OF THE COPYRIGHT OWNER EXCEPT AS PERMITTED BY THE COPYRIGHT ACT 1968.
- ANY PERMITTED DOWNLOADING, ELECTRONIC STORAGE, DISPLAY, PRINT, COPY OR REPRODUCTION OF THIS SURVEY SHOULD CONTAIN NO ALTERATION OR ADDITION TO THE ORIGINAL SURVEY.
- THIS NOTICE MUST NOT BE ERASED.
- THIS PLAN HAS BEEN PREPARED UNDER THE SUPERVISION OF A REGISTERED SURVEYOR



SCALE 1:400@A1
SCALE 1:800@A3

		HORIZONTAL DATUM: CO-ORDINATE SYSTEM: MGA GDA 2020	VERTICAL DATUM: DATUM: AUSTRALIAN HEIGHT DATUM (AHD)	CLIENT: THOMPSON BERRILL LANDSCAPE DESIGN PO BOX 665 MANLY, NSW, 2095	SURVEY PLAN SHOWING DETAIL & LEVEL OVER PART LOT 1 IN DP625921 AND PART LOT 2 IN DP625921 UPPER CANAL KOALA CROSSING (OUSEDALE CREEK) APPIN, NSW, 2560	 C.M.S. Surveyors Pty Limited ACN: 096 240 201 PO Box 463 Dee Why NSW 2099 2/99A South Creek Road, Dee Why NSW 2099 Telephone: (02) 9971 4802 Facsimile: (02) 9971 4822 E-mail: info@cmsurveyors.com.au	<table border="1"> <tr> <td>SURVEYED NS</td> <td>DRAWN GP</td> <td>CHECKED NS</td> <td>APPROVED BG</td> </tr> <tr> <td>SURVEY INSTRUCTION 2094-3</td> <td>SCALE 1:400 @ A1 1:800 @ A3</td> <td>DATE OF SURVEY 9-10/12/2021 & 25/01/2022</td> <td></td> </tr> <tr> <td colspan="3">DRAWING NAME 2094-3detail</td> <td>SHEET 1 OF 4</td> </tr> <tr> <td colspan="3">CAD FILE 2094-3detail 2.dwg</td> <td>ISSUE 2</td> </tr> </table>	SURVEYED NS	DRAWN GP	CHECKED NS	APPROVED BG	SURVEY INSTRUCTION 2094-3	SCALE 1:400 @ A1 1:800 @ A3	DATE OF SURVEY 9-10/12/2021 & 25/01/2022		DRAWING NAME 2094-3detail			SHEET 1 OF 4	CAD FILE 2094-3detail 2.dwg			ISSUE 2
SURVEYED NS	DRAWN GP	CHECKED NS	APPROVED BG																				
SURVEY INSTRUCTION 2094-3	SCALE 1:400 @ A1 1:800 @ A3	DATE OF SURVEY 9-10/12/2021 & 25/01/2022																					
DRAWING NAME 2094-3detail			SHEET 1 OF 4																				
CAD FILE 2094-3detail 2.dwg			ISSUE 2																				
2	OUSEDALE CREEK SURVEYED	27/01/2022	SOURCE: BY GNSS SMARTNET OBSERVATIONS																				
1	FIRST ISSUE	15/12/2021	SOURCE: BY GNSS SMARTNET OBSERVATIONS																				
		LGA: WOLLONDILLY																					



Notes:

- BOUNDARIES SHOWN ARE FROM DIGITAL CADASTRAL DATABASE (DDB) PLOT. NO RESPONSIBILITY IS TAKEN BY C/S SURVEYORS AS TO THE LOCATION OR INTEGRITY OF THESE BOUNDARIES. THE LOCATION OF THESE BOUNDARIES MUST BE TAKEN AS INDICATIVE ONLY AND IS SUBJECT TO SURVEY.
- IF ACCURATE BOUNDARIES ARE REQUIRED LPI SEARCH & GROUND SURVEY WOULD BE REQUIRED.
- TREE SIZES ARE ESTIMATES ONLY.
- THIS PLAN HAS BEEN PREPARED FOR THE EXCLUSIVE USE OF THOMPSON BERRILL LANDSCAPE DESIGN.
- RELATIONSHIP OF IMPROVEMENTS TO BOUNDARIES IS DIAGRAMMATIC ONLY. WHERE OFFSETS ARE CRITICAL THEY SHOULD BE CONFIRMED BY FURTHER SURVEY.
- EXCEPT WHERE SHOWN BY DIMENSION LOCATION OF DETAIL WITH RESPECT TO BOUNDARIES IS INDICATIVE ONLY.
- ONLY VISIBLE SERVICES HAVE BEEN LOCATED. UNDERGROUND SERVICES HAVE NOT BEEN LOCATED. DIA. BEFORE YOU DIG SERVICES (D4100) SHOULD BE USED AND A FULL UTILITY INVESTIGATION, INCLUDING A UTILITY LOCATION SURVEY, SHOULD BE UNDERTAKEN BEFORE CARRYING OUT ANY CONSTRUCTION ACTIVITY IN OR NEAR THE SURVEYED AREA.
- CRITICAL SPOT LEVELS SHOULD BE CONFIRMED WITH SURVEYOR.

- CONTOURS SHOWN DEPICT THE TOPOGRAPHY. THEY DO NOT REPRESENT THE EXACT LEVEL AT ANY PARTICULAR POINT. ONLY SPOT LEVELS SHOULD BE USED FOR CALCULATIONS OF QUANTITIES WITH CAUTION.
- CONTOUR INTERVAL - 0.5 metre. - SPOT LEVELS SHOULD BE ADOPTED.
- POSITION OF RIDGE LINES ARE DIAGRAMMATIC ONLY (NOT TO SCALE).
- THE INFORMATION IS ONLY TO BE USED AT A SCALE ACCURACY OF 1:200.
- DO NOT SCALE OFF THIS PLAN / FIGURED DIMENSIONS TO BE TAKEN IN PREFERENCE TO SCALED READINGS.
- COPYRIGHT © C/S SURVEYORS 2021.
- NO PART OF THIS SURVEY MAY BE REPRODUCED, STORED IN A RETRIEVAL SYSTEM OR TRANSMITTED IN ANY FORM, WITHOUT THE WRITTEN PERMISSION OF THE COPYRIGHT OWNER EXCEPT AS PERMITTED BY THE COPYRIGHT ACT 1968.
- ANY PERMITTED DOWNLOADING, ELECTRONIC STORAGE, DISPLAY, PRINT, COPY OR REPRODUCTION OF THIS SURVEY SHOULD CONTAIN NO ALTERATION OR ADDITION TO THE ORIGINAL SURVEY.
- THIS NOTICE MUST NOT BE ERASED.
- THIS PLAN HAS BEEN PREPARED UNDER THE SUPERVISION OF A REGISTERED SURVEYOR.

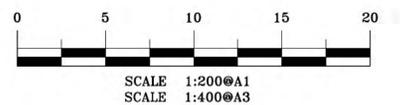
Note:

FOR THE PURPOSE OF THIS SURVEY ALL TITLE PARTICULARS INCLUDING EASEMENTS, COVENANTS RESTRICTIONS, RIGHTS, AND RIGHTS OF CARRIAGEWAY HAVE NOT BEEN INVESTIGATED OR DETERMINED AS PART OF THIS SURVEY.

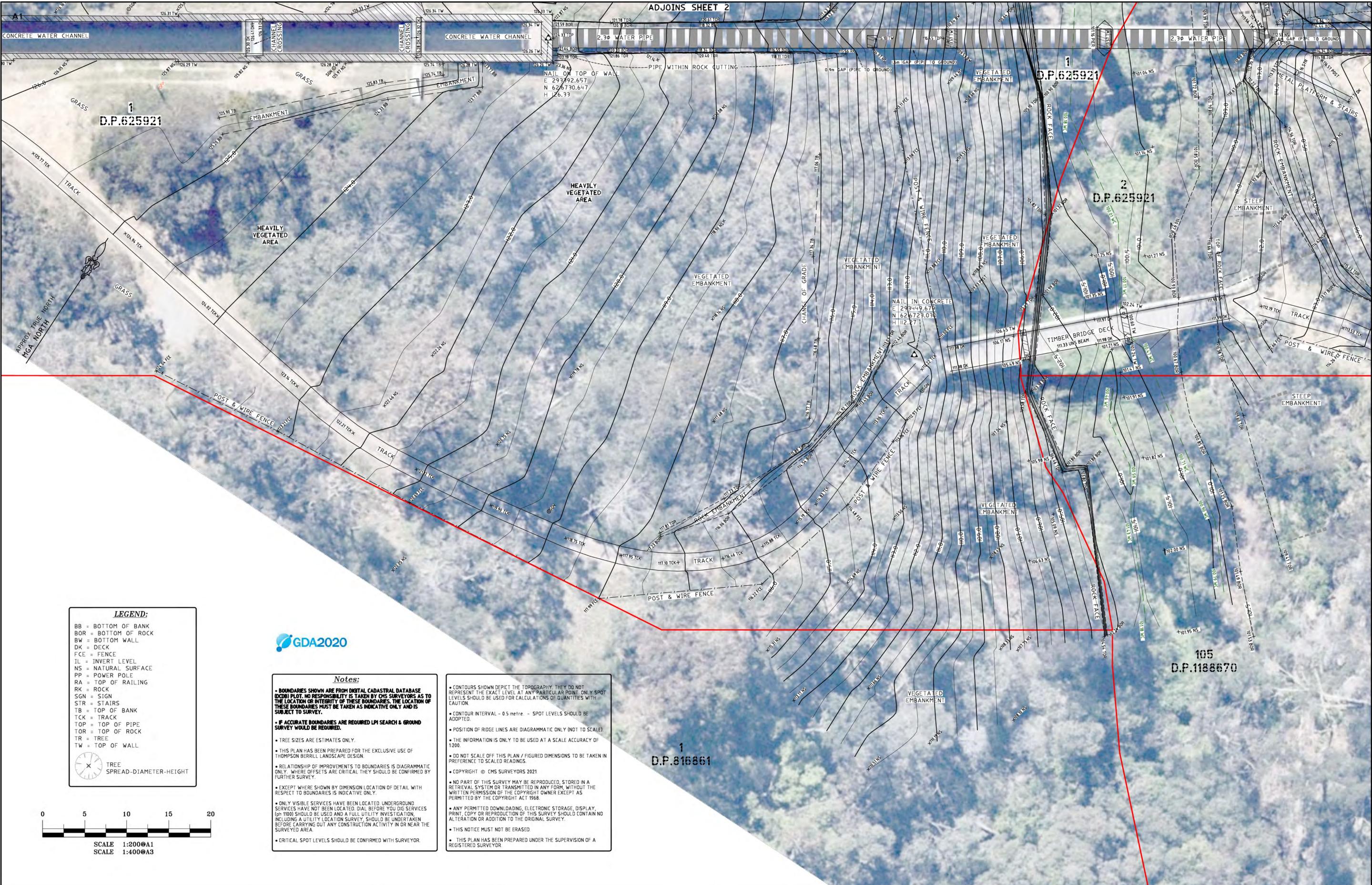
LEGEND:

BB = BOTTOM OF BANK
 BOR = BOTTOM OF ROCK
 BW = BOTTOM WALL
 DK = DECK
 FCE = FENCE
 IL = INVERT LEVEL
 NS = NATURAL SURFACE
 PP = POWER POLE
 RA = TOP OF RAILING
 RK = ROCK
 SGN = SIGN
 STR = STAIRS
 TB = TOP OF BANK
 TCK = TRACK
 TOP = TOP OF PIPE
 TOR = TOP OF ROCK
 TR = TREE
 TW = TOP OF WALL

TREE
 SPREAD-DIAMETER-HEIGHT



		HORIZONTAL DATUM:	VERTICAL DATUM:	CLIENT:	SURVEY PLAN	<p>C.M.S. Surveyors Pty Limited ACN: 096 240 201 PO Box 463 Dee Why NSW 2099 2/99A South Creek Road, Dee Why NSW 2099 Telephone: (02) 9971 4802 Facsimile: (02) 9971 4822 E-mail: info@csmssurveyors.com.au</p>	<table border="1"> <tr> <td>SURVEYED</td> <td>DRAWN</td> <td>CHECKED</td> <td>APPROVED</td> </tr> <tr> <td>NS</td> <td>GP</td> <td>NS</td> <td>BG</td> </tr> </table>	SURVEYED	DRAWN	CHECKED	APPROVED	NS	GP	NS	BG
SURVEYED	DRAWN	CHECKED	APPROVED												
NS	GP	NS	BG												
		CO-ORDINATE SYSTEM: MGA GDA 2020	DATUM: AUSTRALIAN HEIGHT DATUM (AHD)	THOMPSON BERRILL LANDSCAPE DESIGN	SHOWING DETAIL & LEVEL OVER	<table border="1"> <tr> <td>SURVEY INSTRUCTION</td> <td>SCALE</td> <td>DATE OF SURVEY</td> </tr> <tr> <td>20943</td> <td>1:200 @ A1 1:400 @ A3</td> <td>9-10/12/2021 & 25/10/2022</td> </tr> </table>	SURVEY INSTRUCTION	SCALE	DATE OF SURVEY	20943	1:200 @ A1 1:400 @ A3	9-10/12/2021 & 25/10/2022			
SURVEY INSTRUCTION	SCALE	DATE OF SURVEY													
20943	1:200 @ A1 1:400 @ A3	9-10/12/2021 & 25/10/2022													
2	OUSEDALE CREEK SURVEYED	27/01/2022	SOURCE: BY GNSS SMARTNET OBSERVATIONS	PO BOX 665	PART LOT 1 IN DP625921 AND PART LOT 2 IN DP625921	<table border="1"> <tr> <td>DRAWING NAME</td> <td>SHEET</td> <td>ISSUE</td> </tr> <tr> <td>20943detail</td> <td>3 OF 4</td> <td>2</td> </tr> </table>	DRAWING NAME	SHEET	ISSUE	20943detail	3 OF 4	2			
DRAWING NAME	SHEET	ISSUE													
20943detail	3 OF 4	2													
1	FIRST ISSUE	15/12/2021	SOURCE: BY GNSS SMARTNET OBSERVATIONS	MANLY, NSW, 2095	UPPER CANAL KOALA CROSSING (OUSEDALE CREEK)										
		LGA: WOLLONDILLY	SOURCE: BY GNSS SMARTNET OBSERVATIONS		APPIN, NSW, 2560										



ADJOINS SHEET 2

D.P.625921

D.P.625921

D.P.316861

105
D.P.1188670

LEGEND:

- BB = BOTTOM OF BANK
- BOR = BOTTOM OF ROCK
- BW = BOTTOM WALL
- DK = DECK
- FCE = FENCE
- IL = INVERT LEVEL
- NS = NATURAL SURFACE
- PP = POWER POLE
- RA = TOP OF RAILING
- RK = ROCK
- SGN = SIGN
- STR = STAIRS
- TB = TOP OF BANK
- TCK = TRACK
- TOP = TOP OF PIPE
- TOR = TOP OF ROCK
- TR = TREE
- TW = TOP OF WALL

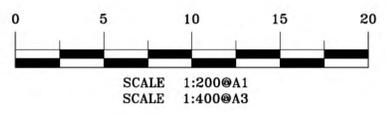
TREE
SPREAD-DIAMETER-HEIGHT



Notes:

- BOUNDARIES SHOWN ARE FROM DIGITAL CADASTRAL DATABASE (DCDB) PLOT. NO RESPONSIBILITY IS TAKEN BY C.M.S. SURVEYORS AS TO THE LOCATION OR INTEGRITY OF THESE BOUNDARIES. THE LOCATION OF THESE BOUNDARIES MUST BE TAKEN AS INDICATIVE ONLY AND IS SUBJECT TO SURVEY.
- IF ACCURATE BOUNDARIES ARE REQUIRED LPI SEARCH & GROUND SURVEY WOULD BE REQUIRED.
- TREE SIZES ARE ESTIMATES ONLY.
- THIS PLAN HAS BEEN PREPARED FOR THE EXCLUSIVE USE OF THOMPSON BERRILL LANDSCAPE DESIGN.
- RELATIONSHIP OF IMPROVEMENTS TO BOUNDARIES IS DIAGRAMMATIC ONLY. WHERE OFFSETS ARE CRITICAL THEY SHOULD BE CONFIRMED BY FURTHER SURVEY.
- EXCEPT WHERE SHOWN BY DIMENSION LOCATION OF DETAIL WITH RESPECT TO BOUNDARIES IS INDICATIVE ONLY.
- ONLY VISIBLE SERVICES HAVE BEEN LOCATED. UNDERGROUND SERVICES HAVE NOT BEEN LOCATED. DIAL BEFORE YOU DIG SERVICES (FOR 1100) SHOULD BE USED AND A FULL UTILITY INVESTIGATION INCLUDING A UTILITY LOCATION SURVEY, SHOULD BE UNDERTAKEN BEFORE CARRYING OUT ANY CONSTRUCTION ACTIVITY IN OR NEAR THE SURVEYED AREA.
- CRITICAL SPOT LEVELS SHOULD BE CONFIRMED WITH SURVEYOR.

- CONTOURS SHOWN DEPICT THE TOPOGRAPHY. THEY DO NOT REPRESENT THE EXACT LEVEL AT ANY PARTICULAR POINT. ONLY SPOT LEVELS SHOULD BE USED FOR CALCULATIONS OF QUANTITIES WITH CAUTION.
- CONTOUR INTERVAL - 0.5 metre. - SPOT LEVELS SHOULD BE ADOPTED.
- POSITION OF RIDGE LINES ARE DIAGRAMMATIC ONLY (NOT TO SCALE).
- THE INFORMATION IS ONLY TO BE USED AT A SCALE ACCURACY OF 1:200.
- DO NOT SCALE OFF THIS PLAN / FIGURED DIMENSIONS TO BE TAKEN IN PREFERENCE TO SCALED READINGS.
- COPYRIGHT © C.M.S. SURVEYORS 2021
- NO PART OF THIS SURVEY MAY BE REPRODUCED, STORED IN A RETRIEVAL SYSTEM OR TRANSMITTED IN ANY FORM, WITHOUT THE WRITTEN PERMISSION OF THE COPYRIGHT OWNER EXCEPT AS PERMITTED BY THE COPYRIGHT ACT 1968.
- ANY PERMITTED DOWNLOADING, ELECTRONIC STORAGE, DISPLAY, PRINT, COPY OR REPRODUCTION OF THIS SURVEY SHOULD CONTAIN NO ALTERATION OR ADDITION TO THE ORIGINAL SURVEY.
- THIS NOTICE MUST NOT BE ERASED
- THIS PLAN HAS BEEN PREPARED UNDER THE SUPERVISION OF A REGISTERED SURVEYOR.



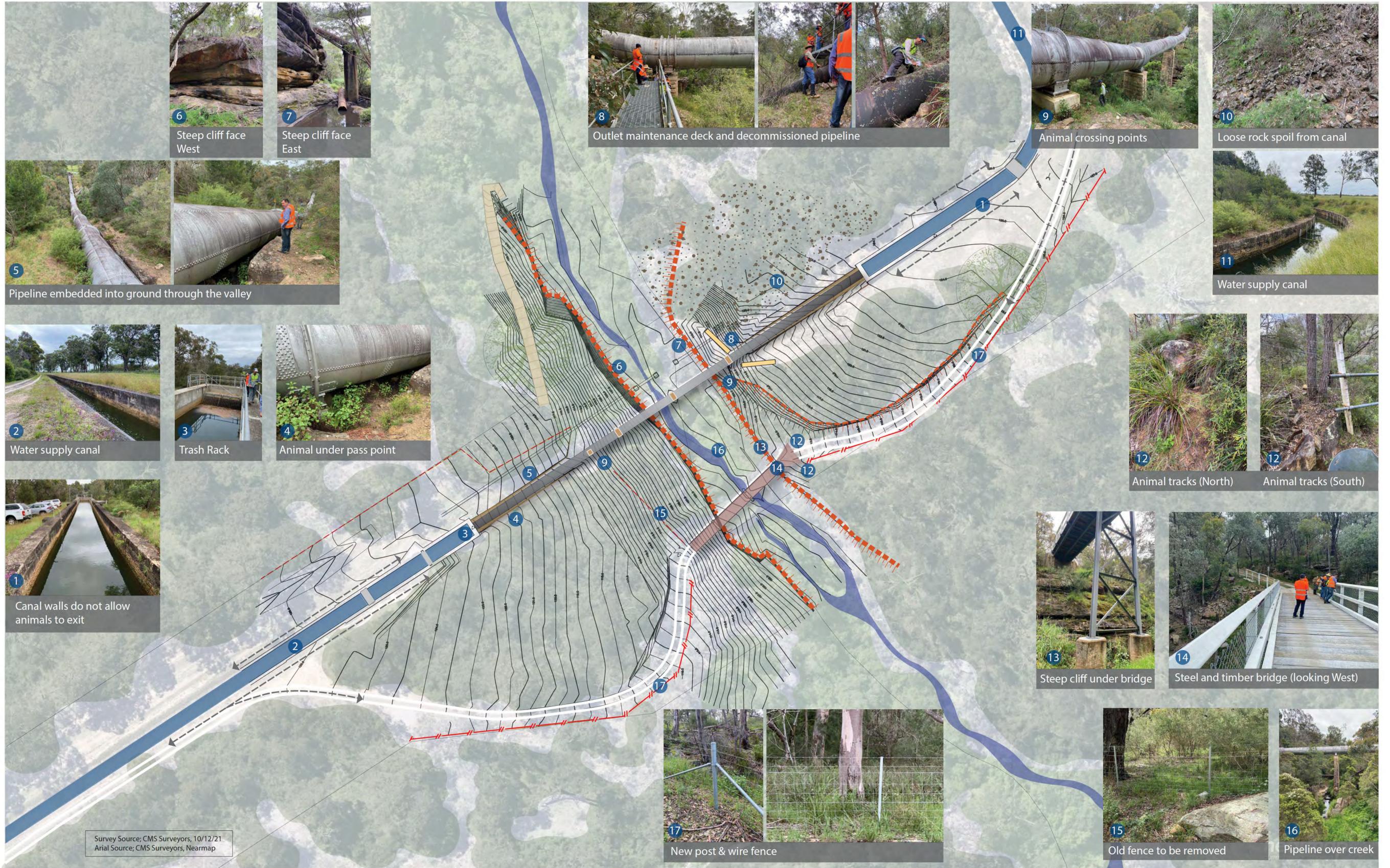
	HORIZONTAL DATUM: CO-ORDINATE SYSTEM: MGA GDA 2020	VERTICAL DATUM: DATUM: AUSTRALIAN HEIGHT DATUM (AHD)	CLIENT: THOMPSON BERRILL LANDSCAPE DESIGN PO BOX 665 MANLY, NSW, 2095	SURVEY PLAN SHOWING DETAIL & LEVEL OVER PART LOT 1 IN DP625921 AND PART LOT 2 IN DP625921 UPPER CANAL KOALA CROSSING (OUSEDALE CREEK) APPIN, NSW, 2560	 C.M.S. Surveyors Pty Limited ACN: 096 240 201 PO Box 463 Dee Why NSW 2099 2/99A South Creek Road, Dee Why NSW 2099 Telephone: (02) 9971 4802 Facsimile: (02) 9971 4822 E-mail: info@cmsurveyors.com.au	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="font-size: 8px;">SURVEYED NS</td> <td style="font-size: 8px;">DRAWN GP</td> <td style="font-size: 8px;">CHECKED NS</td> <td style="font-size: 8px;">APPROVED BG</td> </tr> <tr> <td style="font-size: 8px;">SURVEY INSTRUCTION 20943</td> <td style="font-size: 8px;">SCALE 1:200 AI 1:400 A3</td> <td colspan="2" style="font-size: 8px;">DATE OF SURVEY 9-10/12/2021 & 25/01/2022</td> </tr> <tr> <td colspan="3" style="font-size: 8px;">DRAWING NAME 20943detail</td> <td style="font-size: 8px;">SHEET ISSUE 4 OF 4 2</td> </tr> <tr> <td colspan="3" style="font-size: 8px;">CAD FILE 20943detail 2.dwg</td> <td></td> </tr> </table>	SURVEYED NS	DRAWN GP	CHECKED NS	APPROVED BG	SURVEY INSTRUCTION 20943	SCALE 1:200 AI 1:400 A3	DATE OF SURVEY 9-10/12/2021 & 25/01/2022		DRAWING NAME 20943detail			SHEET ISSUE 4 OF 4 2	CAD FILE 20943detail 2.dwg			
SURVEYED NS	DRAWN GP	CHECKED NS	APPROVED BG																			
SURVEY INSTRUCTION 20943	SCALE 1:200 AI 1:400 A3	DATE OF SURVEY 9-10/12/2021 & 25/01/2022																				
DRAWING NAME 20943detail			SHEET ISSUE 4 OF 4 2																			
CAD FILE 20943detail 2.dwg																						
2 OUSEDALE CREEK SURVEYED	27/01/2022	BY GNSS SMARTNET OBSERVATIONS	BY GNSS SMARTNET OBSERVATIONS			20943detail																
1 FIRST ISSUE	15/12/2021	LGA: WOLLONDILLY																				



Appendix B

TBLD site plans and initial design options





Survey Source; CMS Surveyors, 10/12/21
 Aerial Source; CMS Surveyors, Nearmap



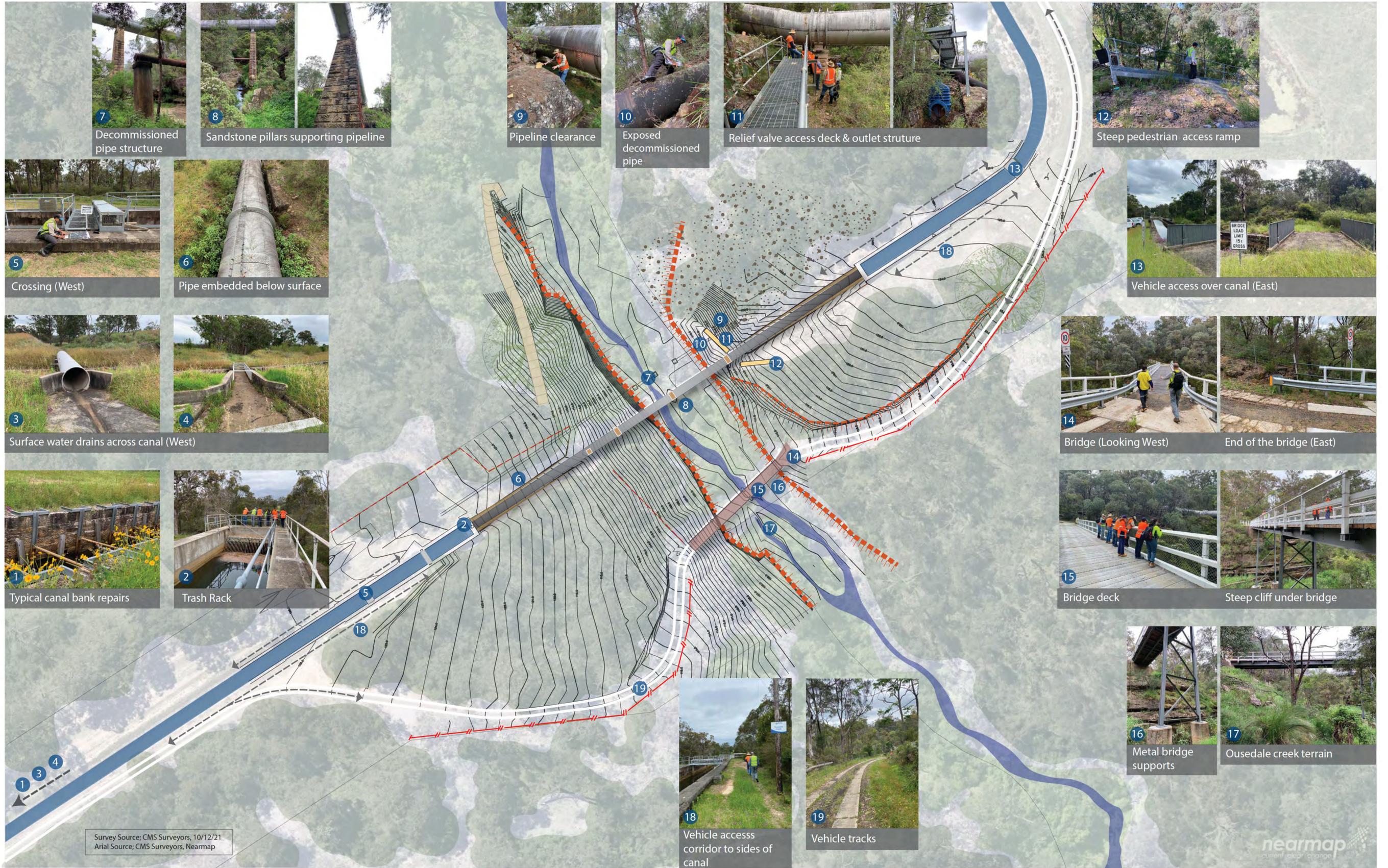
Planning,
 Industry &
 Environment



Photosheet I: Site constraints and risks to Koala movement Koala Crossing - Upper Canal

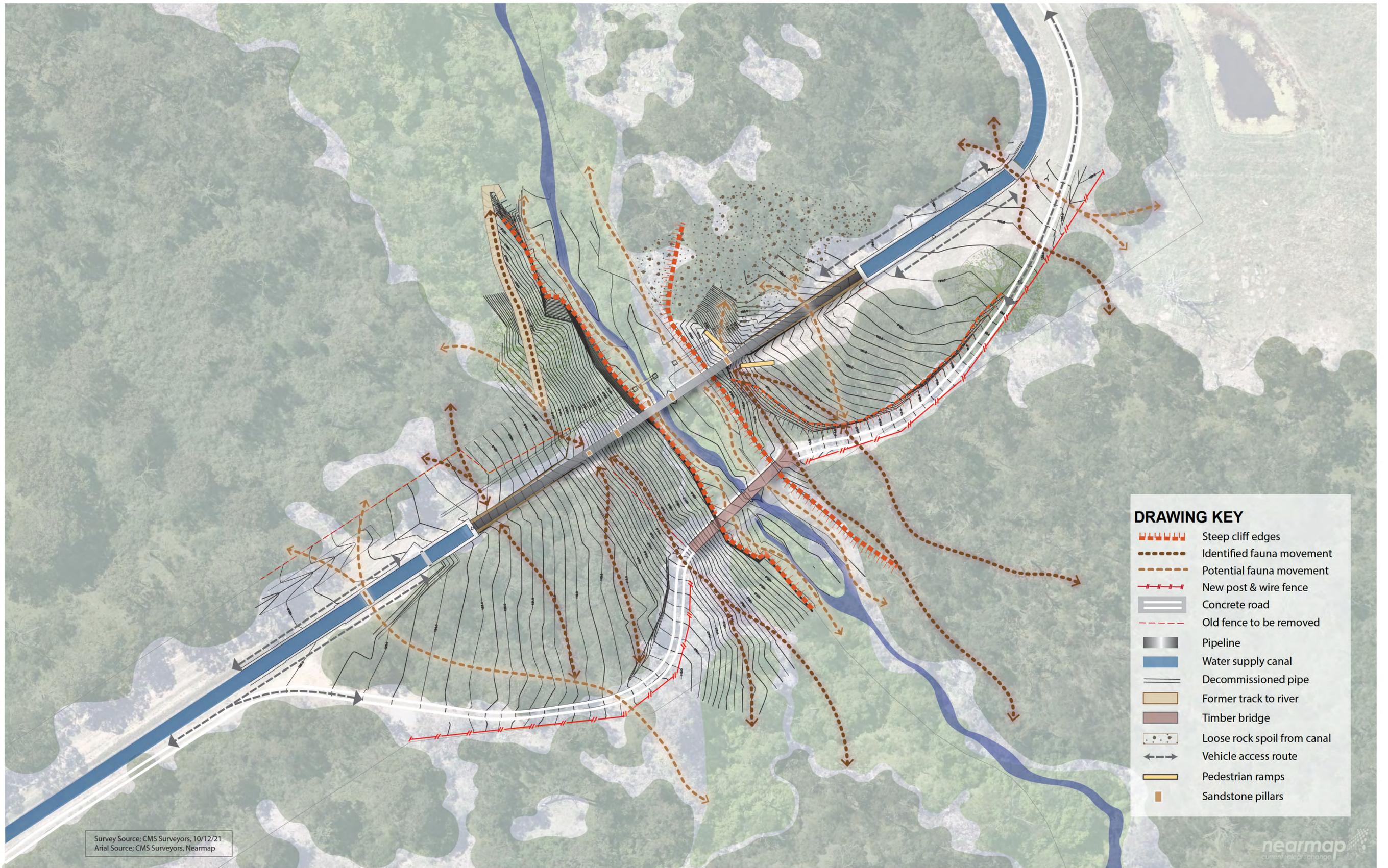
1 MAR 2022
 DWG No. KC_C1
 SCALE 1:500 @A1
 0 5 10 15 20 40m





Survey Source; CMS Surveyors, 10/12/21
 Aerial Source; CMS Surveyors, Nearmap

nearmap
 current history compare



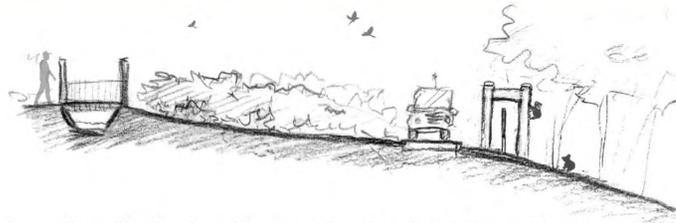
DRAWING KEY

-  Steep cliff edges
-  Identified fauna movement
-  Potential fauna movement
-  New post & wire fence
-  Concrete road
-  Old fence to be removed
-  Pipeline
-  Water supply canal
-  Decommissioned pipe
-  Former track to river
-  Timber bridge
-  Loose rock spoil from canal
-  Vehicle access route
-  Pedestrian ramps
-  Sandstone pillars

Survey Source: CMS Surveyors, 10/12/21
 Aerial Source: CMS Surveyors, Nearmap

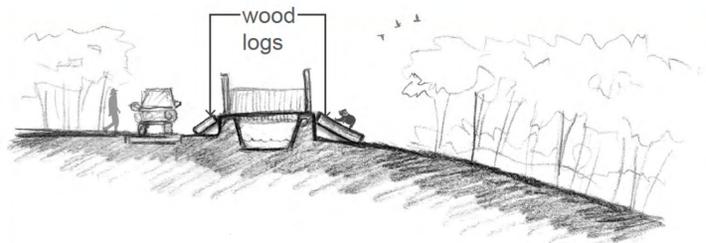


Option 1A



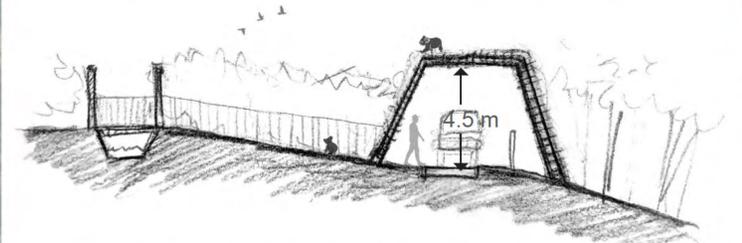
Hole and/or stile, koala grids, canal fencing & existing bridge crossing

Option 1C

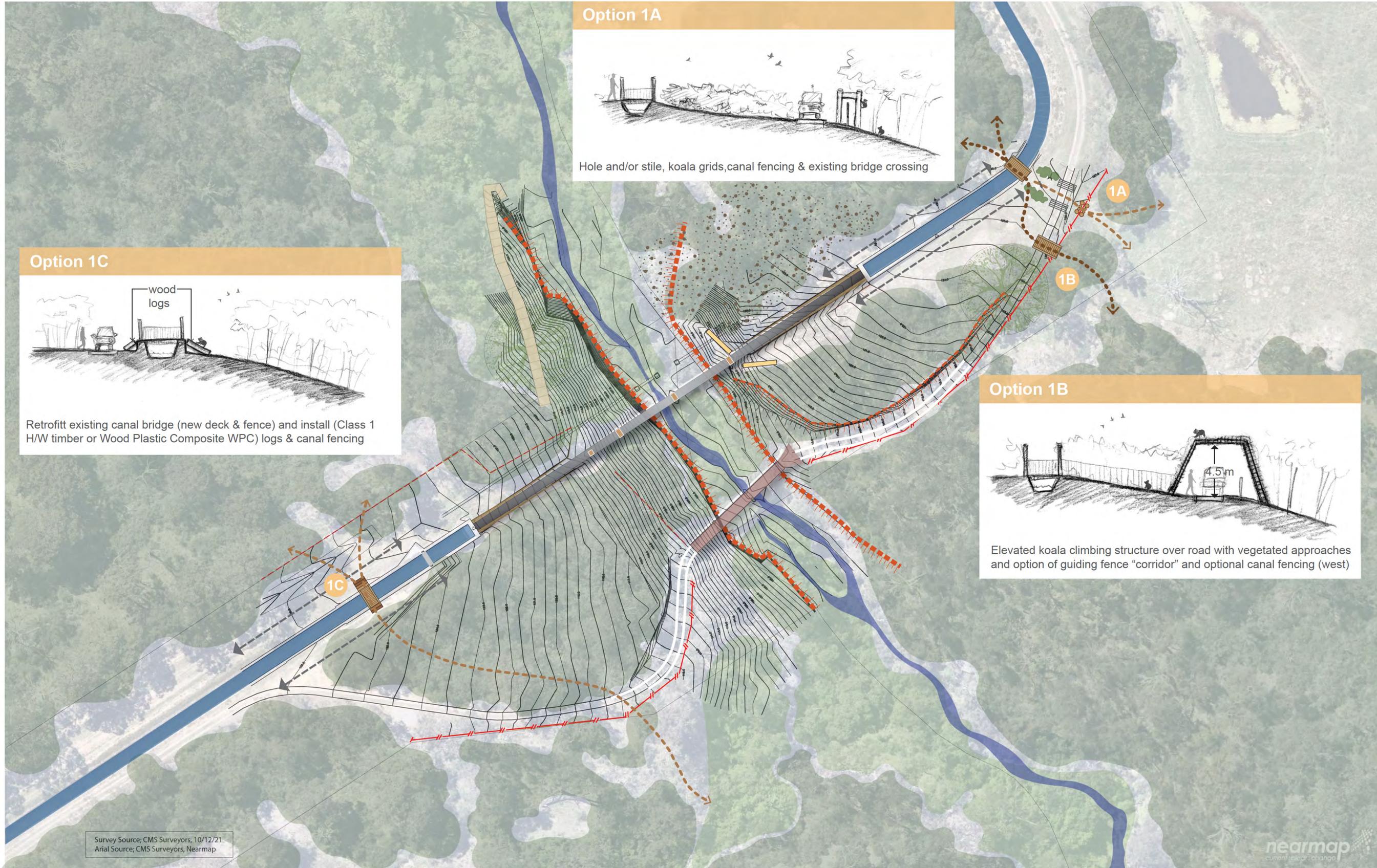


Retrofit existing canal bridge (new deck & fence) and install (Class 1 H/W timber or Wood Plastic Composite WPC) logs & canal fencing

Option 1B



Elevated koala climbing structure over road with vegetated approaches and option of guiding fence "corridor" and optional canal fencing (west)



Survey Source: CMS Surveyors, 10/12/21
Aerial Source: CMS Surveyors, Nearmap

nearmap
current | reliable | change



Planning, Industry & Environment



Concept Design Option I Koala Crossing - Upper Canal

1 MAR 2022
DWG No. KC_C4
SCALE 1:500 @A1
0 5 10 15 20 40m

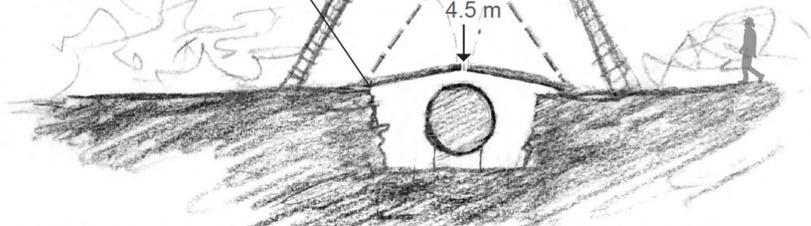
C4

Option 2

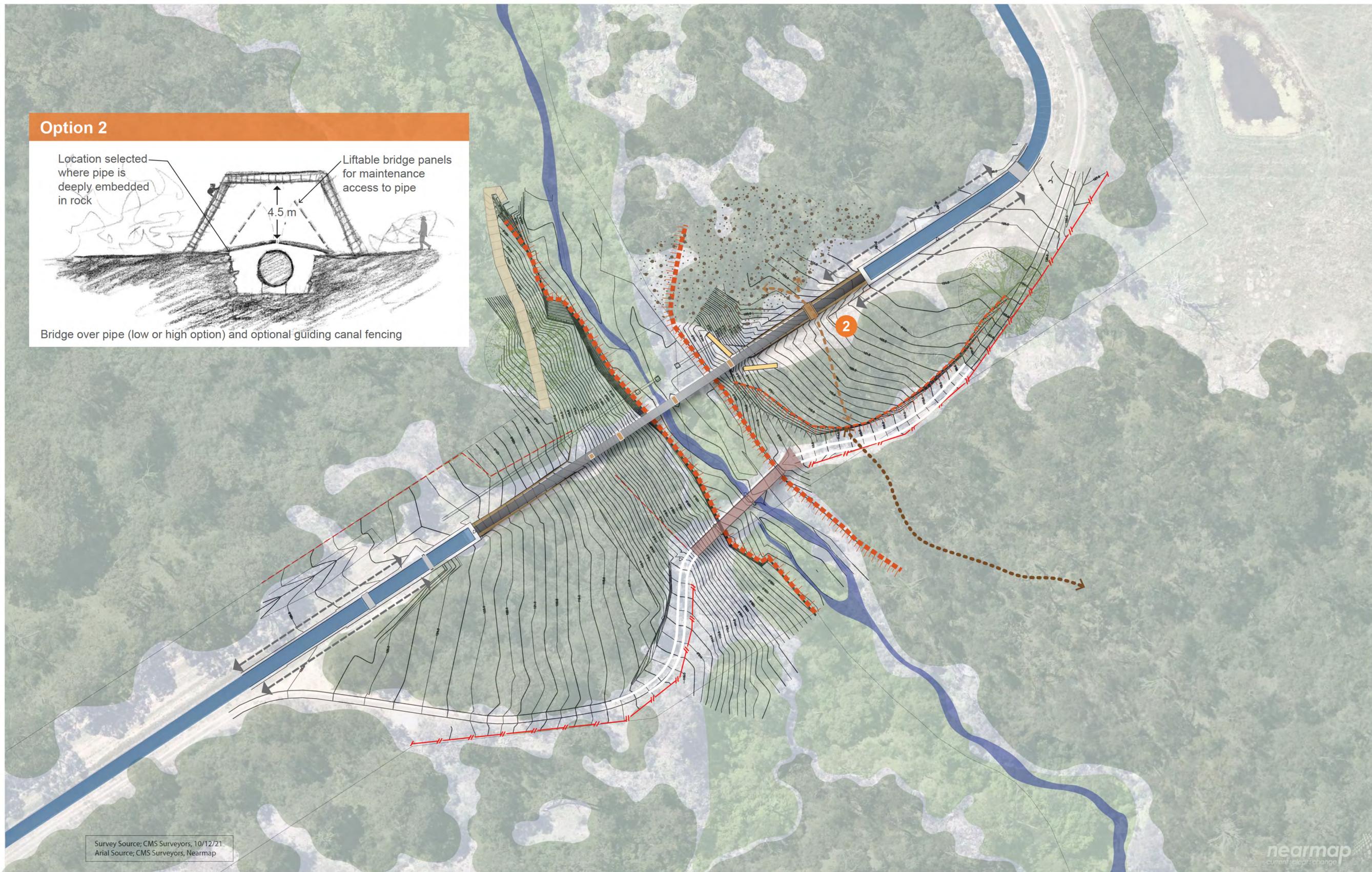
Location selected where pipe is deeply embedded in rock

Liftable bridge panels for maintenance access to pipe

4.5 m



Bridge over pipe (low or high option) and optional guiding canal fencing



Survey Source: CMS Surveyors, 10/12/21
Aerial Source: CMS Surveyors, Nearmap

nearmap
current | clear | change