Soil disturbance is expected to be significant in the direct area of the proposed option alignment as a result of trenching for installation of the pipeline. Impacts are not expected to be widespread like cultivation works would induce.

8.6.3.2 Heritage

8.6.3.2.1 Historic Heritage

Local Heritage

There is one heritage item identified under the Gundagai LEP 2011 in proximity to the proposed option (and none under the and Junee LEP 2012).

- I20: War Memorial Nangus – located on the outskirts of the town of Nangus

The abovementioned locally listed heritage item will not be impacted by the proposed option.

State Heritage

There are no State Heritage Register listed heritage items within proximity of Option 3.

Federal Heritage

- A search of the Australian Government's Australian Heritage Database (DoEE, 2019) identified 15 federally listed heritage items within the Cootamundra - Gundagai LGA.
- A search of the Australian Governments Australian Heritage Database (DoEE, 2019) identified 14 federally listed heritage items within the Junee LGA.
- The PMST search undertaken on 25/7/2019 found that no World Heritage Properties or National Heritage Places were identified within 10 km of the pipeline route.

A search of the Native Title Register and Native Title Claims Register (Native Title Tribunal, 2019) conducted on 25/11/2019 returned no records within the Cootamundra – Gundagai LGA and Junee LGA.

8.6.3.2.2 Aboriginal Heritage

A search of the AHIMS register (NSW OEH, 2019d) on 25/11/2019 identified 5 Aboriginal sites and 0 (zero) Aboriginal places within the locality of Option 3. The search does not identify the precise locations of the sites and Aboriginal heritage constraints would be subject to confirmation during future project stages.

8.6.3.3 Hydrology, Water Quality and Groundwater

The hydrological, water quality and groundwater related features associated with this option are shown on the Hydrology figure in Appendix B.

- From east to west, the proposed Option 3 would traverse:
  - Nangus Creek
  - Billabong Creek
- Waterways range in size and under the Strahler stream order system are classified as ranging from sixth order stream to fourth order watercourses (DPI Water, 2017).
- The Murrumbidgee River is mapped as Key Fish Habitat (DPI Water, 2017)
- While works will be within 40m of these watercourses, a controlled activity approval under the Water Management Act 2000 (WM Act) is not required as the works would be undertaken by a public authority.
- Creek crossings would need to be designed to be sensitive to the biodiversity values present at site.
- Groundwater Dependent Ecosystems (GDE) are aquatic and terrestrial ecosystems which are sustained, to a degree, by groundwater. Two named waterways are crossed by the pipeline (Nangus Creek and Billabong Creek) which are listed as moderate potential GDE (BOM, 2019).
- The pipeline would cross areas mapped as 'sensitive land' according to Gundagai LEP 2011 and within Groundwater Vulnerable areas mapped in Junee LEP 2012.
- There are numerous groundwater bore locations along Option 3 pipeline route. The eastern extent of the alignment in Nangus Village has multiple bores within 50 m of the alignment and the western extents will join the GWCC existing water mains. It is not expected that the pipeline would have any impact on the bores as the alignment could be set to avoid them.

- According to the Australian Flood Study Database, there have been three studies conducted surrounding the Murrumbidgee River and surrounds. The studies include:
  - Gundagai Flood Scoping Study – 2013
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  - Murrumbidgee River Flood Modelling

  A thorough investigation into these studies will help shape future stages of the proposed development.

8.6.3.4 Soil and Contamination

- Soils present within the area are shown on the Soils figure in Appendix B.
- Option 3 traverses multiple different soil classes including:
  - Rudoslos and Tenosols
  - Kandosols
  - Kurosols
  - Rudosols (Aluvial)
- Soil is not mapped as saline land in the DPE (2019) mapping.

A search of the OEH Contaminated Land Record and the Protection of the Environment Operation (POEO) Act Public Register of Licences was undertaken on 24/11/2019. The search highlighted 22 locations where a POEO License has been issued in the LGA of Cootamundra - Gundagai and 4 issued in Junee LGA. The listed locations of issued licences are not impacted by Option 3. There are no known contaminated sites listed on the OEH Contaminated Land Register in the vicinity of Option 3. This does not mean there is no contaminated land on site as not all contaminated areas have been recorded and constraints would need to be confirmed in future project stages.

8.6.3.5 Socio-economic, Land Use and Zoning

- The majority of Option 3 alignment is within land zoned RU1 – Primary Production land zoning. As the alignment enters the township of Nangus the zoning changes to RU5 – Village. (see the land use and zoning map in Appendix B)
- This option traverses both Junee LGA and Cootamundra – Gundagai LGA
- The pipeline option traversed across private properties in multiple locations.
- The PMST search identified 1 potential area of Commonwealth Land protected under the EPBC Act within 10km of this option. The precise location of this land parcel will need to be confirmed in future investigations with impacts to these areas avoided and/or minimised where possible. If the project is likely to have a significant impact on Commonwealth land it may require referral to DoEE under the EPBC Act.
- Socio-economic considerations relevant to this option include:
  - Potential adverse impacts on private properties during pipeline installation
  - Positive impacts associated with securing a water supply for Nangus.

8.6.3.6 Cumulative Impacts

The potential for cumulative impacts was considered through review of the Major Projects Register which identifies major projects proposed, under assessment or approved (including State Significant Development (SSD) and State Significant Infrastructure (SSI) projects) either under assessment of approved. The register was searched for Cootamundra - Gundagai LGA and Junee LGA. Three major projects were identified (the Adjungbilly Wind Farm, Sebastopol Solar and Young to Wagga Looping Pipeline), however the projects are not in close proximity to Option 3 and is therefore unlikely to generate cumulative impacts.

Cootamundra – Gundagai Regional Council DA Tracking portal for Gundagai LGA was accessed on 25 November 2019 to check for any development that may impact on the proposed pipeline option. The search included results from January 2019 through to June 2019 and concluded that there are no relevant DA Applications that will have an influence on the proposed project.

Junee Council DA Tracking portal for Junee LGA was accessed on 25 November 2019 to check for any development that may impact on the proposed pipeline option. The search included results from October

2019 through to November 2019 and concluded that there are no relevant DA Applications that will have an influence on the proposed project.

It is noted that this search was not comprehensive and local developments should be checked as part of future project stages.

8.6.3.7 Summary of Environmental Constraints & Approval Pathway

Summary

The key environmental constraints related to pipeline Option 3 are the biodiversity and heritage constraints identified above. A more detailed assessment of the final alignment during future stages of the development will allow for avoidance or minimisation of potential impacts identified above. Impacts on other matters can generally be managed through careful construction management processes developed at future construction stages of development. Impacts to private property will also need to be minimised where possible with appropriate consultation with interested stakeholders and impacted community members where necessary.

The location and extent of all constraints, but in particular the biodiversity and heritage constraints, will need to be confirmed in future stages of the project through on-ground surveys and research. Significant impacts to biodiversity can trigger the need for an Environmental Impact Statement (EIS) under Part 5, Division 5.1, Subdivision 3 of the EP&A Act. Significant impacts to Commonwealth listed threatened entities or Commonwealth land can trigger the need for a referral to the Federal Government and assessment under the EPBC Act. If an EIS becomes necessary due to unavoidable impacts, the project approval timeframes and budgets allocated could be substantially increased. From this high level desktop constraints analysis, and given the proposed pipeline route could be developed to avoid or minimise such impacts, it is considered unlikely that the proposed alignment would have a significant impact on biodiversity and/or Commonwealth matters. This would need to be confirmed during future stages of the project as the constraints analysis is high level and the design is at a preliminary stage.

Initial approval pathway advice

The project will need assessment under the EP&A Act. State Environmental Planning Policy (SEPPs) guide the approval pathways under the EP&A Act.

The initial approval pathway will be assessed under the State Environmental Planning Policy (Infrastructure) 2001 (ISEPP), as the pipeline and associated ancillary structures is considered a "water reticulation system". Under Clause 125(1) of ISEPP, development for the purpose of a water reticulation system (including reservoirs) may be carried out by or on behalf of a public authority without consent on any land. As the pipeline project would be undertaken by GWCC or CGRC (both public authorities) the proposal would be permissible without consent, and therefore it is currently anticipated that the applicable approval pathway is via a Review of Environmental Factors under Part 5 of the EP&A Act. Clause 14(1) of the State and Regional Development SEPP states that development for the purpose of water storage facilities that has a capital investment value of more than $30 million would be subject to a more intense approvals pathway which may trigger the need for an Environmental Impact Statement.

The approval pathway will need to be confirmed and will be dependent on confirmation of pipeline alignment and potential impacts which will be confirmed at later stages of the project. This will involve specialist studies and on-ground surveys to confirm environmental constraints, confirmation of land use and applicability of Part 5 provisions, confirmation of capital investment value and consideration of 'significant impacts' on the environment which could trigger the need for an EIS.

Further investigations into the direct impacts on the environmental stewardship zone (Zone P1-Z1) will need to occur pending the outcomes of the options analysis. Land use applications and further studies will likely be required if Option 3 proceeds.

8.6.4 Cost Estimate

The estimated capital cost for Option 3 is $3.07 million, excluding GST. A detailed breakdown of this estimate is provided in Appendix E. See Section 5.1 for a description of the inclusions and methodology for cost estimates.

8.6.5 Multi-criteria Analysis and Risk Assessment

MCA scoring (as per the template in Table 5-1), and a discussion on the risks related to each parameter are given in Table 8-10.

Table 8-10 Option 3 – Multi-Criteria Analysis

No.	Criteria	Weighting	Score	Discussion
1	**Security of Supply** Consider the security of the water supply and the impact/risks of prolonged drought.	20%	10	▪ It is assumed that GWCC's Oura water supply network will meet or exceed the 5/10/10 rule. Water is sourced from the Murrumbidgee Regulated Water Source, and has a high level of security.
2	**Water Quality - Health** Consider the reliability and risks to water quality with regard to health criteria.	15%	9	▪ It is assumed that water supplied by GWCC's Oura water supply network will meet the ADWG health requirements. ▪ Chlorine dosing facility to be provided at Nangus reservoir to maintain residual. ▪ Potential for chlorine residuals to fall between chlorine dosing at Nangus reservoir and Nangus, which would necessitate an additional chlorine dosing facility.
3	**Water Quality - Aesthetic** Consider the reliability and risks to water quality with regard to asthenic criteria.	10%	10	▪ It is assumed that water supplied by GWCC's Oura water supply network will meet the majority of current ADWG aesthetic requirements.
4	**Operational Risk** Consider the consequence of failure with regards to operator safety, community safety, scheme complexity, time needed to reinstate supply and resourcing risk.	15%	7	▪ Operation and maintenance of pipeline, PRV, reservoir and chemical dosing facility considered familiar to operators. ▪ Significant length of the pipeline will be located through steep farmland with potentially difficult access for maintenance. ▪ Access to reservoir and chlorine dosing facility will pose difficulties. ▪ In the event of a prolonged failure of the pipeline water may be carted from Gundagai or GWCC to the Nangus reservoir. ▪ Materials readily available and close by in case of repair.
5	**Constructability** Consider the ability to construct each option, including safety, availability of materials, availability of suitably qualified contractors, ground conditions, impact on existing services, access etc.	15%	5	▪ A significant length of the pipeline is through steep, rocky terrain. ▪ Some constructability risk related to unknown geotechnical conditions. ▪ Mostly conventional construction methods – open trenching. ▪ No specialised materials. ▪ Many experienced contractors available for this type of work. Similar works are currently being undertaken at other locations across NSW. ▪ The ability to swiftly construct water pipelines similar to this project has been proven at other sites in NSW. ▪ Two creek crossings to be suspended from bridge or directional drilled.
6	**Project Definition Risk** Consider risk associated with level of definition and potential for currently unknown issues to impact schedule and budget.	10%	6	▪ Geotechnical conditions unknown. Rock is likely to be a risk in elevated terrain near Tenandra and the proposed Nangus reservoir. ▪ Geotechnical conditions for proposed directional drilling of Billabong Creek are not known. ▪ Ability to mount pipeline on bridge (proposed at one location) is not known. Directional drilling or open trenching are alternatives.

No.	Criteria	Weighting	Score	Discussion
7	**Heritage, Environment and Approvals** Consider environmental and heritage impacts and risks and the risk associated with obtaining approvals.	15%	5	▪ Avoidance of impacts to known state and federally listed TEC's and threatened species is likely to be possible. ▪ Waterway crossings will need to be sensitively designed to have minimal impact on the waterways. ▪ Impacts to indigenous heritage and a more accurate and verified survey of the land is needed for future project development. ▪ It is understood from CGRC that there is local opposition to the Option 3 route due to land use issues. ▪ Obtaining easements for installation of the pipeline within private property presents a possible project delivery risk. However, experience has shown that use of private property can avoid delays due to environmental approvals for installation in the road reserve. Significant portions of the pipeline are not close to road reserves, so diverting into the road reserve is not an option if there are issues with easements. ▪ The route passes through an Environmental Stewardship area for Box Gum Grassy Woodlands, for which the landowner has a contractual agreement with the federal government to protect/enhance the ecological value of the area. Mitigation measures, including 'no major soil disturbance' are included within the agreement. The construction of the pipeline will induce major soil disturbance localised to the construction footprint. This presents a risk to the viability of this project, and further investigation will be required to confirm the impact on the approvals.
	Total	100%	7.5	

8.7 Option 4: Pipeline from GWCC water supply – from Tenandra Reservoirs following existing easement

8.7.1 Description

Option 4 incorporates the supply of potable water from GWCC's Oura Water Supply Scheme. This option would see the supply of water via a pipeline built from the existing Tenandra Reservoirs to Nangus.

Key components of this option include:

- Connection to the existing Tenandra Reservoirs outlet pipeline.
- Approximately 1.7 km of PN35 DN100 DI pipeline from the Tenandra Reservoirs to a PRV, located near River Road.
- A PRV located near River Road.
- Approximately 3.9 km of PN35 DN100 DI from the PRV to Nangus reservoir.
- Nangus reservoir, with a usable volume of 250 kL.
- Chlorine dosing facility at Nangus reservoir to maintain quality.
- Approximately 5.0 km of DN150 PVC-O pipeline from Nangus reservoir to Nangus.
- Reticulation (DN100 PVC-O) to service the existing developed area in Nangus.

8.7.2 Preliminary Design and Pipeline Hydraulics

The alignment for pipeline Option 4 connects to GWCC's Oura Water supply scheme at the Tenandra Reservoirs located in Lot 1 DP172773. From here, the pipe heads east along an old pipeline alignment to River Road. The alignment then follows the River Road corridor, before crossing Billabong Creek and following Island Creek and local access roads to Nangus.

A PRV will be located near River Road at the base of the Tenandra mountain to reduce the pressure to that required to convey the water to Nangus.

The proposed Nangus reservoir (CH5600) is located on elevated ground approximately 5 km east of Nangus. The reservoir will have a usable volume of 250 kL (three days of storage for the average day demand). A concrete reservoir is proposed.

While a chlorine dosing facility has been allowed for at the proposed Nangus reservoir, water quality must comply with ADWG requirements at all locations in the network. There is the potential for chlorine residuals to fall between the chlorine dosing at Nangus reservoir and Nangus, and a secondary chlorination facility may be required downstream in the network to ensure chlorine residuals are maintained at suitable levels.

Refer to Appendix A for further details on the proposed pipe alignment for Option 4. The hydraulic grade line and elevation profile are shown in Figure 8-7.

The reticulation system would consist of DN100 PVC-O, with the extents as shown on Figure 8-3, matching the other options.

The pipeline infrastructure has been sized to convey the Nangus and rural MDD to the reservoir as outlined in Table 3-1. From the reservoir to Nangus, the infrastructure has been sized to convey the peak hour demand.

GWCCs preference is for the pipeline to be installed within private property where possible, adjacent to the road reserve. GWCC's recent experience has shown installation in private property provides a more efficient pathway to obtaining environmental approvals than installation within road reserves.

The proposed pipe alignment for Option 3 crosses the following watercourses (stream order 3 and higher) as shown on Figure 8-7. Crossing methodologies are also proposed.

The proposed pipe alignment for Option 4 crosses the following watercourses:

- Un-named creek (River Road) – within pavement above culvert.
- Billabong Creek – horizontal directional drill.
- Nangus Creek – attached to bridge.

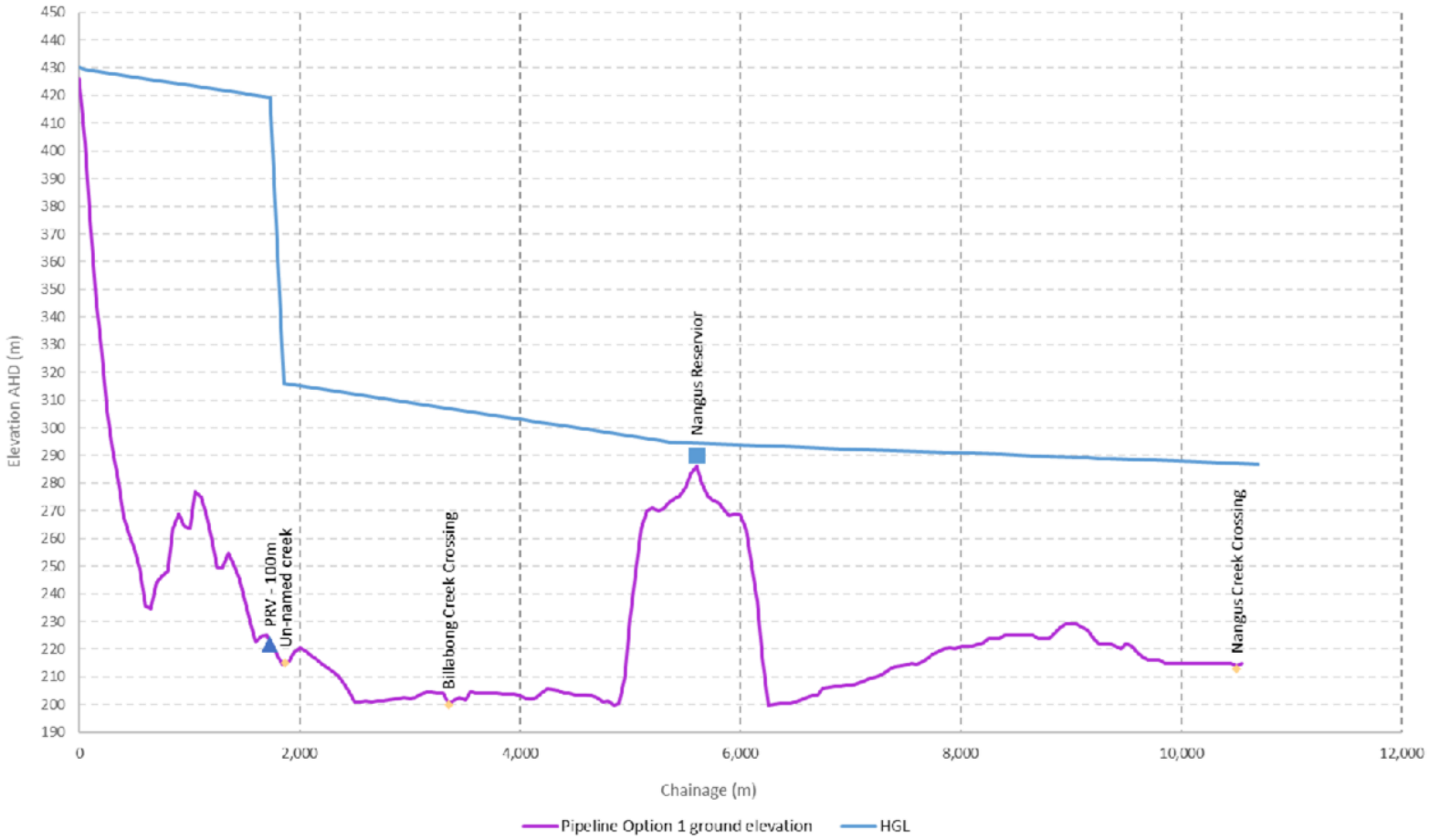

Figure 8-7 Option 4 – Hydraulic Grade & Elevation Profile

The model of the existing GWCC network was also analysed to determine any impacts due to the Nangus supply. No significant impacts were observed and it is therefore considered that no upgrade to the existing network will be required to supply Nangus on the basis of the additional demand. However, as noted in Section 6, future investigations should include consideration of the condition of these existing assets, and what renewals may be necessary to ensure reliability of supply.

As noted in Section 6, the MDD and annual demand on the Oura WTP are projected to be 30.2 ML/d and 4,600 ML/y respectively by 2048 (without the Nangus supply). Supply of water to Nangus would equate to an additional 1.7% to the MDD and 0.8% to the annual demand.

8.7.3 Environmental Constraints

A desktop review has been undertaken using online resources to provide initial high level advice of the environmental constraints associated with Option 4 which includes biodiversity, heritage, major waterbodies and watercourses, socio-economic considerations, soils and contamination, cumulative impacts and land use and land zoning.

Key features are presented in Appendix B and the findings of the desktop review are discussed below. Database searches were conducted between 20 and 25 November 2019 and are considered accurate at the time of writing. Most of the searches conducted present findings at a scale that does not allow for precise impact assessment, and the constraints would need to be confirmed on-site during future stages of the project in order to determine and either avoid and/or minimise potential impacts. This is particularly the case for heritage items and threatened flora, fauna and vegetation communities where the records reported generally relate to those found within a 10 km search area and/or are recorded imprecisely in public databases.

8.7.3.1 Biodiversity

NSW listed biodiversity constraints

The vegetation communities present in the area are mapped on the vegetation map in Appendix B and a brief description of the constraints is provided below:

- The area is primarily dominated by non-native vegetation
- There are three native vegetation communities present along the alignment of Option 4. These PCT's may be associated with TEC's protected under the BC Act as shown in Table 8-11.

Table 8-11 State listed vegetation communities and associated BC Act TECs

PCT - ID	PCT	Associated BC Act listed TEC name*	Probable TEC Status*
5	River Red Gum Herbaceous – Grassy Very Tall Open Forest Wetland	Not listed under the BC Act	NA
79	River Red Gum Shrub/Grass Riparian Tall Woodland or Open Forest Wetland	** Status of this vegetation under state and federal legislation is currently unknown and should be investigated further in later project development stages.	**
266	White Box Grassy Woodland	White Box grassy woodland in the upper slopes sub-region of the NSW South Western Slopes Bioregion	EEC

* Derived from the NSW Vegetation Information System (VIS) which allows you to match PCTs with probable TECs.
** Data not available in the VIS.

- NSW BioNet Atlas (OEH, 2019c) – a search for threatened species, populations and ecological communities was undertaken on 22/11/2019 with 14 listed species under the BC Act were recorded within the vicinity of the alignment. The alignment does not directly impact on known sightings of threatened flora or fauna.
- A search of DPI – Key Fish Habitat found that Option 4 crosses three waterbodies that are considered key Fish Habitat including:

- Billabong Creek
- Nangus Creek
- Island Creek

> According to the Gundagai LEP 2011 and Junee LEP 2012, Option 4 will have an impact on areas mapped as 'sensitive land' according to the Natural Resources Sensitivity Biodiversity Map. The objective of the mapped sensitive land is to help maintain terrestrial and aquatic biodiversity.

Federally listed biodiversity constraints

> NSW BioNet Atlas (OEH, 2019c) – a search for threatened species, populations and ecological communities was undertaken on 22/11/2019 with 4 listed species under the *EPBC Act* found within the vicinity of this option.

> A search of the PMST (DOEE, 2019) was undertaken on 22/11/2019. The following MNES have been identified within 10km of this option. Federally listed TEC's have been identified below in Table 8-12.

- 4 Wetlands of International Importance all of which are located approximately 400km – 800km downstream of Option 4 alignment.
- 30 threatened species and 11 migratory species

Table 8-12 Federally listed TECs

TEC	Status: Endangered (EEC) or Critically Endangered (CEEC)
Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	EEC
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	CEEC

Important conservation tenures

> Areas of Outstanding Biodiversity Value (AOBV): AOBVs are special areas that contain irreplaceable biodiversity values that are important to the whole of NSW, Australia or globally. Areas of declared critical habitat under the TSC Act have become the first AOBVs in NSW with the commencement of the new BC Act. A search of the Critical habitat register NSW Office of Environment and Heritage (OEH, 2019a) was conducted on 22/11/2019 and no areas of critical habitat/AOBVs are located within proximity of this option.

> Option 4 does not impact on any listed National Parks and Wildlife Services (NPWS) reserves and national parks.

> A search of the Biobanking Public Register (NSW OEH, 2019) was used to search for Biobanking agreements, expressions of interest and statements within the Cootamundra - Gundagai LGA and Junee LGA. No Biobanking sites were located within the area of this option.

8.7.3.2 Heritage

8.7.3.2.1 Historic Heritage

Local Heritage

There is one heritage item identified under the Gundagai LEP 2011 in proximity to the proposed option (and none under the and Junee LEP 2012).

> I20: War Memorial Nangus – located on the outskirts of the town of Nangus

The abovementioned locally listed heritage item will not be impacted by the proposed option.

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There are no State Heritage Register listed heritage items within proximity of Option 4.

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  - Kandosols
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8.7.3.5 Socio-economic, Land Use and Zoning

- The majority of Option 4 alignment is within land zoned RU1 – Primary Production land zoning. As the alignment enters the township of Nangus the zoning changes to RU5 – Village (see the land use and zoning map in Appendix B).
- This option traverses both Junee LGA and Cootamundra – Gundagai LGA.
- The pipeline option traversed across private properties in multiple locations.
- The PMST search identified 1 potential area of Commonwealth Land protected under the EPBC Act within 10 km of this option. The precise location of this land parcel will need to be confirmed in future investigations with impacts to these areas avoided and/or minimised where possible. If the project is likely to have a significant impact on Commonwealth land it may require referral to DoEE under the EPBC Act.
- Socio-economic considerations relevant to this option include:
  - Potential adverse impacts on private properties during pipeline installation
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The potential for cumulative impacts was considered through review of the Major Projects Register which identifies major projects proposed (including State Significant Development (SSD) and State Significant Infrastructure (SSI) projects) either under assessment of approved. The register was searched for Cootamundra - Gundagai LGA and Junee LGA. Three major projects were identified (the Adjungbilly Wind Farm, Sebastopol Solar and Young to Wagga Looping Pipeline), however the projects are not in close proximity to Option 4 and is therefore unlikely to generate cumulative impacts.

Cootamundra – Gundagai Regional Council DA Tracking portal for Cootamundra - Gundagai LGA was accessed on 25 November 2019 to check for any development that may impact on the proposed pipeline option. The search included results from January 2019 through to June 2019 and concluded that there are no relevant DA Applications that will have an influence on the proposed project.

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It is noted that this search was not comprehensive and local developments should be checked as part of future project stages.

8.7.3.7 Summary of Environmental Constraints & Approval Pathway

Summary

The key environmental constraints related to pipeline Option 4 are the biodiversity and heritage constraints identified above. A more detailed assessment of the final alignment during future stages of the development will allow for avoidance or minimisation of potential impacts identified above. Impacts on other matters can generally be managed through careful construction management processes developed at future construction stages of development. Impacts to private property will also need to be minimised where possible with appropriate consultation with interested stakeholders and impacted community members where necessary.

The location and extent of all constraints, but in particular the biodiversity and heritage constraints, will need to be confirmed in future stages of the project through on-ground surveys and research. Significant impacts to biodiversity can trigger the need for an Environmental Impact Statement (EIS) under Part 5, Division 5.1, Subdivision 3 of the EP&A Act. Significant impacts to Commonwealth listed threatened entities or Commonwealth land can trigger the need for a referral to the Federal Government and assessment under the EPBC Act. If an EIS becomes necessary due to unavoidable impacts, the project approval timeframes and budgets allocated could be substantially increased. From this high level desktop constraints analysis,

and given the proposed pipeline route could be developed to avoid or minimise such impacts, it is considered unlikely that the proposed alignment would have a significant impact on biodiversity and/or Commonwealth matters. This would need to be confirmed during future stages of the project as the constraints analysis is high level and the design is at a preliminary stage.

Initial approval pathway advice

The project will need assessment under the EP&A Act. State Environmental Planning Policy (SEPPs) guide the approval pathways under the EP&A Act.

The initial approval pathway will be assessed under the State Environmental Planning Policy (Infrastructure) 2001 (ISEPP), as the pipeline and associated ancillary structures is considered a "water reticulation system". Under Clause 125(1) of ISEPP, development for the purpose of a water reticulation system (including reservoirs) may be carried out by or on behalf of a public authority without consent on any land. As the pipeline project would be undertaken by GWCC or CGRC (both public authorities) the proposal would be permissible without consent, and therefore it is currently anticipated that the applicable approval pathway is via a Review of Environmental Factors under Part 5 of the EP&A Act. Clause 14(1) of the State and Regional Development SEPP states that development for the purpose of water storage facilities that has a capital investment value of more than $30 million would be subject to a more intense approvals pathway which may trigger the need for an Environmental Impact Statement.

The approval pathway will need to be confirmed and will be dependent on confirmation of pipeline alignment and potential impacts which will be confirmed at later stages of the project. This will involve specialist studies and on-ground surveys to confirm environmental constraints, confirmation of land use and applicability of Part 5 provisions, confirmation of capital investment value and consideration of 'significant impacts' on the environment which could trigger the need for an EIS.

8.7.4 Cost Estimate

The estimated capital cost for Option 4 is $3.04 million, excluding GST. A detailed breakdown of this estimate is provided in Appendix E. See Section 5.1 for a description of the inclusions and methodology for cost estimates.

8.7.5 Multi-criteria Analysis and Risk Assessment

MCA scoring (as per the template in Table 5-1), and a discussion on the risks related to each parameter are given in Table 8-13.

Table 8-13 Option 4 – Multi-Criteria Analysis

No.	Criteria	Weighting	Score	Discussion
1	**Security of Supply** Consider the security of the water supply and the impact/risks of prolonged drought.	20%	10	▪ It is assumed that GWCC's Oura water supply network will meet or exceed the 5/10/10 rule. Water is sourced from the Murrumbidgee Regulated Water Source, and has a high level of security.
2	**Water Quality - Health** Consider the reliability and risks to water quality with regard to health criteria.	15%	9	▪ It is assumed that water supplied by GWCC's Oura water supply network will meet the ADWG health requirements. ▪ Chlorine dosing facility to be provided at Nangus reservoir to maintain residual. ▪ Potential for chlorine residuals to fall between chlorine dosing at Nangus reservoir and Nangus, which would necessitate an additional chlorine dosing facility.
3	**Water Quality - Aesthetic** Consider the reliability and risks to water quality with regard to asthenic criteria.	10%	10	▪ It is assumed that water supplied by GWCC's Oura water supply network will meet the majority of current ADWG aesthetic requirements.
4	**Operational Risk** Consider the consequence of failure with regards to operator safety, community safety, scheme complexity, time needed to reinstate supply and resourcing risk.	15%	7	▪ Operation and maintenance of pipeline, PRV, reservoir and chemical dosing facility considered familiar to operators. ▪ Significant length of the pipeline will be located through steep farmland with potentially difficult access for maintenance. ▪ Access to reservoir and chlorine dosing facility will pose difficulties. ▪ In the event of a prolonged failure of the pipeline water may be carted from Gundagai or GWCC to the Nangus reservoir. ▪ Materials readily available and close by in case of repair.
5	**Constructability** Consider the ability to construct each option, including safety, availability of materials, availability of suitably qualified contractors, ground conditions, impact on existing services, access etc.	15%	6	▪ A significant length of the pipeline is through steep, rocky terrain. ▪ Some constructability risk related to unknown geotechnical conditions. ▪ Mostly conventional construction methods – open trenching. ▪ No specialised materials. ▪ Many experienced contractors available for this type of work. Similar works are currently being undertaken at other locations across NSW. ▪ The ability to swiftly construct water pipelines similar to this project has been proven at other sites in NSW. ▪ Three creek crossings to be suspended from bridge or directional drilled.
6	**Project Definition Risk** Consider risk associated with level of definition and potential for currently unknown issues to impact schedule and budget.	10%	6	▪ Geotechnical conditions unknown. Rock is likely to be a risk in elevated terrain near Tenandra and the proposed Nangus reservoir. ▪ Geotechnical conditions for proposed directional drilling of Billabong Creek are not known. ▪ Ability to mount pipeline on bridge (proposed at one location) is not known. Directional drilling or open trenching are alternatives.
7	**Heritage, Environment and Approvals** Consider environmental and heritage impacts and risks and the risk associated with obtaining approvals.	15%	8	▪ Avoidance of impacts to known state and federally listed TEC's and threatened species is likely to be possible. ▪ Waterway crossings will need to be sensitively designed to have minimal impact on the waterways.

No.	Criteria	Weighting	Score	Discussion
				▪ Impacts to indigenous heritage and a more accurate and verified survey of the land is needed for future project development. ▪ Obtaining easements for installation of the pipeline within private property presents a possible project delivery risk. However, experience has shown that use of private property can avoid delays due to environmental approvals for installation in the road reserve. Significant portions of the pipeline are not close to road reserves, so diverting into the road reserve is not an option if there are issues with easements. ▪ Environmental approvals unlikely to significantly delay the project as careful route selection should allow avoidance of impacts.
	Total	100%	8.1	

8.8 Option 5: Murrumbidgee River extraction and treatment

8.8.1 Description

For Option 5 raw water would be extracted from the Murrumbidgee River via a new water intake. The raw water would be pumped to a new WTP located near Nangus. The water would be treated in compliance with the ADWG and draft ADWG health based targets (HBTs) and discharged to a reservoir. From the reservoir, treated water would be pumped into the reticulation system for supply.

A map of Option 5 is shown in Figure 8-8. Note that this plan is indicative only, for the purposes of generally displaying the infrastructure required. Locations for the river intake and WTP have not undergone a site selection process.

8.8.2 Preliminary Design

A detailed analysis of the proposed surface water treatment option is in the Surface and Groundwater Treatment Options report in Appendix C. A schematic of the proposed process is shown in Figure 8-9. The system is proposed to comply with all requirements of the ADWG.

A new raw water intake and pump station would be constructed at the Murrumbidgee River to transfer water to the WTP. A typical surface water intake would comprise a wedgewire screen to prevent entry of course solids and to ensure that fish are protected. This would be surrounded by a reinforced concrete structure to protect the screen and channel floor. A pumping station on the shore would transfer the raw water to the treatment plant. It is noted that the actual configuration would need to be determined based on a detailed investigation of the river conditions and adjacent flood plain.

From the raw water pump station a DN100 pipeline would convey raw water to the WTP site.

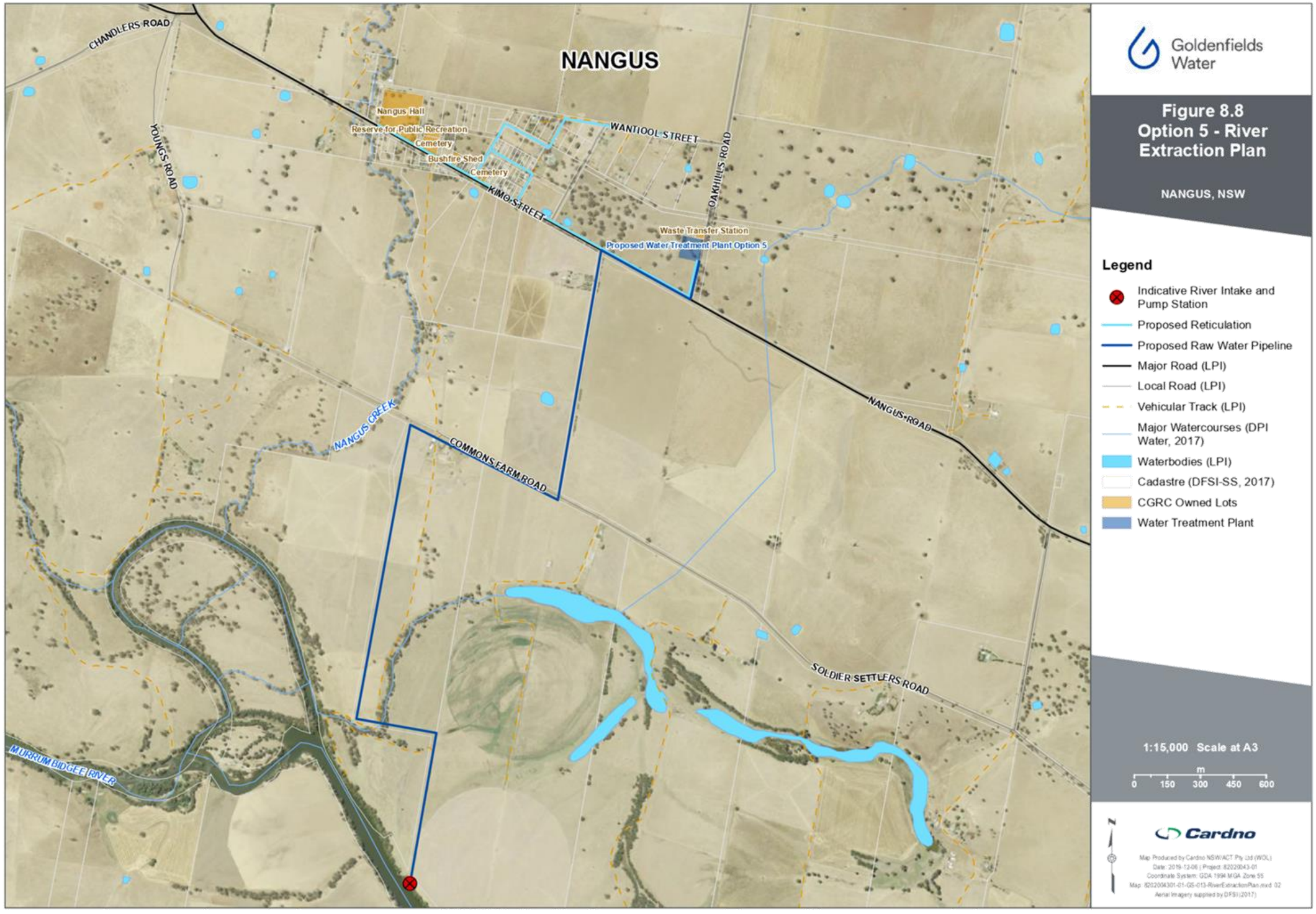
It has been assumed that the raw water source is a vulnerability category 4 (unprotected) catchment under the draft ADWG HBTs. The water treatment process would involve the following major process components:

- Powdered activated carbon (PAC) dosing for taste and odour control
- pH correction
- Oxidation for iron and manganese removal
- Coagulation, flocculation and sedimentation
- Membrane ultrafiltration
- Ultraviolet disinfection
- Chlorine dosing
- Fluoridation
- Sludge ponds for solids management

The production capacity of the WTP would be 400 kL/d, matching the peak demand from Nangus. The peak extraction from the Murrumbidgee River would be approximately 420 kL/d, allowing for 5% losses in waste streams.

A reservoir of approximately 250 kL storage volume is required, to provide for three days of average day demand, in line with GWCC requirements. It is proposed that this reservoir be constructed at ground level from concrete, and the reticulation network be supplied by pumps drawing from the reservoir. A standby generator would be provided for backup power to the pumps.

The reticulation system would consist of DN100 PVC-O, with the extents as shown on Figure 8-8, matching the other options.


NANGUS
CHANDLERS ROAD
YOUNGS ROAD
Nangus Hall
Reserve for Public Recreation
Cemetery
Bushfire Shed
Cemetery
WANTIOOL STREET
OAKHILLS ROAD
KIMO STREET
Waste Transfer Station
Proposed Water Treatment Plant Option 5
NANGUS ROAD
NANGUS CREEK
COMMONS FARM ROAD
SOLDIER SETTLERS ROAD
MURRUMBIDGEE RIVER
Goldenfields Water
Figure 8.8
Option 5 - River Extraction Plan
NANGUS, NSW
Legend
Indicative River Intake and Pump Station
Proposed Reticulation
Proposed Raw Water Pipeline
Major Road (LPI)
Local Road (LPI)
Vehicular Track (LPI)
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
Cadastre (DFSI-SS, 2017)
CGRC Owned Lots
Water Treatment Plant
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Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-12-06 | Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Map: 82020043-01-GIS-013-RiverExtractionPlan.mxd 02
Aerial Imagery supplied by DFSI (2017)

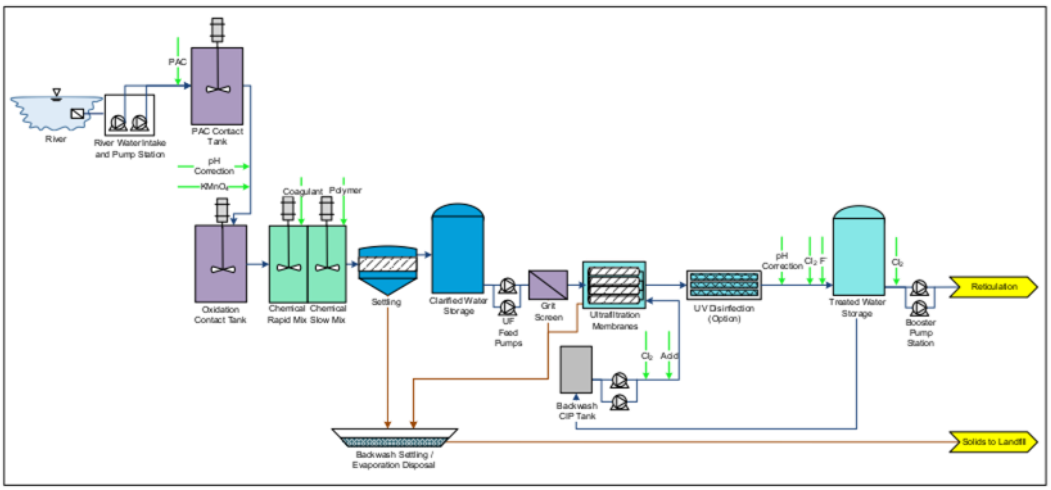


Figure 8-9 Option 5 – Water Treatment Process

8.8.3 Water Access Licence Implications

Option 5 involves extraction of water from the Murrumbidgee Regulated River Water Source. This activity is controlled under the *Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2016* (NSW Government, 2018). A specific purpose WAL in the 'Local Water Utility' category is required to extract water from the Murrumbidgee Regulated River Water Source for town water supply.

GWCC currently holds WAL6456 for extraction of 5,590 ML/y from the Murrumbidgee Regulated River Water Source for use in town water supply. Water extraction for GWCC's Jugiong WTP is carried out under this WAL.

CGRC currently holds WAL6455 for extraction of 1,250 ML/y from the Murrumbidgee Regulated River Water Source for use in town water supply. Water extraction for CGRC's Gundagai WTP is carried out under this WAL.

Both the above WALs do not specify a particular location for the water withdrawal, other than in the referenced works approvals, which specifically relate to the intake works at Jugiong and Gundagai respectively. Advice obtained from the Natural Resource Access Regulator (NRAR) indicates that it should be possible to use the allocations under either of these WALs for Nangus, provided that a new works approval can be obtained for an intake at Nangus, and attached to either WAL. A new works approval would be processed by NRAR, but linking of the works approval to the WAL would be approved via WaterNSW. Both organisations would need the concurrence of DPIE.

Alternatively, under the Water Sharing Plan, a new specific purpose WAL may be granted by the Minister responsible, provided "the Minister is satisfied that the share and extraction component of the access licence is the minimum required to meet the circumstances in which the access licence is proposed to be used". An application would need to be made to the NRAR for approval, and would require endorsement by DPIE. A new works approval for the intake would also be required from NRAR.

8.8.4 Environmental Constraints

A desktop review has been undertaken using online resources to provide initial high level advice of the environmental constraints associated with Option 5 which includes biodiversity, heritage, major waterbodies and watercourses, socio-economic considerations, soils and contamination, cumulative impacts and land use and land zoning.

Key features are presented in Appendix B and the findings of the desktop review are discussed below. Database searches were conducted between 20 and 25 November 2019 and are considered accurate at the time of writing. Most of the searches conducted present findings at a scale that does not allow for precise impact assessment, and the constraints would need to be confirmed on-site during future stages of the project in order to determine and either avoid and/or minimise potential impacts. This is particularly the case for heritage items and threatened flora, fauna and vegetation communities where the records reported generally relate to those found within a 10 km search area and/or are recorded imprecisely in public databases.

8.8.4.1 Biodiversity

NSW listed biodiversity constraints

The vegetation communities present in the area are mapped on the vegetation map in Appendix B and a brief description of the constraints is provided below:

- The area is primarily dominated by non-native vegetation.
- A small portion of the proposed alignment will have an impact on one native vegetation community – the River Red Gum Herbaceous – Grassy Very Tall Open Forest Wetland (known as PCT 5 - PCT 5 is not listed as a threatened ecological community under state or federal legislation.

Table 8-14 State listed vegetation communities and associated BC Act TECs

PCT - ID	PCT	Associated BC Act listed TEC name	Probable TEC Status
5	River Red Gum Herbaceous – Grassy Very Tall Open Forest Wetland	Not listed under the BC Act	NA

- NSW BioNet Atlas (OEH, 2019c) – a search for threatened species, populations and ecological communities was undertaken on 25/11/2019 with 39 listed species under the BC Act recorded within the vicinity of the alignment.
- A search of DPI – Key Fish Habitat) found that Option 5 directly extracts from the Murrumbidgee River which is listed as Key Fish Habitat.

Federally listed biodiversity constraints

- NSW BioNet Atlas (OEH, 2019c) – a search for threatened species, populations and ecological communities was undertaken on 25/11/2019 with 13 listed species under the *EPBC Act* found within the vicinity of the alignment.
- A search of the PMST (DOEE, 2019) was undertaken on 25/11/2019. The following MNES have been identified within 10km of this option.
  - Four Wetlands of International Importance all of which are located approximately 400km – 800km downstream of Option 5.
  - PMST results identified 28 threatened species and 11 migratory species within 10km of Option 5.
- No federally listed TEC within the vicinity of this option.
- According to the Gundagai LEP, Option 5 passes through land that is mapped as sensitive land on the Natural Resources Sensitivity Biodiversity Map.

Important conservation tenures

- Areas of Outstanding Biodiversity Value (AOBV): AOBVs are special areas that contain irreplaceable biodiversity values that are important to the whole of NSW, Australia or globally. Areas of declared critical habitat under the TSC Act have become the first AOBVs in NSW with the commencement of the new BC Act. A search of the Critical habitat register NSW Office of Environment and Heritage (OEH, 2019a) was conducted on 22/11/2019 and no areas of critical habitat/AOBVs are located within proximity of this option.
- Option 5 does not impact on any listed NPWS reserves and national parks.
- A search of the Biobanking Public Register (NSW OEH, 2019) was used to search for Biobanking agreements, expressions of interest and statements within the Cootamundra - Gundagai LGA. No Biobanking sites were located within the vicinity of this option.

8.8.4.2 Heritage

8.8.4.2.1 Historic Heritage

Local Heritage

There are two heritage items identified under the Gundagai LEP 2011 in proximity to the proposed option.

- I20: War Memorial Nangus – located on the outskirts of the town of Nangus

- I14 Nangus Station Group – located east of the option

Neither of these items will be impacted by the proposed option.

State Heritage

There are no State Heritage Register listed heritage items within the vicinity of Option 5.

Federal Heritage

- A search of the Australian Government's Australian Heritage Database (DoEE, 2019) identified 15 federally listed heritage items within the Cootamundra - Gundagai LGA.
- The PMST search undertaken on 25/11/2019 found that no World Heritage Properties or National Heritage Places were identified within 10 km of Option 5.

8.8.4.2.2 Aboriginal Heritage

A search of the AHIMS register (NSW OEH, 2019d) on 25/11/2019 identified 23 Aboriginal sites and 0 (zero) Aboriginal places within the vicinity of Option 5. The search does not identify the precise locations of the sites and Aboriginal heritage constraints would be subject to confirmation during future project stages.

A search of the Native Title Register and Native Title Claims Register (Native Title Tribunal, 2019) conducted on 25/11/2019 returned no records within the Cootamundra – Gundagai LGA.

8.8.4.3 Hydrology, Water Quality and Groundwater

The hydrological, water quality and groundwater related features associated with this option are shown on the Hydrology figure in Appendix B.

- This option would draw water directly from the Murrumbidgee River and cross one associated drainage course as the alignment travels north towards Nangus Village. The Murrumbidgee River has been classed as a higher order watercourse (>8) under the Strahler stream order system. The alignment also crosses an unnamed drainage channel close to the Murrumbidgee (DPI Water, 2017).
- The Murrumbidgee River is mapped as Key Fish Habitat (DPI Water, 2017).
- While works will be within 40m a watercourse, a controlled activity approval under the WM Act is not required as the works would be undertaken by a public authority.
- The requirements for a Water Access Licence and Works Approval are discussed in Section 8.8.3.
- Waterway crossings would need to be designed to be sensitive to the biodiversity values present at site.
- Groundwater Dependent Ecosystems (GDE) are aquatic and terrestrial ecosystems which are sustained, to a degree, by groundwater. Option 5 proposes to extract water directly from the Murrumbidgee River which is classed as high potential GDE (BOM, 2019).
- This option would cross areas mapped as 'sensitive land' according to Gundagai LEP 2011.
- Option 5 does not impact on any existing bores in its proposed locations. It is not expected that the option would have any impact on existing bores as the locations of infrastructure could be set to avoid them.

8.8.4.4 Soil and Contamination

- Soils present within the area are shown on the soils figure in Appendix B.
- Option 5 traverses two different soil classes including Kurosols and Rudosols (Aluvial)
- Soil is not mapped as saline land (DPE, 2019).

A search of the OEH Contaminated Land Record and the POEO Act Public Register of Licences was undertaken on 24/11/2019. The search highlighted 22 locations where a POEO License has been issued in the LGA of Cootamundra - Gundagai. The listed locations of issued licences are not impacted by Option 5. There are no known contaminated sites listed on the OEH Contaminated Land Register in the vicinity of Option 5. This does not mean there is no contaminated land on site as not all contaminated areas have been recorded and constraints would need to be confirmed in future project stages.

8.8.4.5 Socio-economic, Land Use and Zoning

- The majority of Option 5 is covered by RU1 – Primary Production land zoning. As the alignment enters the township of Nangus the zoning changes to RU5 – Village (see the land use and zoning map in Appendix B).

- The option traversed private properties in multiple locations.
- The PMST search identified 1 potential area of Commonwealth Land protected under the EPBC Act within 10km of this option. The precise location of this land parcel will need to be confirmed in future investigations with impacts to these areas avoided and/or minimised where possible. If the project is likely to have a significant impact on Commonwealth land it may require referral to DoEE under the EPBC Act.
- Socio-economic considerations relevant to this option include:
  - Potential adverse impacts on private properties during construction.
  - Positive impacts associated with securing a water supply for Nangus.

8.8.4.6 Cumulative Impacts

The potential for cumulative impacts was considered through review of the Major Projects Register which identifies major projects proposed, under assessment or approved (including State Significant Development (SSD) and State Significant Infrastructure (SSI) projects). The register was searched for Cootamundra - Gundagai LGA and 1 major project was identified (the Adjungbilly Wind Farm), however the project is not in close proximity to this option and is therefore unlikely to generate cumulative impacts.

The Cootamundra – Gundagai Regional Council DA Tracking portal for Cootamundra - Gundagai LGA was accessed on 25 November 2019 to check for any development that may impact on the proposed pipeline option. The search included results from January 2019 through to June 2019 concluded that there are no relevant DA Applications that will have an influence on the proposed project.

It is noted that this search was not comprehensive and local developments should be checked as part of future project stages.

8.8.4.7 Summary of Environmental Constraints & Approval Pathway

Summary

The key environmental constraints related to Option 5 are the biodiversity and heritage constraints identified above. A more detailed assessment of the final infrastructure locations during future stages of the development will allow for avoidance or minimisation of potential impacts identified above. This proposed option would be directly extracting water from the Murrumbidgee River, a key ecosystem for aquatic and terrestrial biodiversity. A detailed investigation into the Murrumbidgee River would be necessary to scope appropriate extraction points and alignment with the *Water Sharing Plan for the Murrumbidgee Unregulated and Alluvial Water Sources 2012*. Impacts on other matters can generally be managed through careful construction management processes developed at future construction stages of development. Impacts to private property will also need to be minimised where possible with appropriate consultation with interested stakeholders and impacted community members where necessary.

The location and extent of all constraints, but in particular the biodiversity and heritage constraints, will need to be confirmed in future stages of the project through on-ground surveys and research. Significant impacts to biodiversity can trigger the need for an Environmental Impact Statement (EIS) under Part 5, Division 5.1, Subdivision 3 of the EP&A Act. Significant impacts to Commonwealth listed threatened entities or Commonwealth land can trigger the need for a referral to the Federal Government and assessment under the EPBC Act. If an EIS becomes necessary due to unavoidable impacts, the project approval timeframes and budgets allocated could be substantially increased. From this high level desktop constraints analysis, the river extraction option could be developed to avoid or minimise such impacts, it is considered unlikely that the proposed alignment would have a significant impact on biodiversity and/or Commonwealth matters. This would need to be confirmed during future stages of the project as the constraints analysis is high level and the design is at a preliminary stage.

Initial approval pathway advice

The project will need assessment under the EP&A Act. SEPPs guide the approval pathways under the EP&A Act.

The initial approval pathway will be assessed under the State Environmental Planning Policy (Infrastructure) 2001 (ISEPP). The pipelines and associated ancillary structures are considered a "water reticulation system". Under Clause 125(1) of ISEPP, development for the purpose of a water reticulation system (including reservoirs) may be carried out by or on behalf of a public authority without consent on any land. As the project would be undertaken by GWCC or CGRC (both public authorities) the proposal would be permissible without consent.

Under Clause 125(3A) of ISEPP, 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. The proposed location of the Water Treatment Plant for Option 5 is on land in a prescribed zone and is therefore permissible without consent. Therefore, it is currently anticipated that the applicable approval pathway is via a Review of Environmental Factors under Part 5 of the EP&A Act.

Option 5 involves the extraction of water directly from the Murrumbidgee River. This activity is controlled under the *Water Sharing Plan for the Murrumbidgee River Water Source 2016* (NSW Government, 2018). A specific purpose Water Access License (WAL) in the 'Local Water Utility' category is required to extract water from the Murrumbidgee River for town water supply. As discussed above in Section 9.3.6, there are multiple options to consider when it comes to accessing this WAL. Advice obtained by NRAR indicates that it should be possible to use allocations of existing WAL's in Nangus for Option 5. A new works approval would be processed by NRAR, but linking of the works approval to the WAL would be approved by WaterNSW.

Clause 14(1) of the State and Regional Development SEPP states that development for the purpose of water storage or water treatment facilities that has a capital investment value of more than $30 million would be subject to a more intense approvals pathway which may trigger the need for an Environmental Impact Statement.

The approval pathway will need to be confirmed and will be dependent on confirmation of pipeline alignment and project footprint. The potential impacts which will be confirmed at later stages of the project. This will involve specialist studies and on-ground surveys to confirm environmental constraints, confirmation of land use and applicability of Part 5 provisions, confirmation of capital investment value and consideration of 'significant impacts' on the environment which could trigger the need for an EIS.

8.8.5 Cost Estimate

The estimated capital cost for Option 5 is $9.12 million, excluding GST. A detailed breakdown of this estimate is provided in Appendix E. See Section 5.1 for a description of the inclusions and methodology for cost estimates.

8.8.6 Multi-criteria Analysis and Risk Assessment

MCA scoring (as per the template in Table 5-1), and a discussion on the risks related to each parameter are given in Table 8-15.

Table 8-15 Option 5 – Multi-Criteria Analysis

No.	Criteria	Weighting	Score	Discussion
1	**Security of Supply** Consider the security of the water supply and the impact/risks of prolonged drought.	20%	10	▪ A high level of water security is provided from the Murrumbidgee River.
2	**Water Quality - Health** Consider the reliability and risks to water quality with regard to health criteria.	15%	9	▪ The proposed treatment system will meet the requirements of the ADWG and the draft HBTs. ▪ Potential risks in maintaining treatment performance at a small facility with low staffing level.
3	**Water Quality - Aesthetic** Consider the reliability and risks to water quality with regard to asthenic criteria.	10%	9	▪ The proposed treatment system will meet the requirements of the ADWG. ▪ Potential risks in maintaining treatment performance at a small facility with low staffing level.
4	**Operational Risk** Consider the consequence of failure with regards to operator safety, community safety, scheme complexity, time needed to reinstate supply and resourcing risk.	15%	6	▪ Risk of damage to intake structure and raw water pump station during flood conditions and from debris. ▪ Relatively complex WTP required due to water quality. Higher risk of operational failure than pipeline options. ▪ Moderate resourcing risk.
5	**Constructability** Consider the ability to construct each option, including safety, availability of materials, availability of suitably qualified contractors, ground conditions, impact on existing services, access etc.	15%	6	▪ Work to install intake in Murrumbidgee River – high risk. ▪ Moderate risk related to procuring suitably qualified construction contractors that can meet program requirements. Construction delays have been observed in treatment plant construction in recent projects in NSW. ▪ Land acquisition delays are a potential risk.
6	**Project Definition Risk** Consider risk associated with level of definition and potential for currently unknown issues to impact schedule and budget.	10%	5	▪ Impacts of flooding unknown. ▪ Geotechnical conditions unknown. ▪ Unknown risks around site selection of intake location – site specific impacts, river morphology etc.
7	**Heritage, Environment and Approvals** Consider environmental and heritage impacts and risks and the risk associated with obtaining approvals.	15%	6	▪ Potential direct impacts to the Murrumbidgee River to be investigated further. ▪ Avoidance of impacts to known state and federally listed TEC's and threatened species is likely to be possible. ▪ Waterway crossings will need to be sensitively designed to have minimal impact on the waterways. ▪ Impacts to indigenous heritage and a more accurate and verified survey of the land is needed for future project development. ▪ Environmental approvals unlikely to significantly delay the project as careful selection of the locations for infrastructure should allow avoidance of impacts. ▪ Several options existing for obtaining rights (WAL) to extract water from the Murrumbidgee River. However, risk remains around this approval. ▪ A new works approval will be required from NRAR for the river intake.
	Total	100%	7.5	

8.9 Option 6: Groundwater extraction and treatment

8.9.1 Description

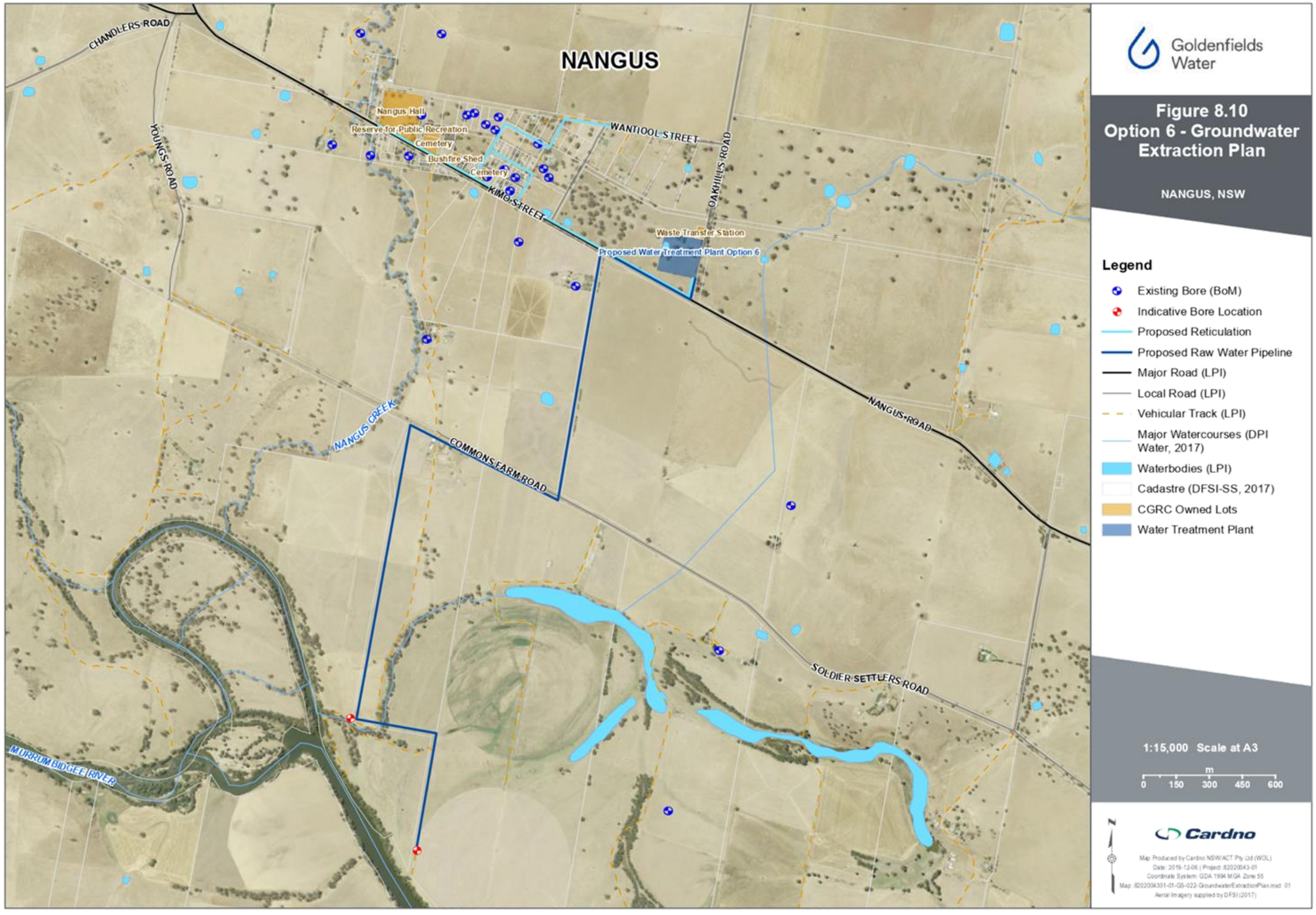
For Option 6 raw water would be taken from new groundwater bores. The raw water would be pumped to a new WTP located near Nangus. The water would be treated in compliance with the ADWG and draft ADWG health based targets (HBTs) and discharged to a reservoir. From the reservoir, treated water would be pumped into the reticulation system for supply.

A map of Option 6 is shown in Figure 8-10. Note that this plan is indicative only, for the purposes of generally displaying the infrastructure required. Locations for the bores and WTP have not undergone a site selection process.

8.9.2 Hydrogeological Study

Cardno has undertaken a Desktop Hydrogeological Review (see Appendix D) to investigate the viability of groundwater resources in the area around Nangus. The Gundagai Alluvial Groundwater Source underlies Nangus, and is controlled under the *Water Sharing Plan for the Murrumbidgee Unregulated and Alluvial Water Sources 2012* (NSW Government, 2016). The report concluded that:

- Groundwater in the study area is likely be present in porous media alluvial aquifers or in fractured bedrock aquifers.
- Groundwater in alluvial aquifers may occur at depths ranging from approximately 5 m to 19 m below ground surface, based on existing bores near the town of Nangus. Depth of groundwater in bedrock aquifers is not known at this stage.
- Groundwater yields are reported to range from approximately 1 to 13 L/s in the alluvial aquifer in the study area, with an average yield of about 3 L/s. Bore yields are expected to be relatively high in the alluvial aquifers, but may not be sufficient for the peak daily requirement which is understood to be 4.6 L/s. Bore yield in the bedrock aquifers is expected to be variable, though generally lower.
- Groundwater quality, with respect to salinity, is expected to be fair to unacceptable in alluvial aquifers (based on available data) and poor to unacceptable in bedrock aquifers (based on our experience of bedrock aquifers).
- A total of 51 registered groundwater bores have been identified within the study area. Groundwater uses mostly include water supply and irrigation, with minor stock/ domestic and monitoring uses. Potential impacts on existing registered bores would need to be considered if town supply bores were to be installed in the study area.
- It is considered that there is potential for suitable groundwater resources to exist in the study area. However, testing of bore yields and salinity is required to confirm this. Low yields may be addressed by using more than one bore for the groundwater supply. Poor groundwater quality can be addressed through the treatment of the groundwater prior to use as drinking water. Further, it is likely that groundwater salinity may be lower closer to the Murrumbidgee River, and groundwater investigations could target areas closer to the river.
- Further investigation is required to confirm the potential yield and quality of groundwater available. This would involve exploratory drilling of one or more groundwater bores at selected locations in the alluvial aquifer in the study area, followed by pumping tests and water quality testing.


NANGUS
CHANDLERS ROAD
YOUNGS ROAD
Nangus Hall
Reserve for Public Recreation
Cemetery
Bushfire Shed
Cemetery
WANTIOOL STREET
OAKHILLS ROAD
KIMO STREET
Waste Transfer Station
Proposed Water Treatment Plant Option 6
NANGUS ROAD
NANGUS CREEK
COMMONS FARM ROAD
SOLDIER SETTLERS ROAD
MURRUMBIDGEE RIVER
Goldenfields Water
Figure 8.10
Option 6 - Groundwater Extraction Plan
NANGUS, NSW
Legend
Existing Bore (BoM)
Indicative Bore Location
Proposed Reticulation
Proposed Raw Water Pipeline
Major Road (LPI)
Local Road (LPI)
Vehicular Track (LPI)
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
Cadastre (DFSI-SS, 2017)
CGRC Owned Lots
Water Treatment Plant
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Map: 82020043301-01-GIS-022-GroundwaterExtractionPlan.mxd 01
Aerial Imagery supplied by DFSI (2017)

8.9.3 Preliminary Design

New bores will be required to be constructed into the alluvial aquifer. We have assumed two bores will be required to provide sufficient yield and redundancy. Each bore would require a bore pump, surface well head protection to prevent contamination and backflow, and an electrical supply.

Bore locations have been indicatively shown near to the Murrumbidgee River, as salinity levels are expected increase with distance from the river (NSW DPI, 2016). The required bore depth is estimated to be around 25 m. There are also few existing bores near these locations that may be impacted.

From the bores, a DN100 raw water pipeline would convey the water to the WTP.

A detailed analysis of the proposed groundwater treatment option is in the Surface and Groundwater Treatment Options report in Appendix C. A schematic of the proposed process is shown on Figure 8-11. The system is proposed to comply with all requirements of the ADWG.

The Draft Chapter 5 Microbial Quality of Drinking Water (NHMRC, 2018) states that for groundwater a starting point for classification of the source is to "assume a groundwater resource is unprotected until objective, credible scientific evidence can conclusively demonstrate otherwise". In the worst case, if information is not available, the aquifer should be considered to be the same category as the surface water that recharges the aquifer.

Based on evidence that existing bores in the locality are shallow, the recharge source is likely to be the Murrumbidgee River and surface rainfall/runoff. There is not yet any water quality monitoring of the particular source, therefore, a conservative approach needs to be taken. For these reasons the groundwater sources within the study area have been given a preliminary microbiological risk assessment of Category 4. With further assessment of an actual source it is possible that the result could be a Category 3 classification.

Based on available data for water quality in the aquifer, total the dissolved solids (TDS) are elevated, ranging from 800 - 4,200mg/L (estimate based on converting electrical conductivity measurements to TDS). According to the ADWG this degree of salinity would be poor to unacceptable quality, with TDS required to be below 600mg/L to be aesthetically acceptable. It is also common that groundwater in the region has elevated iron and manganese. Therefore, it is highly likely that a suitable groundwater treatment process will have to address iron, manganese and TDS.

The proposed water treatment process would involve the following major process components:

- Iron and Manganese oxidation and filtration
- Chlorine neutralisation
- Reverse osmosis for TDS and pathogen removal
- Recarbonation / pH Correction
- UV for disinfection
- Chlorine dosing for disinfection
- Fluoridation
- Brine storage and evaporation
- Sludge ponds for solids management

The production capacity of the WTP would be 400 kL/d, matching the peak demand from Nangus. The peak extraction from the bores would be approximately 600 kL/d, allowing for losses in waste streams, in particular the brine from the reverse osmosis process.

A reservoir of approximately 250 kL storage volume is required, to provide for three days of average day demand, in line with GWCC requirements. It is proposed that this reservoir be constructed at ground level from concrete, and the reticulation network be supplied by pumps drawing from the reservoir. A standby generator would be provided for backup power to the pumps.

The reticulation system would consist of DN100 PVC-O, with the extents as shown on Figure 8-8, matching the other options.

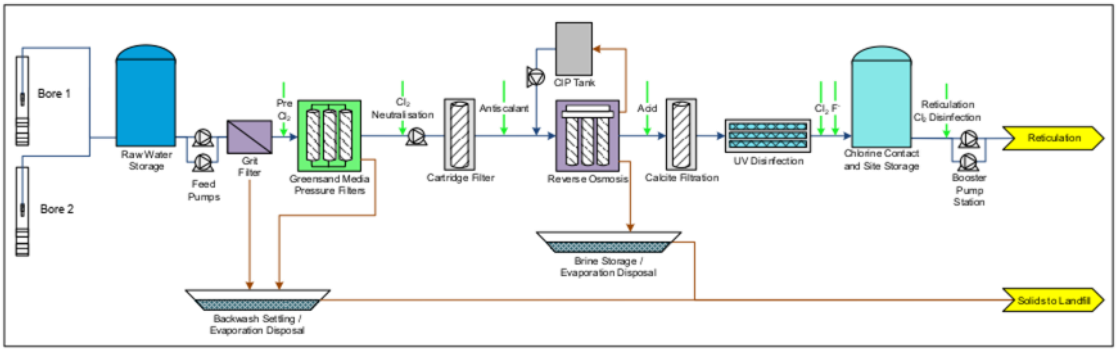

Figure 8-11 Option 6 – Water Treatment Process

8.9.4 Water Access Licence Implications

Option 6 involves extraction of water from the Gundagai Alluvial Groundwater Source. This activity is controlled under the *Water Sharing Plan for the Murrumbidgee Unregulated and Alluvial Water Sources 2012* (NSW Government, 2016).

GWCC currently holds WAL33469 for extraction of 6,000 ML/y from the Wagga Wagga Alluvial Groundwater Source for use in town water supply. This water feeds GWCC's Oura system. As the licence is for a different Source, it cannot be used for groundwater extraction at Nangus, and the water sharing rules for the Gundagai Alluvial Source prevent trading from other sources into this one. Further specific advice may be obtained from WaterNSW relating to water dealings that may allow transfer of a portion of the licence to the Gundagai Alluvial Source, however, these discussions will need to be undertaken directly between GWCC and WaterNSW.

A new WAL will likely be required under the Water Sharing Plan. The Minister responsible may grant a new specific purpose licence, provided "the Minister is satisfied that the share and extraction component of the access licence is the minimum required to meet the circumstances in which the access licence is proposed to be used". An application would need to be made to NRAR for approval, and would require endorsement by DPIE.

A water supply works approval will be required for construction and use of new bores to supply groundwater. The application would be made to NRAR and require the concurrence of DPIE. The Water Sharing Plan and Gundagai Alluvial Groundwater Source rules place a number of conditions on bore construction, including distance restrictions and construction standards. Distance restrictions are implemented to minimise interference between bores, and include:

- 1,000 m from an aquifer access licence bore on another landholding.
- 400 m from a basic landholder rights bore on another landholding.
- 1,000 m from a local or major water utility access licence bore.
- 1,000 m from a DPI Water monitoring bore.
- 500 m from a property boundary.

It may not be possible to comply with the above rules (for example, the property boundary restriction, which would require the purchase of a large amount of land or consent of the adjacent landholders). However, these requirements may be waived by the Minister responsible provided it can be demonstrated "to the Minister's satisfaction that the location of the water supply work at a lesser distance will result in no more than minimal impact on existing extractions within these water sources". A hydrogeological study would be required to determine the impact on existing bores, and confirm the suitability of reduced distances.

8.9.5 Environmental Constraints

A desktop review has been undertaken using online resources to provide initial high level advice of the environmental constraints associated with Option 6 which includes biodiversity, heritage, major waterbodies and watercourses, socio-economic considerations, soils and contamination, cumulative impacts and land use and land zoning.

Key features are presented in Appendix B and the findings of the desktop review are discussed below. Database searches were conducted between 20 and 25 November 2019 and are considered accurate at the

time of writing. Most of the searches conducted present findings at a scale that does not allow for precise impact assessment, and the constraints would need to be confirmed on-site during future stages of the project in order to determine and either avoid and/or minimise potential impacts.

This is particularly the case for heritage items and threatened flora, fauna and vegetation communities where the records reported generally relate to those found within a 10 km search area and/or are recorded imprecisely in public databases.

8.9.5.1 Biodiversity

NSW listed biodiversity constraints

The vegetation communities present in the area are mapped on the Vegetation map in Appendix B and a brief description of the constraints is provided below.

- The area is primarily dominated by non-native vegetation
- A small portion of the proposed alignment will have an impact on one native vegetation community. This PCT may be associated with a TEC protected under the BC Act. See below Table 8-16 for details.

Table 8-16 State listed vegetation communities and associated BC Act TECs

PCT - ID	PCT	Associated BC Act listed TEC name*	Probable TEC Status*
5	River Red Gum Herbaceous – Grassy Very Tall Open Forest Wetland	Not listed under the BC Act	NA

- NSW BioNet Atlas (OEH, 2019c) – a search for threatened species, populations and ecological communities was undertaken on 25/11/2019 with 39 listed species under the BC Act were recorded within the vicinity of the alignment.

Federally listed biodiversity constraints

- NSW BioNet Atlas (OEH, 2019c) – a search for threatened species, populations and ecological communities was undertaken on 25/11/2019 with 13 listed species under the *EPBC Act* within the vicinity of the alignment.
- A search of PMST (DOEE, 2019) was undertaken on 25/11/2019. The following MNES have been identified within 10km of this option.
  - Four Wetlands of International Importance all of which are located approximately 400km – 800km downstream of Option 6 alignment.
  - PMST results identified 28 threatened species and 11 migratory species within 10 km of Option 6.
- No federally listed TEC within this the vicinity of this option.
- According to the Gundagai LEP, Option 6 alignment passes through land that is mapped as sensitive land on the Natural Resources Sensitivity Biodiversity Map.

Important conservation tenures

- Areas of Outstanding Biodiversity Value (AOBV): AOBVs are special areas that contain irreplaceable biodiversity values that are important to the whole of NSW, Australia or globally. Areas of declared critical habitat under the TSC Act have become the first AOBVs in NSW with the commencement of the new BC Act. A search of the Critical habitat register NSW Office of Environment and Heritage (OEH, 2019a) was conducted on 22/11/2019 and no areas of critical habitat/AOBVs are located within proximity of this option.
- Option 6 does not impact on any listed NPWS reserves and national parks.
- A search of the Biobanking Public Register (NSW OEH, 2019) was used to search for Biobanking agreements, expressions of interest and statements within the Cootamundra - Gundagai LGA. No Biobanking sites were located within the vicinity of this option.

8.9.5.2 Heritage

8.9.5.2.1 Historic Heritage

Local Heritage

There are two heritage items identified under the Gundagai LEP 2011 in proximity to the proposed option.

- I20: War Memorial Nangus – located on the outskirts of the town of Nangus
- I14 Nangus Station Group – located east of the option

Both of the abovementioned locally listed heritage items will not be impacted by the proposed option (OEH, 2019).

State Heritage

There are no State Heritage Register listed heritage items within proximity of Option 6.

Federal Heritage

- A search of the Australian Government's Australian Heritage Database (DoEE, 2019) identified 15 federally listed heritage items within the Cootamundra - Gundagai LGA.
- The PMST search undertaken on 25/11/2019 found that no World Heritage Properties or National Heritage Places were identified within 10 km of the pipeline route.

8.9.5.2.2 Aboriginal Heritage

A search of the AHIMS register (NSW OEH, 2019d) on 25/11/2019 identified 23 Aboriginal sites and 0 (zero) Aboriginal places within the locality of Option 6. The search does not identify the precise locations of the sites and Aboriginal heritage constraints would be subject to confirmation during future project stages.

A search of the Native Title Register and Native Title Claims Register (Native Title Tribunal, 2019) conducted on 25/11/2019 returned no records within the Cootamundra – Gundagai LGA.

8.9.5.3 Hydrology, Water Quality and Groundwater

The hydrological, water quality and groundwater related features associated with this option are shown on the Hydrology figure in Appendix B.

- This option would draw water from indicative bore locations south of Nangus village. The bore locations are indicative and proposed shown in Appendix B. A more detailed investigation would be necessary to determine their exact locations during future stages of this project.
- Option 6 only crosses one drainage stream which has been classified as a minor waterway and a class of 3 under the Strahler stream order system. The southern extent of the alignment and final indicative bore location come within 200 m of the Murrumbidgee River which has been given a higher order classification (DPI Water, 2017).
- The Murrumbidgee River is mapped as Key Fish Habitat (DPI Water, 2017).An indicative bore location crosses over a drainage watercourse which is directly associated with the Murrumbidgee River.
- While works will be within 40 m of these watercourses, a controlled activity approval under the WM Act is not required as the works would be undertaken by a public authority.
- The requirements for a Water Access Licence and Works Approval are discussed in Section 9.7.4.
- Creek crossings would need to be designed to be sensitive to the biodiversity values present at site.
- Groundwater Dependent Ecosystems (GDE) are aquatic and terrestrial ecosystems which are sustained, to a degree, by groundwater. Option 6 does not directly impact on GDE's, however, the proposed alignment does cross a drainage channel which is directly associated with the Murrumbidgee River which has been classified as having high potential GDE (BOM, 2019).
- This option would cross areas mapped as 'sensitive land' according to Gundagai LEP 2011.
- Option 6 does not impact on any existing bores in its proposed locations. It is not expected that the option would have any impact on existing bores as the locations of infrastructure could be set to avoid them.
- Option 6 involves the extraction of water from the Gundagai Alluvial Groundwater Source.

8.9.5.4 Soil and Contamination

- Soils present within the area are shown on the Soils figure in Appendix B.
- Option 6 traverses multiple different soil classes including:
  - Kurosols

- Rudosols (Aluvial)

> Soil is not mapped as saline land in the DPE (2019) mapping.

A search of the OEH Contaminated Land Record and the POEO Act Public Register of Licences was undertaken on 24/11/2019. The search highlighted 22 locations where a POEO License has been issued in the LGA of Cootamundra - Gundagai. The listed locations of issued licences are not impacted by Option 6. There are no known contaminated sites listed on the OEH Contaminated Land Register in the vicinity of Option 6. All of these locations are outside of Option 6 alignment. There were no sites listed that were relevant to this option. There are no locations of contaminated lands according to OEH, 2019. This does not mean there is no contaminated land on site as not all contaminated areas have been recorded and constraints would need to be confirmed in future project stages.

8.9.5.5 Socio-economic, Land Use and Zoning

> The majority of Option 6 is covered by RU1 – Primary Production land zoning. As the alignment enters the township of Nangus the zoning changes to RU5 – Village (see the land use and zoning map in Appendix B).

> The option traverses across private properties in multiple locations.

> The PMST search identified 1 potential area of Commonwealth Land protected under the EPBC Act within 10 km of this option. The precise location of this land parcel will need to be confirmed in future investigations with impacts to these areas avoided and/or minimised where possible. If the project is likely to have a significant impact on Commonwealth land it may require referral to DoEE under the EPBC Act.

> Socio-economic considerations relevant to this option include:

- Potential adverse impacts on private properties during construction.
- Positive impacts associated with securing a water supply for Nangus.

8.9.5.6 Cumulative Impacts

The potential for cumulative impacts was considered through review of the Major Projects Register which identifies major projects proposed (including State Significant Development (SSD) and State Significant Infrastructure (SSI) projects) either under assessment of approved. The register was searched for Cootamundra - Gundagai LGA. One major project was identified (the Adjungbilly Wind Farm), however the project is not in close proximity to this option and is therefore unlikely to generate cumulative impacts.

The Cootamundra – Gundagai Regional Council DA Tracking portal for Cootamundra - Gundagai LGA was accessed on 25 November 2019 to check for any development that may impact on the proposed pipeline option. The search included results from January 2019 through to June 2019 and concluded that there are no relevant DA Applications that will have an influence on the proposed project.

It is noted that this search was not comprehensive and local developments should be checked as part of future project stages.

8.9.5.7 Summary of Environmental Constraints & Approval Pathway

Summary

The key environmental constraints related to Option 6 are the biodiversity and heritage constraints identified above. A more detailed assessment of the final infrastructure locations during future stages of the development will allow for avoidance or minimisation of potential impacts identified above. This proposed option would be directly extracting groundwater from the Gundagai Alluvial Groundwater Source. Further investigation would be necessary to determine appropriate bore locations and extraction would need to be within the limits specified in the *Water Sharing Plan for the Murrumbidgee Unregulated and Alluvial Water Sources 2012*. Impacts on other matters can generally be managed through careful construction management processes developed at future construction stages of development. Impacts to private property will also need to be minimised where possible with appropriate consultation with interested stakeholders and impacted community members where necessary.

The location and extent of all constraints, but in particular the biodiversity and heritage constraints, will need to be confirmed in future stages of the project through on-ground surveys and research. Significant impacts to biodiversity can trigger the need for an Environmental Impact Statement (EIS) under Part 5, Division 5.1, Subdivision 3 of the EP&A Act. Significant impacts to Commonwealth listed threatened entities or Commonwealth land can trigger the need for a referral to the Federal Government and assessment under the EPBC Act. If an EIS becomes necessary due to unavoidable impacts, the project approval timeframes

and budgets allocated could be substantially increased. From this high level desktop constraints analysis, the groundwater extraction option could be developed to avoid or minimise such impacts, it is considered unlikely that the proposed alignment would have a significant impact on biodiversity and/or Commonwealth matters. This would need to be confirmed during future stages of the project as the constraints analysis is high level and the design is at a preliminary stage.

Initial approval pathway advice

The project will need assessment under the EP&A Act. SEPPs guide the approval pathways under the EP&A Act.

The initial approval pathway will be assessed under the State Environmental Planning Policy (Infrastructure) 2001 (ISEPP). The pipelines and associated ancillary structures are considered a "water reticulation system". Under Clause 125(1) of ISEPP, development for the purpose of a water reticulation system (including reservoirs) may be carried out by or on behalf of a public authority without consent on any land. As the project would be undertaken by GWCC or CGRC (both public authorities) the proposal would be permissible without consent.

Under Clause 125(3A) of ISEPP, 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. The proposed location of the Water Treatment Plant for Option 6 is on land in a prescribed zone and is therefore permissible without consent. Under Clause 125(5) of ISEPP, a reference to development for the purpose of water supply system of any kind includes a reference to development for a number of purposes including groundwater investigation works, groundwater bore stations, borefields, minewater works and the like. The definition of a 'water supply system' includes a water reticulation system which is what has been proposed in this option. Therefore, it is currently anticipated that the applicable approval pathway is via a Review of Environmental Factors under Part 5 of the EP&A Act.

Option 6 involves the extraction of water directly from the Gundagai Alluvial Groundwater Source. This activity is controlled under the *Water Sharing Plan for the Murrumbidgee River Water Source 2016* (NSW Government, 2018). A new Water Access Licence would be required for the extraction under the Water Sharing Plan, as discussed in Section 9.7.4 above. An application would need to be made to the NRAR for approval, and would require endorsement by DPIE.

Clause 14(1) of the State and Regional Development SEPP states that development for the purpose of water storage or water treatment facilities that has a capital investment value of more than $30 million would be subject to a more intense approvals pathway which may trigger the need for an Environmental Impact Statement.

The approval pathway will need to be confirmed and will be dependent on confirmation of pipeline alignment and potential impacts which will be confirmed at later stages of the project. This will involve specialist studies and on-ground surveys to confirm environmental constraints, confirmation of land use and applicability of Part 5 provisions, confirmation of capital investment value and consideration of 'significant impacts' on the environment which could trigger the need for an EIS.

8.9.6 Cost Estimate

The estimated capital cost for Option 6 is $8.76 million, excluding GST. A detailed breakdown of this estimate is provided in Appendix E. See Section 5.1 for a description of the inclusions and methodology for cost estimates.

8.9.7 Multi-criteria Analysis and Risk Assessment

MCA scoring (as per the template in Table 5-1) and a discussion on the risks related to each parameter are given in Table 8-17.

Table 8-17 Option 6 – Multi-Criteria Analysis

No.	Criteria	Weighting	Score	Discussion
1	**Security of Supply** Consider the security of the water supply and the impact/risks of prolonged drought.	20%	6	▪ Yield and security of the aquifer are currently unknown. Aquifer relies on recharge from the Murrumbidgee River and local rainfall/runoff.
2	**Water Quality - Health** Consider the reliability and risks to water quality with regard to health criteria.	15%	10	▪ The proposed treatment system will meet the requirements of the ADWG and the draft HBTs. ▪ Potential risks in maintaining treatment performance at a small facility with low staffing level.
3	**Water Quality - Aesthetic** Consider the reliability and risks to water quality with regard to asthenic criteria.	10%	10	▪ The proposed treatment system will meet the requirements of the ADWG. ▪ Potential risks in maintaining treatment performance at a small facility with low staffing level.
4	**Operational Risk** Consider the consequence of failure with regards to operator safety, community safety, scheme complexity, time needed to reinstate supply and resourcing risk.	15%	3	▪ Risk of damage to bores located near the Murrumbidgee River during flood conditions. ▪ Complex WTP (reverse osmosis) required due to water quality. Higher risk of operational failure than pipeline options. ▪ Potential for groundwater extraction to impact water level in existing bores. ▪ Resourcing risk for obtaining suitably qualified staff to operate a reverse osmosis plant. ▪ Brine management will remain an ongoing risk: – Potential for leakage or breach of containment. – Alternative disposal routes will be required for emergency conditions.
5	**Constructability** Consider the ability to construct each option, including safety, availability of materials, availability of suitably qualified contractors, ground conditions, impact on existing services, access etc.	15%	5	▪ Risk of finding suitable groundwater resources in terms of yield and quality. ▪ Moderate risk related to procuring suitably qualified construction contractors that can meet program requirements. Construction delays have been observed in treatment plant construction in recent projects in NSW. ▪ Land acquisition delays are a potential risk.
6	**Project Definition Risk** Consider risk associated with level of definition and potential for currently unknown issues to impact schedule and budget.	10%	3	▪ Additional site investigations (exploratory drilling) to confirm the viability of the groundwater source in terms of yield and quality. ▪ Impacts of flooding unknown. ▪ Geotechnical conditions unknown.
7	**Heritage, Environment and Approvals** Consider environmental and heritage impacts and risks and the risk associated with obtaining approvals.	15%	7	▪ Potential direct impacts to the Gundagai Alluvial Groundwater Source to be investigated further. ▪ Avoidance of impacts to known state and federally listed TEC's and threatened species is likely to be possible. ▪ Waterway crossings will need to be sensitively designed to have minimal impact on the waterways. ▪ Impacts to indigenous heritage and a more accurate and verified survey of the land is needed for future project development. ▪ A new WAL will be required for extraction of groundwater. Risk remains around this approval. ▪ A new works approval will be required from NRAR for construction of bores.
	Total	100%	6.0	

8.10 Option 7: Do nothing

8.10.1 Description

For the 'do nothing' option, the current situation is maintained. No reticulated water is supplied to Nangus, and residents will continue to make their own water supply arrangements, as described in Section 2.

8.10.2 Hazards Related to Rainwater and Groundwater Supplies

The hazards related to the existing use of rainwater tanks and groundwater for water supply are outlined below.

8.10.2.1 Rainwater Tanks

NSW Health (https://www.health.nsw.gov.au/environment/water/Pages/rainwater.aspx) and enHealth (2011) provide guidance on the use of rainwater tanks for drinking water supply to individual households.

In NSW around 7.3% of households use rainwater tanks as the main source of drinking water. Rainwater collected from roof catchments is generally considered safe to drink, and the risk of illness is considered low provided that the roof, gutters, tank, piping and surrounds (i.e. overhanging trees) are properly maintained. However, maintenance is generally observed to be poor. Proper maintenance is essential to ensure the supply remains safe to drink.

The greatest risk to human health comes from microbiological pathogens which may be present. Pathogens may come from two primary sources:

- Faecal matter from birds, lizards, mice, rats possums and other animals.
- Dead insects and other animals in gutters or in the tank.

Thermotolerant coliforms and E. coli are commonly identified in domestic rainwater tanks, which implies enteric (intestinal) pathogens may often be present. However, research involving testing for individual pathogens has generally shown low levels of detection.

Studies of gastrointestinal illness rates for people drinking from rainwater tanks vs. drinking from a supply complying with the ADWG have found little evidence for increased illness rates. This may be partly due to acquired immunity to pathogens in people that drink rainwater.

Rainwater can present a higher risk to immunologically compromised people.

Chemical hazards in rainwater can generally come from:

- Off-site sources, such as pesticides, industrial emissions, traffic emissions and windblown particulate.
- On-site sources such as materials used in roof, gutter and tank construction

Proper maintenance is key to reducing the potential for chemical hazards to exist in the supply. For example, sediments that collect in the base of rainwater tanks can contain significant concentrations of chemicals, including lead, and sediment removal is required to manage these risks.

8.10.2.2 Groundwater

It is understood that some residents may use bore water for drinking. The level of treatment of this water, if any, that individual residents undertake is not known.

The aquifer underlying Nangus is shallow and unconfined (see Appendix D). Shallow aquifers are at greater risk of pathogen contamination from septic tanks and animal wastes, as well as chemical contamination from agricultural runoff and other sources. Available data on the local aquifer also shows that the water may have higher levels of salinity, reducing its palatability (see Appendix D).

NSW Health recommends that groundwater sources undergo testing to determine its microbiological and chemical quality and its suitability to be used as a drinking water source. enHealth (2011) recommends that groundwater from shallow aquifers should not be used as a drinking water source unless it has been recently tested for microbial and chemical quality (e.g. arsenic, nitrate, fluoride, health-related heavy metals, petroleum hydrocarbons and other organic chemicals).

8.10.3 Multi-criteria Analysis and Risk Assessment

MCA scoring (as per the template in Table 5-1), and a discussion on the risks related to each parameter are given in Table 8-18.

Table 8-18 Option 7 – Multi-Criteria Analysis

No.	Criteria	Weighting	Score	Discussion
1	**Security of Supply** Consider the security of the water supply and the impact/risks of prolonged drought.	20%	0	▪ No improvement in security of supply. ▪ Potential that security of supply for resident's rainwater tanks would decrease over time due to the impact of climate change.
2	**Water Quality - Health** Consider the reliability and risks to water quality with regard to health criteria.	15%	0	▪ Continued use of rainwater tanks and, in particular, groundwater from the shallow aquifer presents a higher risk to health than from a reticulated supply which will meet the requirements of the ADWG.
3	**Water Quality - Aesthetic** Consider the reliability and risks to water quality with regard to asthenic criteria.	10%	0	▪ Improperly maintained rainwater systems can result in aesthetic issues. ▪ Groundwater supplies may have lower palatability due to high salinity levels.
4	**Operational Risk** Consider the consequence of failure with regards to operator safety, community safety, scheme complexity, time needed to reinstate supply and resourcing risk.	15%	10	▪ No operational risk as no water supply system is installed.
5	**Constructability** Consider the ability to construct each option, including safety, availability of materials, availability of suitably qualified contractors, ground conditions, impact on existing services, access etc.	15%	10	▪ No constructability risks as no works are proposed.
6	**Project Definition Risk** Consider risk associated with level of definition and potential for currently unknown issues to impact schedule and budget.	10%	10	▪ No project definition risks as no works are proposed.
7	**Heritage, Environment and Approvals** Consider environmental and heritage impacts and risks and the risk associated with obtaining approvals.	15%	10	▪ No heritage, environment or approvals risks as no works are proposed.
	Total	100%	5.5	

9 Conclusions and Recommendations

Nangus does not currently have a reticulated water supply, and residents provide their own water supply, typically from roof water, bottled water, bore water or water carting. Seven options for provision of potable water services to Nangus were investigated, including:

- Option 1: Pipeline from Gundagai water supply
- Option 2: Pipeline from GWCC water supply – from Oura Road
- Option 3: Pipeline from GWCC water supply – from Tenandra Reservoirs following existing easement
- Option 4: Pipeline from GWCC water supply – from Tenandra Reservoirs following new route
- Option 5: Murrumbidgee River extraction and treatment
- Option 6: Groundwater extraction and treatment
- Option 7: Do nothing

These options were assessed and compared based on capital cost and a multi-criteria analysis. Estimated capital costs are provided in Table 9-1 and a summary of the MCA scoring is provided in Table 9-2.

Pipeline Options 2, 3 and 4 have similar capital costs, within the level of accuracy of a feasibility assessment. Pipeline Option 1 is significantly more expensive, largely due to the additional length of the pipeline. Options 5 and 6, involving surface and groundwater treatment respectively, are significantly more expensive than any of the pipeline options.

Option 2 scored highest in the MCA. This pipeline option scored higher than the other pipelines mostly due to lower construction risks, lower operational risk and the higher level of project definition that is possible at this stage of the project development.

Pipeline options 1, 2 and 4 scored higher than the surface and groundwater treatment options. Option 7 (do nothing) scored lowest in the MCA.

At the current stage of project development, Option 2 is the preferred option.

It is noted that significant capital outlay will be required to service Nangus. This options analysis is based on a supply for 100 ET. The current number of potential water supply connections is 33 (including occupied dwellings and non-residential developments), with approximately 36 vacant lots in the village. The financial viability of servicing Nangus has not yet been assessed. When financial analysis is carried out in later stages of project development, consideration should be given to the risks related to population projections and sensitivity to different growth rates in the short, medium and long term, as this may impact the financial viability of the project.

Table 9-1 Capital Cost Summary

Option	Estimated Capital Cost (ex. GST)
Option 1: Pipeline from Gundagai water supply	$4,590,000
Option 2: Pipeline from GWCC water supply – from Oura Road	$3,260,000
Option 3: Pipeline from GWCC water supply – from Tenandra Reservoirs following existing easement	$3,070,000
Option 4: Pipeline from GWCC water supply – from Tenandra Reservoirs following new route	$3,040,000
Option 5: Murrumbidgee River extraction and treatment	$9,120,000
Option 6: Groundwater extraction and treatment	$8,760,000
Option 7: Do nothing	$0

Table 9-2 Multi-criteria Analysis Summary

		Option						
Criteria	Weighting	1	2	3	4	5	6	7
Security of Supply	20%	10	10	10	10	10	6	0
Water Quality - Health	15%	8	9	9	9	9	9	0
Water Quality - Aesthetic	10%	10	10	10	10	9	9	0
Operational Risk	15%	7	9	7	7	6	3	10
Constructability	15%	7	9	5	6	6	5	10
Project Definition Risk	10%	7	9	6	6	5	3	10
Heritage, Environment and Approvals	15%	7	8	5	8	6	7	10
Total MCA Score	100%	8.1	9.2	7.5	8.1	7.5	6.0	5.5

10 References

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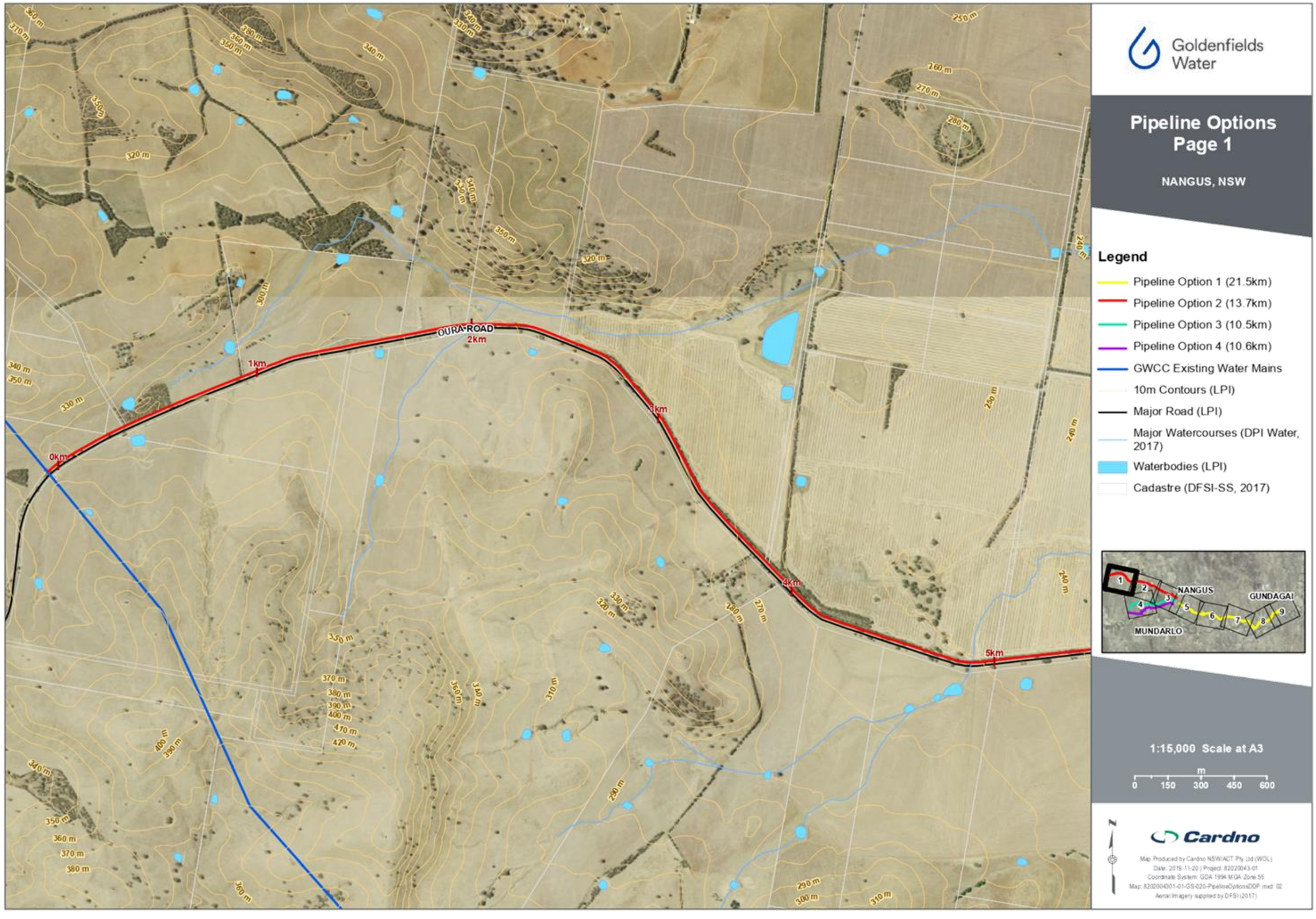
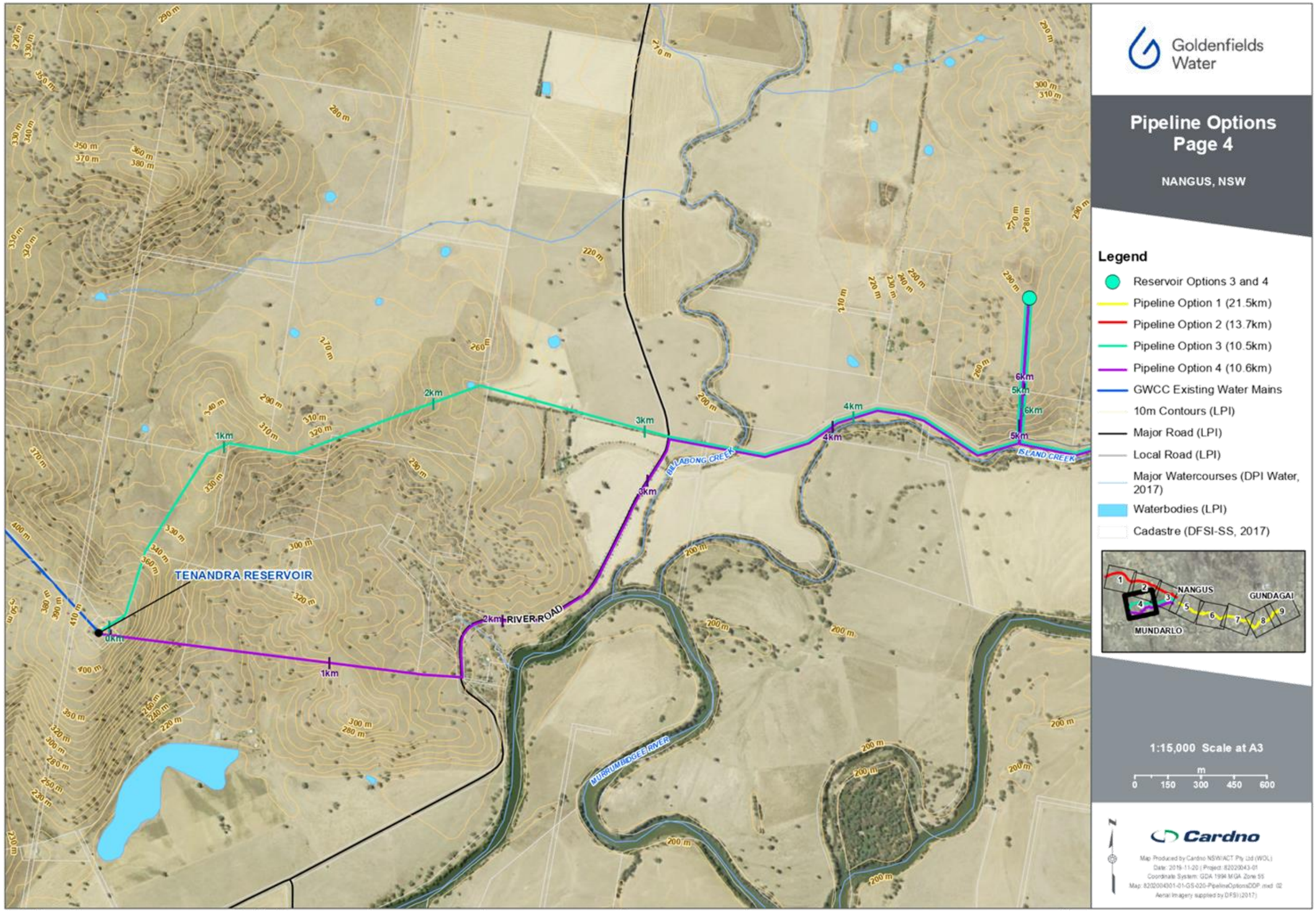
APPENDIX A

PIPELINE OPTION ROUTE MAPS


Goldenfields Water
Pipeline Options Page 1
NANGUS, NSW
Legend
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
GWCC Existing Water Mains
10m Contours (LPI)
Major Road (LPI)
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
Cadastre (DFSI-SS, 2017)
NANGUS
GUNDAGAI
MUNDARLO
OURA ROAD
0km
1km
2km
3km
4km
5km
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-11-20 | Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Map: 8202004301-01-GIS-020-PipelineOptionsDDP.mxd 02
Aerial Imagery supplied by DFSI (2017)


Goldenfields Water
Pipeline Options Page 2
NANGUS, NSW
Legend
Reservoir Option 2
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
10m Contours (LPI)
Major Road (LPI)
Local Road (LPI)
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
Cadastre (DFSI-SS, 2017)
NANGUS
GUNDAGAI
MUNDARLO
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-11-20 | Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Map: 82020043-01-GS-020-PipelineOptionsDDP.mxd 02
Aerial Imagery supplied by DFSI (2017)
OURA ROAD
RIVER ROAD
NANGUS ROAD
BILLABONG CREEK
5km
6km
7km
8km
9km
10km


Goldenfields Water
Pipeline Options Page 3
NANGUS, NSW
Legend
Reservoir Option 2
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
Proposed Reticulation
10m Contours (LPI)
Major Road (LPI)
Local Road (LPI)
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
Cadastre (DFSI-SS, 2017)
NANGUS
GUNDAGAI
MUNDARLO
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-11-20 (Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Map: 82020043-01-GS-020-PipelineOptionsDDP.mxd 02
Aerial Imagery supplied by DFSI (2017)
NANGUS ROAD
BETHUNGRA ROAD
OURA ROAD
KIMO STREET
LEFTA RM CREEK
NANGUS CREEK
ISLAND CREEK
MURRUMBIDGEE RIVER
10km
11km
12km
13km
9km
8km
7km
21km


TENANDRA RESERVOIR
RIVER ROAD
MURRUMBIDGEE RIVER
ISLAND CREEK
0km
1km
2km
3km
4km
5km
6km
Goldenfields Water
Pipeline Options Page 4
NANGUS, NSW
Legend
Reservoir Options 3 and 4
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
GWCC Existing Water Mains
10m Contours (LPI)
Major Road (LPI)
Local Road (LPI)
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
Cadastre (DFSI-SS, 2017)
NANGUS
GUNDAGAI
MUNDARLO
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-11-20 (Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Aerial Imagery supplied by DFSI (2017)


Goldenfields Water
Pipeline Options
Page 5
NANGUS, NSW
Legend
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
Proposed Reticulation
10m Contours (LPI)
Major Road (LPI)
Local Road (LPI)
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
Cadastre (DFSI-SS, 2017)
NANGUS
GUNDAGAI
MUNDARLO
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
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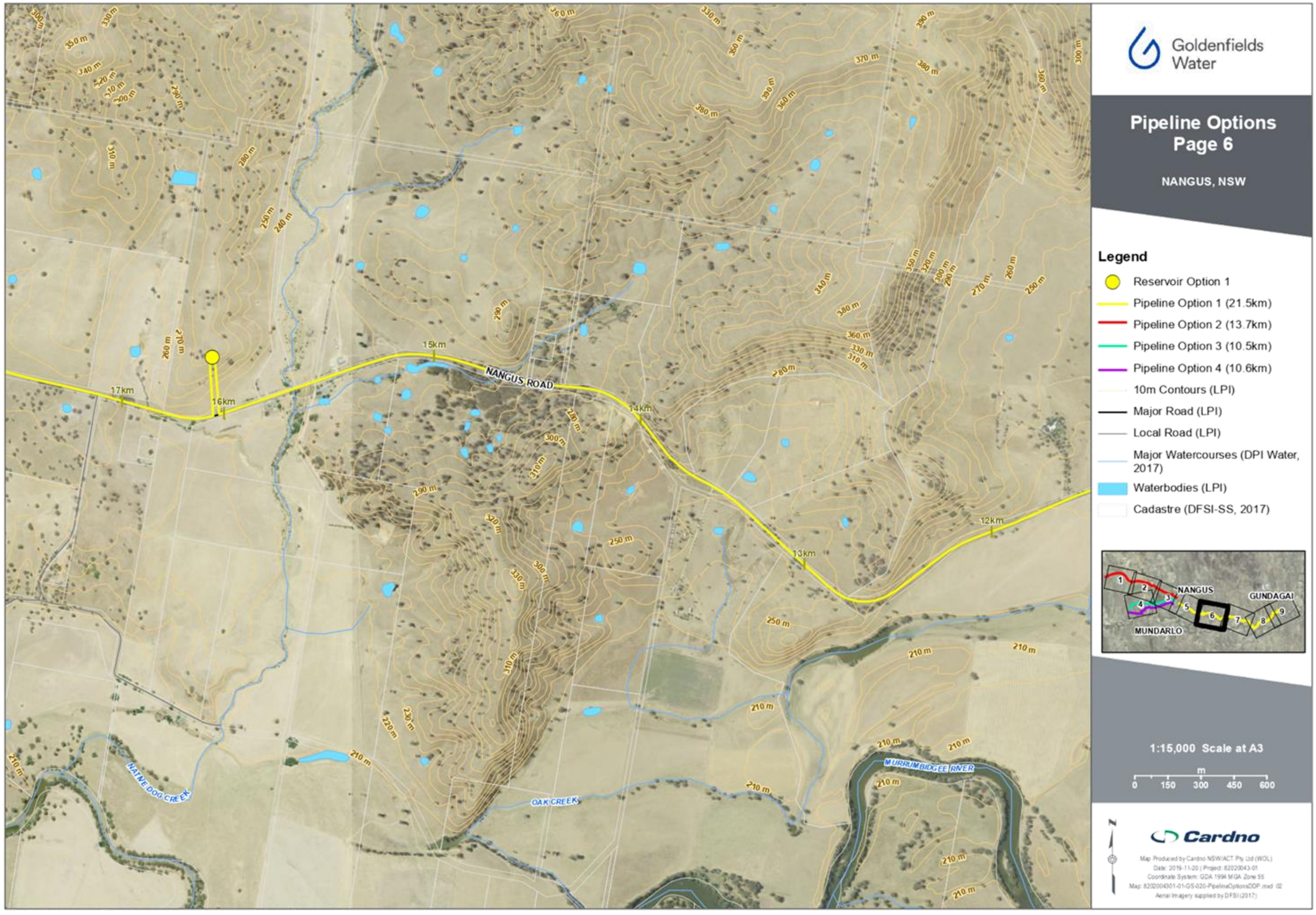
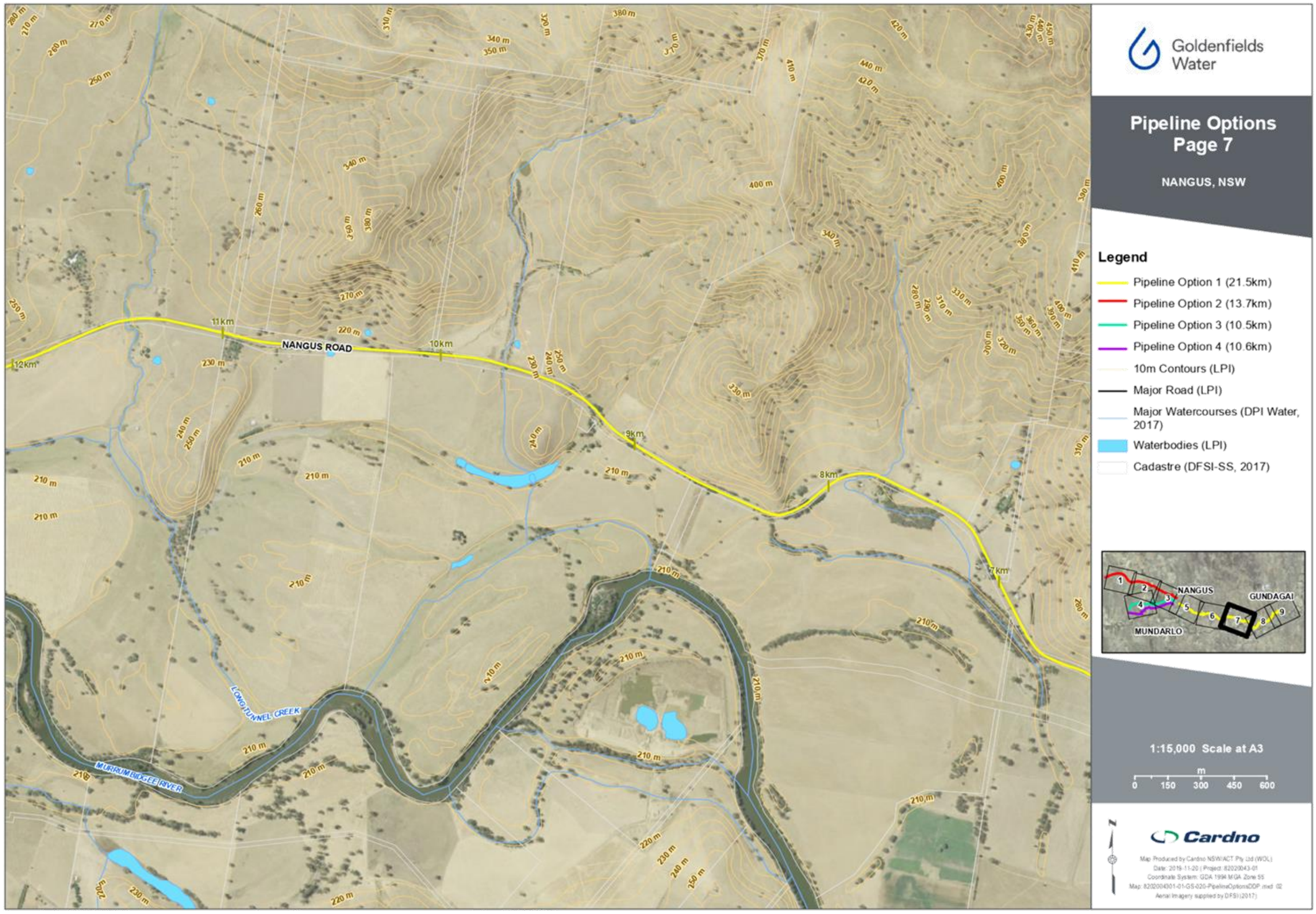
Coordinate System: GDA 1994 MGA Zone 55
Map: 82029043-01-GS-020-PipelineOptionsDOP.mxd 02
Aerial Imagery supplied by DFSI (2017)
KIMO STREET
NANGUS
NANGUS ROAD
NANGUS CREEK
MURRUMBIDGEE RIVER
21km
20km
19km
18km
13km
10km
10km


Goldenfields Water
Pipeline Options
Page 6
NANGUS, NSW
Legend
Reservoir Option 1
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
10m Contours (LPI)
Major Road (LPI)
Local Road (LPI)
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
Cadastre (DFSI-SS, 2017)
NANGUS
GUNDAGAI
MUNDARLO
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno
NANGUS ROAD
NATIVE DOG CREEK
OAK CREEK
MURRUMBIDGEE RIVER
17km
16km
15km
14km
13km
12km


NANGUS ROAD
11km
10km
9km
8km
7km
12km
LONG TUNNEL CREEK
MURRUMBIDGEE RIVER
Goldenfields Water
Pipeline Options
Page 7
NANGUS, NSW
Legend
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
10m Contours (LPI)
Major Road (LPI)
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
Cadastre (DFSI-SS, 2017)
NANGUS
GUNDAGAI
MUNDARLO
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-11-20 | Project: 82029043-01
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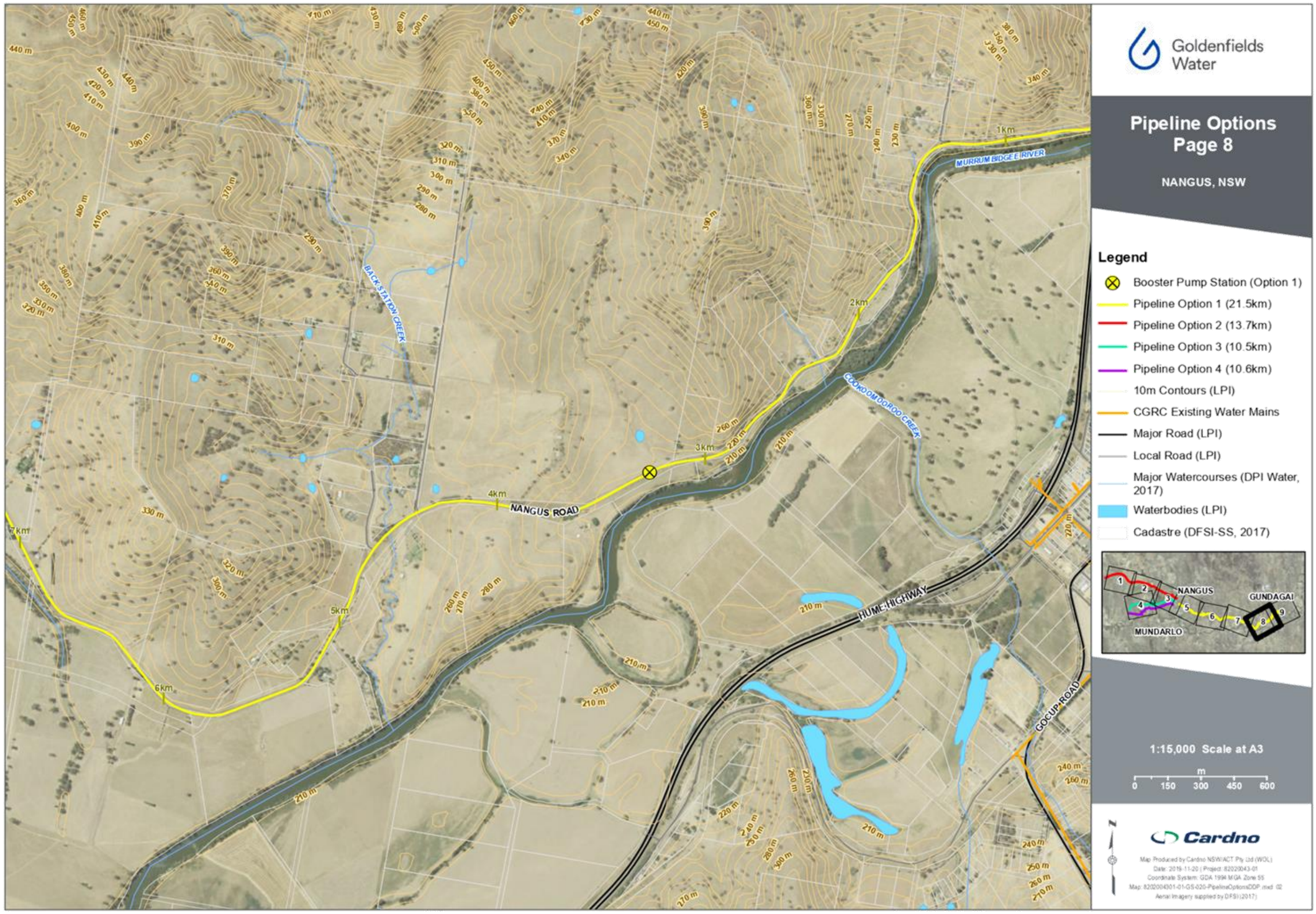
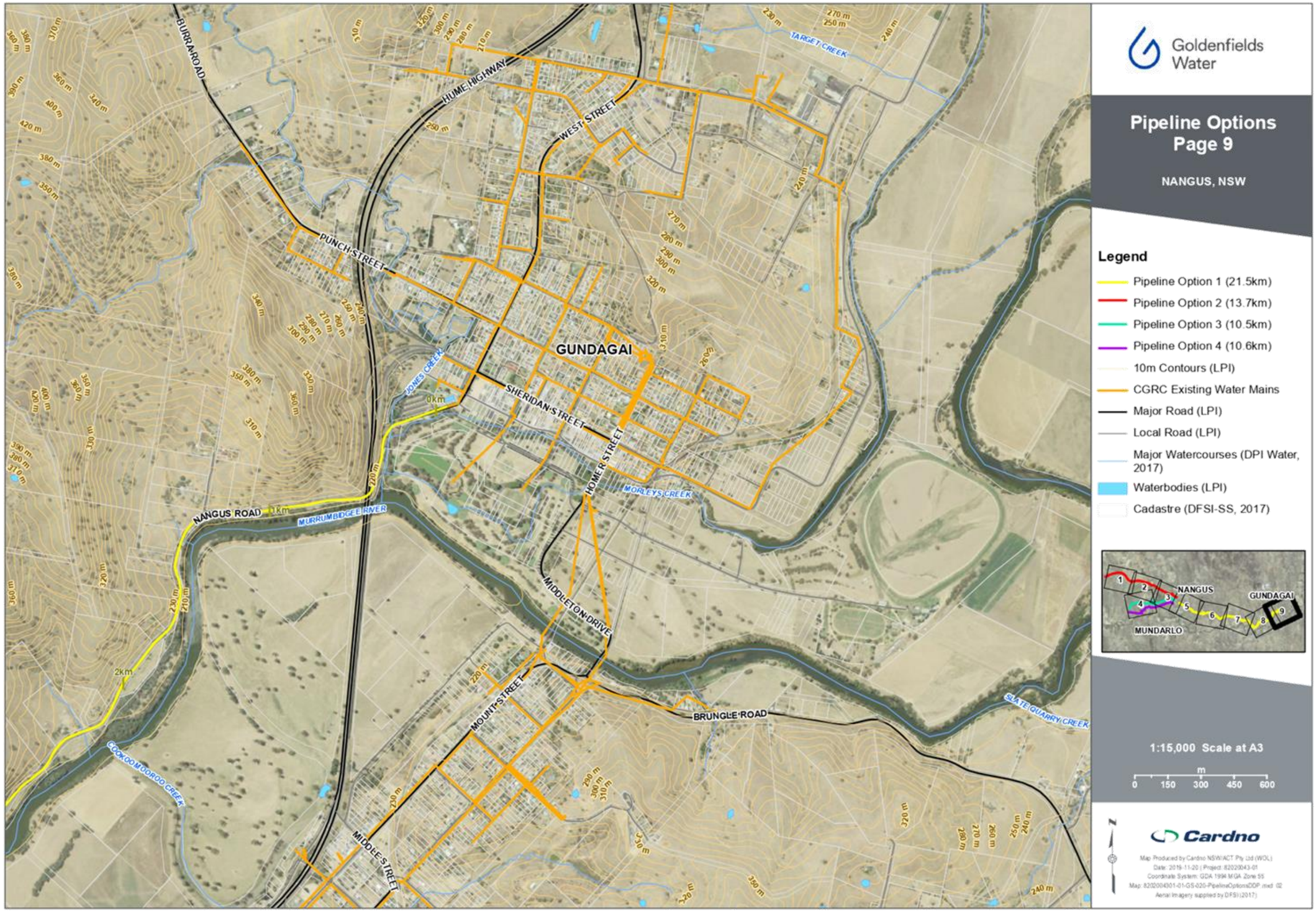
Aerial Imagery supplied by DFSI (2017)

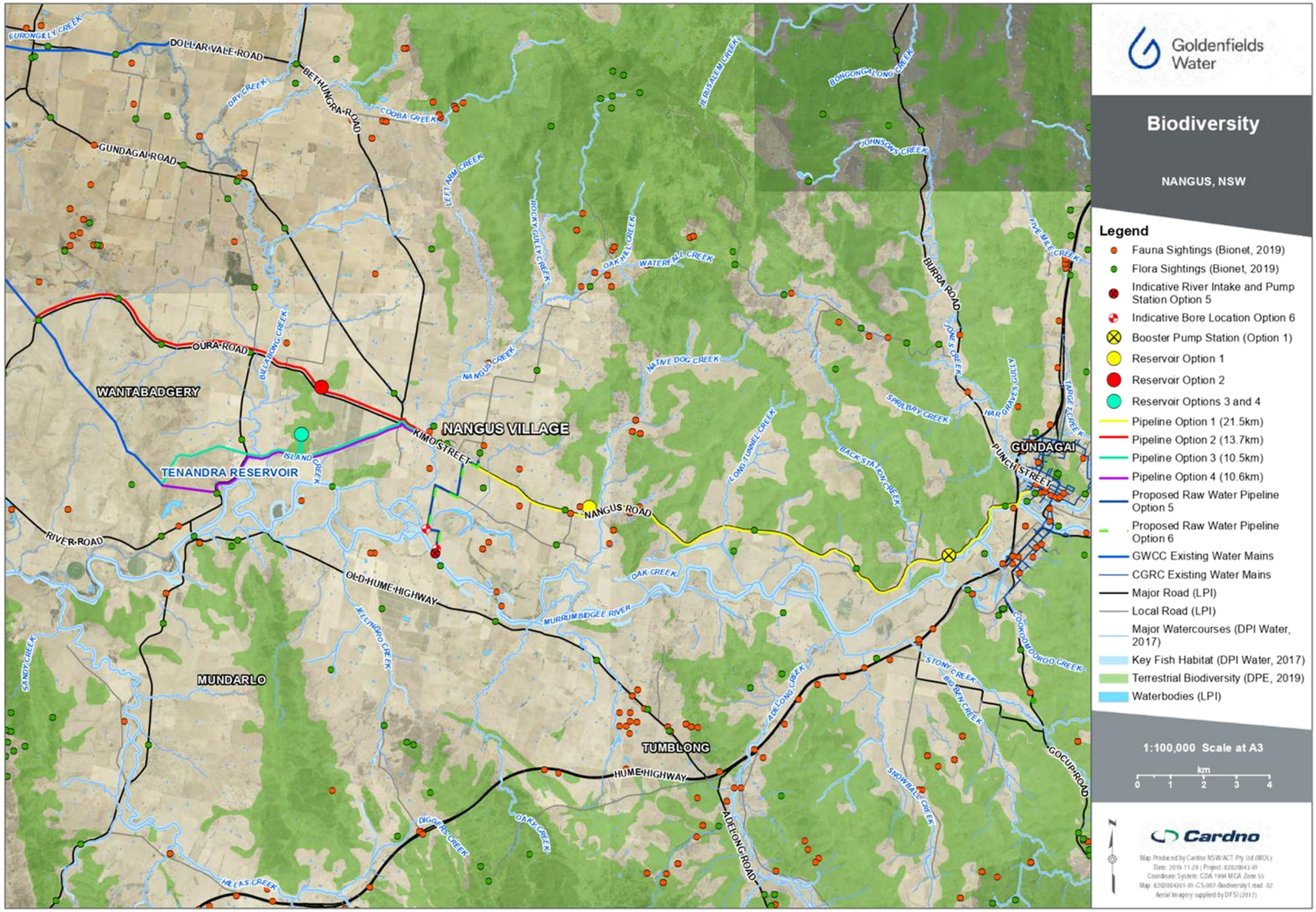

Goldenfields Water
Pipeline Options
Page 8
NANGUS, NSW
Legend
Booster Pump Station (Option 1)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
10m Contours (LPI)
CGRC Existing Water Mains
Major Road (LPI)
Local Road (LPI)
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
Cadastre (DFSI-SS, 2017)
NANGUS
GUNDAGAI
MUNDARLO
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-11-20 | Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Aerial Imagery supplied by DFSI (2017)
MURRUM BIDGEE RIVER
BACK STATION CREEK
COOKOOMOOROO CREEK
NANGUS ROAD
HUME HIGHWAY
GOCUP ROAD
1km
2km
3km
4km
5km
6km
7km

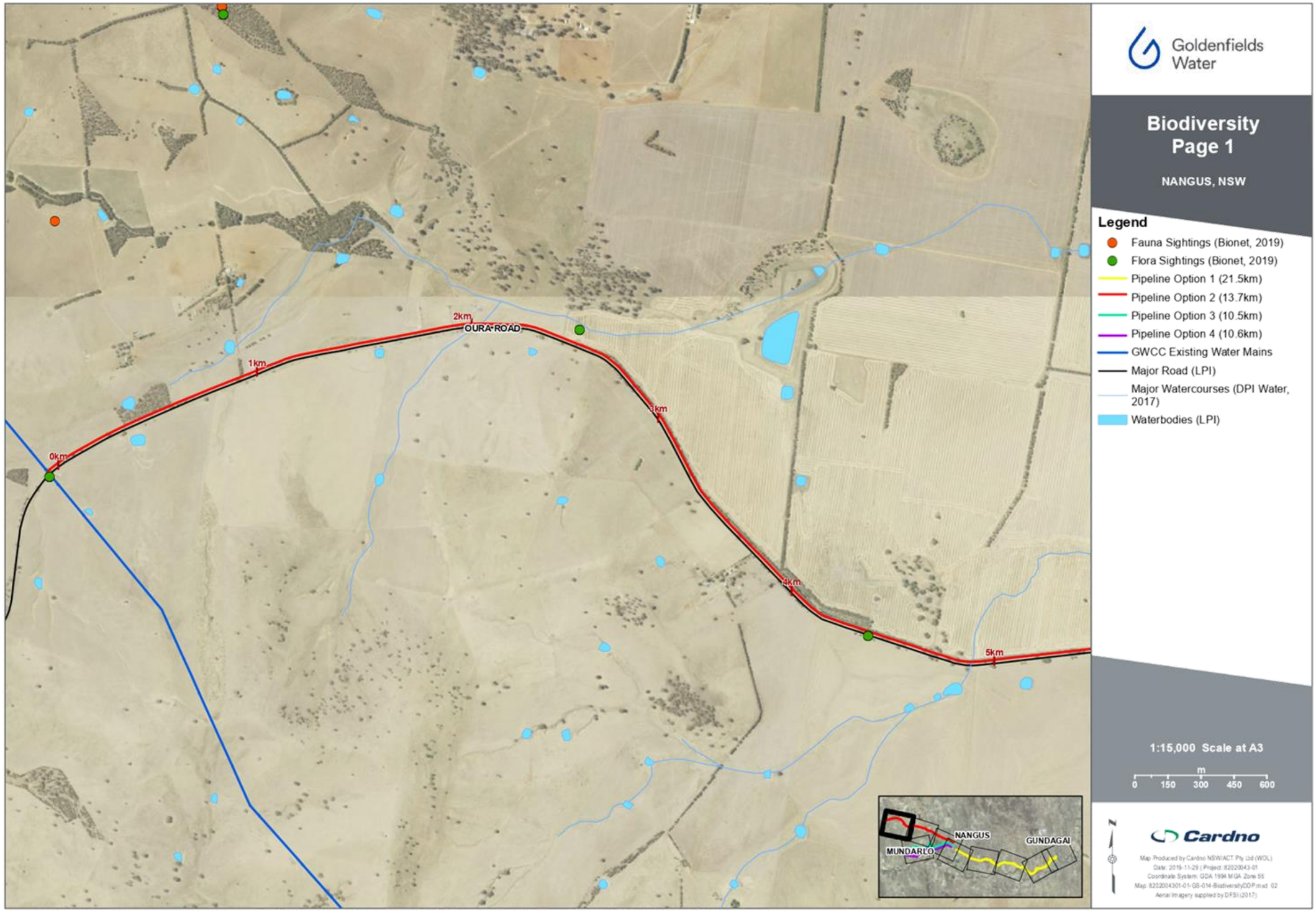

BURRA ROAD
HUME HIGHWAY
WEST STREET
TARGET CREEK
PUNCH STREET
GUNDAGAI
JONES CREEK
SHERIDAN STREET
HOMER STREET
MORLEYS CREEK
NANGUS ROAD
MURRUMBIDGEE RIVER
MIDDLETON DRIVE
MOUNT STREET
BRUNGLE ROAD
SLATE QUARRY CREEK
COOKOOMOORDO CREEK
MIDDLE STREET
0km
1km
2km
Goldenfields Water
Pipeline Options Page 9
NANGUS, NSW
Legend
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
10m Contours (LPI)
CGRC Existing Water Mains
Major Road (LPI)
Local Road (LPI)
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
Cadastre (DFSI-SS, 2017)
NANGUS
GUNDAGAI
MUNDARLO
1:15,000 Scale at A3
m
0 150 300 450 600
N
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-11-20 | Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Map: 82020043-01-GS-020-PipelineOptionsDDP.mxd 02
Aerial Imagery supplied by DFSI (2017)

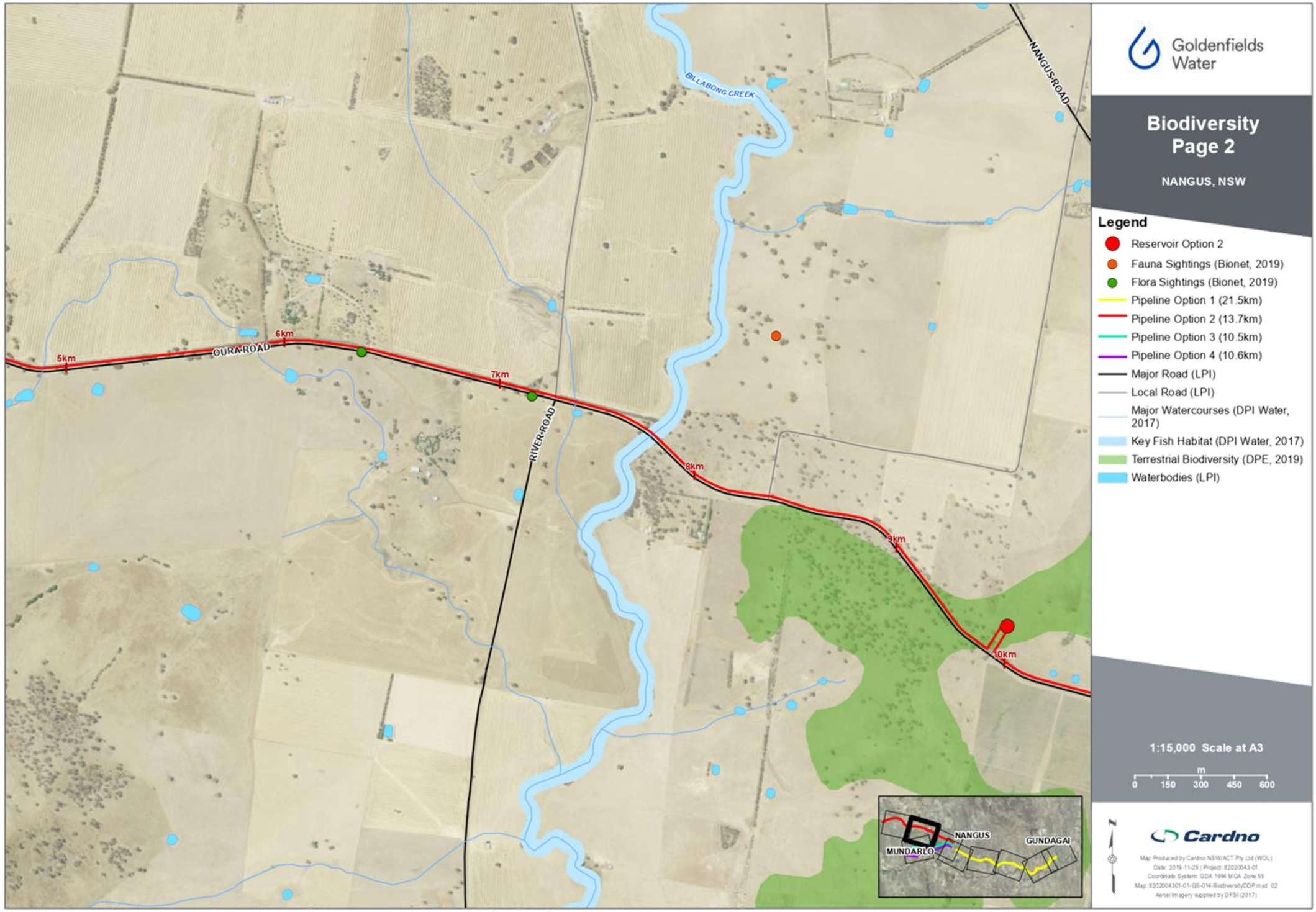
APPENDIX

B

ENVIRONMENTAL CONSTRAINTS


Goldenfields Water
Biodiversity
NANGUS, NSW
Legend
Fauna Sightings (Bionet, 2019)
Flora Sightings (Bionet, 2019)
Indicative River Intake and Pump Station Option 5
Indicative Bore Location Option 6
Booster Pump Station (Option 1)
Reservoir Option 1
Reservoir Option 2
Reservoir Options 3 and 4
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
Proposed Raw Water Pipeline Option 5
Proposed Raw Water Pipeline Option 6
GWCC Existing Water Mains
CGRC Existing Water Mains
Major Road (LPI)
Local Road (LPI)
Major Watercourses (DPI Water, 2017)
Key Fish Habitat (DPI Water, 2017)
Terrestrial Biodiversity (DPE, 2019)
Waterbodies (LPI)
1:100,000 Scale at A3
km
0 1 2 3 4
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-11-29 | Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Map: 82020043-01-GS-007-Biodiversity1.mxd 02
Aerial Imagery supplied by DFSI (2017)
WANTABADGERY
NANGUS VILLAGE
TENANDRA RESERVOIR
GUNDAGAI
MUNDARLO
TUMBLONG
DOLLAR VALE ROAD
GUNDAGAI ROAD
BETHUNGRA ROAD
OURA ROAD
KIMO STREET
NANGUS ROAD
RIVER ROAD
OLD HUME HIGHWAY
HUME HIGHWAY
BURRA ROAD
PUNCH STREET
ADELONG ROAD
GOCUP ROAD
EURONGILLY CREEK
DRY CREEK
COOBA CREEK
LEFT ARM CREEK
ROCKY GULLY CREEK
OAK VALLEY CREEK
WATERFALL CREEK
JERUSALEM CREEK
BONGONGALONG CREEK
JOHNSONS CREEK
FIVE MILE CREEK
BULLABONG CREEK
NANGUS CREEK
NATIVE DOG CREEK
JONES CREEK
SPRINBRY CREEK
HARGRAVES GULLY
LARGE LEE CREEK
ISLAND CREEK
LONG TUNNEL CREEK
BACK STATION CREEK
OAK CREEK
MURRUMBIDGEE RIVER
JELLINGRO CREEK
SANDY CREEK
ADELONG CREEK
STONY CREEK
BIGGEN CREEK
COOKOOMOOROO CREEK
SNOWBALL CREEK
DIGGERS CREEK
OAKY CREEK
HILLAS CREEK


Goldenfields Water
Biodiversity Page 1
NANGUS, NSW
Legend
Fauna Sightings (Bionet, 2019)
Flora Sightings (Bionet, 2019)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
GWCC Existing Water Mains
Major Road (LPI)
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
0km
1km
2km
3km
4km
5km
OURA ROAD
1:15,000 Scale at A3
m
0 150 300 450 600
MUNDARLO
NANGUS
GUNDAGAI
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-11-29 | Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Map: 82020043301-01-GS-014-BiodiversityDDP.mxd 02
Aerial Imagery supplied by DFSI (2017)


BILLABONG CREEK
NANGUS ROAD
OURA ROAD
RIVER ROAD
5km
6km
7km
8km
9km
10km
Goldenfields Water
Biodiversity Page 2
NANGUS, NSW
Legend
Reservoir Option 2
Fauna Sightings (Bionet, 2019)
Flora Sightings (Bionet, 2019)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
Major Road (LPI)
Local Road (LPI)
Major Watercourses (DPI Water, 2017)
Key Fish Habitat (DPI Water, 2017)
Terrestrial Biodiversity (DPE, 2019)
Waterbodies (LPI)
1:15,000 Scale at A3
m
0 150 300 450 600
MUNDARLO
NANGUS
GUNDAGAI
N
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
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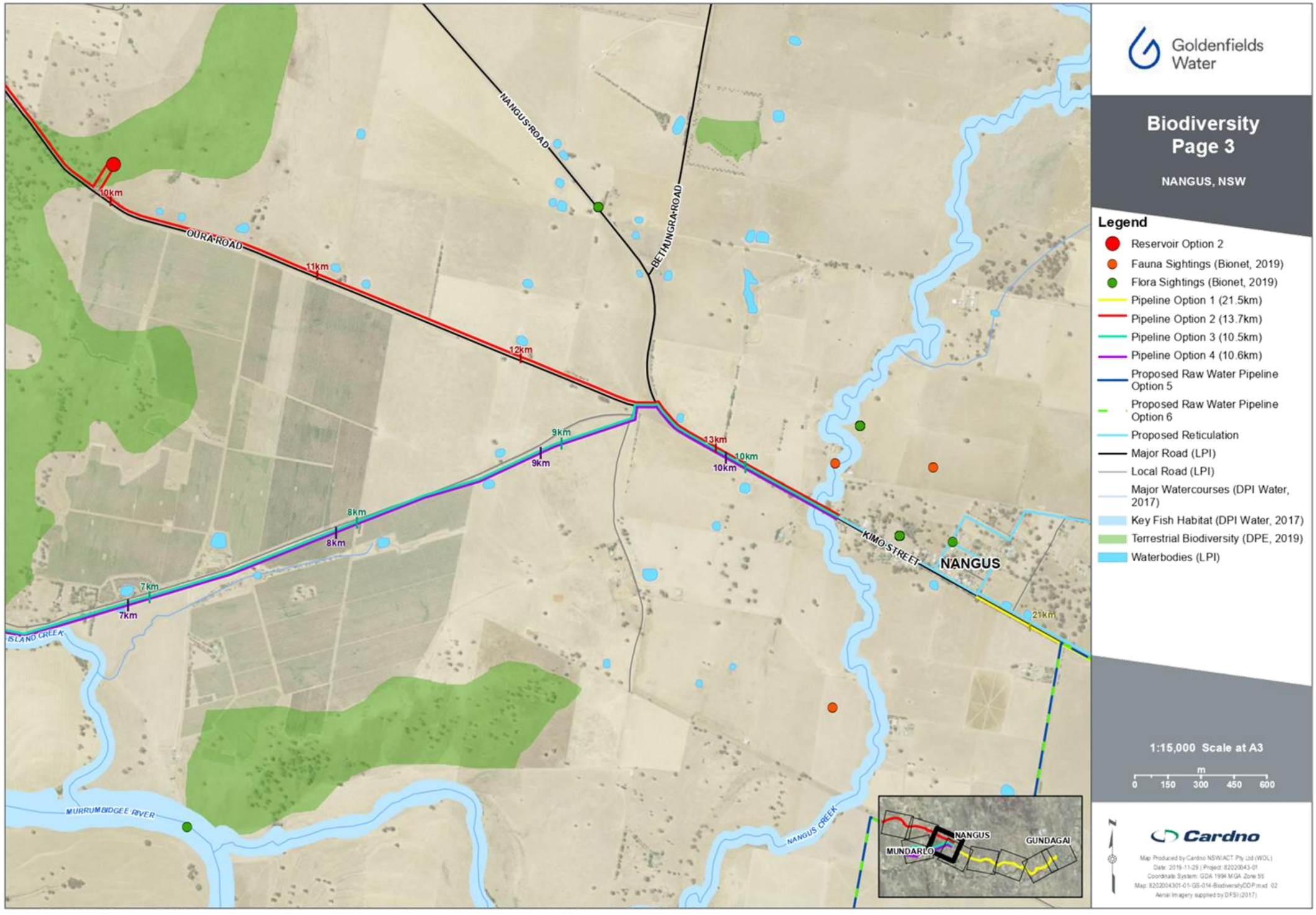
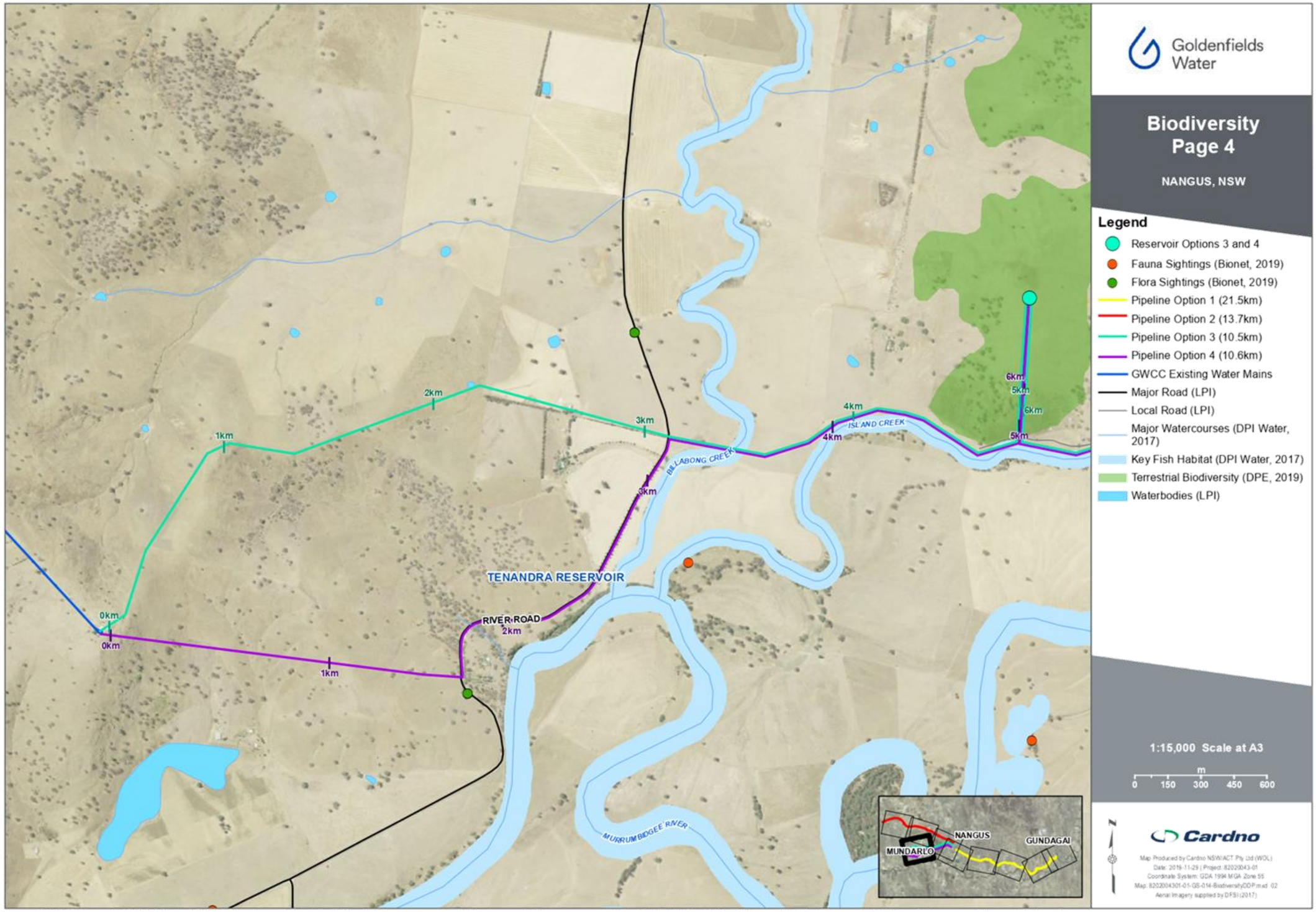
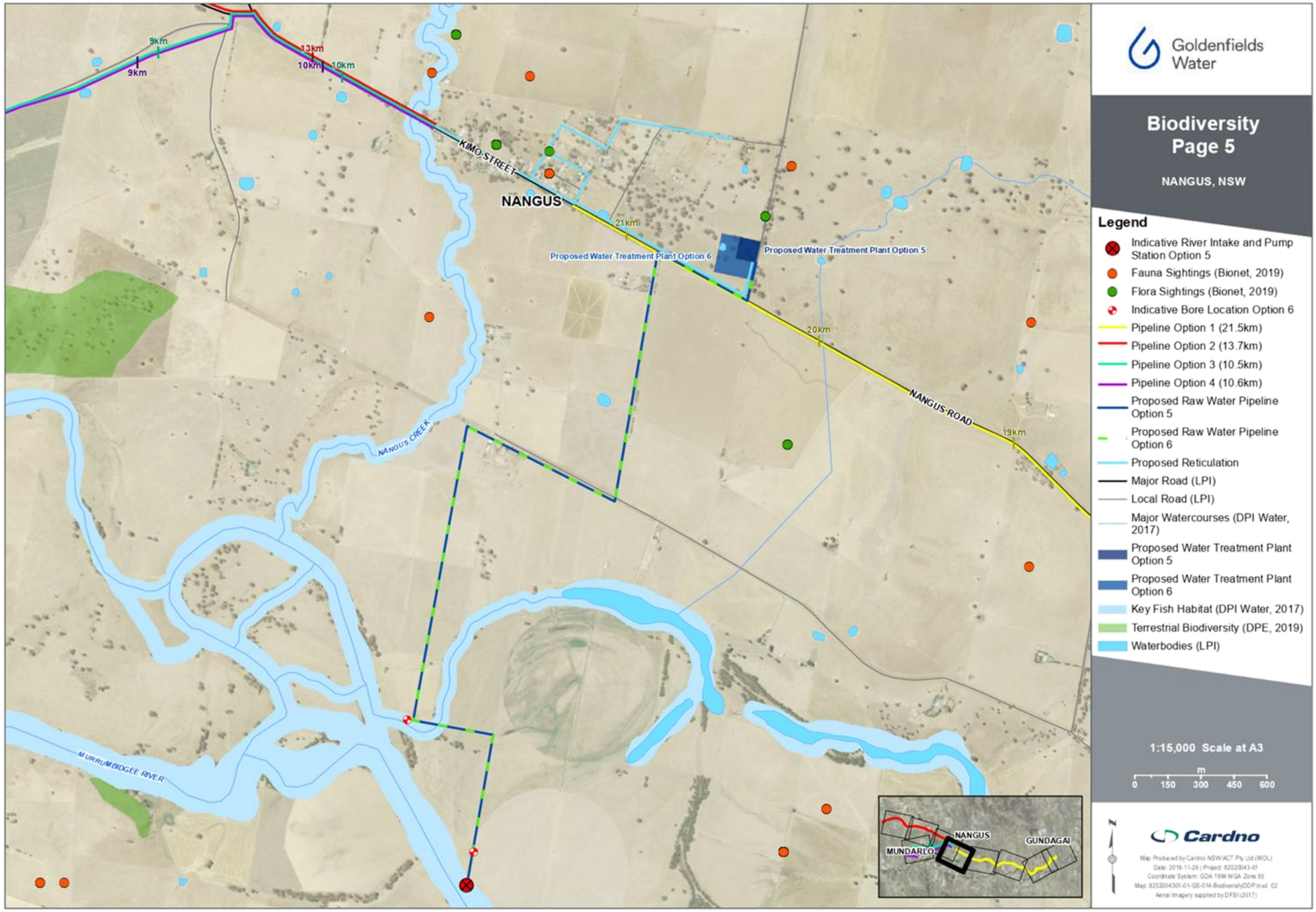

Goldenfields Water
Biodiversity Page 3
NANGUS, NSW
Legend
Reservoir Option 2
Fauna Sightings (Bionet, 2019)
Flora Sightings (Bionet, 2019)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
Proposed Raw Water Pipeline Option 5
Proposed Raw Water Pipeline Option 6
Proposed Reticulation
Major Road (LPI)
Local Road (LPI)
Major Watercourses (DPI Water, 2017)
Key Fish Habitat (DPI Water, 2017)
Terrestrial Biodiversity (DPE, 2019)
Waterbodies (LPI)
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-11-29 | Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Map: 82020430101-GS-014-BiodiversityDDP.mxd 02
Aerial Imagery supplied by DFSI (2017)
NANGUS ROAD
BETHUNGRA ROAD
OURA ROAD
KIMO STREET
NANGUS
ISLAND CREEK
MURRUMBIDGEE RIVER
NANGUS CREEK
10km
11km
12km
13km
10km
9km
9km
8km
8km
7km
7km
21km
MUNDARLO
NANGUS
GUNDAGAI


Goldenfields Water
Biodiversity Page 4
NANGUS, NSW
Legend
Reservoir Options 3 and 4
Fauna Sightings (Bionet, 2019)
Flora Sightings (Bionet, 2019)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
GWCC Existing Water Mains
Major Road (LPI)
Local Road (LPI)
Major Watercourses (DPI Water, 2017)
Key Fish Habitat (DPI Water, 2017)
Terrestrial Biodiversity (DPE, 2019)
Waterbodies (LPI)
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-11-29 (Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Map: 82020043301-01-GIS-014-BiodiversityDDP.mxd 02
Aerial Imagery supplied by DFSI (2017)
TENANDRA RESERVOIR
RIVER ROAD
BILLABONG CREEK
ISLAND CREEK
MURRUMBIDGEE RIVER
0km
1km
2km
3km
4km
5km
6km
NANGUS
MUNDARLO
GUNDAGAI


9km
9km
13km
10km
10km
KIMO STREET
NANGUS
21km
Proposed Water Treatment Plant Option 6
Proposed Water Treatment Plant Option 5
20km
NANGUS ROAD
19km
NANGUS CREEK
MURRUMBIDGEE RIVER
Goldenfields Water
Biodiversity Page 5
NANGUS, NSW
Legend
Indicative River Intake and Pump Station Option 5
Fauna Sightings (Bionet, 2019)
Flora Sightings (Bionet, 2019)
Indicative Bore Location Option 6
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
Proposed Raw Water Pipeline Option 5
Proposed Raw Water Pipeline Option 6
Proposed Reticulation
Major Road (LPI)
Local Road (LPI)
Major Watercourses (DPI Water, 2017)
Proposed Water Treatment Plant Option 5
Proposed Water Treatment Plant Option 6
Key Fish Habitat (DPI Water, 2017)
Terrestrial Biodiversity (DPE, 2019)
Waterbodies (LPI)
1:15,000 Scale at A3
m
0 150 300 450 600
MUNDARLO
NANGUS
GUNDAGAI
N
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-11-29 | Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Map: 82020430 1-01-GIS-014-BiodiversityDDP.mxd 02
Aerial imagery supplied by DFSI (2017)


Goldenfields Water
Biodiversity Page 6
NANGUS, NSW
Legend
Reservoir Option 1
Fauna Sightings (Bionet, 2019)
Flora Sightings (Bionet, 2019)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
Major Road (LPI)
Local Road (LPI)
Major Watercourses (DPI Water, 2017)
Key Fish Habitat (DPI Water, 2017)
Terrestrial Biodiversity (DPE, 2019)
Waterbodies (LPI)
18km
17km
16km
15km
14km
13km
NANGUS ROAD
NATIVE DOG CREEK
OAK CREEK
MUNDARLO
NANGUS
GUNDAGAI
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-11-29 (Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
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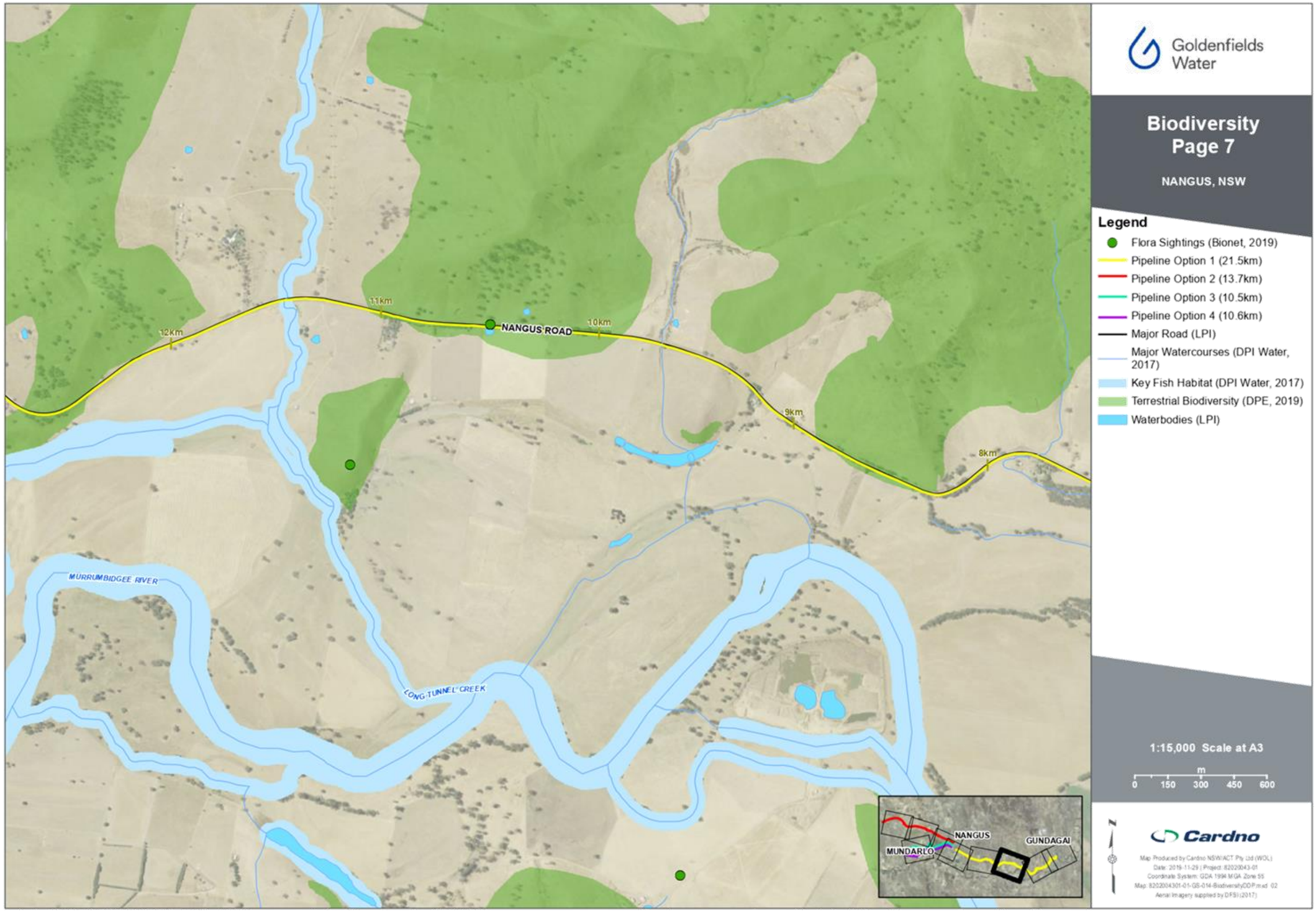
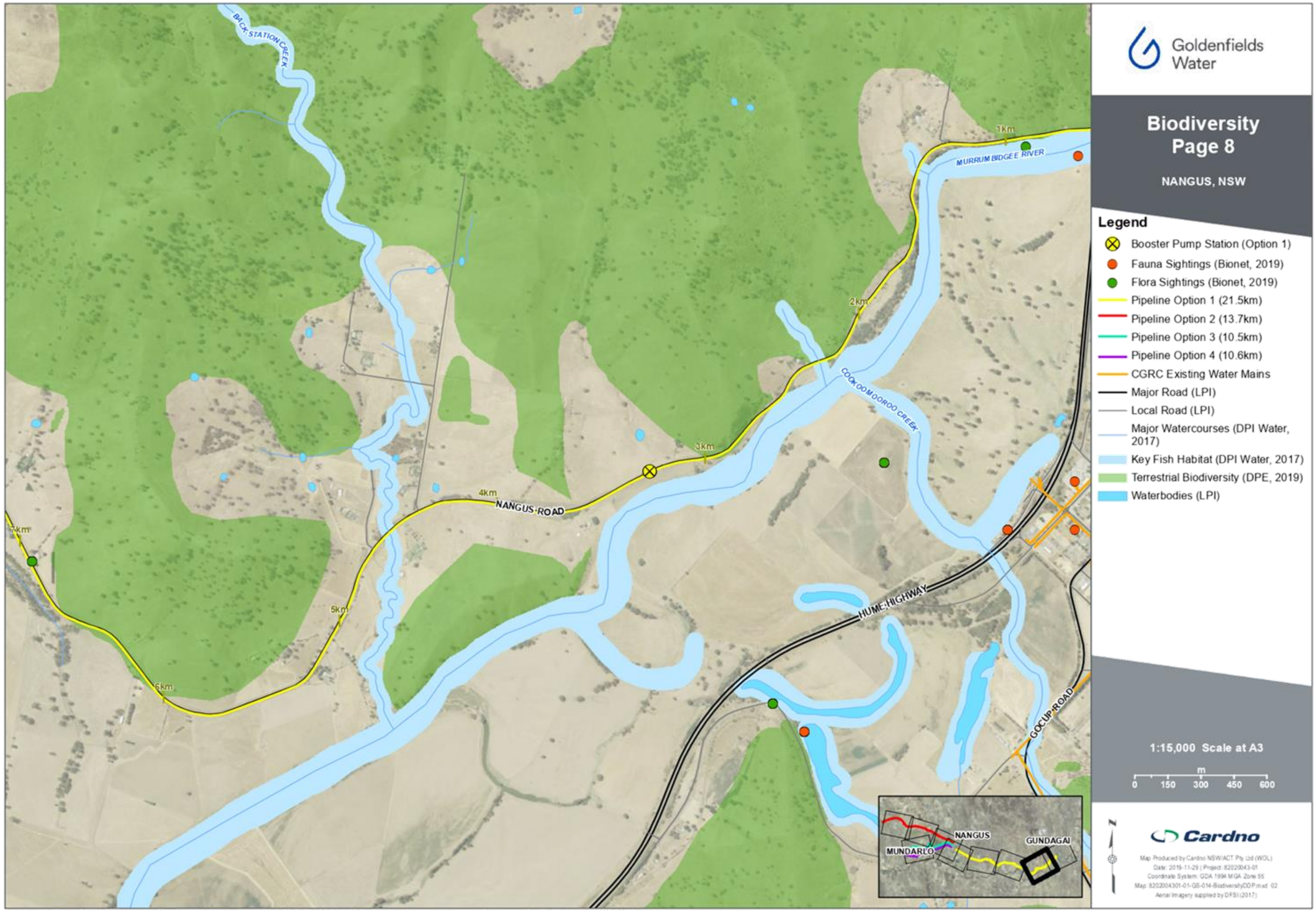
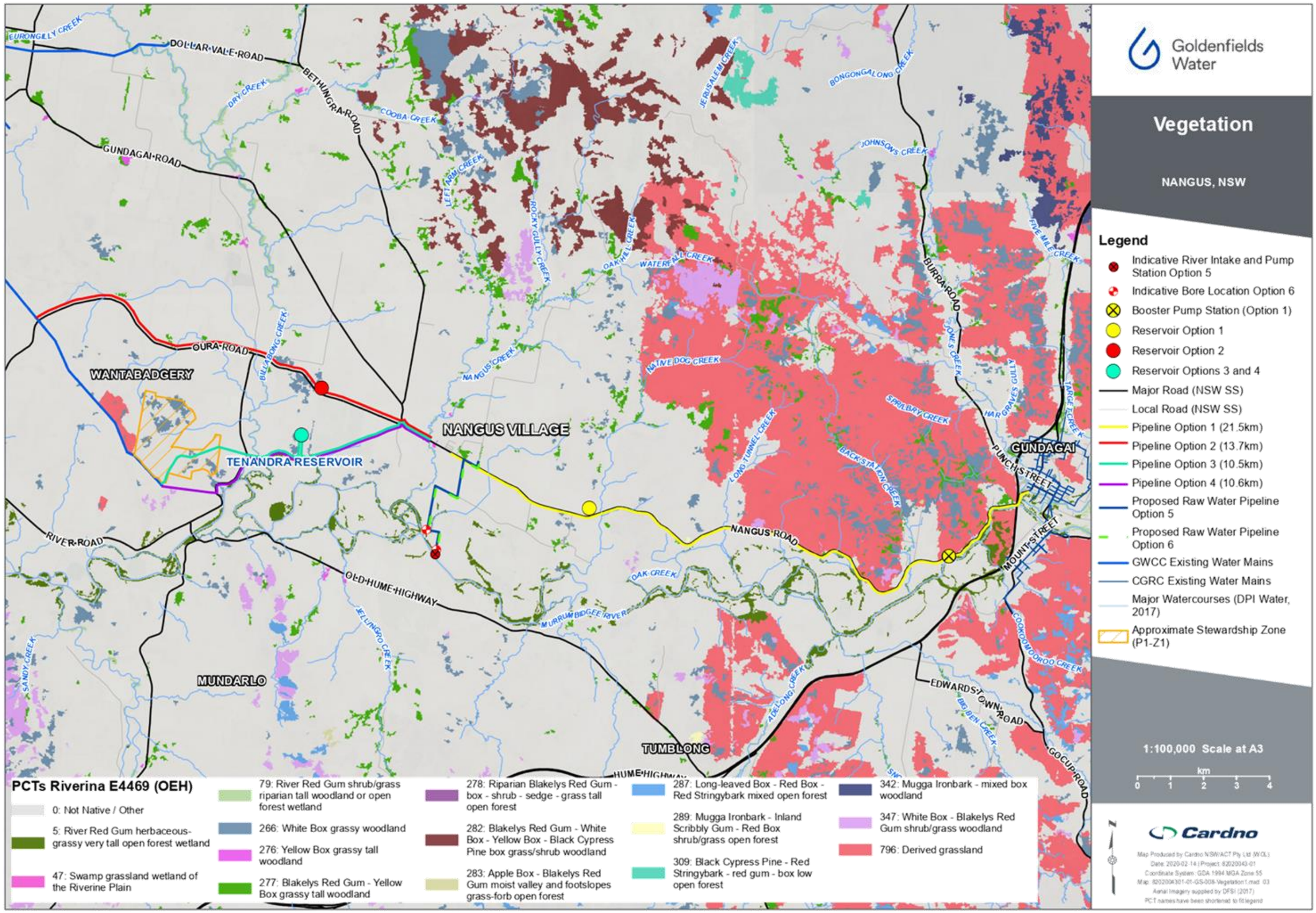
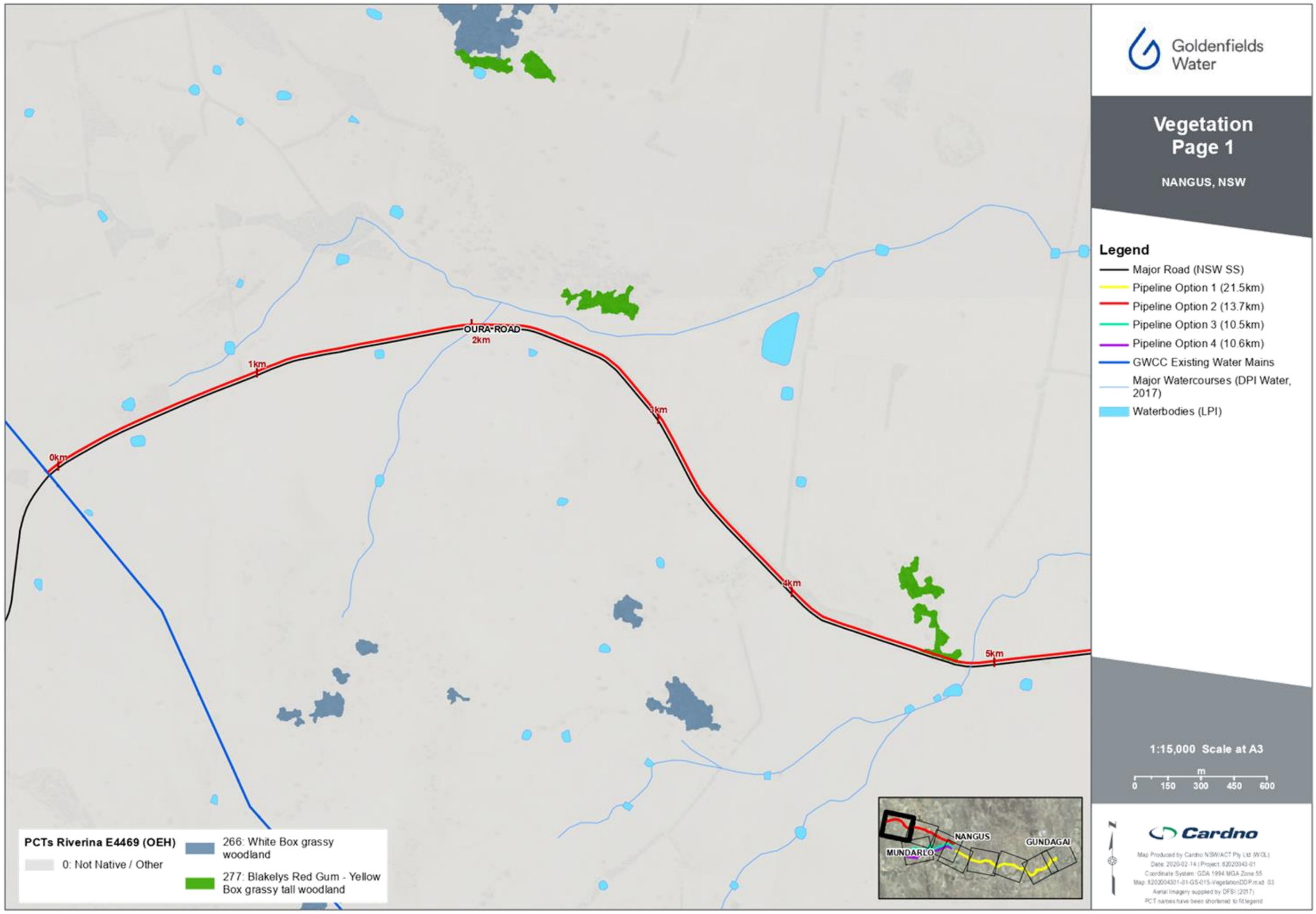
Aerial Imagery supplied by DFSI (2017)

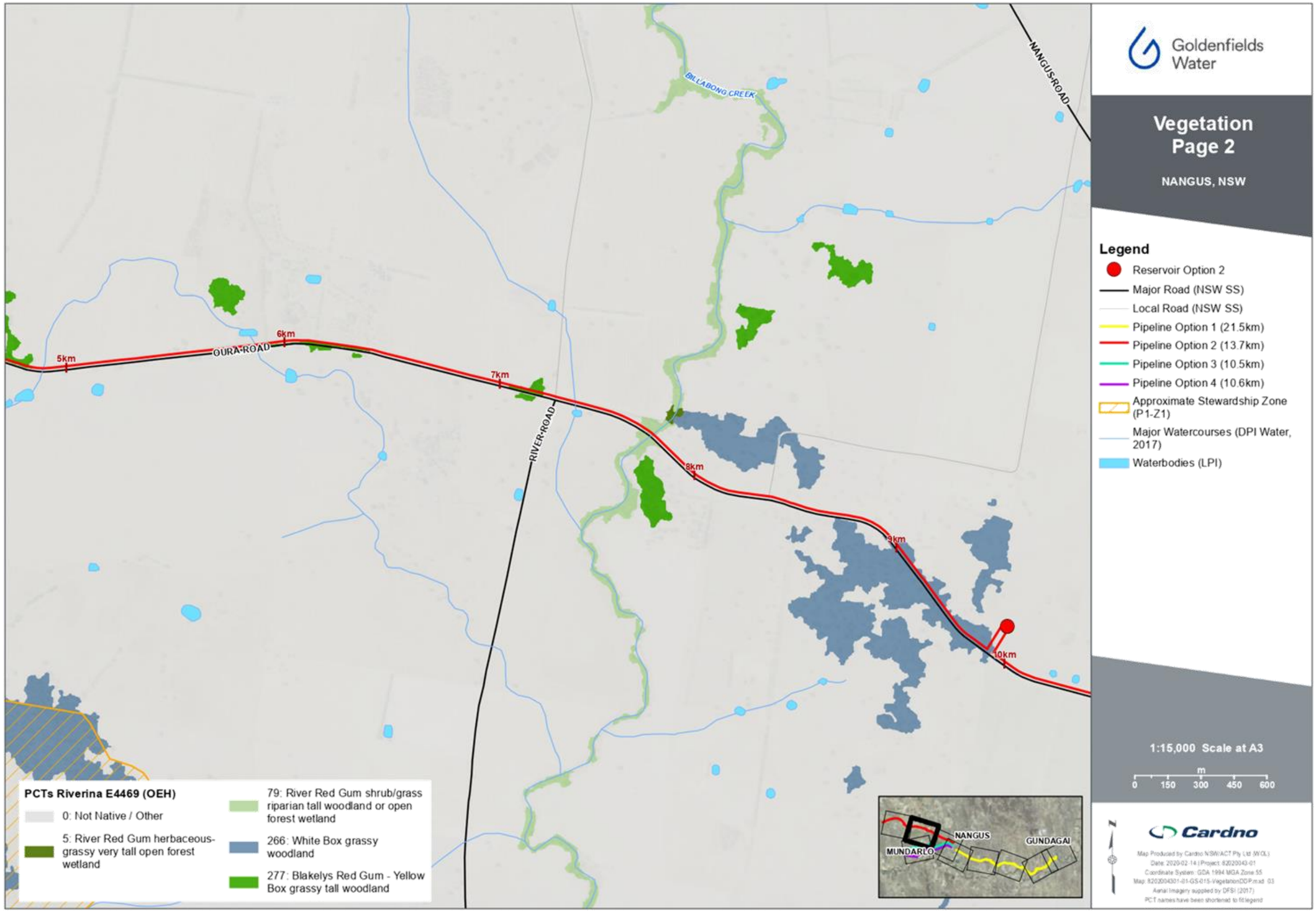

NANGUS ROAD
12km
11km
10km
9km
8km
MURRUMBIDGEE RIVER
LONG TUNNEL CREEK
MUNDARLO
NANGUS
GUNDAGAI
Goldenfields Water
Biodiversity Page 7
NANGUS, NSW
Legend
Flora Sightings (Bionet, 2019)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
Major Road (LPI)
Major Watercourses (DPI Water, 2017)
Key Fish Habitat (DPI Water, 2017)
Terrestrial Biodiversity (DPE, 2019)
Waterbodies (LPI)
1:15,000 Scale at A3
m
0 150 300 450 600
N
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-11-29 | Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Map: 82020043301-01-GIS-014-BiodiversityDDP.mxd 02
Aerial Imagery supplied by DFSI (2017)

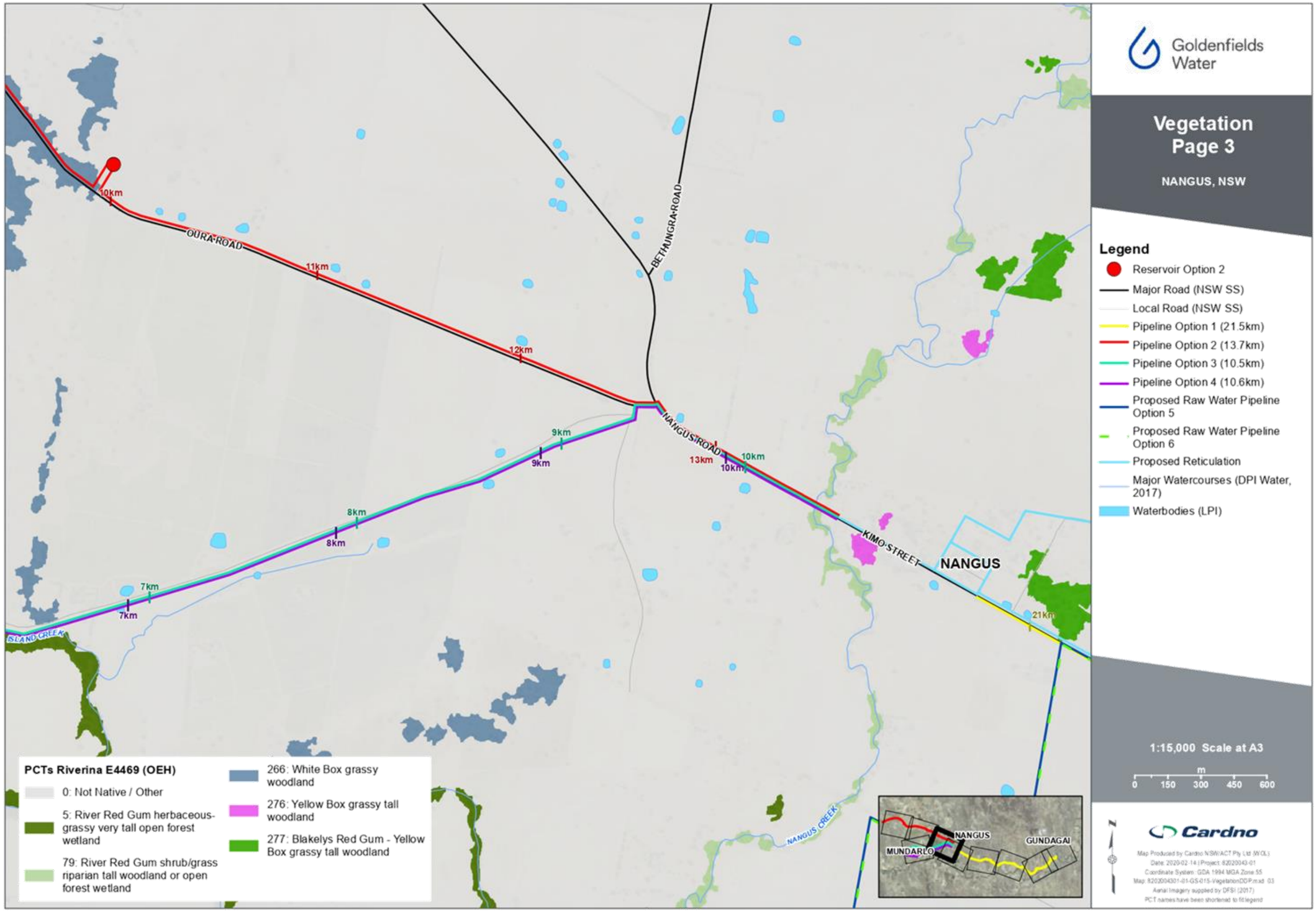

BACK STATION CREEK
MURRUM BIDGEE RIVER
COOKOOMOOROO CREEK
NANGUS ROAD
HUME HIGHWAY
GOCUP ROAD
1km
2km
3km
4km
5km
6km
7km
NANGUS
MUNDARLO
GUNDAGAI
Goldenfields Water
Biodiversity Page 8
NANGUS, NSW
Legend
Booster Pump Station (Option 1)
Fauna Sightings (Bionet, 2019)
Flora Sightings (Bionet, 2019)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
CGRC Existing Water Mains
Major Road (LPI)
Local Road (LPI)
Major Watercourses (DPI Water, 2017)
Key Fish Habitat (DPI Water, 2017)
Terrestrial Biodiversity (DPE, 2019)
Waterbodies (LPI)
1:15,000 Scale at A3
m
0 150 300 450 600
N
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-11-29 | Project: 82029043-01
Coordinate System: GDA 1994 MGA Zone 55
Map: 82029043-01-GS-014-BiodiversityDDP.mxd 02
Aerial Imagery supplied by DFSI (2017)

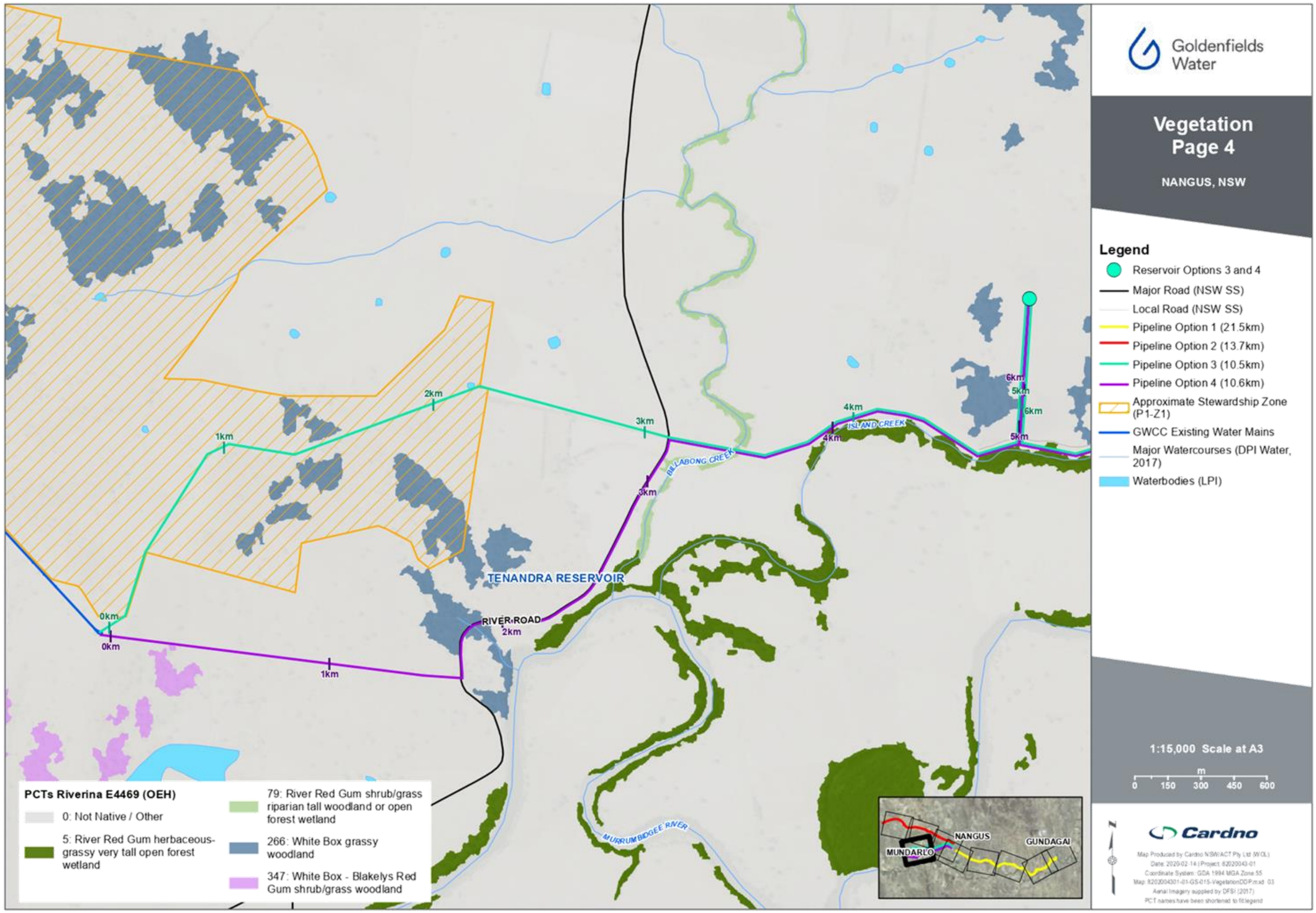

BURRA ROAD
HUME HIGHWAY
TARGET CREEK
WEST STREET
JONES CREEK
PUNCH STREET
GUNDAGAI
SHERIDAN STREET
0km
HOMER STREET
MORLEYS CREEK
1km
NANGUS ROAD
MURRUMBIDGEE RIVER
MIDDLETON DRIVE
2km
MOUNT STREET
BRUNGLE ROAD
SLATE QUARRY CREEK
COOKOOM OORO O CREEK
MIDDLE STREET
NANGUS
MUNDARLO
GUNDAGAI
Goldenfields Water
Biodiversity Page 9
NANGUS, NSW
Legend
Fauna Sightings (Bionet, 2019)
Flora Sightings (Bionet, 2019)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
CGRC Existing Water Mains
Major Road (LPI)
Local Road (LPI)
Major Watercourses (DPI Water, 2017)
Key Fish Habitat (DPI Water, 2017)
Terrestrial Biodiversity (DPE, 2019)
Waterbodies (LPI)
1:15,000 Scale at A3
m
0 150 300 450 600
N
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-11-29 | Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Map: 82020043-01-GIS-014-BiodiversityDDP.mxd 02
Aerial Imagery supplied by DFSI (2017)

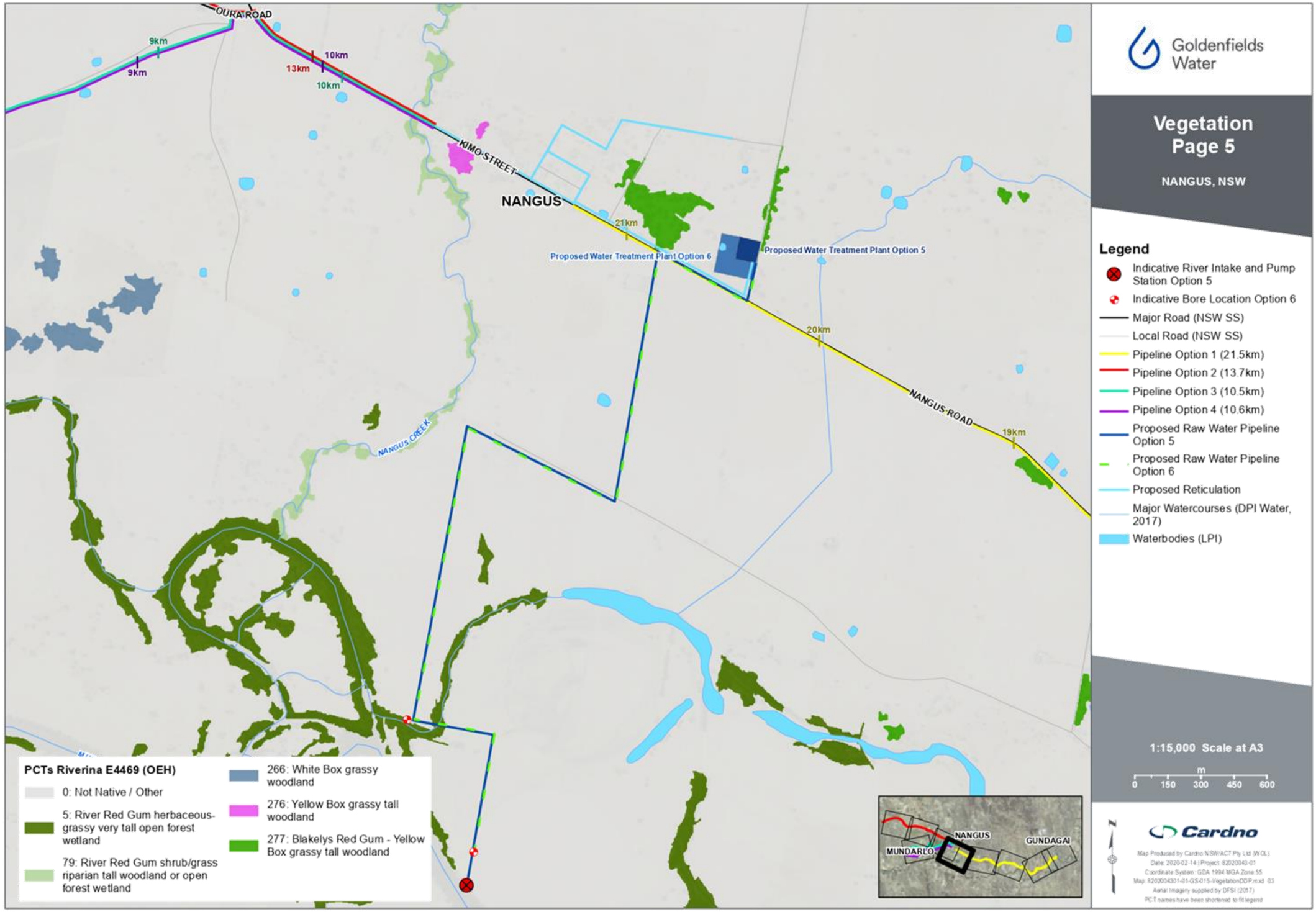

Goldenfields Water
Vegetation
NANGUS, NSW
Legend
Indicative River Intake and Pump Station Option 5
Indicative Bore Location Option 6
Booster Pump Station (Option 1)
Reservoir Option 1
Reservoir Option 2
Reservoir Options 3 and 4
Major Road (NSW SS)
Local Road (NSW SS)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
Proposed Raw Water Pipeline Option 5
Proposed Raw Water Pipeline Option 6
GWCC Existing Water Mains
CGRC Existing Water Mains
Major Watercourses (DPI Water, 2017)
Approximate Stewardship Zone (P1-Z1)
1:100,000 Scale at A3
km
0 1 2 3 4
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-02-14 | Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Map: 82020043-01-GS-008-Vegetation1.mxd: 03
Aerial Imagery supplied by DFSI (2017)
PCT names have been shortened to fit legend
PCTs Riverina E4469 (OEH)
0: Not Native / Other
5: River Red Gum herbaceous-grassy very tall open forest wetland
47: Swamp grassland wetland of the Riverine Plain
79: River Red Gum shrub/grass riparian tall woodland or open forest wetland
266: White Box grassy woodland
276: Yellow Box grassy tall woodland
277: Blakelys Red Gum - Yellow Box grassy tall woodland
278: Riparian Blakelys Red Gum - box - shrub - sedge - grass tall open forest
282: Blakelys Red Gum - White Box - Yellow Box - Black Cypress Pine box grass/shrub woodland
283: Apple Box - Blakelys Red Gum moist valley and footslopes grass-forb open forest
287: Long-leaved Box - Red Box - Red Stringybark mixed open forest
289: Mugga Ironbark - Inland Scribbly Gum - Red Box shrub/grass open forest
309: Black Cypress Pine - Red Stringybark - red gum - box low open forest
342: Mugga Ironbark - mixed box woodland
347: White Box - Blakelys Red Gum shrub/grass woodland
796: Derived grassland
WANTABADGERY
NANGUS VILLAGE
TENANDRA RESERVOIR
GUNDAGAI
MUNDARLO
TUMBLONG
DOLLAR VALE ROAD
BETHUNGRA ROAD
GUNDAGAI ROAD
OURA ROAD
RIVER ROAD
OLD HUME HIGHWAY
NANGUS ROAD
BURRA ROAD
MOUNT STREET
PUNCH STREET
EDWARDS TOWN ROAD
GOCUP ROAD
COOBA CREEK
DRY CREEK
LEFT ARM CREEK
ROCKY GULLY CREEK
OAKVALE CREEK
WATERFALL CREEK
NANGUS CREEK
NATIVE DOG CREEK
SPRUBAY CREEK
LONG TUNNEL CREEK
BACK STATION CREEK
JOHNSONS CREEK
JERUSALEM CREEK
BONGONGALONG CREEK
FIVE MILE CREEK
JONES CREEK
HARGRAVES GULLY
LARGE CREEK
OAK CREEK
MURRUMBIDGEE RIVER
JELLUNGRO CREEK
SANDY CREEK
BILLABONG CREEK
AIDELONG CREEK
BIG BEN CREEK
COOKOOMOOROO CREEK

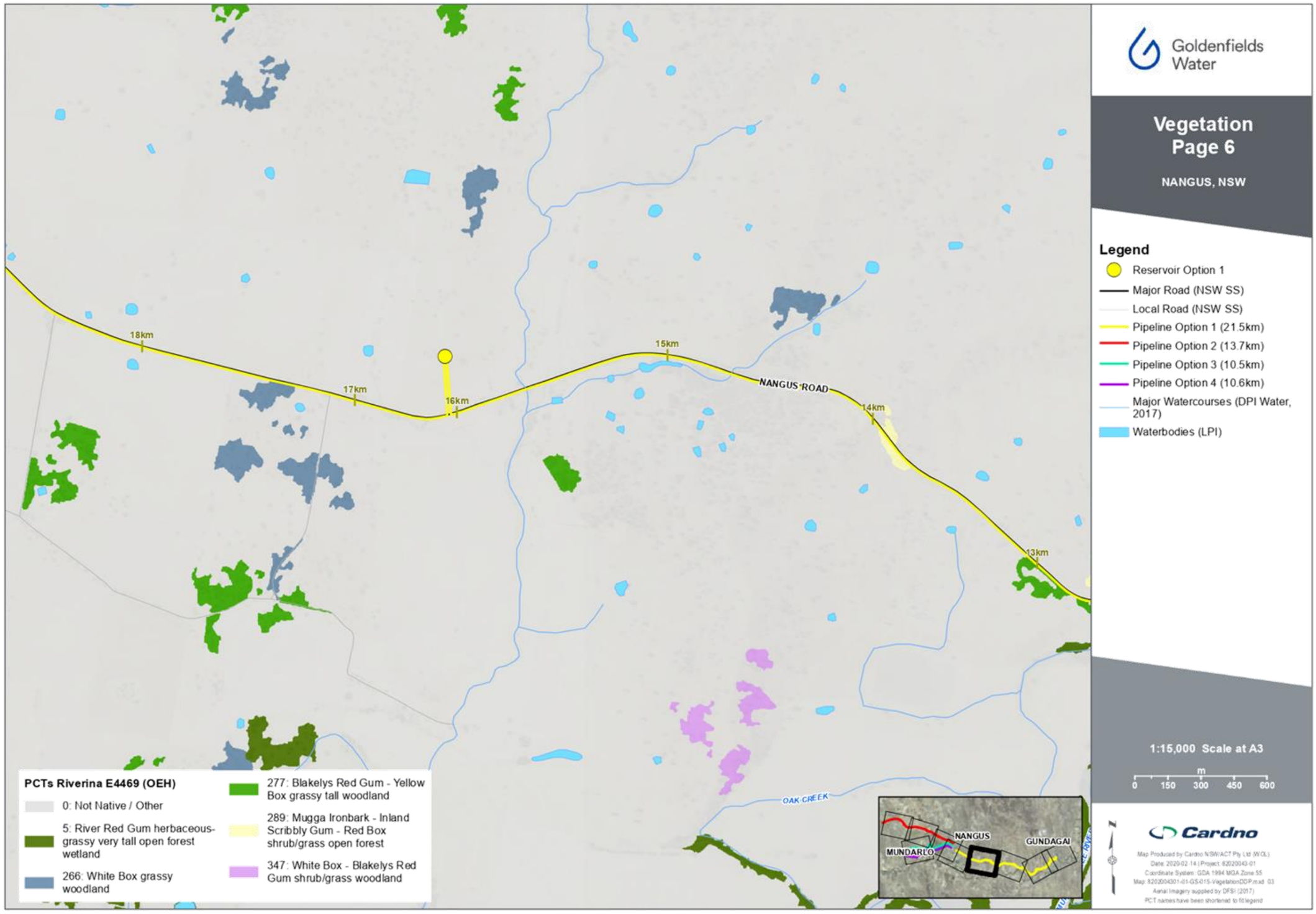

Goldenfields Water
Vegetation Page 1
NANGUS, NSW
Legend
Major Road (NSW SS)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
GWCC Existing Water Mains
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
OURA ROAD
0km
1km
2km
3km
4km
5km
PCTs Riverina E4469 (OEH)
0: Not Native / Other
266: White Box grassy woodland
277: Blakelys Red Gum - Yellow Box grassy tall woodland
MUNDARLO
NANGUS
GUNDAGAI
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-02-14 | Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Aerial Imagery supplied by DFSI (2017)
PCT names have been shortened to fit legend

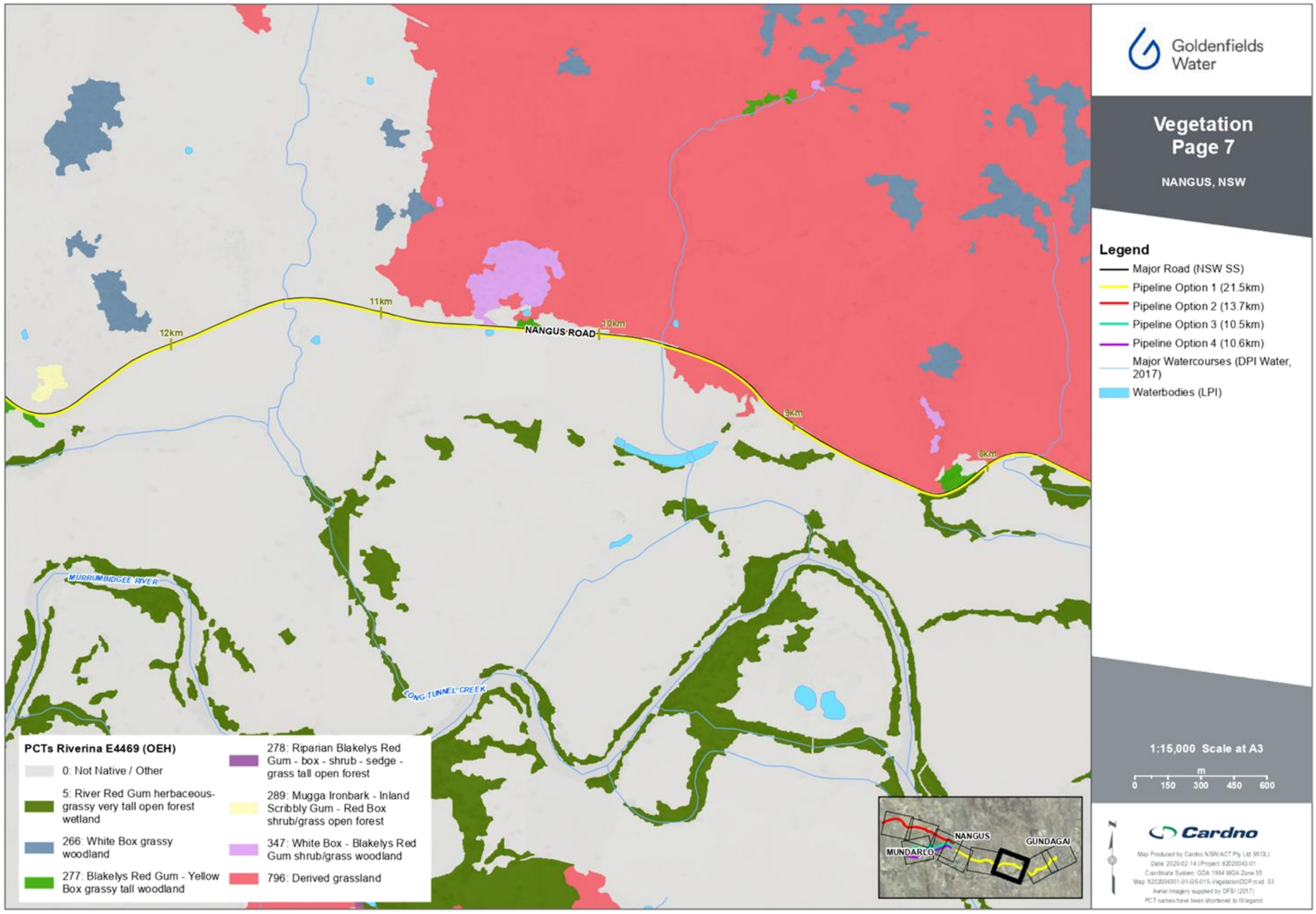

Goldenfields Water
Vegetation Page 2
NANGUS, NSW
Legend
Reservoir Option 2
Major Road (NSW SS)
Local Road (NSW SS)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
Approximate Stewardship Zone (P1-Z1)
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
BILLABONG CREEK
NANGUS ROAD
OURA ROAD
RIVER ROAD
5km
6km
7km
8km
9km
10km
PCTs Riverina E4469 (OEH)
0: Not Native / Other
5: River Red Gum herbaceous-grassy very tall open forest wetland
79: River Red Gum shrub/grass riparian tall woodland or open forest wetland
266: White Box grassy woodland
277: Blakelys Red Gum - Yellow Box grassy tall woodland
MUNDARLO
NANGUS
GUNDAGAI
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno

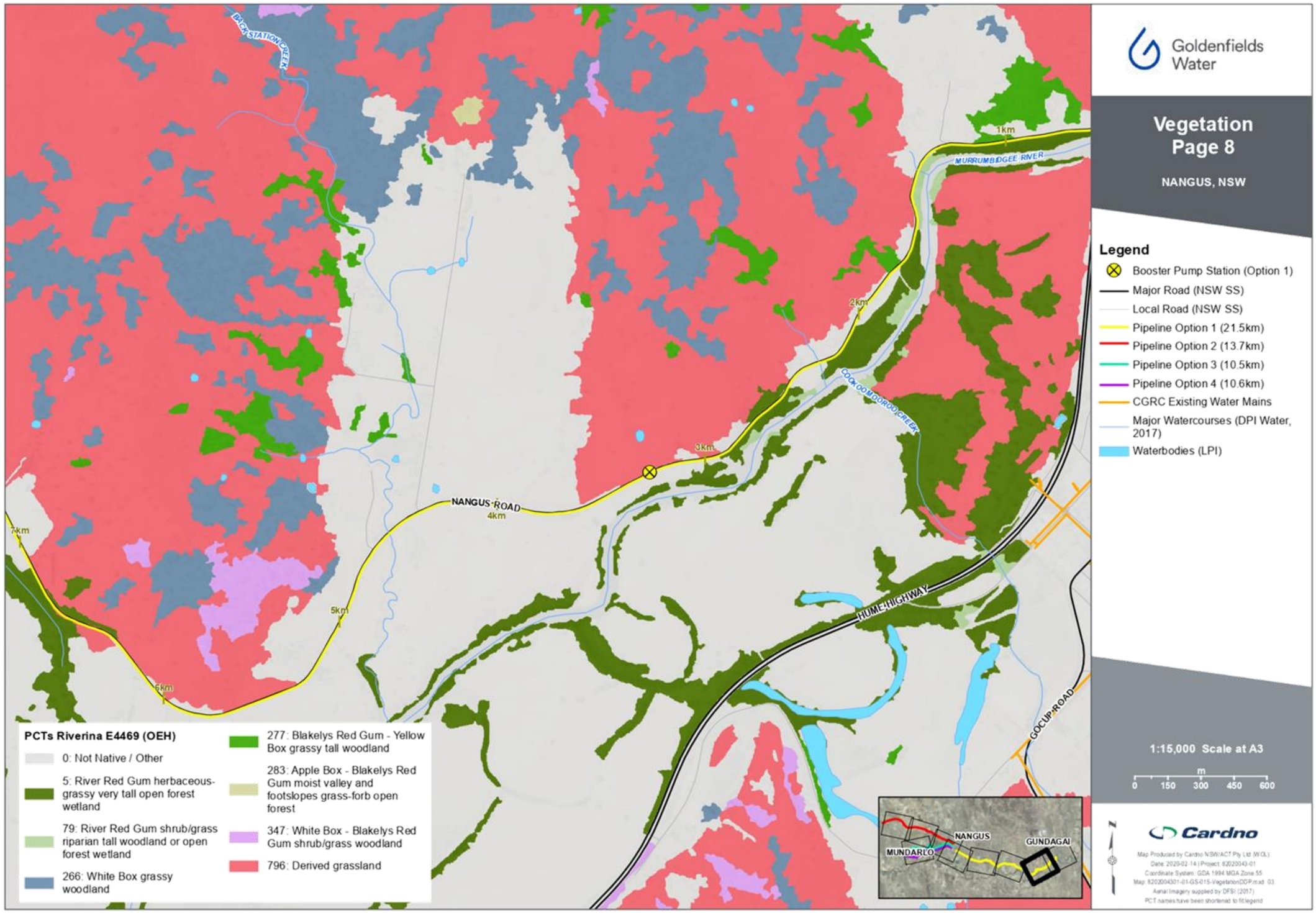

Goldenfields Water
Vegetation Page 3
NANGUS, NSW
Legend
Reservoir Option 2
Major Road (NSW SS)
Local Road (NSW SS)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
Proposed Raw Water Pipeline Option 5
Proposed Raw Water Pipeline Option 6
Proposed Reticulation
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
1:15,000 Scale at A3
m
0 150 300 450 600
OURA ROAD
BETHUNGRA ROAD
NANGUS ROAD
KIMO STREET
NANGUS
NANGUS CREEK
ISLAND CREEK
7km
8km
9km
10km
11km
12km
13km
21km
PCTs Riverina E4469 (OEH)
0: Not Native / Other
5: River Red Gum herbaceous-grassy very tall open forest wetland
79: River Red Gum shrub/grass riparian tall woodland or open forest wetland
266: White Box grassy woodland
276: Yellow Box grassy tall woodland
277: Blakelys Red Gum - Yellow Box grassy tall woodland
NANGUS
MUNDARLO
GUNDAGAI
Cardno

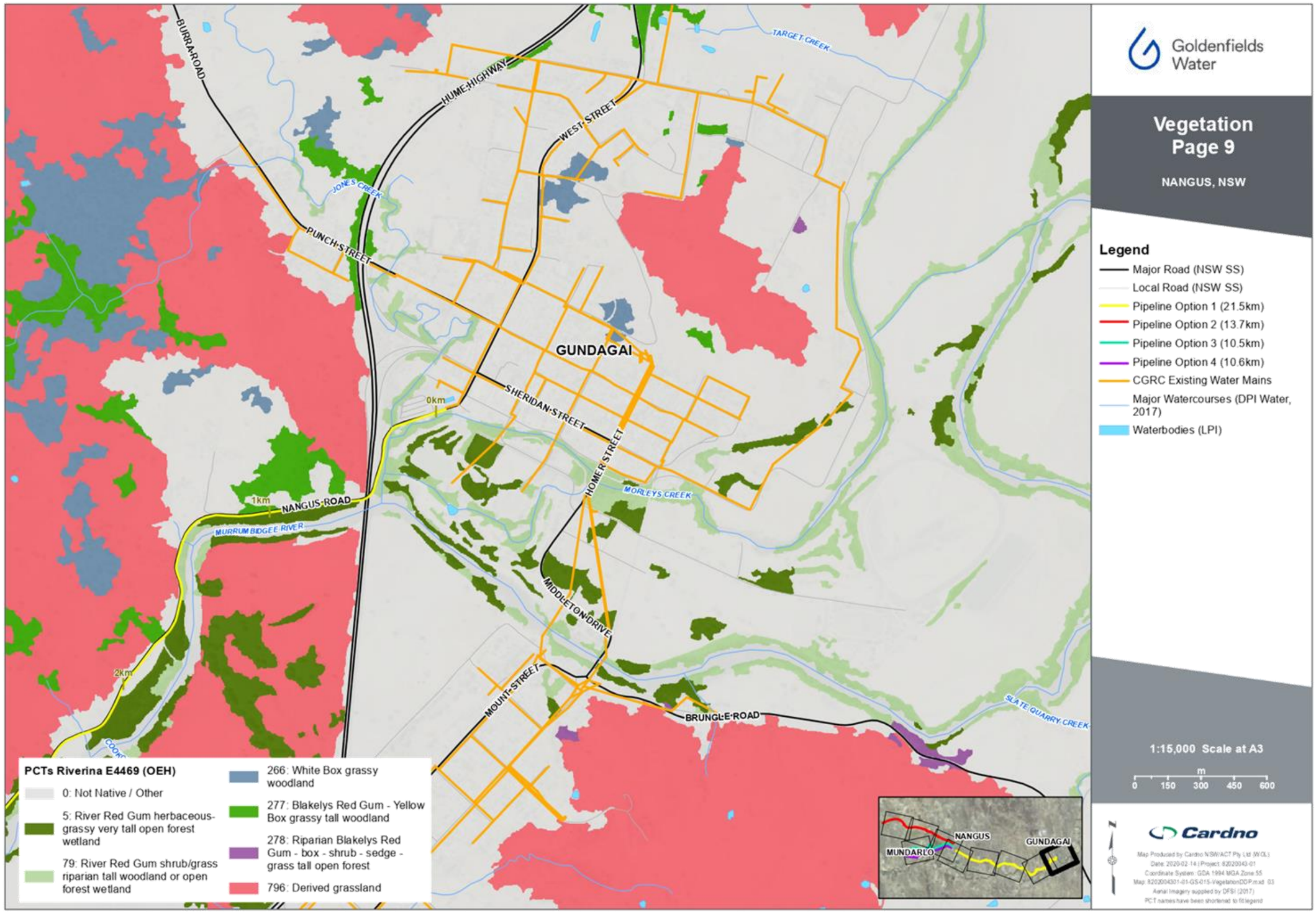

Goldenfields Water
Vegetation Page 4
NANGUS, NSW
Legend
Reservoir Options 3 and 4
Major Road (NSW SS)
Local Road (NSW SS)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
Approximate Stewardship Zone (P1-Z1)
GWCC Existing Water Mains
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
1:15,000 Scale at A3
m
0 150 300 450 600
TENANDRA RESERVOIR
RIVER ROAD
BILLABONG CREEK
ISLAND CREEK
MURRUMBIDGEE RIVER
0km
1km
2km
3km
4km
5km
6km
NANGUS
MUNDARLO
GUNDAGAI
PCTs Riverina E4469 (OEH)
0: Not Native / Other
5: River Red Gum herbaceous-grassy very tall open forest wetland
79: River Red Gum shrub/grass riparian tall woodland or open forest wetland
266: White Box grassy woodland
347: White Box - Blakelys Red Gum shrub/grass woodland
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-02-14 | Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Map: 82020043-01-GS-015-VegetationDDP.mxd 03
Aerial Imagery supplied by DFSI (2017)
PCT names have been shortened to fit legend

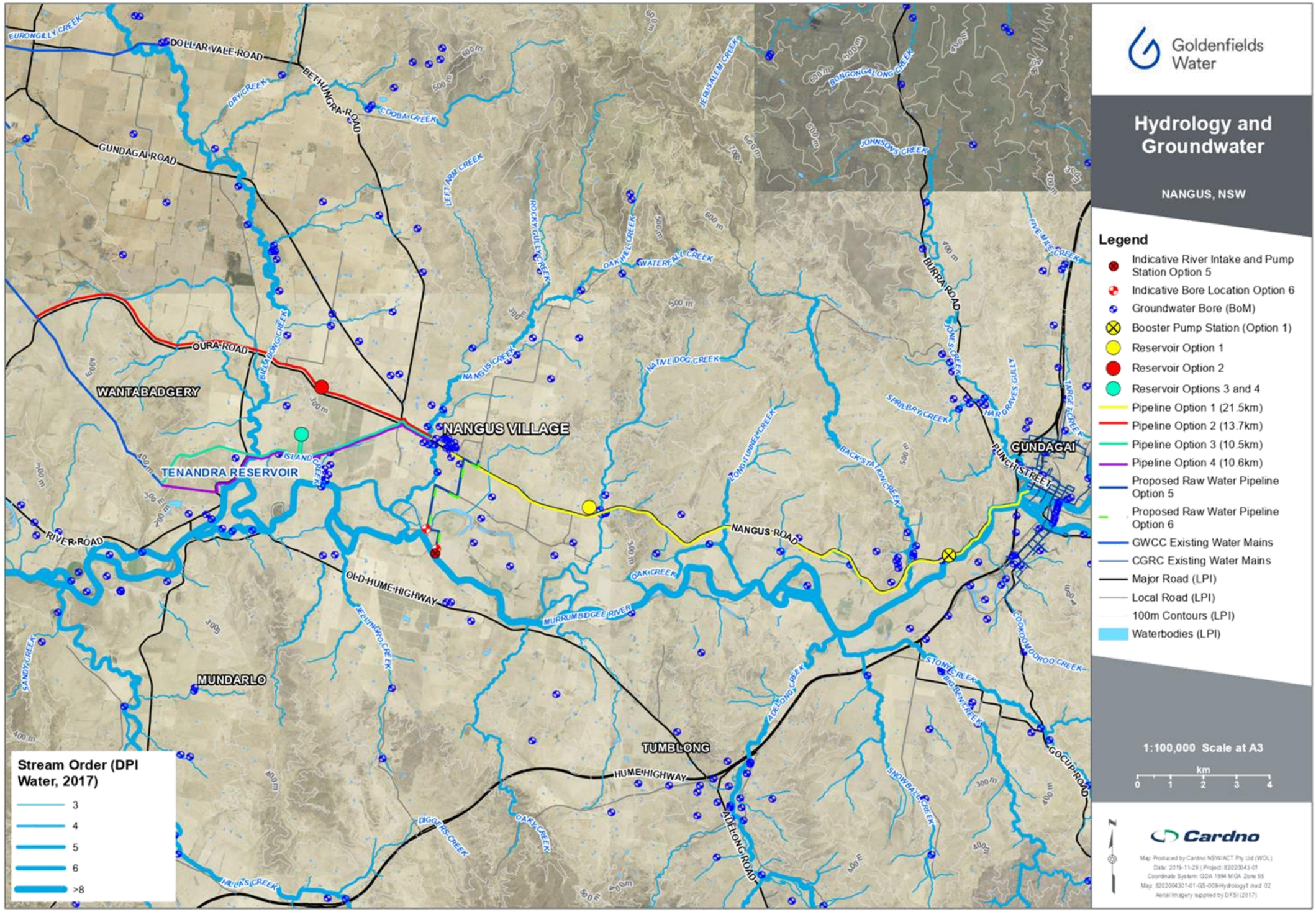

OURA ROAD
9km
9km
13km
10km
10km
KIMO STREET
NANGUS
21km
Proposed Water Treatment Plant Option 6
Proposed Water Treatment Plant Option 5
20km
NANGUS ROAD
19km
NANGUS CREEK
PCTs Riverina E4469 (OEH)
0: Not Native / Other
5: River Red Gum herbaceous-grassy very tall open forest wetland
79: River Red Gum shrub/grass riparian tall woodland or open forest wetland
266: White Box grassy woodland
276: Yellow Box grassy tall woodland
277: Blakelys Red Gum - Yellow Box grassy tall woodland
MUNDARLO
NANGUS
GUNDAGAI
Goldenfields Water
Vegetation Page 5
NANGUS, NSW
Legend
Indicative River Intake and Pump Station Option 5
Indicative Bore Location Option 6
Major Road (NSW SS)
Local Road (NSW SS)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
Proposed Raw Water Pipeline Option 5
Proposed Raw Water Pipeline Option 6
Proposed Reticulation
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno
Map Produced by: Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-02-14 | Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Aerial Imagery supplied by: DFSI (2017)
PCT names have been shortened to fit legend

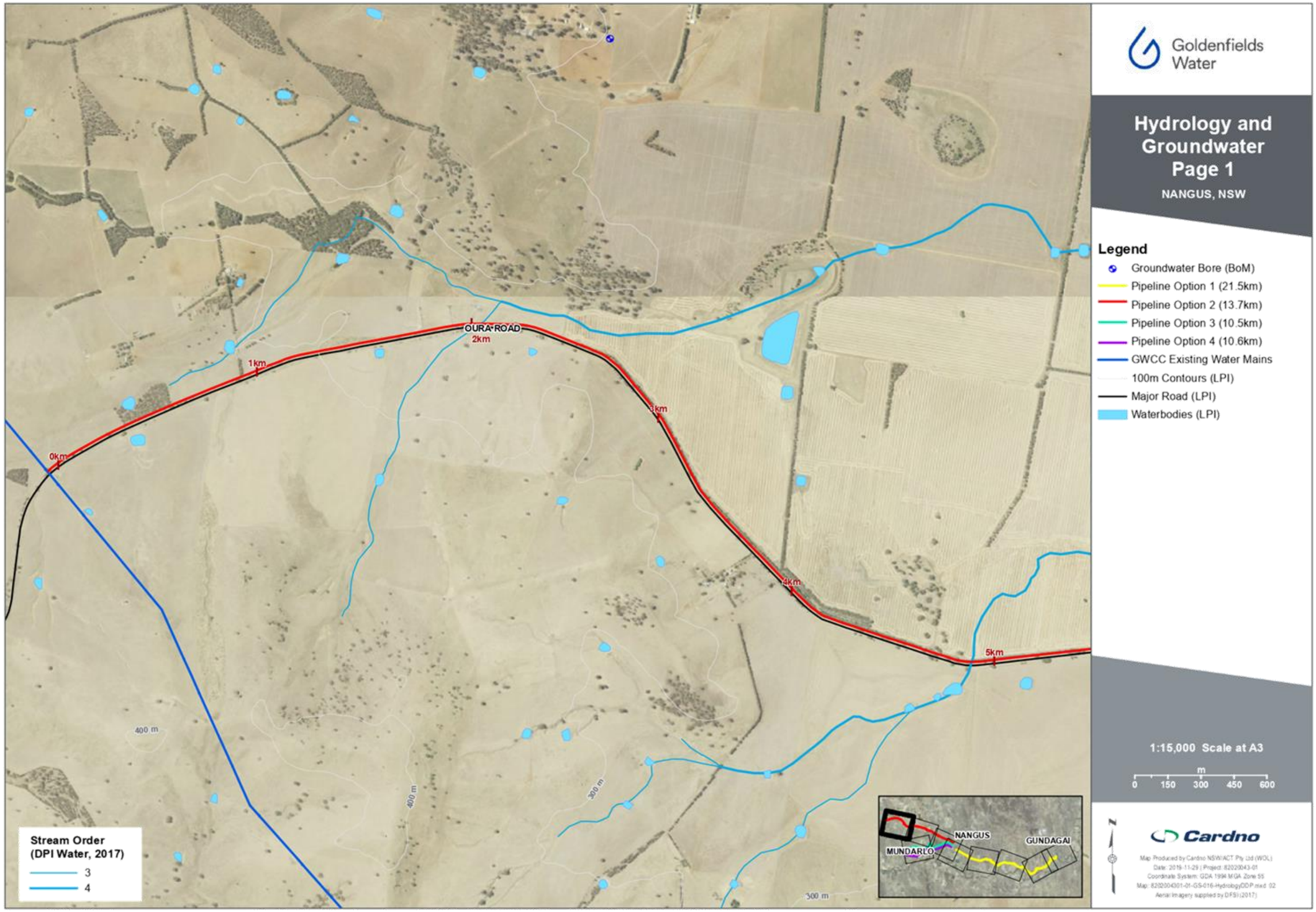

Goldenfields Water
Vegetation Page 6
NANGUS, NSW
Legend
Reservoir Option 1
Major Road (NSW SS)
Local Road (NSW SS)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
18km
17km
16km
15km
14km
13km
NANGUS ROAD
OAK CREEK
PCTs Riverina E4469 (OEH)
0: Not Native / Other
5: River Red Gum herbaceous-grassy very tall open forest wetland
266: White Box grassy woodland
277: Blakelys Red Gum - Yellow Box grassy tall woodland
289: Mugga Ironbark - Inland Scribbly Gum - Red Box shrub/grass open forest
347: White Box - Blakelys Red Gum shrub/grass woodland
NANGUS
MUNDARLO
GUNDAGAI
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-02-14 | Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Aerial Imagery supplied by DFSI (2017)
PCT names have been shortened to fit legend


Goldenfields Water
Vegetation Page 7
NANGUS, NSW
Legend
Major Road (NSW SS)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
12km
11km
10km
9Km
8Km
NANGUS ROAD
MURRUMBIDGEE RIVER
LONG TUNNEL CREEK
PCTs Riverina E4469 (OEH)
0: Not Native / Other
5: River Red Gum herbaceous-grassy very tall open forest wetland
266: White Box grassy woodland
277: Blakelys Red Gum - Yellow Box grassy tall woodland
278: Riparian Blakelys Red Gum - box - shrub - sedge - grass tall open forest
289: Mugga Ironbark - Inland Scribbly Gum - Red Box shrub/grass open forest
347: White Box - Blakelys Red Gum shrub/grass woodland
796: Derived grassland
MUNDARLO
NANGUS
GUNDAGAI
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-02-14 | Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Map: 82020043-01-GS-015-VegetationDDP.mxd 03
Aerial Imagery supplied by DFSI (2017)
PCT names have been shortened to fit legend


Goldenfields Water
Vegetation Page 8
NANGUS, NSW
Legend
Booster Pump Station (Option 1)
Major Road (NSW SS)
Local Road (NSW SS)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
CGRC Existing Water Mains
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
PCTs Riverina E4469 (OEH)
0: Not Native / Other
5: River Red Gum herbaceous-grassy very tall open forest wetland
79: River Red Gum shrub/grass riparian tall woodland or open forest wetland
266: White Box grassy woodland
277: Blakelys Red Gum - Yellow Box grassy tall woodland
283: Apple Box - Blakelys Red Gum moist valley and footslopes grass-forb open forest
347: White Box - Blakelys Red Gum shrub/grass woodland
796: Derived grassland
NANGUS ROAD
HUME HIGHWAY
GOCUP ROAD
MURRUMBIDGEE RIVER
COOKOOMOOROO CREEK
1km
2km
3km
4km
5km
6km
7km
NANGUS
MUNDARLO
GUNDAGAI
1:15,000 Scale at A3
0 150 300 450 600
Cardno


Goldenfields Water
Vegetation Page 9
NANGUS, NSW
Legend
Major Road (NSW SS)
Local Road (NSW SS)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
CGRC Existing Water Mains
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
BURRA ROAD
HUME HIGHWAY
WEST STREET
TARGET CREEK
JONES CREEK
PUNCH STREET
GUNDAGAI
0km
SHERIDAN STREET
HOMER STREET
MORLEYS CREEK
1km
NANGUS ROAD
MURRUMBIDGEE RIVER
MIDDLETON DRIVE
2km
MOUNT STREET
BRUNGLE ROAD
SLATE QUARRY CREEK
PCTs Riverina E4469 (OEH)
0: Not Native / Other
5: River Red Gum herbaceous-grassy very tall open forest wetland
79: River Red Gum shrub/grass riparian tall woodland or open forest wetland
266: White Box grassy woodland
277: Blakelys Red Gum - Yellow Box grassy tall woodland
278: Riparian Blakelys Red Gum - box - shrub - sedge - grass tall open forest
796: Derived grassland
NANGUS
GUNDAGAI
MUNDARLO
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2020-02-14 | Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Map: 82020043-01-GS-015-VegetationDDP.mxd 03
Aerial Imagery supplied by DFSI (2017)
PCT names have been shortened to fit legend


Goldenfields Water
Hydrology and Groundwater
NANGUS, NSW
Legend
Indicative River Intake and Pump Station Option 5
Indicative Bore Location Option 6
Groundwater Bore (BoM)
Booster Pump Station (Option 1)
Reservoir Option 1
Reservoir Option 2
Reservoir Options 3 and 4
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
Proposed Raw Water Pipeline Option 5
Proposed Raw Water Pipeline Option 6
GWCC Existing Water Mains
CGRC Existing Water Mains
Major Road (LPI)
Local Road (LPI)
100m Contours (LPI)
Waterbodies (LPI)
Stream Order (DPI Water, 2017)
3
4
5
6
>8
1:100,000 Scale at A3
km
0 1 2 3 4
N
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-11-29 | Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Map: 82020043-01-GS-009HydrologyT.mxd 02
Aerial Imagery supplied by DFSI (2017)
DOLLAR VALE ROAD
BETHUNGRA ROAD
GUNDAGAI ROAD
OURA ROAD
WANTABADGERY
NANGUS VILLAGE
TENANDRA RESERVOIR
RIVER ROAD
OLD HUME HIGHWAY
MUNDARLO
TUMBLONG
HUME HIGHWAY
NANGUS ROAD
BURRA ROAD
GUNDAGAI
PUNCH STREET
ADELONG ROAD
GOCUP ROAD
COOBA CREEK
DRY CREEK
LEFT ARM CREEK
ROCKY GULLY CREEK
OAKWELL CREEK
WATERFALL CREEK
NANGUS CREEK
NATIVE DOG CREEK
JERUSALEM CREEK
BONGONGALONG CREEK
JOHNSONS CREEK
BULLABONG CREEK
ISLAND CREEK
SPRILBRY CREEK
LONG TUNNEL CREEK
BACK STATION CREEK
FIVE MILE CREEK
JONES CREEK
WAR GRAVES GULLY
LARGE FLOWER CREEK
OAK CREEK
MURRUMBIDGEE RIVER
JELLUNGRO CREEK
SANDY CREEK
DIGGERS CREEK
HUNTS CREEK
ADELONG CREEK
STONY CREEK
BROKEN CREEK
COOCOOMOOROO CREEK
SNOWBALL CREEK


Goldenfields Water
Hydrology and Groundwater Page 1
NANGUS, NSW
Legend
Groundwater Bore (BoM)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
GWCC Existing Water Mains
100m Contours (LPI)
Major Road (LPI)
Waterbodies (LPI)
OURA ROAD
0km
1km
2km
3km
4km
5km
400 m
400 m
300 m
300 m
Stream Order (DPI Water, 2017)
3
4
NANGUS
MUNDARLO
GUNDAGAI
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-11-29 | Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Map: 82020043-01-GS-016-HydrologyDDP.mxd 02
Aerial Imagery supplied by DFSI (2017)


Goldenfields Water
Hydrology and Groundwater Page 2
NANGUS, NSW
Legend
Reservoir Option 2
Groundwater Bore (BoM)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
100m Contours (LPI)
Major Road (LPI)
Local Road (LPI)
Waterbodies (LPI)
BUJABONG CREEK
NANGUS ROAD
OURA ROAD
RIVER ROAD
5km
6km
7km
8km
9km
10km
300 m
Stream Order (DPI Water, 2017)
3
4
6
MUNDARLO
NANGUS
GUNDAGAI
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
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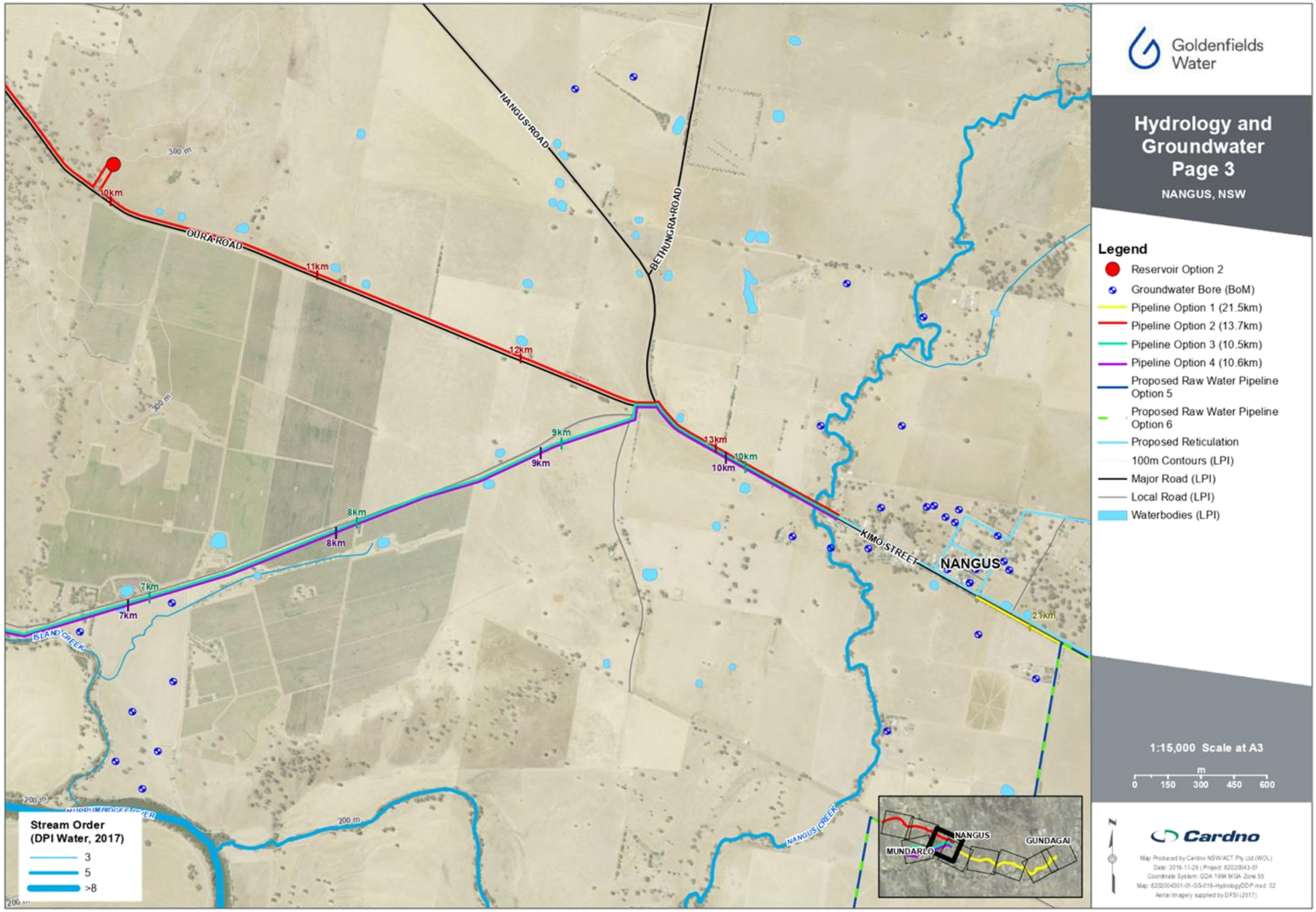
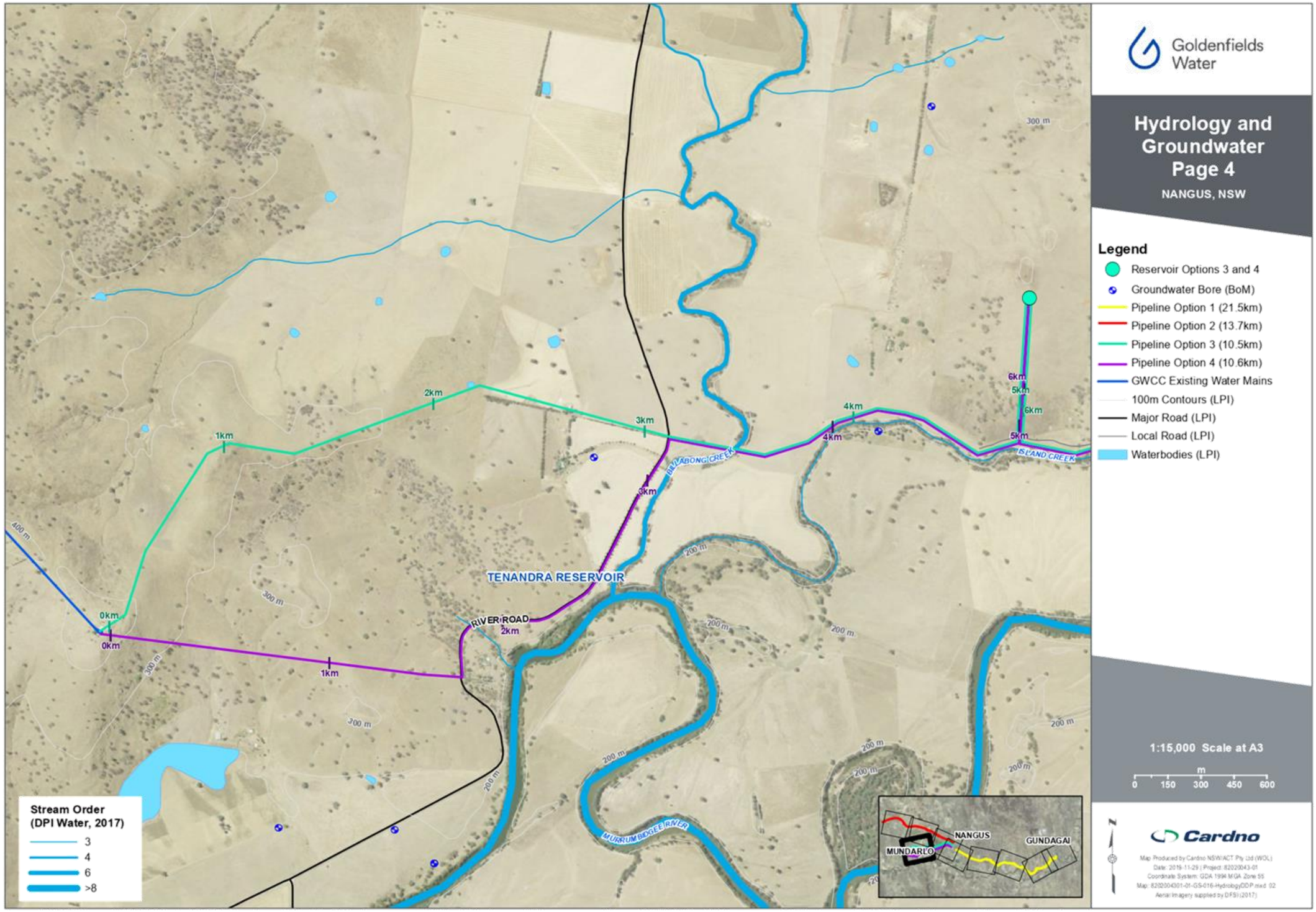
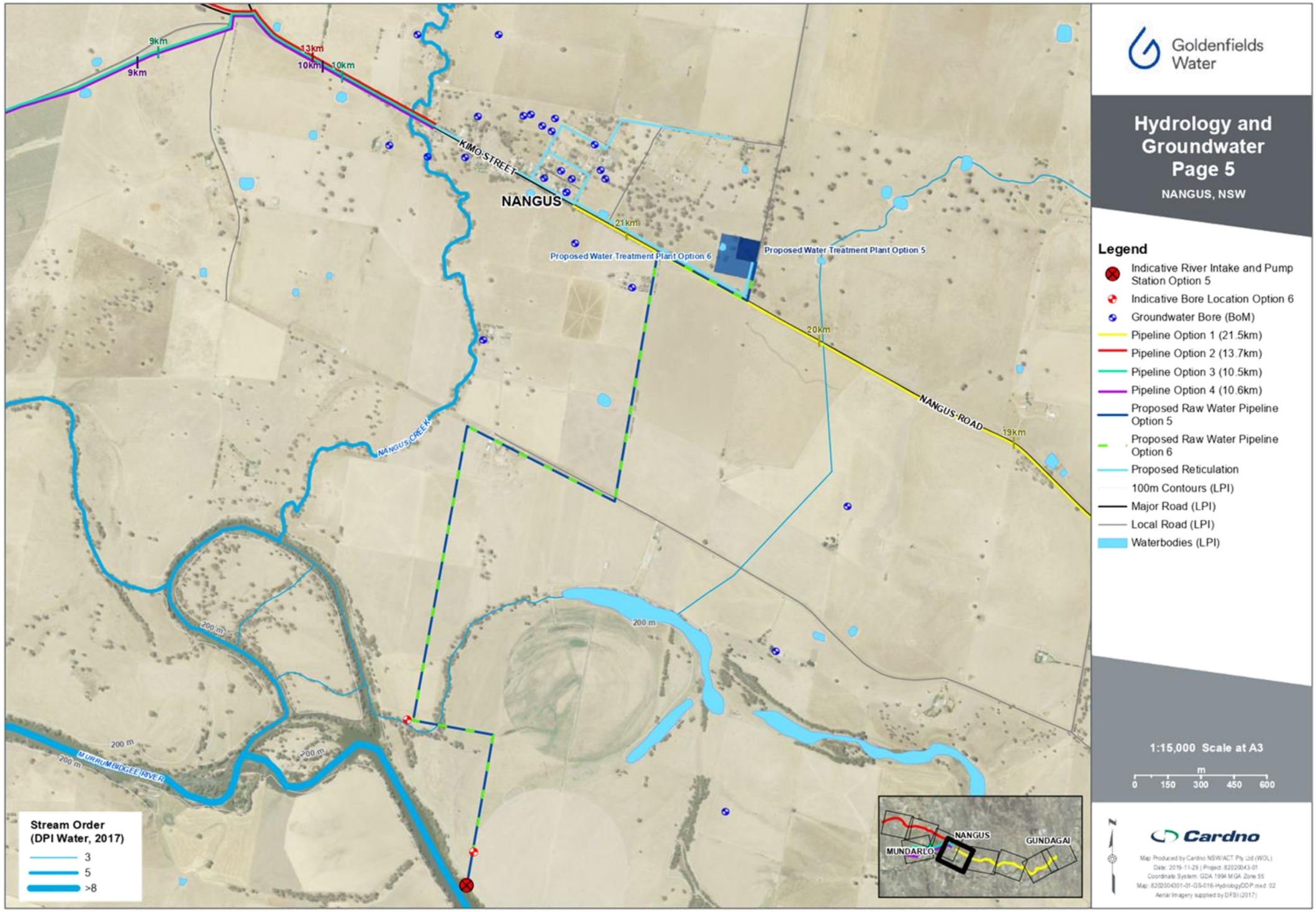
Coordinate System: GDA 1994 MGA Zone 55
Map: 82020043-01-GS-016-HydrologyDDP.mxd 02
Aerial Imagery supplied by DFSI (2017)


Goldenfields Water
Hydrology and Groundwater Page 3
NANGUS, NSW
Legend
Reservoir Option 2
Groundwater Bore (BoM)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
Proposed Raw Water Pipeline Option 5
Proposed Raw Water Pipeline Option 6
Proposed Reticulation
100m Contours (LPI)
Major Road (LPI)
Local Road (LPI)
Waterbodies (LPI)
1:15,000 Scale at A3
m
0 150 300 450 600
Stream Order (DPI Water, 2017)
3
5
>8
NANGUS ROAD
BETHUNGRA ROAD
OURA ROAD
KIMO STREET
NANGUS
MUNDARLO
GUNDAGAI
ISLAND CREEK
NANGUS CREEK
10km
11km
12km
13km
9km
8km
7km
2.1km
300 m
200 m
Cardno


Goldenfields Water
Hydrology and Groundwater Page 4
NANGUS, NSW
Legend
Reservoir Options 3 and 4
Groundwater Bore (BoM)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
GWCC Existing Water Mains
100m Contours (LPI)
Major Road (LPI)
Local Road (LPI)
Waterbodies (LPI)
TENANDRA RESERVOIR
RIVER ROAD
BELLABONG CREEK
ISLAND CREEK
MURRUMBIDGEE RIVER
0km
1km
2km
3km
4km
5km
6km
Stream Order (DPI Water, 2017)
3
4
6
>8
NANGUS
MUNDARLO
GUNDAGAI
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno


9km
13km
10km
10km
9km
KIMO STREET
NANGUS
21km
Proposed Water Treatment Plant Option 6
Proposed Water Treatment Plant Option 5
20km
NANGUS ROAD
19km
NANGUS CREEK
200 m
200 m
200 m
200 m
MURRUMBIDGEE RIVER
Stream Order
(DPI Water, 2017)
3
5
>8
Goldenfields Water
Hydrology and Groundwater Page 5
NANGUS, NSW
Legend
Indicative River Intake and Pump Station Option 5
Indicative Bore Location Option 6
Groundwater Bore (BoM)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
Proposed Raw Water Pipeline Option 5
Proposed Raw Water Pipeline Option 6
Proposed Reticulation
100m Contours (LPI)
Major Road (LPI)
Local Road (LPI)
Waterbodies (LPI)
1:15,000 Scale at A3
m
0 150 300 450 600
MUNDARLO
NANGUS
GUNDAGAI
Cardno
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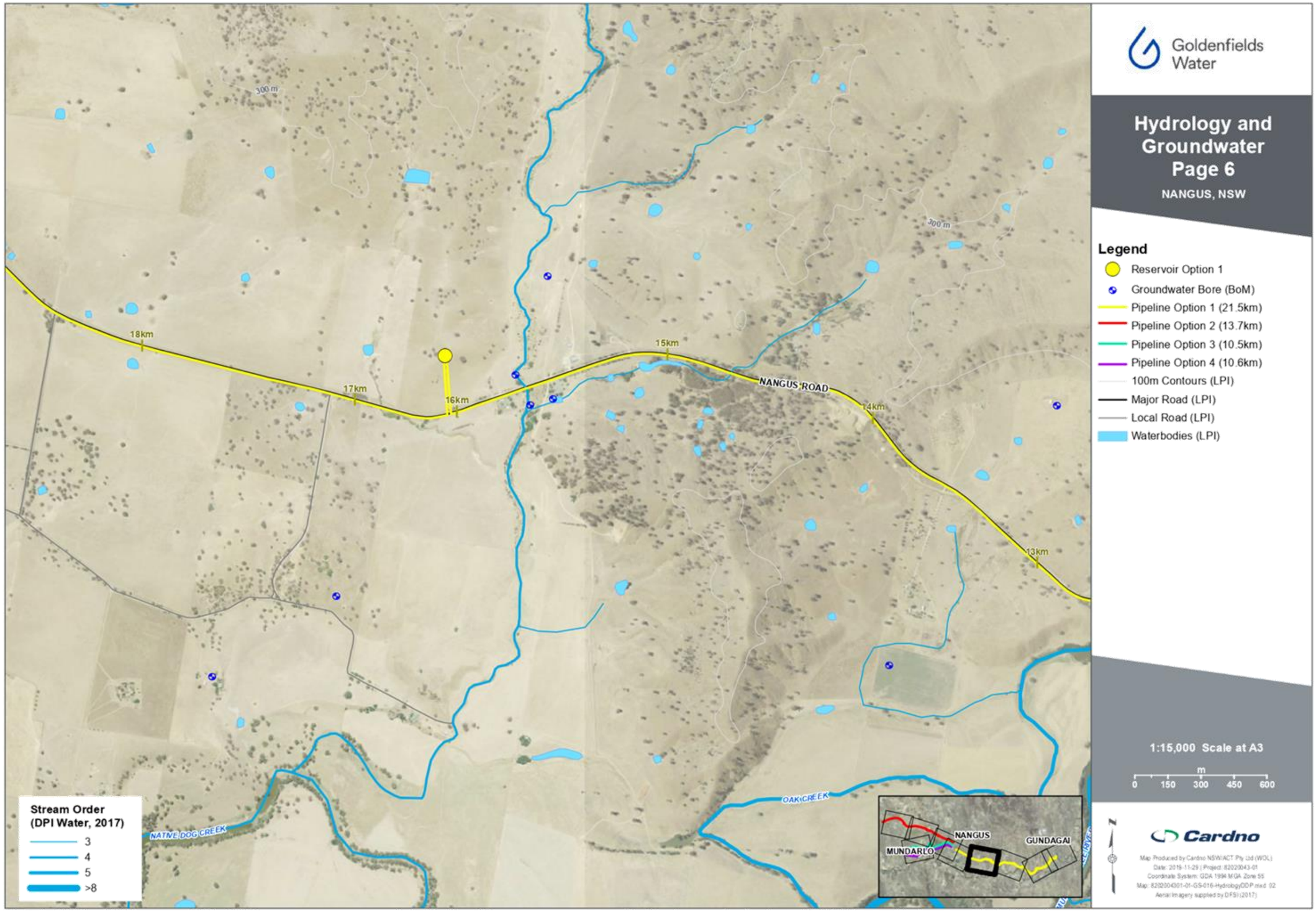
Goldenfields Water
Hydrology and Groundwater Page 6
NANGUS, NSW
Legend
Reservoir Option 1
Groundwater Bore (BoM)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
100m Contours (LPI)
Major Road (LPI)
Local Road (LPI)
Waterbodies (LPI)
1:15,000 Scale at A3
m
0 150 300 450 600
Stream Order (DPI Water, 2017)
3
4
5
>8
NANGUS ROAD
18km
17km
16km
15km
14km
13km
300 m
NATIVE DOG CREEK
OAK CREEK
MUNDARLO
NANGUS
GUNDAGAI
Cardno
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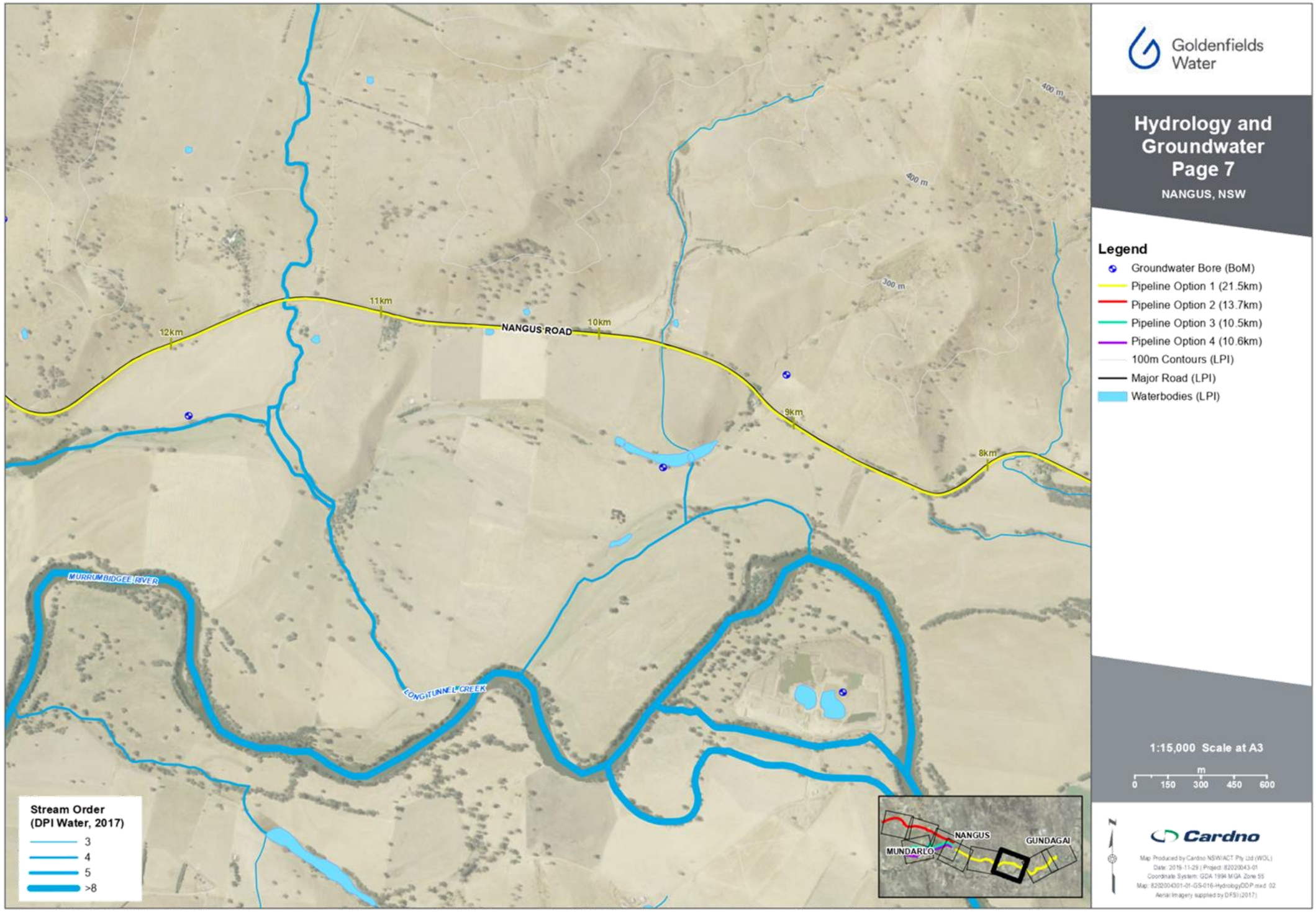
Coordinate System: GDA 1994 MGA Zone 55
Map: 82029043-01-GS-016-HydrologyDDP.mxd 02
Aerial Imagery supplied by DFSI (2017)


Goldenfields Water
Hydrology and Groundwater Page 7
NANGUS, NSW
Legend
Groundwater Bore (BoM)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
100m Contours (LPI)
Major Road (LPI)
Waterbodies (LPI)
NANGUS ROAD
12km
11km
10km
9km
8km
400 m
300 m
MURRUMBIDGEE RIVER
LONGTUNNEL CREEK
Stream Order (DPI Water, 2017)
3
4
5
>8
NANGUS
MUNDARLO
GUNDAGAI
1:15,000 Scale at A3
m
0 150 300 450 600
N
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
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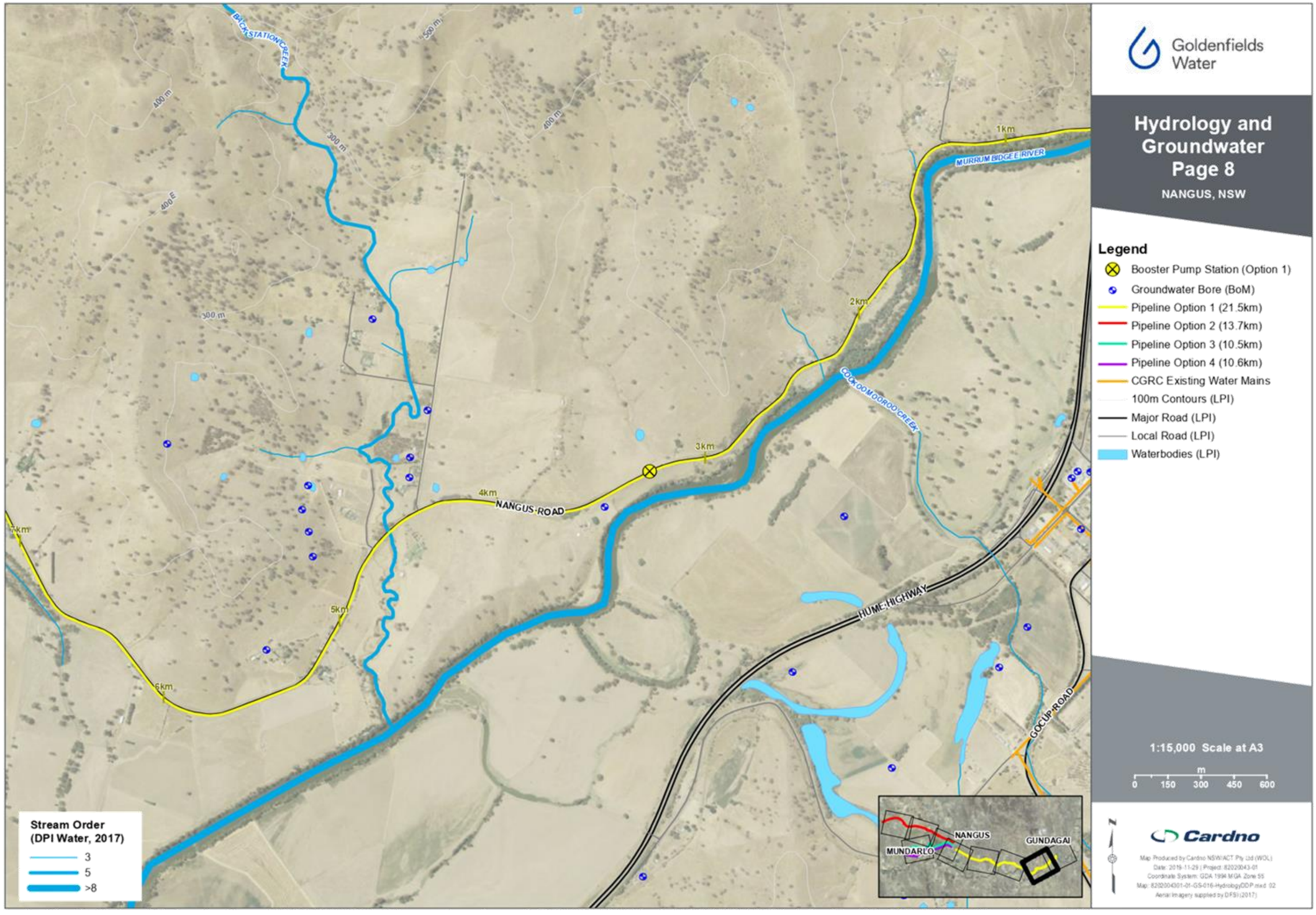
Coordinate System: GDA 1994 MGA Zone 55
Map: 82020043-01-GS-016-HydrologyDDP.mxd 02
Aerial imagery supplied by DFSI (2017)


Goldenfields Water
Hydrology and Groundwater Page 8
NANGUS, NSW
Legend
Booster Pump Station (Option 1)
Groundwater Bore (BoM)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
CGRC Existing Water Mains
100m Contours (LPI)
Major Road (LPI)
Local Road (LPI)
Waterbodies (LPI)
BACK STATION CREEK
MURRUM BIDGEE RIVER
COOKOOMOOROO CREEK
NANGUS ROAD
HUME HIGHWAY
GOCUP ROAD
1km
2km
3km
4km
5km
6km
7km
400 m
500 m
300 m
Stream Order (DPI Water, 2017)
3
5
>8
NANGUS
MUNDARLO
GUNDAGAI
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno
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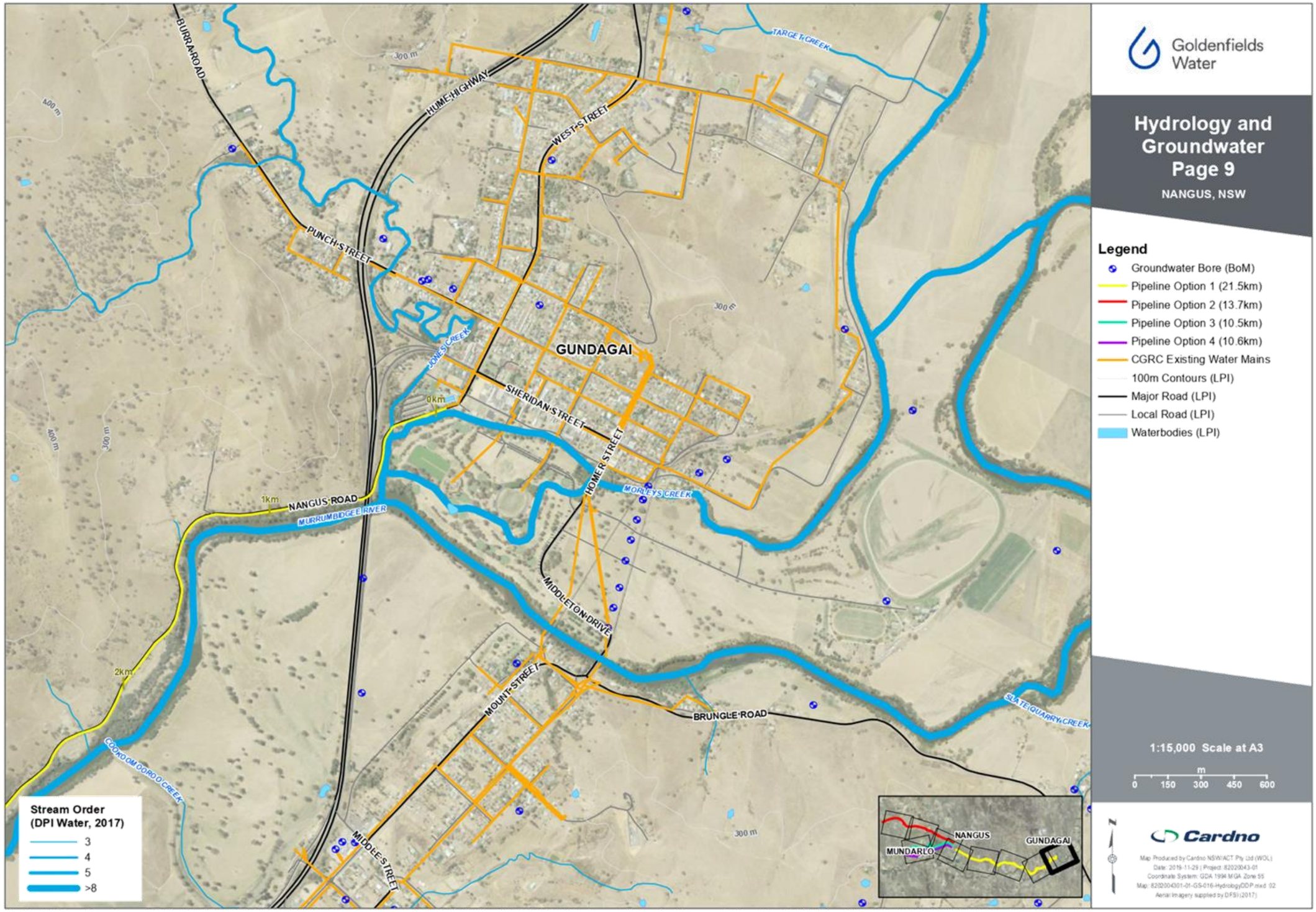
Goldenfields Water
Hydrology and Groundwater Page 9
NANGUS, NSW
Legend
Groundwater Bore (BoM)
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
CGRC Existing Water Mains
100m Contours (LPI)
Major Road (LPI)
Local Road (LPI)
Waterbodies (LPI)
1:15,000 Scale at A3
m
0 150 300 450 600
Stream Order (DPI Water, 2017)
3
4
5
>8
BURRA ROAD
HUME HIGHWAY
WEST STREET
PUNCH STREET
TARGET CREEK
GUNDAGAI
JONES CREEK
SHERIDAN STREET
HOMER STREET
MORLEYS CREEK
NANGUS ROAD
MURRUMBIDGEE RIVER
MIDDLETON DRIVE
MOUNT STREET
BRUNGLE ROAD
SLATE QUARRY CREEK
COOKOOM OORO O CREEK
MIDDLE STREET
NANGUS
MUNDARLO
GUNDAGAI
Cardno
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Map: 82029043-01-GS-016-HydrologyDDP.mxd 02
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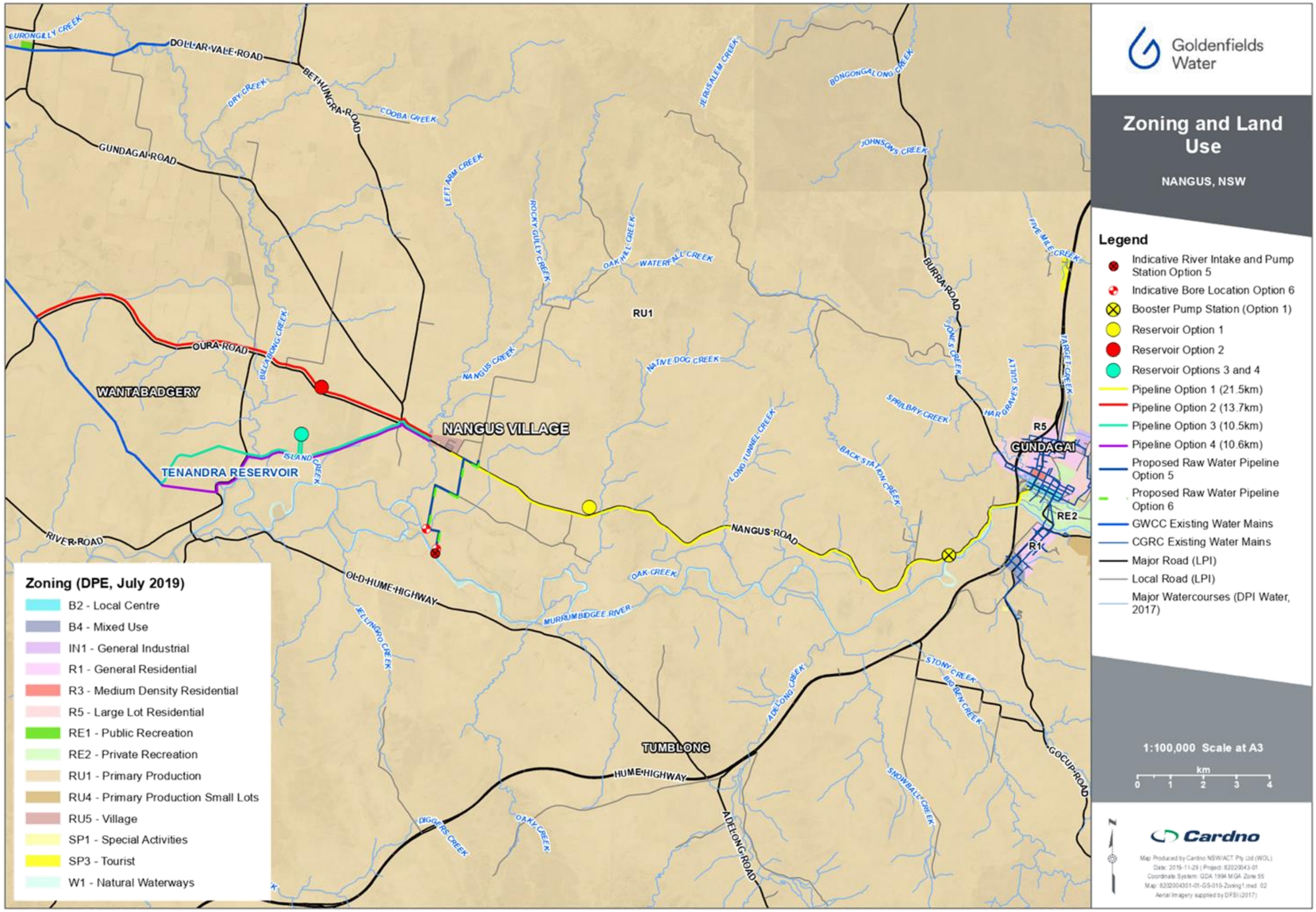
Goldenfields Water
Zoning and Land Use
NANGUS, NSW
Legend
Indicative River Intake and Pump Station Option 5
Indicative Bore Location Option 6
Booster Pump Station (Option 1)
Reservoir Option 1
Reservoir Option 2
Reservoir Options 3 and 4
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
Proposed Raw Water Pipeline Option 5
Proposed Raw Water Pipeline Option 6
GWCC Existing Water Mains
CGRC Existing Water Mains
Major Road (LPI)
Local Road (LPI)
Major Watercourses (DPI Water, 2017)
1:100,000 Scale at A3
km
0 1 2 3 4
Zoning (DPE, July 2019)
B2 - Local Centre
B4 - Mixed Use
IN1 - General Industrial
R1 - General Residential
R3 - Medium Density Residential
R5 - Large Lot Residential
RE1 - Public Recreation
RE2 - Private Recreation
RU1 - Primary Production
RU4 - Primary Production Small Lots
RU5 - Village
SP1 - Special Activities
SP3 - Tourist
W1 - Natural Waterways
Cardno
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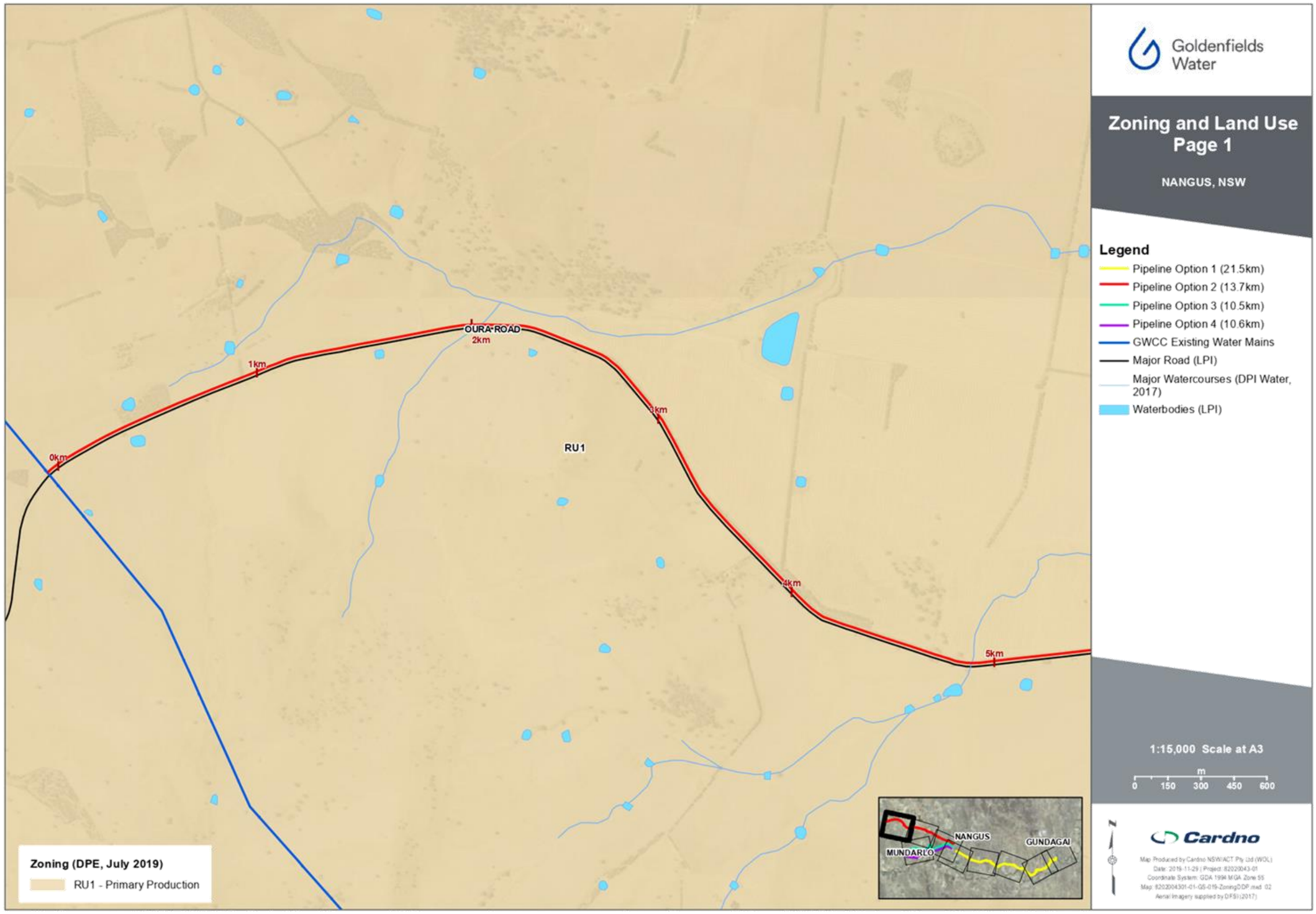
Coordinate System: GDA 1994 MGA Zone 55
Map: 82020043-01-GS-010-Zoning1.mxd 02
Aerial Imagery supplied by DFSI (2017)
EURONGILLY CREEK
DOLLAR VALE ROAD
DRY CREEK
BETHUNGRA ROAD
COOBA CREEK
GUNDAGAI ROAD
LEFT ARM CREEK
ROCKY GULLY CREEK
OAKWELL CREEK
WATERFALL CREEK
JERUSALEM CREEK
BONGONGALONG CREEK
JOHNSONS CREEK
BURRA ROAD
FIVE MILE CREEK
RU1
OURA ROAD
BILLABONG CREEK
NANGUS CREEK
NATIVE DOG CREEK
JONES CREEK
TARGET CREEK
WANTABADGERY
NANGUS VILLAGE
SPRILBRY CREEK
HARGRAVES GULLY
R5
GUNDAGAI
TENANDRA RESERVOIR
ISLAND CREEK
LONG TUNNEL CREEK
BACK STATION CREEK
RE2
R1
NANGUS ROAD
RIVER ROAD
OLD HUME HIGHWAY
OAK CREEK
MURRUMBIDGEE RIVER
JELLINGRO CREEK
STONY CREEK
BIGGEN CREEK
ADELONG CREEK
TUMBLONG
HUME HIGHWAY
GOCUP ROAD
SNOWBALL CREEK
DIGGERS CREEK
OAKY CREEK
ADELONG ROAD


Goldenfields Water
Zoning and Land Use Page 1
NANGUS, NSW
Legend
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
GWCC Existing Water Mains
Major Road (LPI)
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
OURA ROAD
0km
1km
2km
3km
4km
5km
RU1
Zoning (DPE, July 2019)
RU1 - Primary Production
MUNDARLO
NANGUS
GUNDAGAI
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno
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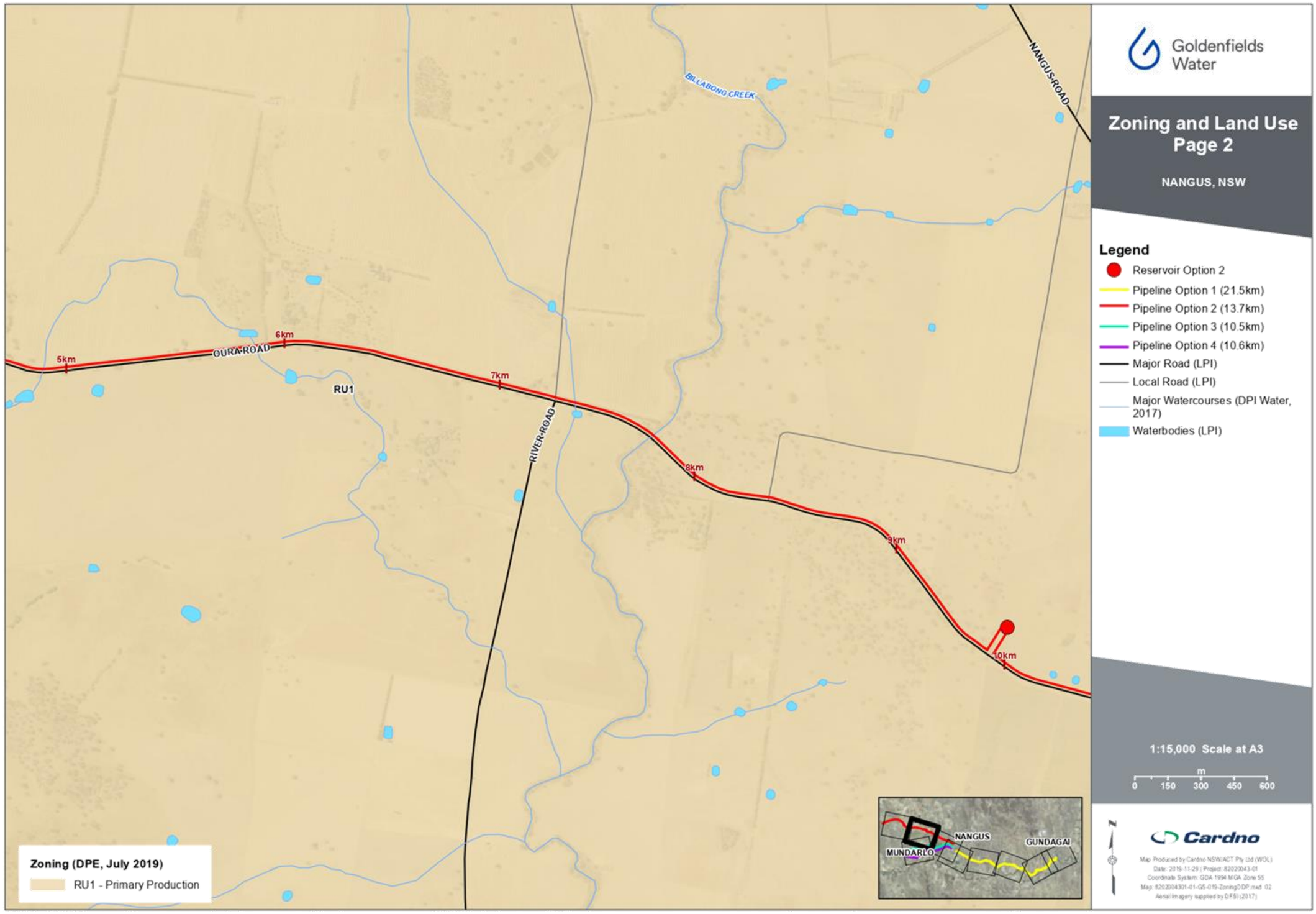
Coordinate System: GDA 1994 MGA Zone 55
Map: 82029043-01-GS-019-ZoningDDP.mxd 02
Aerial Imagery supplied by DFSI (2017)


Goldenfields Water
Zoning and Land Use Page 2
NANGUS, NSW
Legend
Reservoir Option 2
Pipeline Option 1 (21.5km)
Pipeline Option 2 (13.7km)
Pipeline Option 3 (10.5km)
Pipeline Option 4 (10.6km)
Major Road (LPI)
Local Road (LPI)
Major Watercourses (DPI Water, 2017)
Waterbodies (LPI)
BILLABONG CREEK
NANGUS ROAD
OURA ROAD
RIVER ROAD
RU1
5km
6km
7km
8km
9km
10km
Zoning (DPE, July 2019)
RU1 - Primary Production
MUNDARLO
NANGUS
GUNDAGAI
1:15,000 Scale at A3
m
0 150 300 450 600
Cardno
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-11-29 (Project: 82020043-01
Coordinate System: GDA 1994 MGA Zone 55
Map: 82020043301-01-GIS-019-ZoningDDP.mxd 02
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