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Macorna Wind Farm
HYDROLOGY INVESTIGATION

April 2026

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FOR

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Executive Summary

This report presents the preliminary hydrology investigation for the proposed wind farm located around Macorna, Victoria. The study area comprises approximately 23,000 ha and approximately 26 landholder's properties. The study area is located across two councils – Gannawarra Shire Council and Loddon Shire Council. The study area is within the authority of the North Central Catchment Management Authority (CMA).

In the existing condition, the study has mixed uses such as farming, dairy, grazing and cropping. There are two RAMSAR wetlands adjoining the northeast boundary of the proposed project area – Johnson Swamp and Hird Swamp. The study area is within the lower Loddon River catchment. The hydrology investigation has:

- Identified existing waterways within the study area that will be protected from the impacts of the proposed development.
- Liaised with the North Central CMA to determine floodplain extents to minimise development within the floodplain and ensure assets are appropriately protected from major flood events.
- Assessed likely stormwater quality impacts and provided mitigation options.
- Undertaken additional investigations of wetlands to support the ecological assessment.

Owing to the large size of the project area, many waterways exist within in. Detailed study, micro-siting, and engagement with the North Central CMA has allowed the project to minimise impacts and risks to waterways. Buffers to waterways have been provided by the project to mitigate risks of impacting waterways. Buffer requirements are discussed in additional detail in Section 4.

- All proposed turbine locations have a 50-m buffer from major waterways. Waterway classification is based on the Geoscience Australia database (Crossman, S., Li, O., 2015, Surface Hydrology Lines (Regional), Geoscience Australia, Canberra). The buffer from major watercourses is in line with the state planning amendment (VC278). In a meeting 16 January 2026, the North Central CMA indicated that the buffer provides appropriate protection for major waterways.
- All proposed turbine locations have a 30-m buffer from minor waterways. Waterway classification is based on the Geoscience Australia database. In a meeting 16 January 2026, the North Central CMA indicated that the buffer provides appropriate protection for minor waterways.
- All proposed turbine locations have a 30-m buffer from minor and agricultural waterways. Waterway classification is based on the Geoscience Australia database. Waterway location has been confirmed by aerial imagery where the database indicated a possibility of the buffer not being achieved. Turbine location will be further refined through discussions with landowners to ensure impacts to agricultural waterways are minimised.
- All infrastructure is located greater than 2000-m from the RAMSAR wetlands, with the exception of two access roads, the nearest being approximately 1100m, refer to Section 4.5.

The project area is subject to riverine flooding from the Lower Loddon system. Early engagement with the CMA has allowed the project to determine how to manage flood risk across the project area. CMA information and advice have informed the recommended design flood levels and freeboard requirements across the project area.

The hydrology investigation has based the assessment of flood impact on the latest planning overlays and information regarding the Lower Loddon 2011 flood extents from the North Central CMA. The CMA advised the project team that additional flood information, including levels and an updated flood extent, would be provided once finalised, DCE received the flood information from the CMA on 13 March 2026. Flood information available for inclusion in this report is discussed in additional detail in Section 4.2.1.

It is noted that of the 114 turbines:

- One (1) proposed turbine location is within the existing Floodway Overlay (FO).
- Thirty (30) proposed turbine locations are within the existing Land Subject to Inundation Overlay (LSIO)
- Forty-five (45) proposed turbine locations are within the 1% Annual Exceedance Probability (AEP) flood extent as currently mapped by the CMA but not reflected in the LSIO or FO.
- Eighty-four (84) proposed turbine locations are within the 2011 Lower Loddon Flood Extent as mapped by the CMA. The CMA has indicated that this flood extent considers this extent as the 1% AEP flood extent.

Micro-siting has been undertaken during the concept design process to shift proposed turbine locations outside areas of higher velocity within the flood extents. The CMA has confirmed that it is appropriate to locate turbines within flood extents if appropriate freeboard above the 2011 Loddon flood level is provided for sensitive components. During detailed design, the turbine locations will be assessed to demonstrate that they do not cause adverse impact on distributaries or flood levels on neighbouring properties. An investigation of the Loddon 2011 flood levels at each proposed turbine and other proposed infrastructure is detailed in Section 5.2. The investigation demonstrates that freeboard to the Loddon 2011 flood levels can be achieved and that the proposed turbines and infrastructure feasibly can be located as proposed.

Additional hydrological investigations were made to support the ecological assessment being undertaken by Nature Advisory for the project. The additional hydrological investigations included:

- Desktop terrain assessment to refine wetland boundaries for wetlands included in the DEECA data set of listed current wetlands and wetlands included in the brolga habitat suitability model.
- Identification of water-retaining depressions that meet ‘potential’ brolga breeding wetland requirements but are not included in current government data sets in the landscape that could hold water and serve as brolga breeding habitat wetlands.
- Ability of the natural catchment of identified/DEECA wetlands to provide at least 120 days of inundation from July-December in the previous 10-year period.
- Assessment of timing of major flow events that would inundate depressions that may act as wetlands.
- Preparation of GIS layers and data tables based on the additional investigations to provide to the project team and Nature Advisory to inform their ecological assessment.

In addition, this report recommends continuing discussions and data sharing with the North Central CMA. The CMA has agreed to provide the project team with flood models to assess in detail the flood impacts of the proposed project components.

The investigation has assessed hydrology and stormwater management risks associated with the proposed Macorna Wind Farm. The investigation notes:

- Risks to hydrology and stormwater have already been minimised through a thorough assessment of existing conditions and early engagement with the North Central CMA.
- Micro-siting has been undertaken to reduce risks by modifying the proposed design.
- Risks associated with the proposed project can be managed through mitigation measures as summarised in Section 5 and detailed in Appendix E.

The design of the project, combined with the proposed mitigation measures will ensure that:

- Waterways, wetlands, estuaries, and marine environments are unlikely to be affected.
- Streamflows are unlikely to be affected.
- Environmental values linked to surface water flow regimes and quality are unlikely to be affected.

The proposed Macorna Wind Farm's impacts on hydrology and surface water, in combination with the mitigations recommended in Section 5 and detailed in Appendix E, ensure that the project does not have potential to:

- Effect long-term change to the ecological character of wetlands listed under the Ramsar Convention or in *A Directory of Important Wetlands in Australia.*
- Have extensive or major impacts on the use and environmental values of water resources due to changes in water quality, water availability, stream flows, or water system function.

Contents

List of Appendices

List of Tables

List of Figures

1. Introduction

This report presents the preliminary hydrology and surface water investigation for the proposed wind farm located around Macorna, Victoria. The project area comprises approximately 23,000 ha across 26 landholder properties. The proposed wind farm is located across two councils, Gannawarra Shire Council and Loddon Shire Council. The proposed wind farm is within the authority of the North Central Catchment Management Authority (CMA).

Appendices to this report discuss additional hydrology investigations undertaken to support the ecological assessment. The investigation area for the additional hydrological inputs adopted a 5-km buffer to the project area. The investigation area has an area of approximately 81,000 ha.

1.1 Report Purpose

The hydrology and surface water investigation are being undertaken to demonstrate that the project will not significantly impact catchment values and hydrology. The report details existing conditions across the site, discusses design changes made by the project to reduce potential impacts on the function and value of surface water availability and quality. The report discusses how avoidance of adverse effects on environmental values can be achieved.

1.2 Project Description

The project involves the development of 114 wind turbine generators. The project will also include associated infrastructure including:

- Foundations, crane hardstand, crane boom laydown blade and a rotor assembly area.
- Access tracks including
    - New and upgraded tracks within the Project Area generally comprising a minimal 6.5-m wide access track for light vehicles.
    - 30-40-m wide corridor for oversize overmass (OSOM) vehicles within the Project Area.
- Upgrades to proposed transport access routes as required.
- Underground cabling (low voltage (LV) and medium voltage (MV)) and overhead transmission lines (MV and high voltage (HV)) within the project boundary.
- Up to four (4) collector substations with associated battery energy storage systems (BESS), size and duration to be determined.
- Connection to the grid via the adjacent proposed Tragowel VNI West substation.
- Electrical switching station, noting that the switching station infrastructure will be constructed, owned, and operated by the electricity provider.
- Up to seven (7) permanent meteorological masts.
- Construction compounds and laydown areas.
- Concrete batching plants.
- Operational and maintenance facilities.
- Potential construction workers accommodation facility.
- Potential communication towers.

- Native vegetation removal and vegetation screening as required and identified by technical assessments.
- Fencing, gates, and signage.

Figure 1 shows the project area, the proposed locations of the 114 turbines, and the construction disturbance area, where roads and benching/fill pads are proposed.

The assessments presented in this report are based on the locations of the proposed turbines and benched areas where BESS, substations, and operational and maintenance facilities provided by the project team that were current when the report was issued.

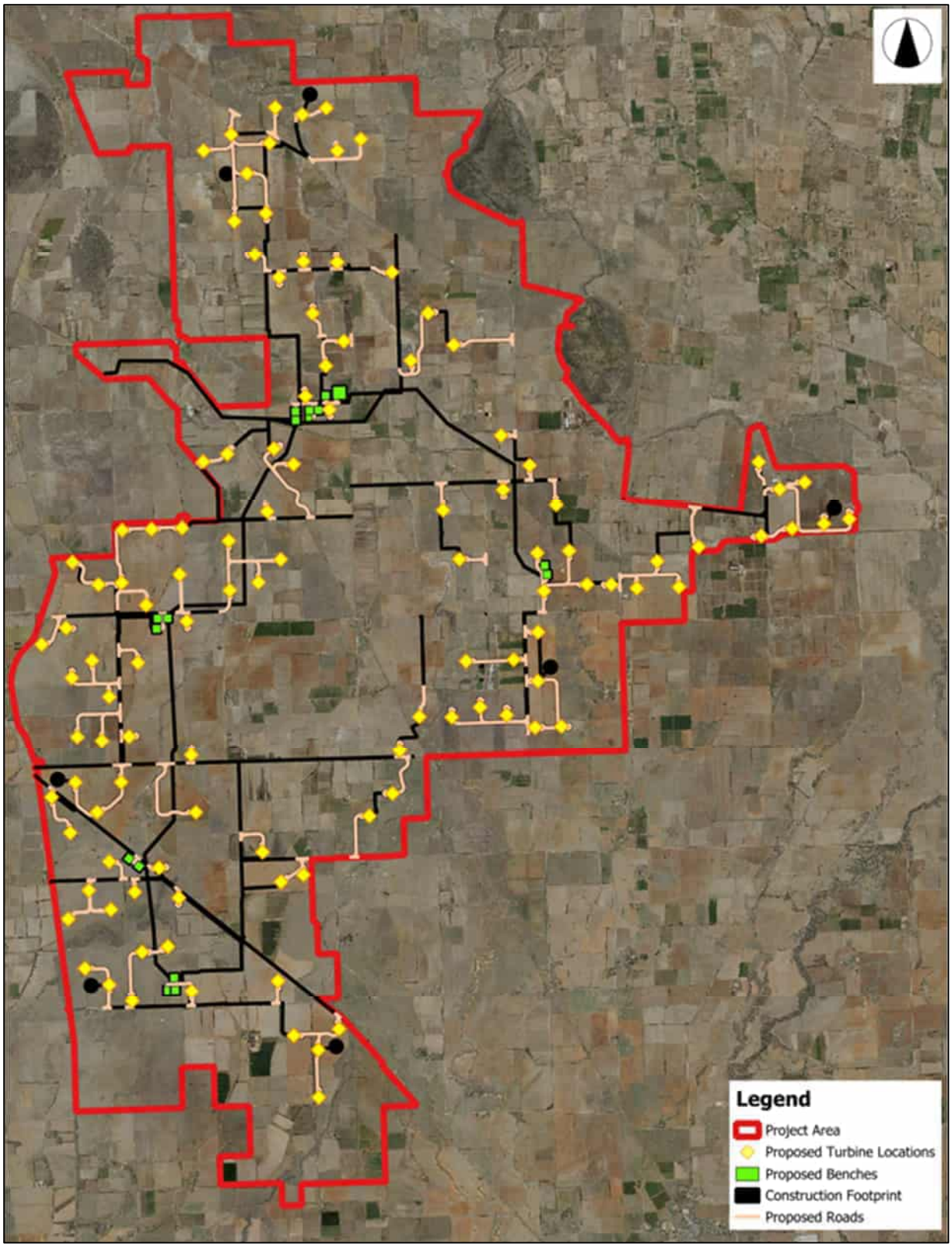

Figure 1: Location of Turbines and Areas of Construction Disturbance

2. Project Area Overview

This section of the report presents an overview of the project area of the proposed wind farm. This section provides context for later in-depth discussions.

2.1 Location

The proposed wind farm is located around Macorna, Victoria. The project area, shown in Figure 2, comprises approximately 23,000 ha. The proposed renewable energy installation is located approximately 250 km north-west of Melbourne via the Loddon Valley Highway.

A broader study area of 26,000 ha was originally investigated. The project area has been reduced by excluding Macorna township and uninvolved landowners. The project area is located across two local government areas (councils) – Gannawarra Shire Council and Loddon Shire Council. The proposed renewable energy installation is within the authority of the North Central CMA.

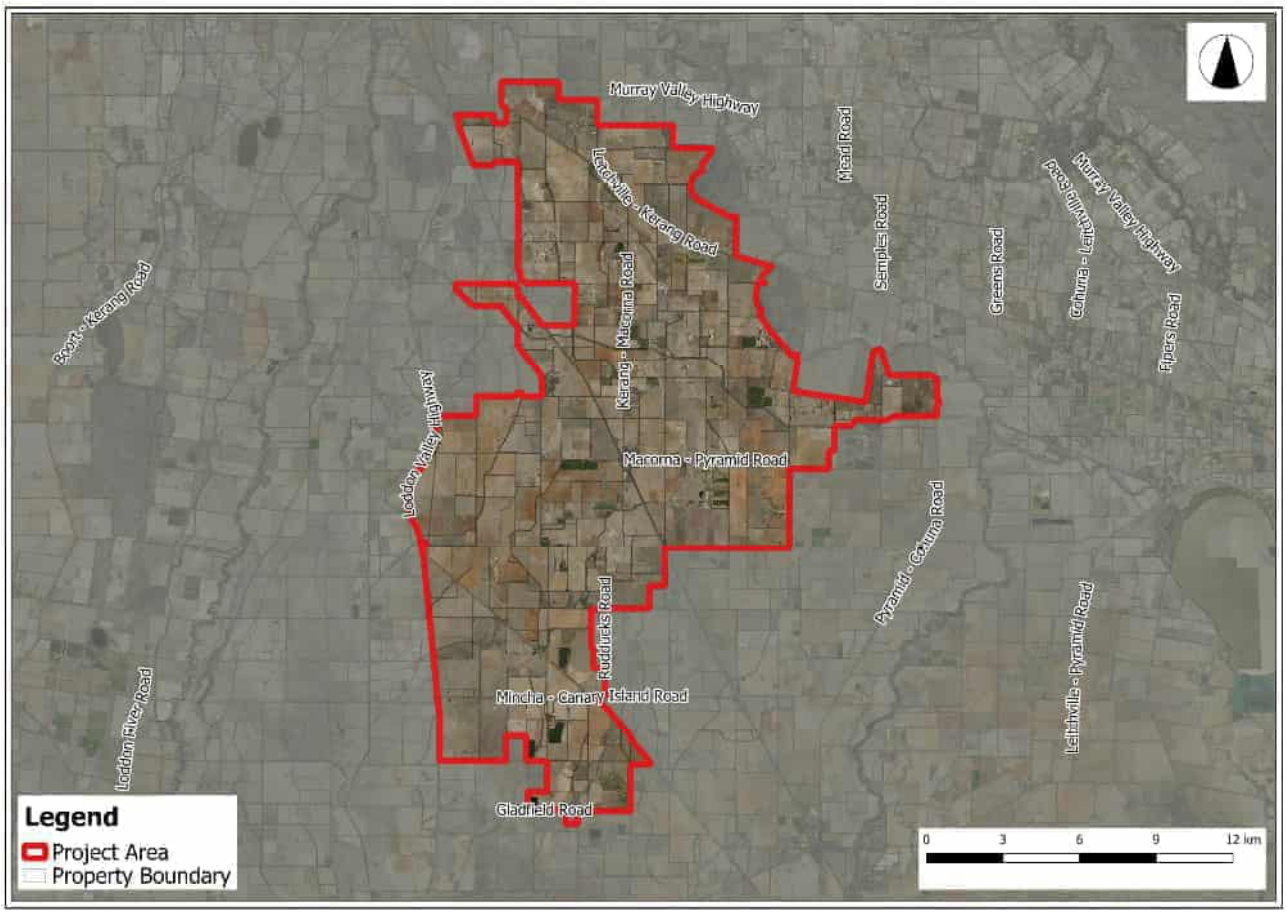

Figure 2: Project Area

2.2 Regional Hydrological Context

The project area is within the floodplain of the Loddon River, specifically the Lower Loddon River. The Loddon River has a catchment area of approximately 1,532,000 ha (15,320 km^2). Whist the project area is large, it is small relative to the wider Loddon River catchment.

Figure 3 shows a plan of the entire Loddon River catchment. The plan has been obtained from the Victorian Environmental Water Holder website (page updated December 2025; page accessed March 2026). The project area is shown indicatively (red outline) within the entire Loddon River catchment. The full-size image of the Loddon catchment is included in Appendix A.

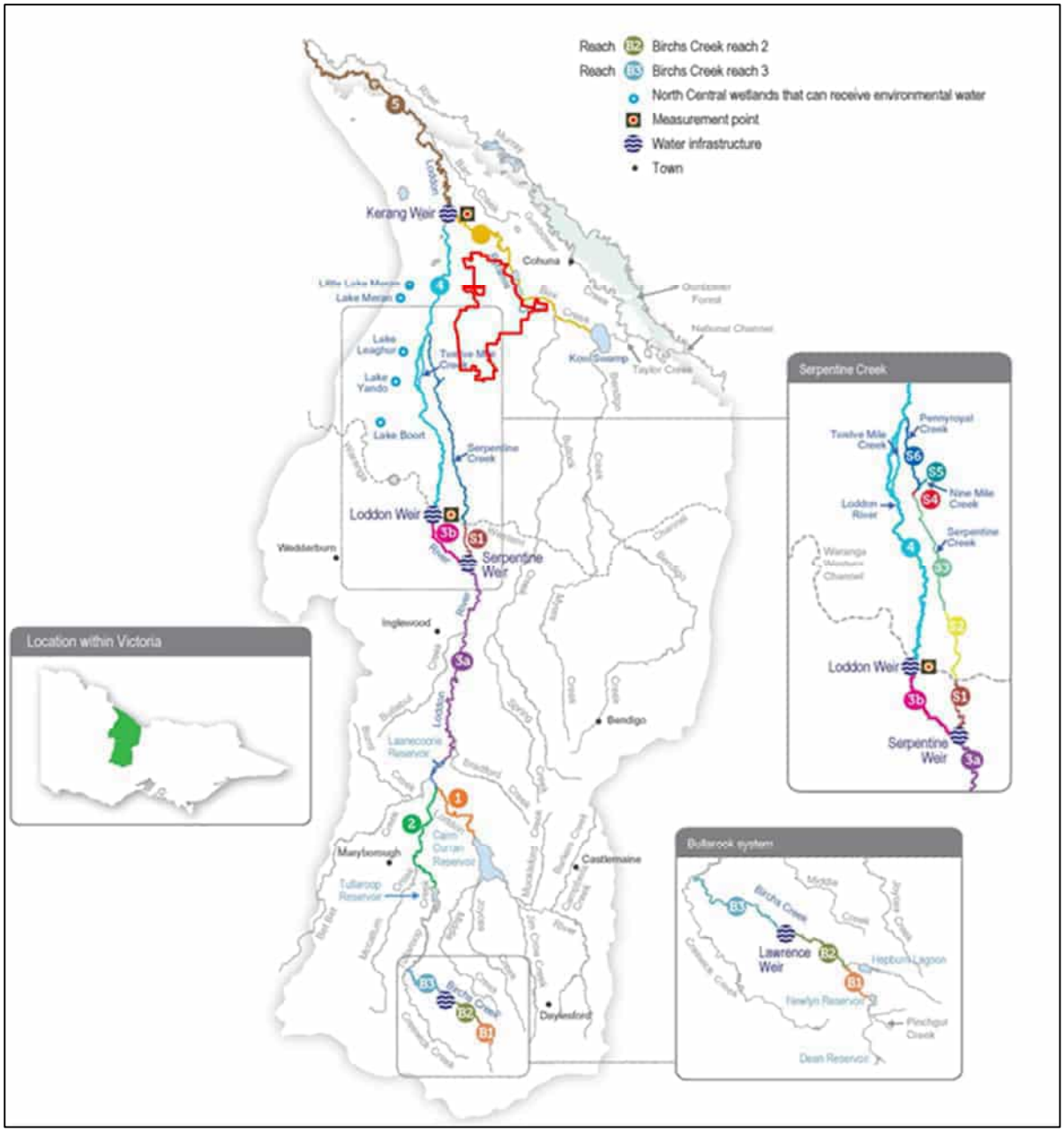

Figure 3: Loddon River Catchment with Indicative Project Area

2.3 Land Use

The land within the project area is predominantly cleared farmland with pockets of remnant vegetation. The land uses include mixed farming, dairy, grazing, and cropping. Two Ramsar wetlands, Johnson Swamp and Hird Swamp, adjoin the northeast project boundary. The project boundary directly abuts the proposed Tragowel Terminal Station.

Understanding existing land uses helps to identify areas with potential planning sensitivities, assess land access constraints, and inform engagement with relevant stakeholders. It also supports early identification of land use conflicts or constraints that may affect turbine placement or construction activities.

2.4 Planning Overlays

The project area contains existing Floodway Overlay (FO) and Land Subject to Inundation Overlay (LSIO) planning layers, indicating that the project area, particularly the southern extent of the project area, is subject to flood-related planning controls, as shown in Figure 4. In a meeting 16 January 2026, the North Central CMA advised the project team that the planning overlays relating to flooding are being revised based on new flood modelling and will likely increase from the overlays shown in Figure 4.

While FO's and LSIO's both relate to flooding, they indicate different types of flood impacts. FO's indicate areas where flood water is conveyed. Areas within FO's are generally subject to higher flood water *velocities* than adjacent areas. Development within FO's generally must continue to allow floodwaters to move across the floodplain, and structures must be protected from the higher expected velocities.

LSIO's indicate areas where flood water is stored. Areas within LSIO's experience high water levels during a flood, but LSIO's generally do not experience the higher velocities (i.e. faster flood water movement) associated with FO's. Development within LSIO's generally must ensure that flood storage volume is not removed from floodplain and that assets are protected by being raised above expected water levels.

Development within FO's or LSIO's will require assessment and approval from the floodplain manager, the North Central CMA. The CMA have indicated that obtaining approval will require ensuring the design of the proposed infrastructure maintains floodplain storage and function, and that existing distributaries (flow paths) are not adversely impacted. Section 4.2 of this report discusses potential flooding impacts in more detail and outlines key considerations that may impact the CMA's approvals process. Furthermore, the CMA has advised the project team that the FO and LSIO boundaries are currently in the process of being updated. As discussed in Section 4.2, the CMA has provided information to assist the project in managing the updated flood risk.

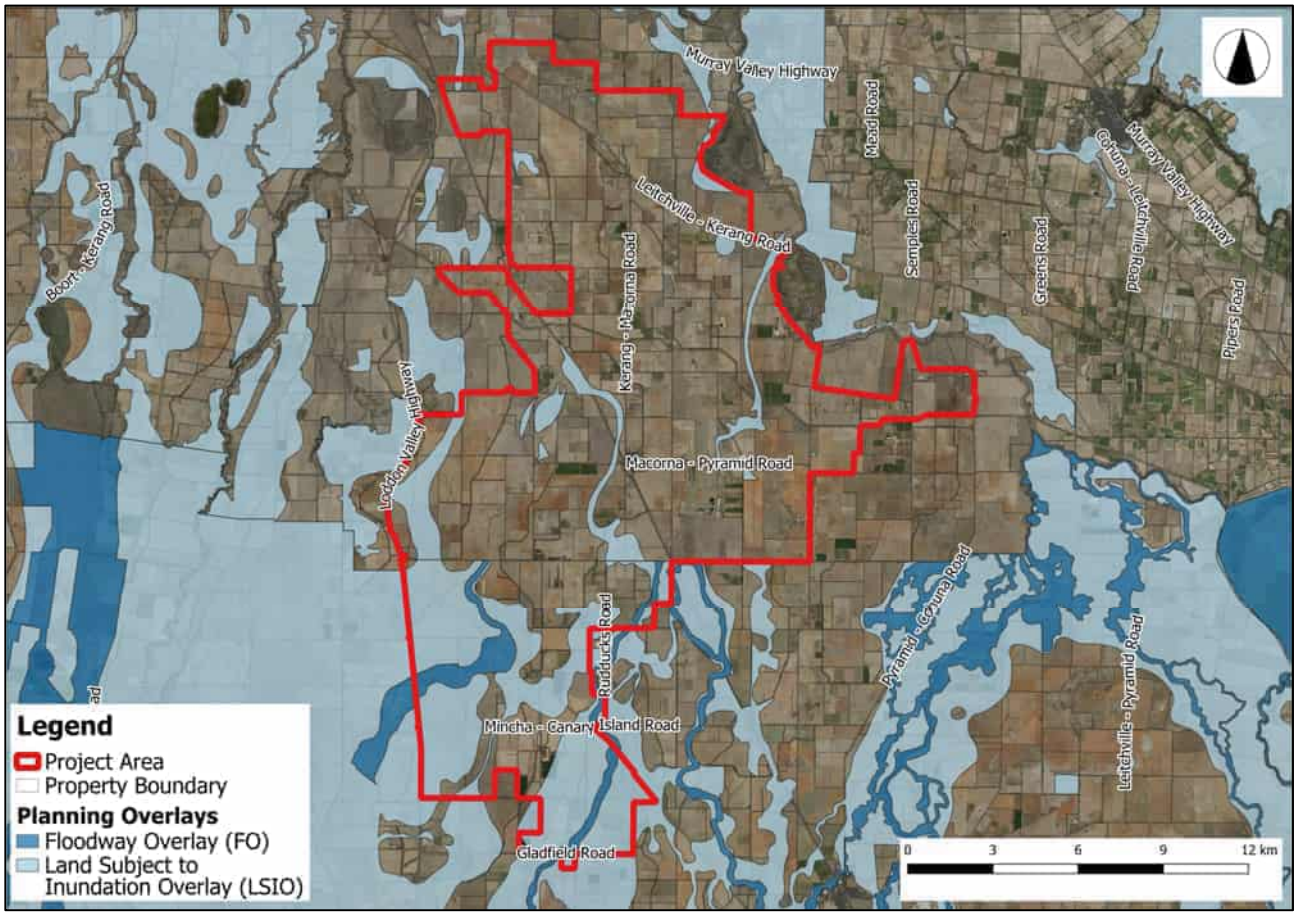

Figure 4: Existing Floodway (FO) and Land Subject to Inundation (LSIO) Overlays

3. Legislation, Policy, and Guidelines

The hydrology investigation undertaken has been undertaken based on Victorian legislation, policy and guidelines that relate to the protection of water and waterways within the project area.

3.1 Environmental Protection Act 1970

The Environment Protection Act (1970) provides the legal framework for environmental protection, including protection of waterways in Voctoria. The State Environmental Protection Policies (SEPP's), including SEPP (Waters), are allowed for under the Environmental Protection Act.

3.2 The Victorian Water Act (1989)

The Water Act (1989) is Victorian state legislation that forms the legal structure for managing Victoria's water resources. The Water Act impacts the proposed Macorna Wind Farm in the following ways:

- The Water Act tasks the responsible authority with the development and management of the regional floodplain strategy, the provision of flooding and flood-related planning controls, and the task of being the referral body for planning applications.
- The responsible authority for the project area under the Water Act is the North Central CMA. The North Central CMA is responsible for waterway protection and floodplain management within the project area.

3.3 The Catchment and Land Protection Act (1994)

The Catchment and Land Protection Act (1994) is Victorian state legislation that further defines the specific requirements for the catchment management authorities. The Catchment and Land Protection Act impacts the proposed Macorna Wind Farm:

- This act specifically states that the North Central CMA, as the referral authority, must advise on planning referrals regarding floodplain management.

3.4 State Environmental Protection Policy (SEPP) (Waters)

The Department of Environment, Land, Water, and Planning (DELWP), currently the Department of Energy, Environment, and Climate Action (DEECA), in collaboration with the Environmental Protection Agency (EPA) Victoria issued SEPP (Waters).

SEPP (Waters) defines protected beneficial uses of water resources and sets the targets for stormwater pollutant reduction to be adopted.

- States that beneficial uses of downstream waterways should be protected specifically:
    - During construction periods
    - If handling and storage of hazardous substances and chemicals occurs on a site

- States that urban stormwater must be managed to minimise the risks to beneficial uses by reducing the impacts of flow, sediment, nutrients, pathogens, toxicants, litter, and other pollutants.
- States that Councils are the responsible authority for ensuring new development meets the environmental management of stormwater as set out in the *Urban Stormwater: Best Practice Environmental Management Guidelines* (CSIRO, 1999) to minimise stormwater quantity and pollution.

3.5 Planning Amendment VC278

As of 20 January 2026, statewide planning amendment VC278 is in effect. The Amendment implements a 50-m planning policy for all waterways, at the discretion of the responsible authority.

- In a meeting with the North Central CMA 16 January 2026, the CMA advised that the 50-m buffer was applicable to the major waterways of Pyramid Creek and Calivil Creek.

3.6 Council Guidelines

Gannawarra Shire Council and Loddon Shire Council are the responsible local government authorities for the proposed Macorna Wind Farm. Separate Council guidelines relate to stormwater management and design and to stormwater quality. Stormwater management guidelines are generally applied through Council design standards. Stormwater quality guidelines are generally applied through planning controls.

Both Gannawarra Shire Council and Loddon Shire Council utilise the *Infrastructure Design Manual* (IDM) (Local Government Infrastructure Design Association, no date). The *IDM* sets consistent requirements and standards for the design of stormwater and drainage infrastructure within Victorian rural and regional councils.

- The IDM recommends providing protection to developments for events up to and including the 1% annual exceedance probability (AEP) event.
- The IDM provides guidance relating to managing peak outflows through stormwater retention systems.
- The IDM recommends passive stormwater quality treatment.
    - Grass swales are noted as providing effective treatment and runoff reduction but require protection from vehicular damage.
    - Regenerative stormwater conveyance is recommended for additional treatment and runoff reduction.
    - Specific stormwater quality treatment (pollutant reduction) targets apply to urban development. **There are no specific stormwater quality requirements for energy generation facilities**.

Both Gannawarra Shire Council and Loddon Shire Council utilise planning controls based on the Victorian Planning Provisions. Clause 53.18 – Stormwater Management in Urban Development sets stormwater quality treatment requirements.

- Clause 53.18 specifically **does not apply** to applications for development associated with the use of land for renewable energy facilities, specifically wind energy facilities.

3.7 Project Requirements

The proposed Macorna Wind Farm will be developed to achieve the requirements of all legislation that applies to hydrological management.

Floodplain impacts and waterway protections will be undertaken to standards required by the North Central CMA under the Water Act (1989) and the Catchment and Land Protection Act (1994) and in accordance with planning amendment VC278.

Stormwater management plans for BESS facilities, substations, and operational and maintenance facilities will ensure that stormwater management for this infrastructure aligns with the requirements of the IDM in terms of reducing peak outflows, safely managing stormwater, and providing appropriate protection in major rainfall events (i.e. up to the 1% AEP).

The proposed Macorna Wind Farm is not required to provide stormwater quality treatment to specific standards. However, the proposed project is required to protect beneficial uses of surface water in accordance with the requirements of SEPP (Waters).

The proposed Macorna Wind Farm will adopt passive (green) infrastructure that manages stormwater while providing stormwater quality treatment. This infrastructure will be assessed to demonstrate that it provides pollutant reduction.

While pollutant reduction targets for the project area have not been set in SEPP (Waters), the *Urban Stormwater: Best Practice Environmental Management Guidelines* (CSIRO, 1999) notes that standard pollutant reduction targets (see Table 1) are considered appropriate to protect receiving waterways in areas where no specific pollutant reduction targets apply. The passive infrastructure's stormwater quality performance can be modelled during detailed design to demonstrate the lack of impact of the project.

Table 1: Best Practice Environmental Management Guidelines Pollutant Reduction Targets

Pollutant	% Removal
Total Suspended Solids (TSS)	80%
Total Phosphorus (TP)	45%
Total Nitrogen (TN)	45%
Gross Pollutants (GP)	90%

4. Existing Condition Hydrology

The hydrology investigation has established the existing hydrology of the project area. Components of existing hydrology discussed in this section of the report include waterways, FO and LSIO planning overlays, and proximity to Ramsar wetlands.

4.1 Existing Waterways

Existing waterways within the project area and study area have been identified based on the Geoscience Australia database of regionally significant waterways (Crossman, S., Li, O., 2015, Surface Hydrology Lines (Regional), Geoscience Australia, Canberra). The existing waterways within the project area are generally heavily modified to serve both drainage and irrigation purposes.

4.1.1 Major Waterways

The project area is located between two (2) major waterways, as shown in Figure 5. The Loddon River is located to the west, and Pyramid Creek is located to the east. Both major waterways are significant within the regional waterway network. The Loddon River drains a total catchment area of approximately 1,532,000 ha (15,320 km^2), as detailed in Section 2.2. The natural catchment of Pyramid Creek is substantially smaller. However, Pyramid Creek receives managed water resources inflows from Ghow (Kow) Swamp for irrigation supply purposes. The major waterways within the study area are heavily modified and managed for irrigation and drainage.

The Loddon River and Pyramid Creek converge near Kerang, north of the proposed utility installation. After the confluence, the waterways continue north as the Loddon River, through floodplain before discharging into the Murray River, approximately 15 km north of Macorna.

The major waterways of the Loddon River and Pyramid Creek are shown in dark blue in Figure 5. Riverine flooding from the major waterways, particularly the Loddon River is an important constraint within the study area. Additional discussion of riverine flooding and floodplain is included in Sections 4.2.2 and 5.1.

4.1.2 Minor Waterways

The project area also contains numerous minor waterways. The minor waterways are shown in aqua in Figure 5. The minor waterways within the project boundary are heavily modified and managed for irrigation and drainage.

The minor waterways are part of a network of modified and natural flow paths used to convey irrigation supply and drain agricultural land. Even minor waterways with ‘natural’ flow paths have experienced historic channelisation or improvements. Discussions with the North Central CMA indicate that minor waterways are often provided with inflows from the irrigation network to achieve land management outcomes. Even ‘natural’ minor waterways support agricultural land use within the project area.

4.1.3 Minor Agricultural Waterways

The agricultural waterways and channels are shown in green in Figure 5. The minor agricultural waterways are part of a network of flow paths used to convey irrigation supply and drain land. The responsible authority for irrigation infrastructure, including channels and agricultural waterways, is Goulburn Murray Water (GMW).

Assessment of the project on agricultural infrastructure assets is outside the scope of the hydrology investigation. Nevertheless, avoiding impact on agricultural assets was included in the micro-siting process, as detailed in Section 5.4.

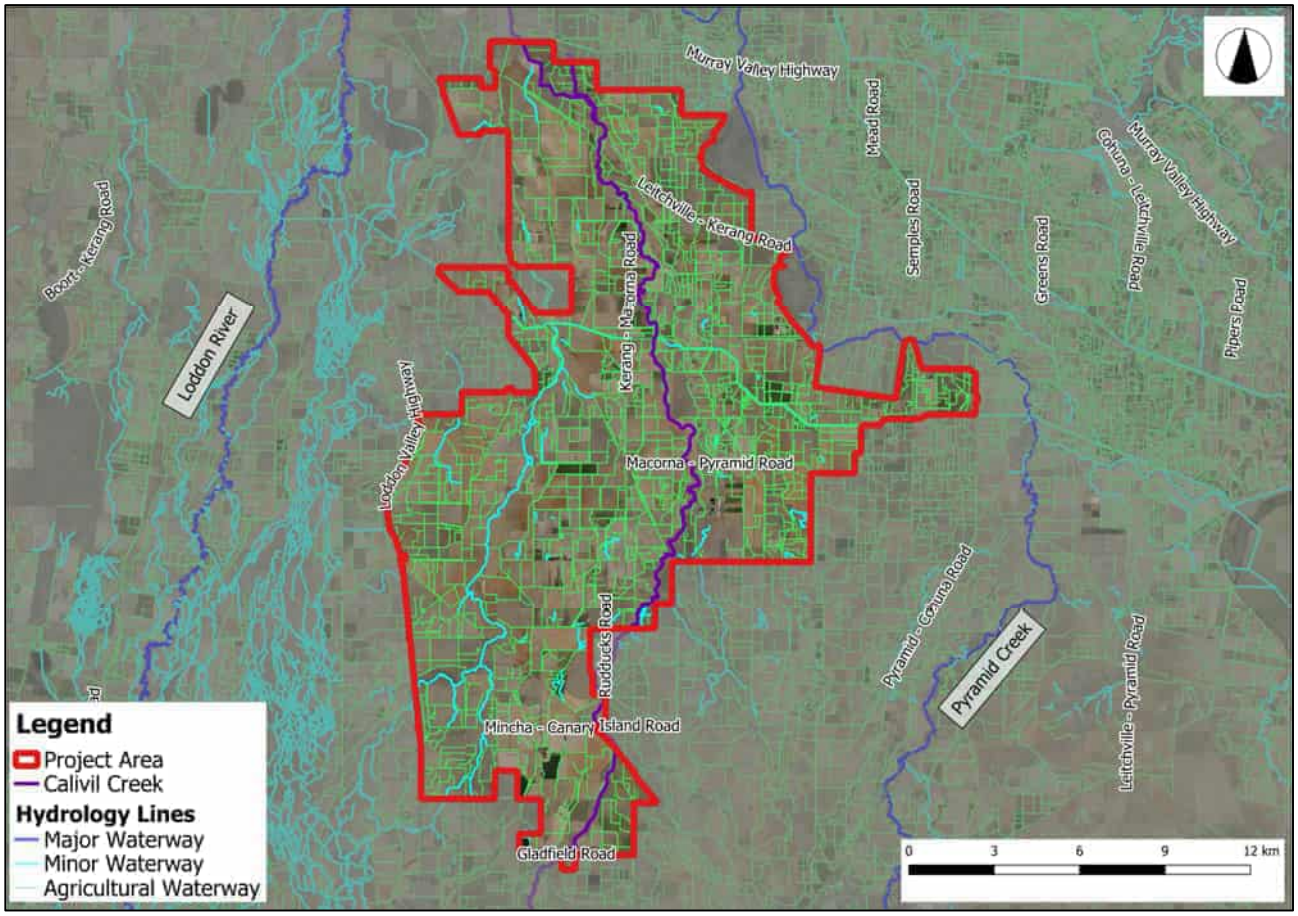

Figure 5: Existing Waterways—Major, Minor, and Agricultural

4.2 Flood Extents, Floodplains, and Associated Overlays

Development of wind energy facility and associated infrastructure which includes utility installations such as transmission and BESS can occur within FO's and LSIO's. Development within these overlays requires mitigation measures to protect the proposed turbines and proposed infrastructure outlined in section 1.2 as well as to minimise impacts to surrounding properties. The North Central CMA have advised the project team that the existing FO's and LSIO's are in the process of being updated. The CMA provided additional information so that the project team could assess the risk to assets against the latest information.

4.2.1 CMA Flood Information

To assist the hydrology investigation, the project team met with the North Central CMA. In a meeting 16 January 2026, the North Central CMA advised the project team that the planning overlays relating to flooding are being revised and will likely increase. The CMA asked the project team to adopt the flood extent and levels of the Loddon 2011 flood event in assessing and mitigating flood risk.

The Loddon 2011 flood extent and associated flood levels provided by the CMA cover a larger area than the existing FO and LSIO planning overlays. More turbines are impacted when the Loddon 2011 extents are considered. Flood levels associated with the Loddon 2011 event are higher than the levels associated with the existing planning layers. Assessing the proposed project against the Loddon 2011 event allows for a deeper understanding of the project's flood risk.

The North Central CMA provided the most recent flood modelling results, including the flood extent and levels for the historic Loddon 2011 event, to the project team for inclusion in the hydrology assessment 13 March 2026. The information provided by the CMA is representative of an actual flood event. It shows a larger portion of the project area impacted than would be inferred based on the existing overlays.

Adopting the Loddon 2011 event to define flood extents (i.e. areas of inundation) within the project area and to set anticipated 1% AEP water levels will ensure that the infrastructure associated with the proposed Macorna Wind Farm is appropriately protected. DCE recommends adopting the latest flood modelling information from CMA to inform flood mitigation measures/requirements such as freeboard to ensure adequate flood protection for the proposed wind turbines and infrastructure.

See below references to flood information provided by the CMA for the hydrology assessment:

- Figure 4 shows the project area overlaid on existing FO and LSIO extents.
- Appendix B shows plans of the project area overlaid on the 2011 Lower Loddon Flood extents, as provided to the project team by the North Central CMA.
- Appendix B shows plans of the project area overlaid on the most recent North Central CMA model of Loddon 2011 and 1% AEP flood extents that will be incorporated into an updated FO and LSIO pending model finalisation.
- Figure 7 shows the project area overlaid on both the latest (updated) 1% AEP flood extents and the 2011 Lower Loddon Flood extents, as provided to the project team by the North Central CMA.

4.2.2 Floodplain Discussion

Based on the information provided by the North Central CMA to the project team, confirmed with the CMA in a meeting 16 January 2026, and corroborated by the data provided by the CMA 13 March 2026, the floodplains within the project area are generally wide. The wide floodplains and flat grades across the project area create a flooding with unique characteristics.

The flow width and flat grades produce a floodplain where water generally moves slowly. The slow-moving nature of the floodplain was confirmed by data provided by the CMA. The maximum modelled flood velocity across the entire project area does not exceed 2.5 m/s. As detailed in the table provided in Appendix C, the maximum velocity within 10 m of a proposed turbine is less than 0.6 m/s. The low velocities and low flood depths contribute to low flood hazard rating across the project area. The CMA advised the project team that the low modelled velocities correspond with actual velocities experienced historically.

Furthermore, the wide floodplain at the project area conveys overland flood flows outside of defined waterways at shallow depths. As detailed in the table provided in Appendix C and Table 2, the average maximum flood depth within 10 m of a proposed turbine is 0.19 m, with the largest peak flood depth of 0.88 m above existing surface. The CMA advised the project team that the shallow modelled depths correspond with actual depths experienced historically. The existing shallow depths also contribute to the low flood hazard that exists across the project area.

Flood hazard is a term that describes the danger that a flood presents to life or property. It is determined by the product of the depth of flooding multiplied by the velocity of the flood water. For example, 0.19 m depth x 0.6 m/s velocity results in a flood hazard of 0.1, category H1, generally safe for people vehicles and buildings, as shown in Figure 6.

Table 2: Loddon 2011 Flood Depth ranges at each proposed turbine location

Flood Depth (m)	Number of Turbines
0	31
0-0.1	26
0.1-0.2	17
0.2-0.3	10
0.3-0.4	9
0.4-0.5	9
>0.5	12
TOTAL	**114**
Average	**0.19 m**
Maximum	**0.88 m**

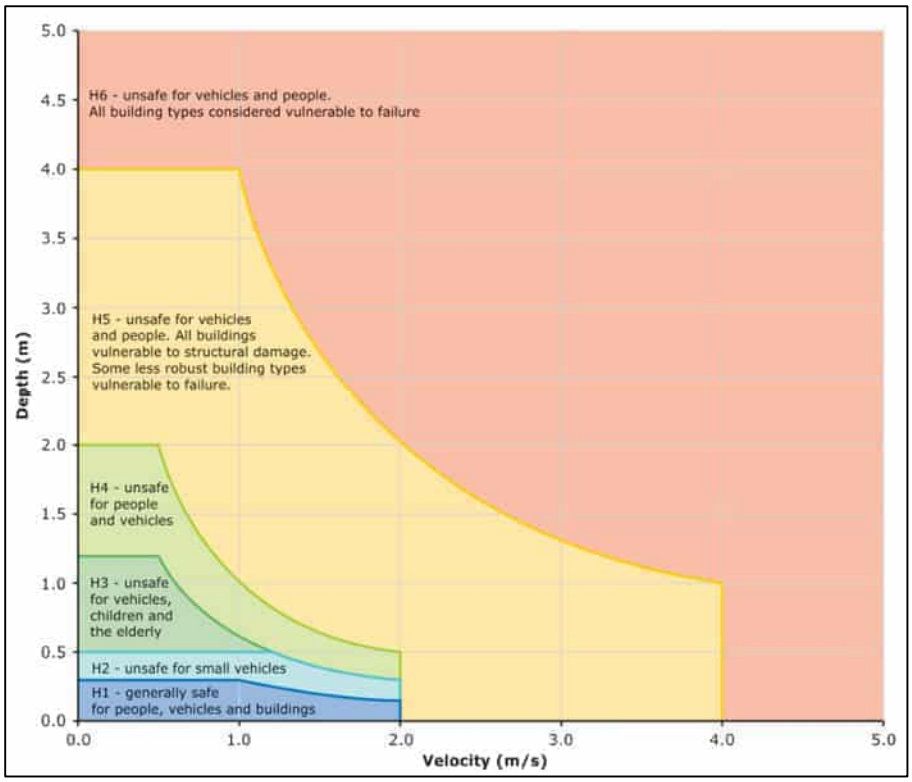

Figure 6: Flood Hazard Categories

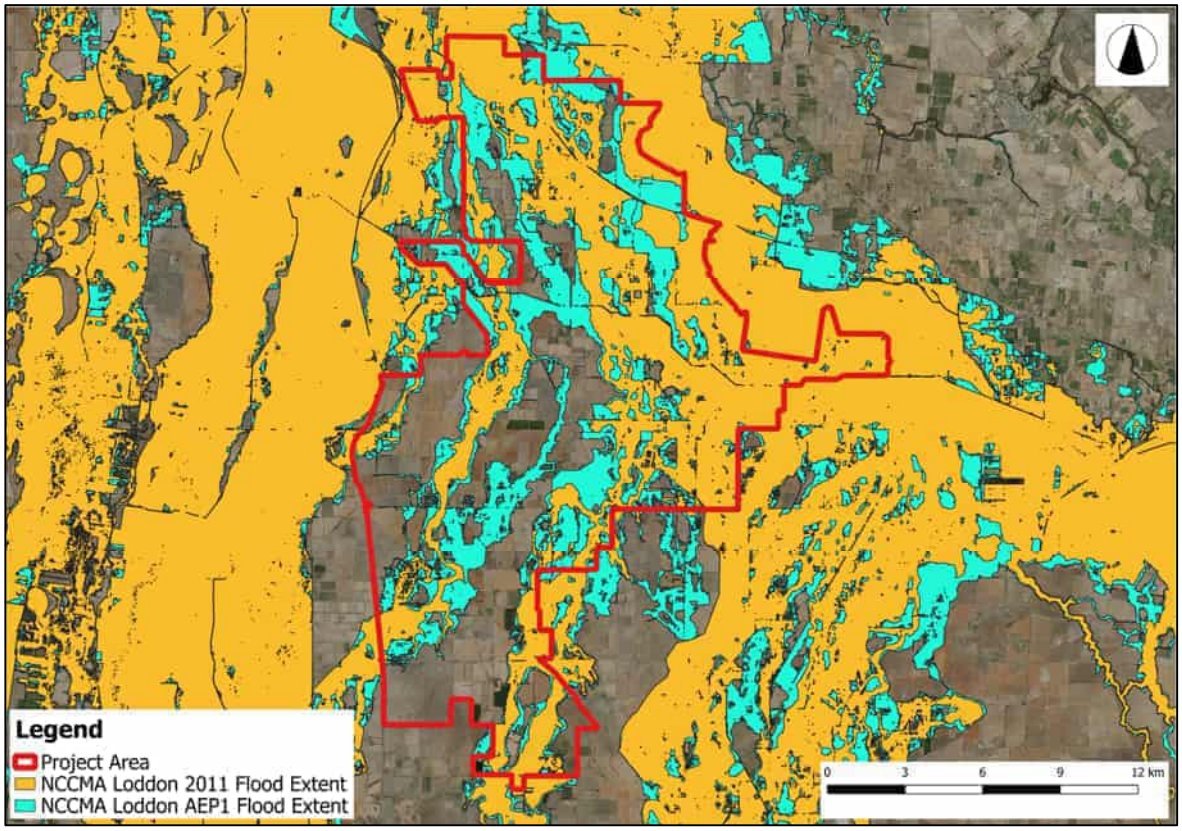

Figure 7: Project Area Overlaid on Draft 1% and Historic 2011 Flood Extents (CMA, 2026)

4.2.3 CMA Advice

In a meeting 16 January, the CMA provided the following general advice to the project team to consider regarding the proposed development:

- A cut-fill balance for the wind turbines within the proposed development is unlikely to be required.
- The proposed development should be mindful of existing flow paths (distributaries) and not alter the carefully managed flow regime within the project area.
- Fill levels must provide a minimum of 300 mm freeboard above the latest Loddon 2011 CMA modelled flood levels, noting that the Loddon 2011 levels and flood extents will, in future, become the revised planning overlays.
- The CMA requirements for electrical controls and finished floor levels must be located a minimum of 300 mm freeboard above the latest Loddon 2011 CMA modelled flood levels.
- Other requirements may apply to non-turbine infrastructure associated with the proposed wind farm development including access roads and BESS facilities.
- Turbines should have a 50-m buffer to Calivil Creek, as detailed in Section 3.5.

Meeting minutes are included as Appendix D.

4.3 Groundwater

A separate groundwater investigation, outside the scope of the hydrology investigation, has been undertaken by Douglas Partners in the *Report on Desktop Study Macorna Wind Farm, Revision 0* (Douglas Partners, August 2025). In the report, it is noted that groundwater levels across the majority of the site are within 5 m of the surface.

In the *Preliminary Hydrogeological Assessment Revision 1.0* (SLR Consulting, March 2026), it is noted that the risk of significant impacts to groundwater resources/receptors is negligible and that the site the project does not trigger the threshold for EES under ministerial guidelines with respect to impacts associated with groundwater.

4.4 Stormwater Quality and Water Quality

In the existing condition, stormwater quality and water quality in general are the result of agricultural land use across the catchment. The North Central CMA have advised the project team that environmental flows of water that would ordinarily be used for irrigation are released within Pyramid Creek and other waterways to maintain water quality in dry conditions.

There is no existing stormwater quality treatment infrastructure within the project area.

Owing to the distributed nature of the proposed wind farm, impacts on stormwater quality and water quality are likely to be low. Section 5.3.2 of this report details how risks associated with stormwater quality and water quality will be managed.

4.5 Ramsar Wetlands

Ramsar wetlands are internationally recognised for their environmental value, and development in proximity to these wetlands may trigger referral under the Environment Protection and Biodiversity Conservation (EPBC) Act 1999. The project team has advised DCE that a 2,000-m turbine-free buffer zone has been applied around Ramsar-listed wetlands. In addition, a 1,100-m buffer has been applied from access roads to Ramsar wetlands to protect the ecological integrity of the wetlands from potential impacts associated with development, including changes to hydrology, sedimentation, disturbance to bird habitat, and noise or vibration during construction and operation. The buffers, proposed turbine locations, and the area of construction disturbance, including roads, BESS, Substation, and Operational and Maintenance facilities, are shown in Figure 8. The Ramsar constraints are summarised in Table 3.

Surface water flows to the Ramsar wetlands are predominately managed through human-controlled water releases outside of the proposed project boundary. Therefore, it is highly unlikely that the proposed development of the wind farm will result in substantial changes to volume, timing, duration, or frequency of surface water flows to the Ramsar wetlands.

As noted in Section 4.4, water quality will be managed across the wind farm to maintain and potentially improve stormwater quality. If water quality is managed appropriately, it is highly unlikely that the proposed windfarm will result in substantial changes to surface water salinity, pollutants, nutrients, or water temperature within the Ramsar wetlands.

Table 3: RAMSAR Wetlands Buffer

Buffer	Application to site
2,000-m buffer	All proposed turbine locations are situated more than 2,000 m from any Ramsar wetland, including Johnson Swamp and Hird Swamp, which lie along the edge of the project area.
1,100-m buffer	All proposed road locations are situated more than 1,100 m from any Ramsar wetland, including Johnson Swamp and Hird Swamp, which lie along the edge of the project area.

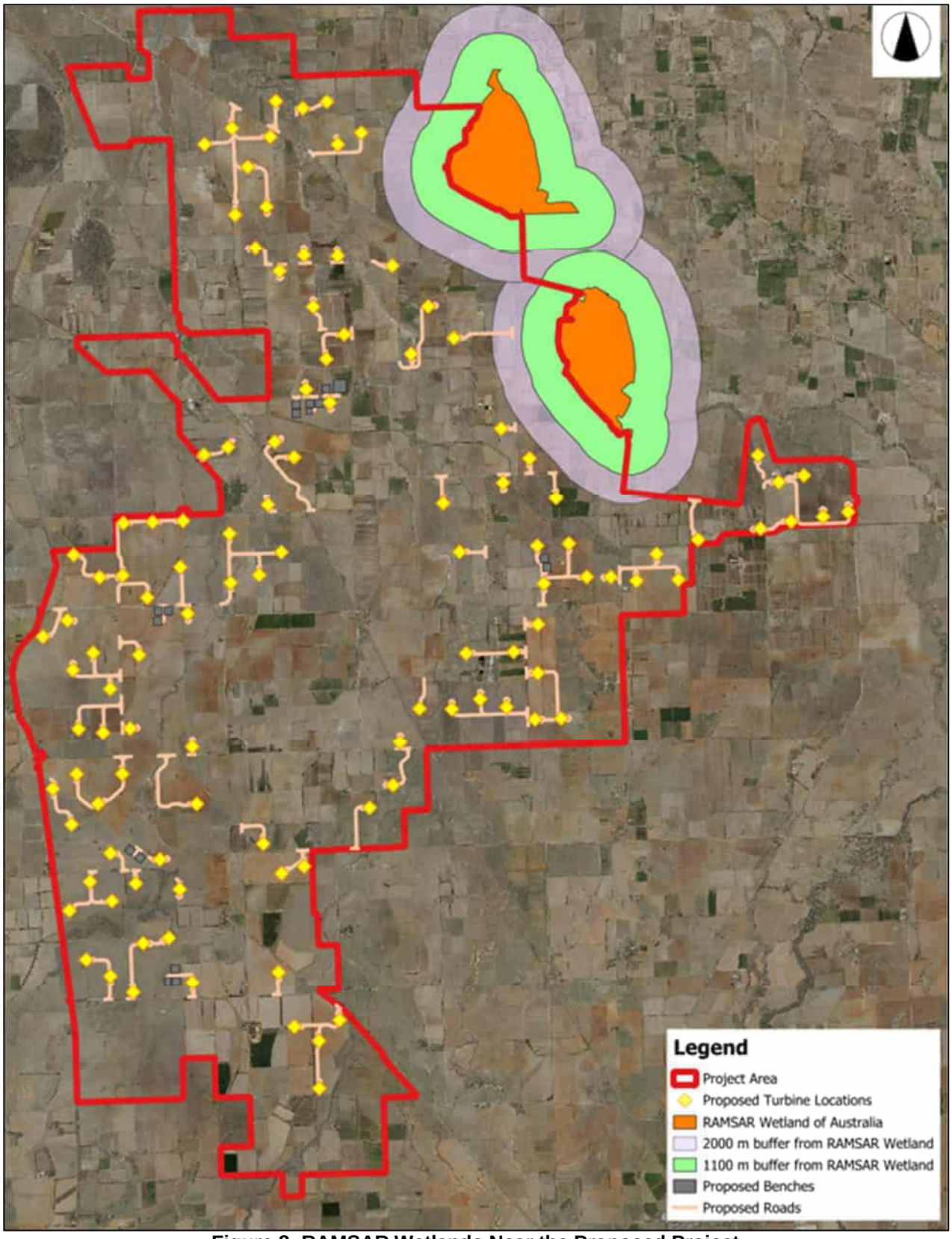

Figure 8: RAMSAR Wetlands Near the Proposed Project

5. Risks and Mitigation

In the developed condition, measures will be taken to mitigate risks to hydrology in the construction and operational phases. Furthermore, the proposed wind farm development itself has responded to existing hydrology within the project area, with design modifications adopted to minimise risk.

5.1 Waterways

5.1.1 Waterways – Risks

The risk to waterways relates to potential changes in surface water and flow in both local and major Loddon River flood events as a result of the proposed development. Potential risks to waterways include:

- Disturbance of waterways during construction
- Change in stormwater runoff directions owing to construction of assets
- Change in stormwater flow patterns owing to construction of assets
- Change in stormwater volume owing to construction of assets
- Change in stormwater quality of runoff entering waterways.

The risk to waterways is considered to be low as a result of the design choices and mitigation measures outlined below. Details of mitigation measures are included in Section 5.1.2 and Appendix E of this report.

5.1.2 Waterways – Mitigation Measures

Risk of disturbance of the waterways during construction has been lowered through a project design that applies appropriate buffers from proposed infrastructure to waterways. Turbines have been assigned buffers to major, minor, and agricultural waterways. The waterway buffers shown in Table 4 have been incorporated into the development plan for the wind farm based on the discussion with NCCMA on 16 January 2026. Appendix F shows the location of each turbine with mapped buffers to demonstrate that the adopted buffers, combined with best practice construction techniques, are appropriate to make the risk of waterway disturbance low. Layouts have been co-designed with landowners to confirm any discrepancies in satellite imagery and mapped agricultural waterways.

Table 4: Waterway Buffers

Waterway	Classification and Source	Buffer to Turbines
Loddon River	Major, Geoscience Australia	50 m
Pyramid Creek	Major, Geoscience Australia	50 m
Calivil Creek	Major, North Central CMA	50 m
Minor (non-Agricultural) Waterways	Minor, Geoscience Australia and confirmed by North Central CMA	30 m
Agricultural Waterways	Agricultural, Geoscience Australia	30 m

The risks to waterways will be managed during detailed civil engineering design through design choices in line with relevant local design standards and best practice construction techniques that

protect waterways, as summarised in Table 5. Appendix E includes additional detail regarding the proposed mitigation measures, residual risks, and remediation options.

Table 5: Waterway Risks and Mitigation Summary

Risk	Consequence	Likelihood	Mitigation Summary
Waterway disturbance	Moderate	Unlikely	Waterway buffers in design, appropriate construction techniques
Change in stormwater runoff directions	Minor	Unlikely	Ensure developed condition earthworks maintain existing flow directions and outlets
Change in stormwater flow patterns (increase in peak flows)	Minor	Unlikely	Calculate pre-and post-development stormwater peak flows, and where there are differences, use retarding basins to mitigate impact.
Change in stormwater flow patterns (increase in runoff frequency)	Minor	Unlikely	Adopt stormwater management infrastructure that promotes evaporation and infiltration of stormwater to minimise runoff frequency.
Change in stormwater volume	Moderate	Unlikely	Calculate pre-and post-development stormwater runoff volumes, and where there are differences, adopt stormwater harvesting to mitigate impact.
(Negative) Change in stormwater quality	Moderate	Unlikely	Utilise green engineering, including vegetated swales, to manage developed condition stormwater. Quantify the treatment provided against BPEM standards.

5.2 Flooding and Flood Impact

5.2.1 Flooding and Flood Impact – Risks

The risks of flooding and flood impact are related to major Loddon River flood events. Major Loddon River flooding poses risks to proposed infrastructure, construction, and existing private property. Potential risks involving flooding include:

- Damage to assets, including structural damage and damage to electrical components
- Change in flood extents that negatively impact private property
- Change in flood depths that negatively impact private property

The risk of flooding and flood impact is considered to be low as a result of the design choices and proposed mitigation measures outlined below. Details of mitigation measures are included in Section 5.2.2 and Appendix E of this report.

5.2.2 Flooding and Flood Impact – Mitigation

The risk of damage to assets forming part of the proposed Macorna Wind Farm has already been reduced through the design process. Throughout the design process, where possible, the location of turbines, roads, substations, BESS's, and operational and maintenance facilities has been modified to avoid mapped flood extents. Complete details of the micro-siting process are included in Section 5.4.

The flooding flood impact risks have been further mitigated through early liaison with the North Central CMA. The CMA have advised the project team that assets impacted by flooding should be determined based on the flood extents associated with the Loddon 2011 event. Design flood levels should be based on the modelled Loddon 2011 maximum flood levels.

Lower Loddon River flooding is flooding that can be forecast. In the latest Sate Emergency Services (SES) North West (Loddon Mallee) Region Emergency Response Plan (SES, August 2019) in is noted that:

- Bridgewater (upstream of the project area) receives approximately 11-16 hours of warning time prior to the Lower Loddon River flooding.
- Kerang (downstream of the project area) receives 4-11 days of warning time prior to the Lower Loddon River flooding.

It is expected that Lower Loddon River flooding at the proposed Macorna Wind Farm will have a long warning period of between 16 – 96 hours (0.75 – 4 days), allowing for preparation for major flood events.

The risk of destruction of or damage to assets is appropriately managed by locating sensitive components (electrical controls, etc.) above the design flood level. Assets will be designed to provide 300 mm of freeboard to modelled Loddon 2011 flood levels. It is proposed that all assets be located above natural surface and where possible. Freeboard requirements are summarised in Table 6. Individual freeboard requirements for turbines, substations, BESS's, and operational and

maintenance facilities are included in Appendix G. Appendix G also includes the mapped flood levels and peak velocities at each location to the freeboard and design considerations to mitigate flood risk.

Table 6: Freeboard Requirements

Asset Class	Recommended design level
Turbines	300 mm above Loddon 2011 flood level at each turbine
Benched Areas (BESS, Operational buildings, Substations)	300 mm above Loddon 2011 flood level
Roads	As required to achieve access requirements and local regulations.

The risks related to flooding will be managed during detailed civil engineering design through design choices in line with relevant local drainage standards and best practice construction techniques that mitigate flood risks, as summarised in Table 7. Appendix E includes additional detail regarding proposed mitigation measures, residual risks, and remediation options.

Table 7: Flood Risks and Mitigation Summary

Risk	Consequence	Likelihood	Mitigation
Change in flood extent (distributaries)	Moderate	Unlikely	Undertake flood modelling to ensure no impact
Flood inundation	Moderate	Rare	Appropriate Freeboard
Damage from fast moving flood water (velocity)	Moderate	Rare	Assessment of Flood Hazard and Appropriate Design of Structures

5.3 Water Quality

5.3.1 Water Quality – Risks

The risks to water quality relate to potential pollution of surface water as a result of the proposed development. Potential risks to waterways include:

- Increase in stormwater pollutants:
  - Total Suspended Solids (TSS)
  - Total Phosphorus (TP)
  - Total Nitrogen (TN)
- Storage and handling of chemicals onsite
- Decrease in permeability
- Sediment loading, especially during the construction phase.

The risk to water quality is considered to be low as a result of type of proposed development, design choices, and the proposed mitigation measures outlined below. Details of mitigation measures are included in Section 5.3.2 and Appendix E of this report.

5.3.2 Water Quality – Mitigation

The risk of negative impacts on water quality has already been reduced through the design process. The proposed infrastructure has small footprints, resulting in only a small area of impervious area generating stormwater pollutants. Furthermore, proposed stormwater management and drainage design for the benched areas (BESS's, substations and operational and maintenance facilities) will incorporate green infrastructure that will provide passive treatment of stormwater pollutants.

The risks to water quality will be managed during detailed civil engineering design through design choices in line with relevant local design standards, operational procedures that limit and control the storage and handling of chemicals, and best practice construction techniques that prevent sedimentation, as summarised in Table 8. Appendix E includes additional detail regarding the proposed mitigation measures, residual risks, and remediation options. There will not be an impact on surface water salinity, pollutants, nutrients, or water temperature as a result of the project.

Table 8: Stormwater Quality Mitigation Summary

Risk	Consequence	Likelihood	Mitigation
Increase in stormwater pollutants	Minor	Rare	Mitigation of pollutants through green infrastructure
Decrease in permeability	Moderate	Rare	Adopt permeable surface treatments where possible
Sediment loading in construction	Moderate	Rare	Adopt best practice construction practices to mitigate impacts

5.3.3 Water Quality Mitigation Summary

Construction activities have the potential to increase sediment loading from disturbed areas. Sedimentation during construction should be managed by standard controls including construction

of temporary sedimentation pond assets, as well as standard temporary controls including straw booms, silt fences, etc., in accordance with best practice construction methodology.

While sediment is the most common water quality concern associated with construction, there are other risks to water quality that must be managed. The presence of construction machinery adjacent to waterways introduces the potential for spills of hazardous materials. Any hazardous materials on site should be managed carefully, including use of bunding and standard controls, to ensure that they are not introduced to waterways.

A surface water management plan (SWMP) should be developed for the entire project. The surface water management plan will include measures to contain any hazardous materials associated with the construction.

A stormwater management strategy (SWMS) should be developed for the entire project. The stormwater management plan will include measures to mitigate peak flows, manage the cut and fill balance, and manage stormwater in the fully developed condition.

5.4 Micro-Siting

The risks to waterways and flood impacts are low as a result of the project's team commitment to micro-siting. Micro-siting has been undertaken during the concept stage of the project. Turbine placement has been adjusted, and in some cases, turbines have been removed where they were proposed in areas that, upon investigation, proved unsuitable.

Between August 2025 and present, turbine location has been shifted to ensure they are located with an appropriate distance to waterways. Five (5) turbine locations have been moved to ensure turbines are at least 30 m from agricultural waterways. As shown in Appendix F, micro-siting has been undertaken to assess turbine locations in the vicinity of agricultural waterways. In the instances documented in Appendix F, the turbine locations in the vicinity of agricultural waterways were investigated but did not require adjustment.

Between August 2025 and present, some turbine locations have been shifted to remove turbines from the FO and LSIO. Whist not every turbine is suitable for removal, turbines within the FO were reduced by 50% (from 2 to 1) and turbines within the LSIO were reduced by 24% (from 41 to 31). Substation siting was also adjusted to remove these sites away from FO and LSIO extents as far as practicable.

Prior to provision of flood modelling results data by the North Central CMA in March 2026, the North Central CMA provided a mapped flood extent based on superseded modelling data and the flood extent from the Lower Loddon floods of 2011 to assist the project team in micro-siting. Between August 2025 and present, turbine location has been shifted to remove turbines from the flood extents provided by the CMA. Whist not every turbine is suitable for removal, turbines within the superseded flood extents were reduced by 36% (from 66 to 42) and turbines within the historic Lower Loddon 2011 flood event were reduced by 27% (from 106 to 77).

Further avoidance and micro siting will be considered upon finalisation of the revised FO/LSIO by NCCMA.

Table 9: Micro-Siting Impacts on Development Plan

Risk	Action	Risk Reduction
Turbines within 30 m of agricultural waterways	Shift turbine location	100% reduction in turbines within 30 m of agricultural waterways
Turbines within FO	Shift turbine location	50% reduction in turbines within FO
Turbines within LSIO	Shift turbine location	24% reduction in turbines within LSIO
Turbines within 2011 Lower Loddon Flood Extents	Shift turbine location	27% reduction in turbines within the Lower Loddon 2011 flood extents
Substations within FO/LSIO	Shifted substation locations where practicable	40% reduction in substations with the Lower Loddon 2011 flood extents

6. Additional Investigation—Ramsar Wetlands

DCE undertook additional hydrological investigations to support the wider project team. The investigations relate to assessment of wetlands. Specific impacts on Ramsar wetlands were investigated. Note that buffers to Ramsar wetlands are discussed in section 4.5 and stormwater quality mitigation measures are discussed in section 4.4.

Ramsar wetlands are internationally recognised for their environmental value, and development in proximity to these wetlands may trigger referral under the Environment Protection and Biodiversity Conservation (EPBC) Act 1999. Details of buffers to Ramsar wetlands are included in section 4.5.

The proposed wind farm will not result in a measurable change in the hydrological regime of the Ramsar wetlands. The individual turbines and any ancillary infrastructure related to the wind farm will provide mitigation to ensure that surface water flows are not impacted because of development. Furthermore, surface water flows to the Ramsar wetlands are predominately managed through human-controlled water releases outside of the proposed project boundary. **Therefore, there will be no measurable changes to volume, timing, duration, or frequency of surface water flows to the Ramsar wetlands because of the proposed project.** Existing stormwater connections are to be maintained by incorporating the mitigation measures detailed in Section 5.

The proposed wind farm will not result in a measurable change in the water quality of the Ramsar wetlands. There will not be an impact on surface water salinity, pollutants, nutrients, or water temperature as a result of the project. Stormwater quality management will be incorporated into the design of any proposed wetland. Appropriate construction techniques to best practice standards must be adopted to protect downstream waterways and wetlands. The proposed wind farm, with appropriate operational procedures, will have minimal potential impact on Ramsar wetlands through changes to water quality.

7. Additional Investigations—Potential Brolga Breeding Habitat Wetlands

7.1 Potential Brolga Breeding Habitat Wetlands Investigation Timeline

The proposed wind farm falls within the Brolga area of interest as defined by the Victorian Department of Energy, Environment, and Climate Action (DEECA). DCE was engaged to undertake multiple investigations of wetlands within the project area and the wider investigation area, the area within 5 km of the project boundary, to assess if the wetlands met the inundation requirements for brolga breeding habitat. The decision as to if the wetlands are potential brolga breeding habitat will be made by a specialist environmental consultant. DCE's two additional investigations into potential brolga breeding habitat wetlands were:

- Initial Investigation—January 2026
    - LiDAR data processing to identify any wetlands that are not already DEECA-mapped wetlands
    - Hydrology investigation of suitable wetlands to identify which wetlands have been inundated July-December during the previous 10 years.
- Follow-up Investigation—February 2026
    - Detailed assessment of wetlands of interest to the environmental consultant including:
        - Assessment of wetland boundaries based on LiDAR data and flood extents.
            - Breakdown of larger depressions into smaller wetlands for individual assessment.
        - Assessment of areas supporting vegetation that may be wetlands
        - Review of typical conditions, flood conditions and expected inundation frequency of the wetlands identified in the Nature Advisory document 24129.04_Wetlands of interest_MH_260205.docx received by email 5 February 2026.

DCE's initial investigation is documented completely in the excerpt from Revision B of this report included as Appendix H. A summary of the initial investigation is included within this project report. The follow-up investigation from February 2026 is also documented in Appendix H.

7.2 Potential Brolga Breeding Habitat Wetlands Investigation Summary

DCE initially reviewed 1042 potential brolga breeding wetlands:

- 4 identified DCE's potential wetlands, from the terrain identification process were identified as irrigation channels not wetlands.
- 937 DEECA wetlands were either smaller than 0.1 ha in size, saline water unsuitable for Brolgas or determined to be a farm dam and not wetlands.
- 3 identified DCE's potential wetlands, from the terrain identification process were identified as farm dams not wetlands.
- 6 DEECA wetlands were found to no longer exist.
- 52 DEECA wetlands were found to be hydraulic linked to major waterways, and their inundation was determined based on historical data.

- 35 DEECA wetlands were modelled in MUSIC to determine if they had the potential to be inundated for >120 days between July-December. 32 of the 35 were modelled with the >120 days of inundation due to the high rainfall from 2017.
- 5 DEECA brolga habitats from the habitat model were reviewed in greater detail and broken down in the follow-up investigation from February 2026 is also documented in Appendix H.

Following initial review DCE reviewed 35 in more detail and found that all 35 wetlands of interest flagged by Nature Advisory are likely to have retained water at some depth for 120 days between July and December through a combination of typical (but wet) and flood conditions.

Further consideration of potential brolga breeding habitats is documented in *Macorna Wind Farm Flora and Fauna Assessment, Nature Advisory, April 2026.*

8. Conclusions and Recommendation

8.1 Conclusions

This desktop investigation has assessed hydrology and stormwater management risks associated with the proposed Macorna Wind Farm. The investigation notes:

- Risks to hydrology and stormwater have already been minimised through a thorough assessment of existing conditions and early engagement with the North Central CMA.
- Micro-siting has been undertaken to reduce risks by modifying the proposed design.
- Risks associated with the proposed project can be managed through mitigation measures as summarised in Section 5 and detailed in Appendix E.

The design of the project, combined with the proposed mitigation measures will ensure that:

- Waterways, wetlands, estuaries, and marine environments are unlikely to be affected.
- Streamflows are unlikely to be affected.
- Environmental values linked to surface water flow regimes and quality are unlikely to be affected.

The proposed Macorna Wind Farm's impacts on hydrology and surface water, in combination with the mitigations recommended in Section 5 and detailed in Appendix E, does not have potential to:

- Effect long-term change to the ecological character of wetlands listed under the Ramsar Convention or in *A Directory of Important Wetlands in Australia.*
- Have extensive or major impacts on the use and environmental values of water resources due to changes in water quality, water availability, stream flows, or water system function.

Atmos Renewables will continue to consider flood hazard and will undertake relevant assessment works during the detailed design process.

8.2 Recommendation – Continue to Work with the North Central CMA

The project team has been assisted in the hydrological investigations by data and advice provided by the North Central CMA. Micro-siting and proactive risk mitigation has occurred based on the Loddon 2011 flood modelling results data provided by the North Central CMA. The CMA have advised that the flood models used to obtain the results shared with the project team are available to be shared. The CMA have advised that they are in the process of obtaining the models from the consultant who prepared them. Once obtained by the project team, the models should be used to determine and mitigate specific flood impacts of areas with larger footprints such as BESS's, Substations, and Operational and Maintenance facilities.

Appendices