CHAPTER 8- WATER

Table of contents

Table index

Figure index

8. Water

This chapter provides a summary of the water-related assessments for the project, including surface water hydrology and quality, watercourse stability, flooding and groundwater. It describes the existing water environment, including surface and groundwater conditions, water sources and flooding; identifies potential impacts of the project during construction, operation and decommissioning; and provides measures to mitigate and manage the impacts identified.

The main potential for impacts on water would occur during construction. The surface water assessment concludes that, with the implementation of the proposed mitigation measures, there would be minimal potential for impacts on watercourse hydrology, stability and water quality. With respect to groundwater, the predicted impacts are consistent with the minimal impact considerations of the *NSW Aquifer Interference Policy* (Department of Primary Industries (DPI) Office of Water, 2012) and no groundwater mitigation measures are required under the policy. The assessment also confirms that the proposed use of regulated water sources for construction water would not affect water availability within the relevant water sources.

The assessment of potential changes to flooding behaviour concluded that construction-related effects would be generally limited and localised to immediately upstream of the construction right of way and downstream at stockpile gaps. No broader changes to flooding patterns were identified, and there is no anticipated risk to public safety, residences or key infrastructure. The assessment concluded that operation and decommissioning would not result in any changes to flooding behaviour.

Further information is provided in Technical Report 3 (Flooding) and Technical Report 4 (Water).

8.1 Approach

8.1.1 Overview

An assessment of the potential impacts during construction, operation and decommissioning on water involved consideration of a range of legislation, statutory instruments, guidelines and policies.

The assessment of the potential impacts on surface water quantity and quality has been undertaken with reference to key guidelines, including the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Governments (ANZG), 2018) (the ANZG Guidelines) (which integrates and updates the earlier ANZECC/ARMCANZ (2000) guidelines) and the *NSW Water Quality and River Flow Objectives* (Department of Environment, Climate Change and Water (DECCW), 2006) (the NSW Water Quality Objectives). The ANZECC/ARMCANZ (2000) guidelines informed the development of the NSW water quality objectives. The assessment involved a desktop review of available water quality information to determine existing water quality baseline conditions and environmental values.

Guidelines considered by the groundwater assessment included the *NSW Aquifer Interference Policy* (DPI Office of Water, 2012) (the Aquifer Interference Policy) and the *Groundwater assessment toolbox for major projects in NSW* (DPE, 2022b). Potential impacts on groundwater were considered with reference to the minimal impact considerations in the Aquifer Interference Policy.

The assessment included consideration of hydrologic processes, including rainfall and stream flows in the catchment, to inform the understanding of the existing surface water and groundwater environment. The project's estimated construction water requirements was considered in the context of available water and existing water entitlements within relevant water sharing plans. Water licensing requirements, in accordance with the *Water Management Act 2000* and the Water Management (General) Regulation 2018, have been considered in relation to potential water sources and aquifer interference.

The flooding assessment was undertaken with reference to relevant guidelines, technical publications and flood management plans, including the *Flood Risk Management Manual* (DPE, 2023a) and *Australian Rainfall and Runoff* (Ball et al., 2019).

An overview of the approach to the assessments is provided below.

Further information on the legislation, policies and guidelines considered, and the assessment methodology applied, is provided in sections 2 and 3 of Technical Report 3 (Flooding) and Technical Report 4 (Water).

8.1.2 Methodology

Study area

The study area for the surface water and groundwater assessments (the water study area) encompasses the watercourses and groundwater that would be intersected the project site, and an area of about two kilometres around the construction right of way and key construction facilities to capture the main areas with the potential for downstream surface water impacts.

The study area for the flooding assessment (the flood study area) encompasses the catchment areas of the watercourses that intersect the project site from the west of the Newell Highway, to the Namoi River to the east, and to the downstream boundary of the flood model.

The study areas are shown in Figure 3.1 of Technical Report 3 (Flooding) and Figure 3.1 of Technical Report 4 (Water).

Surface and groundwater assessment

An assessment of the potential impacts on water resources was undertaken. The results are described in Technical Report 4 (Water). The assessment involved the following key tasks:

- defining the water study area and undertaking a desktop review of available data, including data collected for the Narrabri Gas Project
- reviewing the legislation and policy context for assessing surface water and groundwater impacts and licensing requirements
- identification of sensitive receiving environments and water quality objectives for the project (outlined below)
- identification of the key features and values of the existing environment, including climate, topography, surface water (catchments, watercourses, geomorphology, water quality and water users), geology and soils, and hydrogeology
- assessment of the potential impacts on surface water, including watercourses and water quality, based on water quality sampling undertaken for the EIS and other projects, and consideration of geomorphic risk factors
- assessment of the potential impacts on groundwater, including groundwater systems, quantity and quality, groundwater users and groundwater dependent ecosystems, with reference to the minimal impact considerations of the Aquifer Interference Policy (outlined below)
- assessment of the potential impacts on existing water resources, available supply and users based on preliminary water demand estimates (water balance) for construction
- review of licensing requirements under the *Water Management Act 2000*
- identifying mitigation and management measures.

Water quality objectives

The NSW Water Quality Objectives provide agreed environmental values and long-term goals for water quality and river flow for NSW's surface waters, consistent with the national framework for assessing water quality set out in the ANZG Guidelines. The NSW Water Quality Objectives provide a flexible framework for protecting and enhancing watercourse health across diverse catchments. They are not intended to be applied as regulatory criteria limits or conditions (DECCW, 2006).

It is noted that the trigger values in ANZECC/ARMCANZ 2000 and ANZG 2018, which are referenced by the NSW Water Quality Objectives, are more applicable to permanent water bodies than the ephemeral watercourses present in the water study area (ANZG, 2020). Ephemeral systems, such as those found in the water study area, experience intermittent flow and prolonged dry periods, which can result in natural variability in water quality parameters that fall outside standard trigger value thresholds without subsequent ecological degradation. As such, the applicable trigger values may not be able to be achieved for the ephemeral watercourses in the study area.

The water quality objectives for the Namoi River (provided in the NSW Water Quality Objectives) are conservatively referenced, understanding that ephemeral watercourses are highly unlikely to achieve the specified trigger values associated with some water quality objectives (e.g. aquatic ecosystems). In recognition of this, together with the study area's climate and the short duration of construction activities, a qualitative approach has been adopted for the assessment of water quality.

The water quality objectives referenced for the assessment are summarised in Table 8.1. Other environmental values listed in the NSW Water Quality Objectives (such as drinking water, homestead water supply, primary and secondary contact recreation, and aquaculture activities) are not considered applicable as the watercourses in the study area are not relied upon for these uses. Further information about the objectives is provided in section 3.4.1 of Technical Report 4 (Water).

The water quality objective for the 'aquatic ecosystems' environmental value, together with local baseline water quality data where applicable, are conservatively considered the most relevant, based on the types of watercourses in the water study area and the application area specified by the NSW Water Quality Objectives (see Table 8.1).

Table 8.1 Water quality objectives

Environmental value	Water Quality Objective	Where the objective applies[1]
Aquatic ecosystems	Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term.	Applies to all natural waterways.
Visual amenity	Maintain the aesthetic qualities of waters.	Applies to all waters, particularly those used for aquatic recreation and where scenic qualities are important.
Livestock water supply	Protecting water quality to maximise the production of healthy livestock.	Applies to all surface and groundwaters used to water stock.
Irrigation water supply	Protecting the quality of waters applied to crops and pasture.	Applies to all current and potential areas of irrigated crops, both small and large scale.

Note: 1. As specified by the NSW Water Quality Objectives (DECCW, 2006).

Aquifer Interference Policy minimal impact considerations

Potential impacts on groundwater were considered with reference to the minimal impact considerations in the Aquifer Interference Policy. The following considerations for 'less productive groundwater sources' were used for the assessment:

- Water table – an impact is considered to be minimal where there is less than a cumulative two metre decline at any water supply work. If the impact is greater than two metres, then 'make good' provisions apply; or where the water table change is less than 10 per cent of the cumulative variation in the water table 40 metres from any high priority groundwater dependent ecosystem or high priority culturally significant site included in the relevant water sharing plan.
- Water pressure – an impact is considered to be minimal where the cumulative pressure head decline is less than two metres at any water supply work.
- Water quality – an impact is considered to be minimal where the change in groundwater quality is within the current beneficial use category of the groundwater beyond 40 metres of the activity.

Under the Aquifer Interference Policy, predicted impacts that fall below the minimal impact considerations are deemed acceptable. If predicted impacts exceed these thresholds, mitigation measures, such as 'make good' provisions, may be required to safeguard the groundwater resource and/or receivers.

Flooding assessment

An assessment of the potential impacts on flooding was undertaken and is reported in Technical Report 3 (Flooding). The assessment involved the following key tasks:

- defining the flood study area and undertaking a desktop review of available data
- reviewing the legislation and policy context for assessing flood impacts in NSW
- identifying sensitive receivers and key regional infrastructure with the potential to be flood affected, e.g. State roads/railways, residential dwellings
- updating the flood model from the *Narrabri Gas Project Environmental Impact Statement Flood Study* (GHD, 2016a) (relevant to the western portion of the flood study area) with current data and developing flood models to cover the eastern portion of the flood study area
- analysing existing flood conditions by modelling key design flood events – the one exceedance per year (1EY), 20% annual exceedance probability (AEP), 5% AEP, 1% AEP (including climate change) and probable maximum flood (PMF) events
- assessing potential changes to flooding behaviour during construction using computer modelling to compare flood conditions during the 1EY and 5% AEP events with existing conditions (further outlined below)
- identifying mitigation and management measures, if required.

Flooding impact assessment

Potential changes to flood behaviour during construction, operation and decommissioning were assessed. The construction assessment considered a conservative scenario involving a temporary, continuous spoil stockpile along the length of the construction right of way. Gaps were incorporated in the spoil stockpile at locations where trenchless construction is proposed, at watercourse crossings (with gap sizes relative to the watercourse stream order), access tracks, and a 12 metre wide gap about every one kilometre for fauna and stock movement. This is a conservative scenario, as the construction methodology includes progressive backfilling of the trench and respreading of topsoil as works advance along the construction right of way.

Given the short duration of the main construction works (about four months), flood modelling was limited to the 1EY and 5% AEP events. Larger, less frequent events, such as the 1% AEP, were not modelled due to their low probability of occurrence during the construction period (estimated at about 0.3 per cent) and over the two-year presence of the Baan Baa construction compound (about two per cent).

As the project has limited surface infrastructure with the potential to affect existing flood behaviour, no modelling is considered necessary for the operation phase.

Activities during the decommissioning phase would be limited and of short duration at any given location (typically up to about a week). As a result, these activities are unlikely to influence flood behaviour, and flood modelling is therefore not considered necessary.

8.2 Existing environment

8.2.1 Rainfall and evaporation

Mean monthly and annual rainfall and evaporation data was sourced from a number of weather stations close to the study area to understand rainfall and evaporation rates. Review of the data indicates there are seasonal variations corresponding with a relatively wet summer period (November to March) and drier winter period (April to October). Average annual rainfall varies between about 590 and 622 millimetres.

Evaporation data indicates that the study area is generally characterised by high evaporation with rates typically more than three times as high in the summer months. On average, there is no rainfall surplus in any month, with an annual rainfall deficit between about 1,416 and 1,466 millimetres. This indicates that the study area is typically subject to dry conditions.

8.2.2 Surface water

Catchments

The study areas are located in the Namoi River catchment. The Namoi River catchment, which extends from the Great Dividing Range near Tamworth to the Bowan River near Walgett, has an area of about 42,000 square kilometres. The catchment encompasses the main towns of Tamworth, Gunnedah and Narrabri. The catchment is heavily regulated, mostly via dams and weirs. No public water-related infrastructure (municipal water supply or flood mitigation dams, pipelines, weirs, or water treatment plants) is present within the water study area.

Catchments within the Bibblewindi and Pilliga East State forests are less modified than in the agricultural area in the eastern part of the water study area, where watercourses are modified with erosion berms, and small farm dams and depressions are present that influence flow patterns.

Watercourses

The project site intersects a total of 45 watercourses. This includes 33 watercourses that would be crossed by the construction right of way via trenching, three watercourses and three associated tributaries where trenchless construction is proposed, and three watercourses crossed by roads/tracks that require upgrading and/or proposed new access tracks, and three watercourses crossed by roads that require grading only.

Of the 33 watercourses crossed by the construction right of way via trenching, six watercourses have a Strahler stream order of three or higher. The remaining 27 are lower order watercourses, most with a stream order of one (see Figures 4.4 to 4.7 in Technical Report 4 (Water)). Named watercourses crossed by the project site are shown on Figure 8.1 and Figure 8.2.

All watercourses that cross the project site are ephemeral, which means they only flow for a short time during and after rainfall events and do not maintain a permanent flow. When flowing sufficiently, the watercourses eventually discharge into the Namoi River downstream of the study area. The stream flow characteristics of each watercourse are a result of a number of factors, including the size of the contributing catchment, climate, vegetation density, slope, geomorphology and geology, groundwater contribution and the presence of any modifying features such as erosion banks and farm dams.

The majority of watercourses contain limited habitat suitable for aquatic biota. Higher order watercourses within the water study area have a more developed channel and riparian vegetation.

Geomorphic disturbance risk

The NSW River Styles Framework has been used to describe the physical characteristics and diversity of watercourses, including an assessment of geomorphic condition and fragility. The geomorphic condition of a watercourse refers to the degree of departure, if any, from its natural state. A watercourse may be considered in good geomorphic condition if its form and behaviour are typical for its natural type and state. Conversely, a watercourse is considered in poor condition if it shows signs of instability, such as active erosion, excessive sediment deposition, channel incision or bank collapse. The fragility of a watercourse refers to its susceptibility to changes in geomorphic form when exposed to disturbances. Watercourses with a higher fragility have a lower threshold for disturbance and show more geomorphic and physical change than those with lower fragility.

The geomorphic disturbance risk is a method of combining the geomorphic condition and fragility of a watercourse that indicates its resilience to change, e.g. as a result of the project. Using this method, a watercourse reach within the study area that is in good geomorphic condition but highly fragile is assigned a higher disturbance risk. Watercourses with low fragility (more resilient) that are already disturbed are assigned a low disturbance risk. Watercourses in the western part of the study area were previously assessed as part of the Narrabri Gas Project and these findings have been used to support the assessment (GHD, 2016b). Table 8.2 provides the geomorphic disturbance risk for watercourses of stream order three or higher that would be crossed by the project site.

Table 8.2 Geomorphic disturbance risk for watercourses with a stream order of three or higher

Watercourse	Strahler stream order	Reach geomorphic condition	Reach fragility	Geomorphic disturbance risk[1]
Bohena Creek	6	Poor	High	Moderate
Bibblewindi Creek	4	Poor	Moderate	Moderate
Sandy Creek	3	Good	High – west of KP36 Moderate – east of KP36	High
Little Sandy Creek	3	Good	High	High
Tulla Mullen Creek	4	Moderate	Moderate	Moderate
Baan Baa Creek	3	Poor	High	Moderate
Curracubah Creek	4	Poor	High	Moderate

Note: 1. The table provides information on the geomorphic risk for the named watercourses shown on Figure 8.1 and Figure 8.2. Further information about geomorphic conditions and risks for other watercourses is provided in section 4.3.5 of Technical Report 4 (Water).

Surface water quality

Water quality sampling results from previous assessments undertaken for the Narrabri Gas Project, Inland Rail Narromine to Narrabri, and those undertaken for the project were conservatively compared to the water quality trigger values relevant to the water quality objectives selected for the assessment. Noting that trigger values may not be able to be achieved for the ephemeral watercourses in the study area due to natural variability, data for a number of water quality parameters did not achieve the trigger values, with the following overall conclusions:

- Sampling results for sites within catchments dominated by agricultural activities (Namoi River, Narrabri Creek, Curracubah Creek, Little Sandy Creek and parts of Tulla Mullen Creek) generally exhibited poor water quality with elevated nutrients, electrical conductivity, dissolved oxygen, turbidity and pH, which were above the nominated trigger values.
- Sampling results for sites within the State forests (Bohena Creek) generally exhibited good water quality for metals and physico-chemical parameters, except for pH and electrical conductivity, and for manganese downstream of the project site, which were above the nominated trigger values.

Surface water resources and water users

Water sources in NSW are managed via water sharing plans enacted under the *Water Management Act 2000*. Water sharing plans ensure water is provided to support ecological processes and the environmental needs of groundwater dependent ecosystems and watercourses. Water sharing plans also regulate how the water available for extraction is shared between the environment, basic landholder rights, domestic and stock rights and native title rights.

Within the water study area, surface water resources (in the Bohena Creek Water Source and the Eulah Creek Water Source) are managed under the Water Sharing Plan for the Namoi and Peel Unregulated Rivers Water Sources 2012. Surface water resources to the east of the water study area (in the Lower Namoi Regulated River Water Source) is also relevant to the proposed construction water supply options (see sections 3.6.4 and 8.3.4). This water source is managed under the Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016.

There are eight downstream surface water users, licensed to take water from the Eulah Creek Water Source and Lower Namoi Regulated River Water Source. These licensed users are located between about three kilometres north of and 500 metres east of the project site, adjacent to the Namoi River. Five of the licensed uses relate to irrigation use, two for conveyancing and one for water supply. In addition, there are other surface water uses associated with basic landholder rights that allow landholders to capture and store water in dams on their property.

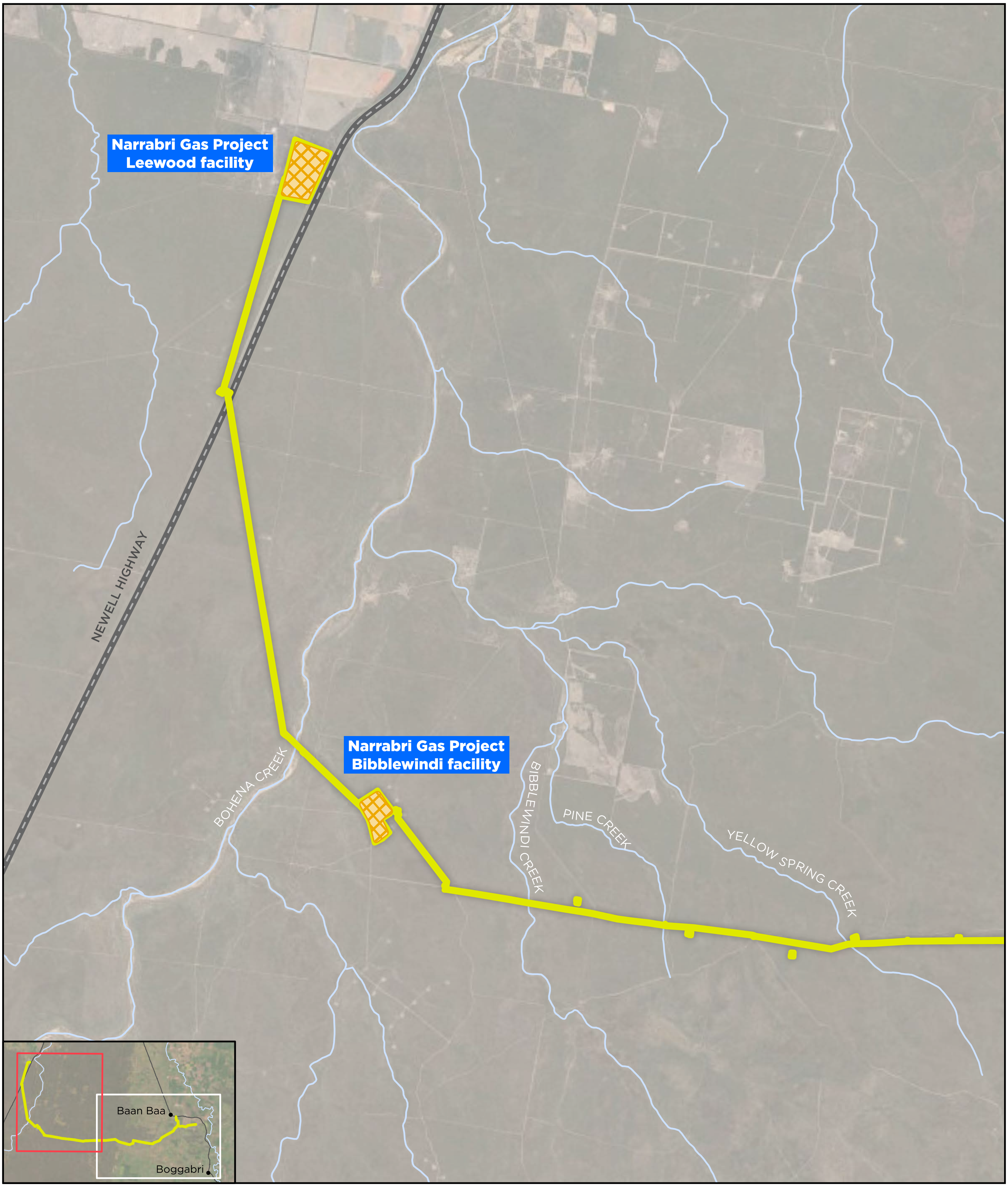


Figure 8.1 Watercourses – map 1

Legend

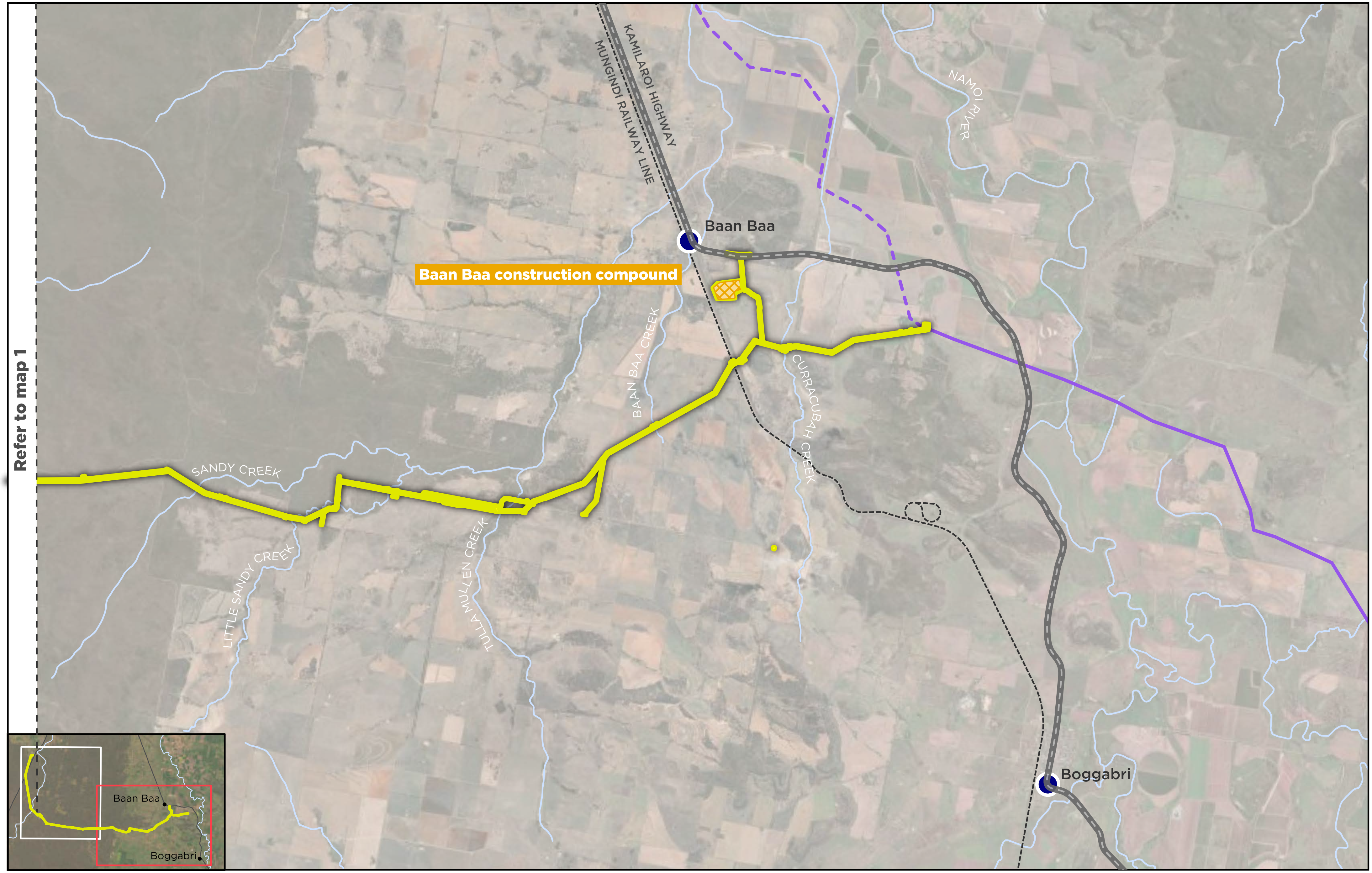
Project infrastructure: Project site; Construction facility

Highway; Watercourse

Data source: Roads, Rail, watercourses - DCS2024; State Forest - Forestry 2024; Hunter gas pipeline - Santos 2023; World Imagery: Earthstar Geographics.

0 1 2 3 4

Kilometres



Santos | HUNTER GAS PIPELINE

Data source: Roads, Rail, watercourses - DCS2024; State Forest - Forestry 2024; Hunter gas pipeline - Santos 2023; World Imagery: Earthstar Geographics.

Legend

Project infrastructure: Project site; Construction facility

Stage 2 Hunter Gas Pipeline – Indicative pipeline route; Stage 3 Hunter Gas Pipeline – Indicative pipeline route

Town; Highway; Railway line; Watercourse

Figure 8.2 Watercourses – map 2

0 1 2 3 4
Kilometres

8.2.3 Groundwater

Groundwater systems and characteristics

Groundwater occurs in shallow alluvial and colluvial sediments along watercourses, with greater thickness in higher order streams like Bohena Creek (stream order 6) and less for lower order watercourses such as Pine Creek (stream order 1). These unconfined, permeable formations are recharged by rainfall and river leakage and drain into the underlying rock formations to recharge deeper groundwater systems.

Groundwater depths in shallow alluvial and colluvial sediments range from about one metre below ground level (mbgl) at Bohena Creek to around four mbgl in Curracubah Creek. Groundwater depths within deeper aquifers include:

- Surat Basin (Orallo Formation, Pilliga Sandstone): with depths ranging from 21.1 to 67.1 mbgl
- Gunnedah Basin (Garawilla Volcanics, Clare Sandstone, Hoskissons Coal): with depths ranging from 19.2 to 33.5 mbgl in the east of the water study area, and deeper in the west
- Namoi River Alluvium: with depths ranging from seven to 10.4 mbgl.

An illustration of these groundwater systems and the relevant water sharing plans is provided in Figure 4.17 in Technical Report 4 (Water).

Within the deeper groundwater sources (below 20 mbgl), groundwater quality is generally fresh to brackish and slightly acidic to slightly alkaline. Shallow groundwater of the Namoi alluvium to the east of the study area is generally fresher groundwater. These groundwater sources support stock, domestic and irrigation use.

Groundwater resources and users

There are four groundwater resources within the water study area managed under four water sharing plans:

- Upper Namoi Zone 5, Namoi Valley (Gins Leap to Narrabri) Groundwater Source – managed under the Namoi Alluvial Groundwater Sources Order 2020
- Southern Recharge Groundwater Source – managed under the Great Artesian Basin Groundwater Sources Order 2020
- Gunnedah-Oxley Basin Murray Darling Basin Groundwater Source – managed under the Murray Darling Basin Porous Rock Groundwater Sources Order 2020
- Lachlan Fold Belt MDB Groundwater Source – managed under the Murray Darling Basin Fractured Rock Groundwater Sources Order 2020.

There are 67 registered bores in the water study area – 43 for monitoring, 12 for stock/domestic use, and others for irrigation, water supply and industrial use. Most are in the Orallo Formation, Pilliga Sandstone and Namoi River alluvium. Only two bores are within 250 metres of the project site, including a bore owned by Santos and a stock and domestic bore located adjacent to the proposed site for the Baan Baa construction compound.

Eight water access licences in the study area are associated with the Upper Namoi Groundwater Source or the Great Artesian Basin Southern Recharge Groundwater Source and have a works approval.

Groundwater dependent ecosystems and springs

Groundwater dependent ecosystems rely on a supply of groundwater to support the species composition, structure and function of the ecosystem. Groundwater dependency can range from total reliance to a proportional, opportunistic use of groundwater. The Groundwater Dependent Ecosystem Atlas maintained by the Bureau of Meteorology (BoM, 2023b) identifies groundwater dependent ecosystems reliant on surface and subsurface groundwater.

There are no known or high potential aquatic groundwater dependent ecosystems mapped within the water study area. Bohena Creek is mapped as moderate potential aquatic groundwater dependent ecosystem while other watercourses and their tributaries that intersect the project site are not classified.

There are areas of low, moderate and high potential terrestrial groundwater dependent ecosystems mapped within the water study area. High potential terrestrial groundwater dependent ecosystems comprise strips and fragmented patches of riparian vegetation located on Bohena Creek, Yellow Spring Creek, Little Sandy Creek and Tulla Mullen Creek, which intersect the project site. The project site also crosses areas mapped as low and moderate potential terrestrial groundwater dependent ecosystems, including woodland and grassland areas, primarily in the eastern portion of the water study area.

The project does not intersect any mapped high priority groundwater dependent ecosystems in the water sharing plans relevant to the project.

Terrestrial and aquatic groundwater dependent ecosystems are shown on Figure 4.21 of Technical Report 4 (Water).

Two springs (65 and Hardys Spring) are located within the water study area. Spring 65 is located on the western side of the Newell Highway about 2.5 kilometres south of the Leewood facility. Hardys Spring is around 980 metres south of the project site near the eastern edge of the Pilliga East State Forest.

8.2.4 Flooding

Topography within the study area is described in section 7.2.1. The lower order watercourses crossed by the project site are generally shallow channels with unformed banks and as a result, flooding tends to quickly break out, resulting in broad-scale shallow inundation of surrounding areas.

Parts of the flood study area and project site are classified as flood prone land in accordance with the *NSW Flood Risk Management Manual* (DPE, 2023). Appendix B of Technical Report 3 (Flooding) provides detailed flood mapping of existing conditions, including flood depth, flood water velocity and flood hazard for a range of storm events.

Areas in the vicinity of the higher stream order watercourses (such as Bohena Creek, Bibblewindi Creek, Little Sandy Creek and Tulla Mullen Creek) experience more extensive flooding, including broader extents and depths during rarer flood events such as the 1% AEP event. During more frequent flood events, such as the 5% AEP event and above, areas of flooding are restricted to watercourse channels and immediate surrounds.

In terms of existing flood (or hydraulic) hazard (the potential risk posed by floodwaters to people, vehicles and infrastructure), mapping shows areas of elevated hydraulic hazard at many of the watercourse crossing locations; Curracabah Road; agricultural lands around Tulla Mullen Creek; areas around Baan Baa Creek and Curracubah Creek (and their tributaries); and parts of Baan Baa.

8.3 Construction impacts

8.3.1 Surface water

Watercourses and stream flow

The project would involve works within and around watercourses, including:

- clearing and grading works, and trenching across watercourses
- movement of plant and equipment across watercourses
- rehabilitating disturbed areas once works are complete.

If inadequately managed, the works have the potential to temporarily alter the flow regime (if ephemeral watercourses are flowing), reduce the stability of bed and banks, impact riparian vegetation and aquatic habitat (considered in chapter 6 (Biodiversity)) and contribute to erosion, sedimentation and downstream water quality impacts.

Considering the climate and ephemeral nature of watercourses within the study area, trenching of watercourses is expected to be undertaken when the watercourses are dry or pooled, and there would be minimal potential for impacts on flow regimes. If pooled water is present, appropriate dewatering methods would be implemented as defined in the construction soil and water management plan (see section 8.6).

The potential impact of trenching on watercourse stability has been considered with reference to watercourse geomorphic disturbance risk, noting that impacts would be avoided at Bohena Creek, Little Sandy Creek and Tulla Mullen Creek where horizontal directional drilling is proposed. The watercourse geomorphic disturbance risk would continue to be an important consideration for ongoing design and construction planning and in development of the rehabilitation strategy (see section 8.6).

All works within and around watercourses would be undertaken with reference to the principles in the *Guidelines for controlled activities on waterfront land* (DPE, 2022c), in combination with other measures to manage erosion as per the APGA Code of Environmental Practice and *Best Practice Erosion and Sediment Control* (IECA, 2008) (including Appendix P: Land-based pipeline construction).

With the implementation of the proposed mitigation measures (see section 8.6), there would be minimal potential for impacts on watercourse hydrology and stability.

Surface water quality

Performance against the water quality objectives

The project involves activities with the potential change downstream water quality, mainly as a result of erosion and transport of sediments into watercourses and disturbance of watercourse bed and banks during trenching activities following heavy rainfall.

Construction would involve storage and handling of materials and wastes that require appropriate management to prevent contamination of nearby watercourses. Implementation of standard measures to manage the potential for accidental spills and leaks of fuel, oils and other hazardous materials would ensure there is minimal potential for contamination to occur. The potential for impacts associated with handling hazardous materials during construction is considered in section 16.3.

The baseline water quality data indicates existing exceedances of the water quality objective trigger values for pH, electrical conductivity, nutrients, dissolved oxygen, turbidity and manganese, depending on location. Given this, the ephemeral nature of the watercourses, and the short duration of works at each crossing location, in combination with the mitigation measures proposed in sections 7.6 and 8.6, minimal potential for impacts on water quality are expected.

Dewatering farm dams

A number of small farm dams and depressions are located within the project site, including within watercourses. These would be avoided (where possible) or removed during construction. If water is present, the dams would need to be dewatered. Dewatering would remove water from the dam and transfer it to the same watercourse downstream of the project site. Dewatering activities, if not carefully managed, have the potential to mobilise sediments and nutrients, leading to increased turbidity and degraded surface water quality downstream. Any water present at the time of the works would be dewatered in accordance with the procedures in the construction soil and water management plan (see section 8.6) to ensure that any potential water quality impacts are effectively managed.

Wastewater

Hydrostatic testing would be undertaken once the pipeline is installed. Once testing is completed, the water would be reclaimed for reuse in the next test section. Following completion of testing, hydrostatic testing water would be reclaimed, tested to determine relevant water quality parameters, and beneficially reused following treatment (if required) or disposed of in accordance with relevant legislative requirements. As such, impacts on surface water quality are not anticipated.

Use of dust suppression water

The application of water for dust suppression would be temporary and localised to the active construction work area.

The water quality of potential water sources for dust suppression water (described in section 8.3.4) was compared with the water quality trigger values to conservatively assess whether any over application of dust suppression water could result in water quality impacts if runoff into surface waters (and drainage to groundwater) occurs during dust suppression activities. Considering the water quality of the potential water sources, the assessment concluded there would be minimal potential for water quality impacts should over-application of dust suppression water occur. Further information about water quality for the proposed water sources is provided in section 5.1.2.2 and Appendix C of Technical Report 4 (Water).

8.3.2 Groundwater

Groundwater resources

Potential interception of shallow groundwater located in alluvial/colluvial sediments during trenching, if it were to occur, is expected to be minor. It would also be limited to the period of construction at any watercourse, which would be short. Where pooled groundwater occurs, it would be dewatered to a downstream location within the same watercourse, resulting in no net loss of water from the system and minimal drawdown. Impacts on the groundwater table would therefore be minimal.

Horizontal directional drilling at Bohena Creek, Little Sandy Creek and Tulla Mullen Creek and adjacent unnamed tributaries may intersect groundwater (if present), at either the shallow alluvium or the underlying rock formations. The proposed construction methods would use drilling fluid and would be undertaken in way to prevent the exchange of liquids between the borehole and the surrounding geological formations. Based on the short duration of these crossings and the methods proposed, no impacts on groundwater resources at these locations are expected.

Potential impacts to deeper groundwater resources from construction water are described in section 8.3.4.

Groundwater users

As discussed above, the interception of shallow groundwater (if present) during construction would be minimal and localised, with no impacts on the local groundwater table expected. There would be no net losses to the groundwater system. As a result, the project would not impact existing shallow groundwater users.

Proposed construction water sources would be from managed resources and within respective managed sustainable licensed allocations as discussed in section 8.3.4.

Groundwater dependent ecosystems

As discussed above, there would be no net loss of water should groundwater be present in shallow alluvial/colluvial watercourse sediments. No impacts on the groundwater table or groundwater dependent ecosystems are expected.

Groundwater quality

Trenched watercourse crossings may intersect shallow alluvial/colluvial sediments. Where groundwater is encountered during excavation, it would be dewatered and directed to a downstream location within the same watercourse, avoiding potential impacts on groundwater quality. Deeper rock aquifers of the Surat and Gunnedah Basin or Namoi Alluvium would not be intersected by trenching, based on the groundwater depths outlined in section 8.2.3.

Drilling fluids used during horizontal directional drilling at Bohena Creek, Little Sandy Creek and Tulla Mullen Creek would be managed to prevent any release into groundwater, and no impacts on groundwater quality are expected from this activity.

Construction would involve storing and handling materials and wastes that require appropriate management to prevent contamination of groundwater. Implementation of standard measures to manage the potential for accidental spills and leaks of fuel, oils and other hazardous materials would ensure there is minimal potential for contamination to occur. The potential for impacts associated with handling hazardous materials during construction is considered in section 16.3.

Surface water runoff during construction, particularly while soils are exposed, may infiltrate shallow groundwater sources if not managed appropriately. However, natural infiltration processes are generally effective at filtering sediments and particulates. As such, the risk of groundwater quality impacts from any naturally occurring soil pollutants in runoff is low. This risk would be further reduced by implementing the soil and water mitigation measures in sections 7.6 and 8.6, respectively.

The application of dust suppression water from the proposed water sources is not expected to impact groundwater quality. Infiltration of this water into underlying aquifers is unlikely, and the quality of proposed water sources has been assessed as suitable for use for dust suppression.

Aquifer interference

All registered groundwater bores (excluding those owned by Santos) used for domestic, irrigation, and commercial purposes are located more than 250 metres from the pipeline alignment. Additionally, no high priority groundwater dependent ecosystems or high priority culturally significant sites are listed in the relevant water sharing plans. No impacts on the groundwater table or groundwater quality are expected at these bore locations.

As these predicted impacts of pipeline construction on groundwater are less than the minimal impact considerations of the Aquifer Interference Policy, no mitigation measures are required.

8.3.3 Flooding

Topsoil stripping and trenching would generate spoil, which would be temporarily stored as a continuous stockpiles (with gaps) along the construction right of way for reuse as backfill and rehabilitation. Modelling of the potential for these stockpiles to alter flooding behaviour was undertaken as outlined in section 8.1.2 and the results are shown on the figures in Appendix C of Technical Report 3 (Flooding).

The modelling shows that flood waters that would have otherwise travelled across the project site would be temporarily redirected and flow parallel to the stockpile to the location of the nearest gap before being discharged into downstream areas. While changes in flood depths are observed at the stockpiles (increases upstream and decreases downstream), these are generally minor and localised to the vicinity of the construction right of way and downstream of gaps in the stockpile.

The largest change in floodwater depth is observed at the Tulla Mullen Creek overbank area where a 0.7 metre reduction in flood depth is predicted and at Little Sandy Creek main channel where a 0.3 metre increase in flood depth is predicted in the 5% AEP event. Minor increases of less than 0.1 metres depth are also predicted in overbank areas near Sandy Creek and in Baan Baa and Curracubah creeks for the 5% AEP event. No changes to flood levels, peak velocities or flood hazard were observed at residential properties or key regional infrastructure locations.

Increases in flood depth up to 0.2 metres are predicted along Curracabah Road and the Mungindi railway line adjacent to the proposed Baan Baa construction compound in the 5% AEP event, noting that the road is already subject to inundation under existing conditions as demonstrated flood modelling of existing conditions (see Technical Report 3 (Flooding)). The Mungindi railway line is elevated at this location and would not be inundated.

The Baan Baa construction compound would be elevated above existing ground levels and would result in minor flood depth increases of up to 0.2 metres immediately adjacent to the proposed compound. These changes are highly localised and would not affect any dwellings or other infrastructure.

With regard to flood hazard, the modelling predicts minor changes near the construction right of way and the Baan Baa construction compound, with some small areas showing slightly increased flood hazard. Importantly, no changes are expected at any dwellings, including those in Baan Baa. Any localised increases in flood risk would be short term.

The design and construction planning will continue to be refined to ensure that the project does not materially affect flood storage capacity, flows or characteristics within and in the vicinity of the project site (see section 8.6).

8.3.4 Water balance

Water uses

As described in section 3.6.4, the main construction water requirements would be non-potable water to control dust and for use during horizontal directional drilling and hydrotesting. Based on preliminary construction planning, it is estimated that a total of about 47 megalitres of non-potable water would be required. There would be minimal requirement for potable (drinking) water to support site offices and ablutions.

Measures to minimise water use have been incorporated into the above demand estimates, including:

- reusing water from the Leewood reverse osmosis water treatment facility (if feasible)
- using a polymer in dust suppression water to bind dust particles (e.g. on stockpiles and steeper slopes), reducing the need for continuous water spraying
- reusing hydrostatic testing water for subsequent pipeline sections.

Water sources and supply

Non-potable water

Santos is developing a water supply strategy for the project that includes the following options for the supply of non-potable water:

- reusing treated water from the Leewood reverse osmosis treatment facility
- using groundwater or surface water from an existing regulated water source managed under a water sharing plan via an existing water access licence under the *Water Management Act 2000* (including Santos water access licences)
- installing/upgrading a new production bore or surface water infrastructure subject to feasibility and relevant approvals
- municipal water supplies.

The identified water sources are used for domestic water supply, irrigation and stock water. Water from the Leewood reverse osmosis treatment facility was identified to meet relevant water quality parameters. As such, the proposed use of these water sources for dust suppression is expected to be suitable.

Construction water would be sourced in accordance with the relevant approval/licensing process under the *Water Management Act 2000* and/or *Protection of the Environment Operations Act 1997* (where applicable) and would not exceed the existing long term average annual extraction limits of the water source.

The water supply strategy would include:

- further investigation of water supply options
- consideration of any impacts on water users
- confirmation of licensing requirements, and any necessary water access licences or approvals for water access, water use and/or water supply works.
- additional assessment of water quality from the potential water sources as required to confirm it is appropriate for the intended use.

Further information about the project's water requirements and water supply options, including the availability of existing water allocations from various groundwater sources and licensing requirements, is provided in section 5.2 of Technical Report 4 (Water).

As all sourced water would be within the long term annual average extraction limits, and with additional assessment of potential impacts on groundwater receptors, there would be no impact on regulated water resources.

Potable water

Potable water would be trucked to site and stored in tanks provided by the local supplier. Bottled water would be provided for drinking water.

8.4 Operation impacts

8.4.1 Surface water

The pipeline and watercourse crossings would be designed and constructed in accordance with industry guidelines and AS 2885 to prevent exposure and scouring during high-flow events. Site-specific scour protection may be installed to stabilise watercourse beds and banks, without affecting stream flow. For watercourses where horizontal directional drilling is proposed, there would be no impacts on bed and bank stability.

Reinstatement and rehabilitation of trenched watercourses would reduce the risk of ongoing erosion and sedimentation. Regular inspections of watercourse crossings would be undertaken during operation to identify the need for any additional erosion control or scour protection. Operation (including maintenance activities) would follow Santos' standard operating procedures, including spill management and the handling of hazardous materials to prevent contamination.

As a result, and with implementation of the design and construction mitigation measures provided in section 8.6, minimal potential for impacts on surface water and surface water quality are expected during operation.

8.4.2 Groundwater

The potential for groundwater impacts during operation is mainly associated with accidental spills during maintenance, which would be minimised by implementing Santos' standard operating procedures. As a result, there would be minimal potential for groundwater impacts. No impacts on groundwater sources and receptors (including water users and groundwater dependent ecosystems) are anticipated.

8.4.3 Water balance

Water requirements during operation would be minimal, limited to small volumes needed for routine maintenance activities.

Any water required during maintenance activities would be brought to site in accordance with the applicable water access licences held by Santos. Water sources are as per the approach to supplying construction water, described in section 8.3.4.

8.5 Decommissioning

At project closure, the pipeline would be decommissioned as described in section 3.8. Activities with the potential to affect surface and groundwater resources (if inadequately managed) include:

- temporary disturbance from removal of surface infrastructure, access and equipment use where required in the vicinity of watercourses
- temporary disturbance from the excavation of bell holes to undertake any cutting, capping and filling of pipeline segments under watercourses (if required by the abandonment plan)
- potential for indirect impacts associated with soil disturbance, contaminant mobilisation, changes to groundwater flow, and temporary water use or discharge.

Decommissioning activities are expected to have minimal potential to affect surface or groundwater quality and resources due to the comprehensive and structured process that governs pipeline retirement. This process ensures that potential risks and impacts (including risks to water quality and watercourses) are systematically identified, assessed and managed. Compared to construction, decommissioning activities would be more limited, localised and undertaken by a small work crew, typically completed within about a week at any given location.

Measures to manage impacts to groundwater surface water during decommissioning will be detailed in the soil and water management plan included in the decommissioning environmental management plan, which will be adapted from the CEMP. The decommissioning environmental management plan (together with the abandonment plan) would ensure effective management of potential environmental impacts, with no adverse effects on surface or groundwater quality or resources expected.

Further information about the decommissioning management plan is provided in section 20.4.

8.6 Mitigation and management

8.6.1 Approach to mitigation and management

The main potential for impacts on water systems and resources would be during construction. Potential impacts on surface water are mainly related to the trenching across watercourses and the potential mobilisation of sediment-laden water from disturbed areas, spoil stockpiles, and impacts within the bed and banks of watercourses that could affect stream stability and local and downstream water quality. A key approach to managing potential impacts on bed and bank stability would be through ongoing design and construction planning using geomorphic disturbance risk to develop effective management approaches.

As described in section 7.6, a soil and water management plan would be prepared as part of the CEMP, including the requirement for the site and activity-specific erosion and sediment control plans prepared by a suitably qualified erosion and sediment control specialist. The soil and water management plan would be prepared with reference to relevant guidelines, in particular the APGA Code of Environmental Practice, *Best Practice Erosion and Sediment Control* (IECA, 2008) and the *Guidelines for controlled activities on waterfront land* (DPE, 2022c). The soil and water management plan will also include additional measures to minimise impacts on water quality and watercourses. In addition, the rehabilitation strategy (see section 3.4.5) will include measures related to the restoration of watercourse crossings.

The preliminary water sourcing strategy proposes the use of regulated water sources from existing water access licences and approved water supply works that are available for use by Santos. This would ensure water sourcing for the project does not affect water availability within the relevant water resources.

Design and construction planning will continue to be refined to ensure that the project does not materially affect flood storage capacity, flows or characteristics within and in the vicinity of the project site.

The project is unlikely to impact on groundwater resources and predicted impacts are less than the minimal impact considerations outlined in the Aquifer Interference Policy. As a result, no groundwater mitigation measures are required.

8.6.2 List of mitigation measures

Measures that will be implemented to address potential impacts on water are listed in Table 8.3.

Table 8.3 Water mitigation measures

Impact/issue	Ref	Mitigation measure	Timing
Watercourse crossings	W1	The design of watercourse crossings will continue to be refined to avoid or minimise impacts within and around watercourses as far as practicable, having regard to the identified geomorphic disturbance risk, *Guidelines for controlled activities on waterfront land* (DPE, 2022c), *Code of Environmental Practice – Onshore Pipelines* (APGA, 2022) and *Best Practice Erosion and Sediment Control* (IECA, 2008) (including Appendix P: Land-based pipeline construction).	Design
Construction impacts on water resources, watercourses and water quality	W2	The construction soil and water management plan, which will be prepared and implemented as part of the CEMP (mitigation measure SC1), will include measures to: • manage watercourse crossings • manage any water present during watercourse crossings • manage any accidental spills and leaks of fuels and chemicals	Pre-construction, construction

Impact/issue	Ref	Mitigation measure	Timing
		• minimise the use of water • dewater any affected farm dams and depressions with water present and any groundwater inflows that may occur during trenching to the same watercourse.	
	W3	The rehabilitation strategy (mitigation measure LU8) will include measures to ensure that watercourse crossings are restored to a condition that, as far as practicable, reflects their existing physical and ecological characteristics. Restoration will be guided by the relevant requirements in section P3.8.5 (Rehabilitation of waterways) in *Best Practice Erosion and Sediment Control,* Appendix P: Land-based pipeline construction (IECA, 2008).	Pre-construction
Construction water supply	W4	The preferred water supply option/s for construction will be confirmed prior to construction. Any third party water sources proposed to be used would be sourced from existing water entitlements within long-term annual extraction limits for the water source. The purchase or transfer of tradeable water to a Santos water access licence will be completed under the NSW Department of Climate Change, Energy, the Environment and Water, and WaterNSW processes, and will be within existing long term average annual extraction limits of water sources.	Pre-construction
Decommissioning impacts on water resources, watercourses and water quality	W5	The soil and water management plan prepared and implemented as part of the decommissioning environmental management plan (mitigation measure SC5) will identify reasonably foreseeable risks relating to water resources and water quality and describe how these risks will be addressed during decommissioning.	Decommissioning
Minimising the potential for flooding impacts	F1	Design and construction planning will continue to be refined to ensure that the project does not materially affect flood storage capacity, flows or characteristics within and in the vicinity of the project site, including at Curracabah Road.	Design, pre-construction
Flooding emergency response	F2	The CEMP will include flood and emergency response measures, including protocols to manage flood risks, facilitate evacuation and support flood recovery.	Pre-construction