Santos

NARRABRI GAS PROJECT

Surface Water Management Plan

PHASE 1

0041-150-PLA-0016

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Santos

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Document review history

In accordance with consent condition D4, this document has been reviewed as follows:

Review Date	Reason for review	Reviewed by	Revision required (Y/N)

Acronyms and abbreviations

Acronym	Description
°C	degrees Celsius
µg/L	micrograms per litre
AHD	Australian Height Datum
AEP	annual exceedance probability
ANZECC	Australia and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AS/NZS	Australian Standard/New Zealand Standard
BOM	Australian Bureau of Meteorology
$CaSO_4$	calcium sulfate (gypsum)
cm	centimetre
CoC	Conditions of consent for the NGP SSD 6456
CSG	coal seam gas
DEC	The former NSW Department of Environment and Conservation
DECC	The former NSW Department of Environment and Climate Change
DO	dissolved oxygen
DPE	NSW Department of Planning and Environment
DPE Water	The Water group within DPE
DPI	The former NSW Department of Primary Industries
DPI Water	The former Department of Primary Industries Water
DPIE	The former NSW Department of Planning, Industry and Environment
dS	deciSiemens
dS/m	deciSiemens per metre
EC	electrical conductivity
EIS	environmental impact statement
EMP	environmental management plan
EPA	NSW Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EP&A Regulation	Environmental Planning and Assessment Regulation 2021
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
EPL	environment protection licence under the POEO Act
ESCP	erosion and sediment control plan
EQuIS	Environmental Quality Information System
ha	hectare
IMP	Irrigation Management Plan
IEA	Independent Environmental Audit
L	litre

Acronym	Description
m	metre
m^2	square metre
m^3	cubic metre
mg/L	milligrams per litre
ML	megalitre
ML/day	megalitre per day
ML/y	megalitre per year
mm	millimetre
NRAR	Natural Resources Access Regulator
PAL	petroleum assessment lease under the PO Act
PEL	petroleum exploration licence under the PO Act
PIRMP	Pollution Incident Response Management Plan
PO Act	*Petroleum (Onshore) Act 1991* (NSW)
POEO Act	*Protection of the Environment Operations Act 1997* (NSW)
POEO Regulation	Protection of the Environment Operations (General) Regulation 2009
PPL	petroleum production lease under the PO Act
PPLA	petroleum production lease application under the PO Act
PWMP	Produced Water Management Plan
RFO	river flow objective
RREO	Resource Recovery Exemption and Order
SEPP	State Environmental Planning Policy
SMS	Santos Management System
SWMP	Surface Water Management Plan (this document)
TDS	total dissolved solids
WM Act	*Water Management Act 2000* (NSW)
WMP	Water Management Plan
WQO	water quality objective
WTAG	Water Technical Advisory Group

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1. Introduction

1.1 Narrabri Gas Project

1.1.1 Background

Resource exploration has been occurring in the north-western area of NSW since the 1960s; initially for oil, but more recently for coal and gas. Santos NSW Pty Ltd began exploring for natural gas from coal seams in north-western NSW in 2008 and is currently conducting coal seam gas (**CSG**) exploration and appraisal activities within Petroleum Exploration Licence (**PEL**) 238, Petroleum Assessment Lease (**PAL**) 2 and Petroleum Production Lease (**PPL**) 3, located in the Gunnedah Basin about 20 kilometres (**km**) south-west of the town of Narrabri. Activities in PAL 2 have focussed on the Bibblewindi and Bohena CSG pilots, whilst recent activities in PEL 238 have focussed on the Dewhurst and Tintsfield CSG pilots.

The Narrabri Coal Seam Gas Utilisation Project (Wilga Park Power Station and associated infrastructure) operates under an existing Part 3A approval under the *Environmental Planning and Assessment Act 1979* (NSW) (**EP&A Act**). It was originally approved in 2008, with various modifications approved between 2011 and 2019. It encompasses a gas gathering system, a compressor and associated flare, a gas flow line from Bibblewindi to Wilga Park within a 10 metre (**m**) corridor with a riser at Leewood and an expansion of the existing Wilga Park Power Station from 12 to 40 megawatts.

1.1.2 Current Project

On 30 September 2020, Santos NSW (Eastern) Pty Ltd (**Santos**) obtained consent for State significant development (**SSD**) 6456 to develop the Narrabri Gas Project (**NGP**) (**the Project**). Approval EPBC 2014/7376 under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (**EPBC Act**) was granted on 24 November 2020.

The Project includes the progressive installation of up to 850 new gas wells on up to 425 new well pads over approximately 20 years and the construction and operation of gas processing and water treatment facilities. The Project area covers about 950 square kilometres (95,000 hectares) in size and the Project footprint will only directly impact about 1% of that area.

Four phases of development are defined under the consent, including:

- Phase 1 - exploration and appraisal;
- Phase 2 - construction activities for production wells and related infrastructure;
- Phase 3 - gas production operations; and
- Phase 4 - gas well and infrastructure decommissioning, rehabilitation and closure.

Phase 1 of the Project is defined in the consent as the phase of the development comprising ongoing exploration and appraisal activities in the Project area, including:

- seismic surveys;
- core and chip holes;
- construction and operation of pilot wells (up to 25 wells on up to 25 well pads across the Project area); and
- pilot well ancillary infrastructure, including access tracks, gas and water gathering lines, water balance tanks, safety flaring infrastructure, utilities and services, and environmental monitoring equipment including groundwater monitoring bores.

Santos plans to continue exploration and appraisal of the resource in the near term until a final investment decision can be made. The exploration and appraisal activities will include continued operation of Santos' existing wells, infrastructure and facilities in PEL 238 and PAL 2, and construction and operation of new core holes, pilot wells and supporting infrastructure permitted under Phase 1.

Santos' existing exploration and appraisal activities in PEL 238 and PAL 2 include:

- Tintsfield Pilot;
- Bibblewindi East Pilot;
- Bibblewindi West Pilot;
- Dewhurst North Pilot;
- Dewhurst South Pilot;
- Dewhurst northern and southern flow lines;
- Leewood Water Management Facility including ponds, the water and brine treatment plant (WBTP) and irrigation area;
- Bibblewindi Facility including gathering system, water balance tank, compressor and flare; and
- Bibblewindi to Leewood buried gas pipeline.

These exploration and appraisal activities will continue as part of the NGP. The initial, new-appraisal Phase 1 scope is a relatively minor extension to these existing exploration and appraisal activities.

The Phase 1 scope is planned to include the construction and operation of:

- 4 coreholes;
- 6 pilot wells;
- 2 deep reservoir monitoring bores (converted coreholes);
- new shallow water monitoring bores;
- associated linear infrastructure;
- seismic surveys (length and location to be determined); and
- continued operation of Santos' existing exploration and appraisal activities, including workover activities.

The full definitions of the approved activities for Phases 2, 3 and 4 of the Project are provided in the consent. Santos is not prevented from carrying out any or all of the phases concurrently, subject to the conditions of this consent.

Further details regarding the NGP, including a full overview of the regulatory framework and statutory provisions of the NGP and the current approvals, leases and licences are provided in the overarching Water Management Plan (**WMP**). Details regarding the staging of the works and the exact scope for each phase are as per the approved Field Development Plan.

1.2 Purpose and scope of the SWMP - Phase 1

This Surface Water Management Plan (**SWMP**) describes the management of surface water generated in the course of coal seam gas exploration, appraisal and production. It has been developed in accordance with the requirements of approval conditions of PEL 238; PAL 2; PPL 3; Environment Protection Licence (**EPL**) 20350 and the SSD 6456 conditions of consent (**CoC**). It applies to the management of surface water during the exploration and appraisal activities of Phase 1 of the Project only. As such, requirements and obligations applicable to subsequent phases of the Project and not relevant as such have not been considered in this Plan. Santos will implement all reasonable and feasible measures to prevent, and if prevention is not reasonable and feasible, minimise any harm to the environment that may result from surface water management activities.

It forms part of a suite of documents prepared as part of the NGP Water Management Plan under Condition B41, which consist of the following:

(i) An Erosion and Sediment Control Plan (**ESCP**), prepared in accordance with the Blue Book and identifying details including but not limited to activities that could cause soil erosion, generate sediment or affect flooding; the location, function, and capacity of erosion and sediment control structures and flood management structures; and measures to manage any effects of soil erosion, sediment transport and flooding;

(ii) A Site Water Balance, which includes but is not limited to details of the inflows and outflows in the Project area; sources and security of water supply for the life of the Project; water storage and treatment capacity; water use and management, including sharing and transfers; licenced discharge points; and reporting procedures, including the annual preparation of an updated site water balance;

(iii) A Surface Water Management Plan (this document);

(iv) A Groundwater Management Plan, which provides details including but not limited to baseline data of hydrogeology and groundwater levels, formation parameters and quality for groundwater resources; a description of the groundwater management and monitoring system; performance criteria, trigger and response levels; a program and procedures for monitoring, evaluation and reporting; and a plan to respond to any exceedances of the groundwater performance criteria, and repair, mitigate and/or offset any adverse groundwater impacts of the Project;

(v) A Produced Water Management Plan (**PWMP**), that provides detailed baseline data on produced water yield and quality, and includes but is not limited to details regarding the produced water management system; performance criteria, including trigger levels; and a program and procedures for monitoring, evaluation and reporting;

(vi) An Irrigation Management Plan (**IMP**), for managing beneficial reuse of treated water for crop irrigation and stock watering, that includes but is not limited to details regarding site selection and assessment; agreements with third parties; baseline soil and groundwater conditions and quality; a protocol for operation of the irrigation management system; and measures to manage any effects on soils structure, erosion, groundwater quality and maintain a water balance;

(vii) A Dust Suppression Protocol for managing beneficial reuse of treated water for dust suppression and construction activities including but not limited to details of site selection and assessment; baseline soil and groundwater conditions and quality; a protocol for operation of the dust suppression system; and measures to manage any effects on soils structure, erosion, surface water runoff, groundwater quality and groundwater levels;

(viii) A Managed Release Protocol for managing disposal of treated water to Bohena Creek, that includes but is not limited to details of water flows, quality and health; predicted plume dispersal; a protocol and detailed procedures for managed release; and measures to manage any effects of water quality, stream and riparian health, erosion and sedimentation

and downstream flooding. It is to be noted that it is not proposed to release to Bohena Creek during Phase 1 of the Project and as such this protocol will be developed for Phase 2 of the Project;

(ix) A Salt Management Plan (included as section 6 of the Produced Water Management Plan for Phase 1), which includes but is not limited to details of salt and other waste volumes and composition generated by the produced water management system; a program for investigating and implementing beneficial reuse options for the salt product; and a protocol and procedures for the full-cycle management of salt and salt-related waste products. It is to be noted that no salt will be generated during Phase 1 of the Project (only brine will be produced) and there is adequate storage in the existing facilities to manage this brine for Phase 1. Section 7 of the PWMP describes this proposed approach to salt management for the Project. A full stand-alone Salt Management Plan will be developed prior to Phase 2 of the Project, based on the findings of the Produced Salt Beneficial Reuse and Disposal Study required by condition B65;

(x) A Pollution Incident Response Management Plan (**PIRMP**), prepared in accordance with the Protection of the Environment Operations (General) Regulation 2009 (POEO Regulation) and which includes detailed procedures for responding to incidents, spills and leaks associated with the produced water management system; and a Dam Safety Emergency Plan for managing potential incidents and emergencies associated with produced water storages, and

(xi) A protocol to report on the measures, monitoring results and performance criteria identified above, in the Annual Review referred to in consent condition D8.

A full list of the key conditions directly applicable to this SWMP is presented in section 3.1.4. A copy of the consent conditions directly relevant to each of the other sub-plans listed above is provided in each of the individual documents.

As required by CoC B42, Santos will implement the latest revision of the WMP (including this SWMP as an attachment) once approved by the Planning Secretary.

1.3 Objectives

The objectives of this SWMP are to provide the following:

- details of the relevant statutory requirements and a description of the measures to be implemented to comply with associated limits, trigger levels; obligations, and performance criteria;
- details of any relevant commitments or recommendations identified in the Environmental Impact Statement (**EIS**) for the Project;
- a program to monitor, evaluate and report on compliance with the requirements, obligations and performance measures and criteria, and
- a program to investigate and implement ways to improve the environmental performance of the surface water management system over time.

1.4 Performance measures

In accordance with consent condition B37, Santos will ensure that the development complies with the following management performance measures related to surface water:

- maintain or improve baseline channel stability in affected watercourses;
- negligible change to surface water quality in any watercourse;
- design, install and maintain any infrastructure within 40 metres of watercourses in accordance with the guidance series for *Controlled Activities on Waterfront Land* (DPI Water, 2012);
- design, install and maintain any creek crossings generally in accordance with the relevant Fisheries policies and guidelines; and
- develop site-specific-in-stream water quality objectives in Bohena Creek in accordance with the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMCANZ, 2000) and *Using the ANZECC Guidelines and Water Quality Objectives in NSW* (DEC, 2006).

1.5 Consultation

For Phase 1, this SWMP has been prepared by a suitably qualified and experienced person in consultation with the Water group within the NSW Department of Planning and Environment (**DPE**) (generally referred to as **DPE Water**), the NSW Environment Protection Authority (**EPA**) and the Water Technical Advisory Group (WTAG).

The comments received from the Natural Resources Access Regulator (**NRAR**) [on behalf of DPE Water] on the draft SWMP (Revision C) and the attachments focussed on surface water capture in storage and diversions, which is not part of the Phase 1 scope. Further, the comments related to the early identification of future watercourse crossings to assist in the collection of baseline data.

No comments were received from the EPA on the draft SWMP.

The comments provided by the WTAG predominantly centred around the quality of treated, amended treated and bore water for dust suppression. The comments also identified a number of discrepancies between tables and a few opportunities for improvement.

Further comments were provided by DPE Water on Revision 0A of the Plan. These have been addressed within the document.

All consultation correspondence and the responses to comments are provided in Appendix A.

1.6 Structure of this Plan

Together with the suite of documents listed in section 1.2, this Plan is a supporting management plan (sub-plan) to the Water Management Plan. The Water Management Plan sets out the overall details how the documents are related and where information or details are located in the event of any overlap or commonality. The structure of this Plan is as follows:

Section 1	Provides an introduction to the Project and the context, scope, purpose and objectives of this Plan. It further provides the performance measures related to surface water
Section 2	Defines the roles and responsibilities of personnel involved with the management of surface water generated through NGP activities
Section 3	Outlines the statutory provisions relevant to the management of surface water generated by development of the NGP
Section 4	Describes the existing environment of the surface water system
Section 5	Provides details of the of any potential surface water impacts
Section 6	Details the risk assessment of potential impacts and a description of measures to be implemented to avoid, minimise, mitigate, offset, manage and/or monitor the potential impacts associated with surface water management
Section 7	Provides a brief description of the surface water management system
Section 8	Outlines the surface water monitoring program implemented across the Project
Section 9	Describes the trigger, action and response plan developed to assess and respond to abnormal conditions and to manage risks to operations and the environment
Section 10	Provides details on the process that is implemented to manage data and records in a consistent, efficient and effective manner
Section 11	Details the actions required for incidents and non-compliances related to the the management of surface waters
Section 12	Describes the reporting, evaluation and review process of this IMP, including the annual review, independent audits and environmental improvement measures
Section 13	References
Section 14	Glossary
Appendix A	Provides copies of the consultation records and responses to all comments
Appendix B	Consent conditions directly relevant to SWMP
Appendix C	Water quality trigger values
Appendix D	Namoi sub-catchment

1.7 Distribution

A copy of the approved SWMP is available to all relevant Santos personnel via the Santos intranet. In accordance with consent condition D13, the latest copy of the Plan including all associated appendices, audits and reports, and summaries of all monitoring data (where relevant), can also be found on the Project website, once these have been approved by the Planning Secretary. This information will be kept up to date.

In accordance with specific licence, approval or code of practice conditions, a copy of this SWMP is available at the Santos Operations Centre located at 300 Yarrie Lake Road in Narrabri. This is where operational and field staff commence and finish each workday.

Note that any printed copies of this SWMP are uncontrolled.

2. Roles and responsibilities

All Santos employees and contractors involved in the Narrabri Gas Project are responsible for the environmental performance of their activities and for complying with all legal requirements and obligations. Project personnel will be required to comply with approval requirements of the activities they undertake and potential environmental impacts from all activities will be managed in accordance with the Project's relevant management plan(s).

In accordance with consent condition D1, the Environmental Management Strategy (**EMS**) sets out the role, responsibility, authority and accountability of all key personnel involved in the environmental management of the Project, including the requirements and obligations in this SWMP. All roles, responsibilities and accountabilities have been assigned in accordance with Santos Management System *SMS-MS_14 People Management Standard*.

3. Regulatory requirements

The Project is permissible with development consent under the *State Environmental Planning Policy (Resources and Mining) 2021*, and is identified as a 'State significant development' under Section 4.38 of the EP&A Act and the *State Environmental Planning Policy (Planning Systems) 2021*.

The Project was subject to the State significant development assessment and approval provisions of Division 4.7 of Part 4 of the EP&A Act and approved as a State significant development under the EP&A Act and the EPBC Act.

The Project will be carried out in accordance with the:

- relevant existing development consents and activity approvals;
- the conditions of relevant tenements including PEL 238, PAL 2, PPL 3, the *provisions of the Petroleum (Onshore) Act 1991* (NSW) (**PO Act**) and relevant codes of practice;
- EPL 20350 issued by the EPA and the provisions of the *Protection of the Environment Operations Act 1997* (**POEO Act**); and the
- conditions of consent for the NGP SSD 6456.

3.1 Compliance conditions

Compliance conditions associated with the following licence(s), lease(s) and consent(s) are relevant to this SWMP:

- PEL 238, granted on 1 September 1980 and most recently renewed on 12 April 2022;
- PAL 2, granted on 30 October 2007;
- PPL 3, granted on 15 December 2003;
- PPLs 13, 14, 15 and 16, once issued;
- EPL 20350, as varied; and
- SSD 6456.

3.1.1 PEL 238

There are no specific conditions or obligations in PEL 238 related to this SWMP.

3.1.2 PAL 2 and PPL 3

Lease condition 2 of PAL 2 and PPL 3 state that activities must only be carried out in accordance with a Petroleum Operations Plan (**POP**) which has been approved by the Director-General of the Department of Primary Industries. Further, the POP must (i) identify how operations will be carried out on site in order to prevent and or minimise harm to the environment; and (ii) reflect conditions of approval under the EP&A Act, the POEO Act, and any other approvals relevant to PAL 2 and PPL 3.

This SWMP supports the POP and satisfies condition 2 of PAL 2 and PPL 3 by providing information about how Santos manages all surface water associated with the operation of its activities within PAL 2 and PPL 3.

3.1.3 EPL 20350

'Petroleum exploration, assessment and production' is a scheduled activity listed in Schedule 1 of the POEO Act). Under Section 48 of this Act, all scheduled activities are required to hold an environment protection licence. EPL 20350 is held for CSG activities in PEL 238, PAL 2 and PPL 3. The requirements for a Soil and Water Management Plan referred to in condition O6.1 to O6.4 of EPL 20350 are specifically addressed in Table B1 in Appendix B of the ESCP. There are no other specific conditions related to surface water other than those associated with the produced water storage dams and ponds, and the amended treated water storage tanks. These conditions are addressed in the PWMP.

3.1.4 Development Consent SSD 6456

There are a number of SSD 6456 consent conditions directly relevant to this SWMP for Phase 1, with the key conditions CoC B36, B37 and B41(d)(iii) provided in full below. Table B1 in Appendix B specifies where each of the requirements of all the relevant SSD 6456 consent conditions are addressed in this Plan.

Consent condition B36 states that Santos must ensure that all surface discharges from the development comply with

(a) discharge limits (both volume and quality) set for the development in any EPL or Resource Recovery Exemption and Order (**RREO**); and

(b) the relevant provisions of the POEO Act.

Consent condition B37 states that Santos must ensure that the development complies with the following surface water management performance measures:

- maintain or improve baseline channel stability in affected watercourses;
- negligible change to surface water quality in any watercourse;
- design, install and maintain any infrastructure within 40 metres of watercourses in accordance with the guidance series for *Controlled Activities on Waterfront Land* (DPI Water, 2012); and
- design, install and maintain any creek crossings generally in accordance with the *Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013) and *Why Do Fish Need To Cross The Road? Fish Passage Requirements for Waterway Crossings* (NSW Fisheries, 2003).

Consent condition B41 states that Santos must prepare a Water Management Plan for the NGP to the satisfaction of the Planning Secretary and that this plan must include a:

(d) include a:

- (iii) Surface Water Management Plan that includes:
- detailed baseline data on surface water flows and quality of watercourses and/or waterbodies potentially impacted by the development (based on at least 3 years of monitoring data, where available), including:
  - stream and riparian vegetation health;
  - channel stability (geomorphology);
  - water supply and quality for other surface water users; and
  - natural methane leaks and accumulations;
- a detailed description of the surface water management system;

- detailed plans, design objectives and performance criteria for water infrastructure, including:
  - any creek restoration works associated with the development;
  - water run-off diversions and catch drains;
  - water storages and sediment dams;
  - water discharge pipelines and infrastructure; and
  - reinstated drainage networks on rehabilitated areas of the Project area;
- detailed performance criteria, including trigger levels for identifying and investigating any potentially adverse impacts associated with the development for:
  - downstream surface water flows and quality;
  - channel stability;
  - downstream flooding impacts;
  - stream and riparian vegetation heath;
  - water supply for other water users; and
  - post-mining water pollution from rehabilitated areas of the Project area
- a program to monitor and evaluate:
  - compliance with the relevant performance measures listed in Table 7 [of the CoC], and the performance criteria established above;
  - controlled and uncontrolled discharges, including upstream and downstream monitoring at discharge sites;
  - seepage and leachate from ponds and dams containing produced water and/or brine;
  - surface water inflows, outflows and storage volumes to inform the Site Water Balance; and
  - the effectiveness of the surface water management systems and the measures within the Erosion and Sediment Control Plan;
- reporting procedures for the results of the monitoring program; and
- a plan to respond to any exceedances of the performance measures or performance criteria, and repair, mitigate and/or offset any adverse surface water impacts of the development.

3.2 Relevant codes, standards, policies and guidelines

3.2.1 Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management

The *Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management* (2013) outlines policies and guidelines aimed at maintaining and enhancing fish habitat for the benefit of native fish species. It aims to help ensure compliance with legislation, policies, and guidelines as they relate to fish habitat conservation and management. It can be used to inform land use and natural resource management planning, development planning and assessment processes. It is also a valuable tool to improve awareness and understanding of the importance of fish habitats and how impacts can be mitigated, managed, or offset. The policy lists general requirements and guidelines for developments, and provides specific requirements for the planning, design and construction of waterway crossings.

Permits for waterway crossings are not required however since Section 4.41 of the EP&A Act states that permits under Sections 201, 205 and 219 the NSW *Fisheries Management Act 1994* are not required for an SSD that is authorised by a development consent granted under Division 4.7 of Part 4 of the EP&A Act.

3.2.2 Fish Passage Requirements for Waterway Crossings

The guidance note *Why Do Fish Need To Cross The Road? Fish Passage Requirements for Waterway Crossings* published by NSW Fisheries in 2003 aims to minimise impacts on fish passage and general aquatic wildlife by providing practical guidelines to those involved in the planning, design, construction and maintenance of waterway crossings. Considerable effort has been taken to make these guidelines applicable across Australia; however, local knowledge, data and experience should always be used to enhance, modify or even replace the information presented within these guidelines.

3.2.3 ANZECC Guidelines

The Australian and New Zealand Environment Conservation Council (**ANZECC**) and Agriculture and Resource Management Council of Australia and New Zealand (**ARMCANZ**), published the revised *Australian and New Zealand guidelines for fresh and marine water quality* in 2000 (**the ANZECC Guidelines**). Potential impacts of the Project on surface water quality were assessed in accordance with methodology from the guidelines and this is the accepted standard under which to manage environmental water quality in Australia. The ANZECC Guidelines provide a risk-based framework under which water quality data may be statistically interrogated, trends analysed, and site-specific trigger values may be derived.

Although the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (the **National Water Quality Guidelines**) were published in 2018 after a scientific review of the ANZECC Guidelines, both consent condition B37 (water management performance measures) and the treated water quality criteria in Appendix 6 of the CoC refer to the 2000 version of the ANZECC guidelines. As such, the 2000 version of the guidelines applies to the Project.

3.2.4 Water Quality Objectives

The NSW Government have published online the NSW Water Quality and River Flow Objectives (the **Objectives**). The Objectives are the agreed environmental values and long-term goals for NSW's surface waters. They set out:

- the community's values and uses for rivers, creeks, estuaries and lakes (i.e. healthy aquatic life, water suitable for recreational activities like swimming and boating, and drinking water); and
- a range of water quality indicators to help assess whether the current condition of our waterways supports those values and uses.

The Objectives are consistent with the agreed national framework for assessing water quality set out in the ANZECC Guidelines. The ANZECC Guidelines provide an agreed framework to assess water quality in terms of whether the water is suitable for a range of environmental values (including human uses). The Objectives provide environmental values for NSW waters and the ANZECC Guidelines provide the technical guidance to assess the water quality needed to protect those values. Refer to section 3.2.3 that the ANZECC Guidelines have been superseded by the national Water Quality Guidelines.

The guideline is split into water quality objectives (**WQOs**) and river flow objectives (**RFOs**). The objectives are divided into categories depending on the type of stream. The Namoi River downstream of Keepit Dam is classed as a “major controlled river”, the Mooki River and all other streams near to the Project are mainly “uncontrolled streams”. The exception to this is Bohena and Baradine Creeks where headwaters are located in a “mainly forested area”.

Based on this, the WQOs for Bohena Creek are:

- aquatic ecosystems;
- visual amenity;
- primary and secondary contact recreation;
- drinking water at point of supply - disinfection only;
- drinking water at point of supply - clarification and disinfection;
- drinking water at point of supply - groundwater; and
- aquatic foods (cooked).

The RFOs for Bohena Creek are:

- protect pools in dry times;
- protect natural low flows;
- manage groundwater for ecosystems; and
- minimise effects of weirs and other structures.

Although Bohena Creek is relatively undisturbed, particularly in the area immediately downstream of the Pilliga State Forest, it also receives runoff from land disturbed to varying degrees by grazing or pastoralism and exotic species are common. Under these circumstances and in accordance with the ANZECC Guidelines, the default level of protection for 'slightly to moderately disturbed systems' is considered appropriate to meet the management goal of maintenance or improvement of ecological conditions.

The WQO also note that '*The ANZECC 2000 Guidelines define upland streams as those above 150 m altitude. However, it is noted in the objectives that recent information suggests that for the NSW Murray-Darling Basin, within which Bohena Creek sits, 250 m may be a scientifically more appropriate altitudinal trigger to distinguish between lowland and upland rivers*.' This corresponds with the findings of ecological survey in Bohena Creek. At the point of proposed discharge, the altitude of Bohena Creek is approximately 249 m above height datum (**AHD**). From here, the river descends in altitude towards Narrabri where the altitude is approximately 194 m AHD. Therefore, the area of assessment is sited below the 250 m altitude. The lowland river classification is adopted for this Plan.

Default trigger values for water quality indicators relevant to the various environmental values from the Objectives are presented in Table C1 in Appendix C. Santos will review the published water quality trigger values during Phase 1 and if sufficient data is available, develop local trigger values based on baseline data using the methods described in the ANZECC Guidelines.

3.2.5 Managing Urban Stormwater: Soils and Construction

The *Managing Urban Stormwater: Soils and Construction - Volume 1* (Landcom 2004), more commonly known as the 'Blue Book', provides support for developments to reduce the impacts of land disturbance activities on waterways by better management of soil erosion and sediment control. It provides guidance for the design, construction and implementation of measures to improve stormwater management during the construction phase of land development.

Volume 1 has been complemented by a series of publications in 2007 and 2008 combined as *Managing Urban Stormwater: Soils and Construction - Volume 2* which cover installation of services, waste disposal sites, quarries and other mining sites, major road and highway construction, and construction of unsealed roads access tracks in bushland and rural area. The requirements of the Blue Book and the supporting guidelines are further addressed in the Erosion and Sediment Control Plan.

3.3 EIS commitments

In the EIS Chapter 31, and updated in Appendix B of the Response to Submissions, Santos committed to implement a number of measures pending Project approval and a final investment decision. The EIS commitments relevant to surface water management have been reproduced below in Table 3.1, in accordance with consent condition D3(c) which states that Santos must ensure that (where relevant) the management plans include any relevant commitments or recommendations identified in the EIS. Note that the majority of the commitments in Table 3.1 have already been included in one or more of the other plans that form part of the Water Management Plan suite of documents. Note also that some commitments do not necessarily apply to the Phase 1 appraisal and exploration activities, e.g. the managed release of treated water to Bohena Creek.

Table 3.1 - EIS commitments relevant to surface water management

Number	EIS commitment relevant to surface water management	Section
3.1	Irrigation of treated water during production will be undertaken in accordance with an irrigation framework, included under the Produced Water Management Plan [Note: Irrigation of treated water is fully described in the IMP]	Refer to the Irrigation Management Plan
3.2 / 5.7	Only treated, amended[1] or bore water will be used for dust suppression and rehabilitation.	Refer to the Dust Suppression Protocol
3.3 / 7.1	Treated water will be released to Bohena Creek[2] at the managed release point only during periods when the flow in Bohena Creek is equal to, or greater than, 100 ML/day as measures at the Newell Highway gauging station	Not relevant to Phase 1
3.4	The managed release point to Bohena Creek[2] will utilise a diffuser designed to promote mixing of water at the release point	Not relevant to Phase 1
3.5	The managed release [to Bohena Creek][2] will be undertaken in a manner that minimises erosion to the bed and banks at the release point and the build-up of sediment at that location.	Not relevant to Phase 1
3.6 / 7.2	The Water Monitoring Plan (Appendix G3 [to the EIS]) will be implemented	Refer to section 8
4.3	Selection of watercourse crossing points will, where practical: • use existing vehicular crossings; • be located on straight sections of channel; and • maximise avoidance of steep, unstable banks, permanent pools and waterholes	Section 6.6
4.5	Construction of watercourse crossings would occur during periods of no flow in the watercourse.	Section 6.6

As described in section 11 of this Plan and section 8 of the EMS, this Plan will be subject to annual evaluation and review. This will include the EIS commitments to ensure they remain current, applicable, and generally improve the environmental performance of the Project.

[1] 'Amended' is defined to mean amended treated produced water.

[2] There will be no managed release to Bohena Creek during Phase 1.

4. Existing surface water environment

4.1 Regional climate

As provided in Chapter 13 of the EIS, rainfall in the Project area is highly variable; with the warmer months generally wetter than the cooler months. Typical rainfall and temperature statistics for the Project works have been sourced from the Bureau of Meteorology (**BOM**) website for the following nearby weather stations:

- rainfall statistics (1870 to 2012) - Narrabri Bowling Club (BOM No. 54120) (BOM, 2020a); and
- temperature statistics (1876 to 2011) - Gunnedah Pool (BOM No. 55023) (BOM, 2020b)

Relevant data (1900 to 2013) are as follows:

- minimum annual rainfall - 269 millimetres (**mm**) in 1994;
- average annual rainfall - 639 mm;
- median annual rainfall - 638 mm; and
- maximum annual rainfall - 1,232 mm in 1950.

The average annual evaporation total as reported in Chapter 13 of the EIS, is approximately 1,969 mm, compared to the annual average rainfall of 639 mm. This gives an annual deficit (difference between annual evaporation and rainfall) of approximately 1,330 mm. Evaporation is highest in the warmer months and lowest in the cooler months.

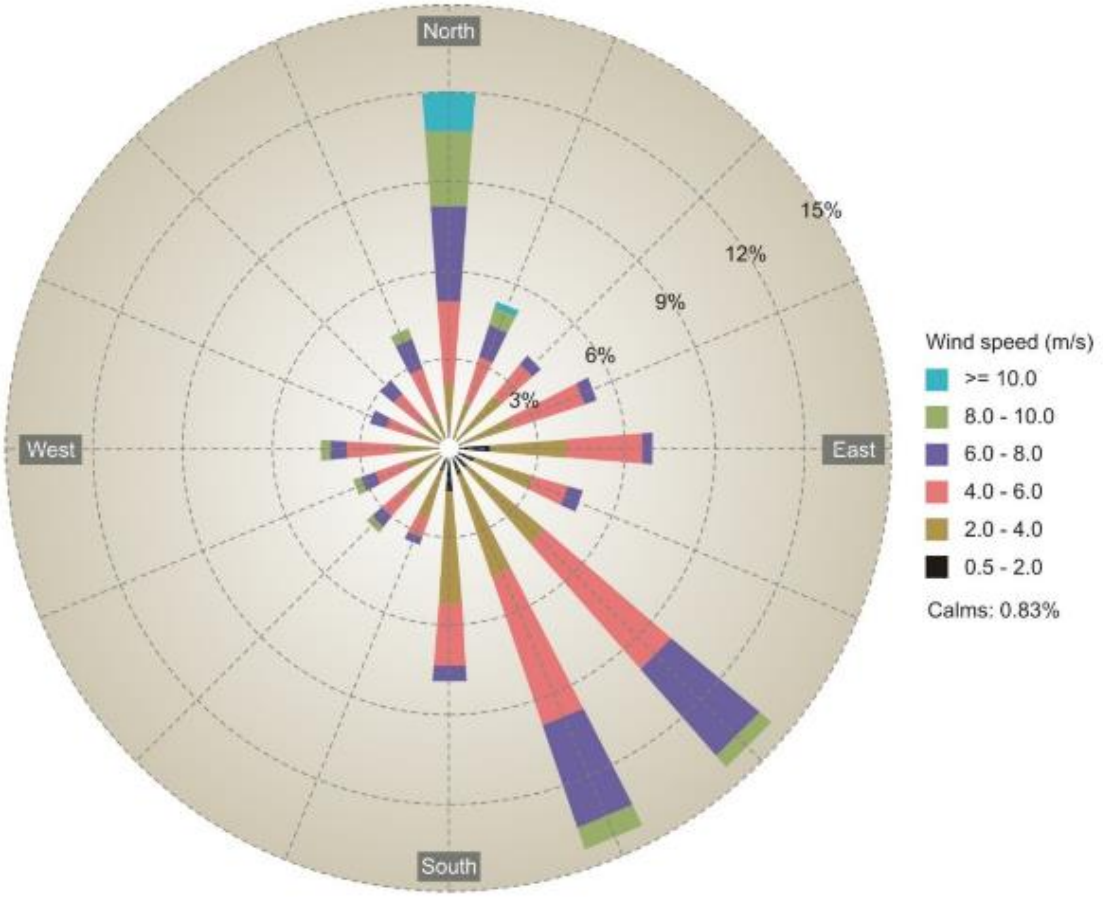
The data obtained by the two weather stations has been used since they are the closest stations to the Project works which provide a reliable record of rainfall/temperature statistics representative of the area. Monthly rainfall and temperature statistics are provided in Table 4.1. They show that:

- rainfall is summer dominant;
- average rainfall is relatively low; and
- temperatures are warm to hot in summer and mild in winter.

Table 4.1 - Monthly rainfall statistics

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean rainfall (mm)	80.2	73.9	53.6	38.2	48.9	50.9	44.9	37.4	39.1	51.2	59.9	67.7
Mean temperature (ºC)	34.0	32.9	30.7	26.4	21.3	17.6	16.9	18.9	22.8	26.7	30.3	32.9

Winds in the Narrabri region are mainly from the south-east and the north, as presented in Figure 4.1. The breakdown of seasonal and daily wind rose diagrams indicate that the distributions of wind from season to season do not change significantly. Overall, the patterns remain relatively consistent. South-easterly winds are a dominant flow throughout each day however; the westerly component tends to develop during the afternoon, while the northerly component tends to ease during the evening. For future monitoring, Santos has installed and operates a meteorological station at the Leewood facility.



(Source: BOM, 2020c)

Figure 4.1 - Annual wind frequency and speed by origin in the Narrabri region

The Project is located in the Namoi River catchment and within the tributary catchments of Jacks Creek and Bohena Creek. The Namoi River flows in a north-westerly direction approximately 5 km to the north of the most northern boundary of the Project area, approximately 7 km and 9 km downstream respectively from the locations where Jacks Creek and Bohena Creek cross the northern Project boundaries.

The Namoi River stretches for over 350 km, with a catchment extending from the Great Dividing Range in the east to Walgett in the west where the Namoi River discharges into the Barwon River. Some of the Namoi River's major tributaries include the Peel River, Mooki River, Manilla River, Cox's Creek, Baradine Creek and Pian Creek. It has a total catchment area of approximately 42,000 km^2 to Walgett. The Namoi River is a perennial system, with highly variable flows. Many of the tributaries are intermittent or ephemeral with flow observed following significant rainfall events.

There are a number of major storages in the Namoi River catchment, namely the Keepit, Chaffey and Split Rock Dams located on the Namoi, Peel and Manilla Rivers respectively. The catchment has been used extensively for agricultural activities for over 100 years and these dams provide water for the licensed water users in the region. It is one of Australia's most developed irrigation areas, supporting significant cotton and broad acre cropping (mainly sorghum, sunflower and wheat) as well as other crops, and some sheep and cattle grazing. In the Project area, surface water is used for irrigation, stock and domestic supplies, and for municipal and industrial supply.

4.2 Local drainage

4.2.1 Watercourses

The Project area lies predominantly within the Lower Namoi sub-catchment, as shown in Figure D1 in Appendix D. Local drainage can be sub-divided into three main areas presented in Figure 4.2, consisting of Bohena Creek, western catchment and eastern catchment. The major drainage lines include Jacks Creek and Bohena Creek, both of which are ephemeral and only flow after significant rainfall. Both Bohena Creek and Jacks Creek drain to the Namoi River.

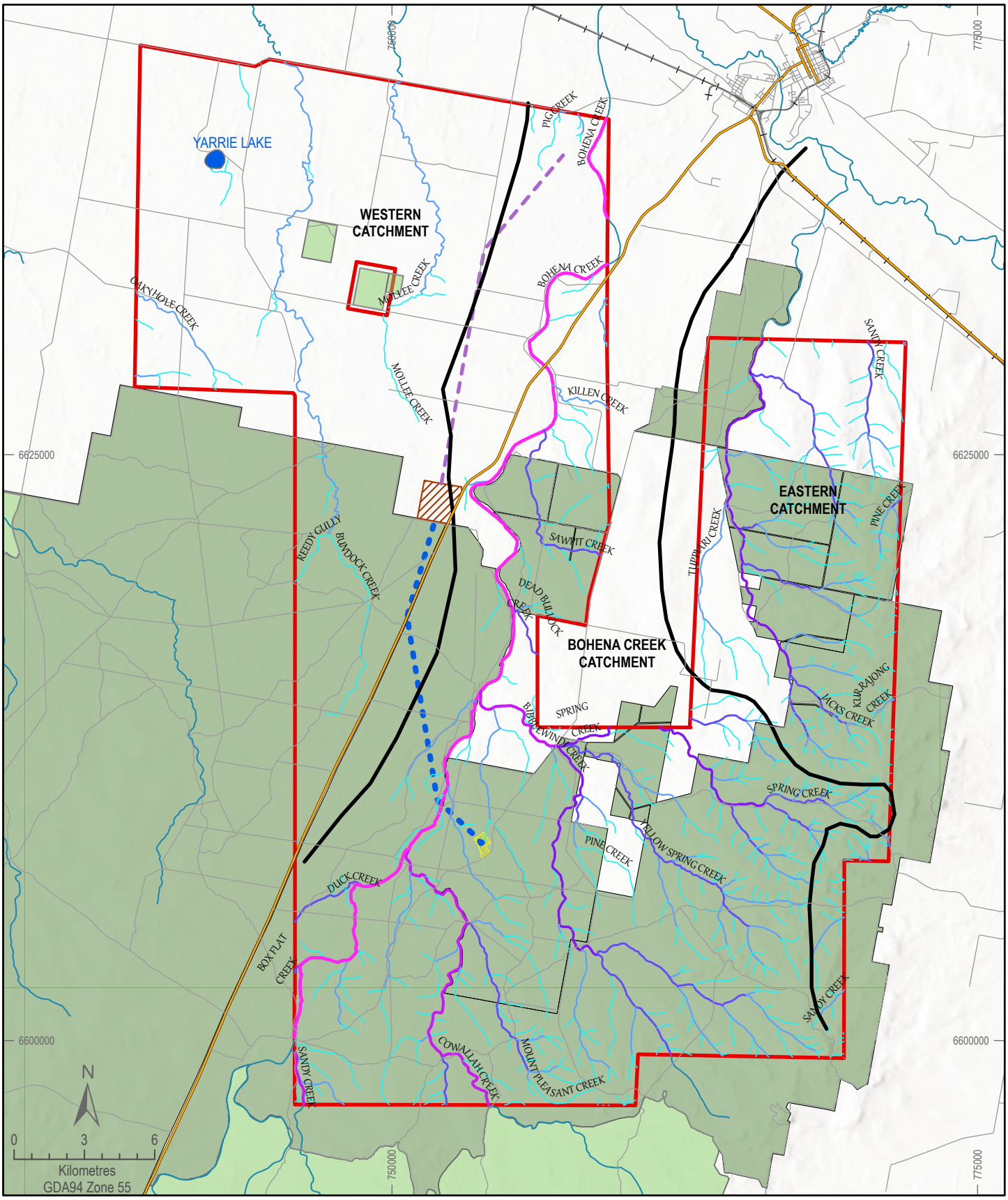
Bohena Creek experiences surface flow approximately 15 per cent of the time - generally if rainfall in the local catchment exceeds approximately 100 to 110 mm in a given month. The creek is dry for extended periods of time although there are deeper intermittent pools that contain permanent water, with the water table an estimated 2 m below the creek bed. Bohena Creek contributes little inflow to the Namoi River under normal conditions, however, during protracted wet conditions, significant flood inflows to the Namoi River can be generated. Bohena Creek is shown in Figure 4.2, along with the other main watercourses within the Project area.

The largest tributaries that drain into Bohena Creek are:

- Spring Creek, which joins Yellow Spring Creek before joining Bibblewindi Creek;
- Yellow Spring Creek, which runs south-east to north-west to join Bibblewindi Creek;
- Bibblewindi Creek, which runs north-west to Bohena Creek;
- Mt Pleasant Creek, which runs north-west to Cowallah Creek; and
- Cowallah Creek, which runs northwards to join Bohena Creek.

Watercourses near major Project infrastructure are as follows:

- Leewood is located approximately 380 m west of Bohena Creek at its nearest point. There are no other watercourses in the vicinity of Leewood, however part of the site can be crossed by overland flow;
- Bibblewindi is not located near defined watercourses. Bohena Creek is approximately two kilometres to the west and Bibblewindi Creek approximately two kilometres to the east. There are also unnamed first order watercourses approximately 650 m east and west of Bibblewindi. The infrastructure at Bibblewindi is subject to minor flooding of less than 100 mm during the one per cent annual exceedance probability (**AEP**) flood event;
- the Bibblewindi to Leewood infrastructure corridor crosses Bohena Creek and a number of un-named first order watercourses that are tributaries to Bohena Creek. Bohena Creek is defined as being in poor condition and at moderate risk of disturbance at the crossing location. The un-named watercourses are classified as being in good condition and at high risk of disturbance. The infrastructure corridor also crosses several overland flow paths which flood during the one per cent AEP flood event; and
- there are no watercourse crossings along the Leewood to Wilga Park underground power line corridor. The corridor crosses potential overland flow paths which flood during the one per cent AEP flood event.



Santos

ONWARD CONSULTING

LEGEND

- NGP boundary
- Leewood
- Bibblewindi
- Bibblewindi to Leewood infrastructure corridor
- Leewood to Wilga Park infrastructure corridor
- Drainage catchments

Strahler stream order

- 1
- 2
- 3
- 4
- 5
- 6

- Highway
- Roads
- Railway
- Watercourses
- State Forest
- Parks and reserves
- Lakes and dams

NARRABRI GAS PROJECT

Figure 4.2

Catchments and Stream Order within the Project Area

As shown in Figure 4.2, the watercourses within the Project area have been allocated an order following the Strahler stream classification system. Numbering begins at the top of a catchment with headwater, or 'new', flow paths being assigned the number one. Where two flow paths of order 1st join, the section downstream of the junction is referred to as a 2nd order stream. Where two second order streams join, the watercourse downstream of the junction is referred to as a third order stream, and so on.

Many watercourses within the Project area are first to third order streamlines. The exceptions are:

- Bohena Creek is a 6th order streamline along its entire length through the Project area.
- Cowallah and Sandy Creeks are 5th order streamlines along their entire length through the Project area.
- Bibblewindi Creek increases from a 3rd to 4th to 5th order streamline along its length through the Project area.
- Spring and Yellow Spring Creeks are defined as 3rd and 4th order stream orders along their lengths through the Project area.
- Jacks Creek is a 5th order stream order along its length through the Project area.

4.2.2 Watercourse geomorphology

There are four main watercourse groups, and seven different stream types in the project area as summarised in Table 4.2. Further detail, including schematics and photographs are included in section 4.6 of Appendix H of the EIS.

Despite the Project area being largely vegetated, the geomorphic condition of many of the streamlines is moderate to poor due to past channel incision and enlargement. It is likely most of these disturbed streamlines were either valley fill or chain of ponds systems prior to European settlement. With the introduction of grazing and then logging in the area, watercourses have been subject to both:

- direct disturbances – for example, construction of tracks across watercourses resulting in channel bed disturbance, leading to scour and incision;
- indirect disturbances – for example, clearing and altered fire frequencies leading to increased runoff rates, more peaked flow events, hillslope erosion and increased sediment delivery to channels.

As a result, many streamlines exhibit planar, mobile sand beds of limited form and aquatic habitat value. Ongoing incision through gully processes is also still evident across the Project area.

Good condition watercourses make up approximately half of the assessed stream length. Good condition reaches are primarily located on first order streamlines and are largely valley fill and headwater stream types. The condition of watercourses generally decreases with increasing stream order, with no fifth order streamlines assessed to be in good condition. The fragility of watercourse geomorphic types in the Project area was assessed based on the potential for the watercourse type to adjust, with further information on this assessment provided in Appendix H in the EIS.

Table 4.2 - Summary of watercourse group and stream types in the Project area

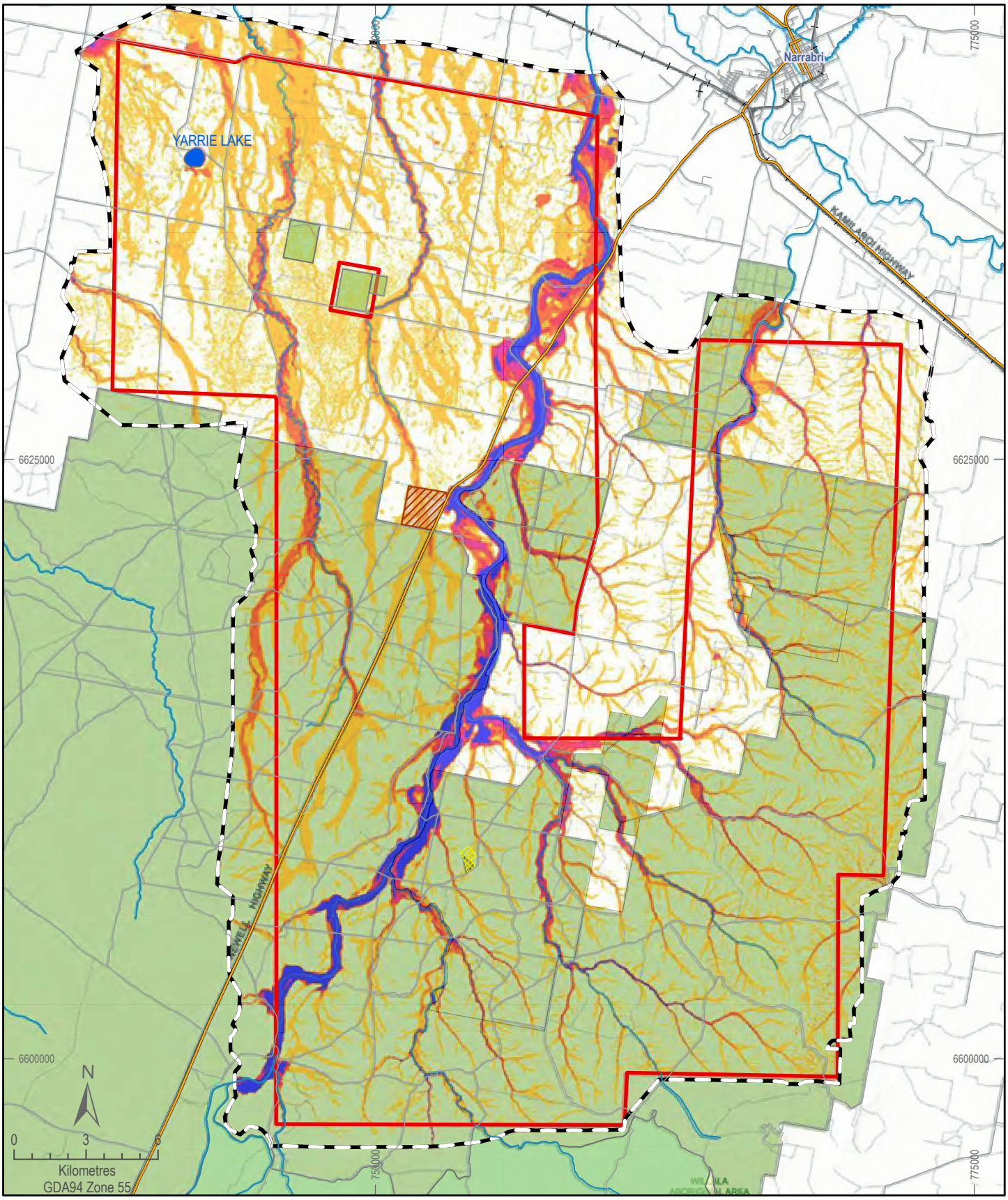
Watercourse group	Stream type	Description
Unchannelised systems Relatively flat, unincised valley floor surface with substrates comprised of alluvial fine silts, sands and muds.	Valley fill systems	Flat valley floor with no defined channel such that the whole valley floor acts as a channel with valley margins as the banks. Valley fill systems are located throughout the Project area along first to fourth order streamlines.
	Chain of pond systems	Display a series of symmetrical (occasionally irregular) ponds that occur at irregular intervals along a poorly defined drainage line set within an alluvial valley floor. Chain of ponds systems occupy lower catchment positions along streamlines set within Pilliga outwash sediments, namely Bohena, Mollee, Bundock and Oakyhole creeks
Confined systems Single, symmetrical channel often in bedrock controlled, irregular V- or U-shaped valleys. Confined systems in the project area included headwater systems and confined valley sand systems.	Headwater systems	Steep gradient channels in a narrow valley (less than 5 metres wide). Headwater systems are largely located in upper catchment positions along first and second order tributaries feeding the eastern drainage streamlines.
	Confined valley sand systems	Low sinuosity channel set within narrow bedrock or terrace bound valley. Confined valley sand systems are located in middle to upper catchment positions, typically along second to third order streamlines.
Partly confined valley Systems Dictated largely by the confinement of the valley that can control between 10 and 90 per cent of the length of the channel.	Platform controlled, low sinuosity sand systems	Slightly irregular valley with valley margins which may be bedrock or terrace that limit lateral migration of the channel. Discontinuous floodplains are formed as the channel crosses the valley floor from one valley margin to the other. Located in middle to lower catchment positions typically along third to sixth order streamlines. The majority of Bohena Creek through the Project area consists of this system.
Laterally Unconfined Valley Systems Limited or no valley influence on the channel and exhibit floodplains bounding both sides of the channel.	Low sinuosity sand systems	Continuous floodplains on both sides of a low to moderate sinuosity channel. The channel bed is a relatively featureless, mobile sand sheet with scattered gravels. Low sinuosity sand systems are located in middle to lower catchment positions on third to fourth order segments of Bibblewindi, Pine and Sawpit creeks.
	Channelised fill systems	Continuous channel that has incised, probably since European settlement, into valley fill or chain of ponds through headcut retreat and channel expansion. Located throughout the Project area in middle to upper catchment positions, typically along first to third order streamlines.

4.3 Flooding

Although the Project area is usually dry it contains a network of ephemeral streams and drainage lines that flow during flood events. The predicted extent and depth of the one per cent AEP event is shown in Figure 4.3.

As shown, flooding is concentrated around the mapped watercourses in the Project area. The flows extend onto floodplains in the northern part of the Project area, particularly in the probable maximum flood event. With regard to the NSW Government 2005 Floodplain Development Manual, it is noted that the extent of the one per cent AEP event represents the flood planning area while the extent of the probable maximum flood event represents flood prone land.

The deepest flooding and highest flow velocities occur along Bohena Creek as the highest order watercourse in the Project area. In the south and east, flow paths are largely confined to relatively narrow corridors of channels and overbank areas. In the flat terrain of the north and west where channels are less defined, large shallow areas of flooding are predicted.



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ONWARD CONSULTING

LEGEND

- NGP boundary
- Leewood
- Bibblewindi
- TUFLOW model extenet
- Highway
- Roads
- Railway
- Watercourses
- State Forest
- Parks and reserves
- Aboriginal areas
- Lakes and dams

Maximum flood depth (m)

- 0.00 - 0.50
- 0.5 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- >2

NARRABRI GAS PROJECT

Figure 4.3
Existing Maximum Flood Depth for One Per Cent AEP Event

4.4 Surface water quality baseline

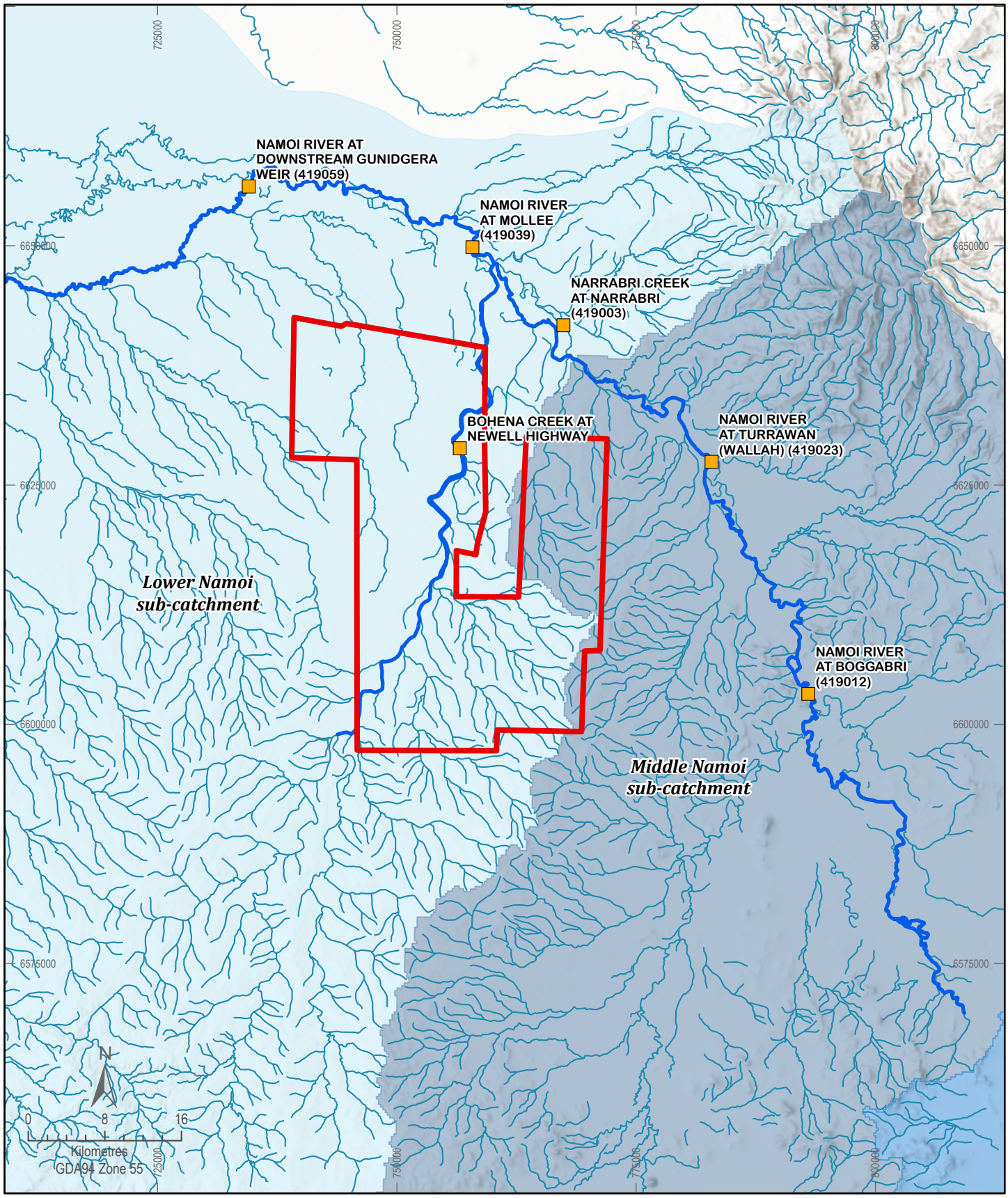
The surface water baseline is compiled from streamflow data collected by DPE Water and surface water quality data collected by Santos. Overviews of these datasets are presented in Table 4.3 and Table 4.4. The baseline for surface water flows consists of data from six streamflow gauging stations. The baseline for surface water consists of water quality measurements from six individual sampling location on both the Namoi River and on Bohena Creek. The locations of the surface water monitoring sites are shown in Figure 4.4 and Figure 4.5.

Table 4.3 - Baseline streamflow gauge locations (DPE)

Station Name	Station Number	Location Description
Bohena Ck at Newell Highway	419905	Newell Highway crossing of Bohena Creek
Namoi River at Boggabri	419012	Boggabri Manilla Road crossing
Namoi River at Turrawan (Wallah)	419023	Namoi River near Turrawan
Narrabri Creek at Narrabri	419003	Newell Highway crossing of Namoi River at Namoi
Namoi River at Mollee	419039	Namoi River between Narrabri and Wee Waa
Namoi at D/S Gunidgera Weir	419059	Namoi River near Wee Waa

Table 4.4 - Baseline surface water quality locations (Santos)

Site ID	Water course	Location description
7505	Bohena Creek	Downstream of the confluence of Yaminba Creek and Borah Creek
7506	Bohena Creek	Downstream of the release point for potential managed release scheme
7510	Bohena Creek	Bohena Creek at crossing of Newell Highway
7511	Bohena Creek	Road culvert at Yarrie Lake
7512	Bohena Creek	Bohena Creek upstream of its confluence with Namoi River
7103	Bohena Creek	Upstream of the release point for potential managed release scheme
7504	Namoi River	Namoi River at Narrabri township
7513	Namoi River	Namoi River near existing irrigation developments
7517	Namoi River	Namoi River at Tarriaro Cultural Reserve
7529	Namoi River	Namoi River upstream of its confluence with Bohena Creek
7533	Namoi River	Namoi River downstream of its confluence with Bohena Creek
7538	Namoi River	Namoi River at Kamilaroi Highway Crossing



Santos

ONWARD CONSULTING

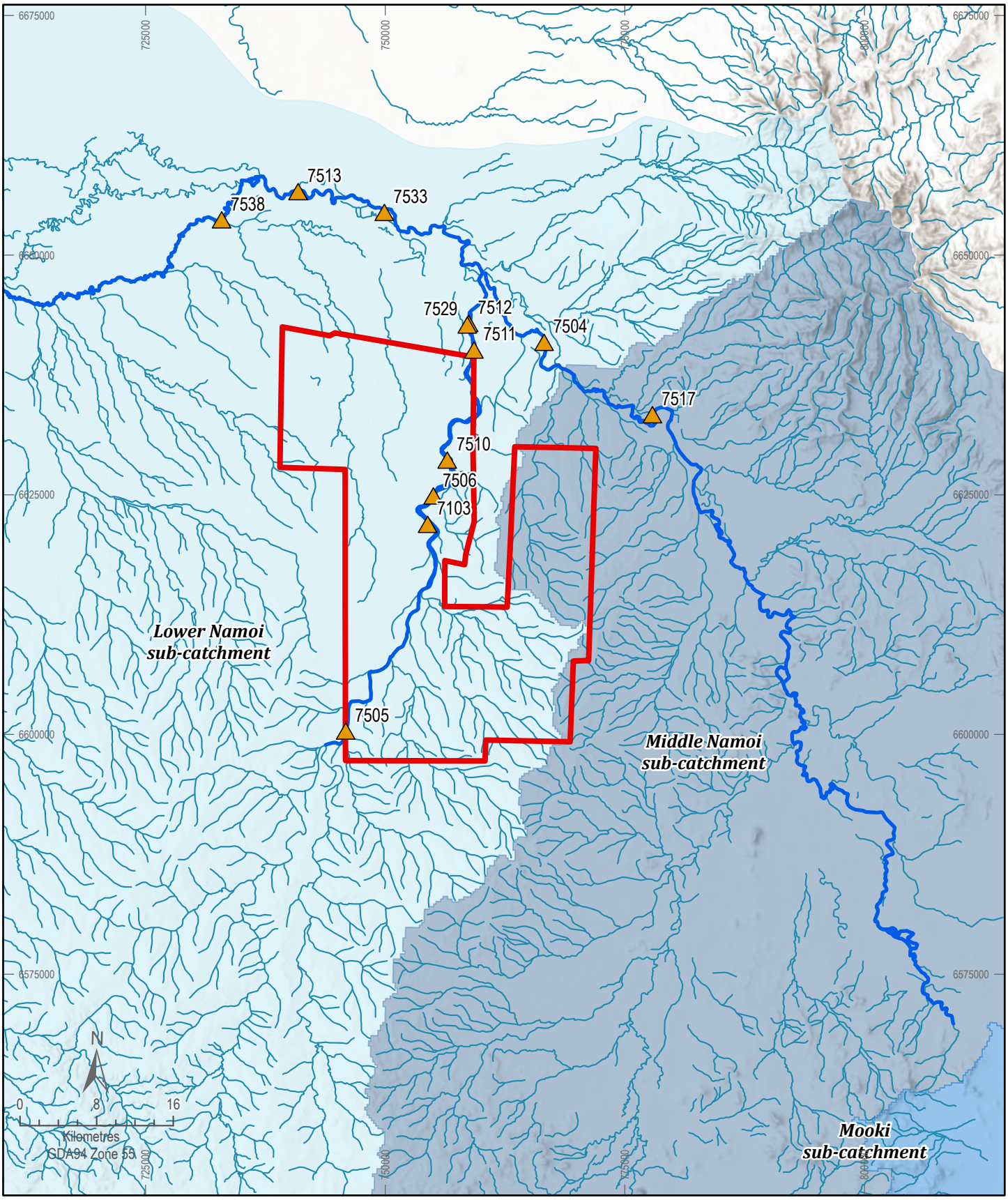
LEGEND

- NGP boundary
- Stream flow stations
- Namoi River and Bohema Creek
- Surface water course

NARRABRI GAS PROJECT

Figure 4.4

Stream Flow Monitoring Locations



Santos

ONWARD CONSULTING

LEGEND

- NGP boundary
- Surface water monitoring locations
- Namoi River and Bohema Creek
- Surface water course

NARRABRI GAS PROJECT

Figure 4.5

Surface Water Monitoring Locations

4.4.1 Namoi River

The water quality of the Namoi River is generally fresh to slightly brackish. The pH values range from slightly acidic to marginally alkaline. A variety of chemical constituents are recognised as a product of the river's overall catchment, with a primary source of total dissolved solids into the Namoi being agricultural and residential runoff. Those sites that reflect a relatively high concentration of total dissolved solids are located within, or close to, Narrabri or irrigated areas. Threshold values derived from the regional water quality baseline data established for the Project (February 2012 to October 2015) are shown in Table 4.5.

Table 4.5 - Baseline water quality data for the Namoi River

Parameter	No. of samples	Min	Max	Ave	Median	16th % percentile	84th % percentile
pH - field (pH units)	93	5.7	9.3	7.8	8	7.1	8.4
Barium (mg/L)	93	0.001	0.058	0.030	0.028	0.0207	0.0413
Boron (mg/L)	93	0.05	0.44	0.056	0.05	0.05	0.05
Calcium (mg/L)	93	3	54	28.66	27	20	40
Chloride (mg/L)	100	6	86	31.96	29	12	51
Electrical Conductivity – Field (µS/cm)	92	128.1	921	396.7	372.0	271.0	544.6
Fluoride (mg/L)	93	0.1	0.5	0.19	0.2	0.1	0.2
Lithium (mg/L)	93	0.001	0.004	0.001	0.001	0.001	0.001
Manganese (mg/L)	93	0.001	0.68	0.040	0.003	0.001	0.053
Potassium (mg/L)	93	2	11	4.6	4	3	6
Sodium (mg/L)	93	7	120	32.9	32	21	46
Sodium Adsorption Ratio (number)	93	0.6	3.77	1.18	1.16	0.89	1.42
Strontium (mg/L)	93	0.001	0.573	0.310	0.3	0.206	0.45
Total Dissolved Solids – Field (mg/L)	93	81	486	247.5	248	165.7	328

The water quality data of the Namoi, including data shown in Table 4.5 suggests that:

- average electrical conductivity concentrations are around 400 microsiemens per centimetre (**µS/cm**), and average total dissolved solids (**TDS**) concentrations of around 250 milligrams per litre (**mg/L**);
- the water has an average pH value of 7.8;
- major ions include sodium, chloride, and calcium, which reflect the dominant water type of the Namoi River;
- electrical conductivity normally is within the ANZECC Guideline for 95 % protection of aquatic species range of 125 to 2,200 µS/cm for lowland rivers. The background electrical conductivity values may be attributed to agricultural and dryland cropping activities in which accumulated salts can be mobilised and discharged into surface water during rainfall events; and

- elevated electrical conductivity values are generally observed during periods of low flow with some indications of peaks following small rainfall events.

4.4.2 Bohena Creek

The headwaters of the tributaries are generally in forested conservation areas (Pilliga Forest). The unforested areas of the sub-catchments are used predominately for sheep and cattle grazing and dryland cropping. Due to the irregular flow regime of Bohena Creek and the difficulty for safe access during times of high flow, water samples collected during flow events and samples collected from pools within the creek were combined to establish baseline values. The baseline water quality data for Bohena Creek between 2012 to 2016 for key analytes is shown in Table 4.6.

Table 4.6 - Baseline water quality data for Bohena Creek

Parameter	No. of samples	No. samples >LOR	Min	Max	Mean	16th percentile	84th percentile
EC - lab (µS/cm)	40	40	115	512	236	186	269
Total Dissolved Solids - field (mg/L)	41	41	86	586	212	141	211
Chloride (mg/L)	41	41	11	100	37	28	40
Fluoride (mg/L)	41	5	0.1	0.1	0.1	0.1	0.1
Calcium (mg/L)	41	41	2	21	7.6	5.4	9.3
Sodium (mg/L)	41	41	9	47	24	21	29
Potassium (mg/L)	41	41	1.0	9.0	3.3	2.6	3.9
Sodium Adsorption Ratio (number)	41	41	0.7	3.0	1.5	1.4	1.6
Barium (mg/L)	41	41	0.0	0.2	0.0	0.0	0.0
Boron (mg/L)	41	0	0.0	0.0	0.0	0.0	0.0
Lithium (mg/L)	41	7	0.0	0.0	0.0	0.0	0.0
Manganese (mg/L)	41	41	0.0	3.0	0.3	0.0	0.5
Strontium (mg/L)	41	41	0.0	0.3	0.1	0.1	0.2
Magnesium (mg/L)	41	41	3.0	23.0	8.6	5.9	11.1
Sulphate (mg/L)	39	3	1.0	45.0	23.5	45.0	45.0
pH - lab	32	32	5.6	8.1	7.2	6.5	7.3

The baseline water quality data for Bohena Creek can be summarised as follows:

- the water quality of Bohena Creek is generally fresh, with average electrical conductivity concentrations of 236 µS/cm, and TDS concentrations averaging around 212 mg/L;
- the water is generally neutral with an average pH value of 7.2;
- major ions include sodium and chloride, which reflect the dominant water type;

- the lower electrical conductivity values measured in Bohena Creek relative to the Namoi River are likely to be indicative of freshwater recharge, consistent with electrical conductivity values in the Bohena Creek alluvium.

4.5 Stream and riparian vegetation

As detailed in Appendix J1 of the EIS, there are approximately 7,011 ha of riparian woodland mapped in the Project area. Riparian woodlands are distributed along riparian corridors throughout the Project area. The major riparian corridor in the Project area is Bohena Creek, which runs south-north through the centre of the Project area and supports continuous linear patches of riparian woodland. Additional riparian corridors in the Project area dominated by riparian woodland include Bibblewindi Creek, Spring Creek and Cowallah Creek in the south and Jacks Creek and Bundock Creek in the north.

Riparian woodland has a canopy layer of mature eucalypts of approximately 5% - 30% projected foliage cover. The midstorey is variable, and in some areas can be a shrubby layer dominated by Leptospermum spp. (tea tree) approximately two metres high whereas in other areas it comprises cypress and other shrubs between one metre and three metres high. The groundcover is often dense grasses with abundant logs, fallen branches and bark.

The majority of the creek beds were dry during surveys for the EIS (except during the flooding in 2010) and provided a flyway or movement corridor for a range terrestrial fauna. Frequent fauna footprints observed in the sandy creek beds included macropods and European fox/cat.

Fauna habitat features of riparian woodland also include foraging resources (seeds, pollen and nectar), mosaics of groundcover density (provides tussocks and low shrubs to protect ground fauna from predators), canopy and midstorey structure suitable for perching and nesting, hollow-bearing trees, decorticating and fallen bark, logs and fallen branches.

Riparian habitat provides a suite of preferred feed trees for Koala and hence was the focus of Koala habitat assessments in the Project area.

4.6 Natural methane leaks and accumulations

In non-coal measures groundwaters of the Gunnedah Oxley Basin, methane is observed at levels up to 20 ppm, but is not ubiquitous and is generally below 10 ppm. In the sampled groundwaters of the GAB, methane levels can reach nearly 5 ppm, but are generally below LOR. Those samples recording methane (45 out of 121 analyses) returned an average level of about 1 ppm. The exceptions occur where previous exploration has targeted conventional gas reserves, such as those associated with PPL3, located in the north-west of the Project area. Previous monitoring of the Namoi Alluvium has detected variable levels of methane, with two bores reporting levels in excess of 1 ppm.

For further information on natural methane leaks and accumulations, refer to section 4.4.4 of the Groundwater Management Plan.

5. Potential surface water impacts

5.1 Erosion and sedimentation

Although the majority of the major construction activities are part of Phase 2 of the development, construction of the Project will involve disturbance of the ground surface, most notably at Leewood and Bibblewindi and along the two infrastructure corridors - particularly at creek crossings. The Bibblewindi to Leewood infrastructure corridor crosses Bohena Creek and an unnamed tributary. Bohena Creek is identified as being at moderate risk of disturbance at the crossing point, while the unnamed tributary is identified as being at high risk. This is further detailed in section 6.

Potential impacts associated with watercourse crossings include destabilisation of watercourses due to direct disturbance resulting in localised erosion and off-site sediment mobilisation and transport, potentially leading to turbidity and sedimentation of watercourses. However, construction during no-flow conditions, and implementation of the erosion and sediment control plan will minimise potential impacts to Bohena Creek and the unnamed tributary. The Leewood to Wilga Park infrastructure corridor does not pass through creeks and therefore water quality impacts are not expected.

5.2 Spills and leaks

Accidental spills of fuel, drilling additives, produced water, brine, chemicals and / or cement could impact water quality. If inadequately controlled, changes to water quality could impact on the aquatic ecology of watercourses and / or downstream water users.

The risks of these potential construction impacts will be managed in a comprehensive and routine manner using the EMS (incorporating materials handling and refuelling protocols; and staff inductions and other initiatives) and the Project Incident Response Management Plan (**PIRMP**). Construction activities at Bibblewindi are relatively remote from watercourses, thereby lowering the risk of spills impacting surface water quality, with Bibblewindi being approximately 2 km from the closest watercourse within the Project area. Water gathering lines and water pipelines/flowlines are predominantly buried at depths >0.75 m and as such are generally not at risk of accidental spills and leaks, with ongoing pressure monitoring using remote telemetry.

The risk of impacts will also be managed by handling and storing chemicals in accordance with relevant Australian Standards, including AS 1940-2004 *The storage and handling of flammable and combustible liquids*. Refuelling will occur in areas of suitable containment when volumes greater than 50 litres are involved and not within 40 m of a waterway.

5.3 Dust suppression, construction and drilling

Any potential impact related to the application of treated, amended treated water or bore water for dust suppression, construction activities and drilling will be managed through routine procedures that will be integrated into the EMS for the Project. The risks have been assessed by comparing the qualities of the three water types against the baseline values for Bohena Creek, as provided in Table 4.5.

It is to be noted that only bore water will be used in dust suppression activities during Phase 1. Further details regarding the use of bore water for dust suppression are presented in the Dust Suppression Protocol.

5.4 Irrigation

The application of amended treated water for irrigation has the potential to result in the following water quality impacts:

- excess irrigation water runoff could disturb the ground surface, potentially mobilising sediments into receiving waters
- the potential for change in the quality of water leaving irrigation areas as a result of the quality of the irrigation water - either via surface runoff or in deep drainage plumes carrying dissolved solutes.

The amended treated water will comply with the quality criteria as presented in Appendix 6 of the CoC and reproduced in Appendix C of the IMP. The irrigation water is classified as 'low effluent' in accordance with the *DEC Environmental Guidelines: Use of Effluent by Irrigation* (2004). This is further described in section 5.3 of the IMP. Managed as detailed in the IMP, there is a very low risk of irrigation water causing any impact to surface water quality through runoff.

5.5 Managed release and discharges

There will be no releases to surface waters during the Phase 1 activities. There will be no discharges from the two existing sediment basins at Leewood, and there will be no construction of sediment basins during Phase 1. There will also not be any discharge from low point drains in the pipeline network, with any water draining directly into storage containers before being emptied using vacuum trucks (refer to Figure 5.1). There will be no releases of irrigation water to surface waters.

Figure 5.1 - Low point drain along gathering lines

5.6 Watercourses

Impacts to watercourse geomorphology associated with construction of Project infrastructure may include:

- disturbance of floodplains from vegetation clearing, trenching and access track construction;
- alteration of watercourse bed from trenching and access track construction;
- erosion of watercourse banks in areas disturbed by construction activities; and
- scour within a watercourse from pipeline construction.

One of the key findings of the impact assessment in relation to hydrology and geomorphology is that negligible impacts are anticipated from the construction of linear infrastructure watercourse crossings, and that any impacts are expected to be short-term and highly localised.

Figure 5.2 presents the proposed Phase 1 linear infrastructure and the propose well pads. The proposed flowlines crossing Yellow Spring Creek, Pine Creek and Bibblewindi Creek are at locations where existing roads, tracks and gathering lines cross the waterways.

5.7 Flooding and geomorphology

Flood analysis over the Project area has been carried out for a 1 % AEP, as previously shown in Figure 4.3. Large ponds and dams, and any ponds or dams that are used for the storage of produced water or brine, will be located outside of the 1 % AEP flood extent to ensure long term protection of these assets and to minimise impact from the Project on surface flow during large flood events. This does not apply to approved ponds and dams in major facilities constructed above the 1% AEP flood extent.

All other infrastructure and activities will be designed and installed to ensure that where they occur within the 1 % AEP, there will be negligible modification of flows and necessary sediment and erosion controls will be implemented, with no ongoing impacts to geomorphology. Activities within the 1 % AEP will be planned and constructed in accordance with the Project commitments and mitigations, and the ESCP.

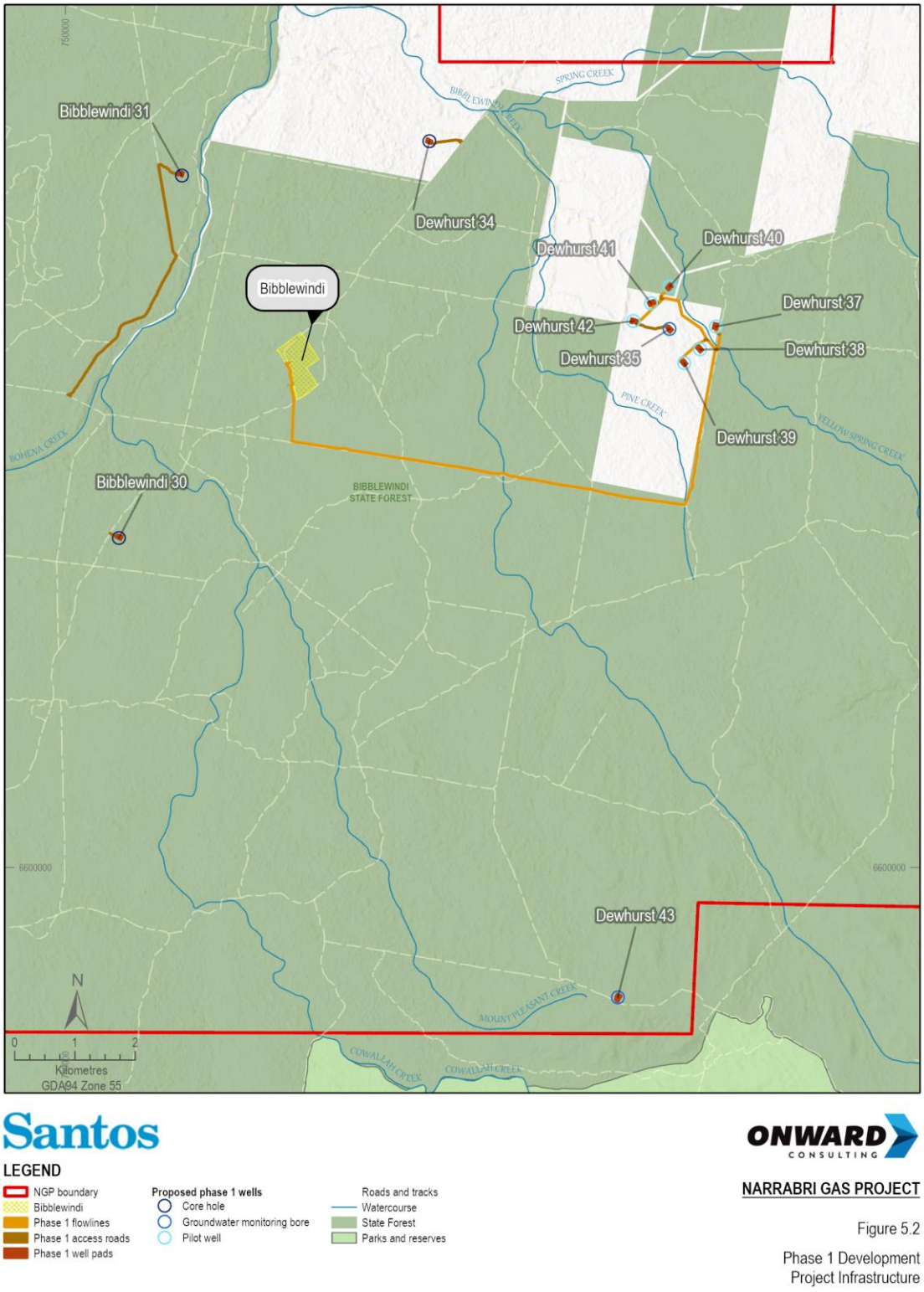


Figure 5.2 – Proposed Phase 1 linear infrastructure and well pads

6. Risk assessment and mitigation

The predominant risks and relevant mitigation measures associated with the surface water management system are identified below and are summarised in Table 6.1.

6.1 Erosion and sedimentation

During construction potential impacts of sedimentation are managed in accordance with the Erosion and Sediment Control Plan. This mitigation and management tool is applicable when constructing (and maintaining) linear infrastructure positioned across ephemeral watercourses. The Erosion and Sediment Control Plan includes:

- allocation of general site practices and responsibilities;
- material management practices;
- surface water and erosion control practices;
- monitoring practices;
- rehabilitation plans.

6.2 Spills and leaks

The risk of impacts from produced water, chemical and hydrocarbon spills will be mitigated through both design and operational level mitigation methods. Potential construction, operational and decommissioning impacts will be comprehensively and routinely managed using the EMS that incorporates materials handling and refuelling protocols, and staff inductions. Further, all hydrocarbon and chemical storage facilities will fully comply with relevant Australian Standard requirements to contain potential chemical spills or leaks.

The infrastructure monitoring program across the produced water and brine storage facilities is presented in the Produced Water Management Plan.

6.3 Dust suppression, construction and drilling

Standard operational procedures for dust suppression, construction and drilling are integrated into the EMS for the Project. The Project will ensure that only bore water is used for dust suppression and rehabilitation activities during Phase 1 - no produced water is used for dust suppression and rehabilitation. The mitigation methods include a requirement that relatively small quantities of bore water is sprayed, and only on an ‘as needed’ basis, to minimise the risk of ponding and runoff. The risk of surface runoff is also reduced by minimising dust suppression adjacent to watercourses.

Dust suppression and rehabilitation activities take into consideration:

- managing spraying to avoid ponding and runoff of water;
- avoiding spraying during significant rainfall events; and
- adjusting application rates based on surface conditions and frequency of application.

All mitigation measures associated with dust control are further addressed in the Dust Suppression Protocol.

6.4 Irrigation

The irrigation of amended treated water is undertaken in accordance with the Irrigation Management Plan, which seeks to ensure that:

- the structure, stability and productive capacity of the soils are maintained;
- erosion is minimised; and that
- there are effective surface water and stormwater runoff controls.

The irrigation also includes a program of regular monitoring (refer to section 6 of the IMP), with the irrigation schedule being adjusted as needed to address trends identified through the monitoring system. In accordance with EPL 20350, treated water application to the irrigation area does not cause any surface runoff. The Project uses the broader surface water monitoring network to monitor for impacts from irrigation activities.

6.5 Managed release

There will be no managed releases to surface waters during the Phase 1 activities. For Phase 1 however, a brief description is provided in section 6 of the PWMP to comply with the requirement under condition B41(d)(viii) that the WMP must include a Managed Release Protocol.

6.6 Watercourses

In accordance with CoC B1, Santos will not construct any non-linear infrastructure within any watercourse or watercourse buffer zone as determined by Strahler stream order, previously shown in Figure 4.2 [and shown in Appendix 5 of the CoC]. Riparian corridors widths are determined consistent with the *NSW Guidelines for riparian corridors on waterfront land* (NSW Office of Water, 2012).

Strahler stream order	Riparian buffer zones
1st order	20 m plus channel width
2nd order	40 m plus channel width
3rd order	60 m plus channel width
4th order and greater	80 m plus channel width

In accordance with commitment 4.3 in the EIS Chapter 31 (as updated in Appendix B of the Response to Submissions), Santos will, where practical, select watercourse crossing points after consideration of the following:

- use existing vehicular crossings;
- locate the crossing points on straight sections of channel; and
- maximise avoidance of steep, unstable banks, permanent pools and waterholes for crossing points.

The selection and planning of watercourse crossings will be aided by the watercourse geomorphology assessment, which includes GIS mapping of watercourse geomorphology disturbance risk. The design, installation and maintenance of any infrastructure within 40 m of watercourses will generally be in accordance with the guidance series for *Controlled Activities on Waterfront Land* (DPI Water, 2012). The design, installation and maintenance of any creek crossings will be conducted generally in

accordance with the *Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013) and *Why Do Fish Need To Cross The Road? Fish Passage Requirements for Waterway Crossings*

Mitigation of watercourse crossing risk will be through good design, location, construction techniques and timing of construction. Watercourse crossings will only be constructed during periods of no flow in the watercourse. Vehicular watercourse crossings will be fords (crossings level with the watercourse bed) which are suitable for ephemeral watercourses within the Project area. The surface of frequently used ford crossings will be constructed using erosion resistant material such as interlocking angular rock or similar.

In particular, unchannelised geomorphic watercourse types (Chain of ponds and Valley Fill) are sensitive to disturbance and concentration of flow can lead to the development of a continuous channel. The primary mitigation measure will be to avoid disturbing such watercourse types by identifying them at the planning stage (through the development of the Field Development Plan) and seeking alternative locations for Project activities where possible. If Project activities such as pipeline and track crossings must be located such that they will cross or disturb these watercourse types, the additional mitigation measures will be considered, together with site-specific assessment and development of mitigation measures as required. Erosion and sediment controls, including run-off diversions and catch drains, will be installed prior to the commencement of construction, where reasonable and feasible. Progressive rehabilitation and regeneration of pipeline corridors that are not required for operation or maintenance, and the reinstatement of drainage networks will be undertaken within six months of completion of construction.

Embankment repair will be implemented in any areas of scour and gully erosion.

6.7 Flooding

Phase 1 exploration gas field infrastructure will have a limited effect on flood conditions. Potential for impacts will be greater in areas that are flat, low-lying or otherwise susceptible to flood. Flood impacts will be avoided by minimising topographic change in planning and design of field infrastructure.

Well pads will be at-grade in flood vulnerable areas and will therefore not be expected to increase flood levels. Access tracks will typically follow existing topography while gas and water gathering lines will be buried and as a result are not expected to increase flood levels.

Where field infrastructure is positioned in areas susceptible to flood there will be potential for localised increases in flood levels. There will also be potential for localised increases in flood levels where access tracks are built on an embankment.

Potential impacts of field infrastructure will be minimised through detailed design to ensure negligible modification of flood flows including incorporation of cross-drainage as appropriate.

Table 6.1 - Risk assessment and mitigation summary

Issue	Phase	Pre-mitigated risk			Mitigation and management measures	Residual risk		
		Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
Direct water quality impacts - Surface water quality impacts due to spills or leaks	Construction	Moderate	Moderate	Moderate	Dangerous goods will be stored and transported in accordance with the Australian Dangerous Goods Code. Chemicals will be stored and handled in accordance with relevant Australian Standards, including AS 1940-2004 *The storage and handling of flammable and combustible liquids*. Refuelling will occur with suitable containment when volumes greater than 50 L are involved and not within 40 m of a watercourse.	Moderate	Low	Low
Surface water quality impacts due to use of amended treated water for dust suppression, drilling, construction, stock watering and / or irrigation	Construction	Moderate	Moderate	Moderate	Irrigation of treated water will be undertaken in accordance with an irrigation framework, included under the IMP. Only bore water will be used for dust suppression (in accordance with the Dust Suppression Protocol) and rehabilitation. Monitoring as detailed in section 7 will be implemented.	Moderate	Low	Low
Increased localised flooding	Construction	Unlikely	Moderate	Medium	Crossings within the one in 100-year flood zone will be designed for negligible modification of flood flows. Infrastructure within the one in 100-year flood zone in the vicinity of residential dwellings will be designed for negligible modification of flood flows.	Unlikely	Minor	Low
Turbidity impacts – Increased sedimentation of watercourses at linear infrastructure crossings	Construction	Moderate	Moderate	Moderate	Erosion and sediment control measures will be implemented during construction of watercourse crossings in accordance with the Erosion and Sediment Control Plan. Construction of watercourse crossings will only occur during periods of no flow in the watercourse. Vehicular crossing will be designed and constructed to include appropriate stabilisation. Selection of watercourse crossing points will, where practical: • use existing vehicular crossings; • be located on straight sections of channel; and • maximise avoidance of steep, unstable banks, permanent pools and waterholes. Implement rehabilitation to minimise erosion of embankments and construction areas by implementing the following: • re-establish riparian zone/grass cover as soon as back-filling and reinstatement has been completed; • restore watercourse banks restored to their original profiles; • respread topsoil over the area from which it was removed and seed the areas of disturbance; • apply stabilising materials such as hydromulch, jute matting or other suitable geotextile materials.	Moderate	Low	Low
Watercourse crossings leading to substantial alteration of bank stability	Construction	Unlikely	Moderate	Medium	Any infrastructure within 40 metres of watercourses will be designed, installed and maintained in accordance with the guidance series for *Controlled Activities on Waterfront Land* (DPI, 2012). Selection of watercourse crossing points will, where practical: • use existing vehicular crossings; • be located on straight sections of channel; and • maximise avoidance of steep, unstable banks, permanent pools and waterholes. Erosion and sediment control measures will be implemented during construction of watercourse crossings in accordance with the Erosion and Sediment Control Plan. Construction of watercourse crossings will only occur during periods of no flow in the watercourse, and for Phase 1 will be located at the same locations as existing water course crossings. Vehicular crossings will be designed and constructed to include appropriate stabilisation.	Unlikely	Minor	Low
Localised scour of bed and banks (Bohena Creek)	Construction	Unlikely	Moderate	Medium	There will be no releases to surface water during Phase 1. All Phase 1 watercourse crossings will be located at the same locations as existing water course crossings.	Unlikely	Minor	Low

7. Surface water management system

Generally, a surface water management system incorporates catchment and diversion structures, water storage dams, sediment basins, water transfer infrastructure, and release or discharge points.

No catchment and diversions will be constructed a part of Phase 1 that flow into dams or basins, and as such will not have any effect on the site water balance. Since there are also no dams or basins proposed as part of Phase 1, and no releases or discharges to surface water will occur during Phase 1, the management of all surface water are fully described in PWMP, the Dust Suppression Protocol and the Irrigation Management Plan.

8. Monitoring and measurement

8.1 Surface water performance criteria

The surface water performance criteria that Santos will apply are outlined in Table 8.1, with further descriptions provided in the following sections.

Table 8.1 – Surface water performance criteria

Aspect	Performance measure	Performance indicator / trigger	Response
Downstream surface water quality	Negligible change in surface water quality (compared to predicted impacts)	Surface water quality monitored is outside of the adopted trigger values (refer below) for at least one parameter for more than two consecutive monitoring events	Surface Water Quality (Watercourses) TARP
Channel stability	No increase in areas of instability within watercourses	Channel stability monitoring indicates one or more areas of decreasing stability in watercourses	Channel Stability TARP
Downstream flooding impacts	Negligible change in downstream flood access (compared to predicted impacts)	No change to flood inundation of downstream properties in major flood events	Unpredicted Impact Protocol (section 11.2)
Stream and riparian health	Riparian health	No evidence of significant weed growth or death of vegetation	Unforeseen Events Protocol in Section 10.7
	Condition of channel	No evidence of significant scour, undercutting or slumping	Channel Stability TARP
	Deposition of sediment and debris	No evidence of significant accumulation or deposition, large blockages in channel	Unpredicted Impact Protocol (section 11.2)
	General conditions	No evidence of significant hazards presented to the public, poor aesthetics or feral animals, or geomorphic instability	Unpredicted Impact Protocol (section 11.2)
Surface water user supplies	Negligible impact to downstream surface water users (compared to predicted impacts)	Disturbance areas lie within approved boundaries, as per the Field Development Protocol. No complaints from downstream water users regarding loss of surface water (quality and/or quantity)	Downstream Water Users TARP
Post-mining water pollution from rehabilitated areas of the site	Water discharged from the Project area is suitable for receiving waters and fit for aquatic ecology and riparian vegetation	Runoff water quality from rehabilitation areas is within the range of water quality data recorded from analogue sites and/or baseline data and does not pose a threat to downstream water quality	Rehabilitation TARP – refer to the Rehabilitation Management Plan

8.2 Diversions of surface water

Surface water diversion data, collected annually by DPE Water, will be reviewed and incorporated in the water monitoring program to assess the consumptive use trends within the context of trends in climate and stream flow, and to assist in assessing the status of watercourse reaches identified as being losing reaches.

8.3 Surface water monitoring network

8.3.1 DPE Water monitoring sites

The surface water facilities that have historically been monitored and maintained by DPE Water will continue under the same arrangement.

Whilst every effort will be made to continue the existing monitoring regime at nominated locations, there may be occasions where it is not possible to access these locations due to health and safety considerations associated with flooding. In these circumstances alternative arrangements will be made, where possible.

Three stream flow-gauging stations maintained by DPE Water are nominated for incorporation into the NGP regional surface water monitoring program. One station is located on Bohena Creek (7510) and two stations are located on the Namoi River (419003 and 419039).

A total of six water quality monitoring sites maintained by DPE Water are also nominated as part of the regional surface water monitoring program. Four of the nominated water quality sites are located on Bohena Creek and two are located on the Namoi River. The rationale for selecting these locations is provided in the next section.

8.3.2 Nominated surface water monitoring

The purpose of the surface water monitoring network is to identify potential adverse impacts to surface water flows and water quality that may be an effect of the Project.

Table 8.2 presents details of the nominated surface water monitoring locations for the Project. Listed in the table are the monitoring requirements for each location, the parameter to be measured, the form of measurement, the management objective to be achieved and the source of baseline data for each site. All nine of the nominated monitoring locations are maintained by DPE Water.

Table 8.2 - Monitoring program details - surface water

Locations	Parameter	Form of measurement	Management objective	Baseline / control data
419003 419039 419905	Stage height and discharge	*Field measured* • stream gauge (reduced to mAHD), using calibrated loggers, converted to discharge rate *Frequency* • Continuous (recording interval set to 6 hrs)	*Quantity* • No adverse change to stream flow regimes (timing, frequency and duration) [b] • No adverse change to water body stage heights [b]	Water baseline data [a]
7103 7506 7510 7512 419003 419039	Water quality	*Field measured* • EC, pH, DO, Eh *Laboratory* • pH, salinity (as EC and TDS), major ions, and other analytes as appropriate *Frequency* • At end of discharge event to Bohena Creek, and within 5 to 7 days after end of discharge event to Bohena Creek. [Note that this is not relevant to Phase 1].	*Quality* • No adverse change to existing beneficial use of surface water assets [b]	Water baseline data [a]

Notes:

(a) Refer to section 4.4 for water baseline data.

(b) Other than those attributable to climate variability, treated water releases, irrigation, mining and other anthropogenic influences.

The following rationale is applied in selecting the surface water monitoring locations:

- flow gauging:
  - one station on Bohena Creek (7510) to measure flows downstream of the proposed location for managed releases; and
  - two stations on the Namoi River, immediately upstream and downstream of the confluence with Bohena Creek, to assess potential effects of flow in Bohena Creek on flow in the Namoi River (419003 and 419039).
- water quality:
  - four stations on Bohena Creek, one immediately upstream (7103) and three downstream of the proposed managed release (7506, 7510 and 7512), to assess potential changes in water quality immediately downstream of the proposed managed release and prior to mixing of Bohena Creek water with Namoi River water (one of these stations is co-located with the flow gauging station on Bohena Creek); and
  - two stations on Namoi River at the same locations as the nominated flow gauging stations, to assess potential changes in water quality immediately upstream and downstream of the confluence with Bohena Creek (419003 and 419039).

Surface water monitoring activities including data analysis and evaluation occurs in accordance with the *Approved Methods for Sampling and Analysis of Water Pollutants in New South Wales* (EPA, 2022) and Santos internal protocols. Annual reporting of monitoring activities will be undertaken including an evaluation of data and review of any observed changes, as described in section 12.1.

8.4 Watercourse stability

Potential impacts on watercourse geomorphology during the Phase 1 construction activities will be limited to localised watercourse crossings for access tracks and gas and water gathering lines. The Phase 1 watercourse crossings will be the proposed flowlines crossing Yellow Spring Creek, Pine Creek and Bibblewindi Creek at locations where existing roads, tracks and gathering lines cross these watercourses.

The construction of new stabilised vehicular watercourse crossings and the implementation of appropriate erosion and sediment controls upstream and downstream will minimise any potential local impacts, and will be monitored through the ESCP. All disturbed areas will be stabilised via progressive rehabilitation, which will be monitored through the Rehabilitation Management Plan.

As part of the watercourse stability monitoring program, Santos will establish a photo monitoring program for any watercourse crossings on Yellow Spring Creek, Spring Creek, Pine Creek, Bibbewindi Creek and Bohena Creek. The program will involve taking photos at each location upstream and downstream of the proposed crossing, at clearly marked locations and from the same vantage point, and identifying any changes in any of the following:

- stream and riparian vegetation cover;
- bed condition;
- active erosion points; and
- potential areas of instability determined by the creek line inspections.

This photo monitoring will be undertaken within one week prior to and at the completion of construction activities and annually thereafter. All photos will be stored and managed through the Santos data management processes (refer to section 10) to be used for baseline and post-construction comparison. All data will be reviewed as part of the Annual Review.

If the desktop review identifies a noticeable change, a follow-up site inspection will be undertaken which will include:

- weather and climate conditions (drought, high rainfall, flooding) for the previous 12 months;
- any identified structure changes (i.e fallen trees, erosion, evidence of a high water flow event)
- any unauthorised activity, trespassing or vandalism.

If the cause of the noticeable change cannot be determined through the site investigation, a suitability qualified specialist will be engaged to assist in the investigation.

All changes will be noted and compared to the relevant TARPs in section 9. If the inspection or investigation determines that the Project activities are a cause of the noticeable change, the Unpredicted Impact Protocol in section 11.2 will be implemented.

9. Trigger action response plans

A Trigger Action Response Plan (**TARP**) is generally developed to identify, assess and respond to abnormal conditions and is implemented to manage risk to operations, personnel and the environment.

TARP(s) have been developed for the various sub-plans under the Water Management Plan, and are included and addressed in each of these individual document. TARPs associated specifically with this SWMP have been developed for Phase 1 for the following aspects, as presented in Table 9.1 to Table 9.6:

- downstream, surface water quality;
- erosion and sediment control;
- channel stability;
- downstream water users;
- downstream flooding impacts; and
- riparian vegetation.

Table 9.1 - TARP for downstream surface water quality (watercourses)

Trigger Level	Trigger	Action	Response
NORMAL	Surface water quality within trigger values for all parameters	N/A	N/A
LEVEL 1	Surface water quality concentrations outside of the adopted trigger values (refer section 3.2.4 and Appendix C) for at least one parameter for two or more consecutive monitoring rounds.	• Notify the Principal Environmental Advisor - Onshore	• Implement the Unpredicted Impact Protocol (refer to section 11.2). • Repeat any relevant recent sampling for comparison. • Investigate the source for the change in surface water quality and whether it was caused by Project-related activities
LEVEL 2	Surface water quality concentrations trending outside of the adopted trigger value (refer section 3.2.4 and Appendix C) for at least one parameter for three or more monitoring rounds.	• Notify the DPE and other relevant external agencies and departments (refer section 11.1) • Notify the EPA in accordance with the PIRMP	• Implement the Unpredicted Impact Protocol (refer to section 11.2). • Increase investigations to determine if the source for the change in surface water quality is Project-related. • Undertake and continue additional monitoring until water quality improves or the cause of the exceedance is identified.

Table 9.2 - TARP for erosion and sediment control

Trigger Level	Trigger	Action	Response
NORMAL	• No transfer of sediment from the site to downstream watercourses. • All controls are appropriately in place and well maintained. • Site inspections do not identify any unstable disturbance areas or migration of sediment away from disturbance areas.	N/A	N/A
LEVEL 1	Controls are in place, however are not maintained. One or more areas have indicated surface erosion in the form of riling, bank erosion or other movement of sediment from an area of disturbance.	• Notify the Principal Environmental Advisor - Onshore	• Seek to stabilise the area to stop the erosion process. Investigate works undertaken prior to the disturbance activities. • Review adequacy of controls and inspection/maintenance schedule.
LEVEL 2	A Stage 1 trigger or other incident leading to sedimentation of a watercourse or off-site discharge (excluding discharges from the two sediment basins at Leewood during rainfall events exceeding basin design capacity).	• Notify the DPE and other relevant external agencies and departments (refer section 11.1) • Notify the EPA in accordance with the PIRMP	• Isolate the problem area through diverting contributing surface flows to another appropriate area, while the cause for the water quality exceedances is determined. • Review adequacy of controls and inspection/maintenance schedule.

Table 9.3 – TARP for channel stability

Trigger Level	Trigger	Action	Response
NORMAL	Watercourse (photo) monitoring indicates no areas of decreased stability from visual inspections compared to the previous inspection.	N/A	N/A
LEVEL 1	Channel stability monitoring indicates one or more areas of decreased stability in watercourses relative to the previous inspection. Note that there are no new watercourse crossings as part of Phase 1.	• Notify the Principal Environmental Advisor - Onshore	• Implement the Unpredicted Impact Protocol (refer to section 11.2). • Where possible, stabilise the instabilities, which may require advice from a geomorphic specialist/engineer. • Investigate cause for instabilities and whether recent construction works or Project-related activities have caused the instability.
LEVEL 2	Channel stability monitoring indicates one or more areas of decreased stability in watercourses upstream or downstream from watercourse crossings, causing sediment loads to migrate and/or impact to riparian vegetation, relative to the previous inspection/photo monitoring event	• Notify the DPE and other relevant external agencies and departments (refer section 11.1) • Notify the EPA in accordance with the PIRMP	• Implement the Unpredicted Impact Protocol (refer to section 11.2). • Where possible, stabilise the instabilities, which may require advice from a geomorphic specialist/engineer. • Investigate cause for instabilities and whether recent construction works or Project-related activities have caused the instability.

Table 9.4 – TARP for downstream water users

Trigger Level	Trigger	Action	Response
NORMAL	No complaints from downstream water users regarding loss of surface water or degradation of water quality.	N/A	N/A
LEVEL 1	Complaint(s) from downstream water user(s) regarding loss of water availability (quality and/or quantity).	• Notify the Principal Environmental Advisor – Onshore • Respond to the complainant.	• Implement the Complaint Management process (refer to section 11.3). • Review of relevant historical monitoring results (water quality and/or flow). • Identification of any potential contributing factors. • Investigate whether the change in water availability is due to Project-related activity. • Provide feedback to complainant.
LEVEL 2	An investigation into Trigger 1 identifies that change in downstream water availability is due to Project-related activity.	• Notify the DPE and other relevant external agencies and departments (refer section 11.1) • Notify the EPA through the PIRMP if required	• Implement the Unpredicted Impact Protocol (refer to section 11.2) and the Complaint Management Process (refer to section 11.3) • Implement appropriate mitigation and management measures, which may include advice from independent water resource specialists. • Undertake additional monitoring of mitigation and management measures. • Assess the requirement to provide compensatory water supply to any landowner whose water supply has been adversely and directly impacted.

Table 9.5 – TARP for downstream flooding impact

Trigger Level	Trigger	Action	Response
NORMAL	No forecast severe weather event. Produced water system managed appropriately, with sufficient freeboard in all produced water tanks and ponds.	N/A	N/A
LEVEL 1	Forecast severe storm event Produced water system managed appropriately, with sufficient freeboard in all produced water tanks and ponds.	• Notify the Principal Environmental Advisor - Onshore	• Inspection of flood management structures to ensure integrity and absence of flow obstructions. • Evacuate construction areas if danger exists or if access is to be cut off.
LEVEL 2	Forecast severe storm event(s) or prolonged high intensity rainfall Insufficient freeboard in produced water ponds and tanks. Severe damage to flood management structures identified	• Notify the DPE and other relevant external agencies and departments (refer section 11.1) • Notify the EPA in accordance with the PIRMP	• Undertake dewatering of relevant storages to ponds where water storage capacity exists. • Inspection of flood management structures to ensure integrity and absence of flow obstructions. • Protect equipment and • infrastructure. • Evacuate construction and operational areas if danger exists or if access is to be cut off.

Table 9.6 – TARP for riparian vegetation

Trigger Level	Trigger	Action	Response
NORMAL	Watercourse monitoring indicates no significant change in riparian vegetation quality or extent when compared with historical results and/or references sites.	N/A	N/A
LEVEL 1	Monitoring indicates significant change in riparian vegetation quality or extent.	• Notify the Principal Environmental Advisor - Onshore	• Identify any potential contributing factors. • Investigate the source for the change in riparian vegetation and whether it was caused by Project-related activities.
LEVEL 2	An investigation into Trigger 1 identifies that change in riparian vegetation is due to Project-related activity.	• Notify the DPE and other relevant external agencies and departments (refer section 11.1)	• Implement appropriate mitigation and management measures, which may include advice from independent specialists. • Undertake additional monitoring of mitigation and management measures.

10. Record keeping

Santos has a data management plan for the NGP that outlines the policies and procedures that will be implemented to ensure that data is managed in a consistent, efficient and effective manner in order to provide accurate records of activity operations and enhance the value of the data collected. An overview of Santos' data management plan is presented in Figure C1 of Appendix C of the Water Management Plan, in the form of a data-management flow chart.

Santos uses a number of systems and platforms to manage the documentation and data associated with the activities under this Plan. These include Sharepoint for management plans, procedures and laboratory reports; Santos' EHS Toolbox for capturing inspections and field assessments; and EQuIS[3], an advanced environmental data management and decision support system, for capturing all data and any laboratory results.

Key records associated with this SWMP that are stored and managed include:

- operational monitoring and performance data;
- inspection and maintenance records;
- records of any review of this Plan;
- water sampling and laboratory analytical reports; and
- calibration records for field instruments and continuous water quality monitoring systems.

Monitoring data is subject to quality assurance (**QA**) and quality control (**QC**) protocols and procedures that ensure that data is accurate and usable. Data is subjected to consistent validation and verification procedures. Any data that fails QA and QC procedures is rejected for future use.

In accordance with the monitoring and recording conditions of EPL 20350 all relevant records are required to be kept for at least 4 years after the relevant event. Records are to be kept in a legible form for production to any inspector of authorised officer for a period of four years following the expiry or termination of a prospecting title (Sections 97D and 97E of the PO Act).

[3] EQuIS (Environmental Quality Information System) is a proprietary software application.

11. Incidents, non-compliances and complaints

11.1 Incidents and non-compliances

Incident reporting and non-compliance notification will be in accordance with CoC D6 and D7 respectively, as described in section 6 of the EMS. Santos will notify the DPE and any other relevant agency via the Major Projects Portal immediately after becoming aware of an incident.

Within 7 days of becoming aware of a non-compliance with the CoC, Santos will notify the Department of the non-compliance via the Major Projects Portal. This notice will set out the non-compliance, the reasons for the non-compliance (if known) and what actions have been taken, or will be taken, to address the non-compliance. A non-compliance which has been notified as an incident will not be notified as a non-compliance.

Where incidents or non-compliances associated with this SWMP are identified, Santos will:

- take all reasonable and feasible steps to ensure that the incident or non-compliance ceases and does not reoccur;
- consider all reasonable and feasible options for remediation (where relevant) and submit a report to the relevant department(s) describing options and any preferred remediation measures or other courses of action; and
- implement remediation measures as directed by the relevant department(s).

11.2 Unpredicted impact protocol

It is considered unlikely that the construction activities associated with Phase 1 will result in any unpredicted or unforeseen impacts to surface water quality, or to surface water in general within the Project area. However, in accordance with CoC D3(f), the following strategy outlined in Table 10.1 will be adopted in the event where the surface water management and impact mitigation measures do not result in the expected outcomes and conditions.

Table 11.1 - Unpredicted impact protocol

Step	Strategy
1	Stop any relevant construction activity that may be causing the unexpected event and implement immediate corrective actions to minimise the impact
2	Review the unpredicted effect or impact and consider the following: • current activities that may have triggered the event; and • activities that may not have been considered in the SWMP in causing the effect or impact; and • relevant monitoring or inspection data.
3	Notify the relevant agencies and departments
4	If appropriate, commission an investigation by an appropriate specialist
5	Based on the results of the investigation, develop the appropriate amendment and amelioration methods to resume relevant construction activities

Step	Strategy
6	Implement the information from the investigation to review, and if necessary, update this SWMP and associated documents (e.g., the ESCP) which will include any or all of the following: • a review and where required, revision of the monitoring scope detailed in section 7; • a review of any actions that may have been taken prior to the event or unpredicted impact; • a review and update of the risk assessment in section 6 (and section 4 of the WMP); and • implement any construction methodology or training based on the findings of the investigation to avoid any recurrence of the unpredicted effect or impact.

11.3 Complaint management

Santos has a documented *Complaint Management Procedure* that is communicated to all relevant staff members. Complaints can be directed to Santos via phone or email 24 hours a day, 7 days a week. Contact details are publicly available on the Project website and are presented in Appendix D of the EMS.

All complaints are logged on a complaint form which includes the following details:

- date and time of the complaint;
- complainant details;
- details of the issue or complaint;
- actions taken to remediate the issue, if any;
- follow up actions required, if any;
- details of further liaison with complainant, if any; and
- closure date and time of the issue.

As per CoC D13, Santos maintains a complaint register which is updated as required and available on the Project website.

12. Reporting, evaluation and review

12.1 Annual Review

In accordance with condition D8 and as further described in section 8 of the EMS, Santos will review the performance of its surface water management for the previous calendar year and report the relevant results within the Annual Review, to the satisfaction of the Planning Secretary. The Annual Review will be submitted via the Major Projects Portal by the end of March each year, and will at minimum provide the following information regarding:

- the effectiveness of the management measures to prevent, and if prevention is not reasonable and feasible, to minimise any impact from the management of surface waters; and
- any surface water incidents or non-compliances.

Further, the annual review under consent condition D8 requires a number of items to be reviewed or assessed. In summary these are:

- monitoring results and complaints;
- non-compliances and incidents;
- compliance with performance measures;
- discrepancies between predicted and actual impacts; and
- measures to be implemented to improve environmental performance.

The Annual Review may also make recommendations for any additions, changes or improvements to the surface water management strategies and processes.

12.2 Independent environmental audits

Within one year of commencement of Phase 1 and every three years thereafter, Santos will commission an Independent Environmental Audit (**IEA**) of the operation, to be conducted in accordance with CoC D9. The audit team will be led by a suitably qualified auditor and include experts in groundwater, well integrity, hazards, and any other fields specified by the Planning Secretary.

The IEA process is further described in section 8.3 of the EMS.

12.3 Management Plan review and evaluation

As required by CoC D4, Santos will review the suitability of existing strategies, plans and programs required under this consent, within two months of:

(a) the submission of an incident report;
(b) the submission of an Annual Review;
(c) the submission of an Independent Environmental Audit;
(d) the submission of a Field Development Plan;
(e) the submission of a Groundwater Model Update; or
(f) the approval of any modification of the conditions of this consent.

This is to ensure the SWMP is updated on a regular basis and to incorporate any recommended measures to improve the environmental performance of the Project.

In view of the various conditions requiring annual reviews, suitability assessments and performance evaluations, it is recommended that this SWMP be reviewed and, if necessary, updated in at least the following circumstances:

- in accordance with any direction from the NSW EPA or the Minister administering the PO Act;
- due to any significant change to the monitoring or management processes as described herein. If there is ambiguity in relation to whether there is a significant change, Santos will consult with the Planning Secretary to determine whether the SWMP must be reviewed; and
- otherwise at intervals of no longer than one year.

The review history table in the front of this Plan provides the details of each review, conducted in accordance with condition D4.

As required by CoC D5, if the review under condition D4 determines that the SWMP requires revision - to either improve the environmental performance of the development, cater for a modification or comply with a direction - then Santos will submit the revised document to the Planning Secretary for approval within 6 weeks of the review.

Further details on the reporting, evaluation and review of the SWMP is provided in section 8 of the EMS.

12.4 Improvement measures

Santos will conduct a program to investigate and implement ways to improve the environmental performance regarding surface water management over time, and implement a protocol for the periodic review of the SWMP, in accordance with CoC D3(g) and (i) respectively.

Measures to improve the environmental performance of the Project that will be implemented following review and evaluation include the following:

- regular internal audits of the surface water management process, and the implementation and maintenance or management measures;
- modifications to the SWMP to reflect changing site and Project conditions; and
- regular monitoring and site inspections.

The protocol for review is set out by consent conditions D8, D4 and D5, which have been addressed in sections 11.1 and 11.3 above.

In accordance with CoC D13 and as described in section 8 of the EMS, all relevant monitoring data and associated reports will be made available on the Project website, for the duration of the Project. This information will be kept up to date.

13. References

ANZECC/ARMCANZ (2000). *Australian and New Zealand guidelines for fresh and marine water quality*. Australian and New Zealand Environment Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand.

BOM (2020a) *Climate statistics of Australian locations, Narrabri bowling club*. Australian Bureau of Meteorology. Accessed 4 November 2020. Bureau of Meteorology.

BOM (2020b) *Climate statistics of Australian locations, Gunnedah pool*. Australian Bureau of Meteorology. Accessed 4 November 2020. Bureau of Meteorology.

BOM (2020c) *Climate statistics of Australian locations, Narrabri Airport*. Australian Bureau of Meteorology. Accessed 4 November 2020. Bureau of Meteorology.

Department of Regional NSW (2022). *Exploration Code of Practice: Rehabilitation*.

DECC (2008). *Managing Urban Stormwater: Soils and Construction, Volume 2C, Unsealed Roads*. Department of Environment & Climate Change

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DPI (2012). *Controlled Activities on Waterfront Land*.

DPI (2013). *Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management*

GHD (2017). *Narrabri Gas Project Environmental Impact Statement*. Prepared for Santos Ltd.

Landcom (2004) *Managing Urban Stormwater - Soils and Construction: Volume 1*.

OEH (2012). *Erosion and Sediment Control of Unsealed Roads - A Field Guide for Erosion and Sediment Control Maintenance Practices*

NSW Fisheries (2003). *Why Do Fish Need To Cross The Road? Fish Passage Requirements for Waterway Crossings*

NRAR (2018). *Guidelines for Controlled Activities on Waterfront Land*.

Standards Australia (2017). *Australian Standard/New Zealand Standard International Standards Organisation 1940:2017 - The storage and handling of flammable and combustible liquids*.

14. Glossary

Term	Definition[4]
Access track	Cleared and graded track constructed where existing tracks are not available
Alignment	The line or lines that describe a linear-infrastructure route; it defines how linear infrastructure (such as a road, access track or pipeline) will be located in relation to the features encountered along the route
Alluvial	Sediments deposited following a decrease in velocity of flowing water
Alluvium	General term for unconsolidated fluvio-lacustrine deposits of inorganic materials (clay, silt, sand, gravel, and boulders) deposited following a decrease in velocity of flowing water
Amended treated water	Produced water that has undergone treatment and amendment, as generally described in the EIS, to enable it to be used for beneficial reuse purposes including irrigation, stock watering, drilling, construction and dust suppression
Approved disturbance area	The disturbance areas shown in the EIS as modified by any approved Field Development Plan
Aquatic ecosystems	The physical and chemical environment that contains a community of organisms (plants, animals, and microbes), and ecological processes within rivers and their riparian zones and reservoirs, lakes, wetlands and their fringing vegetation
Baseline	A starting point used for future comparisons. Water baselines in context of the Narrabri Gas Project have been derived from long term water level and quality data presented in the Narrabri Gas Project Water Baseline Report.
Beneficial use	Beneficial use refers to the use of waters, including produced water from an oil or gas well, for a secondary purpose that has a positive value. Potential beneficial use options for produced water include domestic and livestock supply, industrial supply, irrigation supply, dust suppression and recreation.
Bund (or bunding)	Wall of a secondary containment system, usually in the form of an embankment, used to prevent sediment and liquids from entering the environment
Catchment	The area of land that collects and transfers rainwater into a watercourse
Cation exchange capacity	The number cations (positively charged ions) available in a soil. Cation exchange capacity can be used as a measure of soil fertility
Council	Narrabri Shire Council
Department	NSW Department of Planning and Environment (DPE)
Depressurisation	The extraction of coal seam water to facilitate gas production causes depressurisation of the target coal seams, which has the potential to propagate into surrounding formations.
Discharge spring	Occur where water that has recharged sandstone sediments that outcrop on the margins of the Great Artesian Basin discharges after having travelled underground for relatively large distances and over an extended period of time.
Ecosystem	An interconnected biological community of organisms that interact with each other and their physical environment.
EIS	The Environmental Impact Statement titled Narrabri Gas Project Environmental Impact Statement, dated 31 January 2017, submitted with the development application, including the Applicant's response to submissions

[4] The majority of the definitions are as provided in the Development Consent for SSD 6456.

Term	Definition[4]
	and supplementary response to submissions, and the additional information provided by the Applicant to the Department in support of the application
Ephemeral	Relates to the amount of time that surface water persists in a watercourse or wetland; ephemeral watercourses flow only during significant rainfall events and for a short-time following rainfall events. Also known as intermittent.
Erosion	Wearing away of rock or soil caused by physical or chemical processes
Exploration well	A petroleum well that is drilled to: a) Explore for the presence of petroleum or natural underground reservoirs suitable for storing petroleum, or b) obtain stratigraphic information for the purpose of exploring for petroleum. For clarity, an exploration well is not a production well
Feasible	Means what is possible and practical in the circumstances
Gaining stream	Streams that gain water from inflow of groundwater through the streambed. This can occur permanently or seasonally.
Gas field infrastructure	All Project-related infrastructure, excluding the Leewood facility, Bibblewindi facility and the road upgrades required under SSD 6456
Gas well	Pilot wells and production wells
Gathering lines	Pipelines used to transfer gas and produced water from wells
Incident	An occurrence or set of circumstances that causes or threatens to cause material harm and which may or may not be or cause a non-compliance
Irrigation scheme	The use of water for agricultural production. In the case of the Narrabri Gas Project, treated water is proposed to be used for irrigation as part of the overall Produced Water Management Plan
Linear infrastructure	Project related infrastructure of a linear nature including gas and water gathering lines, gas and water pipelines, access tracks, power lines, communication lines and other service lines
Losing stream	Streams that lose water by outflow through the streambed. This can occur permanently or seasonally
Major facilities	Leewood facility and Bibblewindi facility
Managed release scheme	The managed release of treated water into Bohena Creek as one of the beneficial uses of produced water
Material harm	Is harm that: • involves actual or potential harm to the health or safety of human beings or to the environment that is not negligible, or • results in actual or potential loss or property damage of an amount, or amounts in aggregate, exceeding $10,000 (such loss includes the reasonable costs and expenses that would be incurred in taking all reasonable and practicable measures to prevent, mitigate or make good harm to the environment) This definition excludes “harm” that is authorised under either SSD 6456 or any other statutory approval
Minimise	Implement all reasonable and feasible mitigation measures to reduce the impacts of the Project
Mitigation	Activities associated with reducing the impacts of the development
Namoi Alluvium	The Upper Namoi Alluvium, an aquifer made of coarse-grained river gravels and sands. The Lower Namoi Alluvium, a hydrostratigraphic unit made of shallow alluvial fan deposits associated with the Namoi River. These units contain a significant resource of readily accessible, good quality groundwater that is heavily utilised for irrigation, public water supply, private water supply

Term	Definition[4]
	and livestock
Non-compliance	An occurrence, set of circumstances or development that is a breach of the SSD 6456 consent
Petroleum Assessment Lease 2 (PAL 2)	A PAL is required to hold the exclusive right to prospect for petroleum and to assess any petroleum deposit over a specified area of land in NSW. A lease allows the holder to maintain a title over a potential area, without having to commit to further exploration. The holder can, however, continue prospecting operations and to recover petroleum in the course of assessing the viability of commercial mining. PAL 2 is held by Santos NSW Pty Ltd.
Petroleum Exploration Licence 238 (PEL 238)	Before exploring for minerals or petroleum in NSW, an explorer must first obtain a Petroleum Exploration Licence (PEL) under the Petroleum (Onshore) Act 1991. An exploration licence gives the licence holder exclusive rights to explore for petroleum or specific minerals within a designated area but it does not permit mining, nor does it guarantee a mining or production lease will be granted. PEL 238 is held by Santos NSW Pty Ltd.
Petroleum Production Lease 3 (PPL 3)	A petroleum production lease gives the holder the exclusive right to extract petroleum within the production lease area during the term of the lease. PPL 3 is held by the following titleholders: • Santos QNT Pty Ltd; • Santos NSW (Hillgrove) Pty Ltd; and • Santos NSW (Eastern) Pty Ltd.
Petroleum production lease application (PPLA)	A petroleum production lease gives the holder the exclusive right to extract petroleum within the production lease area during the term of the lease. Development consent under the Environmental Planning and Assessment Act 1979 must be in place before a petroleum production lease can be granted. Santos, on behalf of its joint venture partner lodged four petroleum production lease applications under the PO Act in May 2014 for the Project area, being PPLAs 13, 14, 15 and 16. The ownership of the application is now held by Santos NSW Pty Ltd.
Pilot well	A well for gas and water extraction, for the purpose of exploration, appraisal and assessment of the gas field potential
Planning Secretary	Planning Secretary under the EP&A Act, or nominee
Produced water	Any form of groundwater that is actively extracted from a borehole, well or excavation, excluding incidental groundwater mixed with drilling fluids
Production well	A well for gas and water extraction, for the purpose of commercial gas production and/or use
Project area	The area of approximately 95,000 hectares that encompasses the Project
Project footprint	The area of surface expression being about 1,000 hectares occupied by the infrastructure components of the Narrabri Gas Project
Project-related infrastructure	All infrastructure and other structures associated with the development. This includes linear infrastructure and non-linear infrastructure, surface infrastructure and subsurface infrastructure, major facilities, wells and well pads and other gas field infrastructure
Public infrastructure	Linear and related infrastructure that provides services to the general public, such as roads, railways, water supply, drainage, sewerage, gas supply, electricity, telephone, telecommunications, etc.
Reasonable	Means applying judgement in arriving at a decision, considering mitigation benefits, cost of mitigation versus benefits provided, community views and the nature and extent of potential improvements

Term	Definition[4]
Recharge spring	A spring supported by water that recharges sandstone sediments that outcrop on the margins of the Great Artesian Basin and discharge locally after relatively short residence times.
Registered bore	A water bore whose presence has been notified to the Water NSW and included in its registered groundwater bore database. The database typically includes details on bore location, construction and where possible, the source aquifer.
Rehabilitation	The restoration of land disturbed by the development to ensure it is safe, stable and non-polluting over the short, medium and long term
Riparian	Situated along or near the bank of a watercourse
Spring	A naturally occurring discharge of groundwater flowing out of the ground, often forming a small stream or pool of water. Typically, it represents the point at which the water table intersects the ground level.
Scour	Erosion of sediment that occurs around structures in a watercourse due to increased velocity
Sediment	Particles derived from rocks or biological materials that have been transported by air or water
Sedimentation	Deposition or accumulation of mineral or organic matter deposited by air or water
Strahler stream order	The stream order classification system based on Strahler, A.N. (1952) Dynamic basis of geomorphology. Geological Society of America Bulletin, 63, 923-938
Transmissivity	Rate in which water of a given density and viscosity is transmitted through a unit width of aquifer or aquitard under a unit hydraulic gradient.
Treated water	Produced water that has undergone treatment to enable it to be used for beneficial reuse purposes including irrigation, stock watering, drilling[5], construction and dust suppression, and/or for managed release to Bohena Creek[6]
Unacceptable risk	The level of risk at which mitigation actions are deemed to be warranted.
Watercourse	A river, creek or other stream, including a stream in the form of an anabranch or tributary, in which water flows permanently or intermittently, regardless of the frequency of flow events: In a natural channel, whether artificially modified or not, or in an artificial channel that has changed the course of the stream. It also includes weirs, lakes and dams
Water sharing plan	Legislated plans under the *Water Management Act 2000* that establish rules for sharing water between the environment and water users. Water licences are issued to water users in accordance with water sharing plans
Well	Pilot wells and production wells
Well pad	An area of up to 1 hectare in size upon which the gas wells are to be located, with the area decreasing to no more than 0.25 hectares following rehabilitation[7], or other area as may be approved in the Field Development Plan

[5] Note that when 'drilling' is stated in consent conditions, where relevant this has been interpreted to mean 'drilling and completions'

[6] Note that there will be no discharge to Bohena Creek during Phase 1.

[7] Workover activities will be contained within the operational area of the well pad area of around 0.2 ha, with an additional laydown area that could be approximately 0.2 ha in size.

Appendix A - Consultation records

NSW GOVERNMENT | Natural Resources Access Regulator

Contact: Tim Baker
Phone: 0428 162 097
Email : Tim.Baker@nrar.nsw.gov.au

Our ref: V15/3875-5#53
File No:
Your Ref:

10 November 2021

Dave Gornall
Santos Limited
email: David.Gornall@santos.com

Dear Dave

Re: Narrabri Gas Project - Water Management Plans third batch

Thank you for the opportunity to provide comment on the third set of plans under the Water Management Plan requirement for Phase 1 of the Narrabri Gas Project. It is understood this consultation is in accordance with Condition B41 of Project Approval SSD 6456. The plans reviewed include the Dust Suppression Protocol, Site Water Balance and the Surface Water Management Plan. NRAR is satisfied the consultation requirements have been met in respect to the plan preparation and provides the following comments and recommendations.

Dust Suppression Protocol

- Recommend a reference to the Water Access Licences held under the *Water Management Act 2000* be included in Section 3 that are to be used to account for water take used for dust suppression. Include in Section 3.1 the need to comply with conditions on the licence.
- Include details of monitoring and reporting on the volumes of water taken for dust suppression from the various sources proposed, eg. bores, treated or amended water.
- Include a map to depict the points where water used for dust suppression is sourced from, stored and any transfer infrastructure.
- Include protocols to determine the priority of water sources used for dust suppression. It is noted relevant details are included in Section 5.1.1 of the Site Water Balance.

Site Water Balance

- It is noted two of the WALs in Table 4.2 currently do not nominate any works. If these WALs are to be used to account for water take in Phase 1, the relevant Miscellaneous Work will need to be nominated on the WAL via an application to WaterNSW. Where any WALs that currently nominate works are now not required because of the State Significant Development status, it is recommended these be amended via application to WaterNSW to nominate the relevant Miscellaneous Work.

- Include a detailed plan overlying an aerial image to a suitable scale depicting the location of water related infrastructure, including water supply bores, wells that supply water, water storage facilities (produced water, runoff capture - dirty/clean), water pipelines and monitoring bores. This information is critical to understand the locations of infrastructure to aid interpretation of system operation, monitoring and potential impacts, and to also clarify the location of extraction and storage of licensed water or where exemptions/exclusions apply. It is recommended a table be included which lists each water storage, the source of the water it receives and whether licensed entitlement or an exemption applies.
- Include locations of metering points on the water infrastructure which are to be used to quantify water take from authorised extraction points, water take from exempt sources, and/or used to inform the water balance for the site. Please note metering will need to meet the requirements of the NSW Non-Urban Water Metering Policy and associated roll out timeframes. Further information on this can be obtained at the following link: https://water.dpie.nsw.gov.au/nsw-non-urban-water-metering or email metering.reform@dpie.nsw.gov.au
- In Table 7.1 clarification is requested on the source of water that applies to the reference to "groundwater" in inflows. It is assumed this is referring to supply from bores. If correct, please add a reference to bore supply or something related in the name.

Surface Water Management Plan

- It is noted the Surface Water Management Plan doesn't include any references to management of surface water via capture in storages or diversions. Based on condition B41 which refers to the need for detailed plans, design objectives and performance criteria for these types of works this information should be included in this plan. A detailed plan overlying an aerial image is requested which depicts the surface water management infrastructure eg. sediment basins, diversions, and their design and operational objectives to mitigate impact.
- In Table 6.1 it is recommended to include in the mitigating measures for watercourse crossings a reference to the Guidelines for Controlled Activities on Waterfront Land in relation to the design, construction and rehabilitation of watercourse crossings. This is consistent with condition B37 of the consent.
- As there is a performance measure to maintain or improve baseline channel stability in affected watercourses it is recommended appropriate monitoring sites be selected downstream of potential disturbance areas such as watercourse crossings and discharge points. Disturbance areas associated with future phases of the project should also be considered for monitoring sites as this will assist in gathering required baseline data.

For further information please contact Tim Baker, Senior Water Regulation Officer on 0428162097 or **e:** Tim.Baker@nrar.nsw.gov.au

Yours sincerely

Jeremy Morice
A/Manager Licensing and Approvals – Water Regulatory Operations - West
Natural Resources Access Regulator
Department of Planning, Industry and Environment

Santos

Management Plan Consultation Feedback Form

DOCUMENT TITLE:	**Surface Water Management Plan**
STAKEHOLDER:	**NSW Environment Protection Authority**
CONSULTATION RELEASE DATE:	**30 August 2021**
COMMENTS DUE DATE:	**29 October 2021**

General Feedback	
Key Issues	Apart from the issue relating to unamended effluent reuse for dust suppression (see Dust Suppression Protocol feedback form), the EPA does not have comments on any other aspects of the SWMP.
Suggestions for improvement	Nil

Section	**Type**	**Specific Feedback** *Detail specific issues with certain sections in the document*
eg Section 2	*Legislative + Regulatory reqs./ Readability / Usability /*	*Further detail is required about when a report is required and how the report is to be submitted.*

Department of Planning and Environment

Our ref: OUT22/19586

Wayne Jones

Department of Planning and Environment

Email: wayne.jones@planning.nsw.gov.au

8 November 2022

Subject: **Narrabri Gas Project (SSD – 6456) – Phase 1 Surface Water Management Plan – Revision 0A, 18 October 2022**

Dear Mr Jones

I refer to your request for advice sent on 25 October 2022 to the Department of Planning and Environment (DPE) Water about the above matter.

DPE Water has reviewed the Surface Water Management Plan (SWMP) (Revision 0A, dated 18 October 2022) prepared for Phase 1 activities of the Narrabri Gas Project. We recommend that the proponent:

- include more detail in the trigger action response measures on channel stability to clarify the specific measures proposed.
- develop the water quality trigger values from baseline data using methods described in ANZECC (2000) and more recent updates in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

Please note detailed advice in Attachment A.

Should you have any queries in relation to this submission please do not hesitate to contact DPE Water Assessments at water.assessments@dpie.nsw.gov.au

Yours sincerely

Mitchell Isaacs
Chief Knowledge Officer
Department of Planning and Environment: Water

Department of Planning and Environment

NSW GOVERNMENT

Attachment A

Detailed advice regarding the Narrabri Gas Surface Water Management Plan (SSD-6456-PA-42) – Revision 0A, 18 October 2022

1.0 Monitoring and performance measures

1.1 Recommendation

That the trigger action response measures for channel stability be stated more clearly, including any remedial actions should disturbance lead to scour or slumping of the high sand content banks of the watercourse. These measures should be derived from the guideline, "A Rehabilitation Manual for Australian Streams (Land & Water Resources Research and Development Corporation, 2000)".

1.2 Explanation

The trigger action response measures are generally in line with recommended response actions but are not clearly outlined. Further detail is required, including any remedial actions should disturbance lead to scour or slumping of the high sand content banks of the watercourse.

Bohena Creek is the most vulnerable river in the area and is an intermittent river (not ephemeral as described). Appropriate response measures are critical to ensure impacts can be managed. An 80m buffer zone from the top bank of Bohena Creek as proposed is acceptable from a geomorphic perspective as the channel is very wide along its length outside the Pilliga State Forest.

1.3 Recommendation

That the water quality trigger values be developed from baseline data using methods described in ANZECC (2000) and more recent updates of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

1.4 Explanation

The use of regional objective values and ANZECC default trigger values as triggers for further investigation may indicate when a change in beneficial use category has occurred. However, this will not necessarily indicate negligible change in surface water quality as listed as a performance measure in Table 8.1. Trigger values should be developed from baseline data using methods described in ANZECC (2000) and more recent updates of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

End of Attachment A

Surface Water Management Plan – NRAR comments received on Revision C (draft)

Item	Section #	Section heading	Existing text	Comment	Draft response
1	N/A	General	No specific text reference	It is noted the Surface Water Management Plan doesn't include any references to management of surface water via capture in storages or diversions. Based on condition B41 which refers to the need for detailed plans, design objectives and performance criteria for these types of works this information should be included in this plan. A detailed plan overlying an aerial image is requested which depicts the surface water management infrastructure e.g,. sediment basins, diversions, and their design and operational objectives to mitigate impact	Phase 1 allows for the pilot well ancillary infrastructure, including access tracks, gas and water gathering lines, water balance tanks, safety flaring infrastructure, utilities and services, and environmental monitoring equipment including groundwater monitoring bores There will not be any construction of storages, sediment basins or diversions during Phase 1., and there will be no capture of surface water.
2	6.6	Flooding	Table 6.1 - Risk assessment and mitigation	In Table 6.1 it is recommended to include in the mitigating measures for watercourse crossings a reference to the Guidelines for Controlled Activities on Waterfront Land in relation to the design, construction and rehabilitation of watercourse crossings. This is consistent with condition B37 of the consent.	A reference to the DPI guidelines has been included in the table.
3	N/A	General	No specific text reference.	As there is a performance measure to maintain or improve baseline channel stability in affected watercourses it is recommended appropriate monitoring sites be selected downstream of potential disturbance areas such as watercourse crossings and discharge points. Disturbance areas associated with future phases of the project should also be considered for monitoring sites as this will assist in gathering required baseline data.	The baseline channel stability in the vicinity of any potential disturbance areas such as watercourse crossings and discharge points will be identified and assessed prior to any works. Future work locations will be identified as early as possible to assist in the gathering relevant baseline data.

Note:
The numbering of the sections and appendices between the draft and final version of the document may have changed.

Surface Water Management Plan – WTAG comments received on Revision C (draft)

Comments received from Randall Cox, Jack Warnock and Michael Williams

Item	Section #	Section heading	Existing text	Comment	Final response
1		General	No specific text reference	**[Jack Warnock]** I would like to see more acronyms included in the "Acronyms and Abbreviations" section of reports (e.g. **EQuIS** – page 37, Section 9. Record Keeping, second paragraph)	EQuIS (Environmental Quality Information System) is a proprietary software application. A footnote with an explanation has been provided, and 'EQuIS' has been added to the acronyms and abbreviations list.
2	1.6	Structure of this Plan	Provides details of the of any potential surface water impacts	**[Jack Warnock]** This sentence Requires clarification	Correction has been made: *Provides details of any potential surface water impacts*
3	4.1	Regional climate	No specific text reference	**[Michael Williams]** Is a climate station proposed with the Narrabri Gas Project area?	A suitable meteorological station will be installed in the Project area prior to Phase 1.
4	4.1	Regional climate	No specific text reference	**[Michael Williams]** How and from what data was the evaporation derived?	The evaporation data is a direct reproduction of section 13.2.2 (Rainfall and evaporation) of Chapter 13 of the EIS. The source has been referenced in the Plan.
5	4.1	Regional climate	No specific text reference	**[Michael Williams]** Can the source of the wind data be referenced?	The wind rose and associated data was reproduced from section 18.3 of Chapter 18 of the EIS, with a direct reproduction of Figure 18-2. This in turn was extracted from Appendix L of the EIS. The source has been referenced in the Plan.
6	4.4	Surface water quality baseline	No specific text reference	**[Michael Williams]** Is this site information consistent with the Santos water portal? This information is much more focused on the Narrabri Gas Project (as would be expected).	The information provided in section 4.4 is consistent with the Santos water portal.
7	4.4	Table 4.3 Baseline surface water quality locations	Namoi River near the proposed irrigation areas"	**[Jack Warnock]** Site 7513 may be near **existing irrigation developments.** This sentence requires clarification	A correction has been made to the table, to refer to '*existing irrigation developments*'.
8	4.4	Table 4.3 Baseline surface water quality locations	No specific text reference	**[Randall Cox]** The table calls up the water quality monitoring points as 'Santos' while the flow gauging points in Table 4.2 are called up as 'DPIE'. Chapter 7 (7.3.1) refers to 'six water quality monitoring sites that are maintained by DPIE'. As water quality points perhaps they are not 'maintained' in terms of infrastructure but 'maintained' in the sense that time series data is collected.	The text has been reviewed to clarify the party that collects the actual data.
9	4.4.1	Table 4.4 Baseline water quality data for the Namoi River	No specific text reference	**[Michael Williams]** Is the period over which the samples were collected available?	The text has been amended to include reference to the sampling period which was February 2012 to October 2015.
10	4.4.1	Table 4.4 Baseline water quality data for the Namoi River	The water quality data of the Namoi, including data shown in Table 4.5 suggests that	**[Randall Cox]** The stem sentence for the dot points under Table 4.4 says'…. including data shown in Table 4.5'. The dot points seem to be drawn from Table 4.4 with separate and parallel discussion section 4.4.2 for Bohenia Cr. Should the reference to Table 4.5 be deleted?	A correction has been made to refer to Table 4.4, rather than Table 4.5: The water quality data of the Namoi, including data shown in *Table 4.4* suggests that:…..
11	5.3	Dust suppression, construction and drilling	The risks have been assessed by comparing the qualities of the three water types against the baseline values for Bohena Creek, as provided in Table 4.5.	**[Randall Cox]** Should the reference in 4th line be to 'Table 5.1' rather than 'Table 4.5'	The reference to Table 4.5 is correct. However, the text has been amended to clarify: The risks have been assessed by comparing the qualities of the three water types against the baseline values for Bohena Creek, *as shown* in Table 4.5.
12	5.3	Dust suppression, construction and drilling	No specific text reference	**[Randall Cox]** It seems that the data for 16th and 84th percentiles for Bohena Cr should be same in Tables 4.5 and 5.1, but they are different?	Table 5.1 has been removed, and section 5.3 has been rewritten to refer to the Dust Suppression Protocol.

Item	Section #	Section heading	Existing text	Comment	Final response
13	5.3	Dust suppression, construction and drilling	Note also that the comparison above is indicative only and assumes that treated and / or amended water is directly introduced into Bohena Creek by comparing against baseline water quality. It does not consider environmental factors such as dilution effects from rainfall events and / or catchment runoff for example.	**[Randall Cox]** I see the intent of the second and third last sentences but suggest the point could be made more clearly. The 'comparison' doesn't 'assume' anything. I think the point is that to mitigate risk the treated amended water would be applied in ways that seek to avoid any of the applied water entering the creek.	The last two sentences of section 5.3 were causing some confusion and have been deleted. Section 5.3 has been rewritten to refer to the Dust Suppression Protocol.
14	5.4	Irrigation	No specific text reference	**[Randall Cox]** In Section 5.3 there was a focus on data to point out that there are some (manageable) water quality issues if using treated/amended water for dust suppression. Is the same not the case for irrigation? or is reasoning that dust suppression could be close to Bohena creek but irrigation will be more remote. Seems that the point should be made.	Section 5.3 has been rewritten to refer to the Dust Suppression Protocol, and to apply an approach consistent with section 5.4.
15	5.4	Irrigation	Managed as detailed in the IMP, there is a very low risk of irrigation water causing any impact to surface water quality through runoff.	**[Jack Warnock]** I have mentioned this issue previously, and again I caution SANTOS that there could very well be a situation where runoff is not contained on the irrigation area. Provision for collecting and storing storm water runoff could be important in the future when irrigation area is utilised for treated water application.	Refer to responses to comments on the Irrigation Management Plan.
16	5.5	Managed release	No specific text reference	**[Randall Cox]** In Section 5.3 there was a focus on data to point out that there are some (manageable) water quality issues if using treated/amended water for dust suppression. Although managed release is not intended under Stage 1, it is expected under some future circumstances. I guess the fact that release will occur on the back of 100 ML/d flows is the way the water quality risk will be managed. Seems like the point should be made.	Section 5.5 has been amended to simply state the following: *There will be no releases to surface waters during the Phase 1 activities*.
17	6.6	Flooding	Potential for impacts will be greater in areas that **areas that** are flat, low-lying or otherwise susceptible to flood.	**[Jack Warnock]** This requires editing.	Sentence has been corrected to: *Potential for impacts will be greater in areas that are flat, low-lying or otherwise susceptible to flood.*
18	6.6	Table 6.1 Risk assessment and mitigation	No specific text reference	**[Randall Cox]** Section 5.3 pointed to a risk with regard to quality of water used for dust suppression. The point was made that the treated/amended water is less compatible with the Bohena creek water than is the bore water. To be consistent with 5.3 shouldn't line 2 of the table say that 'bore water will be used in preference' and/or 'if treated/amended water is used runoff will be avoided'. Seems that since a fair bit of trouble has been taken to note the difference in water quality in section 5.3 there should be some follow through in Table 6.1 In section 6.3 there is text about using treated/amended water only on an 'as needed basis' but that doesn't follow into Table 6.1.	The CoC allow the use of treated, amended treated and bore water for dust suppression. Line #2 of Table 6.1 states that dust suppression will be conducted in accordance with the Dust Suppression Protocol. In turn, section 5 of the Dust Suppression Protocol states that only bore water will be used for dust suppression during Phase 1.
19	10	Evaluation and review	No specific text reference	**[Randall Cox]** Should the reference to 'Secretary' be the 'Planning Secretary' as defined in the Glossary	Although 'Secretary' and 'Planning Secretary' are both used in the CoC (refer to CoC D5), a correction has been made to refer to the Planning Secretary in all plans and protocols.
20	Appendix A	Table A1	Towards the bottom of the page: " **water supply for other water users;"**	**[Jack Warnock]** Could this reference be explained and the location in the Irrigation Management Plan? I understand no water supply will be made available to other "water users".	Making treated effluent water available for use by other water users is an option that is under consideration for Phase 2, but would be subject to approval from the EPA. The Irrigation Management Plan refers to potentially other users in section 3.2.1, in Table 3.1 (under Resource use).

Item	Section #	Section heading	Existing text	Comment	Final response
21	General	General	No specific text reference	**[Randall Cox]** I suggest the discussion around water quality could be changed a little to improve readability. Table 4.4 (Namoi) lists ions alphabetically while Table 4.5 (Bohena) lists them in order of decreasing value. Since there is an immediate tendency to compare them it would help if they were presented consistently. There is one dot point at the bottom of the 4.4.2 section that discusses reasons for the difference in conductivity between the two watercourses. Seems that it would be good to have a separate section 4.4.3 that discusses the differences. Chapter 7 Suggest check the use of the words ‘stations, ‘sites’, ‘locations’ in text and tables. I don’t think differences are intended for ‘sites’ and ‘locations’. Earlier (section 4) monitoring sites were called up as either quality or flow gauging, and location maps were given for each. In Chapter 7 two of the gauging sites are now to be used also for quality monitoring. Suggest it would be helpful to include a map of the 7 sites with symbols to show if they gauge sites, quality or both. The map would make it easier to follow the well-argued logic for choosing the sites.	Tables 5.1 has been deleted (in line with the response to Item #12). There is no added value for a further discussion on the differences in EC between Bohena Creek and the Namoi River, since the likely reason (freshwater recharge) is already provided. The use of ‘sites’ and ‘locations’ will be reviewed for the suite of water management plans, once all plans have been reviewed. Where relevant, figures and maps will be provided to clarify.

Note:
The numbering of the sections and appendices between the draft and final version of the document may have changed.

Appendix B - Consent conditions relevant to the SWMP

Table B1 - SSD 6456 consent conditions directly relevant to this SWMP

SSD 6456 consent conditions directly relevant to this SWMP	Section reference
Consent condition A1 In meeting the conditions of this consent, the Applicant must implement all reasonable and feasible measures to prevent and, if prevention is not reasonable and feasible, minimise any material harm to the environment that may result from the construction, operation or rehabilitation of the development.	Section 1.2
Consent condition A5 The Applicant may only undertake the development in the following stages:	Section 1.1.2 Section 1.2
a) Phase 1, comprising ongoing exploration and appraisal activities;	
b) Phase 2, comprising construction activities for production wells and related infrastructure;	
c) Phase 3, comprising gas production operations; and	
d) Phase 4, comprising gas well and infrastructure decommissioning, rehabilitation and mine closure.	
Consent condition A23 With the approval of the Planning Secretary, the Applicant may:	
a) prepare and submit any strategy, plan or program required by this consent on a staged basis (if a clear description is provided as to the specific stage and scope of the development to which the strategy, plan or program applies, the relationship of the stage to any future stages and the trigger for updating the strategy, plan or program	Section 1.2
b) combine any strategy, plan or program required by this consent (if a clear relationship is demonstrated between the strategies, plans or programs that are proposed to be combined);	No combination proposed as part of this Plan
c) update any strategy, plan or program required by this consent (to ensure the strategies, plans and programs required under this consent are updated on a regular basis and incorporate additional measures or amendments to improve the environmental performance of the development); and	Section 1.2 Section 11.4
d) combine any strategy, plan or program required by this consent with any similar strategy, plan or program required by a consent	No combination proposed as part of this Plan
Consent condition B36 The Applicant must ensure that all surface discharges from the development comply with:	
a) discharge limits (both volume and quality) set for the development in any EPL or Resource Recovery Exemption and Order (**RREO**); and	Section 3.1.3 ESCP Appendix B
b) relevant provisions of the POEO Act.	Section 3.1.3
Consent condition B37 The Applicant must ensure that the development complies with the water management performance measures in Table 7 [of the CoC]:	
• Riparian and aquatic ecosystems	
▪ maintain or improve baseline channel stability in affected watercourses;	Section 4.2 Section 8.4
▪ negligible change to surface water quality in any watercourse;	Refer to the ESCP

SSD 6456 consent conditions directly relevant to this SWMP	Section reference
▪ design, install and maintain any infrastructure within 40 metres of watercourses in accordance with the guidance series for *Controlled Activities on Waterfront Land* (DPI Water, 2012); and	Section 6.6
▪ design, install and maintain any creek crossings generally in accordance with the *Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013) and *Why Do Fish Need To Cross The Road? Fish Passage Requirements for Waterway Crossings* (NSW Fisheries, 2003).	Section 6.6
Consent condition B41 Prior to the commencement of Phase 1, the Applicant must prepare a Water Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:	
d) include a	
(iii) Surface Water Management Plan, that includes:	
• detailed baseline data on surface water flows and quality of watercourses and/or waterbodies potentially impacted by the development (based on at least 3 years of monitoring data, where available), including:	Section 4.
▪ stream and riparian vegetation health;	Section 4.5
▪ channel stability (geomorphology);	Section 4.2.2
▪ water supply and quality for other surface water users; and	Section 4.4
▪ natural methane leaks and accumulations;	Section 4.6
• a detailed description of the surface water management system;	Section 7
• detailed plans, design objectives and performance criteria for water infrastructure, including:	
▪ any creek restoration works associated with the development;	Section 6.6
▪ water run-off diversions and catch drains;	Section 6.6. Also refer to the ESCP
▪ water storages and sediment dams;	No water storages or sediment dams in Phase 1
▪ water discharge pipelines and infrastructure; and	Not Phase 1
▪ reinstated drainage networks on rehabilitated areas of the Project area;	Section 6.6
• detailed performance criteria, including trigger levels for identifying and investigating any potentially adverse impacts associated with the development for:	Section 3.2.4 Appendix C Also refer to the ESCP
▪ downstream surface water flows and quality;	Section 8.1
▪ channel stability;	
▪ downstream flooding impacts;	
▪ stream and riparian vegetation heath;	
▪ water supply for other water users; and	

SSD 6456 consent conditions directly relevant to this SWMP	Section reference
▪ post-mining water pollution from rehabilitated areas of the Project area	Not relevant to Phase 1
• a program to monitor, evaluate and report on:	Section 8 No discharge sites in Phase 1 Reporting in section 12.1
▪ compliance with the relevant performance measures listed in Table 7 of condition B37, and the performance criteria established above;	
▪ controlled and uncontrolled discharges, including upstream and downstream monitoring at discharge sites;	
▪ seepage and leachate from ponds and dams containing produced water and/or brine;	Refer to the PWMP
▪ surface water inflows, outflows and storage volumes to inform the Site Water Balance; and	Refer to the PWMP and the Site Water Balance
▪ the effectiveness of the surface water management systems and the measures within the Erosion and Sediment Control Plan;	Section 12.1 Also refer to the ESCP
• reporting procedures for the results of the monitoring program; and	Section 12.1 and 12.4
• a plan to respond to any exceedances of the performance measures or performance criteria, and repair, mitigate and/or offset any adverse surface water impacts of the Project.	Section 9
Consent condition D3 The Applicant must ensure that (where relevant) the management plans required under this consent include:	
a) summary of relevant background or baseline data;	Section 4
b) details of:	
(i) the relevant statutory requirements (including any relevant approval, licence or lease conditions);	Section 3
(ii) any relevant limits or performance measures and criteria; and	Section 3
(iii) the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures;	Section 1.4
c) any relevant commitments or recommendations identified in the documents that together comprise the NGP EIS;	Section 3.3
d) a description of the measures to be implemented to comply with the relevant statutory requirements, limits, or performance measures and criteria;	Table 6.1
e) a program to monitor and report on the:	Section 8 and Section 12
(i) impacts and environmental performance of the development; and	
(ii) effectiveness of the management measures set out pursuant to paragraph (d);	
f) a contingency plan to manage any unpredicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible;	Section 11.2
g) a program to investigate and implement ways to improve the environmental performance of the development over time	Section 11
h) a protocol for managing and reporting any:	

SSD 6456 consent conditions directly relevant to this SWMP	Section reference
(i) incident, non-compliance or exceedance of any impact assessment criterion and performance criterion	Section 11.1
(ii) complaint; or	Section 11.3
(iii) failure to comply with other statutory requirements; and	Section 11.1
i) a protocol for periodic review of the plan.	Section 12.3
Consent condition D4 Within 2 months of: (a) the submission of an incident report; (b) the submission of an Annual Review; (c) the submission of an Independent Environmental Audit; (d) the submission of a Field Development Plan; (e) the submission of a Groundwater Model Update; or (f) the approval of any modification of the conditions of this consent, the Applicant must review the suitability of existing strategies, plans and programs required under this consent.:	Section 12.3
Consent condition D5 If the review determines that the strategies, plans and programs required under this consent require revision – to either improve the environmental performance of the development, cater for a modification or comply with a direction - then the Applicant must submit the revised document to the Secretary for approval within 6 weeks of the review. **Note**: *This is to ensure strategies, plans and programs are updated on a regular basis and to incorporate any recommended measures to improve the environmental performance of the development.*	Section 12.3
Consent condition D6 The Applicant must notify the Department and any other relevant agencies via the Major Projects Portal immediately after it becomes aware of the incident. This notice must describe the location and nature of the incident.	Section 11.1
Consent condition D7 Within 7 days of becoming aware of a non-compliance with the conditions of this consent, the Applicant must notify the Department of the non-compliance via the Major Projects Portal. This notice must set out the non-compliance, the reasons for the non-compliance (if known) and what actions have been taken, or will be taken, to address the non-compliance. **Note**: *A non-compliance which has been notified as an incident does not need to also be notified as a non-compliance*	Section 12.1
Consent condition D8 By the end of March each year, unless the Planning Secretary agrees otherwise, the Applicant must submit an Annual Review of the environmental performance of the development to the Department via the Major Projects Portal.	Section 12.1
Consent condition D9 Within one year of commencement of Phase 1 and every 3 years thereafter, unless the Planning Secretary directs otherwise, the Applicant must commission and pay the full cost of an Independent Environmental Audit of the development.	Section 12.2
Consent condition D13 From the commencement of Phase 1, until the completion of all rehabilitation required under this consent, the Applicant must:	

SSD 6456 consent conditions directly relevant to this SWMP	Section reference
a) make copies of the following information publicly available on its website: (i) the document/s listed in condition A2(c); (ii) current statutory approvals for the development; (iii) approved strategies, plans and programs; (iv) detailed plans for the Phases of the development; (v) minutes of CCC and Advisory Group meetings; (vi) regular reporting on the environmental performance of the development in accordance with the reporting requirements in any plans or programs approved under the conditions of this consent; (vii) a comprehensive summary of the monitoring results of the development, reported in accordance with the specifications in any conditions of this consent, or any approved plans and programs; (viii) a summary of the current phase/s and progress of the development; (ix) contact details to enquire about the development or to make a complaint; (x) a complaint register, updated monthly; (xi) a record of all incidents and non-compliances; (xii) the Annual Reviews of the development; (xiii) audit reports prepared as part of any Independent Environmental Audit of the development and the Applicant's response to the recommendations in any audit report; and (xiv) any other matter required by the Planning Secretary; and	Section 1.7 and section 12.4
b) keep such information up to date.	Section 1.7

Appendix C - Water quality trigger values

Table C1 - Water quality trigger values

Parameter	Unit	Trigger Value						
		Irrigation	Livestock drinking	Ecosystem[1]	Recreation	Homestead water supply	Drinking water for disinfection	Aquatic foods
pH	pH	6.0 - 9.0	-	6.5 - 8.5	5.0 - 9.0	6.5 - 8.5	6.5 - 8.5	-
Electrical Conductivity (EC) (uncompensated)	µS/cm	1,000 [2]	-	-	-	-	-	-
EC (25C)	µS/cm	-	-	125 - 2200	-	-	<1500	-
Dissolved Oxygen (% Saturation)		-	-	85 - 110	-	-	-	-
Total Dissolved Solids (TDS)	mg/L	-	2,000[2]	-	1,000	<500 - 1000	-	-
Turbidity	NTU	-	-	6 - 50	6	5	-	-
Calcium (Ca)	mg/L	-	1000	-	-	-	-	-
Sodium (Na)	mg/L	115 [3]		-	300	-	-	-
Magnesium (Mg)	mg/L	-	2,000[4]	-	-	-	-	-
Sulphate as SO_4	mg/L	-	1000	-	400	-	-	-
Chloride as Cl	mg/L	175 [3]	-	-	400	-	-	-
Aluminium	mg/L	5 [6]	5	-	0.2	-	-	-
Arsenic	mg/L	0.1[6]	0.5[2]	0.013 [2, 5]	0.05	-	-	-
Barium	mg/L	-	-	-	1	-	-	-
Beryllium	mg/L	0.1 [6]	-	-	-	-	-	-
Cadmium	mg/L	0.01 [6]	0.01	0.0002 [5]	0.005	-	-	-
Chromium	mg/L	0.1 [6]	1	0.001 [5]	0.05	-	-	-
Cobalt	mg/L	0.05 [6]	1	-	-	-	-	-
Copper	mg/L	0.2 [6]	0.4[2]	0.0014 [5]	1	-	-	0.005
Iron	mg/L	0.2 [6]	-	-	0.3	-	-	-
Lead	mg/L	2[6]	0.1	0.0034 [5]	0.05	-	-	-
Manganese	mg/L	0.2 [6]	-	1.9[5]	0.1	-	-	-
Mercury	mg/L	0.002 [6]	0.002	0.0006 [5]	0.001	-	-	0.001
Nickel	mg/L	0.2 [6]	1	0.011 [5]	0.1	-	-	-
Selenium	mg/L	0.02 [6]	0.02	0.011 [5]	0.01	-	-	-
Vanadium	mg/L	0.1[6]	-	-	-	-	-	-
Zinc (Zn)	mg/L	2[6]	20	0.008 [5]	5	-	-	0.005
Ammonia	mg/L	-	-	0.013	-	-	-	-
Total phosphorus (Total P)	mg/L	0.05 [6]	-	0.05	-	-	-	-
Total nitrogen (Total N)	mg/L	5[6]	-	0.5	-	-	-	-
NOx	mg/L	-	-	0.015	-	-	-	-
Nitrate-N	mg/L	-	400	0.7 [5]	10	-	-	-
Nitrite-N	pH	-	30	-	1	-	-	-

Source: *Namoi River Water Quality and River Flow Objectives*, *NSW Government (Department of Environment, Energy & Science) 2006*

Notes:

- No recommended trigger value

[1] Lowland river

[2] Lowest recommended value

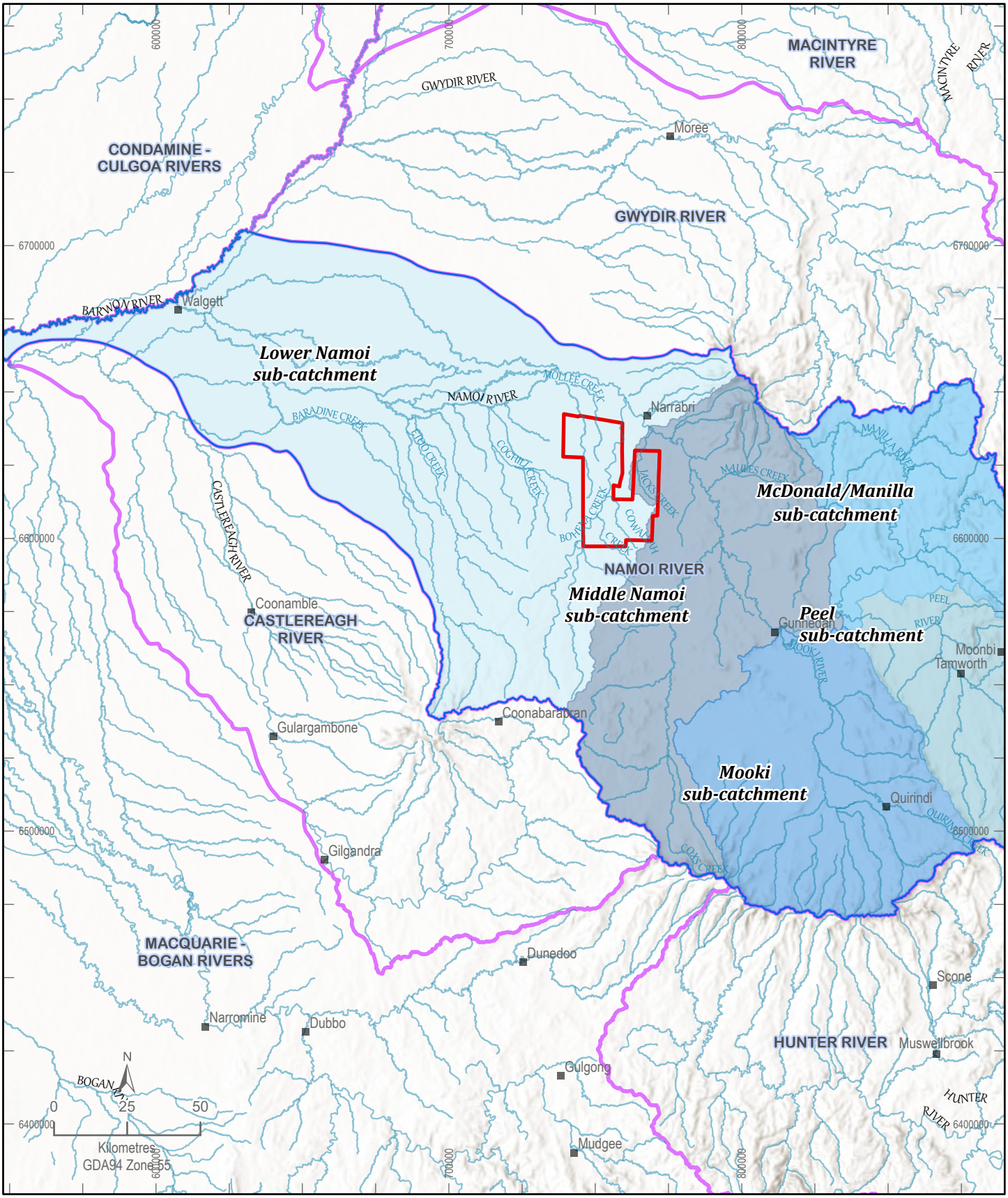
[3] Sensitive crops

[4]. Cattle (insufficient information on other livestock)

[5] 95% of species protected

[6] Long term trigger value

Appendix D - Namoi sub-catchments



Santos

ONWARD CONSULTING

LEGEND

- NGP boundary
- Namoi Catchment
- River Catchment
- Watercourse
- Locality
- Lower Namoi sub-catchment
- McDonald/Manilla sub-catchment
- Middle Namoi sub-catchment
- Mooki sub-catchment
- Peel sub-catchment

NARRABRI GAS PROJECT

Figure D1

Namoi Surface Water Sub-Catchments