



VENA EUROA HYDROGEN PROJECT

FEED HAZOP STUDY REPORT

50MW Hydrogen Production Facility

UGL Project TC- 17695

CLIENT: VENA ENERGY AUSTRALIA

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Executive Summary

This HAZOP study was performed at the FEED stage of the Vena Euroa Hydrogen Project located at a designated site in Aldoga in the Gladstone region, Queensland. It was undertaken to assist with early identification of critical risks that could have an impact on subsequent more detailed design stages of the project leading up to the Final Investment Decision. Further HAZOP, LOPA and CHAZOP studies would need to be conducted in subsequent design stages to ensure that risks identified in this study have been addressed.

The nodes studied in this HAZOP were:

1. Water Treatment Plant- Primary Treatment
2. Water Treatment Plant- Secondary Treatment
3. Water Treatment Plant- Tertiary Water
4. Water Treatment Plant- Potable Treatment
5. Water Treatment Plant- UPW to electrolyser
6. Water Treatment Plant- Clean In Place (Typical)
7. Water Treatment Plant- Chemical Dosing (Typical)
8. Electrolyser- Hydrogen Purification Unit
9. Electrolyser- Hydrogen Purification Unit- Dryer regeneration
10. Electrolyser- Water Purification Unit
11. Compression- Main Compression
12. Dispensing - Tube trailer filling
13. Dispensing- Main Compression
14. Dispensing- Dispensing Compression (by difference to main compression dispensing)
15. Utilities- Flare
16. Utilities- Chilling
17. Utilities- Cooling
18. Utilities-Nitrogen
19. Utilities-Wastewater
20. Overview node

The HAZOP study team had a balanced disciplinary input ranging from:

1. Process engineering
2. Mechanical engineering
3. Design and engineering management
4. Client representation
5. HS&E representation
6. Subject matter experts on:
 - a. Water treatment plant design
 - b. Electrolyser design
 - c. Gas cleaning design
 - d. Compressor design
 - e. Dispensing and storage design

There are 182 recommended actions which need to be addressed through subsequent design stages.

The documentation available to HAZOP participants, whilst preliminary in nature was relevant and presentable.

The state of the design was preliminary in nature having been derived from an early FEED study for the facility. This does not detract from the findings that are relevant to subsequent more detailed design phases of the project. The actions from the HAZOP study form the basis of an early risk register and should be closed out in subsequent phases of the project.

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1 Introduction

Vena Energy Australia (VENA) are proposing the Euroa Hydrogen Project at a designated site in Aldoga in the Gladstone region. The Euroa Hydrogen Project is an integrated hydrogen electrolysis, hydrogen compression and distribution facility located approximately 18 kilometres west of the Gladstone CBD. The project seeks to create an integrated hydrogen production and supply chain solution that will cater to the domestic and international market. The commercial business model for the domestic facility involves the production of hydrogen for transportation and heavy industry purposes.

The Euroa Hydrogen Facility is outlined as follows:

- A hydrogen production rate at the meter of the dispenser unit of approximately 17,280kg/day resulting in a nominal 50 MW hydrogen gas electrolysis facility including water purification, de-oxidation, dehydration, and hydrogen gas compression, storage and dispensing components.
- Electricity requirements sourced from the existing electricity grid.
- Water supply sourced from a newly constructed raw water connection pipeline infrastructure which connects to Boat Creek to East End water pipeline of Gladstone Area Water Board's (GAWB) water pipeline network.
- The 50MW hydrogen gas electrolyser facility will produce up to 900kg/hr of hydrogen gas at a pressure of 16 bar(g).
- The hydrogen gas will be compressed and stored on site; the quantity is 8,000kg at 400 bar(g). Maximum design storage pressure 450 bar(g).
- Stored hydrogen is further compressed as required and dispensed into tube trailers rated at 517 bar(g).
- The facility will produce and distribute approximately 17,280kg of compressed hydrogen gas per day.
- Five pressurised hydrogen tube trailer loading bays are provided to facilitate distribution of 17,280 kg/day of compressed gas into tube trailers.
- Hydrogen gas from various relief and blowdown valves at the electrolyser, storage compression, storage receivers and dispensing will be piped to the flare system. Intermittent and smaller hydrogen gas relief and bleed flows will be directly vented to atmosphere.

The proposed site is located approximately 18km west of the Gladstone CBD in the Aldoga locality within the Gladstone region (refer to Figure 1). It comprises of three (3) freehold lots off Euroa Circuit, Aldoga, formally described as Lot 1, 2 and 3 on SP245955, total site area of approximately 26Ha.

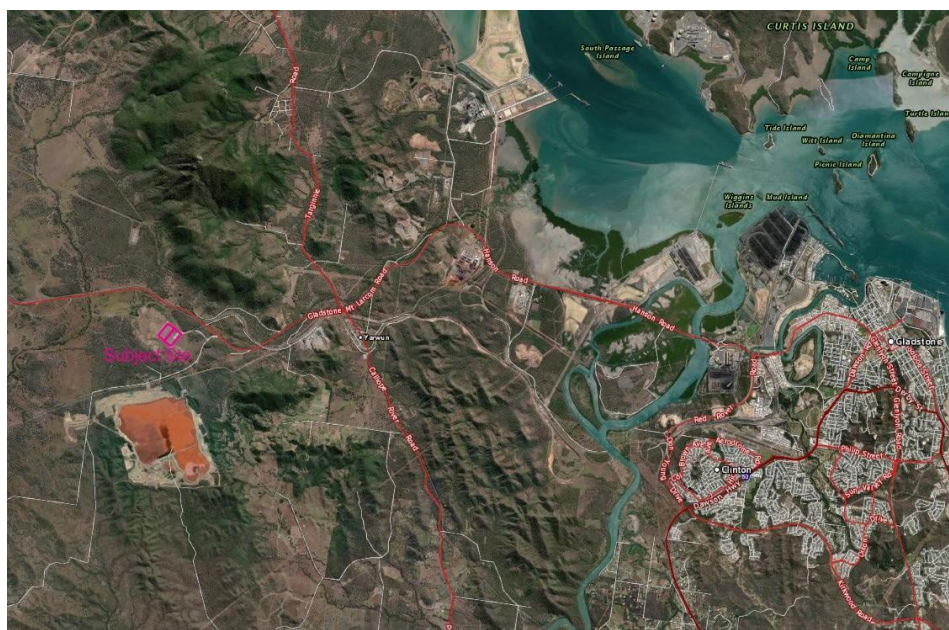


Figure 1 - Subject Site Location

The site fronts Euroa Circuit along all site boundaries. The new Euroa Circuit Road features a new intersection connection to Aldoga Road, which intersects with Gladstone Mount Larcom Road (state-controlled road) enabling the site to have industrial standard access to the wider state-controlled road including the Bruce Highway.

The site has been previously cleared of vegetation with previous earthworks creating several pads across site that were created as part of the previous uses over the site, which primarily were for the laydown, storage and construction yards associated with the LNG pipeline projects in the area. As a result, the site is clear of any notable biodiversity attributes and is relatively flat, thus has minimal ecological or topographical constraints.

The subject site has several advantages, including the proximity to the GAWB's Boat Creek to East End water pipeline running alongside Aldoga Road which will provide the necessary water inputs for the plant through a newly constructed extension pipeline which runs to the southern frontage of the site (refer to **Error! Reference source not found.**). Additionally, there is a new electrical transmission infrastructure currently being constructed across Euroa Circuit connecting to the nearby Larcom Creek substation and the national electricity grid (refer to **Error! Reference**



Figure 2 Subject Site Detail

source not found.).

The subject site is located within the 'High Impact Industry' precinct with the Gladstone State Development Area (GSDA) Development Scheme area which intends to support the emerging hydrogen industry within the Gladstone region.

This document presents the outcomes of the HAZOP study for the Front End Engineering (FEED) phase.

2 Definitions

• AAH	–	Analysis Alarm High
• AAHH	–	Analysis Alarm High High
• AAL	–	Analysis Alarm Low
• AALL	–	Analysis Alarm Low Low
• ADWG	-	Australian Drinking Water Guidelines
• AE	–	Analysis Element
• AS	–	Australian Standard
• ACSS	–	Array Control & Safety System
• AIT	–	Analyser Indicating Transmitter
• BDV	–	Blowdown Valve
• BPCS	–	Basic Process Control System
• CASA	-	Civil Aviation Safety Authority
• Company	–	UGL
• CO ₂		Carbon Dioxide
• CSD	–	Controlled Shutdown
• DC	–	Direct Current
• CEB	–	Cleaning enhanced backwash
• CIP	–	Cleaning In Place
• CHAZOP	-	Control Hazard and Operability Study
• DP	–	Differential Pressure
• DPIT	–	Differential Pressure Indicating Transmitter
• EDI	–	Electro Deionisation
• ESD	–	Emergency Shutdown
• FAH	–	Flow Alarm High
• FAHH	–	Flow Alarm High High
• FAL	–	Flow Alarm Low
• FALL	–	Flow Alarm Low Low
• FCV	-	Flow Control Valve
• FEED	–	Front End Engineering & Design
• FIT	–	Flow Indicating Transmitter
• FS	–	Flow Switch
• FSC	-	Fail Safe Closed
• GAC	–	Granular Activated Carbon
• GAWB	–	Gladstone Area Water Board
• HAZOP	–	Hazard and Operability Study
• HDPE	-	High Density Polyethylene
• HEI	–	High Energy Ignition
• HMI	–	Human Machine Interface
• HP	–	High Pressure
• HTU	–	Hydrogen Treatment Unit
• IBC	–	Intermediate bulk containers
• LAH	–	Level Alarm High
• LAHH	–	Level Alarm High High
• LAL	–	Level Alarm Low
• LALL	–	Level Alarm Low Low
• LEL	-	Lower Explosive Limit
• LI	–	Level Indicator
• LIC	-	Level Indicating Controller
• LIT	–	Level Indicating Transmitter

• LOPA	–	Layers of Protection Analysis
• LS	–	Level Switch
• LP	–	Low Pressure
• LPG	–	Liquid Petroleum Gas
• LV	-	Low Voltage
• MMF	–	Multimedia Filtration
• NEA	-	Neuman and Esser
• NRV	-	Non Return Valve
• OPSO	–	Over-Pressure Shut Off
• PAH	–	Pressure Alarm High
• PAHH	–	Pressure Alarm High High
• PAL	–	Pressure Alarm Low
• PALL	–	Pressure Alarm Low Low
• PCV	–	Pressure Control Valve
• PFAS	–	Per- and polyfluoroalkyl substances
• PFD	–	Process Flow Diagram
• PG	–	Pressure Gauge
• PHM	–	Plug Hydrogen Manager
• PI	–	Pressure Indicator
• PID	–	Proportional–Integral–Derivative
• P&ID	–	Piping and Instrumentation Diagram
• PIS	–	Pressure Indicating Switch
• PIT	–	Pressure Indicating Transmitter
• PLC	–	Programmable logic controller
• PPE	-	Personal Protective Equipment
• PPM	-	Parts per million
• PRV	–	Pressure regulating valve
• PSV	–	Pressure Safety Valve
• PT	–	Pressure Transmitter
• QRA	–	Quantitative Risk Assessment
• RD	–	Rupture disc
• RFID	–	Radio-Frequency Identification
• RPZ	–	Reduced Pressure Zone
• RO	–	Reverse Osmosis
• RTD	–	Resistance temperature detector
• RTU	–	Remote Terminal Unit
• SDV	–	Shutdown Valve
• SIS	–	Safety Instrumented System
• SoC	-	State of Charge
• TAH	–	Temperature Alarm High
• TAHH	–	Temperature Alarm High High
• TAL	–	Temperature Alarm Low
• TALL	–	Temperature Alarm Low Low
• TDS	-	Total Dissolved Solids
• TE	–	Temperature Element
• TIT	–	Temperature Indicating Transmitter
• TMP	-	Traffic Management Plan
• TOC	-	Total Organic Carbon
• TT	–	Temperature Transmitter
• TRV	–	Temperature relief valve
• UF	–	Ultrafiltration
• UPW	–	Ultrapure water

- UV – Ultraviolet
- UGL – UGL Engineering Pty Ltd
- VENA – Vena Energy Australia
- VFD – Variable frequency drive
- VSD – Variable speed drive
- VT – Vibration Transmitter
- WPU – Water Polishing Unit
- WTP – Water Treatment Plant
- ZSOC – Position Switch Open/Closed

3 Process Description

The following is a process overview of the system studied in the HAZOP. The process description should be read in conjunction with the Process Flow Diagrams (PFD) and Piping and Instrumentation Diagrams (P&ID) in Appendix 2.

The Euroa Hydrogen Facility production targets are outlined as follows:

- A hydrogen production rate at the meter of the dispenser unit of approximately 17,280kg/day resulting in a nominal 50 MW hydrogen gas electrolysis facility including water purification, de-oxidation, dehydration, and hydrogen gas compression, storage and dispensing components.
- Electricity requirements are sourced from the existing electricity grid.
- Water supply is sourced from a newly constructed raw water connection pipeline infrastructure which connects to Boat Creek to East End water pipeline of Gladstone Area Water Board's (GAWB) water pipeline network.
- The 50MW hydrogen gas electrolyser facility will produce up to 900kg/hr of hydrogen gas at a pressure of 37 bar(g).
- The hydrogen gas will be compressed and stored on site; the quantity is 8,000kg at 400 bar(g). Maximum design storage pressure 450 bar(g).
- Stored hydrogen is further compressed as required and dispensed into tube trailers rated at 517 bar(g).
- The facility will produce and distribute approximately 17,280kg of compressed hydrogen gas per day.
- Four hydrogen tube trailer loading bays are provided to facilitate distribution of 17,280 kg/day of compressed gas into tube trailers.

The hydrogen production facility comprises of the main of unit operations:

- Water treatment plant
- Electrolysis
- Water Polishing Unit (WPU)
- Hydrogen Treatment Unit (HTU)
- Main Compression
- Dispensing Compression
- Storage and Dispensing
- Flare
- Plant utilities:
 - a. Nitrogen
 - b. Cooling water
 - c. Chilled water
 - d. Wastewater

3.1 Water Treatment Plant Process Description

The water treatment plant is a vendor package provisionally supplied by Hydroflux. Its purpose is to produce demineralised water (ultrapure) which is consumed in the electrolysis process to produce hydrogen.

Given the uncertain quality input of raw water from GAWB, the water treatment plant includes the following main unit operations:

- a) Primary treatment - for removal of solids via settlement, which are further treated into a disposable sludge.
- b) Secondary treatment - for removal of residual suspended solids and macromolecules for protection of subsequent tertiary systems (RO, EDI). This consists of an arrangement of multimedia filtration beds, cartridge filtration and ultrafiltration. Additionally, a granular activated carbon system is incorporated for the removal of potential chlorine. Potable water is also produced in secondary treatment with the aid of UV disinfection and hypochlorite addition.
- c) Tertiary treatment - for the removal of dissolved solids to produce ultra-high purity water. It typically encompasses a combination of reverse osmosis (RO) and electro-deionisation (EDI) technologies. The process consists of:

- Reverse Osmosis: its purpose is to remove dissolved cations and anions by a high-pressure double-pass RO membrane filtration process to obtain a high quality permeate. Passes 1 and 2 are multi-stage type with concentrate recirculation.

RO Pass 1 is a two stages type system that operates with two RO pressure vessels in parallel (stage 1) in series with one RO pressure vessel (stage 2). In every stage and pressure vessel permeate is recovered and manifolded to be fed into RO Pass 2.

Concentrate streams containing the salts removed in stage 1 flows into stage 2 to maximise permeate recovery. Concentrate stream from stage 2 is partially recycled to the head of RO Pass 1 to further maximise the recovery. The balance of the concentrate is directed to the Brine Concentrating RO system for further concentrating.

RO Pass 2 is a two stage system that operates with one RO pressure vessel (stage 1) in series with one stage 2 RO pressure vessel. Permeate from RO Pass 1 is pumped into the RO Pass 2. The concentrate stream from stage 2 is recycled to the head of RO Pass 1. Permeate from RO Pass 2 constitutes the final permeate production of the RO unit.

Electro-deionisation: its purpose is to remove residual dissolved ions by using ion exchange membranes or ion exchange resins (media) and a DC electrical potential.

A DC electrical potential is generated between electrodes on either side of a series of compartments through which the RO Pass 2 permeate is fed. The DC potential causes the ions to migrate through ion selective membranes to adjacent concentrate compartments. The ions are removed in the concentrate flow and directed to the Brine Concentrating RO system for further concentrating. The collected water from the purifying compartments is the final ultra-pure water.

The list of relevant PFD and P&ID drawings are:

- 17695-WATR-PFD-1001-01
- 17695-WATR-PFD-1001-02
- HIM0040-P0100 to HIM0040-P3400 (Hydroflux)

3.2 Electrolysis Plant Process Description

The Plug supplied 10 MW array is designed to produce 178.8 kg/hr of hydrogen (on dry basis). It produces high pressure (45 bar, water-saturated) hydrogen from ultra-pure water. The array also produces (water-saturated) low pressure oxygen that is vented to atmosphere.

The electrolysis process requires ultra-pure water (UPW) produced by the water treatment package. The flow of UPW to the anode separator is regulated to control the level in the vessel.

The UPW from the anode separator is provided to the stacks through the anode side of the stack. The water has a dual purpose i.e., a small portion of the water is converted to hydrogen and oxygen while the bulk is used to remove the reaction heat from the electrolysis process to prevent overheating of the stacks.

When the stacks are energised and water is fed through the stacks, the electrochemical splitting of water occurs. On the anode side of the membrane, oxygen gas (water-saturated) is produced. This oxygen is routed back to the anode separator where it is separated from the UPW water (which serves as waste heat carrier) and vented to atmosphere. On the cathode side of the cell membrane hydrogen gas (water-saturated) is produced. The product gas and liquid water is routed to the HP cathode separator where it is separated from the UPW. The pressurised hydrogen is then sent to the Hydrogen Treatment Unit (HTU).

The UPW removed in the HP cathode separator is routed to the LP cathode separator. The LP cathode separator operates at a lower pressure than the HP cathode separator and serves as a flash vessel to maximize removal of dissolved hydrogen from UPW.

UPW separated in the anode separator is sent to the water polishing unit (WPU). The WPU is a process package supplied by Veolia. In the water polishing unit, water is pumped through a cartridge filter, an ultraviolet unit and then to electro deionisation before being sent back to the electrolyser skid. This process removes residual anions and cations dissolved in the water through the dissolution of membranes or leaching from the stainless-steel components.

Hydrogen gas is sent to the HTU (HTU is a process package supplied by Veolia) where it passes through a knockout drum to remove free water. The hydrogen is then heated in an electric heater prior to entering the deoxygenation column where a catalytic reaction occurs, combining any remaining oxygen with hydrogen and converting it to water.

Hydrogen gas is then cooled prior to further liquid removal in the gas separator. The gas is then routed into one of three dryer vessels, where water is further removed using a desiccant media. As the gas passes through the desiccant bed, water is adsorbed from the gas phase. At this point the hydrogen complies with the product quality specification and flows to the main compression system. When the dryer desiccant bed is saturated, it is regenerated using a slip stream of superheated dry product gas via a dedicated recycle compressor and electric element superheater.

Plug has previously undertaken a HAZOP and LOPA for the 10MW array system (refer to Plug HAZOP reports). This part of the process is not studied again except for the interfaces with adjoining unit operations.

The list of relevant PFD drawings are:

- 17695-ELCT-PFD-1201-01
- 17695-ELCT-PFD-1201-02
- 17695-ELCT-PFD-1201-03
- 17695-ELCT-PFD-1201-04

Refer to Plug and Veolia supplied reference documents:

- Process Flow Diagram – Arrays - P107828-BEDP-PC-PFD-001
- Piping & Instrument Diagram – Arrays - P107828-BEDP-PC-PID-001
- PROCESS FLOW DIAGRAM (WPU) - P107828-PC-PFD-WPU-001
- PROCESS FLOW DIAGRAM (HTU) - P107828-PC-PFD-HTU-001
- PIPING AND INSTRUMENTATION DIAGRAMS (HTU) - P107828-PC-PID-HTU-001
- Plug HAZOP report - VEX4250D-PC-HZP-002-r01, PLU-24001-HAR-001-B, PLU-24001-HAR-001-B

3.3 Main Compression Plant Process Description

3.3.1 System Overview

All the hydrogen process gas production from the upstream electrolysis and purification process is fed into the main compression system at up to 900kg/hr at a nominal 37 bar(g) pressure and compressed up to 450bar(g).

All the hydrogen production from the upstream supply system, the electrolyzers and gas purification systems are required to pass through the main compressors. Where the upstream gas supply exceeds the main compressor capacity or its downstream capacity the excess capacity gas must be sent to flare.

The main compression system is expected to operate 20 hours per day. The main compression system has 3 parallel compressors installed in a 2 operating duty and one installed hot stand-by configuration.

A chilled water recirculation system is supplied for cooling.

Compressed air is provided for instrument control purposes.

Compressed nitrogen gas is provided to inert the main compression system and for process gas purging.

During process disturbances including the system start-up and shutdown the hydrogen process gas is released to a flare system via a common header pipe. Any hydrogen gas production that exceeds main compression operating capacity is also sent to flare.

From the main compression system, the hydrogen gas is piped to the storage and dispensing system.

3.3.1.1 Main Compression Supply Knockout Drum (310-TK-01)

A knockout drum (310-TK-01) is installed immediately upstream the compressor inlet manifold to ensure that no carry over liquid or condensate from the electrolyser process can enter the compressors. Condensate presented in the supply gas to the compressor can quickly damage or destroy a compressor. During normal operation the upstream hydrogen gas is purified to effectively eliminate moisture and condensation to well below -40°C pressure dew point, hence it is unlikely that condensation will be present in the supplied gas. It is for this reason the knockout drum is provided with manual moisture removal valve only and no flash tank. The knockout drum is expected to operate with no condensate present during normal operation.

3.3.1.2 Main Compression Supply Header

The knockout drum discharge is flanged to the main compressor supply header.

There is a main compression suction discharge pressure control valve, 310-PCV-0001 that can be used to direct excess suction demand to flare. This is primarily used during system start-up, shutdown and process gas out of specification events. This allows an upstream electrolyser supply flow that exceeds the main compressor capacity or out of specification gas to be flared.

There is a branch pipe to each main compressor package with a double block and bleed isolation valve.

3.3.1.3 Main Compressors Packages (310-PKG-01/02/03)

Three (two operating, one standby) parallel compressor packages comprising of a three stage, non-lubricated, three crank, vertical frame type arrangement will compress the supplied hydrogen gas up to 450 bar(g) discharge pressure.

Each main compressor will be supplied with its own autonomous controller with full remote access (RTU) with the BPCS. As required SIS control systems will be used in the compressor control package. The compressor's controller will be installed remote from the compressor in an air-conditioned environment, such as an electrical equipment switch room. A local remote control panel will be installed at the compressor in an explosion proof cabinet. Instrumentation will be either wired directly back to the compressor's controller or via a local junction box to simplify field wiring. All field instrumentation enclosures will be suitably explosion proof rated.

The compressors are typical vendor supplied packages and are equipped with standard instruments, controls and safety devices. Each compressor has the following typical instrumented primary process control features:

1. Inlet strainer to prevent inlet gas contamination damage with differential pressure transmitter to detect blockage to prevent damage to compressors.
2. Compressor inlet temperature transmitter with high and high high alarm
3. Each compression stage has the following:
 - a. inlet and outlet pressure gauge per stage
 - b. inlet and outlet primary pressure transmitter with high pressure alarm per stage
 - c. inlet and outlet secondary pressure transmitter with high-high pressure alarm per stage
 - d. outlet primary temperature transmitter with high temperature alarm per piston outlet
 - e. outlet secondary temperature transmitter with high-high temperature alarm per piston outlet
 - f. stage outlet pressure safety relief valve to flare
 - g. stage discharge water cooled heat exchanger (gas intercooler between compression stages and after cooler on final compression stage)

- h. each heat exchanger shell is fitted with flange with burst disk to direct process fluid to flare. Primary consideration is upon tube failure to prevent large hydrogen gas flow into chilled water system or over pressuring heat exchanger shell and chilled water system.
- i. gas heat exchanger gas discharge temperature indicator
- j. gas heat exchanger gas discharge temperature transmitter with high alarm
- 4. At each compressor discharge there is a recycle bypass control valve that controls the outlet gas flow back to the compressor suction inlet after the inlet filters. The bypass is equipped with pressure and temperature transmitters and includes the following features:
 - a. a by-pass control valve that is used to control the compressor capacity from 0 – 100%.
 - b. a by-pass gas water cooled heat exchanger. This heat exchanger is to ensure the compressor inlet temperature of the hydrogen gas is not affected by the recirculation flow.
 - c. Heat exchanger shell is fitted with flange with burst disk to direct process fluid to flare.

The compressor recycle bypass control valve is used to match the capacity of the compressor to the upstream electrolyser hydrogen production rate. As each electrolyser array controls its minimum back pressure with a control valve excess downstream demand will drop pressure to the HTU and main compression. To control this the recycle bypass control valve is controlled via compressor suction pressure, such that insufficient suction pressure causes the by-pass recycle valve to open. The setpoint of this controller can be remotely set either manually or via an automatic cascade PID loop from the overall compression suction or even the electrolyser pressure output.

- 5. The compressor outlet has a check valve to prevent back flow from the discharge connection.

The following additional compressor systems are used to ensure reliable operation.

- 1. Lubrication system, with following features:
 - a. oil level indicating transmitter mounted on to compressor crank case oil reservoir, with low oil level alarm
 - b. crankshaft mounted oil pump used during normal operation
 - c. auxiliary oil pump, used during start-up and shutdown
 - d. pressure safety relief valve on oil pump discharge line back to reservoir
 - e. water cooled oil heat exchanger with thermionically controlled bypass valve on oil.
 - f. duplex oil filter with differential pressure transmitter with high differential pressure alarm
 - g. back pressure regulating valve after duplex filters with oil back to crankcase reservoir
 - h. compressor oil supply pressure transmitter with high and high high alarms
 - i. compressor oil temperature indicator
 - j. compressor oil supply pressure indicator
 - k. compressor oil supply pressure transmitter with high alarm
 - l. compressor oil supply pressure transmitter with high-high alarm
- 2. Cylinder jacket and piston rod packing cooling water system. The typical vendor supplied P&ID shows an electrical power water heater system on this cooling water supply.
 - a. Jacket cooling water inline electrical heater. It is unlikely that this heater will be required as the gas purity is such that no condensate should occur here unless cooling water below normal supply temperature is delivered. If supply gas is contaminated it will be flared before passing to the main compressors.
 - b. Jacket cooling water supply temperature transmitter downstream of the heater with high and low pressure alarms.
 - c. Jacket cooling water supply temperature transmitter downstream the heater with low and high temperatures that operate the heater. On low temperature alarm the heater will switch on. On high temperature alarm the heater will switch off.
 - d. On each cylinder jacket cooling water return pipe:
 - i. Thermal relief valve
 - ii. Temperature transmitter, with high alarm
 - iii. Sight glass

- e. On each cylinder rod gland cooling water return pipe:
 - i. Thermal relief valve
 - ii. Temperature transmitter, with high alarm
 - iii. Sight glass
3. Nitrogen purge gas system for crank case, cross head and piston rod packing:
 - a. A nitrogen supply pressure regulating valve
 - b. A nitrogen supply pressure gauge
 - c. A nitrogen supply pressure gauge with high and low and low-low pressure alarms
 - d. A nitrogen supply pressure safety relief valve to vent excess pressure downstream the supply regulator valve.
4. Condition monitoring system
 - a. The main drive motor is supplied with temperature transmitters in the motor windings and on the drive end and non-drive end bearings
 - i. A high temperature alarm on any of these transmitters will act as a start permissive interlock on the compressor.
 - ii. A high-high temperature on any of these transmitters will interlock the compressor drive.
 - b. The compressor crank bearings are fitted with temperature transmitters:
 - i. A high temperature alarm on any of these transmitters will act as a start permissive interlock on the compressor.
 - ii. A high-high temperature on any of these transmitters will interlock the compressor drive.
5. Compressor pneumatic barring system that provides a spring return mechanical actuator on to the compressor flywheel that prevents the flywheel and crankshaft rotation.
 - a. A manual valve, that can be locked in the open or closed position is used on the instrument air supply to the barring device actuator. The barring device has a pneumatic restrictor to prevent fast actuation of the barring device. Unbarring actuation speed is not restricted.
 - i. The manual valve is locked open to prevent the barring device from actuating when maintenance on the compressor is not required.
 - ii. The manual valve can be locked closed to operate the barring device when maintenance on the compressor is required.
 - b. There are two barring device locked/closed and unlocked/open position switches. If any switch indicated closed/locked or not unlocked/open the compressor drive is interlocked.

3.3.1.4 Main Compression Discharge Header

The discharge from each main compressor is piped to a common main compression discharge pipe. There is a double block and bleed valve installed on each of the compressor discharge pipe upstream the common main discharge header. Normally the downstream system will attempt to control the gas demand to meet the supply.

Where excess downstream demand occurs, 310-PCV-002 will close as required to ensure a minimum backpressure of 150 bar(g) on the compressors. The minimum back pressure is required to increase life of the dispensing compression equipment that has been optimised to operate at higher discharge pressures.

Similarly, when excess upstream supply or insufficient downstream demand occurs, 310-PCV-003 will open as required to exhaust the excess demand to the flare header to ensure the nominal main compression discharge header pressure does not exceed 480bar(g).

The list of relevant PFD and P&ID drawings are:

- 17695-STOR-PFD-1001-01
- 17695-COMP-PID-1001-01
- 10053995-01, 10053995-02, 10053995-03, 10053995-04, 10053995-05, 10053995-06, 10053995-07 (NEA)

3.4 Dispensing Compression Plant Process Description

3.4.1 System Overview

Compressed hydrogen from the upstream main compressors or storage tanks can be used to directly fill tube trailers when the pressure differential to the trailer State of Charge (SoC) is greater than about 50 bar(g). At lower differential pressures, the rate of filling the tube trailers is time consuming and not economical. The dispensing compressors are used in this situation to allow and maintain filling rate.

The 100% SoC design pressure of the tube trailers is 517 bar(g). The design operating pressure of the main compression system is 450bar(g) and the design full SoC pressure of the storage system is nominally 400bar(g) (although the design pressure of the storage pressure vessels is 500bar(g)). At partial SoC the storage system will be at lower than design pressure, actual pressure being nominally proportional to the SoC.

The dispensing compressors of which there are 4 (up to three operating, one standby) is a single stage, horizontal diaphragm compressor with two water-cooled diaphragm heads. Diaphragm compressors have the benefit of being able to operate at discharge pressures above 450bar. No contamination of the product is allowed. Each dispensing compressor is fitted with a by-pass control valve and an inlet gas cooling heat exchanger that allows 0 – 100% design operating capacity. The dispensing compressor controls excess discharge pressure by opening the by-pass control valve. The actual required number of operating dispensing compressors is dependent upon the number of trailers being filled with a SoC relative to the supply pressure requiring operation of the dispensing compressors. The dispensing compressor minimum suction pressure that can achieve 640 bar(g) outlet pressure is 150bar(g) at compressor inlet temperature of 15°C, with compressor mass flow rate is 136kg/hr. Lower inlet dispensing compressor suction pressures will reduce the achievable outlet pressure and mass flowrate. Nominal fill rate of one trailer is 180kg/hr with up to 6 trailers being simultaneously filled resulting in total fill rate of 900kg/hr.

The dispensing compressors will be used when the tube trailer pressure is greater than 350 bar(g) or lower where the supply pressure is lower than 450bar(g) to further compress the hydrogen gas up to 640 bar(g).

There is an inlet cooler hydrogen gas heat exchanger that ensures inlet gas and recirculated capacity control gas is cool to ensure optimal and reliable compressor performance.

There is an after cooler hydrogen gas heat exchanger to cool the hydrogen gas delivered to the dispensing system.

All the heat exchangers provided for hydrogen process gas will have a rupture disk installed on the cooling water shell side to prevent over pressurisation of the heat exchanger shell and the downstream chilled water pipe. Any fluids vented from these heat exchanger rupture disks are piped to the flare system.

There is a heat exchanger to cool the crank oil pumped for lubrication and compensation.

A chilled water recirculation system is supplied for cooling.

Compressed air is provided for instrument control purposes.

Compressed nitrogen gas is provided to inert the main compression system and for process gas purging.

Process upsets from pressure safety relief valves and smaller gas purging are released directly to flare from each dispensing compressor.

During process disturbances including the system start-up and shutdown the hydrogen process gas is primarily released to a high pressure flare system via a common header pipe. Any hydrogen gas production that exceeds dispensing compression operating capacity is also sent to the flare.

From the dispensing compression system, the hydrogen gas is piped to the dispensing system high pressure pipe header.

The compressors are typical vendor supplied packages and are equipped with standard instruments, controls and safety devices. The following is a description of the typical features of a compressor system. The dispensing compressors has a diaphragm leak detection system that measures pressure caused by a leak in the diaphragm system. A detected leak will shutdown the compressor and stop compressor start-up until the leak is repaired, usually with replacement of the diaphragms. A leak will normally be detected before the product is contaminated.

Each dispensing compressor will be supplied with its own autonomous controller with full remote access of the RTU through the BPCS. As required SIS control systems will be used in the compressor control package. The compressor's controller will be installed remote from the compressor in the air-conditioned environment of a switch room. A local remote control panel will be installed at the compressor in an explosion proof cabinet. Instrumentation will be either wired directly back to the compressor's controller or via a local junction box to simplify field wiring. All field instrumentation enclosures will be suitably explosion proof rated.

The list of relevant PFD and P&ID drawings are:

- 17695-STOR-PFD-1001-01
- 17695-COMP-PID-1002-01
- 10060624-01, 10060625-02 (NEA)

3.5 Storage and Dispensing Plant Process Description

3.5.1 System Overview

The Storage and Dispensing systems are made up of the following modules that are vendor packages provisionally supplied by H2 Hauler:

- Storage management system (320-PKG-02)
- Ground storage tanks (320-PKG-01/02/03/04/05/06/07),
- Dispensing panels (410-ME-01/02/03/04 A/B),
- CO2 Chillers (410-HP-01/02/03/04)

The purpose of these packages is to control the flow of hydrogen gas to the tube trailer dispensers and ground storage to match the hydrogen production from the electrolyser plant's hydrogen treatment unit and the main compressors. The goal is to maximise hydrogen production from the electrolyzers and loading of the tube trailers. Excess capacity from the electrolyzers is used to fill ground storage. If ground storage is full, then excess upstream capacity will be disposed to flare and if downstream capacity cannot be increased, then upstream supply capacity needs to be restricted to prevent disposal to flare. Upstream capacity control would be used when required to reduce electrolyser hydrogen production rate.

Insufficient upstream hydrogen capacity or excessive downstream demand to tube trailer filling and storage needs to be controlled to prevent supply pressure from the main compressors being compromised.

The hydrogen electrolyzers are expected to operate up to 20 hrs per day. When the electrolyzers are shut-down the main compressors will also normally be shut-down. There are two duty main compressors required to operate to achieve 900kg/hr hydrogen flow. Each compressor has a by-pass recirculation control that allows 0 – 100% process capacity control, such by-pass control means the compressor is effectively always operating at full load.

When the electrolyzers or main compression are shutdown, the prefilled ground storage can be used to continue tube trailer dispensing and allow the ground storage to be emptied.

3.5.1.1 Storage Management System and Ground Storage

The storage management system has the follow main process connections:

- Upstream hydrogen supply from main compression system (electrolyser hydrogen gas)
- Hydrogen gas to dispensing - low pressure dispensing
- Hydrogen gas to dispensing via dispensing compressors - high pressure dispensing
- Hydrogen gas to and from ground storage
- Hydrogen gas to flare
- Hydrogen gas to flare pilot

The storage management system controls distribution of up to 900kg/hr of hydrogen from the upstream main compressors at 450 bar(g) to the dispensing bays for tube trailer filling and ground storage. Tube trailer filling is normally given priority with any excess hydrogen supply fed to ground storage to stabilise demand and maximise hydrogen

production. When ground storage is full the electrolyser production must be controlled to match tube trailer filling rate, any excess hydrogen supply capacity will need to be automatically flared.

During the daily shutdown of the upstream electrolyser, HTU and main compression systems the storage management system controls the distribution of hydrogen from ground storage to the dispensing bays for tube trailer filling, thereby allowing ground storage to be emptied.

The dispensing controllers will be used to control the rate of hydrogen dispensing to each tube trailer with RTU's to allow remote monitoring and control from the BPCS.

Where the upstream pressure from the main compressors or storage is insufficient to support direct tube trailer filling the hydrogen gas will be directed to flow via the dispensing compressors to boost the pressure. At 400bar inlet pressure to the dispensing compressors three duty dispensing compressors are required to operate to load out at 900kg/hr. The dispensing compressors are rated to operate with inlet pressures ranging from 150 to 450bar(g) and provide outlet pressure up to 640 bar(g). The dispensing compressor capacity is directly proportional to the inlet gas density, hence pressure, below 400bar(g) will reduce their capacity. It is possible that 6 tube trailers may need to be filled simultaneously using the dispensing compressors the same mass flow capacity is required from dispensing compression as main compression, that is 900kg/hr capacity.

Due to the restricted capacity of the dispensing compressors at lower suction pressures it is expected that the ground storage would normally only be operated between 150 to 400 bar, although lower and higher operating pressures are possible. The dispensing compressors will operate at inlet pressures below 150bar(g) however the discharge pressure will also then be lower than 640bar(g) and mass flow capacity greatly reduced. It is not recommended to operate the ground storage vessels below 15bar(g) and preferably above 80bar(g). The storage tube design pressure is 500bar(g). The main compression is designed to achieve 450 bar(g), so pressures above 450bar(g) are unlikely.

The tube trailers have a minimum allowable empty pressure of 12 bar(g). Excessive trailer empty return pressures reduce effective tube trailer delivery capacity, so return pressures significantly above 12bar(g) should be avoided.

Consideration needs to be given to minimise the starting and stopping of compression equipment to improve maintenance life. The standby compressors should be cycled on/off to minimise starting and stopping of individual units.

The flare system requires a reliable source of hydrogen gas for flare hydrogen pilot operation. A connection in the storage management system with pressure reducer and overpressure relief to vent provides a reliable supply of hydrogen.

3.5.1.2 Hydrogen Tube Trailer Dispensing System

Each dispensing panel (410-ME-01/02/03/04 A/B) will have its own controller with an RTU for communication with the BPCS (8 in total). Each dispensing panel can select whether to utilise the low pressure or high pressure hydrogen gas supply for tube trailer filling:

1. Lower pressure filling directly from main compression or ground storage to approximately 400 bar(g).
Low pressure filling is selected when the upstream supply from main compression or ground storage less the tube trailer SoC pressure is greater than 100bar.
2. Higher pressure filling using dispensing compressors is utilised to fill to 517 bar(g).
High pressure filling utilises dispensing compressors to increase the supply pressure up to 640 bar(g) to allow filling when the tube trailer SoC pressure is greater than main compression or ground storage supply pressure less 100bar. The number of operating dispensing compressors needs to match dispensing demand.

There is one CO2 chiller (410-HP-01/02/03/04) for every 2 dispensing panels. Each CO2 chiller has its own controller with RTU to the BPCS (4 in total). Each CO2 chiller is capable of chilling 360kg/hr of hydrogen gas to a temperature of -30°C needed to help speed the tube trailer allowable filling rate to compensate for temperature rise in the trailers tubes due to gas compression and Joule Thompson effects. The CO2 chillers are direct expansion type with a hydrogen gas / CO2 refrigerant heat exchanger in each dispenser system. These heat exchangers are installed at the dispensing area with CO2 refrigerant liquid supply and gas return back to the CO2 chiller main unit.

Each dispensing panel controller communicates with the tube trailer to safely control the filling. There are several connections between the tube trailer and the dispensing panel systems:

- Main hydrogen fill and decant hose connection
- Instrument air supply hose to tube trailer

- Control system communication
- Safety control system communication
- Earth connection

3.5.1.3 Hydrogen Tube Trailer Dispensing Bay Traffic Control System

The dispensing system will also include a traffic control system in the dispensing bays to control movement of the tube trailer A-double trucks. It is expected that truck drivers shall follow the traffic control system. At a high level the traffic control system is as follows:

- If a dispensing bay is empty and ready for trailer filling operations, the entry boom gate is open and a green traffic light is illuminated allowing truck entry into the bay.
- If a truck is already in the dispensing bay or the dispensing system is not ready to receive a truck at that bay the boom gate is down, and a red traffic light is illuminated to prevent entry into the bay.
- If a truck is already in the bay and connected to the dispensing panel, the exit boom gate is down, and a red light is illuminated to stop the truck exiting the bay.
- Once a truck is in the bay and after the truck driver has confirmed ready for filling the exit boom gate will close and a red exit light will be illuminated. The driver can then proceed to perform pre-fill checks (described later) and then connect the trailers to the dispensing system.
- If a truck is already in the bay and disconnected from the dispensing panel, the operator has performed post fill checks and has confirmed with operations that dispensing is complete and disconnected, the exit boom will open and a green light is illuminated to allow the truck to exit the bay.
- In an emergency a siren will be initiated at the filling bays. Truck bay entry lights will be red and boom gates closed. If safe to do so exit green lights will be given and boom gates will be opened for trucks to exit the bays. Subject to emergency procedures, truck drivers and operators are to evacuate the loading bay area to the designated loading bay safety muster zone. Additional procedures need to be considered and written to cover emergency contingencies.

The list of relevant PFD and P&ID drawings are:

- 17695-STOR-PFD-1001-01
- 17695-STOR-PID-1001-01

For details on the tube trailer dispensing operation refer to H2 Hauler supplied documents: -

- 20024-MD-BOD-0002 – Basis of Control Operations
- 23076-PR-PFD-0001 and 0002 – Ground Storage & Filling Terminal

3.6 Flare Plant Process Description

3.6.1 System Overview

The flare is used to combust hydrogen that must be purged from the process system. The main reasons for purging the process gas are, out of product specification, equipment failure, plant start-up and shutdown, and other emergency safety reasons. The hydrogen gas can be purged from the system through the flare system, see the Relief and Blowdown Philosophy, 17695-PROC-RPT-1002 for further details on flaring. The flare is a vendor supplied package and is equipped with standard instruments, controls and safety devices. The following is a description of the typical features of a flare system.

3.6.1.1 Flare Low Pressure Header from Electrolyser Area

The flare system takes lower pressure gas that can be saturated with water vapour from the electrolyser. To minimise water from travelling down the low pressure piping header to the flare, a separate knockout drum and flash tank are located at the electrolyser area. Condensate from the flash drum is drained to the waste water system.

3.6.1.2 Flare High Pressure Header from Compression and Storage Areas

The flare receives higher pressure gas sourced from the storage and compression areas. As the gas is downstream of the electrolyser gas purification system and dry, separate knockout drum system has not been allowed at the compression and storage area.

3.6.1.3 Flare Nitrogen Purge

Continuous nitrogen purge gas is used to help ensure that air containing oxygen cannot enter the flare piping system. Nitrogen is supplied from the plant central nitrogen system and enters the flare gas piping system via nitrogen pressurisation and flow control stations at various points in the flare piping system. Two dissimilar check valves are located in the purge lines to ensure process gas cannot backflow into the nitrogen gas supply system. The purge gas then flows through a pressure regulation valve that controls the purge gas supply pressure down to 0.2bar(g). If the gas system is pressurised by process flare gas greater than 0.2 bar(g), nitrogen gas is not consumed. A nitrogen gas flow meter is used to indicate flow and alarm on low and low-low flow as well as high flow.

Nitrogen is also supplied directly to the flare as purge gas.

3.6.1.4 Flare

The high pressure gas piping header and low pressure gas piping header combine into a common header near the flare and enter in to the flare seal drum, 750-TK-03. The flare seal drum is used to knockout any liquid before the gas flows to the flare and act as a backflow prevention device. The liquid level in the flash tank is maintained and excess liquid flows to a flare flash tank, 750-TK-04 via a level control valve. The flash tank is used to discharge liquid from the flare seal tank and discharge it to drain. The flashed hydrogen gas is safely vented. From the flare seal tank, the gas flows to the flare.

The description of the operation of a typical flare system is given in the supplier document, Uniquip Engineering PTY Limited, 13041C - Control Philosophy.

3.6.1.5 Flare Pilot Systems

The flare has two pilot flame systems, one that operates on LPG (Liquid Petroleum Gas) and another that operates on hydrogen gas. During normal plant operation only the flare hydrogen gas pilot is operated. The flare LPG pilot only operates when the hydrogen gas pilot is unavailable for operation, primarily when hydrogen gas is not available to operate the flare hydrogen gas pilot, such as during initial plant start up, or flare hydrogen pilot failure.

3.6.1.5.1 Flare Hydrogen Fired Pilot Supply

Hydrogen gas for the flare hydrogen pilot is supplied from the hydrogen storage system, see 17695-STOR-PID-1001-01. A hydrogen gas pressure regulator valve, 320-PRV-0001, drops the pressure from the normal 150 to 450 bar(g) hydrogen gas storage pressure range to 10 bar(g) for piping to the flare. A pressure safety relief valve set at 12 bar(g) vents excess pressure from the hydrogen downstream 320-PRV-0001. An orifice valve upstream the regulating valve is used to restrict the hydrogen gas flow in the event of failure of the regulating valve. The storage hydrogen supply pressure to the pilot is monitored with a pressure indicating transmitter providing process alarms on high and low pressure and control shutdown of the hydrogen supply system in the event of a major sustained over pressure. The instrumentation for the hydrogen pilot supply system are detailed in the storage section.

At the flare the hydrogen supply for the pilot is further pressure regulated down to the pressure required for the flare pilot as specified by the flare vendor. Dual regulators are used with an orifice and safety relief valve between these regulators. The final hydrogen pilot gas delivered pressure is measured with a pressure indicating transmitter with high and low pressure alarms provided. Sustained high pressure will cause a trip of the up-stream hydrogen supply system. Sustained low-low pressure coupled with LPG pilot supply low-low will perform an emergency system shutdown.

3.6.1.5.2 Flare LPG Fired Pilot Supply

The LPG pilot system is supplied with LPG from a manifolded bottle system. LPG bottles are individually valve isolated replaced with full bottles when empty. The LPG gas from the supply manifold is pressure regulated to the pressure required by the flare system. The final pressure regulator used has an OPSO (over pressure shut off) regulator, that fail safe shuts in the event of over pressure. A pressure indicating transmitter on the LPG supply to the flare alarms on high

and low pressures and interlocks on high-high pressure and low-low pressure. The low-low pressure interlock only activates if the hydrogen gas pilot supply is also low-low pressure.

The list of relevant PFD and P&ID drawings are:

- 17695-FLAR-PFD-1001-01
- 17695-FLAR-PFD-1001-02
- 17695-FLAR-PID-1001-01
- 17695-FLAR-PID-1001-02
- 17695-FLAR-PID-1001-03
- 1187-PID1 (Uniquip Engineering PTY Limited)

3.7 Cooling Water Plant Process Description

3.7.1 System Overview

The process heat generated during normal operation of the electrolyser and compression units is to be removed via inline heat exchangers. The heat exchangers utilise a combination of cooling and chilling fluids to cool the process fluid.

Air cooled radiator fin fan coolers are provided for cooling. For the electrolysis process, the required supply cooling water temperature is 45°C, and return cooling water temperature is 55°C.

A cooling water tank is provided to maintain stable cooling water flow to the electrolyser cooling water supply header. Automatic filling of the tanks to maintain constant tank levels is through the addition of process water. When required the inlet valve is automatically opened via a solenoid valve once a low level is detected. The facility to dose corrosion inhibitor chemicals into the water circuit from IBCs using chemical dosing pumps is also allowed for. All tanks are nitrogen purged as a precaution against hydrogen gas ingress via leaks in heat exchangers. Air cooled radiators dissipate heat generated in:

- Electrolysers
- Hydrogen Treatment Unit (HTU)

The cooling water system heat load would be the process system load and environmental conditions dependant i.e., number of air-radiators and speed of fans under operation would be determined by the process heat load and ambient air temperature. To control outlet cooling water temperature from the air-cooled fin fan coolers, as well as improve plant energy efficiency, the speed of the air-cooled radiator fans would be controlled by electrical variable speed drives on the fan motors. For reduced process heat loads and at lower ambient air temperatures, the fan speeds will be reduced, thereby reducing power demand and noise produced. There are 17 banks of fin fan coolers which can be switched ON/OFF to provide further flexibility in supplying variable cooling water demand. The cooled water from the air-cooled radiators is circulated back to the electrolyser cooling water supply header utilising the electrolyser cooling water pumps. The cooling water pumps are provided with variable speed drive motors to maintain set flow to the cooling water supply header.

The list of relevant PFD and P&ID drawings are:

- 17695-COOL-PFD-1001-01
- 17695-COOL-PID-1001-01

3.8 Chilling Water Plant Process Description

3.8.1 System Overview

The process heat generated during normal operation of the electrolyser and compression units is to be removed via inline heat exchangers. The heat exchangers utilise a combination of cooling and chilling fluids to cool the process fluid.

Air cooled style chillers are provided for chilling purposes. The required supply process water temperature is 7°C and process water return temperature is 15°C. The air-cooled chillers cool process water from 15°C to 7°C.

Air cooled chillers dissipate heat generated at:

- Hydrogen Treatment (HTU) unit
- Water Polishing (WPU) unit
- Storage compressor and dispensing compressors

The chilling system broadly comprises of two processes:

- Chiller hot water tank and chiller hot water supply pumps to the chillers
- Chiller cold water tank and chiller cold water supply pumps to the chilled water supply header

To maintain stable flow, chiller hot water tanks are topped up with potable make-up process water, and a bi-directional pipe is provided between chiller hot water tanks and chiller cold water tanks to balance the chilling water demand. Automatic filling of the tanks to maintain constant tank levels is through the addition of process water. When required the inlet valve is automatically opened via a solenoid valve once a low level is detected. The facility to dose corrosion inhibitor chemicals into the water circuit from IBCs using chemical dosing pumps is also allowed for. All tanks are nitrogen purged as a precaution against hydrogen gas ingress via leaks in heat exchangers.

The chiller system heat load would be process-system load dependant, and the number of online chillers would be determined by the process heat load. To control outlet chilling water temperature from the chillers, as well as improve plant energy efficiency, the speed of the chiller compressors would be controlled automatically by the vendor package control system. The process water from the chillers is circulated back to the chilling water supply headers of each respective system, i.e., electrolyser chilled water supply header and main and dispensing compression chilling water headers. The chiller water pumps (both hot and cold) are provided with variable speed control drive motors to maintain a set flow to the headers.

The list of relevant PFD and P&ID drawings are:

- 17695-COOL-PFD-1002-01
- 17695-COOL-PFD-1003-01
- 17695-COOL-PID-1002-01
- 17695-COOL-PID-1003-01

3.9 Nitrogen Plant Process Description

Cryogenic liquid nitrogen storage tanks are filled from a liquid nitrogen road tanker. Gaseous nitrogen is generated at the site by the boiling of the liquid nitrogen by passing it through a static vapouriser and then fed into nitrogen gas storage tanks. The cryogenic liquid nitrogen tanks and the vapourisers together with ancillary piping and pressure relief safety systems are supplied by a specialist vendor as a standalone package.

The nitrogen gas is utilised for the following purposes:

- Continuous blanketing of cooling, chiller water tanks, ultrapure water tank.
- Continuous purging of hydrogen compressors and the flare header.
- Intermittent purging of equipment items for maintenance and pre- start conditions.

For tank blanketing and purging of the flare header, nitrogen gas stored in the nitrogen gas storage tanks is utilised. For purging of the electrolyzers, nitrogen gas is routed directly from liquid storage via the vapourisers.

The list of relevant PFD and P&ID drawings are:

- 17695-NIT-PFD-1001-01
- 17695-NIT-PID-1001-01

3.10 Wastewater Plant Process Description

3.10.1 System Overview

The purpose of the wastewater system is to collect process fluids from different locations throughout the facility. Drains are located throughout the plant to collect process fluids from leaks, spills, drains etc. The waste process fluids are gravity fed to pump sumps, strategically located throughout the facility.

The sumps have two submersible pumps per sump and a local control panel, both of which are Ex rated. The local panel will have a Modbus connection, which will be linked to an RTU in the nearest switchroom.

There are 5 sumps with associated pumps through the plant:

1. Electrolyser Area Sump (895-SU-01) and pump (895-PP-01)
2. Dispensing Compressor Area Sump (895-SU-02) and pump (895-PP-02)
3. Main Compressor Area Sump (895-SU-03) and pump (895-PP-03)
4. Utility Island Area Sump (895-SU-04) and pump (895-PP-04)
5. Chiller Area Sump (895-SU-05) and pump (895-PP-05)

The sumps will pump wastewater into two wastewater tanks. They are:

1. A tank dedicated to the electrolyser area wastewater tank (895-TK-01) which is fed from the electrolyser area sump.
2. The other four sumps will be pumped out to the utility island wastewater tank (895-TK-02).

When the wastewater tanks reach full capacity, a wastewater collection road tanker should be organised to come to site to empty the contents and dispose offsite.

The list of relevant PFD and P&ID drawings are:

- 17695-WAS-PFD-1001-01
- 17695-WAS-PFD-1002-01
- 17695-WAS-PFD-1003-01
- 17695-WAS-PID-1001-01
- 17695-WAS-PID-1002-01
- 17695-WAS-PID-1003-01
- 17695-WAS-PID-1004-01

4 HAZOP Study Team

The HAZOP was held at Kara Room, Level 4, 480 Queens Street, Brisbane meeting room, with participants included via remote TEAMS video meeting as noted.

4.1 Attendance Day 1, 7/04/2025

Meeting: HAZOP- EUROA H2 PROJECT 50MW FEED - Day 1
Date: 7/04/2025
Location: KARA Room, 480 Queen St, Brisbane City, Queensland 4000

Name	Role	Company	In Person	Via Teams	Time in	Time out
Ben Willis	Scribe	UGL	x		9:00am	5:00pm
Sven Barthelme	Facilitator	UGL	x		9:00am	5:00pm
Innes MacLennan	Snr Process Engineer	UGL		x	9:00am	5:00pm
Cristina Garcia	Snr Process Engineer	UGL		x	9:00am	5:00pm
Shahanaaz Shaik	Snr Mechanical Engineer	UGL		x	9:00am	5:00pm
Karl Baum	Snr Mechanical Engineer	UGL		x	9:30am	5:00pm
Anil Nangia	Global Head, New Technology	Vena Energy	x		9:00am	5:00pm
Ahmed Halima	Snr Manager Hydrogen & Fuels Engineering	Vena Energy	x		9:00am	5:00pm
Mark Carter	Snr Manager Development & Stakeholders	Vena Energy				
Amit Khedkar	Manager Hydrogen & Fuels Engineering	Vena Energy	x		9:00am	5:00pm
Keith Boylen	HSSE Manager	Vena Energy	x		9:00am	5:00pm
Andrew Devlin	Technical Division Manager	Hydroflux		x	9:00am	5:00pm
Caitlin Brown	Process Engineer	Hydroflux		x	9:00am	5:00pm
Laurent Van Helden	Director Sales & Market Development	PLUG	x		9:00am	5:00pm

4.2 Attendance Day 2, 8/04/2025

Meeting: HAZOP- EUROA H2 PROJECT 50MW FEED - Day 2
Date: 8/04/2025
Location: KARA Room, 480 Queen St, Brisbane City, Queensland 4000

Name	Role	Company	In Person	Via Teams	Time in	Time out
Ben Willis	Scribe	UGL	x		8:00am	4:00pm
Sven Barthelme	Facilitator	UGL	x		8:00am	4:00pm
Innes MacLennan	Snr Process Engineer	UGL		x	8:00am	4:00pm
Cristina Garcia	Snr Process Engineer	UGL		x	8:00am	4:00pm
Shahanaaz Shaik	Snr Mechanical Engineer	UGL		x	8:00am	4:00pm
Karl Baum	Snr Mechanical Engineer	UGL		x	8:00am	4:00pm
Anil Nangia	Global Head, New Technology	Vena Energy	x		8:00am	4:00pm
Ahmed Halima	Snr Manager Hydrogen & Fuels Engineering	Vena Energy	x		8:00am	4:00pm
Mark Carter	Snr Manager Development & Stakeholders	Vena Energy				
Amit Khedkar	Manager Hydrogen & Fuels Engineering	Vena Energy	x		8:00am	4:00pm
Keith Boylen	HSSE Manager	Vena Energy				
Martijn Ruijter	Application Engineer	PLUG		x	8:00am	4:00pm
Gowardhan Agrawal	Instrumentation & Control Engineer	PLUG		x	8:00am	4:00pm
Jitendra Beri	Electrical Engineer	PLUG		x	8:00am	4:00pm
Amit Joshi	Project Manager	PLUG		x	8:00am	4:00pm
Laurent Van Helden	Director Sales & Market Development	PLUG	x		8:00am	4:00pm
Michael Cavill	Process Leader	VEOLIA		x	8:00am	4:00pm
Justin Scerri	Design manger	VEOLIA		x	8:00am	4:00pm
Ronald Bean	Snr Process Engineer	VEOLIA		x	8:00am	4:00pm
Andrew Devlin	Technical Division Manager	Hydroflux		x	8:00am	10:30am
Caitlin Brown	Process Engineer	Hydroflux		x	8:00am	10:30am
Jitander Berri	Project Engineer	Plug		x	8:00am	4:00pm
Yaso Vesely	Commercial	Veolia		x	8:00am	4:00pm

4.3 Attendance Day 3, 9/04/2025

Meeting: HAZOP- EUROA H2 PROJECT 50MW FEED - Day 3
Date: 9/04/2025
Location: KARA Room, 480 Queen St, Brisbane City, Queensland 4000

Name	Role	Company	In Person	Via Teams	Time in	Time out
Ben Willis	Facilitator	UGL	x		8:00am	3:30pm
Sven Barthelme	Scribe	UGL	x		8:00am	3:30pm
Innes MacLennan	Snr Process Engineer	UGL		x	8:00am	3:30pm
Cristina Garcia	Snr Process Engineer	UGL		x	8:00am	3:30pm
Shahanaaz Shaik	Snr Mechanical Engineer	UGL		x	8:00am	3:30pm
Karl Baum	Snr Mechanical Engineer	UGL		x	8:00am	3:30pm
Anil Nangia	Global Head, New Technology	Vena Energy	x		8:00am	3:30pm
Ahmed Halima	Snr Manager Hydrogen & Fuels Engineering	Vena Energy	x		8:00am	3:30pm
Mark Carter	Snr Manager Development & Stakeholders	Vena Energy	x		9:00am	3:30pm
Amit Khedkar	Manager Hydrogen & Fuels Engineering	Vena Energy	x		8:00am	3:30pm
Keith Boylen	HSSE Manager	Vena Energy		x	8:00am	3:30pm
Martijn Ruijter	Application Engineer	PLUG		x	8:00am	3:30pm
Gowardhan Agrawal	Instrumentation & Control Engineer	PLUG		x	8:00am	3:30pm
Jitendra Beri	Electrical Engineer	PLUG		x	8:00am	3:30pm
Amit Joshi	Project Manager	PLUG		x	8:00am	3:30pm
Michael Cavill	Process Leader	VEOLIA		x	8:00am	12:45pm

4.4 Attendance Day 4, 10/04/2025

Meeting: HAZOP- EUROA H2 PROJECT 50MW FEED - Day 4
Date: 10/04/2025
Location: KARA Room, 480 Queen St, Brisbane City Queensland 4000

Name	Role	Company	In Person	Via Teams	Time in	Time out
Ben Willis	Facilitator	UGL	x		8:00am	4:00pm
Sven Barthelme	Scribe	UGL	x		8:00am	4:00pm
Innes MacLennan	Snr Process Engineer	UGL		x	8:00am	4:00pm
Cristina Garcia	Snr Process Engineer	UGL		x	8:00am	4:00pm
Shahanaaz Shaik	Snr Mechanical Engineer	UGL		x	8:00am	4:00pm
Karl Baum	Snr Mechanical Engineer	UGL		x	8:00am	4:00pm
Anil Nangia	Global Head, New Technology	Vena Energy	x		8:00am	4:00pm
Ahmed Halima	Snr Manager Hydrogen & Fuels Engineering	Vena Energy	x		8:00am	4:00pm
Mark Carter	Snr Manager Development & Stakeholders	Vena Energy				
Amit Khedkar	Manager Hydrogen & Fuels Engineering	Vena Energy	x		8:00am	4:00pm
Keith Boylen	HSSE Manager	Vena Energy		x	8:00am	4:00pm
Corey Moore	Process Engineer	H2 Hauler	x		8:00am	4:00pm
Matt Burge	Graduate Engineer	H2 Hauler		x	8:00am	4:00pm
Alex Mayze	Graduate Engineer	Vena Energy	x		8:00am	4:00pm

5 Methodology

HAZOP, an acronym for Hazard and Operability, is a tool that has been developed to bring together all the key stakeholders involved in design and operations to help identify and eliminate (or minimise) inherent risks in a structured and systematic way. The term HAZOP is also selected because a function of both a design and operability review is to provide an opportunity to sit down, pause and reflect on possible problems.

HAZOP provides a rigorous framework for a facilitated discussion that is stimulated by guidewords or prompts. These prompts assist the key stakeholders to collectively identify and reduce safety, operability, construction, maintenance repair and demolition safety risks associated with a design. Those risks are then formally listed for action by the appropriate stakeholders.

HAZOP recognises that a design involves key considerations such as operability, aesthetics and economics with the elements of safety. It also acknowledges that a design process may be determined by many different stakeholders and influences. The HAZOP methodology aims to involve these elements and influences.

It is intended to be applied to projects where the design or construction is unique, unusual, or of sufficient inherent hazard that a formal detailed assessment is warranted.

The primary aim of a HAZOP is to identify and eliminate or minimise risks in a design as soon as possible in the life cycle of a project. A HAZOP study is intended to help identify that a design needs to consider safety, operability, aesthetics, economics, with the elements of safety in process, operability, constructability and maintainability that together form the final design. A HAZOP provides a structured forum to ensure there is opportunity to foresee process, operability, construction, maintenance, repair and demolition safety issues, so they can be eliminated or modified as part of the design process.

The aims of the HAZOP were as follows:

1. Defining the objectives and the scope of the study.
2. Setting the guidewords and prompts to assist brainstorming process (see Appendix 1 – Guidewords List for this study).
3. Partitioning the process design into logical blocks (nodes) of appropriate size.
4. For each node, the various guidewords were used to assist with the identification of safety aspects and issues.
 1. Identify and evaluate the deviations from normal process conditions in a structured way.
 2. Deviation causes based on single failure only were considered.
 3. Causes were identified within the node only.
 4. Consequences could be found both within and outside the node.
 5. Consequences were to be assessed assuming that control valves remain in the normal operating position.
 6. Consequences were to be assessed as if no safeguards or lines of defence are present.
 7. The risk of the deviation and its mitigation of consequences due to the existing safeguards is not evaluated. This is deferred to a LOPA study to be undertaken in subsequent detailed design stages of the project.
8. Documenting comments, actions, and recommendations in the minutes for resolution during later design stages.

The assumptions of the HAZOP were as follows:

1. P&ID design review has taken place prior to HAZOP and updated P&IDs are available.
2. Feed rate and stream composition are assumed to be known and within specifications.
3. Competent and well-trained operating and maintenance staff are available to operate and maintain the facility.
4. Robust and risk assessed operating and maintenance procedures are in place (including clear descriptions of required response to alarms).
5. Meteorological data does not exceed the design parameters.
6. Operators may be present in the vicinity of the plant 100% of the time.
7. No maintenance is to be performed on live systems (Lock Out Tag Out procedures are in place).

The guidelines for the HAZOP were as follows:

- The HAZOP study will be conducted in accordance with the applicable standard AS IEC 61882-2017 and the NSW Planning, Hazardous Industry Planning Advisory Paper No 8 – HAZOP Guidelines.
- The HAZOP study is carried out by a multidisciplinary team in which sufficient knowledge of the process, chemistry, operations and maintenance of the project.
- No redesign is allowed during the HAZOP sessions. If anomalies in the design are discovered during the HAZOP study, they will be minuted and referred to subsequent design stages of the project for minute closeout.
- Only limited time will be allowed for discussing recommendations that may arise during the study. The HAZOP facilitator has full discretion as to the time allotted for discussions on recommendations.
- No discussions will be allowed during the transcription of the minutes by the scribe.
- Mobile phones are to be turned off. No work or messaging on mobile phones during HAZOP sessions. Breaks will be taken for this.
- No unrelated HAZOP work allowed on open computers.

This being a HAZOP based on a FEED study with limited information in some cases, the actions are referred to subsequent more detailed design phases of the project for close out.

6 List of HAZOP Nodes

As this is a FEED study level HAZOP only the key examples of the process nodes have been identified for study review as to allow early front-end identification of potential significant impacts upon the process, its operability, constructability and the Class 3 cost estimate. The specific nodes considered in this study are:

Node ID	Document Binder(s)	Description	Comments
1	17695-SITE-GA-1001-01_H 17695-SITE-GA-1002-01_G HIM0040-L001_B 17695-WATR-PFD-1001-01_J HIM0040-P0100 HIM0040-P0200 HIM0040-P0300 UGL_PFD_HAZOP.pdf WTP PID_Binder_HAZOP.pdf	Water Treatment Plant- Primary Treatment	Raw water feed to multimedia filter feed tank Raw water is fed to the Raw Water Tank --> Reaction/flocculation tank (with coagulant and flocculant dosing) --> Clarifier--> Multimedia Feed tank Clarifier sludge is fed to the sludge tank --> Dewatering bag (Batch dewatering with flocculant) --> dewatered sludge disposed to landfill Supernatant recovered from dewatering bag and sludge tank are returned to the raw water tank.

Node ID	Document Binder(s)	Description	Comments
2	17695-SITE-GA-1001-01_H 17695-SITE-GA-1002-01_G HIM0040-L001_B 17695-WATR-PFD-1001-01_J HIM0040-P0100 HIM0040-P0200 HIM0040-P0300 UGL_PFD_HAZOP.pdf WTP PID_Binder_HAZOP.pdf	Water Treatment Plant- Secondary Treatment	Multimedia Filtration Feed tank to GAC Feed Tank Multimedia filter feed tank --> Multimedia Filters --> Ultra Filtration Feed Tank --> Pre-UF cartridge filter --> Ultra filtration --> GAC Feed tank MMF filter has backwash system (fed from UF Feed tank). Backwash waste to sludge tank UF filter has: Backwash System (fed from GAC Feed tank). Backwash waste to sludge tank CIP System- Chemically enhanced backwash waste to CIP waste tank

Node ID	Document Binder(s)	Description	Comments
3	17695-SITE-GA-1001-01_H 17695-SITE-GA-1002-01_G HIM0040-L001_B 17695-WATR-PFD-1001-01_J HIM0040-P0100 HIM0040-P0200 HIM0040-P0300 UGL_PFD_HAZOP.pdf WTP PID_Binder_HAZOP.pdf	Water Treatment Plant- Tertiary Water	GAC feed tank to Ultrapure Water Tank and brine concentration GAC feed tank --> GAC Filters --> Pre-RO cartridge filter --> Reverse Osmosis (2 pass) --> EDI --> Ultrapure water tank Brine from RO and EDI --> Brine collection tank --> Pre-RO concentration cartridge filter --> Reverse Osmosis- Brine concentration(1 pass) --> GAC Feed tank Brine from Reverse Osmosis- Brine concentration --> Concentrated brine storage tank GAC has backwash system (fed from GAC Feed tank). Backwash waste to sludge tank Reverse Osmosis has CIP System- Chemically enhanced backwash waste to CIP waste tank
4	17695-SITE-GA-1001-01_H 17695-SITE-GA-1002-01_G HIM0040-L001_B 17695-WATR-PFD-1001-01_J HIM0040-P0100 HIM0040-P0200 HIM0040-P0300 UGL_PFD_HAZOP.pdf WTP PID_Binder_HAZOP.pdf	Water Treatment Plant- Potable Treatment	GAC feed tank to potable water distribution GAC feed tank --> UV Disinfection --> Sodium Hypochlorite disinfection --> Potable water tank --> Potable water distribution

Node ID	Document Binder(s)	Description	Comments
5	17695-SITE-GA-1001-01_H 17695-SITE-GA-1002-01_G HIM0040-L001_B 17695-WATR-PFD-1001-01_J HIM0040-P0100 HIM0040-P0200 HIM0040-P0300 UGL_PFD_HAZOP.pdf WTP PID_Binder_HAZOP.pdf	Water Treatment Plant- UPW to electrolyser	Ultra Pure Water tank to Electrolyser Water Polishing Circuit Water pumped from ultra pure water tank to electrolyser water polishing system Water is combined with electrolyser polished water and fed to electrolyser
6	17695-SITE-GA-1001-01_H 17695-SITE-GA-1002-01_G HIM0040-L001_B 17695-WATR-PFD-1001-01_J HIM0040-P0100 HIM0040-P0200 HIM0040-P0300 UGL_PFD_HAZOP.pdf WTP PID_Binder_HAZOP.pdf	Water Treatment Plant- Clean In Place (Typical)	CIP system for 2 pass reverse osmosis Chemically enhanced backwash waste to CIP waste tank System Typical of CIP systems for WTP Ultrafiltration, brine concentration Reverse Osmosis systems (Not considered as separate nodes) System Typical of CIP Systems for Electrolyser Water Polishing EDI system (Not considered as separate nodes)

Node ID	Document Binder(s)	Description	Comments
7	17695-SITE-GA-1001-01_H 17695-SITE-GA-1002-01_G HIM0040-L001_B 17695-WATR-PFD-1001-01_J HIM0040-P0100 HIM0040-P0200 HIM0040-P0300 UGL_PFD_HAZOP.pdf WTP PID_Binder_HAZOP.pdf	Water Treatment Plant- Chemical Dosing (Typical)	Caustic Dosing to CIP system for 2 pass reverse osmosis - Consider as Typical system Caustic IBC --> CIP system for 2 pass reverse osmosis System Typical of WTP chemical dosing for Coagulant, Flocculent (Polymer), Antiscalant, Citric acid, Sodium hypochlorite and Biocide. (Not considered as separate nodes) System Typical of Electrolyser Water Polishing EDI chemical dosing (Not considered as separate nodes)
8	17695-SITE-GA-1001-01_H 17695-SITE-GA-1002-01_G 17695-ELCT-PFD-1201-01_F 17695-ELCT-PFD-1201-02_F VEOLIA-6161172DF001_A VEX4250D-PC-PFD-001_01.1 VEOLIA-616172F100_1 VEOLIA-616172F101_1 VEOLIA-616172F103_1 VEOLIA-616172F104_1 UGL_PFD_HAZOP.pdf PLUG PID_Binder_HAZOP.pdf	Electrolyser- Hydrogen Purification Unit	Hydrogen from Electrolyser System through purification to compressors Hydrogen from electrolyser --> Deoxygenation reactor --> Dehydration Driers --> Dust filters --> purified hydrogen to compressors

Node ID	Document Binder(s)	Description	Comments
9	17695-SITE-GA-1001-01_H 17695-SITE-GA-1002-01_G 17695-ELCT-PFD-1201-01_F 17695-ELCT-PFD-1201-02_F VEOLIA-6161172DF001_A VEX4250D-PC-PFD-001_01.1 VEOLIA-616172F100_1 VEOLIA-616172F101_1 VEOLIA-616172F103_1 VEOLIA-616172F104_1 UGL_PFD_HAZOP.pdf PLUG PID_Binder_HAZOP.pdf	Electrolyser- Hydrogen Purification Unit- Dryer regeneration	Purified hydrogen through regeneration circuit to dryer cooler inlet Purified hydrogen --> Regeneration compressor --> drier to be regenerated --> inlet to dryer inlet coolers

Node ID	Document Binder(s)	Description	Comments
10	17695-SITE-GA-1001-01_H 17695-SITE-GA-1002-01_G 17695-ELCT-PFD-1201-01_F 17695-ELCT-PFD-1201-02_F PLUGPO-WTS-PR-SYS-EN11-DI-001_1 VEX4250D-PC-PFD-001_01.1 PLUGPO-WTS-PR-SYS-EN21-DS-001-01_1 PLUGPO-WTS-PR-SYS-EN21-DS-001-02_1 PLUGPO-WTS-PR-SYS-EN21-DS-001-05_1 PLUGPO-WTS-PR-SYS-EN21-DS-001-07_1 PLUGPO-WTS-PR-SYS-EN21-DS-001-06_1 PLUGPO-WTS-PR-SYS-EN21-DS-001-08_1 UGL_PFD_HAZOP.pdf PLUG PID_Binder_HAZOP.pdf	Electrolyser- Water Purification Unit	UPW from electrolyzers to UPW Feed to electrolyzers UPW from electrolyzers --> HX 1 (cooling) -> HX 2 (cooling) --> Feed tank --> UV system --> Cartridge filter --> EDI system --> HX 1 (heating) Brine from EDI --> EDI Wastewater Tank --> WTP (Brine collection tank)
11	17695-SITE-GA-1001-01_H 17695-SITE-GA-1002-01_G 17695-ELCT-PFD-1201-02_F 17695-STOR-PFD-1001-01_J 17695-COMP-PID-1001-01 17695-COMP-PID-1001-01 17695-COMP-PID-1001-02 UGL_PFD_HAZOP.pdf NE PID Binder_HAZOP H2Hauler PID Binder_HAZOP	Compression- Main Compression	Purified hydrogen to compression and storage Purified hydrogen --> knockout drum --> main compression --> Storage Management --> storage

Node ID	Document Binder(s)	Description	Comments
12	17695-SITE-GA-1001-01_H 17695-SITE-GA-1002-01_G 17695-ELCT-PFD-1201-02_F 17695-STOR-PFD-1001-01_J 17695-COMP-PID-1001-01 17695-COMP-PID-1001-01 17695-COMP-PID-1001-02 UGL_PFD_HAZOP.pdf NE PID Binder_HAZOP H2Hauler PID Binder_HAZOP	Dispensing - Tube trailer filling	Tube trailer arrival, connection, filling and dispatch of tube trailer Movement guideword set used
13	17695-SITE-GA-1001-01_H 17695-SITE-GA-1002-01_G 17695-ELCT-PFD-1201-02_F 17695-STOR-PFD-1001-01_J 17695-COMP-PID-1001-01 17695-COMP-PID-1001-01 17695-COMP-PID-1001-02 UGL_PFD_HAZOP.pdf NE PID Binder_HAZOP H2Hauler PID Binder_HAZOP	Dispensing- Main Compression	Main Compression --> Storage Management --> Dispensing

Node ID	Document Binder(s)	Description	Comments
14	17695-SITE-GA-1001-01_H 17695-SITE-GA-1002-01_G 17695-ELCT-PFD-1201-02_F 17695-STOR-PFD-1001-01_J 17695-COMP-PID-1001-01 17695-COMP-PID-1001-01 17695-COMP-PID-1001-02 UGL_PFD_HAZOP.pdf NE PID Binder_HAZOP H2Hauler PID Binder_HAZOP	Dispensing- Dispensing Compression (by difference to main compression dispensing)	Storage Management --> Dispensing compressors --> dispensing
15	17695-SITE-GA-1001-01_H 17695-SITE-GA-1002-01_G 17695-ELCT-PFD-1201-02_F 17695-STOR-PFD-1001-01_J 17695-COMP-PID-1001-01 17695-COMP-PID-1001-01 17695-COMP-PID-1002-02 17695-FLAR-PID-1001-01 17695-FLAR-PID-1001-02 17695-FLAR-PID-1001-04 UGL_PFD_HAZOP.pdf NE PID Binder_HAZOP H2Hauler PID Binder_HAZOP UNIQUEIP PID_Binder_HAZOP.pdf	Utilities- Flare	Typical vendor package

Node ID	Document Binder(s)	Description	Comments
16	17695-SITE-GA-1001-01_H 17695-SITE-GA-1002-01_G 17695-ELCT-PFD-1201-02_F 17695-STOR-PFD-1001-01_J 17695-COMP-PID-1001-01 17695-COMP-PID-1001-01 17695-COMP-PID-1002-02 17695-COOL-PID-1002-01_G 17695-COOL-PID-1003-01_F UGL_PFD_HAZOP.pdf NE PID Binder_HAZOP H2Hauler PID Binder_HAZOP UNIQUEIP PID_Binder_HAZOP.pdf	Utilities- Chilling	Chilling system and distribution Includes both the electrolyser area and compression chilling systems

Node ID	Document Binder(s)	Description	Comments
17	17695-SITE-GA-1001-01_H 17695-SITE-GA-1002-01_G 17695-ELCT-PFD-1201-02_F 17695-STOR-PFD-1001-01_J 17695-COMP-PID-1001-01 17695-COMP-PID-1001-01 17695-COMP-PID-1002-02 17695-COOL-PID-1001-01_G 17695-COOL-PFD-1001-01_K VEX4250D-PC-PID-001 UGL_PFD_HAZOP.pdf NE PID Binder_HAZOP H2Hauler PID Binder_HAZOP UNIQUEIP PID_Binder_HAZOP.pdf	Utilities- Cooling	Cooling system and distribution - by difference to Node 16 Chilling

Node ID	Document Binder(s)	Description	Comments
18	17695-SITE-GA-1001-01_H 17695-SITE-GA-1002-01_G 17695-ELCT-PFD-1201-02_F 17695-STOR-PFD-1001-01_J 17695-COMP-PID-1001-01 17695-COMP-PID-1001-01 17695-COMP-PID-1002-02 17695-COOL-PID-1002-01_G 17695-COOL-PID-1003-01_F 17695-COOL-PID-1001-01_G 17695-COOL-PFD-1001-01_K 17695-NIT-PID-1001-01_G 17695-FLAR-PID-1001-01 17695-FLAR-PID-1001-02 17695-FLAR-PID-1001-04 UGL_PFD_HAZOP.pdf NE PID Binder_HAZOP H2Hauler PID Binder_HAZOP UNIQUEIP PID_Binder_HAZOP.pdf	Utilities-Nitrogen	Nitrogen receival, storage and distribution

Node ID	Document Binder(s)	Description	Comments
19	17695-SITE-GA-1001-01_H 17695-SITE-GA-1002-01_G 17695-WAS-PFD-1003_01_F 17695-WAS-PID-1001-01_E 17695-WAS-PID-1002-01_G 17695-WAS-PID-1003-01_E 17695-WAS-PID-1004-01_B	Utilities - Wastewater	Waste water collection and disposal from both the electrolyser and compression and storage areas.
Overview	Overview Node		

7 Findings and Conclusions

7.1 Adequacy of HAZOP study

The HAZOP study team had a balanced disciplinary input ranging from:

1. Process engineering
2. Mechanical engineering
3. Design and engineering management
4. Client representation
5. HS&E representation
6. Subject matter experts on:
 - a. Water treatment plant design
 - b. Electrolyser design
 - c. Gas cleaning design
 - d. Compressor design
 - e. Dispensing and storage design

The documentation available to HAZOP participants, whilst preliminary in nature reflecting the FEED study status was relevant and presentable.

The state of the design was preliminary in nature having been derived from a FEED study for the facility. This does not detract from the findings that are relevant to subsequent more detailed design phases of the project. The actions from the HAZOP study form the basis of an early risk register and should be closed out in subsequent phases of the project.

7.2 Safety and Operability

The HAZOP has been used to define the adequacy of the current design with respect to safety and operability. Whilst there were actions discovered during the study, all are deemed as being able to be closed out with amendments to either designs or procedures.

7.3 Additional Work Required

As previously indicated, the current HAZOP study was based on a FEED design. Should the project proceed to the next detailed design stage, more detailed project area specific HAZOP, LOPA and CHAZOP studies should be performed to encompass all the relevant works.

8 Recommended Actions

It was determined during the HAZOP that several recommended actions be considered for implementation in subsequent project design stages. The complete recommended actions summary is presented in Appendix 3 – HAZOP Study Record Sheets Summary. There are 182 recommended actions which need to be addressed through subsequent design stages and broadly consist of:

- Adding additional instruments
- Adding additional alarms and interlocks
- Considering the need for the UV process in the WPU
- Understanding the PFAS implications of the electrolyser process
- Rationalising the nitrogen tank blanketing process
- Adjusting bunding for geobags, CIP wastes and chiller areas.

- Provide position feed back on all automatic actuated valves
- Differentiate between CSD and ESD
- Adding additional valves, RPZs, check valves and strainers
- Add a dangerous goods store
- Reconcile cooling water control around HTU and WPU heat exchangers
- Develop a TMP
- Undertake additional investigations such as water quality analyses, plume dispersion modelling, CASA , geotechnical investigations, contaminated soils

9 Appendices

Appendices Index

9.1	Appendix 1	Guidewords List
9.2	Appendix 2	HAZOP Master Documents List
9.3	Appendix 3	HAZOP Study Record Sheets
9.4	Appendix 4	HAZOP Recommended Actions Summary
9.5	Appendix 5	Master Documents

9.1 Appendix 1 – Guidewords List

9.1.1 Process Nodes –Guidewords and Sub-words

Item	Guideword	Sub-word
1.1	Flow	High flow
1.2		Low flow
1.3		No flow
1.4		Reverse flow
2.1	Level	High level
2.2		Low level
3.1	Pressure	High Pressure
3.2		High Pressure
4.1	Temperature	High temperature
4.2		Low temperature
5.1	Contaminants	Gaseous, liquid, solid
6.1	Composition	State change
6.2		Viscosity
6.3		Side reactions
6.4		Wrong concentration
6.5		2 Phase
7.1	Instrument and controls	Adequacy
7.2		Failure
8.1	Loss of containment	Spill containment
9.1	Electrical safety	Hazardous area classification
9.2		Static discharge
10.1	Maintenance	Access
10.2		Purging of gas
10.3		Inspection and testing
10.4		Isolation

9.1.2 Movement Nodes – Guidewords and Sub-words

Item	Guideword	Sub-word
1.1	Position	Too high
1.2		Too low
1.3		Too far
1.4		Misaligned
1.5		Wrong position
2.1	Movement	High speed
2.2		low speed
2.3		No movement/stuck
2.4		Reverse
2.5		Slip / friction
2.6		Subsidence
3.1	Size	Too large
3.2		Too small
4.1	Load	High load (force)

Item	Guideword	Sub-word
4.2		Low load (force)
4.3		High flow
4.4		Low flow
4.5		Loss of containment
5.1	Timing	Too late
5.2		Too early
5.3		Incorrect sequence
6.1	Physical damage	Dropped objects
6.2		Transport collision
6.3		Vibration
6.4		Corrosion
6.5		Obstacles
7.1	Failure	Utilities- power/water/air/lighting/other?
7.2		Machinery
7.3		Safety shut down
8.1	Contamination	Water
8.2		Dust
8.3		Oil
8.4		Flammables
8.5		Corrosives

9.1.3 Overview Node – Guidewords and Sub-words

Item	Parameters	Guideword
1.1	Toxicity	Handling procedure
1.2		Precautions
1.3		Exposure & monitoring
2.1	Fire/Explosion	Prevention systems
2.2		Detection systems
2.3		Fire protection
2.4		Emergency isolation
2.5		Emergency procedures
3.1	Environmental impact	Vapour / gas emissions
3.2		Dust
3.3		Effluent
3.4		Noise
3.5		Ground seepage
3.6		Waste
4.1	Materials of Construction	Pipes
4.2		Valves
4.3		Fittings
4.4		Instruments
4.5		Filters
4.6		Gaskets

Item	Parameters	Guideword
4.7		Protective Systems
4.8		Coatings
5.1	Access	Operation
5.2		Maintenance
5.3		Emergency escape
6.1	Electrical safety	Hazardous area classification
6.2		Earthing
6.3		Lightning protection
6.4		Static discharge
6.5		Overhead/buried cables
7.1	Utilities & services	Instrument air/gas
7.2		Compressed air
7.3		Breathing air
7.4		Nitrogen
7.5		Cooling water
7.6		Process water
7.7		Steam
7.8		Fuel gas
7.9		Electricity
7.10		Oxygen
7.11		Lighting
8.1	Commissioning	Requirements
8.2		Sequences
8.3		Procedures
9.1	Start - up	First time
9.2		Routine
9.3		Procedure
10.1	Shut down	Planned
10.2		Emergency
10.3		Procedure
11.1	Safety equipment	Personnel protection
11.2		Gas monitoring
11.3		Breathing apparatus
11.4		Safety showers
11.5		Barriers & guards
12.1	Natural hazards	Earthquake
12.2		Flooding
12.3		Thunderstorms
12.4		High winds
12.5		Bush fires
13.1	Inspection and testing	Alarms & trips
13.2		Emergency isolation
13.3		Gas / fire detectors
13.4		Fire protection systems
14.1	Procedures	Temporary works designs
14.2		Operations
14.3		Maintenance

Item	Parameters	Guideword
14.4		Confined space
14.5		Emergency
14.6		Engineering drawings
14.7		Modification control
15.1	Quality Control	Inspection & Test Plans
16.1	External Safety Interface	Members of the public
16.2		Adjacent property
16.3		Services locations
16.4		Response to External Emergency

9.2 Appendix 2 – HAZOP Master Documents List

Item	Description	Company	Document	
			Number	Revision
1	Hazardous Industry Planning Advisory Paper No 8 – HAZOP Guidelines	NSW Government Planning		January 2011
2	Hazard and Operability studies (HAZOP studies)- Application Guide	Australian Standards	AS_IEC_61882-2017	2016
3	STAGE 1: FEED STUDY 50MW ELECTROLYZER SITE GENERAL ARRANGEMENT	UGL	17695-SITE-GA-1001-01	H
4	STAGE 1: FEED STUDY 50MW ELECTROLYZER HYDROGEN PLANT NFPA 2 GROUP 1 SAFETY SPACING QRA GENERAL ARRANGEMENT	UGL	17695-SITE-GA-1003-01	D
5	STAGE 1: FEED STUDY 50MW ELECTROLYZER HYDROGEN PLANT NFPA 2 GROUP 2 SAFETY SPACING QRA GENERAL ARRANGEMENT	UGL	17695-SITE-GA-1003-02	D
6	STAGE 1: FEED STUDY 50MW ELECTROLYZER HYDROGEN PLANT 17695-SITE-GA-1003-01 NFPA 2 GROUP 3 SAFETY SPACING QRA GENERAL ARRANGEMENT	UGL	17695-SITE-GA-1003-03	D
7	STAGE 1: FEED STUDY 50MW ELECTROLYZER HYDROGEN PLANT GENERAL ARRANGEMENT HAZARDOUS AREA CLASSIFICATION	UGL	17695-SITE-GA-1004-01	C
8	Sparing Philosophy	UGL	17695-DM-REG-1002	E
9	Mechanical Equipment List	UGL	17695-DM-REG-1003	D
10	Mechanical & Piping Tie-in List	UGL	17695-DM-REG-1006	E
11	Relief and Blowdown Philosophy	UGL	17695-PROC-RPT-1002	F
12	Process Safety Specification	UGL	17695-PROC-RPT-1003	D
13	STAGE 1: FEED STUDY 50MW ELECTROLYSER PLANT CONTROL SYSTEM NETWORK ARCHITECTURE	UGL	17695-CTRL-NETW-1001-01	B

Item	Description	Company	Document	
			Number	Revision
14	STAGE 1: FEED STUDY 50MW ELECTROLYSER PLANT CONTROL SYSTEM NETWORK ARCHITECTURE	UGL	17695-CTRL-NETW-1001-02	B
15	STAGE 1: FEED STUDY 50MW ELECTROLYSER PLANT CONTROL SYSTEM NETWORK ARCHITECTURE	UGL	17695-CTRL-NETW-1001-03	B
16	UGL PFD binder	UGL	UGL_PFD_HAZOP	-
17	UGL P&ID binder	UGL	UGL PID_BINDER_HAZOP	-
18	Plug HAZOP P&ID binder	Plug	PLUG-PID-BINDER HAZOP	-
19	NEA P&ID binder	Neuman & Esser	NEA PID_BINDER_HAZOP	-
20	Hydroflux P&ID binder	Hydroflux	WTP PID_BINDER_HAZOP	-
21	Uniquip P&ID binder	Uniquip	UNIQUEP PID_BINDER_HAZOP	-
22	H2 Hauler P&ID binder	H2 Hauler	H2 Hauler PID_BINDER_HAZOP	
23	Control Logic Narrative	UGL	17695-CONT-SPC-1001	B
24	HAZOP Report (external) EX4250D	Plug	VEX4250D-PC-HZP-002-r01	1
25	Attachment 04 - HAZOP Worksheets _ stamped	Plug	PLU-24001-HAR-001-B	
26	Attachment 05 - Recommendations _stamped	Plug	PLU-24001-HAR-001-B	

9.3 Appendix 3 – HAZOP Study Record Sheets

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
1	1	Flow	High flow	Actuated valve fail open on inlet (845-TK001)	MMF Feed tank overflows Exceed capacity of bund, discharge into the environment	High Level alarm warning High Level switch + alarm	Convert actuated valve to FSC
1	2	Flow	High flow	Feed pump control loop failure	MMF Feed tank overflows Exceed capacity of bund, discharge into the environment	High Flow alarm MMF tank High Level alarm MMF tank High level switch + alarm+pump interlock	
1	3	Flow	High flow	Clarifier sludge pump setpoint high	High flow into geo-bag Excessive water drawn into sludge pump resulting in floc breakup Return of higher solids content to raw water feed tank	Setpoint refined during commissioning	Add flow meter with high flow alarm
1	4	Flow	High flow	Gravity flow through feed pumps when process is not running	Overflow mixing tank/clarifier/MMF tanks	Nil	Add control valve (FSC) after clarifier feed pumps Add a high flow alarm for stopped condition
1	5	Flow	Low flow	GAWB water supply low	Loss of production	Level monitoring on raw water feed tank Raw Water tank capacity is 24hrs storage	Develop response procedure Feed flowmeter and low alarm Flow study from GAWB study required.
1	6	Flow	Low flow	Sludge pump strainer blocked or valve inadvertently closed	Low flow to geo-bag	Low flow Alarm on clarifier sludge feed	
1	7	Flow	No flow	Sludge handling systems plugged	Low flow from clarifier and sludge tank	Low flow alarms on sludge pump discharge	
1	8	Flow	No flow	Strainer blocked or Valve inadvertently closed	No flow to geo-bag	Low flow Alarm on clarifier feed	

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
1	9	Flow	Reverse flow	High level in feed tank	Reverse flow from tank into GAWB main	High level alarm high level switch + alarm Air break in tank	Consider need for additional RPZ required by GAWB
1	10	Flow	Reverse flow	Pneumatic diaphragm pump- mechanical failure of internal check valves	Reverse flow through pump	Gravity system- reverse flow unlikely	
1	11	Level	High level	Tank level high	Overflow tanks	Over flows on tanks to control overflow High level alarms HI level switch + alarm+ pump interlocks	
1	12	Level	High level	Blockage in sump, filtrate sump overflows	Bund fills with filtrate		High level switch and high alarm
1	13	Level	Low level	Tank levels low	Pumps run dry, damage to pumps	Low level alarms on tanks & interlocked to pumps	
1	14	Pressure	High Pressure	Geo-bag blocked	Burst geo-bag solids flow to sump & back to feed tank	None	Design geo-bag sump such that whole possible volume is contained. Add valve to sump to hold water and check quality before releasing to feed tank
1	15	Pressure	High Pressure	Positive displacement sludge pumps discharge against valve closed	Pump builds up pressure with casing damage		Pressure relief bypass for clarifier sludge pump to be included Add flow meter with FALL
1	16	Pressure	High Pressure	Geo bag overpressure	Potential bag rupture or leak	Air pressure setting to ensure pump stalls prior to bag burst & PAH	
1	17	Pressure	Low pressure	Insufficient pressure in GAWB water main to gravity flow into top of raw water feed tank.	Unable to fill raw water feed tank		Flow study (GAWB) study required. If insufficient pressure available, consider booster pumps or lower elevation for tank in detailed design.
1	18	Temperature	High temperature	No new issues			
1	19	Temperature	Low temperature	No new issues			
1	20	Contaminants	Gaseous, liquid, solid	No new issues			
1	21	Composition	State change	No new issues			

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
1	22	Composition	Viscosity	No new issues			
1	23	Composition	Side reactions	No new issues			
1	24	Composition	Wrong concentration	Overdose or underdose coagulant and polymer	Ineffective solids settling	Coagulation and flocculant jar testing during commissioning and operations. Calibration tubes provided to allow flow rate determination	Water quality data to be confirmed by Gladstone Water Board before detailed design. Access to data being sought. Likely 50MW plant will receive "treated" water quality. Continue to assume raw water quality as is.
1	25	Composition	Wrong concentration	High Solids concentration in raw water feed tank or geo-bag burst introducing high concentration of solids into feed tank via filtrate sump	Solids in tank - blockages - dosing/clarifier ineffective and floc carryover to MMF sump		Add turbidity meter and high alarm on clarifier system Separate bund to hold geobag to contain bag contents. Operator to confirm bag integrity prior to pumping sump to feed tank
1	26	Composition	Wrong concentration	High conductivity from GAWB	Exceed plant conductivity removal capacity		Add conductivity meter and high alarm Conductivity specification with GAWB to be confirmed
1	27	Composition	2 Phase	No new issues			
1	28	Instrument and controls	Adequacy	No new issues			
1	29	Instrument and controls	Failure	Failure or insufficient air supply to pneumatic pumps	Pump operation inadequate	Pressure switch and PAL on pneumatic supply to pumps	
1	30	Instrument and controls	Failure	Failure mode for control valves not noted	Valve failure mode not considered		Feed water solenoid valve confirm FSC
1	31	Loss of containment	Spill containment	Cleaning strainer	Solids into plant sump and into raw water feed tank	Bunded area	Geofabric incorporated into sump grates to retain gross solids
1	32	Electrical safety	Hazardous area classification	No new issues			
1	33	Electrical safety	Static discharge	No new issues			
1	34	Maintenance	Access	Changing out old chemical IBCs with new			Access ramps for forklifts etc. to access geobags and chemical IBC's

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
							Add dangerous goods storage area
1	35	Maintenance	Purging of gas	No new issues			
1	36	Maintenance	Inspection and testing	No new issues			
1	37	Maintenance	Isolation	No new issues			
2	1	Flow	High flow	MMF Feed Pump VFD out of range	Exceed design flow	High pressure alarm High flow alarm	
2	2	Flow	Low flow	Blockages or valves closed	Low flow through plant	High pressure alarms Low flow alarms	
2	3	Flow	No flow	Valve closed	No flow through plant	High pressure alarms Low flow alarms	
2	4	Flow	Reverse flow	Reverse flow through air scour	Blower floods with water, equipment damage	Non return valves Anti syphon valve on scour air	P&ID correction
2	5	Flow	Reverse flow	Reverse flow through backwash system valve failure	Backwash ineffective, loss of media	Automated valve actuation	Valves need feedback limit switches and alarms for position indication
2	6	Flow	Reverse flow	Air scour of UF	Air blows into GAC feed tank and blows out tank vent		Consider alternative vent for UF scour air
2	7	Level	High level	No new issues		Level alarms high level switch + alarm Upstream pumps interlocked with high level	
2	8	Level	Low level	No new issues		Level alarms Downstream pump interlocks	
2	9	Pressure	High Pressure	No new issues		High pressure alarms	
2	10	Pressure	High Pressure	Blower dead headed	Blower damage	Pressure relief valve on blower discharge Pressure indication (local)	Consider pressure switch and high alarm on blower discharge

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
2	11	Pressure	High Pressure	UF membrane blockage	Membrane rupture	Monitoring of normalised pressure and flow	
2	12	Pressure	Low pressure	UF membrane blockage	Out of specification water produced Loss of productivity	Analysers pick up deviation Low pressure alarms	Consider isolation valves on UF membrane modules
2	13	Temperature	High temperature	Blower operating	Discharge pipework likely hot, possible burns if touched		Consider pipe guarding (e.g. perforated mesh) or insulation
2	14	Temperature	High temperature	High water temperature	Adverse impact on membranes	Temperature impact not significant. TAH	
2	15	Temperature	Low temperature	No new issues			
2	16	Contaminants	Gaseous, liquid, solid	MMF rat holing	Solids carryover and membrane damage	Cartridge filters upstream of UF	
2	17	Contaminants	Gaseous, liquid, solid	Degradation of membranes	Possible water contamination with PFAS	PE membranes	Follow up with membrane chemistry
2	18	Composition	State change	No new issues			
2	19	Composition	Viscosity	No new issues			
2	20	Composition	Side reactions	No new issues			
2	21	Composition	Wrong concentration	No new issues			
2	22	Composition	2 Phase	No new issues			
2	23	Instrument and controls	Adequacy	No new issues			
2	24	Instrument and controls	Failure	No new issues			
2	25	Loss of containment	Spill containment	No new issues			
2	26	Electrical safety	Hazardous area classification	No new issues			
2	27	Electrical safety	Static discharge	No new issues			
2	28	Maintenance	Access	No new issues			

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
2	29	Maintenance	Purging of gas	No new issues			
2	30	Maintenance	Inspection and testing	No new issues			
2	31	Maintenance	Isolation	No new issues			
3	1	Flow	High flow	Pumps/VSD set incorrectly	Water quality impacts	High flow and high pressure alarms	
3	2	Flow	Low flow	Valves closed	Low productivity	Low flow and high pressure alarms	
3	3	Flow	No flow	No new issues			
3	4	Flow	Reverse flow	GAC filter valves positioned incorrectly	Process treatment ineffective, possible clean water contamination	Automated valve actuation	Valves need feedback limit switches and alarms for position indication
3	5	Level	High level	GAC feed tank filling rate is greater than GAC feed pump flow rate	GAC feed tank overflow	LAH and LAHH and interlock with upstream pump	
3	6	Level	Low level	No new issues			
3	7	Pressure	High Pressure	No new issues		Pressure transmitters/alarms	
3	8	Pressure	Low pressure	No new issues		Pressure transmitters/alarms	
3	9	Pressure	Low pressure	RO membrane rupture	Out of specification water produced Loss of productivity	Analysers pick up deviation Low pressure alarms	
3	10	Temperature	High temperature	No new issues			
3	11	Temperature	Low temperature	No new issues			
3	12	Contaminants	Gaseous, liquid, solid	Presence of difficult to remove precipitated ions (e.g. silica)	Permanent scaling of RO membrane	Antiscalant use with flow and level monitoring	Detailed analysis of water chemistry as part of detailed design
3	13	Contaminants	Gaseous, liquid, solid	Particulate contaminants in chemicals	Membrane damage	Strainer on pump inlet, cartridge filters	
3	14	Composition	State change	No new issues			

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
3	15	Composition	Viscosity	Brine concentration leads to increased viscosity		Incorporated into design	
3	16	Composition	Side reactions	No new issues			
3	17	Composition	Wrong concentration	Higher TDS than anticipated	Recovery not achieved	Flow and pressure monitored Resistivity monitored and analysers alarmed	Consider where to send out of spec, typically flush to drain at startup. Consider adding alternative return to GAC feed tank or raw water feed tank.
3	18	Composition	2 Phase	No new issues			
3	19	Instrument and controls	Adequacy	Calibrating resistivity analyser	No bypass, difficult to maintain		Add bypass around instruments for maintenance
3	20	Instrument and controls	Adequacy	No pH analysis after EDI	pH out of specification	pH change across EDI not expected.	Add pH meter after EDI
3	21	Instrument and controls	Failure	No new issues			
3	22	Loss of containment	Spill containment	Concrete corrosion from ultrapure water	Drain failure and ground seepage		Check concrete/sewer specification required for sumps, bunds or pipework.
3	23	Electrical safety	Hazardous area classification	No new issues			
3	24	Electrical safety	Static discharge	No new issues			
3	25	Maintenance	Access	No new issues			
3	26	Maintenance	Purging of gas	No new issues			
3	27	Maintenance	Inspection and testing	No new issues			
3	28	Maintenance	Isolation	No new issues			
4	1	Flow	High flow	Too high flow set through UV system	Inadequate disinfection	Flow alarms UV analyser alarms	
4	2	Flow	Low flow	No new issues			
4	3	Flow	No flow	Pump failure/ valve closed/blockage	Damage to UV system from overheating		Consider interlocking UV system with low flow/pumps running Add alarms to high alarm to TT
4	4	Flow	Reverse flow	Backflow from field process water into potable water tank	Contamination of potable water		Add RPZ on process water pumps

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
4	5	Flow	Reverse flow	Hypochlorite backflow into UV system	Fill pipe with hypochlorite	Injection valve	Interlock dosing with water flow
4	6	Level	High level	No new issues			
4	7	Level	Low level	No new issues			
4	8	Pressure	High Pressure	Blockage	Cartridge filter blocked	Pressure switch and high alarm	
4	9	Pressure	Low pressure	No new issues			
4	10	Temperature	High temperature	UV heats water	Damage to UV system		Consider interlocking UV system with low flow/pumps running Add alarms to high alarm to TT
4	11	Temperature	High temperature	HDPE pipes to safety showers exposed to direct sunlight	Hot water in showers resulting in burns		If pipe exposed to direct sunlight, insulate
4	12	Temperature	Low temperature	No new issues			
4	13	Contaminants	Gaseous, liquid, solid	Water treatment failure	Australian Drinking Water Guidelines non compliance. Health effects	Design to Australian Drinking Water Guidelines compliance.	Regular testing in accordance with ADWG requirements
4	14	Contaminants	Gaseous, liquid, solid	Inconsistency in approach for process water to polymer dilution			Relocate UV Filtrate to polymer dilution with other process water consumers
4	15	Composition	State change	No new issues			
4	16	Composition	Viscosity	No new issues			
4	17	Composition	Side reactions	No new issues			
4	18	Composition	Wrong concentration	Too much chlorine residual	Australian Drinking Water Guidelines non compliance. Health effects	Chlorine residual analyser and alarms	
4	19	Composition	2 Phase	No new issues			
4	20	Instrument and controls	Adequacy	No new issues			
4	21	Instrument and controls	Failure	No new issues			
4	22	Loss of containment	Spill containment	No new issues			

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
4	23	Electrical safety	Hazardous area classification	No new issues			
4	24	Electrical safety	Static discharge	No new issues			
4	25	Maintenance	Access	No new issues			
4	26	Maintenance	Purging of gas	No new issues			
4	27	Maintenance	Inspection and testing	No new issues			
4	28	Maintenance	Isolation	No new issues			
5	1	Flow	High flow	Control interface uncertain between node 5 and node 10	Incorrect makeup water flow Loss of production due to insufficient makeup water addition Overflow of anode separator due to too much water	Ultra pure water pump flow controlled to provide maximum required water demand recirculation loop set to maintain constant pressure and provide makeup water on demand when level control in anode separator (bypass excess flow back to tank) Flow alarms FAL and FAH	Review and confirm control philosophy for water flow control. Plug to provide range of makeup water flow rates Drawing correction Hydroflux flow goes to Heat exchanger 1 not Heat exchanger 2
5	2	Flow	Low flow	PCV fails open	Insufficient makeup water	Flow alarms FAL Flow meter in Veolia scope	Move flow meter downstream of pressure control loop
5	3	Flow	No flow	Valve closed	Insufficient makeup water Loss of production	Flow alarms FAL Flow meter in Veolia scope	
5	4	Flow	Reverse flow	Hydrogen backflow into tank	Hydrogen in tank, LEL exceeded with explosion risk	Nitrogen purge on tank	
5	5	Flow	Reverse flow	High pressure in anode separator	Reverse flow via bypass and overflow tank	Tank high level alarms	Add non-return valve downstream of bypass
5	6	Level	High level	Hydrogen backflow into tank	Hydrogen in tank, LEL exceeded with explosion risk	PIT and PAH alarm Burst disk	Add hydrogen analyser and CSD LIT needs dip type with impulse line to tank head space

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
							Interlock GAC feed pump feed pumps on PAH
5	7	Level	Low level	Water recovery efficiency low (insufficient water produced)	Low level in UPW tank and CSD to electrolyser plant shutdown	Low level alarm LALL	
5	8	Pressure	High Pressure	Pressure control loop failure	Overflow water polishing feed tank at WPU	Level alarms FAH Pressure alarms PAH	Consider shutdown on high level (economic benefit of not losing water to drain.) Consider collecting UPW water at WTU polishing feed tank overflow and pump back to WTP
5	9	Pressure	Low pressure	No new issues			
5	10	Temperature	High temperature	No new issues			
5	11	Temperature	Low temperature	No new issues			
5	12	Contaminants	Gaseous, liquid, solid	Debris in tank	Pump blockage Heat exchanger blockage	Upstream filtration	Add strainer to pump suction
5	13	Contaminants	Gaseous, liquid, solid	Carbon dioxide dissolved in water	Water quality degrades	Nitrogen blanket	Add resistivity analyser
5	14	Composition	State change	No new issues			
5	15	Composition	Viscosity	No new issues			
5	16	Composition	Side reactions	No new issues			
5	17	Composition	Wrong concentration	No new issues			
5	18	Composition	2 Phase	No new issues			
5	19	Instrument and controls	Adequacy	No new issues			
5	20	Instrument and controls	Failure	No new issues			
5	21	Loss of containment	Spill containment	No new issues		Bunded WTP	
5	22	Electrical safety	Hazardous area classification	Hydrogen in UPW tank	Hydrogen in tank, LEL exceeded with explosion risk		Not classified as hazardous area since risk low to have flammable mixture
5	23	Electrical safety	Static discharge	No new issues			
5	24	Maintenance	Access	No new issues			

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
5	25	Maintenance	Purging of gas	No new issues			
5	26	Maintenance	Inspection and testing	No new issues			
5	27	Maintenance	Isolation	No new issues			
6	1	Flow	High flow	CIP pump set incorrectly	No consequence identified	High flow alarms	
6	2	Flow	Low flow	CIP pump set incorrectly	Poor cleaning	Low flow alarms	
6	3	Flow	Low flow	CIP pump set incorrectly	Damage to heater	Flow switch and low flow alarm	
6	4	Flow	No flow	No new issues			
6	5	Flow	Reverse flow	Incorrect valve position	Inject CIP chemical to incorrect downstream process	Non return valves	Actuated valves need feedback limit switches and alarms for position indication
6	6	Flow	Reverse flow	Incorrect valve position	Inject CIP chemical to incorrect downstream process	Rinse process	Actuated valves need feedback limit switches and alarms for position indication
6	7	Level	High level	CIP tank overflow overfilled with water	CIP solution into overflows into sump	High level alarms + level switch upstream pumps interlocked	Consider dedicated sump for CIP chemical tanks to segregate from WTP sumps
6	8	Level	Low level	Valve closed blockage	Pump damage Cleaning ineffective	Low level alarms and interlocks downstream pumps	P&ID HIM0040-P2100: add 'P1300-RO pass 2 filtrate to CIP tank actuated valve' to interlock on LAHH (RO/EDI CIP tank).
6	9	Level	Low level	Wash water to drain, tank difficult to empty completely	Mixing residual chemical in tank with subsequent CIP process fluids	Need to flush and rinse last bit of tank volume to sump	Consider conical or sloping bottom of tank to drain outlet
6	10	Pressure	High Pressure	Blocked cartridge filter	Low or no flow through filter	Pressure indicator on cartridge filter	Add pressure switch with high pressure alarms
6	11	Pressure	Low pressure	CIP tank return valve fails	Less effective cleaning	Low pressure alarms	
6	12	Temperature	High temperature	Low or no flow through heater	Damage to heater	Internal thermal cutout switch TAH and	

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
						temperature interlock	
6	13	Temperature	Low temperature	Heater not functioning	Less effective cleaning	TAL temperature interlock	
6	14	Contaminants	Gaseous, liquid, solid	Incorrect chemical dose	Cleaning ineffective	Controlled dosing system for both water and chemical	Add pH instrument on tank recirculation (mixing) loop
6	15	Contaminants	Gaseous, liquid, solid	Residual contaminants line tanks. Rinse not effective	Contamination of downstream water		Length of cycle times determined during commissioning
6	16	Composition	State change	No new issues			
6	17	Composition	Viscosity	No new issues			
6	18	Composition	Side reactions	No new issues			
6	19	Composition	Wrong concentration	No new issues			
6	20	Composition	2 Phase	No new issues			
6	21	Instrument and controls	Adequacy	No new issues			
6	22	Instrument and controls	Failure	No new issues			
6	23	Loss of containment	Spill containment	No new issues			
6	24	Electrical safety	Hazardous area classification	No new issues			
6	25	Electrical safety	Static discharge	No new issues			
6	26	Maintenance	Access	No new issues			
6	27	Maintenance	Purging of gas	No new issues			
6	28	Maintenance	Inspection and testing	No new issues			
6	29	Maintenance	Isolation	No new issues			
7	1	Flow	High flow	Pump set incorrectly	Overdose chemical	pH meter downstream controlling dosing	

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
						pump Calibration curve developed for pump For coagulant and polymer dosing, laboratory jar testing verification required	
7	2	Flow	Low flow	Pump set incorrectly	Underdose chemical	pH meter downstream controlling dosing pump Calibration curve developed for pump For coagulant and polymer dosing, laboratory jar testing verification required	
7	3	Flow	No flow	Valve closed	No chemical dosed	pH meter downstream controlling dosing pump	
7	4	Flow	No flow	Tank empty	No chemical dosed	Level switches and low level alarms	
7	5	Flow	Reverse flow	Higher pressure in line being dosed	Dilution or contamination of chemical	Back pressure regulating injection valves prevents reverse flow	
7	6	Level	High level	No new issues			
7	7	Level	Low level	Empty tank	Run out of chemical	Level switches and low level alarms	
7	8	Pressure	High Pressure	Closed valves	High pressure in dosing line, pipe burst or pump damage	Pump PSV allowing recycle	
7	9	Pressure	Low pressure	No new issues			
7	10	Temperature	High temperature	No new issues			
7	11	Temperature	Low temperature	No new issues			
7	12	Contaminants	Gaseous, liquid, solid	Contaminants in chemicals	Injecting into downstream		Add strainers to dosing pump suction

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
					process resulting in blockages		
7	13	Composition	State change	No new issues			
7	14	Composition	Viscosity	No new issues			
7	15	Composition	Side reactions	No new issues			
7	16	Composition	Wrong concentration	No new issues			
7	17	Composition	2 Phase	No new issues			
7	18	Instrument and controls	Adequacy	No new issues			
7	19	Instrument and controls	Failure	No new issues			
7	20	Loss of containment	Spill containment	Chemical spill	Chemicals in IBC bunds	IBC bund contains spill	
7	21	Electrical safety	Hazardous area classification	No new issues			
7	22	Electrical safety	Static discharge	No new issues			
7	23	Maintenance	Access	Access to replacement chemicals	Chemicals stored in unsafe location		Dangerous goods storage area
7	24	Maintenance	Purging of gas	Pump full of chemical if needed to be removed	Exposure to chemical during maintenance		Add drain valves on dosing pump suction and discharge.
7	25	Maintenance	Inspection and testing	No new issues			
7	26	Maintenance	Isolation	No new issues			
8	1	Flow	High flow	Inconsistent control interface with cooling and chilling water	Chilling and cooling water designs not functional		Constant flow for cooling or chilling water feeds with bypass around heat exchangers as per Plug anode separator approach needs to be adopted
8	2	Flow	High flow	High flow from electrolyser	Potential hydrogen produced out of specification	Flow measurement at electrolyser discharge Not anticipated as limited by	Consider high and low flow alarms on electrolyser gas flow

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
						electrolyser current input	
8	3	Flow	Low flow	Filters blocked or valve closed	Need to change filters out dust filters	Flow meters and low flow alarm High differential pressure alarm on dust filter	Consider parallel filters or logistics of changeout during planned downtime
8	4	Flow	No flow	Isolatable section doesn't meet standard approach	Isolation not effective resulting in gas bypass		Dissimilar non-return valves to be added consistent with isolatable section philosophy
8	5	Flow	No flow	Planned or unplanned downtime	System cools down, off specification gas produced on restart	Recycle loop to maintain temperature during shut down	
8	6	Flow	Reverse flow	Reverse flow via regeneration recycle		Non return valves on regeneration lines	
8	7	Level	High level	No new Issues			
8	8	Level	Low level	No new Issues			
8	9	Pressure	High Pressure	No new Issues			
8	10	Pressure	Low pressure	Startup pressure is lower than design	Compressors cannot start	Purge valve and bypass at compressor. See node 11	
8	11	Temperature	High temperature	High gas temperature	Heater or vessel damage	Temperature alarm and TAAH interlock to stop heater	
8	12	Temperature	Low temperature	Low temperature in drier during plant downtime	Need to preheat drier prior to startup to prevent off specification gas during startup	Recycle loop to maintain temperature	Confirm preheating times
8	13	Temperature	Low temperature	Low temperature	Out of specification gas Damage to catalyst if water condensate forms	Low temperature alarm	Consider additional alarm/interlock requirements to ensure performance/catalyst life is maintained
8	14	Contaminants	Gaseous, liquid, solid	Spent desiccant is not detected	Wet gas off specification gas produced		Regeneration cycle trigger to be considered.

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
							Consider additional dew point analysers
8	15	Contaminants	Gaseous, liquid, solid	Regeneration cycle not completed during plant shut down	Shorter subsequent drying bed cycle operating time	Regeneration continues if hydrogen production is stopped part way through cycle	Consider optimisation to reduce power consumption for regeneration during plant downtime
8	16	Composition	State change	Water released from separator vessels is hydrogen gas saturated.	Hydrogen flashing at discharge with potential fire and explosion in drain	Small volume of water with low hydrogen gas consequences.	Drains needs to handle hydrogen evolution Segregate oxygen and hydrogen discharges to drain. Consider closed sump with vents to safe location
8	17	Composition	Viscosity	No New Issues			
8	18	Composition	Side reactions	Excessive oxygen concentration	Runaway reaction with possible temperatures >100C (would need to be ~100ppm of oxygen)	Temperature alarms on heat exchangers	Confirm maximum likely oxygen inlet concentration
8	19	Composition	Wrong concentration	No analysers	Out of specification hydrogen contaminates downstream storage		Consider hydrogen quality metering (dew point and oxygen) Consider bypass to flare for off specification hydrogen
8	20	Composition	Wrong concentration	Higher than anticipated inlet oxygen concentration	Insufficient oxygen removed, contaminated hydrogen gas		Confirm maximum likely oxygen inlet concentration
8	21	Composition	Wrong concentration	Nitrogen contamination not detected at startup.	Out of specification product		Identify purging time required during commissioning
8	22	Composition	2 Phase	Failure of level control valves	Hydrogen gas discharged to drains	LAHH triggers shut down valve	
8	23	Instrument and controls	Adequacy	Dehydration beds saturated with water	Out of specification product		Consider additional moisture content analysis to asses dehydration bed regeneration trigger
8	24	Instrument and controls	Failure	No new Issues			

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
8	25	Instrument and controls	Adequacy	High pressure not detected	Unable to detect high pressure and potential relief venting	Pressure relief systems Pressure indication	Consider adding pressure transmitters to detect high pressure and allow pressure alarms
8	25	Loss of containment	Spill containment	No new Issues			
8	26	Electrical safety	Hazardous area classification	No new Issues		Included in design	
8	27	Electrical safety	Static discharge	No new Issues		Included in design	
8	28	Maintenance	Access	No new Issues			
8	29	Maintenance	Purging of gas	Nitrogen purging points in system unclear			Clarify nitrogen injection locations
8	30	Maintenance	Inspection and testing	Unclear how to determine catalyst changeout			Clarify life of platinum catalyst and changeout trigger and procedures
8	31	Maintenance	Isolation	No new Issues			
9	1	Flow	High flow	Regeneration flow incorrect	Incorrect flow not measured	Flow control and alarms on compressor	Add flow transmitter, flow controller and alarms downstream of compressor recycle
9	2	Flow	High flow	Compressor recycle failure	Incorrect flow not measured	Flow alarms high and low are limited by compressor capability.	
9	3	Flow	Low flow	No new issues			
9	4	Flow	No flow	No new issues			
9	5	Flow	Reverse flow	No new issues			
9	6	Level	High level	No new issues			
9	7	Level	Low level	No new issues			
9	8	Pressure	High Pressure	No new issues			
9	9	Pressure	Low pressure	Low pressure not alarmed	Operator unaware of low pressure		Consider PAL alarm on PIT downstream compressor discharge

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
9	10	Pressure	Low pressure	DP impulse line location			P&ID update, DP impulse line across dehydration vessels to be located close to inlet.
9	11	Temperature	High temperature	High recirculation load on compressor	Temperature increases too high, compressor trips	Temperature alarms on compressor inlet and discharge	
9	12	Temperature	High temperature	Pre heating the regeneration gas	Overheated gas feeding to heat exchangers. Gas not cooled sufficiently		Confirm suitability of heat exchangers for 180C feed gas. Confirm high temperature trip for deoxygenation vessel
9	13	Temperature	Low temperature	No new issues			
9	14	Contaminants	Gaseous, liquid, solid	No new issues			
9	15	Composition	State change	No new issues			
9	16	Composition	Viscosity	No new issues			
9	17	Composition	Side reactions	No new issues			
9	18	Composition	Wrong concentration	No new issues			
9	19	Composition	2 Phase	No new issues			
9	20	Instrument and controls	Adequacy	No new issues			
9	21	Instrument and controls	Failure	No new issues			
9	22	Loss of containment	Spill containment	No new issues			
9	23	Electrical safety	Hazardous area classification	No new issues			
9	24	Electrical safety	Static discharge	No new issues			
9	25	Maintenance	Access	No new issues			
9	26	Maintenance	Purging of gas	No new issues			

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
9	27	Maintenance	Inspection and testing	No new issues			
9	28	Maintenance	Isolation	No new issues			
10	1	Flow	High flow	High flow into feed tank	Insufficient chilling resulting in heated tank water Tank level high and possible overflow	Flow control on anode separator Tank acts as a buffer to chilling Tank level alarms HH Flow alarms on EDI discharge header common upstream of booster pump	Change pipework in Heat exchanger to Stainless steel to protect from high temperatures Note: Alarms and interlocks are yet to be fully defined (during a later stage of design)
10	2	Flow	High flow	Chiller flow too high due to uncertainty in control interface	Excessive cooling and power consumption		PFD drawing correction FCV upstream of Heat exchanger2 needs to be temperature controlled Temperature control needs to be on chilled water bypass around Heat exchanger2 Constant flow for cooling or chilling circuits as per Plug anode separator approach
10	3	Flow	High flow	Restricted water demand too low for EDI (single electrolyser array operational)	EDI units not operating correctly, potential damage	Bypass around EDI units maintains minimum EDI flow	
10	4	Flow	High flow	Unbalanced flow though manifold to 5 arrays		Each electrolyser has an individual level control valve on water feed Each electrolyser has an individual return pump on flow control	
10	5	Flow	No flow	UPW water not available, valve closed	Damage to EDI units	Flow alarms	
10	6	Flow	Reverse flow	Failed valve in sequencing of automated valves	Unknown reverse flows	Non- return valves	Consider valve position indication and feedback limit switches
10	7	Level	High level	Feed tank level control becomes unstable	Tank overflows	Feed tank level alarms, overflow	Add isolation valves on level instruments Consider the need for redundant instruments. Redundancy inconsistent

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
							with balance of the plant designs.
10	8	Level	Low level	Feed tank level control becomes unstable	Tank runs empty pumps run dry resulting in damage	Low level alarms and interlock downstream pumps	
10	9	Pressure	High Pressure	EDI pressure limit exceeded	Damage to EDI units	Pressure alarms Flow alarms identify blockages	
10	10	Pressure	Low pressure	No new issues			
10	11	Temperature	High temperature	No chilling water	High temperature in WTU polishing circuit, damage to EDI	Temperature alarms after EDI feed pump Divert to bypass to protect EDI	Consider temperature alarm upstream of the feed tank for earlier detection of high temperature
10	12	Temperature	Low temperature	No new issues			
10	13	Contaminants	Gaseous, liquid, solid	Hydrogen backflow from anode separator	Potential hydrogen accumulation in tank head space		Consider nitrogen purge on feed tank for managing potential hydrogen build-up in tank headspace.
10	14	Contaminants	Gaseous, liquid, solid	Carbonic acid build-up in UPW feed tank due to air exposure	Water may exceed EDI treatment capacity	EDI designed to handle elevated carbonic acid and likely to meet discharge requirements Resistivity metering and alarms on EDI discharge	Confirm EDI effectiveness at removing carbonic acid levels
10	15	Contaminants	Gaseous, liquid, solid	PFAS in return water from electrolyser	Water polishing plant not designed to remove PFAS		Plug to confirm PFAS considerations UV TOC process does not address PFAS issue. Consider removing the UV process as it may serve no purpose. Consider ion exchange resin adsorption for PFAS removal
10	16	Composition	State change	No new issues			
10	17	Composition	Viscosity	No new issues			

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
10	18	Composition	Side reactions	No new issues			
10	19	Composition	Wrong concentration	Organic carryover from UPW	Fouling of electrolyser membranes	Feed water is treated in WTP , organics removed from feed water	Consider the need for UV
10	20	Composition	Wrong concentration	Incorrect dosing design due to inconsistent Division of Responsibility	Pumps incorrectly sized, wrong chemical used, damage to EDI		Chemical dosing and storage is in WPU scope of work for supply CIP chemical dosing to be shown on WPU General arrangement. WPU plant general arrangement layout constraints are a width not exceeding 10m.
10	21	Composition	Wrong concentration	Contaminants from EDI process unknown	Potential unknown contaminants returned to water treatment plan		Confirm contaminants present in EDI waste stream
10	22	Composition	2 Phase	No new issues			
10	23	Instrument and controls	Adequacy	Pressure control not identified on drawing			Drawing correction P&ID sheet 2 of 12 PIT transmitters to be relocated
10	24	Instrument and controls	Failure	No new issues			
10	25	Loss of containment	Spill containment	PFAS in CIP waste	CIP waste different to WTP CIP wastes. Cannot mix wastes resulting in costly disposal.		CIP waste tank to be bunded separately Understand the need to manage PFAS waste Separate WPU CIP waste pump out and disposal
10	26	Electrical safety	Hazardous area classification	No new issues			
10	27	Electrical safety	Static discharge	No new issues			
10	28	Maintenance	Access	No new issues			
10	29	Maintenance	Purging of gas	No new issues			
10	30	Maintenance	Inspection and testing	Calibration of resistivity instruments	Plant shut down	Redundant EDI train supplied	

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
10	31	Maintenance	Isolation	No new issues			
11	1	Flow	High flow	Electrolyser over production	Over pressure in pipe lines	Pressure regulating suction and discharge lines to flare	
11	2			Excessive compressor recycle use	Compressor over heats and trips, gas flared	TAHH in compressor recycle	
11	3		Low flow	No new issues			
11	4		No flow	Closed valve	Excessive compressor recycle use Compressor over heats and trips, gas flared	TAHH in compressor recycle	
11	5		Reverse flow	Reverse flow due to recycle flows	Back pressurising the electrolyzers, gas flared	Two dissimilar NRVs in common suction	Add non return valves to each individual compressor suction
11	6	Level	High level	High water level in knockout drum	Water carryover and compressor damage	LAHH0001 and CSD	
11	7		Low level	No new issues			Remove LAL in knock out drum
11	8	Pressure	High Pressure	Stop operating compressors over extended duration	Seal failure		Refer to NEA as to whether continuous nitrogen purging is required during shut downs
11	9			Pressure regulating valves fail	Over pressure vessels	PSV0001 and PAHH0001 and CSD	
11	10		Low pressure	No new issues			
11	11	Temperature	High temperature	Expansion of gas fed into storage containers	Heat release and overheating of the modules	Process simulations show temperature within design specification, TAHH for each storage vessel	

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
11	12			Chilling water maldistribution in chilling water manifolds	Some compressors starved of chilling water, overheating compressors	TAHH0003/4/5	Design manifolds to obtain even flow distribution
11	13		Low temperature	No new issues			
11	14	Contaminants	Gaseous, liquid, solid	Nitrogen from purging operations	Contaminated product		Multiple cycles of hydrogen purging to be determined during commissioning
11	15	Composition	State change	No new issues			
11	16		Viscosity	No new issues			
11	17		Side reactions	No new issues			
11	18		Wrong concentration	No new issues			
11	19		2 Phase	No new issues			
11	20	Instrument and controls	Adequacy	Controls and instruments shown on two sets of P&IDs	Control strategy confusion		Reconcile H2 Hauler & other P&IDs during detailed design
11	21		Failure	No new issues			
11	22	Loss of containment	Spill containment	Compressor maintenance	Oil environmental spills	Bunded areas provided for compressors	
11	23	Electrical safety	Hazardous area classification	No new issues			
11	24		Static discharge	No new issues			
11	25	Maintenance	Access	No new issues			
11	26		Purging of gas	No new issues			
11	27		Inspection and testing	No new issues			
11	28		Isolation	No new issues			

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
12	1	Position	Too high	Access to the back of trailer to open doors and inspect	Cannot reach instruments or valves	Appropriate ladder required	Consider in detailed design around B Doubles
12	2		Too low	Low pipes in overhead pipe rack	Pipe rack damage, burst pipe and hydrogen release, explosion	Designed as high enough, isolatable sections	
12	3		Too far	Truck positioned too far from dispensers	Hose does not reach, cannot fill, have to drive around again		Provide adequate hose length Positions to be marked on bay tarmac
12	4		Misaligned	Truck turning circle too large	Strike dispensers, pipe break with hydrogen release, explosion	Armco barriers between bays	
12	5		Wrong position	No new issues			
12	6	Movement	High speed	Truck drives too fast	Strike dispensers, pipe break with hydrogen release, explosion	Armco barriers between bays	TMP to set site speed limit
12	7		Low speed	No new issues			
12	8		No movement/stuck	Mechanical failure of truck	Dispensing bay blocked, loss of production		Requires recovery procedure for site, unhook trailers, develop in TMP
12	9			Truck runs out of fuel	Dispensing bay blocked, loss of production		TMP to establish refuelling policy
12	10			Cannot drive out of parking bays back onto site in a forward direction	Lost production time while truck exits site		Reconsider extent of truck swept paths
12	11		Reverse	No new issues			
12	12		Slip / friction	No new issues			
12	13		Subsidence	No new issues			
12	14	Size	Too large	No new issues			

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
12	15		Too small	No new issues			
12	16	Load	High load (force)	No new issues			
12	17		Low load (force)	No new issues			
12	18		High flow	No new issues			
12	19		Low flow	No new issues			
12	20		Loss of containment	No new issues			
12	21	Timing	Too late	Time taken too long to fill	Production loss		Consider two operators at the dispensers for the truck connection process
12	22		Too early	No new issues			
12	23		Incorrect sequence	All trucks arrive at once	Truck queuing in the road, traffic jam	Onsite truck overflow parking on site	TMP to establish queuing policy
12	24			Incorrect procedure followed to connect to dispensers	Inability to load tube trailers	Automated feed back to ensure correct procedure followed	
12	25	Physical damage	Dropped objects	No new issues			
12	26		Transport collision	Driver takes a wrong turn	Truck hits pipe rack between storage and compression areas		Ensure that gantry high enough for crane/tube trailer traffic. No entry signs in TMP
12	27			Collision with other site vehicles	Hydrogen release from tubes and explosion	Designed to accommodate explosions, designed to standards & certified	
12	28		Vibration	No new issues			
12	29		Corrosion	No new issues			

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
12	30		Obstacles	No new issues			
12	31	Failure	Utilities-power/water/air/lighting/other?	Loss of air or power	Inability to load tube trailers	Manual override possible	
12	32		Machinery	No new issues			
12	33		Safety shut down	Emergency, fire	Hydrogen release from tubes and explosion	E Stops, trailer burst discs, PSVs and over temp venting	
12	34	Contamination	Water	No new issues			
12	35		Dust	No new issues			
12	36		Oil	No new issues			
12	37		Flammables	No new issues			
12	38		Corrosives	No new issues			
13	1	Flow	High flow	Dispensing controller fails & lower pressure trailer	High flow into low pressure trailers	Low FAL in other dispensers & FAH	
13	2		Low flow	Valves closed	No dispensing	FALL	
13	3		No flow	Filter blocked	No dispensing	FALL	
13	4			Back pressure regulator fails	No dispensing	FALL	Consider bypass
13	5		Reverse flow	No new issues		Two dissimilar NRVs	
13	6	Level	High level	No new issues			
13	7		Low level	No new issues			
13	8	Pressure	High Pressure	Closed valves, PRV failure	High flow, and high pressure	PAHH	
13	9			Chiller heat exchanger rupture	Hydrogen ingress into CO2 chilling	Chiller PSVs and shutdown of chillers	

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
					circuit, high pressure		
13	10		Low pressure	Nitrogen supply pressure	Cannot purge system		Nitrogen pressure required at 300bar, current disconnect with design at 10 bar, consider dedicated high pressure cylinders or reduce nitrogen pressure specification
13	11	Temperature	High temperature	No new issues			
13	12		Low temperature	Blocked filter	Reduced hydrogen flow & low temperature	TALL in dispenser and in tube trailer	
13	13			Handling hose	Low temperature burns		Determine site wide PPE requirements e.g. gloves
13	14	Contaminants	Gaseous, liquid, solid	Custody sampling for Quality Control	Extracting samples at high pressure, gas release, explosion	Sample point provided	Sampling device system still to be determined, need for online analysis to be determined during detailed design Custody flow meter calibration methodology to be determined
13	15	Composition	State change	No new issues			
13	16		Viscosity	No new issues			
13	17		Side reactions	No new issues			
13	18		Wrong concentration	No new issues			
13	19		2 Phase	No new issues			
13	20	Instrument and controls	Adequacy	No new issues			
13	21		Failure	No new issues			
13	22	Loss of containment	Spill containment	No new issues			

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
13	23	Electrical safety	Hazardous area classification	No new issues			
13	24		Static discharge	No new issues			
13	25	Maintenance	Access	No new issues			
13	26		Purging of gas	No new issues			
13	27		Inspection and testing	No new issues			
13	28		Isolation	No new issues			
14	1	Flow	High flow	No new issues			
14	2		Low flow	No new issues			
14	3		No flow	No new issues			
14	4		Reverse flow	No new issues			
14	5	Level	High level	No new issues			
14	6		Low level	No new issues			
14	7	Pressure	High Pressure	No new issues			
14	8		Low pressure	No new issues			
14	9	Temperature	High temperature	No new issues			
14	10		Low temperature	No new issues			
14	11	Contaminants	Gaseous, liquid, solid	No new issues			
14	12	Composition	State change	No new issues			
14	13		Viscosity	No new issues			
14	14		Side reactions	No new issues			

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
14	15		Wrong concentration	No new issues			
14	16		2 Phase	No new issues			
14	17	Instrument and controls	Adequacy	No new issues			
14	18		Failure	No new issues			
14	19	Loss of containment	Spill containment	No new issues			
14	20	Electrical safety	Hazardous area classification	No new issues			
14	21		Static discharge	No new issues			
14	22	Maintenance	Access	No new issues			
14	23		Purging of gas	No new issues			
14	24		Inspection and testing	No new issues			
14	25		Isolation	No new issues			
15	1	Flow	High flow	Maximum flare demand required due to an ESD	Over pressurising the flare resulting in flame failure and flare shut down resulting in untreated hydrogen gas release to the atmosphere	Flame detection fire eye with flame failure alarms, device designed as a gas Type B appliance, automatic electrolyser plant operation shut down stopping hydrogen gas production	Ensure flare has automatic pilot reignition feature
15	2		Low flow	LPG pilot flame fuel runs out	Pilot flame extinguishes, untreated hydrogen gas released to atmosphere	Flame detection fire eye with flame failure alarms, device designed as a gas Type B appliance, automatic electrolyser plant	

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
						operation shut down stopping hydrogen gas production, PAL 0004 and PALL 0004 for fuel gas indication	
15	3			Nitrogen gas runs out	Nitrogen purging of flare headers stops with potential of air ingress into the header and potential explosions with equipment damage	PALL 0002 , FALL 002 and FALL 003 in flare header purge nitrogen line	
15	4		No flow	No new issues			
15	5		Reverse flow	Air ingress into the flare	Oxygen ingress and potential explosion in flare header	Flare seal drum preventing back flow and continuous nitrogen purging. Pressure monitored in flare header with PAL0001	
15	6	Level	High level	Excessive water in flare header due to electrolyser upset	High water level in knockout drum with increased back pressure, relief PSVs may not function correctly	LIC0001 controller maintains constant level with LAH0001 and LAHH0001.	
15	7		Low level	No process water from water treatment plant	High pressure hydrogen gas pushes out of vent on flash tank to atmosphere	LIC0002 controller maintains constant level with LAH0002 and LAHH0002	
15	8	Pressure	High Pressure	Full flow in flare header due to ESD	Knockout drum water seal is lost through flash gas vent	Water seal is designed to maximum flow	Consider flash tank isolation via FSC shut off during an ESD

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
15	9			Electrolyser downstream vent pressures into flare header higher than design 0.8bar	Process will not relieve excess pressure		Electrolyser vent discharges pressures need to be considered in detailed design with back pressures in mind.
15	10		Low pressure	Nitrogen			P&ID drawing correction of line
15	11	Temperature	High temperature	High process temperature e.g. from electrolyser	Higher temperature relieving gas in flare header	Temperature monitoring at TAH0001, equipment designed for worst case	
15	12			Inadequate burner tuning	High flare flame temperature and glassing and premature failure of flare refractory	Reputable vendor designed equipment.	
15	13		Low temperature	Thunderstorm or heavy rain	Flare flame quenching resulting in flame failure and plant shutdown	Flame failure monitoring	Confer with vendor as to flame protection measures
15	14	Contaminants	Gaseous, liquid, solid	Flare operating	Visible steam plume, neighbour complaints	Enclosed flare specified	Plume dispersion modelling and CASA approvals to be investigated as part of Development Application requirements.
15	15	Composition	State change	No new issues			
15	16		Viscosity	No new issues			
15	17		Side reactions	No new issues			
15	18		Wrong concentration	No new issues			
15	19		2 Phase	Water entrainment from electrolyser upset	Quenching of flare flame	Flare knock out drum	

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
15	20	Instrument and controls	Adequacy	Flare fault	Untreated gas released to atmosphere	ESD initiated shutting down plant and releasing gas to flare via BDVs	Flare is in fault mode. ESD not appropriate, review all ESD and consider changing to CSD
15	21		Failure	LPG gas runs out	Pilot flame extinguishes, untreated hydrogen gas released to atmosphere	Hydrogen gas as alternative pilot fuel source	Hydrogen gas deemed as an expensive fuel compared with LPG. Consider eliminating alternative pilot fuel gas from process.
15	22	Loss of containment	Spill containment	Water from knockout and seal drums	Water to environment	Spill to drains	
15	23	Electrical safety	Hazardous area classification	No new issues		Flare included in classification	
15	24		Static discharge	No new issues			
15	25	Maintenance	Access	No new issues			
15	26		Purging of gas	No new issues			
15	27		Inspection and testing	No new issues			
15	28		Isolation	BDV cannot be maintained whilst plant is operational	Plant requires shutdown	Regular plant shutdown to undertake preventative maintenance	Consider duplicate shelf spare for maintenance
16	1	Flow	High flow	Loss of flow control loop FIC0002	Higher flow to consumers	FAH0002	
16	2			High flow due to plant manifold pressure drops	Low water flow to some consumers resulting in overheating		Consider manually adjusted trim valves in manifolds
16	3		Low flow	Pump 520-PP-01A/B flow setting too low	Higher water return temperature TIT0001	TAH0001, flow meters with FAL0002 and balance line, PALL0003	

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
16	4		No flow	No new issues			
16	5		Reverse flow	Multiple chillers online	Reverse flow into chiller		Add NRVs
16	6	Level	High level	Makeup water valve CV0001 fails open	High level in tanks and overflow	LAHH0001, LAHH0002 and CSD	
16	7		Low level	Leak in chiller system	Chiller pump runs dry, pump damage	Automatic water make up & LALL0001 & LALL0002	
16	8	Pressure	High Pressure	Nitrogen blanket pressure in single tank high	Pressure imbalance between tanks resulting in false level indication	PAHH0001 and PAHH0002	Add gas balance line to tanks
16	9		Low pressure	Loss of nitrogen	Tank blanketing failure, potential explosive atmosphere in head space	PAL001 and AAHH0001 for hydrogen gas	
16	10	Temperature	High temperature	No new issues		TAHH0004 and CSD	
16	11		Low temperature	Chiller fails	Freezing of pipe lines	Chiller has own internal RTU trip	Add temperature TAL0004
16	12						
16	13	Contaminants	Gaseous, liquid, solid	Over dosing corrosion inhibitor chemicals	Corrosivity not treated	Supplier / vendor tested	
16	14			Hydrogen gas in circuit	Potential explosive atmosphere in tank head space	Nitrogen blanketing and purging and double tube heater exchangers used in HTU	Check other Heat exchanger specifications, consider if nitrogen blanketing can be eliminated, to be further defined during detailed design
16	15	Composition	State change	No new issues			
16	16		Viscosity	No new issues			
16	17		Side reactions	No new issues			

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
16	18		Wrong concentration	No new issues			
16	19		2 Phase	No new issues			
16	20	Instrument and controls	Adequacy	No new issues			
16	21		Failure	No new issues			
16	22	Loss of containment	Spill containment	No new issues		Bunded equipment	Consider reducing dispensing chiller bunded area
16	23	Electrical safety	Hazardous area classification	No new issues		Bunded equipment	
16	24		Static discharge	No new issues			
16	25	Maintenance	Access	No new issues			
16	26		Purging of gas	No new issues			
16	27		Inspection and testing	No new issues			
16	28		Isolation	No new issues			
17	1	Flow	High flow	No new issues, by difference chilling node			
17	2		Low flow	No new issues, by difference chilling node			
17	3		No flow	No new issues, by difference chilling			
17	4		Reverse flow	No new issues, by difference chilling node			
17	5	Level	High level	No new issues, by difference chilling node			
17	6		Low level	No new issues, by difference chilling node			P&ID correction inlet pipe immersed in water in tank
17	7	Pressure	High Pressure	No new issues, by difference chilling node			

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
17	8		Low pressure	No new issues, by difference chilling node			
17	9	Temperature	High temperature	Fouling of external fins and tubes	High temperature in cooling water	TAHH0003	Regular cleaning with pressure washing required in maintenance regime
17	10		Low temperature	No new issues, by difference chilling node			
17	11	Contaminants	Gaseous, liquid, solid	Electrolyser HEX failure	Hydrogen gas leakage from Heat exchanger failure	Nitrogen blanketing	Electrolyser water circuit, consider removing nitrogen blanketing during detailed design. Consider adding biocide.
17	12	Composition	State change	No new issues, by difference chilling node			
17	13		Viscosity	No new issues, by difference chilling node			
17	14		Side reactions	No new issues, by difference chilling node			
17	15		Wrong concentration	No new issues, by difference chilling node			
17	16		2 Phase	No new issues, by difference chilling node			
17	17	Instrument and controls	Adequacy	No new issues, by difference chilling node			
17	18		Failure	No new issues, by difference chilling node			
17	19	Loss of containment	Spill containment	No new issues, by difference chilling node			
17	20	Electrical safety	Hazardous area classification	No new issues, by difference chilling node			
17	21		Static discharge	No new issues, by difference chilling node			
17	22	Maintenance	Access	No new issues, by difference chilling node			

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
17	23		Purging of gas	No new issues, by difference chilling node			
17	24		Inspection and testing	No new issues, by difference chilling node			
17	25		Isolation	No new issues, by difference chilling node			
18	1	Flow	High flow	Failure of regulators	Excessive nitrogen flow	PAH0001 and PAH0002	Add flow meter with totaliser
18	2		Low flow	Valves shut in nitrogen line	No purging of equipment, LEL conditions more likely	PALL0001	
18	3		No flow	Run out of liquid nitrogen	CSD of plant	LAL0001 & LALL0001 inventory ordering triggers	
18	4		Reverse flow	No new issues			
18	5	Level	High level	No new issues		vendor procedures	
18	6		Low level	Run out of liquid nitrogen	CSD of plant	LAL0001 & LALL0001 inventory ordering triggers	Consider further intermediate alarm trigger levels
18	7	Pressure	High Pressure	No new issues			
18	8		Low pressure	Valves shut in nitrogen line	No purging of equipment, LEL conditions more likely	PALL0001	
18	9	Temperature	High temperature	No new issues		TAH	
18	10		Low temperature	Liquid hydrogen vaporiser carryover	Low temperature and two phase flow in piping, blockages, icing of valves	TALL0001	
18	11	Contaminants	Gaseous, liquid, solid	No new issues			
18	12	Composition	State change	No new issues			

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
18	13		Viscosity	No new issues			
18	14		Side reactions	No new issues			
18	15		Wrong concentration	No new issues			
18	16		2 Phase	No new issues			
18	17	Instrument and controls	Adequacy	No new issues			
18	18		Failure	No new issues			
18	19	Loss of containment	Spill containment	No new issues			Consider how liquid spillages are managed. Add isolation valve to bund sump to avoid liquid nitrogen flowing into sewers
18	20	Electrical safety	Hazardous area classification	No new issues			
18	21		Static discharge	No new issues			
18	22	Maintenance	Access	No new issues			
18	23		Purging of gas	No new issues			
18	24		Inspection and testing	No new issues			
18	25		Isolation	No new issues			
19	1	Flow	High flow	Dropping transformer oil into the transformer bund	Environmental spill and incident	Purceptor to collect oil spill	Consider dry type transformers to avoid oil for LV transformers
19	2			Heavy rain	Waste water tanks full	LAH0002 and LAH0007 for tanker truck ordering, conservative 1:20 year rain event sized for	Consider additional tanks & possible area roofing in detailed design

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
19	3		Low flow	Valve closed in pipe line	Overflow of sump and bund, spill to environment	LAHH in all sumps with strobe and local audible alarm, bund height to retain water	
19	4		No flow	No new issues			
19	5		Reverse flow	No new issues		Check valves included	
19	6						
19	7	Level	High level	Waste water tank high level	Tank overflows	LAHH0002 & 0007 and pump interlock, bund	
19	8		Low level	No water	Pumps run dry, damage to pump	LALL pump interlocks on all pumps	
19	9						
19	10	Pressure	High Pressure	Tanker valve closed	Tanker hose burst, spillages into the environment		Add concrete bunds for tanker offloading areas
19	11		Low pressure	No new issues			
19	12						
19	13	Temperature	High temperature	No new issues			
19	14		Low temperature	No new issues			
19	15			Dropping liquid nitrogen hose into bund	Liquid nitrogen flows into oily water sewer, pump damage		Add isolation valve to nitrogen bund
19	16	Contaminants	Gaseous, liquid, solid	Solids in bunds	Pump blockage, no flow, bund overflow		Operations to add geotextile over sumps to retain gross solids
19	17			Combining hydrogen and oxygen containing	Exothermic reaction in sumps		Segregate hydrogen and oxygen streams and

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
				electrolyser drains into same sump	and heat generation		combine after the sump pumps
19	18	Composition	State change	No new issues			
19	19		Viscosity	No new issues			
19	20		Side reactions	No new issues			
19	21		Wrong concentration	No new issues			
19	22		2 Phase	No new issues			
19	23						
19	24	Instrument and controls	Adequacy	No new issues			
19	25		Failure	No new issues			
19	26						
19	27	Loss of containment	Spill containment	No new issues			
19	28						
19	29	Electrical safety	Hazardous area classification	No new issues			Identify sumps potentially in hazardous areas and move them out of hazardous zones
19	30		Static discharge	No new issues			
19	31						
19	32	Maintenance	Access	No new issues			
19	33		Purging of gas	No new issues			
19	34		Inspection and testing	No new issues			
19	35		Isolation	No new issues			

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
Overview	1	Toxicity	Handling procedure	No new issues			
Overview	2		Precautions	No new issues			
Overview	3		Exposure & monitoring	Site soil contamination	Exposure to contaminants during construction and operations. Site cleanup required.		Assessment to be carried out as during Geotech soil sampling as required by Development Application
Overview	4						
Overview	5	Fire/Explosion	Prevention systems	Fire		Considered in design	
Overview	6		Detection systems	Fire		Fire and gas detection systems considered in design	
Overview	7		Fire protection	Fire		Steel structure covered in fire protection coatings	
Overview	8		Emergency isolation	Fire		Isolatable sections part of preliminary QRA specification	
Overview	9		Emergency procedures	Site emergency			Site emergency procedures will need to be developed including muster points etc during detailed design
Overview	10						
Overview	11	Environmental impact	Vapour / gas emissions	Hydrogen gas releases		Flare	Plume modelling requirements for Development Application and CASA need to be investigated.
Overview	12		Dust	No new issues			
Overview	13		Effluent	Stormwater runoff into ponds		Stormwater routed through gross pollutant traps	To be further developed in detailed design

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
						before discharge into ponds	
Overview	14		Noise	Operating equipment e.g. compressors		Equipment limited to 85dBA	Investigate need for noise study required for Development Application
Overview	15		Ground seepage	Waste water seeping into ground		Liquids contained on bunded areas	
Overview	16		Waste	Waste generation		Septic system for sewerage Dangerous Goods store required for chemical overflow storage	Consider including sump and/or Oil Water Separator to drain the warehouse and workshop
Overview	17						
Overview	18	Materials of Construction	Pipes	No new issues			To be further developed in detailed design
Overview	19		Valves	No new issues			To be further developed in detailed design
Overview	20		Fittings	No new issues			To be further developed in detailed design
Overview	21		Instruments	No new issues			To be further developed in detailed design
Overview	22		Filters	No new issues			To be further developed in detailed design
Overview	23		Gaskets	No new issues			To be further developed in detailed design
Overview	24		Protective Systems	No new issues			To be further developed in detailed design
Overview	25		Coatings	No new issues			To be further developed in detailed design
Overview	26						
Overview	27	Access	Operation	No new issues			
Overview	28		Maintenance	No new issues			

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
Overview	29		Emergency escape	No new issues			Emergency escape planning & muster point to be developed
Overview	30						
Overview	31	Electrical safety	Hazardous area classification	No new issues		Identified in current design	
Overview	32		Earthing	No new issues		Identified in current design	
Overview	33		Lightning protection	No new issues		Identified in current design	
Overview	34		Static discharge	No new issues		Identified in current design	
Overview	35		Overhead/buried cables	No new issues		All cables are buried in trenches	
Overview	36						
Overview	37	Utilities & services	Instrument air/gas	No new issues			
Overview	38		Compressed air	No new issues			
Overview	39		Breathing air	No new issues			
Overview	40		Nitrogen	No new issues			
Overview	41		Cooling water	No new issues			
Overview	42		Process water	GAWB water connection location			Consider additional GAWB water main connection on the southern side of the site
Overview	43		Steam	No new issue			
Overview	44		Fuel gas	No new issues			
Overview	45		Electricity	No new issues			Consider alternative backup power supply (e.g. battery) during detailed design
Overview	46		Oxygen	No new issues			

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
Overview	47		Lighting	No new issues			
Overview	48						
Overview	49	Commissioning	Requirements	No new issues			Commissioning plan will be required
Overview	50		Sequences	No new issues			Commissioning plan will be required
Overview	51		Procedures	No new issues			Equipment preservation requirements for equipment to be identified during detailed design
Overview	52						
Overview	53	Start - up	First time	No new issues			Detailed plans and procedures required during detailed design
Overview	54		Routine	No new issues			Detailed plans and procedures required during detailed design
Overview	55		Procedure	No new issues			Detailed plans and procedures required during detailed design
Overview	56						
Overview	57	Shut down	Planned	No new issues			Detailed plans and procedures required during detailed design
Overview	58		Emergency	No new issues			Detailed plans and procedures required during detailed design
Overview	59		Procedure	No new issues			Detailed plans and procedures required during detailed design
Overview	60						
Overview	61	Safety equipment	Personnel protection	No new issues			
Overview	62		Gas monitoring	No new issues			

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
Overview	63		Breathing apparatus	No new issues			
Overview	64		Safety showers	No new issues			
Overview	65		Barriers & guards	No new issues			Barriers around flare and LPG
Overview	66						
Overview	67	Natural hazards	Earthquake	No new issues		AS requirements ESD provisions	
Overview	68		Flooding	No new issues			
Overview	69		Thunderstorms	No new issues			
Overview	70		High winds	Cyclones	Equipment damage		Consider more conservative wind zone for structural design
Overview	71		Bushfires	Potential adjacent property bush fire		Blue metal and concrete pavements around site	Include in emergency response plan
Overview	72						
Overview	73	Inspection and testing	Alarms & trips	No new issues			Detailed plans and procedures required during detailed design
Overview	74		Emergency isolation	No new issues			Detailed plans and procedures required during detailed design
Overview	75		Gas / fire detectors	No new issues			Detailed plans and procedures required during detailed design
Overview	76		Fire protection systems	No new issues			Detailed plans and procedures required during detailed design
Overview	77						
Overview	78	Procedures	Temporary works designs	No new issues			To be further developed in detailed design
Overview	79		Operations	No new issues			To be further developed in detailed design

Node	Item	Guide Word	Sub Word	Probable Cause	Consequences	Existing Safeguards	Action Recommended
Overview	80		Maintenance	No new issues			To be further developed in detailed design
Overview	81		Confined space	No new issues			To be further developed in detailed design
Overview	82		Emergency	No new issues			To be further developed in detailed design
Overview	83		Engineering drawings	No new issues			To be further developed in detailed design
Overview	84		Modification control	No new issues			To be further developed in detailed design
Overview	85						
Overview	86	Quality Control	Inspection & Test Plans	No new issues			Detailed plans and procedures required during detailed design
Overview	87	External Safety Interface	Members of the public	No new issues		Preliminary Quantitive Risk Assessment undertaken	To be further developed in detailed design
Overview	88		Adjacent property	No new issues			To be further developed in detailed design
Overview	89		Services locations	No new issues			To be further developed in detailed design
Overview	90		Response to External Emergency	FFI has an emergency			To be further developed in detailed design

9.4 Appendix 3 – HAZOP Study Record Sheets Summary

Node	Item	Guide Word	Sub Word	Action Recommended
1	1	Flow	High flow	Convert actuated valve to FSC
1	3	Flow	High flow	Add flow meter with high flow alarm
1	4	Flow	High flow	Add control valve (FSC) after clarifier feed pumps Add a high flow alarm for stopped condition
1	5	Flow	Low flow	Develop response procedure Feed flowmeter and low alarm Flow study from GAWB study required.
1	9	Flow	Reverse flow	Consider need for additional RPZ required by GAWB
1	12	Level	High level	High level switch and high alarm
1	14	Pressure	High Pressure	Design geo-bag sump such that whole possible volume is contained. Add valve to sump to hold water and check quality before releasing to feed tank
1	15	Pressure	High Pressure	Pressure relief bypass for clarifier sludge pump to be included Add flow meter with FALL
1	17	Pressure	Low pressure	Flow study (GAWB) study required. If insufficient pressure available, consider booster pumps or lower elevation for tank in detailed design.
1	24	Composition	Wrong concentration	Water quality data to be confirmed by Gladstone Water Board before detailed design. Access to data being sought. Likely 50MW plant will receive "treated" water quality. Continue to assume raw water quality as is.

Node	Item	Guide Word	Sub Word	Action Recommended
1	25	Composition	Wrong concentration	Add turbidity meter and high alarm on clarifier system Separate bund to hold geobag to contain bag contents. Operator to confirm bag integrity prior to pumping sump to feed tank
1	26	Composition	Wrong concentration	Add conductivity meter and high alarm Conductivity specification with GAWB to be confirmed
1	30	Instrument and controls	Failure	Feed water solenoid valve confirm FSC
1	31	Loss of containment	Spill containment	Geofabric incorporated into sump grates to retain gross solids
1	34	Maintenance	Access	Access ramps for forklifts etc. to access geobags and chemical IBC's Add dangerous goods storage area
2	4	Flow	Reverse flow	P&ID correction
2	5	Flow	Reverse flow	Valves need feedback limit switches and alarms for position indication
2	6	Flow	Reverse flow	Consider alternative vent for UF scour air
2	10	Pressure	High Pressure	Consider pressure switch and high alarm on blower discharge
2	11	Pressure	High Pressure	
2	12	Pressure	Low pressure	Consider isolation valves on UF membrane modules
2	13	Temperature	High temperature	Consider pipe guarding (e.g. perforated mesh) or insulation
2	17	Contaminants	Gaseous, liquid, solid	Follow up with membrane chemistry
3	4	Flow	Reverse flow	Valves need feedback limit switches and alarms for position indication

Node	Item	Guide Word	Sub Word	Action Recommended
3	12	Contaminants	Gaseous, liquid, solid	Detailed analysis of water chemistry as part of detailed design
3	17	Composition	Wrong concentration	Consider where to send out of spec, typically flush to drain at startup. Consider adding alternative return to GAC feed tank or raw water feed tank.
3	19	Instrument and controls	Adequacy	Add bypass around instruments for maintenance
3	20	Instrument and controls	Adequacy	Add pH meter after EDI
3	22	Loss of containment	Spill containment	Check concrete/sewer specification required for sumps, bunds or pipework.
4	3	Flow	No flow	Consider interlocking UV system with low flow/pumps running Add alarms to high alarm to TT
4	4	Flow	Reverse flow	Add RPZ on process water pumps
4	5	Flow	Reverse flow	Interlock dosing with water flow
4	10	Temperature	High temperature	Consider interlocking UV system with low flow/pumps running Add alarms to high alarm to TT
4	11	Temperature	High temperature	If pipe exposed to direct sunlight, insulate
4	13	Contaminants	Gaseous, liquid, solid	Regular testing in accordance with ADWG requirements
4	14	Contaminants	Gaseous, liquid, solid	Relocate UV Filtrate to polymer dilution with other process water consumers
5	1	Flow	High flow	Review and confirm control philosophy for water flow control. Plug to provide range of makeup water flow rates Drawing correction

Node	Item	Guide Word	Sub Word	Action Recommended
				Hydroflux flow goes to Heat exchanger1 not Heat exchanger 2
5	2	Flow	Low flow	Move flow meter downstream of pressure control loop
5	5	Flow	Reverse flow	Add non-return valve downstream of bypass
5	6	Level	High level	Add hydrogen analyser and CSD LIT needs dip type with impulse line to tank head space Interlock GAC feed pump feed pumps on PAH
5	8	Pressure	High Pressure	Consider shutdown on high level (economic benefit of not losing water to drain.) Consider collecting UPW water at WPU polishing feed tank overflow and pump back to WTP
5	12	Contaminants	Gaseous, liquid, solid	Add strainer to pump suction
5	13	Contaminants	Gaseous, liquid, solid	Add resistivity analyser
5	22	Electrical safety	Hazardous area classification	Not classified as hazardous area since risk low to have flammable mixture
6	5	Flow	Reverse flow	Actuated valves need feedback limit switches and alarms for position indication
6	6	Flow	Reverse flow	Actuated valves need feedback limit switches and alarms for position indication
6	7	Level	High level	Consider dedicated sump for CIP chemical tanks to segregate from WTP sumps
6	8	Level	Low level	P&ID HIM0040-P2100: add 'P1300-RO pass 2 filtrate to CIP tank actuated valve' to interlock on LAHH (RO/EDI CIP tank).
6	9	Level	Low level	Consider conical or sloping bottom of tank to drain outlet

Node	Item	Guide Word	Sub Word	Action Recommended
6	10	Pressure	High Pressure	Add pressure switch with high pressure alarms
6	14	Contaminants	Gaseous, liquid, solid	Add pH instrument on tank recirculation (mixing) loop
6	15	Contaminants	Gaseous, liquid, solid	Length of cycle times determined during commissioning
7	12	Contaminants	Gaseous, liquid, solid	Add strainers to dosing pump suction
7	23	Maintenance	Access	Dangerous goods storage area
7	24	Maintenance	Purging of gas	Add drain valves on dosing pump suction and discharge.
8	1	Flow	High flow	Constant flow for cooling or chilling water feeds with bypass around heat exchangers as per Plug anode separator approach needs to be adopted
8	2	Flow	High flow	Consider high and low flow alarms on electrolyser gas flow
8	3	Flow	Low flow	Consider parallel filters or logistics of changeout during planned downtime
8	4	Flow	No flow	Dissimilar non-return valves to be added consistent with isolatable section philosophy
8	12	Temperature	Low temperature	Confirm preheating times
8	13	Temperature	Low temperature	Consider additional alarm/interlock requirements to ensure performance/catalyst life is maintained
8	14	Contaminants	Gaseous, liquid, solid	Regeneration cycle trigger to be considered. Consider additional dew point analysers
8	15	Contaminants	Gaseous, liquid, solid	Consider optimisation to reduce power consumption

Node	Item	Guide Word	Sub Word	Action Recommended
				for regeneration during plant downtime
8	16	Composition	State change	Drains needs to handle hydrogen evolution Segregate oxygen and hydrogen discharges to drain. Consider closed sump with vents to safe location
8	18	Composition	Side reactions	Confirm maximum likely oxygen inlet concentration
8	19	Composition	Wrong concentration	Consider hydrogen quality metering (dew point and oxygen) Consider bypass to flare for off specification hydrogen
8	20	Composition	Wrong concentration	Confirm maximum likely oxygen inlet concentration
8	21	Composition	Wrong concentration	Identify purging time required during commissioning
8	23	Instrument and controls	Adequacy	Consider additional moisture content analysis to assess dehydration bed regeneration trigger
8	25	Instrument and controls	Adequacy	Consider adding pressure transmitters to detect high pressure and allow pressure alarms
8	29	Maintenance	Purging of gas	Clarify nitrogen injection locations
8	30	Maintenance	Inspection and testing	Clarify life of platinum catalyst and changeout trigger and procedures
9	1	Flow	High flow	Add flow transmitter, flow controller and alarms downstream of compressor recycle
9	9	Pressure	Low pressure	Consider PAL alarm on PIT downstream compressor discharge
9	10	Pressure	Low pressure	P&ID update, DP impulse line across dehydration vessels to be located close to inlet.

Node	Item	Guide Word	Sub Word	Action Recommended
9	12	Temperature	High temperature	Confirm suitability of heat exchangers for 180C feed gas. Confirm high temperature trip for deoxygenation vessel
10	1	Flow	High flow	Change pipework in Heat exchanger to Stainless Steel to protect from high temperatures Note: Alarms and interlocks are yet to be fully defined (during a later stage of design)
10	2	Flow	High flow	PFD drawing correction FCV upstream of Heat exchanger2 needs to be temperature controlled Temperature control needs to be on chilled water bypass around Heat exchanger 2 Constant flow for cooling or chilling circuits as per Plug anode separator approach
10	6	Flow	Reverse flow	Consider valve position indication and feedback limit switches
10	7	Level	High level	Add isolation valves on level instruments Consider the need for redundant instruments. Redundancy inconsistent with balance of the plant designs.
10	11	Temperature	High temperature	Consider temperature alarm upstream of the feed tank for earlier detection of high temperature
10	13	Contaminants	Gaseous, liquid, solid	Consider nitrogen purge on feed tank for managing potential hydrogen build-up in tank headspace.
10	14	Contaminants	Gaseous, liquid, solid	Confirm EDI effectiveness at removing carbonic acid levels
10	15	Contaminants	Gaseous, liquid, solid	Plug to confirm PFAS considerations UV TOC process does not

Node	Item	Guide Word	Sub Word	Action Recommended
				address PFAS issue. Consider removing the UV process as it may serve no purpose. Consider ion exchange resin adsorption for PFAS removal
10	19	Composition	Wrong concentration	Consider the need for UV
10	20	Composition	Wrong concentration	Chemical dosing and storage is in WPU scope of work for supply CIP chemical dosing to be shown on WPU General Arrangement WPU plant general arrangement layout constraints are a width not exceeding 10m.
10	21	Composition	Wrong concentration	Confirm contaminants present in EDI waste stream
10	23	Instrument and controls	Adequacy	Drawing correction P&ID sheet 2 of 12 PIT transmitters to be relocated
10	25	Loss of containment	Spill containment	CIP waste tank to be bunded separately Understand the need to manage PFAS waste Separate WPU CIP waste pump out and disposal
11	5	Flow	Reverse flow	Add non return valves to each individual compressor suction
11	7	Level	Low level	Remove LAL in knock out drum
11	8	Pressure	High Pressure	Refer to NEA as to whether continuous nitrogen purging is required during shut downs
11	12	Temperature	High temperature	Design manifolds to obtain even flow distribution
11	14	Contaminants	Gaseous, liquid, solid	Multiple cycles of hydrogen purging to be determined during commissioning

Node	Item	Guide Word	Sub Word	Action Recommended
11	20	Instrument and controls	Adequacy	Reconcile H2 Hauler & other P&IDs during detailed design
12	1	Position	Too high	Consider in detailed design around B Doubles
12	3	Position	Too far	Provide adequate hose length Positions to be marked on bay tarmac
12	6	Movement	High speed	TMP to set site speed limit
12	8	Movement	No movement/stuck	Requires recovery procedure for site, unhook trailers, develop in TMP
12	9	Movement	No movement/stuck	TMP to establish refuelling policy
12	10	Movement	No movement/stuck	Reconsider extent of truck swept paths
12	21	Timing	Too late	Consider two operators at the dispensers for the truck connection process
12	23	Timing	Incorrect sequence	TMP to establish queuing policy
12	26	Physical damage	Transport collision	Ensure that gantry high enough for crane/tube trailer traffic. No entry signs in TMP
13	4	Flow	No flow	Consider bypass
13	10	Pressure	Low pressure	Nitrogen pressure required at 300bar, current disconnect with design at 10 bar, consider dedicated high pressure cylinders or reduce nitrogen pressure specification
13	13	Temperature	Low temperature	Determine site wide PPE requirements e.g. gloves

Node	Item	Guide Word	Sub Word	Action Recommended
13	14	Contaminants	Gaseous, liquid, solid	Sampling device system still to be determined, need for online analysis to be determined during detailed design Custody flow meter calibration methodology to be determined
15	1	Flow	High flow	Ensure flare has automatic pilot reignition feature
15	8	Pressure	High Pressure	Consider flash tank isolation via FSC shut off during an ESD
15	9	Pressure	High Pressure	Electrolyser vent discharges pressures need to be considered in detailed design with back pressures in mind.
15	10	Pressure	Low pressure	P&ID drawing correction of line
15	13	Temperature	Low temperature	Confer with vendor as to flame protection measures
15	14	Contaminants	Gaseous, liquid, solid	Plume dispersion modelling and CASA approvals to be investigated as part of Development Application requirements.
15	20	Instrument and controls	Adequacy	Flare is in fault mode. ESD not appropriate, review all ESD and consider changing to CSD
15	21	Instrument and controls	Failure	Hydrogen gas deemed as an expensive fuel compared with LPG. Consider eliminating alternative pilot fuel gas from process.
15	28	Maintenance	Isolation	Consider duplicate shelf spare for maintenance
16	2	Flow	High flow	Consider manually adjusted trim valves in manifolds

Node	Item	Guide Word	Sub Word	Action Recommended
16	5	Flow	Reverse flow	Add NRVs
16	8	Pressure	High Pressure	Add gas balance line to tanks
16	11	Temperature	Low temperature	Add temperature TAL0004
16	14	Contaminants	Gaseous, liquid, solid	Check other Heat exchanger specifications, consider if nitrogen blanketing can be eliminated, to be further defined during detailed design
16	22	Loss of containment	Spill containment	Consider reducing dispensing chiller bunded area
17	6	Level	Low level	P&ID correction inlet pipe immersed in water in tank
17	9	Temperature	High temperature	Regular cleaning with pressure washing required in maintenance regime
17	11	Contaminants	Gaseous, liquid, solid	Electrolyser water circuit, consider removing nitrogen blanketing during detailed design. Consider adding biocide.
18	1	Flow	High flow	Add flow meter with totaliser
18	6	Level	Low level	Consider further intermediate alarm trigger levels
18	19	Loss of containment	Spill containment	Consider how liquid spillages are managed. Add isolation valve to bund sump to avoid liquid nitrogen flowing into sewers
19	1	Flow	High flow	Consider dry type transformers to avoid oil for LV transformers

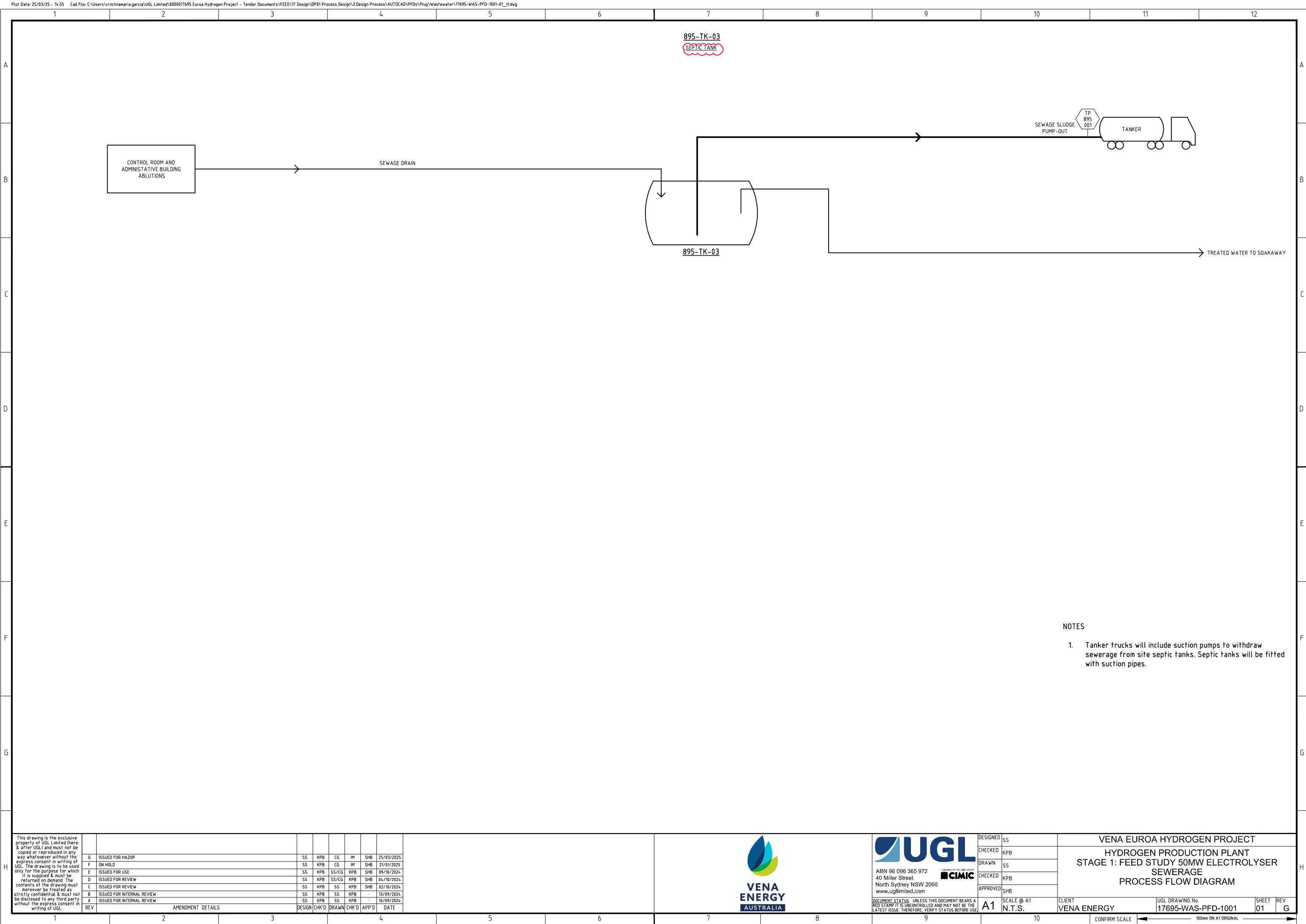
Node	Item	Guide Word	Sub Word	Action Recommended
19	2	Flow	High flow	Consider additional tanks & possible area roofing in detailed design
19	10	Pressure	High Pressure	Add concrete bunds for tanker offloading areas
19	15	Temperature	Low temperature	Add isolation valve to nitrogen bund
19	16	Contaminants	Gaseous, liquid, solid	Operations to add geotextile over sumps to retain gross solids
19	17	Contaminants	Gaseous, liquid, solid	Segregate hydrogen and oxygen streams and combine after the sump pumps
19	29	Electrical safety	Hazardous area classification	Identify sumps potentially in hazardous areas and move them out of hazardous zones
Overview	3	Toxicity	Exposure & monitoring	Assessment to be carried out as during Geotech soil sampling as required by Development Application
Overview	9	Fire/explosion	Emergency procedures	Site emergency procedures will need to be developed including muster points etc during detailed design
Overview	11	Environmental impact	Vapour / gas emissions	Plume modelling requirements for Development Application and CASA need to be investigated.
Overview	13	Environmental impact	Effluent	To be further developed in detailed design
Overview	14	Environmental impact	Noise	Investigate need for noise study required for Development Application
Overview	16	Environmental impact	Waste	Consider including sump and/or Oil Water Separator

Node	Item	Guide Word	Sub Word	Action Recommended
				to drain the warehouse and workshop
Overview	18	Materials of Construction	Pipes	To be further developed in detailed design
Overview	19	Materials of Construction	Valves	To be further developed in detailed design
Overview	20	Materials of Construction	Fittings	To be further developed in detailed design
Overview	21	Materials of Construction	Instruments	To be further developed in detailed design
Overview	22	Materials of Construction	Filters	To be further developed in detailed design
Overview	23	Materials of Construction	Gaskets	To be further developed in detailed design
Overview	24	Materials of Construction	Protective Systems	To be further developed in detailed design
Overview	25	Materials of Construction	Coatings	To be further developed in detailed design
Overview	29	Access	Emergency escape	Emergency escape planning & muster point to be developed
Overview	42	Utilities & services	Process water	Consider additional GAWB water main connection on the southern side of the site
Overview	45	Utilities & services	Electricity	Consider alternative backup power supply (e.g. battery) during detailed design
Overview	49	Commissioning	Requirements	Commissioning plan will be required
Overview	50	Commissioning	Sequences	Commissioning plan will be required
Overview	51	Commissioning	Procedures	Equipment preservation requirements for equipment to be identified during detailed design

Node	Item	Guide Word	Sub Word	Action Recommended
Overview	53	Start - up	First time	Detailed plans and procedures required during detailed design
Overview	54	Start - up	Routine	Detailed plans and procedures required during detailed design
Overview	55	Start - up	Procedure	Detailed plans and procedures required during detailed design
Overview	57	Shut down	Planned	Detailed plans and procedures required during detailed design
Overview	58	Shut down	Emergency	Detailed plans and procedures required during detailed design
Overview	59	Shut down	Procedure	Detailed plans and procedures required during detailed design
Overview	65	Safety equipment	Barriers & guards	Barriers around flare and LPG
Overview	70	Natural hazards	High winds	Consider more conservative wind zone for structural design
Overview	71	Natural hazards	Bushfires	Include in emergency response plan
Overview	73	Inspection and testing	Alarms & trips	Detailed plans and procedures required during detailed design
Overview	74	Inspection and testing	Emergency isolation	Detailed plans and procedures required during detailed design
Overview	75	Inspection and testing	Gas / fire detectors	Detailed plans and procedures required during detailed design
Overview	76	Inspection and testing	Fire protection systems	Detailed plans and procedures required during detailed design

Node	Item	Guide Word	Sub Word	Action Recommended
Overview	78	Procedures	Temporary works designs	To be further developed in detailed design
Overview	79	Procedures	Operations	To be further developed in detailed design
Overview	80	Procedures	Maintenance	To be further developed in detailed design
Overview	81	Procedures	Confined space	To be further developed in detailed design
Overview	82	Procedures	Emergency	To be further developed in detailed design
Overview	83	Procedures	Engineering drawings	To be further developed in detailed design
Overview	84	Procedures	Modification control	To be further developed in detailed design
Overview	86	Quality Control	Inspection & Test Plans	Detailed plans and procedures required during detailed design
Overview	87	External Safety Interface	Members of the public	To be further developed in detailed design
Overview	88	External Safety Interface	Adjacent property	To be further developed in detailed design
Overview	89	External Safety Interface	Services locations	To be further developed in detailed design
Overview	90	External Safety Interface	Response to External Emergency	To be further developed in detailed design

9.5 Appendix 3 – HAZOP Study Record Sheets



12

A

B

C

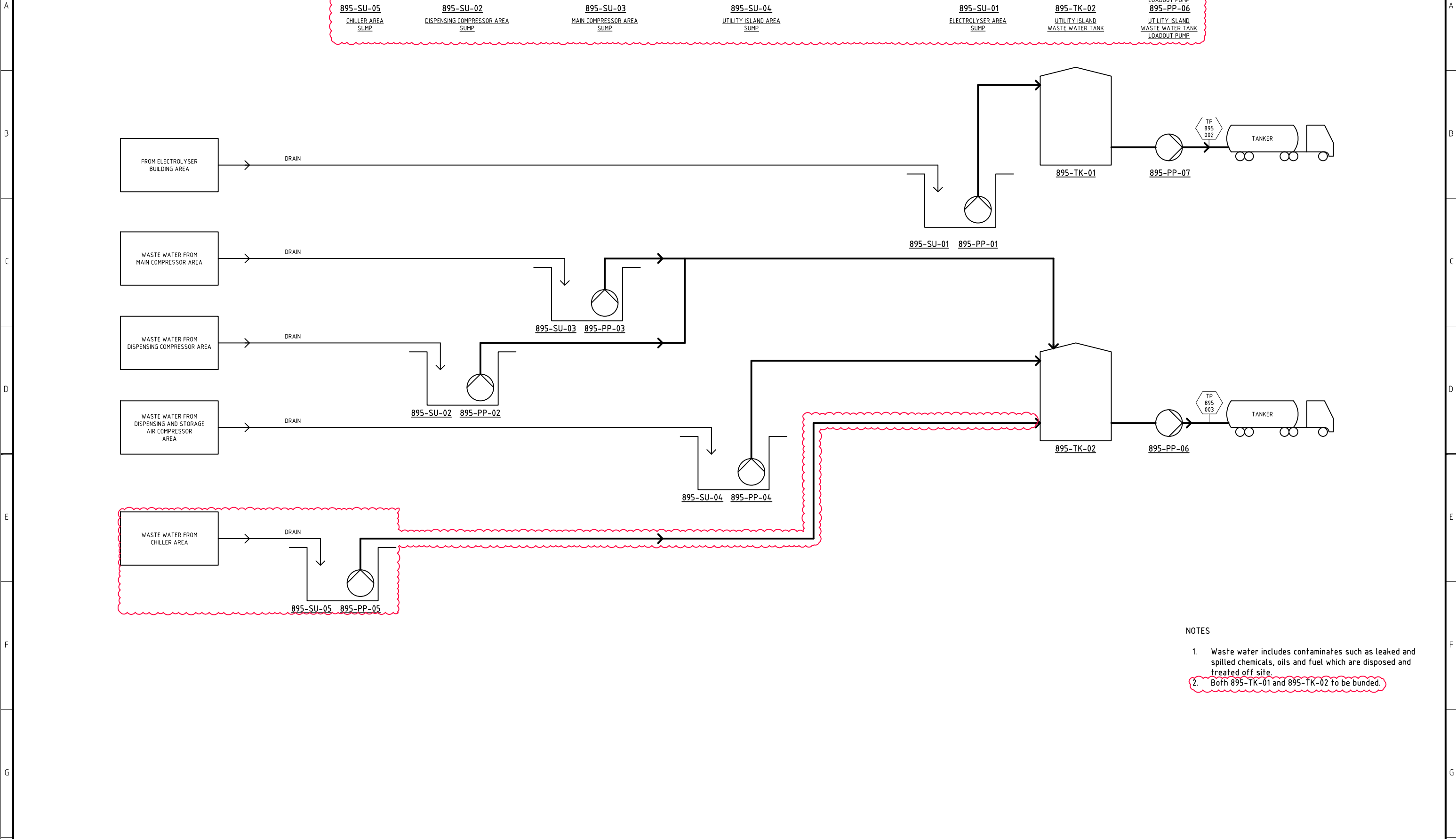
D

E

F

G

H



1. Waste water includes contaminants such as leaked and spilled chemicals, oils and fuel which are disposed and treated off site.
2. Both 895-TK-01 and 895-TK-02 to be banded.

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	A	ISSUED FOR INTERNAL REVIEW	SS	KPB	SS	KPB	-	10/09/2024
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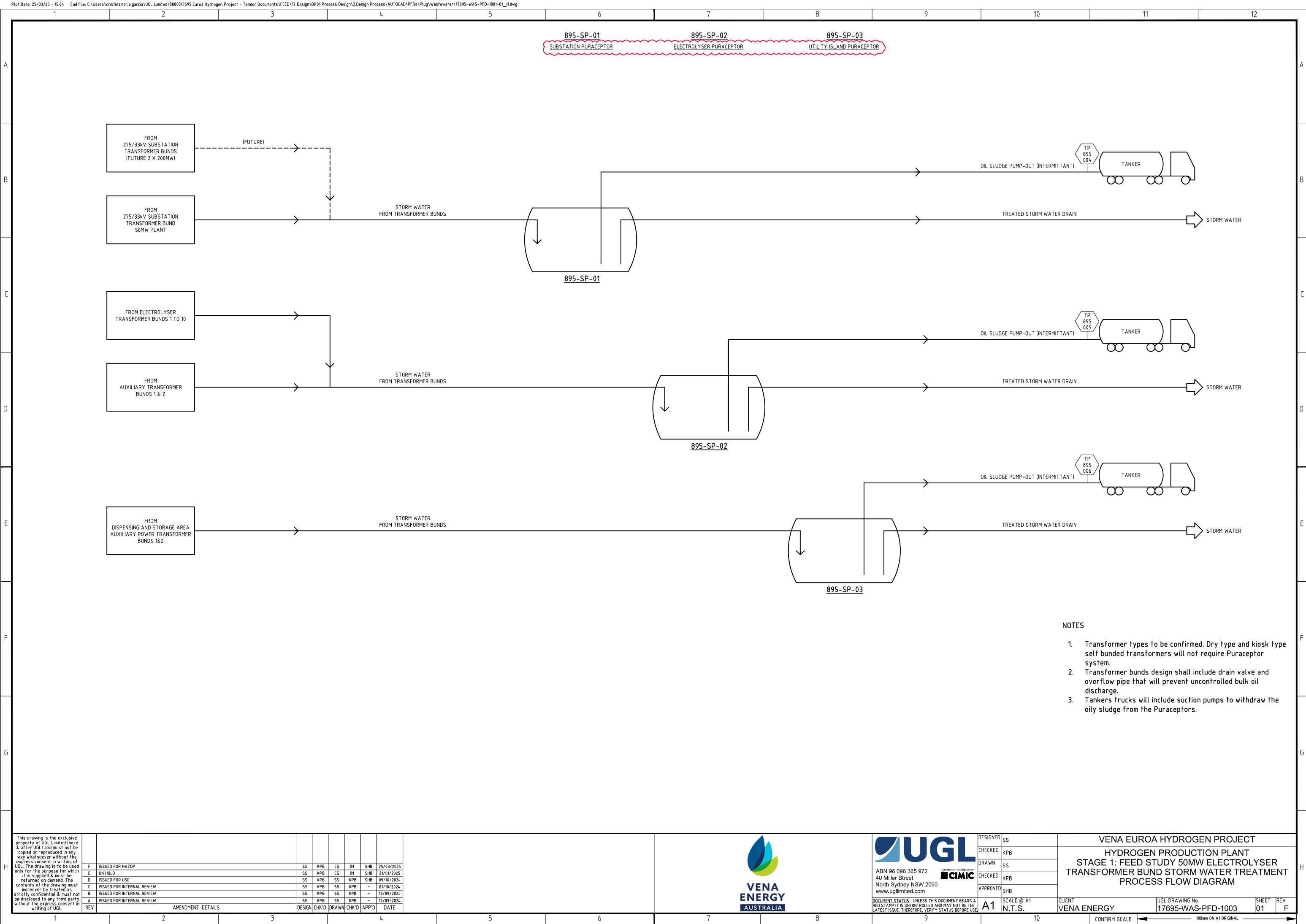


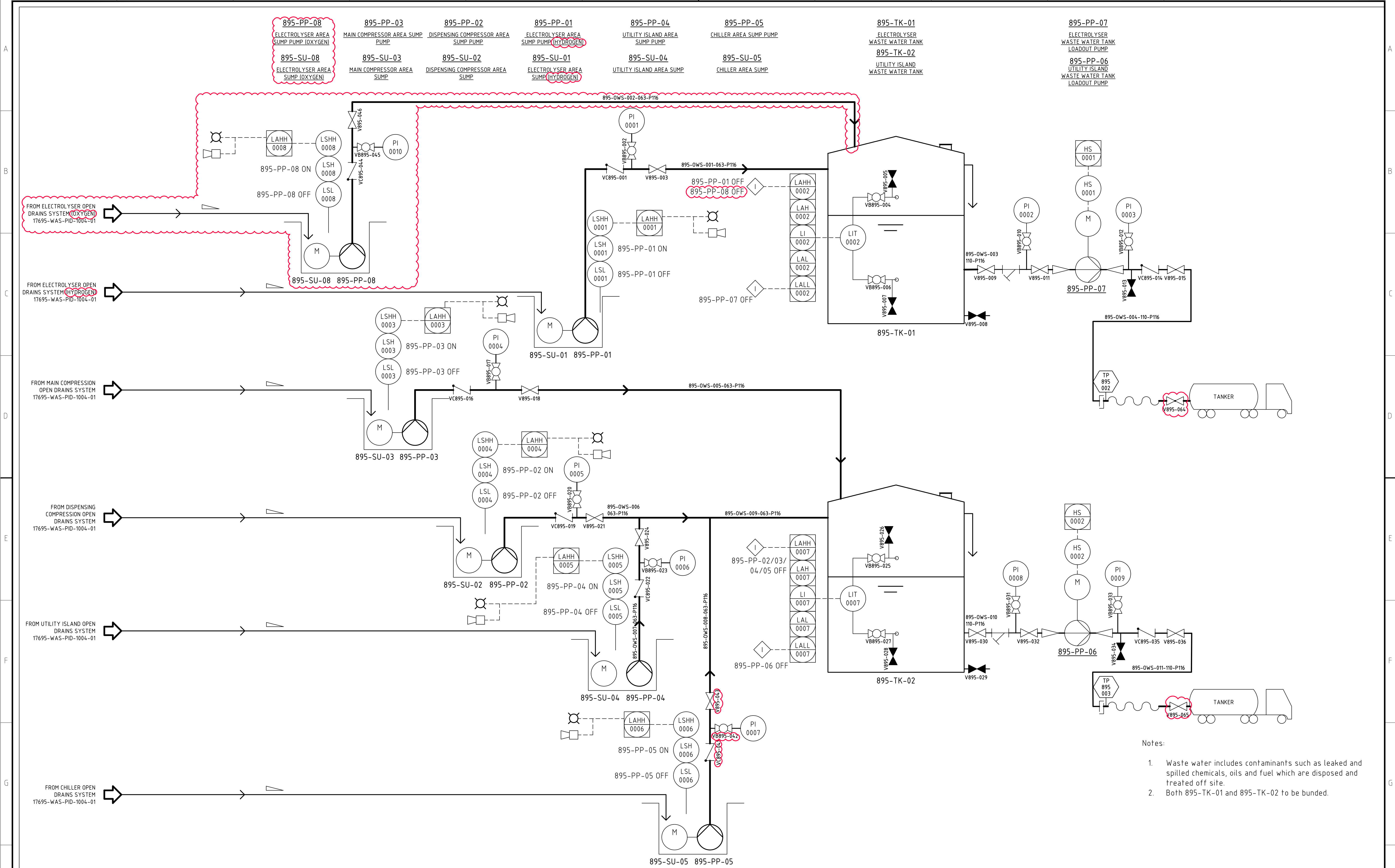
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- Notes:
1. Waste water includes contaminants such as leaked and spilled chemicals, oils and fuel which are disposed and treated off site.
 2. Both 895-TK-01 and 895-TK-02 to be banded.

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	F	ON HOLD				SS	IM	IM	CG	SHB	29/01/25
	E	UPDATED				SS	IM	IM	CG	SHB	16/01/25
	D	ISSUED FOR MILESTONE 1				SS	IM	IM	CG	SHB	12/11/24
	C	DRAFT				SS	IM	IM	SS		01/11/24
	B	ISSUED FOR INTERNAL REVIEW				SS	KPB	SS	KPB	-	09/10/24
	A	ISSUED FOR INTERNAL REVIEW				SS	KPB	SS	KPB	-	30/09/24
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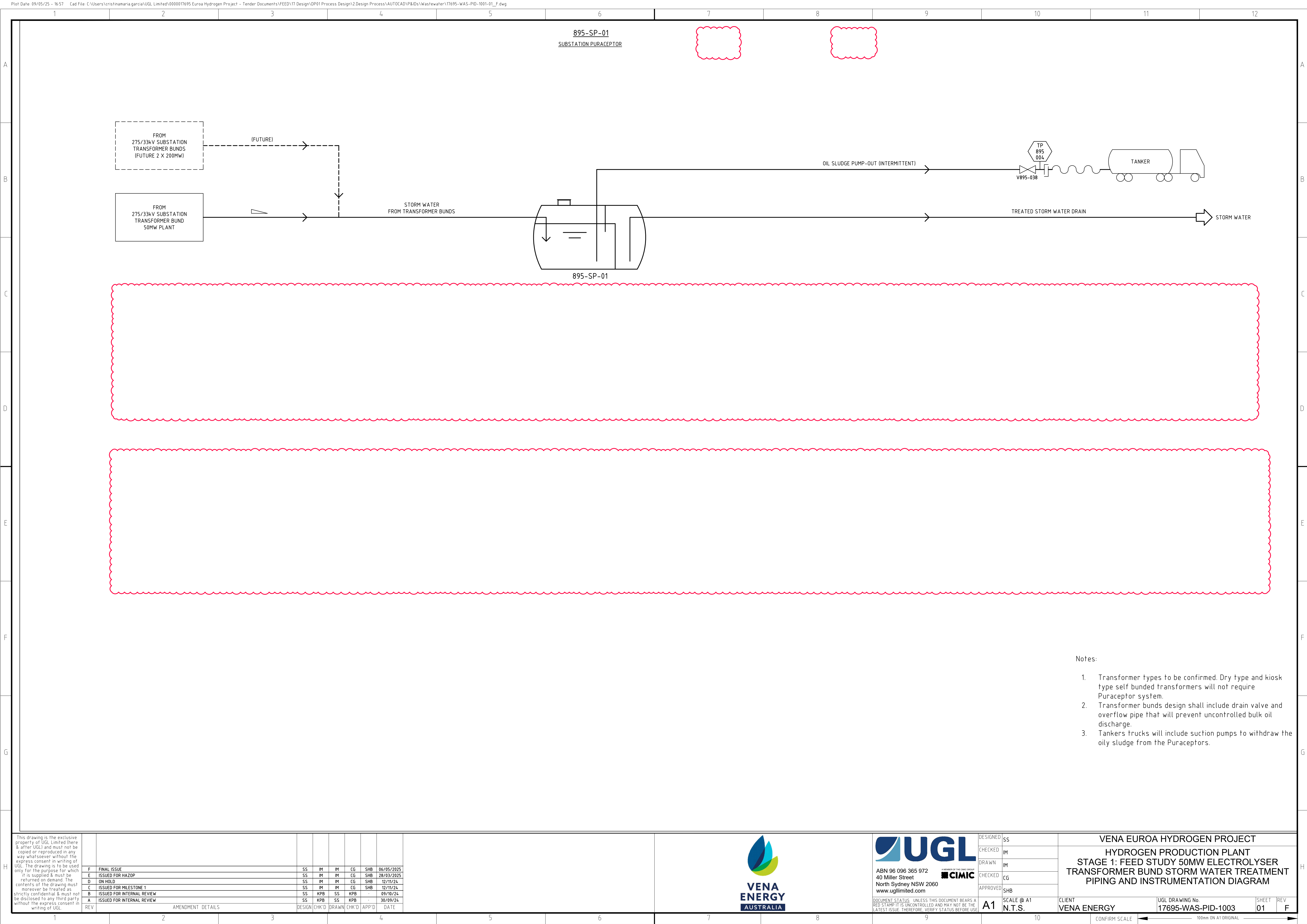
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VENA EUROA HYDROGEN PROJECT
HYDROGEN PRODUCTION PLANT
STAGE 1: FEED STUDY 50MW ELECTROLYSER
WASTE WATER
PIPING AND INSTRUMENTATION DIAGRAM

CLIENT VENA ENERGY	UGL DRAWING No. 17695-WAS-PID-1002	SHEET 01	REV H
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- Notes:
- Transformer types to be confirmed. Dry type and kiosk type self banded transformers will not require Puraceptor system.
 - Transformer bunds design shall include drain valve and overflow pipe that will prevent uncontrolled bulk oil discharge.
 - Tankers trucks will include suction pumps to withdraw the oily sludge from the Puraceptors.

Appendix J Stormwater Management Plan

VENA EUROA HYDROGEN PROJECT

Stormwater Management Plan

50MW Hydrogen Production Facility

UGL Project TC- 17695

CLIENT: VENA ENERGY AUSTRALIA

Document: 17695-CIVIL-RPT-1001

Rev	Date	Prepared By	Checked by	Approved by	Status
A	09/09/2025	CG			Issued For Review
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1 Introduction

1.1 General

Vena Energy Australia (VENA) are proposing the Euroa Hydrogen Project at a designated site in Aldoga in the Gladstone region. The Euroa Hydrogen Project is an integrated hydrogen electrolysis, hydrogen compression and distribution facility located within the 'High Impact Industry' precinct with the Gladstone State Development Area (GSDA) Development Scheme area which intends to support the emerging hydrogen industry within the Gladstone region.

The project seeks to create an integrated hydrogen production and supply chain solution that will cater to the domestic and international market. The commercial business model for the domestic facility involves the production of hydrogen for transportation and heavy industry purposes.

The Euroa Hydrogen Facility is outlined as follows:

- A hydrogen production rate at the meter of the dispenser unit of approximately 17,280 kg/day resulting in a nominal 50 MW hydrogen gas electrolysis facility including water purification, de-oxidation, dehydration, and hydrogen gas compression, storage and dispensing components.
- Electricity requirements sourced from the existing electricity grid.
- Water supply sourced from a newly constructed raw water connection pipeline infrastructure which connects to Boat Creek to East End water pipeline of Gladstone Area Water Board's (GAWB) water pipeline network.
- The 50MW hydrogen gas electrolyser facility will produce up to 900kg/hr of hydrogen gas at a pressure of 37 bar(g).
- The hydrogen gas will be compressed and stored on site; the quantity is 8,000 kg at 400 bar(g). Maximum design storage pressure 450 bar(g).
- Stored hydrogen is further compressed as required and dispensed into tube trailers rated at 517 bar(g).
- The facility will produce and distribute approximately 17,280 kg of compressed hydrogen gas per day.
- Four pressurised hydrogen tube trailer loading bays are provided to facilitate distribution of 17,280 kg/day of compressed gas into tube trailers.
- Hydrogen gas from various relief and blowdown valves at the electrolyser, storage compression, storage receivers and dispensing will be piped to the flare system. Intermittent and smaller hydrogen gas relief and bleed flows will be directly vented to atmosphere.

2 Definitions

- Company – UGL
- FEED – Front End Engineering & Design
- GAWB – Gladstone Area Water Board
- GPT – Gross Pollutant Trap
- UGL – UGL Engineering Pty Ltd
- VENA – Vena Energy Australia
- WPU – Water Polishing Unit
- WTP – Water Treatment Plant

3 Reference Documents

- [1]. 17695-CIVIL-DRG-1001-02: Hydrogen Production Plant Stage 1: FEED Study 50MW Electrolyser Lot 1 - Hydrogen Plant Slab and Footing Plan
- [2]. 17695-CIVIL-DRG-1001-03: Hydrogen Production Plant Stage 1: FEED Study 50MW Electrolyser Lot 1 - Hydrogen Plant Stormwater Plan
- [3]. 17695-CIVIL-DRG-1001-04: Hydrogen Production Plant Stage 1: FEED Study 50MW Electrolyser Pavement and Stormwater Details

- [4]. 17695-CIVIL-DRG-1001-05: Hydrogen Production Plant Stage 1: FEED Study 50MW Electrolyser Lot 1 - Hydrogen Plant Pavement Plan
- [5]. 17695-CIVIL-DRG-1001-08: Hydrogen Production Plant Stage 1: FEED Study 50MW Electrolyser Hydrogen Plant Stormwater Plan Lot 2 & 3 275/33kV Substation
- [6]. 17695-CIVIL-DRG-1001-09: Hydrogen Production Plant Stage 1: FEED Study 50MW Electrolyser Hydrogen Plant Pavement Plan Lot 2 & 3 - 275/33kV Substation

4 Purpose

4.1 General

The purpose of this Stormwater Management Plan is to provide a preliminary strategy for the management of overland flows and detention of stormwater runoff from the site to support the FEED study. The preliminary plan identifies key drainage zones, surface treatments, and pollution control measures. It is noted that a flood study has yet to be undertaken in subsequent design phases of the project.

5 Site description

5.1 General

The proposed site is located approximately 18km west of the Gladstone CBD in the Aldoga locality within the Gladstone region (refer to Figure 1). It comprises of three (3) freehold lots off Euroa Circuit, Aldoga, formally described as Lot 1, 2 and 3 on SP245955, total site area of approximately 26Ha.

The site fronts Euroa Circuit along all site boundaries. The new Euroa Circuit Road features a new intersection connection to Aldoga Road, which intersects with Gladstone Mount Larcom Road (state-controlled road) enabling the site to have industrial standard access to the wider state-controlled road including the Bruce Highway.

The site has been previously cleared of vegetation with previous earthworks creating several pads across site that were created as part of the previous uses over the site, which primarily were for the laydown, storage and construction yards associated with the LNG pipeline projects in the area. As a result, the site is clear of any notable biodiversity attributes and is relatively flat, thus has minimal ecological or topographical constraints.

The subject site has several advantages, including the proximity to the GAWB's Boat Creek to East End water pipeline running alongside Aldoga Road which will provide the necessary water inputs for the plant through a newly constructed extension pipeline which runs to the southern frontage of the site. Additionally, there is a new electrical transmission infrastructure currently being constructed across Euroa Circuit connecting to the nearby Larcom Creek substation and the national electricity grid (refer to Figure 1).



Figure 1 – Site Location

5.2 Site Hydrology Overview

The site is built up on earthworks platforms on Lots 1 and 3 to prevent the site from flooding. The final platform level and overall site hydrology are subject to a flood study that will be undertaken in subsequent design phases of the project.

6 Wastewater Collection Description

6.1 System Overview

The purpose of the wastewater system is to collect process fluids and stormwater falling on those catchments from different locations throughout the facility. Processing equipment is located on concrete pads that are bunded and drain spillages and rainwater into a separate oily water sewer system. The waste process fluids and associated stormwater are gravity fed into pump sumps, strategically located throughout the facility.

There are 7 sumps with associated pumps through the plant:

1. Electrolyser Area Sump (hydrogen condensate drains)
2. Electrolyser Area Sump (oxygen condensate drains)
3. Dispensing Compressor Area Sump
4. Main Compressor Area Sump
5. Utility Island Area Sump
6. Chiller Area Sump
7. Workshop Area Sump

The collected oily water will be pumped into three wastewater tanks. They are:

1. A tank dedicated to the electrolyser area wastewater tank which is fed from the electrolyser area sump.
2. A tank dedicated to the workshop area wastewater tank which is fed from the workshop area sump.
3. The other four sumps will be pumped out to the utility island wastewater tank.

When the wastewater tanks reach full capacity, a wastewater collection road tanker is to empty the tank contents and dispose the oily water offsite to a licenced trade waste facility.

7 Stormwater Collection Strategy

The Lot 1 site is graded to allow the collection of stormwater into kerbs and gutters and direct the flow into a stormwater pipe network that ultimately discharges the stormwater through a gross pollutant trap into the existing receiving stormwater course at the northeastern side of the site. The substation platform in Lot 3 discharges into an existing sedimentation basin before overflowing into the existing receiving stormwater course.

All roads are bitumen sealed. Other areas of the site are either bunded with concrete bunds to retain spillages from processing plant areas and routed to the oily water system or covered with blue metal or grassed to avoid sediment erosion from storm events ([1], [4], [6]).

The stormwater catchment strategy is designed to manage runoff from various functional zones across the site. The system integrates surface grading, conveyance infrastructure, and treatment elements to ensure effective drainage and environmental protection.

Conveyance systems include:

- Swales: used to collect and direct runoff towards treatment or discharge points. They are located where the area is unsealed or landscaped to slow runoff and promote infiltration.
- Kerbs and gutters: used to contain and isolate runoff and protect infrastructure. They are located where the area is paved or hardstand (e.g. vehicular traffic areas)
- Strip Drains: used in high-traffic areas such as tube trailer bays to rapidly collect surface runoff and direct it into pits.

There is a swale system that surrounds both sites Lot 1 and Lots 2 & 3 that acts as a diversion drain preventing stormwater flows originating external to the site from entering the site.

Conveyance systems discharge into pits, which are connected via underground pipes connecting a pit-to-pit stormwater network, that directs flow to the end-of-line treatment.

End-of-line treatment includes:

- Gross Pollutant Trap (GPT) Lot1: used to capture litter, coarse sediments, and floating debris before discharge.
- Sedimentation Pond Lot 3: used to treat runoff from the substation platform by allowing fine particles to settle.
- Anti-scour Pads: installed at discharge points to prevent erosion and protect downstream water courses.

These features are intended to manage sediment, hydrocarbons, and debris, supporting the site's environmental protection objectives.

In Lot 1, stormwater from electrolyser and balance of plant block and compression, storage and dispensing block is conveyed as indicated in Table 1, flowing towards the swales located in the central area which separates both blocks.

All stormwater from the pit-to-pit network is ultimately directed to a single Gross Pollutant Trap (GPT) in the northeastern side of the Lot 1 site. An anti-scour pad is installed at the GPT outlet to prevent erosion and protect downstream stormwater course.

In Lot 2 & 3, stormwater runoff from the 275/33kV substation is directed via the pit-to pit network to the sedimentation pond in the eastern side. Anti-scour pads are installed at the stormwater pipes discharge into the sedimentation pond.

Catchment zones are delineated based on functional use, surface grading, and infrastructure layout. Table 1 summarises each zone.

Table 1 – Stormwater Main Zones

Catchment	Infrastructure	Surface Type	Primary Conveyance	Run off Treatment
Electrolyser, WPU, purification & associated electrical equipment	Electrolyser Building, Electrolyser area switch rooms, auxiliary transformers, electrolyser rectifiers Water polishing unit, Purification Electrolyser chillers Wastewater	Blue Metal	Swale Kerb & gutter	Conveyed through swales, kerb & gutter to pits and then piped towards the swale at the southwest.
Electrolyser cooling & hazardous goods store	Air cooled radiators and tank Hazardous goods store	Blue Metal	Swale Kerb & gutter	Conveyed through swales, kerb & gutter to pits and then piped towards the swale at the southwest.
Water treatment plant	Water treatment plant	Blue Metal	Swale Kerb & gutter	Conveyed through swales, kerb & gutter to pits and then piped towards the swale at the southwest.
Warehouse	Warehouse & workshop building	Medium Duty Asphalt	Swale Kerb & gutter	Conveyed through swales, kerb & gutter to pits and then piped towards parking area.
Parking	Parking	Medium Duty Asphalt	Swale Kerb & gutter	Conveyed through swales, kerb & gutter to pits and then piped south.
Compression	Main compression Dispensing compression Chillers	Blue Metal	Swale	Conveyed through swales and pits, then piped towards the swale at the northeast.
Electrical equipment Compression area	Compression area switch room, auxiliary transformers Wastewater Instrument Air	Blue Metal	Swale Kerb & gutter	Conveyed through swales, kerb & gutter to pits and then piped towards the swale at the northeast.
Flare	Flare	Heavy Duty Asphalt	Swale	Conveyed through swales, kerb & gutter to pits and then piped towards the swale at the north.
Storage	Hydrogen ground storage	Blue Metal	Swale Kerb & gutter	Conveyed through swales, kerb & gutter to pits and then piped towards the swale at the north.
Tube trailer bays	Tube trailer bays	Heavy Duty Asphalt	Strip Drains	Strip drains collect runoff and direct it into pits and then piped northeast.

Catchment	Infrastructure	Surface Type	Primary Conveyance	Run off Treatment
Tube trailer parking	Tube trailer parking	Blue Metal	Swale Kerb & gutter	Conveyed through swales, kerb & gutter to pits and then piped northeast.
Substation	Substation	Blue Metal	Swale Kerb & gutter	Conveyed into swales, kerb & gutter leading to pits connected to the pipe network. End of line treatment is the sedimentation pond.

Regular inspection and maintenance of swales, pits, GPTs, and sedimentation ponds will be required to ensure continued performance and environmental compliance.

7.1 Stormwater Discharge from Site

Stormwater discharged from the GPT (Lot 1) and Sedimentation pond (Lot 2 & 3) flows from the site into the existing stormwater catchment and water courses, ultimately flowing to Larcom Creek. The proposed stormwater flows from

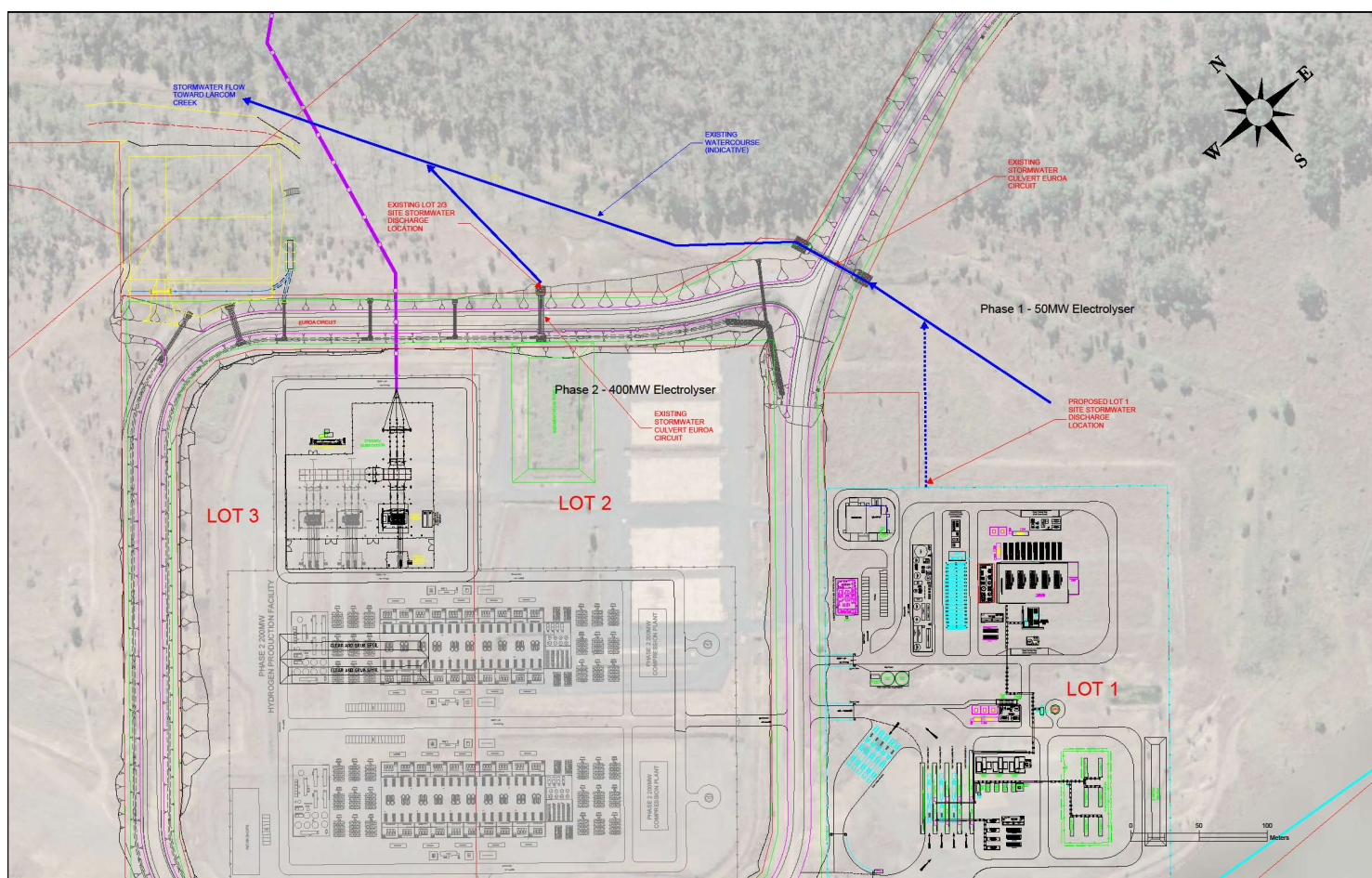


Figure 2 – Stormwater Discharge From Site

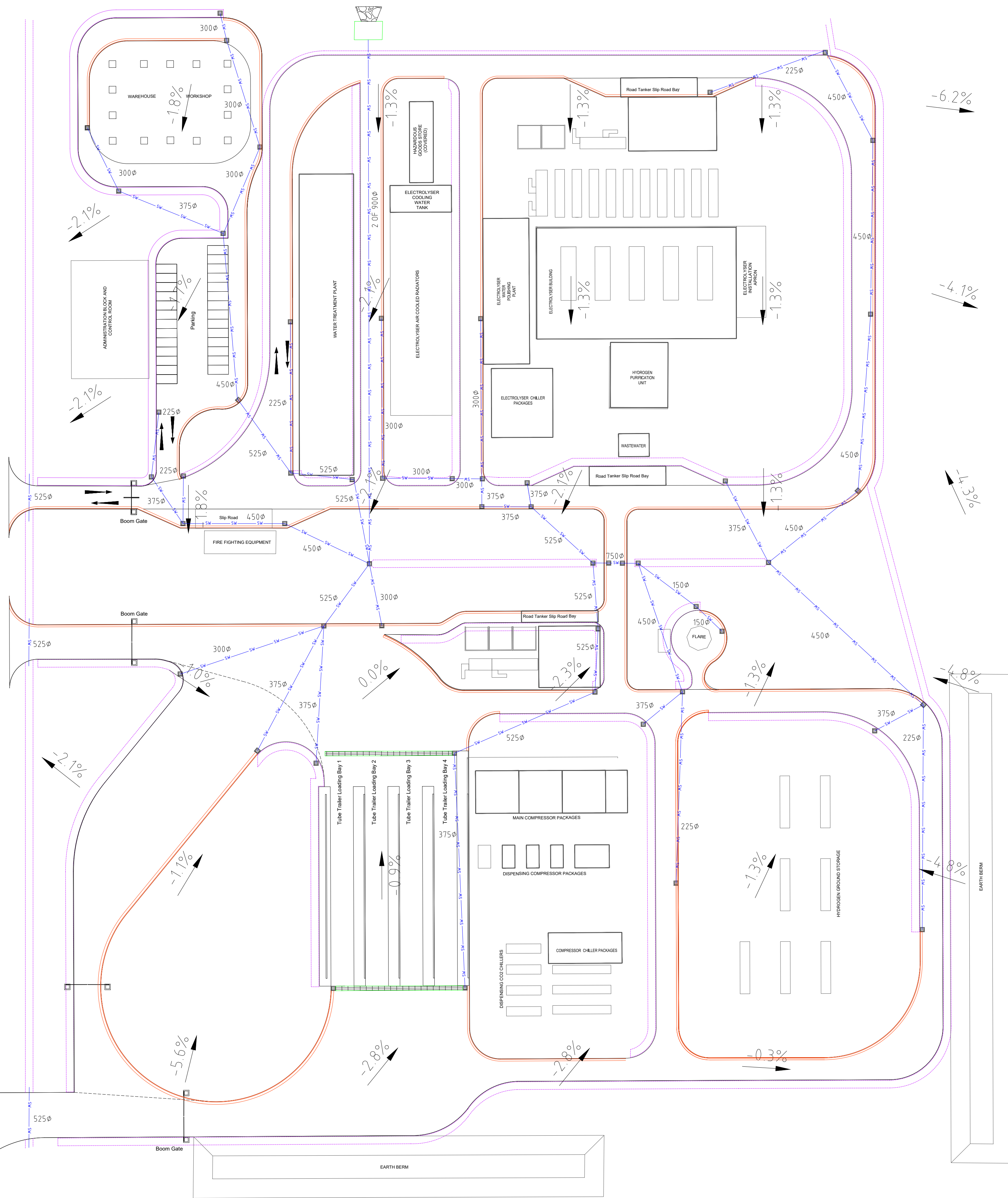
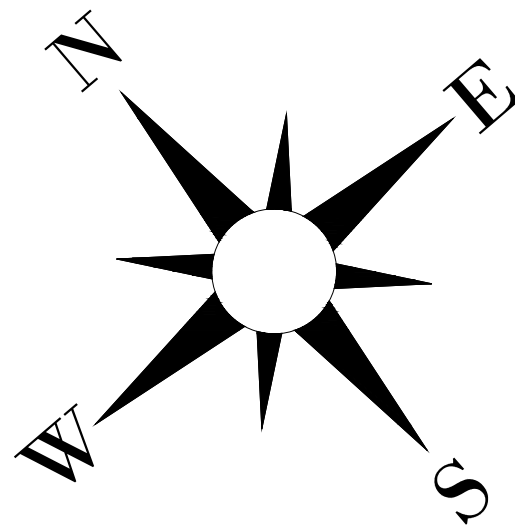
The proposed stormwater discharge from Lot 1 will be to the North East of the site and will flow into the existing stormwater catchment and water courses flowing through the existing Euroa Circuit culvert towards Larcom Creek.

Stormwater discharge from Lot 2 & 3 will continue to be discharged from the site through the existing Euroa Circuit culvert towards Larcom Creek.

Whilst Hydrology investigations are required during future project development phases to determine any impacts to the downstream stormwater catchment, it is anticipated that the stormwater discharges from the site would not significantly alter the existing stormwater catchment

8 Appendices

8.1 Appendix 1 –LOT 1 HYDROGEN PLANT STORMWATER PLAN



LEGEND

PROPOSED STORMWATER PIPES.
UPVC TYPICAL UNO.

PROPOSED STORMWATER PIT - TO DETAIL

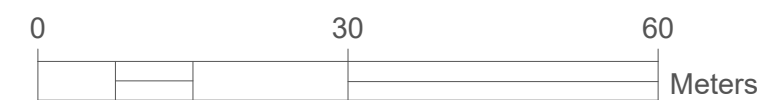
GROSS POLLUTANT TRAPS

ANTI-SCOUR PAD - TO DETAIL

KERB AND GUTTER - TO DETAIL

SWALE - TO DETAIL

STRIP DRAIN

NOTES:
ALL COMPLETE WITH VAPOUR BARRIER

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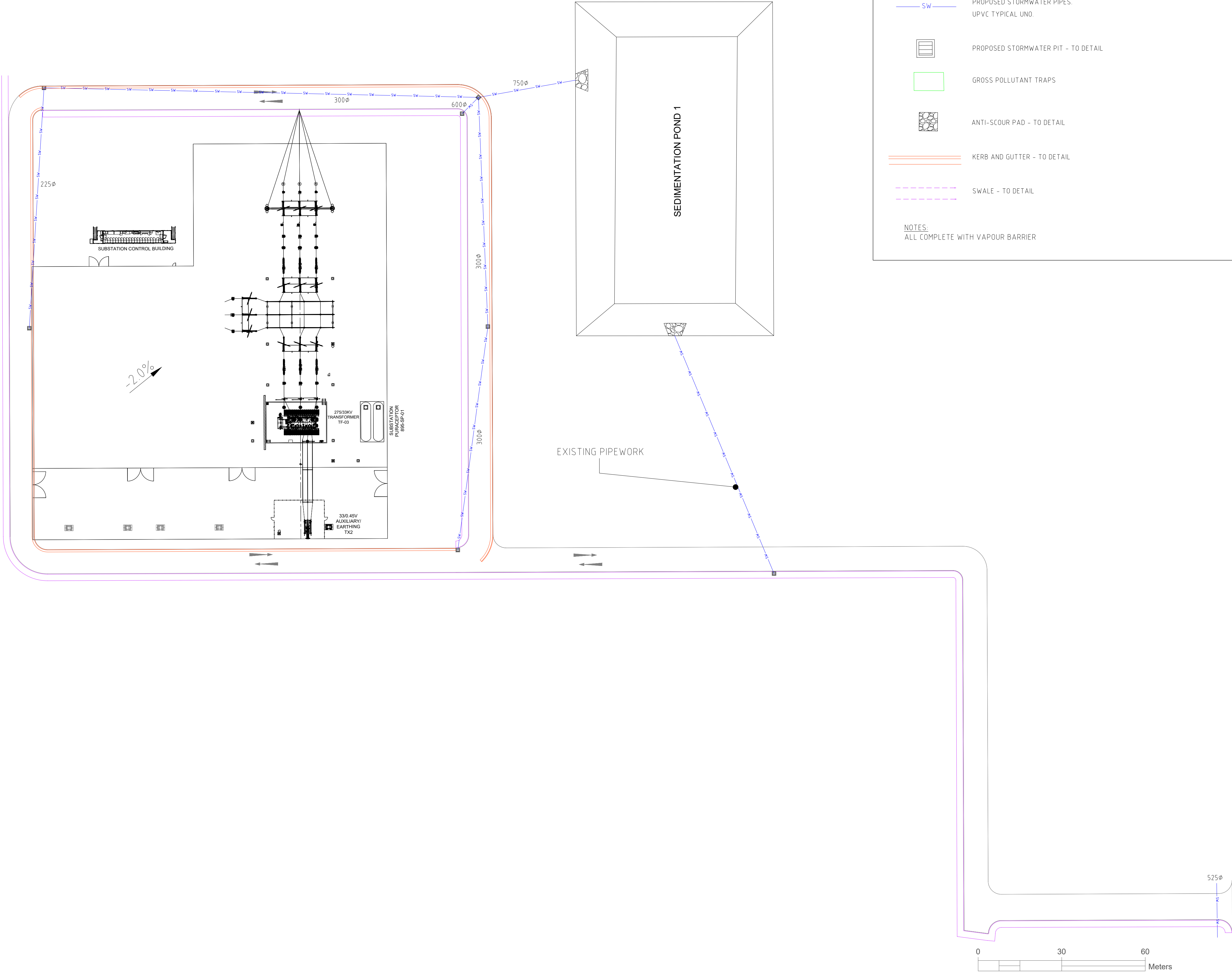
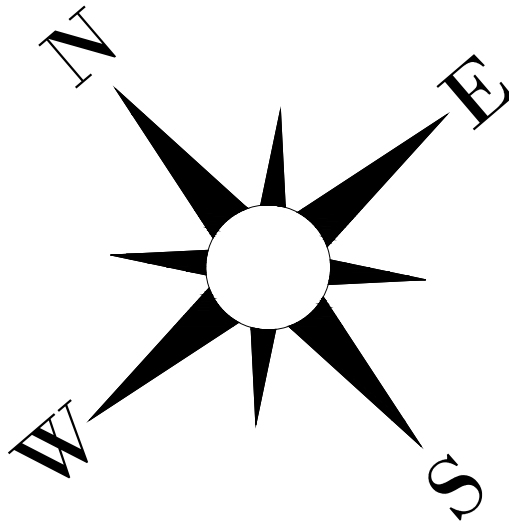
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STAGE 1: FEED STUDY 50MW ELECTROLYZER			
LOT 1 STORMWATER PLAN			
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8.2 Appendix 2 –LOT 2 & 3 275/33KV SUBSTATION STORMWATER PLAN



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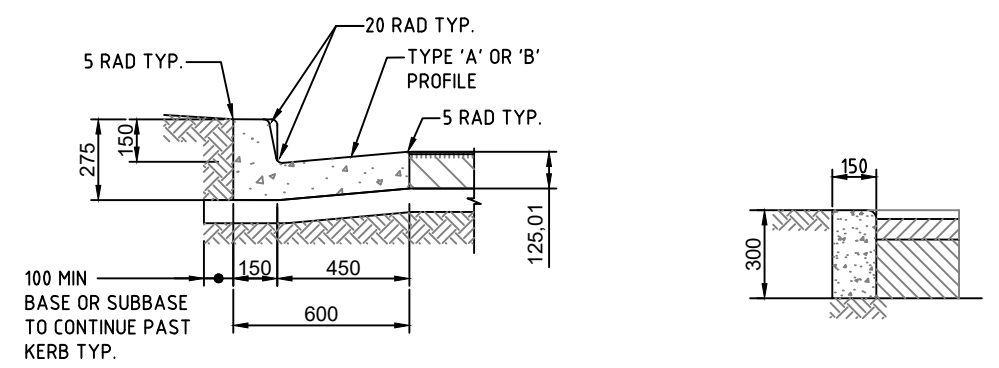


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HYDROGEN PRODUCTION PLANT			
STAGE 1: FEED STUDY 50MW ELECTROLYZER			
HYDROGEN PLANT STORMWATER PLAN			
LOT 2 & 3 275/33KV SUBSTATION			
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VENA ENERGY	17695-CIVIL-DRG-1001	08	B

8.3 Appendix 3 – PAVEMENT AND STORMWATER DETAILS

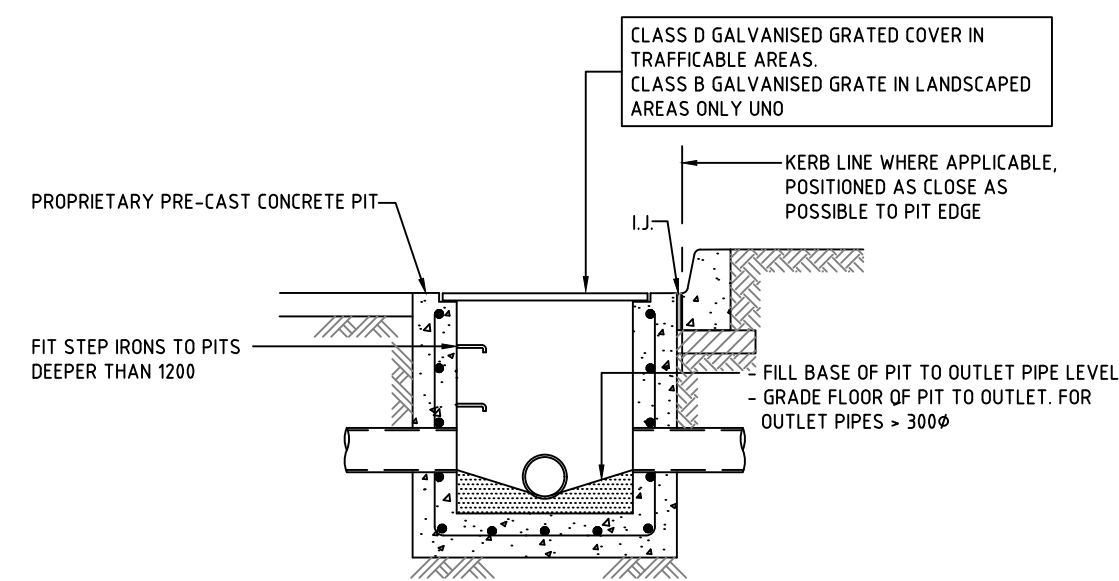


SLIP-FORMED KERB
& GUTTER (K&G)

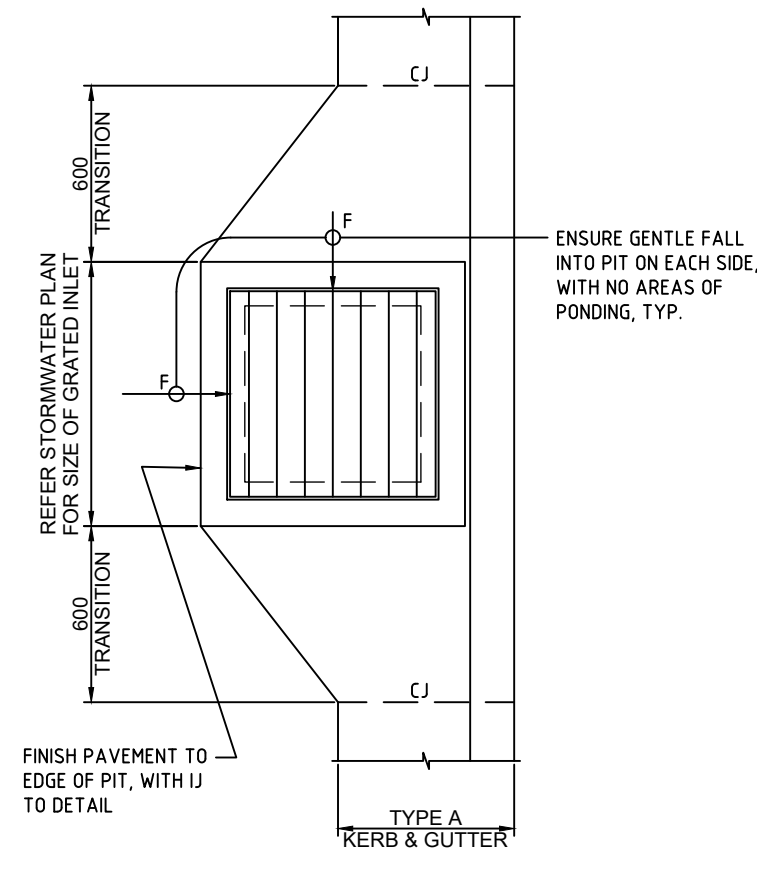
FLUSH KERB (FK)

01 TYPICAL KERB - KERB & GUTTER DETAILS

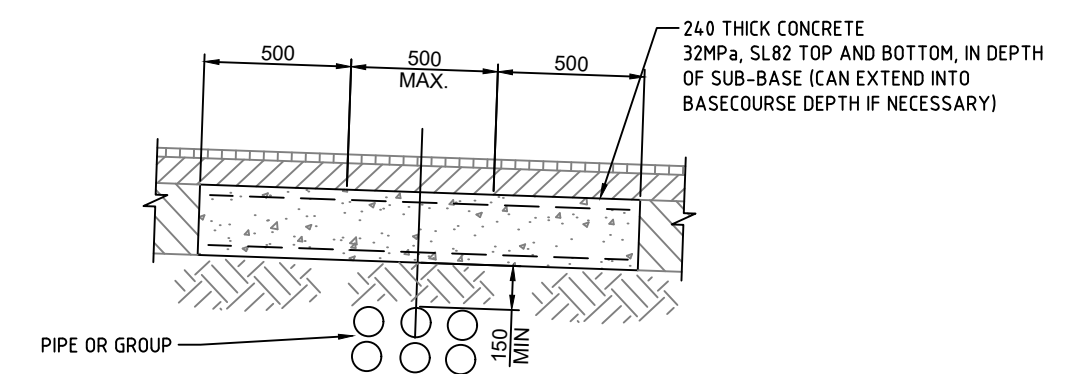
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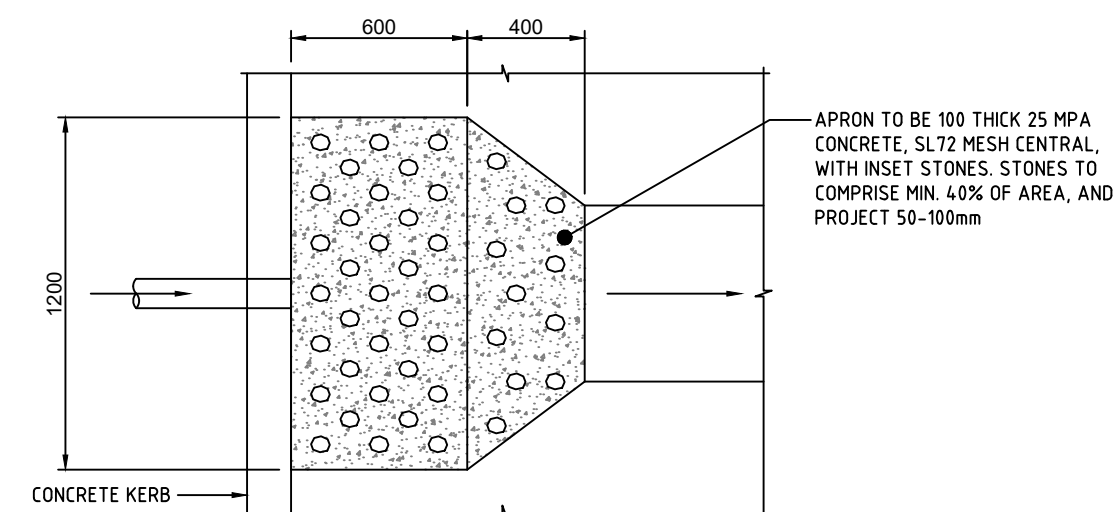
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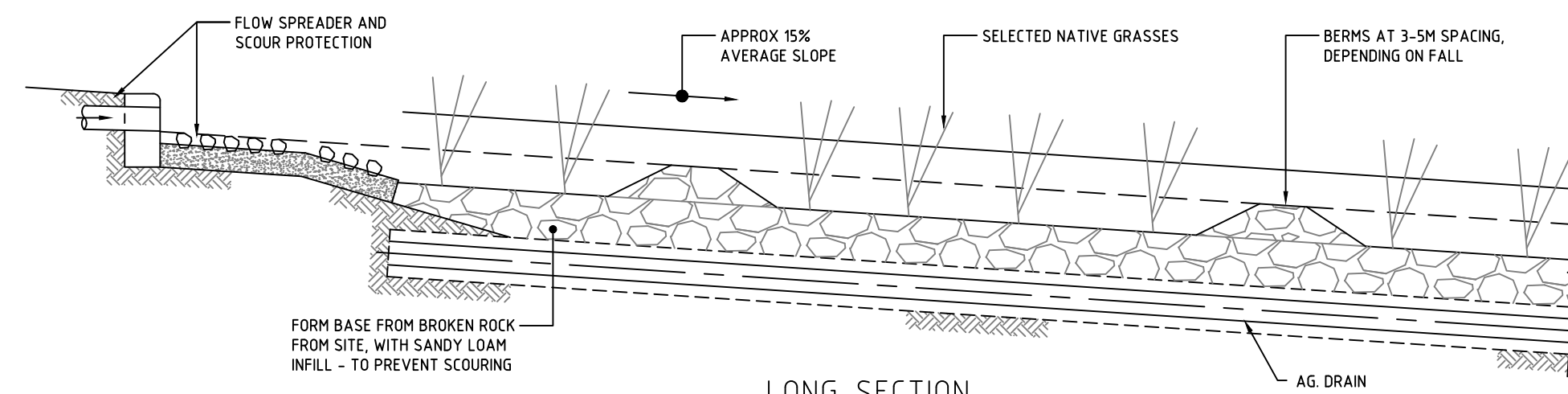
PLAN - PIT IN GUTTER



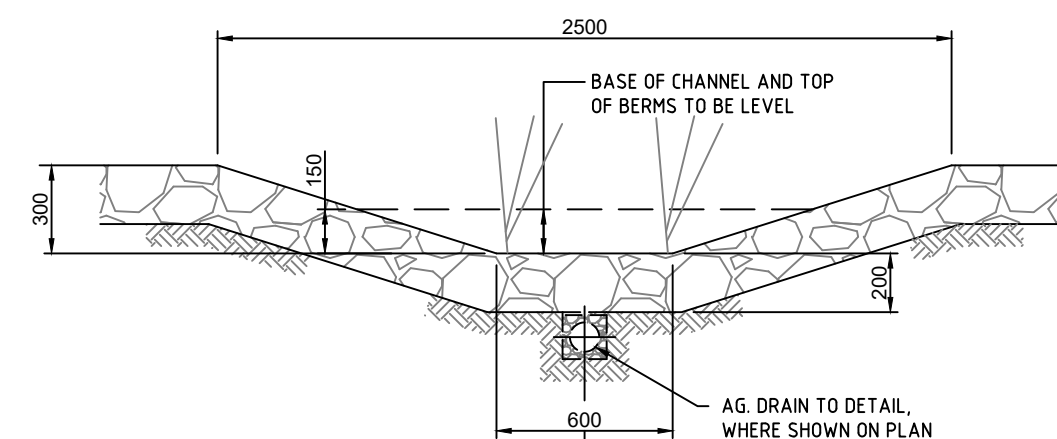
04 PIPE PROTECTION DETAIL - UNDER
ASPHALT ROADS



SWALE FLOW SPREADER PLAN

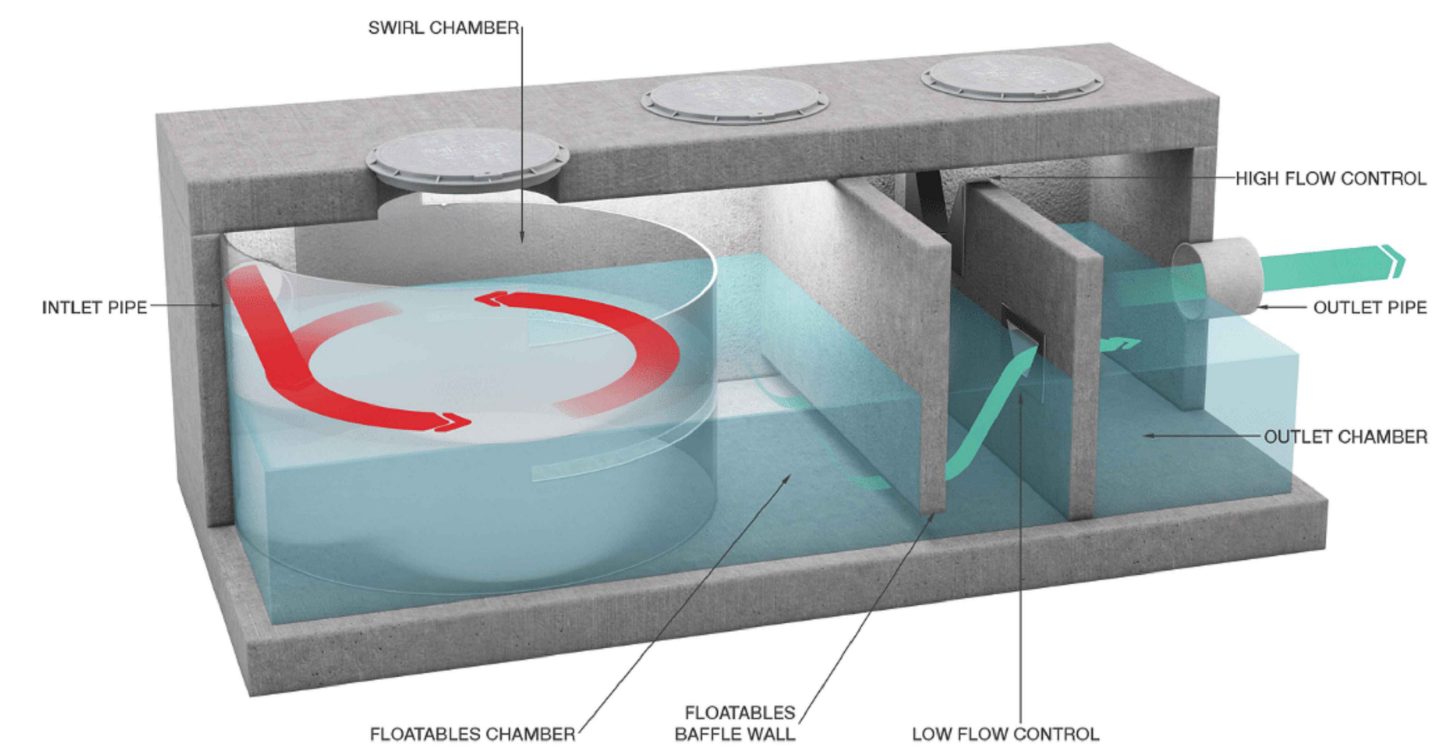


LONG-SECTION



CROSS-SECTION

03 GRASS SWALE DETAILS



APPROXIMATE DIMENSIONS (M)					
MODEL	L	x	W	x	D
VX5000	4.4	x	2.5	x	2.0
VX9000	5.0	x	3.1	x	2.2

05 GPT EXAMPLE - FROM OCEAN-PROTECT

REFER TO OCEAN-PROTECT WEBSITE/STAFF
FOR MORE DETAILED INFORMATION

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HYDROGEN PRODUCTION PLANT
STAGE 1: FEED STUDY 50MW ELECTROLYZER
PAVEMENT AND STORMWATER DETAILS

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Appendix K Ecological Assessment Report

LEADING THE WAY
IN ENVIRONMENTAL
MANAGEMENT

**ECOLOGICAL
ASSESSMENT
REPORT**
**EUROA HYDROGEN
PROJECT, ALDOGA, QLD**
VENA ENERGY
August 2025

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Abbreviations

ALA	Atlas of Living Australia
BA	Biodiversity Australia
DAFF	Department of Agriculture, Fisheries and Forestry
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DETSI	Department of Environment, Tourism Science and Innovation
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
EVNT	Endangered, Vulnerable and Near Threatened
FSC	Fauna Spotter Catcher
ha	Hectares
Km	Kilometre
LGA	Local Government Area
LoOA	Likelihood of Occurrence Assessment
m	Metre
MNES	Matters of National Environmental Significance
MSES	Matters of State Environmental Significance
NC Act	<i>Nature Conservation Act 1992</i>
NJKHT	Non-juvenile Koala Habitat Tree
QLD	Queensland
QLD SPP	Queensland's State Planning Policy
RE	Regional Ecosystem
REDD	Regional Ecosystem Description Database
SQEP	Suitably Qualified Experienced Person
VMA	<i>Vegetation Management Act 1999</i>
SPRAT	Species Profile and Threats Database
WildNet	Wildlife Online Database
WoNS	Weed of National Significance



1. Introduction

Biodiversity Australia Pty Ltd (BA) was commissioned by Vena Energy (the Client) to undertake an Ecological Assessment and provide an Ecological Assessment Report for the *Euroa Hydrogen Project – Phase 1 (EHP)* (the Project). The Project is a proposed integrated hydrogen electrolysis, hydrogen conversion, storage, and distribution facility. The Project is located on Euroa Circuit, Aldoga, QLD (the Site) (Figure 1). The Site encompasses:

- The hydrogen facility on Lots 1, 2, and 3 on Plan SP245955 (approximately 26 hectares (ha)).
- A transmission corridor on part of Lot 6 on Plan SP245936 (approx. 1.6 ha) that will connect to an existing transmission easement.
- A stormwater outlet disturbance area within Lot 7 on Plan SP245955 (approx. 0.1 ha).

The Project will require the removal of vegetation across the Site, considered the Impact Area.

1.1 Aims and Objectives

The overarching objectives of the Ecological Assessment are to:

- Confirm the presence or absence of any key environmental values protected under State or Federal legislation.
- Assess potential Matters of National Environmental Significance (MNES) and Matters of State Environmental Significance (MSES) that may occur on the Site and assess the habitat values present.
- Verify the Regional Ecosystem (RE) mapping across the proposed disturbance area.
- Identify potential legislative risk (if any) to the project.
- Preparation of a concise report detailing findings, addressing the environmental component of the Gladstone State Development Area (GDSA) scheme and assess if a Significant Impact is likely to occur on MNES and MSES due to the Project.

1.2 Project Overview

1.2.1 Desktop Assessment

A desktop assessment of the Site and literature review of previous reports were completed to:

- Assess the vegetation and associated habitat values present.
- Establish a list of MNES and MSES that could potentially occur on Site.
- Inform the field assessment.

Special attention was given to species listed under the Environmental Protection and Biodiversity Act (EPBC) (1999) considered MNES and species listed under the Nature Conservation Act (NC)(1992) considered MSES.

1.2.2 Field Assessment

A field survey was carried out by a Suitably Qualified Experienced Person (SQEP), BA's Principal Ecologist Daniel Joyce, on the 21 July 2025 over a period of a day.

The field survey was undertaken to:



- Assess the presence of native fauna, habitat and breeding places with particular attention given to any species designated MNES or MSES.
- Assess the presence of threatened flora species by conducting a Protected Plants survey in general accordance with the *Flora Survey Guidelines – Protected Plants* (Department of Environment and Science (DES), 2020).
- Verify the REs mapped as being present.
- Identify and map the presence of invasive flora species within the Site, with particular attention given to Weeds of National Significance (WoNS) and weeds classed as restricted under the *Biosecurity Act 2014*.

1.3 Legislation and Permits

Relevant legislation applicable to land clearing and vegetation removal is governed by local, state, and federal authorities. This includes:

- *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- *Nature Conservation Act 1992* (NC Act) and associated regulations.
- Nature Conservation (Koala) Conservation Plan 2017.
- *Environmental Protection Act 1994*.
- *Animal Care and Protection Act 2011*.
- *Biosecurity Act 2014*.
- Queensland State Planning Policy 2017 (QLD SPP).
- *Vegetation Management Act 1999* (VMA).
- *Gladstone State Development Area (GSDA) Development Scheme*.

1.4 Site Description and Context

The Site is located in Aldoga, Queensland, approximately 18 kilometres (km) west of Gladstone township, within the Gladstone Regional Local Government Area (LGA) (Figure 1). The tenure of each Lot of the Site is freehold. The area surrounding the Site contains both cleared and wooded areas, and is predominantly mapped as non-remnant, with some patches of remnant vegetation present. Gladstone Mount Larcom Road and a fenced railway line bound the north of the Site, creating a significant barrier to fauna movement.

Large patches of remnant vegetation are present to the south and southeast of the Site with minor connectivity restrictions from cleared agricultural paddocks and minor roads. Immediately surrounding the Site to the west is cleared agricultural paddocks used for livestock grazing.



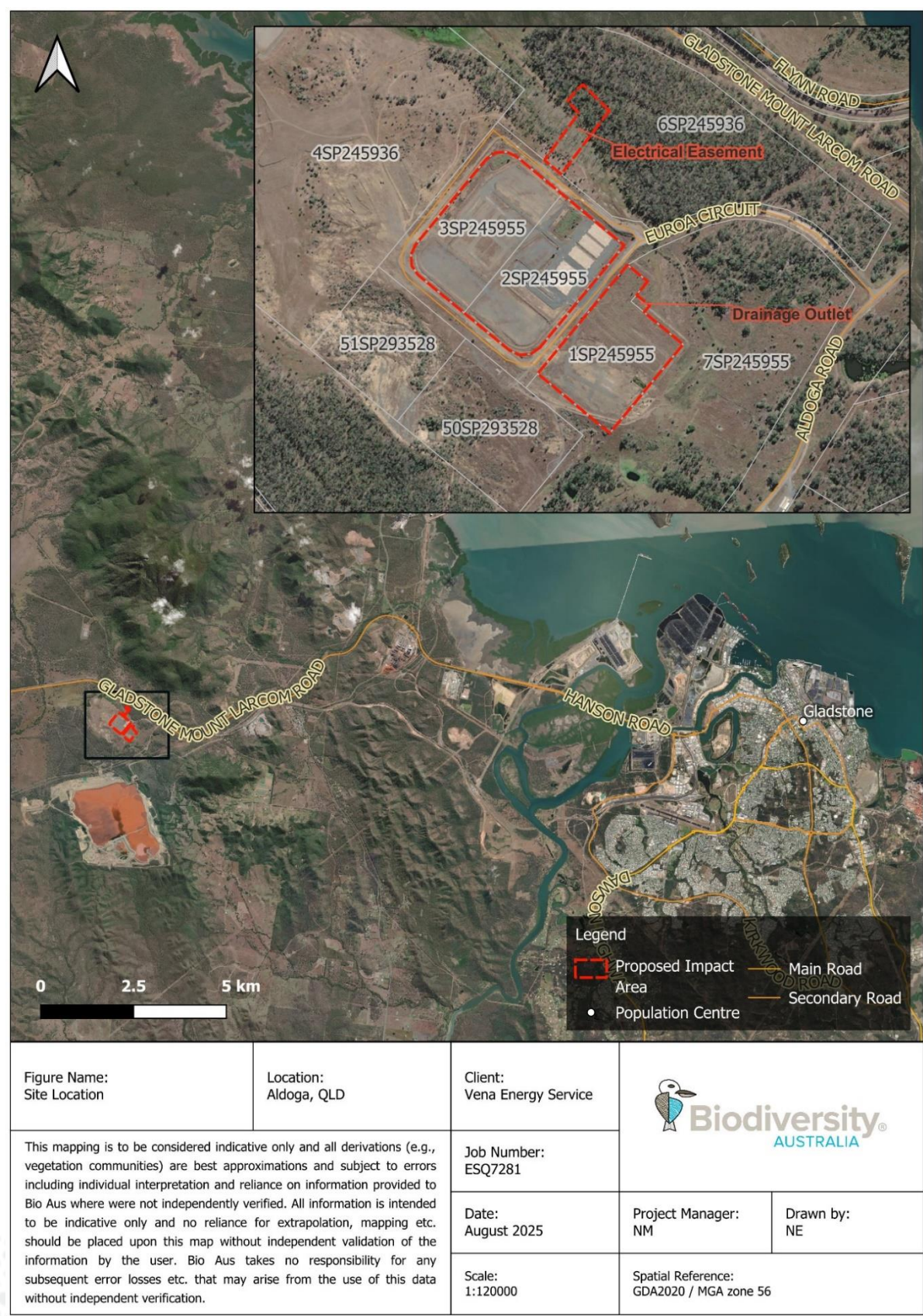


Figure 1. Site Location and Impact Area



1.4.1 Lots 2 & 3 SP245955

The Lots 2, and 3 (Figure 1) combined are approximately 18.5 ha and proposed to contain the hydrogen facility. These lots have been previously subject disturbances in the form of vegetation clearing and earthworks (cut and fill) between 2007 – 2010.

Lot 2 and Lot 3 consist of vegetation dominated by grass species that are regularly slashed and hardstand (concrete) areas and access tracks. A number of rubble piles were also present. Images of the Site area presented below in Image 1 and Image 2.



Image 1: Lot 2 SP245955



Image 2: Lot 3 SP245955

1.4.2 Lot 1 SP245955

Lot 1 on SP245955 is approximately 8 ha and has been subject to previous disturbances in the form of vegetation clearing and earthworks (cut and fill) between 2007 – 2010. The Site contains minor areas of hardstand (access tracks). Vegetation across the lot is currently dominated by kangaroo grass (*Themeda triandra*) (Image 3) and appears to be managed by slashing.



Image 3: Lot 1 SP245955

1.4.3 Lot 7 SP245955

Lot 7 on SP245955 is approximately 102 ha. The area is the edge of an earthworks batter and contains a small drainage line dominated Bulrush (*Typha orientalis*) and surrounded by Kangaroo Grass (Image 4). The proposed development is for the upgrade to a small drainage area (<1 ha) in the western corner immediately adjacent to Lot 1.





Image 4: Proposed drainage works area Lot 7 on SP245955

1.4.4 Lot 6 on SP245936

Lot 6 on SP245936 is proposed to contain a powerline easement and tower and currently consists of:

- Non remnant vegetation dominated by a minor drainage line in the south western portion of the Site (Image 5, Image 6, and Figure 2).
- Remnant vegetation (0.77 ha) in the northern portion is consistent with a mosaic of:
 - RE 11.11.4 (Least Concern) - *Eucalyptus crebra* woodland on old sedimentary rocks with varying degrees of metamorphism and folding. Coastal ranges with significant.
 - RE11.114C (Least Concern) – *Eucalyptus moluccana* dominated woodland. Other tree species listed above may occur as sub or co-dominant species) dominated by *Eucalyptus moluccana* (Image 7).

The presence of RE11.3.4 (Of Concern) *Eucalyptus tereticornis* and/or *Eucalyptus spp.* woodland on alluvial plains was indistinguishable as *E. Tereticornis* is present as a mix with RE11.11.4 and significant earthworks has impacted land zone confirmation within the area. A number of large stages within the non-remnant area of the powerline easement are likely to be the renaissance of this RE, however, clearing and earthworks resulting in changes to the hydrology of the area is likely to have resulted in the removal of this RE.

The Site has significant weed intrusion of Rats tail grass (*Sporobolus pyramidalis*) (Image 8) dominating the understory as well as the presence of Lantana (*Lantana camara*) and groundsel (*Baccharis halimifolia*) Balloon cotton (*Gomphocarpus physocarpus*). An existing cleared powerline easement and tower is present within the lot immediately adjacent to the proposed easement.





Image 5: Lot 6 on SP245936 facing north along proposed easement



Image 7: Lot 6 on SP245936 Remnant vegetation



Image 6: Lot 6 on SP245936 Drainage line



Image 8: Lot 6 on SP245936 Remnant vegetation, adjacent easement and Rats Tail grass



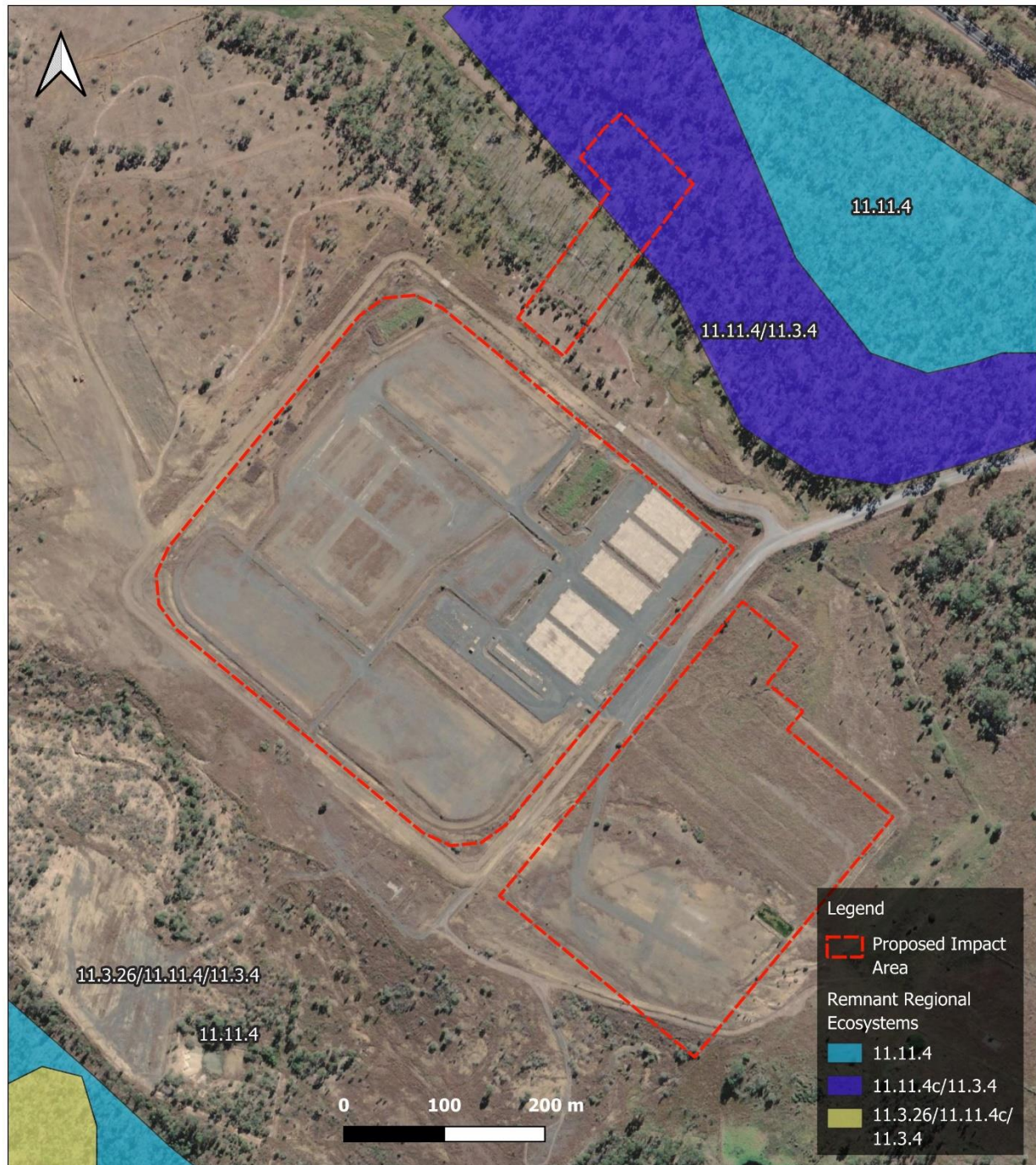


Figure Name: Regional Ecosystems	Location: Aldoga, QLD	Client: Vena Energy Service	 Biodiversity AUSTRALIA	
This mapping is to be considered indicative only and all derivations (e.g., vegetation communities) are best approximations and subject to errors including individual interpretation and reliance on information provided to Bio Aus where were not independently verified. All information is intended to be indicative only and no reliance for extrapolation, mapping etc. should be placed upon this map without independent validation of the information by the user. Bio Aus takes no responsibility for any subsequent error losses etc. that may arise from the use of this data without independent verification.		Job Number: ESQ7281		
		Date: August 2025	Project Manager: NM	Drawn by: NE
		Scale: 1:5000	Spatial Reference: GDA2020 / MGA zone 56	

Figure 2. Regional Ecosystem Mapping



2. Methodology

2.1 Desktop Assessment

A desktop analysis was undertaken to obtain ecological data relevant to the Site and locality. Particularly, background information on:

- Previous threatened species records including:
 - Known and potential distribution range(s).
 - Biological and ecological information (e.g. habitat associations).
 - Status under relevant legislation.
- Current RE mapping.
- Matters of National Environmental Significance (MNES) and Matters of State Environmental Significance (MSES).

This analysis was also used to identify information gaps in existing data. The following key databases and relevant material were reviewed:

- Department of Agriculture, Fisheries and Forestry (DAFF) Protected Matters Report.
- Department of Climate Change, Energy, the Environment and Water (DCCEEW) Species Profile and Threats Database (SPRAT).
- Approved Conservation Advice for relevant species and ecological communities (DCCEEW).
- Environmental Communities of National Environmental Significance GIS Layer (DCCEEW).
- State Planning Regulatory Provisions and Queensland (QLD) SPP Koala Mapping under the Planning Act 2016.
- Department of Environment, Tourism, Science and Innovation (DETSI) Flora Survey Trigger Mapping.
- Wildlife Online (WildNet) Database (DETSI).
- Regional Ecosystem Description Database (REDD) V13.1 (DETSI).
- Department of Natural Resource and Mines Manufacturing and Regional and Rural Development (DNRMMRR) Essential Habitat data (V10.81).
- Queensland Globe 2025 (DNRMMRR).
- Atlas of Living Australia (ALA) records database, 2025.
- Historical imagery via Qimagery.
- Aerial imagery and distribution data through Google Earth Pro (V9.1).

Desktop Database searches are Presented in Appendix A-1.

2.1.1 Likelihood of Occurrence Assessment (LoOA)

A Likelihood of Occurrence Assessment (LoOA) of threatened flora and fauna species that have been recorded in the locality (i.e., Within a 10 km radius from the Site), as determined in the above desktop assessment, were evaluated for their potential to occur within the Site. Species were categorised into the following likelihoods, through assessment of species distribution, required habitat, and the occurrence of recent/historical local records. This assessment was updated following the Site survey:

- Unlikely (<1% probability) - No potentially suitable habitat; too disturbed; or habitat is very poor. No or few records in region or records/Site very isolated, e.g., by pastoral land, urbanisation, etc.



- Low (1-25%) - Few minor areas of potential habitat; highly modified Site/habitat; or few habitat features present, but others absent or relatively insignificant (sub-optimal habitat). Usually very few records in locality.
- Fair (25-50%) - Some significant areas of potential habitat, but some habitat features limited. Potential for occasional foraging e.g., from nearby more optimal areas or known habitat. Records at least within 10-15 km radius of Site.
- Moderate (50-75%) - Quite good potentially suitable habitat on and adjacent to the Site, and/or good quality and abundance of some vital habitat features. Records within <10km, or adjacent to the Site, or adjacent to high quality habitat where species are likely to occur.
- High (>75%) - Very good to optimal habitat occurring on or adjacent to the Site (support breeding pair or population). Recorded within 5-10 km of Site in same or similar habitat.

2.2 Field Assessment

2.2.1 Protected Plants Survey

Biodiversity Australia's Suitably Qualified and Experienced Person (SQEP) Principal Ecologist Daniel Joyce, qualified under the *Flora Survey Guidelines – Protected Plants* (Department of Environment and Science (DES), 2020) undertook a protected Plant Survey of High-Risk Areas (Figure 3) of the Site. Daniel's C.V is presented in Appendix A-2.

The targeted survey was undertaken for species classified as Critically Endangered, Endangered, Vulnerable, and Conservation Dependent species under the EPBC Act and Listed species considered Threatened or Near Threatened under the *Nature Conservation Act (1992)* (NC Act).

The surveys were undertaken in general accordance with the *Flora Survey Guidelines – Protected Plants* (DES 2020) methodologies to ensure best practice when undertaking surveys. Meander surveys were undertaken which involve transversing the Site in a random fashion to maximise the coverage and encounter rate of different species. A buffer area of 100 m was used. Targeted flora species are those identified within the desktop assessment data base searches (Appendix A-1) and assessed within the LoOA (Appendix A-3) with specific attention to those species presented in Table 3 as containing a higher likelihood of occurring on Site.





Figure 3. Protected Plan High Risk Mapping and Survey Transects



2.2.2 Fauna Habitat Assessment

Survey methodologies to assess MNES fauna habitat involved walking the Site, identifying fauna presence, habitat features, and verifying desktop assessments.

Key habitat features include:

- Hollow Bearing Trees
- Hollow stumps and logs
- Hollows
- Bird nests
- Arboreal and terrestrial termite mounds (termitaria)
- Decorticating bark
- General habitat (thick vegetation, rock outcrops)
- Water bodies and/or creeks

Also noted, where present, were features such as:

- Scratch marks (specifically koala)
- Diggings

2.2.2.1 Habitat Evaluation Matrix

Habitat Evaluation Matrices (HEM) were developed for four (4) MNES fauna species using a combination of species specific:

- Known habitat values
- Cited ecology literature
- EPBC "Conservation Advice"
- Professional experience/knowledge

The development of a HEM was undertaken for MNES species considered 'High' or greater within in the LoOA (Appendix A-3).

The development of HEMs was undertaken for the following species:

- Koala
- Greater Glider
- Squatter Pigeon
- Grey-headed Flying-fox

2.2.3 Opportunistic Fauna Survey and Targeted EVNT Searches

The Ecologist recorded all species encountered during the field survey and assessed areas of potential breeding habitat for any threatened species identified in the desktop assessment as having been recorded within 10 km of the Site. This involved general comparison of habitat preferences from literature to Site features.

2.2.4 Regional Ecosystem Verification

During the field survey, the Ecologist visited areas of the Site that were mapped as being adjacent to or containing remnant vegetation and made assessments of the dominant canopy species and tree



communities present. The findings were then cross-referenced with REs to verify or invalidate the presence of mapped REs.

2.2.5 Non-juvenile Koala Habitat Tree Survey

Non-juvenile Koala Habitat Trees are defined by the Queensland Government as trees that are of the genera *Angophora*, *Corymbia*, *Eucalyptus*, *Lophostemon* or *Melaleuca*, are more than 4m high or have a trunk with a circumference of more than 10 centimetres (cm) at 1.3m above the ground. Areas containing Non-juvenile Koala Habitat Tree (NJKHT) were surveyed and mapped as Koala Habitat (Figure 4).

2.2.6 Weed Survey

The weed survey involved traversing the Site and identifying all invasive flora species. The survey focused on any weeds listed as restricted under the *Biosecurity Act, 2014* or listed as a WoNS. All areas occupied by invasive flora species and restricted weeds were recorded with drawn polygons on mapping software using a GPS enabled tablet.

2.3 Method Limitations

Whilst the survey methods used sought to achieve the overarching objectives (refer to Section 1.1), they were not without limitations. The fauna habitat assessment survey and opportunistic fauna survey provides a snapshot of fauna assemblages and habitat conditions at the time of the survey, both of which are strongly influenced by weather and season. It is unlikely that all fauna or fauna habitat features with the potential to occur on the Site were identified during the surveys. Further, individuals within certain lifecycle stages or cryptic fauna species, such as amphibians, can be difficult to locate or identify. As works progress, these species may be observed as they become more visible or readily identifiable.





Figure 4. Non-Juvenile Koala Habitat Tree Area



3. Results

3.1 Desktop Assessment

3.1.1 Matters of National Environmental Significance

The MNES search was undertaken using the Protected Matters Search Tool (PMST) and a 10 km radius from the Site. Table 1 provides a summary of the results of the MNES search with the PMST results presented in Appendix A-1.

Table 1: Summary of MNES search results.

Category	Result	Description
World Heritage Properties	1	The Great Barrier Reef World Heritage Property occurs within the 10 km buffer.
National Heritage Places	1	The Great Barrier Reef National Heritage Place occurs within the 10 km buffer.
Wetlands of International Importance	No	No Wetlands of International Importance occur within 10 km of the Site.
Great Barrier Reef Marine Park	No	The Site is not within or adjacent to the Great Barrier Reef Marine Park.
Commonwealth Marine Area	No	The Site is not within or adjacent to any Commonwealth Marine Areas.
Listed TECs	9	Nine (9) TECs have the potential to occur within the Site including: - Coastal Swamp Oak (<i>Casuarina glauca</i>) Forest of New South Wales and Southeast Queensland ecological community - Coastal Swamp Sclerophyll Forest of New South Wales and Southeast Queensland - Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions - Lowland Rainforest of Subtropical Australia - Poplar Box Grassy Woodland on Alluvial Plains - Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions - Subtropical and Temperate Coastal Saltmarsh - Subtropical eucalypt floodplain forest and woodland of the New South Wales North Coast and Southeast Queensland bioregions - Weeping Myall Woodlands
Listed Threatened Species	70	Seventy (70) species listed as threatened under the EPBC Act have the potential to occur within the Site. The likelihood of occurrence for these species is presented in Appendix A-1. All obligatory marine species (e.g. sharks, turtles and cetaceans) have been excluded from the assessment.
Listed Migratory Species	57	Fifty-seven (57) migratory species protected under the EPBC Act have the potential to occur within the Site. These include migratory wetland, terrestrial and marine species or species with habitat known/likely/may occur within the area. All obligatory marine species (e.g. sharks, turtles and cetaceans) have been excluded from the assessment.

3.1.2 Matters of State Environmental Significance

The MSES search was undertaken using DETSI's WildNet Database and Queensland Globe. The WildNet Database search included a 10 km radius from the Site. Table 2 provides a summary of the results of the MNES search with the database searches presented in Appendix A-1.



Table 2: Summary of MSES search results.

Category	Result	Description
Listed Threatened Species	28	Twenty-eight (28) species listed as threatened under the NC Act have been recorded or sighted on or within 10 km of the Site. The likelihood of occurrence for these species is presented in Appendix A-1.
Remnant Vegetation	Yes	RE 11.11.4/11.3.4 (least concern) is present in within the proposed transmission corridor (Figure 2).
High Value Regrowth	No	High Value Regrowth is not present within the Site.
Protected Areas	No	No MSES Protected Areas are present within the Site.
Marine Park	No	The Site is not a Marine Park.
Regulated Vegetation	Yes	The proposed transmission corridor contains Category B (remnant vegetation) Regulated Vegetation
Essential Habitat	Yes	The proposed transmission corridor contains REs that are mapped as Essential Habitat for the Yellow-Bellied Glider, Squatter Pigeon, and Greater Glider
Protected Areas	No	The Site does not contain Protected Areas.
High Ecological Value (HEV) wetlands/waterways	No	The Site does not contain HEV wetlands or waterways.
Legally Secured Offset Areas	No	The Site does not contain Legally Secured Offset Areas.

3.1.3 Likelihood of Occurrence Assessment

Fifty-seven (57) federally listed and fifty-four (54) state listed species, were assessed based on data base search results for 10 km radius of the Site results from searches of:

- Queensland governments WildNet database.
- Search for PMST.
- Records within ALA.

These species were identified with potential to occur on the Site are considered within the LoOA presented in A-1. Species found to have a likelihood of occurring within the Site of greater than 'unlikely' are summarised below in Table 3 below.

3.1.3.1 Threatened Flora Potential Occurrence

Upon searching the Protected Matters Search Tool and Wildlife Online Database, it was determined that nineteen (19) flora species consisting of thirteen (13) federally listed and sixteen (16) state listed MNES and MSES could occur within the Site. Further likelihood of assessment analysis (Appendix A-3) showed that seven (7) species, six (6) of which are MNES, were identified as an occurrence likelihood of low or higher. These species are presented in Table 3.

Additionally, Lot 6 and lot 7 have portions mapped within the State Government's Protected Plants High Risk Trigger Map, in accordance with the *Nature Conservation (Plants) Regulation 2020* and is considered to have a high likelihood to host threatened or near threatened flora species.

3.1.3.2 Threatened Fauna Likelihood of Occurrence

In total, forty-five (45) fauna species considered threatened under the EPBC and NC Acts were identified consisting of forty-four (44) federally listed and thirty nine (39) state listed species, as having the potential to occur on Site according to the PMST and Wildlife Online Database searches due to suitable foraging or shelter habitat occurring within or immediately adjacent to the Site. Of the threatened fauna species assessed in the likelihood of occurrence assessment (Appendix A-3-2) showed that seven (7)



species (six (6) of which are MNES), were identified as an occurrence likelihood of low to higher based. These species are presented in Table 3.

Table 3: Summary of MNES and MSES threatened species, with a Likelihood of Occurrence at the Site.

Scientific Name	Common Name	NC Act ⁺	EPBC Act*	Likelihood of Occurrence
Plants				
<i>Atalaya collina</i>	Yarwun Whitewood	E	E	Fair
<i>Bosistoa transversa</i>	Three-leaved Bosistoa, Yellow Satinheart	LC	V	Moderate
<i>Cupaniopsis shirleyana</i>	Wedge-leaf Tuckeroo	V	V	Moderate
<i>Cycas megacarpa</i>	-	E	E	High
<i>Dansiea elliptica</i>	-	NT	-	Low
<i>Macadamia integrifolia</i>	Macadamia Nut, Queensland	V	V	Low
<i>Samadera bidwillii</i>	Quassia	V	V	Fair
Birds				
<i>Geophaps scripta scripta</i> ¹	Squatter Pigeon (southern) ¹	E	E	High
<i>Hirundapus caudacutus</i> ^{1,2}	White-throated Needle-tail ^{1,2}	V	V, M, Mar. (OF)	Low
<i>Ninox strenua</i> ²	Powerful Owl ²	V	-	High
Mammals				
<i>Petaurus australis australis</i> ^{1,2}	Yellow-bellied Glider (south-eastern) ^{1,2}	V	V	Low
<i>Petauroides volans</i> ^{1,2}	Greater Glider (southern and central) ^{1,2}	E	E	Low
<i>Phascolarctos cinereus</i> ^{1,2,3}	Koala ^{1,2,3}	E	E	High
<i>Pteropus poliocephalus</i> ¹	Grey-headed Flying-fox ¹	LC	V	High
Reptiles				
<i>Delma torquata</i> ¹	Adorned Delma, Collared Delma ¹	V	V	Low
<i>Egernia rugosa</i>	Yakka Skink		V	Low
<i>Furina dunmali</i>	Dunmall's Snake	V	V	Low
⁺ NC Act status: CR, Critically Endangered; E, Endangered; V, Vulnerable; LC, Least Concern; SLC, Special Least Concern. * EPBC Act status: CE, Critically Endangered; E, Endangered; V, Vulnerable; M, Migratory; Mar. (OF), Marine (Overfly). ¹ MNES; ² MSES; ³ MLES.				



3.1.4 Likelihood of Occurrence Assessment

The desktop search flagged fifty-four (54) MSES and fifty-seven (57) MNES threatened species (sixty-four (64) unique species) as having a possibility of occurring within the Site. The likelihood of occurrence assessments for the flagged species, of the fifty-four (54) MSES and fifty-seven (57) MNES threatened species, six (6) species were assessed as having a moderate or higher likelihood (> 50%) of occurring within the Site, based on nearby records, their habitat requirements and the habitats present. These are detailed in Table 4.

Table 4: Species assessed as having a moderate or higher likelihood of occurring on the Site.

	NCA Status	EPBC Status	WildNet Records	ALA Records	Likelihood of Occurrence
Flora					
Three-leaved Bosistoa	LC	V	19	12	Moderate
Wedge-leaf Tuckeroo	V	V	2	3	Moderate
<i>Cycas megacarpa</i>	E	E	4	4	High
Fauna					
Squatter Pigeon (southern)	E	E	16	21	High
Powerful Owl	V	-	8	14	High
Koala	E	E	6	4	High
Grey-headed Flying-fox	LC	V	-	3	High

* Conservation status: E, Endangered; V, Vulnerable; LC, Least Concern (NC Act).

3.1.5 Vegetation Assessment and Regional Ecosystem Verification

Vegetation mapping, reviewed as part of the desktop assessment, is presented in Figure 2. The results identify a majority of the Site mapped as non-remnant vegetation. However, the northern portion of Lot 6 on SP145936 within the proposed transmission corridor boundary is mapped as remnant vegetation comprising the following REs:

- RE 11.11.4 (Least concern) – *Eucalyptus crebra* woodland on old sedimentary rocks with varying degrees of metamorphism and folding. Coastal Ranges.
- RE 11.3.4 (Of Concern) – *Eucalyptus tereticornis* and/or *Eucalyptus spp.* Woodland on alluvial plains.

Field survey of the Site confirmed:

- Lots 1, 2, 3 and 7 on SP245955 are mapped correctly as with the entire Impact Area within these lots containing non remnant vegetation.
- Lot 6 on SP245955 contains remnant vegetation consistent with RE11.11.4 dominated by *E. Crebra*, *Corymbia citriodora*, *C. tessellaris* and *E. tereticornis*. A majority of the remnant vegetation within the Impact area is dominated by *Eucalyptus moluccana* and considered a mosaic of 11.11.4 and 11.11.4c.

The presence of RE11.3.4 (of Concern) within the proposed development negligible to not present. Significant earth works within the mapped area of the RE has changed the hydraulic regime and resulted in a large number of stags within the mapped non remnant area. *E. tereticornis* individuals were sparse on the southern edge of remnant vegetation and formed part of the mosaic of 11.11.4 rather than a separate RE and indicate a potential boundary change into the non-remnant area.

The Regional ecosystems on Site are not considered consistent with any of the TEC's identified within the desktop assessment presented within the PMST or known. The Site does not contain any TEC's.



3.1.1 Flora Observed

A total of sixty-five (65) flora species were observed during the survey. A species list is presented in Appendix A-4. No flora species considered EVNT under the EPBC Act or NC Act were identified during the field survey.

3.1.2 Fauna Observed

A total of nine (9) fauna species were observed during the field survey (Table 5). No threatened species were detected.

Table 5: Fauna observed within the Site

Common Name	Scientific Name	Method	EPBC ¹ Status	NC Act ² Status
Aves				
Grey Fantail	<i>Rhipidura albiscapa</i>	Observed	-	LC
Laughing Kookaburra	<i>Dacelo novaeguineae</i>	Observed	-	LC
Noisy Miner	<i>Manorina melanocephala</i>	Observed	-	LC
Pied Butcherbird	<i>Cracticus nigrogularis</i>	Observed	-	LC
Rainbow Lorikeet	<i>Trichoglossus moluccana</i>	Observed	-	LC
Red-backed Fairy-wren	<i>Malurus melanocephalus</i>	Observed	-	LC
Torresian Crow	<i>Corvus orru</i>	Observed	-	LC
White-winged Chough	<i>Corcorax melanorhamphos</i>	Observed	-	LC
Willie Wagtail	<i>Rhipidura leucophrys</i>	Observed	-	LC
¹ Environment Protection and Biodiversity Conservation Act 1999 ² Nature Conservation Act 1992 Value Codes: Least Concern (LC)				

3.2 Weed Survey

During the field survey, sixteen (16) weed species were identified and recorded within the Site (Appendix A-4). Four (4) of these are classified as restricted under the *Biosecurity Act 2014*, and two (2) are also classified as WoNS. The restricted weeds identified within the Site during the field survey are presented Figure 5. A large infestation of Rats Tail Grass is prevalent across Lot 6. A dense area of Balloon cotton is also mapped and presented in Figure 5.

Table 6: Significant Weeds identified on Site.

Common Name	Species Name	WoNS	Restricted Classification
Giant Rat's Tail Grass	<i>Sporobolus pyramidalis</i>	-	3
Groundsel	<i>Baccharis halimifolia</i>	-	3
Lantana	<i>Lantana camara</i>	Y	3
Rubber Vine	<i>Cryptostegia grandiflora</i>	Y	3



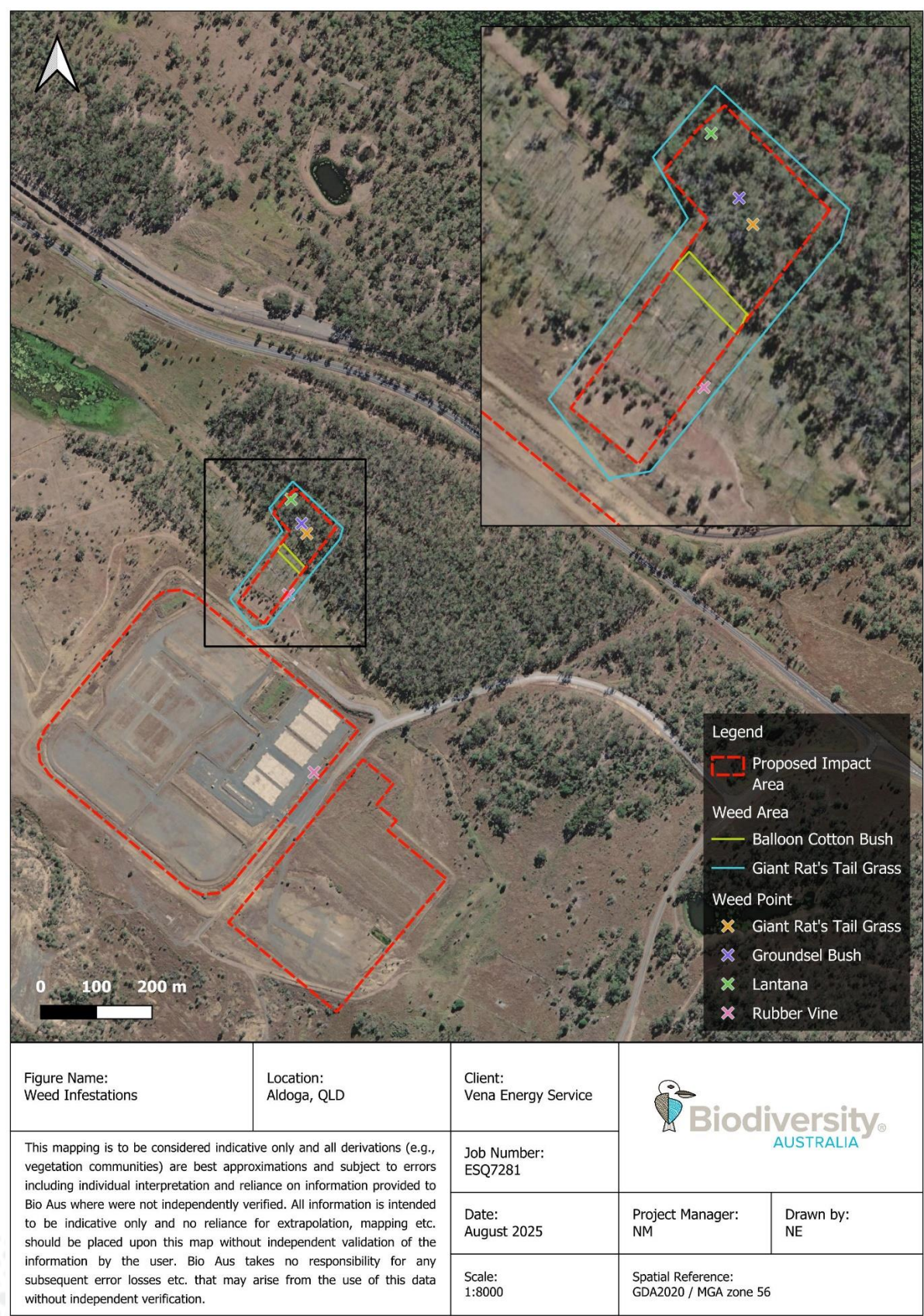


Figure 5. Areas subject to weed infestation



3.3 Fauna Habitat Assessment

Details of the fauna habitat features present within the subject Site and an evaluation of their potential values to threatened species are presented in Table 7 to Table 9. The suitability of the habitat for species identified in the LoOA (summarised in Appendix A-3) was assessed against habitats identified on Site.

When considering Appendix A-3 and Table 3, it was determined that the habitat of a number of species had a likelihood of occurrence above 'low', namely:

- Squatter Pigeon
- Koala
- Grey-headed Flying-fox

A HEM was developed for these species and the results of the HEM's are presented in Table 7, Table 8 and Table 9, below.



Table 7: Habitat Evaluation Matrix for the Koala

Habitat feature	Score				
	1	2	3	4	5
Quality and availability of food and habitat for foraging					
Number of NJKHT species	0	1	2 - 3	4 - 5	>5
Size of trees present (DBH)	<10 cm DBH	>10 cm DBH	<5 individuals >10 cm DBH	>5 individuals >10 cm DBH One individual of 20 cm DBH	>5 individuals >20 cm DBH
Size of trees (height)	< 3 m	3 – 6 m	< 5 individuals >6 m	>5 individuals >6 m One individual >15 m	>5 individuals >15 m
Quality and availability of habitat for shelter and breeding					
Number of NJKHT species	0	1	2 - 3	4 - 5	>5
Number of shelter trees	0	1 - 3	3 - 5	5 – 10	>10
Size of NJKHTs present	< 6 m	6 – 8 m	8 – 12 m	12 – 20 m	>20 m
Quality and availability of habitat for mobility					
Ground density (below 1 m) density	80 – 100%	60 – 80%	40 – 60%	20 – 40%	< 20%
Presence of barriers (logs, fences, roads)	Lots of large logs and chain fence and or road/train line surrounded by cleared areas	Minimal structures present and the surrounding area is open paddocks and open infrastructure	Some large logs, some fencing and access tracks	Minimal structures and <1 strand fence present	No fences or structures
Absence of threats					
Clearing and degradation of koala habitat	No remnant habitat	High	Moderate	Low	Absent
Total: 75/100*					

*25 is allocated to each subcategory (foraging, habitat, mobility and threats)



Table 8: Habitat Evaluation Matrix for the Squatter Pigeon

Scoring attributes	Score				
	1	2	3	4	5
Quality and Availability of Food and Habitat for Foraging					
Presence of suitable (native) tussock grass Species	Absent	Tussock grass present but covers <10%	10 - ≤25%	25 - ≤75%	Over 75% native preferred grasses
Mosaic of bare patches / grass	No bare ground / overrun with weeds	≤5% bare patches or ≥85% bare ground	5-15 or ≥70	≥15-20 or ≥60-70	≥20 - 60% bare ground
Quality and Availability of Habitat for Shelter and Breeding					
Presence of suitable open grassy woodland	Absent	Present but both understorey and tree canopy degraded	Suitable grassland composition but suitable tree species absent / small regrowth	Open woodland with vegetation thickening and/or low grass diversity	Present high quality open woodland with low shrub density
Distance to water	Over 2km	≥ 1-2km	Within 500m - 1km of a breeding season water source	≥ 200-500m of a breeding season water source	Within 200m of a breeding season water source
Quality and Availability of Habitat for Mobility					
Presence of Exotic ground level grasses that would restrict movement	>80% groundcover	70-80% groundcover	60-70% groundcover	50 – 60% groundcover	<60% groundcover
Absence of threats					
Predation by feral predators	Very High: Assessment unit is within 5 km of a town, dump or other source of supplementary food for dogs and cats, and no control programs are in place.	High: Assessment unit is within 18 km of a town, dump or other source of supplementary food for dogs, and no control programs are in place.	Moderate: Assessment unit is within 18 km of a town, dump or other source of supplementary food for dogs and cats, but active control measures (baiting, trapping or shooting) occur within the assessment unit and effectively reduce cat and dog densities (as shown by monitoring).	Low: Assessment unit is further than 18 km from a town, dump or other source of supplementary food for dogs and cats.	Very High: Assessment unit is within 5 km of a town, dump or other source of supplementary food for dogs and cats, and no control programs are in place.
Total: 57.5/100*					

*25 is allocated to each subcategory (foraging, habitat, mobility and threats)



Table 9: Habitat Evaluation Matrix for the Grey-headed Flying Fox

Habitat Feature	Score				
	1	2	3	4	5
Quality of available food and habitat for foraging					
Number of <i>Eucalyptus</i>/<i>Melaleuca</i>/<i>Banksia</i> rainforest fruiting species	0	1 - 5	5-10	10-20	>20
Quality and availability of shelter / breeding habitat					
Number of roosting tree species	0	1	2 - 3	4 - 5	>5
Distance from water	>20km	>10km	>5km	>2.5km	>1km
Quality and availability of habitat required for mobility					
Additional habitat within vicinity of Survey Area	>20km	>10km	>5km	>2.5km	>1km
Absence of threats					
Level of land clearing	No remnant habitat	High	Moderate	Low	Absent
Total: 80/100*					

*25 is allocated to each subcategory (foraging, habitat, mobility and threats)



4. Summary of Assessment

The Lots 1, 2, and 3 of the proposed within the Site contain minimal ecological values and are clear of remnant vegetation. Vegetation within the area has previously been cleared and is generally maintained via slashing.

The proposed Impact Area (0.10 ha) within Lot 7 is within a highly disturbed (earth works batter) and minor drainage line with minimal to no ecological values dominated by Bullrush. Additionally, there are minimal ecological values are present within the Lot 7.

The proposed Impact Area within Lot 6 consists of A non-remnant area highly disturbed and dominated by non-endemic weedy vegetation including Rats Tail Grass considered a WoNS. A drainage line meanders east to west through this area and is highly eroded. A portion of this area (0.079 ha) contains NJKHT. A number of Stags also occurs within this area. Minimal ecological values are present within Lot 6 . It is understood that the proposed Action (vegetation maintenance) is being consistent with historic activities within Lot 6. Minimal to no earthworks is proposed for this area only maintaining vegetation.

Lot 6 also contains a 0.77 ha area of remnant RE11.11.4. The RE is present within the Impact Area and contains a number of habitat features including small hollows, stags, logs, and woody debris. Lot 6 within the RE, is considered potential habitat for three (3) species considered MNES and MSES, namely:

- Koala
- Squatter Pigeon
- Grey-headed Flying-fox

Additionally, the Site is considered suitable habitat for one (1) MNES species, namely the Powerful Owl, however, no suitable roosting Sites for this species were identified on Site, with the Impact Area potentially used for livestock grazing.

Overall, the proposed impact will result in the removal of:

- RE11.11.4 (Least Concern), 0.77 ha.
- Poor quality breeding habitat for the Squatter Pigeon, 0.77 ha.
- Koala habitat, 0.77 ha.
- Foraging habitat for Grey headed flying fox, 0.77 ha
- Poor quality foraging habitat for Powerful Owl, 0.77 ha.

An Assessment Significance in accordance with the *Matters Of National Environmental Significant Guidelines Significant Impact Guidelines 1.1* (Department of Environment 2013) has been completed for the MNES species and is presented in Appendix A-5.

The results of this assessment indicate that the proposed Action is unlikely to have a significant impact on any MNES or MSES species, however, removal of their potential habitat will occur.

A protect plant survey of the Impact Area mapped as High Risk under the NC Act did not identify any MNES or MSES species present on the Site, however Lot 6 contains a significant infestation of Rats Tail Grass considered a WoNS. Control of this species prior to any works occurring on Site is highly recommended.



5. Conclusion

This report has been undertaken for the specific purposes of Vena Energy as detailed in our correspondence to them and is solely for the use of Vena Energy. This report is only to be used in full and may not be used to support objectives other than those set out herein, except where written approval, with comments, is provided by Biodiversity Australia. Biodiversity Australia accepts no responsibility for the accuracy of information supplied to them by second and third parties. Should more detail be required, please do not hesitate to call our office on the details below.



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6. References

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TSSC (2016) Approved Conservation Advice for *Gossia gonoclada* (angle-stemmed myrtle). Accessed July 2025. Available at: <https://environment.gov.au/biodiversity/threatened/species/pubs/78866-conservation-advice-16122016.pdf>

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7. Appendices



A-1 Data Base Search Results





Australian Government

Department of Climate Change, Energy,
the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 31-Jul-2025

[Summary](#)

[Details](#)

[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

[Acknowledgements](#)

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

World Heritage Properties:	1
National Heritage Places:	1
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	9
Listed Threatened Species:	70
Listed Migratory Species:	57

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at <https://www.dcceew.gov.au/parks-heritage/heritage>

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	100
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	1

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	1
Regional Forest Agreements:	None
Nationally Important Wetlands:	2
EPBC Act Referrals:	54
Key Ecological Features (Marine):	None
Biologically Important Areas:	5
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

World Heritage Properties			[Resource Information]
Name	State	Legal Status	Buffer Status
Great Barrier Reef	QLD	Declared property	In buffer area only

National Heritage Places			[Resource Information]
Name	State	Legal Status	Buffer Status
Natural			
Great Barrier Reef	QLD	Listed place	In buffer area only

Listed Threatened Ecological Communities			[Resource Information]
For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.			
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.			

Community Name	Threatened Category	Presence Text	Buffer Status
Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community	Endangered	Community may occur within area	In buffer area only
Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland	Endangered	Community may occur within area	In buffer area only
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Endangered	Community may occur within area	In feature area
Lowland Rainforest of Subtropical Australia	Critically Endangered	Community may occur within area	In buffer area only
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	Community may occur within area	In feature area
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Community likely to occur within area	In buffer area only
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area	In buffer area only
Subtropical eucalypt floodplain forest and woodland of the New South Wales North Coast and South East Queensland bioregions	Endangered	Community likely to occur within area	In buffer area only

Community Name	Threatened Category	Presence Text	Buffer Status
Weeping Myall Woodlands	Endangered	Community may occur	In feature area within area

Listed Threatened Species

[[Resource Information](#)]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text	Buffer Status
BIRD			
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area	In feature area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area	In feature area
Calidris tenuirostris Great Knot [862]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area	In buffer area only
Cyclopsitta diophthalma coxeni Coxen's Fig-Parrot [59714]	Critically Endangered	Species or species habitat may occur within area	In feature area
Epthianura crocea macgregori Capricorn Yellow Chat, Yellow Chat (Dawson) [67090]	Critically Endangered	Species or species habitat may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Erythroriorchis radiatus Red Goshawk [942]	Endangered	Species or species habitat likely to occur within area	In feature area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area	In feature area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat known to occur within area	In feature area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Limnodromus semipalmatus Asian Dowitcher [843]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Endangered	Species or species habitat known to occur within area	In buffer area only
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area	In buffer area only
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area	In feature area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Pluvialis squatarola Grey Plover [865]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Pterodroma neglecta neglecta Kermadec Petrel (western) [64450]	Vulnerable	Foraging, feeding or related behaviour may occur within area	In buffer area only
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area	In feature area
Sternula albifrons Little Tern [82849]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area	In buffer area only
Turnix melanogaster Black-breasted Button-quail [923]	Vulnerable	Species or species habitat known to occur within area	In feature area
Xenus cinereus Terek Sandpiper [59300]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
MAMMAL			
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area	In buffer area only
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Petauroides volans Greater Glider (southern and central) [254]	Endangered	Species or species habitat known to occur within area	In feature area
Petaurus australis australis Yellow-bellied Glider (south-eastern) [87600]	Vulnerable	Species or species habitat may occur within area	In feature area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Endangered	Species or species habitat likely to occur within area	In feature area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour may occur within area	In feature area
Sousa sahalensis Australian Humpback Dolphin [87942]	Vulnerable	Breeding known to occur within area	In buffer area only
Xeromys myoides Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
PLANT			
Atalaya collina Yarwun Whitewood [55417]	Endangered	Species or species habitat known to occur within area	In feature area
Bosistoa transversa Three-leaved Bosistoa, Yellow Satinheart [16091]	Vulnerable	Species or species habitat known to occur within area	In feature area
Bulbophyllum globuliforme Miniature Moss-orchid, Hoop Pine Orchid [6649]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Cossinia australiana Cossinia [3066]	Endangered	Species or species habitat may occur within area	In feature area
Cupaniopsis shirleyana Wedge-leaf Tuckeroo [3205]	Vulnerable	Species or species habitat known to occur within area	In feature area
Cycas megacarpa [55794]	Endangered	Species or species habitat known to occur within area	In feature area
Cycas ophiolitica [55797]	Endangered	Species or species habitat may occur within area	In feature area
Dichanthium setosum bluegrass [14159]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Eucalyptus raveretiana Black Ironbox [16344]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Leichhardtia brevifolia listed as Marsdenia brevifolia [91893]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Macadamia integrifolia Macadamia Nut, Queensland Nut Tree, Smooth-shelled Macadamia, Bush Nut, Nut Oak [7326]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Parsonsia larcomensis Mt Larcom Silk Pod [64587]	Vulnerable	Species or species habitat known to occur within area	In feature area
Samadera bidwillii Quassia [29708]	Vulnerable	Species or species habitat known to occur within area	In feature area
REPTILE			
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In buffer area only
Delma torquata Adorned Delma, Collared Delma [1656]	Vulnerable	Species or species habitat may occur within area	In feature area
Denisonia maculata Ornamental Snake [1193]	Vulnerable	Species or species habitat may occur within area	In feature area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area	In buffer area only
Egernia rugosa Yakka Skink [1420]	Vulnerable	Species or species habitat may occur within area	In feature area
Elseya albagula Southern Snapping Turtle, White-throated Snapping Turtle [81648]	Critically Endangered	Species or species habitat may occur within area	In buffer area only
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Furina dunmalli Dunmall's Snake [59254]	Vulnerable	Species or species habitat may occur within area	In feature area
Hemiaspis damelii Grey Snake [1179]	Endangered	Species or species habitat likely to occur within area	In feature area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat likely to occur within area	In buffer area only
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Rheodytes leukops Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle, White-eyed River Diver [1761]	Endangered	Species or species habitat may occur within area	In buffer area only

SHARK			
Carcharias taurus (east coast population) Grey Nurse Shark (east coast population) [68751]	Critically Endangered	Foraging, feeding or related behaviour may occur within area	In buffer area only
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding may occur within area	In buffer area only
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Sphyrna lewini Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat likely to occur within area	In buffer area only

Listed Migratory Species		[Resource Information]	
Scientific Name	Threatened Category	Presence Text	Buffer Status
null			
Balaenoptera omurai Omura's Whale [87136]		Species or species habitat likely to occur within area	In buffer area only

Migratory Marine Birds			
Anous stolidus Common Noddy [825]		Species or species habitat known to occur within area	In buffer area only
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Fregata minor Great Frigatebird, Greater Frigatebird [1013]	Endangered	Species or species habitat likely to occur within area	In buffer area only
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]		Species or species habitat may occur within area	In buffer area only
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat may occur within area	In buffer area only
Phaethon rubricauda Red-tailed Tropicbird [994]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area	In buffer area only
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]		Species or species habitat may occur within area	In buffer area only
Migratory Marine Species			
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]	Endangered	Species or species habitat likely to occur within area	In buffer area only
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area	In buffer area only
Balaenoptera musculus Blue Whale [36]		Species or species habitat may occur within area	In buffer area only
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area	In buffer area only
Carcharias taurus Grey Nurse Shark [64469]		Foraging, feeding or related behaviour may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area	In buffer area only
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In buffer area only
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area	In feature area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area	In buffer area only
Dugong dugon Dugong [28]		Species or species habitat known to occur within area	In buffer area only
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area	In buffer area only
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat likely to occur within area	In buffer area only
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area	In buffer area only
Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat may occur within area	In buffer area only
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In buffer area only
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area	In buffer area only
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding may occur within area	In buffer area only
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Sousa sahalensis as Sousa chinensis Australian Humpback Dolphin [87942]	Vulnerable	Breeding known to occur within area	In buffer area only
Migratory Terrestrial Species			
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area	In feature area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Migratory Wetlands Species			
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area	In feature area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Species or species habitat known to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area	In feature area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area	In feature area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area	In feature area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area	In buffer area only
Calidris tenuirostris Great Knot [862]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area	In buffer area only
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area	In feature area
Limnodromus semipalmatus Asian Dowitcher [843]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area	In feature area
Numenius phaeopus Whimbrel [849]		Species or species habitat known to occur within area	In buffer area only
Pandion haliaetus Osprey [952]		Breeding known to occur within area	In feature area
Pluvialis fulva Pacific Golden Plover [25545]		Species or species habitat known to occur within area	In buffer area only
Pluvialis squatarola Grey Plover [865]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Tringa brevipes Grey-tailed Tattler [851]		Species or species habitat known to occur within area	In buffer area only
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area	In buffer area only
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area	In buffer area only
Xenus cinereus Terek Sandpiper [59300]	Vulnerable	Species or species habitat known to occur within area	In buffer area only

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]	
Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Anous stolidus Common Noddy [825]		Species or species habitat known to occur within area	In buffer area only
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area overfly marine area	In feature area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In feature area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Species or species habitat known to occur within area	In buffer area only
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area	In feature area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area	In feature area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area overfly marine area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area	In feature area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area	In feature area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area overfly marine area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Calidris tenuirostris Great Knot [862]	Vulnerable	Species or species habitat known to occur within area overfly marine area	In buffer area only
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area	In buffer area only
Charadrius ruficapillus Red-capped Plover [881]		Species or species habitat known to occur within area overfly marine area	In buffer area only
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area	In buffer area only
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat likely to occur within area	In buffer area only
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]	Vulnerable	Species or species habitat known to occur within area overfly marine area	In feature area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area	In feature area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Species or species habitat known to occur within area overfly marine area	In buffer area only
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat likely to occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Limnodromus semipalmatus Asian Dowitcher [843]	Vulnerable	Species or species habitat may occur within area overfly marine area	In buffer area only
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area	In buffer area only
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area	In buffer area only
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat likely to occur within area overfly marine area	In feature area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area overfly marine area	In feature area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area	In feature area
Numenius phaeopus Whimbrel [849]		Species or species habitat known to occur within area	In buffer area only
Pachyptila turtur Fairy Prion [1066]		Species or species habitat likely to occur within area	In buffer area only
Pandion haliaetus Osprey [952]		Breeding known to occur within area	In feature area
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Phaethon rubricauda Red-tailed Tropicbird [994]		Species or species habitat likely to occur within area	In buffer area only
Pluvialis fulva Pacific Golden Plover [25545]		Species or species habitat known to occur within area	In buffer area only
Pluvialis squatarola Grey Plover [865]	Vulnerable	Species or species habitat known to occur within area overfly marine area	In buffer area only
Pterodroma cervicalis White-necked Petrel [59642]		Species or species habitat may occur within area	In feature area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Species or species habitat known to occur within area overfly marine area	In buffer area only
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area overfly marine area	In feature area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area	In feature area
Sternula albifrons as Sterna albifrons Little Tern [82849]	Vulnerable	Species or species habitat may occur within area	In buffer area only
Symposiachrus trivirgatus as Monarcha trivirgatus Spectacled Monarch [83946]		Species or species habitat known to occur within area overfly marine area	In feature area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Tringa brevipes as Heteroscelus brevipes Grey-tailed Tattler [851]		Species or species habitat known to occur within area	In buffer area only
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area overfly marine area	In buffer area only
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area overfly marine area	In buffer area only
Xenus cinereus Terek Sandpiper [59300]	Vulnerable	Species or species habitat known to occur within area overfly marine area	In buffer area only
Fish			
Acentronura tentaculata Shortpouch Pygmy Pipehorse [66187]		Species or species habitat may occur within area	In buffer area only
Campichthys tryoni Tryon's Pipefish [66193]		Species or species habitat may occur within area	In buffer area only
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area	In buffer area only
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area	In buffer area only
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area	In buffer area only
Corythoichthys haematopterus Reef-top Pipefish [66201]		Species or species habitat may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area	In buffer area only
Corythoichthys ocellatus Orange-spotted Pipefish, Ocellated Pipefish [66203]		Species or species habitat may occur within area	In buffer area only
Corythoichthys paxtoni Paxton's Pipefish [66204]		Species or species habitat may occur within area	In buffer area only
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area	In buffer area only
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area	In buffer area only
Festucalex cinctus Girdled Pipefish [66214]		Species or species habitat may occur within area	In buffer area only
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area	In buffer area only
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		Species or species habitat may occur within area	In buffer area only
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area	In buffer area only
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area	In buffer area only
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Hippichthys cyanospilos Blue-speckled Pipefish, Blue-spotted Pipefish [66228]		Species or species habitat may occur within area	In buffer area only
Hippichthys heptagonus Madura Pipefish, Reticulated Freshwater Pipefish [66229]		Species or species habitat may occur within area	In buffer area only
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area	In buffer area only
Hippocampus bargibanti Pygmy Seahorse [66721]		Species or species habitat may occur within area	In buffer area only
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area	In buffer area only
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area	In buffer area only
Hippocampus zebra Zebra Seahorse [66241]		Species or species habitat may occur within area	In buffer area only
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area	In buffer area only
Micrognathus andersonii Anderson's Pipefish, Shortnose Pipefish [66253]		Species or species habitat may occur within area	In buffer area only
Micrognathus brevirostris thorntail Pipefish, Thorn-tailed Pipefish [66254]		Species or species habitat may occur within area	In buffer area only
Nannocampus pictus Painted Pipefish, Reef Pipefish [66263]		Species or species habitat may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area	In buffer area only
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area	In buffer area only
Solenostomus paradoxus Ornate Ghostpipefish, Harlequin Ghost Pipefish, Ornate Ghost Pipefish [66184]		Species or species habitat may occur within area	In buffer area only
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area	In buffer area only
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area	In buffer area only
Mammal			
Dugong dugon Dugong [28]		Species or species habitat known to occur within area	In buffer area only
Reptile			
Aipysurus duboisii Dubois' Sea Snake, Dubois' Seasnake, Reef Shallows Sea Snake [1116]		Species or species habitat may occur within area	In buffer area only
Aipysurus laevis Olive Sea Snake, Olive-brown Sea Snake [1120]		Species or species habitat may occur within area	In buffer area only
Aipysurus mosaicus as Aipysurus eydouxii Mosaic Sea Snake [87261]		Species or species habitat may occur within area	In buffer area only
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In buffer area only
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area	In feature area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area	In buffer area only
Emydocephalus annulatus Eastern Turtle-headed Sea Snake [1125]		Species or species habitat may occur within area	In buffer area only
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Hydrophis elegans Elegant Sea Snake, Bar-bellied Sea Snake [1104]		Species or species habitat may occur within area	In buffer area only
Hydrophis hardwickii as Lapemis hardwickii Spine-bellied Sea Snake [93516]		Species or species habitat may occur within area	In buffer area only
Hydrophis kingii as Disteira kingii Spectacled Sea Snake [93511]		Species or species habitat may occur within area	In buffer area only
Hydrophis major as Disteira major Olive-headed Sea Snake [93512]		Species or species habitat may occur within area	In buffer area only
Hydrophis peronii as Acalyptophis peronii Horned Sea Snake [93509]		Species or species habitat may occur within area	In buffer area only
Hydrophis platura as Pelamis platurus Yellow-bellied Sea Snake [93746]		Species or species habitat may occur within area	In buffer area only

Scientific Name	Threatened Category	Presence Text	Buffer Status
Hydrophis stokesii as Astrotia stokesii Stokes' Sea Snake [93510]		Species or species habitat may occur within area	In buffer area only
Laticauda colubrina Yellow-lipped Sea Krait [1092]		Species or species habitat may occur within area	In buffer area only
Laticauda laticaudata a sea krait [1093]		Species or species habitat may occur within area	In buffer area only
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat likely to occur within area	In buffer area only
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area	In buffer area only

Whales and Other Cetaceans		[Resource Information]	
Current Scientific Name	Status	Type of Presence	Buffer Status
Mammal			
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area	In buffer area only
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area	In buffer area only
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area	In buffer area only
Balaenoptera omurai Omura's Whale [87136]		Species or species habitat likely to occur within area	In buffer area only
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area	In buffer area only

Current Scientific Name	Status	Type of Presence	Buffer Status
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area	In buffer area only
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area	In buffer area only
Orcaella heinsohni Australian Snubfin Dolphin [81322]	Vulnerable	Species or species habitat likely to occur within area	In buffer area only
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area	In buffer area only
Sousa sahulensis Australian Humpback Dolphin [87942]	Vulnerable	Breeding known to occur within area	In buffer area only
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area	In buffer area only
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area	In buffer area only
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area	In buffer area only

Habitat Critical to the Survival of Marine Turtles			[Resource Information]
Scientific Name	Behaviour	Presence	Buffer Status
All year (Jun - Aug)			
Natator depressus Flatback Turtle [59257]	Nesting	Known to occur	In buffer area only

Extra Information

State and Territory Reserves			[Resource Information]	
Protected Area Name	Reserve Type	State	Buffer Status	
Calliope	Conservation Park	QLD	In buffer area only	
Nationally Important Wetlands			[Resource Information]	
Wetland Name		State	Buffer Status	
Port Curtis		QLD	In buffer area only	
The Narrows		QLD	In buffer area only	
EPBC Act Referrals			[Resource Information]	
Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Aldoga Solar Farm Project	2020/8773		Post-Approval	In buffer area only
Calvale to Calliope River Transmission Line Reinforcement Project	2024/10044		Assessment	In buffer area only
CQ-H2 Hydrogen Production Facility (HPF) Project	2024/09902		Assessment	In buffer area only
CQ-H2 Hydrogen Transport Facility (HTF) Project	2024/09901		Assessment	In feature area
CQ-H2 Surplus Industrial Water Pipeline (SIWP) Project	2024/09935		Assessment	In buffer area only
Gladstone - Fitzroy Pipeline	2007/3501		Post-Approval	In buffer area only
Powerlink Gladstone to Larcom Creek 275kV Transmission Line	2003/1229		Completed	In feature area
Renewable Diesel and Sustainable Aviation Fuel Project	2022/09369		Completed	In buffer area only
Controlled action				
Aldoga Aluminium Smelter Gladstone	2001/160	Controlled Action	Post-Approval	In feature area
Arrow Bowen Pipeline (CSG), QLD	2012/6459	Controlled Action	Post-Approval	In buffer area only
Blackwater to Gladstone Gas Pipeline Project	2011/6034	Controlled Action	Completed	In feature area
Clinton Vessel Interaction Project - Clinton Widening, Qld	2017/7976	Controlled Action	Post-Approval	In buffer area only

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Controlled action				
Construct and operate 447km high pressure gas transmission pipeline	2009/4976	Controlled Action	Post-Approval	In feature area
Construction of a Chlor-Alkali/Ethylene Di-Chlorid	2003/922	Controlled Action	Completed	In buffer area only
Construction of a Chlor-Alkali-Ethylene Di-Chloride (CA/EDC) Plant at the Gladst	2002/764	Controlled Action	Completed	In buffer area only
Construction of a high pressure buried gas pipeline, Kogan to Gladstone, QLD	2009/5029	Controlled Action	Post-Approval	In buffer area only
Construction of Bridge and Road to Access Proposed Natural Gas Liquification Park	2008/4060	Controlled Action	Completed	In buffer area only
Development of the Yarwun Coal Terminal	2012/6348	Controlled Action	Completed	In feature area
Gas Pipeline with Alternative Pipeleine to Supply Natural Gas Liquefaction Park	2008/4096	Controlled Action	Post-Approval	In buffer area only
Gladstone New Fuels Development Project - stage 2A	2014/7241	Controlled Action	Completed	In buffer area only
H2-Hub??? Gladstone - Export-class Green Hydrogen and Ammonia Complex	2021/9049	Controlled Action	Referral Decision	In buffer area only
HPAL Nickel Plant	2005/2376	Controlled Action	Post-Approval	In buffer area only
install & operate gas pipeline	2005/2059	Controlled Action	Post-Approval	In buffer area only
LNG Plant and Ancillary onshore and marine facilities	2009/4977	Controlled Action	Post-Approval	In buffer area only
Lot 7 Borrow Pits, Aldoga Road, Gladstone, Qld	2018/8381	Controlled Action	Post-Approval	In buffer area only
Nickel and cobalt laterite mine, High-pressure acid leach plant, slurry pipeline	2005/2257	Controlled Action	Completed	In buffer area only
Port of Gladstone Western Basin Strategic Dredging and Disposal Project	2009/4904	Controlled Action	Post-Approval	In buffer area only
Queensland Curtis LNG Project - LNG Marine Facilities	2008/4401	Controlled Action	Post-Approval	In buffer area only
Queensland Curtis LNG Project - Mainland Road and Bridge	2008/4403	Controlled Action	Completed	In buffer area only

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Controlled action				
Approach				
Queensland Curtis LNG Project - Pipeline Network	2008/4399	Controlled Action	Post-Approval	In buffer area only
Stage 1 and 2 borrow pits, stockpiles, haul roads and Stage 3 red mud dam, Aldoga, Qld	2017/8107	Controlled Action	Completed	In buffer area only
Talisman Saber 2005 Military Exercise	2004/1819	Controlled Action	Post-Approval	In buffer area only
The Arrow Gas Transmission Pipeline, Gladstone to Curtis Island	2009/5008	Controlled Action	Post-Approval	In buffer area only
The Arrow LNG Facility, Curtis Island, Gladstone	2009/5007	Controlled Action	Post-Approval	In buffer area only
Wiggins Island Coal Terminal	2005/2374	Controlled Action	Post-Approval	In buffer area only
Not controlled action				
Aldoga Livestock Handling Facility	2017/7905	Not Controlled Action	Completed	In buffer area only
Aldoga Power Station	2012/6265	Not Controlled Action	Completed	In feature area
Aldoga Solar Farm, Aldoga, QLD	2018/8251	Not Controlled Action	Completed	In buffer area only
Calcining Plant	2001/193	Not Controlled Action	Completed	In buffer area only
Cement Australia East End Mine Extension, Mt Larcom, QLD	2015/7595	Not Controlled Action	Completed	In buffer area only
Fisherman's Landing Port Facility	2000/124	Not Controlled Action	Completed	In buffer area only
Fishermans Landing site conversion for Lime Kiln	2002/740	Not Controlled Action	Completed	In buffer area only
Gladstone Energy and Ammonia Project, Qld	2018/8305	Not Controlled Action	Completed	In buffer area only
Gladstone State Development Area, Ammonia Production Facility	2006/2855	Not Controlled Action	Completed	In buffer area only
Gladstone Steel Making Facility	2009/4786	Not Controlled Action	Completed	In buffer area only
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed	In feature area

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Not controlled action				
Liquefied Natural Gas Export Terminal	2008/3954	Not Controlled Action	Completed	In buffer area only
Moura Link - Aldoga Rail Project	2007/3773	Not Controlled Action	Completed	In buffer area only
Project Sun Liquefied Natural Gas Plant and Pipeline	2008/3994	Not Controlled Action	Completed	In buffer area only
Proposed clay borrow pit and associated haul roads and stockpiles, Gladstone, Qld	2017/7858	Not Controlled Action	Completed	In buffer area only
Rail deviation including construction of 2 new rail lines	2009/4884	Not Controlled Action	Completed	In buffer area only
Replacement of Existing Processing Plant with a smaller Technology Demonstration Plant	2009/5064	Not Controlled Action	Completed	In buffer area only
Referral decision				
Gas Transmission Pipeline to supply Natural Gas Liquefaction Park	2008/4061	Referral Decision	Completed	In buffer area only
Port of Gladstone Western Basin Strategic Dredging and Disposal Project	2009/4826	Referral Decision	Completed	In buffer area only
Biologically Important Areas [Resource Information]				
Scientific Name		Behaviour	Presence	Buffer Status
Dolphins				
Sousa chinensis				
Indo-Pacific Humpback Dolphin [50]		Breeding	Known to occur	In buffer area only
Tursiops aduncus				
Indo-Pacific/Spotted Bottlenose Dolphin [68418]		Breeding	Likely to occur	In buffer area only
Seabirds				
Ardenna pacifica				
Wedge-tailed Shearwater [84292]		Foraging	Likely to occur	In buffer area only
Sharks				
Carcharias taurus				
Grey Nurse Shark [64469]		Foraging	Known to occur	In buffer area only
Whales				
Megaptera novaeangliae				
Humpback Whale [38]		Breeding and calving	Known to occur	In buffer area only

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data is available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on the contents of this report.

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions when time permits.

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded breeding sites; and
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [-Office of Environment and Heritage, New South Wales](#)
- [-Department of Environment and Primary Industries, Victoria](#)
- [-Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [-Department of Environment, Water and Natural Resources, South Australia](#)
- [-Department of Land and Resource Management, Northern Territory](#)
- [-Department of Environmental and Heritage Protection, Queensland](#)
- [-Department of Parks and Wildlife, Western Australia](#)
- [-Environment and Planning Directorate, ACT](#)
- [-Birdlife Australia](#)
- [-Australian Bird and Bat Banding Scheme](#)
- [-Australian National Wildlife Collection](#)
- [-Natural history museums of Australia](#)
- [-Museum Victoria](#)
- [-Australian Museum](#)
- [-South Australian Museum](#)
- [-Queensland Museum](#)
- [-Online Zoological Collections of Australian Museums](#)
- [-Queensland Herbarium](#)
- [-National Herbarium of NSW](#)
- [-Royal Botanic Gardens and National Herbarium of Victoria](#)
- [-Tasmanian Herbarium](#)
- [-State Herbarium of South Australia](#)
- [-Northern Territory Herbarium](#)
- [-Western Australian Herbarium](#)
- [-Australian National Herbarium, Canberra](#)
- [-University of New England](#)
- [-Ocean Biogeographic Information System](#)
- [-Australian Government, Department of Defence](#)
- [Forestry Corporation, NSW](#)
- [-Geoscience Australia](#)
- [-CSIRO](#)
- [-Australian Tropical Herbarium, Cairns](#)
- [-eBird Australia](#)
- [-Australian Government – Australian Antarctic Data Centre](#)
- [-Museum and Art Gallery of the Northern Territory](#)
- [-Australian Government National Environmental Science Program](#)
- [-Australian Institute of Marine Science](#)
- [-Reef Life Survey Australia](#)
- [-American Museum of Natural History](#)
- [-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania](#)
- [-Tasmanian Museum and Art Gallery, Hobart, Tasmania](#)
- [-Other groups and individuals](#)

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

		Scientific n	Common n	ALA	WildNet	NCA status	EPBC statu	Scientific n	Sighting summary
Animalia	Aves	Arenaria int	Ruddy Turn	#N/A	#N/A	SL	Vulnerable	Actitis hypc	1
Animalia	Aves	Calidris aci	Sharp-taile	#N/A	#N/A	SL	Vulnerable	Calidris ruf	1
Animalia	Aves	Calidris car	Red Knot, K	#N/A	#N/A	V	Vulnerable	Calidris ter	1
Animalia	Aves	Calidris fer	Curlew San	#N/A	#N/A	CR	Critically Ei	Charadrius	1
Animalia	Aves	Calidris ten	great knot	1	1	V	V	Charadrius	1
Animalia	Aves	Charadrius	greater san	1	1	V	V	Cuculus op	1
Animalia	Aves	Charadrius	lesser sand	#N/A	1	E	E	Gallinago h	2
Animalia	Aves	Cyclopsitta	Coxen's Fig	#N/A	#N/A		Critically Ei	Geophaps :	21
Animalia	Aves	Epthianura	Capricorn \	#N/A	#N/A		Critically Ei	Hirundapus	5
Animalia	Aves	Erythrotrior	Red Gosha	#N/A	#N/A		Endangerer	Hydroprogr	1
Animalia	Aves	Falco hypol	Grey Falco	#N/A	#N/A		Vulnerable	Limosa lap	2
Animalia	Aves	Fregetta gr	White-belli	#N/A	#N/A		Vulnerable	Ninox stren	14
Animalia	Aves	Gallinago h	Latham's si	3	2	V	V	Numenius i	3
Animalia	Aves	Geophaps :	squatter pi	16	21	V	V	Numenius j	2
Animalia	Aves	Hirundapus	white-thro	4	5	V	V	Pandion ha	4
Animalia	Aves	Limnodrom	Asian Dowi	#N/A	#N/A		Vulnerable	Thalasseus	1
Animalia	Aves	Limosa lap	Western Al	2	2	E	E	Tringa nebu	2
Animalia	Aves	Macronectr	Southern G	#N/A	#N/A		Endangerer	Tringa stagi	1
Animalia	Aves	Neochmia i	Star Finch (	#N/A	#N/A		Endangerer	Turnix mela	2
Animalia	Aves	Ninox stren	powerful ov	8	14	V		Petauroide	18
Animalia	Aves	Numenius i	eastern cur	7	3	CR	CE	Petaurus ai	11
Animalia	Aves	Pachyptila	Fairy Prion	#N/A	#N/A		Vulnerable	Phascolarc	6
Animalia	Aves	Pluvialis sq	Grey Plover	#N/A	#N/A		Vulnerable	Pteropus p	3
Animalia	Aves	Pterodrom	Kermadec I	#N/A	#N/A		Vulnerable	Tachygloss	23
Animalia	Aves	Rostratula	Australian I	#N/A	#N/A		Endangerer	Taphozous	3
Animalia	Aves	Sternula all	Little Tern	1	#N/A		Vulnerable	Acianthus f	2
Animalia	Aves	Thalassarcl	Campbell A	#N/A	#N/A		Vulnerable	Adiantum a	1
Animalia	Aves	Tringa nebu	common gr	2	2	E	E	Adiantum h	8
Animalia	Aves	Turnix mela	black-brea	2	2	V	V	Adiantum h	4
Animalia	Aves	Xenus cine	Terek Sand	#N/A	#N/A		Vulnerable	Adiantum h	1
Animalia	Mammalia	Dasyurus h	Northern Q	#N/A	#N/A		Endangerer	Adiantum h	1
Animalia	Mammalia	Macroderm	Ghost Bat	#N/A	#N/A		Vulnerable	Atalaya col	12
Animalia	Mammalia	Petauroide	southern gr	13	18	E	E	Blechnum c	1
Animalia	Mammalia	Petaurus ai	yellow-belli	12	#N/A	V	V	Bosistoa tra	12
Animalia	Mammalia	Phascolarc	koala	4	6	E	E	Brachychite	7
Animalia	Mammalia	Pteropus p	grey-heade	#N/A	3	C	V	Brunonia ai	1
Animalia	Mammalia	Taphozous	coastal she	#N/A	3	NT		Bulbophyllu	1
Animalia	Mammalia	Xeromys m	Water Mou:	#N/A	#N/A		Vulnerable	Caladenia c	2
Animalia	Reptile	Delma torq	Adorned De	#N/A	#N/A		Vulnerable	Chiloglottis	1
Animalia	Reptile	Denisonia r	Ornamenta	#N/A	#N/A		Vulnerable	Chiloglottis	1
Animalia	Reptile	Egernia rug	Yakka Skinl	#N/A	#N/A		Vulnerable	Cordyline n	1
Animalia	Reptile	Elseya alba	Southern S	#N/A	#N/A		Critically Ei	Corybas ba	2
Animalia	Reptile	Furina dun	Dunmall's S	#N/A	#N/A		Vulnerable	Crinum pec	1
Animalia	Reptile	Hemiaspis	Grey Snake	#N/A	#N/A		Endangerer	Cupaniops	3
Animalia	Reptile	Rheodytes	Fitzroy Rive	#N/A	#N/A		Endangerer	Cycas meg	4
					#N/A			Cymbidiurr	3
Plantae	Equisetops	Atalaya col	Yarwun Wh	24	12	E	E	Dansiea ell	7
Plantae	Equisetops	Bosistoa tra	three-leave	19	12	C	V	Dendrobiur	1

A-2 Suitably Qualified and Experienced Ecologist C.V.



19 August 2025

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Suitably Qualified Persons CVs and Statement of Suitably Qualified Grading Assessment

Daniel Joyce – Suitably Qualified Grading Assessment

- Daniel Joyce holds a Bachelor of Science (Environmental Science) from the University of the Sunshine coast (2001) This degree resulted in a thorough knowledge of plant identification and flora survey and was QLD focused 50 points
- Daniel completed Regional Ecosystem training through the QLD herbarium in 2005, 5 points
- Daniel Joyce has within the last 2 years and a total of at least 5 years at leading flora surveys in a field-based environment at a rate of no less than 5 comprehensive botanical surveys that focus on locating and identifying threatened plant or near threatened plants, per year. 60 Points

A total of 115 points according to Table 1 Suitably Qualified Persons Self-Assessment Grading System

It should also be noted that Daniel Joyce has been accepted as a Certified Environmental Practitioner (CENVP) in 2011 and was a paying member until 2017.

Table A1 Suitably Qualified Persons Self-Assessment Grading System

COMPONENT 1: QUALIFICATION KNOWLEDGE AND ABILITY			
Description	Conditions	Points allocated	Explanation
A relevant qualification from a recognised institution (e.g. University, TAFE) that results in a thorough knowledge of plant identification and flora surveys.	General training (not Aust. or QLD focussed); OR		
	Australian focussed training; OR		
	Queensland focussed training	50	Completed degree from the University of the Sunshine Coast in Environmental Science majoring in Environmental management. Subjects included botany identification
Regional ecosystem training by a recognised and qualified institution, such as the Queensland Herbarium.		5	Completed through the QLD Herbarium in 2005

Member of a recognised group / certificate program relevant to ecology/botany, where skills/knowledge are demonstrated to be granted membership. E.g. Certified Environmental Practitioner (CEnvP) Program			Registered and paying Certified Environmental Practitioner from 2011 to 2017
Lead author of articles/papers published in peer reviewed journals in relation to Qld flora surveys, Qld plant identification, or Qld threatened plants or near threatened plants	10 points per paper to a maximum of 50 points		
COMPONENT 2: FIELD EXPERIENCE			
Experience within the last 2 years and a total of at least 5 years at leading flora surveys in a field-based environment at a rate of no less than 5 comprehensive botanical surveys that focus on locating and identifying threatened plant or near threatened plants, per year.	General (not Aust. based); OR		
	Australian based survey experience; OR		
	Qld based field flora surveys experience	60	See details in Table A2, below
Number of plant specimens you have collected that have been retained/incorporated into the Queensland Herbarium collection:	5 points per 5 plant specimens retained/incorporated, to a maximum of 40 points		
Total Points		115	

Table A2: Daniel Joyce Relevant Queensland Based Flora Survey Experience

Year	Project / Location	Description
August 2024	General Ranges Development – Wide Bay Training Area, Wide Bay, QLD	Protected plant survey as part of Impact assessment for proposed facility upgrade
June 2024	QGC Seismic Investigation, Surat, QLD	Protected plant survey as part of due diligence for proposed seismic investigation
June 2024	Middlemount Coal Mine Offset, Middlemount QLD	Survey of offset areas for protected plant species.
May 2024	Fig Tree Environmental Offset area, Collinsville, QLD	Survey of offset areas for protected plant species and abundance
April 2024	Fig Tree Environmental Offset area, Collinsville, QLD	Survey of offset areas for protected plant species and abundance
January 2024	Burleigh Heads Foreshore, Gold Coast, QLD	Protected plant survey and report for clearing within area of mapped high risk protected plant mapping
November 2023	Hanson Quarry expansion Gold Coast, QLD	Protected plant survey and report for clearing within area of mapped high risk protected plant mapping
October 2023	Fig Tree Environmental Offset area, Collinsville, QLD	Protected Plant survey as part of offset area investigations
September 2023	QGC Seismic Investigation, Surat, QLD	Protected Plant survey as part of due diligence for proposed seismic investigation
July 2023	Woodroffe Park redevelopment Gold Coast QLD	Protected Plant survey as part of due diligence for council project
May 2023	Middlemount Coal Mine Offset, Middlemount QLD	Survey of offset areas for protected plant species.
February 2023	Glencoe Road (QLD) widening and upgrade, Rawbelle, QLD	Protected plant survey and report for clearing within area of mapped high risk protected plant mapping
August 2022	Substation to Euro Circuit Transmission line Gladstone, QLD	Protected plant survey and report for clearing within area of mapped high risk protected plant mapping
May 2022	Caboolture to Steve Irwin Way Bruce Highway Upgrade, Caboolture QLD	Vegetation and habitat preclear surveys including protected plant surveys for north bound clearing
May 2022	Coomera Connector Coomera QLD	Vegetation and habitat preclear surveys including protected plant surveys for north alignment clearing
May 2022	Middlemount Coal Southeast extension Middlemount QLD	BioCondition, habitat and flora survey including protected plant survey SE extension offset site



April 2022	Department of Defense Wide Bay training Area QLD	Targeted flora survey of Wide Bay training facility
April 2022	Department of Defense RAAF Base Amberly, QLD	Targeted flora survey of RAAF Base Amberly facility
April 2022	Department of Defense Gallipoli Barracks, Alderley QLD	Targeted flora survey of Gallipoli Barracks facility
January 2022	Lory Construction Development application Yatala, QLD	Ecological assessment including vegetation habitat and protected plant survey
October 2021	Department of Defense Wide Bay training Area QLD	Vegetation, habitat and protected plant survey including impact assessment for proposed infrastructure projects (roads and toilets)
August 2021	BMD Chambers Flat Road upgrade, Chambers Flat QLD,	Pre-clear survey for habitat, vegetation and protected plant
August 2021	Residential Property Subdivision, Waterford QLD	Environmental impact assessment of proposed 160 lot residential subdivision including targeted flora survey and protected plant survey
June 2021	Bruce Highway M1 upgrade (East Area 7), Deception Bay Interchange Deception Bay, QLD	Protected plant survey for additional clearing areas.
June 2021	Central Rail Network, Central QLD	Vegetation, habitat, and protected plant targeted flora surveys for proposed crossing sites
June 2021	Middlemount Coal Mine, Middlemount, QLD	Senior Ecologist BioCondition assessments and classification for proposed offset area. Including protected plant surveys
May 2021	Residential Subdivision, Mooloolah QLD	Preclear survey including vegetation, habitat and protected plant survey with pre-clear trapping program
May 2021	Bruce Highway M1 upgrade (Freshwater), Deception Bay Interchange Deception Bay, QLD	Protected plant survey for additional clearing areas.
April 2021	Residential Subdivision Bellbird Park QLD	Preclear survey including vegetation, habitat and protected plant survey
Feb 2021	Varsity Lakes to Burleigh - Pacific Motorway upgrade, Varsity Lakes, QLD	Protected plant surveys and ecological surveys for extensions outside of existing clearing approvals.
November 2020	Central Rail Network, Mine site Gregory Development Road QLD	Pre-clearance survey including protected plant surveys of CRN rail alignment, 12-month update
August 2020	Central Rail Network, Lot 150 Avon Downs Access upgrade, QLD	Preclear survey including vegetation, habitat and protected plant surveys for proposed road upgrade and clearing.



June 2020	Central Rail Network, Glen Avon Access upgrade, QLD	Preclear survey including vegetation, habitat and protected plant surveys for proposed road upgrade and clearing.
June 2020	Central Rail Network, Stratford road Access upgrade, Mt. Coolon QLD	Preclear survey including vegetation, habitat and protected plant surveys for proposed road upgrade and clearing.
May 2020	Central Rail Network Mt Coolon QLD	Preclear survey including vegetation, habitat and protected plant surveys for CRN clearing.
September 2014	Abbot Point Rail Loop – Proposed Gravel Extraction Site, Bowen QLD	Environmental Assessment and Ecological Assessment including TEC, MNES and MSES. Targeted species survey and protected plant survey.
August 2014	Residential Development Marcoola, QLD –	Senior Ecologist – Ecological assessment of the site including targeted fauna and protected plant surveys including acid frogs. Project managed surface water, groundwater, acid Sulfate Soil and contaminated land investigations of the site. Protected Plant Survey.
August 2014	Resort Development, Yaroomba, QLD, Australia	Ecological Assessment of a proposed development along Coolom Beach foreshore. Protected Plant Survey. Expert advice was provided on habitat and ecological values associated with the site. Targeted fauna surveys for acid frogs and Protected Plant survey. Development of Environmental Management Plans to minimize impacts on surrounding environmental values.
June 2014	Arrow Energy Moranbah, QLD	Habitat assessment and protected plant survey for 3 well pads and associated access pads
April 2014	Arrow Energy Moranbah, QLD	Habitat assessment and protected plant survey for 2 well pads, associated access pads and proposed laydown area
March 2014	Arrow Energy Moranbah, QLD	Habitat assessment and protected plant survey for 5 well pads and associated access pads and gas pipelines
December 2013	Residential Development Coolom Beach, QLD	Preliminary ecological assessment including vegetation, habitat and protected plant survey for proposed development
September 2013	Quarry Development Sunshine Coast QLD,	Ecological investigation 200 hectare proposed quarry and EPBC referral including habitat assessments, targeted fauna and flora surveys.
August 2013	Burrum Heads QLD, Australia	An assessment of habitat including protected plant survey within a proposed development site was undertaken with Environmental Management and Rehabilitation Plans compiled.

August 2013	Ben Lomond QLD, Australia	Preliminary Ecological Assessment for base line survey for proposed mine site
June 2013	Collinsville QLD, Australia	Vegetation and ecological assessments of proposed power station sites and power line routes to pumping sites.
Feb 2013	Sunshine Coast Airport QLD, Australia	Ecological Impact Assessment of heath and wetland vegetation as part of a proposed flight school extension of the Sunshine Coast Airport. The assessment included the development of an Environmental Management Plan and referral to the Department of Environment and Heritage
March 2012 to August 2012	QGC, Miles Gas field QLD	Secondment to QGC working as an ecologist on pegging parties in gas fields around miles and Chinchilla Numerous protected plant surveys over the period across numerous proposed infrastructure sites including proposed gas well, access tracks and pipeline alignments.

Yours faithfully,

Daniel Joyce
Principal Ecologist

A-3 Likelihood of Occurrence Assessment

The following tables are used as a summary to address threatened species in terms of potential occurrence and requirement for formal assessment. A threatened species has been assessed if it is:

Recorded on-Site; or

A - Not recorded on Site, but recorded within a 10 km radius (the locality), and may occur to some degree on-Site due to potential habitat, key habitat component, etc.

B - The likelihood of occurrence is based on the probability of occurrence in terms of:

A- Habitat extent (e.g., sufficient to support an individual or the local population; comprises all of the home range; forms part of a larger territory, etc.); quality (i.e. condition, including an assessment of threats, historical land uses on and off Site, and future pressures); interconnectivity to other habitats; and ability to provide all the species lifecycle requirements (either the Site alone or other habitat within its range).

B -Occurrence frequency (i.e. on-Site resident; portion of larger territory or seasonal migrant); and

C - Usage, i.e. breeding or non-breeding; opportunistic foraging (e.g., seasonal, migratory or opportunistic); marginal fringe of core range; refuge; roosts; etc.

An indicative 1-5 scale used by the author to indicate the likelihood of the species to potentially occur in the habitat on the study Sites (if they have not been recorded in the locality) is as follows:

0: *Unlikely* (<1% probability) - no potentially suitable habitat; too disturbed; or habitat is very poor. No or few records in region or records/Site very isolated, e.g., by pastoral land, urbanisation, etc.

1: *Low* (1-25%) - few minor areas of potential habitat; highly modified Site/habitat; or few habitat parameters present, but others absent or relatively insignificant (sub-optimum habitat). Usually very few records in locality.

2: *Fair* (25-50%) - some significant areas of potential habitat, but some habitat parameters limited. Potential for occasional foraging e.g., from nearby more optimal areas or known habitat. Records at least within 10-15 km radius of Site.

3: *Moderate* (50-75%) - quite good potentially suitable habitat on and adjacent to the Site, and/or good quality and abundance of some vital habitat parameters. Records within <10km, or adjacent to the Site, or adjacent to high quality habitat where species are likely to occur.



4: *High* (>75%) - very good to optimum habitat occurring on or adjacent to the Site (support breeding pair or population). Recorded within 5-10 km of Site in same or similar habitat.

A-3-1 Threatened Flora Species Likelihood of Occurrence Assessment

The likelihood of occurrence assessments for threatened flora species identified by the Protected Matters Search Tool and Wildlife Online Database as having potential to occur on the Site are detailed in Table 10 below.

Table 10: Flora species likelihood of occurrence assessment.

Scientific Name	Common Name	NC Act	EPBC Act	Distribution	Required Habitat	Likelihood of Occurrence	Justification
<i>Atalaya collina</i>	Yarwun Whitewood	E	E	<i>Atalaya collina</i> is known only from two populations: one west of Gladstone at Yarwun, and another near Ubobo, west of Miriam Vale, Queensland. Both populations occur in non-remnant vegetation.	This small tree to 5m usually occurs in areas of semi-evergreen vine thicket, often where the ground stratum is mostly grasses. Herbarium records are from substrates that include brownish black clay loam, yellow-brown earth or black gravelly clayey sand, usually on hill sides.	Fair	Some habitat features present within the Site, and the Site is situated very close to Yarwun. 24 ALA and 12 WildNet records within 10 km of the Site.
<i>Bosistoa transversa</i>	Three-leaved Bosistoa, Yellow Satinheart	LC	V	This species is known from the Richmond River, NSW to Mt Larcom near Gladstone, Queensland.	This species grows in wet sclerophyll forest, dry sclerophyll forest and rainforest up to 300 m in altitude. Associated species include <i>Argyrodendron trifolliolatum</i> , <i>Syzygium hodgkinsoniae</i> , <i>Endiandra pubens</i> , <i>Dendrocnide photinophylla</i> , <i>Acmena ingens</i> , <i>Diploglottis australis</i> and <i>Diospyros mabacea</i> .	Moderate	Some habitat features present within the Site. 19 ALA and 12 WildNet records within 10 km of the Site, including 1 record 3 km from the Site.
<i>Bulbophyllum globuliforme</i>	Miniature Moss-orchid, Hoop Pine Orchid	-	V	The Hoop Pine Orchid occurs in disjunct populations from north-	This species grows only on the upper branches of mature Hoop Pines (<i>Araucaria cunninghamii</i>).	Unlikely	Hoop Pines not present within the Site. No WildNet or ALA records within 10 km of the Site.



Scientific Name	Common Name	NC Act	EPBC Act	Distribution	Required Habitat	Likelihood of Occurrence	Justification
				eastern NSW to central eastern QLD.			
<i>Cossinia Australiana</i>	Cossinia	E	E	<i>Cossinia Australiana</i> is distributed east of the Great Dividing Range from Rockhampton to Kingaroy, Queensland.	This shrub or small tree to 7 m occurs in Araucarian microphyll vine forest and semi-evergreen vine thicket, particularly on the ecotone margins of these communities. It grows on a variety of soils, including red volcanic soil and black loam (DES 2022).	Unlikely	Habitat features not present within the Site. No WildNet or ALA records within 10 km of the Site.
<i>Cupaniopsis shirleyana</i>	Wedge-leaf Tuckeroo	V	V	This species is known from south-eastern Queensland over a range of approximately 450 km between Brisbane and Curtis Island.	This species occurs in dry rainforest and scrubby urbanized areas on moderate to very steep slopes, scree slopes gullies and rocky stream channels at elevations of 60-550 m above sea level.	Moderate	Some habitat features present within and adjacent to the Site. 2 ALA records and 3 WildNet records within 10 km of the Site, including 1 ALA record 1.5 km from the Site.
<i>Cycas megacarpa</i>		E	E	This species occurs from Bouldercombe in the north to Woolooga in the south, both of which are in Queensland.	Essential habitat factors for this cycad are alluvial flats dry watercourse gentle to steep hill slope, hill crest, coastal flats between 0-700 m elevation on soils that are well drained, shallow, often stony, sandy loam to clay loam derived from sandstones, fine grained sediments and acid and basic volcanic rocks. Associated vegetation is woodland to open forest of <i>Eucalyptus</i> spp. and/or <i>Corymbia</i> spp. often near dry rainforest margins. Tree species frequently present include <i>Corymbia citriodora</i> and	High	Habitat features present. Present Res 11.11.4 and 11.3.4 are essential habitat factors. Previous surveys have identified the species very near to the Site. 4 ALA and 4 WildNet records within 10 km of the Site.



Scientific Name	Common Name	NC Act	EPBC Act	Distribution	Required Habitat	Likelihood of Occurrence	Justification
					<i>Eucalyptus crebra</i> . Other species often present include <i>E. tereticornis</i> , <i>E. drepanophylla</i> , <i>E. melanophloia</i> , <i>C. erythrophloia</i> and <i>E. portuensis</i> .		
<i>Cycas ophiolitica</i>	Marlborough Blue	E	E	This species is found from Marlborough to the Fitzroy River near Rockhampton in Central Queensland.	This cycad grows on hills and slopes in sparse, grassy open forest at altitude ranges from 80-400 m above sea level, often on serpentinite substrates. Associated species include <i>Corymbia dallachiana</i> , <i>C. erythrophloia</i> , <i>C. xanthope</i> and <i>Eucalyptus fibrosa</i> (DCCEW 2022).	Unlikely	Landscape features not present on Site. No WildNet or ALA records within 10 km of the Site.
<i>Dansiea elliptica</i>	N/A	NT	-	This species is endemic to Queensland, where it has a disjunct distribution. It is known from three locations in the Wet Tropics of north-east Queensland, and five localities in central Queensland.	Queensland Herbarium records show this tree from 10-35 m is usually found in coastal rainforest or semi-evergreen vine thicket where it grows on slopes or flats on a variety of soil types.	Low	Habitat features not present within the Site, though there are 7 ALA and 7 WildNet records within 10 km of the Site.
<i>Dichanthium setosum</i>	Bluegrass		V	Large distribution within Australia associated with tropical to subtropical climates.	This species prefers heavy soils, either cracking clays or alluvium. Species is often found in gilgai. Habitat is usually dominated by Acacia (brigalow) or Eucalypt species.	Unlikely	Some habitat features present within the Site. No WildNet or ALA records within 10 km of the Site.
<i>Eucalyptus raveretiana</i>	Black Ironbox	V	V	This species is distributed from Rockhampton to Ayr in Queensland.	This large tree to 21 m tall occurs in riparian woodlands on alluvial flats along riverbanks on sandy and/or	Unlikely	Habitat features not present within the Site. No WildNet or ALA records within 10 km of the Site.



Scientific Name	Common Name	NC Act	EPBC Act	Distribution	Required Habitat	Likelihood of Occurrence	Justification
					alluvial soils (Calvert <i>et al.</i> 2005).		
<i>Graptophyllum excelsum</i>	Scarlet Fuchsia	NT		This species is known from the eastern coast and ranges of Cape York, and the Port Curtis area of central Queensland, near Rockhampton.	This dense prickly shrub to 3m occurs in vine thickets on hillsides, usually in pockets of well-drained soil amongst limestone, sandstone or granite boulders (Calvert <i>et al.</i> 2005).	Unlikely	Habitat features not present within the Site but 1 ALA and 7 WildNet records within 10 km of the Site.
<i>Hernandia bivalvis</i>	Cudgerie	NT	-	This species is restricted to the central coast and southeast of Queensland, from Dryander Creek near Proserpine in the north, to Mt Tamborine in the South.	This tree, ranging from 4.5-20 m height occurs in vine thicket or microphyll vine forest, where it grows on grows in rainforest on rock pavements and outcrops with shallow soils (DES 2022). Queensland Herbarium records also records it on screen and talus slopes or gullies where it often grows in association with Hoop Pine.	Unlikely	Habitat features not present within the Site but 9 ALA and 8 WildNet records within 10 km of the Site.
<i>Leichhardtia (Marsdenia) brevifolia</i>	N/A	V	V	This species occurs from Townsville in northern Queensland to Rockhampton in central Queensland.	This erect or loosely scrambling sub shrub grows up to 1 m tall in open woodland, often amongst boulders and rock outcrops (Calvert <i>et al.</i> 2015). Queensland Herbarium records are mostly from woodland to open woodland communities dominated by a broad range of eucalypt species, but generally on rocky or stony substrates that are usually granitic in the north or serpentinite in the southern part of its range. Although it resprouts after	Unlikely	Habitat features not present within the Site. No WildNet or ALA records within 10 km of the Site.



Scientific Name	Common Name	NC Act	EPBC Act	Distribution	Required Habitat	Likelihood of Occurrence	Justification
					fire (Calvert <i>et al</i> 2015), it usually favours Sites protected from fire.		
<i>Macadamia integrifolia</i>	Macadamia Nut, Queensland Nut Tree, Smooth-shelled Macadamia, Bush Nut, Nut Oak	V	V	This species occurs from Mt Bauple near Gympie to Currumbin Valley on the Gold Coast within South-east Queensland. This species is also known from NSW with species being collected from Camden Haven and Lismore historically.	This species occurs in remnant rainforest, complex notophyll forest and prefers partially open areas such as rainforest edges.	Low	Habitat features not present on the Site. No WildNet or ALA records within 10 km of the Site.
<i>Macropteranthes leiocaulis</i>	N/A	NT	-	This species is distributed from west of Maryborough north to near Mackay in central Queensland.	This species has been recorded in deciduous vine thickets, semi-evergreen vine thickets and araucarian microphyll vine forests on red eucrozems or sandstone talus.	Unlikely	Habitat features not present within the Site but 7 ALA and 10 WildNet records within 10 km of the Site.
<i>Parsonsia larcomensis</i>	Mt Larcom Silk Pod	V	V	This species occurs in the Rockhampton-Mount Perry area of Queensland.	This vine is found in open heathland and shrubland at or near the summits of mountain peaks, in shallow loamy soils on cliffs or among outcrops of acid volcanic rocks and serpentine soils at 350–750 m above sea level (DCCEE, 2022). Essential habitat factors for this species are rock outcrops, platforms and cliff lines at or near mountain summits at altitudes between 100-700 m in complex notophyll vine forest;	Unlikely	Habitat features not present within the Site. 12 ALA and 6 WildNet records within 10 km of the Site.



Scientific Name	Common Name	NC Act	EPBC Act	Distribution	Required Habitat	Likelihood of Occurrence	Justification
					shrubland along cliffines and steep hills; woodland of <i>Eucalyptus fibrosa</i> in gully at base of rock face; tall open shrubland of <i>Leptospermum polygalifolium</i> , <i>Lophostemon confertus</i> , <i>Xanthorrhoea johnsonii</i> with emergent <i>Eucalyptus acmenoides</i> on steep rock slope; riverine rainforest		
<i>Rhodamnia spongiosa</i>	Green Malletwood	CR	-	This species is distributed along Queensland's eastern coastline and into Papua New Guinea.	This species is an understorey tree that grows in well-developed rainforest and drier rainforest associated with Kauri Pine (<i>Agathis robusta</i>).	Unlikely	Habitat features not present within the Site. 11 ALA and 5 WildNet records within 10 km of the Site.
<i>Samadera bidwillii</i>	Quassia	V	V	This species is endemic to Queensland and is currently known to occur in several localities including Scawfell Island near Mackay, Goomboorian, north of Gympie.	This species can be found in lowland rainforest on rainforest margins, open forest and woodland. They prefer temporary and permanent watercourses up to 510 m in elevation.	Fair	Site contains woodland and temporary watercourses. 4 ALA and 4 WildNet records within 10 km of the Site.
<i>Zieria actites</i>	Mt Larcom Stink Bush	V	-	This species is known only from Mount Larcom, an isolated peak north-west of Gladstone.	Essential habitat factors for the Mt Larcom stink bush are open woodland or shrubland on cliff lines or exposed rock outcrops on skeletal soils at altitudes of 200-700 m.	Unlikely	Habitat features not present within the Site though 20 ALA and 5 WildNet records within 10 km of the Site.

*Conservation status: CR, Critically Endangered (NC Act); CE, Critically Endangered (EPBC Act), E, Endangered; V, Vulnerable; LC, Least Concern (NC Act); SL, Special Least Concern (NC Act)



A-3-2 Threatened Fauna Species Likelihood of Occurrence Assessment

The likelihood of occurrence assessments for threatened fauna species identified by the Protected Matters Search Tool and Wildlife Online Database as having potential to occur on the Site are detailed in Table 11 below. Obligate marine and aquatic species have been excluded from the table due to the absence of such environments on the Site.

Table 11: Fauna species likelihood of occurrence assessment.

Scientific Name	Common Name	NC Act	EPBC Act	Distribution	Required Habitat	Likelihood of Occurrence	Justification
Birds							
<i>Arenaria interpres</i>	Ruddy Turnstone	SL	V, M, Mar.	The Ruddy Turnstone is widespread within Australia during its non-breeding period of the year in coastal regions	Australasia, the Ruddy Turnstone is mainly found on coastal regions with exposed rock coastlines or coral reefs. It also lives near platforms and shelves, often with shallow tidal pools and rocky, shingle or gravel beaches.	Unlikely	Habitat features not present within the Site. No ALA or WildNet records within 10 km of the Site.
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	SL	V, M, Mar.	The Sharp-tailed Sandpiper spends the non-breeding season in Australia with small numbers occurring regularly in New Zealand. Most of the population migrates to Australia, mostly to the south-east and are widespread in both inland and coastal locations and in both freshwater and saline habitat	In Australasia, the Sharp-tailed Sandpiper prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, salt pans and hypersaline salt lakes inland.	Unlikely	Habitat features not present within the Site. No ALA or WildNet records within 10 km of the Site.



Scientific Name	Common Name	NC Act	EPBC Act	Distribution	Required Habitat	Likelihood of Occurrence	Justification
<i>Calidris canutus</i>	Red Knot, Knot	E	V, M, Mar. (OF)	The Red Knot is common in all the main suitable habitats around the coast of Australia	In Australasia, the Red Knot mainly inhabits intertidal mudflats, sandflats and sandy beaches of sheltered coasts, in estuaries, bays, inlets, lagoons and harbours; sometimes on sandy ocean beaches or shallow pools on exposed wave-cut rock platforms or coral reefs.	Unlikely	Habitat features not present within the Site. No ALA or WildNet records within 10 km of the Site.
<i>Calidris ferruginea</i>	Curlew Sandpiper	CE	CE, M, Mar. (OF)	In Australia, Curlew Sandpipers occur around the coasts and are also quite widespread inland, though in smaller numbers.	Curlew Sandpipers mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms.	Unlikely	Habitat features not present within the Site. No ALA or WildNet records within 10 km of the Site.
<i>Calidris tenuirostris</i>	Great Knot	CE	V, M, Mar. (OF)	During the non-breeding season, most of the Great Knot population occurs in Australia;	In Australasia, the species typically prefers sheltered coastal habitats, with large intertidal mudflats or sandflats. This includes inlets, bays, harbours, estuaries and lagoons. They are occasionally found on exposed reefs or rock platforms, shorelines with mangrove vegetation, ponds in saltworks, at swamps near the coast, saltlakes	Unlikely	Habitat features not present within the Site. 1 ALA and 1 WildNet record within 10 km of the Site.



Scientific Name	Common Name	NC Act	EPBC Act	Distribution	Required Habitat	Likelihood of Occurrence	Justification
					and non-tidal lagoons. The Great Knot rarely occurs on inland lakes and swamps		
<i>Charadrius leschenaultii</i>	Greater Sand Plover, Large Sand Plover	V	V, M, Mar.	In Australia, the Greater Sand Plover occurs in coastal areas in all states, though the greatest numbers occur in northern Australia, especially the north-west	In the non-breeding grounds in Australasia, the species is almost entirely coastal, inhabiting littoral and estuarine habitats. They mainly occur on sheltered sandy, shelly or muddy beaches with large intertidal mudflats or sandbanks, as well as sandy estuarine lagoons	Unlikely	Habitat features not present within the Site. 1 ALA and 1 WildNet record within 10 km of the Site.
<i>Charadrius mongolus</i>	Lesser Sand Plover, Mongolian Plover	E	E, M, Mar.	Within Australia, the Lesser Sand-Plover is widespread in coastal regions, and has been recorded in all state	In non-breeding grounds in Australia, this species usually occurs in coastal littoral and estuarine environments. It inhabits large intertidal sandflats or mudflats in sheltered bays, harbours and estuaries, and occasionally sandy ocean beaches, coral reefs, wave-cut rock platforms and rocky outcrops. It also sometime occurs in short saltmarsh or among mangroves.	Unlikely	Habitat features not present within the Site. 1 WildNet record within 10 km of the Site.
<i>Cyclopsitta diophthalma coxeni</i>	Coxen's Fig-Parrot	CR	CE	This species is only known from the wild from a low number of reliable records across Queensland and NSW. These locations include	This species is associated with areas abundant in fig trees however other critical habitat is unknown given the poor	Unlikely	Habitat features not present within the Site. No ALA or WildNet records within 10 km of the Site.



Scientific Name	Common Name	NC Act	EPBC Act	Distribution	Required Habitat	Likelihood of Occurrence	Justification
				Rockhampton in Central Queensland to the Richmond Range and Koreelah Range.	state of knowledge about this species.		
<i>Epthianura crocea macgregori</i>	Capricorn Yellow Chat, Yellow Chat (Dawson)	E	CE	The Capricorn Yellow Chat is known from three localities north of Gladstone: Curtis Island, Torilla Plain, and the Fitzroy Delta.	Inhabits marine plain wetlands subject to extensive seasonal inundation with both fresh and saltwater influence. Within the marine plain, it is found in areas with a network of shallow drainage channels and depressions that support a mosaic of vegetation such as grasses, areas of bare or sparsely-vegetated mud and shallow water generally with few or no trees.	Unlikely	Habitat features not present within the Site. No ALA or WildNet records within 10 km of the Site.
<i>Erythroriorchis radiatus</i>	Red Goshawk	E	E	This species is currently known to breed from the Kimberley region, east to Cape York Peninsula and the Tiwi Islands. Since European colonization the Red goshawk have disappeared from approximately 27% of their distribution, becoming extinct in NSW and Southeast Queensland but persist northward.	This species forages in coastal and subcoastal tall open forests and woodlands, tropical savannahs with wooded or forested creeks and rivers, freshwater wetlands and their margins and edges of rainforests. Breeding occurs within large, tall trees (>14 m) with proximity to a watercourse (within 2.5 km) that occur within foraging habitat.	Unlikely	Habitat features not present within the Site. No ALA or WildNet records within 10 km of the Site. May overfly or occasionally forage in the area



Scientific Name	Common Name	NC Act	EPBC Act	Distribution	Required Habitat	Likelihood of Occurrence	Justification
<i>Falco hypoleucos</i>	Grey Falcon	V	V	This species occurs in arid and semi-arid Australia including the Murray-Darling Basin, Eyre Basin, central Australia and Western Australia. They are found in areas with rainfall less than 500 mm except when wet years are followed by drought. These birds are absent from the Cape York Peninsula and east of the Great Dividing Range in Queensland and New South Wales.	This species frequent timbered lowland plains, particularly Acacia shrublands that are crossed by tree-lined water courses. This species has been observed hunting in treeless areas and frequent tussock grassland and open woodland.	Unlikely	Habitat features not present within the Site. No ALA or WildNet records within 10 km of the Site.
<i>Fregetta grallaria</i>	White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian)		V	This species is widespread across the Southern Hemisphere.	This species is primarily marine and breeds on islands throughout the Southern Hemisphere including offshore from Australia.	Unlikely	Habitat features not present within the Site. No ALA or WildNet records within 10 km of the Site.
<i>Gallinago hardwickii</i>	Latham's Snipe, Japanese Snipe	V	V, M, Mar. (OF)	Latham's Snipe is a non-breeding visitor to south-eastern Australia, and is a passage migrant through northern Australia (i.e. it travels through northern Australia to reach non-breeding areas located further south) The species has been recorded along the east coast of Australia from Cape York Peninsula	In Australia, Latham's Snipe occurs in permanent and ephemeral wetlands up to 2000 m above sea-level (Chapman 1969; Naarding 1981). They usually inhabit open, freshwater wetlands with low, dense vegetation.	Unlikely	Habitat features not present within the Site. 3 ALA and 2 WildNet records within 10 km of the Site. May overfly



Scientific Name	Common Name	NC Act	EPBC Act	Distribution	Required Habitat	Likelihood of Occurrence	Justification
				through to south-eastern South Australia			
<i>Geophaps scripta scripta</i>	Squatter Pigeon (southern)	E	E	This species occurs on the inland slopes of the Great Dividing Range with its current distribution extending from the Burdekin-Lynd Divide in Central Queensland, west to Longreach and Charleville, east to the coast between Port Curtis and Proserpine, and south to New South Wales.	This species inhabits grassy understorey of open eucalypt woodland and less often savannas. It is nearly always found near permanent water such as rivers, creeks and waterholes. Sandy areas dissected by gravel ridges, which have open and short grass cover allowing easier movement are preferred.	High	Habitat features present within the Site. 17 ALA and 21 WildNet records within 10 km of the Site, including 1 ALA record within 500 m of the Site.
<i>Hirundapus caudacutus</i>	White-throated Needletail	V	V, M, Mar. (OF)	The species is widespread in eastern and south-eastern Australia. In eastern Australia the species is recorded in all coastal regions of Queensland and NSW, extending inland to the western slopes of the Great Dividing Range and occasionally onto the adjacent inland plains. They will move into Victoria along the Great Dividing Range as well. This species is vagrant in the Northern Territory and Western Australia.	This species is mostly aerial in Australia flying up to 1000 m above the ground. While they do occur among most habitat types, they are recorded most often above wooded areas including open forest, rainforest where they fly below the canopy between trees or in clearings.	Low	Habitat features not present within the Site. May flyover. 4 ALA and 5 WildNet records within 10 km of the Site. May overfly.
<i>Limnodromus semipalmatus</i>	Asian Dowitcher	SL	V, M,	The Asian Dowitcher was first recorded in Australia in 1972 and is a regular	The Asian Dowitcher occurs in sheltered coastal environments,	Unlikely	Habitat features not present within the Site. No ALA or WildNet



Scientific Name	Common Name	NC Act	EPBC Act	Distribution	Required Habitat	Likelihood of Occurrence	Justification
			Mar. (OF)	visitor to the north-west between Port Hedland and Broome. Elsewhere they are sporadic and rare. In Queensland they have been recorded at Cairns, Yeppoon, Lytton, Thorneside, Morton Bay and Clontarf.	such as embayments, coastal lagoons, estuaries and tidal creeks. They are known to frequent shallow water and exposed mudflats or sandflats		records within 10 km of the Site.
<i>Limosa lapponica baueri</i>	Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit	V	E	The Bar-tailed Godwit has been recorded in the coastal areas of all Australian states. It is widespread in the Torres Strait and along the east and south-east coasts of Queensland, NSW and Victoria, including the offshore islands	The Bar-tailed Godwit is found mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbors, coastal lagoons and bays. It is found often around beds of seagrass and, sometimes, in nearby saltmarsh	Unlikely	Habitat features not present within the Site. 2 ALA and 2 WildNet records within 10 km of the Site.
<i>Macronectes giganteus</i>	Southern Giant-Petrel, Southern Giant Petrel	E	E, M, Mar.	The Southern Giant-Petrel breeds on six subantarctic and Antarctic islands in Australian territory; Macquarie Island, Heard Island and McDonald Island in the Southern Ocean, and Giganteus Island, Hawker Island, and Frazier Island in the Australian Antarctic Territory	Predominantly occurs over coastal and pelagic waters	Unlikely	Habitat features not present within the Site. No WildNet or ALA records within 10 km of the Site.
<i>Neochmia ruficauda ruficauda</i>	Star Finch (eastern), Star Finch (southern)	E	E	The distribution of the Star Finch is poorly known. It occurs in central Queensland, and recent records are from	The star finch is found in grasslands and grassy woodlands within close proximity to water (DoE 2022).	Unlikely	Habitat features not present within the Site. No ALA or WildNet records within 10 km of the Site.



Scientific Name	Common Name	NC Act	EPBC Act	Distribution	Required Habitat	Likelihood of Occurrence	Justification
				near Wowan, north to Bowen, and west to beyond Winton.			
<i>Ninox strenua</i>	Powerful Owl	V	-	The Powerful Owl is distributed across central eastern Queensland to south-eastern South Australia.	Occupies a range of habitats and open forests including areas of rainforest. Predominantly nests in tree hollows found in large gum trees.	High	Habitat features present near to the Site. 8 ALA and 14 WildNet records within 10 km of the Site, including positive call identifications within 1 km.
<i>Numenius madagascariensis</i>	Eastern Curlew, Far Eastern Curlew	CR	CE, M, Mar.	The Far Eastern Curlew is widespread in coastal regions in the northeast and south of Australia, including Tasmania, and scattered in other coastal areas.	The Far Eastern Curlew is found on intertidal mudflats and sandflats, often with beds of seagrass, on sheltered coasts, especially estuaries, mangrove swamps, bays, harbors and lagoons.	Unlikely	Habitat features not present within the Site. 7 ALA and 3 WildNet records within 10 km of the Site.
<i>Pachyptila turtur subantarctica</i>	Fairy Prion (southern)	SL	V	The fairy prion (southern) breeds on Macquarie Island and a number of other subantarctic islands outside of Australia	Predominantly a marine species.	Unlikely	Habitat features not present within the Site. No WildNet or ALA records within 10 km of the Site.
<i>Pluvialis squatarola</i>	Grey Plover	SL	V, M, Mar. (OF)	In Australia, the Grey Plover has been recorded in all states, where it is found along the coasts.	In non-breeding grounds in Australia, Grey Plovers occur almost entirely in coastal areas, where they usually inhabit sheltered embayments, estuaries and lagoons with mudflats and sandflats, and occasionally on rocky coasts with wave-cut platforms or reef-flats, or	Unlikely	Habitat features not present within the Site. No WildNet or ALA records within 10 km of the Site.



Scientific Name	Common Name	NC Act	EPBC Act	Distribution	Required Habitat	Likelihood of Occurrence	Justification
					on reefs within muddy lagoons.		
<i>Pterodroma neglecta neglecta</i>	Kermadec Petrel (western)		V	The Kermadec Petrel ranges over subtropical and tropical waters of the South Pacific.	This species nests in rock crevices on Australia's Ball's Pyramid and Phillip Islands.	Unlikely	Habitat features not present within the Site. No WildNet or ALA records within 10 km of the Site.
<i>Rostratula australis</i>	Australian Painted Snipe	E	E, Mar. (OF)	The Australian Painted Snipe has been recorded at wetlands in all states of Australia.	The Australian Painted Snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains.	Unlikely	Habitat features not present within the Site. No WildNet or ALA records within 10 km of the Site. Wetlands present within 1 km of Site, may overfly.
<i>Sternula albifrons</i>	Little Tern	-	V, M, Mar.	This species has been recorded around much of Australia's coastline from Tasmania to north-western Western Australia.	The Little Tern inhabits sheltered coastal environments, including lagoons, estuaries, river mouths, lakes, bays, harbours and inlets, with exposed sandbanks.	Unlikely	Habitat features not present within the Site. 1 ALA record within 10 km of the Site.
<i>Thalassarche impavida</i>	Campbell Albatross, Campbell Black-browed Albatross	SL	V, M, Mar.	The Campbell Albatross is a non-breeding visitor to Australian waters. Non-breeding birds are most commonly seen foraging over the oceanic continental slopes off Tasmania, Victoria and New South Wales. After	The Campbell Albatross is a marine sea bird inhabiting sub-Antarctic and subtropical waters from pelagic to shelf-break water habitats.	Unlikely	Habitat features not present within the Site. No WildNet or ALA records within 10 km of the Site.



Scientific Name	Common Name	NC Act	EPBC Act	Distribution	Required Habitat	Likelihood of Occurrence	Justification
				breeding, birds move north and may enter Australia's temperate shelf waters.			
<i>Tringa nebularia</i>	Common Greenshank, Greenshank	SL	E, M, Mar. (OF)	The Common Greenshank does not breed in Australia; however, the species occurs in all types of wetlands and has the widest distribution of any shorebird in Australia. In Queensland, there have been a few records south of a line from near Dalby to Mt Guide, and sparsely scattered records elsewhere	The Common Greenshank is found in a wide variety of inland wetlands and sheltered coastal habitats of varying salinity. It occurs in sheltered coastal habitats, typically with large mudflats and saltmarsh, mangroves or seagrass.	Unlikely	Habitat features not present within the Site. 2 ALA and 2 WildNet records within 10 km of the Site.
<i>Turnix melanogaster</i>	Black-breasted Button-quail	V	V	The Black-breasted Button-quail is endemic to eastern Australia. It is restricted to coastal and near-coastal regions of south-eastern Queensland and north-eastern New South Wales. The main populations occur within south-east Queensland.	The Black-breasted Button-quail is restricted to rainforests and forests, mostly in areas with 770-1200 mm rainfall per annum (Bennett 1985; Hughes & Hughes 1991; Marchant & Higgins 1993). They prefer drier low closed forests, particularly semi-evergreen vine thicket, low microphyll vine forest, Araucarian microphyll vine forest and Araucarian notophyll vine forest	Unlikely	Habitat features not present within the Site. 2 ALA and 2 WildNet records within 10 km of the Site.
<i>Xenus cinereus</i>	Terek Sandpiper	SL	V, M,	In Australia, the Terek Sandpiper has a primarily	The Terek Sandpiper mostly forages in the	Unlikely	Habitat features not present within the Site.



Scientific Name	Common Name	NC Act	EPBC Act	Distribution	Required Habitat	Likelihood of Occurrence	Justification
			Mar. (OF)	coastal distribution, with occasional records inland. It is more widespread and common in northern and eastern Australia than southern Australia	open, on soft wet intertidal mudflats or in sheltered estuaries, embayments, harbours or lagoons.		No ALA or WildNet records within 10 km of the Site.
Mammals							
<i>Dasyurus hallucatus</i>	Northern Quoll	LC	E	The Northern Quoll now occurs in five regional populations across Queensland, the Northern Territory and Western Australia both on the mainland and on offshore islands.	Occupies a diversity of habitats across its range which includes rocky areas, eucalypt forest and woodlands, rainforests, sandy lowlands and beaches, shrubland, grasslands and desert	Unlikely	Habitat features not present within the Site. No WildNet or ALA records within 10 km of the Site.
<i>Macroderma gigas</i>	Ghost Bat	E	V	The species has a discontinuous, geographically disjunct colonies occurring in the Pilbara, Kimberley, Northern Territory, the Gulf of Carpentaria, coastal and near coastal eastern Queensland from Cape York to Rockhampton and western Queensland.	This species occupies arid habitat such as in the Pilbara, to tropical savanna woodlands and rainforests. During the day they roost in caves or disused mines.	Unlikely	Habitat features not present within the Site. No WildNet or ALA records within 10 km of the Site.
<i>Petauroides volans</i>	Greater Glider (southern and central)	E	E	This species ranges from Proserpine in Queensland, through New South Wales and the Australian Capital Territory to Wombat State Forest in Victoria.	This species is predominantly restricted to montane, moist eucalypt forest on fertile soils with relative old trees supporting abundant hollows. Shelter trees typically	Low	Suitable habitat adjacent to the Site. 13 ALA and 18 WildNet records within 10 km of the Site, including 2 records within the Site boundary. Site does not contain a waterway containing



Scientific Name	Common Name	NC Act	EPBC Act	Distribution	Required Habitat	Likelihood of Occurrence	Justification
					support hollows greater than 10 cm diameter.		remnant vegetation. Significant movement barriers to access Site from Gladstone Mt Larcom Rd, and train line. Population would be highly isolated. Isolated patch below minimal required habitat area for the species.
<i>Petaurus australis australis</i>	Yellow-bellied Glider (south-eastern)	V	V	This species is found at altitudes ranging from sea level to 1400 m and has a widespread by patchy distribution from south-eastern Queensland to far south-eastern South Australia near the South Australian and Victorian border. The species can extend to the western slopes of the Great Dividing Range.	This species occurs in eucalypt-dominated woodlands and forests including both wet and dry sclerophyll forests. Abundance is highly dependent on habitat suitability which is determined by forest age and floristics. They prefer large patches of mature old growth forest that provides suitable trees for shelter and foraging. There is a clear preference for forests with winter flowering species and smooth bark dominated species.	Low	Habitat features present adjacent to the Site. 12 ALA records within 10 km of the Site, including one within 200 m of the Site. Minimal to no connectivity to larger vegetation patch for glider species due to roads and cleared surrounding areas.
<i>Phascolarctos cinereus</i>	Koala	E	E	The koala's distribution includes Queensland, New South Wales, the Australian Capital Territory, Victoria and South Australia	Habitat includes both coastal and inland areas that are typically characterised by Eucalyptus forests and woodlands.	High	Habitat and feed trees (<i>Eucalyptus spp.</i>) present within and adjacent to the Site, but poor quality habitat overall. Minimal connectivity due to fenced rail line and Mt Larcome Rd restricting



Scientific Name	Common Name	NC Act	EPBC Act	Distribution	Required Habitat	Likelihood of Occurrence	Justification
							access from north. Records 4 ALA and 6 WildNet records within 10 km of the Site.
<i>Pteropus poliocephalus</i>	Grey-headed Flying Fox	LC	V	Occurs in the coastal belt from Rockhampton in central Queensland to Melbourne in Victoria	It is a canopy-feeding frugivore and nectarivore, which utilises vegetation communities including rainforests, open forests, closed and open woodlands, <i>Melaleuca</i> swamps and <i>Banksia</i> woodlands	High	Habitat and feed trees present within and adjacent to the Site. 3 WildNet records within 10 km of the Site, including previous observations very close to the Site.
<i>Tapozous australis</i>	Coastal Sheathtail Bat	NT	-	This species is distributed in a thin band along north-east Queensland's coastline from Shoalwater Bay to Cape York.	The coastal sheathtail bat is generally found on coastal islands off Queensland and extends only a few kilometres inland. Roosts are usually located in sea caves and rocky clefts, but they are occasionally found in disused mines, rock fissures and boulder piles. This species forages within 3 km of the coastline above the canopies of a range of habitats including eucalypt forest, melaleuca swamp, heathlands and grasslands. (Hourigan 2011).	Unlikely	Site is too far from the coastline. 3 WildNet records within 10 km of the Site.
<i>Xeromys myoides</i>	Water Mouse, False Water Rat, Yirrkoo	V	V	Occurs in three regions of coastal Australia: The Northern Territory,	Require similar habitat including mangroves and the associated saltmarsh,	Unlikely	Habitat features not present within the Site. No WildNet or ALA



Scientific Name	Common Name	NC Act	EPBC Act	Distribution	Required Habitat	Likelihood of Occurrence	Justification
				central south Queensland and south-east Queensland.	sedgeland, clay pans, heathlands and freshwater wetlands.		records within 10 km of the Site.
Reptiles							
<i>Delma Torquata</i>	Adorned Delma, Collared Delma	V	V	This species is known from the western suburbs of Brisbane, Queensland and other inland Sites from the Southeast Queensland, Condamine, Burnett Mary and Fitzroy Natural Resource Management regions.	This species inhabits eucalypt dominant woodland and open forest where it is associated with suitable micro-habitats. This species prefers habitats dominated by native grasses.	Low	Habitat features present within the Site but no WildNet or ALA records within 10 km of the Site. Understory habitat quality low.
<i>Denisonia maculata</i>	Ornamental Snake	V	V	This species is known only from the drainage systems of the Fitzroy and Dawson Rivers in Queensland. There are records from south-west of Gladstone to south-west of Townsville.	Ornamental snakes are located in moist environments particularly areas with gilgais and depressions in land zone 4. They are also found around lake margins and wetlands in or adjacent to areas with high frog presence. The preferred vegetation type includes communities dominated by <i>Acacia harpophylla</i> , <i>A. cambagei</i> , <i>A. argyrodendron</i> and <i>Eucalyptus coolabah</i> (DoE 2022).	Unlikely	Habitat features not present within the Site. No WildNet or ALA records within 10 km of the Site.
<i>Egernia rugosa</i>	Yakka Skink	-	V	Endemic to Queensland, this species is distributed patchily from St George to Coen and Cape York in the North. The core habitat of this species	Yakka skinks are found in open dry sclerophyll forest and woodlands. Microhabitat preferences for this species include cavities under partly	Low	Habitat features present within the Site but no WildNet or ALA records within 10 km of the Site. Vegetation on Site low association with the



Scientific Name	Common Name	NC Act	EPBC Act	Distribution	Required Habitat	Likelihood of Occurrence	Justification
				can be found in the Mulga Lands and Brigalow Belt.	buried rocks, logs, tree stumps and abandoned animal burrows. (DoE 2022).		species. Generally occurs west of the dividing range, requires a larger vegetation area to maintain a population. No burrows present on Site
<i>Elseya albagula</i>	Southern Snapping Turtle, White-throated Snapping Turtle	-	CE	This species is found only in south-eastern Queensland in the Fitzroy, Mary and Burnett Rivers and their associated smaller drainages and catchments.	The species prefers clear, flowing, well-oxygenated waters. It can also occur in non-flowing waters in much lower densities.	Unlikely	No waterways within the Site. No WildNet or ALA records within 10 km of the Site.
<i>Furina dunmali</i>	Dunmall's Snake	V	V	This species is found in central and south-central and potentially northeastern New South Wales. In Queensland its range extends from Yepoon to Oakey, Glenmorgan and Inglewood in the south of Queensland.	This species is found in open forest, particularly brigalow (<i>A. harpophylla</i>) forest and woodland growing on floodplains of deep cracking black clay and clay loam soils.	Low	Some habitat features present within the Site; however, vegetation and soil type no compatible for the species. No WildNet or ALA records within 10 km of the Site.
<i>Hemiaspis damelii</i>	Grey Snake	E	E	This species is distributed from southern NSW and south-eastern Queensland.	In Queensland this species occurs within Brigalow (<i>Acacia harpophylla</i>) and Belah (<i>Casuarina cristata</i>) woodland on heavy dark brown to black cracking clay soils. They are particularly associated with water bodies, areas with small gullies and ditches and floodplain environments where they	Unlikely	Habitat features not present within the Site. No WildNet or ALA records within 10 km of the Site.



Scientific Name	Common Name	NC Act	EPBC Act	Distribution	Required Habitat	Likelihood of Occurrence	Justification
					shelter underneath rocks, logs and soil cracks.		
<i>Rheodytes leukops</i>	Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy Turtle, White-eyed River Diver	-	E	This species is endemic to the Fitzroy River catchment in Queensland. It occurs exclusively in the freshwater riverine habitats of the mid and lower reaches of the Fitzroy River and its tributaries.	The Fitzroy River Turtle occurs in turbid and clear-flowing rivers with deep pools on rocky, gravelly or sandy substrates. Preferred areas have high water clarity.	Unlikely	No waterways within the Site. No WildNet or ALA records within 10 km of the Site.

* Conservation status: CR, Critically Endangered (NC Act); CE, Critically Endangered (EPBC Act), E, Endangered; V, Vulnerable; LC, Least Concern (NC Act); SL, Special Least Concern (NC Act); C.D., Conservation Dependent.



A-4 Flora Species List

Table 12: Flora Species List

Scientific Name	Common Name	NC Act
<i>Acacia disparrima</i> subsp. <i>disparrima</i>	Hickery Wattle	C
<i>Acacia leiocalyx</i>	Black Wattle	C
<i>Ageratum houstonianum</i> *	Blue Billygoat Weed	
<i>Alloteropsis semialata</i>	Cockatoo Grass	C
<i>Alphitonia excelsa</i>	Soap Bush	
<i>Alstonia constricta</i>	Bitterbark	
<i>Ambrosia artemisiifolia</i> *	Ragweed	
<i>Aristida calycina</i> var. <i>calycina</i>	Dark Wiregrass	C
<i>Baccharis halimifolia</i> *	Groundsel Bush	
<i>Bidens pilosa</i> *	Cobbler's Pegs	
<i>Breynia oblongifolia</i>	Coffee Bush	C
<i>Carissa ovata</i>	Currant Bush	C
<i>Chloris gayana</i> *	Rhodes Grass	
<i>Chrysocephalum apiculatum</i>	Yellow Buttons	C
<i>Cirsium vulgare</i> *	Spear Thistle	
<i>Commelina diffusa</i>	Wandering Jew	C
<i>Corymbia citriodora</i>	Spotted Gum	C
<i>Corymbia tessellaris</i>	Moreton Bay Ash	C
<i>Crotalaria goreensis</i>	Gambia Pea	C
<i>Croton insularis</i>	Queensland Cascarilla	C
<i>Cryptostegia grandiflora</i> *	Rubber Vine	
<i>Cyclophyllum coprosmoides</i>	Coastal Canthium	C
<i>Cyperus exaltatus</i>	Tall Flatsedge	C
<i>Dianella caerulea</i>	Blue Flax Lily	C
<i>Digitaria didactyla</i>	Queensland Blue Couch	C
<i>Dodonaea triquetra</i>	Hop Bush	C
<i>Emilia sonchifolia</i> *	Emilia	
<i>Eragrostis sp</i>	Love Grass	C
<i>Erigeron bonariensis</i> *	Fleabane	
<i>Eucalyptus crebra</i>	Narrow-Leaved Red Ironbark	C
<i>Eucalyptus moluccana</i>	Gum-Topped Box	C
<i>Eucalyptus tereticornis</i>	Forest Blue Gum	C
<i>Eustrephus latifolius</i>	Wombat Berry	C
<i>Fimbristylis dichotoma</i>	Common Fringe-Rush	C



Scientific Name	Common Name	NC Act
<i>Flemingia parviflora</i>	Flemingia	C
<i>Gomphocarpus physocarpus</i> *	Balloon Cottonbush	
<i>Gomphrena celosioides</i>	Gomphrena Weed	C
<i>Heteropogon contortus</i>	Black Spear Grass	C
<i>Hibiscus heterophyllus</i>		C
<i>Imperata cylindrica</i>	Blady Grass	C
<i>Indigofera linifolia</i>		C
<i>Jagera pseudorhus</i>	Foam Bark	C
<i>Lantana camara</i> *	Lantana	C
<i>Lomandra longifolia</i>		C
<i>Lomandra multiflora</i> subsp. <i>multiflora</i>	Many-Flowered Mat-Rush	C
<i>Ludwigia peploides</i>	Water Primrose	C
<i>Macaranga tanarius</i>	Macaranga	C
<i>Melinis repens</i> *	Red Natal Grass	
<i>Paspalum distichum</i>	Water Couch	C
<i>Passiflora foetida</i> *	Stinking Passionfruit	
<i>Passiflora suberosa</i> *	Corky Passion Flower	
<i>Petalostigma pubescens</i>	Quinine Bush	C
<i>Polyscias murrayi</i>	Pencil Cedar	C
<i>Psydrax odorata</i>		C
<i>Senna pendula</i> var. <i>glabrata</i> *	Easter Cassia	C
<i>Sida cordifolia</i>		C
<i>Sida rhombifolia</i> *	Paddy's Lucerne	
<i>Solanum seaforthianum</i> *	Brazilian Nightshade	
<i>Solanum torvum</i>	Devil's Fig	C
<i>Sonchus oleraceus</i>	Common Sowthistle	C
<i>Sporobolus pyramidalis</i> *	Giant Rat's Tailgrass	C
<i>Stachytarpheta jamaicensis</i> *	Blue Snake Weed	
<i>Themeda triandra</i>	Kangaroo Grass	C
<i>Tridax procumbens</i>	Tridax Daisy	C
<i>Typha orientalis</i>	Broad-Leaved Cumbungi	C

*denotes weed/invasive species



A-5 EPBC Significant Impact Assessment

A-5-1 Protected Species Assessments: Vulnerable Species

The guidelines to assessment of significance to this Matter, define an action is as likely to have a significant impact on a Vulnerable species, if it will:

- a) Lead to a long-term decrease in the size of an important population of a species, or:
- b) Reduce the area of occupancy of an important population, or:
- c) Fragment an existing important population into two or more populations, or:
- d) Adversely affect habitat critical to the survival of a species, or:
- e) Disrupt the breeding cycle of an important population, or:
- f) Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or:
- g) Result in invasive species, which are harmful (by competition, modification of habitat, or predation) to a Vulnerable species, becoming established in the Vulnerable species' habitat, or:
- h) Introduce a disease that may cause a species to decline, or:
- i) Interferes substantially with the recovery of the species.

An assessment of significance of the proposal on the below species is as follows:

Grey-headed Flying Fox,

Quassia,

Red Goshawk,

Squatter Pigeon (southern subspecies),

Wedge-leaf Tuckeroo, and

Yellow-bellied Glider.



A-5-2 Assessment of Significance: Grey-headed Flying Fox (*Pteropus poliocephalus*), EPBC Act Status: Vulnerable

Table 13: Grey Headed Flying Fox - Key Species Information

Item	Description
Distribution	The Grey-headed Flying Fox is known to occupy areas on the coastal belt from Rockhampton in central Queensland to as far south as Melbourne in Victoria. This species selectively forages based on food availability, resulting in only a small portion of their range being occupied at any given time and a large variability in occurrence patterns between seasons and years (DoE 2022). As a result, population statistics are hard to estimate and have not been undertaken since 2005.
Threats	Habitat loss and fragmentation is the key existing threat to this species with an increasing loss in foraging resources and loss or destruction of breeding habitats. As foraging resources become less available, the Grey-headed Flying Fox is forced to find alternate food sources, often being fruit crops and urban areas. These areas pose a greater mortality risk to this species with culling by crop farmers, electrocution and poison more prevalent in these areas (DoE 2022).
Survey Results	No roost were identified within the subject Site; however the Impact Area contains 0.77 ha of Eucalyptus species considered suitable for foraging when in flower.
Important Population Assessment	The Grey-headed Flying Fox population potentially utilising the subject Site as a foraging Site is not considered to represent an <i>important population</i> of this species. No breeding colonies for this species are currently located within the immediate locality of the Site.

Table 14: Significant impact assessment - Grey-headed Flying Fox

Significant Impact Criteria	Details
a) Lead to a long-term decrease in the size of an important population of a species	The proposal will require the removal of 0.77 hectares of foraging habitat. The vegetation to be removed comprises 0.77 hectares of remnant vegetation. The proposed clearing area is largely surrounded by remnant vegetation for a highly mobile species. The proposed clearing area likely provides a relatively small nectar resource for the population relative to its ecological requirements and the local extent of potential habitat. While in very strict terms a negative effect, this loss will have a very minor impact on the local Grey-headed Flying Fox populations as the Site in total would only form a very minute fraction of this species wider opportunistic/seasonally variable foraging range. The proposed Action will thus not lead to a long-term decrease in the size of these important populations.
b) Reduce the area of occupancy of an important population	The minor loss of foraging habitat on the subject Site is insignificant relative to the area of occupancy which is measured in terms of hundreds of thousands of hectares. Consequently, the proposal would not reduce the area of occupancy of the important population.
c) Fragment an existing important population into two or more populations	The Grey-headed Flying Fox is highly mobile and known to be capable of crossing human-modified habitat. The proposal will offer no barrier to movement. Thus, it will not fragment an existing important population.
d) Adversely affect habitat critical to the survival of a species	The vegetation on Site is not considered critical habitat for the Grey-headed Flying Fox. Post-development, the remainder of the Site and other habitats in the locality will retain the potential to support this species, hence helping support the viability of the local population.
e) Disrupt the breeding cycle of an important population	The habitat in the Site to be removed does not contain an important population of this species and does not represent potential breeding habitat. The removal of this habitat would hence not be capable of disrupting the breeding cycle of the Grey-headed Flying Fox.
f) Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the	The degree of vegetation loss imposed by the proposed development is not significant enough to affect a local population of the Grey-headed Flying Fox to the point that it could cause a decline of the species.



Significant Impact Criteria	Details
species is likely to decline	
g) Result in invasive species, that are harmful (by competition, modification of habitat, or predation) to a Vulnerable species, becoming established in the Vulnerable species' habitat	No new species that affects the Grey-headed Flying Fox is likely to be introduced as a direct result of the proposal.
h) Introduce a disease that may cause a species to decline	No disease that poses a potential risk to this species is likely to be introduced to the Site.
i) Interferes substantially with the recovery of the species	Ideally, the goal in threatened species recovery is to increase the abundance and range of the threatened species, so that it is not in risk of becoming extinct. The proposal will result in the removal of a relatively small area of foraging habitat for the Grey-headed Flying Fox that is not significant enough to interfere with their recovery.
Resulting Impact	No significant impact

The Grey-headed Flying Fox populations potentially utilising the subject Site is not considered to represent an *important population* of this species. No breeding colonies are currently located within the locality, and no records occur within close proximity of the study Site. The subject Site is also not located within the limit of this species' range.

The above assessment has determined that the proposal is not considered likely to have a significant impact on the Grey-headed Flying Fox. Referral to the DCCEEW is not required for this species.



A-5-3 Assessment of Significance: Squatter Pigeon (*Geophaps scripta scripta*), EPBC Act Status: Vulnerable

Table 15: Squatter Pigeon - Key Species Information

Item	Description
Distribution	The Squatter Pigeon is known to occupy areas from the Cape York Peninsula to the Border Rivers region of northern NSW. This subspecies overlaps with the northern subspecies resulting in a hybrid subspecies. The overlap zone extends from Delta Downs in south-western Cape York, Chillagoe region in the east and just north of Mackay in the south (DoE, 2022). The hybrid subspecies has been excluded from the <i>Geophaps scripta scripta</i> EPBC listing. The southern parts of the distribution are largely fragmented, and the southern boundary has been observed to be contracting north resulting in all populations south of Carnarvon ranges to be considered important sub-populations (DoE, 2022).
Threats	Habitat loss and fragmentation is a major key existing threat to this species with an increasing degradation of remaining habitat largely due to agricultural land practices including the introduction of pasture species such as Buffel grass. The species is further impacted by predation from native predators and introduced species. The sub-populations of this species have declined particularly in areas where foxes are abundant. (DoE, 2022).
Survey Results	This species was not observed on Site, however there are records of the species within 10 km of the Site from 2017 (ALA, 2022).
Important Population Assessment	The Squatter Pigeon population potentially utilising the subject Site is not considered to represent an <i>important population</i> of this species.

Table 16: Significant impact assessment – Squatter Pigeon

Significant Impact Criteria	Details
a) Lead to a long-term decrease in the size of an important population of a species	The proposal will require the removal of 0.77 hectares of poor quality highly isolated potential breeding habitat. The proposed development includes is within 300m of a permanent water body which would be critical habitat requirement for the species. This likely provided a small resource for the population relative to its ecological requirements and local extent of potential habitat. While in very strict terms a negative effect, this loss will have a very minor impact on the populations as the Site, in total would only form a very minute fraction of this species wider opportunistic foraging range. Additionally due to the isolation of the area and present of significant barriers in the form of major roads and train lines it is highly unlikely that the species would occur within the Site. The proposal will thus not lead to a long-term decrease in the size of the important populations.
b) Reduce the area of occupancy of an important population	The minor loss of foraging habitat on the subject Site is insignificant relative to the area of occupancy for the species. Consequently, the proposal would not reduce the area of occupancy of the important population.
c) Fragment an existing important population into two or more populations	The Squatter Pigeon is highly mobile and known to be capable of crossing hum-modified habitat. The proposal will offer no barrier to movement. Thus, it will not fragment an existing important population.
d) Adversely affect habitat critical to the survival of a species	The vegetation on Site is not considered critical habitat for the Squatter Pigeon. Post-development, the remainder of the Site and other habitats in the locality will retain the potential to support this species, hence helping support the viability of the local population.
e) Disrupt the breeding cycle of an important population	The habitat in the Site to be removed does not contain an important population of this species. The action will not significantly impact squatter pigeon movement, available habitat or breeding areas to the degree to disrupt the breeding cycle.



Significant Impact Criteria	Details
f) Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The degree of vegetation loss imposed by the proposed development is not significant enough to affect a local population of the Squatter Pigeon to the point that it could cause a decline of the species.
g) Result in invasive species, that are harmful (by competition, modification of habitat, or predation) to a Vulnerable species, becoming established in the Vulnerable species' habitat	No new species that affects the Squatter Pigeon (southern subspecies) is likely to be introduced as a direct result of the proposal.
h) Introduce a disease that may cause a species to decline	No disease that poses a potential risk to this species is likely to be introduced to the Site.
i) Interferes substantially with the recovery of the species	Ideally, the goal in threatened species recovery is to increase the abundance and range of the threatened species, so that it is not in risk of becoming extinct. The proposal will result in the removal of a relatively minute area of foraging habitat for the Squatter Pigeon that is not significant enough to interfere with their recovery.
Resulting Impact	No significant impact

The Squatter Pigeon population potentially utilising the subject Site is not considered to represent an *important population* of this species. No records occur within the subject Site. The subject Site is also not located within the limit of this species' range.

The above assessment has determined that the proposal is not considered likely to have a significant impact on the Squatter Pigeon. Referral to the DCCEEW is not required for this species.



A-5-4 Protected Species Assessments: Endangered Species

The guidelines to assessment of significance to this Matter, define an action is as likely to have a significant impact on an Endangered species, if it will:

- a) Lead to a long-term decrease in the size of an important population of a species, or:
- b) Reduce the area of occupancy of an important population, or:
- c) Fragment an existing important population into two or more populations, or:
- d) Adversely affect habitat critical to the survival of a species, or:
- e) Disrupt the breeding cycle of an important population, or:
- f) Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or:
- g) Result in invasive species, which are harmful (by competition, modification of habitat, or predation) to a Vulnerable species, becoming established in the Vulnerable species' habitat, or:
- h) Introduce a disease that may cause a species to decline, or:
- i) Interferes substantially with the recovery of the species.

An assessment of significance of the proposal on the below species is as follows:

Australian Painted Snipe,

Cycas megacarpa,

Koala.



A-5-5 Assessment of Significance: Koala (*Phascolarctos cinereus*), EPBC Act Status: Endangered

Table 17: Koala - Key Species Information

Species	Distribution Description
Distribution	The Koala is a wide-ranging marsupial endemic to Australia. It typically occurs in eastern Australian forests and woodlands of predominantly Eucalyptus species. The Koala's distribution includes Queensland, New South Wales, the Australian Capital Territory, Victoria and South Australia. Koalas occur in patchy and often low-density populations across Queensland (DAWE, 2022b). In Queensland, they occur as far north as the Einasleigh Uplands and Wet Tropics bioregions through to South East Queensland where they are most frequently sighted (DAWE, 2022b). Population estimates across the state are limited with the majority of the current data and survey effort focused in south-east Queensland. Recent studies conducted by Adams-Hosking <i>et al.</i> (2016) estimated the Koala population in the South Brigalow Bioregion to be approximately 11,071.
Threats	The koala is threatened by wide-scale climate change drivers which include the increased frequency and intensity of drought and high temperatures, the increasing prevalence of weather conditions which promote bushfire, and a shrinking climatically suitable area (Adams-Hosking <i>et al.</i> 2011; McAlpine <i>et al.</i> 2015; Runge <i>et al.</i> 2021a). Simultaneously, koala populations are also being impacted by diseases, specifically koala retrovirus (KoRV) and Chlamydia (<i>Chlamydia pecorum</i>), human-related activities including habitat loss resulting from land clearance and mining, and mortality due to encounters with vehicles and dogs. These threats can also act synergistically. For example, habitat clearance and climate change drivers are associated with increased levels of physiological stress in wild koala populations (Narayan 2019).
Survey Results	The field survey did not identify the presence of koalas on Site, however there is a record within 10 km of the Site (2007) and suitable habitat occurs on the Site.
Important Population Assessment	The Koala population potentially utilising the subject Site is not considered to represent an <i>important population</i> of this species.

Table 18: Significant impact assessment – Koala

Significant Impact Criteria	Details
a) Will the Action lead to a long-term decrease in the size of a population	The proposal will require the removal of 0.77 hectares of remnant and high value vegetation with the remaining 3.6 hectares being agricultural land. The proposed clearing area is largely surrounded by remnant vegetation. No signs of koala presence (including scat and scratches) were detected on Site. It is unlikely that the project will lead to a long-term decrease in the size of an important population.
b) Will the Action reduce the area of occupancy of the species	Despite favourable fodder species such as <i>Corymbia</i> and <i>Eucalyptus</i> being identified on Site, koalas were not found to present on Site. It is considered highly unlikely that koalas currently use the habitat within the project footprint and therefore the proposed development will not reduce the area of occupancy of the species.
c) Will the Action fragment an existing population into two or more populations	The Site is not considered to be currently utilised by an important koala population. The action will not fragment the population for the species with connectivity still present post-development to the north of the Site.
d) Will the Action adversely affect habitat critical to the survival of a species	Suitable habitat within the Site has the potential to be used by koalas as areas proposed to be cleared contain known koala food trees such as <i>Corymbia</i> and <i>Eucalyptus</i> species. There are no known records of koala within the project or within adjacent suitable habitat (Mount Larcom). It is therefore unlikely that the proposed development will adversely affect habitat critical to the survival of the species.
e) Will the Action disrupt the breeding cycle of a population	There is no evidence of koalas using the suitable habitat within the project footprint (current or historic). It is therefore unlikely that the proposed development will disrupt the breeding cycle of a population.



Significant Impact Criteria	Details
f) Will the Action modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The project area is considered highly unlikely to be utilised by koalas given there is no evidence (current or historic) of koala presence within the project footprint. Thus, the degree of vegetation loss imposed by the proposed development is unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
g) Will the Action result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.	The proposed Action will not result in the invasion of invasive species.
h) Will the Action introduce disease that may cause the species to decline	Chlamydia and koala retro virus are known to affect koalas. Stress increases the susceptibility to infection which can occur when habitat is reduced (McCallum <i>et al.</i> 2017). Since there is no evidence of koalas within the project footprint, the use of a fauna spotter catcher during all clearing activities is considered sufficient to mitigate the impact of stress on a koala in the unlikely instance that one moves into habitat within the project footprint. It is unlikely the proposed development will introduce disease that may cause the species to decline.
i) Will the Action interfere with the recovery of the species.	Ideally, the goal in threatened species recovery is to increase the abundance and range of the threatened species, so that it is not in risk of becoming extinct. The proposal will result in the removal of a relatively small area of suitable koala habitat. Since there is no evidence (current or historic) of koala utilising the habitat within the project footprint or adjacent habitat. Therefore, it is unlikely the proposed development will interfere with the recovery of the species.
Resulting Impact	No significant impact is identified caused by this project as no koala population are recorded within the area or observed on Site. However, the proposed works will adversely affect habitat potentially used by koalas.

The above assessment has determined that the proposal is not considered likely to have a significant impact on the Koala. Referral to the DCCEEW is not required for this species.

