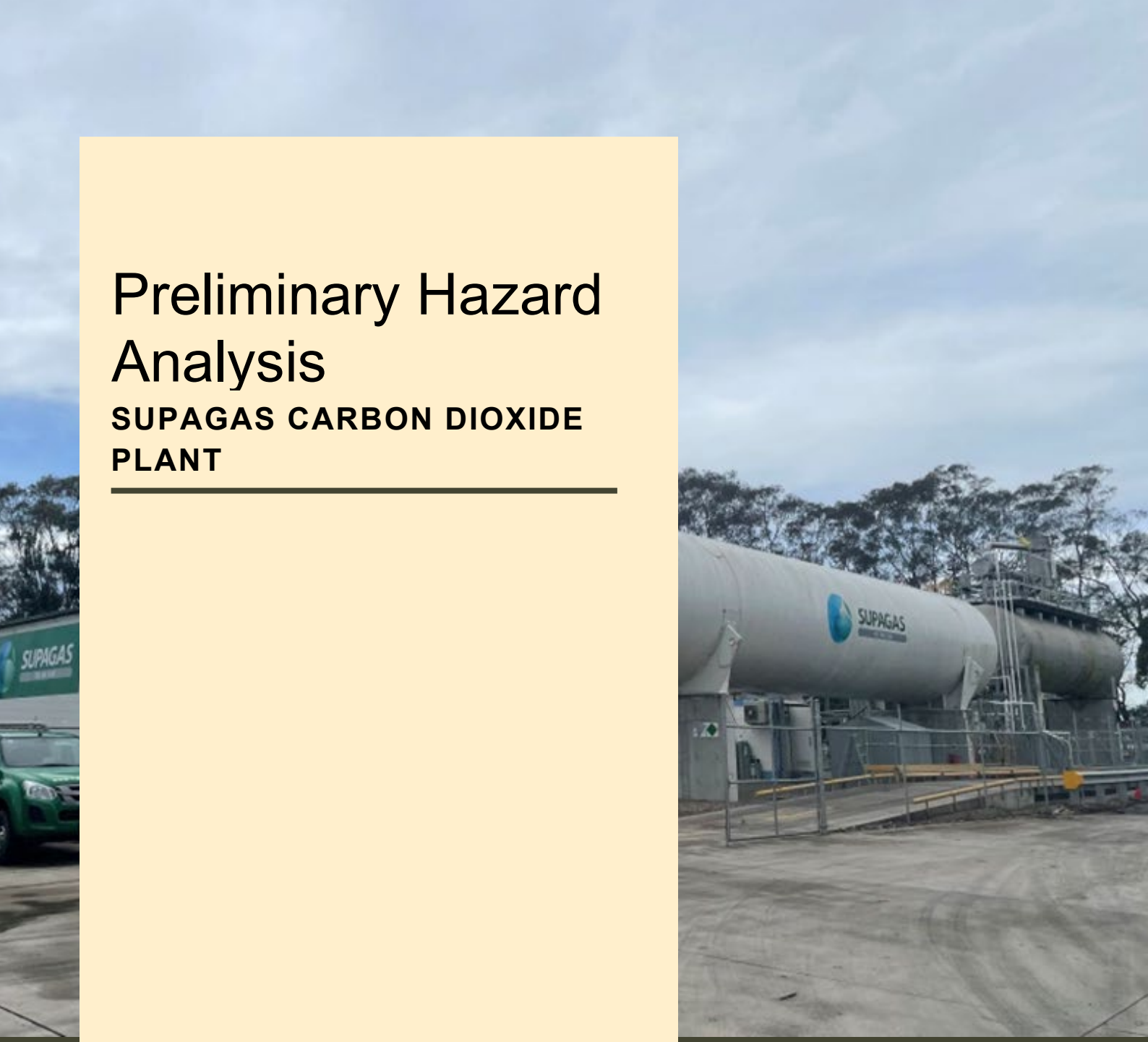
Appendix F

Preliminary Hazard Analysis



Preliminary Hazard Analysis

SUPAGAS CARBON DIOXIDE PLANT

NOVEMBER 2025

Prepared for: Onward Consulting Pty Ltd on behalf of Supagas Pty Ltd

PANDO
CONSULTING

Version control

Revision	Date	Task	By	Company	File name
Rev0.1	13/06/2025	Draft for client review	Scott McGrath	Pando Consulting	24-026 Supagas CO2 PHA Rev0.1 20250613
Rev0.2	26/09/2025	Updated following Onward review	Scott McGrath	Pando Consulting	Supagas CO2 Plant Preliminary hazard analysis PHA Rev0.2 20250926
Rev0.3	12/11/2025	Updated following Supagas review	Scott McGrath	Pando Consulting	24-026 Supagas CO2 Plant PHA Rev0.3 20251112

Table of Contents

Acronyms & abbreviations

ADGC	Australian Dangerous Goods Code
APZ	Asset Protection Zone
ALARP	As Low As Reasonably Practicable
BPM	Bushfire Protection Measures
BFAR	Bushfire Assessment Report
DG	Dangerous Goods
DPE	Department of Planning and Environment (NSW) (now DPHI)
DPHI	Department of Planning, Housing and Infrastructure
EIS	Environmental Impact Statement
EP&A Act	Environmental Planning and Assessment Act 1979 (NSW)
EP&A Regulation	Environmental Planning and Assessment Regulation 2000 (NSW)
FHA	Final Hazard Analysis
FRNSW	Fire and Rescue NSW
HIPAP 4	Hazardous Industry Planning Advisory Paper No 4 Risk Criteria for Land Use 2011
HIPAP 6	Hazardous Industry Planning Advisory Paper No 6 Hazard Analysis 2011
km	kilometres
LEP	Local Environment Plan
LGA	Local Government Area
MEA	Monoethanoloamine
MLRA	Multi-Level Risk Assessment
PBP	Planning for Bush Fire Protection 2019
PHA	Preliminary Hazard Analysis
PLC	Programmable Logic Controller
PPE	Personal Protective Equipment
PRS	Preliminary Risk Screening
Resilience and Hazards SEPP	State Environmental Planning Policy (Resilience and Hazards) 2021
RFS	(NSW) Rural Fire Service
SDS	Safety Data Sheet
SEARs	Secretary's Environmental Assessment Requirements
WHS	Work Health and Safety
WPPS	Wilga Park Power Station

1 Introduction

This Preliminary Hazard Analysis (PHA) has been prepared by Pando Consulting Pty Ltd (Pando) on behalf of Onward Consulting Pty Ltd (Onward) and Supagas Pty Ltd (Supagas). Supagas (the Proponent) is seeking to construct and operate a carbon dioxide (CO_2) plant, which would connect to the adjacent Wilga Park Power Station (WPPS). The CO_2 plant would capture and process exhaust gases from the WPPS gas generators and output a high purity CO_2 product for export and use in food, beverage, and other markets (the Project).

The Project would be located in the Narrabri Local Government Area (LGA), approximately 12 km south-west of Narrabri, NSW. The WPPS is located on Lot 12 of DP 1171292 and is owned and operated by Santos NSW (Eastern) Pty Ltd (Santos). In addition, an Essential Energy substation is located on the eastern boundary of the WPPS site.

The Project would be subdivided from Lot 12 on DP 1171292.

The Project lot is shown on Figure 1-1. The proposed site layout is shown on Figure 1-2.

1.1 Objectives

The objectives of this PHA are to:

- Determine if the Project is 'potentially hazardous' in accordance with *State Environmental Planning Policy (Resilience and Hazards)* 2021
- Develop a comprehensive understanding of credible hazards and risks associated with the operation of the Project and the adequacy of control measures
- Detail commitments made by the Proponent to ensure they are implemented in detailed design, construction and operation of the Project.

1.2 Scope

This PHA has been prepared to address the Hazards key issues from the Planning Secretary's Environmental Assessment Requirements (SEARs) shown in Table 1-1.

Table 1-1 SEARs key issues addressed in this PHA

SEARs key issue	Where addressed
A preliminary risk screening completed in accordance with *State Environmental Planning Policy (Resilience and Hazards)* 2021, Chapter 3 and *Applying SEPP 33* (DoP, 2011), with a clear indication of class, quantity and location of all dangerous goods and hazardous materials associated with the development. Should preliminary screening indicate that the project is 'potentially hazardous' a Preliminary Hazard Analysis (PHA) must be prepared in accordance with *Hazardous Industry Planning Advisory Paper No. 6 - Guidelines for Hazard Analysis* (DoP, 2011) and *Multi-Level Risk Assessment* (DoP, 2011)	Section 4
The PHA must also include all potential hazards and risks associated with the process CO_2 absorption, stripping and liquefaction	Section 5

1.3 Exclusion and limitations

- This report has been prepared by Pando for Onward and Supagas and may only be used and relied on by Onward and Supagas
- This report is limited to a site inspection and desktop study and is based on current and historical information available at the time the report was prepared
- This report does not provide a complete assessment of the environmental status of the site and is limited to the scope outlined above
- This PHA is based on concept design, industry design standards and guidelines, and standard safety controls. Some information is limited as complete data on the design and precise controls is not available at the concept design stage
- The scope of this PHA does not include a transport route analysis and/or assessment of other risks, including, but not limited to, aviation safety, health, landslide/subsidence and telecommunications.

Aerial Imagery 2023

Adjacent to Wilga Park Power Station, Narrabri, NSW 2390

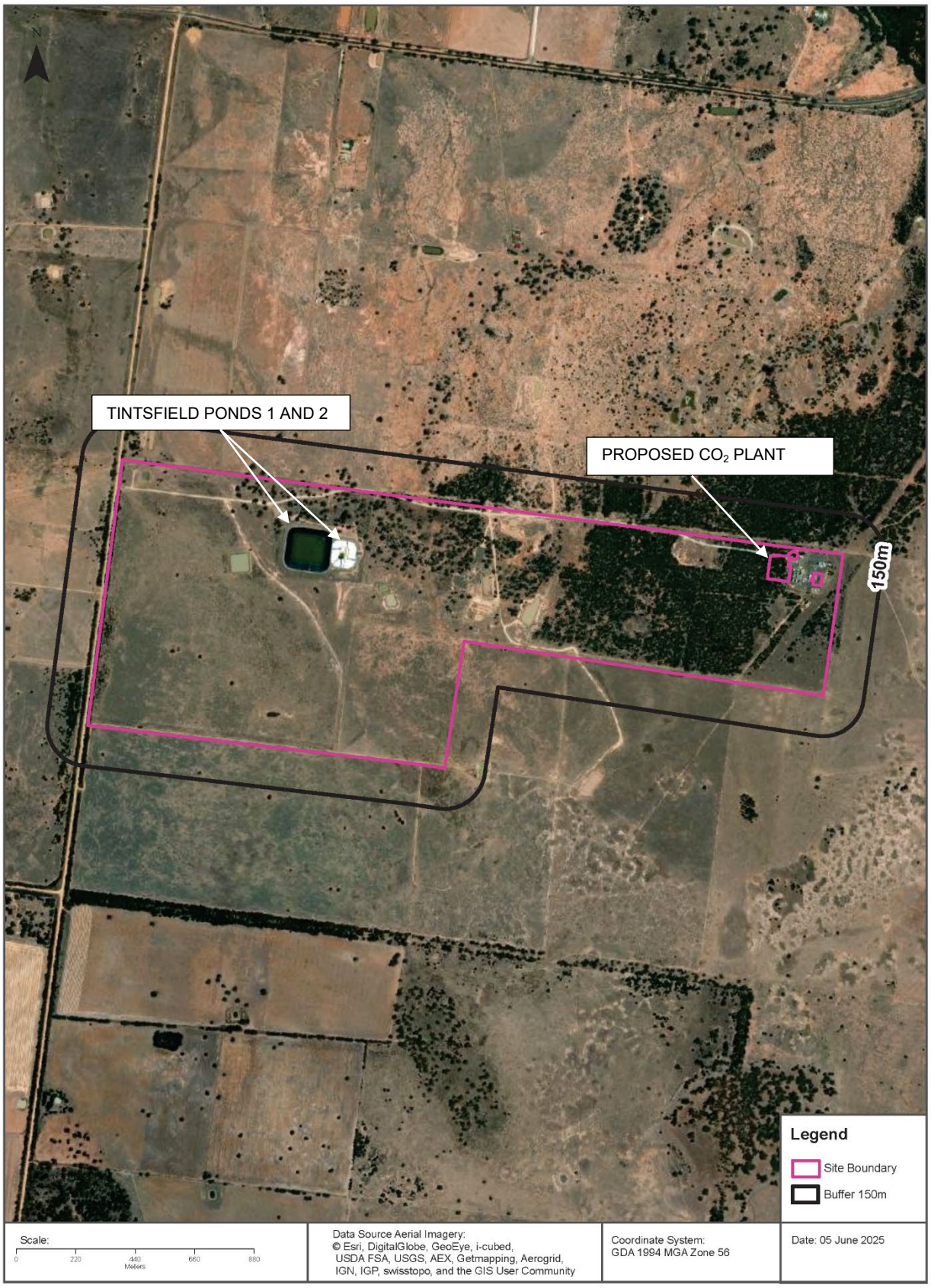


Figure 1-1 The Project Lot (12/DP1171292) (source: Lotsearch)

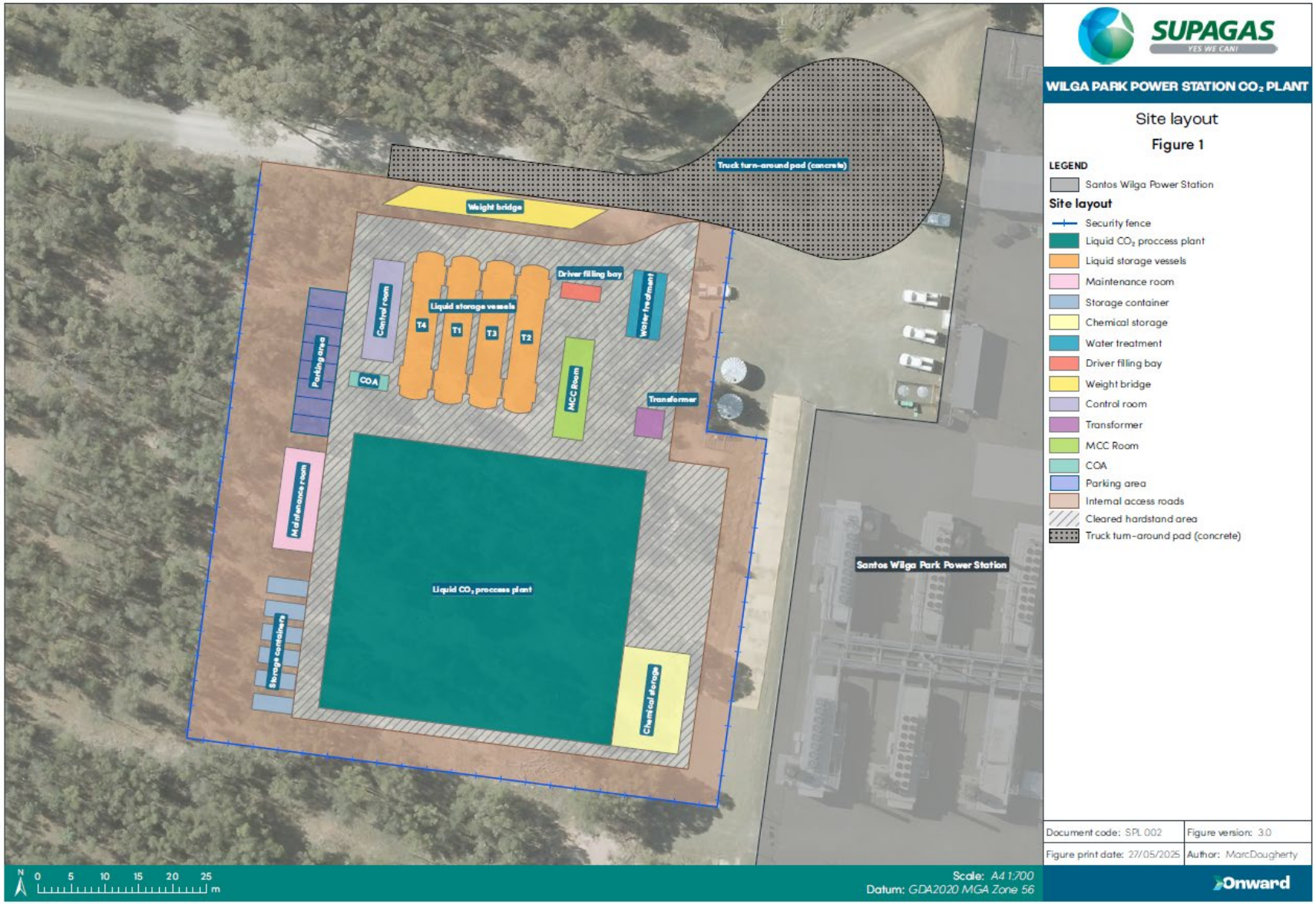


Figure 1-2 Proposed site layout (source: Onward)

2 Site location and assessment

2.1 Site identification

The site identification details are presented in Table 2-1.

Table 2-1 Site identification details

Item	Detail
Lot and DP	Lot 12 DP1171292. The Project would be subdivided from Lot 12 DP1171292 as part of the planning approvals.
Current owners and/or occupiers	Santos (WPPS) and Essential Energy (substation)
Local Council	Narrabri LGA
Current land use	Agriculture, gas extraction and power generation
Proposed land use	Industrial
Surrounding land use	Agriculture, gas extraction and power generation
Land zoning	RU1 Primary Production (Narrabri Local Environmental Plan 2012)

2.2 Site location

The Project would be located in the Narrabri LGA, approximately 12 km south-west of Narrabri, NSW. The WPPS, immediately adjacent to the Project, is located on Lot 12 of DP 1171292 and is owned and operated by Santos. In addition, an Essential Energy substation, located on lot 11 DP1171292, is located on the eastern boundary of the WPPS site.

2.3 Surrounding land use and risk criteria

The existing/approved land uses in the vicinity of the Project are characterised by a combination of agriculture, gas extraction and power generation.

In accordance with *Hazardous Industry Planning Advisory Paper No 4 Risk Criteria for Land Use* 2011 (HIPAP 4), the suggested individual fatality risk criteria for industrial land use, such as the area surrounding the Project, is 50 in a million per year (50 x 10^{-6} per year) and be contained within the boundaries of the Project where applicable.

2.4 Sensitive receivers

There are two receivers within 1 km of the Project (R12 and R23). However, both of these receivers have an existing agreement with Santos Pty Ltd (refer to Figure 2-1).

2.5 Sensitive developments

There are no sensitive developments, as defined by HIPAP 4 and *Hazardous Industry Planning Advisory Paper No 6 Hazard Analysis* 2011 (HIPAP 6), within 1 km of the Project. Sensitive developments include:

- Residential Areas – Where people live, particularly high-density housing and aged care facilities
- Schools and Childcare Centres – Places where children, who are less capable of responding to emergencies, are concentrated
- Hospitals and Aged Care Facilities – Where occupants may be mobility-impaired or require assistance during an emergency
- Public Spaces with High Occupancy – Such as parks, shopping centres, or entertainment venues
- Critical Infrastructure – Including emergency services, transport hubs, and communication centres.

2.6 Flood prone land

The Project site is located outside of flood prone areas and more than 650 m east of the nearest waterway (i.e. Pigs Creek).

2.7 Bushfire

In accordance with the *Supagas CO_2 plant Bushfire Assessment Report* (BFAR) (Peterson Bushfire, 2025) the Project and surrounding area is mapped as bushfire prone land including Vegetation Category 1 and Vegetation Category 3, which represents the potential for forest/woodland and grassland hazards, respectively.

The BFAR bushfire landscape assessment of likely fire behaviour and bushfire threat predicts 'It is the combination of undesirable fire weather (i.e. hot and dry north-westerly winds) combined with ignition (natural or accidental) creating the potential for a bushfire to spread generally in a west to east direction. A fire may impact the Project area from surrounding vegetation to the north and west or spread from the Project area into the adjoining agricultural lands to the east including the Bohena Creek corridor'.

The BFAR includes bushfire protection measures in accordance with *Planning for Bush Fire Protection 2019* (PBP) (NSW Rural Fire Service, 2019) that have been adopted into the hazard register (refer to Table 5-4), including:

- Asset Protection Zones (APZ)
- Vegetation management
- Building construction
- Access for firefighting
- Water supply for firefighting
- Ignition prevention
- Bushfire emergency management.

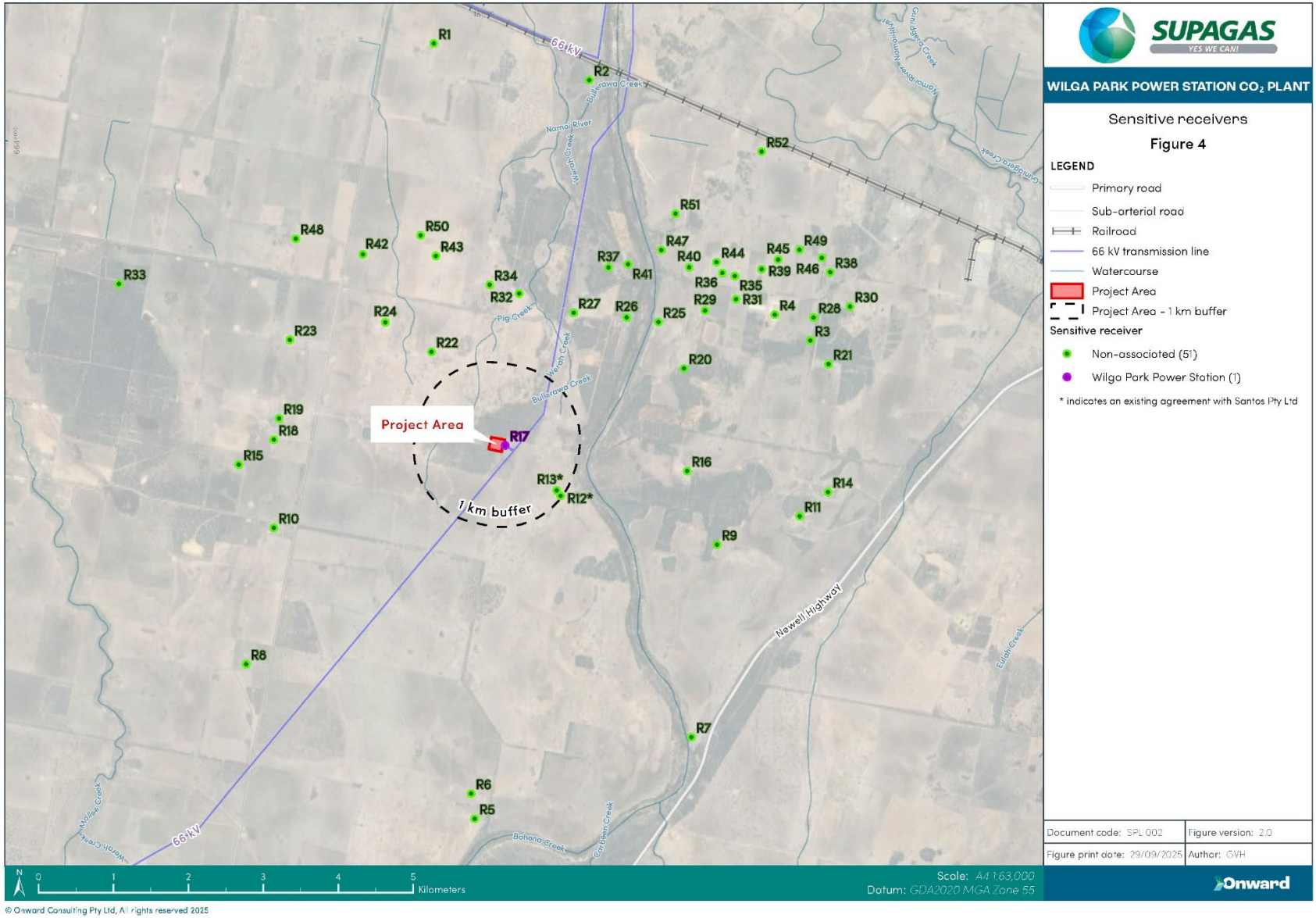


Figure 2-1 Sensitive receivers (source: Onward)

3 Project description

3.1 Overview

The Project, as presented in Figure 1-2, comprises the construction and operation of a CO_2 plant, which would take exhaust gas containing CO_2 from a number of gas generators within the WPPS, with power supplied via an overhead connection to the WPPS electrical network.

This exhaust gas would be processed to produce a CO_2 product of food grade quality for export and use in the food, beverage, and other markets. The Project would process approximately 72 tonnes per day of CO_2 and allow for storage of approximately 800 tonnes of liquid CO_2 prior to delivery off-site.

The Project would include the following key components:

- Operation of the CO_2 plant, including:
    - Associated equipment and structures, including CO_2 storage
    - Power supply
    - Water supply
    - Vehicle access and parking
    - Water treatment for offsite disposal and irrigation
- Truck loading and transportation of the CO_2 product.

The associated equipment and structures would include:

- Above-ground pipeline extending from the WPPS gas generators
- Gas processing equipment
- Transformer
- Insulated CO_2 storage tank, including refrigeration unit
- Water treatment system
- Distribution weighbridge
- Control room
- Workshop
- Water storage
- Truck turning area
- Administration area (i.e. offices, parking, amenities).

3.2 Operational activities

The Project would utilise a range plant and equipment for initial and ongoing site operations. The type of plant and equipment used at the site may change during the life of the Project to meet operational demands and reflect changes in technology.

A typical list of equipment required for Project operation is provided in Table 3-1 and an indicative process flow diagram is presented in Figure 3-1.

Table 3-1 Summary of typical equipment for Project operation

Indicative activity	Indicative equipment	
Operation of the CO_2 plant	Flue gas scrubber	CO_2 compressor
	Absorber	Dehydrator
	Heat exchanger	Reboiler
	Stripper	CO_2 condenser
	Gas cooler and after scrubber	Road trucks (e.g. semi-trailer/truck and trailer)
	Water treatment system	Irrigation system

An indicative overview of the operation of the CO_2 plant is provided below; this provides a summary of the processes undertaken at the relevant equipment and structures:

- **Above-ground pipeline:** Enabling transfer of exhaust gas from a number of gas engines within the WPPS site to the CO_2 plant (i.e. flue gas scrubber).
- **Flue gas scrubber:** The flue gas is cooled and water condensed.
- **Absorber and heat exchanger**: Once cooling and scrubbing is completed, the gas is fed via an exhauster through an absorber, in which the gas flows counter-current to an amine solvent (i.e. Monoethanoloamine (MEA)) solution flow. By chemical reaction, the MEA solution absorbs the CO_2 from the flue gas (referred to as 'rich MEA solution'). The rich MEA is first pressurized and heated in the heat exchanger and then led to a nitric oxides (NOx) (i.e., nitric oxide (NO) and nitrogen dioxide (NO_2)) Nox Flash Polisher (i.e. DeNOx) where most of the contaminants like O_2, N_2, and NO are removed from the rich MEA solution by flashing to the absorber pressure. A stream of CO_2 and steam is added to the bottom of the NOx Flash column for possible CO_2 product without any use of expensive chemicals.
- **Stripper:** The rich MEA solution is pumped to a stripper, where the CO_2 is released from the MEA solution utilising the combustion heat generated in the MEA heater. The CO_2-depleted MEA solution (referred to as 'lean MEA solution') is recycled to the absorber.
- **Gas cooler and after scrubber**: After exiting the top of the stripper, the CO_2-rich gas is cooled in a gas cooler and washed in an after-scrubber for removal of potential MEA carry-over.
- **CO_2 compressor**: The gas is then compressed in two stages to approximately 15-18 gauge pressure (bar[g]) by the CO_2 compressor.
- **Dehydrator and CO_2 condenser**: Before liquefaction, the gas is dried to a dew point of below -60 °C in the dehydrator. Regeneration is done automatically by electrical heating and the use of dry purge gas from the CO_2 condenser. Traces (if any) of acetaldehyde are

also removed in the dehydrator. The CO_2 gas then passes through an activated carbon filter for the removal of any odour substances.

- **Reboiler:** To remove the last non-condensable gases, the CO_2 gas first passes a reboiler in the purification system. It is then condensed at a temperature of approximately -27 °C/ -21 °C in the CO_2 condenser, where the non-condensed gases are purged off.
- **Insulated CO_2 storage tank, including refrigeration unit:** Following completion of condensing in the CO_2 condenser, the liquified CO_2 is fed through a distillation column to an insulated storage tank. A refrigeration unit, controlled by the CO_2 pressure in the CO_2 condenser, supplies the matching refrigeration capacity. The liquid CO_2 is stored under a pressure of approximately 15-18 bar(g) and a corresponding temperature of approximately -27 °C /-21 °C. During a non-CO_2 production period, the refrigeration unit can operate independently of the rest of the CO_2 plant to maintain the correct storage tank temperature/pressure.

The final CO_2 produced during the above process would have purity higher than 99.9% v/v (volume per volume), enabling its use as a food/beverage ingredient which meets the quality standards.

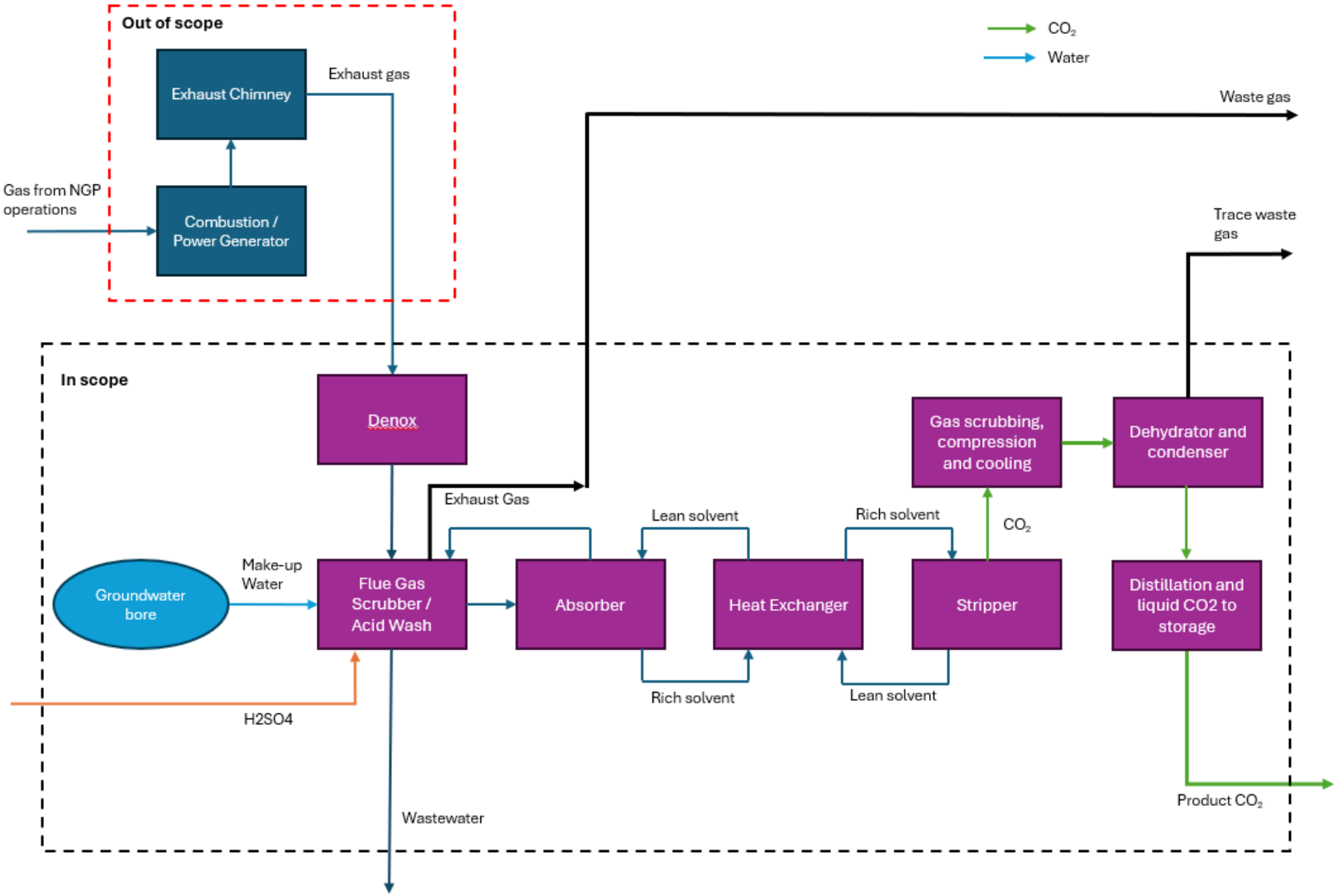


Figure 3-1 Indicative process flow diagram (source: Supagas)

4 Preliminary risk screening

4.1 Introduction

The objective of the Preliminary Risk Screening (PRS) is to determine whether the proposed development is considered as 'potentially hazardous industry' as defined by the Resilience and Hazards SEPP. The Resilience and Hazards SEPP define 'potentially hazardous industry' development as:

'Potentially hazardous industry' means a development for the purposes of any industry which, if the development were to operate without employing any measures (including, for example, isolation from existing or likely future development on other land) to reduce or minimise its impact in the locality or on the existing or likely future development on other land, would pose a significant risk in relation to the locality:

(a) to human health, life or property, or

(b) to the biophysical environment,

and includes a hazardous industry and a hazardous storage establishment.

Projects that are classified as 'potentially hazardous' industry require a PHA in accordance with HIPAP 6 to determine the risk to people, property and the environment. If the residual risk exceeds the acceptability criteria, the development is considered as a 'hazardous industry' and may not be permissible within NSW.

The process to undertake the preliminary risk screening, as required by MLRA (DoP, 2011), is taken from the *Hazardous and Offensive Development Application Guidelines – Applying SEPP 33* (DoP, 2011) (Applying SEPP 33) and presented in Figure 4-1.

The risk screening process considers the type and quantity of hazardous materials to be stored on site as well as the expected number of transport movements.

'Hazardous materials' are defined as substances that fall within the classification of the Australian Dangerous Goods Code (ADGC) (i.e. have a Dangerous Goods (DG) classification). Detail of the DG classification is obtained from the materials' Safety Data Sheet (SDS).

Risk screening is undertaken by comparing the storage quantity and the number of road movements of the hazardous materials with the screening threshold specified in the guideline. The screening threshold presents the quantities below which it can be assumed that significant off-site risk is unlikely.

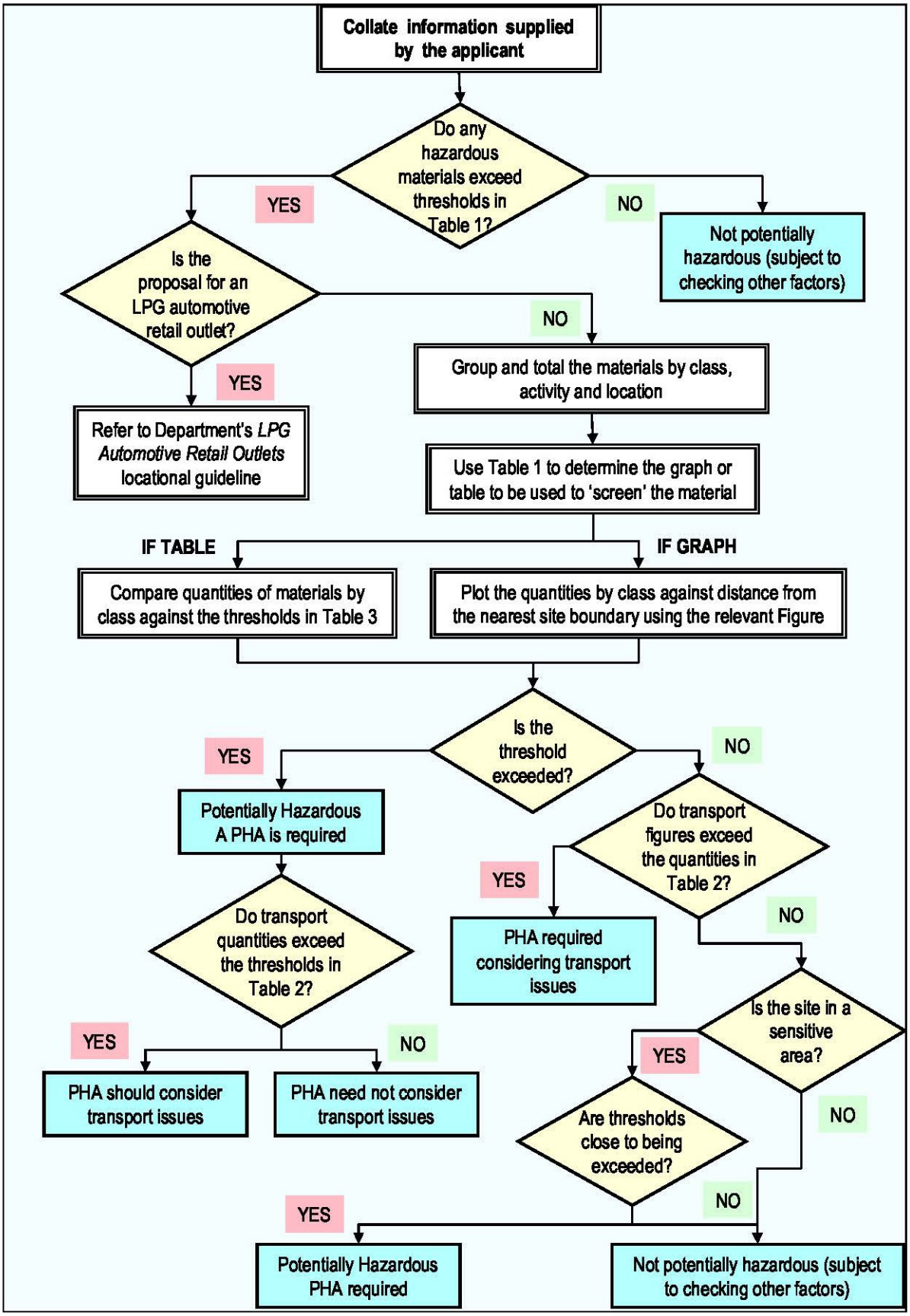


Figure 4-1 The risk screening process (Applying SEPP 33)

4.2 Storage and transport of hazardous material

A summary of the expected hazardous materials to be stored and handled on site for the Project, transport movements and the relevant Resilience and Hazards SEPP screening threshold is presented in Table 4-1 and Table 4-2.

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Table 4-1 Threshold quantities for Hazardous Materials storage

Hazardous material information							**Storage**		Is the SEPP33 threshold exceeded?
Hazardous material	Use (including mode of storage i.e., bulk or packages/containers)	DG class and distance from boundary for DG classes 1.1, 2.1 and 3	DG category	UN Number	Packing group	AS 1940 applicable?	Estimated storage quantity[1]	Storage threshold	
Carbon dioxide (CO_2) (refrigerated liquid)	Product from operation of the Project. Stored in storage vessels	Class 2.2	Non-flammable, Non-toxic gas	UN 2187	Not applicable (gases do not use packing groups)	Not applicable (flammable and combustible liquids only)	800,000 kg	Class 2.2 is excluded from the risk screening. Non-flammable, non-toxic gases not considered to be potentially hazardous with respect to off-site risk	No No
Oxygen (O_2)	O_2 vented to atmosphere. Not stored on site. Vented to atmosphere	Class 2.2	Non-flammable gas	UN 1072 (compressed) UN 1073 (refrigerated liquid)	Not applicable (gases do not use packing groups)	Not applicable (flammable and combustible liquids only)	Not stored on site. Vented to atmosphere		
Ammonia (NH_3)	NH_3 for refrigeration cycle. Stored in closed loop of refrigeration unit	Class 2.3	Toxic Gas, with subsidiary risk class 8 (Corrosive)	UN 1005	Not applicable (gases do not use packing groups)	Not applicable (flammable and combustible liquids only)	1,300 kg	5 tonnes. Anhydrous ammonia, kept in the same manner as for liquefied flammable gases and not kept for sale	No
Monoethanolamine (MEA) 85wt% solution	MEA top up for processing equipment. Stored in chemical storage area and diluted prior to use	Class 8	Corrosive substances	UN 2491	PG III	Not applicable (flammable and combustible liquids only)	3,360 kg	25 tonnes for PG II (dangerous goods of a given class but varying packing groups are assumed to be the most hazardous packing group)	Yes
Monoethanolamine (MEA) ~30-34wt% solution	MEA in processing equipment during operation. Stored in loop of processing equipment.	Class 8	Corrosive substances	UN 2491	PG III	Not applicable (flammable and combustible liquids only)	10,928 kg		
Sodium Hydroxide (NaOH) 30wtr% solution	NaOH for reclaimer. Stored in chemical storage and diluted prior to use	Class 8	Corrosive substances	UN 1824	PG III (likely PG III at 30%)	Not applicable (flammable and combustible liquids only)	1,280 kg		
25% Ammonia (NH_3) water	NH_3 injection for deNOx. Stored in chemical storage and diluted prior to use	Class 8	Corrosive substances	UN 2672	PG III (for concentrations between ~10–25%)	Not applicable (flammable and combustible liquids only)	12,480 kg		
Sulfuric Acid (H_2SO_4) 70% solution	Acid injection for acid wash. Stored in chemical storage and diluted prior to use	Class 8	Corrosive substances	UN 1830	PG II (for concentrations ≥ 51% and ≤ 100%)	Not applicable (flammable and combustible liquids only)	6,857 kg		

[1] Where several hazardous materials of the same class are kept on site in the same general location, total the quantities by class and activity (that is, total all quantities of each class stored in bulk then separately total the quantities of each class stored in packages/containers).

Table 4-2 Threshold movements and quantities for Hazardous Materials transport

Hazardous material information						**Transportation**								Is the SEPP33 threshold exceeded?
Hazardous material	Use (including mode of storage i.e., bulk or packages/containers)	DG class and distance from boundary for DG classes 1.1, 2.1 and 3	DG category	UN Number	Packing group	Estimated vehicle movements		Estimated minimum quantity per load (tonne)		Threshold vehicle movements		Threshold minimum quantity per load (tonne)[2]		
						Cumulative annual	Peak weekly	Bulk	Packages	Cumulative annual	Peak weekly	Bulk	Packages	
Carbon dioxide (CO_2) (refrigerated liquid)	Product from operation of the Project. Stored in storage vessels	Class 2.2	Non-flammable, Non-toxic gas	UN 2187	Not applicable (gases do not use packing groups)	Class 2.2 is excluded from the risk screening. Non-flammable, non-toxic gases not considered to be potentially hazardous with respect to off-site risk								No
Oxygen (O_2)	O_2 vented to atmosphere. Not stored on site. Vented to atmosphere	Class 2.2	Non-flammable gas	UN 1072 (compressed) UN 1073 (refrigerated liquid)	Not applicable (gases do not use packing groups)									
Ammonia (NH_3)	NH_3 for refrigeration cycle. Stored in closed loop of refrigeration unit	Class 2.3	Toxic Gas, with subsidiary risk class 8 (Corrosive)	UN 1005	Not applicable (gases do not use packing groups)	Not applicable. NH_3 stored in closed loop of refrigeration unit.								No
Monoethanolamine (MEA) 99wt% solution	Isotainer, 1000L Intermediate Bulk Container (IBC), or 200L drums	Class 8	Corrosive substances	UN 2491	PG III	<50	1	1000L IBC or 200 L drums		>500	>30	2 tonnes	5 tonnes	No
Sodium Hydroxide (NaOH) 50wtr% solution	Bulk tanker, 1000L IBC	Class 8	Corrosive substances	UN 1824	PG II (likely PG II at 50%)	<50	1	1000L IBC						
25% Ammonia (NH_3) water	Bulk tanker, 1000L IBC	Class 8	Corrosive substances	UN 2672	PG III (for concentrations between ~10–25%)	<50	1	1000L IBC						
Sulfuric Acid (H_2SO_4) 70% solution	Bulk tanker, 1000L IBC	Class 8	Corrosive substances	UN 2796	PG II	<50	1	1000L IBC						

[2] If quantities are below this level, the potential risk is unlikely to be significant unless the number of traffic movements is high

4.3 Other risk factors

Appendix 2 (b) of Applying SEPP 33 includes a checklist of information required to identify other risk factors. The details of other risk factors are provided in Table 4-3.

Table 4-3 Other risk factors

Other risk factors	Applicable (Yes or No)	Details
Any incompatible materials (hazardous and non-hazardous materials)	Potentially	The site handles a range of chemicals with known incompatibility, including • Sodium hydroxide (NaOH) (alkali) and sulfuric acid (H_2SO_4) (acid) • Ammonia and MEA (amines), which may form hazardous vapours or react with oxidizers or acids
Any wastes that could be hazardous	Potentially	The process may generate or concentrate: • MEA degradation products (e.g. heat-stable salts, nitrosamines) • Spent scrubber solutions (e.g. sodium sulfate or carbonate waste streams containing dissolved contaminants)
The possible existence of dusts within confined areas	No	None identified
Types of activities the dangerous goods and otherwise hazardous materials are associated with (storage, processing, reaction)	Potentially	The Project involves storage, processing, compression, reaction, and liquefaction of hazardous materials
Incompatible, reactive or unstable materials and process conditions that could lead to uncontrolled reaction or decomposition	Potentially	The Project requires hazardous materials that may pose chemical incompatibility and decomposition risks in an uncontrolled release event/failure
Storage or processing operations involving high (or extremely low) temperatures and/or pressures	Potentially	Even non-toxic gases, such as CO_2, become dangerous when stored in large volumes under pressure or at extreme temperatures
Details of known past incidents (and near misses) involving hazardous materials and processes in similar industries	Yes	There are documented asphyxiation and ammonia release incidents from CO_2 plants

4.4 Conclusion

The outcomes of this PRS confirm that the proposed storage of hazardous materials on site does exceed the screening thresholds specified in the Applying SEPP 33 guideline. On this basis, and in

the absence of safeguards, codes, and standards, the Project may be considered to constitute a ‘potentially hazardous industry’ under the Resilience and Hazards SEPP.

The PRS also assessed transport quantities of hazardous materials, which were found to be below the relevant SEPP 33 thresholds and therefore do not trigger additional transport assessment requirements.

The PRS has also considered other risk factors beyond simple threshold exceedances, including incompatible materials, potential for toxic gas generation, environmental hazards, and site-specific processing conditions. The presence of these additional risk factors, in combination with the exceedance of the storage thresholds, provides clear justification for the preparation of a PHA to support the Project’s development application.

5 Preliminary hazard analysis

5.1 PHA methodology

The methodology undertaken to prepare this PHA includes:

- Identification of the nature and scale of all hazards at the proposed development, and the selection of representative incident scenarios
- Analysis of the consequences of these incidents on people, property, and the biophysical environment
- Evaluation of the likelihood of such events occurring and the adequacy of safeguards
- Calculation of the resulting risk levels of the facility
- Comparison of these risk levels with established risk criteria and identification of opportunities for risk reduction.

A schematic of the hazard analysis process is included below in Figure 5-1.

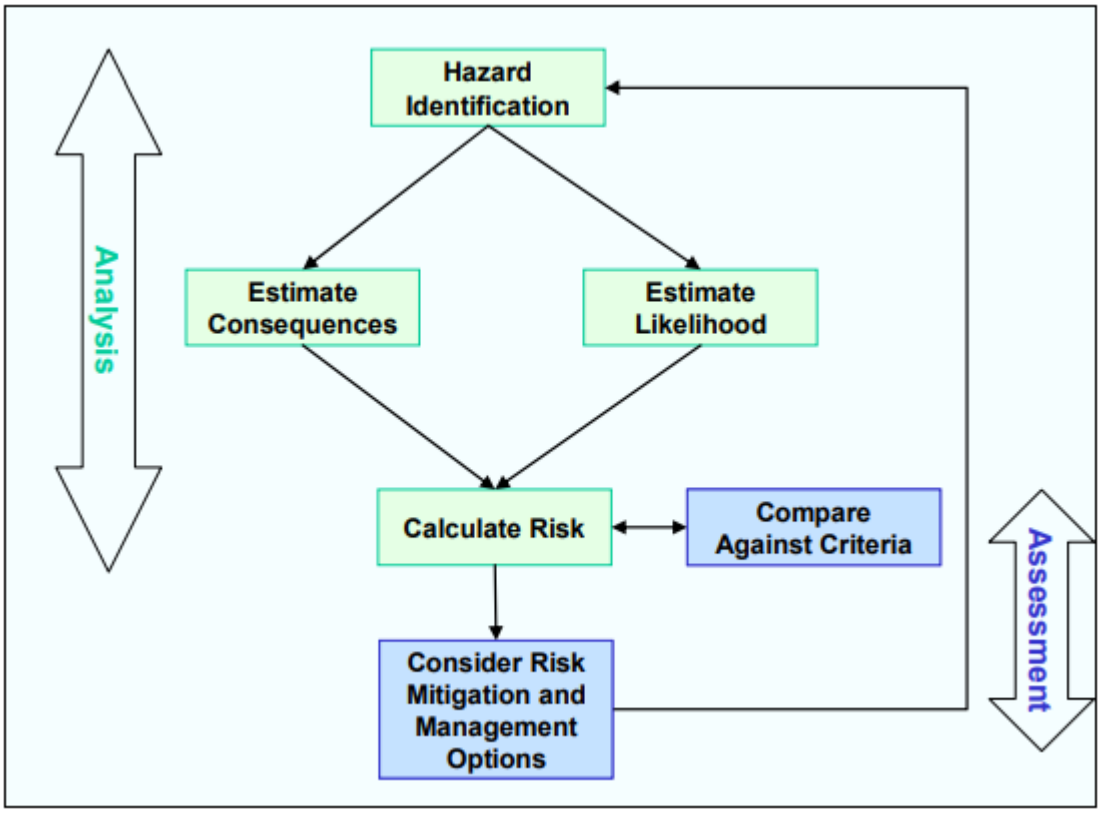

Figure 5-1 Basic methodology for hazard analysis (source: HIPAP 6)

5.2 Hazard Identification

Hazard identification includes the systematic identification of possible hazards, both on-site and off-site including:

- Operation of the Project
- Type of equipment
- Hazardous materials present
- Natural events such as floods, cyclones, earthquakes, or lightning strikes
- Hazardous events on neighbouring sites.

The identified hazards and events are presented in Table 5-4.

5.3 Consequence analysis

Consequence

For each identified event, the resulting consequence was qualitatively described and categorised in accordance with Table 5-1. These include impacts to personnel (e.g., fatality/injury), environment and/or assets.

Table 5-1 Consequence categories

Consequence category	Description
4 – Major	Fatality / permanent injury (on-site or off-site)

Consequence category	Description
3 – Moderate	Severe injury, hospitalisation, serious off-site exposure
2 – Minor	Minor injury or health impact, small, localised release
1 – Insignificant	First aid only, nuisance or procedural deviation

Likelihood

Using a qualitative approach, the likelihood of an event was estimated using the category scale shown in Table 5-2. The likelihood ratings were assigned based on knowledge of historical incidents in the industry. The likelihood ratings were assigned accounting for the initiating causes, resulting consequences with controls (prevention and mitigation) in place.

Table 5-2 Likelihood category

Category	Description
1. Extremely Unlikely	Never heard of in the industry, not realistically expected to occur
2. Very Unlikely	Heard of in the industry, but not expected to occur
3. Unlikely	Could occur in the next 10 years
4. Likely	Could occur in the next year

5.4 Hazard Register

The identified hazards, events, applicable infrastructure and the relationships with causes, consequences, controls, and likelihood ratings are summarised in the hazard register. Information contained in the hazard register is provided in Table 5-3.

The hazard register for the project is presented in Table 5-4.

Table 5-3 Information used in hazard register

Column Heading	Description
Hazard	Description of the source of potential harm
Event	Description of mechanism by which the hazard potential is realised
Cause	Description of the potential ways in which the event could arise
Consequence	Description of consequences of the event and potential impact to people, environment and/or asset
Controls	Any existing aspects of the design which prevent and/or mitigate against the event and resulting consequences
Likelihood Rating	Likelihood rating assigned for the event accounting for the initiating causes, resulting consequences with controls in place

Table 5-4 Hazard register

ID	Hazard	Event	Cause	Consequence	Controls	Likelihood
1	Pressurised CO_2	Sudden gas release	Seal failure / overpressure / hose rupture during loading	Asphyxiation, injury, cold burns	Pressure relief devices, leak detection, emergency stop, operator training	Unlikely
2	Cryogenic CO_2	Contact with skin or eyes	Exposure during maintenance or hose disconnection	Frostbite, cold burns	PPE, cold insulation, operator training, exclusion zones	Unlikely
3	MEA	Chemical spill	Pump seal leak or overfilling during top-up	Corrosive injury, inhalation hazard	Bunds, eyewash/showers, ventilation, spill response kit	Unlikely
4	Ammonia (NH_3)	Toxic gas release	Refrigeration loop failure, valve leak	Toxic exposure, evacuation	Gas detection, ventilation, automated isolation, operator training	Unlikely
5	Compressor	Mechanical failure	Overload, poor maintenance	Equipment damage, gas release	Preventative maintenance, vibration monitoring, automatic shutdown	Unlikely
6	Electricity	Electrical shock	Live work, faulty wiring, inadequate isolation	Injury/fatality	Lockout/tagout, isolation procedures, RCDs	Unlikely
7	Refrigeration system	Loss of cooling	Power failure or mechanical breakdown	CO_2 pressure rise, venting, loss of containment	Programmable Logic Controller (PLC) monitoring, fail safe shutdown, temperature monitoring, alarms	Unlikely
8	Chemical incompatibility	Uncontrolled reaction	Mixing NaOH with sulfuric acid or other incompatible chemicals	Heat, gas evolution, spill	Segregated storage, training, labelling, SOPs	Unlikely
9	WPPS – Fire	Fire in adjacent gas generators	Equipment failure, fuel leak, arc fault	Thermal radiation exposure to CO_2 plant, escalation to CO_2 storage	Separation distance, coordination of emergency response plans, fire monitoring	Unlikely
10	WPPS – Explosion	Explosion in gas generator enclosure	Gas leak and ignition	Blast wave impacting CO_2 plant equipment	Blast-resistant design features, separation, shared emergency response planning	Very Unlikely
11	WPPS – Electrical fault	Electrical arc or fault propagation	Fault in overhead supply or substation	Power loss to CO_2 plant, potential arc flash or equipment failure	UPS for critical systems, surge protection, interlocked shutdown systems	Unlikely
12	Substation – Fire	Fire in switchgear or transformer	Electrical fault, overheating, oil leak	Fire spread to adjacent areas, power interruption	Fire detection/suppression systems, separation, fire-rated enclosures	Unlikely
13	Substation – EMF	Prolonged personnel exposure to EMF	Working near transformers or busbars	Potential neurological effects from prolonged exposure	Limit access time, signage, low-exposure layout design	Extremely Unlikely
14	Absorber	MEA solution overflow or leak	Pump failure, valve malfunction, operator error	Chemical exposure, slip hazard, environmental contamination	Level alarms, bunding, pump interlocks, operator training	Unlikely
15	Absorber	MEA degradation by heat or oxidation	High reboiler temperature, poor heat exchanger control	Formation of harmful byproducts (e.g., nitrosamines)	Temperature control, solvent monitoring, periodic replacement	Unlikely
16	NOx Flash Polisher (DeNOx)	Contaminant release or rich MEA carryover	Flashing instability, excess steam, control failure	Release of NOx gases, poor CO2 product quality	Process monitoring, NOx gas handling design	Unlikely
17	Stripper	Reboiler overpressure or tube rupture	Fouling, blocked flow	Release of hot liquid/gas, potential MEA discharge	Pressure relief valves, temperature monitoring, regular maintenance	Unlikely
18	Gas Cooler / After	MEA carryover	Insufficient scrubbing or mist	Contamination of CO2 stream, emission	Scrubber design, mist eliminators, CO2 monitoring	Unlikely

ID	Hazard	Event	Cause	Consequence	Controls	Likelihood
	Scrubber		eliminator failure	to atmosphere		
19	CO_2 Compressor	Overheating or surge	Process upset, cooling failure, gas slugging	Damage to compressor, gas release, loss of containment	Interlocks, pressure/temp monitoring, staged compression	Unlikely
20	Dehydrator	Regeneration failure	Heater malfunction, purge gas loss	Moisture in product gas, corrosion downstream	Heater control, monitoring, use of non-corrosive stainless steel material	Unlikely
21	Activated Carbon Filter	Clogging or breakthrough	Poor maintenance, unexpected contamination	CO2 odour, off-spec product	Scheduled filter replacement, sampling and QA checks	Unlikely
22	CO2 Condenser	Inadequate cooling	Refrigeration failure or fouling	Incomplete condensation, pressure buildup	Continuous monitoring and maintenance	Unlikely
23	Distillation Column	Flooding or column upset	Flow imbalance, temp instability	Off-spec product, overpressure	Column control system, relief system, sampling	Unlikely
24	Storage Tank	Overfilling or pressure build-up	Refrigeration failure, valve malfunction	Vent release, tank rupture, CO_2 loss	High/low level alarms, pressure relief, using vacuum insulated storage tanks for minimising the pressure built-up	Unlikely
25	Flue Gas Pipeline	Pipeline rupture or leak	Mechanical failure, corrosion, overpressure	Hot gas release, plant shutdown	Pressure relief valves, use of non-corrosive stainless steel material, pipe supports, emergency shutdown	Unlikely
26	Flue Gas Scrubber	Chemical dosing failure	Pump fault, pH sensor failure, human error	Off-spec gas to absorber	Continuous monitoring, pH control alarms, operator training	Unlikely
27	Soda Ash (NaOH)	Spill or incorrect dosing	Handling error, delivery failure	Alkaline exposure to personnel, reduced scrubber efficiency	Bunded chemical storage, spill kits, dosing SOPs	Unlikely
28	Flue Gas Composition	Contaminant breakthrough	Inadequate scrubbing, scrubber bypass	Damage to downstream MEA loop, corrosion, off-spec CO_2	Gas quality monitoring, bypass interlocks, MEA guard system	Unlikely

6 Risk assessment

Risk is the likelihood of a defined adverse outcome. To calculate risk, it is necessary to consider the likelihood and the consequences of each of the hazardous scenarios identified.

Using a qualitative approach, the risk of an event was estimated using the study risk matrix shown in Figure 6-1.

For each identified hazard and associated event, the resulting consequences and likelihood pair was determined from the hazard register. The consequence and likelihood of the identified events are presented in Table 6-1.

			Likelihood			
			1 **Extremely Unlikely**	2 **Very Unlikely**	3 **Unlikely**	4 **Likely**
			Never heard of in the industry, not realistically expected to occur	Heard of in the industry, but not expected to occur	Could occur in the next 10 years	Could occur in the next year
Severity	4 **Major**	Fatality / permanent injury				
	3 **Moderate**	Severe injury / lost time				
	2 **Minor**	Minor injury / visit to doctor				
	1 **Insignificant**	Slight injury / first aid				

Risk Acceptance Criteria	
	High - Unlikely to be tolerable; review activity
	Medium - Tolerable if reasonably practicable
	Low - Broadly acceptable

Figure 6-1 Qualitative risk matrix

Table 6-1 Risk assessment

Hazard ID	Hazard	Event	Consequence (Impact to People, Environment, Asset)	Consequence Category	Likelihood	Risk	Risk Exposure Type
1	Pressurised CO_2	Sudden gas release	Asphyxiation, injury, cold burns	Major	Unlikely	Medium	Operational
2	Cryogenic CO_2	Contact with skin or eyes	Frostbite, cold burns	Major	Unlikely	Medium	Operational
3	MEA	Chemical spill	Corrosive injury, inhalation hazard	Moderate	Unlikely	Medium	Operational
4	Ammonia (NH_3)	Toxic gas release	Toxic exposure, evacuation	Moderate	Unlikely	Medium	Operational
5	Compressor	Mechanical failure	Equipment damage, gas release	Moderate	Unlikely	Medium	Operational
6	Electricity	Electrical shock	Injury/fatality	Major	Unlikely	Medium	Operational
7	Refrigeration system	Loss of cooling	CO_2 pressure rise, venting, loss of containment	Minor	Unlikely	Medium	Operational
8	Chemical incompatibility	Uncontrolled reaction	Heat, gas evolution, spill	Moderate	Unlikely	Medium	Operational
9	WPPS – Fire	Fire in adjacent gas generators	Thermal radiation exposure, escalation	Moderate	Unlikely	Medium	External
10	WPPS – Explosion	Explosion in gas generator enclosure	Blast wave impacting CO_2 plant	Moderate	Very Unlikely	Low	External
11	WPPS – Electrical fault	Electrical arc or fault propagation	Power loss, arc flash, equipment failure	Moderate	Unlikely	Medium	External

Hazard ID	Hazard	Event	Consequence (Impact to People, Environment, Asset)	Consequence Category	Likelihood	Risk	Risk Exposure Type
12	Substation – Fire	Fire in switchgear or transformer	Fire spread, power interruption	Moderate	Unlikely	Medium	External
13	Substation – EMF	Prolonged personnel exposure to EMF	Potential neurological effects	Major	Extremely Unlikely	Low	External
14	Absorber	MEA solution overflow or leak	Chemical exposure, slip hazard, contamination	Moderate	Unlikely	Medium	Operational
15	Absorber	MEA degradation by heat/oxidation	Formation of harmful byproducts	Moderate	Unlikely	Medium	Operational
16	NOx Flash Polisher (DeNOx)	Contaminant release or rich MEA carryover	Release of NOx gases, poor product quality	Moderate	Unlikely	Medium	Operational
17	Stripper	Reboiler overpressure or tube rupture	Release of hot liquid/gas, MEA discharge	Moderate	Unlikely	Medium	Operational
18	Gas Cooler / After Scrubber	MEA carryover	Contamination of CO_2 stream, emission	Minor	Unlikely	Medium	Operational
19	CO2 Compressor	Overheating or surge	Damage, gas release, loss of containment	Moderate	Unlikely	Medium	Operational
20	Dehydrator	Regeneration failure	Moisture in product gas, corrosion	Minor	Unlikely	Medium	Operational
21	Activated Carbon Filter	Clogging or breakthrough	CO_2 odour, off-spec product	Minor	Unlikely	Medium	Operational
22	CO2 Condenser	Inadequate cooling	Incomplete condensation,	Minor	Unlikely	Medium	Operational

Hazard ID	Hazard	Event	Consequence (Impact to People, Environment, Asset)	Consequence Category	Likelihood	Risk	Risk Exposure Type
			pressure buildup				
23	Distillation Column	Flooding or column upset	Off-spec product, overpressure	Minor	Unlikely	Medium	Operational
24	Storage Tank	Overfilling or pressure build-up	Vent release, rupture, CO_2 loss	Moderate	Unlikely	Medium	Operational
25	Flue Gas Pipeline	Pipeline rupture or leak	Hot gas release, plant shutdown	Major	Unlikely	Medium	Operational
26	Flue Gas Scrubber	Chemical dosing failure	Off-spec gas to absorber	Minor	Unlikely	Medium	Operational
27	Soda Ash (NaOH)	Spill or incorrect dosing	Alkaline exposure, reduced efficiency	Moderate	Unlikely	Medium	Operational
28	Flue Gas Composition	Contaminant breakthrough	Damage to MEA loop, corrosion, off-spec CO_2	Minor	Unlikely	Medium	Operational

7 Risk assessment results

7.1 Consequence

The risk assessment indicates that the majority of identified hazards fall within the Moderate consequence category, accounting for over half of all hazards. These relate primarily to chemical releases, process upsets, and equipment failures that could result in significant but manageable impacts on people, the environment, or assets.

A smaller proportion of hazards are classified as Major, typically involving high-risk scenarios such as toxic gas releases, pressurised CO_2 incidents, or electrical shock, which could lead to fatality or permanent injury.

The remaining hazards fall within the Minor consequence category, representing scenarios with limited impact, such as localised chemical exposure, equipment damage, or off-spec product. Importantly, no hazards were classified as Insignificant, reflecting that all identified hazards present at least a measurable level of consequence warranting management controls.

7.2 Likelihood

The risk assessment shows that almost all identified hazards were assessed as Unlikely, indicating that while the events are credible, they are not expected to occur frequently and could reasonably be expected only over a ten-year timeframe.

A smaller number of hazards were assessed as Very Unlikely, representing scenarios that have been heard of within the industry but are not realistically expected to occur at the facility.

Only one hazard was classified as Extremely Unlikely, reflecting a scenario that is considered highly improbable and not realistically anticipated within the industry.

Notably, no hazards were assessed as Likely, highlighting that the identified risks are predominantly low frequency in nature, with effective controls in place to minimise their probability of occurrence.

7.3 Risk assessment

The risk profile indicates that while the Project does involve hazards with potentially severe outcomes, the combination of predominantly Unlikely likelihood ratings and robust control measures ensures that risks are managed to an acceptable level.

Based on the industrial risk acceptance criteria, the risk profile for the Project is considered tolerable, given the measures taken As Low As Reasonably Practicable (ALARP) (refer to Figure 7-1.

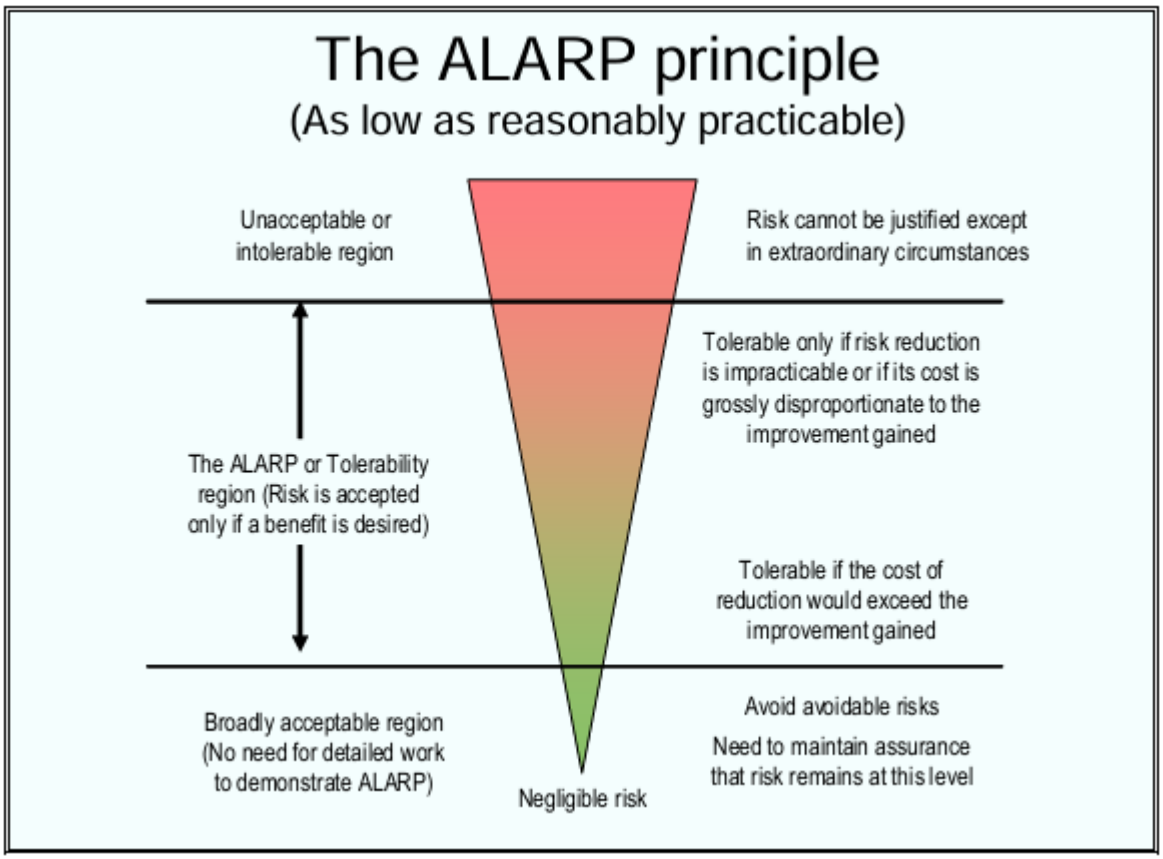

Figure 7-1 The ALARP principle (source: HIPAP4)

Considering the site location and assessment described in Section 2 including the size of the Project site, the proposed location of Project infrastructure within that footprint, the proposed controls, and the distance to neighbouring land uses (including neighbouring properties and agricultural operations), the identified risks will primarily affect the Project's operations workforce.

This risk assessment has determined that there is 'significant but not serious potential for harm' for offsite fatalities or injuries and the risk is ALARP.

8 Multi-level risk assessment

Multi-Level Risk Assessment (DoP, 2011) recommends a multi-level approach to risk assessment where the level and extent of the analysis reflect the nature, scale and location of the Project. The objective is to progress the analysis, and its assessment only as far as is needed to demonstrate that the operation of the Project does not or will not pose a significant risk to surrounding land uses. The approach is presented in Figure 8-1.

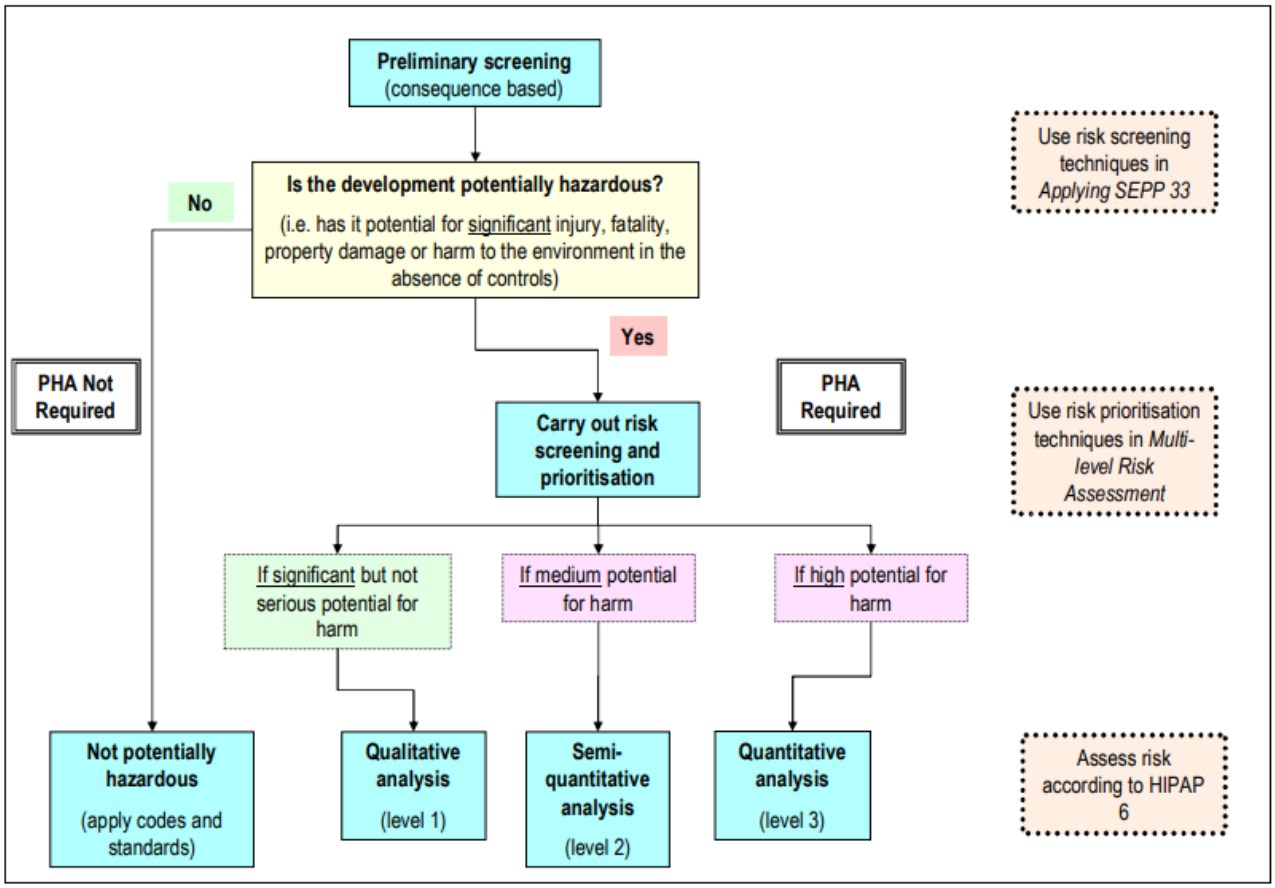

Figure 8-1 The Multi-Level Risk Assessment Approach (source: Muli-level Risk Assessment (DoP, 2011))

The levels of assessment include:

1. Level 1 is an essentially qualitative approach based on comprehensive hazard identification to demonstrate that the activity does not pose a significant off-site risk
2. Level 2 supplements the qualitative analysis by sufficiently quantifying the main risk contributors to show that risk criteria will not be exceeded
3. Level 3 is a full quantitative analysis.

As the Project is 'potentially hazardous and there is 'significant but not serious potential for harm' a Level 1 qualitative analysis has been completed. This is justified as the operation of the Project demonstrates societal risk in the negligible zone and there are no potential accidents with significant off-site consequences.

9 Conclusion

This PHA demonstrates that the risk levels associated with the Project do not impede the approval of the Project. The assessment confirms that the Project does not pose a significant off-site risk and that a Level 1 assessment is appropriate in accordance with the Multi-Level Risk Assessment framework (DoP, 2011).

The steps undertaken to prepare this PHA included:

- Identification of CO_2 plant hazards, analysis of potential incident scenarios arising from these hazards, and assessment of the resulting consequences for people, property, and the environment

- Estimation of the likelihood of hazardous incidents that could have significant consequences
- Development of recommendations for controls to mitigate the consequences and reduce the likelihood of potentially hazardous incidents.

Based on the risk assessment, it was determined that the risk profile for the Project is considered tolerable under the principle of ALARP. The risk profile indicates that while the Project does involve hazards with potentially severe outcomes, the combination of predominantly Unlikely likelihood ratings and robust control measures ensures that risks are managed to an acceptable level.

10 Recommendations

It is recommended that a Final Hazard Analysis (FHA) be undertaken at the detailed design stage to confirm that the final plant configuration, equipment specifications, and operating procedures are consistent with the findings of this PHA and to demonstrate that the risks continue to be managed to a level that is ALARP.