Creating safe environments

Preliminary Hazard Analysis

Tweed Valley Hospital

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Revision History

Date	Rev. No.	No. of Pages	Issue or Description	Checked By	Approved By	Date Approved
19/07/19	1	16	Initial issue PHA	N Browne	S Branca	19/07/19
09/08/19	2	18	Minor updates based upon client feedback	N Browne	S Branca	09/08/19
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10/09/19	4	18	Relocation of the diesel tank and pumps	N Browne	-	10/09/19
12/09/19	5	18	Updated drawings	N Browne	-	12/09/19
19/09/19	6	18	Title page revision	N Browne	-	19/09/19

1. Description of the Proposal

1.1 Overview

On the 11 June 2019 the Minister for Planning and Public Spaces granted approval for the Concept Proposal and Stage 1 Early and Enabling Works for the new Tweed Valley Hospital (SSD 9575) located at 771 Cudgen Road, Cudgen (Lot 11 DP1246853). All documents relating to this consent can be found on the major project website of DPE at https://www.planningportal.nsw.gov.au/major-projects/project/10756.

The Environmental Impact Statement (EIS) has been prepared to assist in the State Significant Development (SSD) Stage 2 Application for the Tweed Valley Hospital which will be assessed under Part 4 Division 4.7 of the Environmental Planning and Assessment Act 1979 (EP&A Act). This, along with supporting documentation, provides a clear outline of the Stage 2 Application.

The Tweed Valley Hospital Project broadly consists of:

- Construction of a new Level 5 major regional referral hospital to provide the health services required to meet the needs of the growing population of the Tweed-Byron region (in conjunction with the other hospitals and community health facilities across the region);
- Delivery of the supporting infrastructure required for the Tweed Valley Hospital, including green space and other amenities, roads and car parking, external road upgrades and connections, utilities connections, and other supporting infrastructure.

1.1.1 Stage 2 Hospital Main Works and Operation

The Stage 2 SSD component seeks consent for the Main Works and Operation of the Tweed Valley Hospital, including:

- **Construction of Main Hospital Building**
    - Main entry and retail area
    - Administration
    - Community health
    - In-Patient units
    - Outpatient clinics and day only units
    - Child and Adolescent Services
    - Intensive Care Unit
    - Mental Health Unit
    - Maternity Unit and Birthing Suites
    - Renal Dialysis
    - Pathology
    - Pharmacy
    - Radiation Oncology as part of integrated Cancer Care
    - Emergency Department
    - Perioperative Services
    - Interventional Cardiology
    - Medical Imaging
    - Mortuary
    - Education, Training, Research
    - Back of House services
    - Rooftop Helipad

- **Construction of Support Buildings, referred to as the 'Health Hub', containing:**
  - Oral Health
  - Community Health
  - Aboriginal Health
  - Administration
  - Education, Training and Research
- **Internal Roads and carparking, including multi-deck parking for staff, patients and visitors;**
- **Construction of a temporary building for the 'Tweed Valley Skills Centre'**
- **External road infrastructure upgrades and main site access**
- **Environmental and wetland rehabilitation, including rehabilitation of existing farm dam as outlined in the Biodiversity Development Assessment Report (BDAR) prepared for the Concept Proposal and Stage 1 works**
- **Site landscaping**
- **Signage**
- **Utility and service works**

The works outlined above comprise five key components, which are subject to various funding allocations and may be delivered independently to each other. Stage 2 has therefore been defined in the following sub-stages1:

- Stage 2A – Main Hospital Building complete with supporting roads, services infrastructure and landscaping
- Stage 2B – Main Hospital Building incremental expansion areas
- Stage 2C – Health Hub
- Stage 2D – Tweed Valley Skills Centre
- Stage 2E – Multi-deck car park.

Development consent is sought for the all 5 components of Stage 2 under this SSDA. Plans for Stage 2 Main Works and Operation are attached in Appendix B of the EIS. Approval of Stage 2 will enable the new Tweed Valley Hospital to be built which will provide a much-needed contemporary health service facilities for the surrounding region.

1.1.2 Potential Future Expansions

Any subsequent stages or modifications to the proposal would be subject to separate applications as required including the potential future expansion of the facility.

2. PHA Introduction

NSW Health propose to build a new, state of the art hospital on a greenfield site to meet the needs of the Tweed-Byron community.

In accordance with the Secretary's Environmental Assessment Requirements (SEAR's) request an analysis of the dangerous goods storage and vehicle movements indicated that the quantity threshold in the guideline 'Applying SEPP33' for all class 2.2/5.1 oxidising gases was exceeded. This concluded that the development would be classified as Hazardous and that a Preliminary Hazards Analysis (PHA) shall be prepared in accordance with the DoP Hazardous Industry Planning Advisory Paper No. 6 Hazard Analysis (HIPAP 6).

More than 93% of the quantity of class 2.2/5.1 oxidising gases is the cryogenic liquid oxygen storage. This PHA covers the risks associated with the bulk liquid oxygen installation at the proposed site.

3. Major Findings and Recommendations

The installation of bulk liquid oxygen tanks is common at major Australian hospitals for the supply of oxygen gas to wards and theatres.

It is proposed to install a 30,000 L liquid oxygen tank and a 3,000 L back-up tank with their Vacuum Insulated Evaporators (VIE)s. These will be located on the west side of the service road west with a lay-by for delivery vehicles, figure 1. Adjacent to the liquid oxygen enclosure will be an underground, 30,000 LPG tank.

The installation of the liquid oxygen tanks will be in accordance with the requirements of AS 1894.

The Preliminary Hazard Analysis identified that a slow leak from the oxygen tanks created very low risk to people and the environment.

A medium size leak of liquid oxygen or jet of oxygen gas could lead to cold burn injuries and a small increase to the flammability of nearby combustible materials. The design of the facility minimizes the risk of impact from vehicles with the tanks located well away from the traffic and a layby provided for delivery vehicles. Failure of a major component such as a seal or valve is more likely a manufacturing or installation error and is considered to be very unlikely with good commissioning of the facility. Regular maintenance inspections should identify small leaks before they become major. The overall risk for the design of the facility is considered to be low.

A catastrophic leak could occur due to major vehicle impact leading to an uncontrolled stream of liquid oxygen. Vehicle speed on the service road will be restricted decreasing the likelihood of a major impact that would cause significant damage. Also, the tank enclosure will be protected by traffic bollards.

An external fire could result in the overpressure disk releasing the pressure and venting significant quantities of oxygen. This would vigorously support the existing fire and compound the emergency. The liquid oxygen tank is protected by a vegetation buffer from a fire in the Environmental Area reducing the likelihood of a catastrophic leak. A fire in the multideck car park is separated by 17 m from the tanks requiring a large fire before heat radiation could impact the liquid oxygen tanks.

The likelihood of these catastrophic scenarios is considered to be rare and the overall risk to people and the environment for the facility is low.

No further assessment is required.

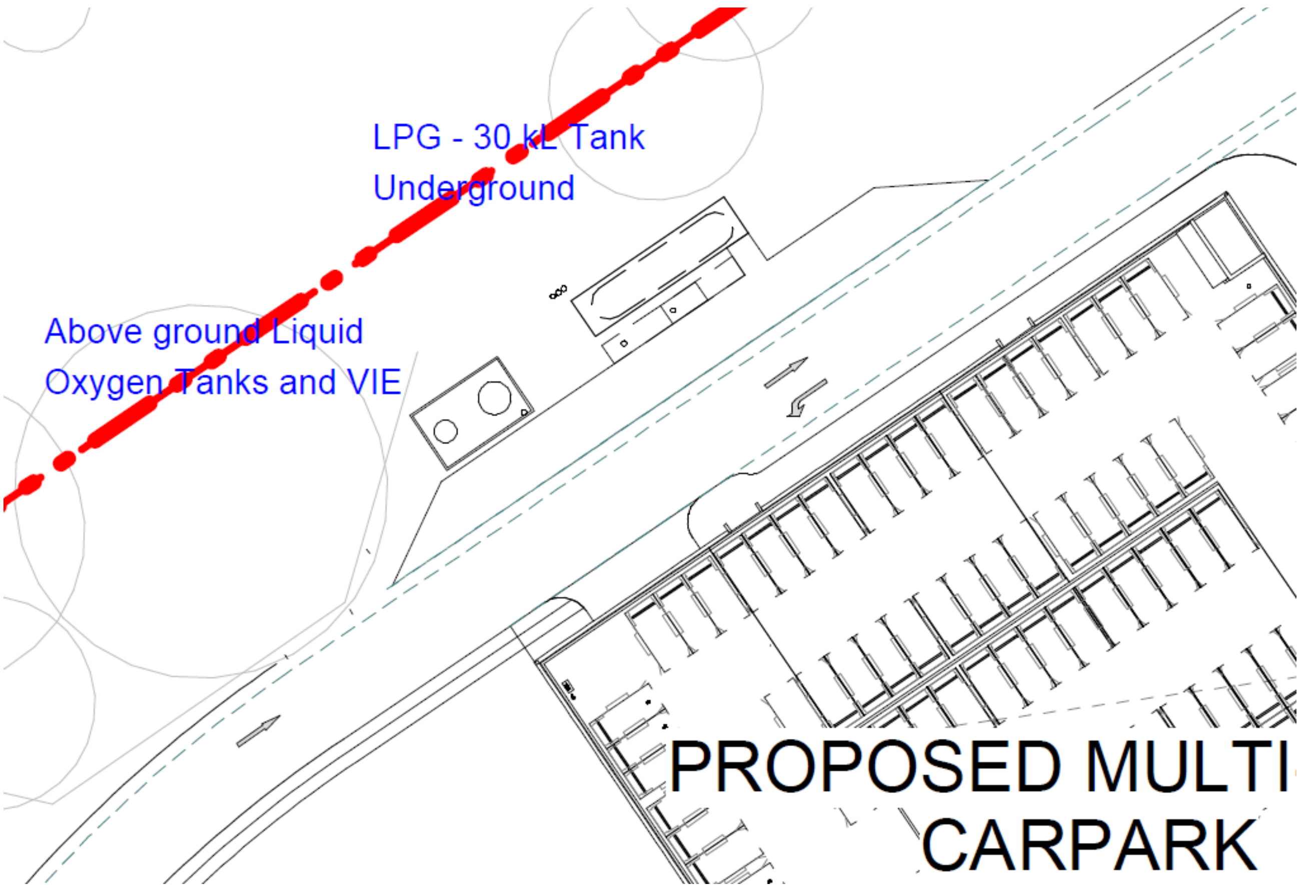

Figure 1. Proposed location for the liquid oxygen enclosure and adjacent LPG tank.

4. Site Description

4.1 Location

The hospital will be located at 771 Cudgen Road (Lot 11 DP 1246853) opposite the Kingscliff TAFE, figure 2. This is on the outskirts of Kingscliff, NSW, figure 3.

The liquid oxygen bulk tank will be located on the western side of the proposed site.

Figure 2. Proposed site for the hospital – farmland north of the Kingscliff TAFE.

Figure 3. Kingscliff and regional surrounds.

4.2 Surrounding Land Uses

Directly across the road to the south of the site is the Kingscliff TAFE.

North of the site is an environmental area. The proposed location for the liquid oxygen tank is outside of the bush fire zone, figure 4. A 10 m wide agricultural buffer will be maintained between the hospital site and the environmental area.

West of the site is open pasture with the township of Cudgen approx. 250 m away, figure 2.

Kingscliff suburbs extend to the east boundary of the hospital site, figure 3.

On site, the liquid oxygen tank will be opposite the open pasture to the west and a multistorey car park on its east side, figure 4.

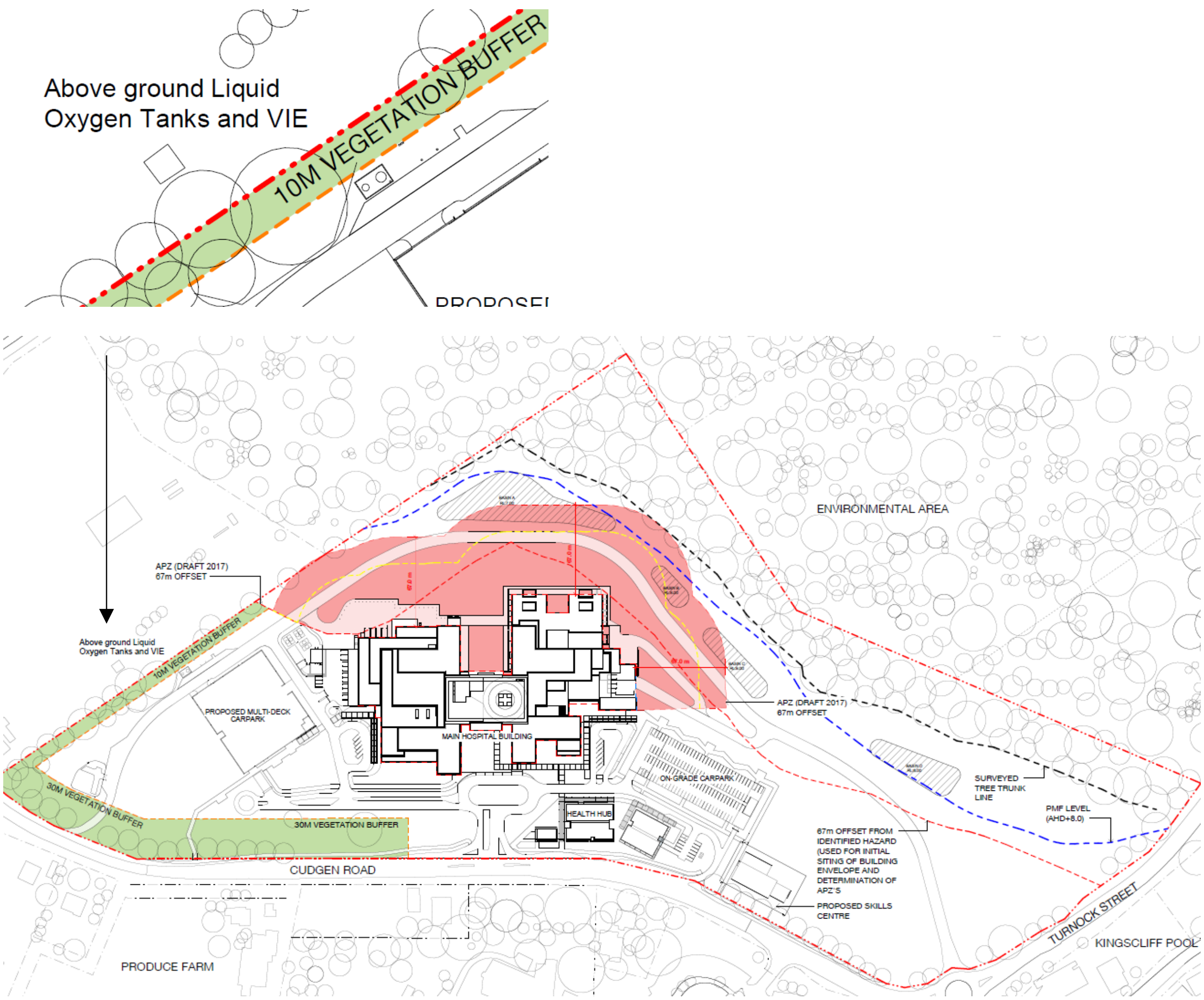

Figure 4. Location of liquid oxygen enclosure outside of the bushfire zone.

4.3 Prevailing Wind Directions

The Bureau of Meteorology has a weather station at Coolangatta which is 13 km from the hospital site. The wind rose data indicates that the annual average prevailing wind direction in the mornings are from the south whereas in the afternoon they are from the north to north east.

These are in accordance with those reported in the Aviation Report.

5. Compliance

The liquid oxygen vessels will be designed in accordance with the requirements of AS 1894. The underground LPG tank will be nearby and separation from the liquid oxygen tanks will comply with requirements of AS/NZS 1596 also.

5.1 Separation Distances

The separation distances of the liquid oxygen tanks from incompatible activities are described in Table 1. For the adjacent LPG tank and connections, the separation distances to the liquid oxygen tanks are described in Table 2. With an underground installation of the LPG the proposed locations will meet these separation requirements, figure 5.

Table 1. Separation of liquid oxygen tanks from incompatible activities, AS 1894

Separation	Distance (Tank >30,000 L)
Minimum separation from fittings, e.g. valves, unions, flanges, in pipeline containing flammable gas	6 m
Continuous section of pipeline containing flammable gas or liquid, not interrupted by fittings, e.g. valves, unions, flanges	6 m
Minimum separation from flammable gas (>20,000 L LPG)	to be determined by risk assessment (AS 1894, Table 4.2)

Table 2. Separation of LPG from incompatible activities, AS/NZS 1596

Separation	Distance (Tank >30,000 L)
Above ground tank to a store of any oxidising substance, clause 6.2.5	6 m
Above ground tank to a store an on-site protected place, AS/NZS 1596, Table 7.1	No specific requirement
Remote connections to an underground tank, clause 6.6.7(c)	12 m, except that, where the loss of liquid upon disconnecting the coupling is less than 1 L, the minimum distance shall be 3 m to a public place or 6 m to a protected place.

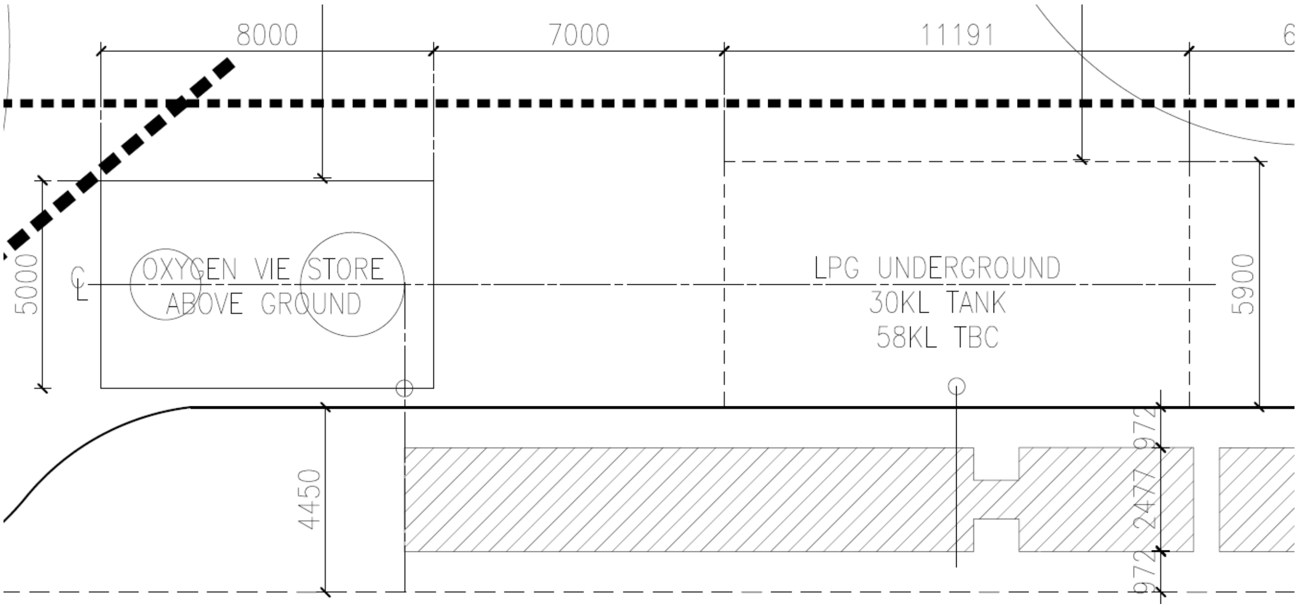

Figure 5. Separation of liquid oxygen tanks and underground LPG tank.

6. Hazard Identification

6.1 Hazards of Enriched Oxygen Atmosphere

Short term exposure to highly oxygen enriched air has, as a rule, no adverse effects on people.

Long term exposure can cause hyperoxia which is an excess of oxygen in body tissues. Symptoms may include disorientation, breathing problems and vision changes such as myopia.

Prolonged exposure to high levels of oxygen, or shorter exposure to very high levels, can cause oxidative damage to cell membranes, collapse of the alveoli in the lungs, retinal detachment and seizures. This is extreme for the proposed usage and very unlikely to occur.

Oxygen toxicity is managed by reducing the exposure to increased oxygen levels. In the long term a robust recovery from most types of oxygen toxicity is possible.

Oxygen is also very reactive. Pure oxygen from a high pressure source can react violently with common materials, like oil and grease. Other materials will burn vigorously, including rubber, textiles (e.g. clothing) and even metals. Some materials may ignite spontaneously in a highly enriched atmosphere.

There is also a risk associated with high oxygen content air being drawn up the exhaust ventilation system and reacting with the oils, greases and metals of the fan motor causing a fire.

SafeWork SA have reported that 30% oxygen in the atmosphere will cause things to burn or explode 8 times faster.

The Australian Standard for Confined Spaces defines the safe oxygen range as having a minimum of 19.5% by volume and a maximum of 23.5% by volume under normal atmospheric conditions.

The main danger to people from an oxygen enriched atmosphere is that clothing or hair can easily catch fire, causing serious or fatal burns. People who are exposed to an enriched atmosphere must be removed to fresh air and ventilate their clothes and hair thoroughly. They should be kept away from ignition sources until their clothes are fully aired.

6.2 Hazard Scenario Descriptions

Location	Hazard	Consequence		Risk Rating – No Controls	Risk Mitigation Strategies	Residual Risk – With Controls
		On-site	Environment			
Liquid Oxygen Tank - Delivery	Loss of containment of liquid oxygen during delivery	Gas could cause respiratory ailment to operators Contact with skin or eyes causing cold burns Increased flammability of combustible materials, including clothing.	Escape into local drains or waterways Small amount may flow on hardstand, but it would evaporate rapidly, adding gaseous oxygen to the atmosphere and causing minimal or no harm to organisms	Medium	• At least 5 m to openings to underground services • Limit delivery quantity to reduce potential magnitude of loss of containment • Emergency Response Plan • PPE supplied • Spill kits provided • Good natural ventilation • Safety shower/eyewash to be provided	Low
Transfer Area	Spill during transfer	Combustion of oil or grease on the hardstand causing fire.	Minimal from smoke.	Low	• Concrete hardstand constructed in accordance with AS 1894. • Hardstand kept clean and gravel free.	Low

Location	Hazard	Consequence		Risk Rating – No Controls	Risk Mitigation Strategies	Residual Risk – With Controls
		On-site	Environment			
Liquid Oxygen Tank – valves and fittings	Slow leak	Gradual but substantial increase in the oxygen content of the local atmosphere Clothing and nearby combustible materials become more highly combustible in an elevated oxygen atmosphere	Minimal – enriched oxygen atmosphere in the environment surrounding the site	Medium	• Gas tank enclosure is open to the atmosphere, diluting leaked oxygen. • Gas tank enclosure is over 8 metres from the site boundary rendering environmental risk low. • A source of cold water is provided for thawing frozen valves.	Low
Liquid Oxygen Tank – Catastrophic Leak	Vehicle Impact	Vehicle impact from a vehicle could damage the tank or pipework causing a serious leak of liquid oxygen. Large cloud of condensed water creates fog in the direction of the prevailing wind causing further vehicle accidents with pedestrians, other vehicles or structures.	Small amount may flow on hardstand, but it would evaporate rapidly, adding gaseous oxygen to the atmosphere and causing minimal or no harm to organisms	Medium	• Bollards to be provided • Ample road width for trucks to pass each other at the narrowest point, even if two trucks were passing simultaneously. • Delivery truck parks off the circulation road. • The swept paths of trucks do not require turning at the narrowest point. • Emergency response plan includes closing openings to all buildings and shutting air intakes in direction of the plume. Evacuation of all people in the path of the plume.	Low

Location	Hazard	Consequence		Risk Rating – No Controls	Risk Mitigation Strategies	Residual Risk – With Controls
		On-site	Environment			
Adjacent LPG tank	LPG reacting with oxygen – fire hazard	A leak from the LPG tank in the presence of an enriched-oxygen atmosphere could cause a jet fire on the LPG tank above ground connections. A BLEVE of the underground LPG tank is extremely unlikely.	Risk of fire introduces the potential for smoke generation, which may adversely affect organisms in the area.	Medium	• The LPG tank and the liquid oxygen tank are separated by at least 7 m in accordance with AS 1894 and AS 1596. • Relocation of diesel tank allows for extra separation from the LPG tank. • Emergency response procedure for leaks from LPG tank. • Control of ignition sources around the LPG tank connections.	Low
Oxygen Supply Pipe	Damage to pipe	Future works local to liquid oxygen pipework could damage or rupture the pipework, causing a serious leak of liquid oxygen.	Minimal – enriched oxygen atmosphere in the environment surrounding the site	Medium	• Detailed as-built drawings – this is a green field site. • VIE is located in the liquid oxygen enclosure and separated from other hazards.	Low
Liquid Oxygen Tank & VIE	External Fire	Damage to fittings with release of oxygen will vigorously support the fire escalating the seriousness of the fire.	Spread of fire to the Environmental Area	Low	• Fire detection and alarm • Overpressure disk will release pressure to prevent BLEVE. • Early response to external fire.	Low

7. Consequence Analysis

7.1 Slow Leak

A slow leak of oxygen gas from a flange, valve, coupling, etc. would enrich the local atmosphere. Outdoors, this would be a negligible increase in the oxygen content having no adverse effects on people.

Materials that are normally of low combustibility can become highly flammable in an oxygen enriched atmosphere. Dilution in the outdoors atmosphere would result in a negligible increase in the oxygen content and negligible increase in flammability of combustible materials.

Exposed skin that comes into contact with the leaking gas may suffer cold burns requiring medical attention.

7.2 Medium Leak

A medium size leak would involve a small jet of oxygen gas or minor flow of liquid oxygen. This would rapidly enrich the local atmosphere and is unlikely to be dispersed rapidly by natural ventilation alone.

The main danger to people from an oxygen enriched atmosphere is that clothing or hair can easily catch fire, causing serious or fatal burns. People who are exposed to an enriched atmosphere must be removed to fresh air and ventilate their clothes and hair thoroughly. They should be kept away from ignition sources until their clothes are fully aired.

Spilled oil or grease may ignite in the oxygen enriched atmosphere. Where other combustible materials are kept away from the tank and VIE the fire would likely remain at a size that can be readily extinguished using water or portable fire extinguishers.

Exposed skin that comes into contact with the leaking gas or liquid would likely suffer severe cold burns requiring emergency level medical response.

7.3 Catastrophic Leak

Leak from an open valve on the tank or delivery vehicle will result in a cloud of cold oxygen expanding out from the enclosure. This generates a thick fog which is difficult to see through.

The cloud of oxygen will flow downhill and in the direction of the prevailing breeze. Combustible material in the path of the cloud will become highly flammable and an ignition source will likely cause a fire. The leaked oxygen will vigorously support the fire.

There are no permanently occupied buildings within 73 m of the liquid oxygen tank and VIE. The nearest major building is the Central Engineering Plant, figure 6. The multistorey car park is separated by at least 17 m and a fire would need to escalate to a major conflagration before heat radiation could impact the liquid oxygen tanks. Neither of these buildings are permanently occupied.

Exposed skin that comes into contact with the spilled liquid would likely suffer severe cold burns that could be life threatening.

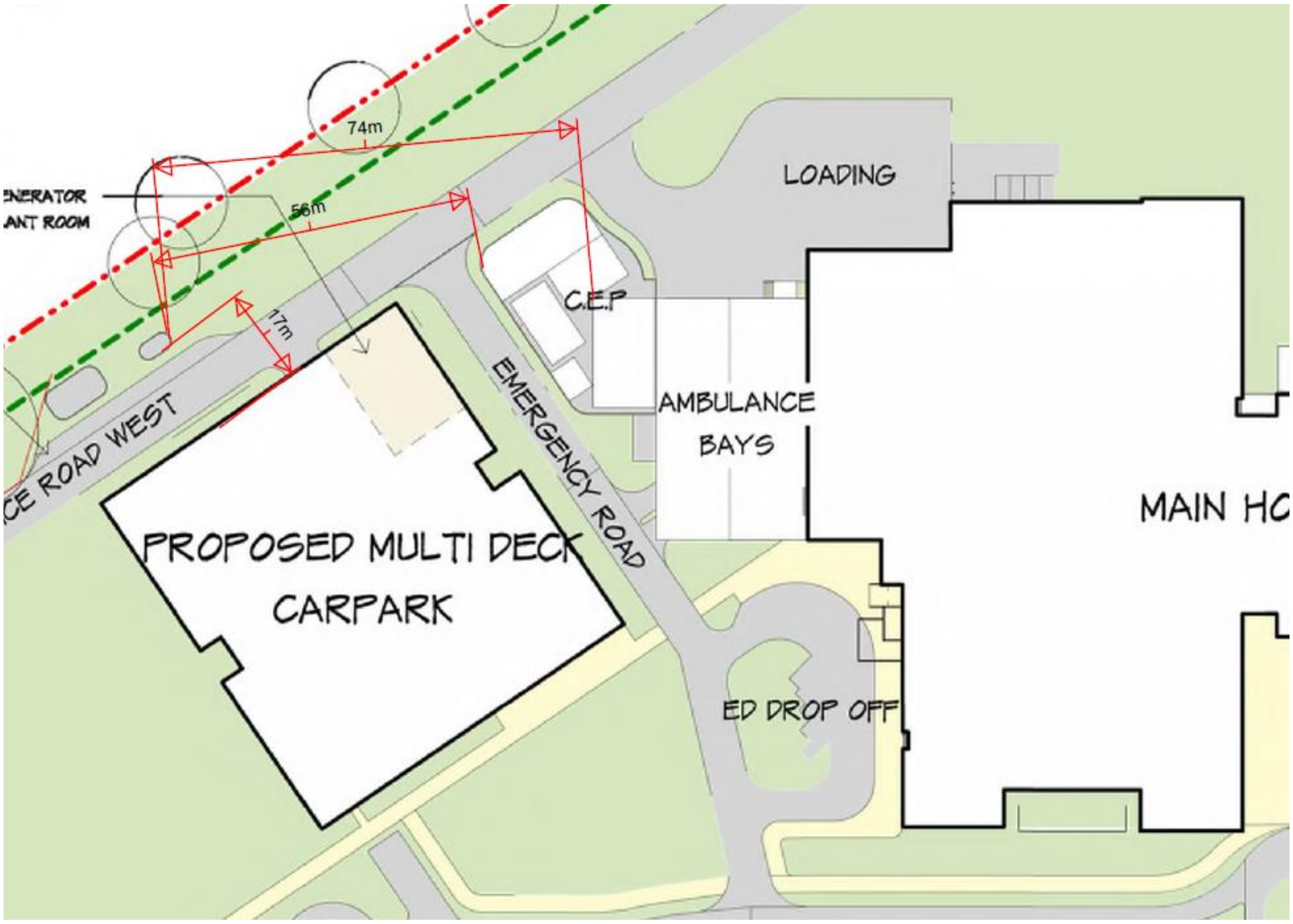

Figure 6. Proximity of the liquid oxygen enclosure to other buildings.

8. Likelihood Analysis

8.1 Slow Leak

A slow leak of oxygen gas from a flange, valve, coupling, etc. would most likely be due to poor maintenance, poorly fitted seal, etc., poor connection during filling operation or minor damage. These are mainly human errors of commission with a moderate probability (1 in 1,000).

8.2 Medium Leak

A medium size leak would involve a small jet of oxygen gas or minor flow of liquid oxygen.

This would most likely be due to damage to pipework or failure of a major seal.

Damage to pipework could be accidental e.g. vehicle impact or operation of power tools nearby or deliberate act by a person intent on causing serious harm to the hospital. These are not common causes and have a probability rating of unlikely (1 in 10,000).

Failure of a major component such as a seal is more likely a manufacturing or installation (e.g. upside down seal) error that would be difficult to conceive how they would occur. The probability of such error is rare (1 in 100,000). Regular maintenance inspections should identify small leaks before they become a major leak and allow for rapid repairs to be undertaken.

8.3 Catastrophic Leak

There are a number of ways that a catastrophic leak could occur.

Major impact of a vehicle (accidental or deliberate) to the main pipework of the tank would cause an uncontrolled stream of liquid oxygen. Vehicle speed on the service road will be restricted decreasing the likelihood of a major impact that would cause significant damage. The tank enclosure will be protected by traffic bollards. The probability of such an event is rare (1 in 100,000).

Heat radiation from an external fire could cause serious increase in pressure inside the tank. The overpressure disk will release the pressure but expel significant quantity of oxygen which will support the existing fire. This is a self-feeding mechanism that would rapidly cause failure of other parts of the assembly leading to release of liquid oxygen. The liquid oxygen tank is protected by a vegetation buffer from a fire in the Environmental Area reducing the likelihood of a catastrophic leak. A fire in the multideck car park is not protected by an automated sprinkler system if under 25 m but is separated by 17 m from the liquid oxygen tank. The probability of such an event due to fire is rare (1 in 100,000).

9. Conclusion

Installation of the 30,000 L and the 3,000 L liquid oxygen tanks in accordance with the requirements of AS 1894 will provide a safe working environment and protect the surrounding land uses in the opinion of the author.

The major risks identified were from

- Impact damage by a vehicle
- Failure of a major equipment component (manufacturing or installation error)
- Heat radiation from an external fire

The preliminary risk assessment has considered these risk scenarios and determined that the overall risk of operation in the proposed location is low with implementation of the risk controls.

No further assessment is required.

10. References

Document	Revision	Description
STB-AR-SKE- PRW-1000021	1	Site Setback Conditions
STB-AR-SKE- PRW-1000015A	1	Proposed Site Plan
Sketch including multiple plans		LCI suggested bulk oxygen VIE position
Avipro	14/08/19	Aviation Report
AS/NZS 1596	2014	The storage and handling of LP Gas
AS 1894	1997	The storage and handling of non-flammable cryogenic and refrigerated liquids
AS 1940	2017	The storage and handling of flammable and combustible liquids
AS 2865	2009	Confined Spaces
AS/NZS 60079.10.1	2009	Explosive atmospheres, Part 10.1: Classification of areas – Explosive gas atmospheres