Prepared for Risen Energy Australia Pty Ltd

Waste Assessment

Hillston Solar Farm

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Acronyms and abbreviations

ABRI	Australian Battery Recycling Initiative
AC	Alternating current
BESS	Battery energy storage system
CSC	Carrathool Shire Council
CCTV	Closed-circuit television
DA	Development application
DC	Direct current
DPI	NSW Department of Primary Industries
ENM	Excavated natural material
EoL	End of life
EPA	Environment Protection Authority
EPBT	Energy Payback Time
EPI	Environmental Planning Instrument
ha	hectare
HV	High voltage
ISEPP	State Environmental Planning Policy (Infrastructure) 2007
km	kilometre
kV	kilovolt
LCA	Life Cycle Analysis
LEP	Local Environmental Plan
LGA	Local Government Area
L	litres
MW	Megawatt

m	metre
NEM	National Energy Market
NSW	New South Wales
POEO Act	Protection of the Environment Operations Act 1997
POEO Waste	Protection of the Environment Operations (Waste) Regulation 2014
PV	Photovoltaic
PVC	Poly-vinyl chloride
sqm	Square metre
t	tonnes
VENM	Virgin excavated natural material
WAR	Waste Assessment Report (the report)
WARR Act	Waste Avoidance and Resource Recovery Act 2001
WMP	Waste Management Plan

1. Introduction

1.1. Overview

Risen Energy Australia Pty Ltd (Risen Energy) is seeking development consent from Carrathool Shire Council (CSC) for a proposed five (5) megawatt (MW) solar farm and ancillary battery energy storage system (BESS) located at 10738 Kidman Way, Hillston. The site is located approximately 3.5 km south of the of the town of Hillston (refer to Figure 1-1).

The proposed solar farm project details are outlined in Table 1-1.

Table 1-1 Project details

Element	Description
Development	Hillston Solar Farm
Lot / DP(s)	Lot 63 DP664722
Street address	10738 Kidman Way, Hillston 2675
Local Government Area	Carrathool Shire Council
DC capacity	Approximately 7 MW
AC capacity	Approximately 5 MW
Subject land	251.9 hectares (ha)
Land use	Agricultural land historically used for cropping

1.2. Scope

CSC has requested that a Waste Assessment Report (WAR) is prepared for the proposed solar farm.

This WAR was prepared by Martin Whyburn, Graduate Environmental Consultant, who holds a Bachelor of Environmental Science (Conservation Management). The preparation of the WAR was directed and reviewed by NGH Principal Environmental Consultant, Olivia Merrick. Olivia has a Master of Laws (LLM), Construction and Bachelor of Engineering (Env), Environmental Science (Hons) and over 20 years of experience developing site standards for and ensuring compliance with environmental conditions for major construction projects. Olivia is a certified Lead Auditor with a technical background in environmental management including acid sulphate soils, drainage erosion and sediment control, waste management, land capability and reinstatement requirements.

This report outlines:

- An assessment of relevant waste legislation that is applicable to the proposed development.
- A prediction of the development waste streams and volumes.
- A desktop review of available waste disposal facilities.
- A detailed waste management and minimisation principles in reference to waste hierarchy.
- A life cycle analysis of development waste.
- Waste mitigation recommendations for the proposal.

Figure 1-1 Locality of the proposed development (NGH, 2023)

2. The proposed development

2.1. Overview

The construction and operation of the proposed development is approximately 3.5 km to the south of the township of Hillston, in the Carrathool Local Government Area (LGA). The subject site is currently used for cropping. The surrounding area is predominantly rural land used for similar agricultural activities.

The proposed development would have an approximate 5 MW capacity, providing energy to the National Energy Market (NEM) grid. Connection to the grid via a new 33 kilovolt (kV) switching station and above-ground t-connection to the existing 33 kV line that runs parallel to the northern boundary of the subject site.

2.2. Proposed development

Key features of the proposed development are summarised in Table 2-1 below. Note that component specifications are subject to further detailed design and final product selection.

Table 2-1 Summary of proposed development

Element	Description
Capacity of the solar farm	7.2 MW DC / 4.998 MW AC
Development site	Approximately 17 ha solar facility infrastructure area.
Solar array	Approximately 10, 300 solar photovoltaic (PV) cells on a ground-mounted tracking system of pole driven steel posts.
Electrical infrastructure	2x SMA MVPS-2660 inverters (or similar) 5 MW / 10 MWh BESS On-site switching station Static volt-ampere reactive (VAR) generators Underground cabling.
Grid connection infrastructure	Onsite overhead line directly to the Essential Energy 33 kV powerlines within the subject land.
Temporary construction site compound	Material laydown areas Construction site offices, generator and skip bins with wind shield and lid Car and bus parking areas for construction workers

	Staff amenities building and portable toilet/s CCTV at construction compound Waste management areas.
Fencing, CCTV, and lighting	Standard wire mesh fencing approximately 2 m high around the perimeter. Infra-red security technology and CCTV cameras may be installed on posts around the perimeter fence and on the main access track.
Landscaping	Landscaping on the northern side of the array and part of the western property boundary would require planting zones (5 m wide with planting shrubs 1 – 2 shrubs deep) to be established and planted out at the commencement of construction.
Construction hours	Standard daytime construction hours would be 7:00am to 6:00pm Monday to Friday and 7:00am to 1:00pm on Saturdays.
Construction duration	Approximately 12 months.
Workforce	Construction – approximately 30 – 40 workers at peak construction. Operation – 2-4 full-time equivalent staff. The solar farm would be monitored remotely from an off-site location with staff only visiting on an as-needed basis.
Operation period	Up to 50 years.
Decommissioning	The site would be returned to its pre-developed state. All areas of soil disturbance would be rehabilitated during decommissioning, consistent with land use requirements. All above ground infrastructure would be removed to a depth of 500 mm.
Capital investment value	Calculated at approximately $16 million

3. Legislative context

Waste management is an integral part of the construction, operation, and decommissioning phases of the proposed development. There are several related legislative instruments that are applicable to the proposal.

3.1. Protection of the Environment Operations (POEO) Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) aims to protect, restore, and enhance the quality of the environment in New South Wales (NSW), while still having regard to the need to maintain ecologically sustainable development.

With relevance to waste management, the POEO Act aims to reduce risks to human health and to prevent degradation of the environment through pollution prevention and encouraging a reduction in the use of materials through the re-use, recovery, and recycling of materials. The POEO Act contains the requirements for management of waste and the offences relating to improper management resulting in pollution. Section 148 of the Act requires that the relevant authority [(i.e. NSW Environment Protection Authority (EPA)] must be notified about any pollution incidents that pose a risk to the environment.

Section 143 states that waste is required to be transported to a licenced facility that can legally accept it. It is an offence under Section 115 to negligently dispose of any waste that may harm the environment, or knowingly transport and dispose of waste to a facility that cannot be used for the waste.

Waste classification definitions are outlined in the Act, and further information is provided in the EPA Classification Guidelines (EPA 2014) (Section 3.4).

Wastes that may be generated as part of the construction and decommissioning stages of the proposed development, including 'building and demolition waste' as defined in the Act and includes unsegregated material resulting from activities. Materials including metal, timber, bricks, concrete, glass, plastics, and paper are included in that category.

3.2. Protection of the Environment Operations (Waste) Regulation 2014

The *Protection of the Environment Operations Waste Regulation 2014* (POEO Waste Regulation) aims to protect human health and the environment and provides the framework for NSW waste industries. The POEO Waste Regulation prescribes the wastes (hazardous waste, restricted solid waste etc) that are inherently deemed as land pollution with the individual guilty of an offence if the waste is dumped illegally.

3.3. Waste Avoidance and Resource Recovery Act 2001

The *Waste Avoidance and Resource Recovery Act 2001* (WARR Act) aims to encourage efficient use of resources and to reduce environmental harm. The WAR has been prepared in accordance with the WARR Act. The proposed development has considered the following:

- Avoidance of unnecessary resource use
- Resource recovery (including reuse, reprocessing, recycling and energy recovery)
- Disposal

Risen Energy has an obligation to minimise harm to the environment as a result of the construction, operation and decommissioning of the proposed development, which is detailed in Section 6 of this report.

3.4. EPA Waste Classification Guidelines

The EPA Waste Classification Guidelines (EPA 2014) encompass four parts:

- **Part 1:** Classifying Waste;
- **Part 2:** Immobilisation of waste;
- **Part 3:** Waste containing radioactive material; and
- **Part 4:** Acid sulphate soils.

Part 1 of the guidelines provide details on all of the waste classification that are defined in section 49 of Schedule 1 of the POEO Act:

- Special waste
- Liquid waste
- Hazardous waste
- Restricted solid waste
- General solid waste (putrescible)
- General solid waste (non-putrescible)

The proposed development's classification of waste is discussed in more detail in Section 4 of this report.

3.5. Carrathool Local Environmental Plan 2012

The Carrathool Local Environmental Plan (LEP) 2012 aims to make local environmental provisions for land in Hillston in accordance with relevant environmental planning instruments (EPI). The LEP does not discuss any specific waste management conditions.

4. Proposal waste streams and volumes

Waste streams that may be generated across the stages of the proposed development are listed below and detailed further in Table 4-1.

4.1. Construction and operation

Potential waste streams during the construction and operational stages include:

- Excavation wastes, including rock and soils.
- Vegetation wastes, from construction (clearing) and maintenance of the facility.
- Packaging materials associated with items delivered to site such as pallets, crates, cartons, plastics and wrapping materials.
- Wastes produced from the cleaning, repairing and maintenance of various heaving construction equipment, including liquid hazardous wastes.
- General wastes including office wastes, scrap materials, broken equipment/ machinery and biodegradable wastes.
- Chemicals and oils.

4.2. Decommissioning

Potential waste streams during the decommissioning stage includes:

- Solar panels and mounting systems.
- Metals from posts and fences.
- Cabling.
- Inverters, transformers, and similar components.
- BESS components including lithium-ion batteries.
- Demolition wastes, such as concrete.
- Wastes produced from the cleaning, repairing and maintenance of various heavy construction equipment, including liquid hazardous wastes.
- General wastes including office wastes, scrap materials, broken machinery, and biodegradable wastes.
- Chemicals and oils.

Table 4-1 Estimated proposed waste streams and volumes

Activity / material	Waste Type	Waste Classification	Approx. annual quantity	Storage and treatment onsite	Proposed reuse /recycling/disposal methods	Reuse/ Recycle target
Construction and/or operation						
Office / staff operations	Paper, cardboard, recyclable plastic, soft plastic	General solid waste (non-putrescible)	800 litres (L)	Separate Bins emptied into secured comingled bulk bins.	Resource recovery off-site - reprocessing at an appropriately licensed waste facility in accordance with the *Waste Classification Guidelines*.	100%
	Glass and aluminium	General solid waste (non-putrescible)	200 L	Separate Bins emptied into secured comingled bulk bins.	Resource recovery off-site - reprocessing at an appropriately licensed waste facility in accordance with the *Waste Classification Guidelines*.	100%
	Food waste	General solid waste (non-putrescible)	600 L	Separate Bins emptied into secured comingled bulk bins.	Disposal off-site at an appropriately licensed waste facility in accordance with the *Waste Classification Guidelines*.	0%
	Effluent	Liquid	300 L	Holding tank	Off-site disposal, collected with bulk effluent tanker	0%
Site establishment	Removal of existing fences/ boundary features	General solid waste (non-putrescible)	0.2 tonnes (t)	Stockpile	Off-site recycling. Loaded into tipper or flatbed truck	100%
Earthworks	Excavated material VENM/ENM	Classification based on soil tests carried out during	<10 m^3	Stockpile	Reused on-site. Topsoil to be segregated for reuse in rehabilitation. Excavated material may be used as aggregate for fill, footings, construction pads or road base.	100%

Activity / material	Waste Type	Waste Classification	Approx. annual quantity	Storage and treatment onsite	Proposed reuse /recycling/disposal methods	Reuse/ Recycle target
		construction and in accordance with Waste Classification Guidelines: Part 1 and 2 (Environmental Protection Authority, EPA 2014)			Where required, disposal off-site at an appropriately licensed waste facility in accordance with the *Waste Classification Guidelines*.	
	Vegetation clearing and grubbing	General solid waste (non-putrescible)	<4 t	Stockpile	Resource recovery off-site - reprocessing at an appropriately licensed waste facility in accordance with the *Waste Classification Guidelines*.	100%
	Weed material	General solid waste (non-putrescible)	<1 t	Skip bin	Weeds removed during work will be managed in accordance with the DPI requirements that relate to its classification status.	0%
Construction	Timber	General solid waste (non-putrescible)	Approx.0 25 t	Skip bin	Resource recovery off-site - Reuse, recycling, reprocessing or energy recovery at an appropriately licensed waste facility in accordance with the *Waste Classification Guidelines*.	100%
	Concrete waste	General solid waste (non-putrescible)	<100 m^3	Stockpile	Resource recovery off-site - Reuse, recycling, reprocessing or energy recovery at an appropriately licensed waste facility in accordance with the *Waste Classification Guidelines*.	100%
	Packaging materials	General solid waste (non-putrescible)	< 7 t	Skip bin	Resource recovery off-site - Reuse, recycling, reprocessing or energy recovery at an appropriately licensed waste facility in accordance with the *Waste Classification Guidelines*.	100%

Activity / material	Waste Type	Waste Classification	Approx. annual quantity	Storage and treatment onsite	Proposed reuse /recycling/disposal methods	Reuse/ Recycle target
Plant and equipment maintenance	Liquid wastes - waste oil, coolants, lubricants.	Liquid waste	Dependent on contamination levels of vehicles and containers to be washed.	Containerised in covered bunded storage	Disposal off-site at an appropriately licensed waste facility in accordance with the *Waste Classification Guidelines*.	0%
	Tyres	Special waste	<200 L	Stockpile	Resource recovery off-site - Reuse, recycling, reprocessing or energy recovery at an appropriately licensed waste facility in accordance with the *Waste Classification Guidelines*.	100%
	Batteries	Hazardous waste	<10 t	Covered bunded storage	Resource recovery off-site - Reuse, recycling, reprocessing or energy recovery at an appropriately licensed waste facility in accordance with the *Waste Classification Guidelines*.	100%
	Spill kit waste	General solid waste (non-putrescible)	<200 L	Covered bunded storage	Disposal off-site at an appropriately licensed waste facility in accordance with the *Waste Classification Guidelines*.	0%
Decommissioning						
PV Panels	Supporting poles and mounts	General Solid Waste (non-putrescible)	Approx. 600 t	Covered bunded storage	Resource recovery off-site - Reuse, recycling, reprocessing or energy recovery at an appropriately licensed waste facility in accordance with the *Waste Classification Guidelines*.	90%
	Glass		Approx. 250 t			
	Silicon wafers		Approx. 40 t			

Activity / material	Waste Type	Waste Classification	Approx. annual quantity	Storage and treatment onsite	Proposed reuse /recycling/disposal methods	Reuse/ Recycle target
PV panels and inverter components	Electrical grade paper	Special waste	<1 t	Covered bunded storage	Resource recovery off-site - Reuse, recycling, reprocessing or energy recovery at an appropriately licensed waste facility in accordance with the *Waste Classification Guidelines*.	65 – 90%
	Coated cloths					
	Laminates / tapes					
	Magnetic wire					
	Lead pads					
	Phase separators					
BESS	Metal	General Solid Waste (non-putrescible)	<2 t	Stockpile	Resource recovery off-site - Reuse, recycling, reprocessing, or energy recovery at an appropriately licensed waste facility in accordance with the *Waste Classification Guidelines*.	95%
	Lithium-Ion Batteries	Hazardous waste	< 1 t	Covered bunded storage		
	Electrical wiring	Special waste	< 1 t	Covered Bunded storage		
	Timber framing	General solid waste (non-putrescible)	< 1 t	Stockpile		
	Foam insulation	General solid waste (non-putrescible)	< 1 t	Covered Bunded storage		

Activity / material	Waste Type	Waste Classification	Approx. annual quantity	Storage and treatment onsite	Proposed reuse /recycling/disposal methods	Reuse/ Recycle target
Electrical cables	Copper / aluminium	General Solid Waste (non-putrescible)	Approx.0 25 t	Covered Bunded storage	Resource recovery off-site - Reuse, recycling, reprocessing, or energy recovery at an appropriately licensed waste facility in accordance with the *Waste Classification Guidelines*.	100%
	Polyvinyl chloride (PVC)					
	Rubber					
Concrete waste	Concrete	General Solid Waste (non-putrescible)	<500 m^3	Stockpile	Resource recovery off-site - Reuse, recycling, reprocessing, or energy recovery at an appropriately licensed waste facility in accordance with the *Waste Classification Guidelines*.	100%
Fencing	Metal	General Solid Waste (non-putrescible)	<5 t	Stockpile	Resource recovery off-site - Reuse, recycling, reprocessing, or energy recovery at an appropriately licensed waste facility in accordance with the *Waste Classification Guidelines*.	100%

5. Waste disposal facilities

Carrathool Shire Council manages and maintains three (3) landfill sites and two (2) transfer stations. Of these, it is noted the Merriwagga transfer station is only open to Merriwagga residents.

The closest waste management facility (landfill) to the proposed development is Hillston Community Recycling Centre on Kidman Way in Hillston, approximately 5.5 km north.

The operating hours of all the relevant waste disposal facilities are detailed in Table 5-1 below.

Table 5-1 Proposed waste management facilities

Waste Management Facility	Operating hours
Hillston	Monday: 7.30am – 10.00am
	Tuesday: 7.30am – 10.00am and 1.00pm – 4.30pm
	Wednesday: 7.30am – 10.00am
	Thursday: 7.30am – 10.00am and 1.00pm – 4:30pm
	Sunday: 8.00am – 2.00pm
	Friday, Saturday and public holidays: Closed
Rankins Springs	Tuesday: 1.00pm – 4.00pm
	Thursday: 1.00pm – 4.00pm
	Sunday: 9.00am – 12.00pm
	Monday, Wednesday, Friday, Saturday and public holidays: Closed
Carrathool	Thursday: 8.00am – 10.00am
	Saturday: 8.00am – 10.00am
	Sunday: 8.00am – 10.00am
	Monday, Tuesday, Wednesday, Friday and public holidays: Closed

Goolgowi	Tuesday: 8.00am – 11.00am
	Thursday: 8.00am – 11.00am
	Sunday: 9.00am – 12.00pm
	Monday, Wednesday, Friday, Saturday and public holidays: Closed

These facilities offer recycling for carboard, paper, glass, plastic, steel, aluminium, used motor oil, car batteries, farm chemical drums, scrap metal and clean fill (by prior arrangement). It is noted that none of these waste facilities accept liquid waste, hazardous waste, or sharps. Goolgowi transfer station does not accept tyres.

In relation to the BESS battery components, Envirostream Australia Pty Ltd (Envirostream) is a Melbourne based company that offers mixed battery recycling, which includes lithium-ion batteries. Ecobatt is another Melbourne based company that offers recycling for lithium-ion batteries and offer certified pickup services for larger batteries. The Australian Battery Recycling Initiative (ABRI) is a collection of groups working to promote battery recycling that provides resources of recycling facilities around Australia, and it is recommended that the project adopts a recycling framework with these battery recycling organisations

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6. Waste management and minimisation

Waste management and minimisation for the proposed development would be in accordance with the POEO Act.

As identified in Table 4-1, food waste, effluent, weed material, liquid waste and spill kit waste require disposal. These waste streams are unable to be reused or recycled and necessitate disposal to minimise environmental impacts and adhere to legal requirements.

All other waste streams have close to a 100% recycle target, to be achieved by reuse, recycling, reprocessing, or energy recovery offsite at an appropriately licensed waste facility, in accordance with the Waste Classification Guidelines outlined in Section 3.4.

The waste management hierarchy would be adopted throughout the proposed development and is illustrated in Figure 6-1 and described below.

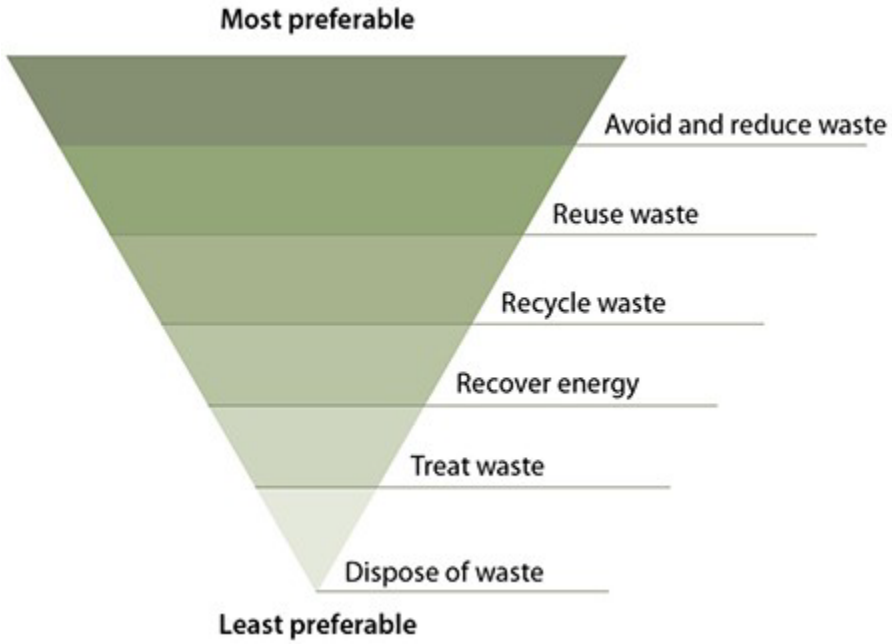

Figure 6-1 Waste management hierarchy

6.1. Avoid and reduce waste

The waste management hierarchy nominates avoidance of generating waste as the most important priority. To achieve this, the following measures will be implemented to avoid the unnecessary creation of waste:

- Unnecessary resource consumption will be avoided (e.g. fuel-efficient practices will be employed in connection with the proposed development).
- Adequate procurement practices to ensure materials are managed with minimal wastage will be implemented.
- Disposal will only occur as a last resort in accordance with the WARR Act.
- Establishing agreements with suppliers for ‘take back’ arrangements for packaging/pallets/drums.

- Ensuring appropriate types and quantities of materials are ordered to avoid excess waste and minimise excess of unused materials.
- Ensuring plant and machinery operators employ fuel-efficient practices and that maintenance for plant and equipment uses the least amount of consumables required.
- Ensure that stored supplies are properly protected from the weather.

6.2. Reuse and recycling waste

Waste separation and segregation will be promoted on-site to facilitate reuse and recycling as a priority of the waste management program as indicated below.

- Waste segregation onsite – waste materials will be separated onsite into dedicated bins / areas for either reuse onsite or collection by a recycling contractor and transported to off-site facilities.
- Where material cannot be reused onsite, the project will utilise resource recovery facilities (reprocessing, recycling, and energy recovery).

6.3. Waste handling and storage

Waste that is handled and stored onsite prior to onsite reuse or off-site recycling / disposal will have applied the following measures:

- Spoil, topsoil and mulch are to be stockpiled onsite within the compound as indicated in Figure 6-2. Mitigation measures for dust control and surface water management will be implemented in accordance with a site Erosion Sediment Control Plan (ESCP), as required.
- Liquid wastes are to be stored in appropriate containers in covered and bunded areas until transported off-site. Bunded areas will have the capacity to hold 110% of the liquid waste volume for bulk storage or 120% of the volume of the largest container for smaller packaged storage.
- Hazardous waste such as used battery modules will be managed by appropriately qualified and licensed contractors, in accordance with the requirements of the POEO Act and NSW Environmental Protection Authority (EPA) waste disposal guidelines.
- All other recyclable or non-recyclable wastes are to be stored in appropriately covered receptacles (e.g., bins or skips) in appropriate locations onsite and contractors commissioned to regularly service the bins and dispose of contents at approved disposal or recycling facilities.

6.4. Waste disposal

Waste disposal is to be in accordance with the POEO Act and WARR Act. Wastes that are unable to be reused or recycled will be disposed of off-site to an EPA approved waste management facility, certified to receive the type of waste in question and following waste classification assessment. Waste that requires disposal will be removed off-site by a licenced transporter to a licensed facility.

The closest facility is the Hillston landfill. There are some restrictions on the types of waste accepted at this facility and the contractor shall ensure that waste has been appropriately classified prior to utilising this facility. A waste transfer station is also located at Goolgowi.

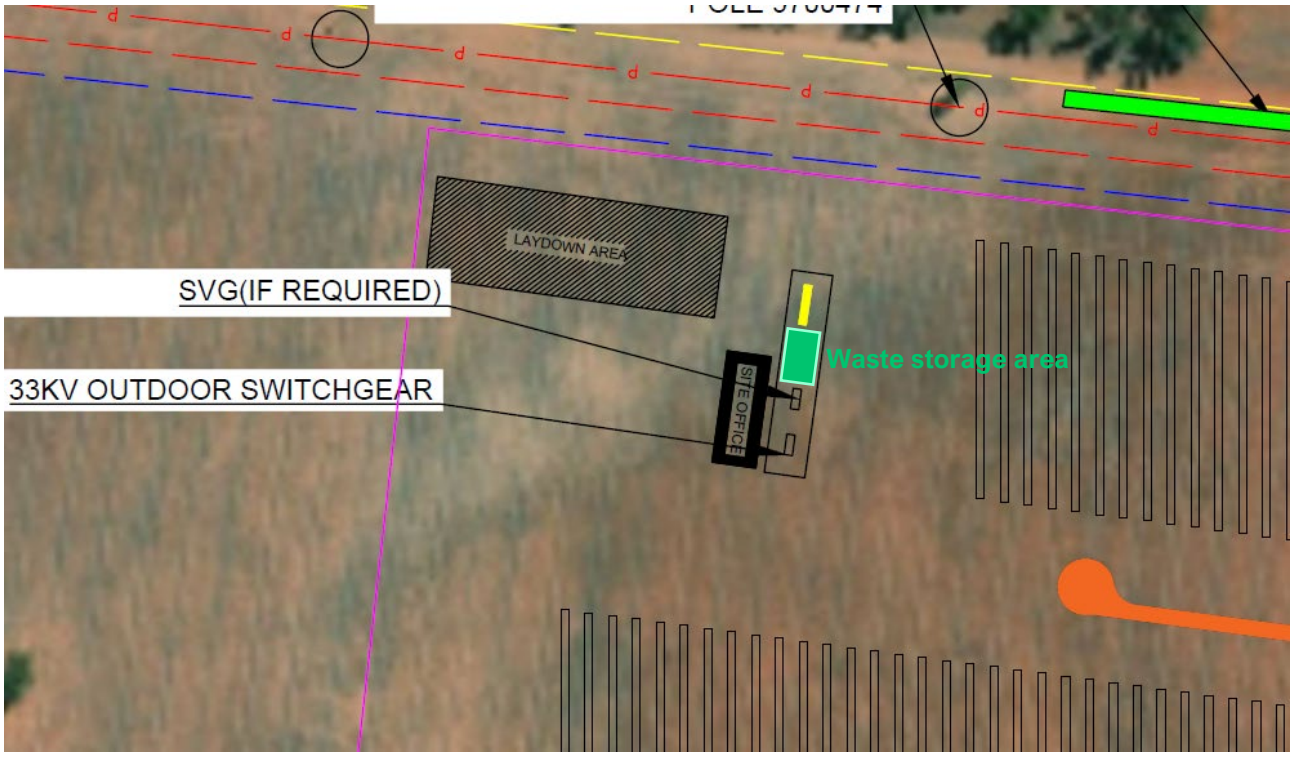

Figure 6-2 Waste storage area (Risen Energy/NGH, 2024).

6.5. Life cycle analysis

A life cycle analysis (LCA), also known as a Life Cycle Assessment, is based on the assumption that every material resource will eventually become waste. The LCA methodology evaluates and quantifies the environmental impacts caused by a material resource during its life cycle (Gerbinet, Belboom, & Leonard, 2014). The main aim of using LCA is to aid in minimising the environmental impacts of materials and guide decision making processes towards a more sustainable outcome (Menoufi, 2011) through the manufacturing, operation, and disposal phases. This is commonly referred to as a 'cradle to grave' approach.

The production of construction materials and the subsequent energy required for solar panels creates wastes. The most energy intensive processes photovoltaic (PV) panel production phase and the manufacturing of silicon (Muteri, et al., 2020). The NSW Department of Industry, Resources and Energy (2016) states that during solar farm operation, PV panels emit no pollution, produce no greenhouse gases, and use no finite fossil fuel resources. As such, it is important to aim for less energy-intensive manufacturing processes to reduce environmental impacts.

It is predicted that solar PV waste will reach around 800 000 tonnes by 2047 (Mahmoudi, Huda, & Behnia, 2020) The large amount of PV waste generated could result in unfavourable environmental impacts if proper end of life (EoL) management is not implemented. Proper EoL management is vital to reduce the overall negative impacts of the PV technologies (Singh, et al., 2021). However, overall, the recycling of solar components is worthwhile due to the increasing potential reuse of components in the future.

The life cycle of a lithium-ion battery consists of the battery manufacturing, operation, reuse, and waste management for recycling the components (Sadhukhan & Christensen, 2021). There are three main processes for recycling lithium-ion batteries, being pyrometallurgy (smelting), hydrometallurgy (leaching) and direct recycling (Gaines, 2018). As such, approximately 95% of the battery components can be recovered

for alternative use or turned into new batteries. The NSW EPA expect that lithium-ion battery waste may grow to approximately 162 000 tonnes by 2036 (EPA, 2021). Correct EoL management processes can reduce the overall negative environmental impacts that arise from the construction of lithium-ion batteries.

In relation to solar projects, the LCA considers the total energy input and annual energy output of the project, termed 'Energy Payback Time'(EPBT). EPBT is a common metric used to represent energy performance of different technologies. It was found that PV panels has an energy payback of 1.5 – 2 years in Europe (Alsema, de Wild-Scholten, & & Fthenakis, 2006). For Australia, it is expected to be at the lower end of the range due to the greater solar resources available. Considering the average lifespan of 30 years for PV panels, and an EPBT of approximately 1.5 years, the panels would be producing free energy for the remaining operational life of the panel, being on average 28.5 years (Mahmoudi, Huda, & Behnia, 2020). This may vary according to the operational life of the solar farm and the anticipated timeframes for upgrade or replacement of the panels.

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7. Waste mitigation

Environmental waste mitigation measures would be incorporated throughout all stages of the proposed development. These measures will minimise any potential adverse impacts arising from the proposed works on the surrounding environment. The implementation of mitigation measures that should minimise impacts to waste are outlined below in Table 7-1.

Table 7-1 Waste mitigation measures

ID	Measure	Timing	Responsibility
WM1	The work site would be kept free of rubbish and cleaned up at the end of each working day.	Construction	Site supervisor
WM2	All waste that cannot be re-used would be disposed at a waste disposal facility authorised for that type of waste.	Construction	Site supervisor
WM3	No waste would be burnt or buried on-site.	Construction	Site supervisor
WM4	All opportunities for recycling would be implemented.	Construction	Site supervisor
WM5	The waste management hierarchy would be adopted throughout the proposed development with a priority to avoidance of waste.	Pre-Construction	Principal Construction Contractor
WM6	All waste would be classified in accordance with the EPA's Waste Classification Guidelines and stored, handled and disposed of in accordance with its classification.	Construction	Site supervisor
WM7	All wastes removed from the site would be recorded. Details would include the quantity of material removed, the contractor transporting it offsite, its location, its category (i.e. disposal or recycling) and its classification.	Construction	Site supervisor

ID	Measure	Timing	Responsibility
WM8	Unnecessary resource consumption will be avoided.	Construction	Site supervisor
WM9	Adequate procurement practices to ensure materials are managed with minimal wastage will be implemented.	Pre-construction	Principal Construction Contractor
WM10	Establishing agreements with suppliers for 'take back' arrangements for packaging/pallets/drums.	Pre-construction	Principal Construction Contractor
WM11	Ensuring appropriate types and quantities of materials are ordered to avoid excess waste and minimise excess of unused materials.	Pre-construction	Principal Construction Contractor
WM12	Ensuring plant and machinery operators employ fuel-efficient practices and that maintenance for plant and equipment uses the least amount of consumables required.	Construction	Site supervisor
WM13	Ensure that stored supplies are properly protected from the weather.	Construction	Site supervisor
WM14	Waste segregation onsite – waste materials will be separated onsite into dedicated bins / areas for either reuse onsite or collection by a recycling contractor and transported to off-site facilities.	Construction	Site supervisor
WM15	Spoil, topsoil and mulch are to be stockpiled onsite in allocated areas, with dust and surface water controls implemented.	Construction	Site supervisor
WM16	Liquid wastes are to be stored in appropriate containers in covered and bunded areas until transported off-site.	Construction	Site supervisor
WM17	All other recyclable or non-recyclable wastes are to be stored in appropriately covered receptacles (e.g., bins or skips) in appropriate locations onsite and contractors commissioned	Construction	Site supervisor

ID	Measure	Timing	Responsibility
	to regularly service the bins and dispose of contents at approved disposal or recycling facilities.		
WM18	Waste disposal is to be in accordance with the POEO Act and WARR Act. Wastes that are unable to be reused or recycled will be disposed of off-site to an EPA approved waste management facility, certified to receive the type of waste in question and following waste classification assessment.	Construction	Site supervisor
WM19	A Construction Waste Management Plan and Operations Waste Management Plans will be developed by the Principal Construction Contractor, and the O&M Principal Contractor, and will be required to be submitted to Council prior to construction commencement.	Pre-construction	Principal Construction Contractor

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ABN 31 124 444 622 ACN 124 444 622

E: ngh@nghconsulting.com.au

GOLD COAST

2B 34 Tallebudgera Creek Road
Burleigh Heads QLD 4220

T. (07) 3129 7633

SYDNEY REGION

Unit 17, 21 Mary Street
Surry Hills NSW 2010

T. (02) 8202 8333

BEGA

Suite 11, 89-91 Auckland Street
(PO Box 470)
Bega NSW 2550

T. (02) 6492 8333

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Level 14, 10-16 Queen Street
Melbourne VIC 3000

T: (03) 7031 9123

TOWNSVILLE

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Townsville QLD 4810

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Fyshwick ACT 2609

T. (02) 6280 5053

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Sippy Downs QLD 4556

T: 13 54 93

WODONGA

Unit 2, 83 Hume Street
(PO Box 506)
Wodonga VIC 3690

T. (02) 6067 2533