Avonlie Solar Farm

Stormwater Management Plan

Avonlie Solar Farm SWMP | D

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Avonlie Solar Farm

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Document history and status

Revision	Date	Description	By	Review	Approved
A	28/08/2019	Initial draft for client review	Thomas Sinclair	John Constandopoulos	Damien Wagner
B	23/09/2019	Final draft issued for DPIE review	Thomas Sinclair	Damien Wagner	S. Reid
C	30/11/2020	Address DPIE Comments	Damien Wagner	S. Reid	S. Reid
D	28/06/2021	Update following Modification 2	Jade McManus	N. Smith	M. Sutherland

Contents

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to provide the development of a Stormwater Management Plan and Principle Erosion and Sediment Control Plan for the proposed Avonlie Solar Farm in accordance with the scope of services set out in the contract between Jacobs and RES Australia Pty Ltd (RES).. That scope of services, as described in this report, was developed with the Client.

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1. Introduction

1.1 Background

Avonlie Solar Project Co Pty Ltd (ACN 636 108 597) as trustee for the Avonlie Solar Project Trust (Project Owner) is proposing to construct, operate and potentially decommission an approximately 200MW solar farm and 100 MW / 100 MW hours of decentralised lithium-ion battery storage at Sandigo, located approximately 20km south of Narrandera, NSW (referred to as the 'Project'). The solar farm was approved by the New South Wales (NSW) Government in August 2019 and will consist of approximately 667,000 solar panels on approximately 581 hectares of land. Construction of the Project would take approximately 15 months to complete. The Project is expected to operate for about 30 years, after which the Project would be reconditioned or decommissioned. The site location and indicative layout is provided in Figure1.1.

1.2 Project Overview

The Project involves constructing, operating and eventually decommissioning a 200MW (~200AC) solar farm to the south of Narrandera in Central Southern NSW. The Project would consist of the following components:

- solar arrays consisting of about 667,000 solar panels supported by piles, driven into the ground to support the solar array's mounting system. The panels to be installed would be:
  - Photovoltaic solar arrays ground-mounted on a single-axis tracking system.
- perimeter security fencing and landscaping around the perimeter of the site where required.
- Power conversion units.100 MW / 100 MW hours DC-coupled (direct current) lithium-ion battery arrangement, spread out across the site.
- A substation including an elevated busbar, switch room, a lightning protection system, current and voltage transformers and a dual connection into two existing TransGrid overhead transmission lines.
- Two additional overhead transmission lines:
  - 132 kV overhead line (around 0.6km) to connect the substation into an existing TransGrid overhead transmission line to the west of the substation location.
  - 132 kV overhead line (around 1.2km) to connect the substation into the second existing TransGrid overhead transmission lines to the north of the substation location.
- Operations and maintenance buildings with associated car parking.
- Site entrance via access point at Muntz Road.
- Underground and overhead cabling.
- Internal access tracks.
- Emergency lighting.
- Subdivision of the property for the purpose of the substation and continued agricultural purposes.
- Clearing of vegetation.
- Road upgrades.
- Temporary facilities.

The proposed solar arrays and associated components are expected to operate for about 30 years. At the end of its operational life, the Project would be decommissioned. Decommissioning would remove all above ground infrastructure and rehabilitating the site to allow it to be used for purposes such as agriculture.

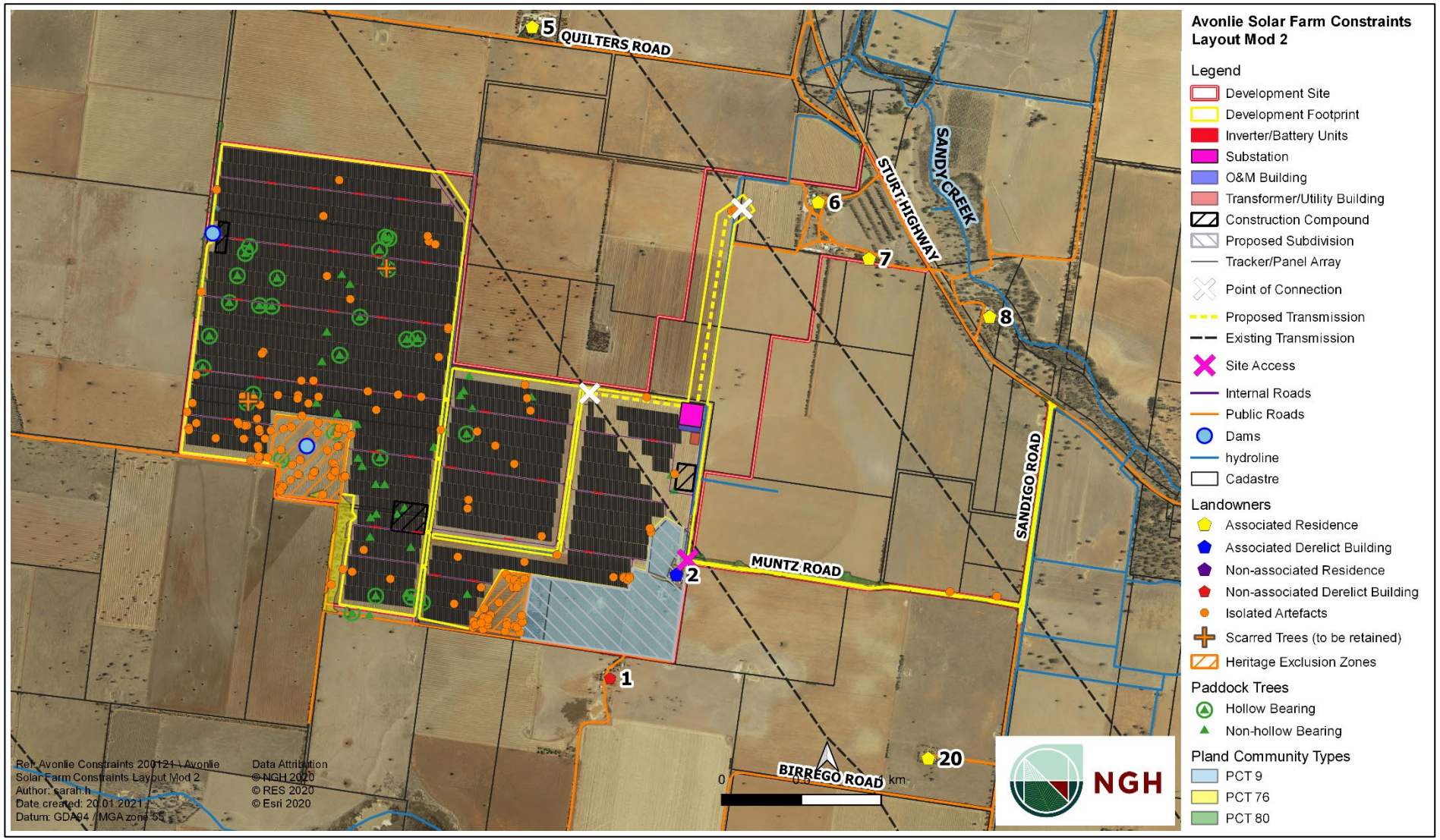


Figure 1.1: Site location and project layout

1.3 Purpose and Scope

The SWMP has been prepared in accordance with the Project approvals including the Minister's consolidated Conditions of Consent (CoC) which includes Modification 1 & 2 andthe Project EIS. The SWMP has been prepared specifically to comply with Schedule 3 CoC 21and CoC 22. The SWMP response to these conditions is summarised in Table 1-1 below.

This Stormwater Management Plan (SWMP) has been developed to provide guidance to site personnel regarding the implementation of the Erosion and Sediment Control (ESC) and water management measures required during the construction phase of the Project.

This SWMP plan will be updated (or a supplementary plan) will be submitted to the DPIE for approval for the operational phase of the project prior to commencement of that stage.

1.4 Objectives

The key objective of the SWMP is to ensure that impacts to soil integrity and water quality during the construction phase of the project are minimised and within the scope permitted by the planning approval. To achieve this objective, the following will be undertaken:

- Provide best management practice controls and procedures for implementation during construction to avoid or minimise potential impacts to soil and water quality.
- Protect topsoil and prevent erosion of the Project site and offsite sedimentation.
- Maintain existing water and soil quality of surrounding surface and ground water courses.
- Protection of the environmental values of the site and surrounding areas.
- Provide best management practice controls and procedures to comply with all relevant legislation and other requirements as described in Section 1.6 of this plan.

1.5 Strategic Framework

This SWMP sits within a suite of management plans and strategy documents required by the CoC which detail the environmental performance criteria and site-specific management measures and procedures to be implemented. The overarching document is the Environmental Management Strategy (EMS) required under the CoC. The SWMP sits within the management plans required under the CoC and should be read in conjunction with the EMS, CEMP and other relevant management plans.

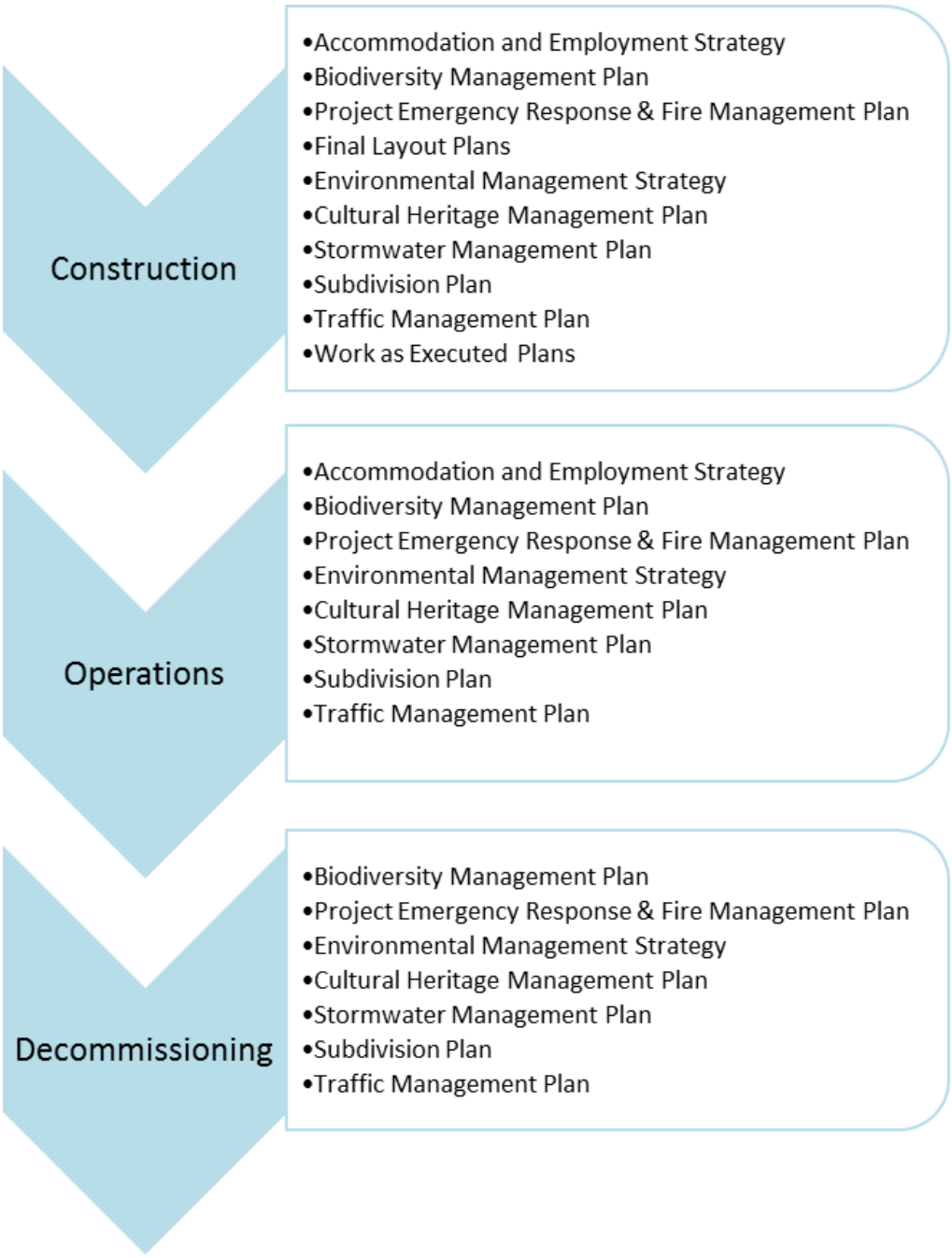


Figure 1.2: EMS Framework

1.6 Statutory Approvals

Legislation, standards, guidelines and other reference documents applicable to this Project, and specific to this SWMP, are identified in this section.

1.6.1 Conditions of Consent

Table 1-1 outlines the requirements of the CoC relevant to this SWMP. A cross reference is also included to indicate where the condition is addressed in this Plan or other Project management documents.

Table 1-1: Conditions of Consent

Requirement	Development Phase	SWMP Cross reference / How Addressed
Schedule 3 Environmental Conditions – CoC 21		
Water Pollution The Applicant must ensure that the development does not cause any water pollution, as defined under Section 120 of the POEO Act.	Construction, Operation and Decommissioning	Section 4.4- Mitigation and Management Measures of this SWMP
Schedule 3 Environmental Conditions – CoC 22		
Operating Conditions The Applicant must: (a) minimise any soil erosion associated with the construction, upgrading or decommissioning of the development in accordance with the relevant requirements in the *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004) manual, or its latest version; and	Construction, upgrading and Decommissioning	Appendix B – Principle ESCP.
(b) ensure all works are undertaken in accordance with the following, unless DPI Water agrees otherwise: • Guidelines for Controlled Activities on Waterfront Land (2012), or its latest version; and • *Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (2004), or its latest version.	Construction, Operation and Decommissioning	Noted- Where applicable, all works are to be undertaken in accordance with this SWMP and with the following: • Guidelines for Controlled Activities on Waterfront Land (2012), or its latest version; and • Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (2004), or its latest version.
Schedule 3 Environmental Conditions – CoC 23		
Stormwater Management Prior to commencing construction, the Applicant must prepare a detailed Stormwater Management Plan for the site to the satisfaction of the Secretary. Following the Secretary's approval, the Applicant must implement the Stormwater Management Plan.	Construction	Entire SWMP – Development and implementation of this SWMP.

1.6.2 Revised environmental management measures

The revised environmental management measures (REMMs) included in the Avonlie Solar Farm Submissions Report which relate to this SWMP are included in Table 1-2.These measures would minimise the potential adverse

impact of the Project. A cross reference is also included to indicate where the condition is addressed in this Plan or other Project management documents.

Table 1-2: Revised environmental management measures relevant to this SWMP

Requirement	Development Phase	SWMP Cross reference / How Addressed
Revised safeguards and mitigation measure – REMM SO1		
A *Soil and Water Management Plan and Erosion and Sediment Control Plans* would be prepared, implemented and monitored during the construction and decommissioning of the proposal, in accordance with Landcom (2004), to minimise soil (and water) impacts. These plans would include provisions such as:	Construction and Decommissioning	Section 4.1 and Section 4.1- outlines the Soil and Water Management Plan and Erosion and Sediment Control Plans. Appendix B – Principle ESCP and Section 4.4- Implementation and monitoring of Soil and Water Management Plan and Erosion and Sediment Control Plans.
• At the commencement of the works, and progressively during construction, install the required erosion control and sediment capture measures.		Appendix B – Implementation of Principle ESCP.
• Regularly inspect erosion and sediment controls, particularly following rainfall.		Section 5.2- addresses inspection requirements for erosion and sediment controls, including post-rainfall.
• Maintain a register of inspection and maintenance of erosion control and sediment capture measures.		Appendix C- Includes an E&S inspection and maintenance register.
• Ensure there are appropriate erosion and sediment control measures in place to prevent erosion and sedimentation occurring within the stormwater channel during concentrated flows.		Appendix B- Principle ESCP.
• Ensure that machinery arrives on site in a clean, washed condition, free of fluid leaks.		Section 4.4- addresses requirements and procedures for machinery/plant.
• Ensure that machinery leaves the site in a clean condition to avoid tracking of sediment onto public roads.		Section 4.4- addresses requirements and procedures for machinery/plant.
• In all excavation activities, separate subsoils and topsoils and ensure that they are replaced in their natural configuration to assist revegetation.		Noted- Minimal excavation activities

Requirement	Development Phase	SWMP Cross reference / How Addressed
• Ground water impacts will be readdressed once excavation depths have been confirmation as part of the final design.		Noted- Based on the maximum depth of subsurface infrastructure (4.5 m Bgl) and observed groundwater levels onsite (>6 m Bgl) no groundwater interception or impacts are considered likely.
• During excavation activities, monitor for increases in salinity, reduce water inputs and remediate the site with salt tolerant vegetation.		Section 4.4- addresses requirements during excavation activities monitor for increases in salinity, reduce water inputs and remediate the site with salt tolerant vegetation.
• Stockpile topsoil appropriately to minimise weed infestation, maintain soil organic matter, and maintain soil structure and microbial activity.		Appendix B- Principle ESCP includes stockpile management measures to minimise weed infestation, maintain soil organic matter, and maintain soil structure and microbial activity.
• Manage works in consideration of heavy rainfall events.		Section 5.2.1.1- addresses requirement to consider heavy rainfall events.
• Areas of disturbed soil would be rehabilitated promptly and progressively during construction.		Section 4.1.2- outlines site rehabilitation requirements for disturbed soil.
Revised safeguards and mitigation measure – REMM SO6		
Best Management Practices (BMPs) should be employed where applicable to reduce the risk of erosion and sedimentation control:	Construction, Operation and Decommissioning	Noted- Erosion and sedimentation control measures have been developed in accordance with Managing Urban Stormwater: Soils and Construction (Landcom, 2004) manual and Best Practice Erosion and Sediment Control Guidelines (ICEA, 2008).
• Integrate project design with any site constraints.		Noted- Controls and mitigation measures detailed within SWMP have been developed in consideration of known site constraints.
• Preserve and stabilise drainageways.		Noted- Minimal impacts on flows onto, through and from the site drainageways are currently anticipated during construction.
• Minimise the extent and duration of disturbance.		Section 3.1.1- Details the construction methodology used to minimise the extent and duration of disturbance.

Requirement	Development Phase	SWMP Cross reference / How Addressed
• Control stormwater flows onto, through and from the site in stable drainage structures.		Noted- Minimal impacts on flows onto, through and from the site in stable drainage structures are currently anticipated during construction.
• Install perimeter controls.		Appendix B- Principle ESCP address the installation of site perimeter controls.
• Stabilise disturbed areas promptly.		Section 4.1.2- addresses Site Rehabilitation requirements.
• Protect steep slopes.		Noted- No steep slopes are currently anticipated onsite during construction and decommission phases.
• Employ the use of sediment control measures to prevent off- and on-site damage.		Appendix B- Includes sediment control measures to prevent off- and on-site damage.
• Protect inlets, storm drain outlets and culverts.		Noted- Minimal impacts on flows onto and through inlets, storm drain outlets and culverts are currently anticipated during construction.
• Provide access and general construction controls.		Section 3.1.1- Addresses access and general construction controls.
• Inspect and maintain sediment and erosion control measures regularly.		Section 5.2.1- Addresses inspection requirements for erosion and sediment controls.
Revised safeguards and mitigation measure – REMM WA1 to WA10		
WA1 - All staff would be appropriately trained through toolbox talks for the minimisation and management of accidental spills.	Construction, Operation and Decommissioning	Implementation requirement addressed in Section 5.1.1
WA 2 - All fuels, chemicals, and liquids would be stored at least 50 m away from any waterways or drainage lines and would be stored in an impervious bunded area.	Construction, Operation and Decommissioning	Implementation requirement addressed in Section 4.3.2 and Appendix C.

Requirement	Development Phase	SWMP Cross reference / How Addressed
WA3 - Adequate incident management procedures will be incorporated into the Construction, Operation and Decommissioning Environmental Management Plans, including requirement to notify the relevant agencies of pollution incidents that cause material harm to the environment (refer s147-153 Protection of the Environment Operations Act).	Construction, Operation and Decommissioning	Implementation requirement addressed in Section 5.1.
WA4 - The refuelling of plant and maintenance of machinery would be undertaken in impervious bunded areas.	Construction, Operation and Decommissioning	Implementation requirement addressed Appendix C.
WA5 - Machinery would be checked daily to -- ensure there is no oil, fuel or other liquids leaking 444from the machinery. All staff would be appropriately trained through toolbox talks for the minimisation and management of accidental 0spills.	Construction and Decom4missionin g	Implementation requirement addressed Appendix C.
WA6 - Emergency management procedures will be prepared in consultation with Council.	Construction and Operation	Implementation requirement addressed in Section 1.6.5.
WA7 - Erosion and sediment control measures that would be implemented to mitigate any impacts in accordance with Managing Urban Stormwater: Soils & Construction (Landcom 2004)	Construction, Operation and Decommissioning	Principle ESCP provided in Appendix B developed in accordance with Landcom 2004.
WA8 - A comprehensive Emergency Response Plan (ERP) would be developed for the site and specifically address foreseeable on-site and off-site emergency incidents in consultation with Narrandera Shire Council in accordance with the NSW Government's Flood Prone Land Policy and the Floodplain Development Manual. It would detail appropriate risk control measures that would need to be implemented to safely mitigate potential risk to health and safety of firefighters and first responders in the case of a hazardous spill or flood risk.	Construction, Operation and Decommissioning	Narrandera Shire Council (NSC) have noted in consultation they anticipate this development to have little influence on existing stormwater runoff. Consultation will continue with NSC and the EPC contractor to develop an Emergency Response Plan for the project site.

Requirement	Development Phase	SWMP Cross reference / How Addressed
WA9 - Water from dams will only be used for construction and operation of the proposal within the landholding.	Construction, Operation and Decommissioning	EPC contractor to determine the necessity for dam water usage and comply with use criteria.
WA10 - The proponent will obtain the relevant licence and/or entitlement for groundwater extraction prior to any extraction, if it is proposed to be used.	Construction, Operation and Decommissioning	Noted, assessment to be carried out by the EPC contractor to determine necessity for ground water use and comply with use criteria.

1.6.3 Guidelines and Standards

In addition to the requirements listed in Table 1-1 above, this SWMP has been developed in consideration of the following policies as relevant to the proposed scope of works:

Managing Urban Stormwater: Soils and Construction (Landcom, 2004) manual;

Guidelines for Controlled Activities on Waterfront Land (2012);

Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (2004);

Best Practice Erosion and Sediment Control Guidelines (IECA 2008);

Australian Rainfall and Runoff: A guide to flood estimation, (Commonwealth of Australia (Geoscience Australia), 2019).

Review of Narrandera Floodplain Risk Management Study & Plan (FRMS 2019 and FRMP 2019), Lyall & Associates; and

Narrandera Shire Council Engineering Guidelines for Subdivisions and Development Standards, Part 3 - Stormwater Drainage Design (2011), GHD.

1.6.4 Licensing and Approvals

No additional licensing and/or approvals required.

1.6.5 Consultation

Whilst the statutory approvals did not require that this SWMP be developed consultation with third-party stakeholders, consultation with Narrandera Shire Council was undertaken to ensure the relevance of local standards and local environmental risks is clearly understood and communicated within this document. Key stakeholders and consultation proposed and/or undertaken to date is summarised in Table 1-3.

Table 1-3: Stakeholder Engagement

Stakeholder	Comments	SWMP Cross reference / How Addressed
Narrandera Shire Council (NSC)	NSC has noted in early consultation that: *It is envisaged that this development will have little influence on the existing stormwater run-off.*	Noted- further assessment undertaken within this SWMP indicates development will have minimal influence on the existing stormwater run-off during construction.
	Council's existing flood study does not extend to this area and the developer will have to do his own risk assessment as to the impact of river flooding.	Noted- A site specific flood study is under development, the preliminary results of the assessment have been incorporated into this SWMP with impacts and mitigation measures detailed in 3.3.3 and 4.3.3 respectively.
	The proposed road network may collect and concentrate local runoff which will need to be address local flooding and ensure that downstream properties are not adversely affected.	Noted- A assessment of pre-development and construction phase flows has been incorporated into this SWMP with impacts and mitigation measures detailed in 3.3.3 and 4.3.3 respectively.
	Steps will need to be taken to prevent erosion where flows are concentrated.	Appendix B- The Principle ESCP provides measures to minimise erosion where flows are concentrated.
	Council's Engineering Guidelines need to be updated as the guideline's stormwater drainage calculations use an outdated rational method of calculations.	Noted- Council's Engineering Guidelines were reviewed against *Australian Rainfall and Runoff (ARR) 2019* within this SWMP. *Where design inputs were available for both guidelines* the more conservative value was used as the input parameter.
	Councils existing Engineering Guidelines are outdated, and the developer should comply with current Australian Rainfall and Runoff design procedures.	Noted- Council's Engineering Guidelines were reviewed against *Australian Rainfall and Runoff (ARR) 2019* within this SWMP. *Where design inputs were available for both guidelines* the more conservative value was used as the input parameter.

2. Existing Environment

2.1 Surrounding Land Uses and Sensitive Receptors

2.1.1 Surrounding Land Uses

The existing land use of the development site is agriculture. The land capability class of the site is Class 3. Class 3 is described as land capable of sustaining cultivation on a rotational basis. The land surrounding the development site is RU1 (primary production), RU3 (forestry) and RU4 (primary production small lots). Surrounding agriculture land consists of cropping and grazing. Buckingbong State Forest is within 5 km of the site.

2.1.2 Aboriginal Heritage

NGH Environmental (2017) prepared an Aboriginal Cultural Heritage Assessment Report (ACHAR) to provide an assessment of the Aboriginal cultural values associated with the development site. Four artefact scatters, two scar trees and 64 isolated artefacts were recorded during the survey. Based on the land use history, an appraisal of the landscape, soil, level of disturbance and the results from the field survey it was concluded that there was negligible potential for the presence of intact subsurface deposits with high densities of objects or cultural material within the development site.

2.2 Geology, Soils and Topography

The site is characterised by uniformly flat topography, with the difference in ground elevation expected to be less than 5 m across the entire site, with a low elevation of approximately 150m AHD (Berembed Weir 1:50,000 Topographic map sheet (8228-S)). The site geology is distributed over one unit: Cainozoic alluvium and the landform.

Two soil landscapes have been identified within the development site, classified as Chromosols and Sodosols (DM McMahon Pty Ltd, 2018). Sodosols onsite are typically associated with underlying subsoils and once disturbed, are prone to high levels of erodibility moderate salinity risk and waterlogging. Sodosols are dispersible soils with extremely high risks of erosion, associated impacts includes gully and streambank erosion have been noted along some drainage lines at the development site Sodosols (DM McMahon Pty Ltd, 2018).

Golders (2019) noted localised dispersive features typically associated with grey soil clay pans and topographic low points predominately observed in the western and southern sections of the site. The depth of the observed erosion/dispersion features was generally observed at up to 500 mm from surrounding surface levels. Soil-structures in these areas may have undergone partial collapse and may be susceptible to dispersion and tunnel erosion when exposed to flowing fresh water.

No occurrences of acid sulfate soils (ASS) have been noted on site (Golders, 2019). A review of the Australian Soil Resource Information System (2019) shows a low probability of occurrence across most of the site. Therefore, for the purpose of this SWMP, it has been assumed that no ASS are located on site. Past and present agriculture activities at the site (e.g. use and disposal of herbicides and pesticides) have the potential to pose a contamination risk. However, no indications of soil contamination were observed during soil surveys.

Vegetation comprises several large paddocks which are generally flat, largely cleared and cultivated for cropping and grazing. Scattered paddock trees remain within the paddocks and planted windbreaks occur throughout the site. Remnant vegetation is predominately comprised of groundcover, including wheat stubble, broadleaf weeds and heliotrope.

2.3 Hydrology

The development site is located within the Sandy Creek subcatchment of the Murrumbidgee catchment. The site is located on the drainage plains in the Murrumbidgee River system catchment area. Sandy Creek is located within 1 km of the northern boundary of the site. An ephemeral irrigation channel approximately 1 to 1.5 m deep, runs along the eastern site boundary. The channel is considered unlikely to support aquatic habitat of value. Two farm dams located in the north western and south western sections of the development footprint (refer to Figure 1.1). A number of ephemeral drainage lines are distributed throughout the site, which flow following rainfall only.

Natural flow paths have been extensively modified and altered with the introduction of irrigation and drainage channels. These channels include gravity-fed irrigation and drainage channels that have been privately constructed irrigation and managed.

2.3.1 Rainfall

The closest Bureau of Meteorology Weather Station is Narrandera Airport NSW, located about 17 km north of the development site. The mean rainfall for Narrandera is approximately 482.8mm per annum, with the wettest months being October, August and September. Variability in rainfall totals and intensity is high. Daily mean evaporation for the region is 1715.5mm with mean daily evaporation ranges from 1.2mm in July to 9.2mm in January as shown in Table 2-1. Rainfall and temperature data from Narrandera Airport NSW (74148) and evaporation data from Wagga Wagga Agricultural Institute (73127), located 79km away (www.bom.gov.au).

Table 2-1: Mean rainfall and mean evaporation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annum.
Mean Rainfall(mm)	34.2	34.6	30.2	33.4	39.4	38.6	36.4	39.4	35.4	39.7	35.4	37.3	482.8
Mean Evaporation(mm)	9.2	8.1	6.4	3.9	1.9	1.4	1.2	1.8	2.8	4.4	6.6	8.8	4.7

2.3.2 Sandy Creek

Sandy Creek is ephemeral stream located immediately north east of the Site across the Sturt Highway, which drains into the central southern section of the Murrumbidgee River. An existing irrigation along the eastern boundary of the development site connects the site to Sandy Creek.

2.3.3 Flooding risk

The development site does not occur within a Flooding planning under the Narrandera LEP (NSW Government, 2013). The extent of modelled overland and riverine flooding for the Site has been mapped under the pre-development scenario (Water Modelling Solutions, 2019). Flood events for a 1% (100-year ARI) annual exceedance probability (AEP) under the pre-development scenario peak depth, velocity and water surface levels are shown in Figures 1 to 3 of Appendix D.

The mapping show shallow overland flooding across the majority of the southern and western sections of the site, with floodwater depths typically in the order of 300-600mm as shown in Figure 1. Shallow riverine flooding likely associated with overflow from Sandy is observed in the north eastern corner of the site Creek with peak depths typically in the below 300mm. The velocity of the runoff is shown in Figure 2, with a majority of the site

with a maximum velocity of 0.25m/s. The areas of flow greater than 0.25m/s are located adjacent to the dam at the south of the site and around the eastern boundary of the site. The model and supporting technical memo can be viewed in Appendix E. Given the anticipated short construction period of 15 months, the 80th percentile 5-day rainfall depth in accordance with Blue Book (2004) is considered more applicable to the inundation risks presented to site personnel and infrastructure during the construction phase.

2.4 Hydrogeology

A geotechnical investigation for detailed design was undertaken in July 2019, with 21 boreholes across the development site terminated at a target depth at approximately 6-6.45 metres below ground level (Bgl) and no groundwater encountered (Bgl). Within 1 km of the site there are sites listed as terrestrial Groundwater Dependent Ecosystems (GDEs) as they interact with groundwater. There are high potential GDEs along Sandy Creek, within 1 km north of the development site. There are areas of moderate to high potential GDEs along Sandy Creek, outside of the development site.

3. Environmental Impacts

3.1 Construction Activities

Key aspects of the Project that could result in adverse impacts to soils and water during construction include:

- Site establishment.
- Construction compound operations including fuel and chemical storage, refuelling and chemical handling.
- Vegetation clearing, mulching and topsoil stripping.
- Bulk earthworks, including excavation or filling.
- Piling of Solar Arrays
- Trenching for the underground cabling and activities
- Concreting
- Transportation of cut or fill materials.
- Movement of heavy vehicles across exposed earth.
- Construction in any contaminated land.
- Culvert and drainage work.
- Landscaping and re-vegetation.
- Material stockpile
- Water use / extraction.
- Road upgrade works.
- Noxious weed treatment including herbicide spraying.

3.1.1 Construction methodology

Appropriate construction methodology is critical to reducing the overall volume of erosion and sediment control measures required to negate the disturbance on site. The total soil disturbance footprint is estimated at 14 ha, with bulk earthwork and road construction to be completed in the initial stages of construction to facilitate early stabilisation and revegetation of disturbed areas.

- Site disturbance from bulk earthworks and civil works is distributed evenly throughout the site.
- Works will generally commence at the site entrance/compound location in the south east corner of the site and progress over the duration towards the north west corner of the site.
- Perimeter controls shall be constructed prior to the commencement of works. Refer to the relevant design drawings attached in Appendix B for details.

Temporary hardstand areas associated with construction compounds and satellite laydown created using compacted road base and gravel as a surface.

- Internal access roads will be constructed at existing surface so as to not concentrate flows and/or, disturb natural flow paths.
- The piling of solar trackers is envisaged to be undertaken using a pile driver, with minimal surface re-grading to be undertaken in order to preserve the existing ground cover and minimise ground disturbance. Designated concrete wash-out area with appropriate containment and controls will be provided
- Designated stockpile area with appropriate containment and controls will be provided to manage excess spoil

The construction methodology proposed minimises the duration and scale of disturbance resulting in an overall reduction to erosion and sedimentation potential.

3.2 Soil and water

The proposed activities for the construction and decommissioning stages of the solar farm have the potential to increase soil erosion and impact local water quality through the erosion, contamination and transport of sediment due to the loss of vegetation cover, spills and the exposure of soils to erosion. Construction of the Project presents a risk to degradation of downstream water quality if management measures are not implemented, monitored and maintained throughout the Construction phase.

Potential impacts of the Project on soil and water during construction are summarised in Table 3-1 below.

Table 3-1: Potential Soil and Water Impacts

Activity	Potential Impact
Site establishment including erection of construction compounds	• Increased hardstand and impervious surfaces resulting in increased surface runoff, risk of inundation and decreased soil infiltration • Alteration of natural and existing flow paths and disruption of flow into existing drainage lines.
Construction compound operations including fuel and chemical storage, refuelling and hazardous material/chemical handling	• Pollution of local waterways arising from accidental spillage, failure of a control or inappropriate storage • Ground contamination • Damage to ecosystems, aquatic species due to pollution of ephemeral drainage lines and receiving watercourses including Sandy Creek
Vegetation clearing mulching and topsoil stripping	• Erosion and sedimentation of disturbed area • Increased flow or more concentrated flows causing increased turbidity, scouring of channel and downstream impacts to receiving watercourses • Carriage of nutrients to waterways causing algal growth and eutrophication • Carriage of weed material to waterways causing weed infestation • Promotion of weed growth. • Increased soil compaction • Decreased soil permeability and/or rainfall infiltration resulting higher velocity surface runoff • Increased potential and severity of onsite inundation
Concreting	• Pollution of local waterways arising from accidental spillage, failure of a control or inappropriate storage • Ground contamination • Increased surface runoff from hard surfaces
Dust generating works	• Increased sedimentation of local waterways impacting the natural flow • Sedimentation causing damage to existing drainage infrastructure • Visual impacts to sensitive Aboriginal heritage items identified onsite

Activity	Potential Impact
Bulk Earthworks including excavation, trenching or filling	• Erosion of exposed soil horizons including dispersive subsoils associated with Sodosol • Erosion and sedimentation of disturbed areas • Sedimentation of local waterways impacting the natural flow • Sedimentation causing scouring of drainage lines and downstream impacts to receiving watercourses • Exposure of previously unidentified contaminated soil • Erosion and sedimentation of disturbed areas due to exposure of dispersive subsoils associated with Sodosol • Promotion of weed growth to due improper backfilling. • Loss of soil structure and Soil organic matter
Erection and piling of solar arrays	• Concentrated rainfall and tunnel erosion of soil directly underneath the solar array panels • Interception of Groundwater flows
Transportation of cut or fill materials	• Pollution caused by dust and spillage during haulage on internal and external roads • Soil compaction from repeated traversing of heavy vehicles over haulage routes causing increased surface runoff and decreased soil infiltration
Movement of heavy vehicles across exposed earth	• Soil compaction from repeated traversing of heavy vehicles over haulage routes causing increased surface runoff and decreased soil infiltration, in particular sodic soil areas • Hydrocarbon and Hydraulic fluid leaks causing ground contamination and/or water quality impacts
Material stockpile	• Pollution caused by stockpile and wind erosion • Prolonged Exposure of previously unidentified contaminated soil • Increased dust generation and temporary reductions to onsite air quality
Road upgrade works	• Erosion of exposed soil horizons • Erosion and sedimentation of disturbed areas • Pollution of local waterways arising from accidental spillage, failure of a control or inappropriate storage • Ground contamination • Increased surface runoff from hard surfaces

3.3 Site runoff

The Project presents a risk to degradation of downstream water quality if management measures are not implemented, monitored and maintained throughout the construction phase. Key aspects of the Project that could result in adverse impacts to stormwater during construction include:

- Construction compound operations including fuel and chemical storage, refuelling and chemical handling.
- Vegetation clearing, mulching and topsoil stripping.
- Movement of maintenance vehicles across exposed earth.
- Water use / extraction

- Noxious weed treatment including herbicide spraying.
- Increases in peak flows and changes to existing flow paths due increases in compacted and/or impervious areas

3.3.1 Pre-development V. Construction Phase Flows

As construction progresses the volume of stormwater runoff is anticipated to increase due to minor increases in impervious surfaces. However, no significant increase in impermeable area is proposed and routing of runoff will be similar in both pre and construction scenarios. No increase in flow capable of causing an actionable nuisance is expected due to the proposed solar farm development during the construction phase. As a result, any increase in water level or velocity external to the site due to obstruction of flow or increase in runoff is considered unlikely to have a significant impact on the receiving environment or downstream properties.

3.3.2 Runoff Quality

During the construction phase of the project, there are a number of risks to water quality including land clearing, roadworks, mechanical and electrical installation. It is likely these risks can be mitigated through best practice sediment and erosion control practices, safe storage of chemicals, and revegetation of soil beneath solar panels for stabilization.

3.3.3 Flooding Impacts

The EIS developed for the project assessed that the development of the solar farm is unlikely to increase any impacts associated with flooding of the area (page 151).

Further flooding assessment of the development site has been undertaken by the Project Owner (August 2019, ICUBED) with the peak depths, water levels and velocities for the existing scenarios attached as Appendix D.

The flood modelling indicates the majority of the site has a **maximum depth of flow of less than 0.3m** and a **maximum velocity less than 0.25m/s.**

Temporary onsite flooding has the potential to interfere with construction and poses a safety risk for workers onsite. Additionally, flooding has potential to impact the water quality of the site and downstream waterways through the washing away of construction equipment, fuels and chemicals stored onsite. Under existing conditions, the project area is partially affected by predominately shallow overland flooding for the 1% AEP scenario. However, given the limited construction period of 15 months and shallow nature of flooding observed, the 1% AEP scenario is considered highly conservative and disproportionate to the minimal flood risk presented during the construction phase.

This plan will be updated (or a supplementary plan) incorporating the final development footprint flood study report and will be submitted for approval for the operational phase of the project prior to commencement of that stage in accordance with the staging option set out in the Conditions of Consent.

4. Mitigation and Management Measures

4.1 Soil and Water Management

4.1.1 Land clearing

Land clearing must be delayed as long as practicable and must be undertaken in conjunction with development of each stage of works, unless otherwise approved. All reasonable and practicable efforts must be taken to delay the removal of, or disturbance to, existing ground cover (organic or inorganic) prior to land-disturbing activities.

No land clearing shall be undertaken unless preceded by the installation of adequate control measures, unless such clearing is required for the purpose of installing such measures, in which case, only the minimum clearing required to install such measures shall occur. Land clearing must be immediately followed by specified temporary stabilisation measures (e.g. temporary grassing, or mulching) prior to commencement of each stage of construction works. Vegetation removed during tree clearing should be mulched on site and reused for erosion control where possible.

All reasonable and practicable measures must be taken to minimise the removal of, or disturbance to, those trees, shrubs and ground covers (organic or inorganic) that are intended to be retained. Land clearing is to be minimised where possible during periods when soil erosion due to wind, rain or surface water is possible.

4.1.2 Site Rehabilitation

All disturbed areas must be suitably stabilised and revegetation commenced within 20 days from the day that soil disturbances on the area have been finalised. The type of ground cover applied to completed earthworks must be compatible with the anticipated long-term land use, environmental risk, and site rehabilitation measures. Where reasonable and feasible, a minimum of the following ground cover must be achieved on all completed earthworks exposed to accelerated soil erosion:

- 60% ground cover within 30 days during those months when the expected rainfall is less than 30mm;
- 70% cover within 30 days if between 30 and 45mm;
- 70% cover within 20 days if between 45 and 100mm;
- 75% cover within 10 days if between 100 and 225mm; and
- 80% cover within 5 days if greater than 225mm.

Unless otherwise directed by the approved revegetation plan, topsoil must be placed at a minimum depth of 75mm on slopes 4:1 (H:V) or flatter, and 50mm on slopes steeper than 4:1. The pH of the topsoil must be between 6.5 and 8.5 prior to initiating the establishment of vegetation. The pH level of topsoil must be adequate to enable establishment and growth of the specified vegetation. Where reasonable and feasible, revegetation will be undertaken with deep-rooted and/or salt-tolerant species.

The stabilisation works must not rely upon the longevity of non-vegetated erosion control blankets, or temporary soil binders. All unstable or disturbed soil surfaces must be adequately stabilised against erosion (minimum 70%) prior to completion of construction. Site vegetation will be undertaken in accordance with the Biodiversity Management plan.

4.2 Erosion and Sediment Control

The Principle Erosion and Sediment Control Plan (ESCP) provides recommendations and commitments for erosion and sediment control in accordance with the *Best Practice Erosion and Sediment Control Guidelines* (IECA, 2008) and *Managing Urban Stormwater: Soils and Construction (Landcom, 2004)* including:

- Background assessment for erosion and sediment control design.
- Instructions for staged implementation of erosion and sediment controls.
- Instructions for the preparation of Progressive ESCPs.
- Dust control.
- Access control.
- Sediment traps (e.g. sediment fences, straw bales, coir logs).
- Stockpile and soil management and diversion drainage.
- Stabilising and rehabilitating the site at various stages of Construction.
- Site inspection, monitoring and maintenance of erosion and sediment controls.
- Water control devices and scour protection.

A summary of the consolidated Erosion and Sediment Control management and mitigation measure is provided in Table 4-1: Mitigation Measures. Refer to Appendix B for further details on the erosion and sediment control strategy and typical ECSP.

4.3 Stormwater Management

4.3.1 Site Runoff

No significant increase in impermeable area is proposed and routing of runoff is anticipated to be similar in both pre-development and construction phase scenarios. No increase in flow capable of causing an actionable nuisance is expected due to the proposed solar farm development. As a result, any increase in water level or velocity external to the site due to obstruction of flow or increase in runoff is considered unlikely to have a significant impact on the receiving environment or downstream properties.

Based on the likely absence of any significant impact to storm water volumes, no mitigation measures were identified. Potential impacts and mitigation measures will be subject to further assessment in accordance with the development of the site drainage design.

4.3.2 Water Quality

A range of mitigation measures are identified to minimise potential impacts, summarised as follows:

- Implementation of best practice erosion and sediment control measures during the construction phase (including dust control) in accordance with the Principle Erosion & Sediment Control Plan (Appendix B) and Blue Book (2004);

- Safe storage of hazardous substances (away from waterways and drainage lines), to ensure that any spillages do not impacts on land or water;

- Design, construction and maintenance of temporary and permanent stream crossings in accordance with Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (2004); and

- Use of glyphosate-based products (or similar non-residual and non-persistent herbicides) to manage weeds on-site, to minimise the potential risk of harmful herbicide by-products entering the surface water receiving environment.

4.3.3 Flood immunity

Given the limited construction period of 15 months and shallow nature of flooding observed, it is considered that minimal flood risk is presented to construction activities and site personnel during the construction phase. Daily monitoring of weather conditions is to be undertaken in accordance with Section 5.2.1.1, with construction activities to cease where extreme rainfall events are forecast. Critical ancillary facilities and electrical equipment including the substation and Transformer should be protected from floodwaters during the construction phase in consideration of the 10% AEP event.

4.4 Mitigation measures

A complete overview of specific mitigation measures required to be implemented at each stage of development is provided in Table 4-1 below.

Table 4-1: Mitigation Measures

No.	Control	Phase				Timing	Accountability	Source
		Site Preparation	Construction	Rehabilitation	Decommissioning			
Soil and Water								
SW1	All staff would be appropriately trained through toolbox talks for the minimisation and management of accidental spills.	✓	✓		✓	Ongoing	Site Manager	*REMM WA1*
SW2	All fuels, chemicals and hazardous liquids would be stored away a minimum of 50 m away from drainage lines, within an impervious bunded area in accordance with Australian Standards, EPA Guidelines.		✓		✓	Ongoing	Site Manager	*REMM WA2*
SW3	Adequate incident management procedures will be incorporated into the Construction, Operation and Decommissioning Environmental Management Plans, including requirement to notify the relevant agencies of pollution incidents that cause material harm to the environment (refer s147-153 Protection of the Environment Operations Act).		✓		✓	Ongoing	Site Manager	*REMM WA3*
SW4	The refuelling of plant and maintenance of machinery would be undertaken in impervious bunded areas.	✓	✓		✓	Ongoing	Site Manager	*REMM WA4*
SW5	Machinery would be checked daily to ensure there is no oil, fuel or other liquids leaking from the machinery. All staff would be		✓		✓	Ongoing	Site Manager	*REMM WA5*

	appropriately trained through toolbox talks for the minimisation and management of accidental spills.							
SW6	Emergency management procedures will be prepared in consultation with Council.	✓	✓			Ongoing	Site Manager	*REMM WA6*
SW7	Erosion and sediment control measures that would be implemented to mitigate any impacts in accordance with Managing Urban Stormwater: Soils & Construction (Landcom 2004)	✓	✓		✓	Ongoing	Site Manager	*REMM WA7*
SW8	A comprehensive Emergency Response Plan (ERP) would be developed for the site and specifically address foreseeable on-site and off-site emergency incidents in consultation with Narrandera Shire Council in accordance with the NSW Government's Flood Prone Land Policy and the Floodplain Development Manual. It would detail appropriate risk control measures that would need to be implemented to safely mitigate potential risk to health and safety of firefighters and first responders in the case of a hazardous spill or flood risk.	✓	✓		✓	Ongoing	Site Manager	*REMM WA8*
SW9	Water from dams will only be used for construction and operation of the proposal within the landholding.	✓	✓		✓	Ongoing	Site Manager	*REMM WA9*
SW10	The proponent will obtain the relevant licence and/or entitlement for groundwater extraction prior to any extraction, if it is proposed to be used.	✓	✓		✓	Ongoing	Site Manager	*REMM WA10*
SW11	Land clearing must be delayed as long as practicable and must be undertaken in conjunction with development of each stage of works, unless otherwise approved. All reasonable and practicable efforts must be taken to delay the removal of, or disturbance to, existing ground cover (organic or inorganic) prior to land-disturbing activities.	✓	✓		✓	Ongoing	Site Manager	*REMM SO1*
SW12	All reasonable and practicable measures must be taken to minimise the removal of, or disturbance to, those trees, shrubs and ground cover (organic or inorganic) that are intended to be retained. Land clearing is to be minimised where possible during		✓			Ongoing	Site Manager	*Best Practice*

	periods when soil erosion due to wind, rain or surface water is possible.							
SW13	No land clearing shall be undertaken unless preceded by the installation of adequate drainage and sediment control measures, unless such clearing is required for the purpose of installing such measures, in which case, only the minimum clearing required to install such measures shall occur.		✓			Ongoing	Site Manager	*Best Practice*
SW14	In the event that any previously unidentified contamination or acid sulfate soils are encountered, the Environmental Manger will be notified immediately and the material will be separated, contained, managed and disposed of in accordance with the *Waste Classification Guidelines* (OEH 2008) and *Acid Sulfate Soils Assessment Guidelines* (ASSMAC 1998) respectively.		✓		✓	Ongoing	Site Manager	*Best Practice*
SW15	Manage Aboriginal heritage impacts in accordance with the Project Aboriginal Heritage Items Management Plan.		✓		✓	Ongoing	Site Manager	*Best Practice*
Stockpile Management								
SW16	All reasonable and practicable measures must be taken to obtain the maximum benefit from existing topsoil. Stockpiles of erodible material that has the potential to cause environmental harm if displaced, must be: • Appropriately protected from wind, rain, concentrated surface flow and excessive up-slope stormwater surface flows; Located at least 2m from any hazardous area, retained vegetation, or concentrated drainage line; and • Stockpile areas should be stabilised using hydromulch or an approved equivalent. Batters should be stabilised with mulch to a depth of 50mm (utilising mulched vegetation where feasible).		✓		✓	Ongoing	Site Manager	*REMM SO1*

	• Where excavated material is considered suitable for on-site reuse, separate subsoils and topsoils and ensure that they are replaced in their natural configuration to assist revegetation. • Stockpile topsoil appropriately so as to minimise weed infestation, maintain soil organic matter, maintain soil structure and microbial activity • Where feasible and reasonable sediment fences must be established downslope of stockpiles containing erodible material; and • Located at least 2m from any hazardous area, retained vegetation, or concentrated drainage line.							
SW17	Where feasible and reasonable, a suitable diversion system must be established immediately up-slope of a stockpile of erodible material that has the potential to cause environmental harm if displaced.		✓		✓	Prior to construction commencing and ongoing	Site Manager	*Best Practice*
Erosion and Sediment Control (ESC)								
SW18	Prior to commencement of each work stage, site-specific Progressive Erosion and Sediment Control Plan(s) would be prepared in accordance with the 'Blue Book' *Managing Urban Stormwater: Soils and Construction Guidelines* (Landcom, 2004) and the Principle Erosion and Sediment Control Plan (ESCP). Progressive Erosion and Sediment Control Plans would be updated throughout construction, so they remain relevant to the activities. The Erosion and Sediment Control Plan measures would be implemented prior to commencement of each work stage and maintained throughout Construction.	✓	✓			Prior to construction commencing and ongoing	Site Manager	*REMM SO1 &* *CoC Sch 3, 22*

SW19	All erosion and sediment controls will be designed, installed and maintained in accordance with the Principle Erosion and Sediment Control Plan (ESCP) and Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004).	✓	✓		✓	Prior to construction commencing and ongoing	Site Manager	*REMM SO1, WA6 & CoC Sch 3, 22*
SW20	Ensure a single access and egress point is maintained and equipped with rumble grid during construction.	✓	✓			Ongoing	Site Manager	*REMM SO1*
SW21	Apply gypsum, where required, to reduce dispersibility of disturbed subsoils and to minimise potential for tunnel erosion and surface rilling. The application rate is to be determined by site specific soil testing as required. To assist in dissemination and depth of treatment, tilling and mixing should be considered.	✓				As required	Site Manager	*REMM SO5*
SW22	Ensure the solar panels and associated infrastructure are located, constructed and maintained to avoid causing any tunnel erosion on site.	✓	✓			Prior to construction and Ongoing	Site Manager	*Best practice*
SW23	Dust producing activities shall be avoided or minimised wherever practical during windy conditions and a water truck shall be available and used on-site when construction activities are being undertaken.		✓		✓	Ongoing	Site Manager	*Best practice*
Site Runoff								
SW24	All staff would be appropriately trained through toolbox talks for the minimisation and management of accidental spills.	✓	✓			Prior to construction and Ongoing	Site Manager	*Best practice*
SW25	Use of glyphosate-based products (or similar non-residual and non-persistent herbicides) to manage weeds on-site, to minimise the potential risk of harmful herbicide by-products entering the surface water receiving environment	✓	✓			Ongoing	Site Manager	*Best practice*

SW26	Safe storage of hazardous substances (away from waterways and drainage lines), to ensure that any spillages do not impacts on land or water;	✓	✓			Prior to construction and Ongoing	Site Manager	*Best practice*
SW27	Design, construction and maintenance of temporary and permanent stream crossings in accordance with Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (2004);		✓		✓	Ongoing	Site Manager	*CoC Sch 3, 22*
SW28	Critical ancillary facilities and electrical equipment including the substation and Transformer shall be protected from floodwaters during the construction phase in consideration of the 10% AEP (10-Year ARI) event.	✓	✓			Prior to construction and Ongoing	Site Manager	*Best practice*
SW29	Where identified onsite, ensure there are appropriate measures in place to stabilize drainageways in accordance with Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004).	✓	✓			Prior to construction and Ongoing	Site Manager	*REMM S01*
Rehabilitation								
SW30	Revegetated disturbed soils with native or naturalised perennial species, to stabilise the land, reduce peak storm water flows and reduce erosion and sedimentation. Where reasonable and feasible, deep-rooted and salt-tolerant species will be used for revegetation.		✓	✓		As required	Site Manager	*REMM SO1 & REMM SO6*
SW31	The pH level of topsoil must be adequate to enable establishment and growth of the specified vegetation.		✓	✓		As required	Site Manager	*Blue Book (2004)*

SW32	Unless otherwise directed by the approved revegetation plan, topsoil must be placed at a minimum depth of 75mm on slopes 4:1 (H:V) or flatter, and 50mm on slopes steeper than 4:1.		✓	✓		As required	Site Manager	*REMM SO6*
SW33	All disturbed areas must be suitably stabilised within 20 days from the day that soil disturbances on the area have been finalised.		✓	✓		As required	Site Manager	*Blue Book (2004)*
SW34	The type of ground cover applied to completed earthworks must be compatible with the anticipated long-term land use, environmental risk, and site rehabilitation measures.		✓	✓		As required	Site Manager	*Blue Book (2004)*
SW35	Where reasonable and feasible, a minimum of the following ground cover must be achieved on all completed earthworks exposed to accelerated soil erosion: • 60% ground cover must within 30 days during those months when the expected rainfall is less than 30mm; • 70% cover within 30 days if between 30 and 45mm; • 70% cover within 20 days if between 45 and 100mm; • 75% cover within 10 days if between 100 and 225mm; • 80% cover within 5 days if greater than 225mm.		✓	✓		As required	Site Manager	*Best practice*
SW36	Stabilisation works must not rely upon the longevity of non-vegetated erosion control blankets, or temporary soil binders. All unstable or disturbed soil surfaces must be adequately stabilised against erosion (minimum 70%) prior to commencement of re-use.		✓	✓		As required	Site Manager	*Best practice*
Monitoring								

SW37	During excavation activities, monitor for increases in salinity, reduce water inputs and remediate affected areas with salt tolerant vegetation.		✓		✓	During excavation activities	Site Manager	*REMM SO1*
SW38	Meteorological forecasts and data are to be collected to enable the pre-warning of significant storm events to enable the preparation of mitigation measures within a sufficient time frame. Rainfall will be considered when scheduling works and controlling access to and through the site.		✓		✓	Ongoing	Site Manager	*Best practice*
SW39	Areas in which gypsum treatment has been applied to manage dispersion should be monitored for performance and further treatment where required.		✓			As required during construction	Site Manager	*Best practice*
SW40	Site inspections are to be undertaken in accordance with requirements outlined in Section 5.2.1 and recorded on the Site Inspection Checklist (Appendix C) to ensure controls (e.g. diversion drains, sediment fences) are performing adequately.		✓			Ongoing	Environmental Manager	*REMM SO1*
SW41	Equipment storage areas including fuel and chemical storage to be located away from flood risk areas in the 1% AEP scenario. If equipment storage areas are within this zone appropriate flood protection measures are to be in place such as on a raised earth embankment or suitably design structure	✓	✓			Ongoing	Site Manager	*Best practice*
SW42	Daily monitoring of weather conditions is to be undertaken in with construction activities to cease where extreme rainfall events are forecast.	✓	✓			Ongoing	Site Manager	*Best practice*
SW43	Critical ancillary facilities and electrical equipment including the substation and Transformer should be protected from floodwaters during the construction phase in consideration of the 10% AEP event	✓	✓			Ongoing	Site Manager	*Best practice*

5. Implementation

5.1 Roles and Responsibilities

The following roles and responsibilities are assigned to individuals.

Table 5-1: Roles and responsibilities

Role	Responsibility
Project Manager	• Overall responsibility of SWMP implementation, inspection, monitoring, maintenance, operation and decommissioning; • Inform ESC design about any changes to the construction staging and scheduling; • Notify the quality and environment manager immediately of any non-compliance with the SWMP; • Notify the quality and environment manager when runoff generating rainfall occurs; and • Maintain current records of rainfall, storage volumes, water quality, treatment practices, and discharge volumes.
Site Manager	• Control the implementation and effectiveness of the SWMP; • Install the ESC measures as specified in the Progressive ESCPs; • Operate and maintain the ESC measures; • Communicate any concerns with proposed ESC measures; • Communicate to project manager any failure of any ESC measures; and • Respond promptly to any direction received from the project manager, or environmental manager.
Environment Manager or nominated Environment representative	• Conduct site inspections and prepare inspection reports; • Conduct in-situ monitoring and prepare monitoring reports; • Communicate recommendations and feedback regarding the applications of SWMP measures to the project manager and contractor; • Lead the development of the Progressive ESCPs; • Select and design ESC practices that suit the construction site / environmental conditions; and • Review and approve of on-site design modifications.

In addition to the responsibilities identified above, all parties undertaking works associated with the project are responsible for ensuring the immediate reporting of environmental incidents. This includes reporting up to appropriate regulatory agencies in the event that the incident causes or threatens to cause significant harm to the environment.

5.1.1 Subcontractor management

As a minimum, subcontractors and their employees will be required to comply in full with the requirements of the SWMP as it applies to site environmental management and control. Subcontractors' personnel are considered equivalent to contractor project personnel in all aspects of environmental management and control.

All site personnel (including subcontractors) will be informed during the site induction of soil and water management issues prior to Construction commencing. The training will address elements related to soil and water management including:

- Existence and requirements of the SWMP and all plans and procedures prepared under the SWMP.
- Relevant legislation and regulations.
- Incident response, management and reporting.
- Emergency response measures in high rainfall or flood events.
- Topsoil Stockpile location criteria.
- Complaints response and reporting.
- Roles and responsibilities for soil and water management.
- ERSED control installation methodology.
- Water quality management and protection measures.
- Groundwater issues and dewatering procedures.
- Spill response.
- The location of sensitive receiving environment.
- Soil and water quality control measures.
- Procedure to be implemented when managing soil and water quality impacts.

Targeted training in the form of Toolbox talks or specific training will also be provided to personnel with a key role in soil and water management or those undertaking an activity with a high-risk environmental impact.

Daily pre-start meetings conducted by the Site Manager will inform site personnel of any environmental issues relevant to soil and water. Daily pre-start meetings conducted by site staff will inform the site workforces of any environmental issues relevant to soil and water that could potentially be impacted by, or impact on, the days or future activities.

5.2 Monitoring program

During the construction phase, site inspections are required to ensure that the SWMP is being appropriately implemented and that mitigation measures comply with relevant standards. Site inspections are to be undertaken in accordance with the Blue Book (2004) and the Site Inspection Register in Appendix C. Best practice site management requires all measures to be inspected by the site manager or nominated representative:

- at least daily when rain is occurring;
- at least weekly (even if work is not occurring on-site);
- within 24 hours prior to expected rainfall; and
- within 18 hours of a rainfall event of sufficient intensity and duration to cause on-site runoff.

5.2.1 Inspection Requirements

Site inspections are to be conducted in accordance with the below requirements.

Weekly site inspections must check:

- All drainage and ESC measures;
- Occurrences of excessive sediment deposition (whether on-site or off-site);
- Occurrences of construction materials, litter or sediment placed, deposited, washed or blown
- from the site, including deposition by vehicle movements;
- Litter and waste receptors; and
- Oil, fuel and chemical storage facilities.

Site inspections prior to anticipated runoff producing rainfall must check:

- All drainage and ESC measures; and
- All temporary flow diversion and drainage works.

Site inspection following runoff producing rainfall must check:

- All drainage and ESC measures;
- Occurrences of excessive sediment deposition (whether on-site or off-site);
- Occurrences of construction materials, litter or sediment placed, deposited, washed or blown
- from the site, including deposition by vehicle movements; and
- Occurrences of excessive erosion, sedimentation, or mud generation around the site office, car park and/or material storage areas.

In addition to the above, **monthly site inspections** must check:

- Surface coverage of finished surfaces;
- Sediment depth in all sediment sumps and/or basins
- Health of recently established vegetation; and
- Proposed staging of future land clearing, earthworks and site/soil stabilisation.

5.2.1.1 Meteorological Monitoring

Meteorological forecasts and data are to be collected to enable the pre-warning of significant storm events to enable the preparation of mitigation measures within a sufficient time frame. Actions as required to address the impending weather forecast would be programmed in a timely manner.

Rainfall will be considered when scheduling works and controlling access to and through the site. An overview of the meteorological monitoring program is provided in Table 5-2.

Table 5-2: Meteorological Monitoring

Location	Parameter	Equipment Type	Frequency
Weather Radar	Cloud density and rate rain chart	Bureau of Meteorology website: http://www.bom.gov.au/ or weatherzone.com.au	Daily

5.3 Auditing

During the construction phase of the Project, audits are to be conducted to ensure the effective implementation of the SWMP. Audits will be carried at intervals in accordance with the CEMP. Such audits must be:

- Undertaken by a person suitably qualified and experienced in ESC that can be verified by an independent third party (this person must not be an employee or agent of the principal contractor).

Audits must include, as a minimum:

- Copies of all original completed site inspection checklists;
- Non-conformance and corrective action reports;
- Progressive ESCPs showing the areas of completed soil stabilisation; and
- Rainfall records including date and rainfall depth.

Audit reports are to be compiled within 5 business days of completion of the site inspection and forwarded to the relevant stakeholder.

5.4 Compliance management

The implementation of the SWMP will be undertaken in line with CEMP and CoC. Specifically, conditions 4 and 5of Schedule 4 will be complied with.

5.5 Review and Improvement

5.5.1 Environmental Management Review

The effectiveness and proper implementation of the SWMP will be reviewed in accordance with requirements of the CEMP and EMS. Review will be undertaken by the management team. The review will comprise:

- Reviewing the results of audits.
- Evaluation of the system, which improvements and corrective actions will be sought.
- Evaluation of the operation of the SWMP.

Condition 2 of Schedule 4 will be complied with during the implementation and review of the SWMP.

5.5.2 Continual Improvement

Continual improvement of the SWMP will be achieved by the regular evaluation of environmental management performance against environmental policies, objectives and targets for the purpose of identifying opportunities for improvement. During the construction phase, the continual improvement process will:

At least bi-annually:

- Review the adequacy of this plan.
- Consider any recent developments in practices and technology to ensure Best Management ideals are
- followed to minimise potential impacts to soil and water quality.

At least quarterly:

Review monitoring results and identify areas of opportunity for improvement of environmental management which leads to improved environmental performance.

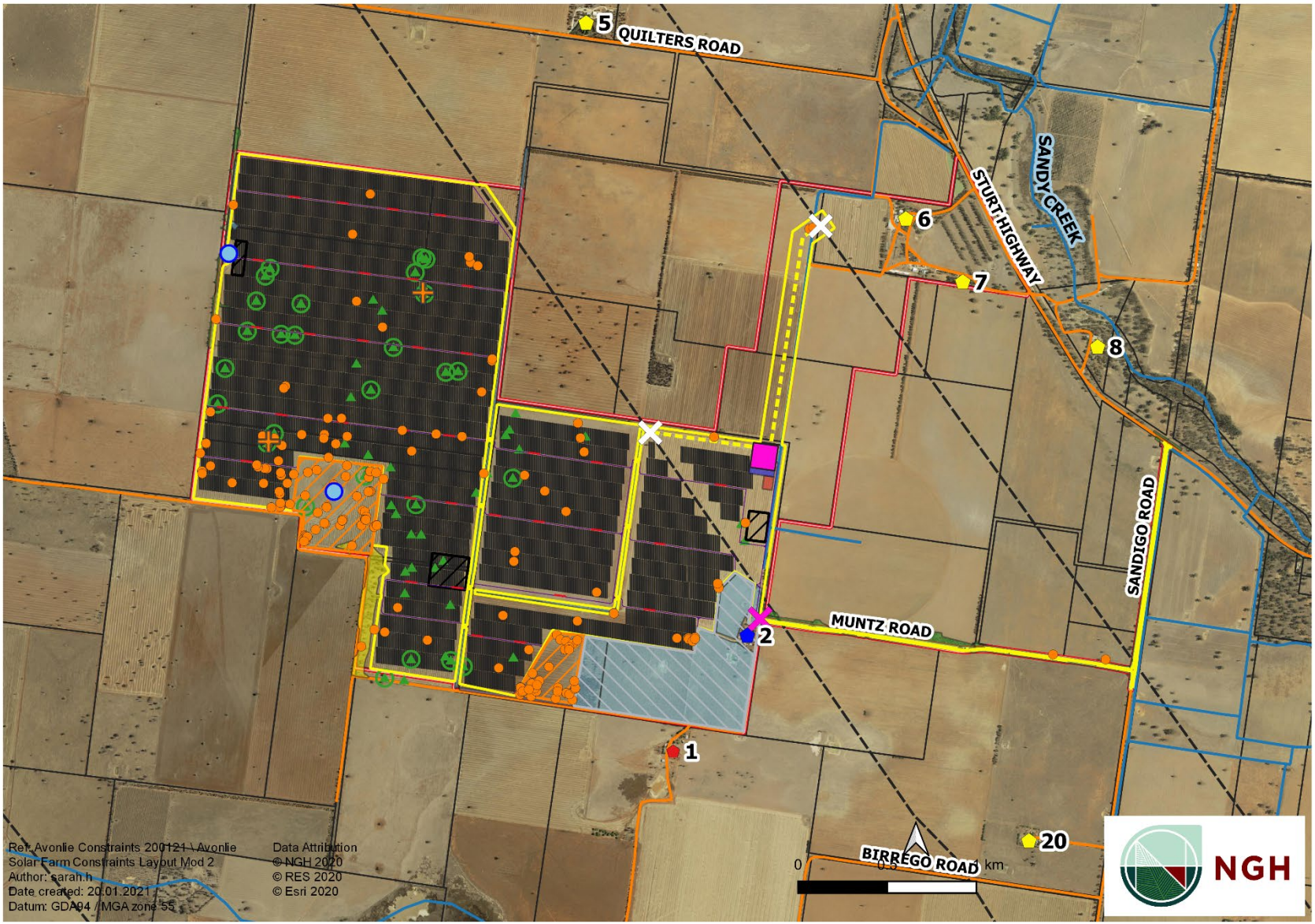
- At least monthly (or as incidents / non - conformances occur):
- Determine the root cause or causes of non - conformances and deficiencies.
- Develop and implement a plan of corrective and preventative action to address non - conformances and deficiencies.

- Verify the effectiveness of the corrective and preventative actions.

Outcomes of these reviews shall be documented and retained for the duration of the project.

Appendix A. Site Layout

JACOBS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6
7
8
STURT HIGHWAY
SANDY CREEK
SANDIGO ROAD
MUNTZ ROAD
2
1
20
BIRREGO ROAD
0
0.5
km
Ref: Avonlie Constraints 200121 \ Avonlie Solar Farm Constraints Layout Mod 2
Author: sarah.h
Date created: 20.01.2021
Datum: GDA94 / MGA zone 55
Data Attribution
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NGH
Avonlie Solar Farm Constraints Layout Mod 2
Legend
Development Site
Development Footprint
Inverter/Battery Units
Substation
O&M Building
Transformer/Utility Building
Construction Compound
Proposed Subdivision
Tracker/Panel Array
Point of Connection
Proposed Transmission
Existing Transmission
Site Access
Internal Roads
Public Roads
Dams
hydroline
Cadastre
Landowners
Associated Residence
Associated Derelict Building
Non-associated Residence
Non-associated Derelict Building
Isolated Artefacts
Scarred Trees (to be retained)
Heritage Exclusion Zones
Paddock Trees
Hollow Bearing
Non-hollow Bearing
Pland Community Types
PCT 9
PCT 76
PCT 80

Appendix B. Primary Erosion and Sediment Control Plan

1. Introduction

1.1 Project Background

The Project Owner is proposing to develop an approximately 100MW solar farm near Sandigo, roughly located 20km south of Narrandera, NSW (referred to as the Project). The Project Owner will appoint an EPC contractor to construct, operate and potentially decommission the Solar Farm. The solar farm was approved by the NSW Government in October 2019 and will consist of approximately 667,000 solar panels on approximately 581 hectares of land. Construction of the proposal would take approximately 15 months to complete. The Project is expected to operate for about 30 years, after which the proposal would be reconditioned or decommissioned.

As part of the proposed Avonlie Solar Farm (ASF) development, Jacobs Pty Ltd was commissioned the to develop a Primary Erosion and Sediment Control Plan as part of the Stormwater Management Plan (SWMP) for the foundations of the solar panel arrays, associated structures and access roads within the proposed development site.

1.2 Purpose of this plan

This Primary Erosion and Sediment Control Plan (ESCP) is a document which describes intentions and fundamental principles Erosion and Sediment Control and water management measures required during the construction phase of the project works. This ESCP informs the development of the Progressive Erosion and Sediment Control Plans (PESCPs) to be detailed for each construction stage and/or disturbance area prior to commencement of works to the area.

1.3 Technical standards and documents

This Erosion and Sedimentation Control Plan is based on the requirements and guidelines contained in the following manuals/documents:

- Landcom (2004), Managing Urban Stormwater: Soils and Construction, Vol 1, 4th Edition (i.e. Blue Book).
- Best Practice Erosion and Sediment Control Guidelines (IECA 2008).
- Australian Rainfall and Runoff: A guide to flood estimation, (Commonwealth of Australia (Geoscience Australia), 2019).
- Narrandera Shire Council Engineering Guidelines for Subdivisions and Development Standards, Part 3 - Stormwater Drainage Design (2011), GHD.

The strategies and techniques detailed in the above documents are appropriate for the protection of the adjacent environment of this project.

1.4 Objectives

This Primary ESCP has been developed in accordance with Blue Book (2004) and the Best Practice Erosion and Sedimentation Control (IECA, 2008). The objective of this SWMP is to minimise the impact of erosion and sediment discharge on undisturbed land and downstream receiving waters during the construction period of the solar farm.

2. Existing Environment

2.1 Topography

The site is characterised by uniformly flat topography, with the difference in ground elevation expected to be less than 5m across the entire site, with a low elevation of approximately 150m AHD (Berembed Weir 1:50,000 Topographic map sheet (8228-S)). The site geology is distributed over one unit: Cainozoic alluvium and the landform.

2.2 Soils

Two soil landscapes have been identified within the development site, classified as Chromosols and Sodosols (DM McMahon Pty Ltd, 2018). Sodosols onsite are typically associated with the underlying subsoils and once disturbed, are prone to high levels of erodibility moderate salinity risk and waterlogging. Sodosols are dispersible soils with extremely high risks of erosion, associated impacts includes gully and streambank erosion have been noted along some drainage lines at the development site Sodosols (DM McMahon Pty Ltd, 2018).

Golders (2019) noted localised dispersive features typically associated with grey soil clay pans and topographic low points predominately observed in the western and southern sections of the site. The depth of the observed erosion/dispersion features was generally observed at up to 500 mm from surrounding surface levels. Soil-structures in these areas may have undergone partial collapse and may be susceptible to dispersion and tunnel erosion when exposed to flowing fresh water.

2.1 Hydrology

The development site is located within the Sandy Creek subcatchment of the Murrumbidgee catchment. The site is located on the drainage plains in the Murrumbidgee River system catchment area. Sandy Creek is located within 1km of the northern boundary of the site. An ephemeral irrigation channel approximately 1 to 1.5m deep, runs along the eastern site boundary. The channel is considered unlikely to support aquatic habitat of value. Two farm dams located in the north western and south western sections of the development footprint (refer to Appendix A). Natural flow paths have been extensively modified and altered with the introduction of irrigation and drainage channels. These channels include gravity-fed irrigation and drainage channels that have been privately constructed irrigation and managed.

2.2 Rainfall

The closest Bureau of Meteorology Weather Station is Narrandera Airport NSW, located about 17km north of the development site. The mean rainfall for Narrandera is approximately 482.8mm per annum, with the wettest months being October, August and September. Annual mean evaporation for the region is 1715.5mm with mean daily evaporation ranges from 1.2mm in July to 9.2mm in January. Rainfall and temperature data from Narrandera Golf Club (74221) and evaporation data from Wagga Wagga Agricultural Institute (73127), located 79km away (www.bom.gov.au).

2.2.1 Design Rainfall

The design input parameters for this Principle ESCP are presented in Table 2-1 below. The parameters were selected in accordance site-specific characteristics and Blue Book, 2004. The rainfall erosivity factor (R-factor) is a measure of the ability of rainfall to cause erosion. It is the product of the total energy and the intensity of the rainfall event. The calculated R-factor for the site is 909.25. Calculations for the R-factor are provided in Appendix B.3.

The 80th Percentile 5-Day Rainfall depth was selected due to the duration of site disturbance (>6 months) and limited sensitive receivers surrounding the site. Utilising Table 6.3a (Blue Book, 2004); Wagga Wagga approximately 80km south-east of the site, was selected as the closest available location with a value 18.8 mm used as the rainfall depth.

Table 2-1: Design Input Parameters

Parameter	Value	Source
Rainfall Erosivity (R Factor)	909.25	$Equation$ 1 Blue Book, 2004; S = 2-year 6-hour storm derived from AR&R 1987
80th Percentile 5-Day Rainfall depth (mm)	18.8	*Table 6.3a* Blue Book, 2004

3. Erosion and Sedimentation Risk assessment

The erosion risk assessment described in Appendix B.3 acts as an indicator to determine what levels of erosion and sedimentation control measures should be applied to the project. The assessment has been undertaken in accordance Blue Book (2004) and Erosion Risk Categorisation detailed in Table 3-1. Blue Book (2004) requires calculations assessing the need for a sediment basin where the area of disturbance is excess of 2,500 m_2. As the total disturbance footprint during the construction phase is estimated at 14 ha calculations assessing the need for a sediment basin has been assessed and provided in Appendix B.3. Blue Book (2004) nominates a threshold of 150 m_3 of average annual soil loss as the minimum site disturbance requiring a sediment basin.

Table 3-1: Erosion Risk Categorisation (Blue Book, 2004)

Soil Loss class	Soil Loss Rate (t/ha/yr)	Erosion Risk
1	0 to 150	Very Low
2	151 to 225	Low
3 to 4	226 to 500	Moderate
5 to 6	501 to 1500	High
7	> above 1500	Extremely High

3.1.1 Soil Loss Rate and Required Controls

The site-specific erosion risk assessment below conservatively estimates site soil loss rate has been for each catchment as detailed in Catchment ID Based on the estimated average annual soil loss sediment basins are not considered necessary in accordance with the threshold of 150 m_3 (Blue Book, 2004). The values also correspond to a low risk rating in accordance with the risk categorisation framework detailed Table 3-2.

Due to the limited topographic relief, runoff is considered to be unlikely to cause substantial erosion or lead to substantial sediment loads entering any natural waterways. Suitable controls measures including sediment fences, sediment traps and site rehabilitation are considered adequate to manage this level of risk. The complete erosion risk assessment has been provided in Appendix B.3.

Table 3-2: Soil Loss Rate and Required Controls

Catchment ID	Catchment Size (ha)	Average annual Soil Loss Rate (t/ha/yr)	Average annual Soil Loss Rate (m^3)	Soil Erosion Hazard	Sediment Basin Required
Catchment A					
A1	83	19	125	Very Low	**No**

A2	29.6	19	125	Very Low	**No**
A3	42.5	19	125	Very Low	**No**
A4	157.4	18	120	Very Low	**No**
A5	373.9	19	125	Very Low	**No**
Catchment B					
B1	49.5	17	111	Very Low	**No**
Catchment C					
C1	497.1	19	125	Very Low	**No**

4. Key management strategies

4.1 Erosion Control

4.1.1 Existing Groundcover

The construction methodology will be developed to minimise the duration and extent of impacts to the existing groundcover wherever possible. Where land clearing is required, topsoil stripping and/or groundcover removal will be delayed for as long as possible. Refer to Section 4.1.1 of the SWMP for further details on management of land clearing.

Where required, gypsum is to be applied on areas of disturbed subsoils prone to dispersibility in order to minimise potential for tunnel erosion and surface rilling. The application rate is to be determined by site specific soil testing as required. To assist in dissemination and depth of treatment, tilling and mixing should be considered.

4.1.2 Stockpile Management

All reasonable and practicable measures must be taken to obtain the maximum benefit from existing topsoil. Stockpiles of erodible material that has the potential to cause environmental harm if displaced, must be:

- Appropriately protected from wind, rain, concentrated surface flow and up-slope surface runoff;
- Stockpile areas should be stabilised using hydromulch or an approved equivalent. Batters should be stabilised with mulch to a depth of 50mm (minimise mulched vegetation where feasible);
- Where excavated material is considered suitable for on-site reuse, separate subsoils and topsoils and ensure backfilling is undertaken in accordance with their natural configuration to assist revegetation;
- Where feasible and reasonable sediment fences must be established downslope of stockpiles containing erodible material; and
- Located at least 2m from any hazardous area, retained vegetation, or concentrated drainage line.

4.1.3 Drainage controls

During the construction period, where reasonable and practical measures the following drainage controls measures are to be implemented:

- Control flow velocities in such a manner than prevents soil erosion along drainage paths and at the entrance and exit of all drains during all storms up to the relevant design storm discharge.
- Wherever reasonable and practicable, clearwater diversion drains shall be installed along the site boundary upstream of the disturbed areas in accordance with the typical site layout provided in Appendix B.1. Diversion drains control measures will be applied and maintained in accordance with the SWMP and Blue Book (2004).
- Level spreaders are required at any locations where concentrated flow would otherwise discharge off the site to ensure that runoff is returned to its existing “sheet flow” condition before leaving the site.
- All waters discharged during the construction phase must discharge onto stable land, in a non-erosive manner, carry water to disperse widely onto undisturbed ground at a sufficient distance. Clean surface waters must be diverted away from sediment control devices and any untreated, sediment-laden waters.
- Drainage lines are to be vegetated to prevent excessive rutting and tunnel erosion.

4.1.4 Stabilisation

Temporary stabilising of exposed areas will be required on disturbed areas. The temporary stabilising measures below should be considered for flat land (i.e. slope less than 1 in 10):

- Seeding;
- Temporary cover cropping
- Hydro mulching;
- Erosion control blankets;
- Gravelling; and
- Soil binder.

Soil stabilizing techniques should be used on exposed land where implementing the revegetation process is not able to be completed in a timely manner or is not feasible at that stage of construction. The stabilising works must not rely upon the longevity of non-vegetated erosion control blankets, or temporary soil binders. Permanent revegetation and site rehabilitation requirements are detailed in Section 4.1.2 of the SWMP.

4.2 Sediment Control

4.2.1 Site Access

Site entry/exit during the construction phase is to be restricted to a single stabilised site access point provided on the eastern boundary to minimise the risk of tracking dust and dirt throughout the surrounding local road networks. The access point is to be equipped with a vibration grid to minimise and contain dust and dirt collected on construction vehicles and plant entering or exiting site.

4.2.2 Site controls

All site sediment controls will be designed, installed and maintained in accordance with the Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004). A summary of the following ESC measures required for site construction activities is as follows:

- Sediment fences or similar measures are to be installed at the downstream of the disturbed areas along the site boundary to treat sheet-flow, alternative suitable control measures for sheet flow may be considered including fabric wrap field inlet sediment traps.
- Restrict access to areas that do not require land disturbance;
- Ensure the solar panels and associated infrastructure are located, constructed and maintained to avoid causing any tunnel erosion on site.

The details of typical control measures are included in Appendix B.1.

4.2.3 Road work activities controls

The proposed site works include potential disturbances to the internal and external local road networks for access onto and throughout the site. A summary of the following ESC measures required for external road activities is as follows:

- Vibration grids are required at construction entries/exits.
- Sediment fences required to control sediment down-slope of any batters where sedimentation may present in “sheet” flow conditions during rain events.
- Dust control measures such as watering may be required where stockpiles, demolition areas and any clearing and excavation take place.

Further controls regarding the management of the transportation of dirt and dust throughout the external local road network during construction is detailed within the Project Traffic Management Plan. The details of typical control measures are included in Appendix B.1.

4.2.4 Dust control

Dust producing activities shall be avoided or minimise wherever practical during windy conditions and a water truck shall be available and used on-site when construction activities are being undertaken. Meteorological forecasts and data are to be collected and considered during the scheduling of dust generating works as detailed in Section 5.2 of the SWMP.

5. Implementation

5.1 Progressive Erosion and Sediment Control Plans

Progressive ESCPs will be prepared prior to the commencement of each work stage. The Progressive ESCPs will be prepared in accordance with this Primary Erosion and Sediment Control Plan and all relevant guidelines including:

- Landcom (2004), Managing Urban Stormwater: Soils and Construction, Vol 1, 4th Edition (i.e. Blue Book).
- Best Practice Erosion and Sediment Control Guidelines (IECA 2008).

The Progressive ESCPs would generally contain finalised details of the following, as relevant to the local conditions and each work stage:

- Method of tree removal, leaving groundcover undisturbed where possible.
- Final design and location of erosion and sediment control measures required before clearing and grubbing of the site.
- How upstream 'clean' water will be managed and diverted around disturbed areas, so it is not polluted by potential 'dirty' or sediment-laden water resulting from the construction activities.
- Scour protection measures for haul roads and access tracks when these are as an erosion hazard due to either their steepness, soil erodibility or potential for concentrating runoff flow.
- The methods for minimising disturbed areas and temporary drains.
- Additional methods to minimise and monitor tunnel erosion that may occur underneath the solar arrays where required.
- The methods of maintenance of erosion and sediment controls.
- Any additional measures to minimise erosion and control sedimentation from stockpiles (if required).

Any Additional controls to be implemented during heavy rainfall events based the latest site conditions (if required).

PESCPs will also show the finalized locations of the following:

- Access and haulage tracks.
- Stockpile and storage areas.
- Temporary work areas.
- Compound areas.

PESCPs will be updated regularly to reflect changes on site as each construction progresses and site conditions change.

5.2 E&S Maintenance

The installation and maintenance of all ESC measures is to be overseen by a suitably qualified person. Installation is to be consistent with this Primary ESCP. All ESC measures, including drainage control measures, must be maintained in proper working order at all times during their operational lives. All temporary ESC measures, including drainage control measures, must be fully operational and maintained in proper working order at all times during the maintenance period. If ESCs are observed to have reduced capacity, damage or insufficient effectiveness, they are to be repaired, improved or substituted as follows:

- Identified soil erosion areas are to be resolved as soon as possible, with additional control measures implemented to prevent recurrence.
- All sediment control devices (other than sediment basins) must be de-silted and made fully operational as soon as reasonable and practicable after runoff-producing rainfall, or if the sediment retention capacity of the device falls below 75% of the design retention capacity (IECA 2008).

Spare materials including geo-fabric, sediment fence material, mulch and rock are to be stored on-site to enable repairs to be conducted within a short timeframe. Sediment removed from sediment traps and places of sediment deposition must be disposed of in a lawful manner that does not cause ongoing soil erosion or environmental harm. All drainage and ESC measures must be inspected as outlined in Section 4.2.1 of the SWMP.

5.3 Review and improvement

The Progressive ESCPs are dynamic documents, typically requiring updating as construction stages progress and site characteristics alter. Any alterations to the implementation of erosion and sediment controls within specific areas will be recorded and outlined in progressive ESCPs. This may include the following scenarios:

- Controls require alteration due to change in work practices or new stage of works is commenced;
- Controls require alteration due to change in seasonal conditions (e.g. dry season vs wet season);
- Changes occur in slope gradients and drainage paths, with their exact form unpredictable before works start;
- Changes in the project design that potentially impacts on ESC requirements; and
- The desired objectives (e.g. protection of receiving environments) is not being achieved.

Appendix B. 1 Erosion and Sediment Control Plan – Typical Layout

NOTES TO ACCOMPANY EROSION & SEDIMENT CONTROL PLAN – TYPICAL LAYOUT

GENERAL NOTES

1. The purpose of this environmental site control plan is to prevent/minimise environmental harm through the provision of a typical site layout, environmental controls and disturbance area for the development site. The layout provided in this ESCP-TYPICAL LAYOUT is indicative only and shall be read in conjunction with the Stormwater Management Plan all relevant project management plans and documentation including the Construction Environmental Management Plan (CEMP) and Environmental Management Strategy
   (EMS).
2. The implementation of ESC measures and site layouts for each stage of works shall be confirmed onsite by the Environmental Manager or nominated delegate prior to commencement of ground disturbance in close co-ordination with site personnel and detailed within the Progressive ESCP's.
3. Site rehabilitation and stabilisation is to be undertaken in accordance with the objectives and procedures outlined in the section 4.2.1 of the SWMP and section 4.1.4 to the Principle ESCP.

EROSION AND SEDIMENT CONTROL NOTES

1. All ESC measures are to be designed, installed and maintained in accordance with Landcom's Blue Book (2004).
2. Wherever possible, existing vegetative groundcover within the site boundary must be preserved to minimise erosion risk.
3. The height, location and taper of downstream and upstream controls for each work stage will be confirmed onsite by the Environmental Manager or nominated delegate prior to commencement of ground disturbance in accordance with observed site conditions including site gradient, groundcover and proximity to water natural drainage lines and receiving waterbodies.
4. Adequate supplies of erosion and sediment control measures shall be maintained and available for deployment at all times.
5. Sediment and erosion controls are to be inspected daily and cleaned out regularly to ensure they operate effectively. Where implemented, all control measures shall be maintained in a fully functional condition and must be repaired as soon as possible after rainfall events.
6. Refer to the Principle ESCP for further details on site erosion and sediment controls.

LEGEND

Catchment A

Catchment B

Catchment C

Channels

Catchment Delineation

SubcatchmentDelineation

Internal Roads

Direction of flow

Area, 0.830 sq.km

Area, 3.139 sq.km

Area, 0.42S sq.km

Area, 0.42S sq.km

Area: 0.495 sq.km

Area, 4.911 sq.km

Indicative Site aoundaY

Indicative sediment fence

Indicative Clear water

Substation (IO

Existing Irrig

Main Site Entry

Emergency Site Entry/ Exit

clear- -

d. iverSion

EB

Siemens Gamesa

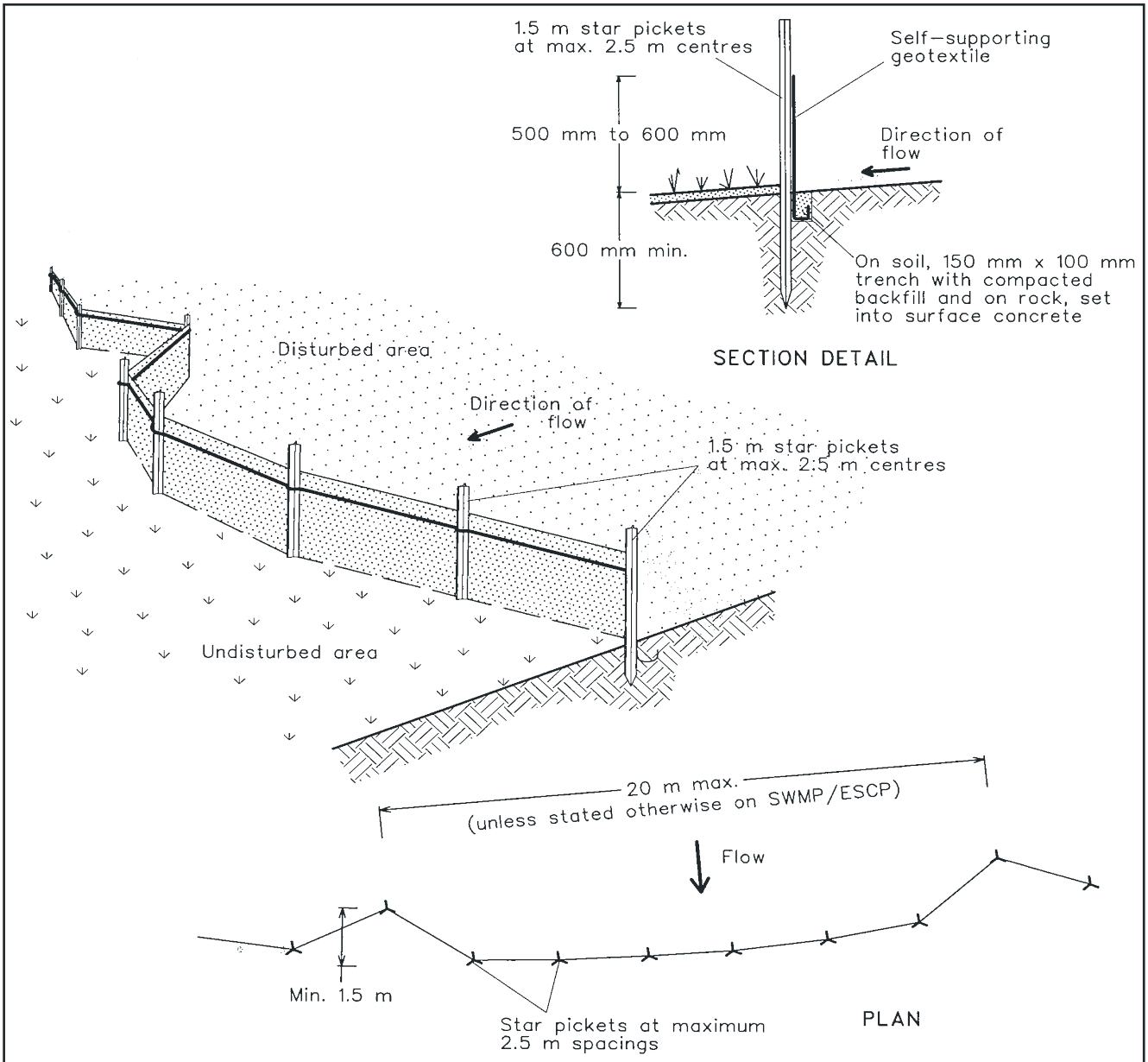
JACOBS

Principle Erosion and Sediment Control Plan- Typical Layout

SHEET 1 OF 1

A

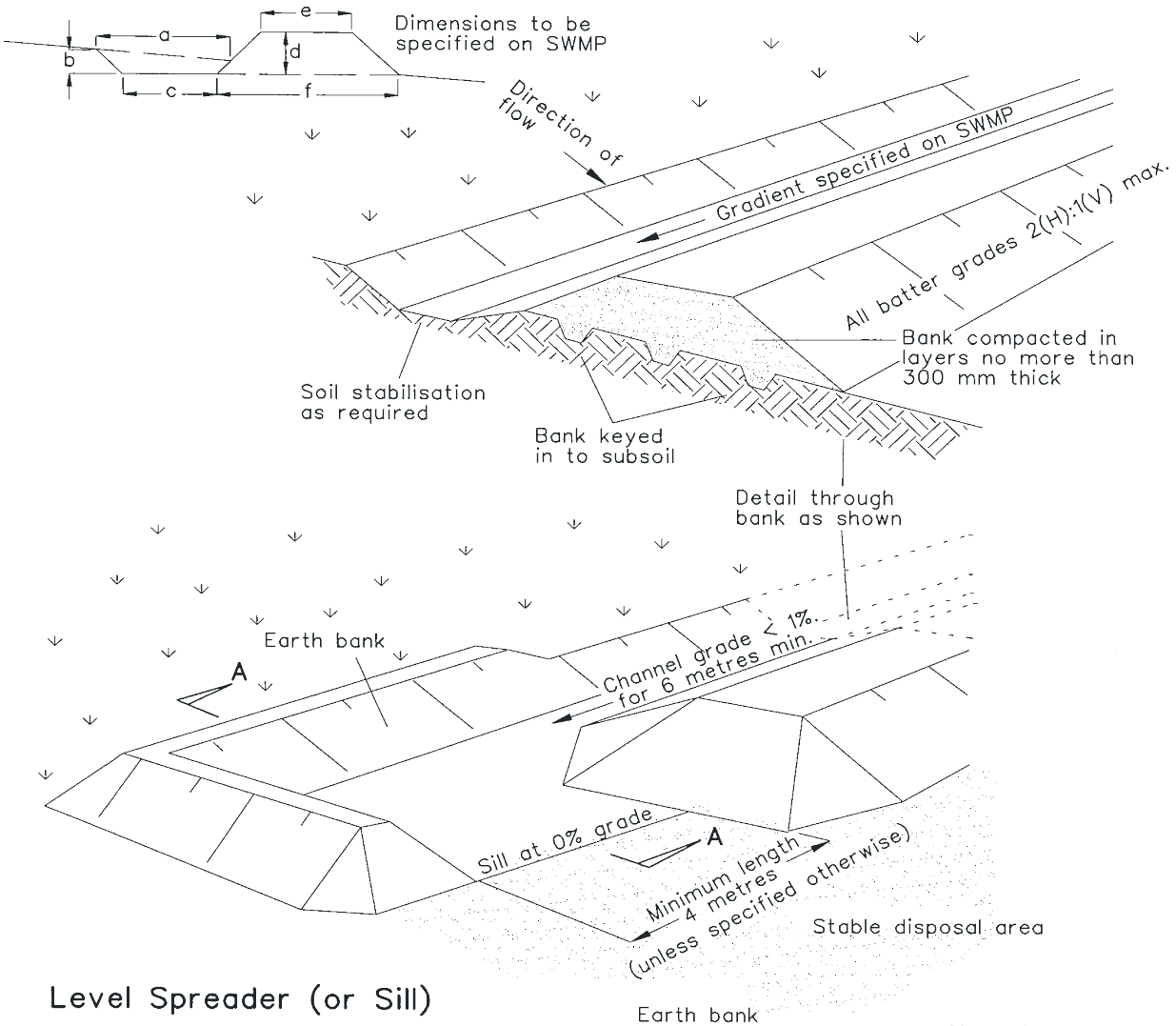
Appendix B. 2 Typical Erosion and Sediment Control Measures



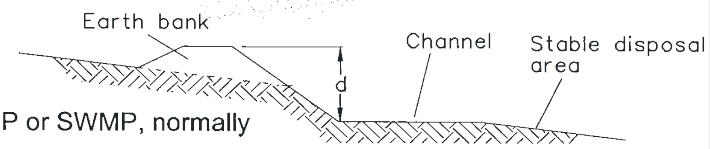
Construction Notes

1. Construct sediment fences as close as possible to being parallel to the contours of the site, but with small returns as shown in the drawing to limit the catchment area of any one section. The catchment area should be small enough to limit water flow if concentrated at one point to 50 litres per second in the design storm event, usually the 10-year event.
2. Cut a 150-mm deep trench along the upslope line of the fence for the bottom of the fabric to be entrenched.
3. Drive 1.5 metre long star pickets into ground at 2.5 metre intervals (max) at the downslope edge of the trench. Ensure any star pickets are fitted with safety caps.
4. Fix self-supporting geotextile to the upslope side of the posts ensuring it goes to the base of the trench. Fix the geotextile with wire ties or as recommended by the manufacturer. Only use geotextile specifically produced for sediment fencing. The use of shade cloth for this purpose is not satisfactory.
5. Join sections of fabric at a support post with a 150-mm overlap.
6. Backfill the trench over the base of the fabric and compact it thoroughly over the geotextile.

SEDIMENT FENCE SD 6-8



Level Spreader (or Sill)



Section AA

Construction Notes

1. Construct at the gradient specified on the ESCP or SWMP, normally between 1 and 5 percent
2. Avoid removing trees and shrubs if possible - work around them.
3. Ensure the structures are free of projections or other irregularities that could impede water flow.
4. Build the drains with circular, parabolic or trapezoidal cross sections, not V-shaped, at the dimensions shown on the SWMP.
5. Ensure the banks are properly compacted to prevent failure.
6. Complete permanent or temporary stabilisation within 10 days of construction following Table 5.2 in Landcom (2004).
7. Where discharging to erodible lands, ensure they outlet through a properly constructed level spreader.
8. Construct the level spreader at the gradient specified on the ESCP or SWMP, normally less than 1 percent or level.
9. Where possible, ensure they discharge waters onto either stabilised or undisturbed disposal sites within the same subcatchment area from which the water originated. Approval might be required to discharge into other subcatchments.

EARTH BANK (HIGH FLOWS) SD 5-6

Appendix B. 3 Erosion Hazard Assessment

1.1 Erosion Risk Assessment

The erosion risk assessment described below acts as an indicator to determine what levels of erosion and sedimentation control measures should be applied to the project. The estimated soil loss from a range of slopes was calculated using the RUSLE. This equation aims to predict the long-term soil loss rate from a given site based on the site characteristics.

$A = K * R * Ls * P * C$ ($Equation$ 1 Blue Book, 2004)

Where:

A = $Predicted\ soil\ loss\ per\ hectare\ per\ year$

K = $Soil\ erodibility\ factor$

R = $Rainfall\ erosivity\ factor$

$P = Erosion\ Control\ Practice\ factor$

$C = Cover\ factor$

Ls = $Slope\ length/gradient\ factor$

1.2 Disturbance footprint

The total estimated disturbance footprint was utilised to calculate the volume (m_3) of average annual soil loss for each catchment area within the development site. The total soil disturbance footprint is estimated at 14 ha, with bulk earthwork and road construction to be completed in the initial stages of construction to facilitate early stabilisation and revegetation of disturbed areas. Site disturbance from bulk earthworks and civil works is generally distributed evenly throughout the site.

However, as the final distribution of soil disturbance is not yet known a highly conservative value of 50% of the total land disturbance (7 ha) was applied uniformly across each contributing catchment in order to account for this uncertainty. As a result, the average annual soil loss rates detailed in Table 1-4 are considered conservative and likely to over-estimate the annual soil loss rates for each catchment during construction.

1.3 Soil Erodibility Factor

Laboratory testing on soil samples recovered during the field investigation has been completed with a summary of test results presented in the accompanying geotechnical report. Geotechnical investigations have revealed that the development site consists of a firm silty-clay topsoil layer approximately 0.1 - 0.3m deep. A corresponding conservatively derived K-factor of **0.06** has been adopted based on the Unified Soil Classification System soil code of OL (IECA Book 2 Table E5).

1.4 Rainfall Erosivity Factor

The rainfall erosivity factor (R-factor) is a measure of the ability of rainfall to cause erosion. It is the product of the total energy and the intensity of the rainfall event. The calculated R-factor for the site is **909.25**. The calculations for the site-specific R-factor are provided below.

Intensity Frequency Duration (IFD) data for the site was taken from the Engineering Guidelines for Subdivisions and Development Standards, Part 3 - Stormwater Drainage Design (2011) for Narrandera as shown in the Table below. The site-specific Intensity Frequency Duration (IFD) data was reviewed under the *Australian Rainfall and Runoff: A guide to flood estimation* 1987 and 2016 datasets. The 2-year 6-hour storm was identified as 5.42 mm/hr under AR&R 2016 and 5.49 mm/hr under AR&R 1987. As a result, the more conservative value of **5.49 mm/hr** was selected as the design input parameter.

Table 1-1: Narrandera — Rainfall Intensity Frequency Duration Table (6 minutes to 60 minutes) (AR&R, 1987)

	Average Recurrence Interval						
Duration	**1 Year ARI** (mm/hour)	**2 Year ARI** (mm/hour)	**5 Year ARI** (mm/hour)	**10 Year ARI** (mm/hour)	**20 Year ARI** (mm/hour)	**50 Year ARI** (mm/hour)	**100 Year ARI** (mm/hour)
6mins	48.48	64.06	88.84	104.97	125.84	154.87	178.24
10mins	39.07	51.89	71.74	84.63	101.31	124.48	143.11
20mins	28.06	37.2	51.18	60.22	71.93	88.16	101.18
30mins	22.6	29.92	41.04	48.2	57.49	70.35	80.65
1Hr	15.13	19.99	27.26	31.91	37.96	46.31	52.99
2Hrs	9.28	12.22	16.52	19.26	22.82	27.72	31.62
3Hrs	6.93	9.1	12.24	14.23	16.83	20.38	23.21
6Hrs	4.19	5.49	7.32	8.47	9.97	12.03	13.65
12Hrs	2.54	3.32	4.39	5.05	5.93	7.11	8.05
24Hrs	1.57	2.05	2.67	3.06	3.57	4.26	4.8
48Hrs	0.95	1.23	1.58	1.8	2.09	2.48	2.78
72Hrs	0.68	0.88	1.13	1.28	1.48	1.75	1.96

Rainfall Factor

R= 164.74 x (1.1177) ^ 5.49 x 5.49 x (5.49) ^ 0.6444 ($Equation$ 1 Blue Book, 2004)

S= 2-year 6-hour storm

R= **909.25**

1.5 C and P-Factors

Within the Revised Universal Soil Loss Equation (RUSLE), the C and P factors are used to describe the management of the site with respect to reducing soil loss. The C-factor measures the combined effect of all the interrelated cover and management characteristics adopted over the site. It also

reflects the covering applied to the site with the use of matting, chemical stabilisers and or by products. The P-factor measures the combined effect of all support practices and management variables. By reducing the velocity of runoff and the tendency of runoff the P-factor will reduce. As such the industry accepted defaults for C and P have been adopted and values of **1.0** and **1.3** will be used respectively.

1.6 Ls Factor

The slope length (Ls) factor varies between different slope lengths and different slope gradients. Table 3.2 shows the range of Ls factors for RUSLE. In absence of factors for slopes less than 1%, the 1% Ls factors were used. The selected Ls factors were calculated using slope value conservatively derived from the steepest grade identified based on-site contours mapped at 5m intervals and the maximum available slope length of 300m.

Table 1-2: Ls Factors (Blue Book, 2004)

Grade	Slope Length (m)													
%	10	20	30	40	50	60	70	80	90	100	150	200	250	300
1	0.11	0.13	0.15	0.16	0.17	0.18	0.19	0.19	0.2	0.2	0.23	0.24	0.26	0.27
2	0.18	0.24	0.28	0.31	0.34	0.36	0.39	0.41	0.43	0.44	0.52	0.58	0.64	0.69
3	0.24	0.34	0.41	0.47	0.52	0.57	0.61	0.65	0.69	0.72	0.87	1	1.11	1.22
4	0.30	0.44	0.54	0.63	0.71	0.78	0.85	0.91	0.97	1.03	1.26	1.47	1.65	1.82
5	0.36	0.54	0.68	0.8	0.91	1.01	1.1	1.19	1.27	1.35	1.7	2	2.28	2.53
6	0.42	0.64	0.81	0.97	1.11	1.24	1.36	1.47	1.58	1.68	2.14	2.54	2.91	3.25
8	0.53	0.8	1.08	1.31	1.51	1.7	1.68	2.05	2.21	2.37	3.07	3.7	4.28	4.82
10	0.68	1.09	1.44	1.75	2.04	2.31	2.56	2.81	3.04	3.27	4.06	4.94	5.75	6.52
12	0.85	1.39	1.85	2.27	2.66	3.02	3.37	3.7	4.02	4.33	5.77	7.07	8.28	9.42
14	1.02	1.69	2.26	2.79	3.28	3.74	4.18	4.61	5.02	5.42	7.27	8.95	10.52	12.01
16	1.19	1.98	2.67	3.31	3.9	4.46	5	5.52	6.02	6.51	8.78	10.86	12.81	14.65
18	1.35	2.27	3.07	3.82	4.51	5.17	5.81	6.42	7.02	7.59	10.3	12.78		
20	1.5	2.55	3.47	4.32	5.12	5.88	6.61	7.32	8.01	8.68	11.92	14.84		
25	1.88	3.23	4.43	5.54	6.59	7.6	8.57	9.51	10.43	11.32				
30	2.23	3.86	5.32	6.69	7.99	9.23	10.43	11.6	12.74	13.84				
40	2.83	4.98	6.92	8.74	10.48	12.15	13.77							
50	3.33	5.89	8.22	10.42	12.52	14.55								

Table 3: Erosion Risk Categorisation and Annual Soil Loss (t/ha/yr) for Various Slopes and K = 0.033

Grade	Slope Length (m)													
%	10	20	30	40	50	60	70	80	90	100	150	200	250	300
1	8	9	11	11	12	13	13	13	14	14	16	17	18	19
2	13	17	20	22	24	26	28	29	30	31	37	41	45	49
3	17	24	29	33	37	40	43	46	49	51	62	71	79	87
4	21	31	38	45	50	55	60	65	69	73	89	104	117	129
5	26	38	48	57	65	72	78	84	90	96	121	142	162	179
6	30	45	57	69	79	88	96	104	112	119	152	180	206	230
8	38	57	77	93	107	121	119	145	157	168	218	262	304	342
10	48	77	102	124	145	164	182	199	216	232	288	350	408	462
12	60	99	131	161	189	214	239	262	285	307	409	501	587	668
14	72	120	160	198	233	265	296	327	356	384	516	635	746	852
16	84	140	189	235	277	316	355	391	427	462	623	770	909	1039
18	96	161	218	271	320	367	412	455	498	538	730	906		
20	106	181	246	306	363	417	469	519	568	616	845	1052		
25	133	229	314	393	467	539	608	674	740	803				
30	158	274	377	474	567	655	740	823	904	982				
40	201	353	491	620	743	862	977							
50	236	418	583	739	888	1032								

Table 1-4: Soil Loss Rate and Required Controls

Catchment ID	Catchment Size (ha)	Catchment Disturbance Size (ha)	Slope* (%)	Natural Overland flow Length** (m^2)	Ls length** (m^2)	K Factor	Ls	Average annual Soil Loss Rate (t/ha/yr)	Estimated Average annual Soil Loss Rate*** (m^3)	Soil Erosion Hazard	Sediment Basin Required	Notes
Catchment A												
A1	83	7	1	360	30	0.06	0.27	19.15	124.92	Very Low	**No**	Disturbance footprint conservatively taken as 50% of total estimated land disturbance of 14 ha.
A2	29.6	7	1	379	300	0.06	0.27	19.15	124.92	Very Low	**No**	Disturbance footprint conservatively taken as 50% of total estimated land disturbance of 14 ha.
A3	42.5	7	1	277	300	0.06	0.27	19.15	124.92	Very Low	**No**	Disturbance footprint conservatively taken as 50% of total estimated land disturbance of

												14 ha.
A4	157.4	7	1	243	250	0.06	0.26	18.44	120.30	Very Low	**No**	Disturbance footprint conservatively taken as 50% of total estimated land disturbance of 14 ha.
A5	373.9	7	1	333	100	0.06	0.27	19.15	124.92	Very Low	**No**	Disturbance footprint conservatively taken as 50% of total estimated land disturbance of 14 ha.
Catchment B												
B1	49.5	7	1	200	200	0.06	0.24	17.02	111.05	Very Low	**No**	Disturbance footprint conservatively taken as 50% of total estimated land

												disturbance of 14 ha.
Catchment C												
C1	497.1	7	1	930	300	0.06	0.27	19.15	124.92	Very Low	**No**	Disturbance footprint conservatively taken as 50% of total estimated land disturbance of 14 ha.

Note:

* Slope value conservatively derived from the steepest grade identified on-site based on site contours mapped at 5m intervals.

** Catchment overland flow length has been calculated assuming Uniform Sheet flow and conservatively rounded-up to the nearest available value provided in Table A1 (Blue Book, 2004).

*** Average annual soil loss calculated using density of Clay, dry lump as g cm_3 = 1.073 g/cm

Appendix C. Site Inspection Register

Erosion & Sediment Inspection Register

Inspection date / time:		**Rain in the last 24hrs (mm)?**	
Inspected by:		**Forecasted rain in next 24hrs (mm)**	
Attended by:		**Weather Conditions during inspection:**	
Location:			

Action Risk Rating[1]:

Action Risk Rating	Risk Level	Priority	Examples
1	Extreme	Immediately - must be closed out on the day of inspection	• Any actual or potential non-compliance with any Co • Adverse weather conditions are predicted that may result in above if controls are not adequate
2	High	Within 24hrs	• Critical ERSED controls are damaged and need to be reinstated before a rain event
3	Medium	Within 3 Working Days	• Stabilisation required
4	Low	Within 5 Working Days	• Stockpiles need to be stabilised, maintenance on ERSED controls
Improvement Item	Improve	-	• Suggested improvement to improve performance

Positive Observation		-	• Examples of best practice

Summary: x positive observations, **x** compliance actions (x critical), **x** Improvement items

General Comments:

Erosion & Sediment Control Aspect	Compliance			Comments / Action (if required)	Action Risk Rating[1]				Completion Signoff
	Yes	No	N/A		1	2	3	4	
General Observations									
The site is generally in a tidy condition	☐	☐			☐	☐	☐	☐	
All materials and equipment are contained within the project footprint	☐	☐			☐	☐	☐	☐	
All works are contained within the project footprint	☐	☐			☐	☐	☐	☐	
Designated access roads and access points are clearly stabilised and signposted	☐	☐			☐	☐	☐	☐	
Soil & Water Management									

Erosion & Sediment Control Aspect	Compliance			Comments / Action (if required)	Action Risk Rating[1]				Completion Signoff
	Yes	No	N/A		1	2	3	4	
Approved Progressive erosion and sediment control plans prepared prior to commencement of works (in accordance with Blue Book guidelines). Plans to be reviewed by suitable qualified person and endorsed prior to commencement on site.	☐	☐			☐	☐	☐	☐	
Topsoil is being stripped and stockpiled appropriately and placed away from drainage lines	☐	☐			☐	☐	☐	☐	
Erosion and sediment controls are checked and maintained on a daily basis and after every rainfall event	☐	☐							
Works scheduled around forecast of significant storm events	☐	☐			☐	☐	☐	☐	
Disturbed areas rehabilitated after works complete	☐	☐			☐	☐	☐	☐	
Evidence of sedimentation off disturbed areas into sensitive areas including heritage sites	☐	☐			☐	☐	☐	☐	
No damage or deterioration to equipment fuel systems or other systems that have the potential to cause leaks	☐	☐			☐	☐	☐	☐	
Fuels/ hazardous materials kept within the designated compound storage area. No storage of fuel or hazardous materials at excavation sites	☐	☐			☐	☐	☐	☐	
Refuelling processes onsite greater than 50m from waterways	☐	☐			☐	☐	☐	☐	

Erosion & Sediment Control Aspect	Compliance			Comments / Action (if required)	Action Risk Rating[1]				Completion Signoff
	Yes	No	N/A		1	2	3	4	
Emergency spill kit kept on site at all times. Staff aware of its location and trained in its use	☐	☐			☐	☐	☐	☐	
An emergency procedure for hydrocarbon spills in place and tool boxed	☐	☐			☐	☐	☐	☐	
Air Quality/Dust Management									
No works carried out during high wind events	☐	☐			☐	☐	☐	☐	
Vehicles carrying materials to site that may produce dust are covered during transportation	☐	☐			☐	☐	☐	☐	
Machinery or plant not left running/idling when not in use	☐	☐			☐	☐	☐	☐	
Equipment/machinery well maintained and serviced to manufacturer's specifications	☐	☐			☐	☐	☐	☐	
Disturbed areas rehabilitated after works complete	☐	☐			☐	☐	☐	☐	
Waste Management & Storage of Hazardous Materials									
Works sites kept clean, all rubbish and waste removed	☐	☐			☐	☐	☐	☐	

Erosion & Sediment Control Aspect	Compliance			Comments / Action (if required)	Action Risk Rating[1]				Completion Signoff
	Yes	No	N/A		1	2	3	4	
Waste collected and sorted into waste streams, and, where possible, recycled	☐	☐			☐	☐	☐	☐	
Wastes disposed off-site only at appropriate EPA-approved facilities in compliance with relevant legislation	☐	☐			☐	☐	☐	☐	
Waste disposal records retained for compliance purposes	☐	☐			☐	☐	☐	☐	
Storage of hazardous chemicals on site complies with the EPA Guidelines 'Bunding and Spill Management'	☐	☐			☐	☐	☐	☐	

Site inspection photos

Photo 1	Photo 2

Appendix D. Flood Maps

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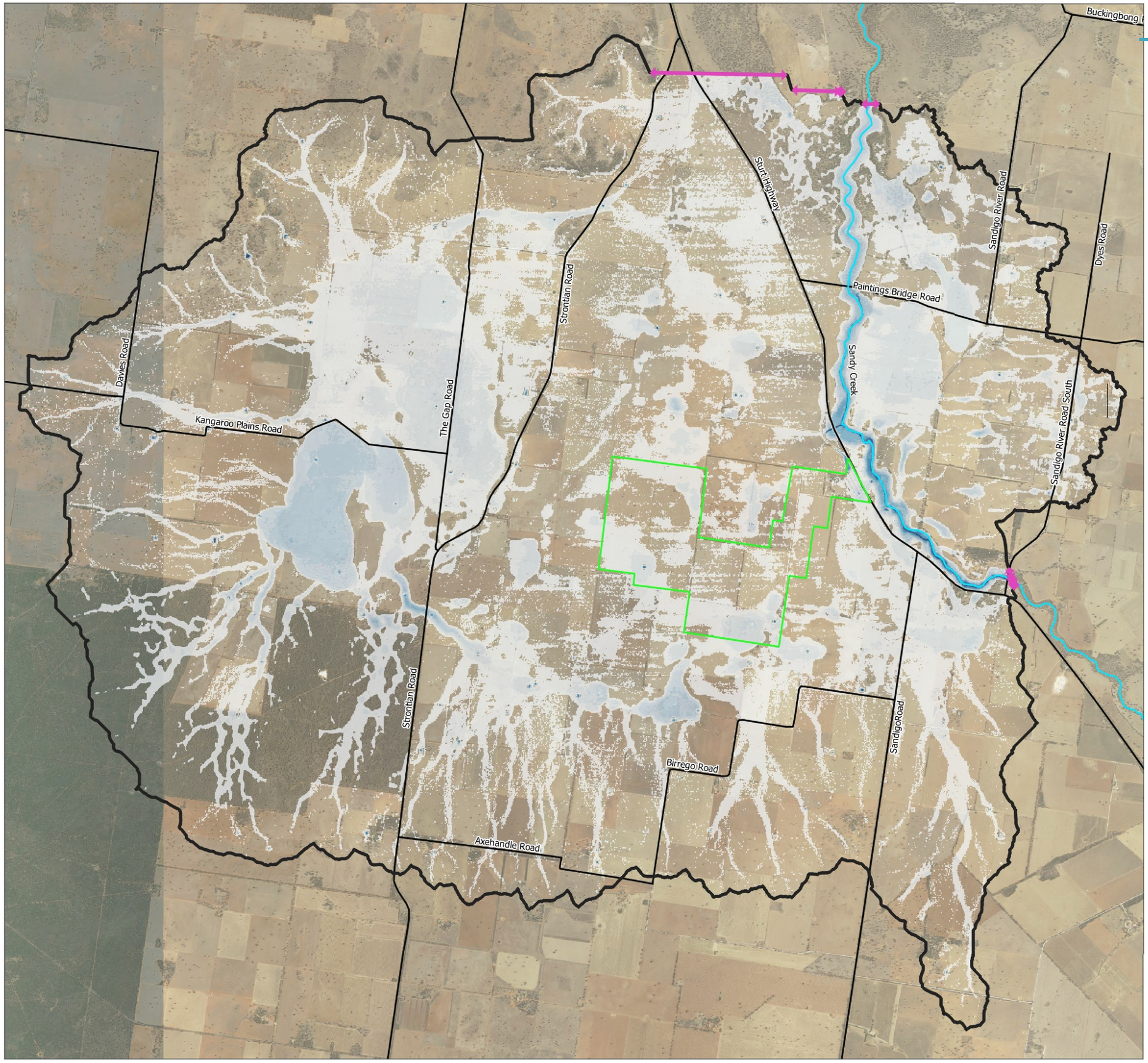
WATER MODELLING

Existing Scenario Peak Depth 1% AEP Event



LEGEND

- Model Extent
- Model Boundary
- Proposed Solar Farm Boundary
- Roads
- Waterways

Depth (m)

- <= 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- 1.2 - 1.5
- 1.5-1.8
- 1.8 - 2.1
- 2.1 - 2.4
- 2.4 - 2.7
- 2.7 - 3.0

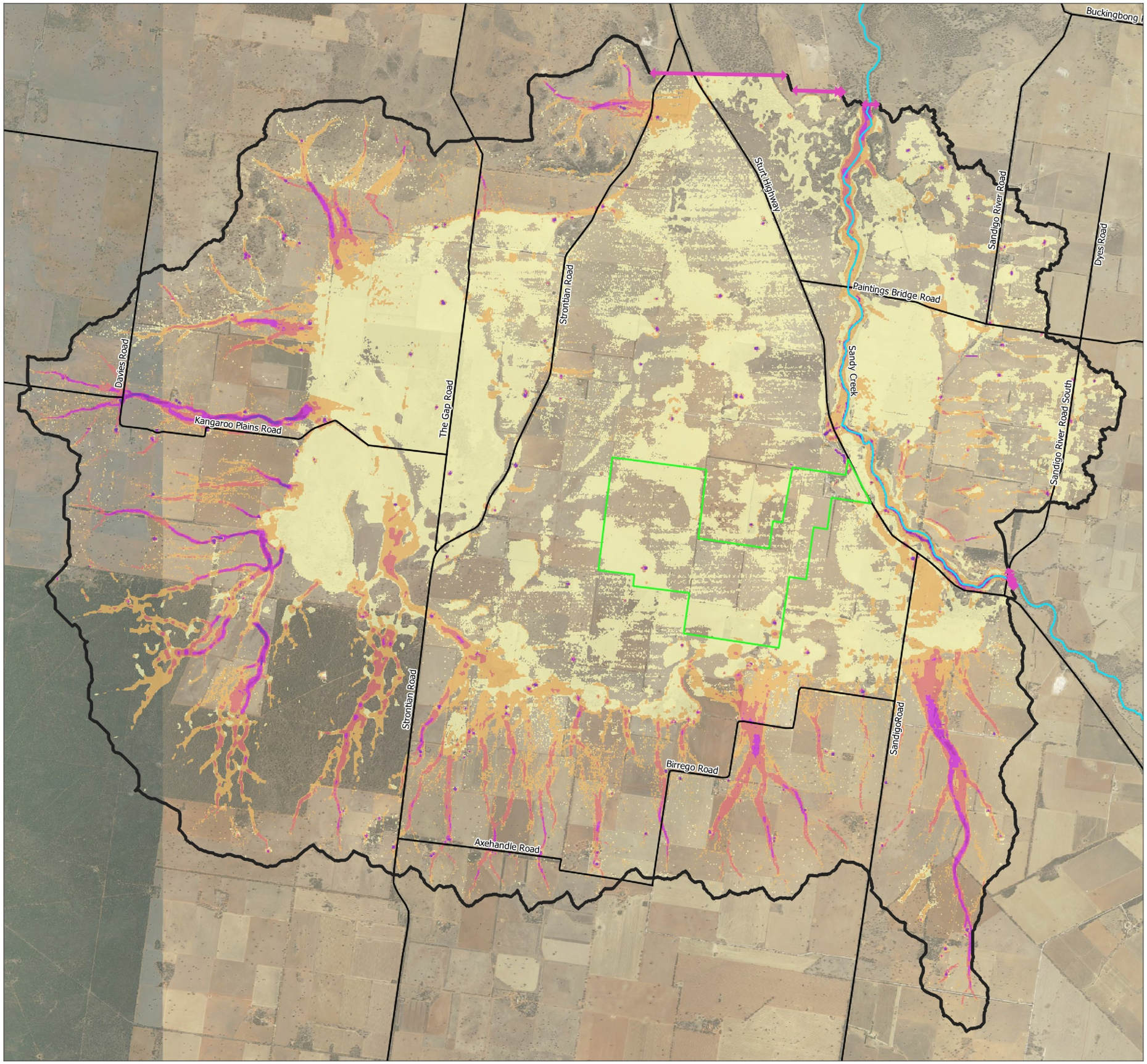
Avonlie Solar Farm Flood Impact Assessment

A3 Scale: 1:65000
GOA 1994 / MGAZone 55
0 0.75 1.5 2.25 Km

Job No: 10435
Date: 16/08/2019

solutions
WATER MODELLING

Existing Scenario Peak Velocity 1%AEP Event



LEGEND

- Model Extent
- Model Boundary
- Proposed Solar Farm Boundary
- Roads
- Waterways

Velocity (m/s)

- <= 0.25
- 0.25 - 0.55
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- > 1.25

Avonlie Solar Farm Flood Impact Assessment

A3 Scale: 1:65000
GOA 1994 / MGAZone 55
0 0.75 1.5 2.25 Km

Job No: 10435
Date: 16/08/2019

solutions
WATER MODELLING

Existing Scenario
Peak Water Surface Level
1% AEP Event

LEGEND

- Model Extent
- Model Boundary
- Proposed Solar Farm Boundary
- Roads
- Waterways

Water Surface Level (mAHD)

- <= 150.5
- 150.5 - 151.0
- 151.0 - 151.5
- 151.5 - 152.0
- 152.0 - 152.5
- 152.5 - 153.0
- 153.0 - 153.5
- 153.5 - 154.0
- 154.0 - 154.5
- > 154.5

Buckingbong
Sturt Highway
Sandigo River Road
Dyes Road
Paintings Bridge Road
Strontian Road
Davies Road
Kangaroo Plains Road
The Gap Road
Sandy Creek
Sandigo River Road South
Strontan Road
Birrego Road
SandigoRoad
Axehandle Road

Avonlie Solar Farm Flood Impact Assess

A3 Scale: 1:65000
GOA 1994 / MGAZone 55
0 0.75 1 5 2.25 Km

Job No: 10435
Date: 16/08/2019