Winterbourne Wind Farm
Soils and Water Assessment

Prepared for WinterbourneWind Pty Ltd October 2022

The Business of Sustainability

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Winterbourne Wind Farm

Soils and Water Assessment

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EXECUTIVE SUMMARY

Environmental Resources Management Australia Pty Ltd (ERM) was engaged by WinterbourneWind Pty Ltd (WWPL) to undertake a Soils and Water Assessment for the proposed Winterbourne Wind Farm, located on the plateau at its closest point 6.5 km to the north east of Walcha NSW.

The proposed wind farm will include up to 119 turbines with an approximate capacity of 700 megawatts (MW). The proposal includes ancillary infrastructure such as access tracks, laydown areas, road upgrades, concrete batching facilities, underground and overhead electrical cabling, substations, battery energy storage system (BESS), a switching station and grid connection to the existing Tamworth to Armidale 330 kilovolt (kV) transmission line.

The purpose of the Soils and Water Assessment is to characterise the existing soils and water environment in the Project Area, identify potential impacts, describe suitable mitigation measures, quantify the required water supply and identify available water supply options.

Overall soils and water constraints are relatively minor due to the moderate erosion hazard over the majority of the Project Area to be impacted by construction. A standard suite of erosion and sediment controls will be adopted in most areas.

The Project will require an estimated 113 ML of water during the 30-month construction period. Water supply options are available to meet the requirements of the construction phase. Water access licensing would need to be addressed depending on the preferred option and should be discussed with WaterNSW.

The Oxley Wild Rivers National Park is located adjacent to the eastern boundary of the Project Area. The World and National Heritage listed Gondwana Rainforests of Australia is mapped as a subset of the National Park and primarily follows the deep gorge country of the Apsley River and its major tributaries from Aspley Gorge downstream to its confluence with the Macleay River and then further upstream and downstream along the Macleay River and key tributaries. The World and National Heritage area at its closest point to the Development Footprint is approximately 1.3 km to the north east, 2.4 km to the east and 1.0 km to the south (Apsley Gorge).

The primary risk from activities associated with the Project to impact upon the World and National Heritage site and the National Park is associated with runoff and sediment deposits. However, standard construction measures can be effectively implemented to mitigate impacts associated with the sensitive locations in the adjacent National Park.

A detailed Soil and Water Management Plan will be prepared for the Project prior to construction commencing that incorporates the measures identified within this assessment.

1. INTRODUCTION

1.1 Background

WinterbourneWind Pty Ltd (WWPL / the Proponent) is seeking approval to construct and operate the Winterbourne Wind Farm, located to the northeast of Walcha in the Northern Tablelands region of New South Wales (NSW) (the Project). A regional locality plan is provided in **Figure 1-1**. The Project would provide approximately 700 megawatts (MW) of renewable energy capacity and would be connected into the national electricity grid through a proposed overhead 330kV transmission line, which would connect to a new switching station, located approximately 7 km south of Uralla.

The proposed development involves the construction and operation of:

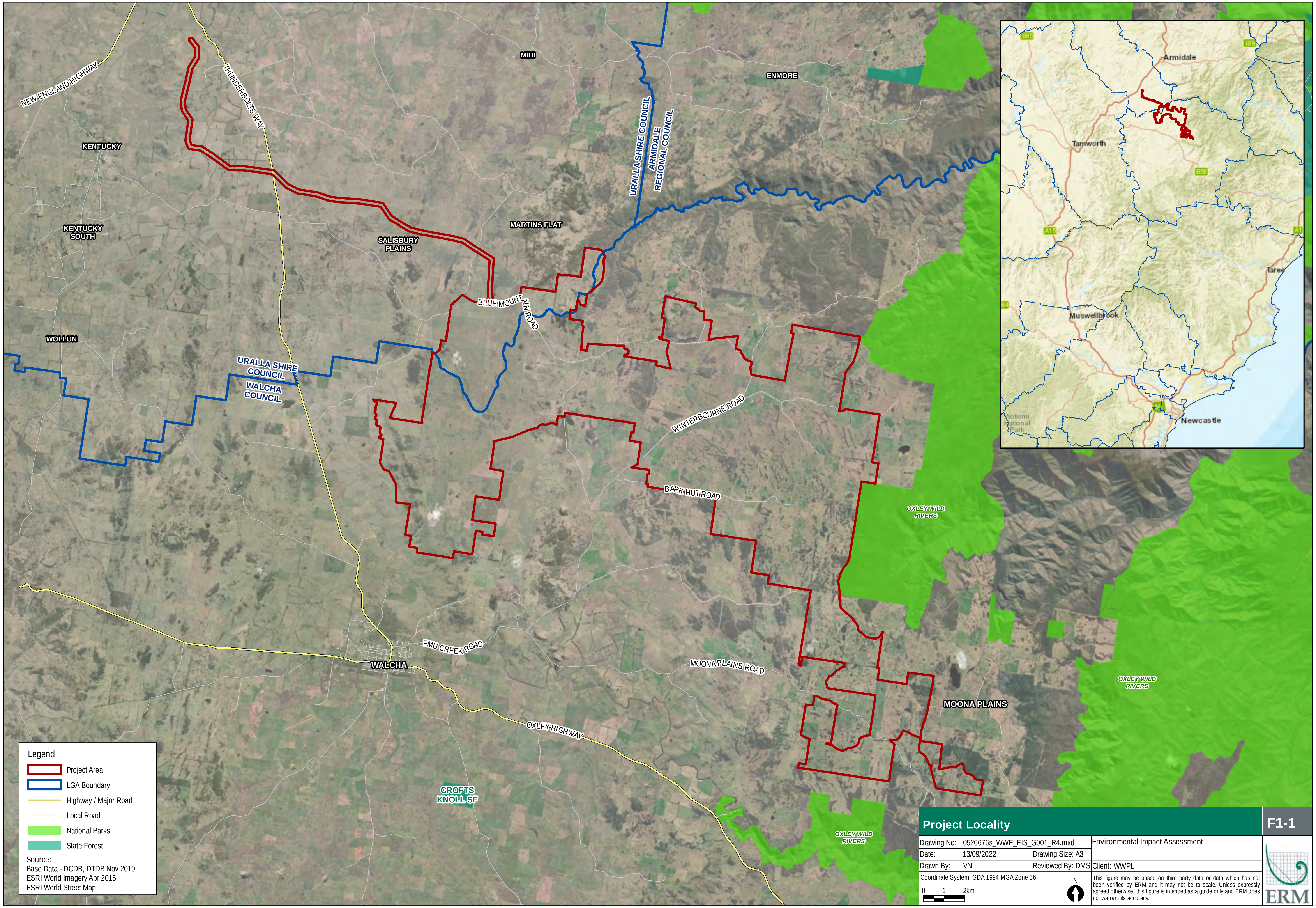
- 119 wind turbines generators (WTG) with maximum height of 230 metres (m) (to blade tip); and
- ancillary infrastructure including internal access tracks, road upgrades, internal electrical reticulation network (both overhead and underground), two on-site substations, a battery energy storage system (BESS), meteorological masts, and operation and maintenance (O&M) buildings.

A Project overview map is provided in **Figure 1-2**.

1.2 Objectives

The Soils and Water Assessment has been prepared to:

- address the Secretary's Environmental Assessment Requirements (SEARs) issued for the proposed project;
- describe the existing soil and water conditions across the Project Area;
- provide details of waterway crossings;
- identify likely impacts at water crossing locations and measures to minimise these impacts;
- identify the key potential soil and water impacts and assess associated risks;
- identify appropriate management and mitigation measures to ensure that construction and operation of the proposed wind farm would result in an acceptable level of environmental impact, pursuant to the *Environmental Planning and Assessment Act 1979* (EP&A Act) and other relevant legalisation. A Conceptual Soil and Water Management Plan has been provided to outline such measures;
- analyse water demands and supply options to determine whether an adequate and secure water supply is available for the life of the Project;
- assess potential environmental impacts associated with the identified sources, including impacts to groundwater;
- identify the statutory (licensing) context of the water supply sources; and
- determine the balance of water supply based on expected construction and operation water requirements.



NEW ENGLAND HIGHWAY
THUNDERBOLTS WAY
MIHI
ENMORE
KENTUCKY
URALLA SHIRE COUNCIL
ARMIDALE REGIONAL COUNCIL
KENTUCKY SOUTH
SALISBURY PLAINS
MARTINS FLAT
BLUE MOUNTAIN ROAD
WOLLUN
URALLA SHIRE COUNCIL
WALCHA COUNCIL
WINTERBOURNE ROAD
BARK HUT ROAD
OXLEY WILD RIVERS
EMU CREEK ROAD
WALCHA
MOONA PLAINS ROAD
MOONA PLAINS
OXLEY HIGHWAY
OXLEY WILD RIVERS
CROFTS KNOLL SF
OXLEY WILD RIVERS
Armidale
Tamworth
Taree
Muswellbrook
Wollemi National Park
Newcastle
B56
A15
A1
Legend
Project Area
LGA Boundary
Highway / Major Road
Local Road
National Parks
State Forest
Source:
Base Data - DCDB, DTDB Nov 2019
ESRI World Imagery Apr 2015
ESRI World Street Map
Project Locality
F1-1
Drawing No: 0526676s_WWF_EIS_G001_R4.mxd
Date: 13/09/2022
Drawing Size: A3
Drawn By: VN
Reviewed By: DMS
Coordinate System: GDA 1994 MGA Zone 56
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Environmental Impact Assessment
Client: WWPL
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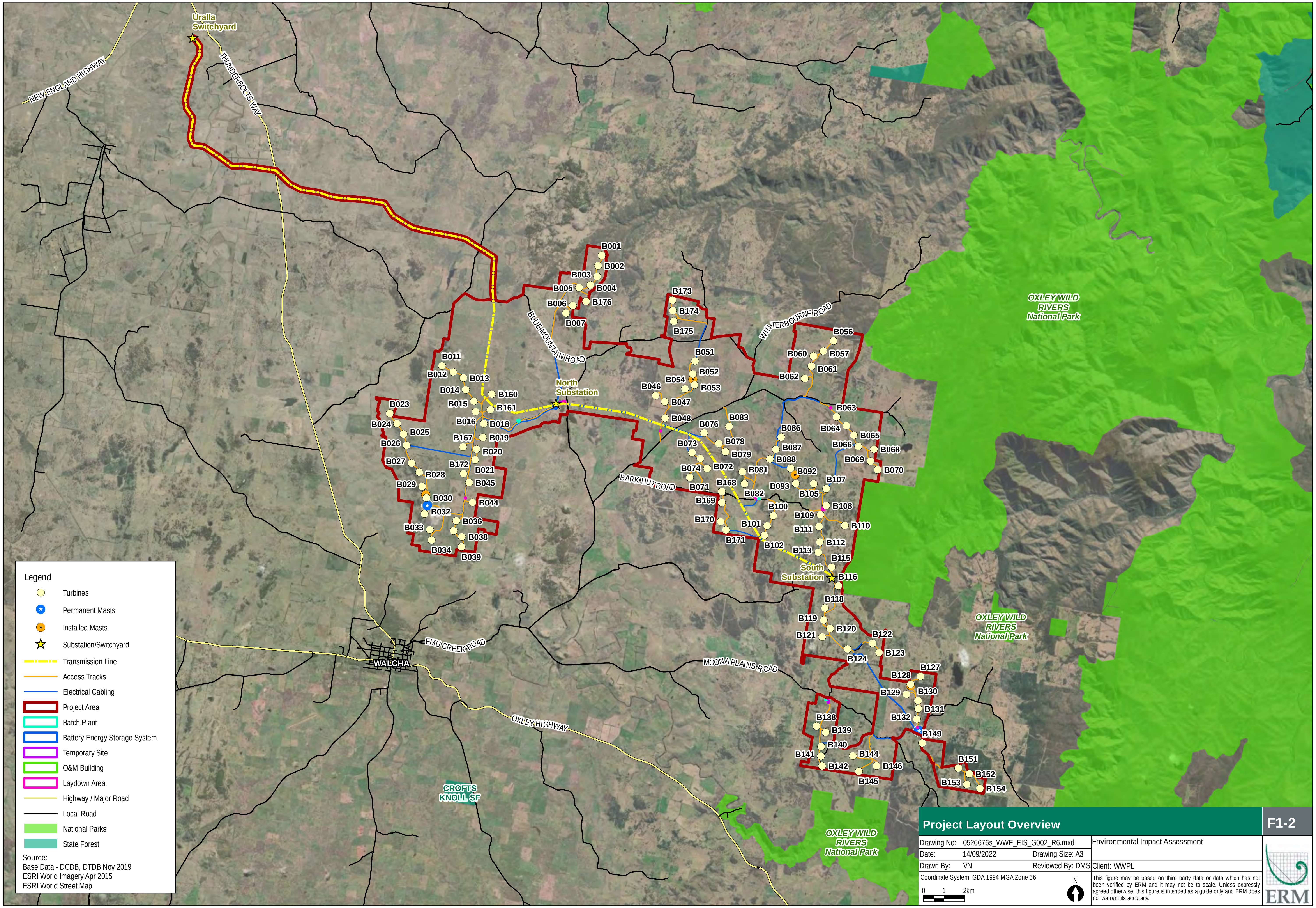

Uralla Switchyard
NEW ENGLAND HIGHWAY
THUNDERBOLTS WAY
BLUE MOUNTAIN ROAD
North Substation
WINTERBOURNE ROAD
BARK HUT ROAD
South Substation
OXLEY WILD RIVERS National Park
OXLEY WILD RIVERS National Park
OXLEY WILD RIVERS National Park
EMU CREEK ROAD
MOONA PLAINS ROAD
WALCHA
OXLEY HIGHWAY
CROFTS KNOLL SF
Legend
Turbines
Permanent Masts
Installed Masts
Substation/Switchyard
Transmission Line
Access Tracks
Electrical Cabling
Project Area
Batch Plant
Battery Energy Storage System
Temporary Site
O&M Building
Laydown Area
Highway / Major Road
Local Road
National Parks
State Forest
Source:
Base Data - DCDB, DTDB Nov 2019
ESRI World Imagery Apr 2015
ESRI World Street Map
Project Layout Overview
F1-2
Drawing No: 0526676s_WWF_EIS_G002_R6.mxd
Date: 14/09/2022
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Client: WWPL
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1.3 Secretary's Environmental Assessment Requirements

The Proposal was determined to be State Significant Development with approval under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). SEARs were issued for the Proposal on 17 September 2020 by the Department of Planning and Environment (DPE). The SEARs relevant to Soil and Water are presented in **Table 1-1**.

Table 1-1 Secretary's Environment Assessment Requirements

Issue	Requirement	Reference
Water & Soils	■ quantify water demand, identify water sources (surface and groundwater), including any licensing requirements, and determine whether an adequate and secure water supply is available for the development; ■ assess potential impacts on the quantity and quality of surface and groundwater resources, including impacts on other water users and watercourses; ■ where the project involves works within 40 metres of the high bank of any river, lake, or wetlands (collectively waterfront land), identify likely impacts to the waterfront land, and how the activities are to be designed and implemented in accordance with the *DPI Water Guidelines for Controlled Activities* (DPI, 2012) and (if necessary) *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (DPI, 2003); and ■ describe the measures to minimise surface and groundwater impacts, including how works on steep gradient land or erodible soil types would be managed and any contingency requirements to address residual impacts.	■ Section 2 and 3 ■ Section 4 ■ Section 4.2 ■ Section 4.3.3 and Section 5
Consultation Requirements	During the preparation of the EIS, consultation is required with relevant local, State and Commonwealth Government authorities, service providers, community groups and affected landowners (as relevant to this Soils and Water Assessment): ■ Uralla Shire Council ■ Walcha Shire Council ■ DPE Biodiversity and Conservation Division ■ DPE Water Group ■ Environment Protection Authority ■ Regional NSW – Mining, Exploration & Geoscience (MEG) ■ Department of Primary Industries – Agriculture and Fisheries divisions ■ Northern Tablelands Local Land Services	■ Refer EIS Section 5

1.4 Regional and Local Context

The Project Area is located along the eastern slopes of the Great Dividing Range in NSW. The area is characterised by hills and ridgelines that rise out of the Walcha Plateau. The topography within the Project Area varies in altitude significantly, ranging between 1,050 m to 1,350 m.

The Project Area is located within the Macleay River catchment. While there are a number of small local creeks present within the Project Area, for much of the year they may not have running water. There are no wetland areas or lakes (other than small farm dams) within the Project Area.

A search of the Australian Soil Classification (ASC) Soil Type Map of NSW (OEH, 2017) reveals that the Project Area is largely dominated by the Kurosols soil type. Kurosols have strong texture contrast between A horizons and strongly acidic B horizons, and with low water holding capacity Kurosols are often sodic. They tend to have low fertility and land use is generally restricted to grazing pastures.

The areas surrounding the Project Area are generally also zoned RU1 – Primary Production, except for the Oxley Wild Rivers National Park to the east and south of the Project Area, which is zoned E1 – National Parks and Nature Reserves. Walcha town centre is located approximately 6 km from the closest edge of the Project Area.

1.5 Project Description

The Winterbourne Wind Farm Project involves the construction and operation of a wind farm with up to 119 WTGs, together with associated and ancillary infrastructure.

The Project design has been revised and refined in response to the identification and assessment of environmental constraints, constructability requirements, and consideration of the outcomes of Agency, landowner, and community consultations.

The Project consists of the following key components:

- up to 119 WTGs, each with:
  - a generating capacity of approximately 6.2 MW;
  - three blades mounted to a rotor hub (hub height of 149 m) on a nacelle above a tubular steel tower, with a blade tip height (blade length plus hub height) of up to 230 m AGL;
  - a gearbox and generator assembly housed in the nacelle; and
  - adjacent hardstands for use as crane pads, assembly, and laydown areas;
- decommissioning of four temporary meteorological monitoring masts and installation of up to two permanent meteorological monitoring masts for power testing. The permanent monitoring masts will be located close to a WTG location with a maximum height of approximately 149 m AGL, equivalent to the hub height of the installed WTGs;
- two 33/330 kV electrical substations, including control room, transformers, circuit breakers, switches, and other ancillary equipment;
- an operations and maintenance facility;
- a battery energy storage system (BESS) of up to 100 MW / 200 MWh capacity (two hours of storage);
- aboveground and underground 33 kV electrical reticulation and fibre optic cabling connecting the WTGs to the onsite substations (generally following site access tracks);
- a 330 kV single or double circuit twin conductor overhead transmission line (transmission line) route of approximately 50 km connecting the two substations to a new electrical switchyard (including circuit breakers, switches, and other ancillary equipment), located approximately 7 km south of Uralla and adjacent to TransGrid's 330 kV Tamworth to Armidale transmission line (Line 85);
- internal access tracks (combined total length of approximately 113 km) connecting the WTGs and associated Project infrastructure with the public road network; and
- upgrades to roads and intersections required for the delivery of oversize and overmass WTG components, transformers and associated construction-phase materials and vehicular movements.

The following temporary elements will be required during the construction phase of the Project:

- site buildings and facilities for construction contractors / equipment, including site offices, car parking and amenities for the construction workforce;
- mobile concrete batching plant/s to supply concrete for WTG footings and substation construction works;

- earthworks for access tracks, WTG platforms and foundations, potentially including controlled blasting in certain areas;
- potential rock crushing facilities for the generation of suitable aggregates for concrete batching and/or for access track and hardstand construction;
- hardstand laydown areas for the storage of construction materials, plant, and equipment;
- up to four temporary meteorological monitoring masts. The temporary monitoring masts will be located close to a WTG location with a maximum height of approximately 149 m AGL;
- external water supply and storage for concrete batching and construction activities;
- the transport, storage and handling of fuels, oils and other hazardous materials for construction and operation of wind farm infrastructure; and
- beneficial reuse of materials won from within the development footprint during cut and fill and WTG foundation excavation works for use in access tracks, hardstands, and foundation material.

The Project may also require the subdivision of land for the substations and switchyard.

Ultimately, the Project will be decommissioned and the Project Area will be rehabilitated.

Table 1-2 provides an overview of the approximate dimensions of the Project components.

Table 1-2 Project Components and Approximate Dimensions

Project Components and Infrastructure	Approximate Dimensions	Quantity
WTGs		
Rotor diameter	162 m	119 WTGs
Blade length	Blade length of 79.3 m. Distance from the centre point of the hub to the tip of the blade equals 81 m	
Uppermost blade tip	230 m	
Tower (hub) height	149 m	
WTG hardstand	0.70 ha per WTG required for construction 0.26 ha per WTG after rehabilitation	
Ancillary Infrastructure		
100 MW / 200 MWh Battery energy storage system (BESS)	100 m x 100 m	1
33/330 kV Substation	100 m x 100 m	2
O&M Facility including carpark	50 m x 40 m	1
New 330 kV transmission line	Towers approximately 40 m high, spaced approximately 500 m (subject to terrain) or monopoles approximately 50 m high, spaced approximately 250 m (subject to terrain), within 60 m easement	50 km
Underground and/or overhead 33 kV cables	Trenching for underground electrical cabling will be approximately 0.6 m wide per circuit by 1.0 m deep. Note: Where ground conditions are not suitable for open cut trench installation, overhead single circuit electricity lines will be installed using concrete poles.	324 km
Switchyard	160 m x 120 m	1
New internal access tracks and drainage	Approximately 15 m wide formation including 5.5 m roadway plus shoulders and drainage as required	113 km
Permanent meteorological masts (with concrete footings for mast and guy wires)	Sensor height at 149 m on approximately 3 m x 3 m concrete foundation	Up to 2
Temporary Facilities		
Concrete batching plants	100 m x 100 m	Up to 3
Laydown Areas	6 laydown areas at 50 m x 50 m 2 laydown area at 100 m x 100 m	Up to 8
Site office, car parking and storage areas	180 m x 90 m 120 m x 60 m 100 m x 60 m	Up to 3
Temporary meteorological masts (with concrete footings for mast and guy wires)	Sensor height at 149 m on approximately 3 m x 3 m concrete foundation	Up to 4

1.5.1 Climate

The Project is located within the Walcha Plateau subregion of the New England Tableland Bioregion. The bioregion is characterised by warm summers, with steady rainfall generally occurring in summer. Areas of higher elevation are characterised by mountainous climates, experiencing mild summers and no dry seasons.

An understanding of the existing climatic context of the Project Area has been developed through data available from the Australian Government's Bureau of Meteorology (BoM).

Climate data is available from BoM weather stations located at Woolbrook - Danglemah Road (Station No. 055136) located approximately 23 km south west of the Project Area. The Woolbrook (Danglemah Road) weather station is located at an elevation of approximately 925 m.

1.5.2 Rainfall

Monthly rainfall data from the Woolbrook - Danglemah Road Station, which has been operational since 1958, was considered a robust data source for average rainfall offering extensive historical data for the mean monthly rainfall in the region. The station is located approximately 23 km south west of the Project Area. The average annual rainfall was 773.4 mm during years 1958 – 2021, with most rain falling in November, December, and January (BOM, 2021). The mean monthly precipitation is summarised in **Table 1-3**. **Figure 1-3** presents the mean, lowest, median and highest monthly rainfall for the area, with an increase in average rainfall typically experienced during the summer months. The annual change in average rainfall since 1958 is shown in **Figure 1-4**.

Table 1-3 Monthly Precipitation Data for 1958[1]-2021 (mm)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	97.5	76.1	54.1	40.7	45.5	45.9	51.3	51.8	54.0	72.3	83.5	100.7	773.4
Lowest	10.8	1.8	0.8	0.3	0.4	3.4	2.6	0.0	2.5	15.0	2.8	10.8	252.3
Median	88.3	67.9	38.3	34.6	33.6	40.9	45.5	48.4	44.8	74.7	78.0	94.8	800.8
Highest	265.4	176.7	185.5	135.8	152.1	148.4	178.4	148.8	180.6	154.5	203.2	237.8	1031.1

[1] Woolbrook (Danglemah Road) weather station has collected data since 1958.
Note: Data collected from BoM's climate data online, accessed 10 June 2022.

Figure 1-3 Monthly Precipitation Data for 1958-2021 (mm)

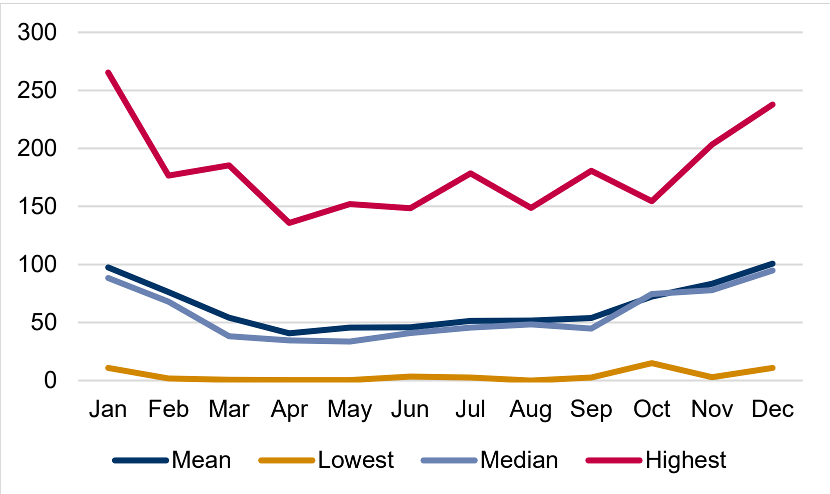
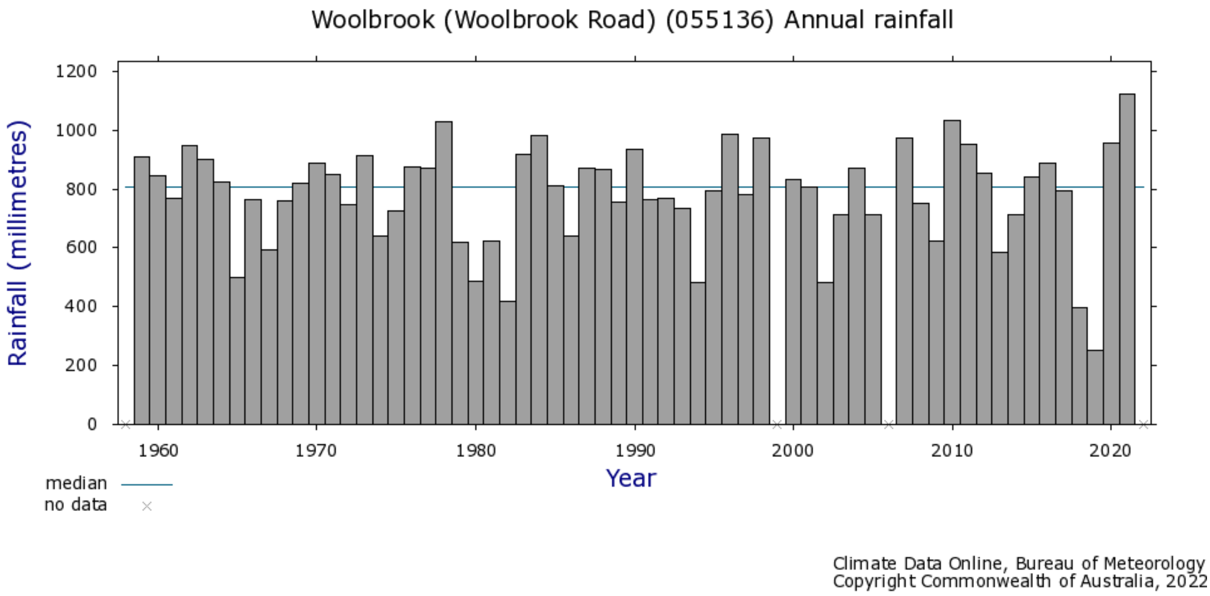


Figure 1-4 Woolbrook (Danglemah Road) Annual Rainfall



2. WATER LICENSING AND STATUTORY MATTERS

2.1 Water Management Act 2000

The objectives of the *Water Management Act 2000* (WM Act) are to provide for the sustainable and integrated management of the water sources of the State. This includes, among other matters, to protect, enhance and restore water sources and their associated ecosystems; to recognise and foster the significant social and economic benefits that result from the sustainable and efficient use of water; to provide for the sharing of water from water sources; and to encourage best practice in water management and use.

Section 4.41 of the EP&A Act confirms that approved State Significant Development (SSD) does not require approvals under WM Act Section 89 (water use), Section 90 (water management work) or Section 91(2) (controlled activity), however Section 91(3) aquifer interference approvals are not exempt (aquifer interference approvals have not been activated).

Given the SSD status, the Project is exempt from a controlled activity approval and does not require the application of the *Guidelines for controlled activities on waterfront land* (DoI, 2018).

The WM Act regulates the use and interference with surface and groundwater in NSW through 'Water Sharing Plans' (WSP). Two WSPs intersect with the Project Area:

- *Water Sharing Plan for the Macleay Unregulated and Alluvial Water Source 2016*
- *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016*

Figure 2-1 shows the applicable boundaries of the plan in relation to the Project Area. The provisions of the WSP applies where water supply for the Project is to be accessed via surface water and/or groundwater. Further discussion of how the plan relates to the Project is provided in the following sections and in **Table 2-1**.

2.1.1 Water Sharing Plans

WSPs are established as a statutory obligation under the WM Act and developed as a 10-year management plan tailored to the guide water provisions and allocation for a given catchment area. Once a WSP commences, the licencing provisions of the WM Act come into effect in the plan area.

The purpose of WSPs is to:

- provide water users with a clear picture of when and how water will be available for extraction;
- protect the fundamental environmental health of the water source; and
- ensure the water source is sustainable in the long-term.

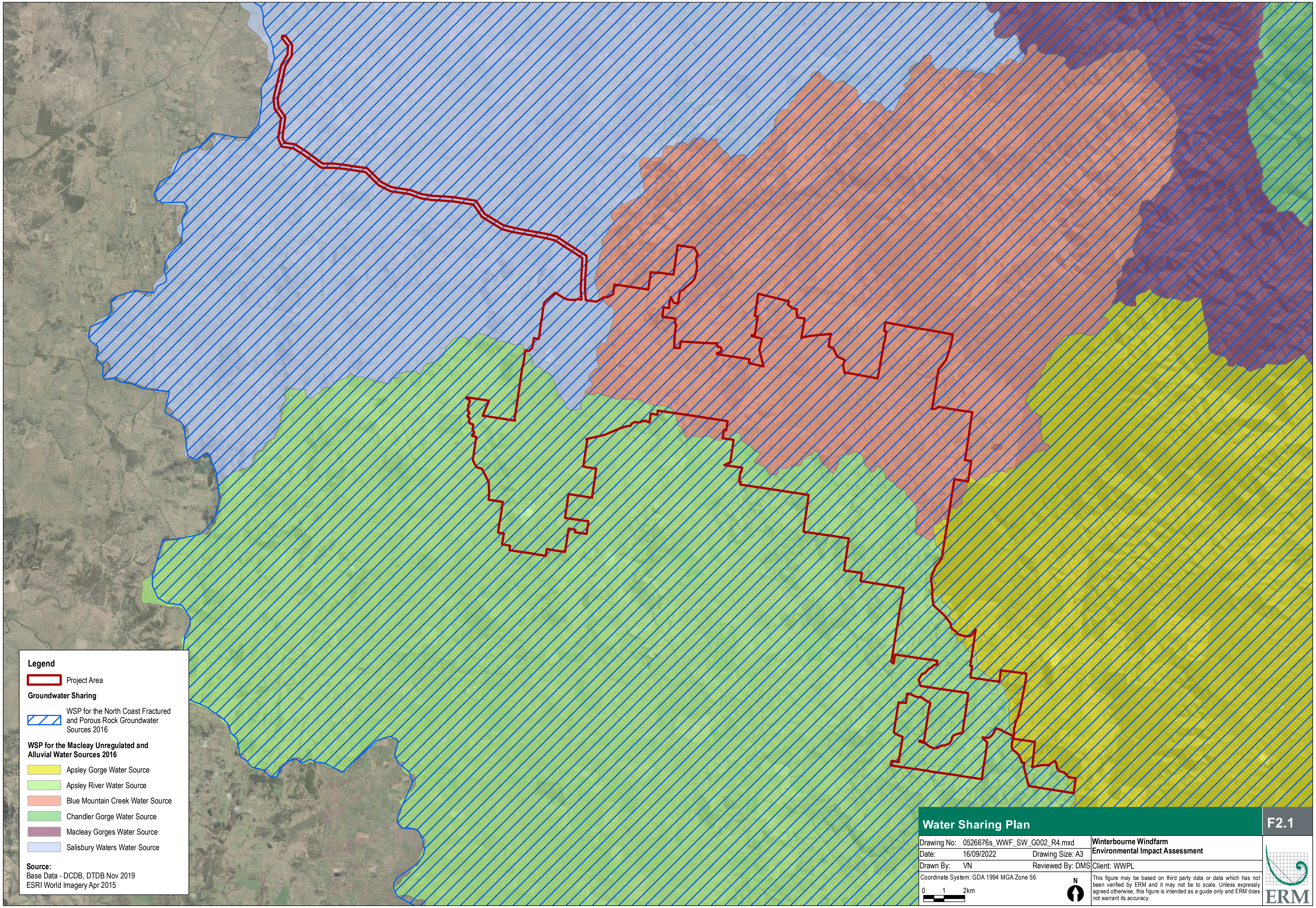

Legend
Project Area
Groundwater Sharing
WSP for the North Coast Fractured and Porous Rock Groundwater Sources 2016
WSP for the Macleay Unregulated and Alluvial Water Sources 2016
Apsley Gorge Water Source
Apsley River Water Source
Blue Mountain Creek Water Source
Chandler Gorge Water Source
Macleay Gorges Water Source
Salisbury Waters Water Source
Source:
Base Data - DCDB, DTDB Nov 2019
ESRI World Imagery Apr 2015
Water Sharing Plan
F2.1
Drawing No: 0526676s_WWF_SW_G002_R4.mxd
Date: 16/09/2022
Drawing Size: A3
Drawn By: VN
Reviewed By: DMS
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Table 2-1 Applicable Water Sharing Plan

Water Sharing Plan	Groundwater (GW) or Surface Water (SW)	Effective Date	WSP Capacity
Water Sharing Plan for the Macleay Unregulated and Alluvial Water Sources 2016	SW/GW	July 2016 to July 2026	■ At the commencement of the water sharing plan approximately 14,635 ML/year of surface and groundwater entitlement occurs in the plan area. Water trading is permitted, only if the total licensed entitlement in the water source does not increase (no net gain).
Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016	GW	July 2016 to July 2026	■ At the commencement of the water sharing plan approximately 24,532 ML/year of unassigned groundwater entitlement occurs in the New England Fold Belt Coast groundwater source. Water trading is permitted within the groundwater source subject to assessment.

2.1.2 Basic Landowner Rights

Under the WM Act, extraction of water for basic landholder rights (BLR) does not require a licence, although in the case of accessing groundwater under BLR the bore must still be approved by WaterNSW. Part 1 of the WM Act outlines basic landholder rights that include domestic and stock rights (Section 52 of the Act), harvestable rights (Section 53 of the Act) and native title rights (Section 55 of the Act). In relation to harvestable rights, Section 53 of the WM Act states:

> *'(1) An owner or occupier of a landholding within a harvestable rights area is entitled, without the need for any access licence, water supply work approval or water use approval, to do each of the following in accordance with the harvestable rights order by which the area is constituted:*
>
> > *(a) to construct and use one or more water supply works for the purpose of capturing and storing water of a kind specified by the harvestable rights order,*
> >
> > *(b) to take and use that water.'*

The WM Act establishes basic rights for access to water by rural landowners and outlines several categories of farm dams that do not require a licence. The harvestable rights provisions enable landholders to construct dams in certain positions (e.g., on hillsides and minor watercourses) that capture up to 10% of the average regional rainfall run-off for their property without requiring a licence. This is known as the maximum harvestable rights dam capacity (MHRDC).

2.1.3 Water Access Licences

Except for basic landholder rights (discussed in Section 2.1.2), all other water extraction either requires an authorisation under a water access licence (WAL) or some form of exemption. The WM Act establishes categories and sub-categories of access licences.

The most relevant WAL categories for the Project are the 'unregulated river' (for surface water extraction) and aquifer (for groundwater extraction) categories. The total entitlement or share component for each category of access licence that applies at the start of the plan is estimated and is included in the relevant plan.

Surface Water Extraction

Extraction from a surface water supply from an unregulated water source (e.g., the Aspley River) will require a WAL under Section 56 of the WM Act in accordance with the annual extraction limits of the *'Water Sharing Plan for the Macleay Unregulated and Alluvial Water Sources 2016'* and access rules for the relevant water source (as listed in **Table 2-1** above).

Groundwater Extraction

Although the depth of groundwater with the Project Area has been recorded at approximately 28 and 51 m at GW303480, located in the south east section of the Project Area, other areas have recorded groundwater bearing zones at approximately 12 to 15 m. Excavations for Project construction are relatively shallow, with the turbine foundation construction activity at approximately 3 m - 5 m and cuttings up to approximately 5 m, therefore it could be expected that the proposed construction activities are unlikely to intercept groundwater.

There is the potential for one or more new groundwater production bores to be installed to supply water for construction (discussed further in Section 3.2.1). If this option is pursued then an application for a WAL under Section 56 of the WA Act will be required, in accordance with annual extraction limits and access rules of the relevant water sharing plan.

2.1.4 Aquifer Interference Policy

The NSW Aquifer Interference Policy (2012) describes the assessment process for protecting and managing potential impacts of aquifer interference activities on the water resources of NSW. The WM Act defines an aquifer interference activity as that which involves either:

- the penetration of an aquifer;
- the interference with water in an aquifer;
- the obstruction of the flow of water in an aquifer;
- the taking of water from an aquifer while carrying out mining or any other activity prescribed by the regulations; or
- the disposal of water taken from an aquifer while carrying out mining or any other activity prescribed by the regulations.

Section 3.3 of the Aquifer Interference Policy identifies activities such as trenching, access tracks, and building and work pads as activities defined as having minimal impact on water dependent assets. The Project works are considered as having minimal impact on water dependent assets with the most significant excavation works being the work pads and associated wind turbine foundations to a depth of approximately 3 m - 5 m. Cuttings may be approximately 5 m. Aquifer interception is not anticipated, noting the estimated depth of the water table exceeding 12 m from existing recorded bore depths.

2.2 Implications for the Project

Given the SSD status of the Project, Section 4.41 of the EP&A Act negates the requirements for relevant approvals otherwise obtained through the WM Act, including a water use approval under Section 89, a water management work approval under Section 90, or an activity approval under Section 91 of the WM Act.

As discussed further in Section 0 of this report, the Project has four viable options available to source water, being:

- Council water supply (or treated wastewater), in agreement with the relevant Council(s);
- extraction of water collected from existing (or new) dams using landowner harvestable rights or from an existing nearby landowner bore, in agreement to use their allocation;
- extraction from a new groundwater bore, which will require a WAL in consultation with WaterNSW; and
- extraction from a large private dam located approximately 20 km to the north of the Project Area, which will require a WAL in consultation with WaterNSW and the licence holder.

Confirmation of the proposed source(s) will be determined following detailed design.

3. WATER BALANCE

3.1 Construction Water Demands

During the construction period, water will need to be sourced for the following purposes:

- concrete production (batching plant);
- construction of roads and hardstands; and
- dust suppression.

Based on an understanding of the construction requirements and the construction schedule, estimates have been made on the likely quantities of water required.

Information used to determine likely water requirements included:

- Good quality water is required for concrete production for WTG footings. The footing design is subject to final geotechnical investigations and turbine selection and is expected to be available prior to construction. However, an estimate based on 119 WTGs, with hexagonal footings approximately 25 m in diameter, assuming 700 m^3 per foundation, yields a concrete volume of approximately 83,300 m^3. Additional concrete will be required for construction of the substations and O&M foundations etc. and is estimated at 2,700 m^3.

  Water input estimate is based on a typical cement:sand:aggregate ratio of 1:2:3 and a water:cement ratio of 0.4. The total water estimate to produce 86,000 m^3 of concrete is approximately 5,733 m^3 (or say 6 ML). Concrete production is expected to occur mainly between months 7 and 16 of project construction and with production at a relatively consistent rate during this time.

- The total length of internal unsealed road network (may be either upgraded existing tracks, or new tracks) is approximately 113 km. The internal road network will be constructed progressively over approximately a 12 month period with final wearing surface using compacted selected aggregates providing a stabilised all-weather surface which will require minimal dust control. For determining potential water demand, the length of access roads under construction at any one time will vary and is estimated at approximately 5-8 % of the internal network. The demand for water for dust control is driven by prevailing weather and the volume of plant and transport movements over sections of the road network disturbed but to be stabilised. Internal construction traffic movements vary as construction of individual footings and turbine erection progress, with some branch roads not trafficked for relatively long periods.

  It is assumed that access roads will be constructed to 5.5 m wide with 1.5 m shoulders on either side and with approximately 0.3-0.4 m depth of onsite and/or imported road base/aggregate that will be laid and compacted. Quarry sourced material can be supplied with moisture content at near optimum for compaction to minimise requirement for onsite addition. Hence, water demand for compaction is highly variable depending on moisture content of material and antecedent conditions with minimal constraints on quality and is estimated at 150 kL/km.

- Crane hardstands of approximately 0.7 ha will need to be constructed adjacent to the base of the WTGs to enable the erection of the turbine. Each pad will be constructed from cut and fill material and compacted selected aggregates providing a stabilised all-weather surface which will require minimal dust control. As for the access roads water demand for compaction is highly variable depending on moisture content of material and antecedent conditions and is estimated at 65 kL/pad. A similar allowance has been included for establishing ancillary facility areas such as substations, laydowns, O&M buildings, and temporary compounds etc.

- Water demand for dust suppression is determined by the extent of disturbed areas and whether under traffic, weather conditions such as rainfall, evaporation rates and wind speeds and is minimised by the construction of stabilised all-weather access roads. There is also increasing use of polymers and soil binders to combat dust generation on roadways, stockpiles and hardstands which greatly reduces the demand for water.

  An allowance of approximately 200 kL/day is provided for road maintenance, dust suppression and wash down, for the intensive 12 month period where the internal access roads are under construction. A lower demand of approximately 40 kL/day for the remaining portion of the 30-month period where traffic volumes associated with construction activities continue is predicted (assuming full days on Monday to Saturday).

Based on a worst-case scenario, the total water demand for non-potable supply over the 30-month construction period is approximately 113 ML. This water would be required during the construction phase, primarily for road works and dust suppression, but also for cleaning, concreting, and on-site amenities. Water for road works and dust suppression can be of lower quality than is required for concrete production. Water from farm dams or potentially from the Walcha treated wastewater supply can potentially be utilised for dust suppression.

A small amount of potable (drinking) water (approximately 20-50 kL) would be collected in rainwater tanks from temporary site compound buildings or imported during the construction period on an as-needs basis to top up the water tanks.

The estimated total construction water demand is summarised in Table 3-1 and is based on the construction of 119 WTGs.

Table 3-1 Water Demand by Activity (ML)

Project Stage	Activity	Water Requirement
Construction	**Non-Potable Supply**	
	Foundation concrete volume for WTGs	6 ML
	General Use including roads and earthworks compaction	26 ML
	Dust Suppression – 30 months of construction	81 ML
	Total (Non-Potable)	113 ML
	Potable Supply	
	Potable (drinking) supply for site amenities	3 ML
	TOTAL	**116 ML**

3.2 Water Supply Options

A final decision on preferred water supply option/s will be determined at the construction phase of the Project. There are feasible options for the supply of water for the 30-month Project construction period, the key options being:

- surface water collection from existing (or new) dams;
- groundwater pumping from bores;
- water abstraction from a nearby permanent water source; and
- tanking water to site from Council supply (including treated wastewater) or other local WAL owners.

The Project may utilise several existing property dams scattered throughout the Project Area to store water during the construction period. These dams could be topped up with imported water providing an option to stage the water stores near earthworks during construction of access tracks and turbine construction pads.

Water storages would be provided at the batching plant sites and for potable water at the site compounds.

If water is assessed to be best sourced through extraction of a new groundwater bore or other water sources covered by water sharing plans, all required Water Access Licences and approvals will be applied for and obtained.

3.2.1 Groundwater Pumping

A new bore, or bores, would need to be constructed to allow for groundwater pumping should this be considered a viable option. The bore/s would need to be licenced for industrial purposes. A water entitlement would then likely need to be purchased on the open market.

Within a 15km radius of the Project Area there are over 70 groundwater bores located across various properties which are primarily used for stock and domestic use. Of these 70 bores, approximately 17 are located within the footprint of the Project area. Table 3-2 outlines the groundwater bearing zones of several bores across the Project Area.

Table 3-2 Groundwater Bearing Zones Across Project Area

Project Area	Bore ID	Location	Status / Use	Total Depth (m)	Groundwater bearing zone (m)	Yield (l/s)
South-East	GW303480	Approximately 2km west of B116	Current / Domestic Stock	51.80	24.40 to 28.70 47.30 to 51.80	0.51 1.30
North-west	GW300571 GW300572	Approximately 1km west of B006 & B007	Current / Domestic Stock	16.00 41.00	12.00 to 14.00 15.00 to 20.00	1.00 0.40
Central	GW901258	Approximately 1km west of B047	Unknown / Stock	16.00	13.00 to 15.00	2.50
South-west	GW300511	Approximately 200m east of B044	Current / Domestic Stock	30.90	13.00 to 13.60	1.02

It could be reasonably assumed that if additional bores were established within the Project Area a yield of approximately 1.0 l/s could be secured. This amounts to a potential long-term pumping rate during standard construction hours of approximately 40 kL/day, or 1.2 ML/month. Assuming such yields were achieved, this would be capable of supplying a significant proportion of the construction water needs of the Project and hence reducing the demand for importing using water tankers. Consideration would need to be given to water storage and this could be in a new or existing dam or temporary tanks. All work would be subject to agreement with the landholders. It would be possible to on-sell any water entitlement over the new bore to the landholder at the completion of construction. Alternately, the landholder could apply for a new stock and domestic license over the bore.

3.2.2 Surface and Ground Water Abstraction

As outlined in Section 2.1 a WAL may be applied to source water from an unregulated surface water source or groundwater aquifer. A potential water source is water from farm dams or potentially from the Walcha treated wastewater supply and the Aspley River. Review of online river flow data (available at https://realtimedata.waternsw.com.au/) indicated that the Aspley River at Aspley Falls) had a daily flow rate over the past 12 months (to June 2022) ranging from 9 ML/day to 15,888 ML/day, indicating variable seasonal flow rates.

The Apsley River water source has an unregulated allocation of 326 ML, which is currently fully licenced. As none of the allocation was used last year, 326 ML was carried over into this year. As at 10 June 2022, there has been no usage this year and 652 ML is available to use (refer https://waterinsights.waternsw.com.au/11896-apsley-river/allocation).

The New England Fold Belt Coast groundwater source has an aquifer allocation of 15,385 ML, which is currently fully licenced. 2,967 ML was carried over into this year. As at 10 June 2022, there has been no usage this year and 18,333 ML is available to use (refer https://waterinsights.waternsw.com.au/17812-new-england-fold-belt-coast-groundwater/allocation).

Review of water levels at Chaffey Dam, located 120 km south west of the Project Area, on 10 June 2022, identified that the dam is currently at 100.3 % capacity with a current volume of 103,164 ML, receiving a net inflow of 125 ML in the past 24 hours. Review of water levels at Malpas Dam, located 100 km north of the Project Area, on 10 June 2022, identified that the dam is also currently at 101 % capacity with a current volume of 12,396 ML.

Given the total requirement for all Project activities is limited to the 30-month construction period is approximately 113 ML, it could be possible to permit water abstraction for the Project without impacting environmental flows. WALs would have to be purchased to meet the Project needs.

3.2.3 Commercial Water Tanker

If required, WWPL may source high quality water for concrete production required for the construction of the Project, via commercial water tankers which will be transported to the site batching plant via tanker trucks. This water could potentially be sourced from existing Council supplies, subject to agreement with the relevant Council(s).

3.2.4 Summary

There are feasible options for the supply of water for the 30-month Project construction period. The four viable options available to source the estimated 113 ML of water required for construction include:

- Council water supply (including treated wastewater), with agreement with the relevant Council(s);
- extraction of water from an existing landowner bore or farm dam, with agreement from the landowner;
- extraction from a new groundwater bore; and
- extraction from an external surface water source (e.g., dams; Aspley River etc.).

If water is sourced from any bore or surface water source, then all required water access licences would be obtained to authorise this.

All options involve different considerations and different water licencing and approval requirements.

Confirmation of the proposed water source will be determined following detailed design; however, it has been confirmed that adequate water supply is available for the development.

4. SOILS AND WATER ASSESSMENT

4.1 Methodology

Information was extracted from the SEED Portal (OEH, 2019), including the following datasets:

- the Australia Soil Classification (ASC) Soil Type map of NSW, which provides soil types across NSW using the Australian Soils Classification at Order level; and
- the Land and Soil Capability (LSC) mapping of NSW, which depicts the capability and limitations of land for sustaining certain land uses.

A desktop investigation of soil profile and soil map information was conducted by:

- Search of eSPADE data for NSW (OEH, 2012), including Soil Profiles, Bioregions and Hydrologic Soil Groups;
- Search of WaterNSW data (available at https://realtimedata.waternsw.com.au/), including existing groundwater bores and real-time dams and rivers data; and
- Consideration of the NSW Water Quality Objectives (WQO) as they apply to the Macleay River catchment area of the Project Area, (refer to Section 4.2.3).

Site based soil and/or water sampling was not undertaken given the availability of the online resources and the limited disturbance to existing watercourses associated with the construction, operation, and decommissioning of the wind farm.

4.2 Existing Environment

4.2.1 Topography and Bioregions

Landform and Elevation

The Project Area is situated within the New England Tablelands Bioregion with a gradient incline from west to east as part of the Great Dividing Range. The New England Tablelands have a general elevation between 600 and 1,500 metres ASL on Permian sedimentary rocks, intrusive granites, and extensive Tertiary basalts. The geology of the area has a strong influence on the topography. Large basalt plateaus (Walcha Plateau) occur to the west of the Project Area, whereas steeper granite country (Oxley National Park) occurs to the east of the Project Area (DPIE, 2016).

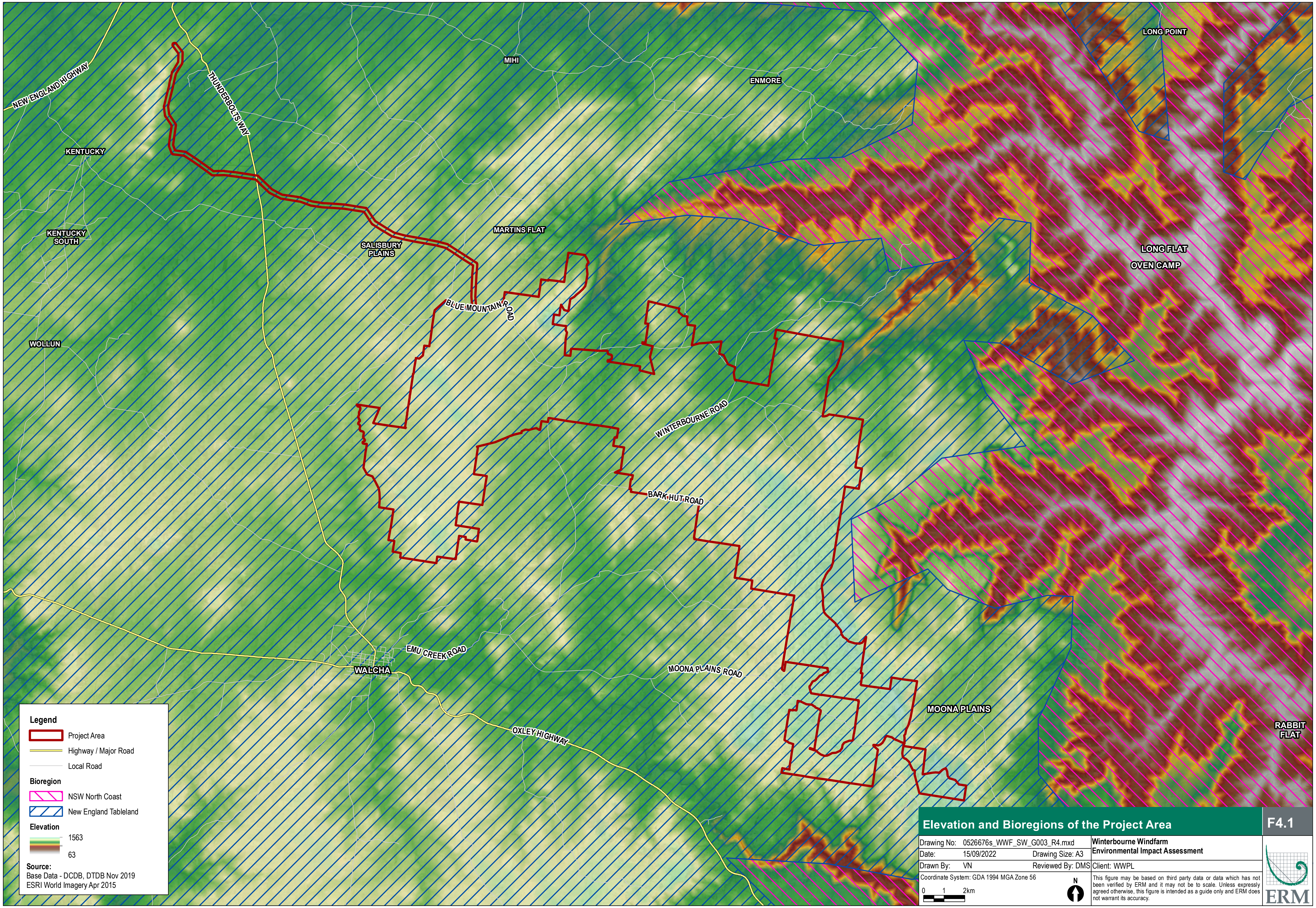
The elevation across the Project Area ranges from 1,100 m to 1,300 m Australian Height Datum (AHD). The proposed wind turbine with the highest elevation is WTG B130 with a ground elevation of 1,329 metres Australian Height Datum (AHD) and an overall height of 1,559 metres AHD. Elevations and bioregions of the Project Area are presented in **Figure 4-1**.

Site Slope Analysis

A detailed analysis of slopes at the wind farm site has been prepared using ArcGIS software. The mapping presented as **Figure 4-2** provide a colourised representation of slope generated dynamically using the ArcGIS function 'Terrain' with 1 m contour data. The percent of slope steepness is depicted by light to dark colours - flat surfaces as blue, shallow slopes as grey, moderate slopes as yellow, steep slopes as brown, with slopes greater than 50 percent coloured with red.

The Project Area is located along an elevated plateau with rolling hills that is exposed to prevailing wind directions. The slope analysis confirms that most of the Project Area is relatively flat with slopes less than 10%. The Development Footprint including turbine locations tend to follow localised higher areas with steeper side slopes.

The Development Footprint has been developed to minimise bulk earthworks and associated disturbance to soils and biodiversity. The current Project design is preliminary and will be refined further during detailed design to optimise infrastructure grades and hence reduce overall earthworks.



Elevation and Bioregions of the Project Area F4.1

Drawing No:	0526676s_WWF_SW_G003_R4.mxd		Winterbourne Windfarm Environmental Impact Assessment
Date:	15/09/2022	Drawing Size: A3	
Drawn By:	VN	Reviewed By: DMS	Client: WWPL

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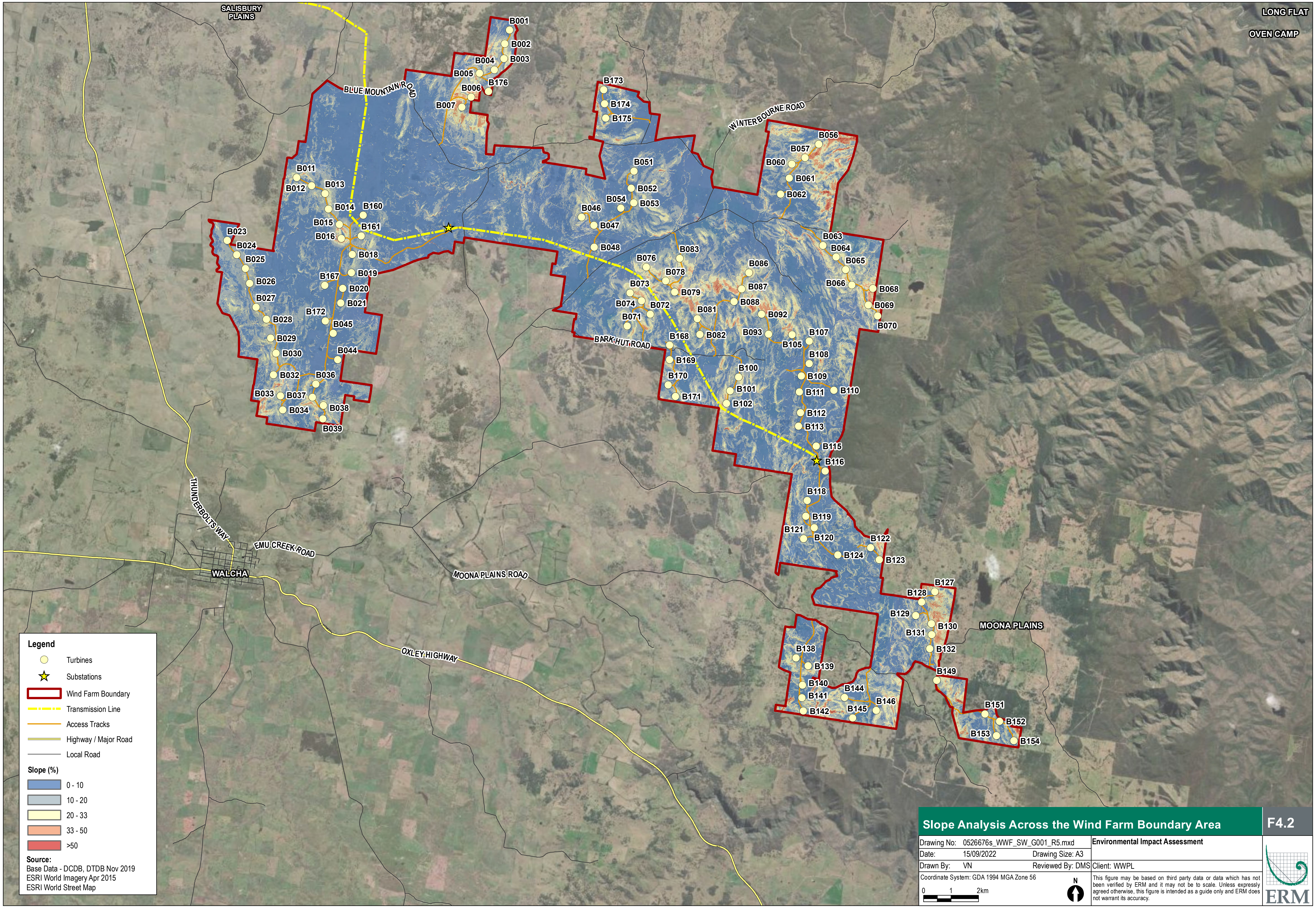
SALISBURY PLAINS
LONG FLAT
OVEN CAMP
BLUE MOUNTAIN ROAD
WINTERBOURNE ROAD
BARK HUT ROAD
THUNDERBOLTS WAY
EMU CREEK ROAD
MOONA PLAINS ROAD
OXLEY HIGHWAY
WALCHA
MOONA PLAINS
Legend
Turbines
Substations
Wind Farm Boundary
Transmission Line
Access Tracks
Highway / Major Road
Local Road
Slope (%)
0 - 10
10 - 20
20 - 33
33 - 50
>50
Source:
Base Data - DCDB, DTDB Nov 2019
ESRI World Imagery Apr 2015
ESRI World Street Map
Slope Analysis Across the Wind Farm Boundary Area
F4.2
Drawing No: 0526676s_WWF_SW_G001_R5.mxd
Environmental Impact Assessment
Date: 15/09/2022
Drawing Size: A3
Drawn By: VN
Reviewed By: DMS
Client: WWPL
Coordinate System: GDA 1994 MGA Zone 56
0 1 2km
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Suitable measures for soil erosion and sediment control are presented in Section 5.2.

Bioregions

The Interim Biogeographic Regionalisation for Australia (IBRA) mapping provides a national and regional framework for understanding bioregions. Bioregions are relatively large land areas characterised by broad, landscape-scale natural features and environmental processes that influence the functions of entire ecosystems. Sub-regions are based on finer differences in geology, vegetation and other biophysical attributes and are the basis for determining the major regional ecosystems (Morgan & Terrey, 1992).

The Walcha Plateau is a subregion of the New England Tableland Bioregion. The Walcha Plateau consists of faulted inliers of Devonian and Carboniferous sandstone, conglomerate, minor limestone, slate, schist, amphibolite and small volcanics. The Walcha Plateau further consists of small stock of granodiorite and central peak and ridge top fingers of Tertiary Basalt.

The Project Area is situated within the Walcha Plateau IBRA Sub-region of the New England Tableland Bioregion (refer **Figure 4-1**) which is described below in **Table 4-1**.

Table 4-1 Walcha Plateau IBRA Sub-region of the New England Tableland Bioregion

Feature	Description
Geology	Faulted inliers of Devonian and Carboniferous sandstone, conglomerate, minor limestone, slate, schist, amphibolite and volcanics. Small stock of granodiorite and central peak and ridge top fingers of Tertiary basalt.
Characteristic Landforms	Eastern and southern margin is the Great Escarpment. High central plateau capped by basalts. General topography undulating with small, rugged areas often related to geology.
Typical Soils	Mellow and harsh texture contrast soils on sediments and granite. Red brown to black structured loams on basalt, thin in places and often stony.
Vegetation	Snow gum and black sallee on coldest wet ridges. Ribbon gum, mountain gum, silvertop stringybark, New England blackbutt, narrow-leaved peppermint, in moist high areas. New England stringybark, ribbon gum, and cool temperate rainforest elements in moist sheltered gullies.

4.2.2 Soils

Land and Soil Capability

Land capability is the inherent physical capacity of the land to sustain a range of land uses and management practices in the long term without degradation to soil, land, air, and water resources (OEH, 2012). The NSW land and soil capability assessment scheme (OEH, 2012) describes and maps eight land and soil capability classes. The classification is based on the biophysical features of the land and soil (including landform position, slope gradient, drainage, climate, soil type and soil characteristics) and susceptibility to hazards (including water erosion, wind erosion, soil structure decline, soil acidification, salinity, waterlogging, shallow soils, and mass movement).

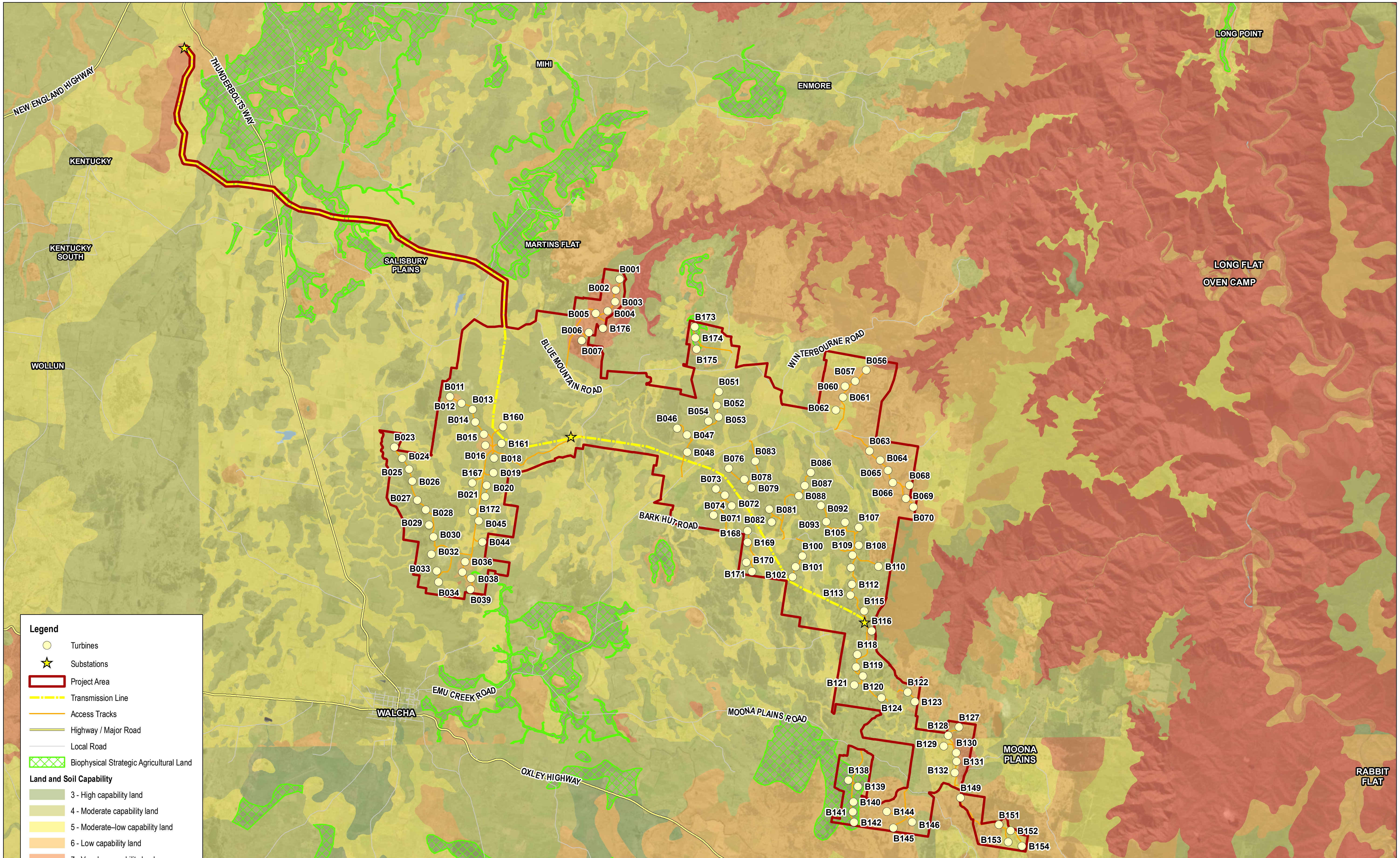
The mapping is based on an eight-class system with values ranging between 1 and 8 which represents a decreasing capability of the land to sustain productive agricultural land use. Class 1 represents land capable of sustaining most land uses including those that have a high impact on soil (e.g., regular cultivation), whilst Class 8 represents land that can only sustain very low impact land uses (e.g., nature conservation), as shown in **Table 4-2**.

Table 4-2 Land and Soil Capability Scheme Classification

LSC Class	General Definition
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation).	
1	**Extremely high capability land**: Land has no limitations. No special land management practices required. Land capable of all rural land uses and land management practices.
2	**Very high capability land**: Land has slight limitations. These can be managed by readily available, easily implemented management practices. Land is capable of most land uses and land management practices, including intensive cropping and cultivation.
3	**High capability land**: Land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation, using more intensive, readily available, and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, gazing, some horticulture, forestry, nature conservation)	
4	**Moderate capability land**: Land has moderate to high limitations for high-impact land uses. Will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment, and technology.
5	**Moderate–low capability land:** Land has high limitations for high-impact land uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.
Land capable for a limited set of land uses (grazing, forestry, and nature)	
6	**Low capability land**: Land has very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation
Land generally incapable of agricultural land use (selective forestry and nature conservation)	
7	**Very low capability land**: Land has severe limitations that restrict most land uses and generally cannot be overcome. Onsite and offsite impacts of land management practices can be extremely severe if limitations not managed. There should be minimal disturbance of native vegetation.
8	**Extremely low capability land:** Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation.

The rural land within the region is primarily used for grazing. The land and soil capability mapping provided in **Figure 4-3** suggests that there are a range of the land and soil capability classes within the Project Area.

Broadly, land within the Project Area has been classified as either Class 4 or Class 5, though several small patches of Class 3 and Class 6 land are scattered across the Project Area. A larger patch of Class 3 land occurs in the very south west corner of the Project Area and a larger section of land along the eastern and southern boundary of the Project Area is mapped as Class 6. An area of Class 7 land is mapped in the northern extremity of the Project Area.



Land and Soil Capability Mapping and Biophysical Strategic Agricultural Land — F4.3

Drawing No: 0526676s_WWF_SW_G004_R4.mxd		Winterbourne Windfarm Environmental Impact Assessment
Date: 15/09/2022	Drawing Size: A3	
Drawn By: VN	Reviewed By: DMS	Client: WWPL

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Biophysical Strategic Agricultural Land

The NSW Government introduced a range of measures designed to deliver greater protection to agricultural land from the impacts of developments. These measures included the safeguarding of 2.8 million hectares of Biophysical Strategic Agricultural Land (BSAL) across the state, and Critical Industry Clusters (CIC). BSAL is land identified with high quality soil and water resources capable of sustaining high levels of productivity, which is critical to sustaining the state's agricultural industry, while CICs are concentrations of highly productive industries within a region that are related to each other, contribute to the identity of that region, and provide significant employment opportunities. There is approximately 1,525,462 ha of mapped BSAL within the New England North West Region (NSW Government 2012).

Most of the Project Area is not mapped as being BSAL or CIC. Only two discrete locations within the Project Area totalling approximately 327.7 ha include BSAL, coinciding with larger patches of soil and land capability Class 3 land (refer **Figure 4-3**). The majority of this mapped BSAL will not be impacted by the Project, the Development Footprint covers only about 22.5 ha of BSAL.

Regional Soil Landscapes

The distribution of soil landscape at the Project Boundary is mapped in the DPE eSPADE tool (DPIE, 2020). Summarised descriptions of these soil landscapes are provided in **Table 4-3**.

Table 4-3 Soil Landscapes of the Project Area

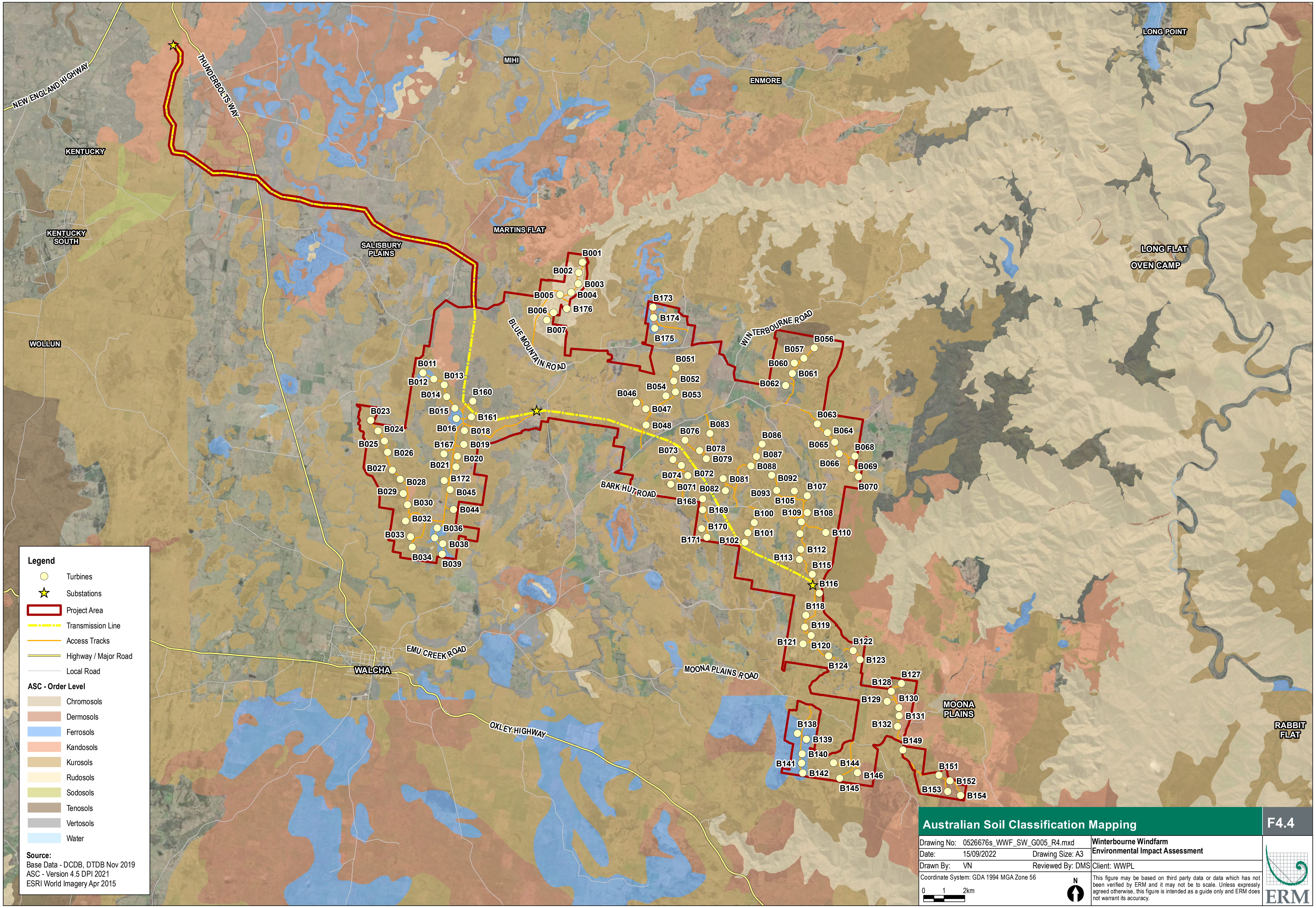
Soil Landscape	Geology	Typical Soil Erosion
Whites Hill	Geological Unit as described in the Soil Landscape: Devono-Carboniferous Sandon Association. Parent Rock: greywackes, slates, cherts, phyllites.	Significant sheer erosion of A1 horizon, particularly in exposed situations. Contour banks have been introduced in places to reduce sheet erosion. Minor partially stabilized (non-branched) gully erosion occurs on some drainage depressions.
Mihi	Geological Unit as described in the Soil Landscape: Devono-Carboniferous Sandon Association. Parent Rock: greywackes, slates, cherts, phyllites, schist, jasper, amphibolite, mudstone.	Moderate to severe gully erosion evident among most drainage lines and some foot slopes. Many active gullied areas, with recent slumping and gully head erosion. Gully height 1 – 1.5m. Sheet erosion accompanies most of gully erosion.
McCanns Flat	Geological Unit as described in the Soil Landscape: Devono-Carboniferous Lochaber Greywacke. Parent Rock: lithic sandstone, slate, chert, jasper, metabasalt.	Minor gully/streambank erosion.
Rowleys Creek	Geological Unit as described in the Soil Landscape: Devono-Carboniferous Lochaber Greywacke. Parent Rock: greywacke, lithic sandstone, slate, chert, and jasper with minor metabasalt.	Minor sheet erosion on some slopes.
Winterbourne	Geological Unit as described in the Soil Landscape: Devono-Carboniferous-Permian metasediments Parent Rock: sandstones, siltstones, slate, chert, jasper, and uncommon limestone, metabasalt and other volcanics.	Some sheet erosion evident especially on unprotected slopes. Gully erosion along some drainage lines.
Bellevue (variant A)	Geological Unit as described in the Soil Landscape: Enmore Adamellite.	Minor areas of sheet and gully erosion.

Soil Landscape	Geology	Typical Soil Erosion
	Parent Rock: biotite monzogranite and biotite adamellite.	
Ironstone	Geological Unit as described in the Soil Landscape: Tertiary ferricrete/ironstone or sometimes referred to as laterite Parent Rock: Iron minerals in Tertiary basaltic soil profiles. Iron/manganese globules various fragments of quartz and other surrounding rocks such as basalt, silcrete, chert, greywacke, and jasper	Sheet erosion is a problem on unprotected slopes and minor gully erosion is evident along some drainage depressions.
Enmore	Geological Unit as described in the Soil Landscape: Enmore Adamellite. Parent Rock: biotite monzogranite and biotite adamellite.	Sheet erosion on most slopes, can be severe where lacking protective groundcover, particularly in areas of fine sandy topsoil and moderately inclined slopes. Some gully erosion on some drainage lines.
Bald Knob	Geological Unit as described in the Soil Landscape: Tertiary basalt and associated basalt colluvium. Parent Rock: gravels, ferricrete, ferruginous sandstones and silcrete.	Sheet erosion when wet. Contour banks in some areas reduces soil loss from sheet erosion. Steeper areas with deeper soils prone to mass movement.
Salisbury Plains	Geological Unit as described in the Soil Landscape: Devono-Carboniferous Sandon Beds. Parent Rock: sandstone, siltstone, chert, slate, jasper and (rarely) metabasalt.	Sheet erosion with topsoil layer completely eroded in some areas. Gully erosion along some drainage depressions.

Australian Soil Classification

A search of the Australian Soil Classification Soil Type Map of NSW (OEH, 2019) reveals that the Kurosols soil type dominates the Project Area along with Kurosols Natric, a Great Group of Kurosols in which a major part of the upper 0.2 m of the B2t horizon is sodic. They have strong texture contrast between A horizons and strongly acidic B horizons, and with low water holding capacity Kurosols are often sodic. Kurosols generally have low fertility and land use is restricted to grazing pastures.

The mapping also revealed, to a lesser extent, the presence of Ferrosols, Dermsols and Kandosols across the Project Area, and Rudosols on ridge lines surrounding the Project Area to the east and north. The Australian Soil Classification mapping is presented in **Figure 4-4**.



NEW ENGLAND HIGHWAY
THUNDERBOLTS WAY
MIHI
ENMORE
LONG POINT
KENTUCKY
KENTUCKY SOUTH
SALISBURY PLAINS
MARTINS FLAT
WOLLUN
LONG FLAT
OVEN CAMP
BLUE MOUNTAIN ROAD
WINTERBOURNE ROAD
BARK HUT ROAD
EMU CREEK ROAD
WALCHA
MOONA PLAINS ROAD
OXLEY HIGHWAY
MOONA PLAINS
RABBIT FLAT
B001
B002
B003
B004
B005
B006
B007
B176
B173
B174
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B146
B151
B152
B153
B154
Legend
Turbines
Substations
Project Area
Transmission Line
Access Tracks
Highway / Major Road
Local Road
ASC - Order Level
Chromosols
Dermosols
Ferrosols
Kandosols
Kurosols
Rudosols
Sodosols
Tenosols
Vertosols
Water
Source:
Base Data - DCDB, DTDB Nov 2019
ASC - Version 4.5 DPI 2021
ESRI World Imagery Apr 2015
Australian Soil Classification Mapping
F4.4
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Date: 15/09/2022
Drawing Size: A3
Drawn By: VN
Reviewed By: DMS
Coordinate System: GDA 1994 MGA Zone 56
0 1 2km
N
Winterbourne Windfarm
Environmental Impact Assessment
Client: WWPL
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Soil Profiles

A search of OEH eSPADE (OEH, 2017) identified 22 soil profiles recorded either within or immediately adjacent the Project Area. These 22 soil profiles are described in **Table 4-4**.

Table 4-4 Soil Profiles in Project Area

Soil Profile	Survey Date	Easting	Northing	Horizons	Soil Type	Surface pH
1003622 – 17	27/05/1998	391304	6567789	3	Melanic Red Dermosol (ASC), Krasnozem (GSG)	-
1004305 – 59	03/07/2002	386814	6566379	3	Bleached-Mottled Eutrophic Grey Chromosol (ASC), Yellow Podzolic Soil (GSG)	6.0
1001020 – 317	09/05/2001	388024	388024	3	Mottled Eutrophic Red Kurosol (ASC), Red Podzolic Soil (GSG)	6.0
1001020 – 379	09/01/2002	386214	6587408	3	Yellow Podzolic Soil (GSG)	7.0
1001020 – 343	13/06/2001	379234	6587788	1	Basic Lithic Leptic Rudosol (ASC), Lithosol (GSG)	7.0
1001020 – 342	13/06/2001	379334	6587093	2	Haplic Eutrophic Grey Kandosol (ASC)	6.5
1001020 – 341	13/06/2001	372004	6584768	3	Eutrophic Yellow Chromosol (ASC), Soloth (Solod) (GSG)	7.0
1001020 – 333	01/06/2001	368064	6581328	3	Bleached-Mottled Eutrophic Yellow Kurosol (ASC), Yellow Podzolic Soil (GSG)	6.5
1001020 – 332	01/06/2001	369024	6580139	2	Haplic Eutrophic Yellow Kandosol (ASC)	6.0
1001020 – 331	10/06/2001	368744	6577409	1	Basic Lithic Leptic Rudosol (ASC), Lithosol (GSG)	6.0
1001020 – 121	21/06/1999	385064	6574948	3	Bleached-Mottled Eutrophic Yellow Kurosol (ASC), Yellow Podzolic Soil (GSG), Dy3.41 (PPF	6.0
1001020 – 116	21/06/1999	381804	6579329	3	Yellow Earth (GSG), Um4.25 (PPF)	6.0
1001020 – 117	21/06/1999	386714	6577838	3	Red Earth (GSG)	6.0
1001020 – 94	27/04/1999	374004	6588128	1	Basic Lithic Leptic Rudosol (ASC), Lithosol (GSG)	6.0
1001020 – 91	20/04/1999	373674	6588788	2	Haplic Eutrophic Grey Kandosol (ASC)	6.0
1001020 – 90	20/04/1999	373804	6588238	2	Mottled Mesotrophic Grey Kurosol (ASC), Gleyed Podzolic Soil (GSG)	6.0
1001020 – 89	20/04/1999	371454	6588788	3	Bleached Eutrophic Yellow Chromosol (ASC), Yellow Podzolic Soil (GSG)	6.5
1001020 – 86	20/04/1999	376974	6586688	3	Eutrophic Yellow Chromosol (ASC), Yellow Podzolic Soil (GSG)	5.5

Soil Profile	Survey Date	Easting	Northing	Horizons	Soil Type	Surface pH
1001020 – 85	20/04/1999	371854	6588908	3	Bleached-Mottled Eutrophic Yellow Kurosol (ASC), Yellow Podzolic Soil (GSG)	4.0
1003627 – 41	15/05/1998	386134	6581588	3	Sodic Eutrophic Yellow Chromosol (ASC), Yellow Podzolic Soil (GSG)	6.0
1003627 – 39	14/05/1998	382304	6586578	3	Haplic Eutrophic Yellow Chromosol (ASC), Yellow Podzolic Soil (GSG)	-
1003627 – 36	14/05/1998	369684	6588828	3	Bleached Eutrophic Yellow Chromosol (ASC), Yellow Podzolic Soil (GSG)	6.0

Soil Regolith Stability

The Soil Regolith Stability classification (aka. soil erodibility) is used in the assessment of soil erosion and water pollution hazards. Regolith includes all soil layers and biological cover above bedrock, with the classification assessed to a depth of one metre. The Project Area predominantly contains the classification R3 with small, isolated areas mapped as R1, R2 and R4. These classifications are described as being:

- Class R1 – High coherence soils with low sediment delivery potential
- Class R2 – Low coherence soils with low sediment delivery potential
- Class R3 – High coherence soils with high sediment delivery potential
- Class R4 – Low coherence soils with high sediment delivery potential

The Development Footprint is primarily mapped as classed as R3(R4, R1) where R3 is the dominant class and R4 and R1 the sub-dominant class, as summarised below:

- R3 stability class:
  - Clayey and silty soils which are liable to sheet erosion;
  - Typically, slowly permeable with drainage generally impeded;
  - Earth batters and exposed surfaces subject to minor to moderately extensive rilling and minor slumping;
  - Minor gully erosion may develop in drainage lines and incision may occur along road drains; and
  - Localised films of fine sediment at drain outlets and in drainage lines.
- R4 stability class:
  - Unstable, dispersible soils which are prone to severe sheet and rill erosion and gully erosion;
  - Riling and/or slumping is common on batters and gully erosion is common in drainage lines and along road drains;
  - Snig tracks display frequent rill erosion and drainage lines show extensive fine sediment films. R1 stability class are stable soils with no appreciable erosion;
  - Generally well-drained, permeable soils;
  - Earth batters stable; and
  - No or little general evidence of coarse or fine sediment movement.

Soil Hydrologic Groups

A search of the OEH eSPADE view (OEH, 2017) was utilised to identify the Hydrologic Groups within the Project Area. Hydrological Grouping of soils in NSW is a four class system, which identifies the soils infiltration and permeability characteristics. Across the Project Area, the soils are assigned ratings of C and D, representing the soils having slow to very slow infiltration rates, respectively. These two soil classes are described as:

- C – soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.
- D – soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

Most of the Project Area is assigned to the C rating with narrower D rated areas typically assigned to creek alignments throughout the Project Area. Hence the Project Area has generally slow to non-permeable soils which increase runoff potential with the depth to any water impermeable layer greater than 0.5 m.

Areas rated B are soils having moderate infiltration rates when thoroughly wetted and have been assigned to ridgelines traversing the northern and eastern boundaries of the Project Area. A small pocket assigned to the A rating, as soils having high infiltration rates and water transmission, is in the north east corner of the Project Area. A second pocket assigned to the A rating is located at the southernmost extent of the eastern side of the Project Area.

Modelled Soil Characteristics

eSPADE provides modelled soil properties for the State and has been used to gain a broad understanding of the site soil characteristics that will be encountered. The modelled soil properties considered relevant to the Project Area is provided in this section.

Soil acidity modelling demonstrates that across the Project Area, soil acidity ranges between a pH of 4.0 and 5.5 in the 0-30 cm layer. The soil acidity in the 30-100 cm layer becomes slightly less acidic, still ranging between 4.0 and 6.0, however the extent of area mapped with a pH between 4.5 and 5.5 is greater. These soil pH characteristics are not considered to be restrictive to construction activities or any required revegetation activities that may be required.

Exchangeable sodium percentage (ESP) is a measure of soil sodicity, with values of greater than 6% indicative of sodic soils. Issues related to sodic soils include:

- water permeability issues;
- surface crusting;
- more susceptible to erosion; and
- high sediment load in runoff that will not settle out over time.

eSPADE soil modelling for the Project Area identifies that in the 0-30cm soil profile, ESP is predominantly less than 4%. With increasing depth, in the 30-100cm soil profile, most of the site remains less than 6% though there are isolated, small pockets greater than 6%.

The soils do not exhibit a significant constraint that cannot be managed through considered design and construction technique or management measure/potential amelioration. If sodic soils are identified, management measures following limited soil sampling should be implemented such as topsoil and subsoil separation.

Acid Sulfate Soils

A review of acid sulfate soil risk mapping has identified that no potential acid sulfate soils (PASS) are expected to occur across the Project Area (Naylor, et al., 1998).

A search for acid sulphate soils was undertaken on the 10 June 2022, via NSW Government online databases (NSW Planning Portal and eSPADE). The Project Area is not mapped within a known area of acid sulphate soils. The probability of encountering acid sulphate soils within this locality is extremely low.

Naturally Occurring Asbestos

A search for Naturally Occurring Asbestos (NOA) was undertaken on 10 June 2022 via NSW Government online databases (DPIE, 2021). The Project Area contains no mapped areas with geological units containing asbestos. There are areas with geological units mapped as low asbestos potential located to the east of Walcha, south of the Project Area. A small area mapped with geological units containing medium asbestos potential is located north east of the Project Area on the boundary of the Oxley Wild River National Park.

Soils Summary

Overall, the soil character of the Project Area is identified as having moderate to high erodibility and generally lower permeable soils which increases runoff potential. The primary concern for soil management is the disturbance of steep sloped areas. Detailed design has avoided proposed disturbance of steep sloped areas, with the primary ground excavation works associated with access tracks which are mainly on flatter plateaus, or along low to moderate slopes that lead to small ridges where most turbine hardstands are located.

4.2.3 Hydrology

Surface Water and Watercourses

The Project Area is within the Northern Tablelands Local Land Services area and Macleay River Catchment. The Macleay River catchment covers 11,450 square-kilometres (km^2) and comprises the region popularly known as the mid-north coast (DPIE, 2020). It is bound by the Clarence, Bellinger and Coffs Harbour and Nambucca catchments in the north, and by the Williams and Karuah and Great Lakes catchments in the south. The dominant surface water feature within the catchment is the Macleay River, located approximately 13km east of the Project Area.

The Aspley River, a perennial stream of the Macleay River catchment, runs past the southern and eastern extent of the Project Area. Ohio Creek runs south west of the Project Area and several small local creeks traverse the site including Grose Creek, Draytons Creek, and Winterbourne Creek. For much of the year these creeks may have no running water. Small farm dams occur onsite. There are no wetland areas or lakes (other than small farm dams) within the Project Area.

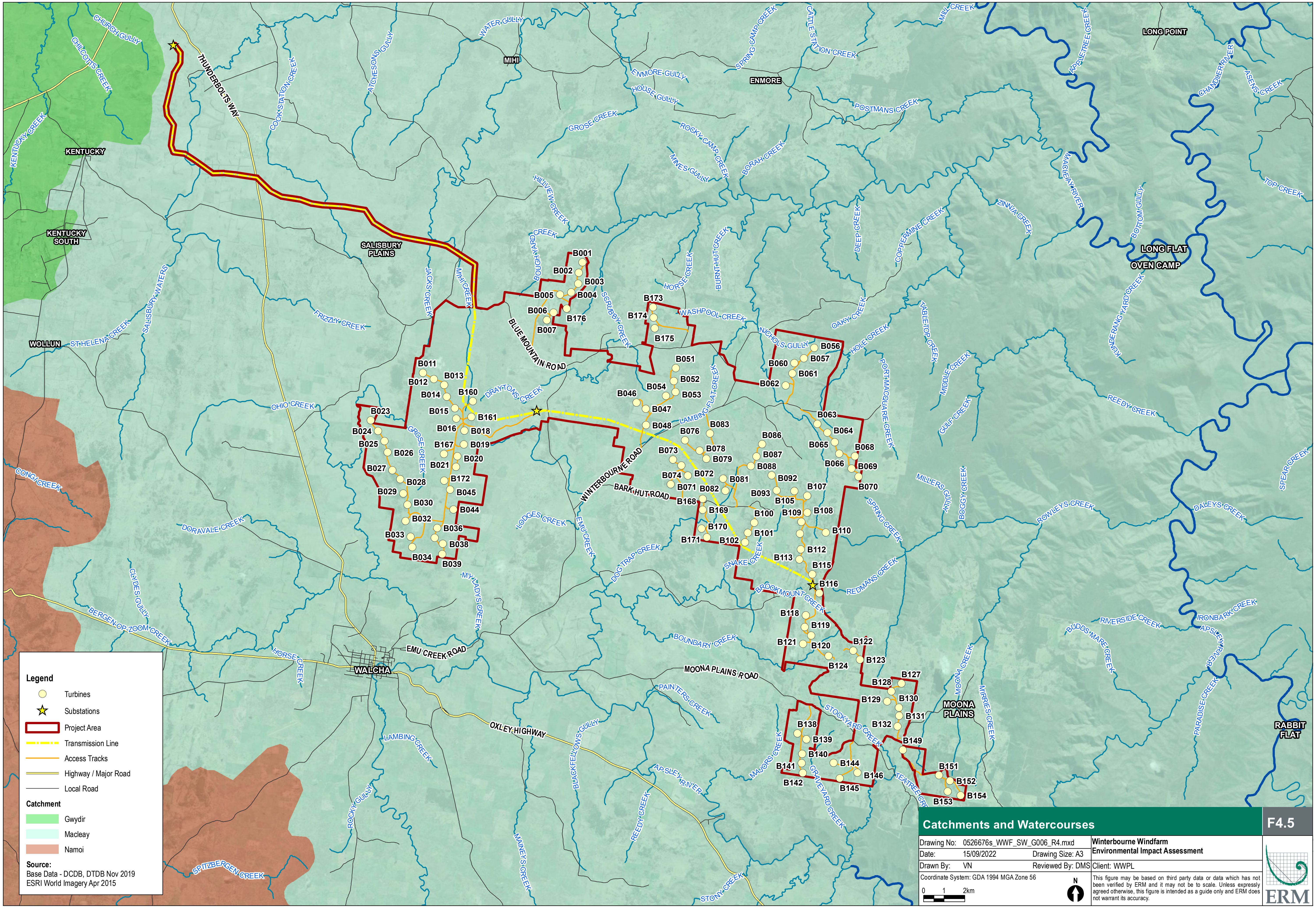
In this section and elsewhere throughout this report, a reference to stream order relates to the Strahler system of stream ordering. This is explained as follows:

- starting at the top of a catchment, any watercourse that has no other watercourses flowing into it is classed as a first-order watercourse;
- where two first-order watercourse join, the watercourse becomes a second-order watercourse;
- if a second-order watercourse is joined by a first-order watercourse – it remains a second-order watercourse;
- when two or more second-order watercourses join they form a third-order watercourse; and
- a third-order watercourse does not become a fourth-order watercourse until it is joined by another third-order watercourse, and so on.

The *Fisheries Management Act 1994* does not define Key Fish Habitat (KFH), however the NSW DPI definition of KFH was developed to include all marine and estuarine habitats up to highest astronomical tide level (that reached by 'king' tides) and most permanent and semi-permanent freshwater habitats including rivers, creeks, lakes, lagoons, billabongs, weir pools and impoundments up to the top of the bank. Small headwater creeks and gullies (known as first and second order streams), that only flow for a short period after rain are generally excluded, as are farm dams constructed on such systems. Wholly artificial waterbodies such as irrigation channels, urban drains and ponds, salt and evaporation ponds are also excluded except where they are known to support populations of threatened fish or invertebrates.

There are numerous first order and second order unnamed tributaries located across the Project Area; however, these are generally ephemeral gullies and are characteristic of the ridgeline topography. There are 14 named tributaries classified as Strahler third order or above within the Project Area that are classified as KFH (refer **Figure 4-5** and **Table 4-5**).

These waterways would not meet the definition of rivers that constitute 'waterfront land' under the *Water Management Act 2000*. As such, the Project does not involve works within 40 metres of the high bank of any river, lake, or wetlands (collectively waterfront land).



Catchments and Watercourses

F4.5

Drawing No:	0526676s_WWF_SW_G006_R4.mxd		Winterbourne Windfarm Environmental Impact Assessment
Date:	15/09/2022	Drawing Size: A3	
Drawn By:	VN	Reviewed By: DMS	Client: WWPL

Coordinate System: GDA 1994 MGA Zone 56

0 1 2km

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Table 4-5 Strahler Stream Order (>3rd order) within the Project Area

Named Tributary	Strahler
Snake Creek	3rd order
Graveyard Creek	3rd order
Boundary Creek	3rd order
Brookmount Creek	3rd order
Grose Creek	3rd order
Lambing Flat Creek	3rd order
Dog Trap Creek	3rd and 4th order
Mihi Creek	3rd and 4th order
Stockyard Creek	4th order
Jacks Creek	4th order
Cook Station Creek	4th order
Draytons Creek	=>5th order
Salisbury Waters	=>5th order
Winterbourne Creek	=>5th order

Water Quality Objectives

The NSW Water Quality Objectives (WQOs) are the agreed environmental values and long-term goals to achieve healthy waterways in surface water catchments across the State. The WQOs include a range of water quality indicated to help assess the current conditions of waterways and their ability to support its respective uses and values.

The Macleay River catchment contains the towns of Armidale, Walcha, Guyra and Kempsey and supports a diverse range of water uses. Key users include local councils, water utilities, conservation, livestock grazing including dairying, dryland agriculture, some forestry and tourism. Water sharing plans have been developed in the Macleay River catchment to address environmental requirements and to ensure sustainable use of water by all water users.

The Macleay River Catchment Water Quality Objectives (WQO) have been developed to provide guideline levels to assist water quality planning and management. Considering the Project Area is situated across tributaries that are 3rd order and above, meeting the WQO is vital for protecting the local ecosystem, environmental values, and uses people have for the water downstream of the Project.

The corresponding WQO for the Macleay River Catchment are detailed in **Table 4-6**.

Table 4-6 Macleay River Catchment Water Quality Objectives

Catchment Areas	Applicable Water Quality Objectives	
Macleay River	■ Aquatic ecosystems,	*Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term*
	■ Visual amenity,	*Aesthetic qualities of waters*
	■ Secondary contact recreation	*Maintaining or improving water quality for activities such as boating and wading, where there is a low probability of water being swallowed*
	■ Primary contact recreation	*Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed*
	■ Livestock water supply	*Protecting water quality to maximise the production of healthy livestock*
	■ Irrigation water supply	*Protecting the quality of waters applied to crops and pasture*
	■ Homestead water supply	*Protecting water quality for domestic use in homesteads, including drinking, cooking, and bathing*
	■ Drinking water – disinfection only, or ■ Drinking water – clarification and disinfection, or ■ Drinking water – groundwater	*Refers to the quality of drinking water drawn from the raw surface and groundwater sources before any treatment*
	■ Aquatic foods (to be cooked)	*Refers to protecting water quality so that it is suitable for the production of aquatic foods for human consumption and aquaculture activities.*
	■ Industrial water supplies	*Recognises the economic value of water as a resource for industrial use.*

Waterway health is assessed against the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (formerly ANZECC, 2000). The Guideline establishes values for various water quality measures which support the WQO's.

The Apsley River headwaters are located to the south of Walcha and the river flows through Walcha and eastward to Apsley Gorge. The Walcha sewage treatment plant is located adjacent to the Apsley River downstream of Walcha and is licensed under the provisions of the *Protection of the Environment Operations Act 1997* by NSW EPA (EPL 2613) to discharge 219 ML of treated effluent annually into the river. The licence allows for the treated effluent to contain certain pollutants that must not exceed the concentration limits specified in the licence. These pollutants include biochemical oxygen demand (BOD), oil and grease, and total suspended solids.

Sensitive Locations

The Oxley Wild Rivers National Park is located adjacent to the eastern boundary of the Project Area. The World and National Heritage listed Gondwana Rainforests of Australia is mapped as a subset of the National Park and primarily follows the deep gorge country of the Apsley River and its major tributaries from Aspley Gorge downstream to its confluence with the Macleay River and then further upstream and downstream along the Macleay River and key tributaries. The World and National Heritage area at its closest point to the Development Footprint is approximately 1.3 km to the north east, 2.4 km to the east and 1.0 km to the south (Apsley Gorge).

The primary risk from activities associated with the Project to impact upon the World and National Heritage site and the National Park is associated with runoff and sediment deposits.

Suitable measures can be effectively implemented to appropriately mitigate impacts associated with the sensitive locations in the adjacent National Park. Measures are to be included in the progressive Erosion Sediment Control Plan (ESCP) to either;

- direct disturbed runoff away from the catchment areas that flow directly to the National Park, or
- process runoff through additional sediment controls (e.g., sumps and/or sediment basins) and discharge at a low, non-erosive velocity.

These measures are described in Section 5.3 and Section 5.4, for inclusion in environmental management plans to be implemented across the site and to protect the identified sensitive locations.

4.3 Assessment

4.3.1 Construction Impacts

Soils will be subject to disturbance during construction activities to allow for site establishment, installation of infrastructure and replacement of soils for revegetation. Specific construction activities that will potentially impact soils, and resultant potential downstream watercourse impacts, are outlined in Table 4-7.

Table 4-7 Potential Construction Impacts to Soils and Water

Construction Activities	Potential Impacts to Soils and Water
All-weather Unsealed Road Network	■ creation of fugitive dust due to vehicle movements; ■ erosion of unsealed roadways and resultant sedimentation of runoff from road surfaces; ■ erosion of roads and roadside drainage in areas of steep terrain or in inappropriately 'finished' locations; ■ insufficient compacting of the road surface which could lead to erosion or batter slips in areas of steep terrain; and ■ mud tracking at the confluence of internal access roads with the public road network.
Watercourse Crossings	■ erosion of drainage lines and subsequent sedimentation; ■ removal of vegetation and subsequent increased erosion potential; ■ any vehicle movement across unaltered watercourses during construction phase leaving wheel tracks and causing damage to creek beds; ■ potential for any unstable steep banks collapsing under weight of vehicles/machinery; and ■ bank erosion at creek crossings from culvert installations.
Water Supply	■ over-extraction of surface water or groundwater resulting in reduced environmental flows, reduced water availability for existing licensed users and impacts on water dependent ecosystems.
Establishment of hardstands (e.g., crane pads, access roads laydown areas etc)	■ erosion of relatively large, disturbed areas during establishment and subsequent sedimentation of runoff.
Turbine and Transmission Pole Foundations	■ erosion of soils around turbine/pole foundations; ■ potential increase to water filtration and subsequent impacts to groundwater; and ■ erosion from spoil stockpiles and subsequent sedimentation should it reach a waterway.
Dewatering of Site	■ potential interception of subsurface water during construction of turbine foundation, requiring dewatering.
Ancillary Infrastructure (e.g., substation,	■ erosion of relatively large, disturbed areas during establishment and subsequent sedimentation of runoff; and

Construction Activities	Potential Impacts to Soils and Water
operations, and maintenance facility)	■ erosion from spoil stockpiles and subsequent sedimentation should it reach a waterway.
Stockpile Management	■ erosion of stockpiles and loss of soil resource; and ■ subsequent sedimentation impacts.
General Construction Activities (e.g., Machinery Operations)	■ erosion of soil stockpiles created during excavation works; ■ hydrocarbon spills from machinery (burst hoses, mechanical failures, leaking machinery, etc); ■ contamination of soils from poor refuelling practices; and ■ discovery of previously contaminated sites.

4.3.2 Operational Impacts

Specific operational activities that will potentially impact soils, and resultant potential downstream watercourse impacts, are outlined in **Table 4-8**.

Table 4-8 Potential Operational Impacts to Soils

Operational Activities	Potential Impacts to Soils and Water
Driving on All-weather Unsealed Road Network	■ creation of fugitive dust due to vehicle movements; ■ erosion of roads and roadside drainage in areas of steep terrain; and ■ mud tracking at the confluence of internal access roads with the public road network.
Watercourse Crossings	■ any vehicle movement across unaltered watercourses during operational phase leaving wheel tracks and causing damage to creek beds; and ■ bank erosion at culvert crossings.
Pad Sites	■ potential for erosion and subsequent sedimentation of runoff during heavy rainfall.
General Operational Activities (e.g., Machinery Operations)	■ hydrocarbon spills from machinery (burst hoses, mechanical failures, leaking machinery, etc); ■ contamination of soils from poor refuelling practices; and ■ increased soil erosion following heavy rainfall and potential subsequent sedimentation.

4.3.3 Soils and Water Assessment

A review of the baseline data presented above, combined with a physical site inspection, suggests that overall potential risks to water and soils are relatively minor to moderate, with the primary constraints being steeper slopes and large disturbed areas. This is on the basis that:

- for the most part, hardstands and access road construction occur on relatively low-moderate gradient lands high up in the respective drainage catchments;
- there is generally a very low risk of run-on or runoff of concentrated stormwater flows;
- construction sites within the Project Area generally present a moderate erosion hazard considering factors such as climate, soils, and landform. A quantitative estimation of the sites erosion hazard was undertaken using the Revised Universal Soil Loss Equation (RUSLE) as described in Section 5.2 and provided in Appendix A;
- the landscape of the Project Area is relatively stable with no significant areas of erosion, except for a few existing drainage lines;

- impacts to water flows are not anticipated for the construction of the Project, given the localised impacts are located upstream of mainly first and second order streams and formal waterway crossings installed across higher order streams. Potential impacts downstream can be effectively managed at the source of works (i.e., velocity controls in areas with steep slopes) through the implementation of a progressive Erosion and Sediment Control Plan (ESCP);
- vegetated buffers lie between work areas and watercourses;
- sustainable water supply options will be pursued through consultation with landowners and relevant Government agencies. Licenses would be obtained as required; and
- additional measures can be effectively implemented to appropriately mitigate impacts associated with the identified sensitive locations in the adjacent National Park. Measures are to be included in the progressive ESCP to either:
  - direct disturbed runoff away from the catchment areas that flow directly to the National Park, or
  - process runoff through additional sediment controls (e.g., sumps and/or sediment basins) and discharge at a low, non-erosive velocity.

The identified risks can be managed through implementation of appropriate preventative and management measures. These would be outlined in the Project Soil and Water Management Plan, supplemented by a progressive ESCP prepared post-approval. Section 5 outlines a range of management practices that would contribute to sound management of the Project Area’s soil and water resources.

5. CONCEPTUAL SOIL AND WATER MANAGEMENT PLAN

5.1 Introduction

In NSW, best practice guidance on soil and water management at construction sites is provided in the document *Managing Urban Stormwater: Soils and Construction*, *Volume 1, 4th edition* (Landcom, 2004). Landcom (2004) provides an overarching guideline, though is particularly targeted to urban development. Several more targeted supporting guidelines are published under Volume 2 of the Managing Urban Stormwater series and include the following that are particularly relevant to construction of the Project:

- *Managing Urban Stormwater: Soils and Construction, Volume 2A, Installation of Services* (NSW Department of Environment and Climate Change, 2008a) (hereafter referred to as "Volume 2A"); and
- *Managing Urban Stormwater: Soils and Construction, Volume 2C, Unsealed Roads* (NSW Department of Environment and Climate Change, 2008b) (hereafter referred to as "Volume 2C").

ERM has prepared this Conceptual Soil and Water Management Plan (SWMP) to outline the fundamental principles to be followed in the planning and implementation of erosion and sediment control measures for the Project. This Conceptual SWMP provides guidance on the suite of appropriate management practices that may be relevant to control soil and water impacts during construction, and outlines how a combination of controls may be used during particular activities.

It is not feasible to prepare a detailed SWMP at this stage that addresses all work sites, as works will be dispersed over large distances, will occur in stages, and in many cases have not yet been subject to detailed design.

This Conceptual SWMP does not include detailed engineering design of structures, nor does it provide plans showing the layout of all erosion controls across the site. It is recommended that Progressive ESCPs should be prepared for this purpose once detailed design plans are available, particularly the detailed road, drainage and creek crossing designs. In many cases these progressive ESCPs will be relatively simple documents, such as a sketch plan showing the layout of controls with attached commentary, prepared on topographic or drainage plans.

WWPL will prepare an Environmental Management Strategy (EMS) post approval including a detailed Soil and Water Management Plan that will include elements of this Conceptual SWMP and any additional measures required to manage the erosion, sedimentation, and water quality risks of the Project. The SWMP will outline the requirements for preparation of Progressive ESCPs for each area of works, and with a particular focus on high-risk locations such as on steep lands and in the vicinity of watercourses. It is recommended that the SWMP be prepared in accordance with the Managing Urban Stormwater guidelines, particularly Volumes 2A and 2C.

5.2 Erosion Hazard and Assessment

Erosion hazard was estimated using the Revised Universal Soil Loss Equation (RUSLE), provided in **Appendix A**. The RUSLE provides a quantitative estimation of erosion hazard based on five factors: rainfall erosivity; soil erodibility; slope length and gradient; soil cover and management practices. A detailed description of the RUSLE equation and its contributing factors is provided in Landcom (2004).

The overall erosion hazard has been assessed as moderate. This is a consequence of favourable climatic conditions (low rainfall erosivity) and the lower slope gradient where disturbance will generally occur on slopes under 10%, which limit the generation of high velocity, erosive run-off. Localised areas of greater erosion hazard will exist, for example where steeper slopes occur (e.g. road batters) and in areas of concentrated water flow, such as along watercourses and table drains. Particular attention to erosion control should be applied in these areas.

5.3 General Management Practices

Landcom (2004) provides a range of soil and water management principles for construction sites. These principles should be a key component of the decision-making process as earthworks are planned and undertaken. These principles are:

- investigate site features and assess constraints;
- develop and implement plans for the management of soil and water;
- minimise disturbance;
- strip and stockpile topsoil for use in subsequent rehabilitation;
- divert upslope (clean) stormwater around the disturbed site;
- reduce erosion;
- capture sediment-laden run-off from within the disturbed site for diversion to sediment control devices;
- rehabilitate the site promptly and progressively as works progress; and
- inspect and maintain erosion and sediment control devices for the duration of the Project.

Industry standard erosion and sediment control measures are outlined in the following sections that will assist in meeting the principles outlined above.

Standard Drawings which further detail a management measure are referenced where relevant and provided in **Appendix B**.

5.3.1 Staging of Work

Staging of works is one of the simplest and most effective forms of erosion and sediment control. By limiting the exposed area to the minimum possible at any one time, reduces the risk of soil loss than if the entire sites earthworks are exposed.

Prior to disturbing an area, the following management measures should be implemented:

- have a single stabilised site access point defined by barrier or sediment fencing, to prevent unnecessary disturbance at access locations;
- prior to disturbance, install sediment fence downslope and boundary fencing/flagging around perimeter of site to define the work areas and minimise disturbance outside construction boundaries (to be regularly maintained);
- install upstream stormwater diversion drains / bunds and stabilise their outlets (where required);
- install sediment traps with stabilised outlets as shown in Progressive ESCPs;
- direct run-off from disturbed areas to sediment traps during construction, using earth banks or drains;
- install checks at regular intervals to reduce scour velocity of flows;
- remove vegetation and store in appropriate locations (e.g., away from watercourses and riparian lands) and re-spread cut / mulched vegetation where appropriate during rehabilitation;
- commence earthworks, stripping topsoil and subsoil independently and storing these separately. Topsoil should be preserved for use later in rehabilitation;
- install erosion and sediment controls as required during progression of construction works and maintain existing controls;
- rehabilitate site as soon as practicable after completion of construction; and
- decommission / remove controls when site is successfully stabilised, and vegetation established.

5.3.2 Stormwater Management

The following stormwater management controls apply to all construction activities and will be utilised during site development:

- where required, divert clean stormwater run-on away from areas to be disturbed by construction activities using earth banks or catch drains. Note that in some cases low-impact diversions can be created using sandbags or similar. Earth banks may also be used, and construction requirements are shown in **Appendix B**:
  - SD 5-5 for temporary earth banks (low flow); and
  - SD 5-6 for permanent earth banks (high flow).
- permanent diversion banks will be sized by a suitably qualified person, using hydrological data and design standards as recommended in Landcom (2004). Note that the need for upslope diversion may be removed where construction sites have minimal upslope catchment, or the risk of stormwater run-on is low. This is likely to be the case for most WTG sites;
- collect dirty water in earth banks or catch drains for diversion to sediment control structures as determined in the Progressive ESCP Drawings;
- install temporary earth diversion banks (refer SD 5-5) at the direction of the site manager to mitigate against unforeseen erosion hazards, particularly when rain is forecast. These shall be used to shorten slope lengths, or to divert localised run-on away from high hazard areas (such as unstable batters);
- check dams (SD 5-4) using rock aggregate, sandbags or geotextile “sausages” may be installed within drains and diversion channels to help reduce flow velocity and consequent erosion, especially on steep sections. Care to be taken to ensure there is adequate provision for a spillway that allows flows to be retained within the diversion channel and not escape thereby potentially causing scouring and/or flooding of adjacent lands; and
- maintain slope lengths no greater than 80 m in disturbed areas and preferably <50 m on exposed road surfaces and steep slopes. To reduce slope lengths in construction areas install temporary earth diversion banks following SD 5-5. On roads consider the use of cross banks and mitre drains to shed water from the surface.

5.3.3 Erosion Control

Erosion control should be prioritised in all aspects of the work – this being the most effective way to minimise site degradation and reduce potential impacts on land and water resources. Effective erosion control reduces the loss of sediment and improves the effectiveness and reliability of downstream sediment and pollution controls.

In addition to the erosion control measures outlined in the staging section above, the following are a series of general erosion control measures that apply to the day-to-day construction activities:

- stabilise the access point by sealing with concrete, asphalt, or loose rock fill (refer SD 6-14);
- limit unnecessary vehicle movements across the Project Area to those only required for construction activities and ensure movements are contained to the predefined construction access ways;
- limit stripping of topsoil to within two weeks of commencing construction activities to minimise the time and area that soil is exposed to erosive forces;
- where more than one contractor is onsite at any one time, coordinate works so that sites do not remain disturbed for longer than is necessary;
- stockpiles should be located greater than 40 m from natural waterways (refer SD 4-1);

- stockpiles are to have a buffer of at least 5 m from areas likely to receive concentrated water flows, including earth banks and roads;
- unsealed access roads are to be kept moist by water carts during windy conditions and times of heavy traffic, to prevent dust generation; and
- all areas of concentrated flow (diversion banks and waterways), will be designed by a suitably qualified person to convey and remain stable during the design storm event. Stabilisation with 350 gram per square metre (gsm) jute matting or equivalent may be required (refer SD 5-7).

5.3.4 Sediment Control

Sediment traps will be used to treat sediment laden run-off that is generated from disturbed areas and maintain the sediment as close as possible to its source.

Sediment traps work by trapping water and allowing the coarser fragment of the sediment to settle out under gravity. Sediment traps are most effective for sheet flows of run-off rather than concentrated flow. Use of sediment traps in areas of concentrated flow such as drains are often ineffective, with the result often being scouring and further erosion.

The most easily recognisable and common form of sediment trap is sediment fencing, but sediment traps may also include earth or mulch bunds, geotextiles, rock, or a combination of these (such as a rock-sock which involves wrapping rock in geotextile). Installation and sizing of these traps should be such that water does not find an alternative flow path underneath or around the trap. Anchoring of the traps should be sufficient to provide for strength and reliability of the trap. Traps should be designed with consideration to larger storm events and incorporate spillways and bypasses to prevent scouring and erosion of adjacent areas.

Sediment fencing will be a primary sediment control method used throughout the construction stage of the project. The following principles apply to the use of sediment fencing:

- sediment fence (refer SD 6-8) should be placed downslope of disturbed areas to help retain the coarser sediment fraction;
- sediment fences will have a return of 1 m upslope at intervals of approximately 20 m. Returns are installed to subdivide the catchment area of the sediment fence, to improve its effectiveness and help prevent structural damage during peak flows. The catchment area of each section of fence should be small enough to limit flow if concentrated at one point to less than 50 L/s in the 10-year ARI storm event;
- place sediment fence as close as possible to along the contour, to provide a maximum surface area to the passage of stormwater;
- sediment fences require regular maintenance, with captured sediment to be removed prior to it reaching a third of the height of the sediment fence. Place sediment extracted from maintenance in a suitable location to prevent further sedimentation; and
- sediment basins are a specific type of sediment trap comprising large earth dams designed to capture dirty water run-off and are the most effective of all sediment trapping devices. They may only be required at the larger construction sites such as the concrete batching plant and substation. A large sump or sediment basin should be considered upgradient of the sensitive creeklines of the adjacent National Park. Otherwise most of the work areas are relatively small and dispersed, and sediment control can be achieved using conventional sediment traps, without the use of sediment basins. Detailed design and sizing of sediment basins, where required, will be included in the Progressive ESCPs.

5.3.5 Pollution Control and Waste Management Measures

All fuels, oils and hazardous substances used onsite will be stored in appropriately bunded locations to prevent release to the environment. Bulk storage areas for fuels, oils and chemicals used during construction will be contained within an impervious bund to retain any spills of more than 110% of the volume of the largest container in the bunded area. Any spillage will be immediately contained and absorbed with a suitable absorbent material. Storage will comply with AS 1940- 2004 The Storage and Handling of Flammable and Combustible Liquids.

Spill clean-up kits will be in numerous, well-known locations throughout the site, and particularly within the precinct where the main infrastructure is proposed. Use of items within the spill kit will be demonstrated to all construction personnel. Spill kits should include floating booms in locations close to waterways (where relevant). Spill kits require regular maintenance to ensure that sufficient material is available in the event of a spill.

Material Safety Data Sheets (MSDS) will be available for all chemicals used on the site. All site personnel should be aware of the location of the MSDS.

Refuelling of equipment onsite or any other activity which could result in a spillage of a chemical, fuel or lubricant will be undertaken away from watercourses and stormwater drainage lines. In the event water is polluted by chemicals and/or firefighting materials (e.g., foams), the water will be collected, and disposed at an approved Liquid Waste Treatment Facility. A designated refuelling area should be established with drip trays installed and spill kits on stand-by. Should refuelling in the field be required, absorptive mats and drip trays are to be used in the refuelling process.

Bins will be available for the deposit of waste materials. Where possible, bins for recycling will be made available to facilitate separation and appropriate reuse or disposal of recyclable materials.

5.3.6 Site Rehabilitation

Most of the areas that will be disturbed will be stabilised by the placement of concrete or the construction of a hardstand surface. However, rehabilitation of distributed soil will still be required progressively on the site as different aspects of the project are completed. As some individual construction areas are completed, rehabilitation should be undertaken immediately to stabilise and effectively finalise areas to prevent erosion and sediment issues. Site stabilisation can be achieved by several measures including the following:

- vegetative cover;
- mulch;
- rock armouring;
- paving;
- concrete;
- geofabrics; and
- synthetic soil binders.

It is essential that all disturbed lands be stabilised to mitigate ongoing erosion problems and prevent sediment pollution of downstream lands and waterways. The preferred site stabilisation method will be identified on a site-by-site basis and included within the Progressive ESCPs. In most areas it is likely that revegetation to pasture grasses would be the preferred approach.

When selecting stabilisation methods, a key factor that will be considered is the form of water runoff over the stabilised area. Areas subject to concentrated flow (i.e., watercourses and drains) will require different stabilisation techniques to those subject to sheet flow.

In areas of sheet flow vegetation will generally be acceptable and the revegetation goal over much of the site will be to re-establish pasture grasses, to achieve a similar condition and pasture species composition to present so that the lands may continue to be used for grazing purposes.

Areas of concentrated flow can be subject to scouring velocities and periodic inundation that render vegetation establishment difficult or impossible. Therefore, measures like hard armouring, and use of geofabrics to assist vegetation establishment is often required. To determine appropriate stabilisation techniques in areas of concentrated flow peak flows will be calculated and stabilisation designed accordingly, by reference to guidelines such as Landcom (2004) that provide advice for acceptable velocities within vegetated channels. Particularly steep slopes may require protection in the form of hard armouring if it is considered unlikely that vegetation will become established or will become stressed and jeopardise the stability of the slope. This detail will be outlined in the Progressive ESCPs.

5.4 Specific Construction Activity Mitigation Measures

5.4.1 Pad Sites

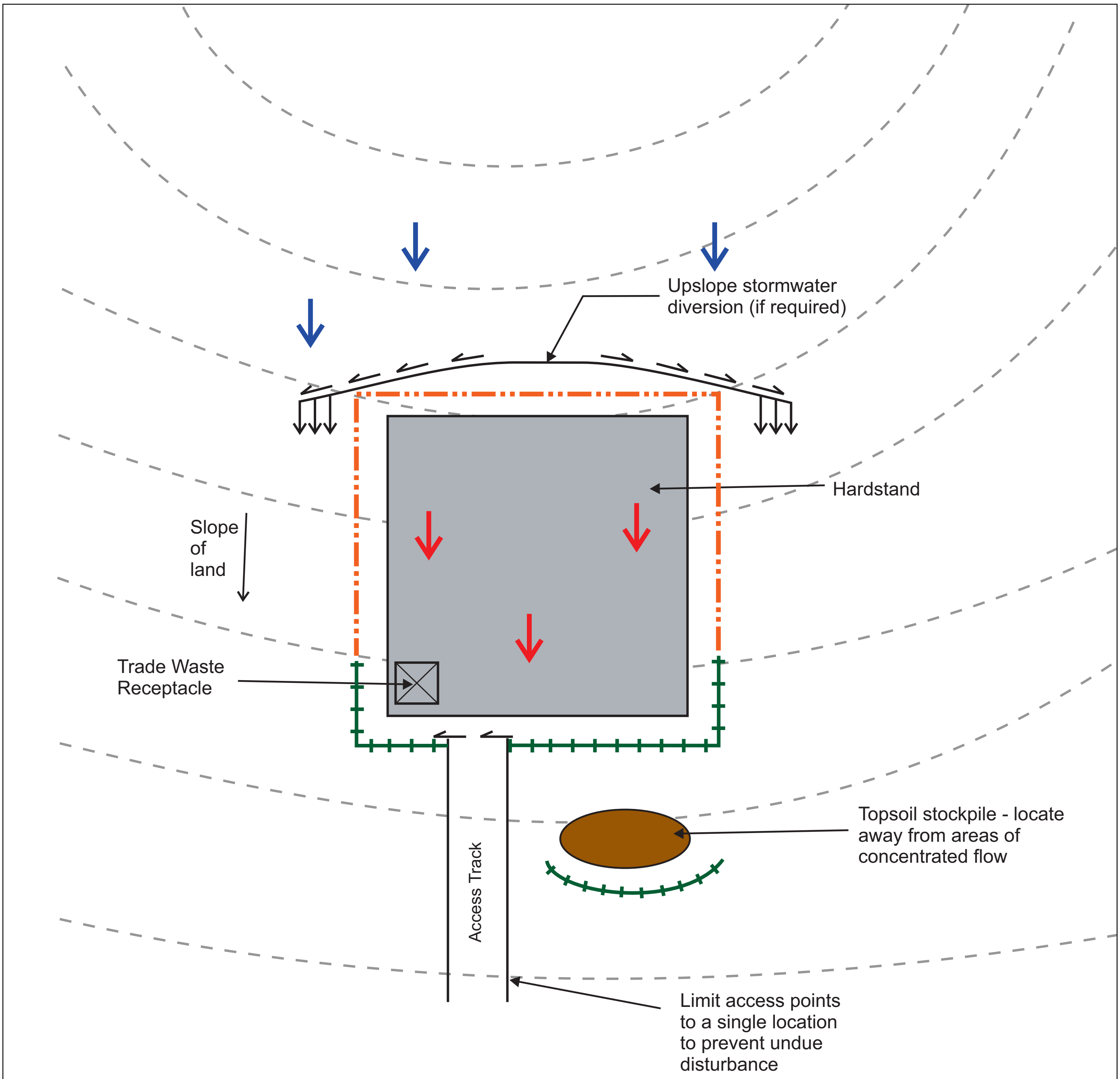
The term ‘hardstands’ is used to describe areas that may be cleared, levelled, and then stabilised with road base and aggregate, for example crane pads, the substation site, and the concrete batching plant. Hardstand sites should be established in accordance with Section 5.3.1.

A Generic Erosion Sediment Control Plan (ESCP) has been developed for the layout of a Hardstand site, refer to **Figure 5-1**.

5.4.2 Trenching

The turbines will be linked across the Project Area through a network of underground electricity and fibre optic cables that predominantly follow the internal access road network. The following management measures are relevant to trenching activities:

- minimise the land area to be disturbed;
- avoid trenching in locations of concentrated, permanent water flows;
- where possible utilise directional drilling techniques in areas of concentrated, permanent water flow;
- monitor weather and avoid opening trenches prior to forecast rainfall;
- fill trenches as soon as possible after opening – aim for three days from opening to closing trench;
- separate topsoil and subsoil during excavation and ensure that topsoil is replaced on the surface;
- manage topsoil resources to minimise the risk of erosion and sedimentation, and maximise reuse of topsoil during rehabilitation;
- in the event sodic soils are identified, soil testing at 0-30cm and 30-100cm will be undertaken during the geotechnical investigation phase or prior to construction to determine if ameliorants are to be added to soils to address fertility/soil chemistry issues;
- when trenching parallel to site contours (across grade), soil from the excavation should be placed and compacted on the uphill side of the trench to form an earth bank. This is to prevent clean stormwater entering the trench (where after it must be managed as “dirty” water) by directing stormwater around and away from the open trench. This measure may be avoided where trenches are expected to be open for less than 24 hours and where the likelihood of rain is low;
- when trenching perpendicular to contours use sandbag plugs or bulkheads to shorten the length of stormwater flow and consequent erosion in the trench; and
- progressively backfill trenches and rehabilitate as soon as possible. Leave backfilled trenches with a slightly elevated profile to allow for settlement, and to prevent the trenches from becoming a depression that can concentrate stormwater run-off, and potential erode the replaced soil.



Notes:

1. Monitor weather forecasts and avoid large ground disturbances prior to rain.
2. Install controls prior to disturbance.
3. Separate topsoil and subsoil during works.
4. Limit time of disturbance to minimum extent possible.
5. Progressively rehabilitate/stabilise as soon as possible.

Legend

- Earth Bank (refer to SD5-5)
- Level Spreader (refer to SD5-6)
- Sediment Fence (refer to SD6-8)
- Barrier Fence
- Topsoil Stockpile (refer to SD4-1)
- Clean Runoff
- Project Impacted Runoff
- Example Contours

Generic Erosion and Sediment Control Plan for Hardstand

F5.1

Drawing No: 0526676s_WWF_SW_G007_R0.cdr		Winterbourne Wind Farm
Date: 10/06/2022	Drawing size: A4	
Drawn by: VN	Reviewed by: MC	Client: WinterbourneWind P/L
Drawing Not to Scale	N	This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

ERM

An outline of the erosion and sediment control measures to be undertaken during trenching activities is also provided in **Appendix B** as Figure 6.1, Figure 6.2, and Figure 6.3 (reference numbers as per Landcom, 2004). The relevant Progressive ESCP will be developed following detailed design.

5.4.3 Dewatering

Water has the potential to collect in trenches, sediment traps and low-lying depressions in the construction areas following rainfall events. This water is likely to become contaminated with suspended sediment and will require management to ensure that downstream waterways are not polluted.

Dewatering can be undertaken such that water collected is reused on the site within water carts, for dust suppression on unsealed access roads and watering of rehabilitated areas. Discharging run-off directly to a natural waterway is not supported. Low volumes of water can be discharged through vegetated areas to encourage infiltration and settlement of entrained sediment. Vegetated areas act as a filter, assisting in the removal of sediment from the discharged water. Dewatering bags may also be used.

5.4.4 Unsealed Internal Access Roads

A network of unsealed roads will be developed throughout the Project Area to allow access to the turbines, batching plant, and other project infrastructure.

The focus of erosion and sediment control for unsealed roads will be on maintaining good stormwater drainage. The primary aim is to ensure that stormwater is readily shed from the road surface and, most importantly, is not allowed to track longitudinally along the road for any great distance. Onsite assessment and review of topographical mapping noted that proposed roads are located along ridgelines and in areas without large upslope catchments thus minimising the erosion hazard and drainage requirements.

The access tracks link to several public roads in the local road network. Mud tracking will be a risk in these locations and as such stabilised entry points will be required. Options may involve the sealing of the internal roads with bitumen for 50 m into the Project Area at confluence points with the public roads or the use of cattle grids and wheel washes, or a layer of crushed rock.

The following mitigation measures should also be considered during the planning and implementation phases of the access road construction:

- limit the clearing width to the minimum that is practicable;
- retain any cleared vegetation (i.e. as mulch and sheared timber) for use later in rehabilitation;
- strip and stockpile topsoil separately for use in rehabilitation;
- minimise cut and fill by constructing the road at-grade where ever possible;
- ensure the road surface has a cross-sectional grade to allow free surface drainage and avoid excessive ponding and concentration of flow in wheel ruts;
- employ outfall drainage where practicable to shed water over the downslope batter of the road, especially where the road alignment is generally parallel to the contours;
- where the road is positioned along a crest or ridge use a crowned road surface that sheds water to both sides;
- when grading roads, avoid the formation of windrows along the shoulders. These retain water on the road surface and increase erosion;
- where table drains are used, ensure these are properly stabilised and install regularly spaced mitre drains to discharge water from drains, releasing to well vegetated, stable areas;

- mitre drains shall be installed regularly to convey runoff from the road shoulders and any table drains to disposal areas away from the road alignment. Generally the maximum spacing between mitre drains should be 50 m, however this may be reduced in high erosion hazard areas (e.g. on steep slopes). Mitre drains should have a grade of no more than 5 %. They should discharge to areas that are well stabilised and free of obstructions (e.g. large rocks, tree trunks);
- cross-banks (or rollover banks) or cross-drains should be considered in suitable locations to shed water from the road surface, discharging water in well vegetated, stable areas. Cross-banks are earth banks that extend across the road roughly perpendicular to the road alignment. They contain a bank and upstream channel to direct run-off across the road surface, to prevent the concentration of run-off along the road surface and reduce runoff velocities, thereby reducing erosion. These measures are highly useful where roads are aligned acutely to or perpendicular to the contours over long distances; and
- stabilise road batters using a suitable combination of rolled erosion control products (RECPs) such as jute matting, mulching, spray-on stabilisation measures (e.g. hydromulching or bitumen emulsion) revegetation and hard armouring where required (e.g. within flow lines).

A recommended waterway crossing standard drawing (SD5-1) is provided in **Appendix B**.

5.4.5 Concrete Batching Plants

Establishment of the concrete batching plants will be like the establishment of all the hardstand sites and as such erosion and sediment controls are universal. However new water management issues arise during the operation of the plant due to the creation of runoff with entrained fine sediment and higher alkalinity runoff. The following mitigation measures are proposed during the operation of the concrete batching plants:

- separate stormwater collection and drainage systems will be provided to allow for discharge of clean stormwater (through a system designed to minimise local erosion) and collection and reuse of contaminated stormwater (through a first flush collection pit);
- a stormwater recycling system will be provided with capacity sufficient to store contaminated runoff generated by 20 mm rain within 24 hours, with operating management system to use collected wastewater as soon as possible (to maintain containment capacity);
- suitable washout locations will be provided for the placement of waste concrete and mortar slurries (either at the concrete batching plant or at individual works compounds, or both). These may comprise shallow excavations that are suitably bunded to prevent non-project impacted stormwater from entering the washout. Dried concrete will be disposed by an approved means;
- water within the washout will be encouraged to evaporate and/or infiltrate the soils;
- wet weather stormwater discharges will be monitored for pH and suspended solids;
- any excess contaminated waste water will be disposed of off-site by a licensed waste contractor; and
- the areas of the batching plants will be fully rehabilitated after the construction phase is completed.

5.5 Site Monitoring and Maintenance

Essential to an effective system of sediment control devices, is an adequate inspection, maintenance, and cleaning program. Inspections, particularly during storms, will show whether devices are operating effectively. Where a device proves inadequate, it should be quickly redesigned to make it effective.

Recommended Inspection Schedules will be developed in the Detailed Construction Soil and Water Management Plan following approval.

5.6 Compatibility with Other Land Uses

The Project Area has historically been used for agricultural purposes, noting land clearing of the area to allow for agricultural utility. The main land uses of the surrounding area are agriculture and tourism. Surrounding land uses are described in Section 4.2.

To understand compatibility with other land uses, identifying and assessing the potential for land use conflict to occur between neighbouring land uses is key. This process helps land managers and consent authorities assess the possibility for and potential level of future land use conflict.

In accordance with the Land Use Conflict Risk Assessment (LUCRA) Guide (DPI, 2011), a risk ranking matrix is used to rank the identified potential land use conflicts, by assessing the environmental, public health and amenity impacts according to both the ‘probability of occurrence’ and the ‘consequent of the impact’.

The risk ranking matrix yields a rank from 1 to 25. A rank of 25 is the highest magnitude of risk (aka. an almost certain and severe risk) while a rank of 1 represents the lowest (aka. a rare and negligible risk). Each activity associated with the Project has been assigned an initial risk ranking determined through the risk ranking matrix.

Activities which score a risk ranking of 10 or lower are considered a low risk for conflict to arise and subsequently do not need further management to reduce their potential impact. However, for activities that were identified to have a risk ranking above 10, the LUCRA is designed to define controls through various management strategies to reduce the risk for conflict.

To lower the risk values of activities associated with the proposed development, relevant risk reduction controls are identified for each identified potential conflict as management strategies. Consideration is given to lower both the probability and the negative consequences. The risk reduction controls will allow a revision of the risk level based on the implementation of the management strategies. The objective is to identify and define controls that lower the risk ranking score to 10 or below.

In this way, management strategies are developed to minimise such effects or potential for land use conflict to arise. For each of the management strategies, performance targets and monitoring requirements are identified.

This LUCRA process has identified and assessed the potential for activities associated with the Project to potentially cause land use conflict. The management strategies listed in Table 5-1 provide plans to reduce identified potential conflict items that originally received a Risk Rating above 10. To ensure these management strategies are successfully implemented, performance monitoring is an important ongoing tool throughout the construction and operation stages of the Project. Performance targets are outlined below in **Table 5-1**.

Table 5-1 Management Strategy

Identified Potential Conflict	Original Risk Ranking (ORR)	Management Strategy (Method of Control)	Revised Risk Ranking (RRR)	Performance Target
Adjacent Land Use Activities	Probability: B Consequence: 3 ORR: 17	■ Consideration of neighbouring activities will be taken during the preparation of the Environment Management Strategy (EMS). ■ Onsite dust suppression will be adopted to minimise the potential of dust dispersion generated from the Project impacting upon neighbouring land. ■ Conversely, adjacent land uses are not anticipated to significantly impact upon the operation and functionality of the Project.	Probability: D Consequence: 5 RRR: 2	Comply with Conditions of Approval (CoA) and Environment Protection Licence (EPL); and Management measures in EMS
Soil Erosion	Probability: B Consequence: 3 ORR: 17	■ The Soils and Water Assessment has assessed the impacts of construction and operation for the Project and provided mitigation measures. ■ Soil erosion measures will be implemented during construction and operation in accordance with the EMS.	Probability: C Consequence: 5 RRR: 4	Comply with Conditions of Approval (CoA) and Environment Protection Licence (EPL); and Management measures in EMS, Soil and Water Management Plan (SWMP), and Erosion and Sediment Control Plan (ESCP)
Water	Probability: D Consequence: 3 ORR: 9	■ The Soils and Water Assessment has assessed the impacts of construction and operation for the Project and provided mitigation measures. ■ Water management measures will be implemented during construction and operation in accordance with the EMS.	Probability: D Consequence: 5 RRR: 2	Comply with Conditions of Approval (CoA) and Environment Protection Licence (EPL); and Management measures in EMS, SWMP and ESCP.
Noise	Probability: A Consequence: 3 ORR: 20	■ The Noise and Vibration Impact Assessment has assessed the noise impacts of construction and operation for the Project and provided mitigation measures, as outlined in Section 7 and Appendix G of the EIS. ■ Construction activities will be limited to working hours: – Monday to Saturday, 7am to 6pm – No construction work is to take place on Sundays or public holidays. ■ Construction noise management and mitigation will be addressed in the EMS.	Probability: D Consequence: 4 RRR: 5	Comply with Conditions of Approval (CoA) and Environment Protection Licence (EPL); and Management measures EMS and Noise Management sub-plan

Identified Potential Conflict	Original Risk Ranking (ORR)	Management Strategy (Method of Control)	Revised Risk Ranking (RRR)	Performance Target
Visual	Probability: A Consequence: 3 ORR: 20	■ The Visual Impact Assessment has considered the visibility of Project infrastructure and has provided mitigation measures as outlined in Section 8 and Appendix H of the EIS.	Probability: C Consequence: 4 RRR: 8	Successful implementation of landscape management measures, and Monitoring of landscaping management measures will be monitored in accordance with the EMS.
Aviation	Probability: E Consequence: 1 ORR: 15	■ Aviation safety impacts are assessed in the Aviation Impact Assessment. ■ To accommodate the WTGs at 230 m AGL, air route W128 LSALT should be increased by 200 ft from 5,900 ft to 6,100 ft AMSL. ■ Recommendations and mitigation measures, as detailed in the AIA, are outlined in Section 10.1 and Appendix J of the EIS.	Probability: E Consequence: 4 RRR: 3	Successful implementation of aviation mitigation measures.
Bushfire	Probability: C Consequence: 2 ORR: 18	■ Implementation of a Bushfire Emergency Management and Operational Plan will significantly reduce the potential for a bushfire arising during operation of the wind farm, and to reduce the threat of damaging Project assets.	Probability: D Consequence: 4 RRR: 5	Implementation of mitigation measures through the EMS and Bushfire Emergency Management and Operational Plan. .
Air Quality	Probability: B Consequence: 3 ORR: 17	■ Dust generated during the construction and decommissioning stages of the Project are to be managed using dust suppression as required. ■ During operation, dust is not expected to generate a significant potential conflict, however this will be managed in accordance with the EMS.	Probability: C Consequence: 5 RRR: 4	Comply with Conditions of Approval (CoA) and Environment Protection Licence (EPL); and Management measures in the EMS.

6. MITIGATION MEASURES

6.1 Project Mitigation Management

The following measures will be implemented to address potential soil and water impacts:

- prepare a detailed Soil and Water Management Plan (SWMP) prior to construction commencing. The SWMP should be prepared by a suitably qualified person, such as a soil conservationist;
- prepare Progressive Erosion and Sediment Control Plans within the SWMP as the Project progresses to address management requirements at individual work sites;
- design and construct the Project to minimise land disturbance and therefore reduce the erosion hazard;
- stage construction activities to minimise the duration and extent of land disturbance;
- manage topsoil resources to minimise the risk of erosion and sedimentation, and maximise reuse of topsoil during rehabilitation;
- divert upslope (clean) stormwater around the disturbed sites and capture sediment-laden run-off from within the disturbed site for diversion to sediment control devices;
- rehabilitate the site promptly and progressively as works progress;
- inspect and maintain erosion and sediment control devices for the duration of the Project construction stage;
- avoid land disturbance beyond that identified in the assessment within 20 m of minor streams (first and second order watercourses) and 40 m of third order or higher watercourses;
- ensure appropriate procedures are in place for the transport, storage and handling of fuels, oils, and other hazardous substances, including availability of spill clean-up kits;
- construct required access tracks at any early stage to minimises disturbance during construction;
- obtain all necessary water access licences; and
- ensure appropriate stormwater, collection, treatment, and recycling at the concrete batch plant, in accordance with good practice and any requirements of the NSW Environmental Protection Authority.

6.2 Runoff Management

Changes to the catchment runoff characteristics due to project activities primarily relate to upgrading existing access tracks and replacing open vegetated ground cover with hardstand (all weather) access tracks, crane pads and turbine footings as well as construction of sealed areas for the O&M building and a mix of sealed and gravel areas within the BESS and substation.

6.2.1 Construction

Mitigation measures in addition to those recommended in Section 6.1.

- the drainage design for hardstand and access track infrastructure will aim to direct runoff from all hardstands and access tracks to appropriate sediment control facilities such as sediment basins, grassed filter strips or swales to trap sediments and filtered off before being discharged (to appropriate vegetated areas or drainage lines);
- installation of geotextile silt fences (with sedimentation basins where appropriate) on all drainage lines from the site which are likely to receive runoff from disturbed areas;
- installation of appropriate sediment traps or sediment ponds near waterways to contain surface water contaminated with sediment runoff entering the waterway;

- procedures to ensure that steep batters are treated appropriately for sediment control;
- a process for overland flow management to prevent the concentration and diversion of water onto steep or erosion prone areas; and
- thorough visual inspections following significant rain events with a requirement for immediate remediation of localised erosion caused by runoff (within specified response times).

'Dirty' runoff from disturbed areas will be graded away where possible from the adjacent National Park catchments to collection drains that convey flows via outlet water quality controls. Where it is not possible to grade away, runoff from fill batters facing towards the National Park can be retained as sheet flows utilising vegetated filter strips or concentrated in collection drains diverted either via culverts beneath the access tracks to join the drainage network or to enhanced sediment controls prior to release.

The separation of 'clean' and 'dirty' runoff is the first principle of best management practices in erosion and sediment control and minimises flows to be subject to water quality controls and will be implemented throughout the Project.

Mitigation measures will be included in site specific Erosion and Sediment Control Plans developed by a suitably qualified person.

6.3 Operation

Runoff from Project infrastructure will be at a higher velocity with less infiltration compared to existing conditions. However, this will be somewhat offset by the capture of runoff in rainwater tanks at the O&M building to provide supply for amenities and use of controls such as grass swales with regular rock checks in access track and other constructed drainage lines, and level spreaders onto naturally vegetated areas at flow outlets to reduce velocities and encourage infiltration.

Engineered designed and constructed hardstand areas graded to perimeter drains have minimal available fine materials on surfaces and limited potential to erode and hence the potential to generate sediment. Erosion risk is primarily during construction when working on disturbed surfaces and constructing cut and fill batters prior to completion of permanent stabilising works. Erosion risk also continues after construction in concentrated flow paths such as access track drainage lines, however these can be managed using appropriate controls as noted above.

6.4 Sensitive Areas Mitigation Measures

The Oxley Wild Rivers National Park is located adjacent to the Project Area, immediately to the east. Additional considerations to ensure activities associated with the Project do not impact on the integrity of the National Park are required. The primary risk to impact upon the "sensitive location" is associated with runoff and sediment deposits.

Suitable measures can be effectively implemented to mitigate impacts associated with the identified sensitive location in the adjacent National Park. Measures are to be included in the progressive ESCP to either;

- direct disturbed runoff away from the catchment areas that flow directly to the National Park, or
- process runoff through additional sediment controls (e.g., sumps and/or sediment basins) and discharge at a low, non-erosive velocity.

These measures are to be included in any environmental management plans to be implemented across the site, to protect the identified sensitive locations.

7. CONCLUSION

This Soils and Water Assessment identifies soil and water constraints related to the Project. Overall constraints are relatively minor due to the moderate erosion hazard over most of the Project Area to be impacted by construction. A standard suite of erosion and sediment controls may be adopted in most areas.

Review of groundwater wells within the Project Area identifies that the groundwater aquifer occurs at depths greater than would be intercepted by earthworks associated with the Project construction.

Water supply options are available to meet the needs of the construction phase. The four viable options available to source the estimated 113 ML of water required for construction include:

- Council water supply (or treated wastewater), in agreement with the relevant Council(s);
- extraction of water collected from existing (or new) dams using landowner harvestable rights or from an existing nearby landowner bore, in agreement to use their allocation;
- extraction from a new groundwater bore, which will require a WAL in consultation with WaterNSW; and
- extraction from a surface water source (e.g., Aspley River or nearby dams), which will require a WAL in consultation with WaterNSW.

Water access licencing requirements will be confirmed in consultation with WaterNSW, and all required licences obtained once the preferred option has been determined.

The Project Area is in the Macleay River Catchment, primarily within the catchment of the Apsley River. There are numerous first order and second order unnamed tributaries located across the Project Area; however, these are generally ephemeral gullies and are characteristic of the ridgeline topography. There are 14 named tributaries classified as Strahler third order or above within the Project Area. The Project will include new and enhanced creek crossings, including specific management measures, which will mitigate sediment impacts and water quality.

Several mitigation measures are proposed for the Project to address potential soil and water impacts, including the preparation of progressive ESCP's to address management requirements at individual work sites. A detailed Soil and Water Management Plan should also be prepared for the project prior to construction commencing that incorporates the measures identified within this assessment.

8. REFERENCES

DPI Water. (2019). *Water Sharing Plan for the Macleay Unregulated and Alluvial Water Sources.*

Landcom. (2004). Managing Urban Stormwater: Soils and construction (Blue Book) - Volume 1, 4th Edition. NSW Government. Retrieved from https://www.environment.nsw.gov.au/research-and-publications/publications-search/managing-urban-stormwater-soils-and-construction-volume-1-4th-editon.

NSW National Parks and Wildlife Service (2003) *The Bioregions of New South Wales: their biodiversity, conservation and history*, NSW National Parks and Wildlife Service, Sydney.

NSW Office of Environment & Heritage (OEH). (2016c). *NSW – The Bioregional Landscape*: Retrieved from http://www.environment.nsw.gov.au/bioregions/BioregionsNswoutlineLandscape.htm

Office of Environment and Heritage (2012) *The land and soil capability assessment scheme – a general rural land evaluation system for New South Wales*, NSW Office of Environment and Heritage, Sydney

Office of Environment and Heritage (2017) *Australian Soil Classification (ASC) Soil Type map of NSW*, NSW Office of Environment and Heritage, Sydney

Office of Environment and Heritage (2017) *Land and Soil Capability Mapping for NSW*, NSW Office of Environment and Heritage, Sydney.

Office of Environment and Heritage (2017) *Hydrologic Groups of Soils in NSW*, NSW Office of Environment and Heritage, Sydney.

APPENDIX A EROSION HAZARD ASSESSMENT

A.1 REVISED UNIVERSAL SOIL LOSS EQUATION

Managing Urban Stormwater: Soils and Construction, Volume 1 (Landcom 2004) describes a method for assessing erosion hazard using the revised universal soil loss equation (RUSLE). The RUSLE is designed to predict the long term, average, annual soil loss from sheet and rill erosion at nominated sites under specified management conditions. It is used to assess erosion hazard at construction sites and estimate sediment flux to sediment traps.

The RUSLE equation is represented by:

A = R K LS P C

where,

A = computed soil loss (tonnes/ha/yr)

R = rainfall erosivity factor

K = soil erodibility factor

LS = slope length/gradient factor

P = erosion control practice factor

C = ground cover and management factor.

R-Factor

The rainfall erosivity factor, *R*, is a measure of the ability of rainfall to cause erosion. It is the product of two components; total energy (E) and maximum 30-minute intensity for each storm (I_{30}). Rosewell and Turner (1992) identified a strong correlation between the R-factor and the 2-year ARI, 6-hour storm event (denoted S) and proposed the following equation:

$R = 164.74\ (1.1177)^{S}\ S^{0.6444}$

Where S = 8.275 mm/h (at the Project Area, from IFD chart plus 25% due localised topographical factors)

Using the above, at the Project Area **R = 1,620.**

K-Factor

The soil erodibility factor, K, is a measure of the susceptibility of soil particles to detachment and transport by rainfall and run-off. Texture is the principal component affecting K, but structure, organic matter and permeability also contribute. In the RUSLE, it is a quantitative value that is normally experimentally determined.

Soil K-factor data was estimated with reference to the soil descriptions and modelled erosion characteristics data of the Project Area using eSPADE NSW (OEH, 2012) and Figure A3 of Landcom (2004). Review of all the soil landscapes and the erodibility of the topsoil and subsoils allowed for the conservative estimate of the average erodibility to be high and thus a conservative estimate for the K-factor of 0.06 is considered appropriate. Generally, K-factor ranges from 0.005 (very low) to 0.075 (very high) (Landcom 2004).

Therefore, **K = 0.06**.

LS-Factor

The slope length-gradient factor, LS, describes the combined effect of slope length and slope gradient on soil loss. It is the ratio of soil loss per unit area at any site to the corresponding loss from a specific experimental plot of known length and gradient. The LS factor can be read from Table AI in Landcom (2004). It should be noted that an increase in slope gradient has a proportionately greater effect on LS, compared with an increase in slope length.

The Project Area has variable gradients including some areas with slopes up to about 15 % (and in some areas higher), but in the turbine locations is commonly only gently sloping with gradients less than 10%. Slope lengths in disturbed areas would be typically less than 80 m. Under the combination of 80 m slope length and 10 % gradient the **LS Factor is 2.81**. On gentler slopes the combination of 80 m slope length and 5 % gradient the **LS Factor is 1.19**. On steeper slopes it is assumed that slope lengths would be kept shorter using appropriate stormwater controls. However, a more conservative assumption of is used with 80 m slope length and 15 % gradient the **LS Factor is 5.065**.

P-Factor

The erosion control practice factor, P, is the ratio of soil loss with a nominated surface condition ploughed up and down the slope. It is reduced by practices that reduce both the velocity of run-off and the tendency of run-off to flow directly downhill. At construction and mining sites, it reflects the roughening or smoothing of the soil surface by machinery. The **P-factor used here is 1.3** that is normally assigned to compacted construction sites.

C-Factor

The cover factor, C, is the ratio of soil loss from land under specified crop or mulch conditions to the corresponding loss from continuously tilled, bare soil. The most effective method of reducing the C-factor is maintenance, or formation of a good ground cover. The best practices are those that reduce both the amount of soil exposed to raindrop impact and the erosive effects of run-off.

The C-factor assigned here during construction operations is 1.0, typical of that for bare, compacted soil. Table A3 in Landcom (2004) provides estimated C-factors for various cover types. It is worth noting that the C-factor is the factor that can be most readily manipulated to affect a change in erosion hazard. For example, changing the soil surface from a condition of bare, compacted earth (C = 1.0) to one with 70% cover of grasses (C = 0.05) leads to a proportionate reduction in soil loss, i.e., 20 times lower erosion hazard. Other temporary erosion controls such as use of chemical soil binders also significantly reduce the C-Factor and hence the use of 1.0 is worst case.

C-Factor = 1.0

A.2 PREDICTED SOIL LOSS

A = R K LS P C

where,

R = 1,620

K = 0.06

LS = 2.81

P = 1.3

C = 1.0

Therefore, A = 355 tonnes per hectare per year.

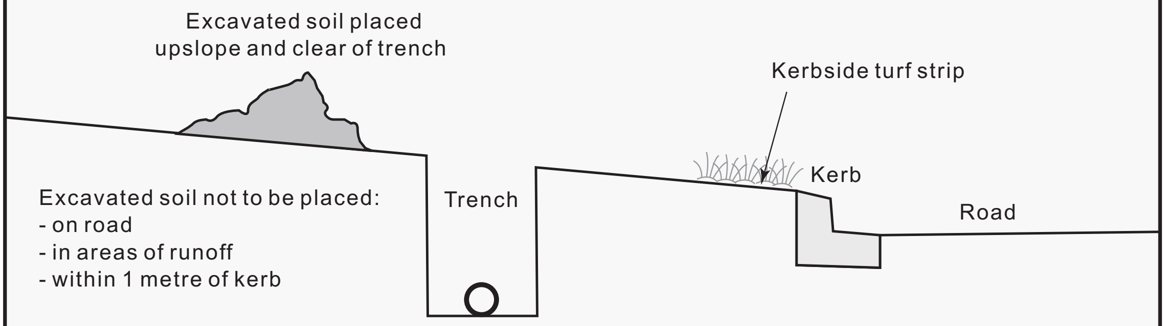
Using the RUSLE, using this worst-case scenario the predicted annual soil loss is 355 tonnes/hectare/year under the combination of 80 m slope length and 10 % gradient. This is Soil Loss Class 4 (351 to 500 tonnes/ha/yr) which is rated moderate (refer Table 4.2 in Landcom 2004).

A sensitivity analysis based on the combinations of 80 m slope length and 5 % gradient; 80 m slope and 15% gradient; predicted annual soil loss of 150 tonnes/hectare/year - Soil Loss Class 1 (very low); and 640 tonnes/hectare/year - Soil Class 5 (high), respectively.

Based on this assessment, it is concluded that the overall site erosion hazard will vary across the site. The majority of the Development Footprint has been assessed as moderate erosion hazard class, with gentler slopes in the low erosion hazard class and steeper areas in the high erosion hazard class. Consequently, a standard suite of erosion and sediment controls may be widely employed. Specialised techniques using enhanced control measures will be required in high hazard areas, such as steep slopes and areas of concentrated flow.

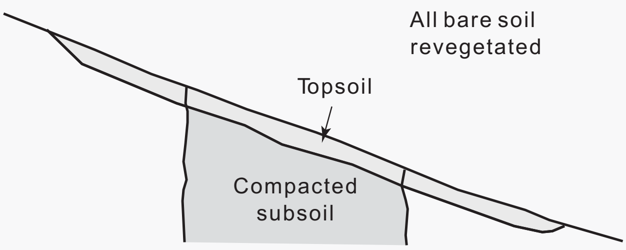
APPENDIX B STANDARD DRAWINGS

When excavating trench...

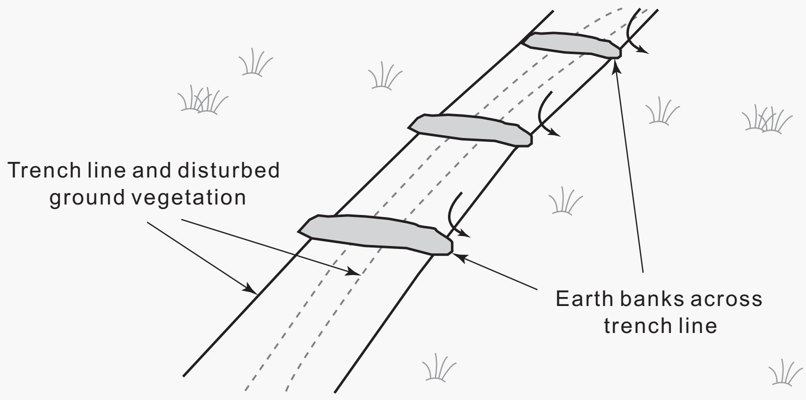


When backfilling trench...

Trench backfilled, compacted to 95 per cent standard compaction, topsoiled, levelled and topped up as necessary should subsidence occur



On steep and/or long sections of trench...



Construction notes for figure 6.1

1. Do not open any trench unless it is likely to be closed in three days
2. Place excavated material up-slope of the trench
3. Stockpile topsoil separately from subsoil
4. Divert runoff from the line of the cut with diversions as directed by SD 5-2
5. Rehabilitate in accordance with specification

Figure 6.1 Erosion and sediment control during trenching activities

Source: Managing Urban Stormwater: Soils and Construction - Volume 2A Installation of Services

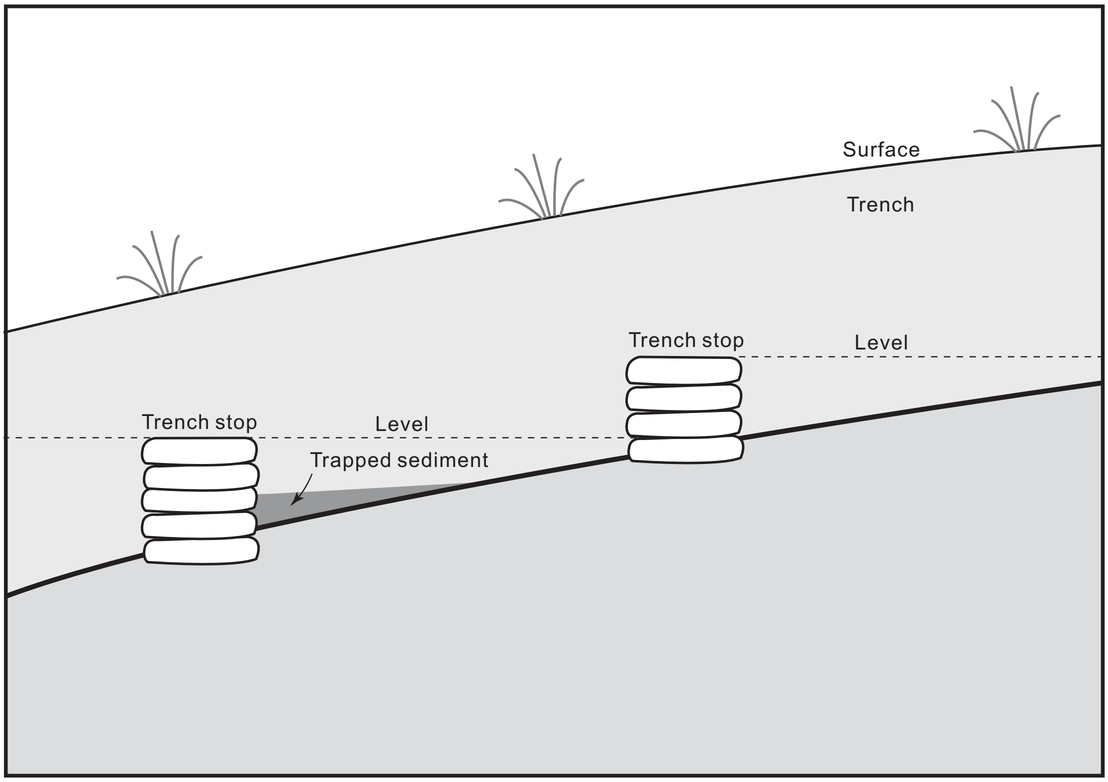


Figure 6.2 Typical trench stop detail

Source: Managing Urban Stormwater: Soils and Construction - Volume 2A Installation of Services

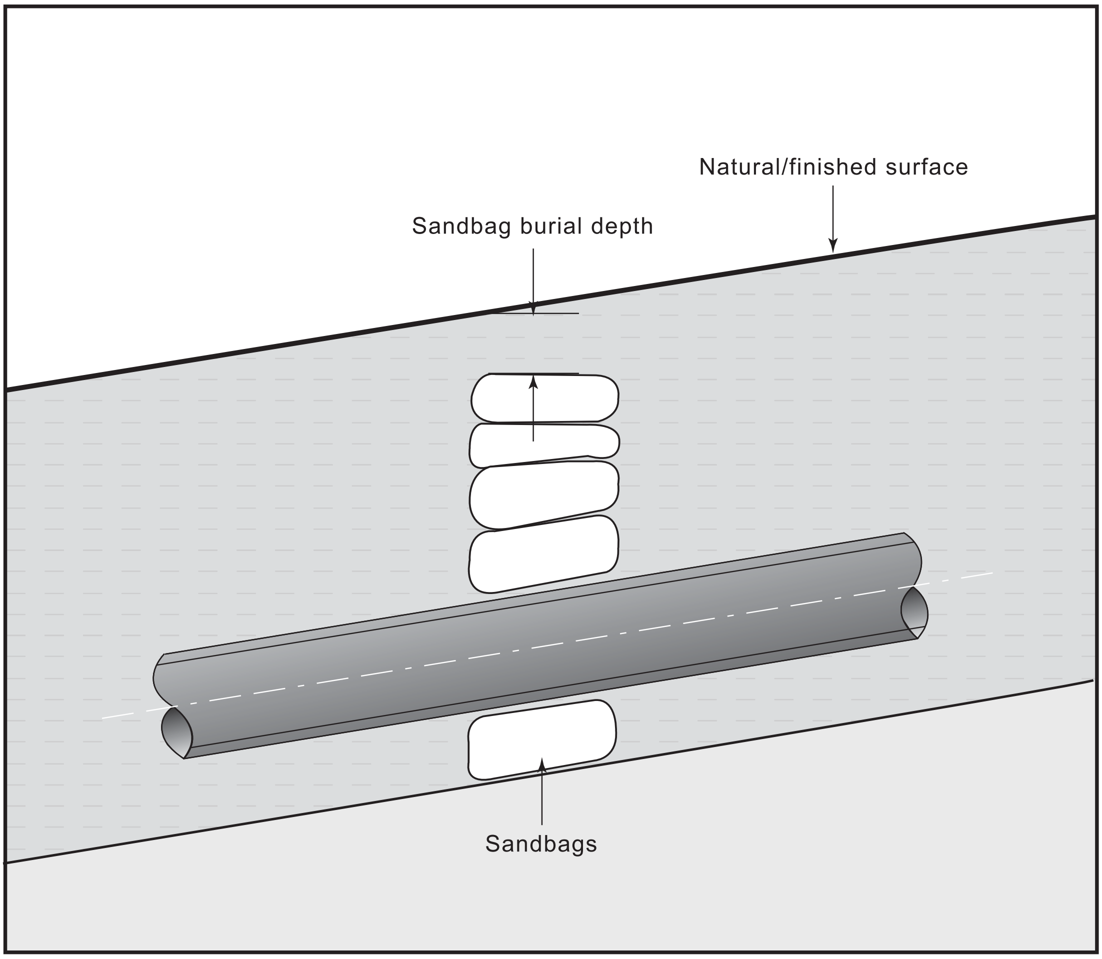
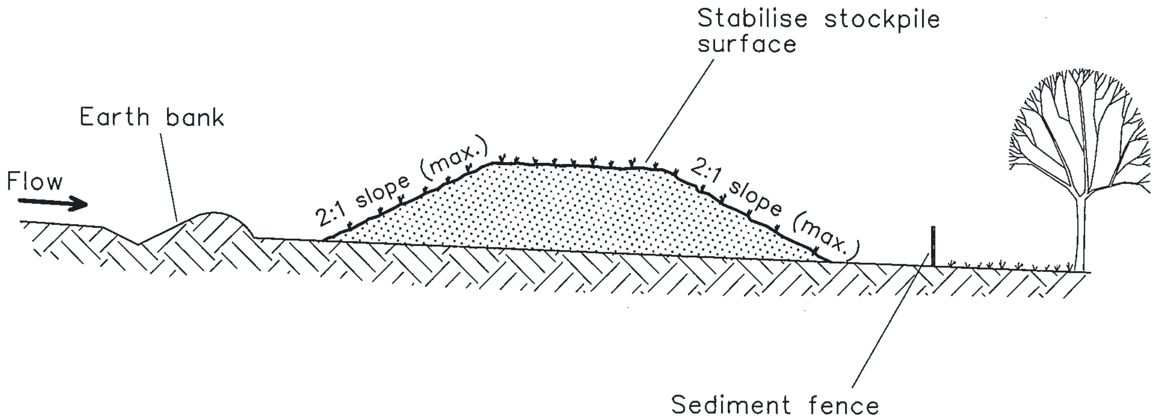


Figure 6.3 Detail of typical seepage collar or bulkhead

Source: Managing Urban Stormwater: Soils and Construction - Volume 2A Installation of Services

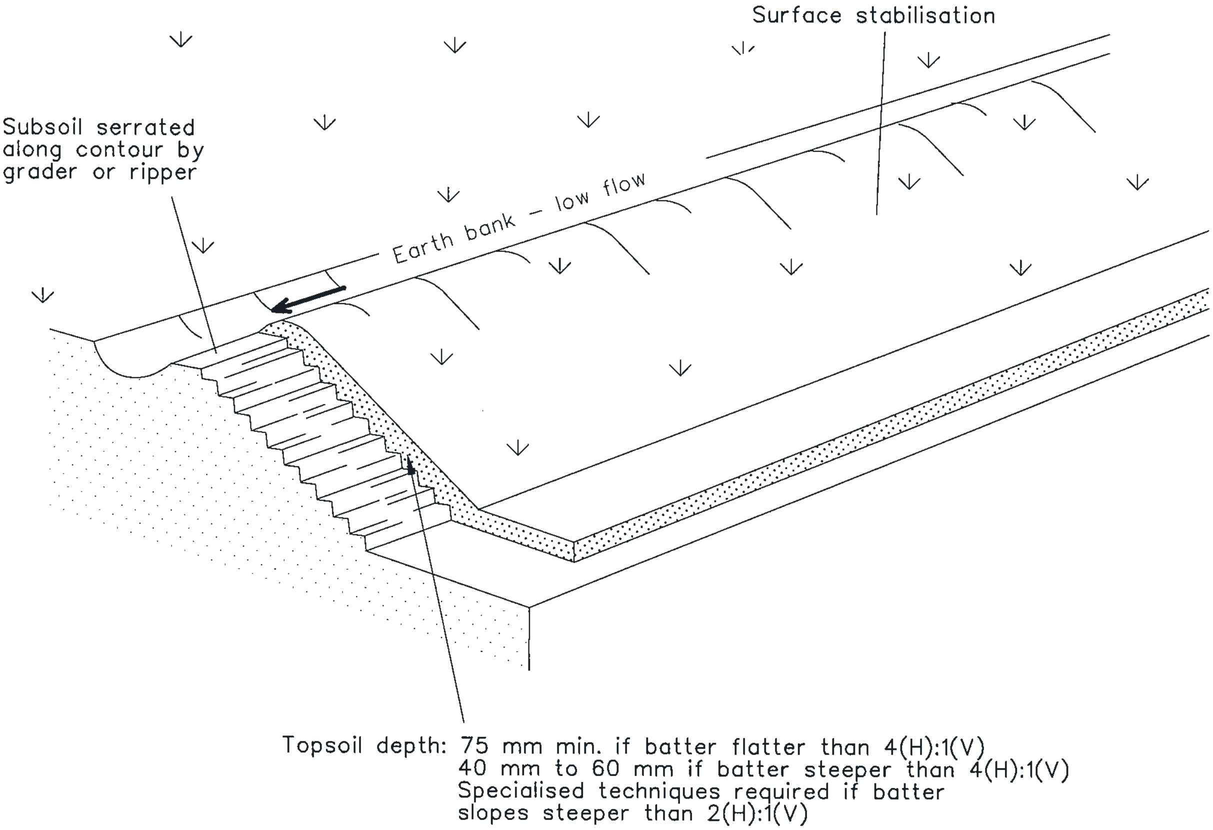


Construction Notes

1. Place stockpiles more than 2 (preferably 5) metres from existing vegetation, concentrated water flow, roads and hazard areas.
2. Construct on the contour as low, flat, elongated mounds.
3. Where there is sufficient area, topsoil stockpiles shall be less than 2 metres in height.
4. Where they are to be in place for more than 10 days, stabilise following the approved ESCP or SWMP to reduce the C-factor to less than 0.10.
5. Construct earth banks (Standard Drawing 5-5) on the upslope side to divert water around stockpiles and sediment fences (Standard Drawing 6-8) 1 to 2 metres downslope.

STOCKPILES **SD 4-1**

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)

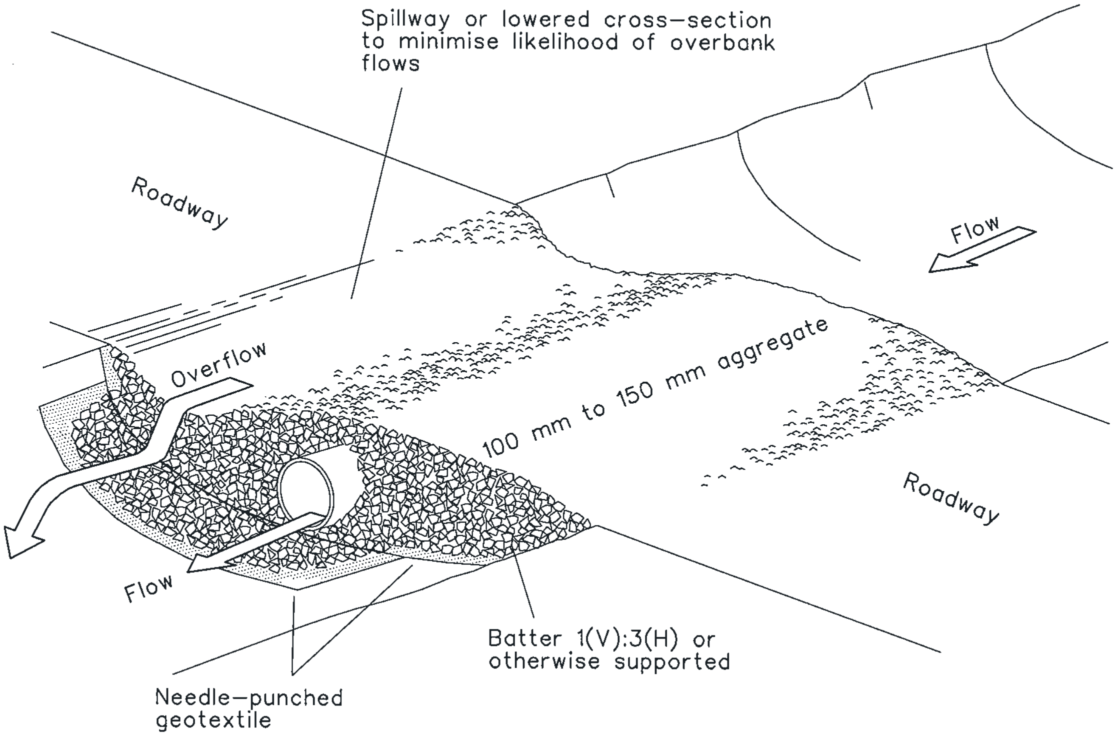


Construction Notes

1. Scarify the ground surface along the line of the contour to a depth of 50 mm to 100 mm to break up any hardsetting surfaces and to provide a good bond between the respread material and subsoil.
2. Add soil ameliorants as required by the ESCP or SWMP.
3. Rip to a depth of 300 mm if compacted layers occur.
4. Where possible, replace topsoil to a depth of 40 to 60 mm on lands where the slope exceeds 4(H):1(V) and to at least 75 mm on lower gradients.

REPLACING TOPSOIL **SD 4-2**

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)

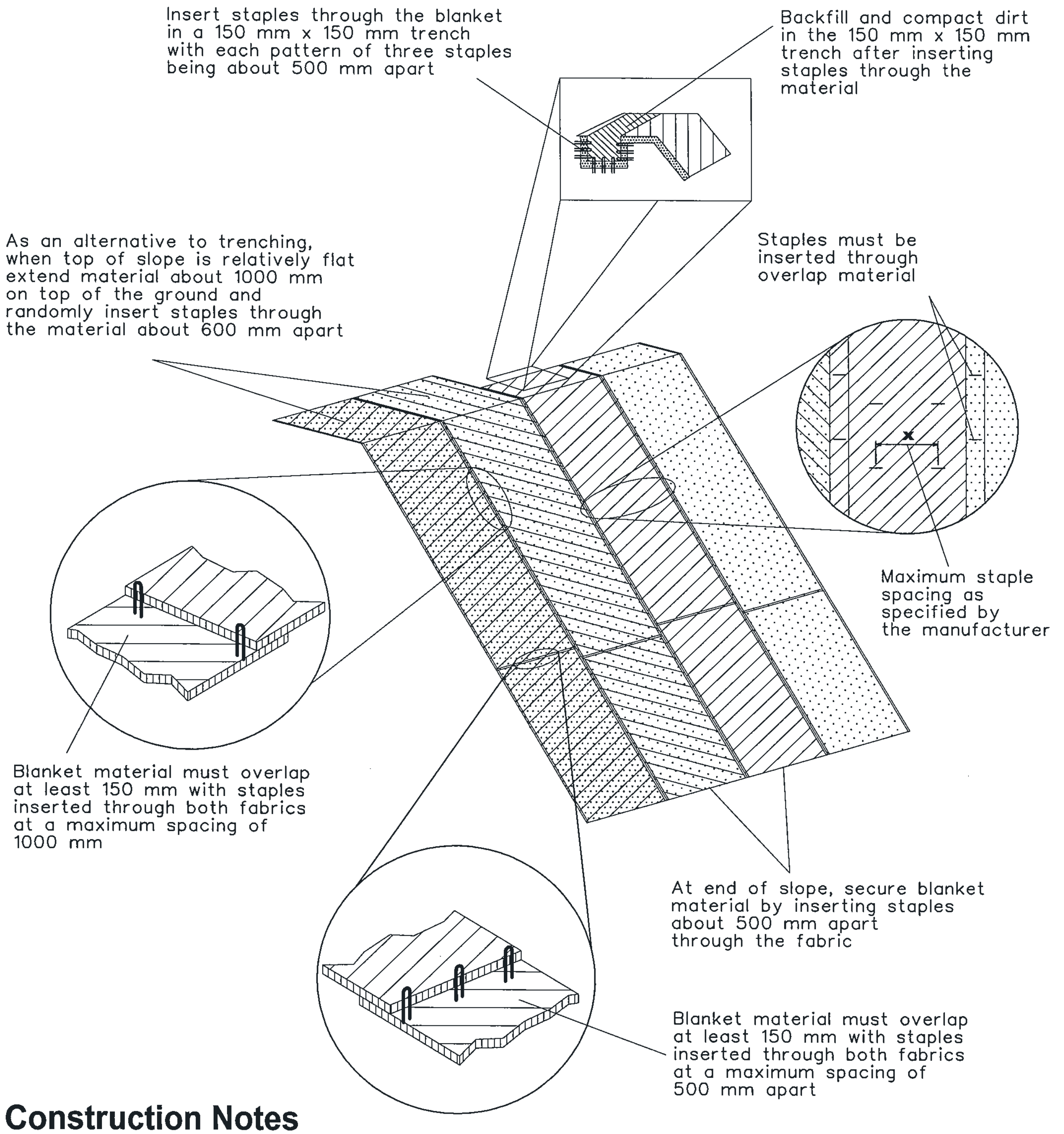


Construction Notes

1. Prohibit all traffic until the access way is constructed.
2. Strip any topsoil and place a needle-punched textile over the base of the crossing.
3. Place clean, rigid, non polluting aggregate or gravel in the 100 mm to 150 mm size class over the fabric to a minimum depth of 200 mm.
4. Provide a 3-metre wide carriageway with sufficient length of culvert pipe to allow less than a 3(H): 1 (V) slope on side batters.
5. Install a lower section to act as an emergency spillway in greater than design storm events.
6. Ensure that culvert outlets extend beyond the toe of fill embankments.

TEMPORARY WATERWAY CROSSING **SD 5-1**

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)



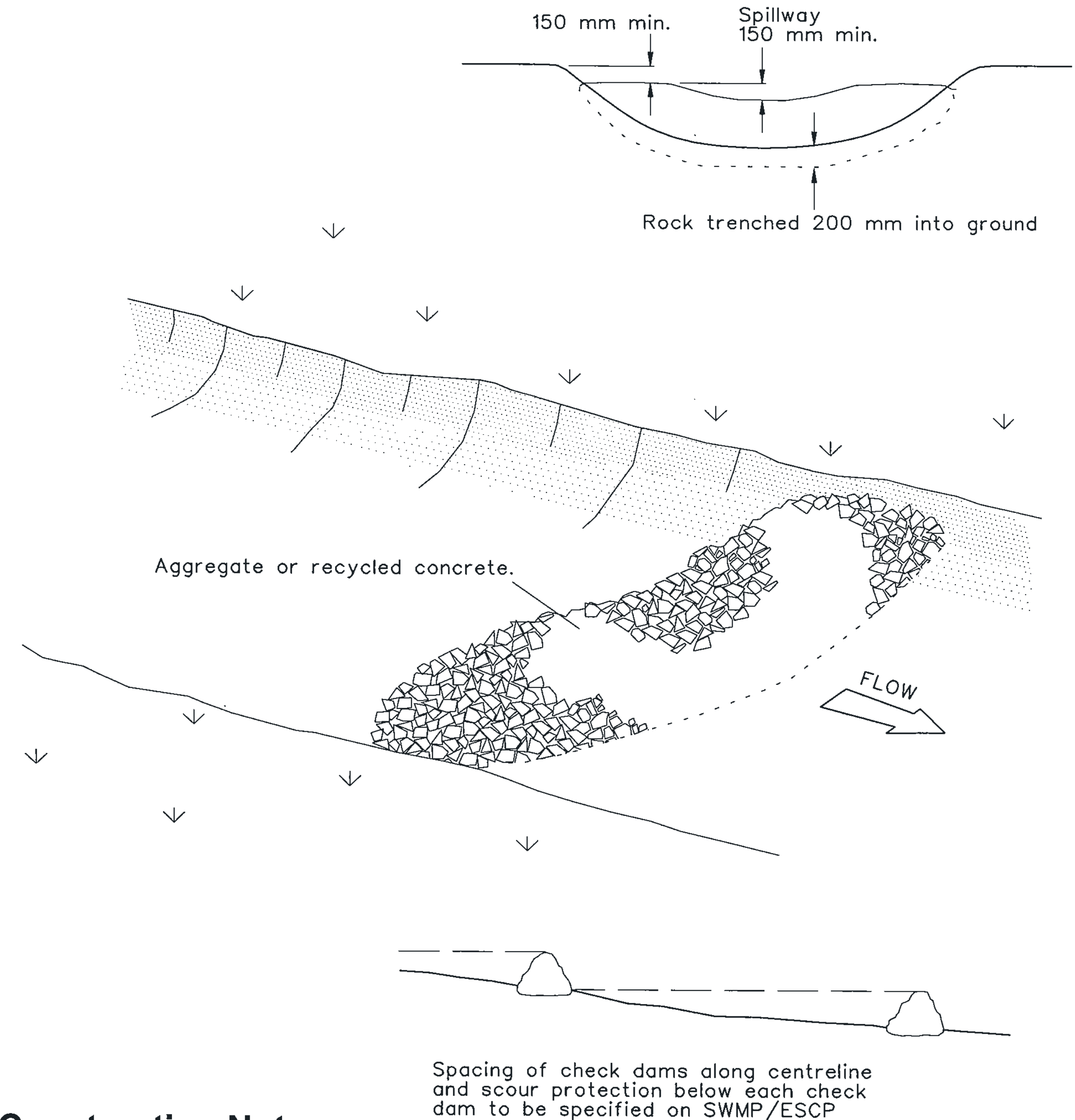
Construction Notes

1. Remove any rocks, clods, sticks or grass from the ground surface before laying the matting.
2. Spread topsoil to at least 75 mm depth.
3. Where appropriate, complete fertilising and seeding on a properly prepared seedbed (Standard Drawing 7-1) before laying the matting.
4. Ensure the fabric can be continuously in contact with the soil by grading the surface carefully first.
5. Lay the matting in "shingle-fashion" with the ends of each upstream roll overlapping the next roll downslope.
6. Ensure sufficient staples are used to maintain a good contact between the soil and the matting.

RECP : SHEET FLOW

SD 5-2

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)



Construction Notes

1. Check dams can be built with various materials, including rocks, logs, sandbags and straw bales. The maintenance program should ensure their integrity is retained, especially where constructed with straw bales. In the case of bales, this might require their replacement each two to four months.

2. Trench the check dam 200 mm into the ground across its whole width. Where rock is used, fill the trenches to at least 100 mm above the ground surface to reduce the risk of undercutting.

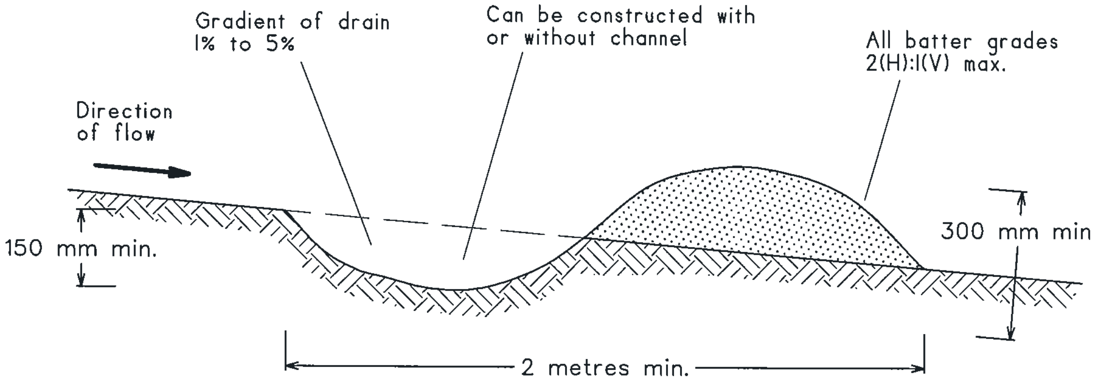
3. Normally, their maximum height should not exceed 600 mm above the gully floor. The centre should act as a spillway, being at least 150 mm lower than the outer edges.

4. Space the dams so the toe of the upstream dam is level with the spillway of the next downstream dam.

ROCK CHECK DAM

SD 5-4

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)



NOTE: Only to be used as temporary bank where maximum upslope length is 80 metres.

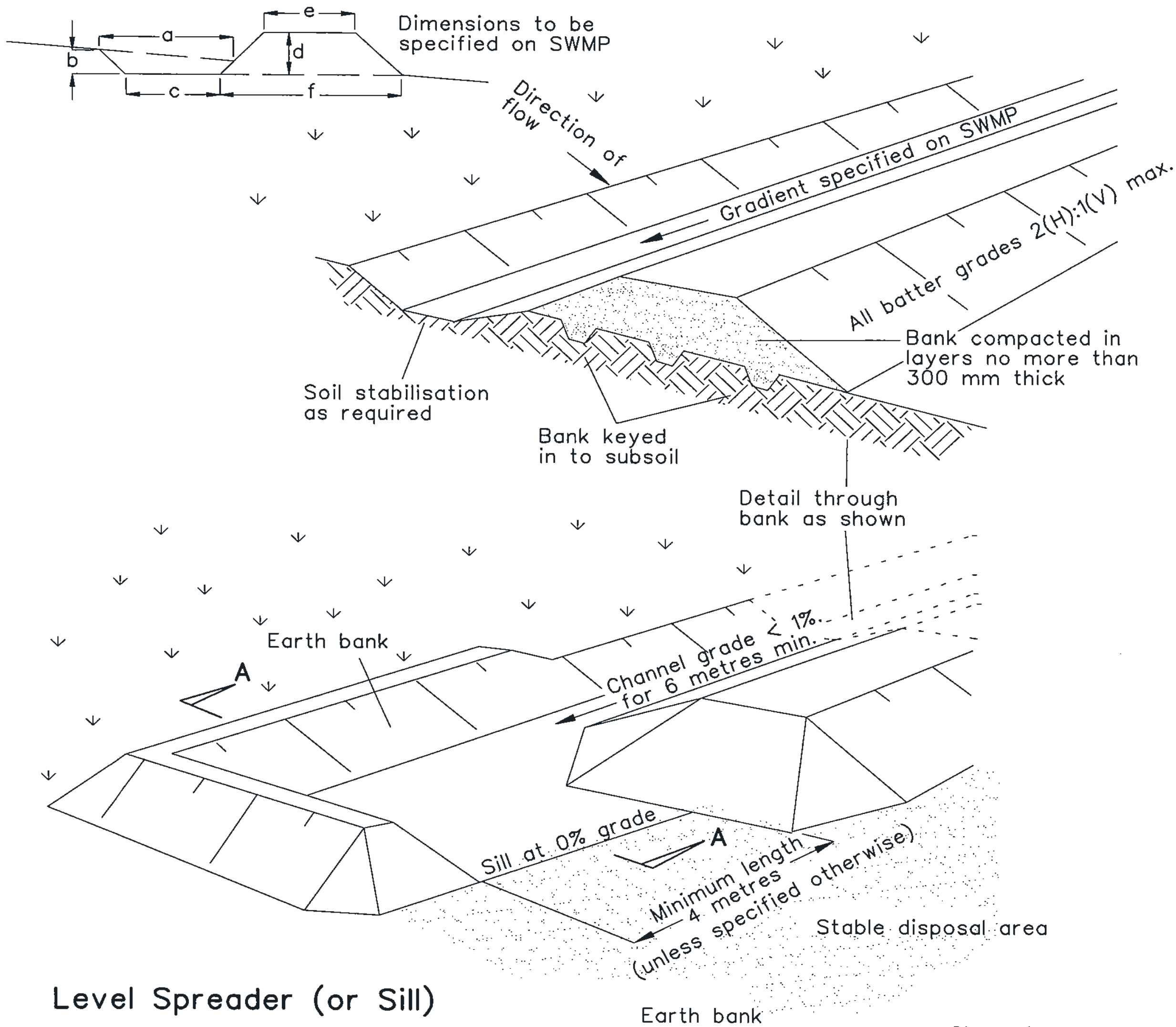
Construction Notes

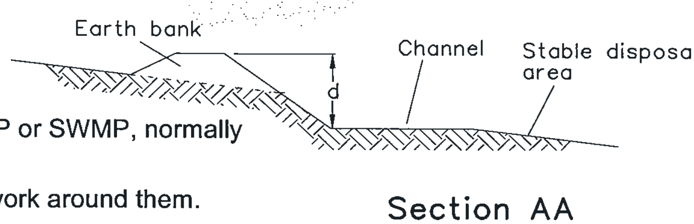
1. Build with gradients between 1 percent and 5 percent.
2. Avoid removing trees and shrubs if possible - work around them.
3. Ensure the structures are free of projections or other irregularities that could impede water flow.
4. Build the drains with circular, parabolic or trapezoidal cross sections, not V shaped.
5. Ensure the banks are properly compacted to prevent failure.
6. Complete permanent or temporary stabilisation within 10 days of construction.

EARTH BANK (LOW FLOW)

SD 5-5

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)



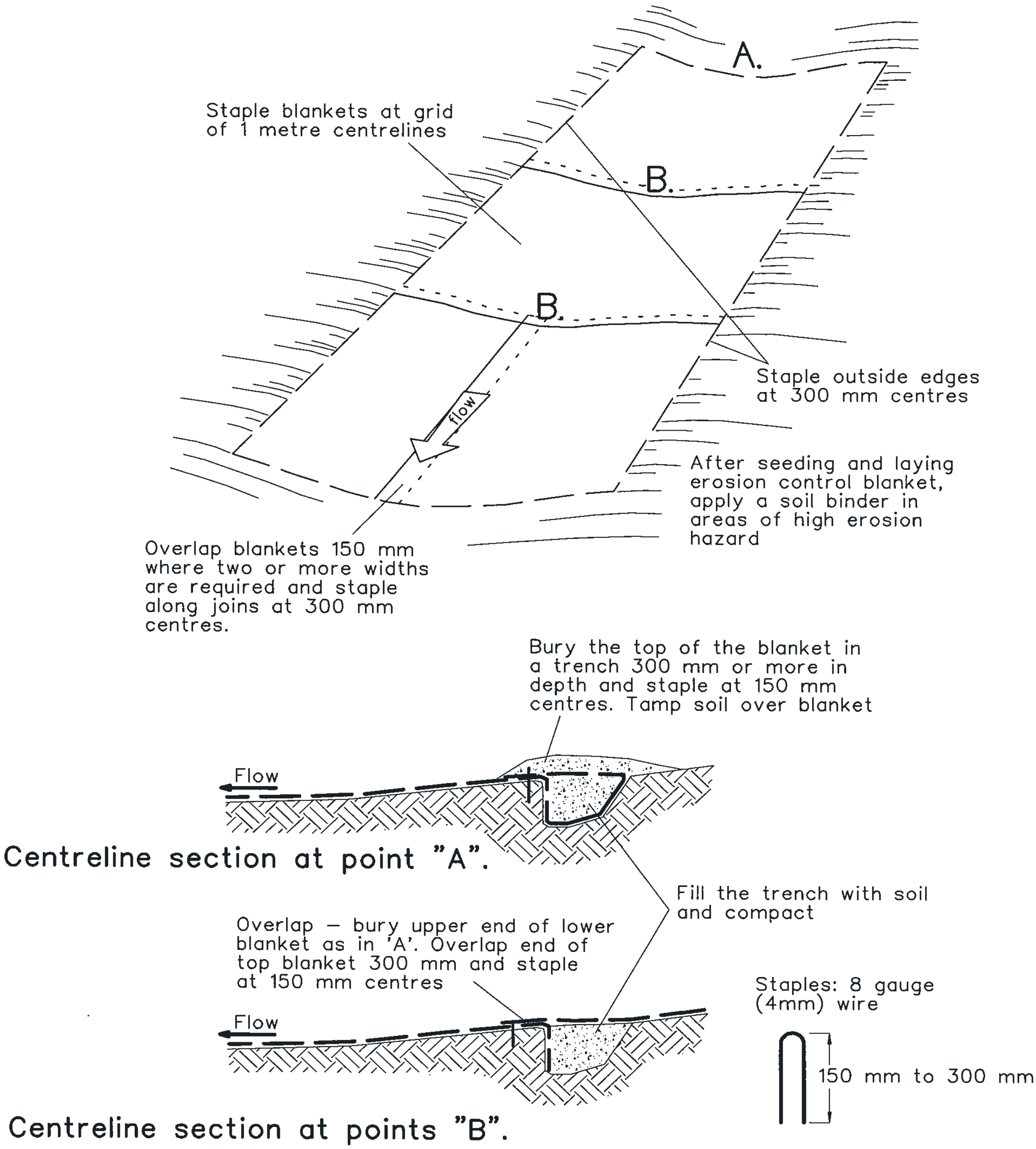


Construction Notes

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

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)

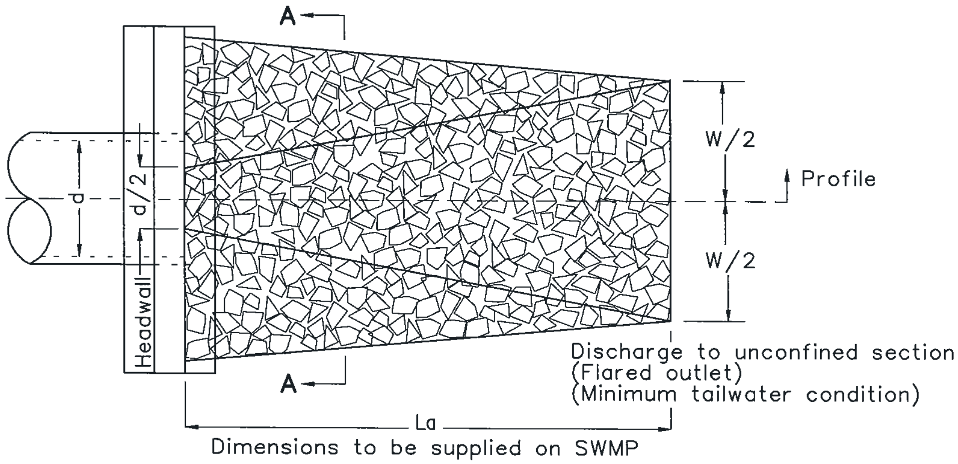


Construction Notes

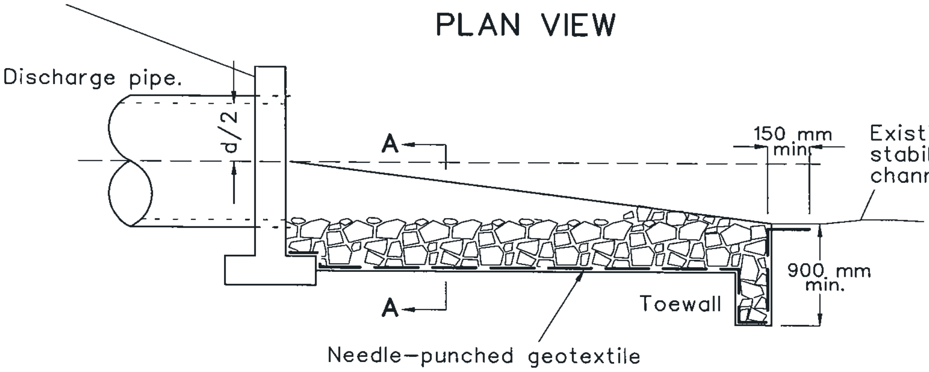
1. Remove any rocks, clods, sticks or grass from the surface before laying matting
2. Ensure that topsoil is at least 75 mm deep.
3. Complete fertilising and seeding before laying the matting.
4. Ensure fabric will be continuously in contact with the soil by grading the surface carefully first.
5. Lay the fabric in "shingle-fashion", with the end of each upstream roll overlapping those downstream. Ensure each roll is anchored properly at its upslope end (Standard Drawing 5-7b).
6. Ensure that the full width of flow in the channel is covered by the matting up to the design storm event, usually in the 10-year ARI time of concentration storm event.
7. Divert water from the structure until vegetation is stabilised properly.

RECP : CONCENTRATED FLOW **SD 5-7**

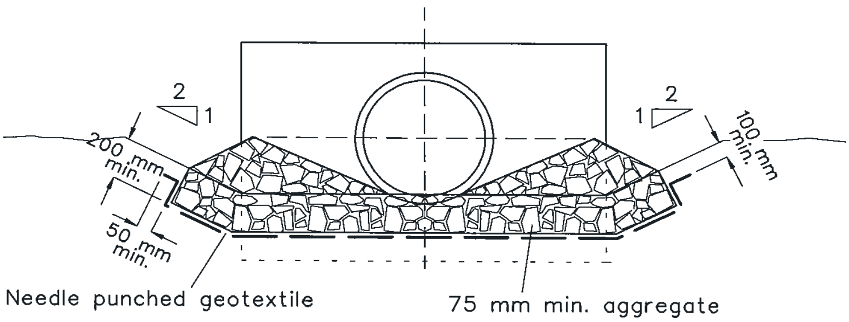
SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)



PLAN VIEW



PLAN VIEW



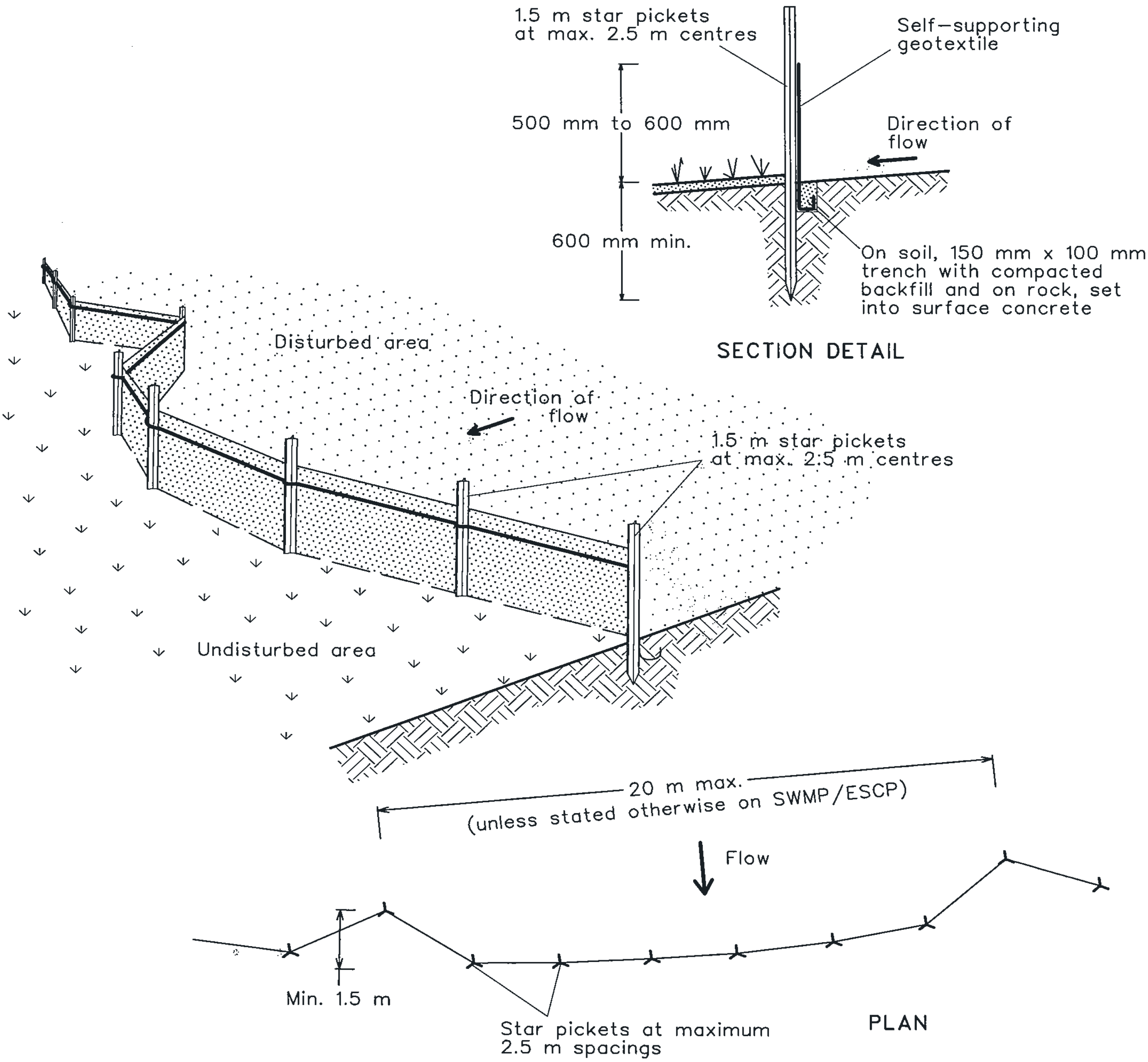
CROSS SECTION AA

Construction Notes

1. Compact the subgrade fill to the density of the surrounding undisturbed material.
2. Prepare a smooth, even foundation for the structure that will ensure that the needle-punched geotextile does not sustain serious damage when covered with rock.
3. Should any minor damage to the geotextile occur, repair it before spreading any aggregate. For repairs, patch one piece of fabric over the damage, making sure that all joints and patches overlap more than 300 mm.
4. Lay rock following the drawing, according to Table 5.2 of Landcom (2004) and with a minimum diameter of 75 mm.
5. Ensure that any concrete or riprap used for the energy dissipater or the outlet protection conforms to the grading limits specified on the SWMP.

ENERGY DISSIPATER **SD 5-8**

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)



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.

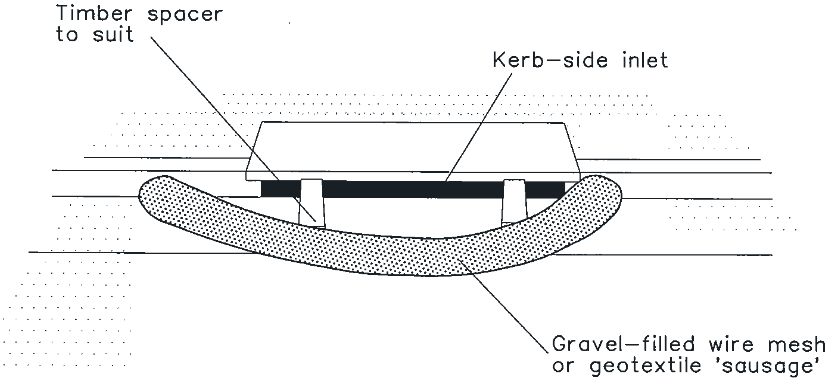
5. Join sections of fabric at a support post with a 150-mm overlap.

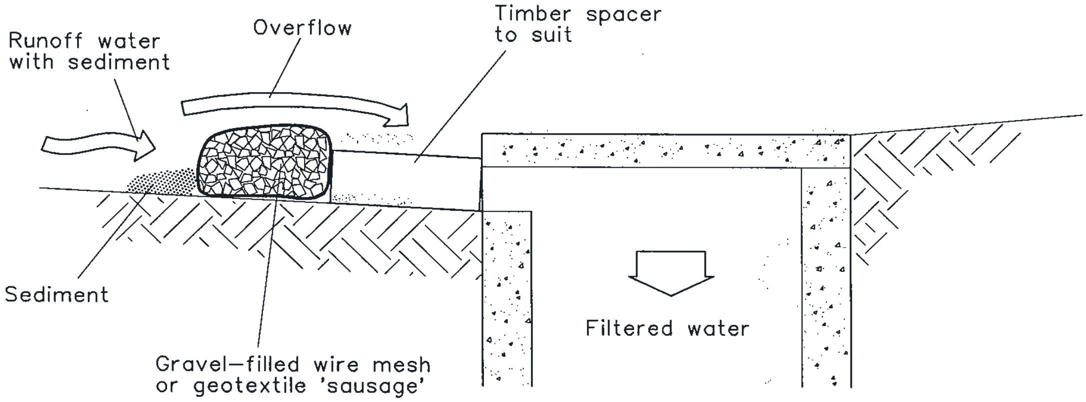
6. Backfill the trench over the base of the fabric and compact it thoroughly over the geotextile.

SEDIMENT FENCE

SD 6-8

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)





NOTE: This practice only to be used where specified in an approved SWMP/ESCP.

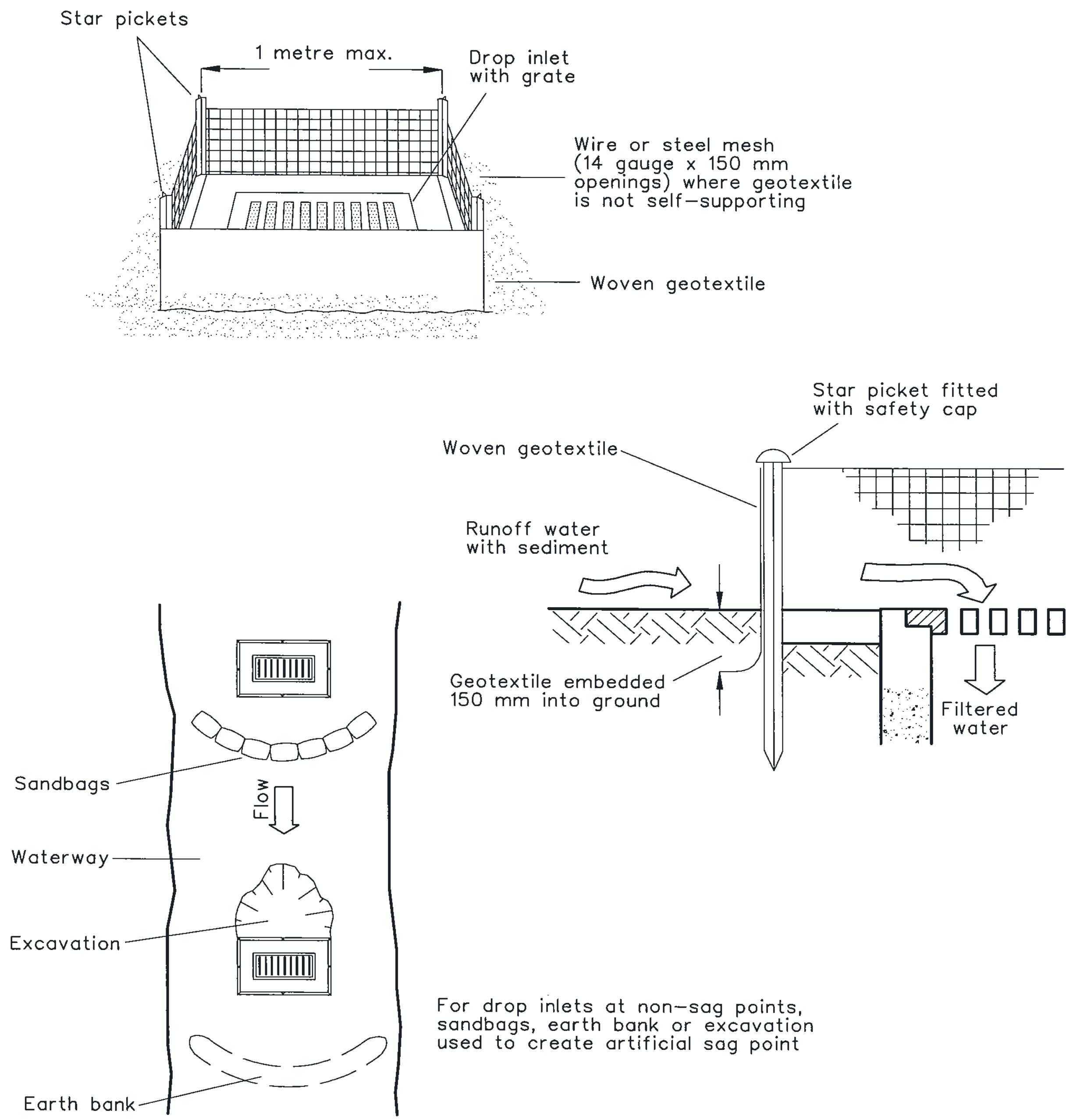
Construction Notes

1. Install filters to kerb inlets only at sag points.
2. Fabricate a sleeve made from geotextile or wire mesh longer than the length of the inlet pit and fill it with 25 mm to 50 mm gravel.
3. Form an elliptical cross-section about 150 mm high x 400 mm wide.
4. Place the filter at the opening leaving at least a 100-mm space between it and the kerb inlet. Maintain the opening with spacer blocks.
5. Form a seal with the kerb to prevent sediment bypassing the filter.
6. Sandbags filled with gravel can substitute for the mesh or geotextile providing they are placed so that they firmly abut each other and sediment-laden waters cannot pass between.

MESH AND GRAVEL INLET FILTER

SD 6-11

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)



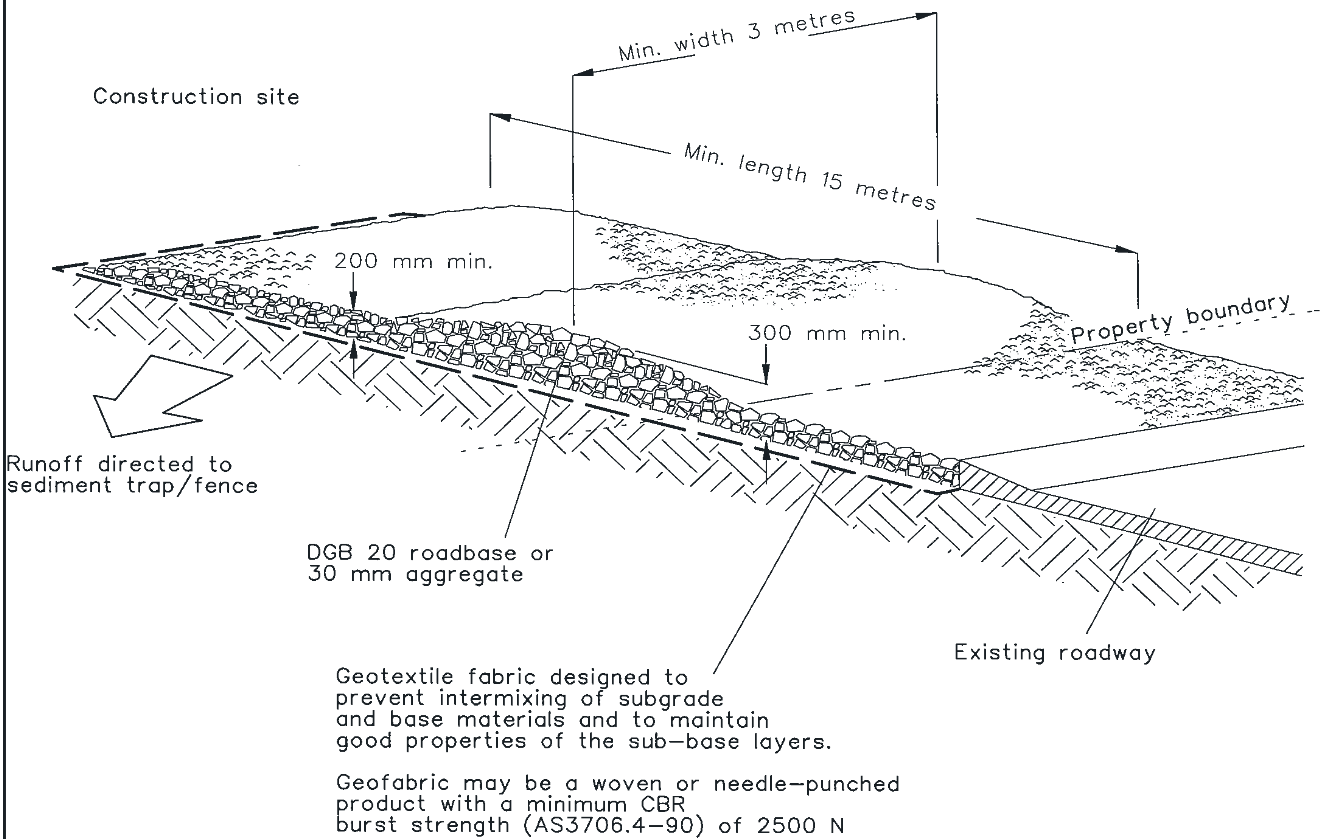
Construction Notes

1. Fabricate a sediment barrier made from geotextile or straw bales.
2. Follow Standard Drawing 6-7 and Standard Drawing 6-8 for installation procedures for the straw bales or geofabric. Reduce the picket spacing to 1 metre centres.
3. In waterways, artificial sag points can be created with sandbags or earth banks as shown in the drawing.
4. Do not cover the inlet with geotextile unless the design is adequate to allow for all waters to bypass it.

GEOTEXTILE INLET FILTER

SD 6-12

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)

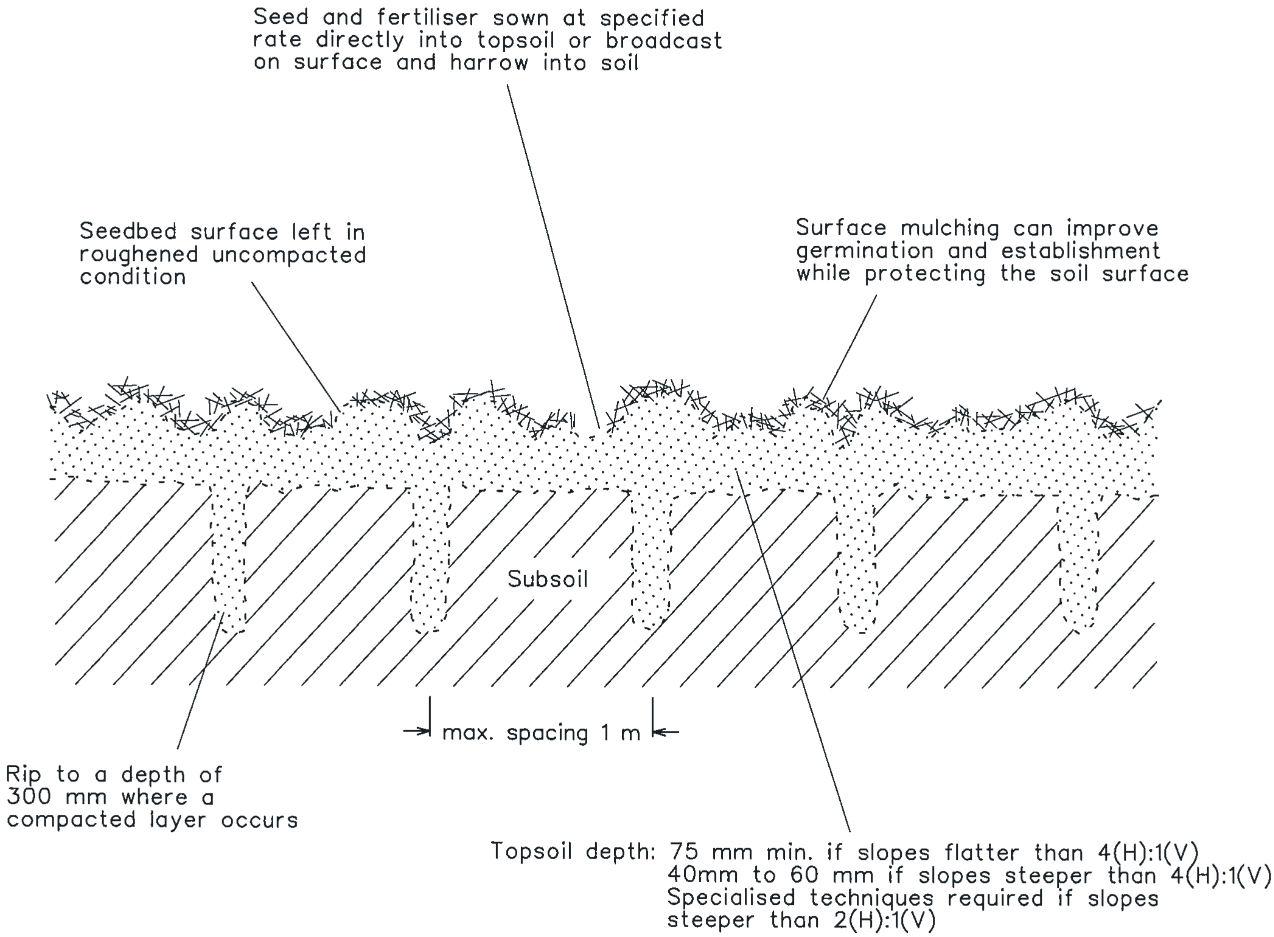


Construction Notes

1. Strip the topsoil, level the site and compact the subgrade.
2. Cover the area with needle-punched geotextile.
3. Construct a 200-mm thick pad over the geotextile using road base or 30-mm aggregate.
4. Ensure the structure is at least 15 metres long or to building alignment and at least 3 metres wide.
5. Where a sediment fence joins onto the stabilised access, construct a hump in the stabilised access to divert water to the sediment fence

STABILISED SITE ACCESS SD 6-14

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)



Construction Notes

1. Loosen compacted soil before sowing any seed. If necessary, rip the soil to a depth of 300 mm. Avoid rotary hoe cultivation.
2. Work the ground only as much as necessary to achieve the desired tilth and prepare a good seedbed.
3. Avoid cultivation in very wet or very dry conditions.
4. Cultivate on or close to the contour where possible, not up and down the slope.

SEEDBED PREPARATION

SD 7-1

SOURCE: Managing Urban Stormwater, Soils and Construction (Vol 1, 4th ed.)

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