Forest Wind

Stormwater and Erosion and Sediment Control Management Strategy

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Revision	Date	Description	Author	Approved
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R009-0.02	23/09/19	For Application for MCU Development Approval, minor updates	I. Robb/ M. Page	J. Pennay
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Glossary of terms

Term	
AEP	Annual Exceedance Probability (Bureau of Meteorology)
ARR	ARR2016 - Australian Rainfall and Runoff (Bureau of Meteorology)
CPESC	Certified Professional in Erosion and Sediment Control
EPC	Engineer Procure and Construct
ESC	Erosion and Sediment Control
ESCP	Erosion and Sediment Control Plan
FW	Forest Wind
FWH	Forest Wind Holdings Pty Ltd
IECA	International Erosion Control Association
IFD	Intensity, Frequency, Duration (Bureau of Meteorology)
LA	Logging Area
PO	Performance Outcome
RPEQ	Registered Professional Engineer Queensland
TN	Total Nitrogen (expressed as mg/l)
TP	Total Phosphorous (expressed as mg/l)
TSS	Suspended Solids (expressed as mg/l)
WTA	Wind Turbine Area

Units	
hr	hour
km	kilometre
m	metre
mg/l	milligram per litre
mm/hr	millimetre per hour
MW	megawatt

1. Introduction

1.1 General

This preliminary Stormwater and Erosion and Sediment Control Management Strategy (the Strategy) has been prepared to outline Forest Wind Holding's (FWH) approach to stormwater and erosion and sediment control management during the construction and operation of Forest Wind (FW) (the Project) within the Wind Turbine Area (WTA) to ensure:

- the potential for soil loss from construction and maintenance works is mitigated
- stormwater flows from site works do not result in a deterioration of the quality or quantity of water within water courses
- there is "no-harm" to catchment values.

This Strategy has been prepared to provide supporting information in response to the State Development Assessment Provisions State Code 23 for Wind Farm Development in particular Performance Outcome (PO) 7 & PO8 as follows:

- PO7 Stormwater management - Development avoids, or minimises and mitigates, adverse impacts on water quality objectives to achieve no worsening to receiving waters during the operation of the wind farm.
- PO8 Watercourses and drainage features - Development avoids or minimises the clearing of vegetation within any watercourse or drainage feature to protect:
  - bank stability by protecting against bank erosion
  - water quality objectives by filtering sediments, nutrients and other pollutants
  - aquatic habitat
  - terrestrial habitat.

1.2 Scope

The Strategy applies to all earth work disturbance associated with the construction and operational phases of Forest Wind.

A Construction Environment Management Plan (CEMP) will be required to be prepared by the Construction Contractor prior to construction commencing. The CEMP will include a Stormwater Management Plan that details management and mitigation measures for the protection of soil and water quality through the implementation of stormwater management and erosion and sediment controls (ESC). This Strategy provides supporting information to assist with the preparation of the CEMP, Stormwater Management Plan and erosion and sediment control plans (ESCP) including the following:

- identifies the soil types within the Project footprint
- establishes an erosion risk rating for each soil type
- identifies the tasks that may result in an erosion hazard
- identifies controls to minimise erosion soil loss.

It will be the responsibility of the Construction Contractor to confirm the relevance and suitability of this data prior to preparation of the CEMP, Stormwater Management Plan and ESCP. The Stormwater Management Plan and ESCPs will be prepared by a suitably qualified person prior to construction commencing on site. A suitably qualified person may be either a Registered Professional Engineer of Queensland (RPEQ) or a Certified Professional in Erosion and Sediment Control (CPESC).

1.3 Area of application

The Forest Wind Project is located within an actively managed and operational exotic pine plantation in Queensland Government (the State) owned Toolara, Tuan and Neerdie State Forests situated between Gympie and Maryborough in the Wide Bay Region of Queensland. Specifically, the Project comprises a wind farm with up to 226 wind turbines and ancillary infrastructure (herein referred to as the Wind Turbine Area) and a 60m wide Overhead Transmission Corridor in which a high voltage transmission line (the

Transmission Line) will be located to transfer generated electricity to an existing Powerlink Queensland (Powerlink) substation located at Woolooga to the west of Gympie. The Project will be located within the Gympie Regional Council and Fraser Coast Regional Council Local Government Areas.

The Overhead Transmission Corridor transmits the generated electricity to on-site substations and to an existing Powerlink Queensland substation located at Woolooga to the west of Gympie, which will be the transmission connection point to the National Electricity Market. The high voltage transmission line from the Wind Farm to Woolooga Substation will be located within a Connection Corridor extending from the boundary of the Wind Turbine Area to Woolooga Substation. The Connection Corridor is not included in this Strategy.

2. Legislation

Table 1 summarises legislation and compliance requirements of relevance to the management of stormwater and erosion and sediment control on the Project.

Table 1 Legislation

Legislation	Requirements and relevant sections
Environmental Protection Act (1994)	Ch1: Part 2.5: Obligations of persons Ch1: Part 3: Environmental harm Ch5: Div 4: Relationship with Planning Act Ch7: Part 1 Div 1, Duty to prevent environmental harm Ch7: Part 1 Div 2, Duty to notify environmental harm Ch8: Part 3C, Offences relating to water contamination
Environmental Protection (Water) Policy (2009)	Part 3 Sec 6: Environmental values to be enhanced or protected Schedule 1: Basin 140 Great Sandy Strait and Coastal Creeks environmental values and Water Quality Objectives (2010) Schedule 1: Basin 138 Mary River Mary River Environmental Values and Water Quality Objectives (2010)
Forestry Act (1959)	Part 7A, 69A – 69J: Pollution and waste on State Forest and Timber Reserves
Planning Act 2016 and Planning Regulation (2017)	State Development Assessment Provisions – State Code 23: Wind Farm Development
Water Act (2000)	Part 4 Riverine protection permits

3. Stakeholders

3.1 Key stakeholders

Table 2 summarises key stakeholders and how they may be affected by soil and water management within the Project Area.

Table 2 Stakeholders

Stakeholder	Interest / potential impact
The Plantation Licensee	Accountable to regulator and public for soil/water quality issues within the Plantation Licence Area. Forest sustainability certification. Plantation productivity, soil nutrition and stability.
Downstream neighbours	Downstream landowners draw water from streams for agriculture and grazing purposes. Need for clean secure water sources.
Wide Bay Water Corporation (Fraser Coast Regional Council)	Responsible for domestic water supply to the Maryborough community. Teddington Weir 3,710ML and Talegalla Weir 385ML lie within the Tinana Creek catchment. Forestry represents 39% of the catchment and FW construction works will occur within the catchment.
Gympie Regional Council	Gympie sources its water from the Mary River Jones Hill Water Treatment Plant on the south side of Gympie. FW does not have any potential impact on Gympie supply. However, Council will have an interest on behalf of landholders who are downstream of the FW project.
Department of Environment and Science (DES)	Monitoring water quality outcomes in the Mary and Great Sandy Straits catchments.
Construction Contractor	Responsible for all FW construction civil works ESC, monitoring and reporting.
Operations Contractor	Responsible for all FW operations maintenance ESC, monitoring and reporting.

3.2 Consultation engagement

The Plantation Licensee's production and sustainability certification is dependent upon soil health and stability. The Plantation Licensees (current and previous) have completed a body of research into soil erosion and flood impacts on turbidity, nutrient balance and stream dynamics at Fraser Coast. Learnings from this research provide a foundation for FW erosion hazard identification and controls.

The Strategy has been developed with consideration of the current Plantation Licensee's operations and requirements.

4. Background

This section provides:

- an overview of Fraser Coast Plantation forest - paired catchment erosion research, and
- preliminary data for the development of an ESCP.

4.1 Fraser Coast Erosion Research

The Plantation Licensees (current and previous) have undertaken research to quantify the potential environmental impacts from plantation production. Much of this research has been undertaken on the Fraser Coast Tuan-Toolara-Neerdie plantations.

4.1.1 Kelly Logging Area Paired Catchment Study

Over a six-year period (1994 to 2000) a paired catchment study was established on Kelly Logging Area (LA) plantations, Toolara State Forest (the Kelly LA Study). The Kelly LA Study (Bubb *et al,* 2002) separated a 395ha upper controlled catchment from a downstream 904ha catchment in which plantations totalling 330ha were subsequently clear-felled or thinned and the catchment's water quality monitored. Two V-notch weirs, Chieti and Ari and auto samplers were installed. A set of benchmark parameters were established and monitoring of Total Nitrogen (TN), Total Phosphorous (TP) and Total Suspended Solids (TSS) was assessed over the six-year period.

Neighbouring local streams outside the plantation (Tinana, Deep, Teewah and Coondoo Creeks) were also sampled over a one-year period. Land use in these catchments ranged from undisturbed (Teewah Creek) to more intensive cane and grazing (Tinana and Coondoo Creeks).

4.1.1.1 Study Findings

Findings from the Kelly LA Study that have relevance to Forest Wind include:

- Annual stream flow was highly variable with extended periods of no-flow followed by spikes up to 3.2m above the relative level.
- During the six years only 7.3% to 12.6% of incident rainfall volume entered the watercourse.
- Intense one-off events resulting in significant stream height rises were responsible for most sediment and nutrient runoff. The study recorded that of the total nutrient and sediment movement over six years 70% of all TN, 62% of TP and 85% of TSS was discharged in one year (1998/99). The year was highlighted by several storm-flood events and above average rainfall.
- Poor historic plantation establishment practice (cultivation up and down slopes plus removal of riparian vegetation and cultivation through watercourses) resulted in a legacy of turbidity and nutrient loss.
- Conversely, improved plantation design, drainage 1%, contour cultivation, residue retention, and retained riparian vegetation resulted in minimal soil movement or nutrient loss.
- Separation distance from water courses reduces risk of sediment-nutrient export to streams.
- Drainage (without structures) should not exceed 1% fall.
- Retention and re-spreading of vegetation mulch residues reduced site soil loss.
- Direct drainage back to established plantation drainage systems and away from water courses where practical.
- Riparian vegetation plays a major role in filtering sediment.
- Road and road creek crossings are point sources of erosion and water quality impact.

Low and high stream flow records from the two stream gauging stations, Chieti and Ari are detailed in Table 3.

Table 3 Kelly LA paired catchment nutrient ranges

Analyte		Low flow (mg/litre)	High flow (mg/litre)
	Chieti - no harvest (Larger Upper catchment, historic, poorer site preparation techniques leave legacy of higher TN, TP and TSS compared to Ari pre-harvest)		
Total Nitrogen		0.60	2.44
Total Phosphorous		<0.01	0.15
Total Suspended Solids		<10	227
	Ari – pre-harvest (lower catchment, improved site design and litter retention)		
Total Nitrogen		<0.1	1.80
Total Phosphorous		<0.01	0.03
Total Suspended Solids		11	87
	Ari - post harvest (Average of two-years post-harvest)		
Total Nitrogen		0.36	2.01
Total Phosphorous		<0.01	0.28
Total Suspended Solids		<10	264

4.2 Waterways

The Project is located within the Mary River Catchment (Drainage Basin 138) and the Great Sandy Strait Catchment (Part of Noosa Drainage Basin 140). The WTA is dissected by a number of waterways that are mapped under the *Water Act* (2000) and the *Fisheries Act* (1994). The sub catchments within the Project Area are illustrated in Figure 1.

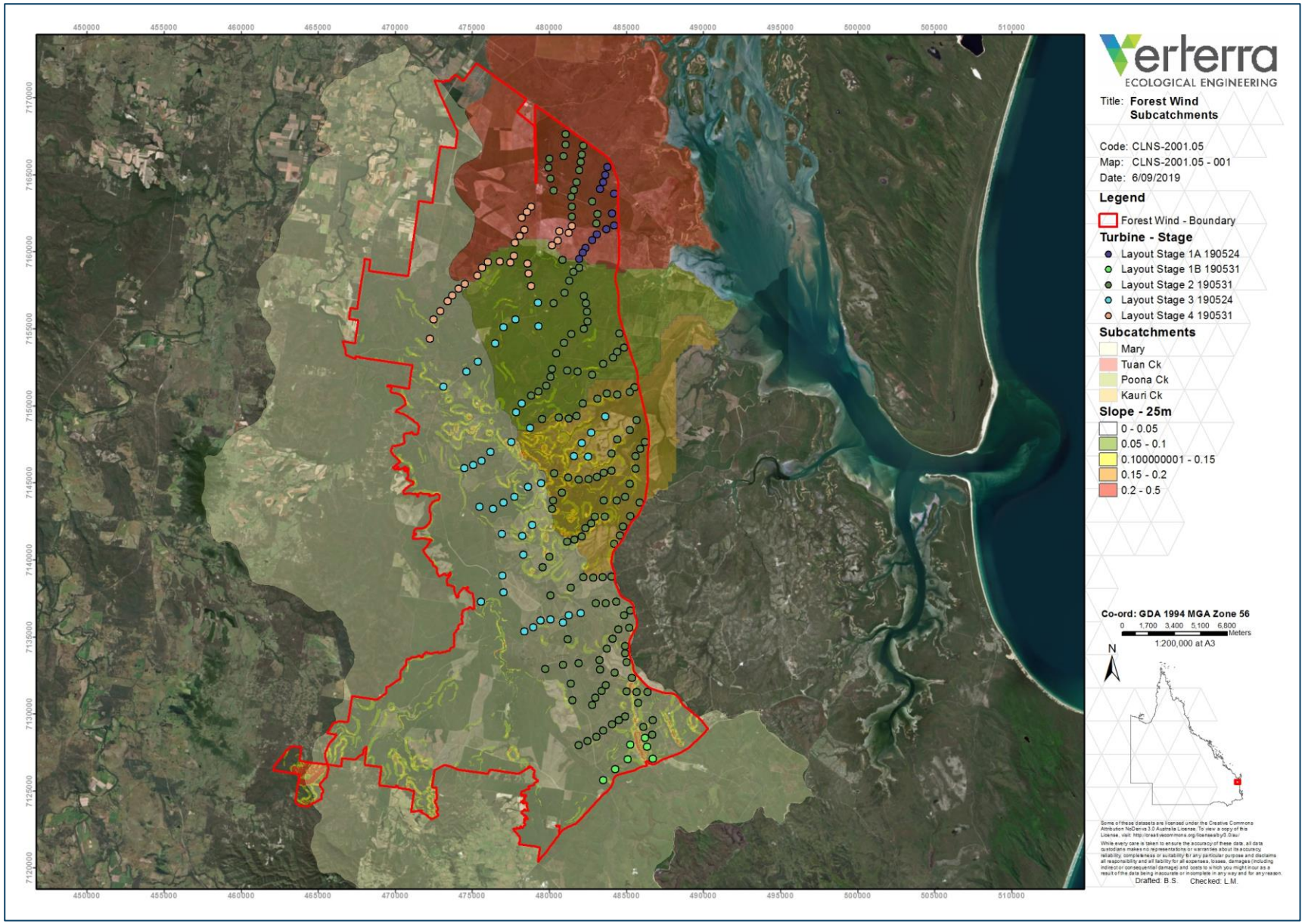

Figure 1 Sub-catchments

4.3 Water quality objectives

DES sets environmental values and water quality objectives for the Mary River and Great Sandy Straits Catchments as part of the *Environmental Protection (Water) Policy* 2009 as detailed in the following:

- *Mary River Environmental Values and Water Quality Objectives Basin No.138, including all tributaries of the Mary River* (MREVWQO), DERM July 2010
- *Great Sandy Straits Environmental Values and Water Quality Objectives* (GSSENVQO), DERM July 2010.

In accordance with the MREVWQO and the GSSENVQO the waterways in the Project Area are classified as Lowland Freshwater tannin stained streams. The specific environmental values for the waterways in the Project Area have not been assessed as part of this Strategy.

The MREVWQO and the GSSENVQO provide water quality objectives for Lowland Freshwater tannin stained streams as outlined in Table 4.

Table 4 MREVWQO and the GSSENVQO water quality objectives

Analyte	MREVWQO lowland freshwater tannin stained water quality objectives	GSSENVQO lowland freshwater tannin stained water quality objectives	Units
Turbidity	<50	<50	NTU
Total Suspended Solids	<6	<6	mg/l
Chlorophyll a	<0.005	<0.005	mg/l
Total Nitrogen	<0.5	<0.5	mg/l
Oxidised N	<0.06	<0.06	mg/l
Ammonia N	<0.02	<0.02	mg/l
Organic N	<0.42	<0.42	mg/l
Total Phosphorous	<0.05	<0.05	mg/l
Filterable Reactive Phosphorous	<0.02	<0.02	mg/l
Dissolved Oxygen	85%-110%	85%-110%	%
pH	6.0-8.0	6.0-8.0	#
Secchi depth	NA	2.5	m

Extract from: Table 2 Mary River EV and WQ objectives 2010; Table 2 Great Sandy EV and WQ objectives 2010

It is noted that these are objectives only and may not be representative of the site-specific water quality.

4.4 Climatic conditions

The Wide Bay Region rainfall pattern is typically a summer wet and winter dry pattern with ephemeral stream flows. Storms impact the Wide Bay Region from time to time with increased likelihood of occurrence between October and March each year. Summer rainfall can be influenced by storm events and tropical low depressions that result in significant short-term stream rises and saturated coastal lowland water tables. Severe wet conditions can result in temporary operational shutdowns.

The annual average rainfall for Maryborough is 1,138mm. Monthly average rainfall distribution for Maryborough is detailed in Figure 2.

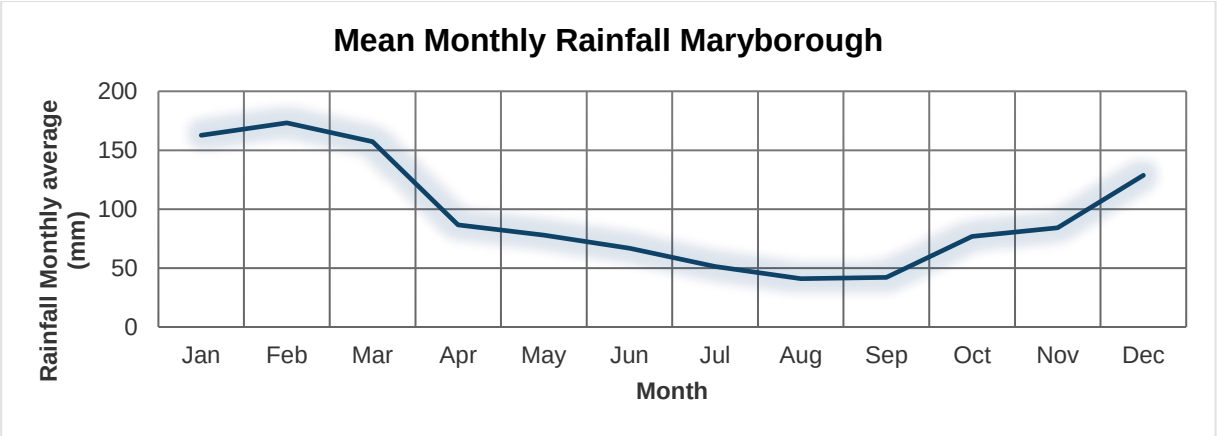

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Figure 2 Average monthly rainfall Maryborough

The ESCP developed for individual sites will be required to consider the Australian Rainfall and Runoff Record (ARR2016) and account for rainfall event intensity, frequency and duration (IFD). Preliminary data has been provided below.

4.4.1 Rainfall intensity and duration

The embedded energy in raindrops is a driver of erosion. On non-dispersive soils, erosive events are thought to occur when rainfall intensity exceeds 50mm/hr (Kinnell 1983). Rainfall depth and intensity for a range of durations and annual exceedance probabilities are presented in Appendix A.3. An extract of predicted Tuan-Toolara rainfall intensity for a 10% (1:10 year) Annual Exceedance Probability is summarised in Table 5.

Table 5 Tuan Toolara rainfall intensity x duration

IFD design rainfall intensity (mm/hr)	**10%**	**1 in 10**
Annual exceedance probability (AEP)		
Duration		
1 min	287	mm/hr
2 min	245	mm/hr
3 min	230	mm/hr
4 min	218	mm/hr
5 min	209	mm/hr
10 min	171	mm/hr
15 min	146	mm/hr
20 min	128	mm/hr
25 min	114	mm/hr
30 min	103	mm/hr
45 min	81.6	mm/hr
1 hour	**68.2**	**mm/hr**
1.5 hr	52.4	mm/hr
2 hrs	43.3	mm/hr
3 hrs	33	mm/hr
4.5 hrs	25.3	mm/hr
6 hrs	21	mm/hr
9 hrs	16.2	mm/hr
12 hrs r	13.6	mm/hr
18 hrs	10.6	mm/hr

IFD design rainfall intensity (mm/hr)	10%	1 in 10
24 hrs	8.91	mm/hr
30 hrs	7.78	mm/hr
36 hrs	6.94	mm/hr
48 hrs	5.77	mm/hr
72 hrs	4.37	mm/hr
96 hrs	3.51	mm/hr
120 hrs	2.92	mm/hr
144 hrs	2.49	mm/hr
168 hrs	2.15	mm/hr

4.4.2 Rainfall frequency

Table 6 and Figure 3 provide an analysis of Maryborough rainfall frequency over the past 5 years (2014-2018).

Table 6 Maryborough rainfall frequency

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	#Days per year
Average # rain days	11.8	12.2	16	11.8	10.4	11.6	8.2	10	8.4	11	10.2	12	133.6

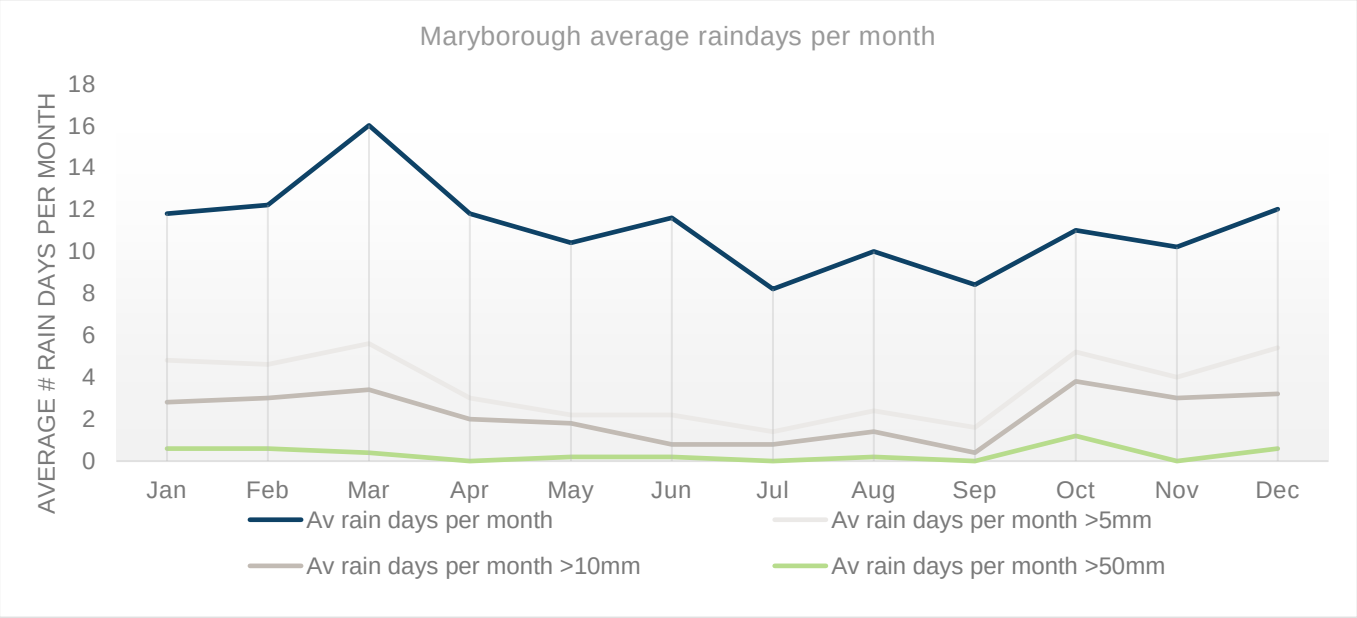

Figure 3 Maryborough rainfall frequency

Based on Maryborough's average rain days per month, there are 133 days per year when a rainfall event could occur in the Project Area.

There are 14.6 days per year when rainfall exceeds 10mm in a single event and an overland flow event could be expected. Overland flow events are most likely to occur between the months of October and April A key learning from the Fraser Coast paired catchment research is that maximum soil - nutrient movement occurs during intensive infrequent high flow events.

4.4.3 Flood history

Bureau of Meteorology recorded flood events at Maryborough indicate a flood event occurs every 3-4 years. While the source of Maryborough floods is generated in the upper Mary River catchment the event frequency indicates that the FW Project needs to plan for periodic severe events. Stormwater controls will be developed to accommodate this event frequency.

4.5 Stream and flood flow hydrology

Except for some major streams such as Tinana Creek, watercourses within the Project Area are ephemeral with a seasonal summer wet season flow and a winter dry season where streams reduce to a series of pools. Much of the lowland plantations such as the Boonooroo Plains become seasonally wet and remain so for months due to suspended water tables.

Infrequent flood events are the major generators of turbidity, sediment and nutrient movement. Over a six-year monitoring period *Bubb et al (2002)* found that 12.6% of incident rainfall converted to stream flow and 85% of total sediment movement from the Kelly LA paired catchment study occurred in one year where above average rainfall resulted in stream rises to 3.2 metres above base flow.

The paired catchment study indicates a positive stream flow probability of 26.4% and a flood flow (>2m stream rise above nil flow) probability of 13.9% per year.

4.6 Site topography and soils

4.6.1 Topography

The Tuan Toolara forest is a flat to undulating coastal lowland landscape with occasional low hills (Mt Eaton, Kelly Range). Figure 4 shows the soils and slope class within the Project Area.

4.6.2 Soil type

Soils are generally coarse textured low phosphorous-nitrogen and consequent low fertility. Prolonged water logging is a common feature of many areas within the Project Area primarily because of low slope and a clay aquitard at depths of between 0.5m and 10m.

Bubb et al 2002 using Great Soil Group nomenclature described the soils as Siliceous sands, Lithosols, Grey and Gleyed podzolics, Yellow earths, Yellow podzolics and Humic podzols. Comparable Australian Soil Orders are, Dermosols, Hydrosols, Kandosols, Podosols and Sodosols.

Soil types and characteristics are detailed in Appendix A.1 and illustrated in Figure 4.

All soil types are prone to erosion if they are exposed and overland water flows are concentrated.

4.7 Erosion hazard

An erosion risk rating will be assigned to each constructed asset including wind turbine pads, crane hardstands, substations and laydown compounds. The rating is the aggregate of erosion hazard scores assigned to:

- soil type
- slope class
- asset cleared land area.

Hazard ratings are detailed in Appendix A.2.

Preliminary erosion risk rating outcomes are presented in Figure 5.

The disturbed land area, soil type and slope influence the erosion risk ranking. The ranking assumes there are no controls applied. 89.5% of the Wind Farm assets are in the Low (green) erosion risk category. Sites that fall into the Medium (amber) and High (red) categories have an increased land area on undulating or steeper slopes. A “High” ranking means that additional attention to ESC control structure design is required to ensure surface water leaving a site meets established quality criteria. Table 7 summarises the preliminary Wind Farm asset count within each erosion risk category. This will be required to be confirmed prior to construction by the Construction Contractor.

Table 7 Erosion risk ranking

Risk ranking	Asset count	%
Low	220	90.53%
Medium	22	9.05%
High	1	0.41%
All	242	100.0%

Asset count includes 226 wind turbines and 17 other hard surfaced permanent infrastructure assets. HV line corridors and temporary construction sites are not included

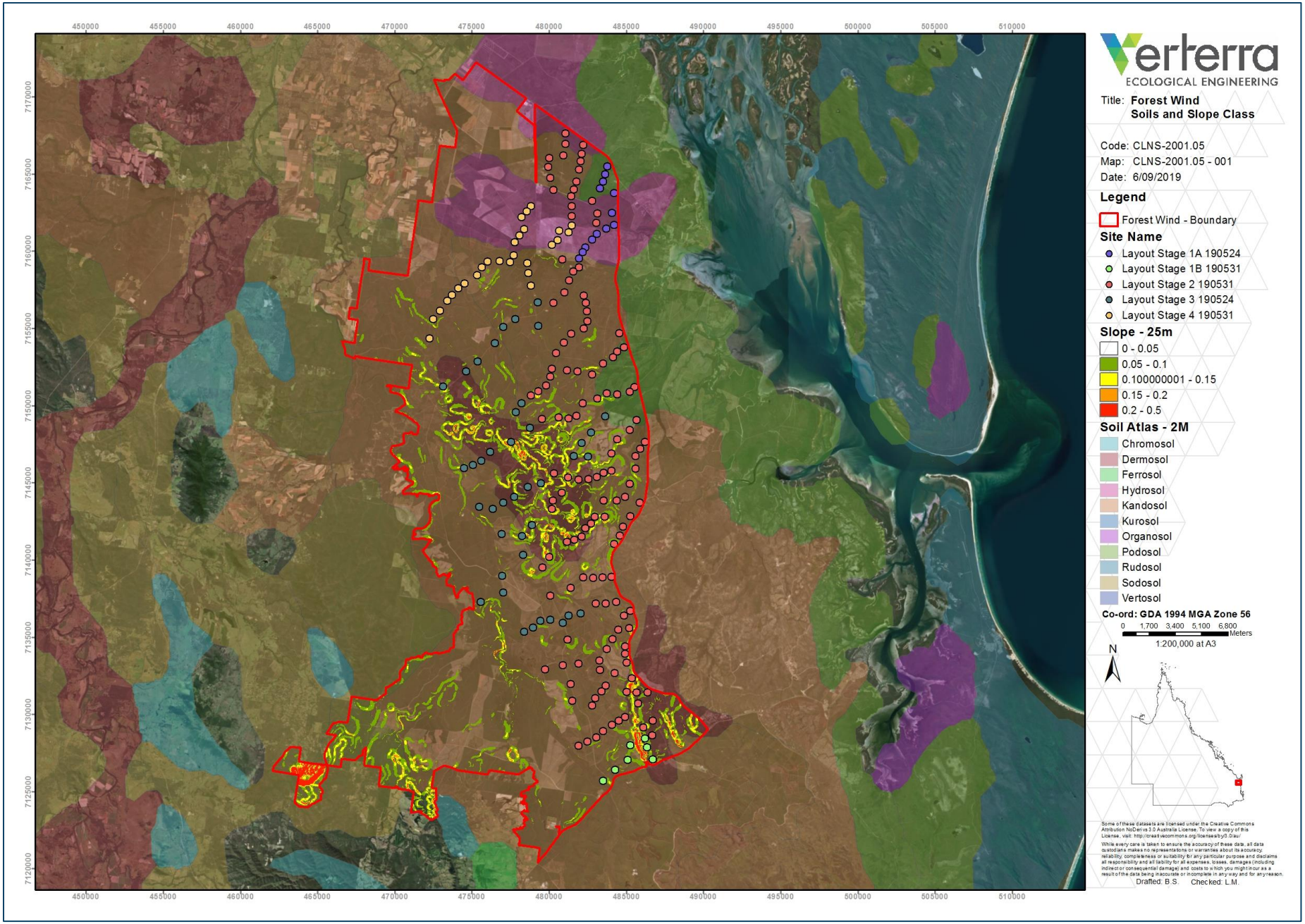

Figure 4 Soils and slope class

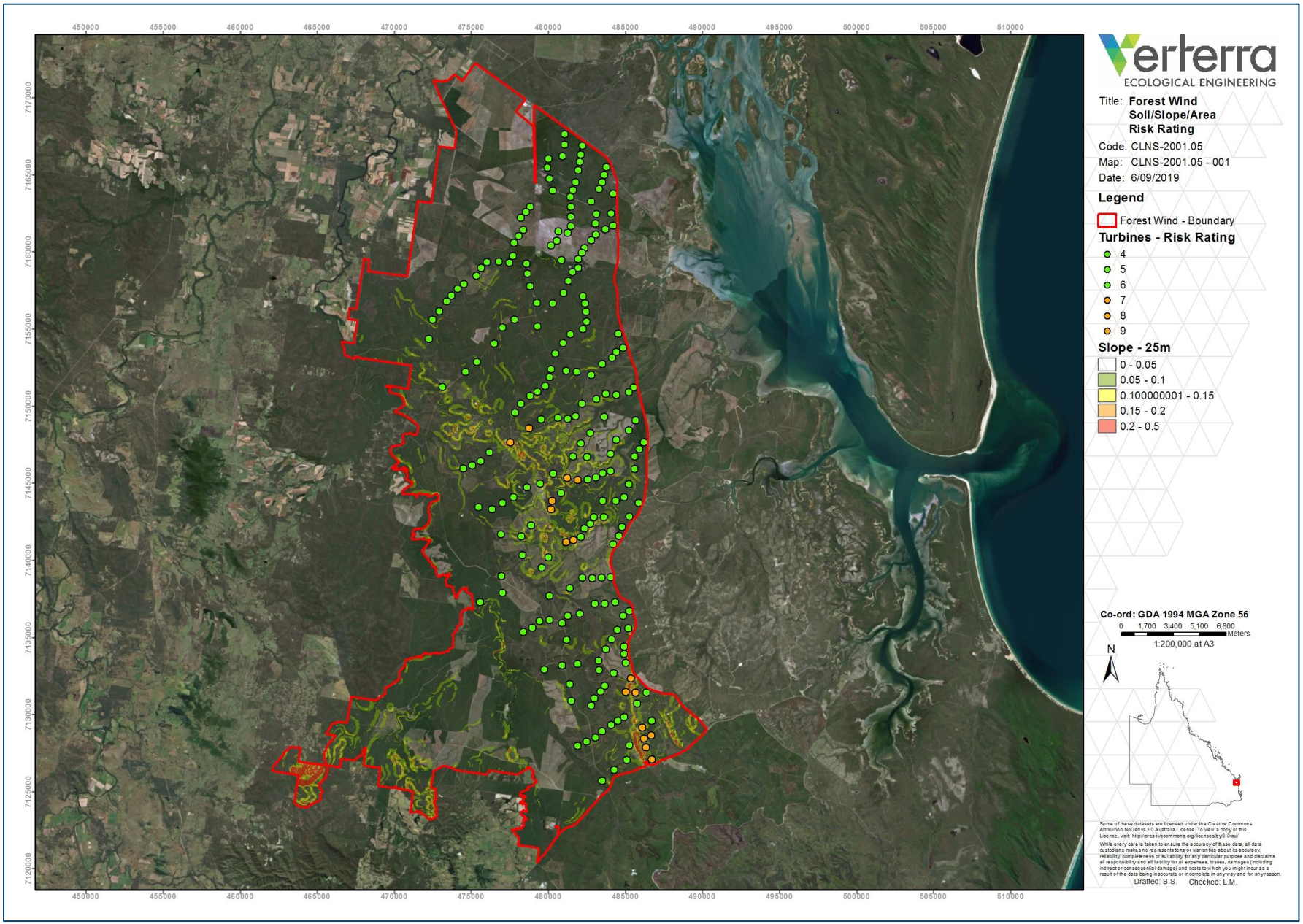

Figure 5 Asset erosion risk assessment

5. Impacts

5.1 Overview

Construction areas for the wind turbines and other infrastructure will drain to plantation compartments. Research by *Bubb et al 2002* demonstrated that 7%-12% of incident rainfall over the plantation generates overland flow. The dispersed nature of individual turbine pads and drainage into plantation compartments will allow the maximum infiltration and sediment capture, however the collective effect of overland flows as level 1 streams aggregate to higher order streams may result in a net increase in turbidity if controls are not applied.

5.2 Potential impacts

The following potential impacts to water quality during the construction of the Project have been identified:

- clearing of exotic pine plantation for the following uses:
    - permanent wind farm infrastructure including the wind turbines, crane hardstands and laydown areas and all related and or ancillary uses such as substations and battery storage facilities, above-ground transmission lines.
    - temporary construction facilities such as construction compounds, concrete batching plants, and manufacturing and assembly plants.
    - minor re-alignments of existing forestry access tracks.
- civil earthworks will create site disturbance and potential erosion hazards.

There are no anticipated clearing works during the operational phase of the Wind Farm. Occasional minor works will be required to maintain access and manage vegetation around facilities and corridors. The use of machinery and herbicide, if not controlled, can result in exposed soils and an erosion hazard.

6. Management and mitigation measures

6.1 Principles

FW will adopt the following principles to mitigate the erosive impact of increased rainfall intensity and overland flows:

- minimising extent of exposed soil
- minimising infrastructure design footprint
- minimising drain grades and slope batters
- maximising vegetative cover and soil permeability
- avoiding the concentration of water and reducing overland flow rates
- maintaining the integrity of riparian vegetation filter strips
- using existing vegetation and enhanced vegetation cover to maintain permeability and filter fine sediments.

The following standards and designs guides will be applied to the techniques adopted by Forest Wind and its contractors:

- Queensland Urban Drainage Manual 4th ed. Institute of Public Works Engineering Australasia
- IECA Best practice erosion and sediment control – for construction and building sites
- Plantation Licensee environmental standards for road and plantation drainage design.

6.2 Stormwater management

The Construction Contractor will be required to prepare a Stormwater Management Plan as part of the CEMP for the Project. A preliminary Stormwater Management Plan has been provided in Section 9 of this Strategy. Table 8 identifies the risks, hazards and controls relating to erosion and sediment control that are associated with stormwater management.

Table 8 Stormwater hazard impact assessment

Stormwater risk	Erosion hazard	Controls
Storm event impacts the FW land assets and plantation estate.	Stream rises of up to 3.2m above base line flows have been recorded in the catchment. Increased short term overland flows result in exponential increases in sediment fines flows to waterways and streams.	**Design** – Consult the: — Australian Rainfall and Runoff (ARR2016) guide — Australian Rainfall Intensity (ARI) data — Queensland Urban Drainage Manual (2017). FW design will ensure that drainage and water management structures accommodate predicted rainfall intensities and quantities. **Weather** – FW will monitor weather projections daily and advise field teams of impending storm events. **Maintenance plan** – FW site earth works stability inspection monitoring included in FW Maintenance Plan. **Maintenance delivery** FW Estate work team in place to respond to any site-drainage deterioration.
	Overland flows from permanent Wind Turbine pads. 0.5-1ha	**Design** Locate wind turbine pads a minimum 50m from a major waterway.

Stormwater risk	Erosion hazard	Controls
		Site hard surface drainage is designed to split storm volumes and direct to multiple low-points per pad, as required. Install low profile compacted contour mounds to direct water and split overland flows on pads, where required. Wind turbine pad drainage is preferentially directed back to the adjoining plantation into ground litter and away from local waterways. Vegetation cover is maintained on wind turbine pad aprons, batters and uncapped soil surfaces. Drain outlets <5% slope will be maintained with a grass cover, or similar. Mulch will be used as required to enhance the filter effect and establish a cover. Drain outlets >5% slope will be covered in geo fabric and rip-rap to de-energise water flows. Grass vegetation regrowth will be encouraged on these outlet structures. Silt fences, geo-fabric, bales and coir fibre logs may be deployed to slow water flows and stabilise water way beds as required. **Maintenance** *Maintenance plan* - FW site earth works stability inspection monitoring included in FW Maintenance Plan. **Maintenance delivery** FW Operations team in place to respond to any site-drainage deterioration. **Timely response** FW will: — Warehouse a supply of erosion control materials such as silt fencing, geofabric, coir fibre, rock ballast; and — Identify preferred suppliers for grass seed fertiliser and hay bales for deployment to repair any damaged sites.
	Overland flows from permanent substations and compound areas. 4ha to 16ha	**Design** Design approach aligns with wind turbine pads with the following additional controls to meet increased land area footprint. An ESCP will be applied to each site to ensure that overland flows are separated into sub-units using low contour mounds or bund devices, as necessary. Each sub-unit will discharge at designated low points. Low point site discharge points will be constructed as broad waterways with geotextile mat and riprap. Low points will drain to waterways that flow into plantation litter layers and supporting drainage systems.
	Overland flows from temporary and permanent laydown. Areas 5ha to >20ha	**Design** As above for substations and wind turbine pads, temporary sites may be in place for 5 years and should be treated with the same level of storm water design rigour as permanent sites.

6.3 Erosion and Sediment Control Plan

The Construction Contractor will be required to prepare a CEMP prior to construction commencing. The CEMP will include management and mitigation measures for the protection of water quality through the implementation of stormwater management and ESC. The CEMP will include an ESCP prepared for each stage and site-specific areas as relevant in accordance with the IECA Best practice erosion and sediment control – for construction and building sites.

The ESCP will be prepared a RPEQ or a CPESC.

6.4 Erosion and sediment control

A preliminary assessment of erosion hazards during the construction phase of the Project has been undertaken as outlined in Table 9. Potential control measures to manage each hazard have been identified. Controls nominated in this Strategy will be referenced in the Civil Specifications drainage design standard as relevant.

Table 9 Erosion hazard assessment

Task	Erosion hazard	Controls
Early works		
Access track widening and pavement upgrades.	Soil and gravel fines enter table drains and local waterways increasing turbidity - sediment.	**Design**- An RPEQ/CPESC approved drainage design/ ESCP and site stabilisation strategy: Adopt IECA best practice approach to design. Is incorporated into FW Civil Specifications. Is required for each access track upgrade work package. Aligns with the Plantation Licensee's drainage. **Test** – Ensure materials used for access track upgrades are not reactive or dispersive. **Mulch** – Pine stump and harvest residues mulched and stockpiled for re-use as drainage temporary cover. **Sediment control** – Ensure drainage levels are surveyed to ensure positive flow away from the road and no ponding in plantations. Deploy geo fabric, bales, sandbags, coir fibre logs, silt fencing and compost filter berms as required to ensure no turbid water leaves the work site. Install silt fence around all sub-base and gravel stockpiles when material is to be held over for any length of time. Install geofabric and rip-rap beds to trap silt and slow water flow rates on low point discharge where slope is >5% for more than 5m. **Rehab** - Apply prescribed native grass seed, nutrition and water to stabilise disturbed areas.

Task	Erosion hazard	Controls
Clearing / de-stumping for turbines, HV lines, substations and laydown areas.	Increased water discharge rate from cleared area or changed grades results in scouring and fine sediment load to waterways. Plantation Licensee minor access track and compartment drains impeded.	**Survey** – Sites surveyed to identify limits to work drainage grades and low points. **Weather** – Monitor weather and avoid clearing during wet weather. **Design** – RPEQ/CPESC approved ESCP to align with established plantation systems and adopts IECA best practice approach. **Soil test** – Include salinity, pH and sodicity analytes in site soil analysis to ensure soils are not reactive or dispersive. Remediate as required. **Mulch** – Tub grind and stockpile all stumps and post-harvest residues. **Remediation** – When clearing is complete, adopt the following as required: Remediate any sub-base material with dispersive soil (saline-sodic) characteristics. Leave cleared surfaces in a “rough” texture state until ready for form and gravel. Install temporary cross drains “whoa-boys” to direct flows into established compartment drainage and away from streams. Apply mulch to upstream side of whoa-boys to filter sediments. Install temporary perimeter bunds, sandbags and blocks if required to retain incident rainfall within the cleared area and direct to low point drains. Apply prescribed pasture and native grass seed, nutrition and water to rapidly stabilise batters and low point drains. Spread stockpiled mulch to site discharge points and batters < 5%. If mulch is not available, install geofabric, bales or silt fencing in low point drains. Where site discharge points are >5% slope, install geofabric and rip-rap ballast to create a waterway and de-energise exit flows.
Construction works		
Construction earthworks turbine pads, substations, HV towers and laydown areas.	Overland flows scour disturbed soil from construction earthworks and deposit suspended fine sediment into waterways and creeks. Plantation drainage compromised by earthworks.	**Design** – RPEQ/ CPESC approved ESCP for the minimum compacted gravel hard surface footprint at all Project assets. Include drainage requirements in Civil Design specifications.

Task	Erosion hazard	Controls
		Align drainage control structures with established Plantation Licensee systems. Adopt IECA best practice approach. **Location** – Maintain at least 50m separation distance major waterways **Construction** -When pads and lay down areas are formed; — Cap vehicle movement areas on turbine pads and laydown areas with road-base. — Use road base to form permanent low-profile contour (1%) berms cross drainage on pads to slow flow rates and direct surface runoff to low point discharge. **Runoff control** – Spread stockpiled mulch to site discharge low points and batters < 5%. When mulch is not available, install geofabric, bales or silt fencing in low point drains; <5% grade. Where site discharge points are >5% slope, install geofabric or, geo-cell and rip-rap to create a waterway. Install sumps if required to arrest any sediments before exiting the worksite. Apply prescribed native grass seed, nutrition and water to rapidly stabilise aprons, batters and low point drains.
Trenching for electrical cable installation	Electrical cables will be buried in existing forestry access tracks. Overland flows scour access tracks with sediment and fines discharge to local waterways and streams.	**Design** – Civil Specification nominates required compaction rates on trench backfill and cap. **Construction** – Adopt a daily trench and backfill work method. Minimal exposed trench at any one time. Avoid trenching in wet weather. When backfilling cable trenches: — Use non-dispersive road base cap (low sodicity) — Ensure compacted road base capping sits proud of the access track surface. **Monitor –** Monitor and top-up any slumps with compacted road base.
Construction traffic	Vehicle frequency results in dust, and pavement degrade leading to silt fines in waterways.	**Standard** – Establish a maintenance work standard for access tracks. **Pavement maintenance** – Access track pavements and drainage to be regularly serviced.

Task	Erosion hazard	Controls
		Regular watering on high use dust risk pavements. Consider access track surface stabilisers on high use dust risk pavements. Ensure table drains are vegetated or filters installed into drains. (bales, mulch).
Operations		
Road maintenance	Light vehicle and periodic heavy transport traffic disturbance to access tracks pavements. Results in sediments and fines discharge to waterways in overland flows.	**Contribution** – FW will recognise the impact of its vehicles on the Plantation Licensee access tracks by contributing to the Plantation Licensee road maintenance for shared roads. The Plantation Licensee access track maintenance standards will apply following handover from the construction phase.
FW Asset site maintenance. FW will undertake infrastructure maintenance works from time to time. These works include: — Minor civil works. — Heavy transport and cranage to repair equipment. — Weed control. — Worksite surface re-sheeting. — Drainage repair.	FW maintenance works may result in disturbance to work site surfaces and exposure of soil to erosion.	**Maintenance Plan** – FW site earth works stability inspection monitoring included in FW Operations Maintenance Plan to be prepared prior to completion of construction. **Monitoring -** FW will implement a monitoring schedule that includes inspection and reporting on FW site erosion hazards and rectification actions. **Maintenance delivery -** FW Estate work team in place to respond to any site-drainage deterioration. **Maintenance approach -** FW estate team will: — Install any temporary drainage controls required to affect any civil works or erosion/spill reduction. — Undertake routine maintenance. — Effect repairs to at risk drainage structures. — Respond to erosion hazard ID reports. Collaborate with the Plantation Licensee to ensure the Plantation Licensee plantation drainage system is not compromised by undertaking works on FW sites.

6.5 Control techniques

Table 10 identifies the controls that may be adopted in the delivery of erosion and sediment management.

Table 10 Control techniques

Control technique	Detail
Soil testing and remediation	Undertake construction site soil testing across the range of soil types to ensure that there are no dispersive or reactive soils. Remediate as required to ensure soil stability around WF facilities.
Design	Adopt IECA designs for erosion and sediment control structures.

Control technique	Detail
	https://www.austieca.com.au/publications/best-practice-erosion-and-sediment-control-bpesc-document. Designs will be adapted to fit specific site requirements. Designs will be prepared and signed by an RPEQ/ CPESC as part of the overall site civil works design. Turbine pad, substation and compound area designs will split hardstand areas into discreet drainage units. The aim is to allow water to leave from several low points rather than one concentrated flow. Designs should aim to put water back into the plantation debris layer and not directly to streams. Site locations will be at least 50m separation from any stream.
Survey	The gradient in many parts of the lowland plantations is subtle. It will be necessary to undertake survey to ensure that established drainage works such as roadside table drains are effective and do not pond water against assets or plantation trees.
Weather monitoring	Contractors will ensure that all temporary drainage control and sediment filter structures are in place at the end of each workday. Monitor weather for predicted rain events. Implement any additional measures to protect the work sites and suspend works during excessively wet conditions where vehicles cause damage (rutting, potholing, soil shear).
Mulch	Pine plantation trees will be salvaged as part of pre-clearing early works. Stumps removed in site preparation will be tub ground and stockpiled. Mulch produced onsite will be free of any “new” weed species. Mulch will be used as a filter or cover material in berms, batters, and drains.
Culverts	Where access tracks pavements are upgraded any water that needs to be moved across the access tracks will be via a culvert drain, not a wet crossing. Culvert size should be appropriate for the upstream catchment.
Sand bagging	Sand bagging can be applied as a temporary measure to trap silts in drains or direct water flows away from sensitive areas. *https://www.austieca.com.au/documents/item/288*.
Coir fibre	Coir fibre can be delivered as a mat or a log. Coir fibre logs can be used as filter material and permeable drain blocks to arrest sediments during construction works. Poor positioning can lead to scouring, overtopping or undermining.
Rip Rap ballast	Ballast rock of various grades up to 200mm can be applied to low point drains where water velocity /energy needs to be diffused and sediments trapped over steeper grades. Rock ballast can be used to develop a permeable barrier that over time will raise the bed of a waterway by trapping sediment and ultimately slowing water velocity by reducing the water way gradient. Where ballast is deployed in waterways it needs to be bedded with geofabric and tied into adjoining waterway banks. Poor design can lead to undercutting, scouring and further erosion.
Silt Fencing	Silt Fencing may be deployed to create a trap for coarse sediments. They are often subject to failure and being undermined if not installed properly. Fencing should be installed around all stockpiles of road base, sand and materials that are not going to be used immediately. Long term stockpile areas should be earth bunded to contain overland flows and direct to sediment sumps.
Bunding	Bunding could be portable or a constructed earth barrier that could be armoured with rock, geofabric, geo-core or mulch filter material. Bunding will be applied around permanent stockpile areas and any areas that contain hazardous substances.
Contour drains	Low constructed contour drains will be installed on compacted road base surfaces to trap and re-direct water flows towards low point drains.
Turn out drains	Plantation Licensee access tracks have an established turn out drain layout. When road pavements are upgraded, turn out drains will be reconditioned to accommodate the new pavement condition. Where drains are exposed, hay bales, coir fibre logs, mulch, geo fabric mat rip rap and sandbagging and geo-cell will be deployed in any

Control technique	Detail
	combination to arrest sediment movement and encourage revegetation to grass cover. Drains will be survey levelled to ensure positive fall and no ponding.
Track Cross drains	Where steeper unformed tracks are to be used, track surfaces will be cross drained with “whoa-boy” cross drain inverts. Spacing will vary with slope and soil type and be installed to fit available turn outs. Drains should be angled at 30 degrees to the track.
Geo-cell	There are a range of products that can be applied to more extensive batters and drains to arrest sediments, contain heavier ballast materials, soil and establish vegetation cover. *https://www.austieca.com.au/documents/item/310*.
Geo-fabric	Geofabrics will be applied to form temporary culvert drains, filters, batter cover and bed matting for rock ballast (rip-rap”). *https://www.austieca.com.au/documents/item/310.*
Bales	Hay bales will be used as a temporary permeable filter in table drains and on batters to slow the flow and arrest seeds and sediment. Bales form a substrate for grass and more stable vegetation.
Sumps and settlement ponds	Sumps should only be employed on sites where increased water volumes and flows are expected or when water quality monitoring indicates existing drainage structures are not delivering the required outcome. Poorly designed settlement dams (sumps) may exacerbate downstream turbidity if not designed appropriately. An RPEQ/ CPESC will be required to design and supervise installation. *https://www.austieca.com.au/documents/item/308*.
Vegetation management	Mixtures of fast-growing pasture and native grasses will be used to stabilise exposed soil batters and waterways. Additional mulch, organic fertiliser, composted materials and periodic watering will be used to ensure effective establishment. Application rates will be based on seed count per kilogram and effective seed germination rates. Seed mixtures up to 10kg per ha can be applied. The Plantation Licensee will be consulted on acceptable species for site stabilisation.
Slope management	Soil type x slope x slope length influence rates of water overland flow and potential erosion. For the most part erosion control structures on slope lengths under 10m and less than 5% grade will be treated with a soft engineering approach i.e. the use of permeable filters, contours and techniques that encourage rapid revegetation to stabilise disturbed sites and waterways. Where slopes exceed 5% and 5m length the designer will need to consider installation of drainage control structures such as geofabric x ballast water ways and diffusion beds below a change of grade to direct and de-energise water before it enters a waterway.
Splitting large areas	Larger FW areas such as substations and compounds will be sub-divided into maximum 2ha drainage units. Each unit will be designed to collect storm flows and direct them through sediment sumps or drainage structures before exiting the FW site. This approach aims to reduce the risk of a concentrated flow at one low point drain.
Plantation Drainage system	The Plantation drainage system is the best filter available to FW. Integrating Wind Farm infrastructure with the Plantation Licensee drainage system and directing water into the plantation will provide the greatest benefit to water quality before it enters a water course.

7. Monitoring

The requirement for water quality monitoring during the construction of the Project will be determined during the final design stage of the layout of the wind turbines and their proximity to waterways. If water quality monitoring is required water quality criteria will be determine with reference to the MREVWQO and GSSENVQO water quality objectives provided in Section 4.3 of this Strategy, existing water quality data and any baseline monitoring that may be completed.

8. Roles and responsibilities

Table 11 defines the proposed roles and responsibilities of site staff with respect to erosion and sediment control, this will be confirmed by the Construction Contractor.

Table 11 - Roles and responsibilities

Role	Responsibility
Project Manager	— Overall responsibility of ESC implementation — Ensure the prompt implementation of measures to mitigate erosion and sediment generation
Project Engineer	— Provide design information as required
Site Supervisor/Foremen	— Monitor daily rainfall — Notify Environmental Advisor when runoff generating rainfall occurs in the previous 24 hours — Installation and maintenance of ESC
Environmental Advisor	— Conduct in-situ monitoring (as required) — Collect and submit samples to laboratory (as required) — Collate results and prepare reports (as required) — Conduct site inspections — Inspect ESC installation and maintenance
Erosion and Sediment Control Auditor / Advisor (CPESC)	— Prepare ESCP — Conduct site inspections and audits (as required) — Prepare audit reports (as required) — Provide advice regarding ESC site improvement (as required)
All Personnel	— Report any damage to ESC devices and any potential or actual environmental harm in line with Duty to Notify under the requirements of the Environmental Protection Act 1994

9. Preliminary Stormwater Management Plan

9.1 General

The State Code 23: Wind Farm development Planning Guideline (2018) requires a Stormwater Management Plan to be prepared in order to meet the requirements for PO7. This Strategy provides background information and principles to support the preparation of a plan by the Construction Contractor as part of the CEMP for the Project. The Queensland Urban Drainage Manual provides general guidance on the requirements for a Stormwater Management Plan.

9.2 Preliminary Stormwater Management Plan

A preliminary Stormwater Management Plan has been prepared for Forest Wind based on the information provided in this Strategy and in accordance with the Queensland Urban Drainage Manual and is provided in Table 12.

Table 12 – Preliminary Stormwater Management Plan

Issue (as per Queensland Urban Drainage Manual)	Control measures
Protection from flooding	The FW Project final land footprint will comprise assets distributed across sub catchments within the Tuan-Toolara-Neerdie State Forests. Permanent assets include up to 226 wind turbines with associated crane hardstands and laydown areas within the Wind Turbine Area. Wind turbines will be located at least 50m from a major watercourse. Turbine and substation construction pad work areas will be surfaced with compacted road base and will be above the surrounding ground level, where possible. Wind farm infrastructure flood risk will be low, however, seasonal soil profile saturation is common in the State Forests. Overland flows are expected during high water table conditions. Drainage structures will be installed to accommodate flood plain management and design structure to accommodate rainfall events with approximately AEP 10% (ARR2016). Each turbine will sit on a raised concrete plinth and water ingress to the turbine tower is not possible. Ancillary or related assets include substations and temporary lay down areas. These assets are planned to be located above localised flood zones.
Acceptable health risk	The Project will be co-located within the Tuan-Toolara-Neerdie State Forests. The project catchments include the Mary River (Tinana Creek) and coastal streams of the Great Sandy Straits. Downstream communities include; Maryborough, Tuan, Maaroom, Boonooroo, Poona and Tinnanbar. FW construction will be delivered over 3-5 years. Construction issues that could result in health risk to communities from stormwater contamination if uncontrolled include: *Construction workers onsite* — Ablutions and sewerage management during construction will involve onsite treatment or closed pump out facilities that will be all weather accessible and lie above any flood zone. *Hazardous substances - Fuels, oils, hydraulic fluids* — All hydrocarbons will be contained in AS1940:2017 compliant storage areas located above flood inundation zones. — All bulk facilities will be hard surfaced and bunded to ensure any spills are contained.

	— Spill kits will be available for deployment. *Cleared land* — Erosion and Sediment Control Plan and this Strategy. FW Operations will occur concurrently with construction until all construction stages are completed. Operations issues that could result in health risk to downstream communities from storm water contamination if uncontrolled include: *Operational staff onsite* — Operations ablutions and sewerage will be onsite treatment facilities located at each permanent compound that will be all weather accessible and lie above the flood zone. *Hazardous substances - Fuels, oils, hydraulic fluids*. — All hydrocarbons used in operations (Unleaded fuel, diesel fuel and hydraulic fluids) will be contained in AS1940:2017 compliant storage areas located at permanent compounds and above flood inundation zones. — All bulk facilities will be hard surfaced and bunded to ensure any spills are contained. — Spill kits will be available for field deployment. *Hazardous substances-Agricultural chemicals* — Minor quantities of herbicide (grass and woody weed control) will be held onsite in permanent compounds for site weed control. All herbicides will be held in bunded sealed and ventilated containers that meet AS2507:1998; The storage and handling of agricultural and veterinary chemicals. *Cleared land* — There will be no land clearing during the operations phase. Minor earthworks will be undertaken to ensure drainage structures and the integrity of Forest Wind land assets are stable and serviceable. The Project's Construction and Operations teams will be additional to the 150-200 forest industry people working in the plantation and associated catchments on any day.
Measures to reduce changes to the volume and velocity of stormwater runoff and changes to the natural flow regime of urban waterways (waterway stability, frequent flow management, catchment imperviousness)	The Project is located within an existing operational exotic pine plantation. While the facility has no urban interface, stormwater flows from Project infrastructure will flow to the plantation compartments and then to streams. The plantation compartments have an extensive network of internal drains, waterways and riparian filter strips that manage water before entry to local waterways and steams. The plantation soils and their ability to cope with stormwater flows are detailed in Section 4.6 of this Strategy. This Strategy details potential erosion hazards and control measures that may be adopted by the Construction Contractor.
Measures to maximise the infiltration of stormwater into the ground, thus providing long-term environmental flows to minor streams	The soils on-site are generally non-dispersive (not sodic, low salinity) however some of the types have a coarse sand component and will be subject to erosion if soils are exposed and waterflow gradients exceed 1% on the coastal lowlands. Heavy coarse sediments will fall out however fine suspended sediments will find their way to streams if not mitigated. Infiltration will be maximised when: — Soil permeability is maintained — Stormwater residency time is maximised.

	This Strategy details potential erosion hazards and control measures that may be adopted by the Construction Contractor. The design will be progressed to minimise the clearing footprint as far as reasonably practical. Where clearing is required, useful plantation trees will be salvaged. Residual stumps may be mulched and stockpiled for re-use on exposed construction work sites, as appropriate. A 5% slope transition has been adopted in this Strategy and considers the following: — On slopes and grades <5%, waterways and low point drains are traffic free zones, stabilised with bales, silt fence, coir fibre or available mulch. Native grass will be established on all non-hardened exposed soil surfaces. — On slopes and grades >5% overland flow controls escalate to engineered installations such as, rip rap, geofabric, low point sumps hydromulching and revegetation to extensive vegetation grass cover on all non-hardened work surfaces. — Regular vehicle traffic will be restricted to hardened surfaces and disturbance to soil aprons and batters will be avoided. — Larger areas, >2ha will be subdivided for drainage purposes to have internal drainage every 2ha. — Low contour mounds will be used to split and slow overland flow velocities on hardened surfaces.
Opportunities to prevent the initial contamination of stormwater and to remove introduced contaminants	Potential stormwater contaminants include: — Coarse and fine sediment transport arising from clearing, road works and civil works on turbine hardstands and substations and towers for the Transmission Line. — Potential spillages from fuel, oil and hydraulic fluids, herbicide chemicals. The ESCP will establish a set of controls and storm water infrastructure design strategies to contain, slow and manage low point exit waterways. Management and mitigation options are provided in Section 6 of this Strategy. To prevent the initial contamination of stormwater the following will be adopted where relevant: — Design for the minimum clearing footprint. — Minimum 50m separation distance between a Project asset and any major waterway. — Survey all clearing worksites and establish all drain outlets. — Apply design strategies to slow water on hard surfaces and drop sediments prior to water exiting Project areas. — Design final landform hard surfaces to split overland water flows. — Use shallow contour mounds on low (1%) fall to slow water and direct to sumps and low point filter strips. — Where grades exceed 5% use low point sumps to capture water and allow sediments to settle out before exiting the worksite. — During construction, use bunding and install filter layers in low points such as bales, silt fence, coir fibre and available mulch. — Native grass will be established on all non-hardened exposed soil surfaces and be traffic free zones. These strategies will enable the Project to capture mobilised sediments before they exit the site. All drainage will be re-directed back into established plantation (high litter layers) compartments. Other considerations will include:

	— Monitor weather forecasts and temporarily suspend works during wet weather where an overland flow (storm event) is anticipated. — Bund and / or filter fence the perimeter of all work material stockpiles (gravel sand). — Native grass will be established on all non-hardened exposed soil surfaces and be traffic free zones. — All access track drainage will be re-directed back into established plantation (high litter layers) compartments. — Water access tracks during construction to minimise dust emissions and fine sediment wash risk.
Options for roadside pollution containment systems i.e. the temporary trapping of pollutants from accident and traffic spills for later removal and treatment	The risk during construction is a hydrocarbon (fuel, oil, hydraulic oil) spill. The Project will: — Ensure bulk fuels and other hydrocarbons are stored in compliant AS1940:2017 bunded containers at compounds. — Bulk fuel containers will not be placed in the plantations. — Field operators will only take enough fuel to the field for one days refuelling at a time or a registered compliant fuel provider will service field plant directly. — Each field construction works team will have a spill kit onsite as a hazard control. — Install filter coir fibre absorbent logs into table drains as a block filter where required. There are no bitumen pavements or concrete drain corridors in the plantation that could be used to contain a spill. Available controls include: — flexible emergency booms to isolate the spill — absorbent material to capture any free hydrocarbons — identify the affected ground and excavate soil at the earliest opportunity using onsite equipment. Contaminated soil will be taken to a registered hazardous waste site for disposal and replacement material installed. Flexible booms and absorbent materials will be held onsite as an emergency response. Any fuel spill would be a reportable environmental incident and subject to investigation and systems review.
Community needs including education and participation in the planning process	A Community Engagement Plan has been prepared for the Project. If required, FWH will: — Inform the community and stakeholders how project construction and operations phases will pro-actively manage water quality and impacts from storm events
Aesthetics, public safety and other social concerns	The Project's drainage system will integrate with the established Plantation Licensee drainage system. All drainage control infrastructure will be located within the Project worksite and connected to the Plantation Licensee system. There is no drainage and storm water infrastructure planned that would have a bearing on aesthetics or public safety. Substation and permanent compound infrastructure will be secured by fencing.
Water conservation and recycling	Water used in concrete batching plants and maintenance of the access tracks will not generate residual water streams. Water used in work team ablutions will be either treated onsite and applied to dedicated land areas or pumped and removed from site. Construction and Operations site office roof surface areas will be used to harvest rainfall, where possible. A poly-tank storage at each office and storage facility will be installed to harvest rainfall for domestic, fire protection and field team use.

Recreational, open space, landscape and ecological values of waterway corridors	Up to 17% of the Plantation Licence Area is Stream Protection Zone comprised of native forest riparian vegetation. The minimum separation distance from any major waterway to a Project asset will be 50m and no turbine substation or compound will be in a place that results in riparian vegetation disturbance. The commercial plantation is dominated by forest silviculture and harvesting activities. There is a requirement for a High Voltage Transmission Line and the prospect of upgrades to existing waterway crossings on forestry tracks that may affect some riparian vegetation. Design will aim to place towers so that streamside vegetation is not disturbed, and ecological values are maintained.
Protection or rehabilitation of riparian vegetation along waterways	The minimum separation distance from a major waterway to a Project asset will be 50m and no turbine substation or compound will be in a place that results in riparian vegetation damage. Minor impacts to vegetation may occur as a result of minor upgrades to existing forestry access tracks and the installation of the Transmission Line. Design will aim to place towers so that streamside vegetation is not disturbed, and ecological values are maintained. Where vegetation has to be removed and not de-stumped FW will adopt a felling strategy that leaves sufficient stump material to encourage epicormic shoot development and coppicing.
Rehabilitation of degraded drainage corridors	A limit of works boundary will be established for each of the work areas. The design objective will be to integrate the Project's drainage system with the Plantation Licensee's established plantation drainage system and direct water to plantation water ways wherever practical. The presence of a wind turbine hardstand will result in a marginal increase in hard surfacing (compacted gravel and concrete plinth). During operations the Construction Contractor will have a field maintenance team that will monitor land assets and make any repairs to drainage.
Integration of stormwater planning with catchment and land use planning	Section 4.4 of this Strategy examines the climatic data for Tuan-Toolara and rainfall intensities where the likelihood of an event occurring with nominated intensity frequency and duration. Storm events (>50mm) are included in this data. The project area is separated into two primary catchments; the Mary River Tinana Creek and the Great Sandy Straits coastal creeks. Tinana Creek flows through plantations, grazing and farmland to Teddington Weir, Maryborough's domestic water supply. The Great Sandy Straits creeks flow through plantations to the Tuan, Boonooroo, Poona communities and into the Great Sandy Straits Marine Park. Relevant plans include: — Wide Bay Regional Water Supply Security Assessment; Department of Energy and Water Supply. State of Queensland, 2016. — Mary River Environmental Values and Water Quality Objectives; EHP 2010. — Great Sandy Strait Coastal Creek Environmental Values and Water Quality Objectives; EHP 2010. — Plantation Licensee Forest Stewardship Certification sustainability principles and supporting Plantation Licensee Management plans.
Consideration to the release of stormwater across beaches or into poorly circulated waters	Drainage across beaches is not applicable.

10. References

IECA Best Practice Erosion and Sediment Control (BPESC). International Erosion Control Association, Australia (IECA).

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Kinnell, P. I. A. (1983). The effect of kinetic energy of excess rainfall on soil loss from non-vegetated plots. Aust. J. Soil Res. 21, 445-53

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Queensland Urban Drainage Manual (2017). 4th ed. Institute of Public Works Engineering Australasia.

A.1 Soils

Great soil group	Aust soil order	Characteristics	Australian soil group code	Principal profile form	Erosion hazard rating (1 low-5 high)	Comment
Gleyed podzolic	*Hydrosol*	Grey loamy sand to sandy loam surface over a conspicuously bleached A2 horizon (0.5 to 0.8m) over an acid, mottled, non-sodic, grey light clay to medium clay.	MF1	Gn3.04	3	Can stay wet for months due to poor drainage and suspended water tables
		Grey or black sand to sandy loam surface over a conspicuously bleached A2 horizon (0.35 to 0.8m) over an acid, mottled, massive, grey sandy clay loam to sandy light clay.	MT1	Gn2.91	3	
Yellow earth	*Kandosol*	Grey loamy sand to sandy loam surface over an acid, mottled, yellow sandy clay loam to clay loam. (Yellow Kandosol)	Mb10	Gn2.74	2	Usually lighter better drained soils
			Mr6	Gn2.24	2	
Yellow podzolic	*Dermosol*	Grey or black loam fine sandy to clay loam surface over a bleached A2 horizon (0.3 to 0.45m) over an acid, mottled, yellow or brown light clay to medium clay with ferruginous nodules	Mf16	Gn3.81	3	Moderately deep well drained
Podzol	*Podosol*	Grey sand surface over a conspicuously bleached A2 horizon (0.25 to 0.5m) over a brown sand B2 horizon (0.35 to 0.65m) over a bleached sand (0.75 to 1.1m) over an acid, mottled, structured, grey sandy light clay to sandy medium clay. (Possible coffee rock underlay)	Cb31	Uc2.33	3	

Great soil group	Aust soil order	Characteristics	Australian soil group code	Principal profile form	Erosion hazard rating (1 low-5 high)	Comment
Soloth	*Sodosol*	Grey or black fine sandy loam to clay loam fine sandy surface over a conspicuously bleached A2 horizon (0.15 to 0.35m) with ferruginous nodules over an acid, mottled, grey or occasionally brown medium clay to heavy clay (0.35 to 1.5m) over weathered rock.	Tb76	Dy3.41	4	Potential for sodium presence and instability if exposed
	Tenosol	Well structured, organic matter darkened surface (A) horizons but no significant pedologic development at depth. They are moderately to strongly acid and are commonly underlain by a gravel bed at about one metre depth	Fu5	Um2.12		

A.2 Erosion Hazard Rating

Soil type hazard rating	1 low-5 high
Australian soil order	
Hydrosol	3
Kandosol	2
Dermosol	3
Podosol	3
Sodosol	4

Slope hazard rating		1 low-7 high
From	**To**	
0%	2.999%	1
3.00%	4.999%	2
5.00%	9.999%	3
10%	14.999%	4
15%	19.999%	5
20%	24.999%	6
25%	30.00%	7

Area hazard rating		1 low-6 high
From ha	**To ha**	
0.5	1	1
1	1.999	2
2	3.999	3
4	9.999	4
10	19.999	5
20	999	6

Soil type	Slope rating	Area rating		Erosion risk
1	1	1		Low
2	2	2		
3	3	3		Medium
4	4	4		
5	5	5		High
5	6	6		
5	7	6		

A.3 Rainfall Intensity Tuan Toolara

Rainfall depth and intensity for a range of durations and annual exceedance probabilities are detailed below. Data Source: Bureau of Meteorology; Australian Rainfall and Runoff (ARR2016).

Link:

http://www.bom.gov.au/water/designRainfalls/revised-ifd/?multi

Terms:

Exceedances per Year -(EY) the number of times an event is likely to occur or be exceeded within a given year.

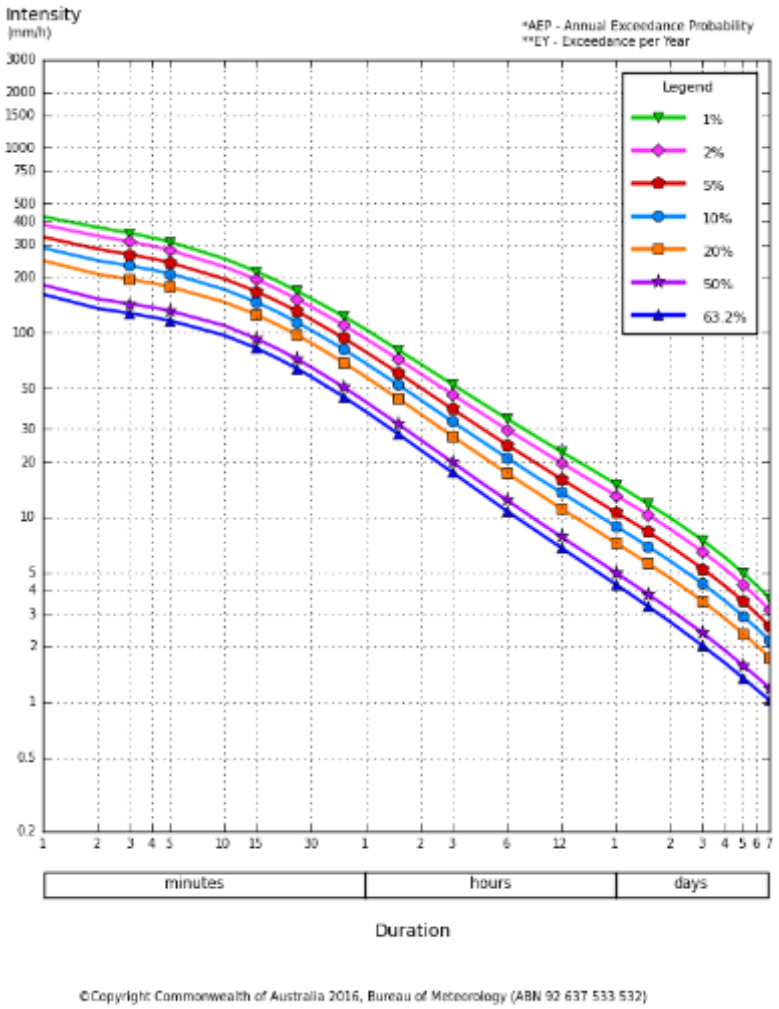
Annual Exceedance Probability (AEP) – the probability or likelihood of an event occurring or being exceeded in any given year, usually expressed as a percentage.

IFD Design Rainfall Intensity (mm/h)								
Issued:	14-Feb-19							
Location Label:								
Requested coordinate:	Lat	-25.765	Long	152.809				
Nearest grid cell:	Lat	25.7625 (S)	Long	152.8125 (E)				

		Annual Exceedance Probability (AEP)			1 in 10	1 in 20	1 in 50	1 in 100
	Duration	63.20%	50%	20%	10%	5%	2%	1%
1 min		161	181	245	287	329	383	424
2 min		135	152	207	245	283	333	371
3 min		127	143	194	230	264	311	346
4 min		121	137	185	218	251	294	326
5 min		116	131	177	209	239	279	310
10 min		96.5	109	146	171	195	227	251
15 min		82.3	92.6	125	146	167	194	214
20 min		71.8	80.9	109	128	146	170	188
25 min		63.9	72	97.2	114	131	152	168
30 min		57.7	65	87.9	103	118	138	153
45 min		45.1	50.9	69.1	81.6	93.8	110	123
1 hour		37.4	42.2	57.6	68.2	78.7	92.7	104
1.5 hr		28.4	32.1	44.1	52.4	60.8	72.1	80.9
2 hr		23.2	26.3	36.3	43.3	50.4	60	67.7
3 hr		17.5	19.9	27.5	33	38.6	46.3	52.5
4.5 hr		13.2	15	21	25.3	29.7	35.8	40.8
6 hr		10.8	12.4	17.3	21	24.7	29.9	34.2
9 hr		8.25	9.43	13.4	16.2	19.2	23.4	26.8

12 hr	6.82	7.82	11.1	13.6	16.1	19.7	22.6
18 hr	5.22	6.02	8.67	10.6	12.6	15.5	17.9
24 hr	4.32	5	7.25	8.91	10.6	13.1	15.1
30 hr	3.72	4.32	6.31	7.78	9.31	11.5	13.2
36 hr	3.29	3.83	5.62	6.94	8.33	10.3	11.8
48 hr	2.7	3.15	4.66	5.77	6.94	8.58	9.89
72 hr	2.01	2.36	3.51	4.37	5.26	6.51	7.51
96 hr	1.62	1.89	2.82	3.51	4.23	5.23	6.04
120 hr	1.35	1.58	2.35	2.92	3.52	4.34	5.01
144 hr	1.16	1.36	2.01	2.49	2.98	3.67	4.24
168 hr	1.02	1.19	1.74	2.15	2.57	3.15	3.65

Intensity example; Rainfall with an intensity of 68.2 mm/hr can be expected on a frequency of 1 in 10 years (AEP10%)



Tuan Toolara rainfall intensity (mm/hr) for durations (mins, hrs, days) and Annual Exceedance Probabilities (AEP)