GOO-GRS-HS-PLN-0003

Soil & Water Management Plan

Project: GOONUMBLA

Author	Rev.	Aprob.	N.º	Reason of issue	Date
SL	DT	JMM	A2	Incorporate comments from Parkes Shire Council	19/06/2019

Plan Control

The latest approved version of this Plan will be available for all Project personnel on the Electronic Document Management System 'AIMS'.

Uncontrolled Copies

All uncontrolled hard copy documents will be up-to-date at issue and issued to outside organizations, customers, etc., upon request and approval by a Workplace Manager. Such uncontrolled documents will be clearly marked "Uncontrolled Copy When Printed" and will not be subject to an update.

Review & distribution

This document will be reviewed according to the section Document Amendment and distribution of this document.

The Integrated Management System - Systems Representative on the Project is responsible for the controlled internal distribution of this document and changes. Personnel have access to the latest revision of the Plan through AIMS.

Disclosure

Title roles and responsibilities mentioned within this Plan are not intended to be formal designation. Position titles, roles and authority can be subject to change. The titles listed within this Plan are a conventional depiction of the role's function.

Revision History

As per section in this document Revision status

This document is an 'uncontrolled copy when printed'.

Controlled copies are stored on the document management database.

Note:

This Plan is subject to modification and adaptation to the meet the specific Project Scope Requirements or Contract Specifications. The content listed within provides the general processes and procedures undertaken by GRANSOLAR at corporate level.

The content of this document is subject to each Workplace contractual and Client requirements.

Index

1 INTRODUCTION

1.1 *Purpose*

The purpose of this Soil and Water Management Plan (SWMP) is to provide a strategy to control soil and water related impacts during construction in the goonumbla Solar Farm project.

The aim of this Plan is to comply with all statutory requirements and implement all environmental controls listed in this SWMP to ensure that construction activities that have the potential to impact on soil and water are controlled to avoid degradation of the environment.

In **Appendix 2** is attached a **Compliance Summary Table with Development Consent Conditions** where can be checked easily all the matters considered in the Development Consent Conditions and the section of this document where the matter is addressed

1.2 *Document Responsibilities*

Responsibility	Role
Development	Environmental Manager
Review	Project Manager
Approval	Project Director

Any person may request updating of this Plan.

1.3 *Document Amendment and Distribution*

This document shall be reviewed as follows:

- ✓ As requested by Management Review
- ✓ When there is a change of method and/or technology that may affect the accuracy of this document; or
- ✓ When there has been a significant event to which this document was relevant; or
- ✓ As a result of a non-conformance resulting from an audit

New and amended documentation issued after the initial approval and distribution of this plan to controlled copy holders shall be identified in the Document Control Register. Revision details shall be recorded in the Revision Status Section of this plan.

All changes to documents shall be reviewed and approved by the same function that performed the original review and approval and as per the cover of this plan, unless specifically designated otherwise.

1.4 *Revision Status*

Revision	Revision Date	Issued Date	Nature of modification
A1	03/06/2019	03/06/2019	Issue to comply with DC conditions 21, 22 & 23.
A2	19/06/2019	19/06/2019	Comply with the comments from Parkes Shire Council.

1.5 *Key Reference Documents*

The SWMP is to be read in conjunction with the below mentioned Management Plans to be developed in the time frames as noted within the contract agreement and to enable site works to commence as quickly as possible:

Construction Management Plan
Logistic Management Plan
Mobilisation & Site establishment Plan
Subcontractor Management Plan
site Vehicle Movement Plan (VMP)
Health & Safety Management Plan
Environmental Management Plan
Soil & Water Management Plan
Cultural Heritage Management Plan
Emergency Response Plan
Traffic Management Plan
Communication Management Plan
Procurement Management Plan
Quality Plan

2 DEFINITIONS

GRS	Gransolar
EMP	Environmental Management Plan
SWMP	Soil and Water Management Plan

3 PROJECT DESCRIPTION

3.1 *Project Overview*

The Goonumbla Solar Farm site is located about 10 Km West of the city of Parkes in the central West of NSW in a locality known as Goonumbla.

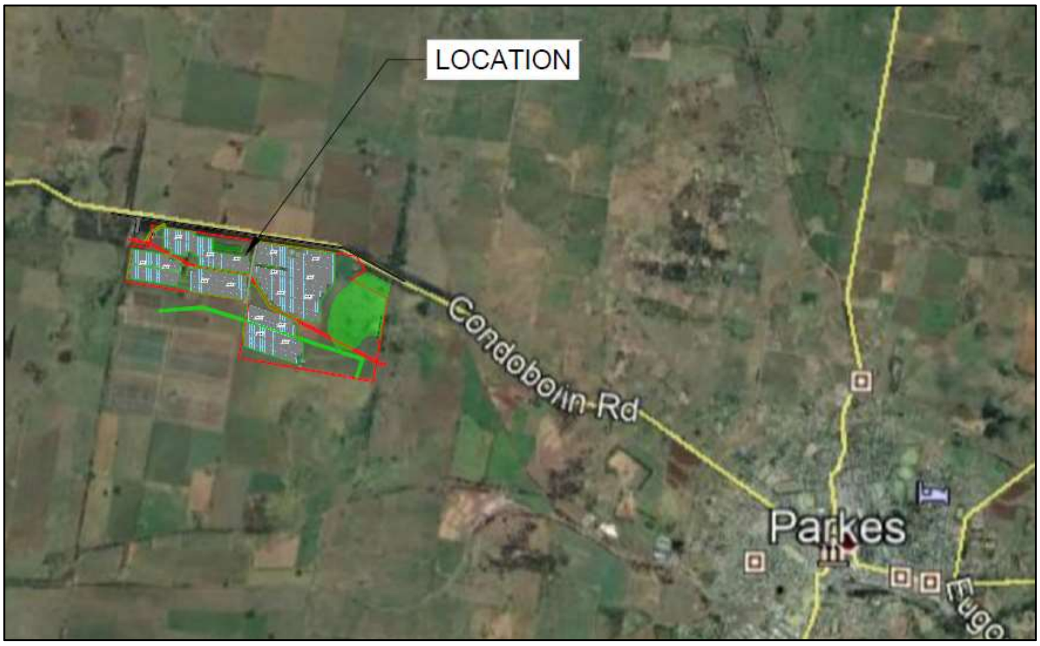


Figure 2.1.1 Site Location

The site is located in the western part of Millers Lookout Road and Henry Parkes Way at north. The site consists of an area of approximately 385 ha of rural land. Out of this area, a maximum of 200 ha aprox. will be utilised for electricity generating equipment.

The geographic coordinates of the project are:

- Latitude: 33º 06'14.61'' S
- Longitude: 148º 5'25.89'' E
- Elevation: 283 m.a.m.s.l.

The construction will last approximately 12 months and the plant will be operated for a duration of 25 years. This document covers the construction stage.

GRS is the Principal Contractor for the scope of works, and is responsible for Engineering, Procurement and Construction (EPC).

The project will be delivered in a number of stages outlined below:

Stage 1 – Civil works consisting of land clearing, levelling and earthworks, internal road construction, drainage installation, laydown area preparation, fencing installation, site establishment, preparation of delivery station and inverter station, and vegetation screening/landscaping.

Stage 2 – Mechanical works consisting of foundation piling (ramming and augering), tracker installation, module installation and delivery.

Stage 3 – Electrical works consisting of solar cabling of aerials and conduits, DC main cabling via direct burial, MV cabling from inverter station to delivery station through direct buried, module connection, connection of junction boxes-inverters-delivery station, connection to grid and finally testing and commissioning.

Stage 4 – Substation works consisting of all civil and electrical works related to the new Substation.

For further information about the Project Scope please refer to the Construction Management Plan.

4 ORGANISATION

4.1 Responsibilities and Authorities

The Project Organisational chart and overall roles and responsibilities are outlined in the Project Quality Management Plan, being the key responsibilities for Soil and Water Management are as follows:

a) Project Manager

- ✓ Ensuring appropriate resources are available for the implementation of this plan
- ✓ The Project Manager is responsible for obtaining client approval in accordance with Contract conditions

b) HSE Coordinator

In relation to Soil and Water management, the HSE coordinator is responsible for:

- ✓ The HSE coordinator is responsible for reviewing the SWMP to ensure it meets Contract conditions and other Stakeholder requirements
- ✓ Providing assistance and advice to the Project Engineers and Environmental Coordinators to fulfil the requirements of this Plan, assessing data from inspections, monitoring and reporting, and providing project-wide advice to ensure consistent approach and outcomes are achieved
- ✓ Ensuring data is collected/reported and associated records maintained (e.g. delivery/waste dockets)
- ✓ Ensure that the workforce identify, analyse and treat the risks before commencing works each day and ensure that the appropriate controls are implemented and effective; thus controls may be increased or decreased as required
- ✓ Reviewing weather forecasts and current weather observations
- ✓ Maintaining sediment and erosion controls on a weekly basis, or daily during and immediately after rainfall
- ✓ In the event that a complaint is received, to conduct an investigation to determine the potential parameters of influence and assess that all control measures are effective
- ✓ The HSE coordinator is also responsible for the review and update of this Plan

c) Civil Superintendent

- ✓ Identifying, analysing and treating the risks before commencing works each day and ensuring that the appropriate controls are implemented and effective; thus controls may be increased or decreased as required

- ✓ Reviewing weather forecasts and current weather observations
- ✓ Maintaining sediment and erosion controls on a weekly basis, or daily during and immediately after rainfall

d) All Workers on Site

In relation to Soil and Water management, all workers on site are required to:

- ✓ Implement and maintain all applicable control measures
- ✓ Report any potential and/or actual incidence of sediment/erosion
- ✓ Report any potential incident that could contaminate water bodies

5 APPLICABLE REQUIREMENTS

5.1 *Legal Requirements*

The following Acts, Regulations and Standards are applicable to this Project:

- ✓ Protection of the Environment Operations Act 1997
- ✓ Environmental Planning and Assessment Act 1979
- ✓ Environmental Planning and Assessment Regulation 2000
- ✓ Contaminated Land Management Act 1997
- ✓ Soil Conservation Act 1938
- ✓ Water Management Act 2000
- ✓ Managing Urban Stormwater: Soils and Construction, Volume 1, 4th Edition (Landcom 2004) (Blue Book)
- ✓ Department of Environment and Climate Change NSW, 2008, Managing Urban Stormwater: Soils and Construction – Volume 2A Installation of Services
- ✓ NSW State Groundwater Quality Protection Policy (Department of Land & Water Conservation 1998)
- ✓ Bunding and Spoil Management (EPA 1997)
- ✓ ANZECC (2000) Australian and New Zealand Guidelines for Water Quality Monitoring and Reporting (collectively known as the “ANZECC Guidelines’)

5.2 *Contractual Requirements*

GRS have identified the most critical Environmental Contractual requirements for the project (Captured in Appendix 1) these are:

- ✓ Submission and management through Council
- ✓ The Applicant shall ensure that the development does not cause any water pollution, as defined

under Section 120 of the POEO Act.

- ✓ The applicant must:
  - (a) Minimize any soil erosion associated with the construction, upgrading or decommissioning of the development in accordance with the relevant requirements in the Managing Urban Stormwater: Soils and construction (Landcom, 20014) manual, or its latest version; and
  - (b) Ensure solar panels and associated infrastructure are designed, constructed and maintained to avoid causing any tunnel erosion on site.
- ✓ The Applicant must:
  - (a) Prepare detailed Stromwater Plans for the site to the satisfaction of council, in accordance with the requirements in Council´s Engineering Guidelines – Subdivisions and Development Standards and Stormwater Drainage and disposal Policy; and
  - (b) Submit a copy of these plans to the Department of Planning and Environment.

6 COMPETENCE, TRAINING AND AWARENESS

As stated in the EMP all project personnel, subcontractors and consultants will receive training in the group and personal environmental obligations during the Site Inductions and Toolbox Talks. From time-to-time staff may also attend specific training sessions, when necessary, by the HSE coordinator.

Examples of topics that will be covered during project induction and toolboxes include:

- ✓ Stormwater pollution prevention
- ✓ Protection of groundwater system

7 SOIL AND WATER MANAGEMENT

7.1 *Objectives*

The environmental objectives regarding to Soil and Water Management during the construction phase are:

a) Surface Water

Surface water management objectives are as follows:

- ✓ Protection of the ecosystem surrounding the project area
- ✓ Emissions are to not adversely affect environmental values or the health, welfare and amenity of people and land uses
- ✓ Statutory requirements will be implemented, and acceptable agreed standards will be monitored and maintained
- ✓ Minimisation and management of potential impacts to the quality of surface water resources caused by the Construction work
- ✓ Maximisation of the efficient use of water for the project
- ✓ Ensure the continued use of water resources

b) Groundwater

Groundwater management objectives are as follows:

- ✓ Maintenance and protection of the quality and use-ability of groundwater within the underlying groundwater system
- ✓ Minimisation and management of potential impacts to the quality of surface water and groundwater resources caused by the Construction work
- ✓ Maximisation of the efficient use of water for the Project

c) Soil

The soil and erosion management objectives are:

- ✓ To reduce the potential for erosion and subsequent sedimentation
- ✓ Ensure that stockpiles are managed effectively to minimize any sediment run off

7.2 Potential Environmental Impacts

a) Surface Water

Potential environmental impacts to surface water:

- ✓ Alteration in hydrology and hydrogeology of the environment of underlying aquifer(s), estuaries, lakes and rivers; as a result of disturbance to groundwater-surface water connectivity
- ✓ Impacts to water quality due to landfill contaminants and leachate seeping into the groundwater and surface water bodies
- ✓ Indirect surface water contamination risks associated with construction activities adjacent to a lake and river environment due to chemical and fuel spills, unmanaged stormwater flows and run-off

b) Groundwater

No Groundwater Dependent Ecosystems are known to occur within the site. As the Project would not alter existing groundwater supplies within the solar farm site, it is considered that impacts to Groundwater Dependent Ecosystems (GDE) are not likely to result from the Construction. Furthermore, the Goonumbla solar Farm is not predicted to have any impact on any High Priority Groundwater Dependent Ecosystems (GDEs) listed in the relevant Water Resource Plans (WSPs) given their distance from the proposal site.

c) Soil

Potential environmental impacts to soil are:

- ✓ Sediment runoff from newly exposed surfaces
- ✓ Sedimentation of waterways, wetlands, swamps and low-lying areas
- ✓ Increased turbidity in creeks and associated waterways
- ✓ Sedimentation of creeks, swamps and low-lying areas

- ✓ Sediment runoff/water pooling during heavy rainfall events

Erosion and sedimentation impacts associated with soil disturbance from construction activities can be minimised by undertaking works in accordance with provisions of the Managing Urban Stormwater: Soils and Construction series, in particular:

- ✓ Managing Urban Stormwater: Soils and Construction, Volume 1, 4th edition (Landcom 2004), known as 'the Blue Book'
- ✓ Volume 2A Installation of Services (DECC 2008a)
- ✓ Volume 2C Unsealed Roads (DECC 2008b)

7.3 Management and Contingency Mitigation Measures

Management and contingency mitigation measures (including the erosion and sediment control plan) will be carried out in accordance with the Rainwater Drainage Calculation prepared for the Project (see Appendix 3).

a) Excavation and Removal of Uncontrolled Fill/Contaminated Soils

If any onsite excavation and removal of uncontrolled fill/contaminated soil to waste control facilities is required (not anticipated) it will be undertaken as follows:

- ✓ Uncontrolled fill areas will be surveyed and clearly marked by offset pegs
- ✓ Uncontrolled fill will be analysed to assess the level of contamination before excavation. The level of contamination will determine the procedures to be followed during excavation, haulage and placement
- ✓ The area will be heavily watered before the excavation of uncontrolled fill commences
- ✓ Uncontrolled fill will be directly loaded into semi-tipper road trucks
- ✓ Each truck will be issued with a docket detailing the level of contamination, the wright, the source of excavation and the destination of the exaction
- ✓ Each truck will pass over the wheel wash system before exiting the site
- ✓ Each truck will receive an official receipt from a licensed waste disposed facility detailing the tonnage and Class of material received
- ✓ All volumes of uncontrolled fill will be documented and recorded
- ✓ All documentation will be received and collated by the project team and will be available for the State's representative to audit
- ✓ Wheel wash will be cleaned and emptied regularly to ensure correct wash down procedures are adhered to
- ✓ If asbestos or Asbestos Containing Material (ACM) is identified soils/material will be managed in accordance with procedures outlined in the Safety Management Plan (SMP).

b) Acid Sulphates Soils (ASS)

Acid sulphate soil is the common name for soils that contain metal sulphides. In an undisturbed and waterlogged state, these soils may pose no or low risk. However, when acid sulphate soils are disturbed or exposed and react with oxygen, they produce sulphuric acid which may be accompanied by certain hazards. Metals may be released from sediments and become bioavailable in the environment, oxygen may be removed from the water column and gases such as hydrogen sulphide, sulphur dioxide and methane may be released.

ASS runoff has significant environmental, economic and social impacts on coastal communities. Besides the obvious impacts on the environment such as fish kills, death of other aquatic organisms and decline of riparian and aquatic vegetation, acid runoff has been attributed to the decline or failure of agriculture, fishery and aquaculture industries. The ecological damage can also affect valuable tourist resources including fishing grounds, swimming areas and other water sports areas. Acid discharges can damage infrastructure services and structures such as pipes, foundations, drains, bridges and flood controls. High levels of iron and manganese may precipitate in receiving waters, causing aesthetic issues, staining infrastructure, coating aquatic vegetation and preventing photosynthesis or blocking the gills of aquatic fauna. High levels of some elements such as aluminium and arsenic may also have human health implications.

If ASS are present on site the following management measures shall be applied:

1. The disturbance of ASS should be avoided wherever possible. This is by far the best option, both economically and environmentally.
2. Where disturbance of ASS is unavoidable, preferred management strategies are:
    - minimisation of disturbance
    - neutralisation
    - strategic reburial
3. Other management measures may be considered. All strategies must be subject to detailed technical assessment and must not pose unacceptably high risks to human health, the environment or infrastructure.
4. Where disturbance of acid sulphate soils is likely, a management plan is required for any works which may disturb the soil or groundwater. This plan should detail the technical feasibility of measures proposed to manage risks
5. Receiving waters (marine, estuarine, or fresh) shall not be used as a primary means of diluting and/or neutralising ASS or associated contaminated waters
6. Stockpiling of untreated ASS with or without containment is not an acceptable long-term management strategy. Soils that are to be stockpiled, placed as temporary or permanent cover on land or in waterways, sold or exported off the treatment site or used in earth bunds must be treated / managed to eliminate the short- and long-term risks of pollution.

The following issues should be considered when formulating ASS environmental management strategies:

- ✓ the sensitivity and environmental values of the receiving environment. This includes the conservation, protected or other relevant status of the receiving environment
- ✓ whether groundwaters and/or surface waters are likely to be directly or indirectly affected

through overland flow or infiltration

- ✓ the heterogeneity, geochemical and textural properties of soils on-site; and
- ✓ the management and planning strategies of Local and/or State Government, including Catchment Management Plans/Strategies and Coastal Management Plans

c) Control of Other Potential Sources of Stormwater Pollution

The following sections describe the control measures to be used at the Project construction site to prevent and/or minimise the contamination of stormwater from other potential sources of pollution on site. Details regarding the siting criteria, size, design, maintenance and operation of the non- hazardous and hazardous waste management areas can be found in the specific waste management plan.

i. Concrete and Bitumen

There are a few non-hazardous wastes generated from the pouring of concrete namely: discarded forms made of wood, cardboard, plastic or metal materials; waste or surplus concrete; and, rinse waste used to clean concrete handling tools.

Set or cured concrete or asphalt poses little risk to the environment unless it is cut or crushed. Any water that comes into contact with unset concrete, concrete fines, concrete dust or concrete washings becomes highly alkaline (i.e. it has a very high pH). This water will burn and kill all fish, aquatic insects and plants that come into contact with it.

The contaminated water cannot be diluted to a level that is safe for discharge to the receiving environment. If it enters the sea or a stream, it only spreads the contaminated water further. It would take at least 100,000 litres of clean water to dilute the concrete fines from a very small cutting job to a neutral pH (pH7).

Asphalt / bitumen rinse and cutting waste water contains large amounts of hydrocarbons (i.e. like petrol), which are very toxic to people, plants and animals. Hydrocarbons cannot be diluted to a level that is safe for discharge to the receiving environment.

On the event that concrete or bitumen works are to be performed on site the following guidelines will be applied:

- ✓ Do not undertake concrete or asphalt works if there is a chance of heavy showers or rain
- ✓ Disposable concrete forms will be collected and disposed as any other general construction waste. Excess or surplus concrete delivered for a pour will be returned to the concrete supplier or used in another area or pour if possible. Supply management and delivery schedules will be coordinated to minimise any surplus concrete from being delivered to the site
- ✓ Rinse water (rinsate) from the cleaning of concrete handling tools will be held in a lined basin or tank until it can be reused for cleaning tools or used for curing concrete, or returned to the concrete supplier for reuse
- ✓ Hardened concrete waste will be hauled off-site to a concrete recycler; or, sent to a landfill for disposal if a suitable recycler cannot be found.
- ✓ Where possible, completely block off stormwater drains with drain plugs and use a submersible pump or vacuum truck to remove contaminated run off from the catchpit. If this is not practicable then careful sandbagging or bounding around the catchpit grate can be used as an alternative

- ✓ Minimise the amount of water used on site - as it means there is less to control
- ✓ Dust is created during dry concrete or asphalt cutting. Use saws that can have a vacuum attached to minimise the amount of dust
- ✓ Use a wet / dry vacuum, or vacuum truck for larger jobs, to collect all concrete or asphalt contaminated material or runoff on site. If this is not practical, then divert all run off to the construction pit or unsealed ground, away from surface water flow paths
- ✓ Use of a tarpaulin sheets under concrete pumps and delivery chutes should be used to capture any spills.
- ✓ Concrete trucks or concrete pumpers to wash out on designated wash area.

ii. Spoil Disposal

Excess soils (non-contaminated) will be reused on site. Appropriate erosion control measures will be implemented for all soil stockpiles on the construction site.

iii. Sanitary Wastes

Typically, construction site will utilise portable toilets and/or septic holding tanks to hold sanitary wastewater. The sanitary wastewater is periodically removed by vacuum truck and disposed of at a domestic wastewater treatment works. Only licensed waste haulers will be utilised to service the septic holding systems on site.

iv. Dewatering Practices

It may be necessary to conduct dewatering operations during the installation of underground utilities (e.g.: electrical conduits, telephone lines), excavating for structural foundations, water piping, sewer and stormwater piping, and excavation for installation of the sewer pump station. To minimise the entrainment and discharge of sediment-laden water, the following practices will be used when dewatering is necessary (sheet piling options will also be assessed):

- ✓ Intakes of pump hoses used to withdraw water from trenches or excavations will be elevated above the bottom of the trench/excavation to minimise pumping of sediment
- ✓ Locations for discharge of water will be visually inspected and approved by the HSE Manager or designed
- ✓ The discharge should be directed to a containment structure, surrounded by silt fence to allow settlement of solids
- ✓ Under no circumstances will trench or excavation water be directly discharged onto exposed soil or into any surface water body
- ✓ Any dewatering of pits or other below-grade areas, where stormwater might temporarily accumulate before being fully developed, will be directed to a vegetated area
- ✓ If water must be discharged to the municipal stormwater collection system, necessary permits and/or approvals will be obtained prior to discharge
- ✓ Dewatering activities must be approved by HSE coordinator and a dewatering permit issued

v. Stormwater Discharge

Stormwater should be considered as a potential resource for reuse if possible. GRS will capture stormwater within the catchment area and where the water quality meets the water quality objectives for the site this water will be used for flushing, cooling water or dust suppression.

The excess stormwater within the construction area, after it has been effectively treated and reused will be discharged to a local government or Water Corporation main drainage system, where approved after consideration of flow capacity and water quality characteristics.

vi. Hazardous Substances

Common hazardous materials that are typically used on site during the course of construction, or waste generated as a result of their use, may include (but are not limited to):

- ✓ Petroleum products and lubricants
- ✓ Solvents and thinners
- ✓ Acids and bases
- ✓ Waste oil (e.g.: hydraulic fluids)
- ✓ Used oil filters
- ✓ Paint wastes
- ✓ Batteries

vii. Material Storage Areas

On site storage areas for hazardous substances (new materials for use in construction) will be designed and maintained to prevent and/or minimise any contact with stormwater. Containers of hazardous substances will always be kept closed when filing or dispensing product and materials will be kept in their original shipping containers until used.

Designated storage areas will be designed with an underlying impermeable surface (e.g.: concrete or plastic lining) surrounded by curbing, dikes or other means to prevent their release into the environment (self-bounded containers will also be assessed).

viii. Waste Storage for Disposal Areas

The Project site will have designated storage areas, for the temporary storage of containerised wastes (and oil destined for offsite recycling) generated during the course of construction activities.

Containers of hazardous wastes will always be kept closed except when filling.

The temporary storage area will be under the control of the site construction contractor and all wastes placed in this area must be cleared prior to being transferred. Similarly, contractors with the need will be allowed to temporarily retain hazardous wastes on site in Satellite Accumulation Areas immediately adjacent to their primary work locations for the limited storage (time and amount) of hazardous waste generated during their work activities.

Both the storage area and any Satellite Accumulation Areas will be designed with a roof (or equivalent) and an underlying impermeable surface surrounded by secondary containment to minimise the mixing of waste with stormwater and to prevent the direct release of liquid wastes to the environment.

ix. Vehicles and Equipment Operations

Vehicle maintenance will typically be performed in designated areas on the construction site. These areas will be located away from stormwater drainage pathways and offsite water courses in order to minimise the potential for stormwater pollution. A roving maintenance truck will also be used to perform routine refuelling and maintenance activities (e.g.: oil, lubricant and coolant changes, filter changes) on vehicles and equipment at their work location on the Project site.

Standard Operating Procedures on site will require that all used or spent fluids resulting from these maintenance activities be collected in sealed, marked containers and transferred to the storage area for temporary storage prior to recycling or disposal off site at a licensed facility. Furthermore, authorised personnel responsible for performing this type of maintenance will be required to ensure that they have access to spill clean-up materials prior to beginning these activities.

Similarly, the roving maintenance truck will be equipped with a spill kit (e.g.: pads, absorbents) and the used oil, lubricants and collected in closed containers to further minimise the potential for spills to the environment. The truck operator will be knowledgeable about conducting refuelling and maintenance activities in accordance with standards spill prevention practices, including performing these activities only in locations that do not pose a significant risk to on or off-site environmentally sensitive areas.

x. Stockpiling of Contaminated Soils

Potentially contaminated soils will be located away from surface water channels and conduits. Stockpiles will remain protected from surface runoff with plastic sheeting cover, and sandbags to prevent the spread of contamination during a storm event.

xi. Spill Response

All site personnel will be informed that in the event hazardous substances are spilled onto the ground, they are to immediately contact the HSE Manager to initiate proper clean-up response activities. In the event of a spill, site personnel will be required to prevent further spillage, contain the spill, and begin clean-up when directed.

8 IMPLEMENT CONTROLS

8.1 Soil and Water Management Control Measures

Environmental risk control measures and responsibilities for identified actions to minimise and mitigate Soil and Water impacts during construction are outlined in below table- Soil and Water Mitigation Measures below.

Table 1 - Soil and Water Mitigation Measures

Source/Reference			
Mitigation Measure	**Responsibility**	**Timing**	**Records**
Incorporate discussion on Soil and Water measures into Site Induction.	HSE Manager	Pre-Construction	Project Site Induction
Establish and seek approval (if required) for detailed sedimentation basins and appropriate water runoff controls – both temporary during construction and permanent post construction.	HSE Manager/ Project Manager	Pre-Construction	Plan to be submitted to Council prior to commencement
Establish all appropriate water controls, including sediment basins, diversion drains etc.	HSE Manager	As required	Environmental Inspection
Ensure all stormwater collection points are protected with sediment and erosion controls as appropriate for the site	HSE Manager	Ongoing	Environmental Inspection

Inspect and maintain sediment controls	HSE Manager	Following a Significant rainfall event	Environmental Inspection
Stockpiles management Sediment fences will be installed prior to stockpiling material Stockpiles that are proposed to be at a location for an extended period will be seeded to stabilise the surface and minimise sediment runoff and wind erosion. Stockpiles are not to be placed inside vegetation protection areas or within drip zones of retained trees. Stockpiles are not to be located near watercourses.	HSE Manager	Ongoing	Environmental Inspection
Unsealed Road/Surface Management Unsealed surfaces will be wetted down with a water cart. Runoff from unsealed surfaces will be directed towards site drainage structures such as catch drains and sediment basins.	HSE Manager	Ongoing	Environmental Inspection
Wastewater from site amenities to be removed by a licensed waste subcontractor and disposed of at an appropriate facility.	Subcontractor	Ongoing	Waste Register
Vehicle wash-down areas will be located 20-50m away from watercourses.	HSE Manager / Superintendent	Ongoing	Environmental Inspection
Dewatering within the construction site will be discharged to a construction sediment basin. Where this is not appropriate, dewatering can be discharged onto vegetated areas 50m away from any waterway or drainage line.	HSE Manager / Superintendent	Ongoing	Environmental Inspection
All water captured in the construction sediment basins will be allowed to settle before being discharged as clear water into a waterway or drainage line. If the water is not clear, it cannot be discharged. Where required sediment basins may be treated with a flocculent to reduce turbidity and settle suspended sediments.	HSE Manager / Superintendent	Ongoing	Environmental Inspection
When releasing captured water from the sediment basins it must be clear. If it is not clear it is not to be pumped.	HSE Manager / Superintendent	Ongoing	Environmental Inspection
Sediment basins will be maintained to ensure that the amount of accumulated sediment does not exceed 60% of the sediment storage area.	HSE Manager	Ongoing	Environmental Inspection
Accumulated sediment will be removed with plant equipment but must not damage the structures. Removed sediment must be disposed of appropriately and must not enter waterways.	Superintendent	Ongoing	Environmental Inspection
Maintenance of the construction sedimentation basins will be monitored by completing weekly checklists.	HSE Manager	Ongoing	Environmental Inspection
Location of sediment fencing and stockpiles to be discussed with HSE Manager pre-construction.	Superintendent	Pre-construction/ design	Environmental Inspection
Incorporate discussion on sediment and erosion sources, impacts and mitigation measures into Site Induction.	Superintendent	Pre-Construction	Project Site Induction
Install sediment controls (coir bales and/or sediment fences) in drainage lines and down slope site areas affected by runoff.	Superintendent	Pre-Construction	Environmental Inspection
Ensure all stormwater collection points are protected with sediment and erosion controls as appropriate for the site (e.g. sediment fences, sediment socks, geotextile etc).	Superintendent	Ongoing	Environmental Inspection

Temporary spoil stockpiles to be dampened regularly or covered to prevent windblown dust nuisance.	Superintendent	As required	Environmental Inspection
Inspect, maintain and improve (where required) sediment controls .	Superintendent	immediately after rainfall.	Environmental Inspection
Incorporate discussion on Ground Contamination, impacts and mitigation measures into Site Induction	Superintendent	Pre-Construction	Project Site Induction
Review Asbestos Survey Reports for potential contamination	Superintendent	Pre-Construction	As applicable
Ensure construction activities are designed and operated to minimise the potential for ground contamination and to comply with the requirements of the Environmental Protection Act 1997	HSE Manager	Ongoing	Environmental Inspection
Undertake ongoing visual monitoring for ground contamination (e.g. site inspections) to assess the effectiveness of mitigation measures	Superintendent	Ongoing	Environmental Inspection
Ensure all constructions wastes are appropriated segregated and stored prior to off-Site removal	Superintendent	Ongoing	Environmental Inspection
Ensure qualified contractor is engaged to remove all Asbestos Containing Materials (ACM)	Superintendent	Prior to and during asbestos removal	As applicable
Obtain and record Asbestos Clearance Certificate upon completion of removal	Superintendent	After asbestos removal	Asbestos Clearance Certificate
Ensure all designated washout areas are appropriately utilised	Superintendent	Ongoing	Environmental Inspection
Report all incidents of ground contamination to General Superintendent, and implement and maintain all applicable control measures	All Workers	Ongoing	Environmental Incident Report & Investigation
Any petrol, oils, fuels, lubricants, chemicals, hazardous substances or other contaminants are to be stored in areas as agreed and nominated by the HSE Manager. These areas are to be secure, bounded and on an impervious surface.	Superintendent	Ongoing	Environmental Inspection
All substances are to have Safety Data Sheet (SDS) available and within 10m of storage area.	Superintendent	As required	Environmental Inspection
The chemical storage area is to be designed, operated and maintained in accordance with the relevant Australian Standard(s) – (e.g. Flammable and Combustible Liquids; Corrosive Substances etc).	Superintendent	Ongoing	Environmental Inspection
Spill kits with spill containment equipment are always to be present on site and all spills are to be reported to REO immediately.	Superintendent	Ongoing	Environmental Inspection

9 INSPECT ANDTEST

9.1 Monitoring, Inspection and Reporting

Daily visual inspections of the construction site will be undertaken by the HSE Manager and construction personnel to identify any potential waste management issues. Any actions to be undertaken as a result of site inspections will be recorded.

All inspections will be conducted as per the Environmental Management Plan.

10 RECORDS

A record shall be maintained as per Document Control and Record Management Procedure.

Appendix 1 Relevant Conditions of Approval

LAND MANAGEMENT

12. Following any construction or upgrading on site, the Applicant must:
    (a) restore the ground cover of the site as soon as practicable, using suitable species;
    (b) maintain ground cover; and
    (c) keep this ground cover free of weeds.

SOIL & WATER

Water Pollution

21. The Applicant must ensure that the development does not cause any water pollution, as defined under Section 120 of the POEO Act.

Soil Erosion

22. The Applicant must:
    (a) minimise any soil erosion associated with the construction, upgrading or decommissioning of the development in accordance with the relevant requirements in the *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004) manual, or its latest version; and
    (b) ensure the solar panels and associated infrastructure are designed, constructed and maintained to avoid causing any tunnel erosion on site.

Stormwater Drainage

23. Prior to the commencement of construction, the Applicant must:
    (a) prepare detailed Stormwater Plans for the site to the satisfaction of Council, in accordance with the requirements in Council's *Engineering Guidelines - Subdivisions and Development Standards* and *Stormwater Drainage and Disposal Policy*; and
    (b) submit a copy of these plans to the Department.

Appendix 2 Compliance Sheet

Schedule	Section	Section of the Plan where the matter is addressed
Schedule 3 Environmental Conditions	21	Section 5.2 Section 7
	22	Section 7 Secftion 8 Appendix 2
	23	Appendix 2

Appendix 3 Comments from Parkes Shire Council to GOO-GRS-HS-PLN-0003_A1_Soil & Water Management Plan.

ma. 18/06/2019 11:04

NM Nathan McWilliam <Nathan.McWilliam@parkes.nsw.gov.au>

RE: GOO-GRS-HS-PLN-0003_A1_Soil & Water Management Plan

Para Juan Manuel Madrid Guijarro

CC Annalise Cummings; javier.herrera@frv.com; cliona.gormley@frv.com; alan.robinson@frv.com; David Trilles Antoli; Javier Lapiedra Pintado

Mensaje reenviado el 18/06/2019 11:06.

Hi Juan,

The submitted soil & water management plan seems to be missing the detailed stormwater plans for the site. Detailed calculations for stormwater for the 10yr ARI have been included but the drawing that shows the locations of any pipes, channels and/or sediment and erosion control devices to be installed will need to be provided to meet condition 23 of consent.

Regards,

Nathan McWilliam
Projects & Development Engineer | Parkes Shire Council

P 02 6861 2333
E Nathan.McWilliam@parkes.nsw.gov.au
W parkes.nsw.gov.au
Parkes NSW 2870

Appendix 4 STORM WATER DRAINAGE CALCULATIONS GOO-ISE-CV-CAL-0001-A2

TECHNICAL SPECIFICATION FOR:

RAINWATER DRAINAGE CALCULATION

GOONUMBLA SOLAR FARM
(AUSTRALIA)

Doc.: GOO-ISE-CV-CAL-0001-A2_RAINWATER DRAINAGE CALCULATION.docx

A2	[illegible]	[illegible]	[illegible]	[illegible]		
A1	[illegible]	[illegible]	[illegible]	[illegible]		
REV	DATE	DESCRIPTION	BY	APPR	EPC	CLIENT

TECHNICAL SPECIFICATION FOR:

RAINWATER DRAINAGE CALCULATION

GOONUMBLA SOLAR FARM

(AUSTRALIA)

Doc.: GOO-ISE-CV-CAL-0001-A2_RAINWATER DRAINAGE CALCULATION.docx

A2	19/06/2019	Annex B added	POL	MBS		
A1	28/05/2019	First issued	POL	MBS		
REV	DATE	DESCRIPTION	BY	APPR	EPC	CLIENT

INDEX

1. INTRODUCTION

1.1. Object

This technical document refers the calculation and justification of the **RAINWATER DRAINAGE SYSTEM** measures within the Solar Plant called "Goonumbla Solar Farm" that will be constructed in New South Wales, Australia. The design of the Rainwater Drainage System has taken into account all the applicable constrains and requirement as the Development Consent and the Environmental Impact Statement for Goonumbla Solar Farm.

This calculations report provides conceptual internal drainage infrastructure for the proposed Goonumbla Solar Farm. The purpose of this report is to provide a description of the hydraulic calculations for understand the behaviour of local flooding originating from upstream and within the site and designing the drainage infrastructure of the PV plot while complying with the applicable standards

The principal requirement for routine drainage design it is based on peak discharge from the catchment for a specific AEP. To complete these calculations, some simple assumptions are required to define the design storm and these assumptions tend to produce a conservative peak discharge, intensity, frequency and duration are the three parameters used to define rainfall events.

The design rainfall intensity is dependent on storm frequency and duration. This one varies with location and topography and this should be considered when using the rainfall intensity-frequency-duration (IFD) calculations.

The premises used for the design of the drainage network have been:

- Protect internal paths with ditches to avoid flooding with a 10% AEP event
- Avoid scour and erosion for all structure supports for a 10% AEP event.

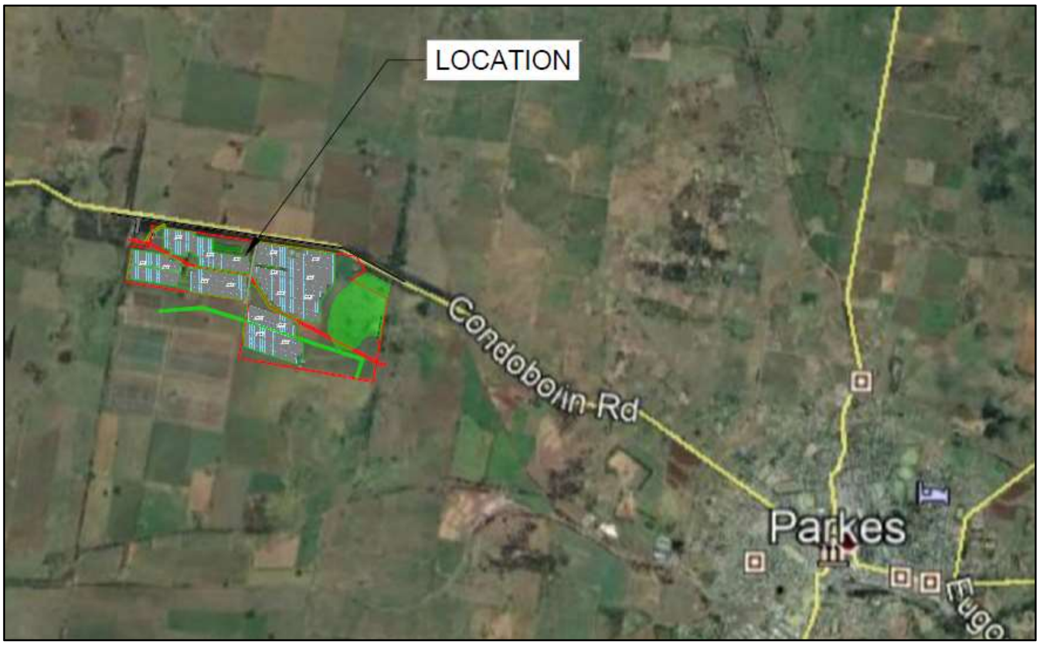
The AEP value was approached according to the characteristics of the installations of the single plant.

A 10% AEP event has been considered for the gutters and the piles of the structures. This value is appropriate to the type of infrastructure due to the fact that if there was a rainfall with higher ARI it would only produce a damage in places located on the sides of roads or occasional dislocations in the piles of the structure. Under no circumstances there would be personal or material damage to be considered. It is mandatory the photovoltaic plant to have a permanent personal maintenance to solve every damage suffered.

1.2. Location

The Goonumbla Solar Farm site is located adjacent to Transgrid's Parkes substation, approximately 11 km west of the city of Parkes, New South Wales, in the Parkes Shire Council area of New South Wales.

Figure 1.2.1 Site Location



The site is located in the western part of Millers Lookout Road and Henry Parkes Way at north. The site consists of an area of approximately 385 ha of rural land including the following plots:

- Lot 409 DP750152
- Lot 1 DP602329
- Lot 1 DP877903
- Lot 5 DP854193

Of this area, a maximum of 200 ha aprox. will be utilised for electricity generating equipment.

The UTM geographic coordinates of the project are:

	SOLAR FARM
X	601,755.0481
Y	6,336,648.134
Elevation	283 AHD

Datum MGA Zone 55

1.3. Site conditions

The final proposed solution shall be the appropriate considering the climatic conditions of the area. As far as it may concern, the design requirements to be taken into account are presented at the following:

Figure 1.3.1 Summary climate statistics PARKES AIRPORT AWS (1941-2019)
Data of Commonwealth of Australia, Bureau of Meteorology

Statistic Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
TEMPERATURE (ºC)													
Mean maximum temperature	33.5	32.2	28.8	24.3	19	15.1	14.3	16	20.1	24.2	28.3	31.1	23.9
Mean minimum temperature	17.5	17.2	14	9.5	5.1	3.7	2.3	2.3	4.5	7.7	12.1	14.7	9.2
RAINFALL (mm)													
Mean rainfall	61.5	58.7	54	31.4	47	52.6	47.5	44.1	44.8	50.7	59.9	54.5	636.2
Median rainfall	38.6	43.9	35.8	25.2	40.2	42	44.2	38.8	36.8	37	44	41.2	623.9
Mean nºdays of rain >=1mm	6,0	5,8	4,1	2,8	2,2	3,1	1,5	2,0	2,4	3,7	5,4	6,0	45,0
9am CONDITIONS													
Mean temperature (°C)	24.2	23.3	20.9	17.7	12.7	9.1	8	10	13.7	17.9	20.3	22.9	16.7
Mean relative humidity (%)	51	57	60	63	75	85	86	78	69	57	54	48	65
Mean wind speed (km/h)	17.5	15.3	13.1	12.7	9.1	9.5	9	11.3	13.5	16.3	16.4	16.6	13.4
3pm CONDITIONS													
Mean temperature (°C)	31.1	29.7	27.2	22.9	18.1	14.1	13.2	14.7	18.4	22.3	26.3	28.2	22.2
Mean relative humidity (%)	27	34	35	39	48	63	62	54	47	38	33	30	42
Mean wind speed (km/h)	17.8	17.5	17.1	16.5	16.6	17.6	17.1	18.5	18.2	20.1	18.6	18.7	17.9

All of these above parameters are means. In order to obtain a proper operation of the equipment, shall be taken into account in the design and selection of the materials that the highest ambient temperature considered in design is 45ºC.

1.4. Design rainfall

For this project the terminology has been used is consistent with Australian Rainfall and Runoff (AR&R). AEP is defined as the probability of an event occurring or being exceeded in any year. Its relationship with Average Recurrence Interval (ARI) is also included the following Table 1.4.1.

Table 1.4.1- Relationship AEP%&ARI (years)

AEP(%)	1EY	39	18	10	5	2	1	0.05
ARI (years)	1	2	5	10	20	50	100	2000

All the drainage structures have been designed for the AEP storm event appropriate for the class of road in accordance with the characteristics of the internal paths and the structures for a Solar Farm. The annual exceedance probability (AEP) of 10% has been considered for the internal paths

The IFD data values from Bureau of Meteorology of Australia, with the exact coordinates of Goonumbla Solar Farm are in the table 1.4.2.

Table 1.4.2- Annual Exceedance Probability (AEP)

	Annual Exceedance Probability (AEP)						
Duration	**63.2%**	**50%#**	**20%***	**10%**	**5%**	**2%**	**1%**
1 min	101	116	163	196	230	276	313
2 min	85.9	98.5	139	168	197	236	267
3 min	78.8	90.3	127	153	180	215	244
4 min	73.5	84.1	118	142	167	200	226
5 min	68.9	78.8	111	133	156	187	212
10 min	53.0	60.6	85.1	102	120	144	163
15 min	43.5	49.7	69.9	84.2	98.7	119	135
20 min	37.1	42.5	59.7	72.0	84.5	102	115
25 min	32.6	37.2	52.4	63.2	74.2	89.3	101
30 min	29.1	33.3	46.9	56.6	66.4	79.9	90.6
45 min	22.4	25.6	36.1	43.6	51.1	61.5	69.7
1 hour	18.4	21.1	29.8	35.9	42.1	50.5	57.3
1.5 hour	14.0	16.0	22.5	27.1	31.7	38.0	43.0
2 hour	11.4	13.1	18.4	22.1	25.8	30.9	34.9
3 hour	8.65	9.88	13.8	16.6	19.3	23.0	25.9
4.5 hour	6.55	7.47	10.4	12.4	14.4	17.1	19.3
6 hour	5.39	6.13	8.50	10.1	11.8	13.9	15.6
9 hour	4.10	4.65	6.42	7.63	8.83	10.4	11.7
12 hour	3.37	3.83	5.26	6.24	7.21	8.51	9.51
18 hour	2.55	2.89	3.97	4.70	5.43	6.39	7.14
24 hour	2.08	2.36	3.24	3.84	4.43	5.22	5.82
30 hour	1.77	2.01	2.76	3.27	3.78	4.45	4.96
36 hour	1.55	1.76	2.41	2.86	3.31	3.90	4.35
48 hour	1.24	1.41	1.94	2.31	2.67	3.15	3.52
72 hour	0.896	1.02	1.41	1.68	1.95	2.31	2.58
96 hour	0.703	0.801	1.11	1.33	1.55	1.83	2.04
120 hour	0.579	0.660	0.918	1.10	1.28	1.51	1.69
144 hour	0.493	0.561	0.780	0.933	1.08	1.28	1.43

Rainfall can be defined as an intensity, generally a constant intensity as in the case for the rational method, or as a hyetograph where the depth is associated with a temporal distribution.

2. EXTERNAL FLOW

The external flow to the PV plot has been studied in order to know the possible affections to the internal drainage system or the structure of the PV plot.

2.1. CALCULATION METHOD - HEC HMS

The Hydrologic Modelling System (HEC-HMS) is designed to simulate the complete hydrologic processes of dendritic watershed systems. The software includes many traditional hydrologic analysis procedures such as event infiltration, unit hydrographs, and hydrologic routing.

2.1.1. Watershed Physical Description

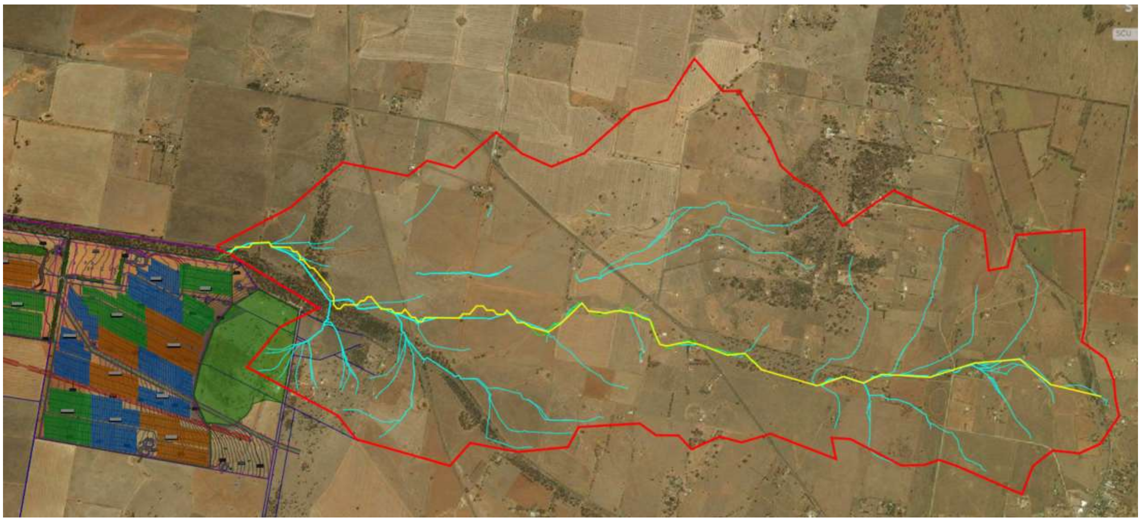
External catchment has been studied from a Digital Elevation Model with a geographic information system, QGIS, in order to obtain the incoming flow to the project plot.

The Digital Elevation Model (DEM) has been downloaded from the portal:

http://elevation.fsdf.org.au/

QGIS works for visualization of most formats of spatial data, for analysis of raster and vector data, for geographic data editing, and for cartography.

A set of maps indicating flow accumulation, drainage direction, the location of streams and watershed basins are generating with a QGIS plugging using the downloaded DEM from the affecting area.



Using HEC HMS, the physical representation of a watershed is accomplished with a basin model. Hydrologic elements are connected in a dendritic network to simulate runoff processes.

There are different methods available to simulate infiltration losses. Options for event modelling include SCS curve number, which was the chosen.

Many methods are included for transforming excess precipitation into surface runoff. User-specified unit hydrograph has been used.

2.1.2. Time of concentration

As per AUSTROADS Part 5, the type of concentration for rural areas in Australia, especially in New South Wales is defined according to the following equation

Region	Time of concentration
NSW – Eastern	$t_c = 0.76\ A^{0.38}$ where: t_c = time of concentration (hours) A = catchment area (km^2)
NSW – Western (flat catchments)	$t_c = 0.76\ A^{0.38}$ where: t_c = time of concentration (hours) A = catchment area (km^2)

2.1.3. Meteorology Description

Four different methods for analysing historical precipitation are included. The user-specified hyetograph method is for precipitation data analysed outside the program and it has been used.

Next table shows the hietogram for a rain event which duration coincide with the time of concentration of the external catchment and 20 years of return period.

t (min)	P (mm)
5	0.242
10	0.575
15	0.908
20	0.207
25	0.785
30	1.351
35	0.748
40	1.758
45	1.754
50	2.300
55	3.508
60	6.917
65	13.083
70	4.725
75	2.767
80	2.593
85	0.903
90	1.244
95	1.651
100	1.073
105	0.483
110	1.075
115	0.742
120	0.408

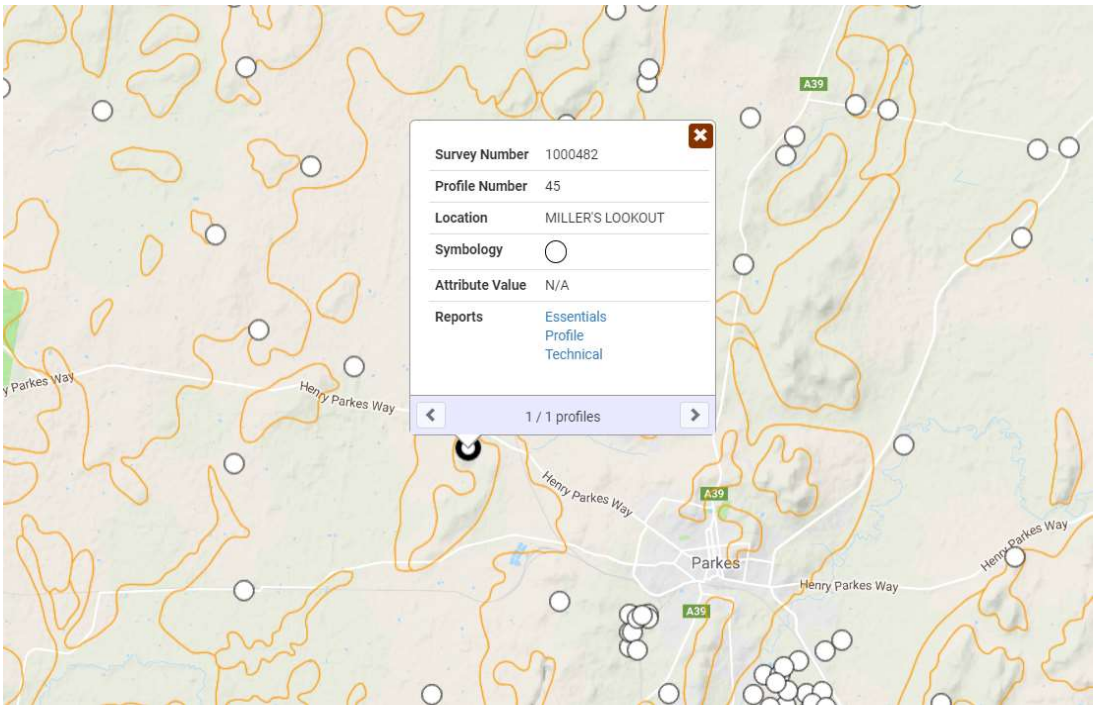
2.1.4. Estimation of Curve number

The SCS Runoff Curve Number method is developed by the United States Department of Agriculture (USDA) Soil Conservation Service (SCS) and is a method of estimating rainfall excess from rainfall (Hjelmfelt, 1991).

The SCS curve number method is a simple, widely used and efficient method for determining the amount of runoff from a rainfall even in a particular area. The curve number is based on the area's hydrologic soil group, land use, treatment and hydrologic condition.

Soil Group

A soil technical report had founded in the portal "NSW SOIL AND LAND INFROMATION SYSTEM":



The valuable information obtained from the document:

SOIL GROUP		
	TEXTURE	SOIL WATER STATUS
LAYER 0	as rock outcrop	
LAYER 1	sandy clay loam	Dry
LAYER 2	sandy clay loam	Dry
LAYER 3	clayey sand	Dry

Based on the report, a "C" classification for soil group had determinate.

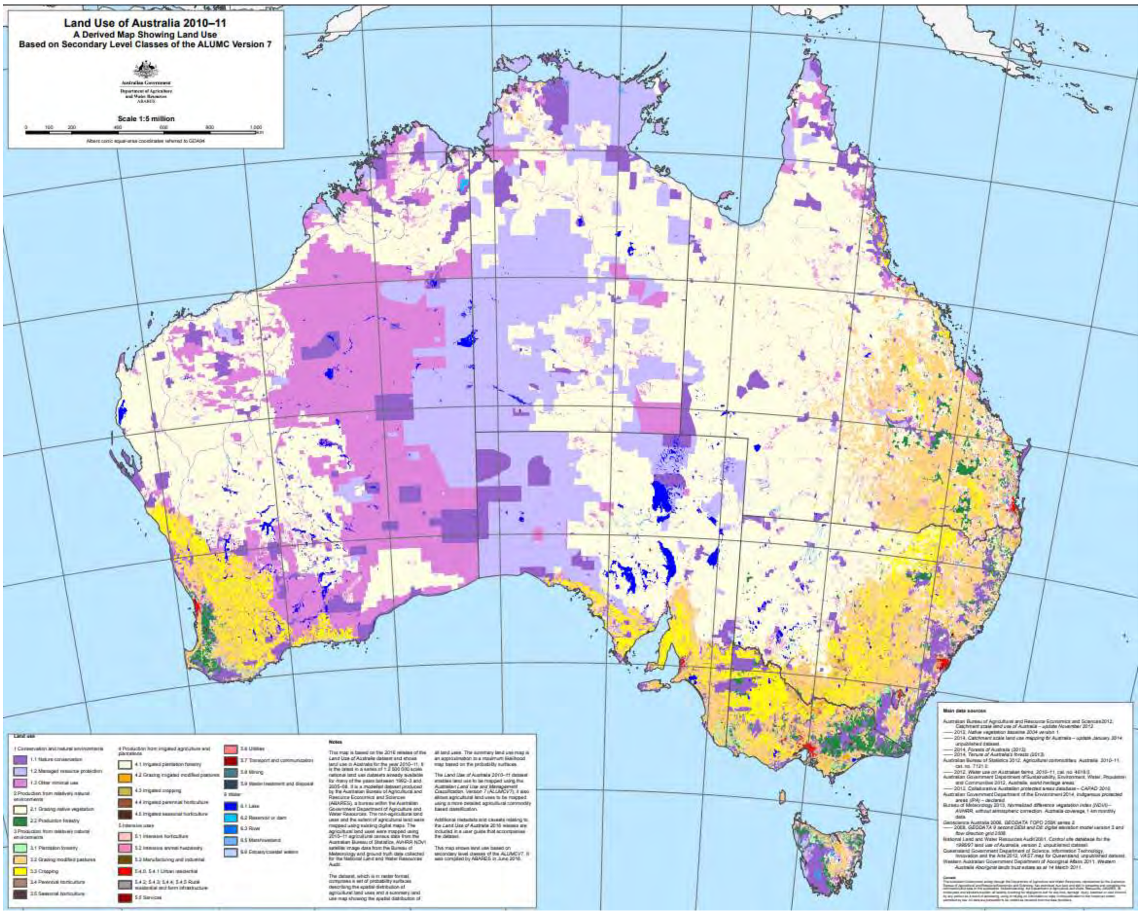
Group C soils have slow infiltration rates when thoroughly wetted and consisting of primarily of soils with a layer that impedes downward movement of water, or soils with a moderately find texture. These soils have a slow rate of transmission.

Land Use

Land use for the study area was found in the portal "http://www.agriculture.gov.au" This website contains information about land use, land management practices and land cover mapping in

Australia, access to national classification systems, technical reports supporting mapping work, and analysis of land information.

This site provides access to downloadable data and the ability to view data using different analytical mapping tools. Using QGIS was possible to define the area for every piece with different CN value.



Hydrologic condition

In order to afront the most unfavourable situation, the hydrologic poor condition had selective.

Curve Number Table

A table which come from the report “Urban hydrology for small watersheds”, or more commonly known as TR-55, provide estimates of the curve number (CN) as a function of hydrologic soil group, cover type, treatment, hydrologic condition, antecedent runoff condition and impervious area in the catchment.

SCS TR-55 Table 2-2b – Runoff curve numbers for cultivated agricultural lands[1]

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment[2]	Hydrologic condition[3]	A	B	C	D
Fallow	Bare soil	–	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89

Cropping = 4234364.84 m2 = 32.21 %

CN = 88

SCS TR-55 Table 2-2c – Runoff curve numbers for other agricultural lands[1]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Hydrologic condition	A	B	C	D
Pasture, grassland, or range – continuous forage for graving.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow – continuous grass, protected from grazing and generally mowed for hay.	–	30	58	71	78
Brush – brush-weed mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30[4]	48	65	73
Woods – grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30[4]	55	70	77
Farmsteads – buildings, lanes, driveways, and surrounding lots.	–	59	74	82	86

Residential and farm infrastructure = 3043921.92 m2 = 23.16 %

CN = 82

SCS TR-55 Table 2-2c – Runoff curve numbers for other agricultural lands[1]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Hydrologic condition	A	B	C	D
Pasture, grassland, or range – continuous forage for graving.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow – continuous grass, protected from grazing and generally mowed for hay.	–	30	58	71	78
Brush – brush-weed mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30[4]	48	65	73
Woods – grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30[4]	55	70	77
Farmsteads – buildings, lanes, driveways, and surrounding lots.	–	59	74	82	86

Grazing native vegetation = 2521081.08 m2 = 19.18 %

CN = 77

SCS TR-55 Table 2-2c – Runoff curve numbers for other agricultural lands[1]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Hydrologic condition	A	B	C	D
Pasture, grassland, or range – continuous forage for graving.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow – continuous grass, protected from grazing and generally mowed for hay.	–	30	58	71	78
Brush – brush-weed mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30[4]	48	65	73
Woods – grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30[4]	55	70	77
Farmsteads – buildings, lanes, driveways, and surrounding lots.	–	59	74	82	86

Grazing modified pastures = 1883717.58 m2 = 14.33 %

CN = 86

SCS TR-55 Table 2-2b – Runoff curve numbers for cultivated agricultural lands[1]

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment[2]	Hydrologic condition[3]	A	B	C	D
Fallow	Bare soil	–	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89

Irrigated cropping = 1074662.86 m2 = 8.18 %

CN = 85

SCS TR-55 Table 2-2a – Runoff curve numbers for urban areas[1]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area[2]	A	B	C	D
Fully developed urban areas					
Open space (lawns, parks, golf courses, cemeteries, etc.)[3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89

Road = 387434.21 m2 = 2.95 %

CN = 95.8

2.2. RESULTS

Next table shows the parameter which need HEC HMS to calculate the hydrograph.

Catchment area id	Chainage	Max. Height	Min. Height	Length	Area	Equal area slope	Time of Concentration
		HM	Hm	L	A	Se	Tc
	m	(m)	(m)	(m)	(km2)	(m/km)	(hr)
1	668,025	381,44	290,66	7768,6	13,1452	11,69	2,02

The weighted CN is calculated by taking the sum of each CN value (section 2.2.1) multiplied by its fraction of the total subcatchment area.

	A (m2)	CN
TOTAL	13.145.182,50	**84,21**

Computing these parameters in HEC HMS, the hydrograph for a rain event with a 2 hours duration (the time of concentration of the external catchment) and 20 years of return period is:

t (seg)	Q (m3/sg)
5	0.1
10	0.5
15	1.3
20	2.5
25	4.1
30	6.1
35	8.6
40	11.7
45	15.4
50	19.4
55	23.4
60	27.2
65	30.6
70	33.5
75	35.8
80	37.5
85	38.8
90	**39.4**
95	39.4
100	39.0
105	38.1
110	36.7
115	35.0
120	32.8
125	30.3
130	27.7
135	25.3

t (seg)	Q (m3/sg)
140	23.0
145	20.9
150	18.9
155	17.0
160	15.3
165	13.8
170	12.4
175	11.1
180	9.9
185	8.9
190	7.9
195	7.1
200	6.4
205	5.8
210	5.2
215	4.7
220	4.2
225	3.7
230	3.3
235	3.0
240	2.7
245	2.4
250	2.2
255	2.0
260	1.8
265	1.6
270	1.4
275	1.3
280	1.1
285	1.0
290	0.9
295	0.8
300	0.7
305	0.7
310	0.6
315	0.5
320	0.5
325	0.4

t (seg)	Q (m3/sg)
330	0.4
335	0.4
340	0.3
345	0.3
350	0.3
355	0.2
360	0.2
365	0.2
370	0.1
375	0.1
380	0.1
385	0.1
390	0.0

2.3. CONCLUSION

It has been determined than the external flow does not affect to the internal drainage system or the structures due the natural flow path is clearly defined in the current status (pre-construction) with a crossing under the Condobolin Road and the existing ditch to the natural detention basins whose natural flow is going to be respected according to the Environmental Impact Statement for Goonumbla Solar Farm.

3. INTERNAL DRAINAGE

The study of the raining consequences in the project has focused on the effects of runoff on the trackers structure, internal paths and buildings.

The ditches have been calculated according to the Rational Method included in the AUSTROADS.

3.1. Rational Method (AUSTROADS PART 5)

The adopted standard method of run-off calculation for small rural and urban catchments is the Rational Method. The Rational Method is a simple, statistical method used to calculate peak discharge from a catchment for a given ARI and is widely accepted and used in New South Gales.

The Rational Method assumes a relationship between the duration of a constant intensity rainfall event required to produce peak outflow from a catchment and the longest travel time or 'time of concentration', tc, of the catchment.

The application of the Rational Method is based on the following assumptions:

- the rainfall has a uniform area distribution across the catchment.
- the rainfall has a uniform time distribution during the time of concentration
- the peak discharge occurs at the end of the critical storm duration or time of concentration.
- the run-off coefficient remains constant throughout the duration of the storm.
- the return period of the peak flow is the same as that of the rainfall intensity.

As per AUSTROADS Part 5: Drainage – General and Hydrology Considerations in section 6.6.1 Rational Method estimates Peak catchment discharge as follows:

$$Q_Y = k \text{ x } C_Y \text{ x } I_{t_c,Y} \text{ x } A$$

where

Q_Y = Flow rate, Q (m^3/s) for an ARI of Y years

k = A conversion factor, k = 0.278 when A is in km^2 and 0.00278 when A is Ahectares (ha) and for smaller catchments (i.e. urban) when A is m^2, $k = 0.278 \times 10^{-6}$

C_Y = Run-off coefficient, C (dimensionless) for an ARI of Y years

$I_{t_c,Y}$ = Average rainfall intensity, I (mm/h) for design duration of t_c(time of concentration, see Section 6.6.2 – Time of Concentration) and ARI of Y years

A = Area of catchment either hectares, km^2 or m^2

3.2. Estimation of run-off coefficient

The run-off coefficient relates the volume of water that is discharged from a catchment to the rain falling over the catchment.

The run-off coefficient includes effects of catchment characteristics, infiltration and other losses as well as rainfall intensity. It depends on many features of the catchment area including:

- Rainfall intensity
- Relief or slope of catchment
- Storage or other detention characteristics
- Ground characteristics such as vegetation cover and soil types.

Run-off coefficient value

According the Hydrological Study provided by the client FRV, included in the annex B, the runoff coefficient on the PV plot ranges between 0.18-0.22. However, this value has been set on 0.3 because it is considered more reliable with the real conditions of the PV plot according to the Australian documentation studied.

It has been checked the soils conditions and the land use of the PV plot according the NSW Office of Environment & Heritage of the Australian Government. The land use of the site is characterised as Grazing modified pasture and Dryland cropping.

The characteristics and the pervious of the soil as well as the existing vegetation are not going to be modified with the installation of the solar panels so it can be considered the same value after the execution. In any case, the vegetation will be more stable due no animal activity after the construction which means that the value considered would be more conservative. This situation post-execution can be easily checked on the adjacent Parkes Solar Farm executed where the vegetation under and between the trackers remains in his natural states protecting the soils from the water and reducing the runoff flow.

In addition, as mentioned on the beginning of this point, the slope of the internal catchments (average of 0.7%) and the storage and existing detention basins of the PV plot indicate a reduction of the runoff flow over the surface and consequently a minor runoff coefficient.

3.3. Time of concentration

As per AUSTROADS Part 5, the type of concentration for rural areas in Australia, specially in New South Wales is defined according to the following equation

Region	Time of concentration
NSW – Eastern	$t_c = 0.76\ A^{0.38}$ where: t_c = time of concentration (hours) A = catchment area (km^2)
NSW – Western (flat catchments)	$t_c = 0.76\ A^{0.38}$ where: t_c = time of concentration (hours) A = catchment area (km^2)

3.4. Catchments

Using an estimated time of concentration, coefficient of runoff, the obtained IFD data and the estimated catchment areas a rational method calculation was performed on catchments. Design storm flows rates have been calculated for standard storms with an ARI of 10 years.

Catchment area id	Max. Height	Min. Height	Lenght	Area	Equal area slope	Time of Concentration	Average Rainfall Intensity 10 years	Runoff Coefficient	Peak Flow (Austroads)
	HM	Hm	L	A	Se	Tc	I	C	Q
	(m)	(m)	(m)	(km2)	(m/km)	(hr)	(mm/h)		(m3/s)
1	333.95	289.33	917	0.29	48.6586696	0.48	56.7	0.3	1.39
2	334.05	291.33	787	0.12	54.2820839	0.34	75.1	0.3	0.75
3	324	293.93	909	0.27	33.080308	0.46	56.7	0.3	1.26
4	324	293.93	1118	0.54	26.8962433	0.60	52.58	0.3	2.35
5	296.7	283.34	531	0.18	25.1600753	0.39	67	0.3	0.98
6	288.22	278.68	731	0.07	13.0506156	0.28	80	0.3	0.47
7	298.66	281.57	924	0.25	18.495671	0.45	56.7	0.3	1.19
8	285	278.47	632	0.14	10.3322785	0.36	67.5	0.3	0.79
9	286	279.74	582	0.03	10.7560137	0.21	92	0.3	0.25
10	296.26	287.57	333	0.04	26.0960961	0.23	92	0.3	0.33
11	297.13	286.51	448	0.02	23.7053571	0.18	92	0.3	0.19
12	298.17	282.23	1037	0.16	15.3712633	0.38	67.5	0.3	0.91
13	286	284.13	265	0.03	7.05660377	0.19	102	0.3	0.21
14	288.2	281.42	647	0.08	10.4791345	0.29	78	0.3	0.50
15	293.11	286.18	657.63	0.11	10.5378404	0.33	67.5	0.3	0.61
16	282.12	281.09	160	0.01	6.4375	0.15	102	0.3	0.12
17	282.12	281.09	145.6	0.01	7.07417582	0.13	118	0.3	0.09
18	283.84	277.97	576.83	0.10	10.1763084	0.32	75.1	0.3	0.66
19	280.62	275.06	779	0.05	7.13735558	0.25	86	0.3	0.39
20	279.92	273.3	538	0.04	12.3048327	0.23	75	0.3	0.28
21	281.06	276.96	642.5	0.11	6.38132296	0.33	72	0.3	0.65
22	275.05	270.89	624.42	0.02	6.66218251	0.18	102	0.3	0.18
23	277.72	270.77	896	0.18	7.75669643	0.40	67	0.3	1.00
24	279.25	274.57	578.27	0.06	8.0931053	0.26	84.2	0.3	0.42
25	281.16	280.66	82	0.01	6.09756098	0.12	117	0.3	0.07

3.5. Side Channel Sizing

The side channel is sized to drain the peak flow rate evaluated in the previous section, according to the type of cross section used for side channel. The flow rate drained by the side channel would be obtained by Manning-Strickler.

$$Q = \frac{J^{1/2} \times {R_H}^{2/3} \times S}{n}$$

Where:

Rh = Hydraulic radius, m.

J = Channel bed slope, m/m

S = Hydraulic section, m^2.

n = Roughness coefficient for Manning-Strickler equation, To define the ditches section, we use the iterative process. According to the grade, the Manning coefficient and an initial section set, we start to iterate till the height of the water slide and the velocity of the water in the section are accurate to the peak flow and material of the inner face of the section defined.

The table outlines the input data for every proposed ditch and the type designed after de calculation. The n value has been considered n=0.015 for concrete section and n=0.033 for ditches with stable vegetal cover.

Ditches	Catchments	Type	Slope	Flow	Manning	V	Maximum Q
			(m/m)	m3/s	n	m/s	m3/s
A	1	4.00	0.004	1.39	0.033	1.05	1.62
B	2	3.00	0.004	0.75	0.033	0.94	1.02
C	3	3.00	0.010	1.26	0.033	1.49	1.61
D	4	5.00	0.006	2.35	0.015	2.83	3.39
E	2+3+4	5.00	0.010	4.35	0.015	3.65	4.38
F	5	3.00	0.005	0.98	0.033	1.05	1.14
G	5+6	4.00	0.006	1.45	0.033	1.29	1.99
H	7	4.00	0.004	1.19	0.033	1.05	1.62
I	9	1.00	0.010	0.25	0.033	0.97	0.29
J	15	3.00	0.004	0.61	0.033	0.94	1.02
K	10	2.00	0.008	0.33	0.033	1.12	0.78
L	11	1.00	0.005	0.19	0.033	0.68	0.20
M	12	3.00	0.005	0.91	0.033	1.05	1.14
N	10+11+12+13+14	5.00	0.004	2.15	0.015	2.31	2.77
O	16	1.00	0.004	0.12	0.033	0.61	0.18
P	17	1.00	0.004	0.09	0.033	0.61	0.18
Q	8	3.00	0.005	0.79	0.033	1.05	1.14
R	18	3.00	0.005	0.66	0.033	1.05	1.14
S	19	2.00	0.006	0.39	0.033	0.97	0.68
T	20	2.00	0.006	0.28	0.033	0.97	0.68
U	21	3.00	0.005	0.65	0.033	1.00	1.08
V	22	1.00	0.004	0.18	0.033	0.61	0.18
W	23+24	4.00	0.006	1.43	0.033	1.24	1.90
X	24	2.00	0.004	0.42	0.033	0.79	0.55
Y	21+20+19	4.00	0.006	1.32	0.033	1.29	1.99
Z	10+11+12+13+14+7+16+17	7.00	0.004	3.55	0.015	2.59	4.35
AA	13+11	2.00	0.004	0.40	0.033	0.79	0.55
AB	10+11+12+13+14+7+16+17	6.00	0.006	3.55	0.033	1.48	3.90
AC	16+17	1.00	0.006	0.21	0.033	0.75	0.22

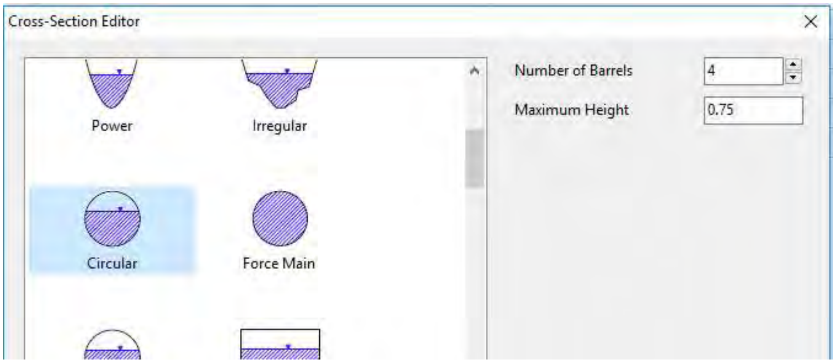
3.6. CROSSING

The crossing has been designed with the software SWMM to simulate the behaviour of the water though the pipes.

EPA's Stormwater Management Model (SWMM) is used throughout the world for planning, analysis, and design related to stormwater runoff, combined and sanitary sewers, and other drainage systems. It can be used to evaluate gray infrastructure stormwater control strategies, such as pipes and storm drains, and is a useful tool for creating cost-effective green/gray hybrid stormwater control solutions.

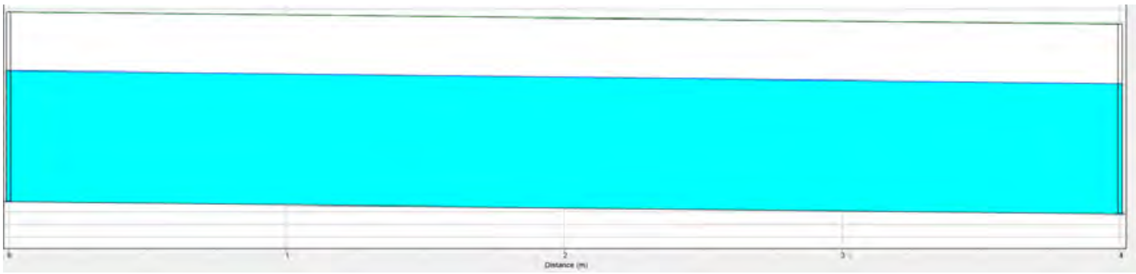
The data of the crossing are as follows:

CROSSING DETAILS				
Flow required (m3/s)	Number of pipes	Size (mm)	Slope m/m	Maximum Calculated Q (m^3/s)
3.54	4	750	0.01	4.27



The depth of the water flow with the flow required is as follows:

Node	Type	Average Depth Meters	Maximum Depth Meters
1	Inflow	0.52	0.52
2	Outflow	0.52	0.54



ANNEX A: LIST OF DRAWINGS

- GOO-ISE-CV-DRW-0007-01 RAINFALL DRAINAGE.WATER BASINS
- GOO-ISE-CV-DRW-0007-02 RAINFALL DRAINAGE SYSTEM. DITCHES
- GOO-ISE-CV-DRW-0007-03 RAINFALL DRAINAGE SYSTEM. DETAILS I
- GOO-ISE-CV-DRW-0007-04 RAINFALL DRAINAGE SYSTEM. DETAILS II

ANNEX B: INITIAL HYDROLOGY REPORT

HYDROLOGY ANALYSIS FOR A SITE IN PARKES, NSW

Study done for FRV in Australia

Contents

1. Background

FRV (the "Client") commissioned SenseHawk to conduct a hydrology analysis for their site in Parkes, New South Wales. The Client wishes to build a solar park at this site and requires the hydrology study to estimate peak runoff at the site and plan solar plant design suitably to account for these considerations.

The AOI ("Area of Interest") is located in the UTM Zone 55S with the X extent ranging from 600060.65 to 603527.01 and Y extent ranges from 6336997.38 to 6334886.82. The site is located in the Murray-Darling river basin and is predominantly open farmland.

2. Local Climatology

The AOI lies in the transition between humid sub-tropical and semi-arid climates. Rainfall usually falls in Spring and Summer in the form of thunderstorms. The closest weather station is the Parkes Airport AWS (located 13.7 kms away) – the data from this weather station was used to conduct our analysis. We analysed rainfall trends for the four main seasons:

- Spring: Between the months of September to November
- Summer: Between the months of December to February
- Autumn: Between the months of March to May
- Winter: Between the months of June to August

Rainfall data for the period 1998-2018 was studied and modelled. The graphs below indicate the peak rainfall observed in the different months over this twenty-year period.

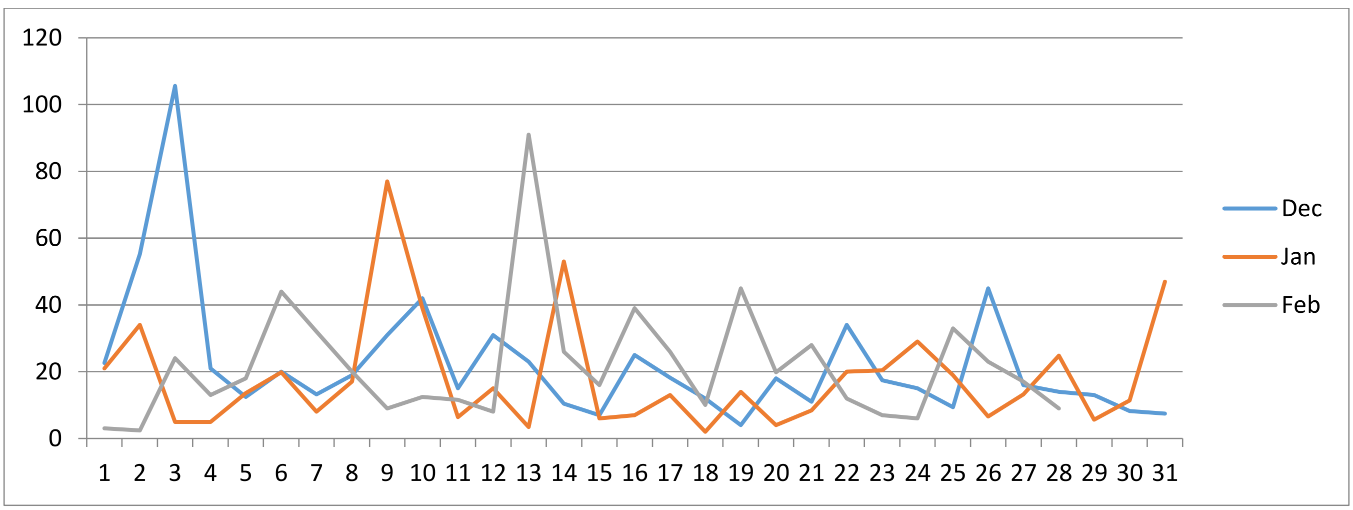


Figure 1 Peak rainfall observed in Summer between 1998-2018 (in mm)

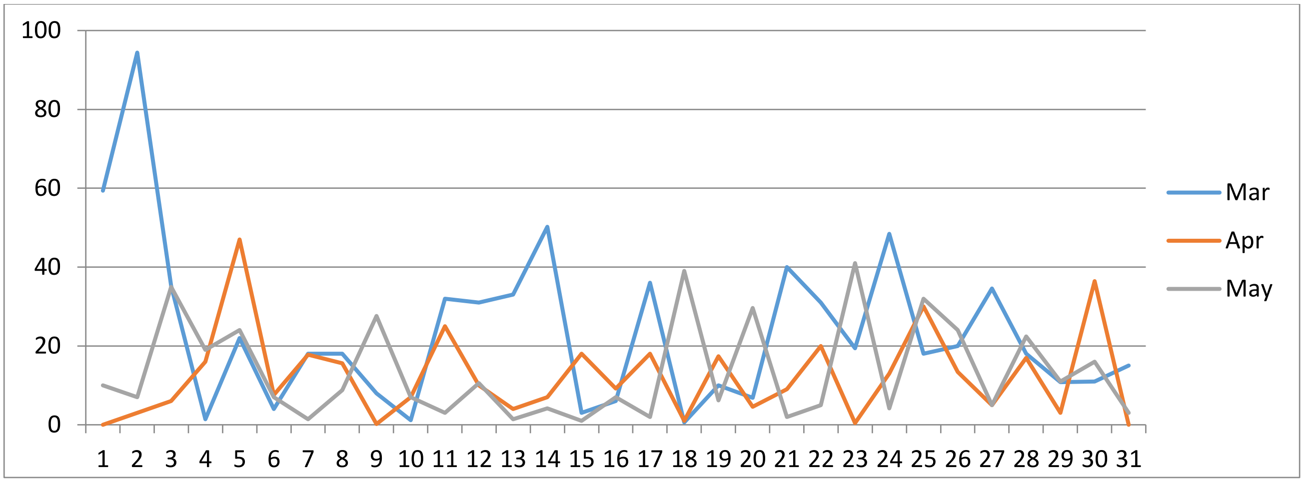


Figure 2 Peak rainfall observed in Autumn between 1998-2018 (in mm)

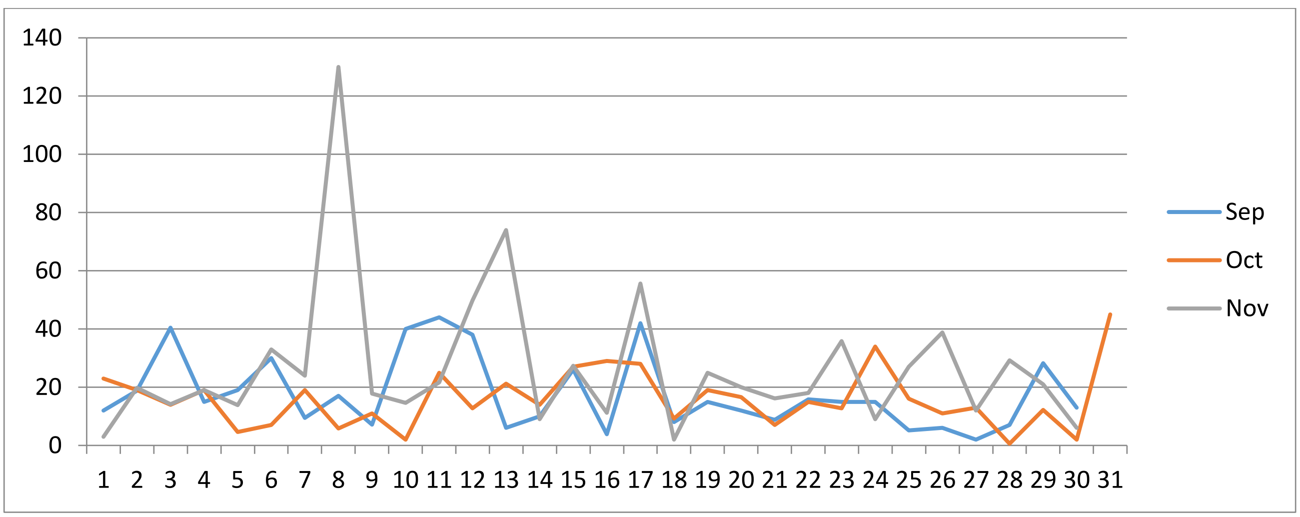


Figure 3 Peak rainfall observed in Winter between 1998-2018 (in mm)

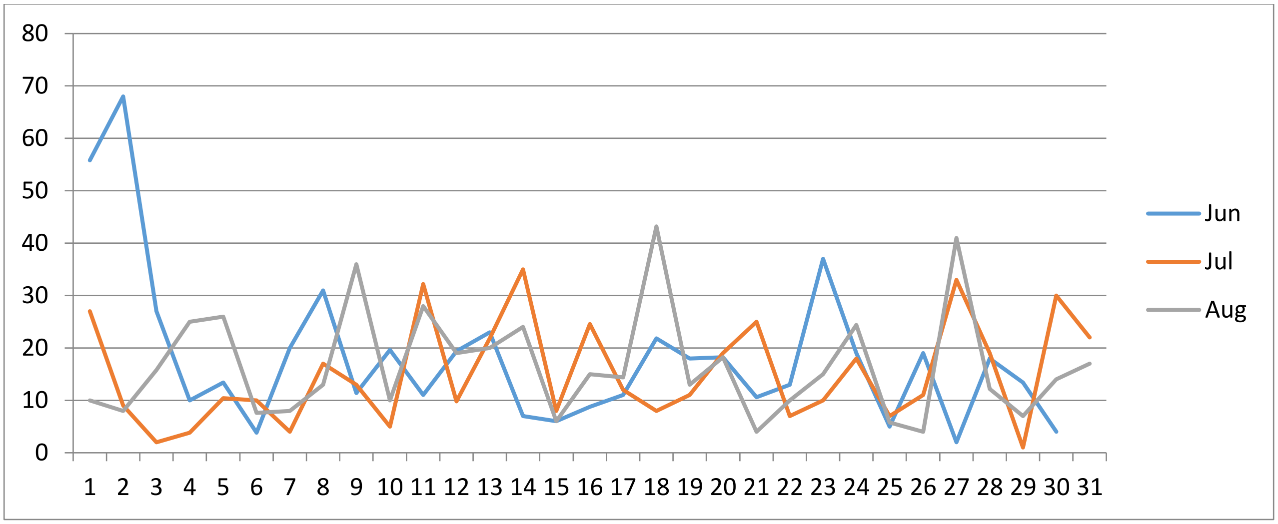


Figure 4 Peak rainfall observed in Spring between 1998-2018 (in mm)

3. Methodology

The overarching objective of the study is to identify the main drainage channels and runoff rates for the site as well as its flood characteristics. A detailed workflow of the study is described below:

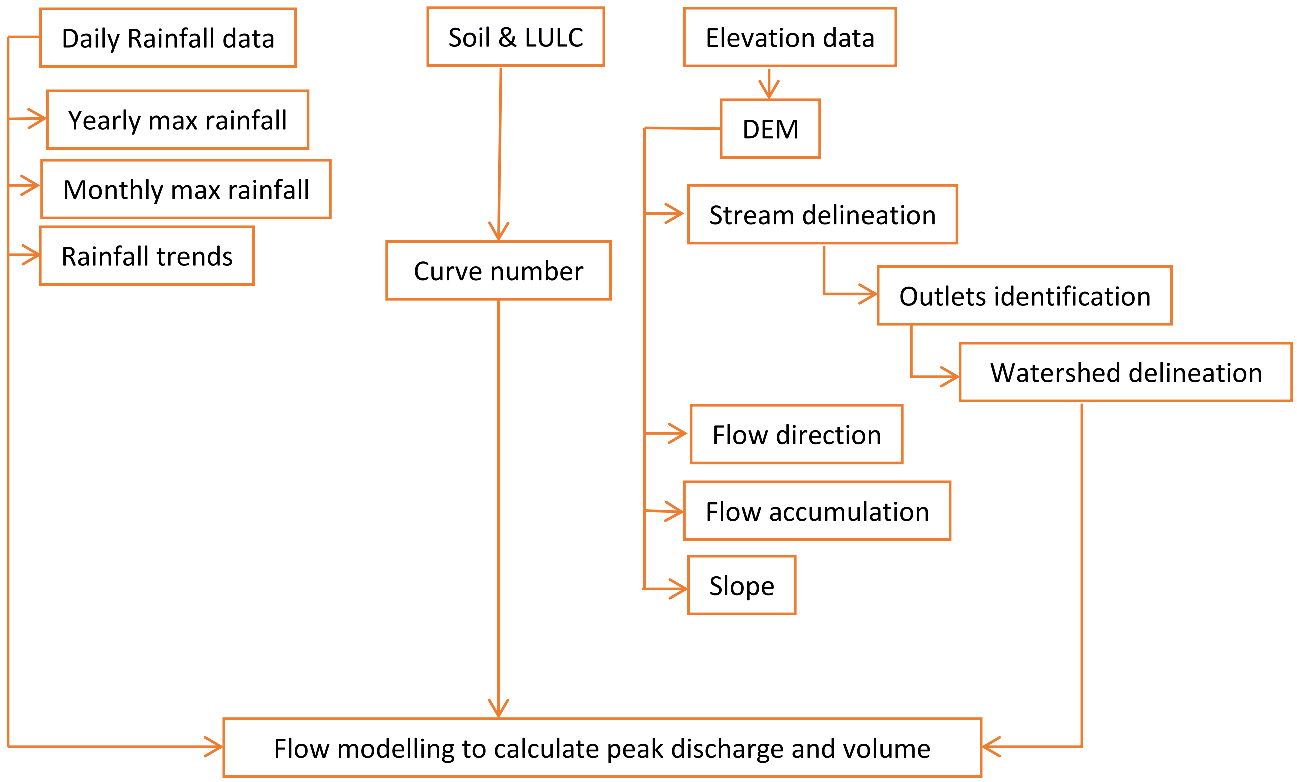


Figure 5 Workflow

Three major inputs went into our model:

- **Rainfall data:** Rainfall data was acquired from the databases of the Australian Government, Bureau of Meteorology
- **Soil and LULC (Land Use and Land Cover):** The soil type and land cover determine run-off and absorption rates. This data was acquired from the databases of the NSW Soil and Land Information
- **Elevation Data:** The elevation data was obtained from the AutoCAD contours shared by the client as well as publicly available SRTM data

a) Rainfall Intensity and Return Period

The precipitation data of Parkes Airport referenced in Section 2 of this report was used to study the rainfall intensity. The Intensity Duration Frequency ("IDF") curve for this site was determined as shown below. Since data from this station is available only for 22 years, the return period is shown for a 1/22-year ARI.

Return Period(years)	Precipitation/day (mm)
22	130.0
11	105.6
5	91.0
3	59.4
1	44.2

Table 1 Return period-Parkes airport weather station

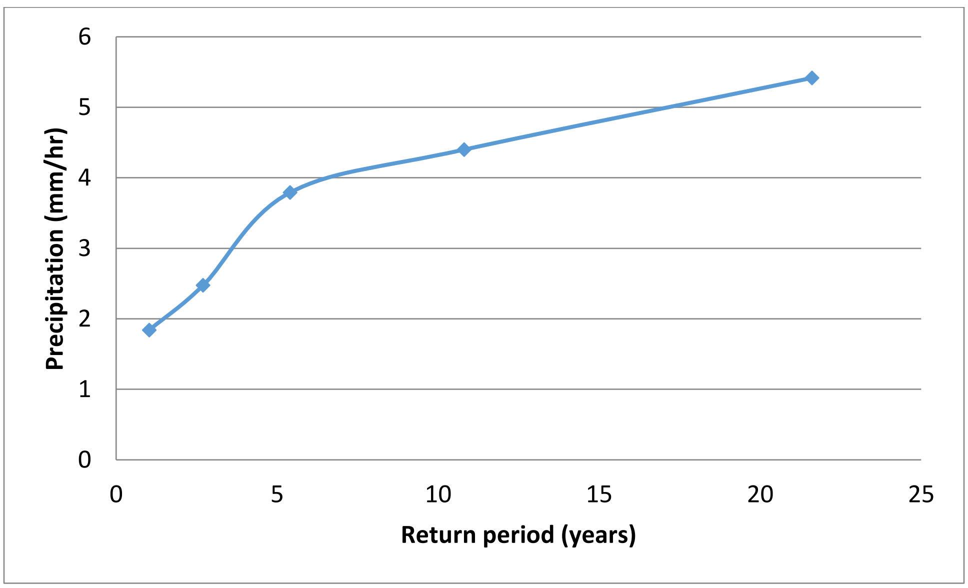


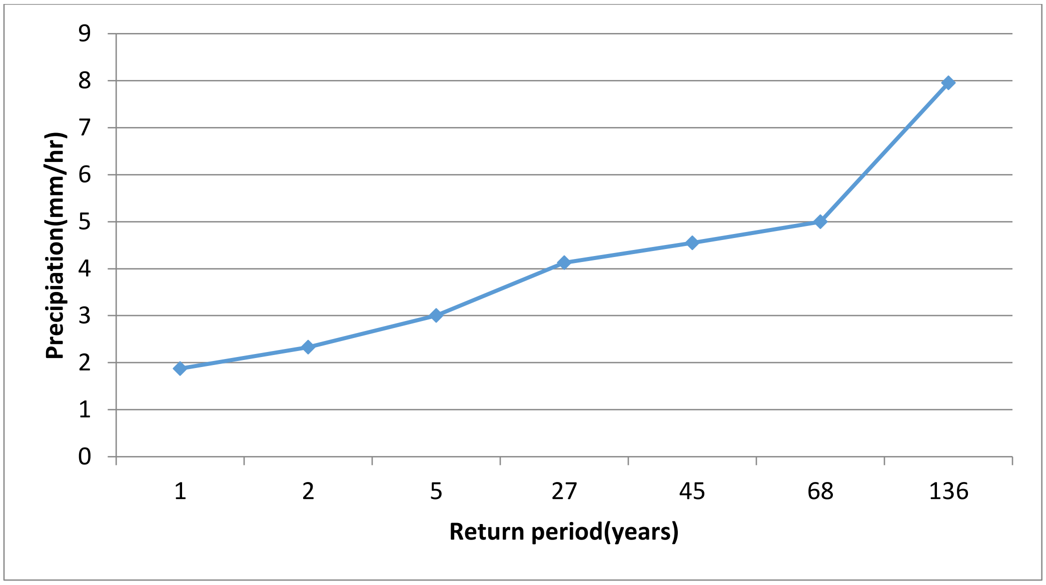
Figure 6 IDF Curve-Parkes airport

In order to get some idea of more extreme weather cases, we considered rainfall data from the next closest weather station, namely the Goonumbla Weather station. Since this data is available for 136 years, we have been able to plot the IDF using a longer 1/136-year ARI.

Return period(years)	Precipitation/day (mm)
136	190.8
68	119.9

Return period(years)	Precipitation/day (mm)
45	109.2
27	99.1
5	72.1
2	55.9
1	45.0

Table 2 Return period-Goonumbula weather station



b) Extreme Weather events

Rainfall data for the period 1998-2018 was studied for extreme weather events. The top five wettest days and wettest months for this site are listed below. This will give an idea of realistic extreme weather scenarios one can expect at the site.

Year	Month	Day	Rainfall (mm)
2005	November	8	130.0
2010	December	3	105.6
2012	March	2	94.4
2010	February	13	91.0
2014	January	9	77.0

Figure 7 Extreme Rainfall Days

Year	Month	Rainfall (mm)
2010	December	239.4

Year	Month	Rainfall (mm)
2005	November	203.4
2010	February	202.2
2017	March	195.4
2012	March	193.2

Figure 8 Wettest Months Recorded

c) External flood risk from nearby water bodies:

The site is located in the Lachlan Catchment area, pictured below:

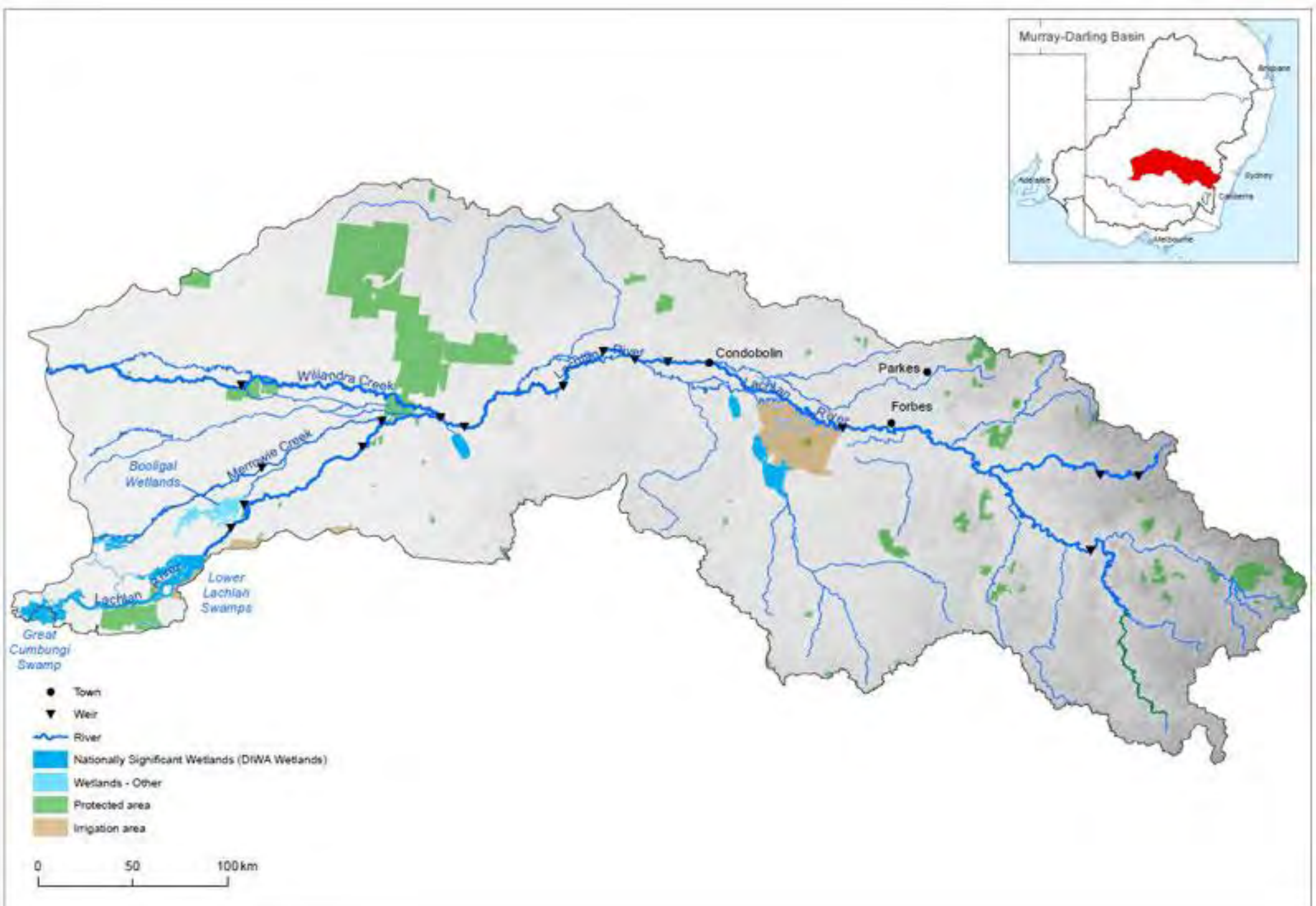


Figure 9 Lachlan Catchment Area

A study was done of the hydrology map of the area (source). The closest named water body is Ridgey Creek pictured below, to the west of the site. The Ridgey Creek further flows into the Lachlan River which is nearly 100 kilometres away from the creek. As per the drainage map delineated by Department of Primary Industries ("DPI"), in March 2017, there is no external source of flooding to site. In cases of extreme weather (detailed later in Section J), there is very minor inundation within the site boundary due to this water source.

Figure 10 Waterbody map of the site

Satellite imagery indicates that the creek is primarily dry with water flow present during periods of rain. To get a better idea of the flood risk posed by this, the Parkes Shire Local Flood Plan was studied (source). The flood plan mentions that the Parkes-Condobolin Road (MR61) that runs just to the north of the site can be cut off by Ridgey Creek for up to four hours at the point where it intersects the road. This might cause disruption to vehicle movement to and from the plant in case an exit road is designed on the western edge of the site. No other external sources of flood risk were identified. Please refer to Section J for a more detailed account of the flood characteristics of the AOI and surrounding areas.

d) Soil Analysis

The AOI was found to comprise three different soil groups.

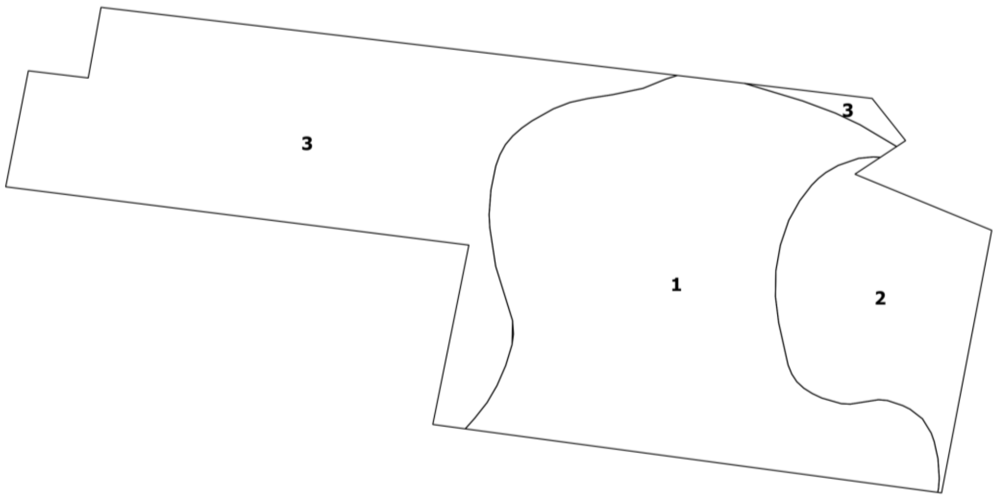


Figure 11 Soil Map

#	Soil type	Farm Class	Erosion Characteristics
1	Reddish sandy loam, 2 to 5% slope	Open woodland	Highly erodible by water
2	Brown sandy clay loam, up to 15% slope	Open woodland	Potentially erodible by water
3	Brown sandy loam, 0 to 2% slope	Open woodland	Highly erodible and prone to flooding

Figure 12 Soil Characteristics

e) Digital Surface Model of the Site

The Client had conducted a terrestrial land survey of the site in February of 2018. The AutoCAD contour data from this survey was made available to SenseHawk and was used to create a Digital Elevation Model that was used for subsequent flood modelling.

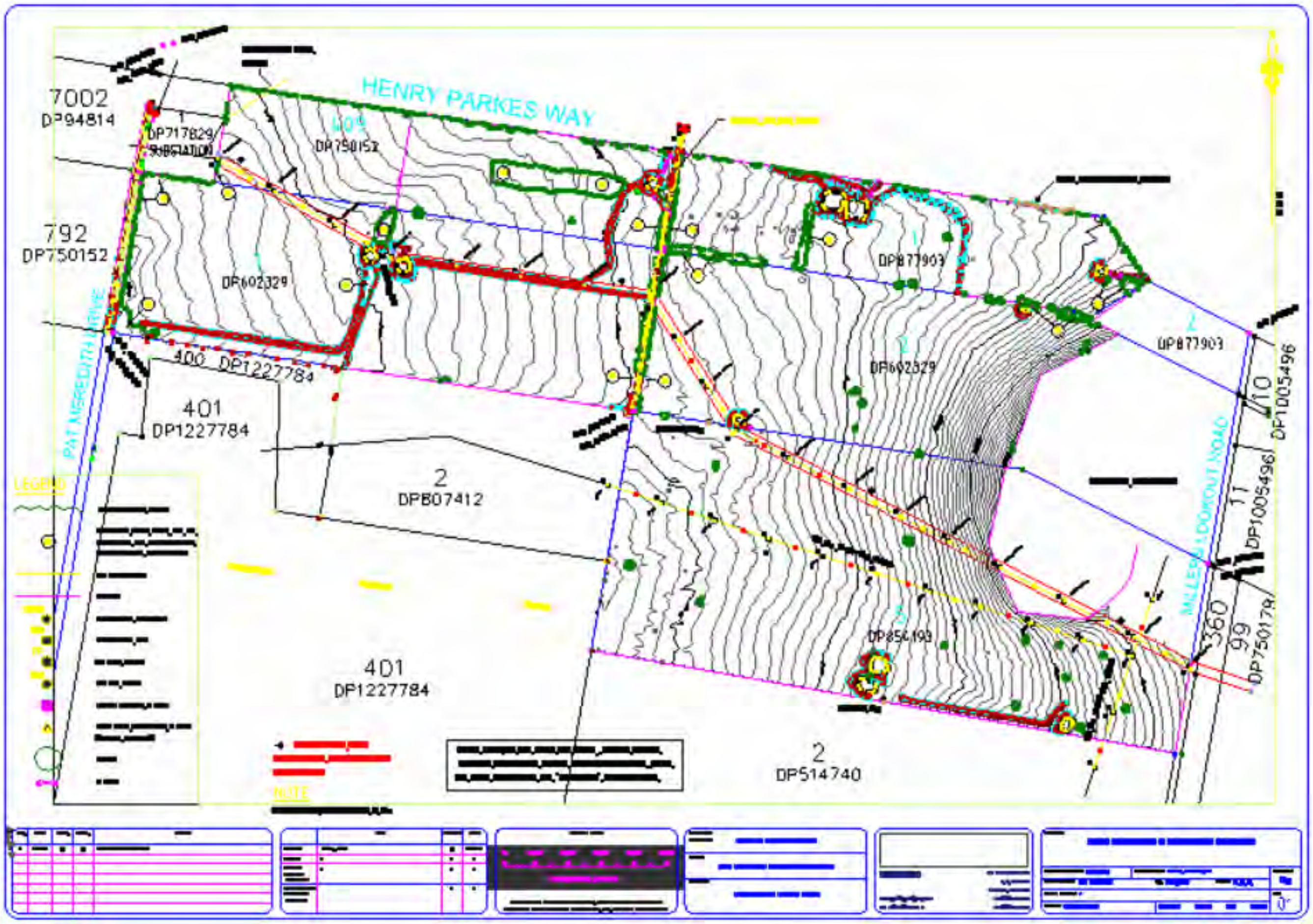


Figure 13: Contour map of site

f) Delineating the streams and watersheds on site

Using the AutoCAD file provided by the Client, the surface waterbodies in the site were first delineated.

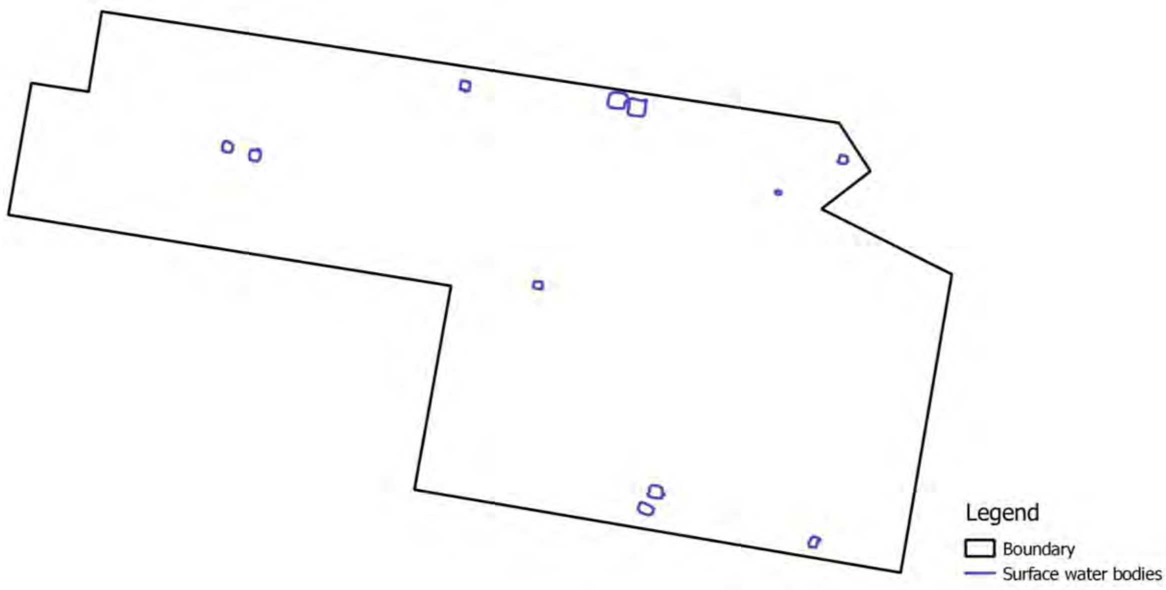


Figure 14 Surface water bodies

Using the contour map provided, a 10m DEM was generated and fed into our Hydrology Analysis system. The streams in the AOI were then mapped and the basin boundary was delineated with the elevation points in the AOI. The delineated boundary was found to have a spread of around 725 acres. The streams delineated were found to be from order of 1 to 3 which was further used to identify the outlets and delineate the watersheds.

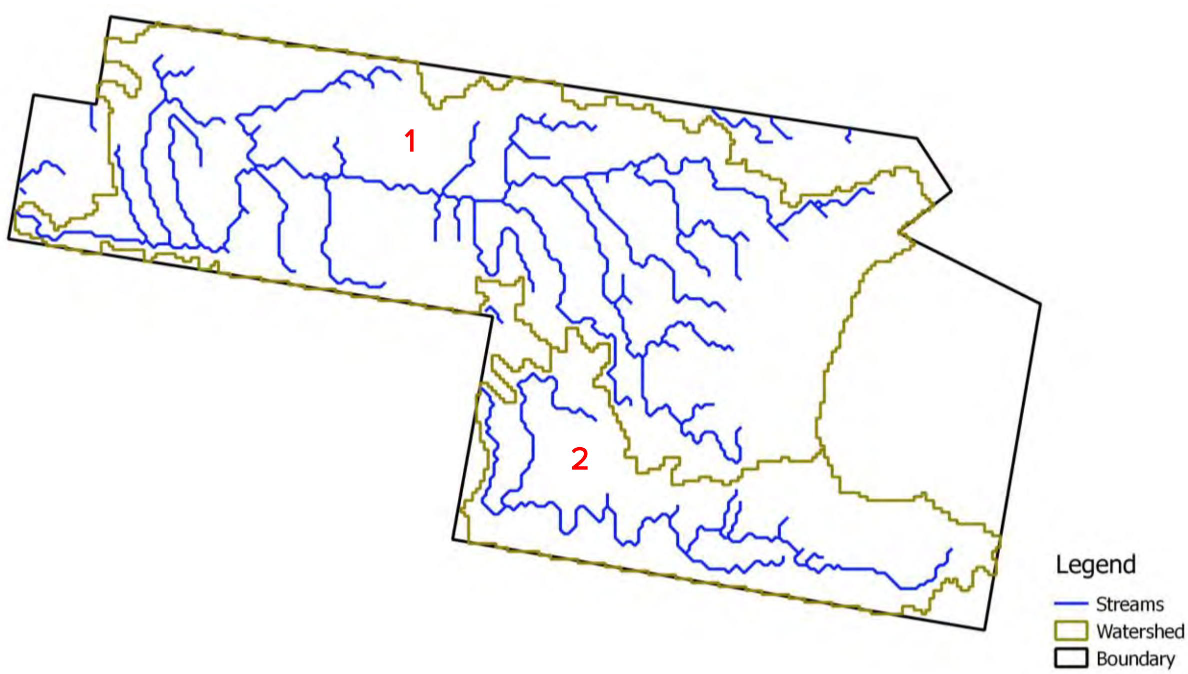


Figure 15 Watershed Boundaries

Two watersheds were identified in the site:

Watershed	Area (sq-m)	Perimeter (m)	Average elevation (m)	Minimum elevation (m)	Maximum elevation (m)	Average slope (deg)	Time of Concentration (minutes)*
1	2,175,858	12,172	281.6	279.0	300.3	0.87	12.29
2	745,752	6,996	286.6	278.0	302.1	1.15	8.72

Figure 16 Watershed Characteristics

*tc = 0.0078 ($L^{0.77}/S^{0.385}$), L = Longest travel path, S = average slope

g) Determining water flow direction and accumulation in the watersheds

Using the DEM generated, a map of the water flow and water accumulation in the site was generated.

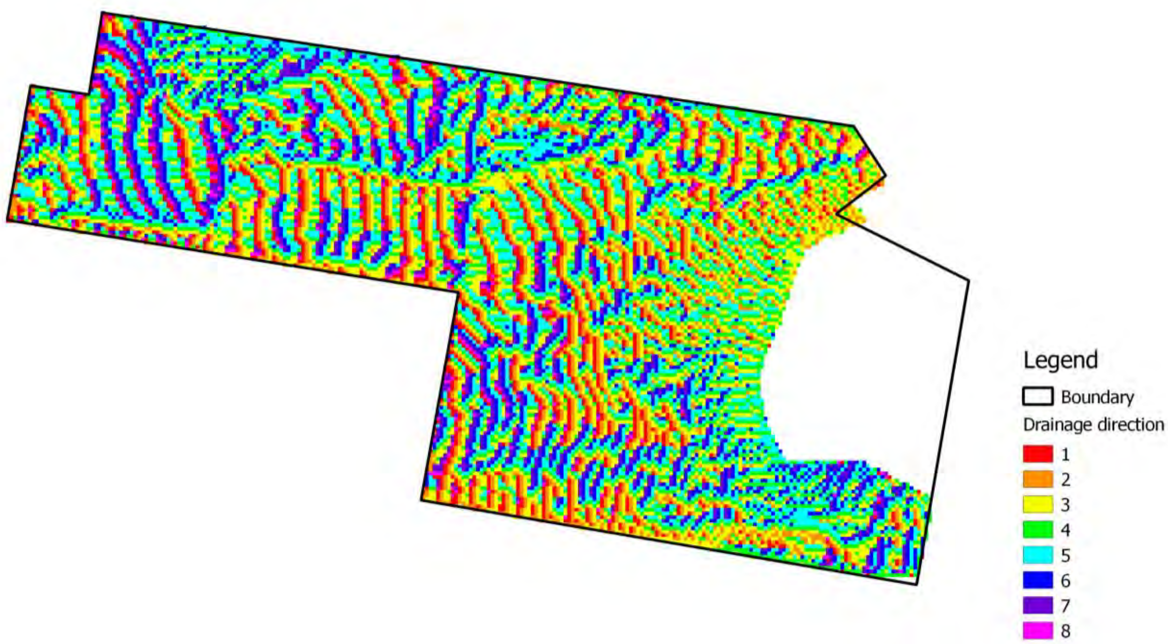


Figure 17 Flow Direction Map[1]

[1] 1 – East, 2 – South East, 3 – South, 4 – South West, 5 – West, 6 – North West, 7 – North, 8 – North East

Figure 18 Flow Accumulation Map

Further, a slope map for the site was also developed to ensure that areas with steep slope (i.e. greater than 4) may be earmarked as keep-out areas in the plant design.

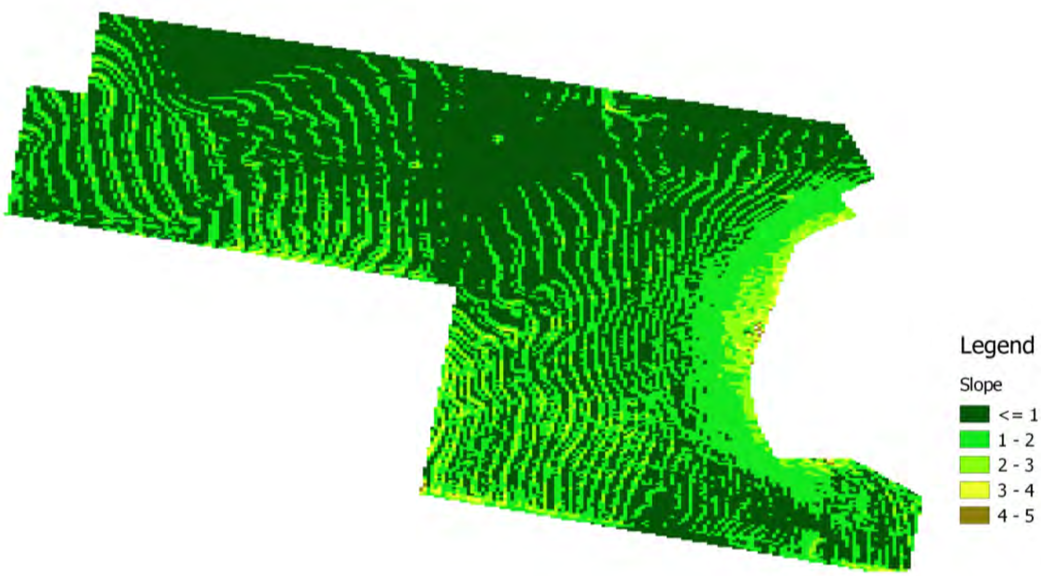


Figure 19 Slope Map

h) Defining the outlet points

Based on the watershed analysis, the outlet points for the streams were identified on site.

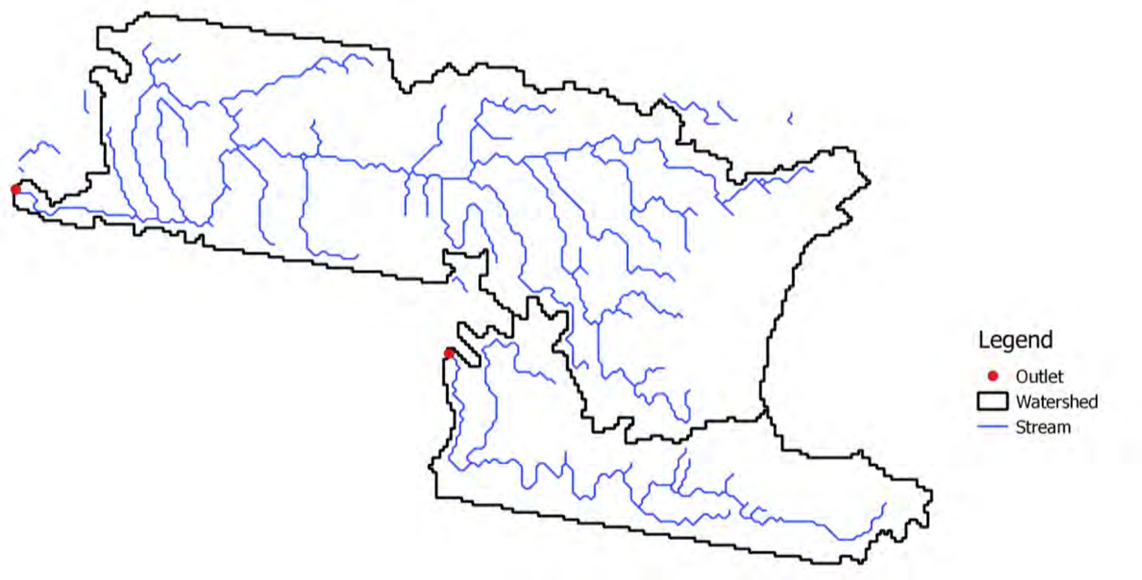


Figure 20 Identified Watersheds with Outlet Points

i) Determining total discharge and volume of flow from each watershed and the runoff coefficient for the site

The outputs of the rainfall analysis, soil analysis along with the streams and watersheds delineated were used to determine the total discharge and volume of flow in the watersheds. The flow modelling was done based on Soil Conservation Service-Curve Number (SCS-CN) method and the curve number 80 was used as per TR-55 specifications. With reference to the standards defined by ARR, the runoff coefficient in the AOI ranges between 0.18-0.22.

j) Flood Modelling and External Water Contributions

Based on the inputs discussed above and the ARR, a flood estimation model was developed. The peak discharge for both the watersheds over the last 22-year period was determined:

Watershed	Intense Rainfall Scenario (cubic meter/ second)	Average Rainfall Scenario (cubic meter/ second)
1	2.4	0.2
2	0.8	0.1

Figure 21 Peak Discharge

The Client is advised to use the Intense Rainfall Scenario while designing the solar PV plant. The total discharge along with confidence bands is detailed below for the two watersheds.

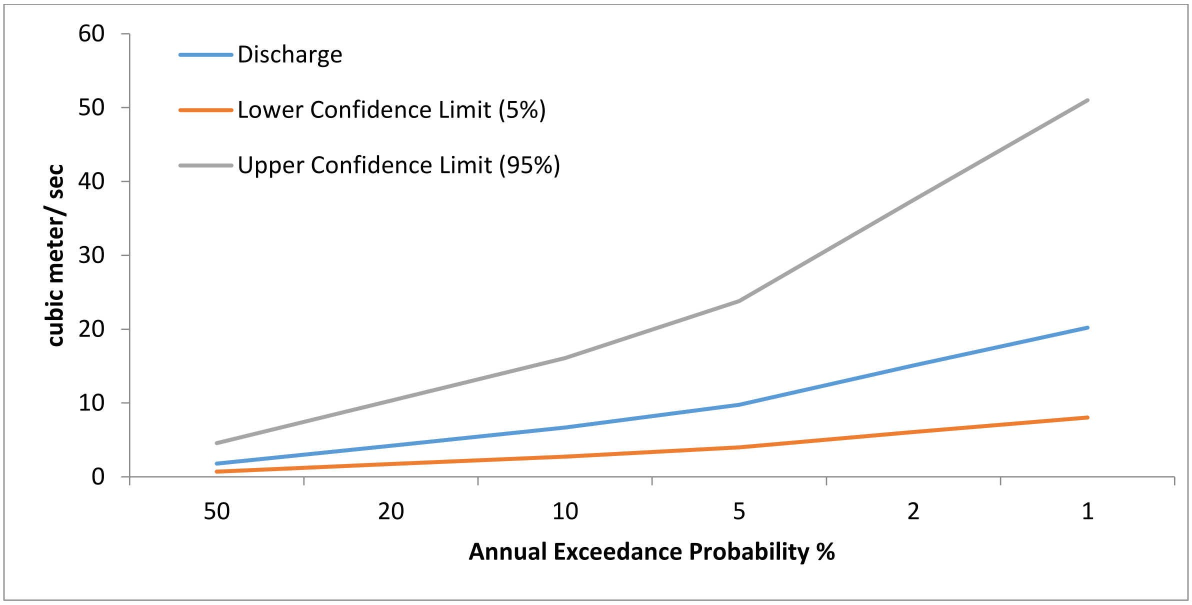


Figure 22 Flood modelling for Watershed 1

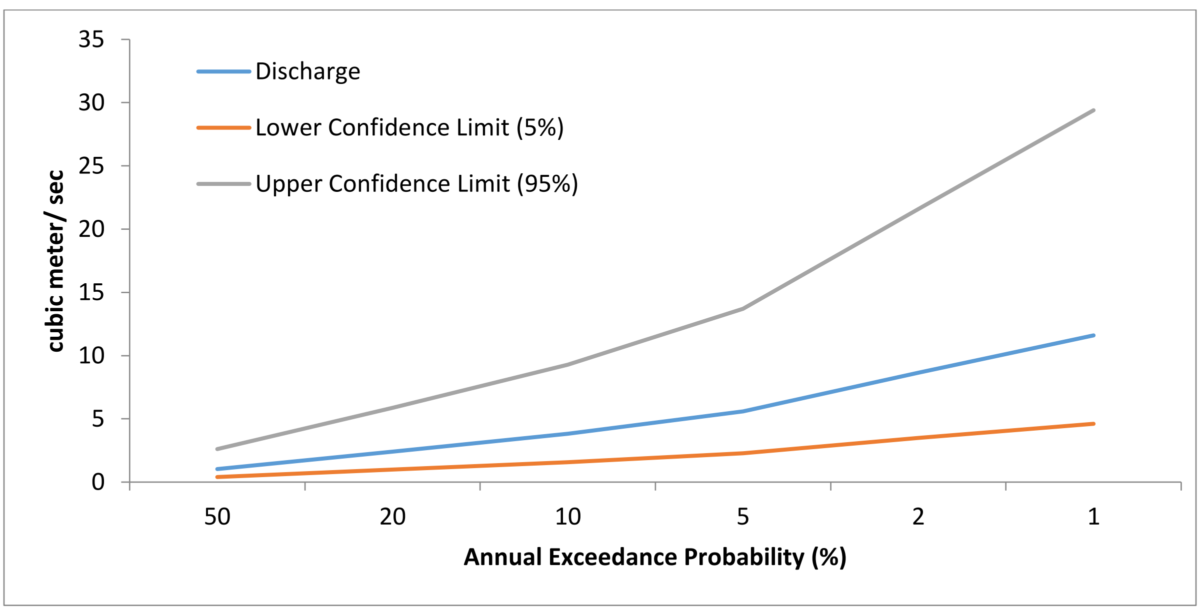


Figure 23 Flood modelling for Watershed 2

In order to accurately model the flood characteristics of the site, we need to account for the effect of the creek that lies outside the site boundary, to the west of the site. We also extended the northern and eastern boundaries of the site to examine the effects of flooding in these areas on the AOI. The topography of these extended regions was derived from SRTM elevation data (30m) dated 23rd September 2014. Stormwater exits the site through the southwestern part of the site and get drained into the creek which flows west to the study area. Please note that the stream delineation and outlet points here differ slightly from the ones identified using the more recent contour survey because of differing topo data. These results can nevertheless be used as an indicator of the flood levels on site. The flood inundation depth was studied by simulating maximum return period (i.e. 22-year return period) rainfall over 5 continuous days (refer section a: Rainfall Intensity and Return Period). This equates to 130mm rainfall per day over 5 days. Under these extreme rainfall conditions, it has been observed that there is a maximum flood threat of 2m only in the high accumulation area, under the assumption of maximum return period levels of rain over continuous days of rainfall. The inundation depth map is shown below:

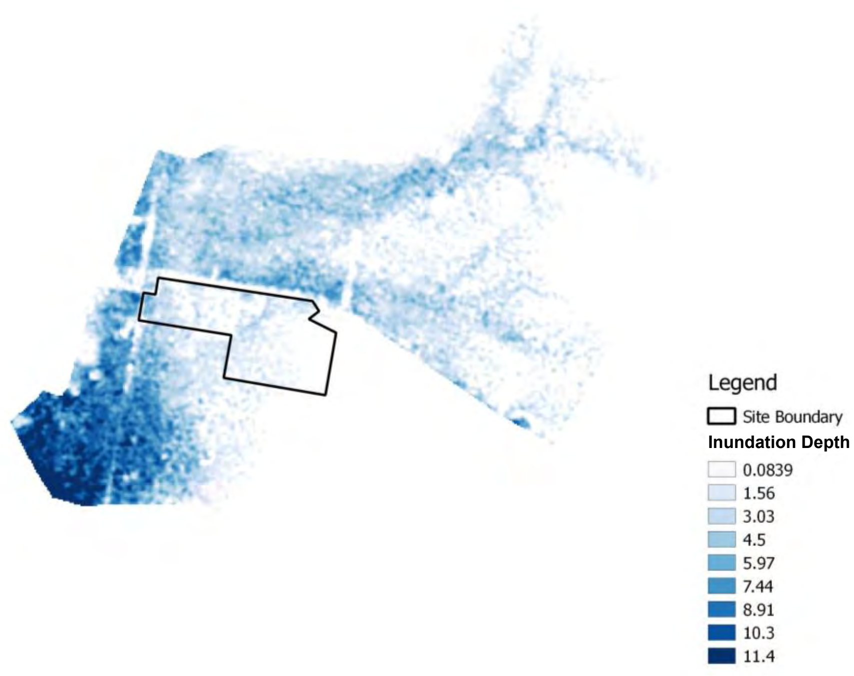


Figure 24 Flood inundation depth

The corresponding AutoCAD file indicating flood inundation levels has also been shared.

4. Results and Recommendations

Based on the peak runoff analysis and flood modelling studies detailed above, the following keep out areas and outlet points have been identified. Alternatively, the foundation of the plant is these areas needs to be reinforced to prevent flooding. The AutoCAD file corresponding to the below map has also been shared.

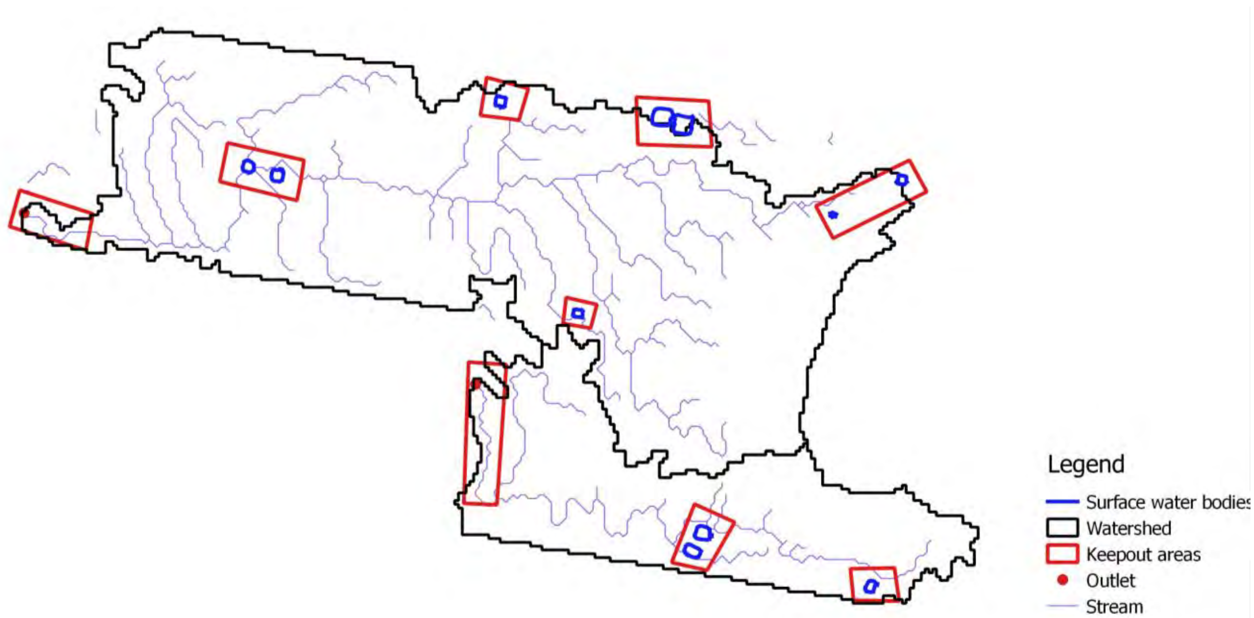
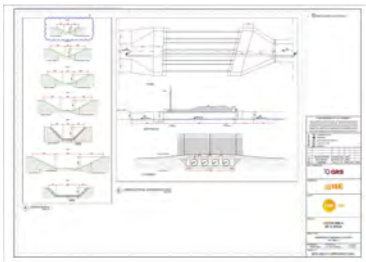
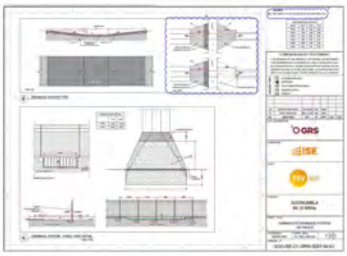
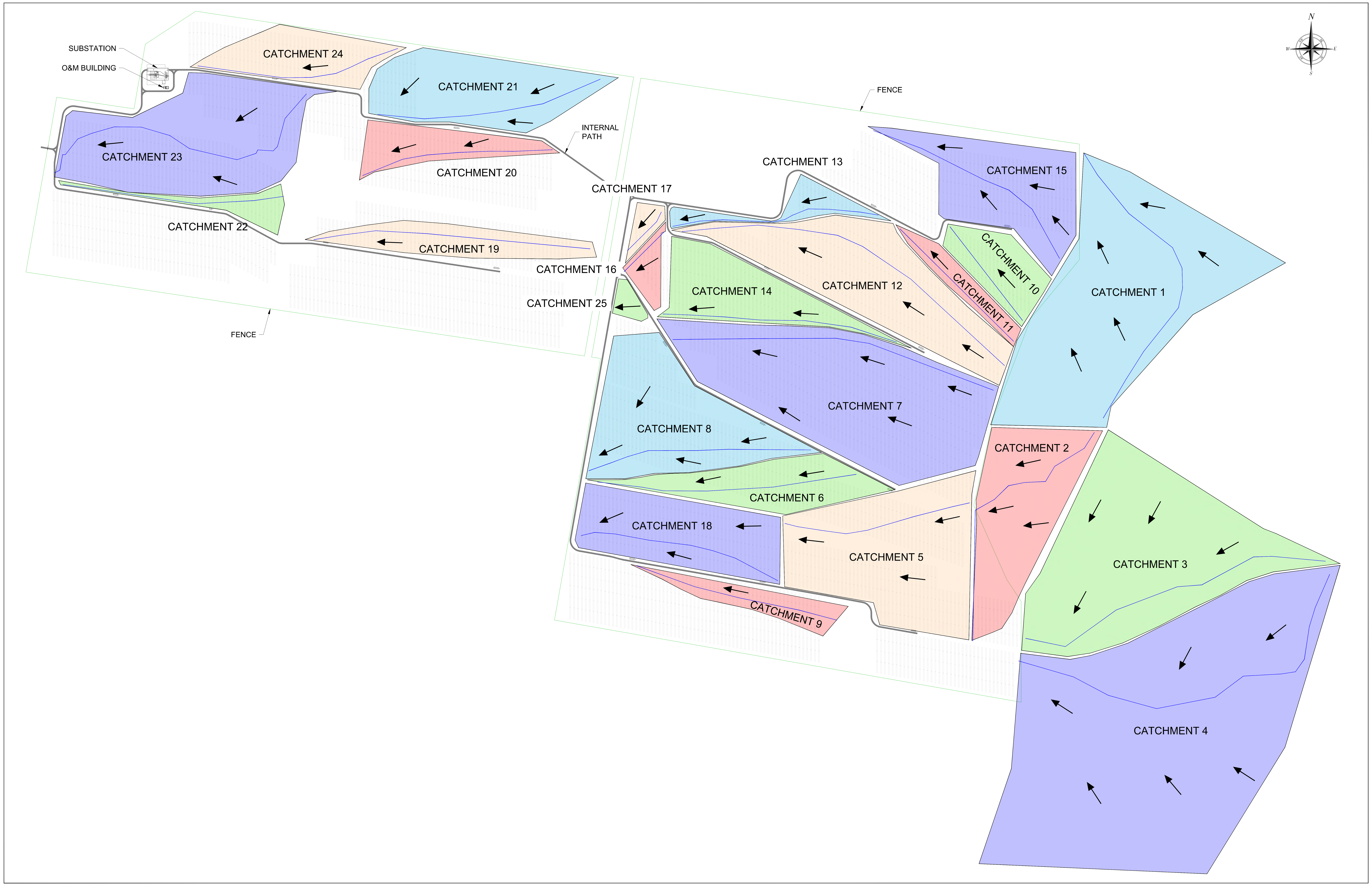


Figure 25 Keep-out areas identified

Appendix 5 Drawings







A WATER BASINS LAYOUT
Scale 1/6,000

SURFACE AREA BASINS (Ha)		
	1	29.31
	2	11.92
	3	26.61
	4	53.54
	5	17.50
	6	7.06
	7	25.24

SURFACE AREA BASINS (Ha)		
	8	14.09
	9	3.28
	10	4.36
	11	2.42
	12	16.22
	13	2.51
	14	7.71

SURFACE AREA BASINS (Ha)		
	15	10.92
	16	1.39
	17	0.90
	18	10.48
	19	5.44
	20	4.46
	21	10.83

SURFACE AREA BASINS (Ha)		
	22	2.12
	23	17.93
	24	6.04
	25	0.70

WATER BASINS LEGEND
CATHMENT BOUNDARY
FLOW DIRECTION
PRINCIPAL WATER FLOW PATH

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REV.	DESCRIPTION	DATE	BY	APPR.	EPC	CLNT
A1	FIRST EMISSION	MAY-2019	LHH	MBS		

EPC CONTRACTOR: GRS

ENGINEERING: ISE

CLIENT: FRV FOTOWATIO RENEWABLE VENTURES

PROJECT:
GOONUMBLA
89.10 MWdc

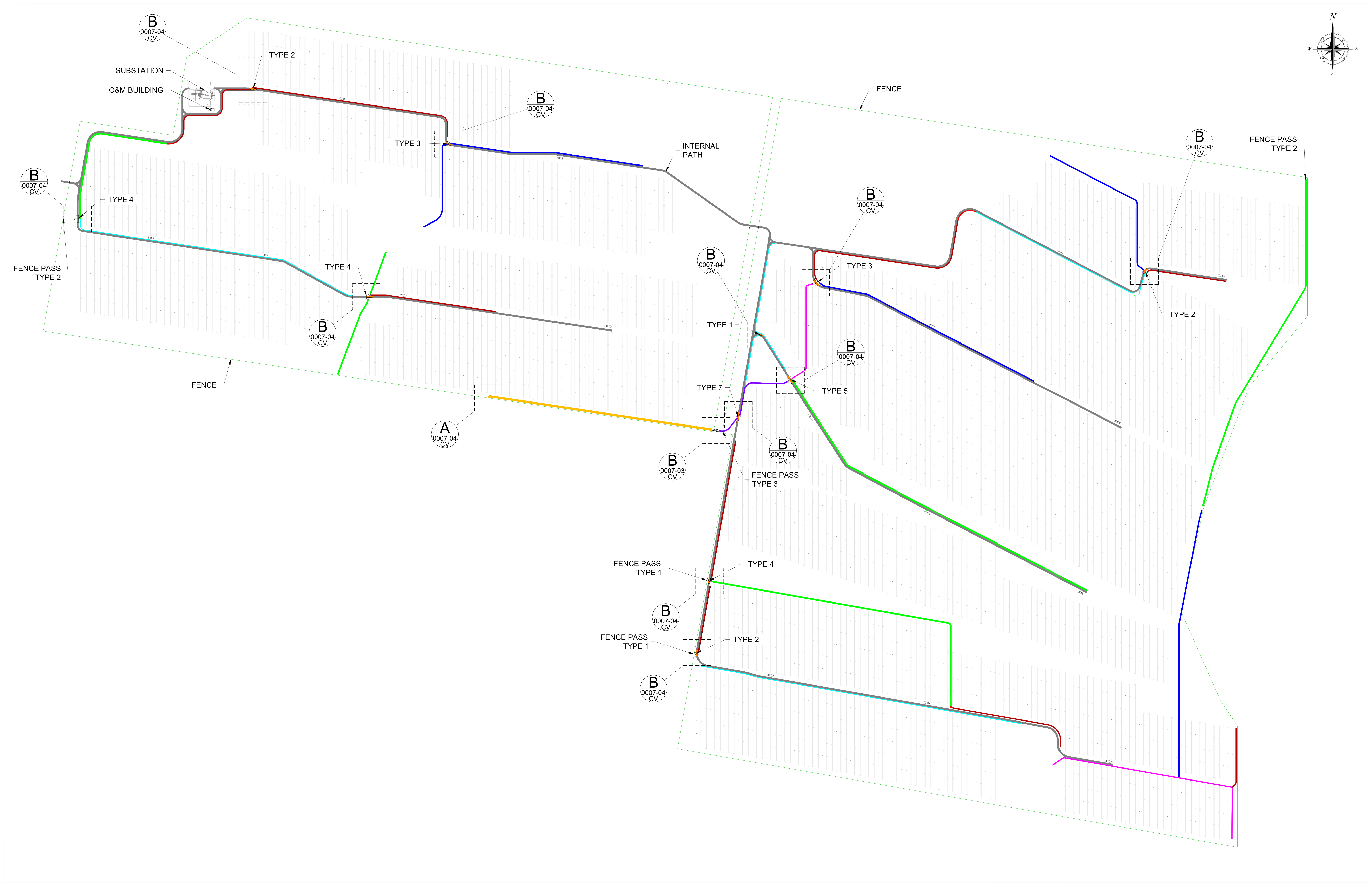
SHEET TITLE
RAINFALL DRAINAGE SYSTEM
WATER BASINS

REFERENCE: I18-0031-ING
PAPER SIZE: A1: 840 x 594 mm.

DRAWING N°
GOO-ISE-CV-DRW-0007-01-A1

NOTES:

1. FOR DITCHES, CROSSFENCE AND CROSSROAD DETAILS SEE:
   - GOO-ISE-CV-DRW-0007-03 - DETAILS I
   - GOO-ISE-CV-DRW-0007-04 - DETAILS II



A RAINFALL DRAINAGE SYSTEM. DITCHES LAYOUT

Scale 1/5,000

LEGEND
DITCH TYPE 1
DITCH TYPE 2
DITCH TYPE 3
DITCH TYPE 4
DITCH TYPE 5
DITCH TYPE 6
DITCH TYPE 7
TRANSITION
CROSSING ROADS
INTERNAL PATHS

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CLIENT: FRV FOTOWATIO RENEWABLE VENTURES

PROJECT: GOONUMBLA 89.10 MWdc

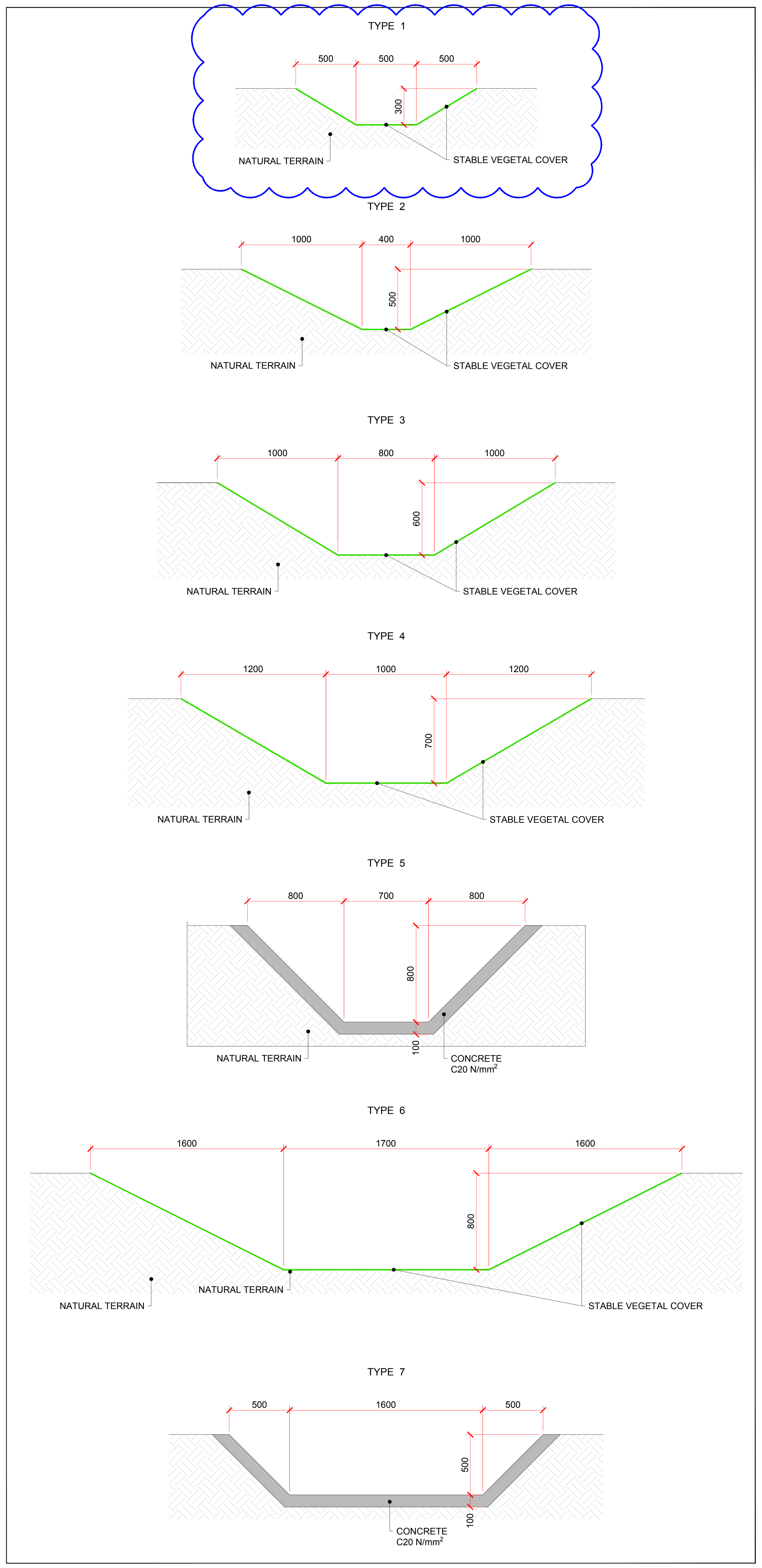
SHEET TITLE: RAINFALL DRAINAGE SYSTEM DITCHES

REFERENCE: I18-0031-ING

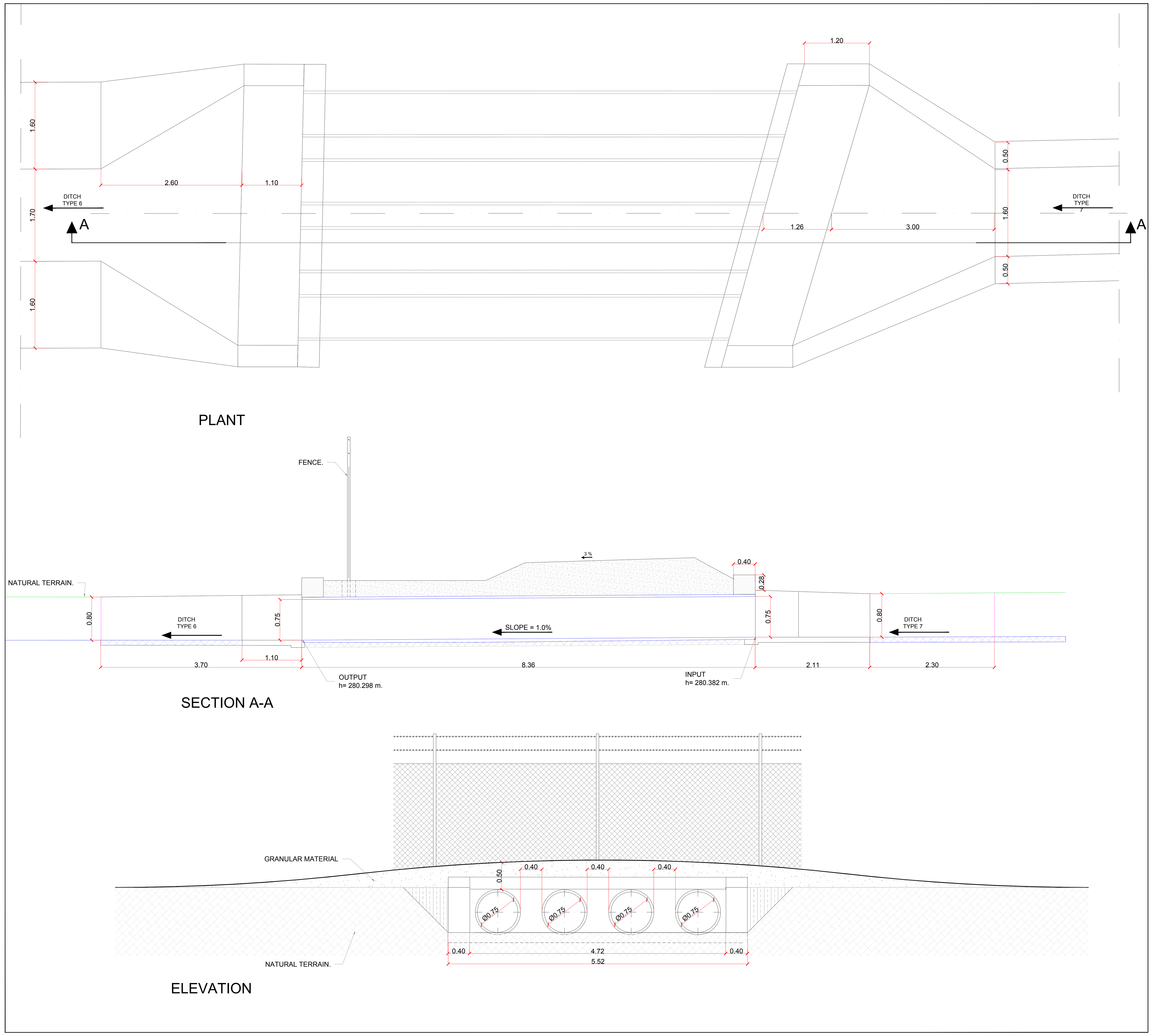
PAPER SIZE: A1: 840 x 594 mm.

DRAWING N°: GOO-ISE-CV-DRW-0007-02-A1

X:\01_PROYECTOS\2018\01_PROYECTO INGENIERÍA\I18-0031-ING-GOONUMBLA-AUSTRALIA\05_Eng_Det\D. CV\GOO-ISE-CV-DRW-0007-03-04_RAINWATER DRAINAGE SYSTEM DETAILS



A DITCHES DETAILS
Scale 1/30



B DRAINAGE SYSTEM - CROSSROADS DETAILS
Scale 1/50

NOTES:

1. MEASUREMENTS IN MILLIMETRES, UNLESS NOTED OTHERWISE.

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A2	SECOND EMISSION	JUN-2019	JGG	MBS		
A1	FIRST EMISSION	MAY-2019	JGG	MBS		

EPC CONTRACTOR: GRS

ENGINEERING: ISE

CLIENT: FRV FOTOVATIO RENEWABLE VENTURES

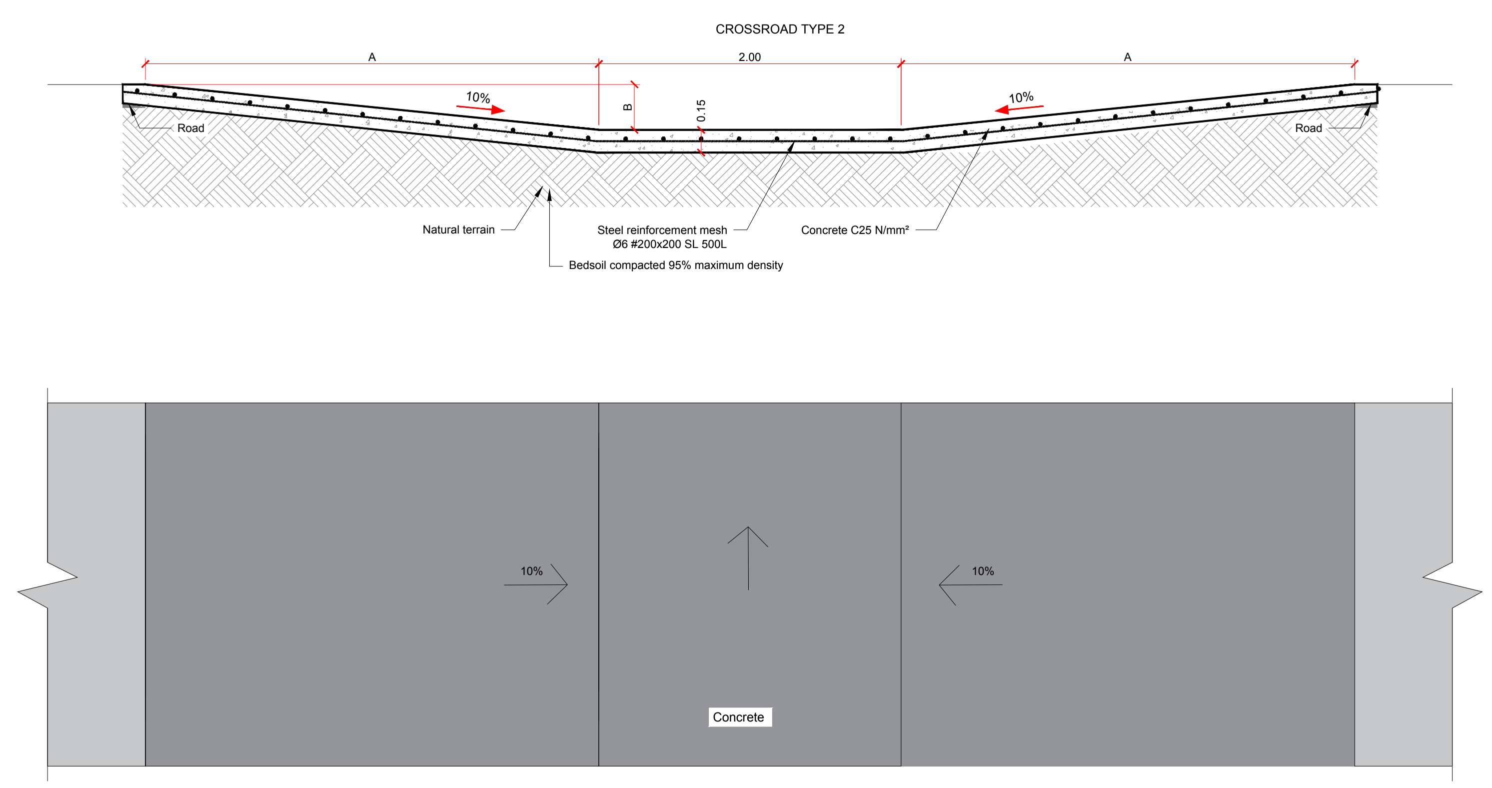
PROJECT:
GOONUMBLA
89.10 MWdc

SHEET TITLE:
RAINWATER DRAINAGE SYSTEM
DETAILS I

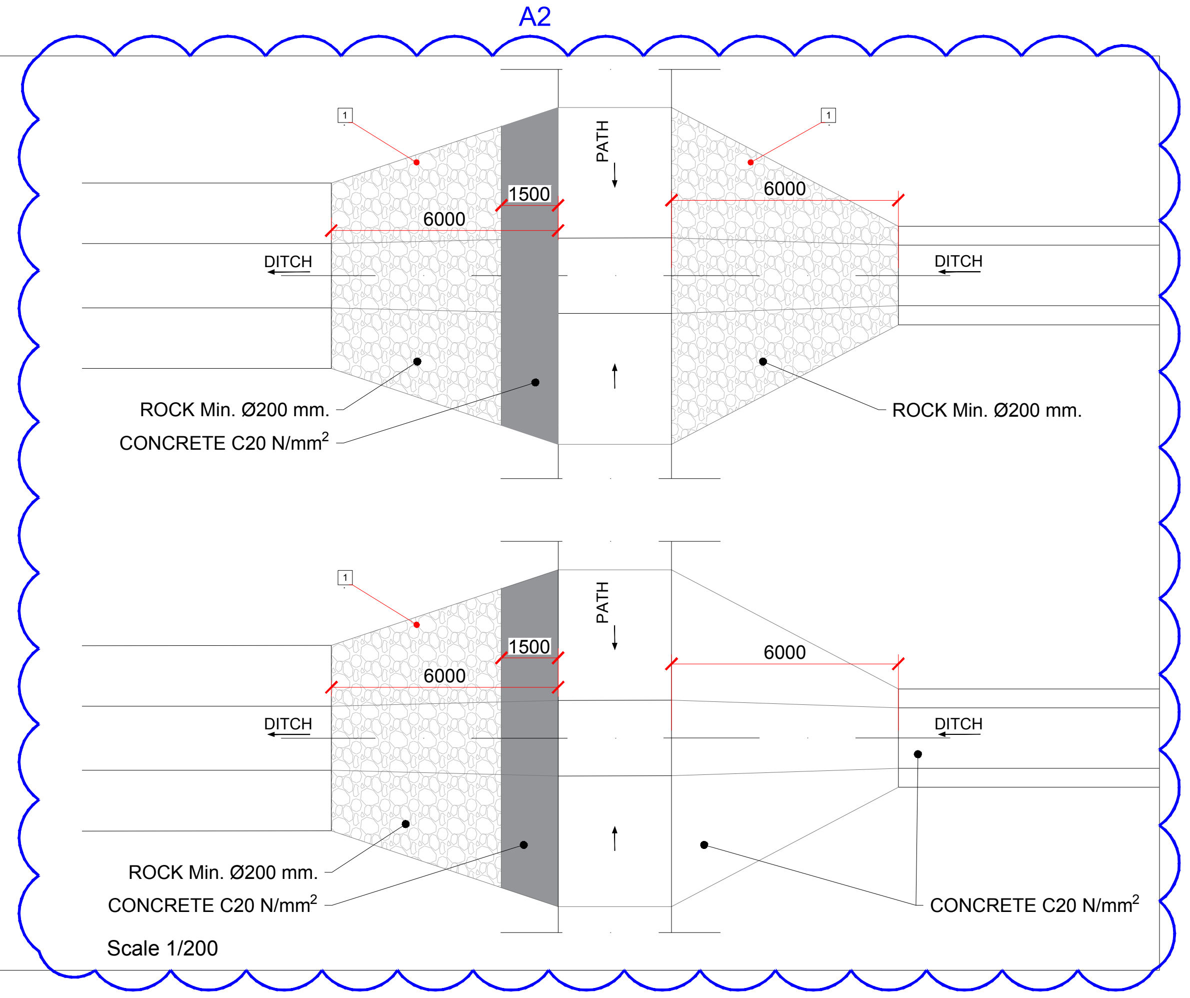
REFERENCE: I18-0031-ING

PAPER SIZE: A1: 840 x 594 mm.

DRAWING Nº
GOO-ISE-CV-DRW-0007-03-A2

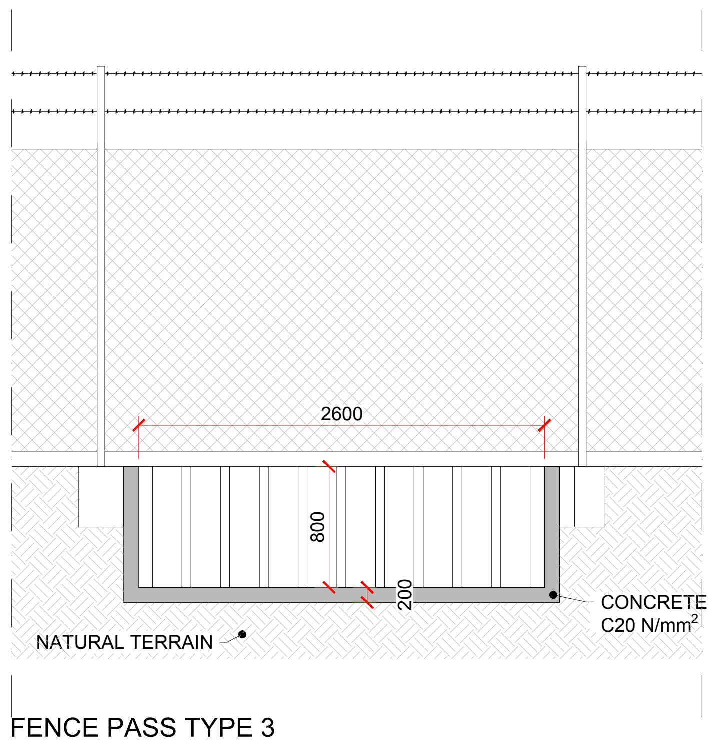


Scale 1/50



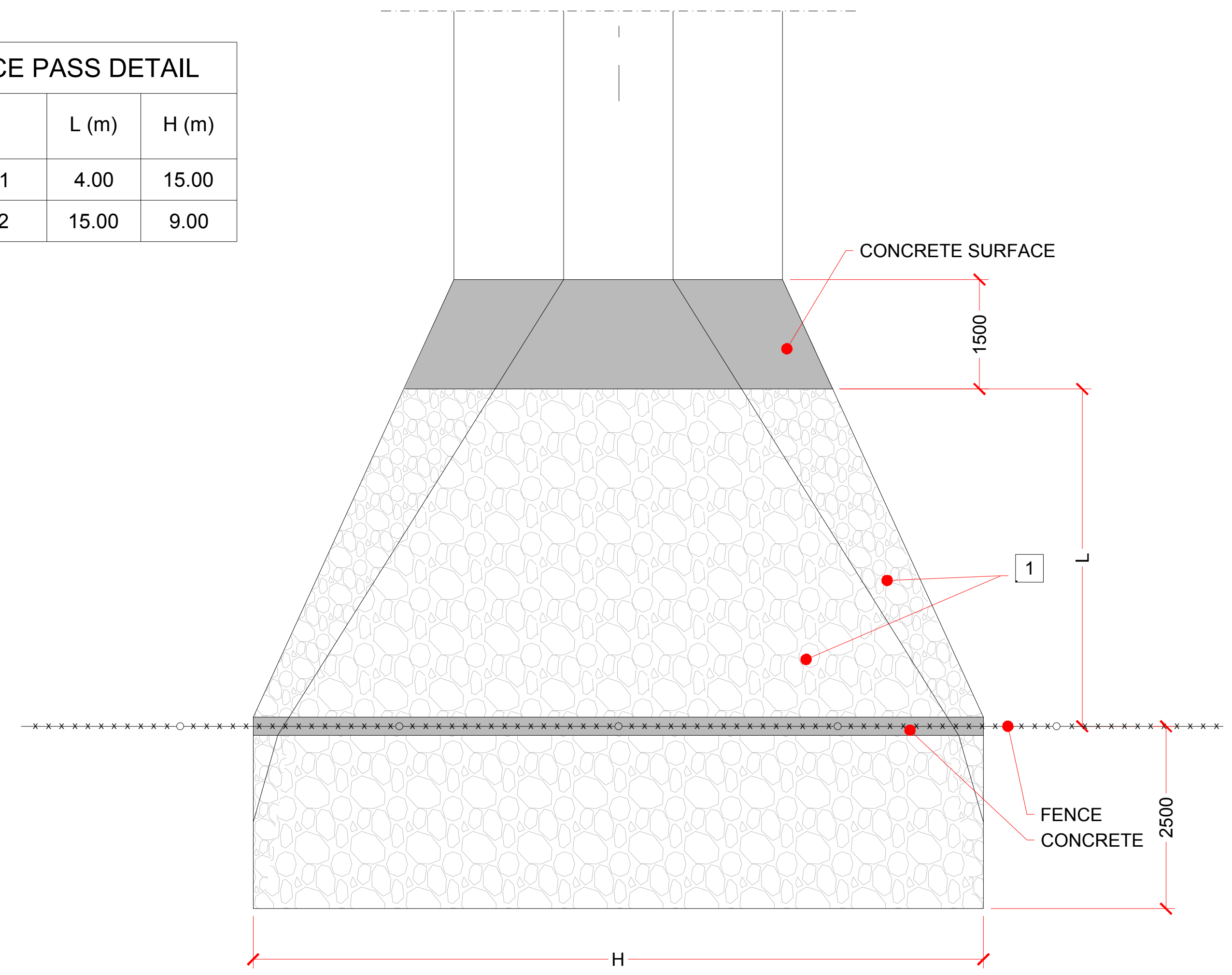
Scale 1/200

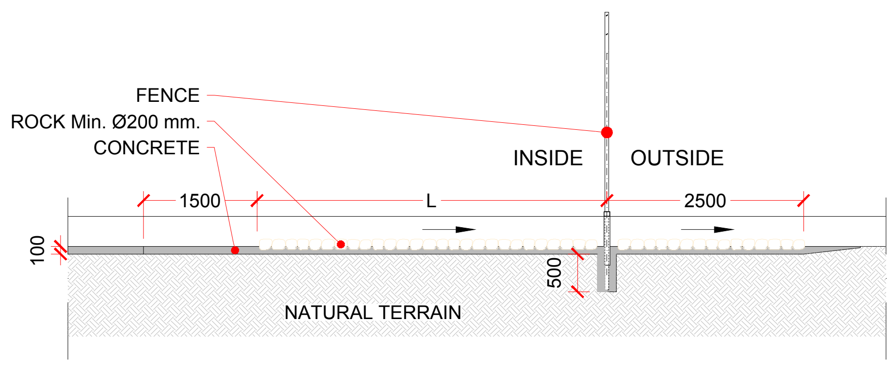
B DRAINAGE SYSTEM TYPE

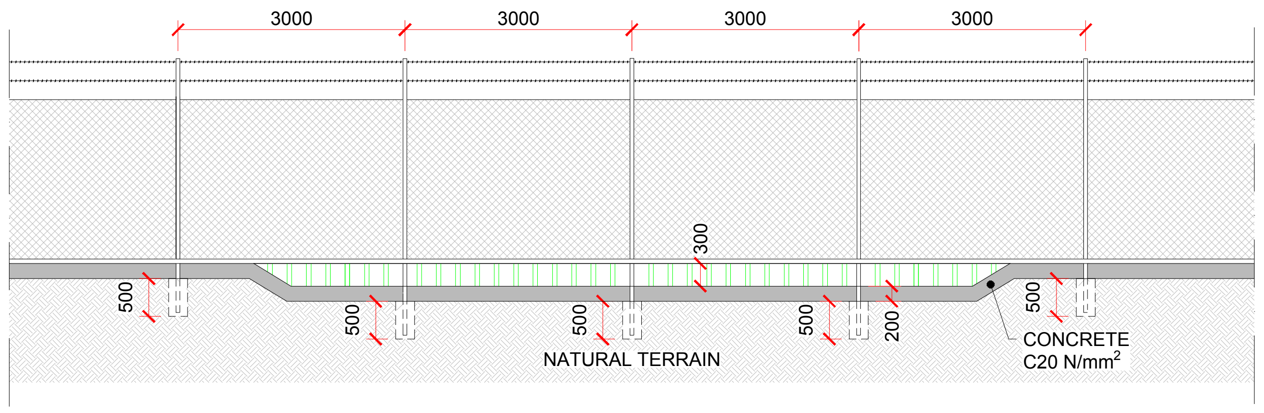


FENCE PASS TYPE 3

FENCE PASS DETAIL		
	L (m)	H (m)
TYPE 1	4.00	15.00
TYPE 2	15.00	9.00







A DRAINAGE SYSTEM - FENCE PASS DETAIL

Scale 1/100

KEYED NOTES: A2

1 ROCK PROTECTION TYPICAL DIAMETER MIN. NOM.Φ200 (200MM THICK)

CROSSROADS DETAILS			
DITCH	A (m)	A (m)	C (m)
TYPE 1	3.00	3.00	0.30
TYPE 2	5.00	5.00	0.50
TYPE 3	6.00	6.00	0.60
TYPE 4	7.00	7.00	0.70
TYPE 5	8.00	8.00	0.80
TYPE 7	8.00	8.00	0.80

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A2	SECOND EMISSION	JUN-2019	JGG	MBS		
A1	FIRST EMISSION	MAY-2019	JGG	MBS		

EPC CONTRACTOR: GRS

ENGINEERING: ISE

CLIENT: FRV FOTOWATIO RENEWABLE VENTURES

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