Stormwater Management Report

Clermont Solar Farm

within
Isaac Regional Council

for

CLERMONT SOLAR PTY LTD

EPURON

Project 16-076

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1. Introduction

1.1 Background

icubed consulting was commissioned to undertake the stormwater quantity and quality documentation required for a Renewable Energy Facility (150MW Solar Farm) for Clermont Solar Pty Ltd over land located at Alpha Bypass Road, Clermont. The subject land can be further identified as lot 6 on SP159756, Lot 220 on CLM102 and Lot 153 on CLM203.

The proposed development will comprise of a Renewable Energy Facility (150MW Solar Farm). The development will be completed two stages.

The proposed development is shown on drawing 16-076-A00 in Appendix A.

1.2 Objectives

This report has been compiled to address the stormwater quality and quantity requirements of the State Planning Policy 2016 and identify the requirements for conveying the major runoff from the development through the site.

1.3 Scope

The scope of this report encompasses:

- in detail the post construction phase of development; however the construction phase is briefly addressed
- the modeling and assessment of the developed catchment, and the major channel flows within the site.

2. Location

The proposed site is located at Alpha Bypass Road, Clermont. The subject land can be further identified as lot 6 on SP159756, Lot 220 on CLM102 and Lot 153 on CLM203. Primary access is gained via Alpha Bypass Road which fronts the northern boundaries of the site. The site is located in 2 parts (north and south) which has sustained the overland flow path between the 2 parts of the site. The southern part of the solar farm has the majority of site area grading to the north at an average grade of approximately 1.4%. The northern part of the site has an average grade of 3%. The site in its current form is used as grazing land.

Figure 1: Locality Plan, (2016, Copyright Google Map) – Not to scale, generally indicative only.

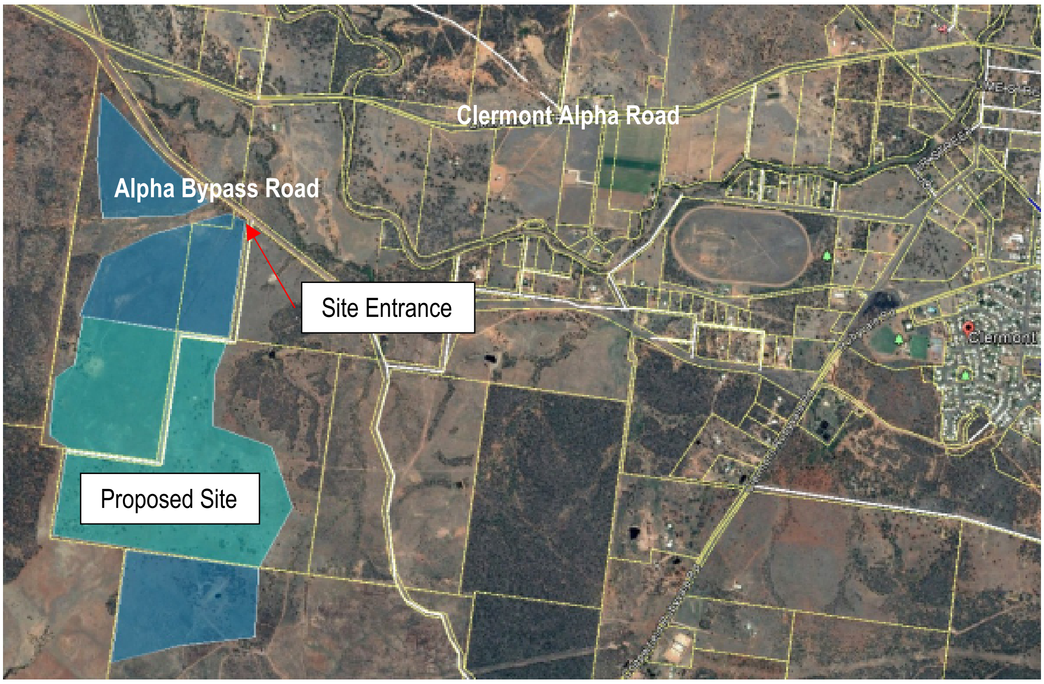

Figure 2: Aerial Photo, (2016, Copyright Google Earth / Qld Globe) – Not to scale, generally indicative only.

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3. Site Hydrology

3.1 Method and Approach

The stormwater discharges from this site were calculated using the rational method. This method as described in the Queensland Urban Drainage Manual (QUDM) is commonly used in municipal hydrology and is more than adequate for the design requirements. The Rational Method is based around the Rational formula:

$$Q_y = \frac{C_y \, {}^tI_y A}{360}$$

Where:
- Q_y = Peak flow rate (m^3/s) for the average recurrence interval (ARI) of y years
- C_y = Coefficient of runoff for ARI of y years
- A = Area of catchment (ha)
- ${}^tI_y$ = Average rainfall intensity (mm/hr) for design duration of t hours and an ARI of y years.

When designing the stormwater drainage system the following points have been considered:

Stormwater treatment shall be designed for a 3 month storm event, calculated as Q_1 x 0.5; and Stormwater reticulation is to cater for $Q_{3\ month}$ and Q_{20} storm events.

For the purposes of this stormwater quality assessment, the area of the proposed development requiring stormwater quality treatment has been divided up into 8 catchments:

Table 1 details catchment names, areas and storm event flows for each of the 8 catchments based on the Rational Formula. Refer to Appendix C for details of catchment calculations and Appendix A, drawing 16-076-C01, for catchment areas.

Table 1: Catchments and Discharge

Catchment	Area (ha)	*Minor Storm Event* Q_{20}		*Treatable Storm Event* $Q_{3\ month}$	
		Intensity (mm/hr)	Discharge (m3/s)	Intensity (mm/hr)	Discharge (m3/s)
Catchment 1 - PV Array 1	144.41	61	16.70	14.6	3.04
Catchment 2 - PV Array 2	33.40	94	5.95	22.5	1.08
Catchment 3 - PV Array 3	11.35	105	2.26	25.0	0.41
Catchment 4 - PV Array 4	5.35	123	1.25	29.0	0.22
Catchment 5 - Site Facilities and Substation	1.15	170	0.50	39.5	0.09
Catchment 6 - PV Array 6	101.83	89	17.18	21.3	3.13
Catchment 7 - PV Array 7	8.24	148	2.31	34.5	0.41
Catchment 8 - PV Array 8	18.04	105	3.59	25.0	0.65

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4. External Catchment Review and Flooding Risk

4.1 External Catchments

The southern part of the site is located on a crest and for this reason catchments fall to the north, west, south-west and north-east where runoff will flow to nearby overland flow paths and local waterways which are on the edge of the development. The northern part of the site has an external catchment to the west and overland flow paths on the edge of development on the southern and northern sides of this part of the development.

Because there are no flood studies covering the project site that we are aware of, flow widths of these existing flow paths are not known by icubed consulting at this time. Despite that some overland flow paths are located in close proximity to the site and may have potential to flood locally in some areas of the site, these possibly affected areas are proposed as PV Array area which are elevated between 600mm to 1,500mm above the ground level on poles.

The management of flow conveyance is investigated further in Section 6 of this report.

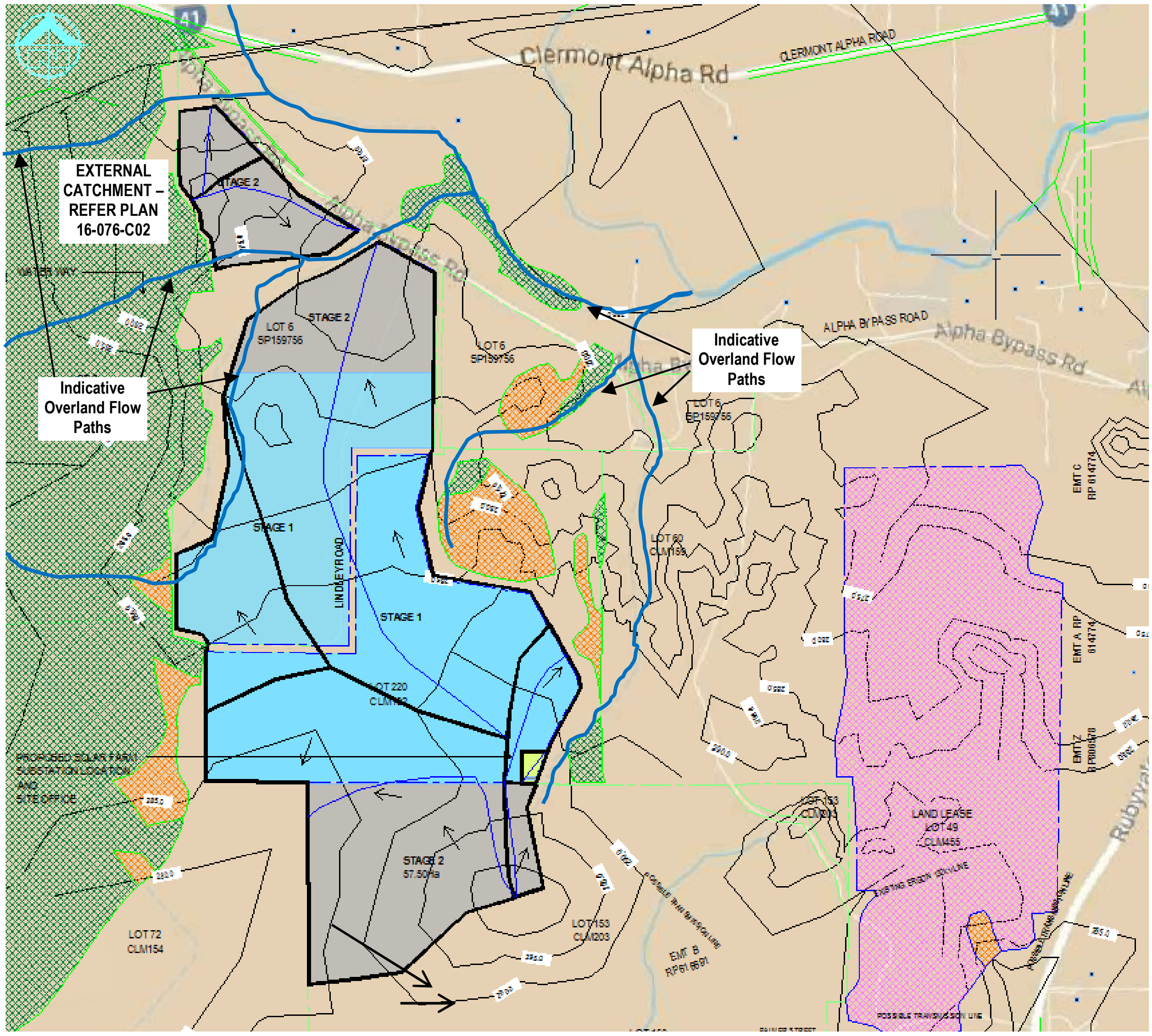

Figure 3: Project Overview and Internal Catchment Sketch (2016, Copyright Google Maps) – N.T.S.,indicative
Source: Google Maps

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4.2 Riverine Flooding Risk

Regional flooding was investigated by reviewing available flood information from the Queensland Department of Natural Resources and Mines (DNRM) that was dated December 2014. The DNRM flood mapping available did not extend as far to the west to include the section of Sandy Creek adjacent to the project site but was approximately 1.3km to the east at closest. The 100 year flood level reported approximately 1.3km to the east on Sandy Creek was shown to be about 10m lower than the lowest level of the project site, based on site levels investigated using Google Earth. In summary, it may be possible that flooding could occur in some locations along the lower edges of the site particularly from overland flow paths. Despite this, as described in Section 4.1, solar panel arrays will be elevated on poles, at a height of a minimum of 600mm to 1,500mm above the ground and therefore a low depth of flooding would be considered a very low risk to the proposed development.

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5. *Water Quantity*

The water quantity strategy for the development will be split into three distinct areas of the site, the Photovoltaic Array, Site facilities and the Substation. These are discussed in detail below.

5.1 Photovoltaic Array

The Photovoltaic Array ground surface level will remain undeveloped as the panels will be pole mounted with the runoff discharging to the surface and traversing the undeveloped pervious surface to the outlet. Soil conservation bunds will be used to divert and control drainage flows through the site as required and maintained for the life of the project. As such there will not be an increase in runoff from the Photovoltaic Array and no water quantity mitigation will be required.

5.2 Substation and Site Facilities

The substation and site facilities stormwater quantity mitigation will consist of a detention basin integrated into the bioretention basin for the combined substation and site facilities site. The modelling for the detention basins has been detailed below.

5.2.1 Predevelopment Flows

The predevelopment flows for the site are based of the catchment characteristics of the predevelopment site. The predevelopment runoff from the site was calculated using the ILSAX method within Watercom Drains. The runoff was calculated at the existing outlet in the north eastern corner of the substation/site facility area and has been summarised in Table 2.

5.2.2 Detention Storage

The detention storage within the basin was calculated by Watercom DRAINS. The inflow and outflow hydrographs are shown in Appendix C. The hydrographs clearly show that the runoff entering the system has been greatly reduced so that in conjunction with the remaining unmitigated flow there is less than the existing amount of runoff entering the downstream system. The 1 hour duration storm was found to be the worst case scenario.

The hydrographs are for the storms:

Major events:

- AR&R 100 year, 1 hour storm, Zone 3
- AR&R 50 year, 1 hour storm, Zone 3

Minor events:

- AR&R 20 year, 1 hour storm, Zone 3
- AR&R 10 year, 1 hour storm, Zone 3
- AR&R 5 year, 1 hour storm, Zone 3
- AR&R 2 year, 1 hour storm, Zone 3
- AR&R 1 year, 1 hour storm, Zone 3

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Designed Basin sizes:
Basin A will be an approximately 30m long by 16m wide with a detention depth of 1.0m. The minimum volume will be approximately 480m^3.

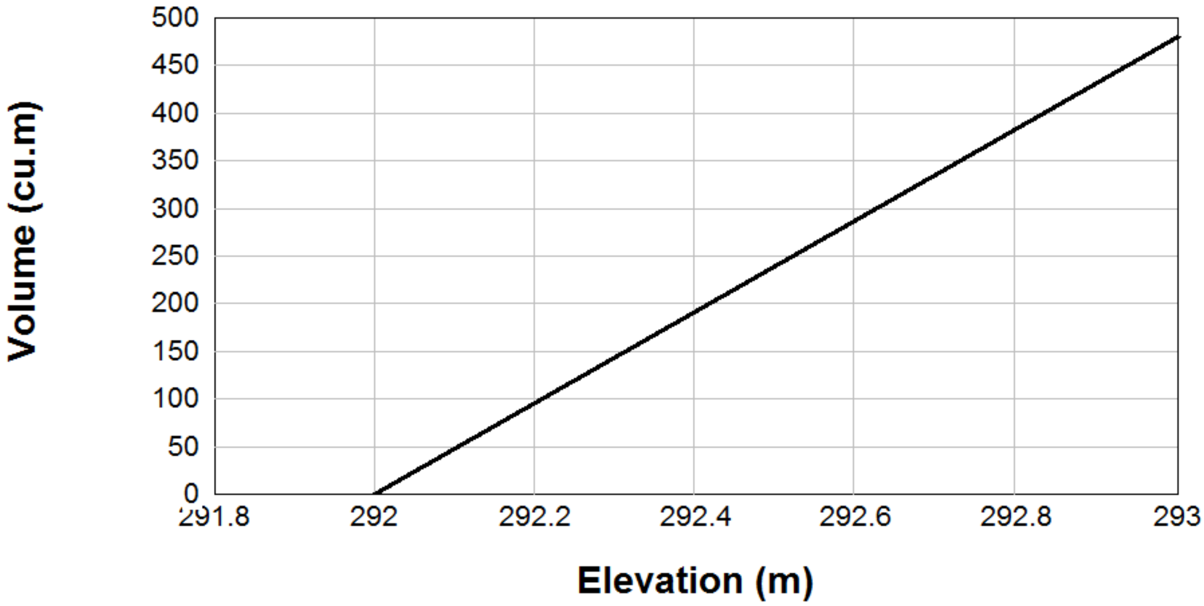

Figure 4: Volume vs Elevation for Basin A

Based on outputs from DRAINS for Pre development, Post development and Mitigated Flows, the basin is shown to adequately mitigate post development flows at the site outlet for all cases.

Table 2: Detention Basin A Flow Mitigation Table

Event Frequency (years)	A.E.P.	Pre Development Flows (DRAINS)	Post Development Flows (DRAINS)	Mitigated Flows (DRAINS)
1	0.632	0.153 m^3/s	0.226 m^3/s	0.055 m^3/s
2	0.393	0.222 m^3/s	0.290 m^3/s	0.139 m^3/s
5	0.181	0.300 m^3/s	0.366 m^3/s	0.277m^3/s
10	0.095	0.346 m^3/s	0.412 m^3/s	0.327 m^3/s
20	0.049	0.409 m^3/s	0.474 m^3/s	0.334 m^3/s
50	0.020	0.461 m^3/s	0.525 m^3/s	0.344 m^3/s
100	0.010	0.520 m^3/s	0.585 m^3/s	0.356 m^3/s

Inflow/Outflow and Storage data for worst case durations for each event modeled have been included in Appendix D.

The calibration of the DRAINS model has been checked using the rational method and results have been included Appendix C.

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6. Water Quality

6.1 Construction Phase

Potential exists during the construction phase for sediment to become mobilised by stormwater as suspended solids from the erosion of exposed soil areas and stockpiles, and as a result of spillages from construction and plant operations.

Stormwater quality during the construction phase of the development should be addressed in an Erosion and Sediment Control Plan. The plan should address construction phase erosion and sediment control issues in accordance with the International Erosion Control Association (IECA) Erosion and Sediment Control Guidelines. The Erosion and Sediment Control Plan should also be in accordance with the Water Sensitive Urban Design Guidelines for South East Queensland.

The following measures should generally be implemented prior to the commencement of construction:

- Education of all site workers in sediment and erosion procedures;
- Specified storage areas for construction materials and plant that are bunded to prevent any spillages from escaping; and
- Construction of silt fences and catch drains adjacent to the downstream boundaries to divert runoff to temporary sediment basins.

The following measures should be implemented during the construction phase of the project:

- Temporary sedimentation basins should be constructed in accordance with Council's requirements;
- Silt fences should be erected downstream of all disturbed areas; and
- All erosion and sediment control devices should be regularly inspected and maintained following storm events.

6.2 Operational Phase

During the operational stage of the development, the following impacts have been identified in relation to stormwater runoff and water quality of the receiving waterways:

- Potential exists for gross pollutants which include human derived litter, course sediment and vegetation affecting the drainage capacity of stormwater systems. Gross pollutants are also typically unsightly reducing the visual amenity of the site. Gross pollutants can also physically affect the downstream waterway habitats and organisms such as entangling birds and marine animals in plastic;

- Sediment and Suspended Solids can become mobilised by stormwater as suspended solids from the erosion of exposed soil areas, un-mulched garden beds and sediment deposited on car park and hardstand areas by vehicles and by atmospheric deposition of sediment. Sediment can affect receiving waterways physically through smothering aquatic flora and fauna. Sediments can also block stormwater systems leading to local flooding. Suspended solids may also be used as a transport medium for nutrients and heavy metals making their way into waterways; and

- Nutrients can enter the waterways from stormwater runoff through many sources including, detergents used in car washing, fertilizers from landscaping and lawn areas, nitrous oxide deposition from vehicle exhausts, and organic waste. Large nutrient levels can lead to eutrophication of the receiving waterways resulting in algal blooms and excessive macrophyte growth.

Implementation of the appropriate SQID's would ensure that stormwater leaving the developed site shall be acceptable to Healthy Waterways, Water Sensitive Urban Design Guidelines for South East Queensland's requirements.

6.3 Selection of Stormwater Management Objectives

6.3.1 Substation and Site Office

The Performance Criteria required to be met for discharges from development sites during the 'operational' (post-construction) phase of the development is detailed in Table B: Post construction phase – stormwater management design objectives, Appendix 3 of the State Planning Policy 2016.

The load-reduction targets that must be achieved when assessing the post-developed sites treatment train, (comparison of unmitigated developed case versus developed mitigated case) as determined from the State Planning Policy 2016 (refer SPP 2016, Table B, Western Queensland Climatic Region) are listed in Table 3.

Table 3: Stormwater Quality Objectives for the Site. (Operational Stage)

Pollutant Issues	Load Reduction Objectives (%)
Total Suspended Solids	85
Total Phosphorus	60
Total Nitrogen	45
Total Gross Pollutants	90

6.3.2 PV Array

Due to the low impact of the PV Array on the water quality in comparison to the existing agricultural land use, the process and objectives as outlined in the State Planning Policy 2016 are not relevant or practical.

The existing agricultural use pollutant load is based on the sediment runoff from cultivation of the land (TSS) and application of fertiliser (TP & TN). As part of the proposed land use the site is expected to be planted out with grass species to stabilise the soil and no fertiliser will be required.

As such the stormwater management objectives will be based on a baseline of the existing pollutant rates with the objective being to provide an overall reduction.

6.4 Predevelopment Catchment Annual Pollutant Loads

An assessment of stormwater quality was undertaken for the developed unmitigated site. The discharge concentrations of key pollutants from the site were then compared to the Water Quality Objectives. The pollutant concentrations were obtained by running a MUSIC model with the model parameters sourced from the Water by Design MUSIC Modelling Guidelines. MUSIC is the Model for Urban Stormwater Improvement Conceptualisation, developed by the MUSIC Development Team of the CRC for Catchment Hydrology.

MUSIC has the ability to simulate quality of runoff from catchments ranging from a single house block up to many square kilometres, and the effect of a wide range of treatment facilities on the quality of runoff downstream. By simulating the performance of stormwater quality improvement measures, MUSIC determines if proposed systems can meet specified water quality objectives.

6.4.1 Substation and Office Facility Site

Table 4 details the MUSIC parameters utilised in running the model.

Table 4: MUSIC Model Parameter Summary

Meteorological Data	BLAIR ATHOL (035010) Data 2000-2010 6 minute BOM
Source Node	Industrial
Effective Impervious Area	80%
Effective Pervious Area	20%
Modelling Time Steps	6 Minute
Drainage Link	No Routing
Pollutant Concentration	Industrial
Soil Properties	Industrial
Treatment Devices	Bioretention Basins

MUSIC calculated the following annual pollutant loads for the catchment:

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Table 5: Predevelopment Annual Pollutant Loads

Pollutant	Annual Load – Substation and Office Facility Site
Total Suspended Solids	525 kg/yr
Total Phosphorus	1.4 kg/yr
Total Nitrogen	9.07 kg/yr
Total Gross Pollutants	111kg/yr

The above loads have been based on land use as an Industrial site as designated in the Water by Design MUSIC Modelling Guidelines.

6.4.2 PV Array

Table 6 details the MUSIC parameters utilised in running the model.

Table 6: MUSIC Model Parameter Summary

Meteorological Data	BLAIR ATHOL (035010) Data 2000-2010 6 minute BOM	
	Pre Development	**Post Development**
Source Node	Agricultural	Rural Residential
Effective Impervious Area	2%	2%
Effective Pervious Area	98%	98%
Modelling Time Steps	6 Minute	6 Minute
Drainage Link	No Routing	No Routing
Pollutant Concentration	Agricultural	Rural Residential
Soil Properties	Agricultural	Rural Residential
Treatment Devices		Buffer

MUSIC calculated the following annual pollutant loads for the catchment:

Table 7: Predevelopment Annual Pollutant Loads

Pollutant	Annual Load
Total Suspended Solids	89200 kg/yr
Total Phosphorus	70.7 kg/yr
Total Nitrogen	580 kg/yr
Total Gross Pollutants	362 kg/yr

The above loads have been based on land use as an Agricultural site as designated in the Water by Design MUSIC Modelling Guidelines.

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6.5 Selection of Stormwater Treatment Options

6.5.1 Substation Site and Office Facility Site

Based on the understanding of Isaac Regional Councils requirements for stormwater quality treatment for Industrial sites a Bioretention Basin has been utilised as the Stormwater Quality Improvement Devices for this site.

6.5.1.1 Bioretention Basins

Bioretention basins are vegetated areas where runoff is filtered through a filter media layer as it percolates downwards. It is then collected via perforated under-drains and flows to downstream waterways or to storages for reuse. Bioretention basins often use temporary ponding above the filter media surface to increase the volume of runoff treated through the filter media. They treat stormwater in the same way as bioretention swales; however, 'above design' flows are conveyed through overflow pits or bypass paths rather than over the filter media. This has the advantage of protecting the filter media surface from high velocities that can dislodge collected pollutants or scour vegetation.

Bioretention basins operate by filtering stormwater runoff through densely planted surface vegetation and then percolating runoff through a prescribed filter media. During percolation, pollutants are retained through fine filtration, adsorption and some biological uptake. The vegetation in a bioretention system is a vital functional element of the system providing a substrate for biofilm growth within the upper layer of the filter media. Vegetation facilitates the transport of oxygen to the soil and enhances soil microbial communities which enhance biological transformation of pollutants.

Plants with extensive fibrous or a spreading, rhizomatous root system able to withstand periods of inundation are preferred in bioretention systems. As such, it is recommended that Carex or similar plant selected from the WSUD guidelines be planted in the Bioretention Basins to assist in the uptake of identified pollutants. These plants shall be planted at a density of 6-8 per square metre to provide maximum effect. A sandy loam filtration media with a hydraulic conductivity of 200mm/hr will ensure that filtration media does not become waterlogged (Australian Runoff Quality (ARQ), 2004, Section 9.4). The ARQ states that bioretention systems are efficient in treating, TSS, TN, TP and Hydrocarbons (where attached to fine sediments). Refer to drawings in Appendix A for bioretention basin details.

The uPVC slotted pipe will collect the treated Q3 Month flow after it has filtered through a layer of sandy loam. The treated runoff water in the slotted pipe will connect into the side of the field inlet. The treated flow will be piped from the field inlet together with the collected minor flow via the sites stormwater drainage network. The MUSIC parameters used for the Bioretention Basins are shown on Table 8.

Table 8: Bioretention Basin MUSIC Parameters

Parameter	Basin
Extended detention depth (m)	0.290 m
Seepage Loss (mm/hr)	0 mm/hr
Filter Depth (m)	0.5 m
Particle Diameter (mm)	0.45 mm
Saturated Hydraulic Conductivity (mm/hr)	200 mm/hr
Depth below underdrain pipe (% of Filter Depth)	0 %

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6.5.2 PV Array

Based on the understanding of Isaac Regional Councils requirements for stormwater quality treatment for Rural sites, a buffer has been utilised as the SQID's for this site.

6.5.2.1 Buffer

Buffer strips are primarily intended to remove sediment, as well as some nutrients and hydrocarbons. Buffer strips can be used as edges to swales and drains, particularly where flows are distributed along the banks of the swale or drainage channel, as an alternative to kerb and gutter drainage systems.

Buffers strips provide a number of functions including:

- The removal of sediments by filtration through the vegetation;
- A reduction in runoff volumes (by promoting some infiltration to the subsoils);
- A delay in runoff peaks by reducing flow velocities;
- With appropriate vegetative cover and diversity, buffer strips can form part of a multi-use habitat (i.e. provide a habitat corridor for wildlife); and
- Effective pre-treatment for other WSUD measures such as bioretention and infiltration systems.

Buffer strips initially immobilise pollutants by binding them to organic matter and soil particles. Ultimate pollutant removal is achieved by settling, filtration and infiltration into the subsoil. Certain pollutants, such as nutrients and hydrocarbons, may be digested and processed by the soil microorganisms in the filter strip. Consequently, adequate contact time between the runoff and the vegetation and soil surface is required to optimise pollutant removal. The MUSIC parameters used for the Buffer areas are shown on Table 9.

Table 9: Buffer MUSIC Parameters

Parameter	Buffer 1
Percentage of upstream area buffered (%)	100%
Buffer Area (% of upstream impervious area)	50%
Exfiltration Rate (mm/hr)	0 %

6.6 Treatment Train effectiveness in Pollution Reduction

The MUSIC Model was run calculating the effectiveness in pollution reduction for the substation and PV Array based on treatment being undertaken by Bioretention Basins and Grass Buffers respectively. Table 10 and

Table 11 show the post treatment pollutant loads in comparison to their water treatment objectives for both stages of the development.

Table 10: Substation and Office Facility Site MUSIC Output Results (Basin A)

Pollutant	Post Development Load	Post Treatment Load	Water Quality Objectives	Reduction in Pollutant
TSS	525 kg/yr	47.2 kg/yr	85 %	**91.0 %**
TP	1.4 kg/yr	0.555 kg/yr	60 %	**60.4 %**
TN	9.07 kg/yr	4.63 kg/yr	45 %	**49.0 %**
GP	111kg/yr	0 kg/yr	90 %	**100 %**

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Table 11: PV Array MUSIC Output Results

Pollutant	Pre Development Treatment Load	Post Development Treatment Load	Reduction in Pollutant load from existing Grazing use
TSS	89200 kg/yr	56000 kg/yr	**37.2 %**
TP	70.7 kg/yr	48.9 kg/yr	**30.8 %**
TN	580 kg/yr	485 kg/yr	**16.4 %**
GP	362 kg/yr	362 kg/yr	**0.0 %**

(Refer to Appendix E for Treatment Train Effectiveness)

The MUSIC treatment measures and assumptions adopted for this development include:

- Bioretention Basin Area:
  - Basin B = 240sq.m
- Buffer Area:
  - Buffer 1 = 100% Site Area

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7. Conveyance

The existing irrigation and drainage channels that traverse the site will be removed and replaced with soil conservation bunds such that the maximum depth of flow beneath the PV arrays is no more than 300mm deep and that proposed catchment and flows are directed to their predeveloped outlets.

Given that Stage 1 of the proposed solar farm development is located on either side of Lindley Road, the proposed bund locations have also been positioned to ensure that the Lindley Road has not been impacted upon.

7.1 Catchment Hydrology Method and Approach

The catchment hydrology for the development was calculated using the ILSAX loss model. The inputs for the ILSAX model were identified through site inspection, aerial photography and a topographical survey. The runoff from each catchment was modelled for a 100 year ARI for the following durations:

- 5 minute;
- 15 minute;
- 30 minute;
- 1 hour;
- 3 hours; and
- 6 hours.

7.1.1 Time of Concentration

The time of concentration methods used to determine stormwater discharges from this site were calculated using the average velocity method. This method is as described in the Australian Rainfall and Runoff Book IV, Section 1

Velocity Method

Type of Country	Average Slope of Catchment Surface (%)	Approx. Velocity of Stream (m/s)
Flat	0 to 1.5	0.3
Rolling	1.5 to 4	0.7
Hilly	4 to 8	0.9
Steep	8 to 15	1.5
Very Steep / Rocky / Mountainous	> 15	3.0

Figure 5: Velocities for calculations of tc for areas <5km2 AR&R Book IV Section 1

The time of concentration for each of the catchments is summarized in Table 12.

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Table 12: Time of Concentration Summary

Catchment	Area (ha)	Length of Critical Path (m)	Slope%	Tc (min)
A	8.24	360	2.80%	20.0
B	18.04	736	1.37%	41.0
C	11.35	609	1.33%	34.0
D	5.35	477	1.05%	27.0
E	20.31	861	0.93%	48.0
F	23.49	1320	0.43%	73.0
G	21.57	1011	0.63%	56.0
H	22.56	1132	0.30%	63.0
I	17.79	1291	0.48%	72.0
J	23.62	1112	0.75%	62.0
K	23.43	1154	1.06%	64.0
L	24.40	888	1.05%	49.0
M	21.92	1400	0.83%	78.0
N	21.69	1075	0.91%	60.0
O	24.83	1058	1.18%	59.0
P	22.55	945	1.01%	53.0
Q	11.77	269	2.51%	15.0

The catchments are shown on drawing 16-076-C102.

7.2 Developed Flows

7.2.1 Substation and Site Facilities

The substation/ office facility site will be largely sealed and therefore runoff attenuated as per Section 5.2 of this report.

7.2.2 PV Array

The Solar PV Array will not increase discharges from the site due to the implementation and maintenance of the grassed understory to the entire project area. There will be no changes to the topography within this area with the exception of the removal of the existing irrigation channels and the addition of soil conservation bunds.

This is due to the very long critical path lengths and time of concentration that exist at present. This is demonstrated in Figure 6 for a panel located in Catchment M.

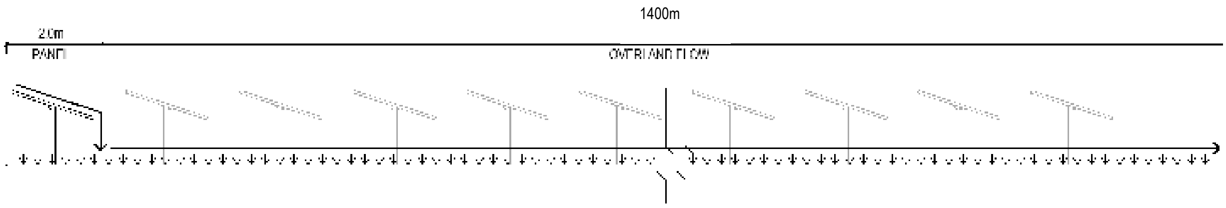

Figure 6: Catchment M – Runoff Critical Path – Not to scale, generally indicative only.
Source: i[3] consulting pty ltd

The existing surface of the PV Array will be vegetated and soil conservation bunds will be installed to ensure no scouring, erosion and gullying. The maintenance staff for the facility will ensure that the vegetation and drainage will be maintained.

7.3 Drainage Hydraulics

This section of the report assesses the conveyance properties of the soil conservation bunds and channels that convey runoff from the PV array areas to the drainage channels and then natural flow paths.

The system is modelled in DRAINS using the ILSAX routing method. The inputs for the ILSAX model were identified through site inspection, aerial photography and a preliminary topographical levels.

The bund /channel layout is shown on Table 7 and in drawing 16-076-C100.

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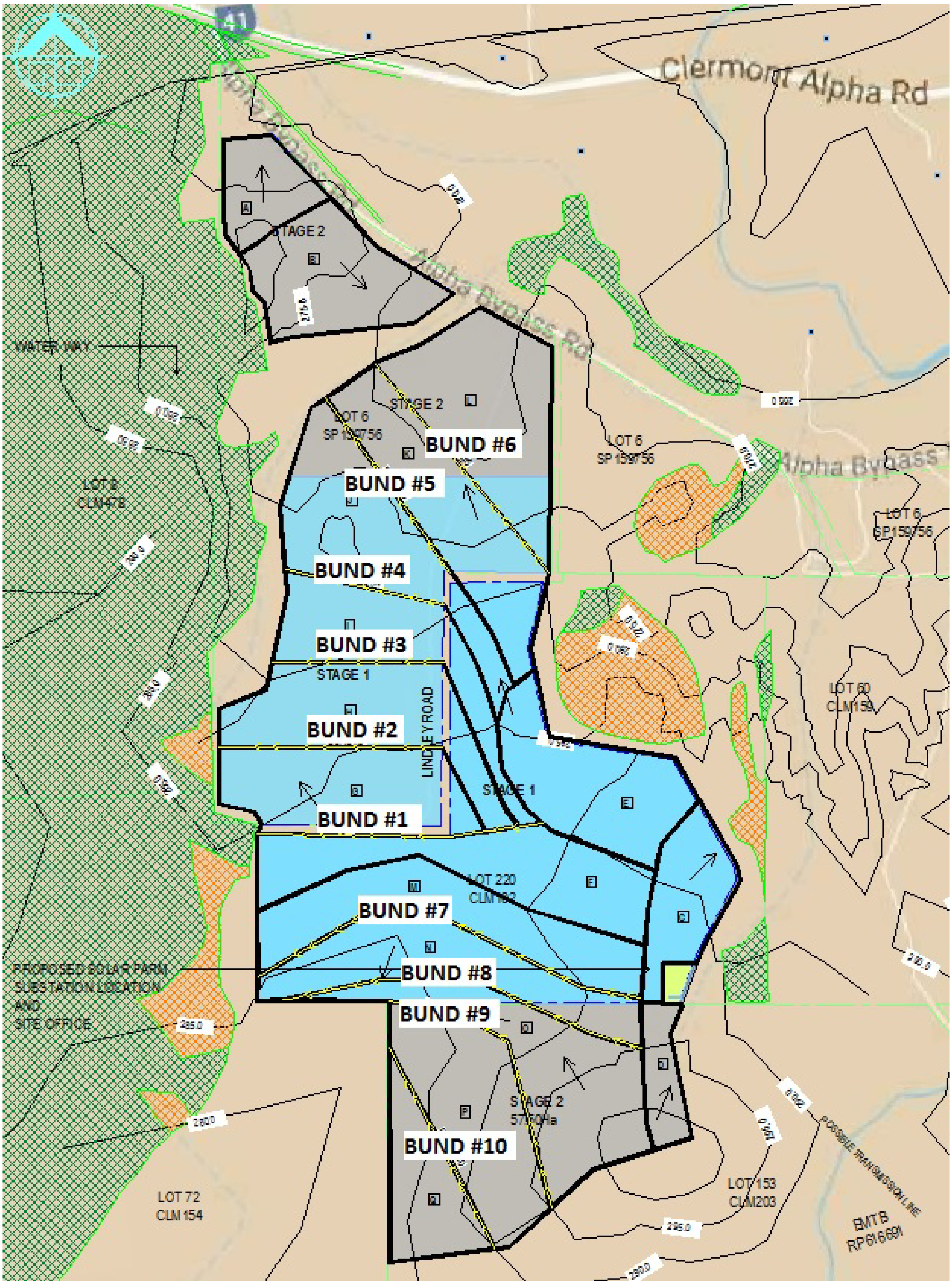

Figure 7: Bund / Channel Layout – Not to scale, generally indicative only.
Source: i³ consulting pty ltd

7.3.1 Channel Cross Section

The soil conservation bunds that traverse the site and run beneath the PV arrays will be limited to a maximum depth of 300mm thus allowing for vehicular traversal to occur. Soil conservation bunds will be vegetated and shaped to ensure no soil erosion and gullying.

The maintenance staff for the facility will ensure that vegetation and drainage will be maintained.

All of the soil conservation bunds will discharge in the existing natural flow paths as indicated on plan 16-076-C09 in Appendix A.

The proposed channel cross sections are shown on Figure 8.

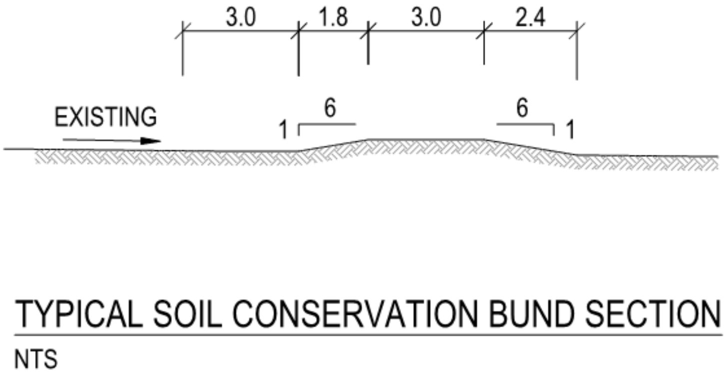

Figure 8: Cross Sections – Not to scale, generally indicative only.
Source: i³ consulting pty ltd

7.4 Access Tracks

The project will be largely grassed, however access tracks will be provided for routine maintenance access.
No culverts are proposed where the access tracks cross the soil conservation bunds as their cross section enables vehicular traversal.

7.5 Model Calibration

The ILSAX model will be calibrated using the rational method as described in the Queensland Urban Drainage Manual (QUDM). The calibration was carried out for the 1.5 hour duration event which was found to be the worst case storm event.

The results for each of the catchments from the DRAINS model and Rational check are shown in Table 13. Catchments not listed in Table 13 were excluded (Catchments A, B, C, D, E, L and Q) as they did not required bunds to control drainage flows and therefore were not modelled in DRAINS.

Table 13: Rational Check Method

Catchment	Event Frequency (years) & Duration	Development Flows (DRAINS) m^3/s	Development Flows (RATIONAL) m^3/s	Flow Variation %
F	100 year, 1.5 hour	2.460	4.167	169.4%
G	100 year, 1.5 hour	1.150	4.543	395.0%
H	100 year, 1.5 hour	2.090	4.458	213.3%
I	100 year, 1.5 hour	1.450	3.192	220.1%
J	100 year, 1.5 hour	2.230	4.715	211.4%
K	100 year, 1.5 hour	2.150	4.582	213.1%
M	100 year, 1.5 hour	1.640	3.704	225.9%
N	100 year, 1.5 hour	2.010	4.214	209.7%
O	100 year, 1.5 hour	2.470	5.100	206.5%
P	100 year, 1.5 hour	2.460	4.905	199.4%

The calibration in this case shows that the rational method calculations are conservative and based on a peak flow. DRAINS software that was used to check bund sizing is however calculated on a different method using flow hydrographs which gives an analysis in more detail and accuracy based on the full duration of many different storm events.

Sample Calculation

Catchment F

MAJOR STORM EVENT Q_{100}
AREA = 23.49 ha
RAINFALL INTENSITY
I_{100} = 81.87mm/hr (From AR&R)
For 73 min duration

COEFICIENT OF RUNOFF
C_{100} = 0.65
DISCHARGE

$$Q_1 = \frac{CIA}{360} = 4.167\ m^3/s$$

8. Water Quality Maintenance

The following maintenance protocols detailed in Section 8 have been adapted from the Healthy Waterways Water Sensitive Urban Design Engineering Guidelines for South East Queensland – Version 1 June 2006. They should generally be adopted as standard maintenance procedures upon construction of stormwater treatment devices.

8.1 Bioretention Basins

Bioretention Basins require ongoing maintenance to ensure water treatment efficiencies are maintained. Attached in Appendix F is a Bioretention Checklist adapted for WSUD Guidelines.

Vegetation plays a key role in maintaining the porosity of the filter media of a bioretention basin and a strong healthy growth of vegetation is critical to its performance. Therefore the most intensive period of maintenance is during the plant establishment period when weed removal and replanting may be required.

Inflow systems and overflow pits require careful monitoring, as these can be prone to scour and litter build up. Debris can block inlets or outlets and can be unsightly, particularly in high visibility areas. Inspection and removal of debris should be done regularly, and debris should be removed whenever it is observed on a site. Where sediment forebays are adopted, regular inspection of the forebay is required (3 monthly) with removal of accumulated sediment undertaken as required.

For larger bioretention basins, it is essential that a maintenance access point is designed for and maintained in the bioretention basin. The size and complexity of the system will guide its design and may involve provision of a reinforced concrete ramp/ pad for truck or machinery access.

Typical maintenance of bioretention basin elements will involve:

- Routine inspection of the bioretention basin profile to identify any areas of obvious increased sediment deposition, scouring from storm flows, rill erosion of the batters from lateral inflows, damage to the profile from vehicles and clogging of the bioretention basin (evident by a 'boggy' filter media surface).
- Routine inspection of inflows systems, overflow pits and under-drains to identify and clean any areas of scour, litter build up and blockages.
- Removal of sediment where it is smothering the bioretention basin vegetation.
- Where a sediment forebay is adopted, removal of accumulated sediment.
- Repairing any damage to the profile resulting from scour, rill erosion or vehicle damage by replacement of appropriate fill (to match onsite soils) and revegetating.
- Tilling of the bioretention basin surface, or removal of the surface layer, if there is evidence of clogging.
- Regular watering/ irrigation of vegetation until plants are established and actively growing.
- Removal and management of invasive weeds (herbicides should not be used).
- Removal of plants that have died and replacement with plants of equivalent size and species as detailed in the plant schedule.
- Pruning to remove dead or diseased vegetation material and to stimulate growth.
- Vegetation pest monitoring and control.

Resetting (i.e. complete reconstruction) of the bioretention basin will be required if the system fails to drain adequately after tilling of the surface. Maintenance should only occur after a reasonably rain free period when the soil in the bioretention system is dry. Inspections are also recommended following large storm events to check for scour and other damage.

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All maintenance activities must be specified in an approved Maintenance Plan (and associated maintenance inspection forms) to be documented and submitted to Council as part of the Development Approval process. Maintenance personnel and asset managers will use this Plan to ensure the bioretention basins continue to function as designed. An example operation and maintenance inspection form is included in the checking tools provided in Appendix F. These forms must be developed on a site-specific basis as the nature and configuration of bioretention basins varies significantly.

8.2 Buffer

Buffer treatment relies upon good vegetation establishment and therefore ensuring adequate vegetation growth is the key maintenance objective. In addition, they have a flood conveyance role that needs to be maintained to ensure adequate flood protection for local properties. The most intensive period of maintenance is during the plant establishment period when weed removal and replanting may be required. It is also the time when large loads of sediments may impact on plant growth, particularly in developing catchments with an inadequate level of erosion and sediment control.

The potential for rilling and erosion over a buffer needs to be carefully monitored, particularly during establishment stages of the system.

Typical maintenance of buffer elements will involve:

- Routine inspection of the buffer to identify any areas of obvious increased sediment deposition, scouring of the buffer from storm flows, rill erosion of the diversion batters from lateral inflows or damage to the diversion profile from vehicles;
- Repairing damage to the swale diversion bund resulting from scour, rill erosion or vehicle damage;
- Regular watering/ irrigation of buffer until plants are established and actively;
- Mowing of turf or slashing of vegetation (if required) to preserve the optimal design height for the Vegetation;
- Removal and management of invasive weeds;
- Litter and debris removal;
- Vegetation pest monitoring and control.

Inspections are also recommended following large storm events to check for scour. All maintenance activities must be specified in a maintenance plan (and associated maintenance inspection forms) to be developed as part of the design procedure. Maintenance personnel and asset managers will use this plan to ensure the buffer continues to function as designed. Maintenance plans and forms must address the following:

- inspection frequency
- maintenance frequency
- data collection/ storage requirements (i.e. during inspections)
- equipment needs
- maintenance techniques
- occupational health and safety
- public safety
- environmental management considerations
- disposal requirements (of material removed)
- access issues
- stakeholder notification requirements

8.3 Vegetation Maintenance Management Plan

In order to ensure the vegetated stormwater assets continue to function as intended, regular maintenance activities are required. The process in which this maintenance will be implemented has been developed based on the "Water by Design – Maintaining Vegetated Stormwater Assets Guideline". Inspection of the vegetated stormwater assets will be carried out using the checklist supplied in section 4 of the "Water by Design – Maintaining Vegetated Stormwater Assets Guideline, with all and any rectifications being carried out as required.

Where required as part of the checklist, suitably qualified personal will be required to carry out the assessment. i.e. Engineering or Horticultural.

Inspections are to be initially carried out on a quarterly basis. Where an asset fails to meet one or more of the performance indicators on at least two consecutive maintenance inspections, the frequency of inspections is to be increased. One of the inspections annually should be carried out directly after a major rainfall event to ensure the asset is operating properly in wet conditions.

9. Chemical and Hydrocarbon Assessment

9.1 Cleaning of panels

The panels shall be cleaned up to twice annually, dependent upon observed soiling rates. Cleaning is undertaken using only water. No chemicals and detergents are used in the cleaning of panels as this can impact the long term performance of the panels and vendor warranties.

9.2 Mechanical Systems

The biodegradable grease is the preferred lubricant for the solar panel tracking system. We note that the maintenance program will be undertaken in accordance with a strict Work Method Procedure and any spillage of grease during the maintenance procedure would be collected and disposed of in accordance with the Hydrocarbon spill procedure, which will be prepared as part of the Operations and Maintenance Manual for the project. This procedure will eliminate the opportunity for hydrocarbons to enter the environment.

Maintenance vehicles such as water carts, tractors used for weed control and grass slashing etc. will be diesel powered. The spill procedure for the maintenance of the tracking system will be identical for these vehicles. Periodic maintenance servicing of these vehicles will be offsite.

The proposed inverters are air cooled and do not require any liquid coolant. Inverter transformers are oil filled with mineral oil and will be sealed and fully bunded for 110% of capacity to ensure that in the event of a leak or complete loss of fluid, any oil spilled from the steel enclosed transformer is captured by the outer bunding.

Compliance with AS1940 will prevent any hydrocarbons associated with these plant items from entering the environment.

9.3 Dust suppression and weed control

During the operational phase of the project, no chemicals or dust surfactants will be applied to the access tracks. The need to traffic these areas will be limited and speed controls of 10km per hour will be implemented.

The project area will be largely vegetated with a mix of perennial grasses. These areas and the vegetated buffer will need to be managed with respect to potential herbaceous weeds. This will include occasional spaying with selective herbicides such as 24D and for more invasive weed species, spot spraying with glyphosate. Both of these products are not systemic and will not accumulate. As the site grasses and vegetated buffer become more established, the need and frequency of weed control will significantly diminish.

9.4 Impacts on Stormwater Quality Improvement Devices

The primary means of stormwater quality improvement devices for this project comprise grasses for the main part of the project and a bio-retention system for the substation area, which will cater for this area which comprises largely sealed pavements. Effective management of the site spill control measures and implementation of bunding in accordance with AS1940 and AS2067 will prevent release of any hydrocarbons to the treatment systems.

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9.5 Heavy metals in solar panels

As of June 2016 rooftop PV installations in Australia exceed 5.4GW, many of which are in rural areas where the supporting roofs also form part of the potable water supply. There is no evidence to indicate that the minor concentrations of heavy metals within solar panels can be mobilised during normal operating conditions or in the case where a panel may be cracked. It is important to note is that the modules as connected electrically, in series and therefore if a panel does become cracked or damaged, the entire string in that array will not produce electricity.
The completed installation at this site will be subject to frequent visual inspections as well as periodic UAV survey using thermal imaging cameras to identify damaged or defective modules, which would immediately be removed and replaced. This is to ensure power production at optimum availability and as consequence eliminates any concerns regarding damaged panels.

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10. *Conclusion*

Based on a review of the site, the upstream catchment will run along natural flow paths near the edge of the site in some areas. Therefore flooding could occur in some locations along the lower edges of the site particularly from overland flow paths. Despite this, solar panel arrays will be elevated on poles, at a height of a minimum of 600mm to 1,500mm above the ground and therefore a low depth of flooding would be considered a very low risk to the proposed development.

New soil conservation bunds will be installed to maintain existing overall catchment characteristics whilst reducing depth of drainage channels traversing the site.

The water quality and quantity mitigation elements are summarised for each of the catchments below:

PV Array

No stormwater quantity mitigation will be required as part of the PV Array works.

The MUSIC modelling results in Section 6.6 indicate that a Buffer will adequately treat the identified pollutants associated with the $Q_{3\ Month}$ stormwater runoff. The development will generally reduce pollutant load in comparison to the existing agricultural use.

Substation and Site Office Facility Site

The DRAINS modelling indicates that the detention basin will adequately mitigate the site runoff to predevelopment flows.

The required Detention Basin size is:

- Basin A = 480 cu.m

The MUSIC modelling results in Section 6.6 indicate that a Bioretention Basin will adequately treat the identified pollutants associated with the $Q_{3\ Month}$ stormwater runoff.

The required size of the Bioretention Basin is:

- Basin B = 240sq.m

The required bioretention filter depth is 0.5m with a 100mm uPVC slotted pipe located 0.8m below the surface of the filter material and will carry the Q3 Month stormwater runoff to the outlet drain, as per drawing 16-253-C11.

In addition, adherence to the maintenance measures detailed in Section 8 will ensure the ongoing effectiveness and longevity of the proposed SQID's.

Based on the existing site conditions and the above DRAINS and MUSIC results, i^3 consulting considers that proposed treatment with Bioretention/Detention Basins for the substation and laydown yard, and a buffer for the PV Array will satisfy Isaac Regional Council's requirements for stormwater quantity and quality treatment for the proposed development.

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11. Reference List

Healthy Waterways, Water Sensitive Urban Design Guidelines for South East Queensland – Version 1, June 2006.

Water by Design, MUSIC Modelling Guidelines
Version 1.0, 2010

SPP, State Planning Policy, April 2016

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Appendix A – Drawings

Table 14: Drawings prepared by i3 consulting pty ltd

Drawing Number	Drawing Description
16-076-A00	Project Over View
16-076-C101	Stormwater Quality Catchment Plan
16-076-C100	Stormwater Layout Plan
16-253-C102	Stormwater Quantity Catchment Plan
16-253-C103	Stormwater Details

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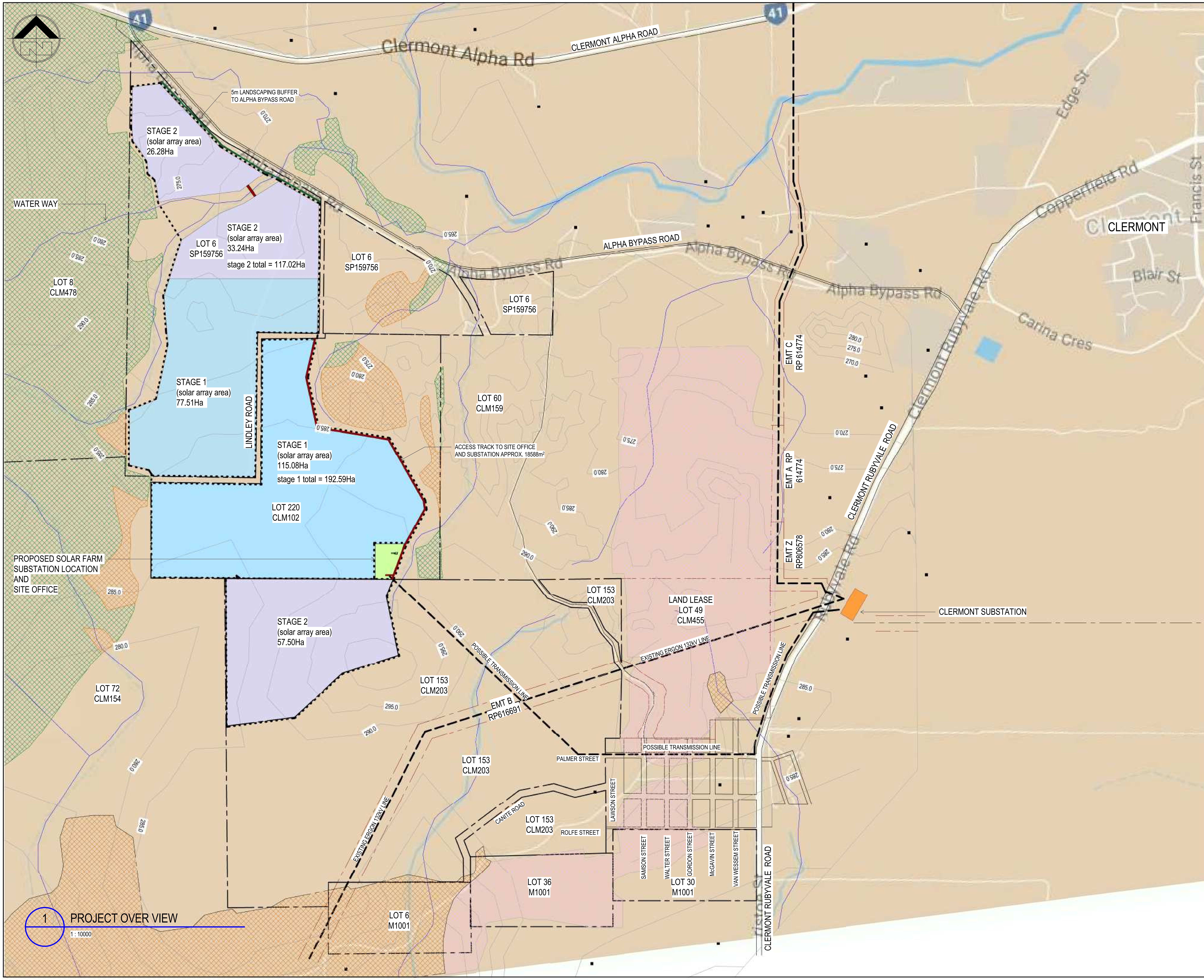

PROJECT TEAM

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EPURON

SITE LEGEND

- PROPOSED SOLAR ARRAY AREA STAGE 1
- PROPOSED SOLAR ARRAY AREA STAGE 2
- PROPOSED SOLAR FARM SUBSTATION LOCATION
- PROPOSED LANDSCAPING BUFFER
- VEGETATION AREA - CATEGORY A AND B AREA THAT IS A LEAST CONCERN REGIONAL ECOSYSTEM
- VEGETATION AREA - CATEGORY A AND B AREA CONTAINING OF CONCERN REGIONAL ECOSYSTEMS
- VEGETATION AREA - CATEGORY C AND B AREA CONTAINING ENDANGERED REGIONAL ECOSYSTEMS
- ACCESS TRACK LOCATIONS
- EXISTING RESIDENCES
- WATERWAY CORRIDORS

REV	DESCRIPTION	DATE	BY
G	PLAN UPDATED	18.01.2017	R.J.R.
F	FOR APPROVAL	13.01.2017	R.J.R.
E	ACCESS TRACK AREA ADDED	13.01.2017	R.J.R.
D	LANDSCAPING BUFFER ADDED	11.01.2017	R.J.R.
C	FOR APPROVAL	23.12.2016	R.J.R.
B	FOR APPROVAL	16.12.2016	R.J.R.
A	PLAN UPDATED	09.12.2016	R.J.R.

Status

FOR APPROVAL

NOT TO BE USED FOR CONSTRUCTION

Project

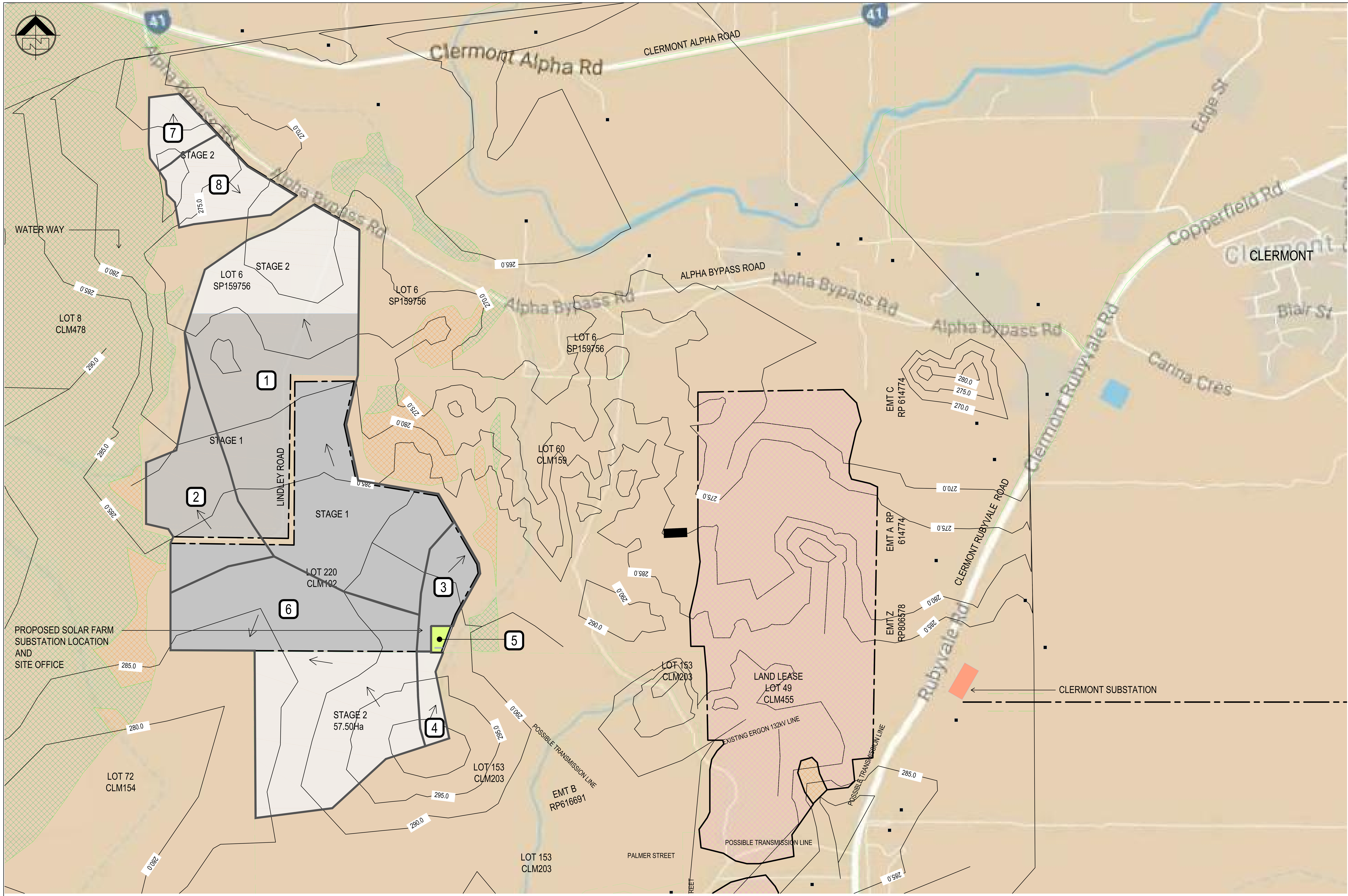
CLERMONT SOLAR FARM

for
Epuron

Title

PROJECT OVER VIEW

Drawn R.J.R.	Date 05.12.2016	Chkd E.C.	Date
Design R.J.R.	Date	Apprd	Date
Scale As indicated	A1	Certif	Date
Project No. 16-076		Dwg. No. A00	Rev G



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- EXISTING RESIDENCES
- WATERWAY CORRIDORS
- CATCHMENT BOUNDARY
- 1 CATCHMENT LABEL
- SOIL CONSERVATION BUND

CATCHMENT TABLE

CATCHMENT	AREA (ha)
1	144.41
2	33.40
3	11.35
4	5.35
5	1.15
6	101.83
7	8.24
8	18.04

A STORMWATER QUALITY CATCHMENT PLAN

1 : 10000

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Plotted by Katherine Leggett
Plot date 4:45 PM

REV	DESCRIPTION	DATE	BY
A	FOR APPROVAL	01.02.2017	K.J.L.

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EPURON

Project
CLERMONT SOLAR FARM

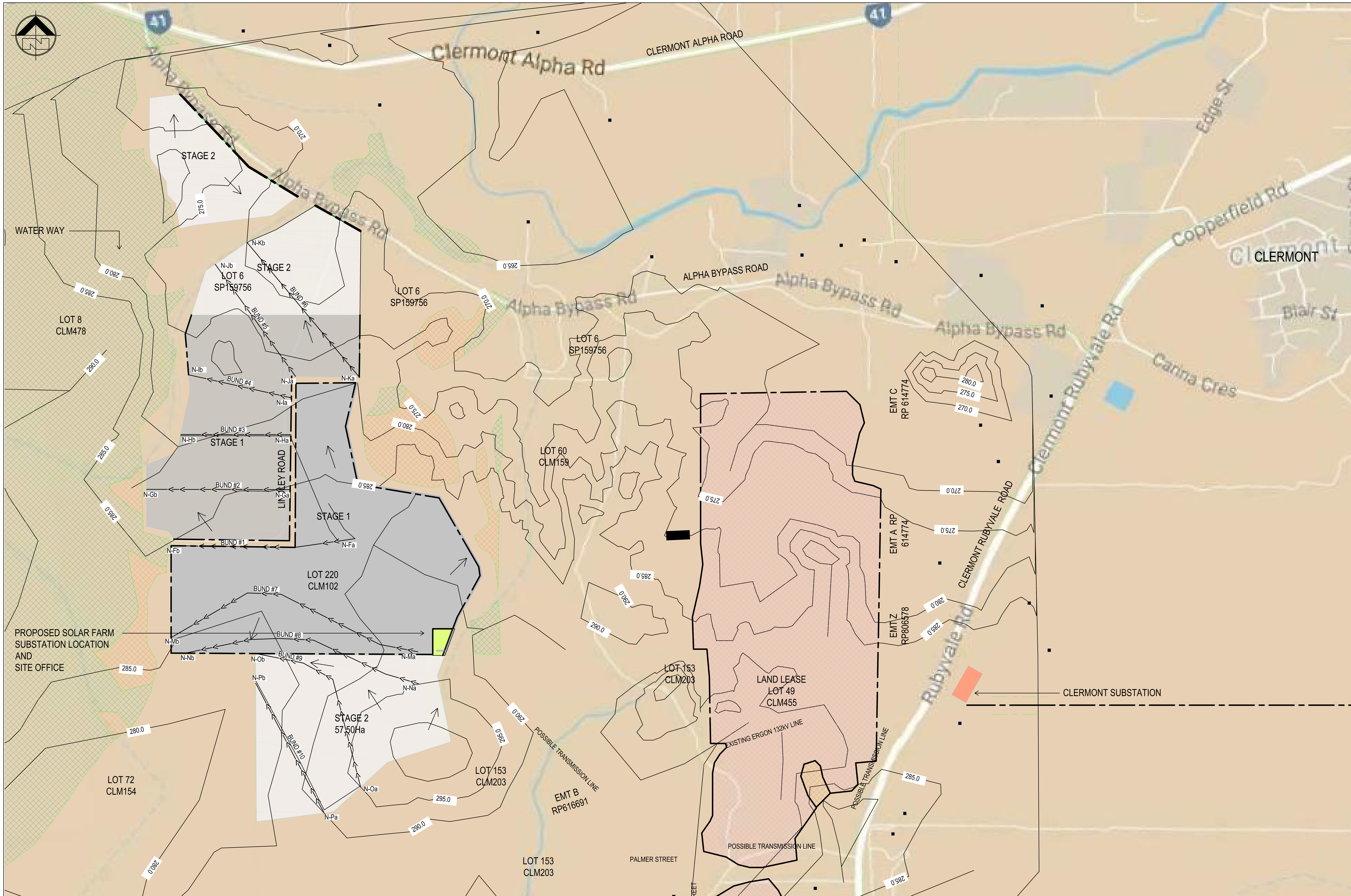
for
EPURON

Title
STORMWATER QUALITY CATCHMENT PLAN

Status
FOR APPROVAL

Drawn	Date	Chkd	Date
K.J.L.	01.02.17	M.B.	
Design	Date	Apprd	Date
M.B.	01.02.17		
Scale	A1	Certif	Date
AS SHOWN			

Project No.	Dwg. No.	Rev.
16-076	C101	A



SITE LEGEND

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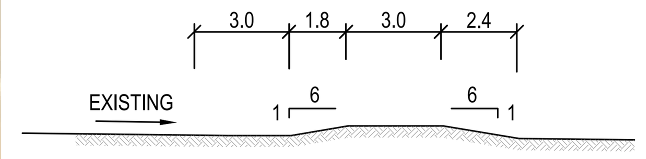
- SOIL CONSERVATION BUND
- N-Jb NODE LABEL



TYPICAL SOIL CONSERVATION BUND SECTION
NTS

A STORMWATER LAYOUT PLAN
1 : 10000

REV	DESCRIPTION	DATE	BY
B	FOR APPROVAL	02.02.2017	K.J.L.
A	FOR APPROVAL	01.02.2017	K.J.L.

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EPURON

Project: CLERMONT SOLAR FARM
for EPURON

Title: STORMWATER LAYOUT PLAN

Status: FOR APPROVAL

Drawn	Date	Chkd	Date
M.B.	01.02.17	M.B.	

Design	Date	Apprd	Date
M.B.	01.02.17		

Scale	A1	Certif	Date
AS SHOWN			

Project No.	Dwg. No.	Rev.
16-076	C100	B

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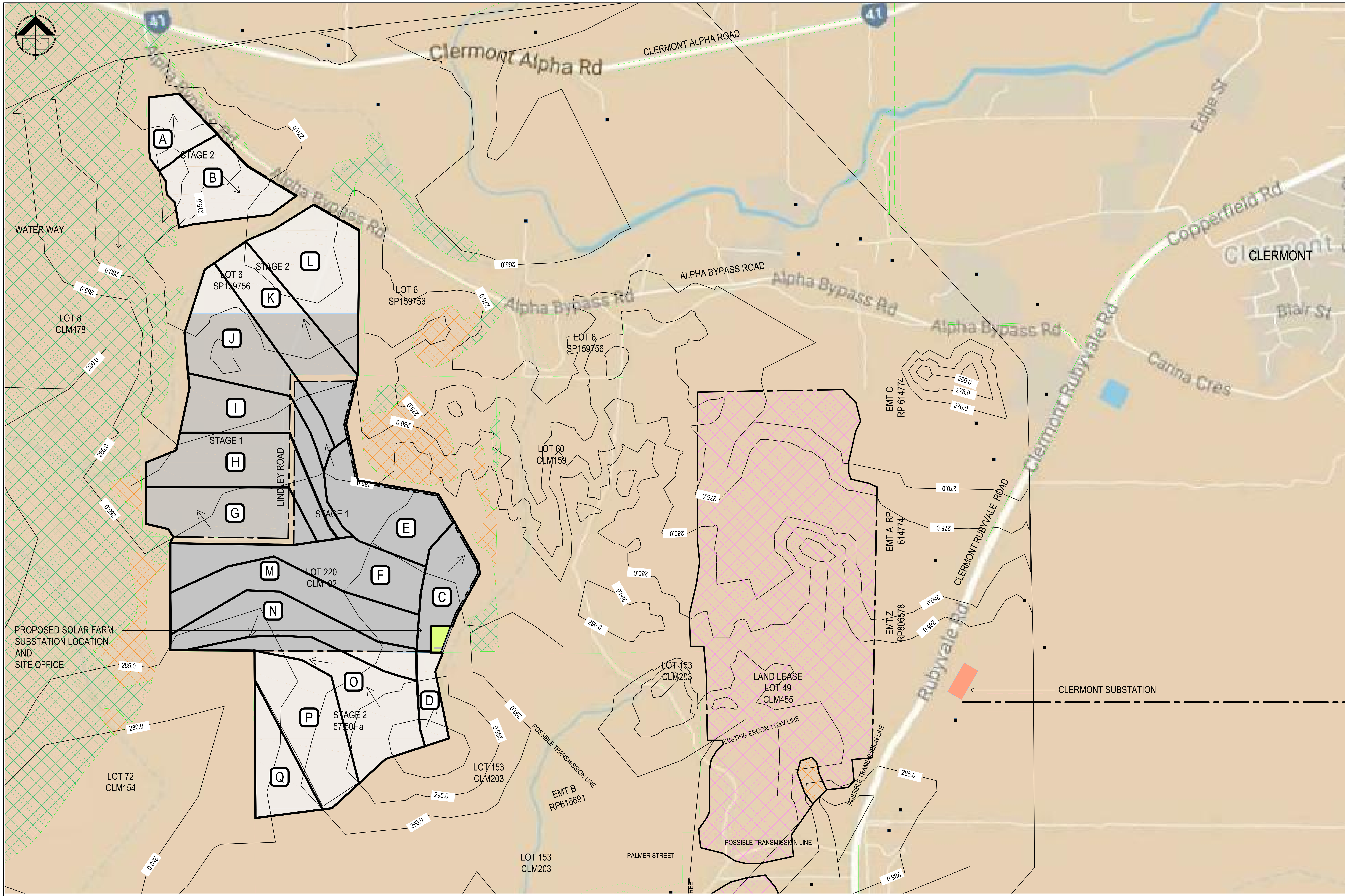

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- 1 CATCHMENT LABEL
- SOIL CONSERVATION BUND
- NODE LABEL

CATCHMENT TABLE

CATCHMENT	AREA (ha)
A	8.24
B	18.04
C	11.35
D	5.35
E	20.31
F	23.49
G	21.57
H	22.56
I	17.79
J	23.62
K	23.43
L	24.40
M	21.92
N	21.69
O	24.83
P	22.55
Q	11.77

A STORMWATER QUANTITY CATCHMENT PLAN

1 : 10000

REV	DESCRIPTION	DATE	BY
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A	FOR APPROVAL	01.02.2017	K.J.L.

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EPURON

Project: CLERMONT SOLAR FARM

for EPURON

Title: STORMWATER QUANTITY CATCHMENT PLAN

Status: FOR APPROVAL

Drawn	Date	Chkd	Date
M.B.	01.02.17	M.B.	

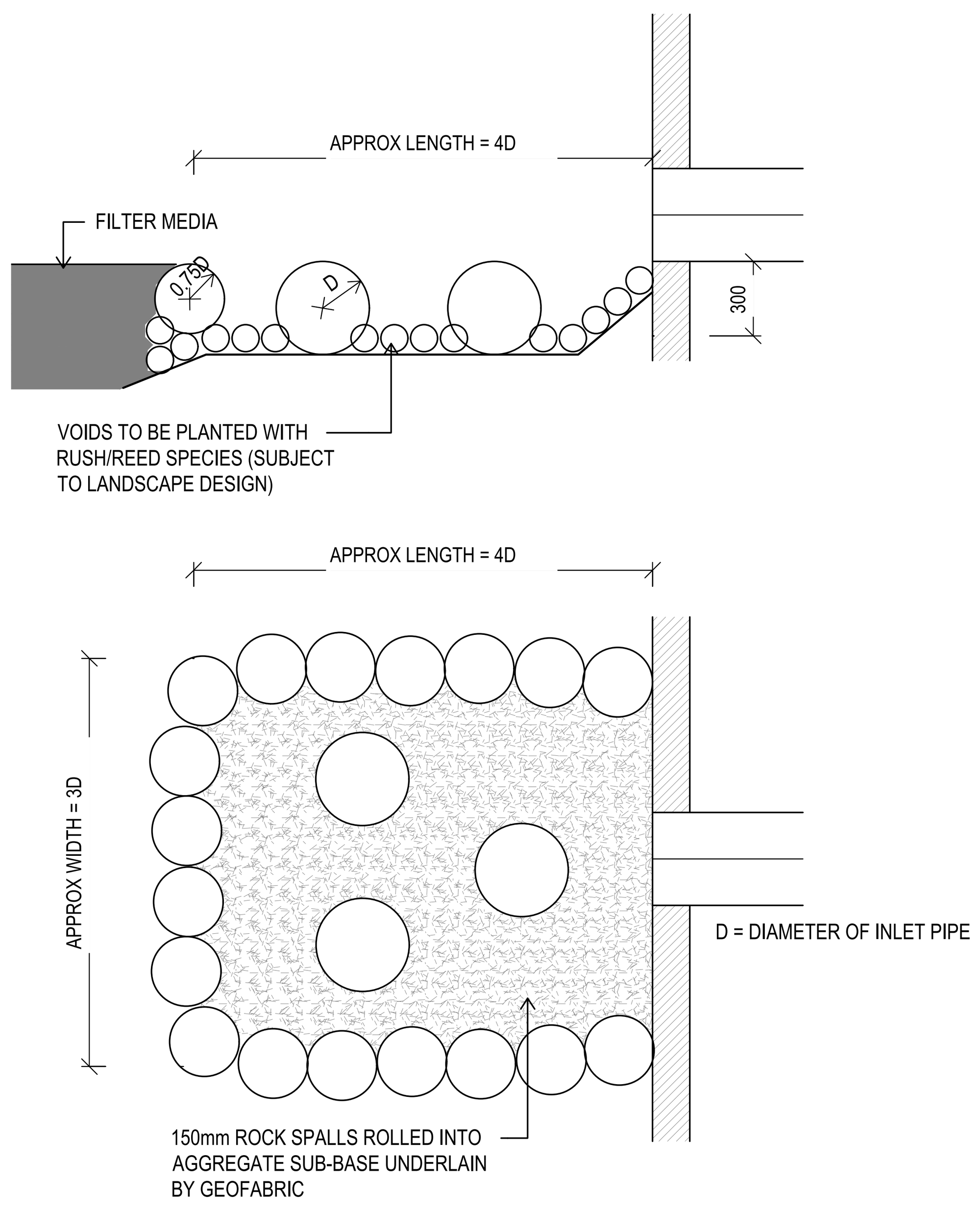
Design	Date	Apprd	Date
M.B.	01.02.17		

Scale		Certif	Date
AS SHOWN	A1		

Project No.	Dwg. No.	Rev.
16-076	C102	B

BIORETENTION NOTES

1. BIORETENTION MEDIA SPECIFICATION SHALL BE IN ACCORDANCE WITH THE FACILITY FOR ADVANCING BIOFILTRATION "GUIDELINE FOR SOIL FILTER MEDIAN IN BIORETENTION SYSTEMS". BIORETENTION HYDRAULIC CONDUCTIVITY SHALL BE IN ACCORDANCE WITH THE FACILITY FOR ADVANCING BIOFILTRATION "PRACTICE NOTE 1: IN SITU MEASUREMENT OF HYDRAULIC CONDUCTIVITY". THE NUMBER OF SAMPLES TO BE TESTED SHALL BE IN ACCORDANCE WITH THE "WATER SENSITIVE URBAN DESIGN CONSTRUCTION AND ESTABLISHMENT GUIDELINES - SWALES, BIORETENTION SYSTEMS AND WETLANDS (WATER BY DESIGN).
2. UNDER-DRAIN: SLOTTED RIGID PIPE (uPVC OR SIMILAR TO AS 2439.1) OR APPROVED EQUIVALENT, 0.5% MIN. GRADE. REFER PROJECT DRAWINGS FOR DIAMETER AND INVERT LEVEL. PIPE SHOULD NOT BE INSTALLED WITH A FILTER SOCK SURROUNDING PIPE. UNDER-DRAINAGE PIPES SHALL BE SEALED INTO PITS USING GROUT OR OTHER APPROVED WATERTIGHT SEAL.
3. REFER TO PROJECT DRAWINGS FOR VEGETATED BATTER SLOPES (1 IN 3 MAX, 1 IN 4 TYPICAL) AND BATTER TOPSOIL REQUIREMENTS.
4. IMPERMEABLE LINER - HDPE, BENTONITE, COMPACTED CLAY OR APPROVED EQUIVALENT TO BASE AND SIDES, INSTALLED AS PER MANUFACTURERS AND/ OR GEOTECHNICAL ENGINEERS SPECIFICATION. WHERE COMPACTED CLAY LINER IS ADOPTED, FILTER CLOTH IS TO BE USED AS PER NOTE 9. REFER TO THE "WATER SENSITIVE URBAN DESIGN CONSTRUCTION AND ESTABLISHMENT GUIDELINES - SWALES, BIORETENTION SYSTEMS AND WETLANDS" (WATER BY DESIGN) FOR DETAILS.
5. BASIN FINISHED SURFACE LEVEL IS TOP OF FILTER MEDIA. SURFACE TO CONTAIN 75mm SUGAR CANE MULCH TIED DOWN WITH JUTE MESH (NOT MATTING) OR FINE NETTING AS PER ICC REQUIREMENTS.
6. CONSTRUCTION TOLERANCES AS DOCUMENTED IN THE "WATER SENSITIVE URBAN DESIGN CONSTRUCTION AND ESTABLISHMENT GUIDELINES - SWALES, BIORETENTION SYSTEMS AND WETLANDS" (WATER BY DESIGN) MUST BE ACHIEVED. CONSTRUCTION TOLERANCES MUST BE NOTED ON PROJECT PLANS. INVERT LEVELS OF PITS, PIPES AND BASE LEVELS MUST BE NOTED ON PROJECT DRAWINGS.
7. BIORETENTION BASIN TO CONTAIN FOLLOWING PLAN SPECIES 6-10 per sq.m:
   - CAREX APPRESSA
   - DIANELLA TASMANICA
   - DIETES GRANDIFLORA
8. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
9. FILTER CLOTH - NON-WOVEN GEOTEXTILE . FILTER CLOTH NOT TO BE PLACED BETWEEN ANY FILTER LAYERS. IMPERVIOUS LINER MAY BE REQUIRED SUBJECT TO SOIL TESTING REQUIREMENTS IN ACCORDANCE WITH THE "WATER SENSITIVE URBAN DESIGN TECHNICAL DESIGN GUIDELINES" (WATER BY DESIGN).



D SEDIMENT FOREBAY DETAIL

1 : 25

SEDIMENT FOREBAY NOTES

SEDIMENT FOREBAY	AREA OF CATCHMENT	VOLUME OF FOREBAY	MINIMUM AREA OF FOREBAY
A	1.150 ha	1.472 m^3	4.910 m^2

THE SIZE OF THE SEDIMENT FOREBAY IS ESTABLISHED USING THE FOLLOWING:

$V_s = A_c \times R \times L_o \times F_c$

WHERE: V_s = VOLUME OF FOREBAY SEDIMENT STORAGE REQUIRED (m^3)
A_c = CONTRIBUTING CATCHMENT AREA (ha)
R = CAPTURE EFFICIENCY (ASSUME 80%)
L_o = SEDIMENT LOADING RATE (m^3 / ha /year) = 1.6
F_c = DESIRED CLEANOUT FREQUENCY (years) = 1.0

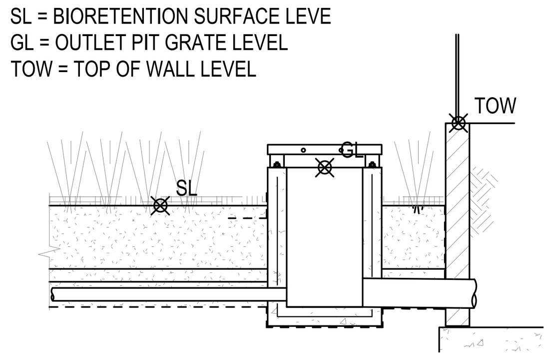
THE AREA OF THE SEDIMENT FOREBAY IS ESTABLISHED USING THE FOLLOWING:

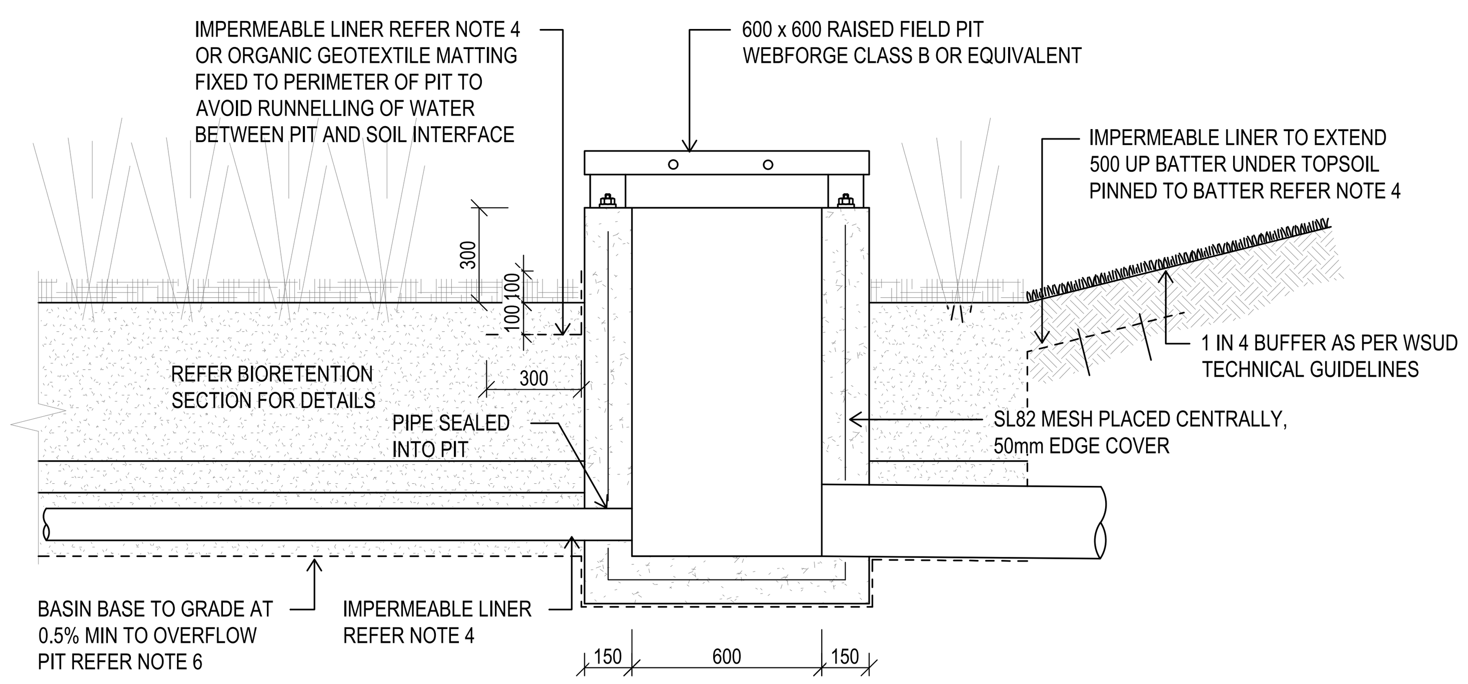
$$A_s = \frac{V_s}{D_s}$$

WHERE: D_s = DEPTH OF SEDIMENT FOREBAY (m) = 0.3m

BIORETENTION LEGEND

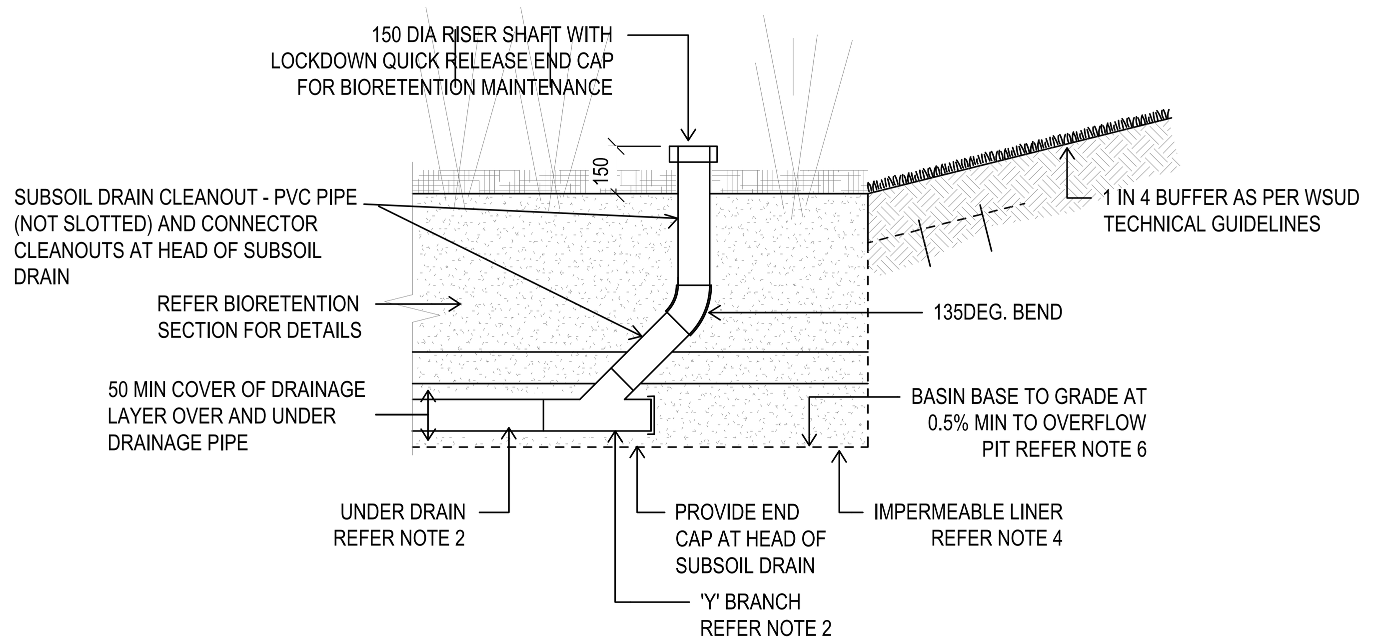
SL = BIORETENTION SURFACE LEVE
GL = OUTLET PIT GRATE LEVEL
TOW = TOP OF WALL LEVEL





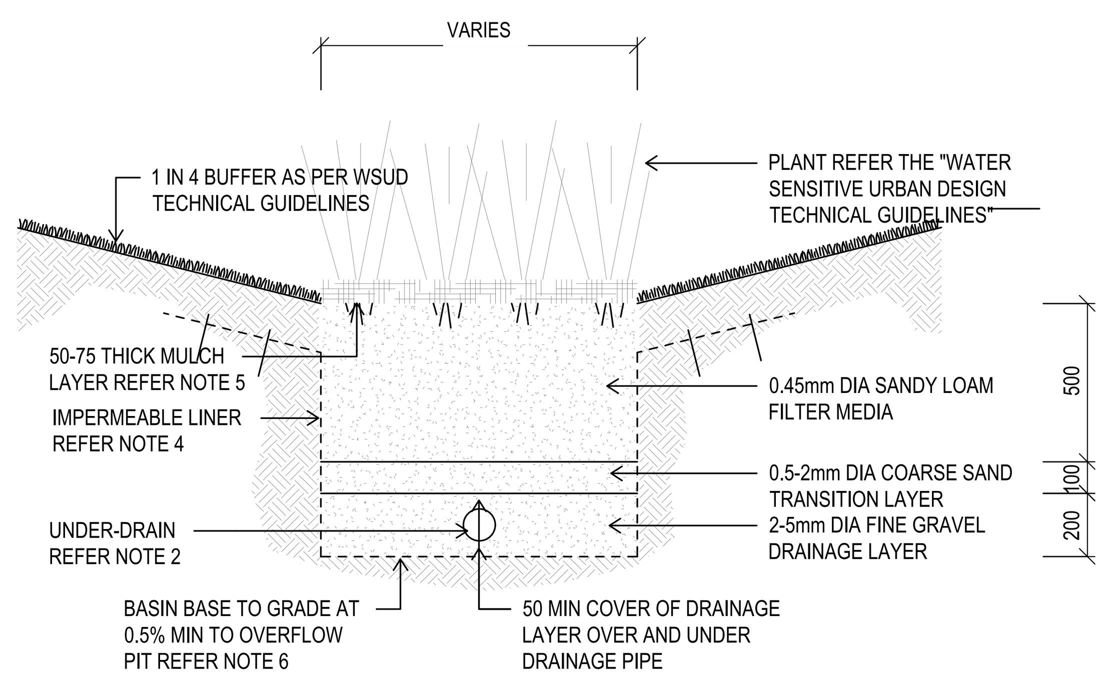
A BIORETENTION OUTLET PIT

1 : 20



B BIORETENTION UNDER-DRAIN CLEANOUT

1 : 20



C TYPICAL BIORETENTION SECTION

1 : 20

File Location P:\16-076 - Clermont Solar Farm\D
Plotted by Katherine Leggett
Plot date 4:47 PM

REV	DESCRIPTION	DATE	BY
A	FOR APPROVAL	19.01.2017	K.J.L.

Consulting Engineer:

i3 consulting pty ltd
engineering consultants
innovation, ingenuity, inspiration
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PO Box 909 Toowong, Qld 4066
www.icubed.com.au
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ABN 89 106 675 156
ACN 106 675 156
p 07 3870 8888

EPURON

Project
CLERMONT SOLAR FARM

for
EPURON

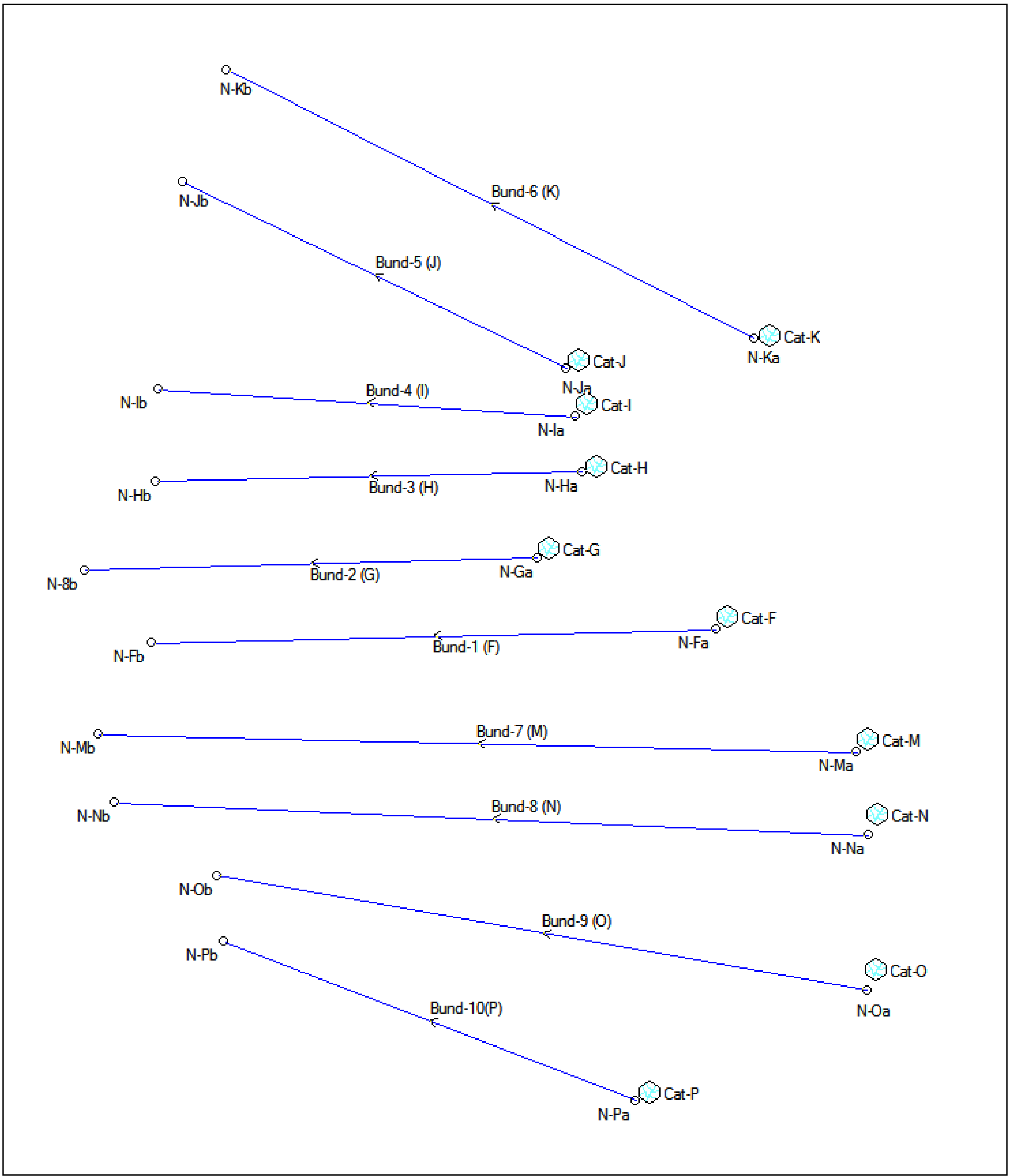
Title
STORMWATER DETAILS

Status
FOR APPROVAL

Drawn	Date	Chkd	Date
K.J.L.	19.01.17	M.B.	
Design	Date	Apprd	Date
M.B.	19.01.17		
Scale	A1	Certif	Date
AS SHOWN			
Project No.		Dwg. No.	Rev.
16-076		C103	A

Appendix B – DRAINS Conveyance Modelling

Model Layout



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Appendix C – Calculations

Table 15: Discharge Calculation Table

Catchment	Area (ha)	*Minor Storm Event* Q_{20}		*Treatable Storm Event* $Q_{3\ month}$	
		Intensity (mm/hr)	Discharge (m3/s)	Intensity (mm/hr)	Discharge (m3/s)
Catchment 1 - PV Array 1	144.41	61	16.70	14.6	3.04
Catchment 2 - PV Array 2	33.40	94	5.95	22.5	1.08
Catchment 3 - PV Array 3	11.35	105	2.26	25.0	0.41
Catchment 4 - PV Array 4	5.35	123	1.25	29.0	0.22
Catchment 5 - Site Facilities and Substation	1.15	170	0.50	39.5	0.09
Catchment 6 - PV Array 6	101.83	89	17.18	21.3	3.13
Catchment 7 - PV Array 7	8.24	148	2.31	34.5	0.41
Catchment 8 - PV Array 8	18.04	105	3.59	25.0	0.65

Sample Calculations

MINOR STORM EVENT Q_{20}
AREA = 144.41 ha

RAINFALL INTENSITY
I_{20} = 61 mm/hr (From AR&R)
For 84 minute duration

COEFICIENT OF RUNOFF
C_{20} = 0.65

DISCHARGE
$Q_{20} = \frac{CIA}{360} = 16.70\ m^3/s$

TREATABLE STORM EVENT $Q_{3\ month}$
AREA = 144.41 ha

RAINFALL INTENSITY
$I_{3\ month}$ = 14.6 mm/hr (From AR&R)
For 84 minute duration

COEFICIENT OF RUNOFF
$C_{3\ month}$ = 0.52

DISCHARGE
$Q_{3\ month} = \frac{CIA}{360} = 3.035\ m^3/s$

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Table 16: Rational Check Table (Basin A)

Event Frequency (years) & Duration	Post-development Flows (DRAINS)	Post-development Flows (RATIONAL)	Flow Variation
1 year, 1 hour	0.226 m^3/s	0.176 m^3/s	128%
2 year, 1 hour	0.290 m^3/s	0.241 m^3/s	120%
5 year, 1 hour	0.366 m^3/s	0.343 m^3/s	107%
10 year, 1 hour	0.412 m^3/s	0.409 m^3/s	101%
20 year, 1 hour	0.474 m^3/s	0.496 m^3/s	96%
50 year, 1 hour	0.525 m^3/s	0.639 m^3/s	82%
100 year, 1 hour	0.585 m^3/s	0.712 m^3/s	82%

Sample Calculations

MINOR STORM EVENT Q_1
AREA = 1.150 ha
RAINFALL INTENSITY
I_1 = 79mm/hr (From AR&R)s
For 10 minute duration

COEFICIENT OF RUNOFF
C_1 = 0.70
DISCHARGE
$Q_1 = \frac{CIA}{360}$ = 0.176 m^3/s

MINOR STORM EVENT Q_2
AREA = 1.150 ha
RAINFALL INTENSITY
I_2 = 102mm/hr (From AR&R)
For 10 minute duration

COEFICIENT OF RUNOFF
C_2 = 0.740
DISCHARGE
$Q_2 = \frac{CIA}{360}$ = 0.241 m^3/s

MINOR STORM EVENT Q_{10}
AREA = 1.150 ha
RAINFALL INTENSITY
I_{10} = 147mm/hr (From AR&R)
For 10 minute duration

COEFICIENT OF RUNOFF
C_{10} = 0.87
DISCHARGE
$Q_{10} = \frac{CIA}{360}$ = 0.409 m^3/s

MINOR STORM EVENT Q_{20}
AREA = 1.150 ha
RAINFALL INTENSITY
I_{20} = 170mm/hr (From AR&R)
For 10 minute duration

COEFICIENT OF RUNOFF
C_{20} = 0.910
DISCHARGE
$Q_{20} = \frac{CIA}{360}$ = 0.496 m^3/s

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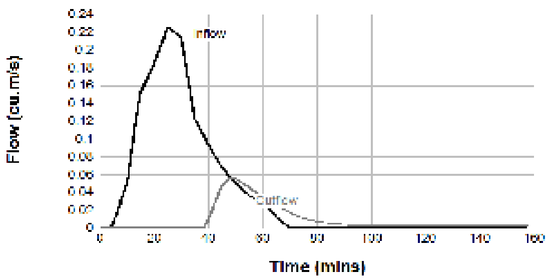
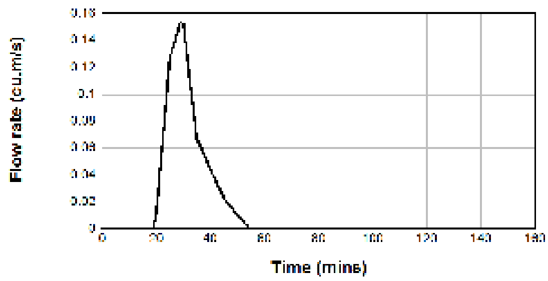
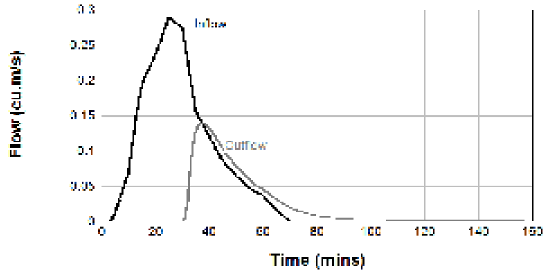
Appendix D – DRAINS Detention Basin Modelling

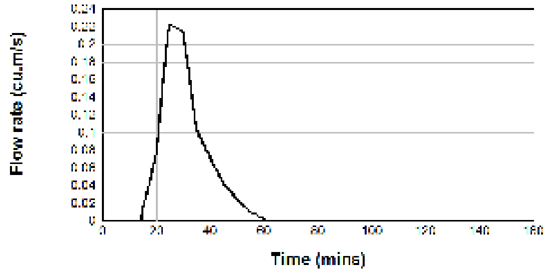
BASIN A



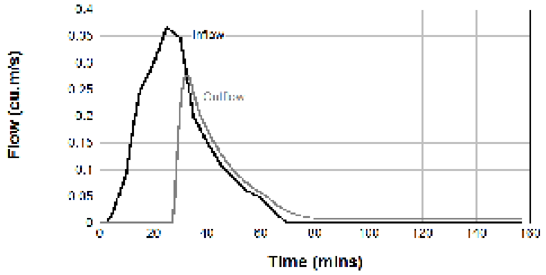


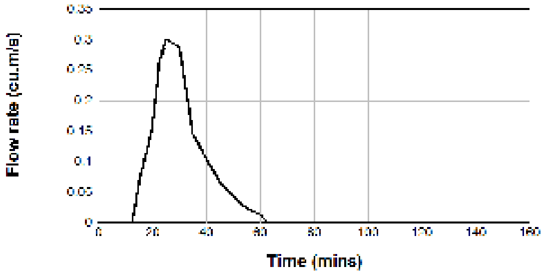
Q1



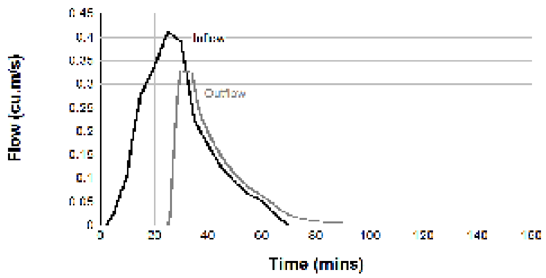


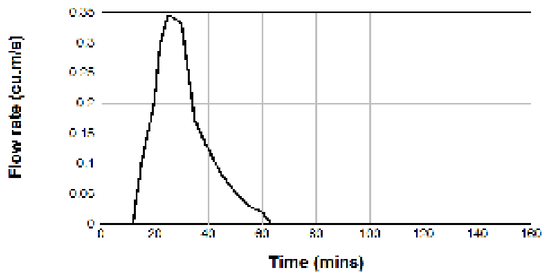
Q2





Q5





Q10

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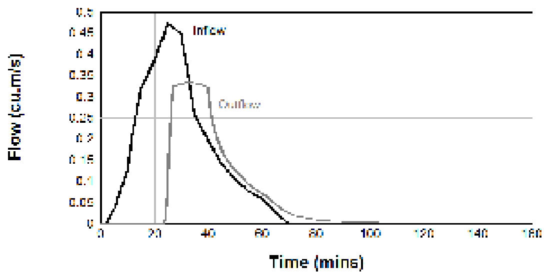
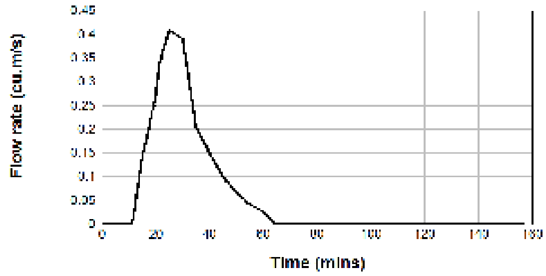
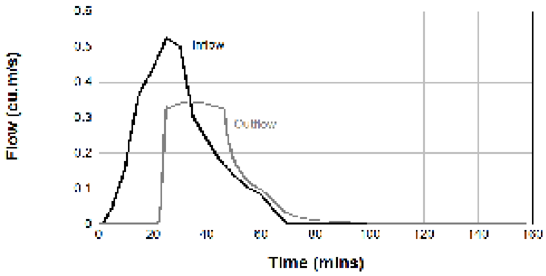
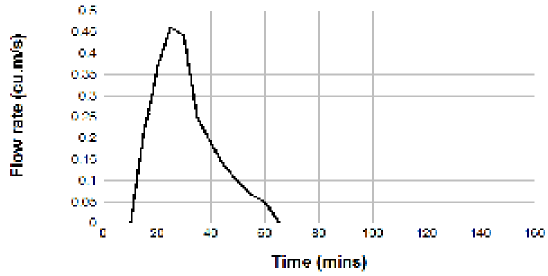


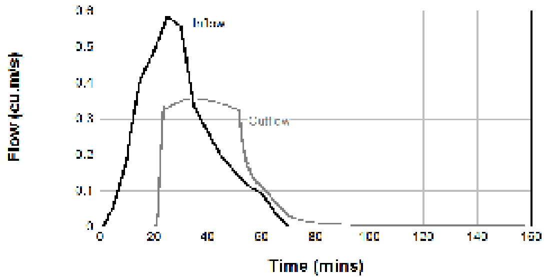


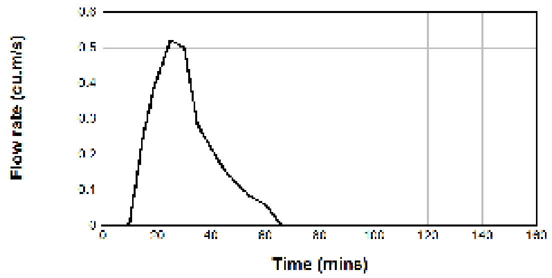
Q20





Q50





Q100

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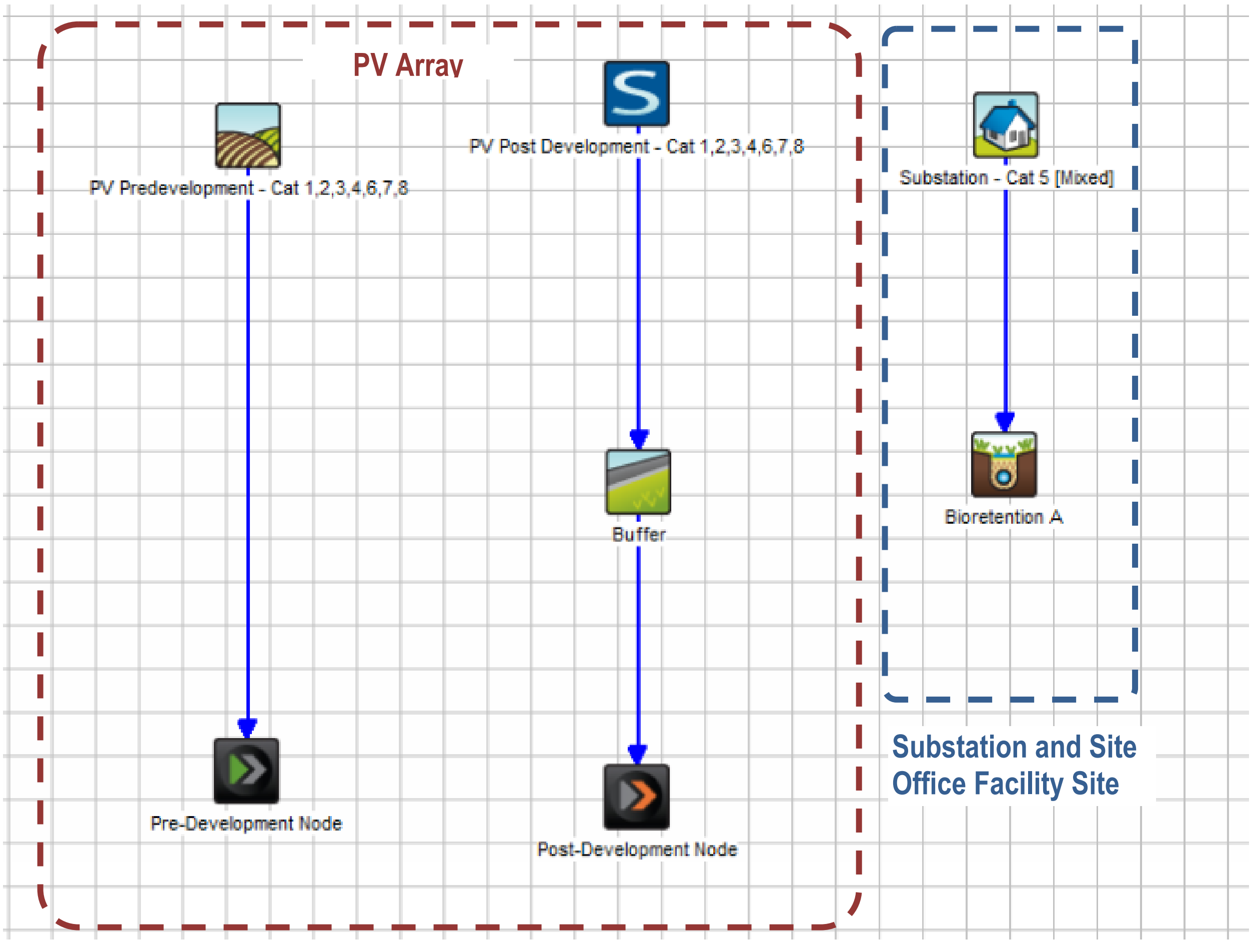
Appendix E – Music Output

Music Model



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Treatment Train Effectiveness

PV Array

	Sources	Residual Load	% Reduction
Flow (ML/yr)	217	217	0
Total Suspended Solids (kg/yr)	89200	56000	37.2
Total Phosphorus (kg/yr)	70.7	48.9	30.8
Total Nitrogen (kg/yr)	580	485	16.4
Gross Pollutants (kg/yr)	362	362	0

☐ Include Pre-Development

Substation

	Sources	Residual Load	% Reduction
Flow (ML/yr)	3.97	3.62	8.9
Total Suspended Solids (kg/yr)	525	47.2	91
Total Phosphorus (kg/yr)	1.4	0.555	60.4
Total Nitrogen (kg/yr)	9.07	4.63	49
Gross Pollutants (kg/yr)	111	0	100

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Appendix F – Bioretention Checklist

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4.3 Inspection and maintenance checklist for bioretention systems

ASSET TYPE	**Bioretention**	**ASSET ID**
Location		
Date		
Date of last rainfall		Weather
Officer's name		
Bioretention plan *Insert diagram or plan of the asset showing key features e.g. locations of inlet, outlet, and overflow*		

Additional information	
Time taken to complete inspection or maintenance	
Photos of site (explanatory notes)	1. 2. 3. 4. 5. 6.
General comments and sketches	
Officer's signature	

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What to look for	Performance Indicator (PI)	Condition rating*	Maintenance undertaken**	Additional work needed
SURROUNDS				
Damaged or removed structures e.g. traffic bollards	No damage that poses a risk to public safety or structural integrity			
INLET				
Erosion	Inlet is structurally sound and there is no evidence of erosion or subsidence/settlement			
Damaged or removed structures e.g. pit lids or grates	No damage that poses a risk to public safety or structural integrity			
Sediment, litter, or debris	No blockage			
COARSE SEDIMENT FOREBAY (IF PRESENT)				
Erosion	Minor erosion only that does not pose a risk to public safety or structural integrity and would not worsen if left unattended			
Sediment	Coarse sediment forebay <75% full and no litter			

*1 – PI met; 2 – PI met after maintenance activity undertaken; 3 – Additional maintenance needed; 4 – Rectification may be needed; NI – not inspected; NA – not applicable

** Quantify where possible e.g. amount of sediment or litter removed

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What to look for	Performance Indicator (PI)	Condition rating*	Maintenance undertaken**	Additional work needed
BATTER SLOPES AND BASE INVERT				
Erosion	Minor erosion only that does not pose a risk to public safety or structural integrity and would not worsen if left unattended			
Crust of fine sediment	No surface crusting			
Depressions or mounds	No surface depressions or mounds > 100 mm			
Hydraulic conductivity or permeability	Filter media is draining freely, whereby water is not ponded on the surface for more than 12 hours after rainfall and there is no obvious impermeable or clay-like surface on the filter media**			
Underdrains/clean out points	Clean out points not damaged and end caps securely in place			
Litter	Maximum 1 piece litter per 4 m^2			
Unusual odours, colours, or substances (e.g. oil and grease)	None detetcted			
Vegetation	Minimum 95% vegetation cover (minimal bare batches)			
	Plants healthy and free from disease			
	Average plant height > 500 mm			

*1 – PI met; 2–PI met after maintenance activity undertaken; 3 – Additional maintenance needed; 4 – Rectification may be needed; NI – not inspected; NA – not applicable

** Quantify where possible e.g. amount of sediment or litter removed

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