

PLANS AND DOCUMENTS
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Goonyella Road

CONCEPTUAL STORMWATER MANAGEMENT PLAN

Client: ISAAC Regional Council

Project No:

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Executive Summary

Burchills Engineering Solutions has been commissioned by Isaac Regional Council to prepare a Stormwater Management Plan (SMP) for the proposed industrial development on Lot 2 on M97361, Goonyella Road Moranbah (the subject site). This report has been prepared to accompany and be considered part of a Development Application.

This report identifies the stormwater treatment measures required to satisfy the requirements of Isaac Regional Council and the State Planning Policy (SPP).

Stormwater Management Concept

The proposed stormwater management concept for the development will feature a stormwater quantity and quality system within each individual industrial allotment (giving a total of three). A stormwater easement consisting of a pipe and drainage swale is proposed within the northern portion of the allotments to convey flows from stormwater treatment measures to the point of discharge.

Stormwater Quantity

Peak flow rates will be maintained at the Lawful Point of Discharge (LPD) through the inclusion of three (3) on-site detention basins (above the proposed bioretention systems) located within each proposed industrial allotment. To ensure there is no increase in peak discharges as a result of the development, the following outlet configurations and storage volumes have been estimated as part of the basin design:

- 1,695 m³ of detention storage (total) for mitigation of the 100 year Average Recurrence Interval (ARI) event, referred to as the Q100;
- Each basin will configure of the following;
 - Low Flow Outlet: 600 x 600 mm Riser (Crest @ 0.3 m above the top of the basin filter media) and 1 x 300 mm RCP (pipe to join easement pipe which in-turn joins to proposed 600 RCP connection by neighbouring site); and
 - High Flow Outlet: 7 m wide Weir (crest @ 1.1 m above basin filter media). Weir flows will be conveyed along the swale component of the proposed easement to the point of discharge. High flows in excess of the piped drainage capacity will discharge the site via a road sag which will discharges into the neighbouring drainage channel

Stormwater Quality

Water sensitive urban design features will also be incorporated into the development to ensure the Queensland Water Quality Objectives (2009) can be satisfied. These measures will include three individual bioretention systems within each industrial allotment. These systems will feature filter areas of 300 m², extended detention depths of 0.3 m and filter depths of 0.4 m.

Treatment Train Effectiveness

Results of the water quality modelling indicate the 85%, 70% and 45% reduction target for TSS, TP and TN respectively can be achieved for the rainfall data set simulated, as summarised below Table E1.

Table E1: Treatment Train Effectiveness

Point of Discharge	Pollutant	Source (kg/yr)	Residual (kg/yr)	Reduction (%)	Target	Target Achieved
A	TSS	12,000	1,280	89.4	85%	✓
	TP	23.5	6.89	70.7	70%	✓
	TN	135	56.4	58.1	45%	✓

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1. Introduction

Burchills Engineering Solutions has been commissioned by Isaac Regional Council to prepare a Conceptual Stormwater Management Plan (CSMP) for the proposed industrial development on Lot 2 on M97361, Goonyella Road, Moranbah (the subject site). This report has been prepared to accompany and be considered part of a Development Application (DA).

A comprehensive review of available Stormwater Quality Improvement Devices (SQID) and Best Management Practices (BMP) was undertaken as part of this investigation. The following sections provide a summary of the mitigation measures required to meet Council's stormwater quality and quantity objectives during both the construction and operational phases of the development.

This management plan is to be considered as part of a Development Application and provides conceptual stormwater management design details. The level of detail provided within this report is not suitable for construction purposes; a Detailed Stormwater Management Plan outlining detailed designs will need to be completed in conjunction with detailed civil design documentation.

1.1 Scope

Specifically, this report details the following:

1. Catchment hydrology, soils and stormwater conveyance including:
 - topography; and
 - vegetation.
2. Water quality issues including:
 - an estimate of sediment and nutrient transport from the subject site; and
 - water quality objectives of the receiving waters.
3. Stormwater Management Controls for the construction and operational phases; and
4. Maintenance and Monitoring Program.

To minimise the impact of the proposed development on the external environment the proponent shall implement this CSMP. To avoid significant and/or sustained deterioration in downstream water quality this CSMP may be amended as required, in response to the Monitoring and Maintenance Program described herein.

1.2 Objective

The objective of this CSMP is to ensure:

- No increase in peak discharge from the subject site (up to the Q100 storm event) to ensure conveyance and flooding on downstream properties is not adversely impacted;
- Discharge of sediment laden stormwater is avoided for the nominated design storm and minimised when the nominated design storm is exceeded during the construction phase; and
- Compliance with the load based reduction targets during the 'operational' (post-construction) phase of the development, in accordance Queensland Water Quality Guidelines (2009).

These objectives will be achieved through the implementation of:

- Management strategies designed to maintain pre-development peak discharges for the full range of ARI events at the existing Lawful Points of Discharge (LPD);
- Specific construction phase controls to minimise erosion and control sediment loss;
- Water quality control measures to achieve load based reduction targets during the 'operational' (post-construction) phase of the development, in accordance with Queensland Water Quality Guidelines (2009);
- A monitoring and maintenance program for both the construction and operational phases; and
- Defined performance criteria and actions to be taken if the criteria are not met.

1.3 Description of Subject Site

The subject site is rectangular in shape and covers an area of 4.0 ha. The south-western boundary of the site fronts Goonyella Road, which provides access to the allotment. The site is located on the western outskirts of the township of Moranbah within the Isaac Regional Council area. There are no major drainage features located on or in close proximity to the site. Mackay, the nearest major city lies approximately 150 km north-east from the subject site, where the nearest river systems of Grosvenor Creek and the Isaac River exist 1.5 km south and 3.0 km north of the site respectively. For more information regarding the site location, refer to Figure 1.1.



Figure 1.1 - Site Locality Plan

1.3.1 Land Use and Vegetation

The site was previously utilised by the Moranbah Pony Club, however minimal use of the site is now evident. Aerial photography and site inspections reveal the site is mainly comprised of a mix of short and tall grasses. Three (3) small structures also exist on the subject site, previously used for Pony Club meets.

1.3.2 Topography and Stormwater Conveyance

The subject site's highest elevation of approximately 254.2 m AHD is located in the southern corner. The lowest elevation is located in the northern corner of the site, with a magnitude of approximately 249.0 m AHD. The subject site is very flat and the ground slopes in a northern direction consistently at a grade of approximately 1.7%. No external catchments are recognised for the site, as swale systems direct flows around the allotment. The subject site has a single LPD located in the northern corner of the site, at this point of discharge, flows cross into the neighbouring site as sheet flow.

1.3.3 Downstream Environment

Runoff from the subject site is discharged as sheet flow over the northern boundary and into the neighbouring allotment before being concentrated within a drainage channel which conveys flows to the Isaac River, and ultimately flowing to the Coral Sea.

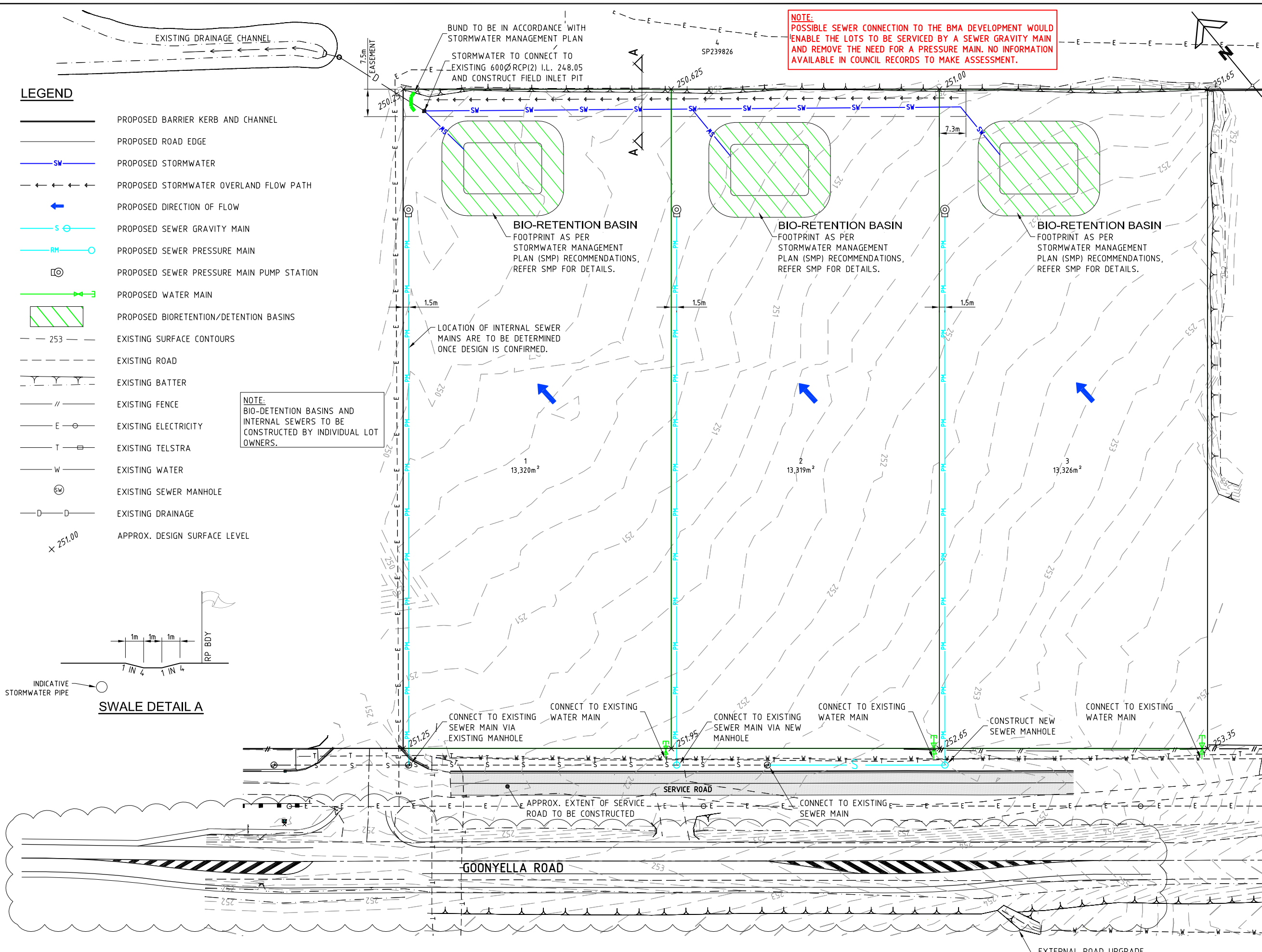
1.3.4 Rainfall

Mean annual rainfall for the site has been estimated to be 615.8 mm from the data set obtained from the nearest local rainfall station (Moranbah Water Treatment Plant 34038).

1.4 Description of Development

The proposed development is presented on Figure 1.2 and includes the following:

- Three (3) industrial Lots



INDUSTRIAL ESTATE

GOONYELLA ROAD

FOR

ISAAC REGIONAL COUNCIL

A1

ORIGINAL SIZE BEFORE REDUCTION

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PROJECT:

INDUSTRIAL ESTATE MORANBAH

DRAWING TITLE:

FUNCTIONAL LAYOUT PLAN

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DESIGNER:	MARK MORRIS
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2. Hydrological Analysis

The natural hydrology of the site has been assessed in accordance with QUDM, 2008, Section 4. The Rational Method has been relied upon to gain an initial understanding of the relative impact of the proposed development on peak flow rates at the site's LPD. The Rational Method provides a basic method for assessing peak flow rates and is considered suitable given the catchment area is less than 500 ha and the time of concentrations within the contributing catchments are less than 30 minutes.

2.1 Catchment Delineation

In the pre-development scenario, the subject site is a single catchment 4.0 ha in size (Catchment A), where no external catchments are recognised. Runoff discharges as overland sheet flow from the subject site catchment with little concentration, eventually flowing into the neighbouring site to the north, the site's existing Lawful Point of Discharge (LPD – A). Within the neighbouring development, conveyance of the subject sites flows have been accommodated for via the provision of a 600 mm dia RCP which runs underneath the access road adjacent to the subject site. In addition a road sag has been provided within the before mentioned neighbouring access road for conveyance of flows above the provided pipe capacity.

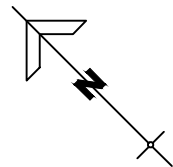
In the post-development Catchment A will be subdivided into three (3) representing each industrial allotment. Flow discharge conditions to the site's existing Lawful Point of Discharge (LPD – A) will alter from the pre-development scenario. The provided downstream conveyance systems (600 RCP and Road sag) will be utilised with minor flows being conveyed as piped flow, and major flows will be conveyed within the road sag.

The catchment area is summarised in Table 2.1 with the catchment delineation shown in Figure 2.1 and Figure 2.2 for the pre and post-development scenarios respectively.

Table 2.1 Catchment Delineation

Catchment ID	Pre-Development (ha)		Catchment ID	Post-Development	
A	Internal	4.0	A1	Internal	1.33
			A2	Internal	1.33
			A3	Internal	1.33
LPD-A	Total	4.0	LPD A	Total	4.0

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- LEGEND**
- PRE-DEVELOPMENT CATCHMENT
 - FLOWPATHS
 - POINT OF DISCHARGE

SCALE 5 0 5 10 15 20 25 (metres)
 1 : 500 (FULL SIZE)

INDUSTRIAL ESTATE
 GOONYELLA RD
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A1 ORIGINAL SIZE BEFORE REDUCTION

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 FIGURE 2.1
 PRE - DEVELOPMENT
 CATCHMENT DELINIATION
 PLAN

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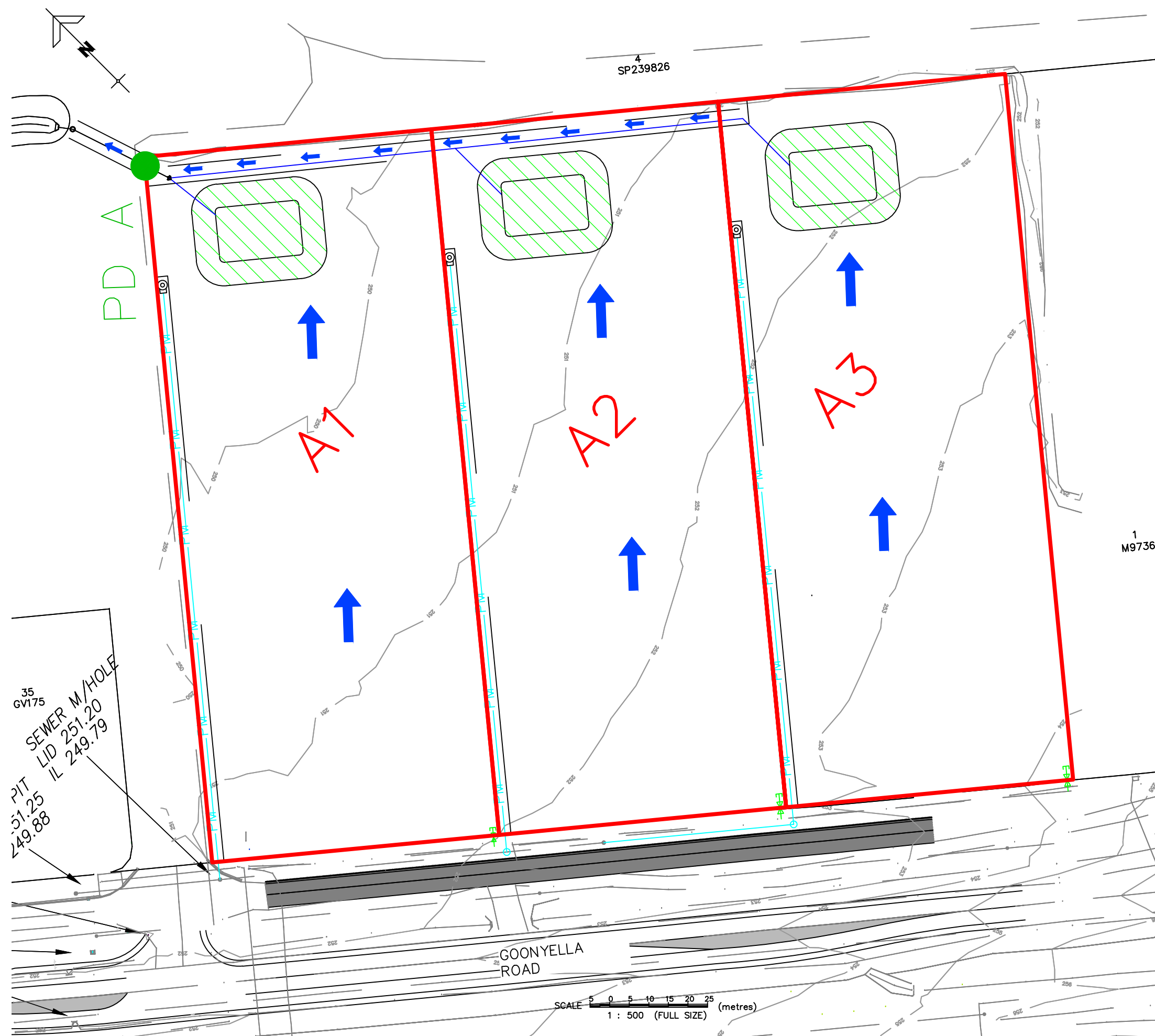
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FIGURE 2.2
POST - DEVELOPMENT
CATCHMENT DELINIATION
PLAN

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2.2 Pre-Development Hydrology

Summaries of the hydrologic calculations are contained in the table below. In the pre-development scenario, runoff coefficients have been calculated through the use of site plans, site investigation, aerial photography and QUDM. Details of these assumptions, time of concentration and Rational Method calculations are contained in more detail within Appendix A.

Table 2.2 Pre-Development Hydrology

Catch.	Area (ha)	tc (min)	I100 (mm/hr)	C	Q100 (m³/s)	I50 (mm/hr)	C	Q50 (m³/s)	I20 (mm/hr)	C	Q20 (m³/s)	I10 (mm/hr)	C	Q10 (m³/s)	I5 (mm/h)	C	Q5 (m³/s)	I2 (mm/h)	C	Q2 (m³/s)	I1 (mm/h)	C	Q0.25 (m³/s)
A	4.00	19.56	152.00	0.64	1.07	138.00	0.61	0.93	119.00	0.56	0.74	105.00	0.53	0.62	94.90	0.50	0.53	77.10	0.45	0.39	60.80	0.42	0.14
LPD A	4.00	19.56	152.00	0.64	1.07	138.00	0.61	0.93	119.00	0.56	0.74	105.00	0.53	0.62	94.90	0.50	0.53	77.10	0.45	0.39	60.80	0.42	0.14

2.3 Post-Development Hydrology

The natural hydrology of the site has been assessed in accordance with QUDM, 2008, Section 4. Summaries of the hydrologic calculations are contained in Table 2.3. In the pre-development scenario, runoff coefficients have been calculated through the use of site plans, site investigation, aerial photography and QUDM. Details of these assumptions, time of concentration and Rational Method calculations are contained in more detail within Appendix A.

Table 2.3 Un-Mitigated Post-Development Hydrology

Catch.	Area (ha)	tc (min)	I100 (mm/hr)	C	Q100 (m³/s)	I50 (mm/hr)	C	Q50 (m³/s)	I20 (mm/hr)	C	Q20 (m³/s)	I10 (mm/hr)	C	Q10 (m³/s)	I5 (mm/hr)	C	Q5 (m³/s)	I2 (mm/hr)	C	Q2 (m³/s)	I1 (mm/hr)	C	Q0.25 (m³/s)
A	1.33	5.33	268.67	1.00	1.00	241.39	0.99	0.88	206.22	0.9	0.69	179.67	0.86	0.57	160.11	0.82	0.48	127.09	0.73	0.34	99.16	0.69	0.13
A2	1.33	5.33	268.67	1.00	1.00	241.39	0.99	0.88	206.22	0.9	0.69	179.67	0.86	0.57	160.11	0.82	0.48	127.09	0.73	0.34	99.16	0.69	0.13
A3	1.33	5.33	268.67	1.00	1.00	241.39	0.99	0.88	206.22	0.9	0.69	179.67	0.86	0.57	160.11	0.82	0.48	127.09	0.73	0.34	99.16	0.69	0.13
LPD A	4.00	7.43	266.79	1.00	2.96	239.70	0.99	2.63	204.77	0.9	2.05	178.39	0.86	1.70	158.95	0.82	1.44	126.16	0.73	1.02	98.43	0.69	0.38

2.4 Comparative Analysis of Pre- and Post- Development Hydrology

The hydrological analysis below in Table 2.4 shows that the proposed development will result in an increase in flow of approximately 116% at the LPD.

Table 2.4 Hydrological Analysis

Peak Discharge (m ³ /s)	Average Recurrence Interval - Years						
	Q100	Q50	Q20	Q10	Q5	Q2	Q0.25
Pre LPD – A	1.07	0.93	0.74	0.62	0.53	0.39	0.14
Post LPD – A	2.96	2.63	2.05	1.70	1.44	1.02	0.38
Difference	1.89	1.70	1.31	1.08	0.91	0.63	0.24

3. Quantity Management – Operational Controls

To ensure the expected increased flow rates from the developed site have minimal impact and protect the receiving waterway and mitigate any increase in flooding on downstream properties, the following hydrological objective has been set for stormwater exiting the subject site:

- No increase in peak discharge from the site for events up to the Q100.

To achieve this objective, site flows will need to be adequately treated prior to discharge.

In order to mitigate peak flows at the LPD, it is proposed that site runoff from each industrial allotment be conveyed to three (3) Onsite Detention Basins (OSD) located within the northern portion of each allotment.

3.1 Conveyance of Site Flows

Site flows are currently discharged from the subject site via overland flow to the downstream property. It is noted that this neighbouring property is currently undergoing development, and has allowed for the conveyance of upstream flows (from the subject site) via the construction of a 600 mm Reinforced Concrete Pipe (RCP) and road sag (for flows above the given pipe capacity). This has been included within the XP-STORM model constructed for the site.

3.1.1 Conveyance of minor and major flows

All minor and major flows will be conveyed to the proposed OSD basins within each allotment for retention and treatment. A stormwater easement consisting of a pipe and 3 m wide drainage swale is proposed within the northern portion of the allotments to convey flows from stormwater treatment measures to the point of discharge. The stormwater pipe within the easement will connect to the provided 600 mm dia RCP at the point of discharge. High flows in excess of the piped drainage capacity will discharge the site via a road sag which will discharge into the neighbouring drainage channel.

3.2 On-site Detention

It is proposed that the post development peak discharge will be mitigated through the inclusion of OSD Basins. The detention is to be provided above the proposed bioretention systems. Appendix B presents a typical section of the proposed bioretention/OSD systems.

4. Quantity Analysis – XP-STORM

In order to further progress and advance the proposed stormwater quantity controls XP-STORM was utilised. This modelling software is a link-node model capable of performing hydrology and hydraulics of stormwater drainage systems simultaneously.

4.1 Rainfall Parameters

Australian Rainfall and Runoff (ARR) temporal patterns and Intensity Frequency Duration (IFD) data from the Bureau of Meteorology has been utilised. The IFD data used in the hydrologic analysis for a range of storm events is presented in Table 4.1.

Table 4.1 Adopted Intensity Frequency Data (mm/hr)

Storm Duration	Average Recurrence Interval - Years						
	1	2	5	10	20	50	100
15 minute	68.19	86.76	107.53	119.54	136.13	157.97	174.79
20 minute	60.80	77.10	94.90	105.00	119.00	138.00	152.00
25 minute	55.10	69.79	85.49	94.42	106.94	123.35	135.96
30 minute	50.50	63.90	78.00	86.00	97.30	112.00	123.00
45 minute	40.52	51.21	62.34	68.64	77.53	89.15	98.04
60 minute	33.90	42.90	52.30	57.60	65.10	74.90	82.40
90 minute	25.71	32.58	39.90	44.11	49.96	57.65	63.52
120 minute	20.80	26.40	32.50	36.10	41.00	47.50	52.40
180 minute	15.10	19.30	24.10	26.90	30.70	35.80	39.70
360 minute	8.61	11.10	14.20	16.10	18.60	21.90	24.50

To input the IFD information into XP-STORM, rainfall multipliers are generated to represent the depth of rainfall for a given storm event and storm duration. The rainfall multipliers are then applied to the temporal patterns within XP-STORM to generate flood hydrographs for use within the hydraulic analysis.

Table 4.2 Rainfall Multipliers Applied to Temporal Patterns (mm)

Storm Duration	Average Recurrence Interval - Years						
	1	2	5	10	20	50	100
15 minute	17.05	21.69	26.88	29.89	34.03	39.49	43.70
20 minute	20.27	25.70	31.63	35.00	39.67	46.00	50.67
25 minute	22.96	29.08	35.62	39.34	44.56	51.40	56.65
30 minute	25.25	31.95	39.00	43.00	48.65	56.00	61.50
45 minute	30.39	38.41	46.75	51.48	58.15	66.87	73.53
60 minute	33.90	42.90	52.30	57.60	65.10	74.90	82.40
90 minute	38.56	48.87	59.86	66.16	74.94	86.48	95.28
120 minute	41.60	52.80	65.00	72.20	82.00	95.00	104.80
180 minute	45.30	57.90	72.30	80.70	92.10	107.40	119.10
360 minute	51.66	66.60	85.20	96.60	111.60	131.40	147.00

4.2 Laurenson Routing Parameters

In this study, the “Laurenson” routing method was applied to XP-STORM for hydrograph generation. To enable this method to be used, each catchment must be split into pervious (undeveloped) and impervious (developed) portions. Adopted parameters for the Laurenson routing method included:

- The fraction impervious has been determined by analysis of aerial photographs and the proposed development layout;
- Manning Roughness coefficient (n):
 - Pervious portion: 0.035; and
 - Impervious portion: 0.014.
- Initial Loss (IL) and Continuing Losses (CL) have been applied to the hydrologic model. Details of IL and CL parameters applied in the XP-STORM model are presented in Table 4.3.

Table 4.3 Adopted Initial and Continuing Losses

Impervious Area		Pervious Area	
IL (mm)	CL (mm/hr)	IL (mm)	CL (mm/hr)
0	0	15	2.5

Analysis of the catchment has been undertaken to determine the average slope, with the results of this being applied to the model.

Table 4.4 Pre-Development Catchment Parameters

Catchment	Impervious Area			Pervious Area		
	Area (ha)	Fraction Impervious (%)	Slope (%)	Area (ha)	Fraction Impervious (%)	Slope (%)
A	0.0	100	1.7	4.0	0	1.7

Table 4.5 Post-Development Catchment Parameters

Catchment	Impervious Area			Pervious Area		
	Area (ha)	Fraction Impervious (%)	Slope (%)	Area (ha)	Fraction Impervious (%)	Slope (%)
A1	1.266	100	1.7	0.067	0	1.7
A2	1.266	100	1.7	0.067	0	1.7
A3	1.266	100	1.7	0.067	0	1.7

4.3 Model Calibration

A comparison between the peak discharge values obtained using the Rational Method and the XP-STORM model for all ARI events at the legal point of discharge is contained in Table 4.6.

The peak discharges generated by XP-STORM compare well to the values obtained from Rational Method calculations.

Table 4.6 Rational Method vs XP-STORM Generated Peak Discharges

Catchment	Pre-Development			Catchment	Post-Development		
	Rational (m ³ /s)	STORM (m ³ /s)	Difference (%)		Rational (m ³ /s)	STORM (m ³ /s)	Difference (%)
A	1.074	1.118	3.9	A1	0.995	0.924	-7.7
				A2	0.995	0.924	-7.7
				A3	0.995	0.924	-7.7

4.4 OSD Configuration

XP-STORM requires a depth area relationship to be defined when modelling an onsite detention basin (OSD). As it is proposed that the required detention volume will be located above bioretention extended detention depth, an initial depth of 0.3 m was applied to storage node to represent the extended detention depth being full at the onset of the storm event.

A summary of the total depth-area relationship applied to the storage node of the XP-STORM model in the post-development (mitigated) scenario is contained in Table 4.7.

Table 4.7 Depth - Area Relationship Adopted for OSD

Basin ID	Post-Development	
	Depth (m)	Surface area (ha)
A1	0.0	0.0300
	1.5	0.0824
A2	0.0	0.0300
	0.6	0.0824
A3	0.0	0.0300
	0.3	0.0824

4.5 OSD Outlet Configuration

XP-STORM requires appropriate outlet structures to be defined when modelling a detention basin. A summary of the outlet structures modelled is provided in Table 4.8. These outlet structures are a combination of a riser with orifices and low flow pipe for minor flows and a high flow weir for the larger ARI flood events.

Table 4.8 Modelled Outlet Structures of OSDs

Basin	Low Flow			High Flow
	Orifice	Riser	Outlet Pipe(s)	Weir
A1	-	600x600mm crest @ RL 249.1	1x300 mm dia	7 m wide crest @ RL 249.9
A2	-	600x600mm crest @ RL 249.47	1x300 mm dia	7 m wide crest @ RL 250.27
A3	-	600x600mm crest @ RL 249.84	1x300 mm dia	7 m wide crest @ 250.64

4.6 Performance of OSD

To confirm the performance of the proposed OSD Basin, an XP-STORM model has been constructed for the pre- and post-development scenarios. These models compare the discharge hydrographs for a range of storm durations at the existing LPD. The 100, 50, 20, 10, 5 and 2 year ARI events have been simulated for 15, 20, 25, 30, 45, 60, 90 and 120 minute ARR storms. Copies of these models have been submitted to the Isaac Regional Council with this application for review.

A summary of the modelling results for different ARI events is contained in Table 4.9. Results of the modelling indicate the proposed detention basin is capable of maintaining the pre-development peak discharges for the all storm events up to the 100 year ARI event at the LPD.

Table 4.9 Comparison of Pre-Development vs Post-Development (Mitigated) Peak Discharges at LPD

ARI Event	Peak Discharge (m ³ /s)	
	Pre- Development	Post- Development
100 year	1.118	1.044
50 year	0.976	0.752
20 year	0.823	0.493
10 year	0.684	0.469
5 year	0.591	0.450
2 year	0.429	0.415

A plot of the pre-development vs post-development (mitigated) hydrographs for the 100-year ARI event is included as Figure 4.1. The detention volume required to achieve these results is summarised in Table 4.10.

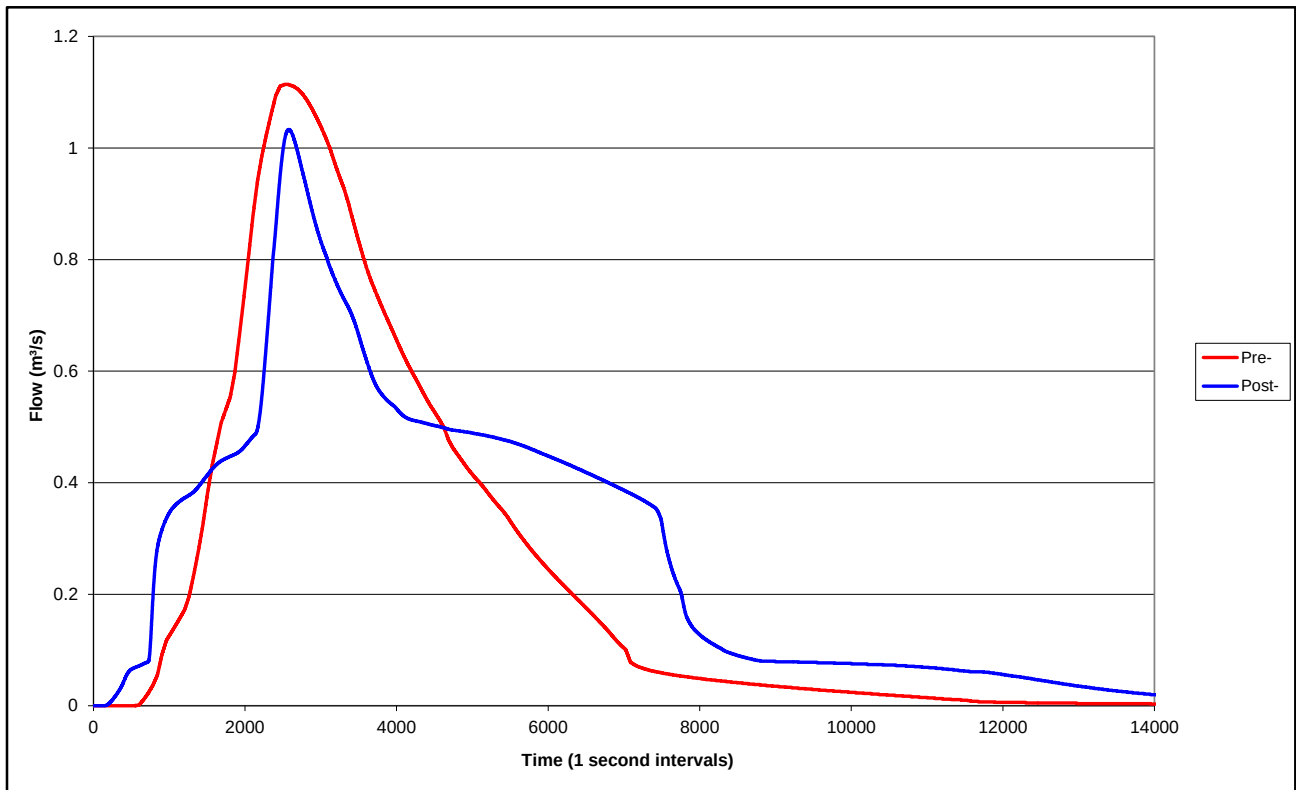


Figure 4.1 Plot of Pre-Development vs Post-Development Q100 Hydrographs

Table 4.10 OSD Basin Volume (Q100)

Basin ID	Volume (m ³)	Peak Depth of Water (m)
A1	561.70	1.170
A2	565.21	1.172
A3	567.98	1.176

4.6.1 Basin Depth

QUDM requires demonstration of the depth of water in the detention basin does not exceed 1.5 m during the Q100 storm event. The Q100 storm event was simulated for the post development scenario to confirm this requirement and the results are presented in Table 4.11. Table 4.11 demonstrates the depth of water within the proposed basin does not exceed 1.2 m during the Q100 storm event, and is limited to less than 1.2 m for the Q20 event.

Table 4.11 Detention Basin Depths 100 year ARI Event

Basin ID	Basin Floor Level (m AHD)	Peak Water Surface (m AHD)	Peak Depth of Water (m)
A1	248.800	249.970	1.170
A2	249.170	250.342	1.172
A3	249.535	250.711	1.176

4.6.2 Sensitivity Analysis

Basin Sensitivity

In accordance with the requirements of QUDM Section 5.08.2, consideration has been given to the consequences of a fully blocked low level outlet. In this case, the low flow (riser structure) components of the outlet structure were turned off, leaving only the high flow weir. A summary of the results observed during the 100 year ARI event is contained in Table 4.11.

Table 4.11 Sensitivity Analysis Results for 100 year ARI Event

Basin ID	Peak Water Level (m AHD)	Top of Bund (m AHD)
A1	250.04	250.300
A2	250.41	250.670
A3	250.78	251.035

Based on the conceptual basin design (which assumes the basins will be 1.5 m deep), the peak water level does not exceed the TOB during a 100 year ARI event in the unlikely scenario that the low level outlet becomes fully blocked. The requirements of QUDM Section 5.08.2 are therefore satisfied.

All proposed outlet structures will be refined at Operational Works stage of the development.

Road Flow Depth and Velocity

In accordance with the requirements of QUDM Section 7.03.1, consideration has also been given to the flow depth and velocity product (DV Product) over the proposed road sag downstream of the OSD Basins. A fully blocked scenario within the basin was modelled similar to the before mentioned. A summary of the results observed during the 100 year ARI event is contained in Table 4.12 (below).

Table 4.12 Road Flow Depth and Velocity Results for 100 year ARI Event

Road Sag Width (TBC)	Road Sag Level (m AHD) (TBC)	Peak Water Level (m AHD)	Depth Over Road (m)	Velocity Over Road (m/s)	DV Product (m ² /s)
5 m	249.2	249.351	0.151	2.255	0.341

Based on the conceptual design, the depth of flow over the road does not exceed 250 mm, nor does the DV Product exceed 0.4 m²/s. Therefore the requirements of QUDM, 2008, section 7.03.1 have been met.

5. Quality Management – Construction Controls

During the construction phase of the development the following sediment and erosion control devices and stormwater management controls will be implemented on the site. Developed in accordance with IECA Best Practice Erosion and Sediment Control (2008) guidelines, the location of control devices is presented in Figure 5.1.

It is important to note that the measures identified below are a generic approach to construction phase stormwater quality management. Erosion and sediment control is highly dependent on local site conditions and staging of the proposed earth disturbing activities. Therefore, further details of the erosion and sediment control systems and procedures will be provided at the detailed design stage when more information is available regarding in-situ soils and development staging.

5.1 Sediment Basin Requirements

Sediment basins are generally required where:

- The disturbed area is greater than 2,500 m²;
- The disturbed solids are dispersive; and/or
- Where there is a need to control runoff suspended solids/turbidity.

As the subject site is greater than 2,500 m², a sediment basin will be required. In the absence of site specific soil data, this sediment basin has been designed in accordance with the IECA Guidelines as a Type F Basin for fine-grained soils. The design parameters utilised for the sediment basin sizing is presented below as Table 5.1.

Table 5.1 Sediment Basin Design Parameters

Catchment	Area (ha)	K1 (Constant)	K2 (Constant)	I _(1yr, 120hr) (mm/hr)	R _(Y%, 5-day) (mm)	C	V _s Volume of Settling Zone (m ³)	Settling Depth (m)	Batter Slope (m) (eg. 3/1 =3)	Width (m)	Length (m)	Sediment Storage Volume (m ³)
A	4.0	17.0	11.2	0.86	25.8	1.0	1033	0.6	3	27.6	75.5	516

Artificial flocculation will be applied on retained runoff to assist in the settling process. This will be completed via the application of Gypsum within 24 hours of the conclusion of each storm event and before any pumping out of the basin. Application of the Gypsum will occur by broadcasting it over the surface by hand, ensuring an even spread over the basin surface at a rate of 32 kg per 100 m³ of water.

Further detailed investigation of the sedimentation basin requirements will be provided during the detailed design phase of the project. Figure 5.1 illustrates the Conceptual Construction Erosion and Sediment Control Plan.

5.2 Pre-Construction

The following erosion control measures will be implemented to minimise disturbance and ensure the performance criteria for water quality are met:

- Designation and marking of transport routes across undisturbed portions of the site to ensure minimal vegetation disturbance. Transport routes will have construction exits in accordance with IEAust Guidelines at the designated exit points on the site;
- Diversions will be constructed to divert clean stormwater away from exposed soils and development areas. The exact location and time of construction for each diversion measure will depend on the composition of future development stages. To help facilitate the diversion of clean stormwater it is recommended that piped networks, within road reserves be constructed at early stages of development;
- Where possible proposed open space areas are to be fenced and remain as buffer zones/filter strips; and
- Site personnel complete an environmental induction covering the erosion and sediment controls.

5.3 During Construction

Measures to mitigate water quality impacts during the construction will include:

- Sediment fences to be erected at the base of all batters to prevent sediment laden stormwater from flowing onto road surfaces;
- Grass filter strips to be placed along all road verges;
- Progressive re-vegetation of filled and disturbed areas;
- Sediment fences to be erected around soil stockpiles;
- Regular inspections as soon as practicable after storm events to check and maintain controls;
- Sediment to be removed from fences when controls are 40% full and at the completion of construction. All material to be re-used or stored on-site in a controlled manner or taken off-site for re-use or disposal at a licensed waste disposal facility; and
- Monitoring of water quality to determine the effectiveness of the sediment and erosion control management practices (refer to Section 8).

5.4 Bioretention Basin Staged Construction and Establishment

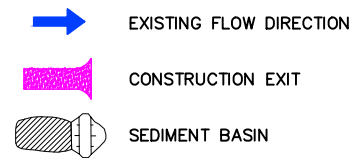
In accordance with the Water by Design Construction and Establishment Guidelines: Swales Bioretention Systems and Wetlands (C&E Guidelines), inflow of sediment-laden runoff is a major risk to the successful and long-term functioning of bioretention systems. During the construction phase of developments, sediment can seal the surface of the filter media, move into and clog the filter media and accumulate in the under-drainage. Within the C&E Guidelines, there are 4 options recommended to overcome the challenges associated with delivering bioretention systems. These generally include the following options:

- Option 1: Surface Protection
- Option 2: Bypass flows and early establishment of vegetation;
- Option 3: Sediment basin and bioretention function; and

- Option 4: Leave as sediment basin.

It is proposed that Option 4 method for staged construction and establishment of the bioretention system and the utilisation of these systems as sediment basins during the construction phase be implemented for the proposed development. This method will generally include the bulk earthworks component of the basin being undertaken with the placement of the filter media delayed until 80-90% of the building work is complete.

For details of the procedure and order of construction for Option 4 method please refer to Section 3.9 (Steps 1-40) of the C&E Guidelines.



SCALE  (metres)
1 : 500 (FULL SIZE)

INDUSTRIAL
ESTATE

GOONYELLA
RD

FOR

ISAAC
REGIONAL
COUNCIL

A1 ORIGINAL SIZE BEFORE REDUCTION

A	ORIGINAL ISSUE		---
VER.	DESCRIPTION	APPR.	DATE

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PROJECT:

FIGURE 5.1
CONCEPTUAL SEDIMENT &
EROSION CONTROL PLAN

DEVEL. APPLIC. No.: *		DATE : 06.05.14	
PROJECT LEADER : LF			
DESIGNER : AK			
DRAFTSPERSON : AK			
CHECKED : PB			
APPROVED FOR AND ON BEHALF OF BURCHILLS ENGINEERING SOLUTIONS ABN 75 166 942 365			
RPEQ No.:			
SCALE : AS NOTED	DATUM : AHD	FULL SCALE : A1	
PROJECT No.: GC130256	DRAWING No. : N300	VERSION: A	

- GENERAL NOTES:

1. THESE EROSION AND SEDIMENT CONTROL PLANS TO BE READ IN CONJUNCTION WITH THE APPROVED STORMWATER MANAGEMENT PLAN.
2. PRIOR TO THE COMMENCEMENT OF SITE WORKS, THE LOCATION OF THE SITE ACCESS POINT MUST BE VERIFIED WITH THE LOCAL AUTHORITY.
3. SITE EXIT POINTS MUST BE APPROPRIATELY MANAGED TO MINIMISE THE RISK OF SEDIMENT BEING TRACKED ONTO SEALED, PUBLIC ROADWAYS.
4. ALL OFFICE FACILITIES AND OPERATIONAL ACTIVITIES MUST BE LOCATED SUCH THAT ANY LIQUID EFFLUENT (E.G. PROCESS WATER, WASH-DOWN WATER, EFFLUENT FROM EQUIPMENT CLEANING, OR PLANT WATERING), CAN BE TOTALLY CONTAINED AND TREATED WITHIN THE SITE.
5. SEDIMENT FENCE MATERIAL TO BE APPROVED BY ENVIRONMENTAL ENGINEER. PRIOR TO COMMENCEMENT OF SITE WORKS, FENCE RETURNS TO BE LOCATED EVERY 20m.
6. STOCKPILES OF ERODIBLE MATERIAL THAT HAS THE POTENTIAL TO CAUSE ENVIRONMENTAL HARM IF DISPLACED MUST BE APPROPRIATELY PROTECTED FROM WIND, RAIN, CONCENTRATED SURFACE FLOW AND EXCESSIVE UP-SLOPE STORMWATER SURFACE FLOWS.
7. BARRIER FENCING TO BE ERECTED AROUND ALL NON-DISTURBED AREAS TO PREVENT ACCESS BY CONSTRUCTION MACHINERY.
8. THE CONTRACTOR SHALL TAKE ALL NECESSARY PRECAUTIONS TO CONTROL AND MINIMISE EROSION AND DOWNSTREAM SEDIMENTATION DURING ALL STAGES OF CONSTRUCTION INCLUDING THE MAINTENANCE PERIOD.
9. THE CONTRACTOR IN CONJUNCTION WITH THE ENVIRONMENTAL ENGINEER IS TO MAINTAIN A WATER QUALITY LOG IN ACCORDANCE WITH THE APPROVED STORMWATER MANAGEMENT PLAN. THE LOG SHALL NOMINATE DATE, TESTS UNDERTAKEN, RESULTS, NOTES AND CORRECTIVE ACTIONS UNDERTAKEN. THE LOG SHALL ALSO CONTAIN RELEVANT INFORMATION RELATING TO CHEMICAL FLOCCULATION RATES, RESIDENCE TIME ETC, IF USED ON THE SITE.
10. PLANS AND ALL CALCULATIONS HAVE BEEN CONDUCTED IN ACCORDANCE WITH THE INTERNATIONAL EROSION CONTROL ASSOCIATION (IECA) BEST PRACTICE EROSION AND SEDIMENT CONTROL GUIDELINES, NOVEMBER 2008.
11. ALL EROSION AND SEDIMENT CONTROL MEASURES, INCLUDING DRAINAGE CONTROL MEASURES, MUST BE MAINTAINED IN PROPER WORKING ORDER AT ALL TIMES DURING THEIR OPERATIONAL LIVES.
12. SEDIMENT REMOVED FROM SEDIMENT TRAPS AND PLACES OF SEDIMENT DEPOSIT MUST BE DISPOSED OF IN A LAWFUL MANNER THAT DOES NOT CAUSE ONGOING SOIL EROSION OR ENVIRONMENTAL HARM.
13. ALL DRAINAGE CONTROL MEASURES INCLUDING DIVERSION BUNDS AND CATCH DRAIN HAVE BEEN DESIGNED TO INCLUDE 150mm FREEBOARD FOR THE 5 YEAR ARI EVENT.
14. SEDIMENT BASIN TO BE DOSED WITH GYPSUM TO AT A RATE OF 33kg PER 100m³ OF WATER AFTER EACH RAINFALL EVENT.
15. THE SEDIMENT BASIN MUST NOT BE DECOMMISSIONED UNTIL ALL UP-SLOPE SITE STABILISATION MEASURES HAVE BEEN IMPLEMENTED AND ARE APPROPRIATELY WORKING TO CONTROL SOIL EROSION AND SEDIMENT RUNOFF IN ACCORDANCE WITH THE SPECIFIED ESC STANDARD.
16. ALL TEMPORARY EARTH BANKS, FLOW DIVERSION SYSTEMS, AND EMBANKMENTS ASSOCIATED WITH CONSTRUCTED SEDIMENT BASINS MUST BE MACHINE-COMPACTED, SEEDED AND MULCHED FOR THE PURPOSE OF ESTABLISHING A TEMPORARY VEGETATIVE COVER WITHIN 10 DAYS AFTER GRADING.
17. SUITABLE ALL-WEATHER MAINTENANCE ACCESS MUST BE PROVIDED TO ALL SEDIMENT CONTROL DEVICES.
18. GRASS FILTER STRIPS TO BE INSTALLED ALONG ALL ROAD VERGES (MINIMUM 500mm WIDTH) WITH LATERAL STRIPS (MINIMUM 400mm LENGTH) AT 5m SPACINGS TO AVOID SCOUR AT BACK OF TURF.
19. THE CONTRACTOR IS TO RESTRICT ACTIVITIES TO THOSE AREAS DESIGNATED. AT NO TIME SHALL THE CONTRACTOR ENTER OR CROSS ADJOINING AREAS WITHOUT WRITTEN AUTHORISATION FROM THE SUPERINTENDENT.
20. ANY SUPPLEMENTARY CLEARING SHALL BE UNDERTAKEN UNLESS PRECEDED BY THE INSTALLATION OF ADEQUATE DRAINAGE AND SEDIMENT CONTROL MEASURES, UNLESS SUCH CLEARING IS REQUIRED FOR THE PURPOSE OF INSTALLING SUCH MEASURES, IN WHICH CASE, ONLY THE MINIMUM CLEARING REQUIRED TO INSTALL SUCH MEASURES SHALL OCCUR.
21. LAND CLEARING MUST BE LIMITED TO 5m FROM THE EDGE OF PROPOSED CONSTRUCTED WORKS, 2m OF ESSENTIAL CONSTRUCTION TRAFFIC ROUTES, AND A TOTAL OF 10m WIDTH FOR CONSTRUCTION ACCESS, UNLESS OTHERWISE APPROVED BY THE LOCAL AUTHORITY.
22. ALL SEDIMENT CONTROL DEVICES MUST BE DE-SILTED AND MADE FULLY OPERATIONAL AS SOON AS REASONABLE AND PRACTICABLE AFTER A SEDIMENT PRODUCING EVENT, WHETHER NATURAL OR ARTIFICIAL. IF THE DESIGNER'S SEDIMENT RETENTION CAPACITY FALLS BELOW 75% OF ITS DESIGN RETENTION CAPACITY.
23. ANY EROSION OR DISTURBED SOIL SURFACES MUST BE ADEQUATELY STABILISED AGAINST EROSION (MINIMUM 70%) PRIOR TO COMMENCEMENT OF USE, OR SURVEY PLAN ENDORSEMENT.
24. THE TYPE OF GROUND COVER APPLIED TO COMPLETED EARTHWORKS IS COMPATIBLE WITH THE ANTICIPATED LONG-TERM LAND USE, ENVIRONMENTAL RISK, AND SITE REHABILITATION MEASURES.
25. THE PERMANENT STORMWATER TREATMENT FEATURES MUST BE APPROPRIATELY PROTECTED FROM THE ADVERSE EFFECTS OF SEDIMENT RUNOFF.

6. Quality Management – Operational Controls

The modification of an urban rural area to an industrial area has the potential to affect many water quality parameters within stormwater. The key pollutants generated by various urban developments are listed in the Queensland Water Guidelines for both the Operational (Post-Construction) and Construction phases.

Key stormwater performance indicators need to be identified for differing types of development as:

- Different types of development have differing waterborne pollutants which may be exported from a site; and
- The environmental value of a waterway may also be sensitive to particular waterborne pollutants.

To minimise the potential adverse impacts, the proposed development should reduce contamination in stormwater runoff through the incorporation of Water Sensitive Urban Design (WSUD) measures such as constructed wetlands, bio-retention systems and swales.

For an industrial development, the following pollutants have been identified as the minimum key performance indicators:

- Suspended Solids (sediment),
- Nutrients (Total Nitrogen & Total Phosphorus); and
- Litter.

This SMP will concentrate on the potential increase in pollutant values as a result of the proposed development, and in turn, the required treatment to mitigate potential increases.

6.1 Water Quality Objective (WQO)

In accordance with the Queensland Water Quality Guidelines (2009), the total effect of permanent water quality control measures are to achieve reductions in the mean annual load generated by the development site at a minimum of:

- 85% for Suspended Sediment;
- 45% for Total Nitrogen;
- 70% for Total Phosphorus; and
- 90% for Gross Pollutants.

This will ensure the environmental values of the downstream receiving waters are maintained and have been chosen as the WQO for the development.

6.2 Treatment Train

Based on the site characteristics and the range of available SQIDs, this study has developed an overall concept that will satisfy the requirements of downstream environmental protection. Figure 6.1 shows a schematic representation of the proposed treatment train elements, while their location within the proposed development is illustrated in Figure 6.3.

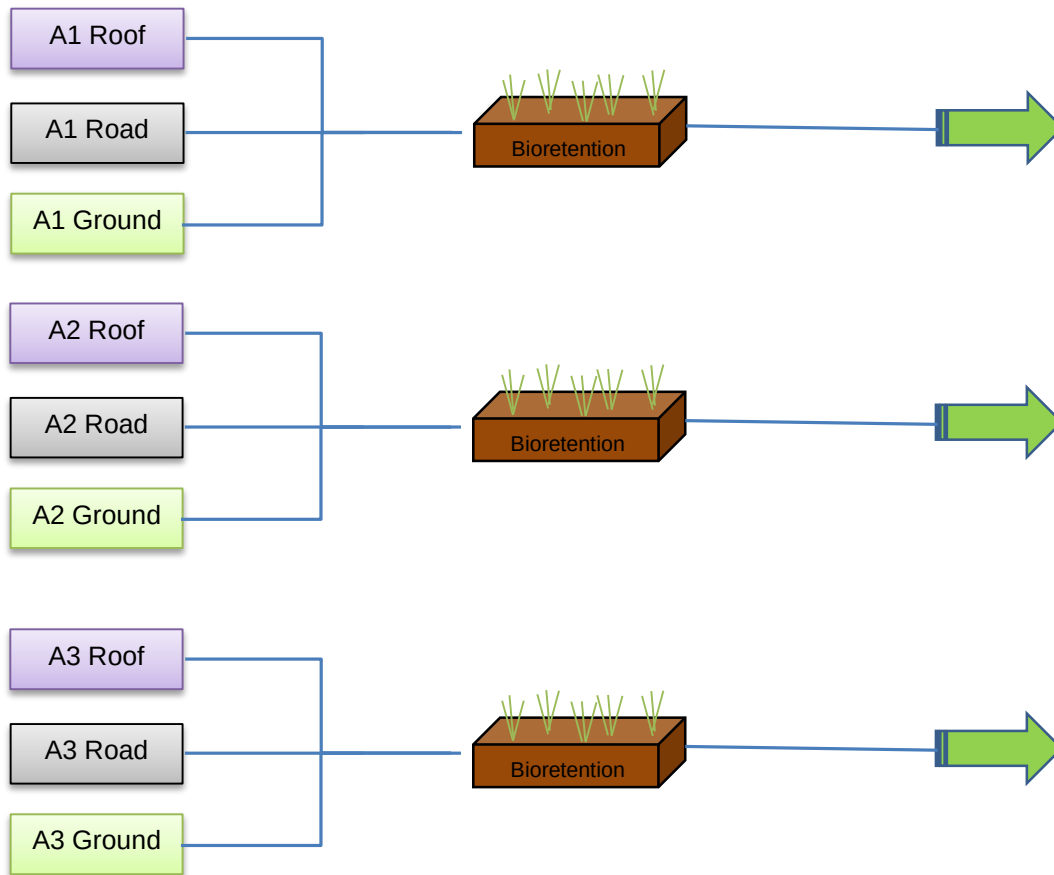


Figure 6.1 - Proposed Stormwater Treatment Train

6.2.1 Rainwater Tanks

As rainwater tanks are no longer mandatory as part of the Queensland Development Code (QDC), they have not been included within the proposed stormwater treatment train and the stormwater quality modelling for the site. It is noted however that that substantial reductions in potable water demand can be achieved if rainwater tanks are included onsite. Furthermore through the retention of and reuse of collected stormwater, reductions in the sizes of other treatment devices (such as bio-retention systems) can be achieved.

6.2.2 Bioretention System

Bioretention systems operate by filtering runoff through a soil media prior to discharge into the drainage system. These systems remove pollutants through a number of processes, including:

- Sedimentation in the extended detention storage;
- Filtration by the filter media;
- Nutrient uptake by biofilms;
- Nutrient adsorption and pollutant decomposition by soil bacteria; and
- Adsorption of metals and nutrients by filter particles (Somes & Crosby, 2007).

Water captured in the ponding area should be no more than 400 mm deep for a maximum of four (4) days to prevent anaerobic conditions, plant death and insect breeding.

Refer to Figure 6.2 (below) for typical a typical bioretention section presenting the different media components. Please note this is not for construction purposes.

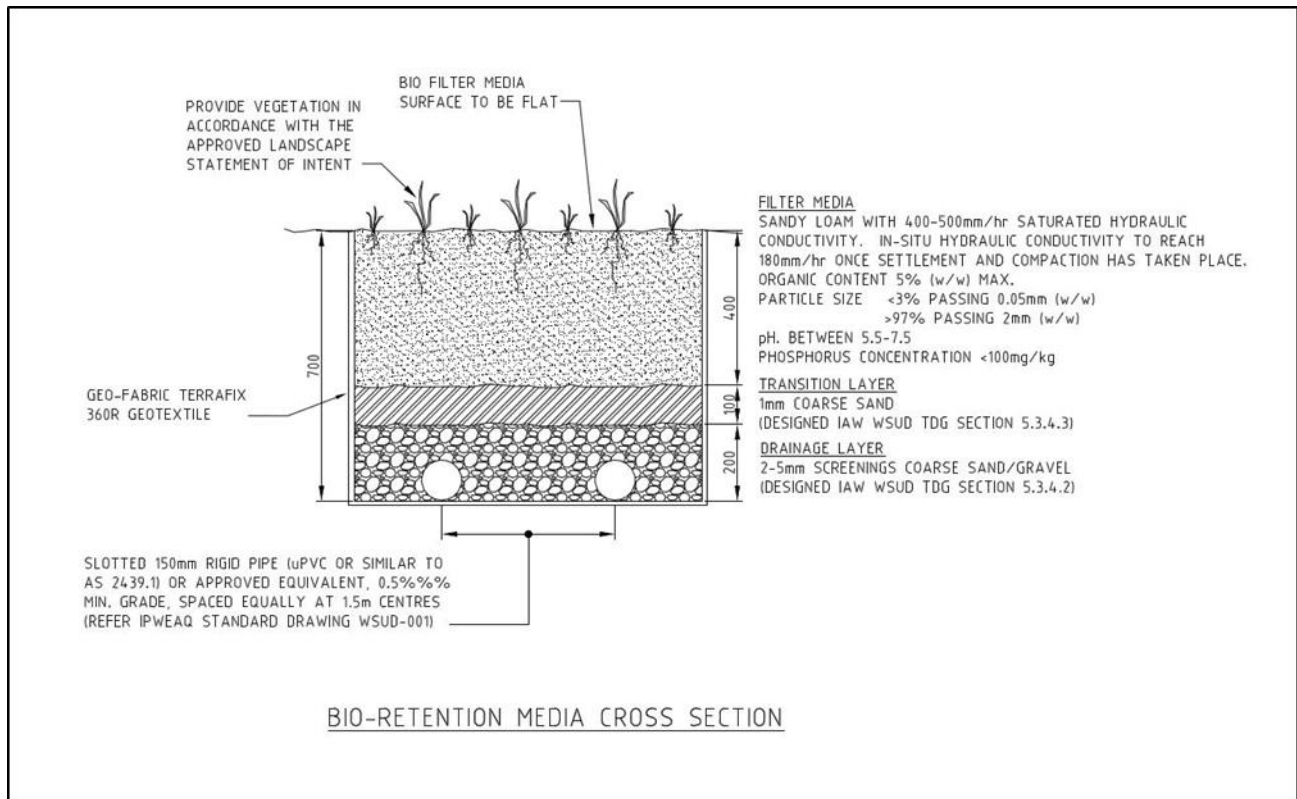


Figure 6.2 – Typical Bioretention Media Components

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PROJECT:

DEVEL. APPLIC. No. : -	DATE : 06.05.14
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PROJECT LEADER: LF

DESIGNER : AK

DRAFTSPERSON: AK

CHECKED : PB

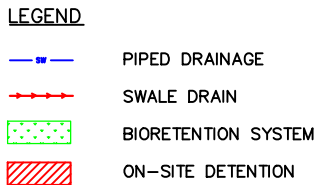
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GC130256	N400	A
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SCALE  (metres)
1 : 500 (FULL SIZE)

FILENAME: C:\Users\Anna\Documents\WORK\Burchillis\GC130256 - Heavy Industrial Estate, Moranbah (LMF)\Enviro\Dwgs Issued\GC130256-N400-A.dwg

7. Quality Analysis - MUSIC

Water quality modelling has been undertaken of the post-development (mitigated) scenario using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) software to demonstrate the load based reduction targets are achieved. A stormwater treatment train has been developed and modelled to determine the effectiveness of the proposed system in achieving the relevant water quality objectives

7.1 Rainfall and Evapotranspiration Parameter

MUSIC modelling was based on 6-minute interval data obtained from the Bureau of Meteorology (BOM) for the Mackay rainfall station, as summarised in Table 7.1.

Table 7.1 Meteorological and Rainfall Runoff Data Reporting Table

Input	Data Used in Modelling
Rainfall Station	33119 Mackay
Time Step	6 Minute
Modelling Period	01/01/1990 to 31/12/1999 (10 years)
Mean annual rainfall (mm)	1566
Evapotranspiration	1831
Rainfall runoff parameters	Industrial
Pollutant export parameters	Industrial

7.2 Catchment Parameters

Based on the proposed land uses within the development, the subject site has been modelled as an Industrial land use, as detailed in Table 7.2. The site catchment has been divided into roof, road and ground level source nodes based on the typical catchment splits provided in Tables 3.3 and 3.5 of the Water by Design MUSIC Modelling Guidelines (2010). The pollutant loads and runoff parameters for each source node are based on the data from the Water by Design MUSIC Modelling Guidelines (2010), as summarised in Table 7.4 and Table 7.5.

Table 7.2 Land Use Parameters

Catchment ID	Area (ha)	Land use	Total Impervious (%)
A1 – Roof	0.667	Industrial - Roof	100
A1 – Ground	0.133	Industrial - Ground Level	70
A1 – Road & Carpark	0.533	Industrial – Road & Carpark	100
A2 – Roof	0.667	Industrial - Roof	100
A2 – Ground	0.133	Industrial - Ground Level	70
A2 – Road & Carpark	0.533	Industrial – Road & Carpark	100
A3 – Roof	0.667	Industrial - Roof	100
A3 – Ground	0.133	Industrial - Ground Level	70
A3 – Road & Carpark	0.533	Industrial – Road & Carpark	100
TOTAL	4.0	-	-

Table 7.3 Rainfall Runoff Parameters

Parameter	All Nodes
Landuse	Industrial
Rainfall threshold (mm)	1
Soil storage capacity (mm)	18
Initial storage (% capacity)	10
Field capacity (mm)	80
Infiltration capacity coefficient a	243
Infiltration capacity exponent b	0.6
Initial depth (mm)	50
Daily recharge rate (%)	0
Daily baseflow rate (%)	31
Daily deep seepage rate (%)	0

Table 7.4 Pollutant load Parameters (Industrial)

Industrial	Total Suspended Solids (log mg/L)		Total Phosphorous (log mg/L)		Total Nitrogen (log mg/L)	
	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.
Storm Flow Concentration	1.30 ⁽¹⁾ 2.43 ⁽²⁾ 1.92 ⁽³⁾	0.44	-0.89 ⁽¹⁾ -0.30 ⁽²⁾ -0.59 ⁽³⁾	0.36	0.25	0.32
Base Flow Concentration	0 ⁽¹⁾ 0.78 ^(2,3)	0 ⁽¹⁾ 0.45 ^(2,3)	0 ⁽¹⁾ -1.11 ^(2,3)	0 ⁽¹⁾ 0.48 ^(2,3)	0 ⁽¹⁾ 0.14 ^(2,3)	0 ⁽¹⁾ 0.20 ^(2,3)

NOTE: (1) Values applied to "Roof" areas
(2) Values applied to "Road" areas
(3) Values applied to "Ground" areas

7.3 Treatment Node Parameters

The following sections describe the modelling parameters applied to MUSIC for each of the treatment nodes included as part of the water quality assessment.

7.3.1 Bioretention Parameters

Three (3) OSD/Bioretention systems have been proposed for each allotment capable of treating flows from the ground, road, and industrial lot areas. The input parameters for the bioretention system are summarised in Table 7.6 below.

Table 7.5 Bioretention Parameters

Catchment ID	Bioretention A1	Bioretention A2	Bioretention A3
Surface area (m ²)	375	375	375
Has the filter area been calculated appropriately?	Yes	Yes	Yes
Extended detention depth (m)	0.3	0.3	0.3
Filter area (m ²)	300	300	300
Unlined filter media perimeter (m)	0.01	0.01	0.01
Saturated hydraulic conductivity (mm/hour).	200	200	200
Filter depth (m)	0.4	0.4	0.4
TN content of filter media (mg/kg)	400	400	400
Orthophosphate content of filter media (mg/kg)	45	45	45
Is the base lined?	Yes	Yes	Yes
Effectiveness of plant TN removal	Effective	Effective	Effective
Overflow weir width (m)	7	7	7
Exfiltration rate (mm/hr)	0.00	0.00	0.00
If an exfiltration rate has been used, have node water balance losses been used in calculation of treatment train effectiveness?	N/A	N/A	N/A
If exfiltration rate has been used, is the exfiltration rate justified?	N/A	N/A	N/A
Underdrain present?	Yes	Yes	Yes
Submerged zone with carbon present?	No	No	No
Depth of submerged zone (m)	N/A	N/A	N/A
Confirmation that K and C* remain default?	Yes	Yes	Yes

7.4 MUSIC Results

7.4.1 Treatment Train Effectiveness

Results of the MUSIC modelling for the treatment train effectiveness are summarised in Table 7.7. The results indicate the 85%, 70%, 45% and 90% reduction target for TSS, TP, TN and gross pollutants respectively are achieved for the rainfall data set simulated. A screen capture of the MUSIC modelling results is included as Figure 7.1.

Table 7.6 Treatment Train Effectiveness

Point of Discharge	Pollutant	Source (kg/yr)	Residual (kg/yr)	Reduction (%)	Target	Target Achieved
A	TSS	12,000	1,280	89.4	85%	Yes
	TP	23.5	6.89	70.7	70%	Yes
	TN	135	56.4	58.1	45%	Yes

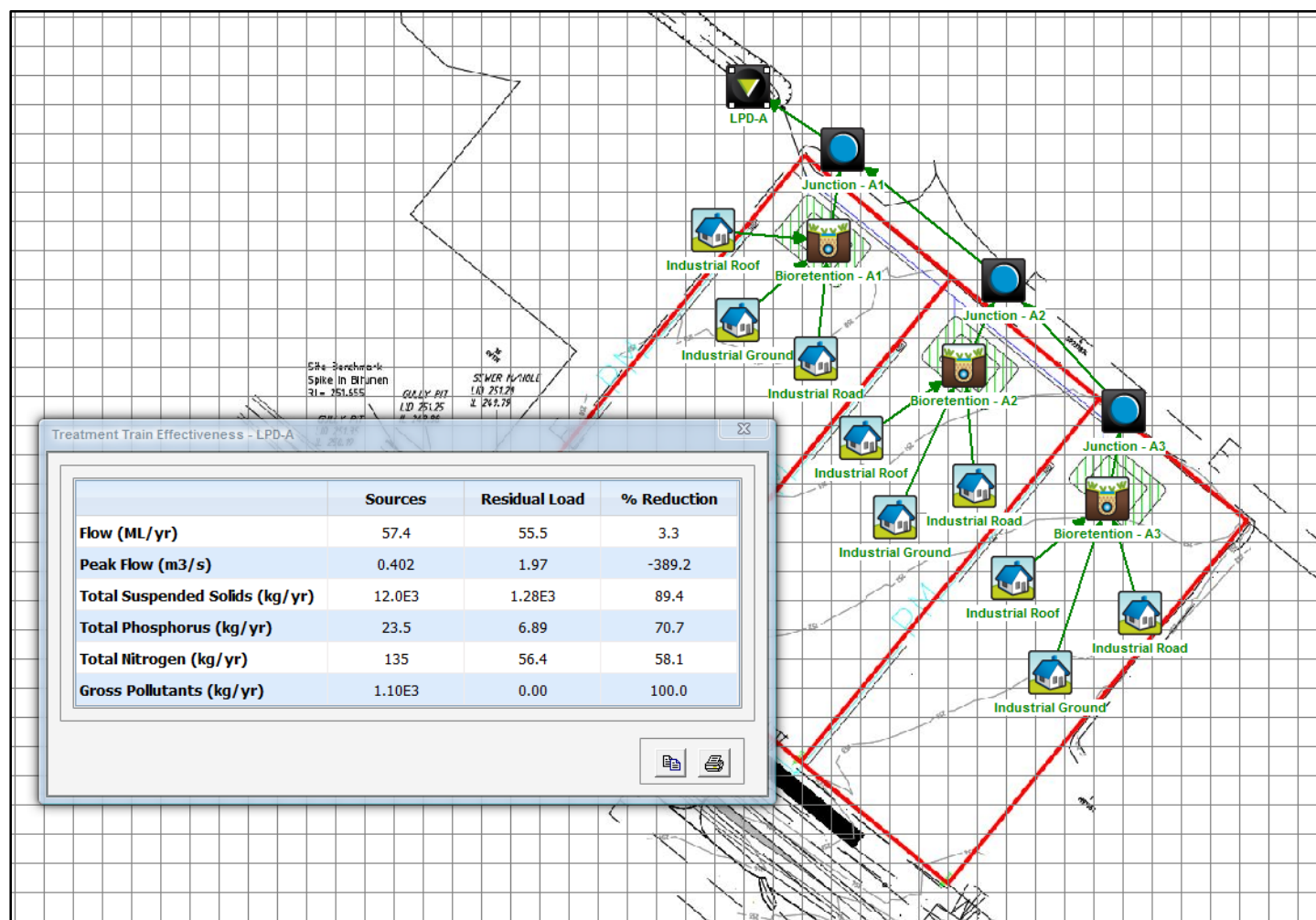


Figure 7.1 Treatment Train Layout and MUSIC Results

8. Water Quality Monitoring

To minimise the impact of the proposed changes on the external environment the proponent shall implement this SMP. This SMP shall be amended as required in response to the Monitoring and Maintenance Program described herein to avoid significant and/sustained deterioration in existing water quality of waterways downstream, when operational works are approved.

8.1 Construction Phase Monitoring

Prior to construction onsite, it is recommended the developer undertake a series of data collection exercises to define the existing stormwater quality. This will comprise the collection of water samples after the following rainfall events:

- 3 storm events of greater than 25mm; and
- 3 smaller rainfall events.

Samples will be analysed for total suspended solids (TSS), pH, dissolved oxygen (DO) and hydrocarbons with the results being used as water quality indicators for construction phase monitoring. Monitoring during the construction phase will be conducted to determine the impact of activities on the subject site only.

Monitoring sites:	At the outlet of any sediment basins or site discharge points.
Parameters:	TSS, pH, DO and hydrocarbons.
Frequency:	Following single rain events in excess of 25 mm per day during the construction phase.
Monitoring Procedures:	Sampling by the proponent in accordance with procedures set out in the Environmental Protection Authority's Water Quality Sampling Manual. A NATA registered laboratory will be used to perform the analysis of collected samples.
Corrective Actions:	TSS - Artificial flocculation will be applied on retained runoff to assist in the settling process. This will be completed via the application of Gypsum within 24 hours of the conclusion of each storm event and before any pumping out of the basin. Application of the Gypsum will occur by broadcasting it over the surface by hand, ensuring an even spread over the basin surface at a rate of 32kg per 100 m³ of water. pH – Addition of hydrated lime to raise the pH to an acceptable level. To be undertaken in accordance with the dosing rates specified in Table 5 of the State Planning Policy 2/02 Guideline – Acid Sulfate Soils. DO – Mechanical aeration until DO reaches a minimum of 6mg/L. Hydrocarbons – Locate source of hydrocarbons to prevent further contamination. Licensed waste contractor to be used to remove

contaminated water. If the source cannot be located, a floating boom may be required to contain any future spills.

Reporting: Monthly reports to be compiled upon request.

8.2 Operational Phase Monitoring

Monitoring during the operational phase will be undertaken to determine the impact of activities on the receiving waters. Surface water quality monitoring is to be undertaken at discharge points from the site. Water quality monitoring will be completed following rainfall events of 25mm or greater in any 24 hour period and on a monthly basis for a minimum period of 12 months, or as specified by the Local Authority conditions of approval for the development.

Monitoring sites: Outlet of treatment devices.

Parameters: TSS, Total-N and Total-P.

Frequency: Monthly following a single rain event in excess of 25 mm per day until the site is fully stabilised.

Monitoring Procedures: Sampling by the proponent in accordance with procedures set out in the Department of Environment and Resource Management (DERM) Monitoring and Sampling Manual. Alternatively calibrated probes may be used.

Reporting: Monthly reports to be compiled.

8.2.1 Investigation Indicators

The following indicators are used to identify if the objectives of the SMP are being met:

- Visible evidence of deterioration of baseline water quality of downstream watercourses that is directly attributable to the site;
- Pollutant concentrations that exceed the water quality objectives (TSS 90th Percentile all other analytes 80th percentile);
- Visible significant erosion; and/or
- Failure of control measures.

The triggering of an investigation indicator will require the following remedial actions:

- Locate source of water quality deterioration;
- Prevent continuing deterioration with temporary controls;
- Repair existing controls, construct additional controls or modify procedures to prevent future deterioration in water quality; and
- During the operational phase of the development, if there is a significant deterioration in water quality, the management plan and strategies will be reviewed.

9. Conclusion

This study has reviewed the hydrology and hydraulics of the site for pre-development and post-development scenarios and investigated the impact of the proposed development on downstream properties and receiving waters. Several alternative stormwater management strategies were examined in consultation with the project manager. The agreed strategy is documented in this report.

Based on this study the following conclusions have been drawn:

- Pre-development peak discharges are maintained from the site, therefore the proposed development will not adversely impact downstream properties;
- On-site detention storage will be provided within three (3) basins above the bioretention treatment component located within north portions of each industrial allotment. A total of 1,695 m³, of detention storage will be required at the peak water depth for mitigation of the Q100 ARI event;
- The Water Quality Objectives specified in the Queensland Water Quality Guidelines (2009) are achieved for all pollutants; and
- Water sensitive urban design features are incorporated into the open space areas. Stormwater runoff from each allotment will be conveyed to three (3) bioretention systems each with 300 m² (at 0.4 m depth) of filter treatment area.

10. References

The information presented herein has been prepared with reference to the following:

- Department of Environment and Resource Management 2009, Monitoring and Sampling Manual, September 2009.
- Department of Environment and Resource Management 2009, Queensland Water Quality Guidelines, September 2009.
- Department of Environment and Resource Management (2010), Planning Guidelines for Water Supply and Sewerage, 2010.
- DesignFlow 2010. *Burnett-Mary Stormwater Quality Modelling – Development of Rainfall datasets*.
- Healthy Waterways 2006, WSUD Technical Guidelines for South East Queensland.
- Water by Design, 2009. *Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands*, South East Queensland Healthy Waterways Partnership, Brisbane, Queensland.
- Water by Design, 2010. *MUSIC Modelling Guidelines*. South East Queensland Healthy Waterways Partnership, Brisbane, Queensland
- Water by Design, 2010. *Deemed to Comply Solutions – Stormwater Quality Management (South East Queensland)*, South East Queensland Healthy Waterways Partnership, Brisbane, ISBN 978-0-9806278-2-4.

Appendix A – Time of Concentration and Rational Methods Calculations

Pre-Development Hydrology

The natural hydrology of the site has been assessed in accordance with QUDM 2008 Section 4.06.3. The time of concentration for all catchments has been determined using Friend's Equation as per QUDM Table 4.06.3, combined with a channel time flow calculation.

Friend's Equation $t_c = (107nL^{0.333})/S^{0.2}$

Table A1 presents a summary of the catchment parameters used within Friend's Equation and the calculated time of concentration for the pre-development scenario.

Table A1 – Time of Concentration for Pre-Development Scenario

Catchment ID	Pre A	LPD A
Overland Flow		
Estimated Sheet flow Length (Table 4.06.3)	100	100
Horton's Roughness Value	0.035	0.035
Slope (%)	1.7	1.7
tc (minutes)	15.61	15.61
Channel/Creek Flow		
Length of channel flow (m)	166	166
Velocity (m/s)	0.7	0.7
tc (minutes)	3.95	3.95
TOTAL tc (minutes)	19.56	19.56

Post-Development Hydrology – Unmitigated

The total time of concentration calculated for the subject site contains a standard inlet time of 5 minutes and pipe flow time. Table A2 presents a summary of the catchment parameters used for the calculated time of concentration for the post-development scenario.

The time of concentration for the external catchment is presented in Table A1 above.

Table A2 – Time of Concentration for Post-Development Scenario

Catchment ID	Post A1-A3	LPD A
Standard Inlet time (minutes)	5	5
Estimated Sheet flow Length (Table 4.06.3)	-	-
Horton's Roughness Value	-	-
Slope (%)	-	-
tc (minutes)	-	-
Pipe Flow		

Slope (%)	0.5	0.5
Length of pipe flow (m)	20	146
Velocity (m/s)	1	1
tc (minutes)	0.33	2.43
Channel/Creek Flow		
Length of channel flow (m)	-	-
Velocity (m/s)	-	-
tc (minutes)	-	-
TOTAL tc (minutes)	5.33	7.43

Design storm event flows across the site were derived using the Rational Method as per the above-mentioned manuals. This involved:

- Determination of a C10 value (derived in accordance with QUDM Table 4.05.3(b)). A value of 0.53 was applied to the pre-development catchments and 0.86 were applied to the post-development catchments;
- Derivation of design rainfall using IFD data for Moranbah; and
- Calculation of design flows through the site for Q100, Q50, Q20, Q10, Q5, Q2 and Q3month, where Q3month is deemed to be 50% of Q1.

Summaries of the hydrologic calculations are contained in Table A3 and Table A4 for pre and post-development (un-mitigated) scenarios respectively.

Table A3 Pre-Development Hydrology

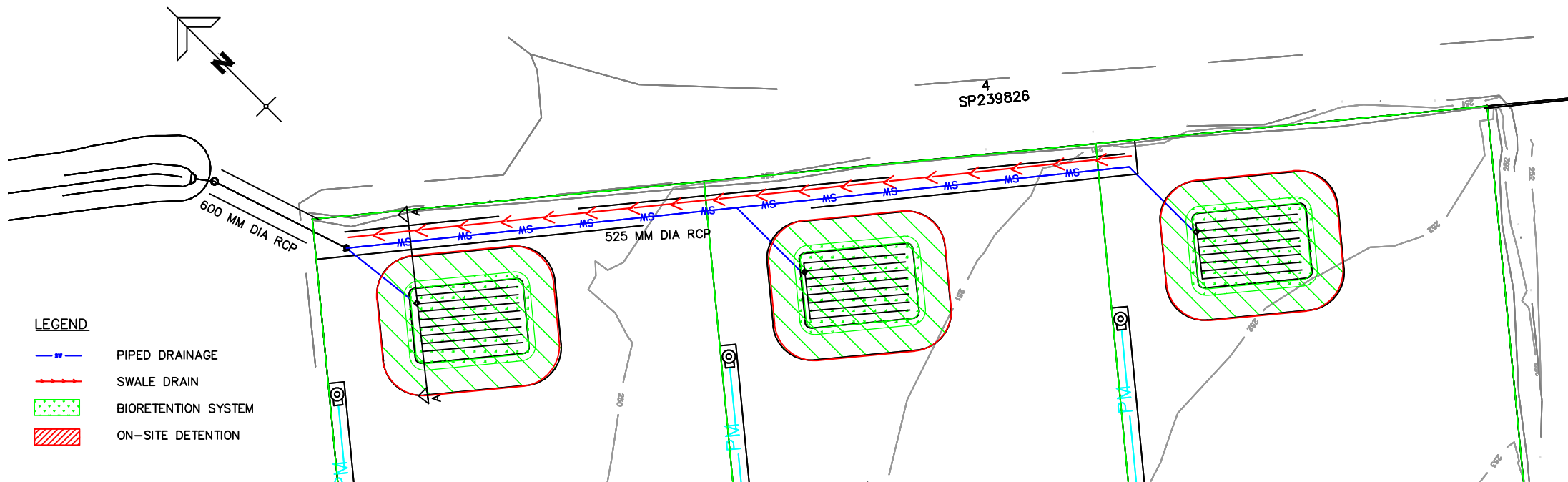
Catch.	Area (ha)	tc (min)	I100 (mm/hr)	C	Q100 (m³/s)	I50 (mm/hr)	C	Q50 (m³/s)	I20 (mm/hr)	C	Q20 (m³/s)	I10 (mm/hr)	C	Q10 (m³/s)	I5 (mm/h)	C	Q5 (m³/s)	I2 (mm/hr)	C	Q2 (m³/s)	I1 (mm/h)	C	Q0.25 (m³/s)
A	4.00	19.56	152.00	0.64	1.07	138.00	0.61	0.93	119.00	0.56	0.74	105.00	0.53	0.62	94.90	0.50	0.53	77.10	0.45	0.39	60.80	0.42	0.14
LPD A	4.00	19.56	152.00	0.64	1.07	138.00	0.61	0.93	119.00	0.56	0.74	105.00	0.53	0.62	94.90	0.50	0.53	77.10	0.45	0.39	60.80	0.42	0.14

Table A4 Un-Mitigated Post-Development Hydrology

Catch.	Area (ha)	tc (min)	I100 (mm/hr)	C	Q100 (m³/s)	I50 (mm/hr)	C	Q50 (m³/s)	I20 (mm/hr)	C	Q20 (m³/s)	I10 (mm/hr)	C	Q10 (m³/s)	I5 (mm/hr)	C	Q5 (m³/s)	I2 (mm/hr)	C	Q2 (m³/s)	I1 (mm/hr)	C	Q0.25 (m³/s)
A	1.33	5.33	268.67	1.00	1.00	241.39	0.99	0.88	206.22	0.9	0.69	179.67	0.86	0.57	160.11	0.82	0.48	127.09	0.73	0.34	99.16	0.69	0.13
A2	1.33	5.33	268.67	1.00	1.00	241.39	0.99	0.88	206.22	0.9	0.69	179.67	0.86	0.57	160.11	0.82	0.48	127.09	0.73	0.34	99.16	0.69	0.13
A3	1.33	5.33	268.67	1.00	1.00	241.39	0.99	0.88	206.22	0.9	0.69	179.67	0.86	0.57	160.11	0.82	0.48	127.09	0.73	0.34	99.16	0.69	0.13
LPD A	4.00	7.43	266.79	1.00	2.96	239.70	0.99	2.63	204.77	0.9	2.05	178.39	0.86	1.70	158.95	0.82	1.44	126.16	0.73	1.02	98.43	0.69	0.38

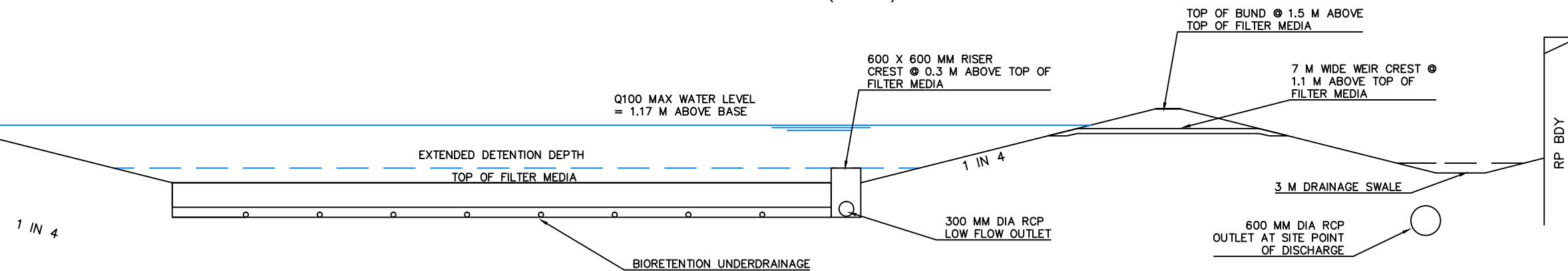
Appendix B – Typical OSD/Bioretentoin Section

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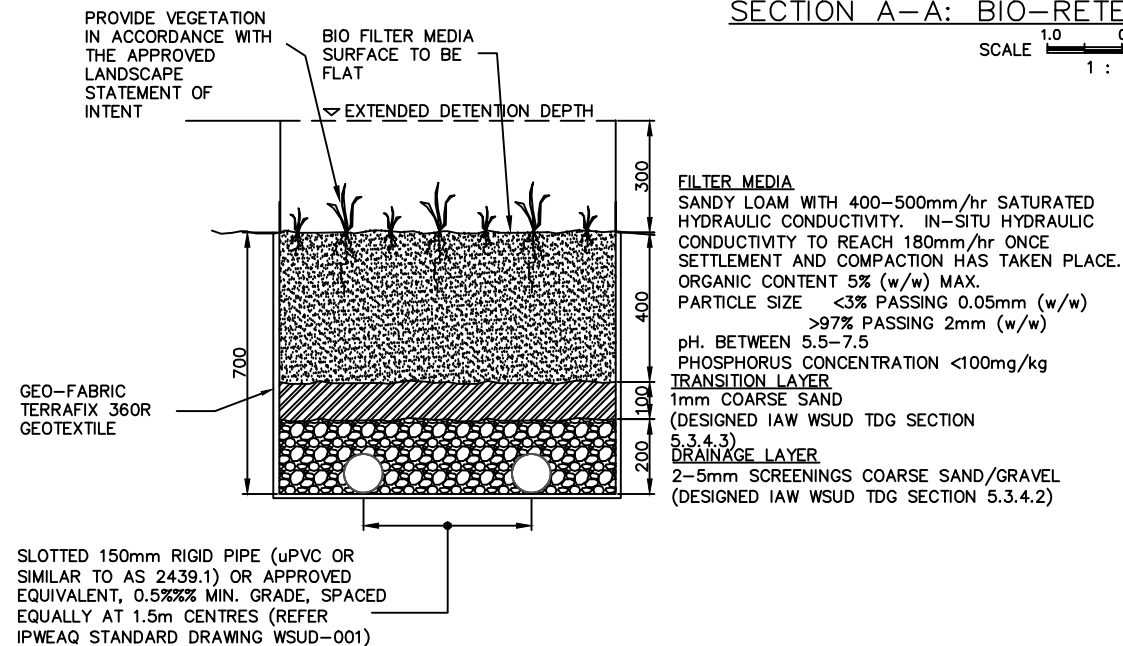
BIO-RETENTION/OSD BASIN PLAN VIEW

SCALE 0 5 10 15 20 25 (metres)
1 : 500 (FULL SIZE)



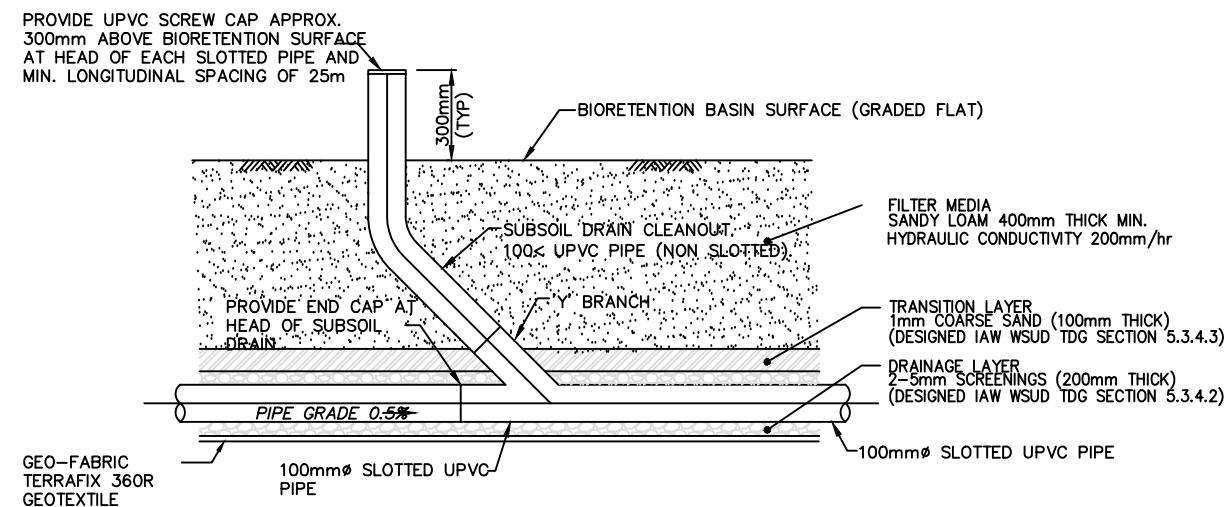
SECTION A-A: BIO-RETENTION/OSD BASIN A1-A3 TYPICAL DETAIL

SCALE 1.0 0 1.0 2.0 (metres)
1 : 50 (FULL SIZE)



BIO-RETENTION MEDIA CROSS SECTION

N.T.S.



BIO-RETENTION BASIN SUBSOIL DRAIN CLEANOUT

N.T.S.

INDUSTRIAL
ESTATE

GOONYELLA
RD

FOR

ISAAC
REGIONAL
COUNCIL

A1 ORIGINAL SIZE BEFORE REDUCTION

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PROJECT:

DRAWING TITLE:
APPENDIX B -
BIORETENTION/OSD BASIN
TYPICAL SECTIONS

DEVEL. APPLIC. No.:	-	DATE:	06.05.14
PROJECT LEADER:	LF		
DESIGNER:	AK		
DRAFTSPERSON:	AK		
CHECKED:	PB		
APPROVED FOR AND ON BEHALF OF BURCHILLS ENGINEERING SOLUTIONS ABN 76 166 942 365			
RPEQ No.:			
SCALE:	AS NOTED	DATUM:	AHD
PROJECT No.:	GC130256	FULL SIZE:	A1
DRAWING No.:	N401	VERSION:	A