ARCADIS Design & Consultancy for natural and built assets

4499 – 4651 MOUNT LINDESAY HIGHWAY, NORTH MACLEAN

Site Based Stormwater Quality Management Plan

15 AUGUST 2023

PLANS AND DOCUMENTS
referred to in the
PDA DEVELOPMENT APPROVAL
Approval no.: **DEV2018/961/8**
Date: **27/09/2023**

Queensland Government

Incorporating Hyder

CONTACT

DARLAN CASTRO
Principal Engineer

T + 61 7 5503 4822
M + 61 410 720 757
E darlan.castro@arcadis.com

GARY ELLIS
Technical Director

T + 61 7 3337 0859
M + 61 41 817 290
E gary.ellis@arcadis.com

THEA FANNING
Civil Engineer

T + 07 3337 0803
M + 61 405 972 982
E thea.fanning@arcadis.com

ARCADIS Design & Consultancy for natural and built assets

Arcadis
Level 35, 111 Eagle Street
Brisbane City, QLD 4000

CHARTER HALL PRIME INDUSTRIAL FUND 4499-4651 MOUNT LINDESAY HIGHWAY, NORTH MACLEAN

Site Based Stormwater Quality Management Plan

Author	Thea Fanning	
Checker	Brook Kitson	
Approver	Darlan Castro RPEQ 19918	
Report No	EAG003-30109334-AAR	
Date	15/08/2023	
Revision Text	4	

REVISIONS

Revision	Date	Description	Prepared by	Approved by
01	31/01/2023	DRAFT Issue	TF	DC
02	13/02/2023	For Approval	EP	DC
03	22/06/2023	Response to RFI	TF	DC
04	15/08/2023	ROL Update	TF	DC

CONTENTS

APPENDICES

APPENDIX A

Functional Layout Plan

APPENDIX B

Engineering Drawings and Site Topography

APPENDIX C

Existing Approval Decision Notice

APPENDIX D

Construction and Establishment Guidelines – Swales, Bioretention Systems and Wetlands.

APPENDIX E

Water by Design "Maintaining Vegetated Assets"

APPENDIX F

Water by Design – Inspection and Maintenance Checklist for Bioretention Systems

1 EXECUTIVE SUMMARY

Arcadis has been engaged by Charter Hall Prime Industrial Fund to prepare a Site Based Stormwater Quality Management Plan (SBSQMP) for the proposed industrial development, situated at 4499-4651 Mount Lindesay Highway, North Maclean. The site is located in the Greater Flagstone Priority Development Area located within the Logan City Council local government area. On 21 September 2021, the Minister for Economic Development Queensland (EDQ) granted approval for a PDA development application over the site for a Development Permit for Reconfiguring a Lot – 1 into 4 lots, plus roads and open space. The proposed development seeks approval to amend this PDA development approval for a Development Permit for the reconfiguring a lot - one (1) lot into eleven (11) lots and new roads, consisting of five super lots and six auxiliary lots, comprising drainage, open space and a sewer pumpstation.

This report demonstrates the proposed development will be constructed and operated in accordance with the Water Sensitive Urban Design (WSUD), requirements of Council, the South-East Queensland State Planning Policy (SPP), the Queensland Development Code, the Queensland Urban Drainage Manual (QUDM) Economic Development Queensland (EDQ) PDA guidelines and the Environmental Protection (Water) Policy (2009). This report also demonstrates the proposed amendment will not result in substantially different development to the existing approval.

The primary objective of this SBSQMP is to ensure that:

1. Details of a proposed stormwater quality treatment train are provided to ensure the discharge of stormwater from the site is of adequate quality standards to comply with the requirements of Economic Development Queensland (EDQ), Logan City Council (LCC) and the State Planning Policy 2017 (SPP 2017).

A stormwater quality assessment is provided which demonstrates that a specially tailored treatment system will be required to satisfy the pollutant removal targets of LCC and the South-East Queensland Healthy Waterways Partnership during the operational phase of the proposed development.

A regional bio-retention system has been proposed to treat stormwater runoff from Lot 1 and a portion of the circulation roadway (INTNL-1). Bio-retention pods are to be incorporated into the road reserves to treat stormwater runoff from the new roads. Individual water quality treatment plans are to be provided and implemented for Lots 2 – 5 (Catchments INTNL-2A - INTNL-4C) upon development. Additional filter media has been added to the northern regional bio-retention system to allow for the compensatory offset treatment of the flows from Crowson Lane and external properties to the north in place of treating runoff from the eastern portion of the Powerlink easement (Catchment INTNL-3C). This compensatory offset approach is necessary as Powerlink will not permit infrastructure such as water quality device to be located in the easement corridor and it is impractical to externally treat associated runoff elsewhere within the development footprint.

1.1 Revision 03

Revision 03 of this report has been prepared in response to Item E(d) of the Further Clarification email received from Mr Manjurul Alam of EDQ on Friday 31 March 2023, related to the Compliance Assessment for Conditions 21, 23 and 24 of the Decision Notice received for the PDA Development Permit for reconfiguring a lot – 1 lot into 4 lots, plus roads and open space. A review of the site grading has revealed that the western portion of the Powerlink Easement grades north-east as such has been included in Catchment INTNL-2B and will be treated accordingly.

Further discussion has been provided regarding the compensatory catchment treatment.

1.2 Revision 04

Revision 04 of this report has been prepared to support the amended ROL application, increasing the number of proposed allotments from four (4) to eleven (11) and new roads, consisting of five super lots and six auxiliary lots, comprising drainage, open space and a sewer pumpstation. The proposed amendments to the existing ROL development approval do not result in substantially different development from a stormwater management perspective. Minor changes were made to the MUSIC modelling as a result of this amendment.

2 INTRODUCTION

Arcadis has been engaged by Charter Hall Prime Industrial Fund to prepare a Site Based Stormwater Quality Management Plan (SBSQMP) for the proposed industrial development situated at 4499 - 4651 Mount Lindesay Highway, North Maclean. The site is situated within the Greater Flagstone Priority Development Area (PDA) located within the Logan City Council (LCC) local government area.

On 21 September 2021, the Minister for Economic Development Queensland (EDQ) granted approval for a PDA development application over the site for a Development Permit for Reconfiguring a Lot – 1 into 4 lots, plus roads and open space. The proposed development seeks approval to amend this PDA development approval for a Development Permit for the reconfiguring a lot - one (1) lot into eleven (11) lots and new roads, consisting of five super lots and six auxiliary lots, comprising drainage, open space and a sewer pumpstation. The proposed amended ROL layout is shown in Figure 2-1, below.

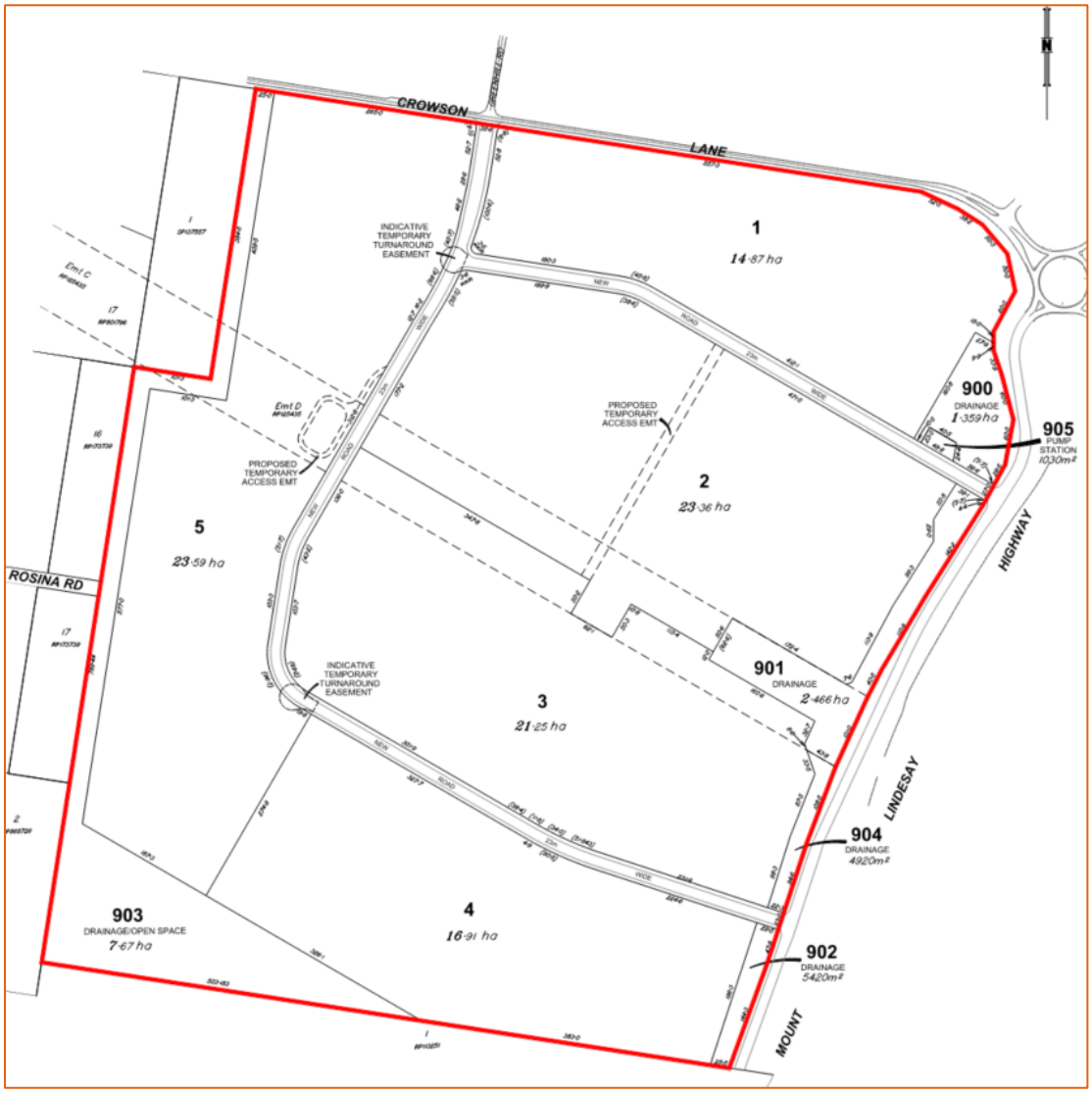


Figure 2-1 – Proposed Amended ROL Layout (Source: Wolters, August 2023)

The following report demonstrates the proposed development will be constructed and operated in accordance with the Water Sensitive Urban Design (WSUD) requirements of Council, the Queensland State Planning Policy (SPP 2017), the Queensland Development Code, the Queensland Urban Drainage Manual (QUDM), Economic Development Queensland (EDQ) PDA guidelines and the Environmental Protection (Water) Policy (2009) with respect to the attenuation of stormwater runoff from both quality and quantity perspectives. This report also demonstrates the proposed amendment will not result in substantially different development to the existing approval.

3 SITE CHARACTERISTICS

3.1 Site Description

The subject site is located within Logan, South-East Queensland, Australia on the following lot:

- Lot 39 on SP258739 (4499-4651 Mount Lindesay Highway, North Maclean)

The site in generally bounded by the following co-ordinates (GDA94 / MGA zone 56)

- South-West: 500708, 6928700
- North-East: 501974, 6929628

The proposed area for the development is approximately 117.9ha.

3.2 Existing Land Usage

The site is predominantly vegetated with cleared areas relating to the existing residential dwelling and associated land use and High Voltage Electrical Power transmission lines and towers.

The site currently has direct property frontage to Mount Lindesay Highway to the east, predominantly trees and vegetation to the south and rural residential developments to the north and west. A MEDQ Approved context plan published 10 September 2021 includes the subject site. The site is approved for specific land use "*Industry and Business Zone*" with overlay for indicative future bio-diversity corridor. An existing high voltage easement running through the site from the south into the existing rural residential dwelling to the north. A further high voltage (275kV) easement runs through the site within the cleared area.

A site locality plan is provided in Figure 3-1 below:

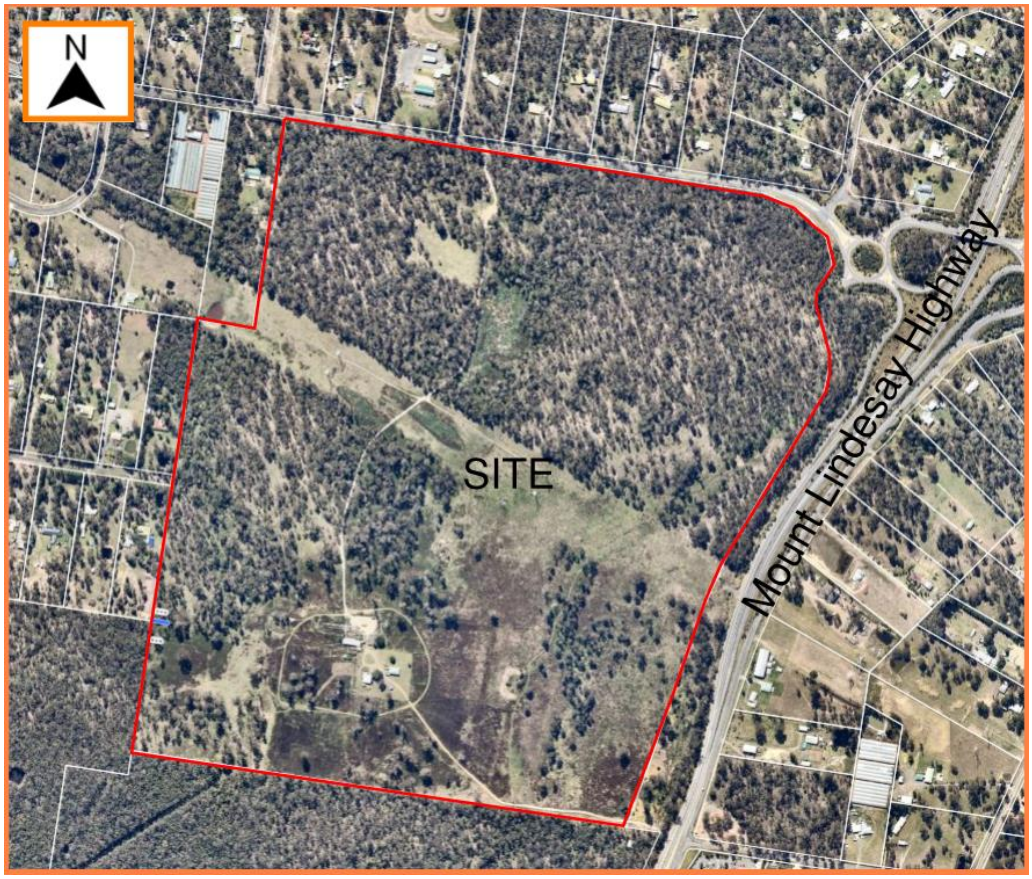


Figure 3-1- Development Locality Plan (Source: NearMap, June 2022)

3.3 Existing Topography and Site Drainage

In its current state, a ridge traverses the development site from the north-western corner to the southern site boundary, with further undulations dividing the site into three sub-catchments, as shown in Figure 3-2. The northern catchment slopes east at an average of 2% from RL44.0 to a culvert with a minimum invert level of RL20.90 which allows flows to pass beneath Mount Lindesay Highway to the opposite side. From here, water is ultimately discharged east of Mount Lindesay Highway towards the Logan River located approximately 1.1kmn east of the site.

The western portion of the site slopes south from RL44.0 to RL26.5 at an average grade of 1.6%. An overland flow path commences in this portion of the site, exiting the site across the southern boundary before re-entering the site in the east through the third catchment area. The overland flow path flows north-east to the abovementioned culverts. The third catchment area site also slopes to this culvert at an average grade of 1.2%.

Figure 3-2- Internal Catchment Plan (Source: NearMap, June 2022)

Stormwater runoff from upstream external catchments enter the site from the north, south and west. The extent of the external catchments are shown in Figure 3-3.

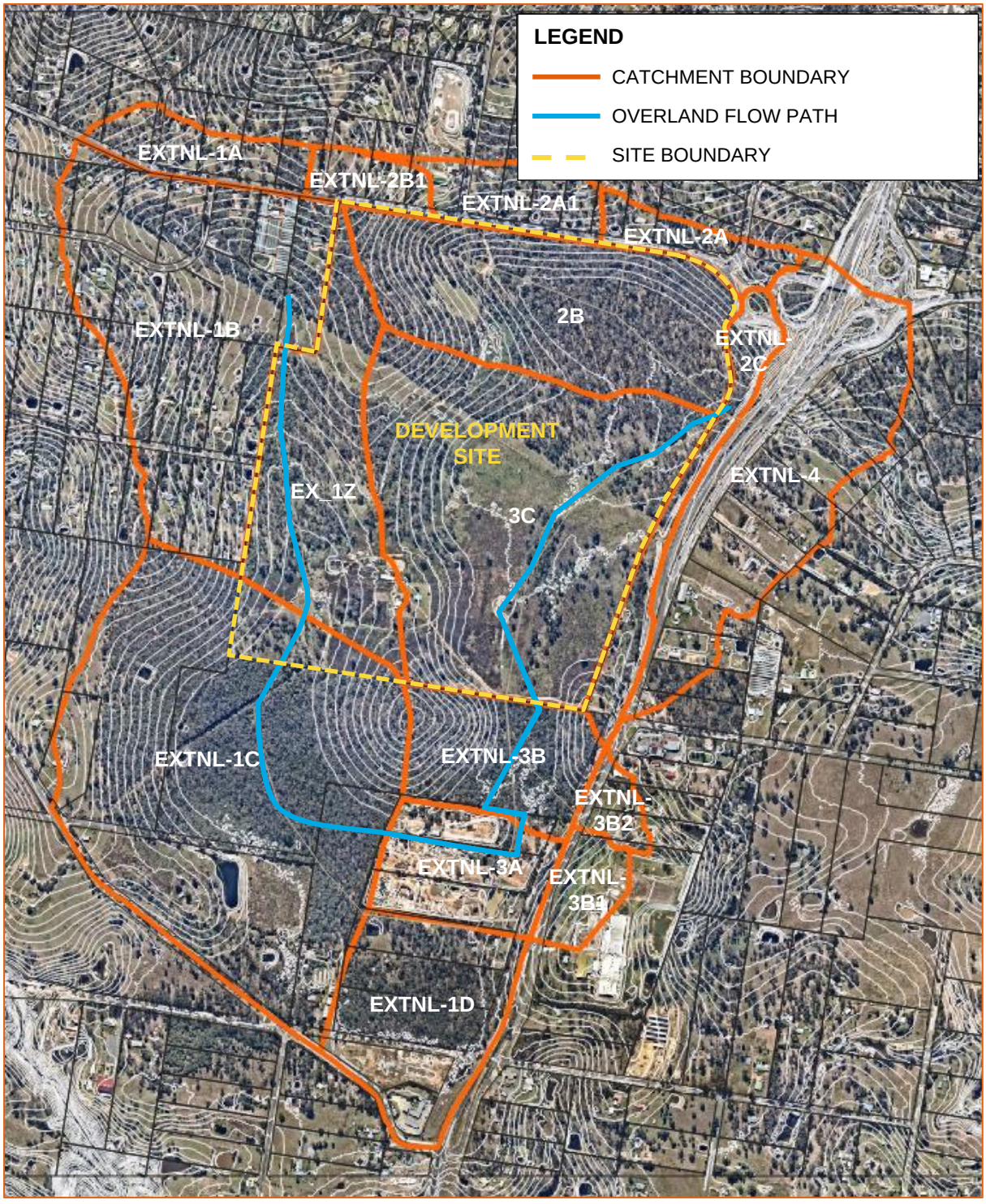


Figure 3-3: Existing Catchment Plan

3.3.1 Existing Approvals

It is understood that the existing EDQ approval (DEV 2018/961) over the site is for a reconfiguring a lot – 1 lot into 4 lots, plus roads and open space. As part of this approval Operational Works Approvals have been awarded, these works include:

- Construction of a service road along the western side of the Mount Lindesay Highway accessed via the existing Crowson Lane / Mount Lindesay Highway off ramp roundabout;

- Construction of a trunk rising sewer main running through the existing electrical main of the proposed development, ending at Greenbank Road.
- Connection to existing potable water mains along Crowson Lane and the Mount Lindesay Highway
- Proposed stormwater infrastructure;
- Construction of internal roads; and
- Proposed connection to existing underground electrical and telecommunication services along Crowson Lane and the Mount Lindesay Highway.

Further details on the works associated with the adjacent approval can be found within the relevant Decision Notice attached within Appendix C. The approved EDQ Context Plan is shown below in Figure 3-4 below.

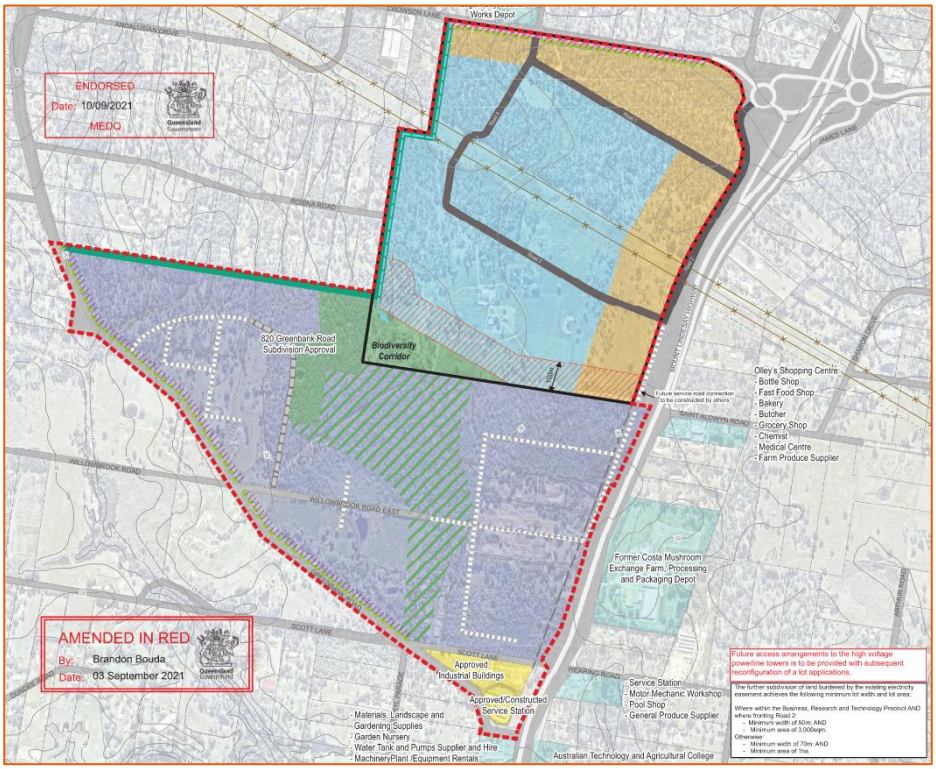


Figure 3-4- North Maclean Enterprise Context Plan (Source: Reel Planning, September 2021)

3.3.2 Geotechnical Investigation

A geotechnical investigation was completed separately by Protest Engineering in October 2021. Borehole testing revealed the ground profile generally comprises of silty sand (Emerson Class 6) up to 0.6m depth, overlaying silty/sandy clay up to 4m depth followed by low to high strength sandstone. Groundwater was not encountered during the investigation; however, Protest Engineering noted that groundwater levels can be seasonal and fluctuate during and after heavy rainfall events. Refer to Protest Engineering Report PTP/07651-0001-Rev3 for further details.

3.4 Existing Stormwater Infrastructure

Limited stormwater drainage infrastructure is present within the vicinity of the development site. A set of culverts is situated near the eastern property boundary discharging stormwater under the Mount Lindsay Highway and ultimately towards the Logan River located approximately 1.1kmn east of the site. The culverts comprise two 1.75m high, 2.1m wide reinforced concrete box culverts at RL21.09m AHD, between which sit two 1.75m high, 2.1m wide reinforced concrete box culverts at RL20.90m AHD

Smaller culverts are present within Crowson Lane, directing stormwater runoff from the northern upstream catchments beneath the road and discharging into the subject site. The pipes vary in size from approximately 375mm dia to 4 x 675mm dia.

4 DISCHARGE LOCATIONS

4.1 Pre-Developed Discharge Characteristics

As previously outlined in this report, the site in its pre-developed state consists of multiple catchments, discharging via concentrated flows into either local flood plain area to the south (Catchment EX_1Z) and/or ultimately to the highway infrastructure to the east (Catchments 2B and 3C).

4.2 Proposed Discharge Characteristics and Objectives

The proposed development will retain the existing discharge locations. To comply with the Water Sensitive Urban Design (WSUD) requirements of Council, the Queensland Development Code and the Environmental Protection (Water) Policy (2009), the following primary objective is to be achieved:

- suitable treatment train measures are determined and are either future infrastructure or incorporated in the development to achieve required water quality objectives.

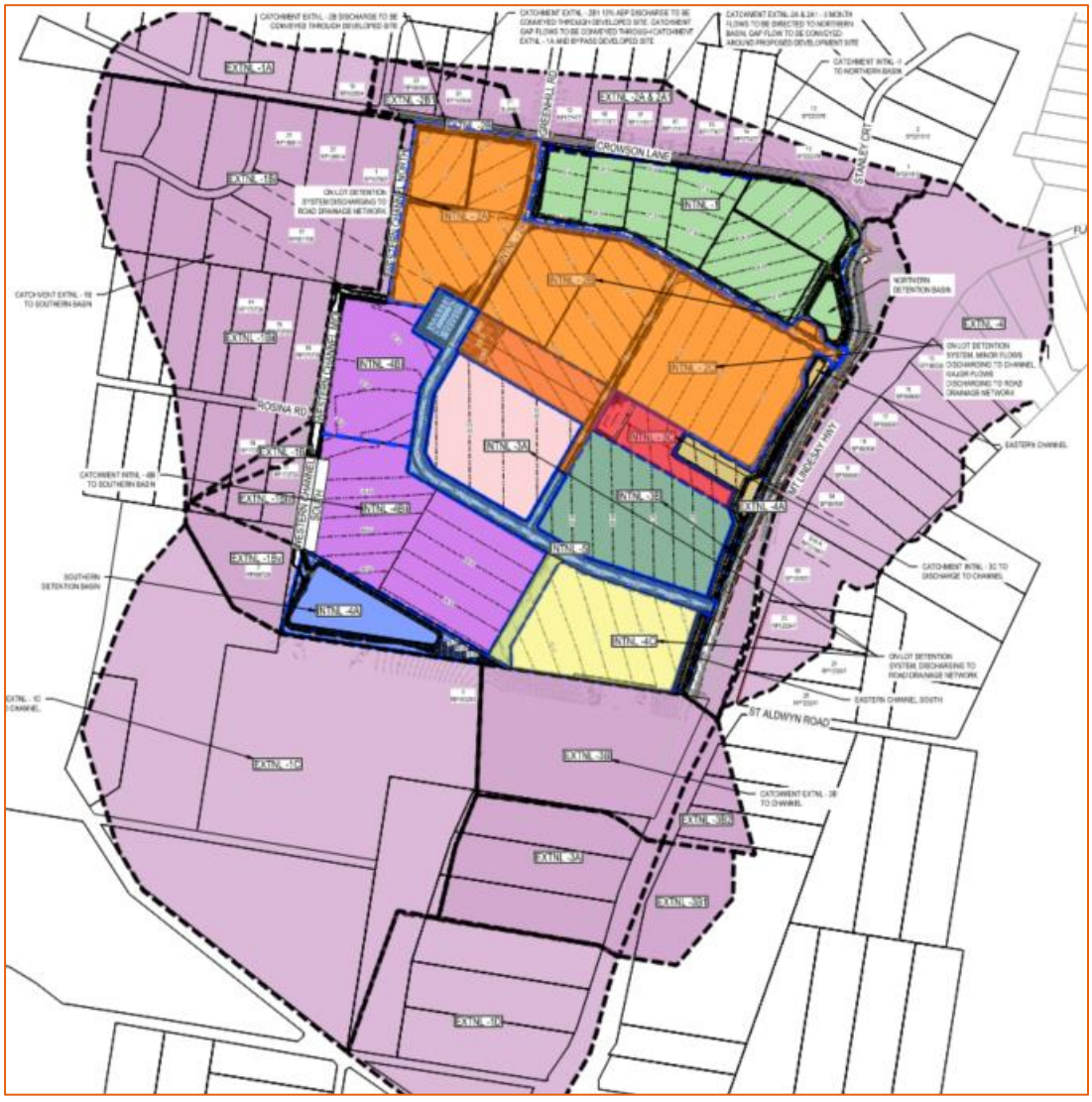


Figure 4-1: Stormwater Catchment Plan

5 ENVIRONMENTAL VALUES AND WATER QUALITY OBJECTIVES (WQO)

Water quality parameters and the proposed limits applicable for this site have been selected in accordance with South-East Queensland Healthy Waterways Partnership's Water by Design MUSIC Modelling Guidelines – Consultation Draft (Version 3, 2018). The Water Quality reduction targets stipulated by the State Planning Policy are presented in Table 5-1.

Table 5-1 Water Quality Operational Phase Performance Criteria

Pollutant	Criteria
Total Suspended Solids	80%
Total Phosphorus	60%
Total Nitrogen	45%
Gross Pollutants	90%

5.1 Stormwater Quality Treatment Approach

Bioretention systems are proposed for inclusion within the development layout to treat stormwater runoff from the internal road reserve and Catchment INTNL-1 as well as EXTNL-1A and EXTNL-1B in place of the eastern portion of the Powerlink Easement (INTNL-3C). Site specific SBSMPs will be required to accompany MCU applications for INTNL-2A - INTNL-4C to formulate an appropriate allotment specific stormwater treatment train and will not be addressed in this report. Please note that onus for treating the western portion of the Powerlink Easement has been delegated to INTNL-2B.

Stormwater runoff from Lot 1 (INTNL-1) and external catchments 1A and 1B (EXTNL-1A and EXTNL-1B) will be treated by the Northern Bio-retention Basin. Rainwater tanks are to be included in each allotment for the harvesting of roof water runoff which is to be reused across each lot through irrigation and toilet flushing. It has been assumed that half of each roof catchment is directed to the tanks.

Bio Pods are to be included in the internal road layout at a maximum of 100m intervals to treat stormwater runoff from the road reserve. The internal road is an Industrial Connector with an asymmetrical cross-section. The carriage way is crowned with two 4.0m wide traffic lanes centred either side of the crown, each with an adjacent 2.5m wide parking lane. The verge on the narrow side of the cross-section has a 4.5m wide verge with a 1.5m wide footpath. The wider side of the cross-section has a 5.5m wide verge with a 2.5m wide combined footpath and cycle way.

As the road is crowned, the catchment to each bio pod will consist of a half road catchment. Two half road catchments have been modelled in MUSIC to reflect the different footpath widths and corresponding fraction impervious.

Table 5-2 provides stormwater sub-catchment pervious/impervious area information modelled in MUSIC.

Table 5-2 Stormwater Catchments Areas

Catchment Name	Roof Area to Bio		Roof Area to Tank		Road Area		Ground Area	
	[Ha]	% impervious	[Ha]	% impervious	[Ha]	% impervious	[Ha]	% impervious
INTNL-1	3.358	100%	3.359	100%	4.505	100%	2.361	10%
Industrial Half Road – 2.5m Wide Footpath, 100m Road Length	-	-	-	-	0.120	76%	-	-
Industrial Half Road – 1.5m Wide Footpath, 100m Road Length	-	-	-	-	0.110	75%	-	-
INTNL-3C (Industrial)	-	-	-	-	-	-	3.685	90%
EXTNL-1A&B (Crowson Lane)	-	-	-	-	2.789	80%	-	-
EXTNL-1A&1B (Rural Residential)	-	-	-	-	-	-	8.286	7%

5.2 Proposed Stormwater Quality Improvement Devices

Water Sensitive Urban Design (WSUD) aims to minimise the impact of a development on the natural water cycle by reducing the export of pollutants, sediments and nutrients from the site into the natural watercourse. To treat the stormwater runoff from the site, various treatment devices can be used throughout the development area and these concepts can be integrated into the overall design of the road layouts, road cross sections, stormwater layouts and water supply reticulation systems. Stormwater from the development will follow a specially designed stormwater quality treatment train prior to discharge from the site, which will ensure compliance with the water quality objectives.

5.2.1 Bio-retention Systems

A bio-retention area is a vegetated region where runoff is filtered through a filter media layer (e.g. sandy loam) as it percolates downwards to receiving underlying reticulation. Specific vegetation is to be incorporated into the landscaping of bio-retention areas which effectively reduce nutrient loads. Tables 19 and 20 of the Water by Design Bioretention Technical Design Guidelines provide guidance on selecting appropriate plant species for systems where the plants have a functional role in stormwater treatment, such as the aforementioned bio-retention basins.

Bio-retention areas are incorporated into the proposed development with planted bio-retention filter areas. The northern Bio-retention Basin is to be incorporated into the base of the stormwater detention structure; the lower 300mm of the basin has been excluded from the stormwater detention analysis of the basin and is to be dedicated to extended detention, ensuring that sufficient volume from frequent storm events will pond in the basin and percolate through the filter media receiving treatment.

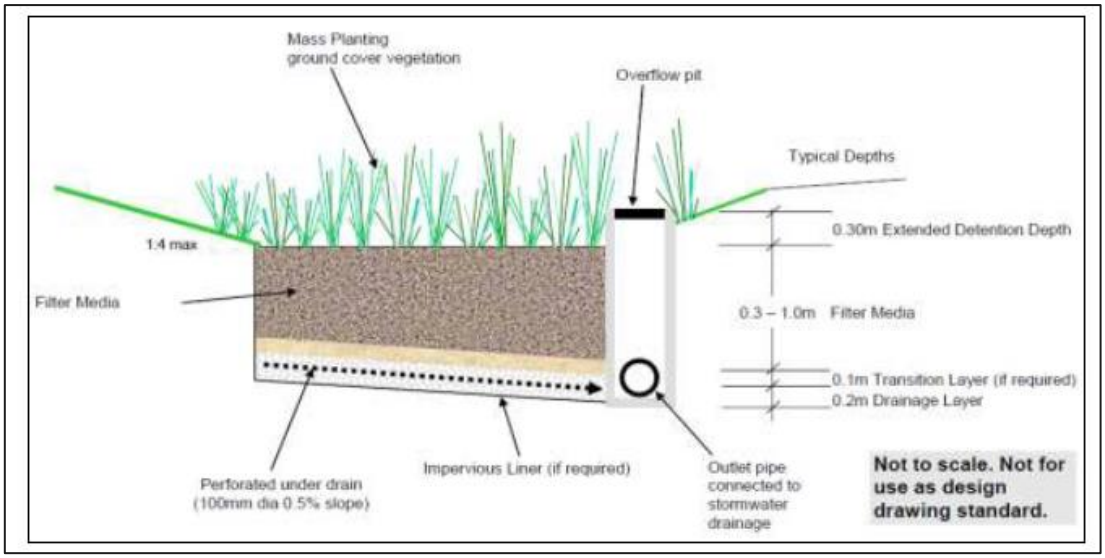


Figure 5-1 Bio-retention basin typical cross-section (courtesy of Healthy Waterways)

5.2.2 Essential Stormwater Harvesting Tanks

Essential rainwater harvesting tanks behave as stormwater quality improvement devices by removing stormwater from the treatment train. Rainwater harvesting tanks are proposed to be incorporated into each lot layout and are to be used for toilet flushing and landscape irrigation.

5.3 Modelling of the Development Site

In developing the modelling parameters for the site, the Water Sensitive Design concepts for the developed site were produced with the proposed method of improvement as follows:

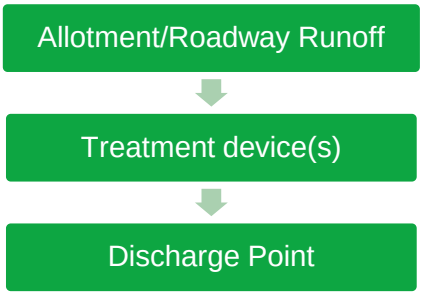


Figure 5-2 Modelling Strategy

This treatment train will be adopted to control stormwater quality from the development area. Modelling of the site was undertaken using the 'Model for Urban Stormwater Improvement Conceptualisation (MUSIC)' as promoted by the South-East Queensland Healthy Waterways Partnership. An appropriate type of land use was applied to all developed sub-catchments based on the proposed development's characteristics for either a residential or commercial land use. Each individual treatment system was assigned the relevant modelling treatment module. Consequently, a treatment train was established for each sub-catchment and ultimately combined to control the total discharge from the development area.

Meteorological data for input to MUSIC was obtained from the Bureau of Meteorology for the Thompson Road Greenbank station (40659), which is located approximately 9km north-west of the site. Six minute time step rainfall data was obtained from the years 1980 to 1989.

The catchment parameters of the MUSIC modelling were amended in accordance with the South-East Queensland Healthy Waterways Partnerships' Water by Design MUSIC Modelling Guidelines – Consultation Draft (2018)'.

5.3.1 Pollutant Source Node Details

The following tables show the pollutant source node parameters that were input to the MUSIC model, as determined using the South-East Queensland Healthy Waterways Partnership's *Water by Design MUSIC Modelling Guidelines for South-East Queensland*.

Table 5-3 Commercial and Industrial Rainfall-Runoff Parameters

Parameter	Industrial	Rural Residential
Soil Storage Capacity (mm)	18	98
Initial Storage (%)	10	10
Field Capacity (mm)	80	80
Infiltration Capacity Coefficient A	243	84
Infiltration Capacity Coefficient B	0.6	3.30
Initial Depth (mm)	50	50
Daily Recharge Rate (%)	0	100
Daily Baseflow Rate (%)	31	22

Table 5-4 Pollutant Export Parameters (Log Values)

Flow Type	Pollutant Source	TSS Log Values		TP Log Values		TN log values	
		Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Industrial							
Baseflow	Roof	N/A	N/A	N/A	N/A	N/A	N/A
	Ground	0.78	0.45	-1.11	0.48	0.14	0.20
	Roads	0.78	0.45	-1.11	0.48	0.14	0.20
Stormflow	Roof	1.30	0.44	-0.89	0.36	0.25	0.32
	Ground	1.92	0.44	-0.59	0.36	0.25	0.32
	Roads	2.43	0.44	-0.30	0.36	0.25	0.32
Rural Residential							
Baseflow	Lumped	0.53	0.24	-1.54	0.38	-0.52	0.39
Stormflow		2.26	0.51	-0.56	0.28	0.32	0.30

5.3.2 Treatment Device Details

Stormwater run-off from the developed site will be collected via a series of drainage systems flowing into the various treatment devices prior to being discharged to the corresponding reporting point. The following section provides details of how each treatment device was modelled.

5.3.2.1 Rainwater Tanks

The rainwater tanks and reuse have been modelled specifically in accordance with the Water By Design MUSIC Modelling Guidelines (2018) and the Blacktown City Council WSUD Developer Handbook – MUSIC Modelling and Design Guide 2020. The reuse has been calculated based on an annual irrigation application of 548mm/m^2/yr across the landscaped areas and a toilet/urinal demand of 0.1kL/toilet/day. Internal building layouts are not available at this stage, so a conservative estimate of the number of toilets has been made.

Table 5-5 below, summarises the parameters used to model the rainwater tanks.

Table 5-5 Rainwater Tank Modelling Parameters and Assumptions

Parameter	INTNL-1
Assumed irrigated landscape area (m^2)	14,866
Assumed number of toilets/urinals	23
Number of Tanks	8
Volume below overflow pipe (kL) (per tank)	20
Depth above overflow pipe (kL)	0.2
Surface Area (m^2) (per tank)	10
Initial Volume (kL)	0
Overflow Pipe Diameter (mm) (per tank)	90
Max Drawdown Height (m)	2
Demand (kL/yr)	8,745

5.3.2.2 Bio-Retention Areas

The bio-retention systems have been designed specifically in accordance with the Water by Design Bioretention Technical Design Guidelines Consultation Draft (2018). The bio-filtration areas have been modelled with a filter media depth of 450mm with median particle diameter of 0.45mm, a design saturated hydraulic conductivity of 200mm/hr (sandy loam), a maximum total nitrogen content for filter media of 400mg/kg; and a maximum orthophosphate content for filter media of 30mg/kg. An extended detention depth of 300mm has been adopted for the basins and 200mm for the bio pods. Table 5-6 summarises the spatial requirements of the bio-retention basins. Details of the exact location and design of the proposed treatment device are also presented in the Engineering Drawings in Appendix B.

Table 5-6 Bio-Retention Area Requirements

Catchment	Type	Basin Filter Area (m^2)
INTNL-1	Bio-retention (North)	1200
Industrial Half Road – 2.5m Wide Footpath, 100m Road Length	Bio pod	12
Industrial Half Road – 1.5m Wide Footpath, 100m Road Length	Bio pod	11

5.3.3 MUSIC Model Layout

The development site has been modelled in MUSIC based on the assumptions outlined in section 7.1. Appropriate percentage impervious factors have been applied to all nodes as per Table 5-2.

A diagrammatic view of the MUSIC model layout is presented in Figure 5-3 below.

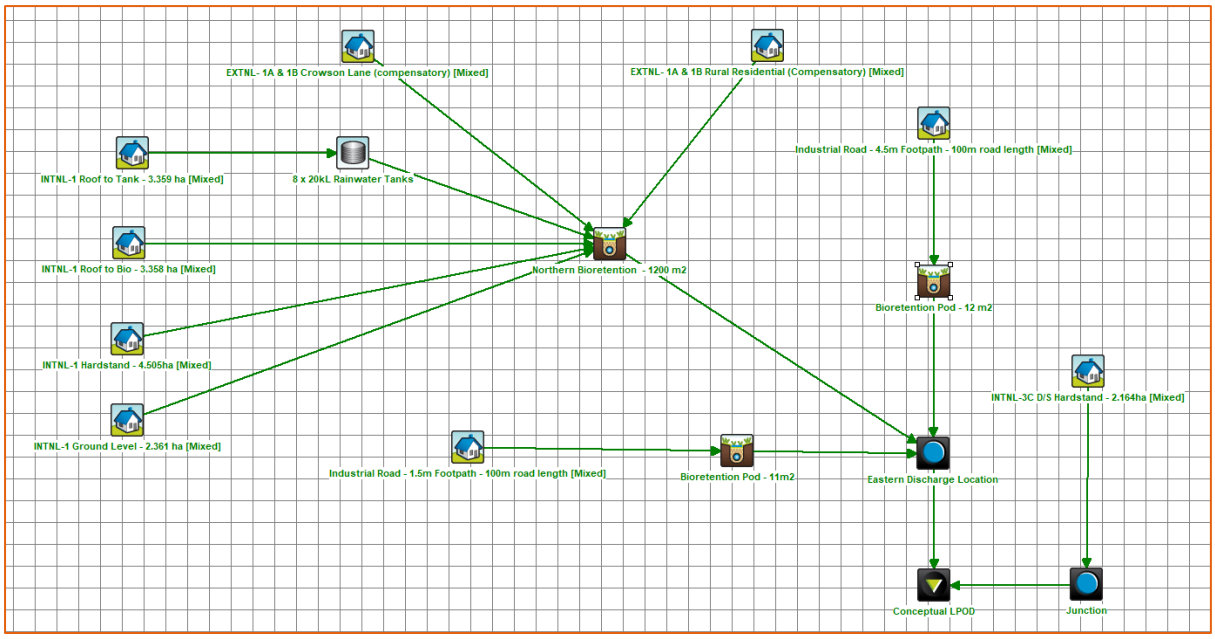


Figure 5-3 MUSIC Model Layout

5.3.4 MUSIC Results

The reduction in pollutant loadings at the discharge locations are presented in Tables 5-7 and 5-8, below.

Table 5-7 MUSIC Treatment Train Effectiveness – Road Bio Pods

Reporting Location	Total Suspended Solids	Total Phosphorus	Total Nitrogen	Gross Pollutants
Industrial Half Road Bio Pod – 2.5m Footpath	82.0%	74.6%	45.6%	100%
Industrial Half Road Bio Pod – 1.5m Footpath	82.7%	75.3%	45.8%	100%
WQO	**80.0%**	**60.0%**	**45.0%**	**90.0%**

Careful consideration was given to the way in which the compensatory catchments and treatment measures were modelled and analysed to ensure the Northern Bioretention Basin is sufficiently sized to capture an adequate volume of pollutants, meeting the WQOs. As the compensatory catchment (EXNTL1A & 1B) has a different landuse, fraction impervious and size to the by-pass catchment (INTNL-3C), a like-for-like approach was deemed unsuitable. Further to this, the Northern Bioretention Basin also treats Catchment INTNL-1, further complicating the matter. As such, mean annual loads produced by each catchment (pre-treatment) were extracted from MUSIC and the minimum volume of pollutants to be retained by the Northern Bioretention System was calculated based on the application of the WQO's to the sum of the mean annual loads produced by Catchments INTNL-3C and INTNL-1. These values were subtracted from the combined mean annual loads applied to the Northern Bioretention Basin from Catchments INTNL-1 and EXTNL 1A & 1B to determine the maximum volume of pollutants allowable to be discharge from the Northern Bioretention Basin.

The Northern Bioretention Basin filter media area was adjusted until the mean annual load discharged from the basin was less than or equal to the maximum volume, as described above.

Table 5-8 provides details of the analysis.

Table 5-8 MUSIC Treatment Train Effectiveness – Northern Bioretention Basin

Reporting Location	Total Suspended Solids	Total Phosphorus	Total Nitrogen	Gross Pollutants
INTNL-3C Mean Annual Load (kg/yr) [1]	6,110	9.56	32.6	352
INTNL-1 Mean Annual Load (kg/yr) [2]	16,200	32.9	192.0	1,430
Combined INTNL-3C and INTNL-1 Mean Annual Load (kg/yr) [1+2]	22,310	42.5	224.6	1,782
WQO Pollutant Reduction (%)	**80.0%**	**60.0%**	**45.0%**	**90.0%**
Mean Annual Load Pollutant Retention Target (kg/yr) [3]	**17,848**	**25.5**	**101.1**	**1,604**
Combined INTNL-1 and EXTNL 1A & 1B Mean Annual Load (kg/yr) [4]	29,900	50.5	275.0	2,060
Maximum Combined INTNL-1 and EXTNL- 1A & 1B Mean Annual Load Post Treatment (kg/yr) [4-3]	**12,052**	**25**	**173.9**	**456**
Actual Combined INTNL-1 and EXTNL-1A & 1B Mean Annual Load Post Treatment (kg/yr) [5]	3,130	9.8	130	0
Reduction (%) Achieved [(4-5)/4*100]	89.5%	80.6%	52.7%	100%

Table 5-8 demonstrates that the Northern Bioretention Basin has been adequately sized to treat the flows from both INTNL-1 and EXTNL-1A & 1B to compensate for allowing INTNL-3C to bypass treatment, achieving the WQO's for Total Suspended Solids, Total Phosphorus, Total Nitrogen and Gross Pollutants.

6 CONSTRUCTION PHASE WATER QUALITY

During the construction phase of the development, an Erosion and Sediment Control Program will be implemented to minimise water quality impacts. A detailed Erosion and Sediment Control Program will be employed throughout the site; the sediment control measures shall include silt fences, cut-off drains for polluted stormwater and diversion channels for clean stormwater run-off, gully pit sediment barriers, field inlet sediment traps and temporary bio-retention filter protection.

Details of the sediment and erosion control measures shall be provided on the engineering drawings for the clearing, site earthworks and civil engineering works. The contractor shall be responsible for the provision of the construction phase water quality objectives which shall be enforced by the preparation and implementation of an Erosion and Sediment Control Program.

The following information is provided to identify controls and procedures, and who is responsible for them, which will be incorporated into the Erosion and Sediment Control Program.

6.1 Pre-construction

- Establish a single stabilised entry/exit point (rumble pad) for each stage of construction. This point should also include a vehicle shakedown device to mitigate the transportation of dust and dirt.
- Sediment fences are to be placed along the low side of the site to slow flows, reduce scour and capture some sediment runoff.
- Sediment fences are to be constructed at the base of fill embankments.
- Divert up-slope water around the work site and appropriately stabilise any drainage channels.
- Areas for plant and construction material storage are to be designated along with associated diversion drains and spillage holding ponds.
- Diversion banks are to be created at the upstream boundary of construction activities to ensure upstream runoff is diverted around any areas to be exposed. Catch drains are to be created at the downstream boundary of construction activities.
- Construction of temporary sediment basins.
- Site personnel are to be educated to the sediment and erosion control measures implemented on site.

6.2 During Construction

- Progressive re-vegetation of filled areas and fill batters.
- Construction activities are to be confined to the necessary construction areas.
- The provision of a construction exit to prevent the tracking of debris from tyres of vehicles onto public roads.
- The topsoil stockpile location will be nominated to coincide with areas previously disturbed. A sediment fence is to be constructed around the bottom of the stockpile to trap sediment. A diversion drain is to be installed upstream of the stockpile if required.
- Transport loads that are subject to loss through wind or spillage shall be covered or sealed to prevent entry of pollutants to the stormwater system.
- Regular inspection and maintenance of silt fences, sediment basins and other erosion control measures. Following rainfall events greater than 50mm inspection of erosion control measures and removal of collected material should be undertaken. Replacement of any damaged equipment should be performed immediately.

8.2.1 Bio-retention Basin Construction Requirements

The construction of the bio-retention basins for the development must be in accordance with “Option 1: Surface Protection” from the Water by Design “*Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands*”. A copy of the step-by-step construction sequence and sign-off forms are included in Appendix D.

6.3 Operational Management and Maintenance Plan

6.3.1 Aims and Objectives

Long term management and maintenance of the bio-retention basins on site is required after construction has finished. The objective of the bio-retention basins is to allow stormwater from the development to be treated through the vegetation and filter media before discharging into the downstream catchment. By having an Operational Management and Maintenance Plan (OMMP) in place, the bio-retention basins can be maintained to ensure that it is operating to optimal functionality.

6.3.2 Maintenance Requirements and Locations

Maintenance requirements for the bio-retention basin consists of:

- Regular and storm event inspection to ensure:
  - Sufficient vegetation within bio-retention areas; and
  - Ensuring no erosion has occurred.
- Regular mowing/harvesting to ensure vegetation is maintained at acceptable levels.
- Removal of litter within bio-retention areas.
- Regular trash removal.

The Sediment and Erosion Control Management Plans should be provided to all people involved with the site, including sub-contractors, private certifiers, home owners and regulators. These guidelines have been formed in accordance with the Healthy Waterways Fact Sheet 'Erosion and Sediment Control Management Plans' and the 'Best Practice Erosion and Sediment Control.

6.3.3 Personnel Responsible

The Contractor/Developer will be responsible for the maintenance of erosion and sediment control and stormwater devices from the possession of the site until the site is accepted 'Off Maintenance' or until stabilisation has occurred to the satisfaction of the superintendent and Council.

After "Off Maintenance", all devices remain the property of the developer and their responsibility for maintenance.

6.3.4 Scheduling of Inspections and Monitoring

Regular Maintenance is used for activities that require a small number of resources. These activities include weeding and removing litter and debris. Table 8.1 below sets out recommended frequency for inspections and regular maintenance of stormwater quality treatment devices.

Table 6-1 Inspection and Maintenance Frequency

Asset Type	Wet Season	Dry Season
Bio-Retention Systems	2 Months	3 Months

Responsive Maintenance is used to check for erosion, the condition of structures and the cover and health of vegetation. This should be carried out at least once a year during or immediately after a significant rainfall event. A check that the system is free-draining should also be carried out at this time.

Renewal Period The eWater MUSIC model states that, on average, bio-retention systems may need their filtration media replaced every 25 years. Therefore, as the proposed redevelopment is being designed with a 25-year design horizon.

6.3.5 Maintenance Techniques and Rectification Procedures

As outlined in the Water by Design "Maintaining Vegetated Assets" document, maintenance activities for bio-retention systems include the following:

- Repairing erosion;
- Unblocking inlets and outlets;
- Removing sediment;
- Removing litter and debris;
- Replanting and Controlling weeds; and
- Managing algal or moss growth on the bio-retention system.

Identification and rectification procedures for all of the above are included in Appendix E (taken from the Water by Design "*Maintaining Vegetated Assets*" document).

6.3.6 Record Keeping and Reporting Requirements

The Water by Design "*Inspection and Maintenance Checklist for Bioretention Systems*" included in Appendix F should be used whenever an inspection is conducted and kept as a record on the asset condition and quantity of removed pollutants over time.

7 CONCLUSION

This SBSQMP has been prepared to provide a design proposal and guide to the stormwater quality management techniques for the site.

The primary objective of this SBSQMP has been to ensure that:

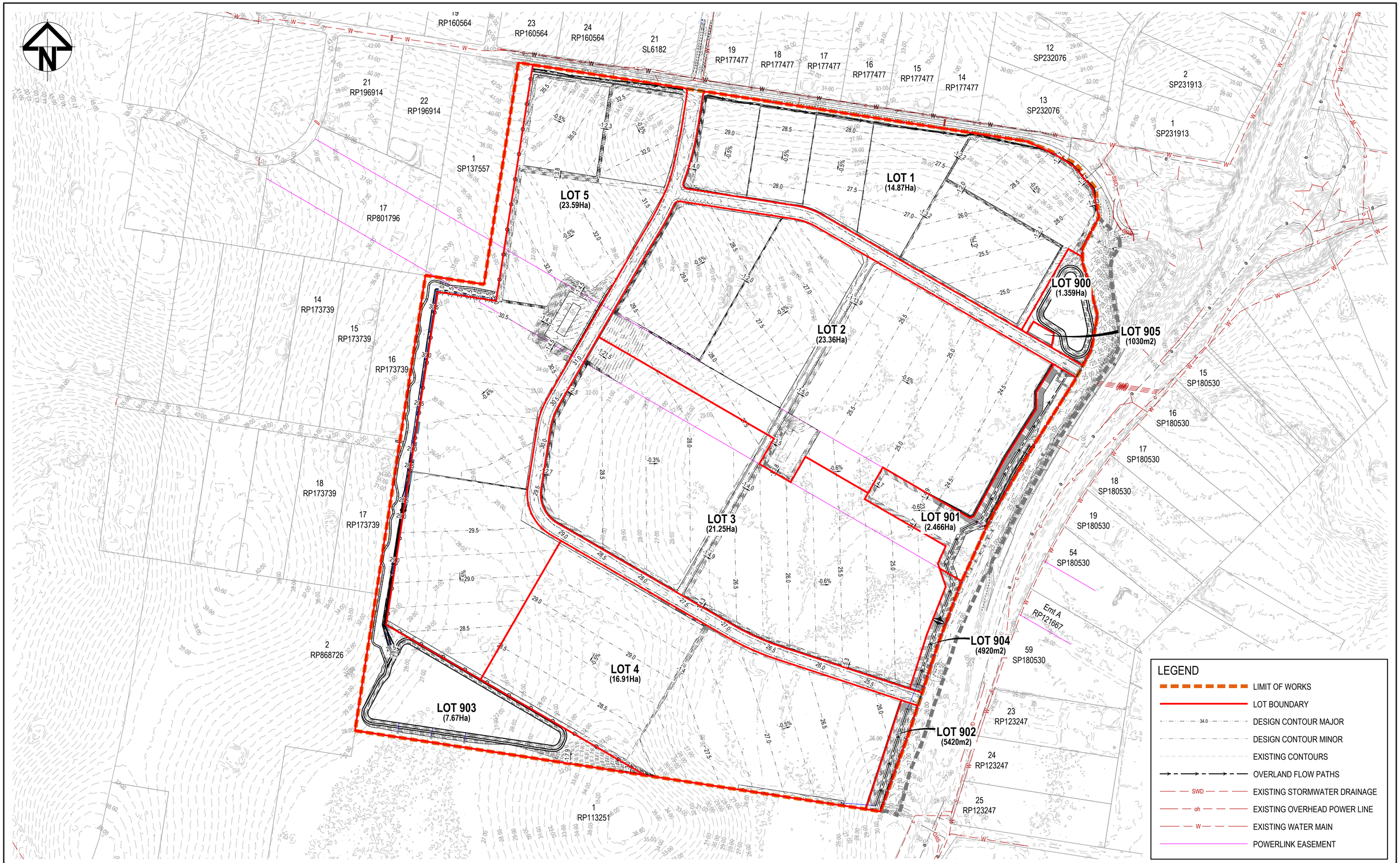
1. **Details of a proposed stormwater quality treatment train are provided to ensure the discharge of stormwater from the site is of adequate quality standards to comply with the requirements of Economic Development Queensland (EDQ), Logan City Council (LCC) and the South-East Queensland Healthy Waterways Partnership.**

A stormwater quality assessment is provided which demonstrates that a specially tailored treatment system will be required to meet the pollutant removal targets of LCC during the operational phase of the proposed development. The proposed treatment system includes routing of stormwater through discharge locations. Site specific SBSMPs will be required to accompany the MCU applications for catchments INTNL-2A - INTNL-4C to formulate an appropriate stormwater treatment train and has not been addressed in this report.

Construction phase sediment control devices are to be implemented during construction works in accordance with requirements associated with Type 1 sediment discharge zones, comprising of a vehicle shakedown, sediment fences, gully inlet protection, sediment basin and check dams.

APPENDIX A

Functional Layout Plan



Issue	Description	DR	CH	VE	Date
05	OVERALL LAYOUT CHANGES	GP	GP	BK	15.08.2023
04	OVERALL LAYOUT CHANGES	GP	GP	BK	8.08.2023
03	DESIGN UPDATES ALONG 11m RESUMPTION BDY	GP	GP	BK	2.08.2023
02	DESIGN UPDATES	JG	EP	GE	13.02.2023
01	ORIGINAL ISSUE	EP	EP	GE	29.09.2022

Scales

0 30 60 120 180 240 300m

1 : 3000

100mm on Original

Surveyor

WOLTER consulting group

Planning Urban Design Landscape Environment Surveying

Architect

-

Client

Charter Hall

Status

CONCEPT DESIGN ONLY
NOT TO BE USED FOR CONSTRUCTION

Original Issue Signatures			
Drawn	G.PUMNUT	Original Size	A1
Designed	G.PUMNUT	Height Datum	AHD
Project Manager	T.FANNING	Grid	MGA
Verified	B.KITSON		

Project

4499-4651 MOUNT LINDESAY HIGHWAY, NORTH MACLEAN

Title

OVERALL SITE LAYOUT

ARCADIS

Arcadis Australia Pacific Pty Limited
Level 35, 111 Eagle Street
BRISBANE QLD 4000
ABN 76 104 485 289

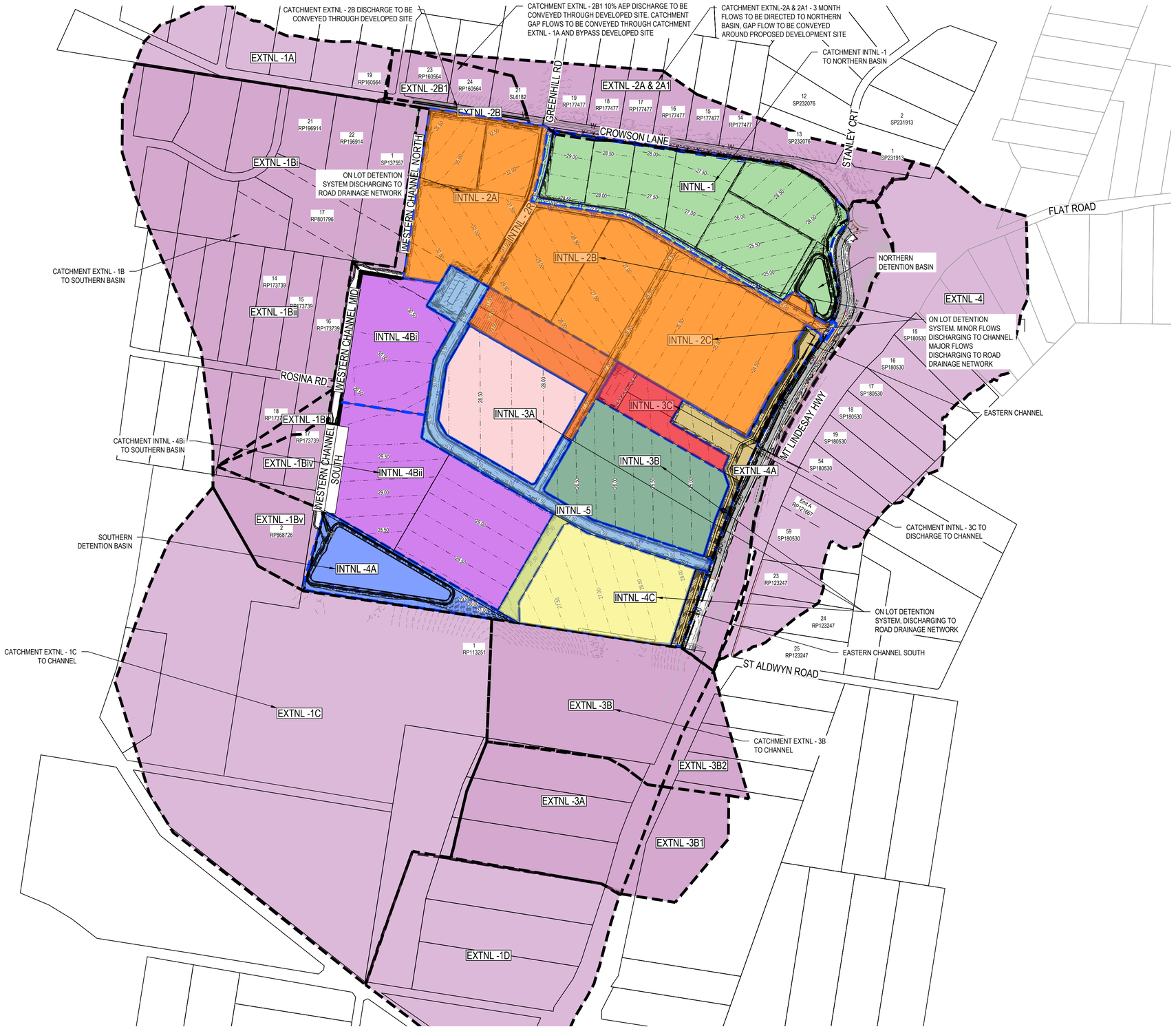
Tel No: +61 7 3337 0000
www.arcadis.com/au

Project No.	Folder Prefix	Zone | Stage | Phase	Discipline	Type	Drawing No.	Issue
30109334	AAP	WS00OP	CV	SKT	018	05

Date Plotted: 15 Aug 2023 - 08:45AM File Name: C:\Users\gp117798\DC\ACCDocs\Arcadis\AAU-30109334-4499-4651 Mount Lindesay Highway\Project Files\01_WIP\01_Package-00_Civil_CV\Drawings\30109334-AAP-WS00OP-CV-SKT-018-Lot Layout.dwg V1

APPENDIX B

Engineering Drawings and Site Topography



LEGEND

- EXISTING SURFACE CONTOURS
- PROPOSED MAJOR CONTOURS
- PROPOSED MINOR CONTOURS
- EXTERNAL STORMWATER CATCHMENT
- POST DEVELOPMENT STORMWATER CATCHMENT

CATCHMENT AREAS

LABEL	AREA (Ha)
EXTNL - 1A	7.224
EXTNL - 1Bi	23.636
EXTNL - 1Bii	16.974
EXTNL - 1Biii	0.903
EXTNL - 1Biv	3.366
EXTNL - 1Bv	4.203
WESTERN CHANNEL NORTH	1.244
WESTERN CHANNEL MID	0.960
WESTERN CHANNEL SOUTH	0.517
EXTNL - 1C	64.974
EXTNL - 1D	19.78
EXTNL - 2A & 2A1	12.652
EXTNL - 2B1	2.070
EXTNL - 3A	12.150
EXTNL - 3B	14.090
EXTNL - 3B1	4.830
EXTNL - 3B2	2.810
EXTNL - 4	34.632
EXTNL - 4A	8.764
INTNL - 1	17.052
INTNL - 2A	8.918
INTNL - 2B	11.407
INTNL - 2C	10.479
INTNL - 2R	3.472
INTNL - 3A	7.740
INTNL - 3B	9.165
INTNL - 3C	3.685
INTNL - 4A	5.529
INTNL - 4Bi	6.553
INTNL - 4Bii	13.967
INTNL - 4C	8.857
INTNL - 5	5.017
EASTERN CHANNEL	2.904
EASTERN CHANNEL SOUTH	0.546

Issue	Description	DR	CH	VE	Date
02	RFI RESPONSE				20.06.23
01	FOR APPROVAL	J.G.	E.P.	G.E.	24.01.23

Scales

0 50 100 200 300 400 500m

1 : 5000

Surveyor

WOLTER consulting group

Planning Urban Design Landscape Environment Surveying

Architect

-

Client

Charter Hall

Status

CONCEPT DESIGN ONLY
NOT TO BE USED FOR CONSTRUCTION

Original Issue Signatures			
Drawn	L. STAUNTON	Original Size	A1
Designed	L. STAUNTON	Height Datum	AHD
Project Manager	T. FANNING	Grid	LOCAL
Verified	G. ELLIS	R.P.E.Q. No: 7884 Date 8/08/2023	

Project

4499-4651 MOUNT LINDESAY HIGHWAY, NORTH MACLEAN

Title

POST-DEVELOPMENT QUALITY CATCHMENT PLAN

ARCADIS
Arcadis Australia Pacific Pty Limited
Level 35, 111 Eagle Street
BRISBANE QLD 4000
ABN 76 104 485 289
Tel No: +61 7 3337 0000
www.arcadis.com/au

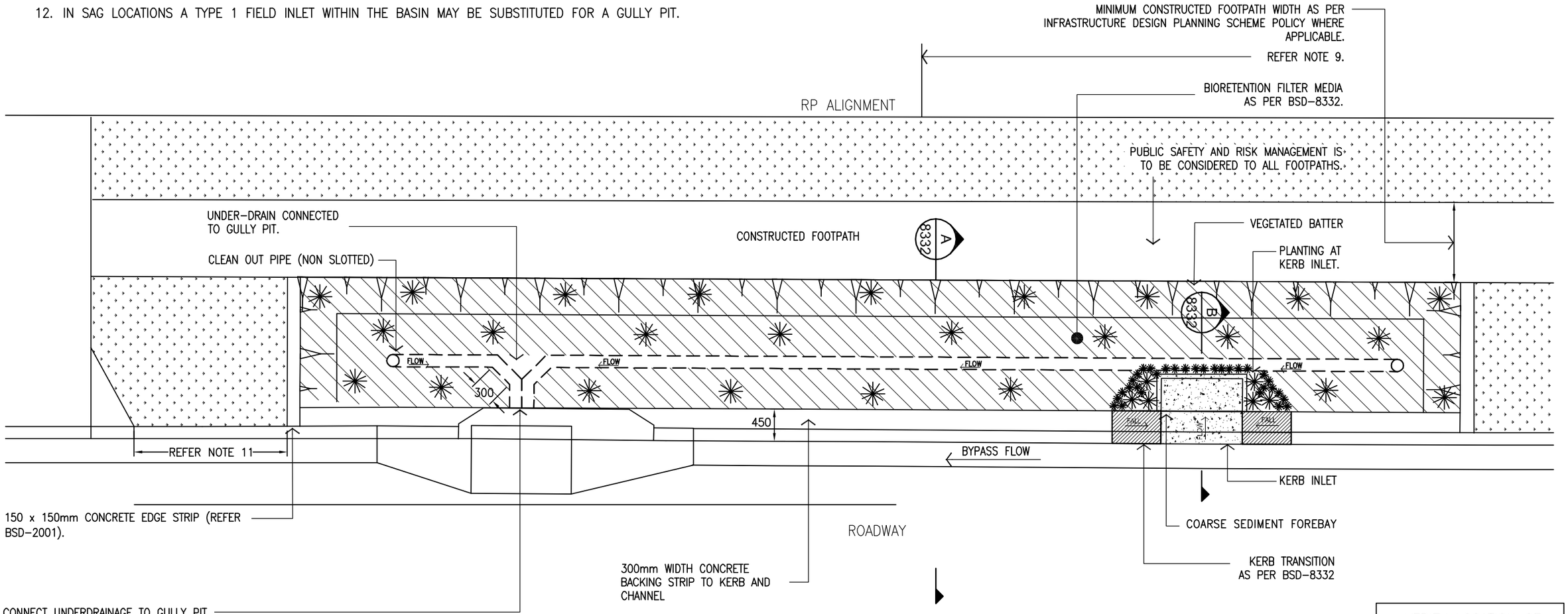
Project No.	Folder Prefix	Zone | Stage | Phase	Discipline	Type	Drawing No.	Issue
30109334	AAP	WS00OP	CV	SKT	024B	02

100mm on Original

Date Plotted: 15 Aug 2023 - 04:51PM File Name: C:\Users\ao67297\DC\ACCDocs\Arcadis\AAU-30109334-4499-4651 Mount Lindesay Highway\Project Files\01_WIP\01_Package-00_Civil_CV\Drawings\30109334-AAP-WS00OP-CV-SKT-024-SWDReportCatchments.dwg V1

NOTES

1. THIS PLAN IS TO BE READ IN CONJUNCTION WITH BSD–8331.
2. FOR BIORETENTION SYSTEM NOTES AND DIMENSIONS REFER TO BSD–8332.
3. DETAIL TO BE INCORPORATED IN DEVELOPMENTS WHERE SERVICES/ GRADES ENABLE THE CONSTRUCTION OF THE BIORETENTION SYSTEM AND WHERE THE UNDER–DRAIN CAN BE DRAINED TO A STORMWATER GULLY PIT.
4. SELECTION OF APPROPRIATE PLAN LAYOUT IS BASED ON SITE SPECIFIC DETAILS INCLUDING SPACE, SERVICES, DRAINAGE, TOPOGRAPHY, TRAFFIC CONDITIONS ETC.
5. APPROVAL FOR VARIATIONS TO EXISTING ROADS/VERGES SHALL BE OBTAINED FROM BCC.
6. STEEP VERGE OR ROAD GRADES MAY LIMIT THE FEASIBILITY OF STREETSCAPE BIORETENTION.
7. WHEN LOCATED NEXT TO STREET PARKING CONSIDER ACCESS TO AND FROM VEHICLES.
8. MULTIPLE KERB INLETS MAY BE REQUIRED DEPENDING ON CONTRIBUTING CATCHMENT, GRADE, LENGTH, AND INFLOWS.
9. CONSIDER PLACEMENT OF BIORETENTION POD AT DIVIDING BOUNDARY TO PREVENT IMPINGING ON AVAILABLE PROPERTY ACCESS.
10. CONCRETE EDGE STRIP (150 X 150mm) REQUIRED AT BACK EDGE OF DEVICE WHERE NO FOOTPATH IS PROPOSED.
11. MAXIMUM LENGTH OF DEVICE IS TO BE SIZED TO ALLOW ADEQUATE SPACE FOR DRIVEWAY CROSSOVERS AND WASTE PICKUP. TYPICAL MAXIMUM LENGTH IS 8 METERS.
12. IN SAG LOCATIONS A TYPE 1 FIELD INLET WITHIN THE BASIN MAY BE SUBSTITUTED FOR A GULLY PIT.



STREETSCAPE BIORETENTION POD (VERGE TYPE) – TYPICAL LAYOUT

VERIFY LOCATION OF SERVICES PRIOR TO EXCAVATION.

DESIGN REVIEWED & CERTIFIED FOR ISSUE
NAME: MARK.R.GIBSON RPEQ: 6722
SIGNATURE: SIGNATURE ON ORIGINAL DATE: 03/04/14

ISSUE	AMENDMENT	DRAWN DATE	CHK'D DATE	APPR'D DATE
D	CLARIFICATION & IMPROVEMENT TO NOTES & DESIGN	Nov '16	Nov '16	Dec '16
C	Drawing Title Amended	FEB '16	JUL '16	JUL '16
B	NOTES UPDATED	Feb '15	Feb '15	Feb '15
A	ORIGINAL ISSUE	Apr '14	Apr '14	Apr '14

DESIGN AUTHORISED FOR PUBLICATION
INGA CONDRIC SIGNATURE ON ORIGINAL DATED 14/04/14
ASSET ENGINEERING MANAGER
STRATEGIC ASSET MANAGEMENT

DESIGN APPROVED
PETER KURAS SIGNATURE ON ORIGINAL DATED APRIL '14
PRINCIPAL PROGRAM OFFICER
NATURAL ENVIRONMENT WATER & SUSTAINABILITY

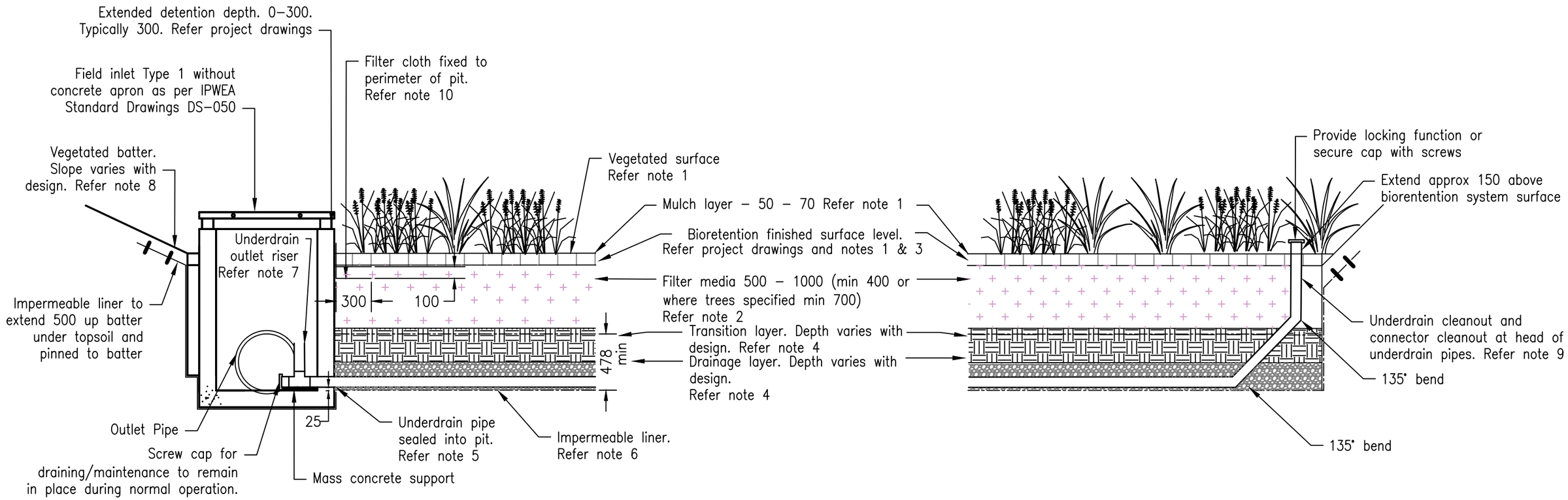
DESIGN	CPO - P&D	DATE	Apr '14
DRAWN	CPO - P&D	DATE	Apr '14
CHECKED	M. GIBSON	DATE	Apr '14
DRAWING FILENAME	BSD-8331.dwg		
ASSOCIATED PLANS			

BRISBANE CITY

BRISBANE CITY COUNCIL STANDARD DRAWING

WATERSMART BIORETENTION POD (VERGE TYPE) – LAYOUT

SCALE: NOT TO SCALE
DWG No.: BSD–8331
ORIGINAL SIZE: A3
REVISION: D



NOTES:

1. Bioretention system surface. Surface level is top of filter media. Surface to be mulched and planted as per project drawings and the 'Bioretention Technical Design Guidelines' (Water by Design).
2. Filter media specification shall be in accordance with the 'Adoption guidelines for Stormwater Biofiltration Systems (CRC for water sensitive cities) and the Bioretention Technical Design Guidelines (Water by Design). Bioretention hydraulic conductivity shall be in accordance with Practice Note 1: in situ Measurement of Hydraulic Conductivity' (FAWB). The number of samples to be tested shall be in accordance with the 'Construction and Establishment Guidelines – Swales, Bioretention Systems and Wetlands' (Water by Design).
3. Construction tolerances shall be in accordance with the 'Construction and Establishment Guidelines –Swales, Bioretention Systems and Wetlands' (Water by Design)
4. Transition layer and drainage layer depths vary with design. Depths and specification to be in accordance with project drawings and the 'Bioretention Technical Design Guidelines' (Water by Design)
5. Underdrain. Slotted rigid pipe laid flat. Refer to project drawings for diameter and pipe invert. Pipe should not be installed with a filter sock surrounding pipe. Underdrain pipes shall be sealed into pits using grout or other approved watertight seal.
6. Impermeable liner. Compacted clay or synthetic liner with permeability of no greater than 1×10^{-9}m/s. Impermeable liner to be sealed around all protrusions. Synthetic liners to be installed and sealed in accordance with manufacturers requirements. Impermeable liner as per project drawings and 'Bioretention Technical Design Guidelines' (Water by Design)
7. Underdrain outlet riser establishes max saturated zone water level. Underdrain outlet riser as per project drawings and 'Bioretention Technical Design Guidelines' (Water by Design)
8. Vegetated batter. Slope and planting to be in accordance with project drawings and 'Bioretention Technical Design Guidelines' (Water by Design).
9. Inspection/cleanout point. Vertical solid pipe section attached to the end of each underdrain in accordance with project drawings and the 'Bioretention Technical Design Guidelines'(Water by Design)
10. Filter cloth to be fixed to perimeter of pit to avoid runnelling of water between pit and soil interface. Begin filter cloth 100 above surface. Extend to 100 below surface. Continue 300 horizontally into filter media.
11. For general design and construction notes refer to DS–078
12. All dimensions in millimetres unless otherwise noted.

Rv.	DATE	REVISIONS
A	11/15	ORIGINAL ISSUE February, 2016 Original Issue

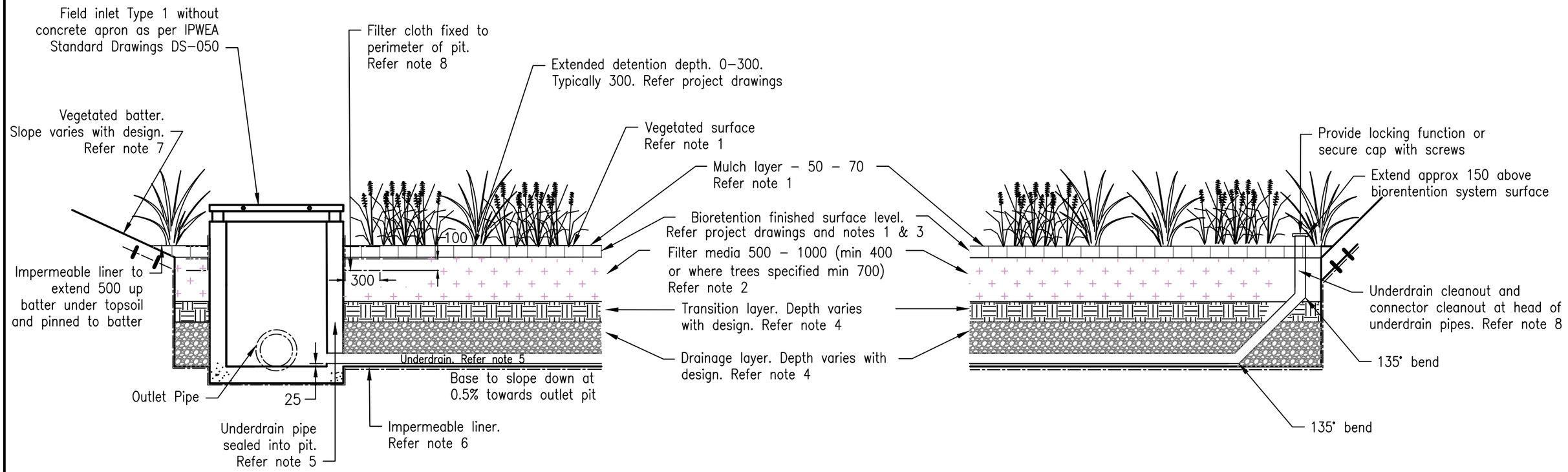
INSTITUTE OF PUBLIC WORKS ENGINEERING AUSTRALASIA

STANDARD DRAWINGS

BIORETENTION DRAINAGE PROFILE – TYPE 1 SATURATED ZONE – UNCONSTRAINED

DS–070

Rv. A



NOTES:

1. Bioretention system surface. Refer note 1 DS–070
2. Filter media specification. Refer not 2 DS–070
3. Construction tolerances. Refer note 3 DS–070
4. Transition layer and drainage layer. Refer note 4 DS–070
5. Underdrain. Refer note 5 DS–070
6. Impermeable liner. Refer note 6 DS–070
7. Vegetated batter. Refer note 8 DS–070
8. Inspection/cleanout point. Refer note 9 DS–070
9. Filter Cloth refer note 10 DS–070
10. For general design and construction notes refer to DS–078
11. All dimensions in millimetres unless otherwise noted.

Rv.	DATE	REVISIONS
A	11/15	ORIGINAL ISSUE
	February, 2016	Original Issue

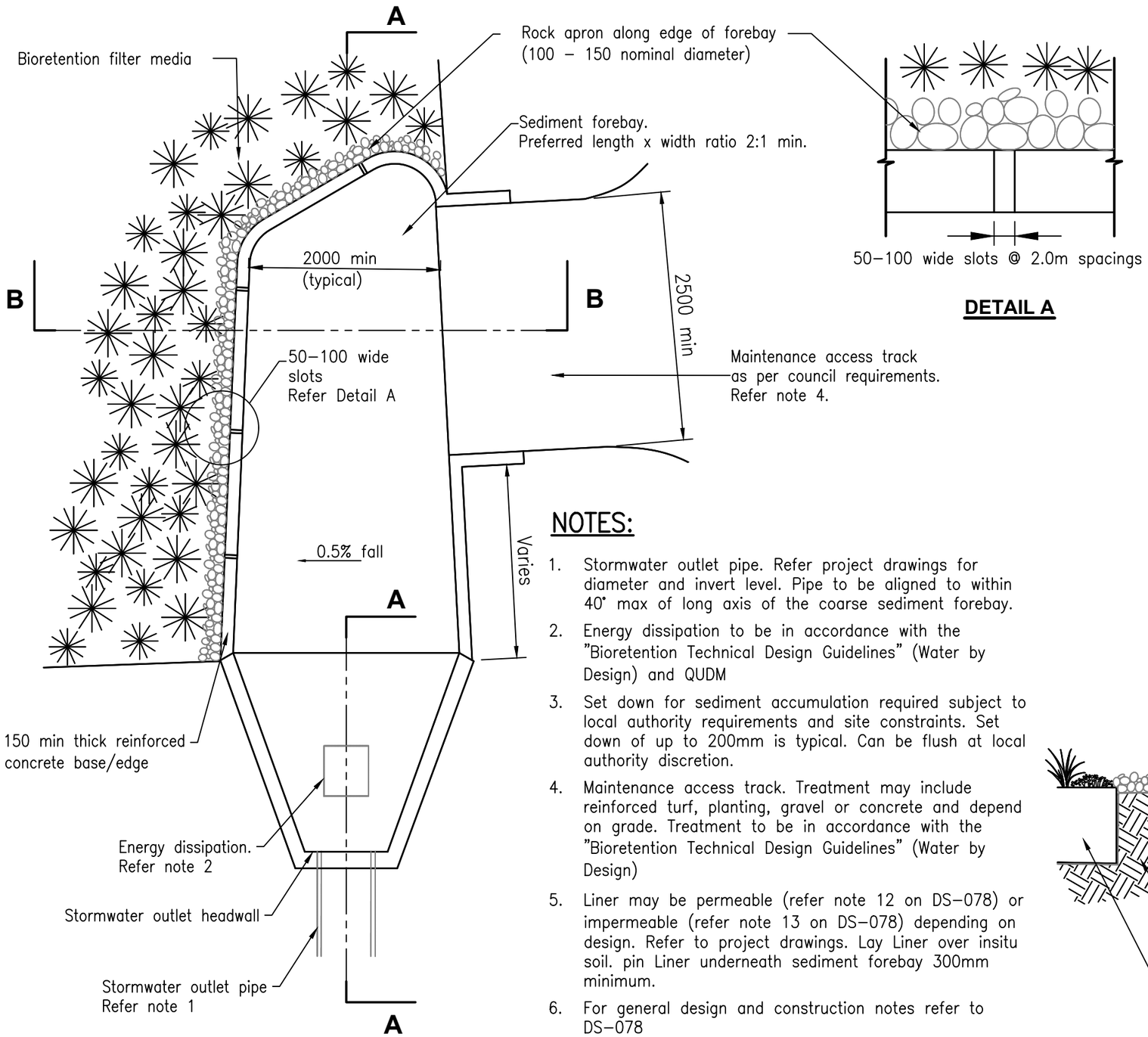
INSTITUTE OF PUBLIC WORKS ENGINEERING AUSTRALASIA

STANDARD DRAWINGS

BIORETENTION DRAINAGE PROFILE – TYPE 2 SEALED

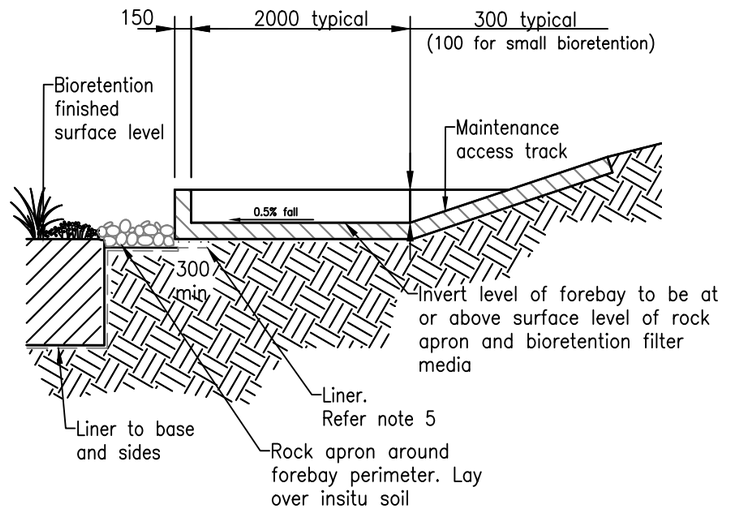
DS–072

Rv. A



PLAN

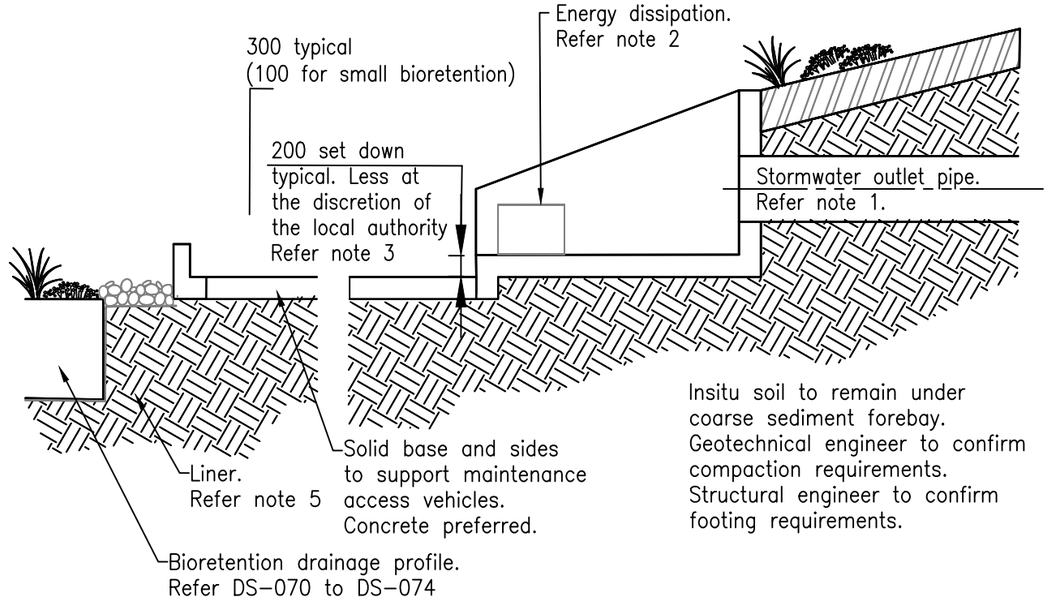
DETAIL A



SECTION B-B

NOTES:

1. Stormwater outlet pipe. Refer project drawings for diameter and invert level. Pipe to be aligned to within 40° max of long axis of the coarse sediment forebay.
2. Energy dissipation to be in accordance with the "Bioretention Technical Design Guidelines" (Water by Design) and QUDM
3. Set down for sediment accumulation required subject to local authority requirements and site constraints. Set down of up to 200mm is typical. Can be flush at local authority discretion.
4. Maintenance access track. Treatment may include reinforced turf, planting, gravel or concrete and depend on grade. Treatment to be in accordance with the "Bioretention Technical Design Guidelines" (Water by Design)
5. Liner may be permeable (refer note 12 on DS–078) or impermeable (refer note 13 on DS–078) depending on design. Refer to project drawings. Lay Liner over insitu soil. pin Liner underneath sediment forebay 300mm minimum.
6. For general design and construction notes refer to DS–078
7. All dimensions in millimetres unless specified otherwise.



SECTION A-A

Rv.	DATE	REVISIONS
A	11/15	ORIGINAL ISSUE
	February, 2016	Original Issue

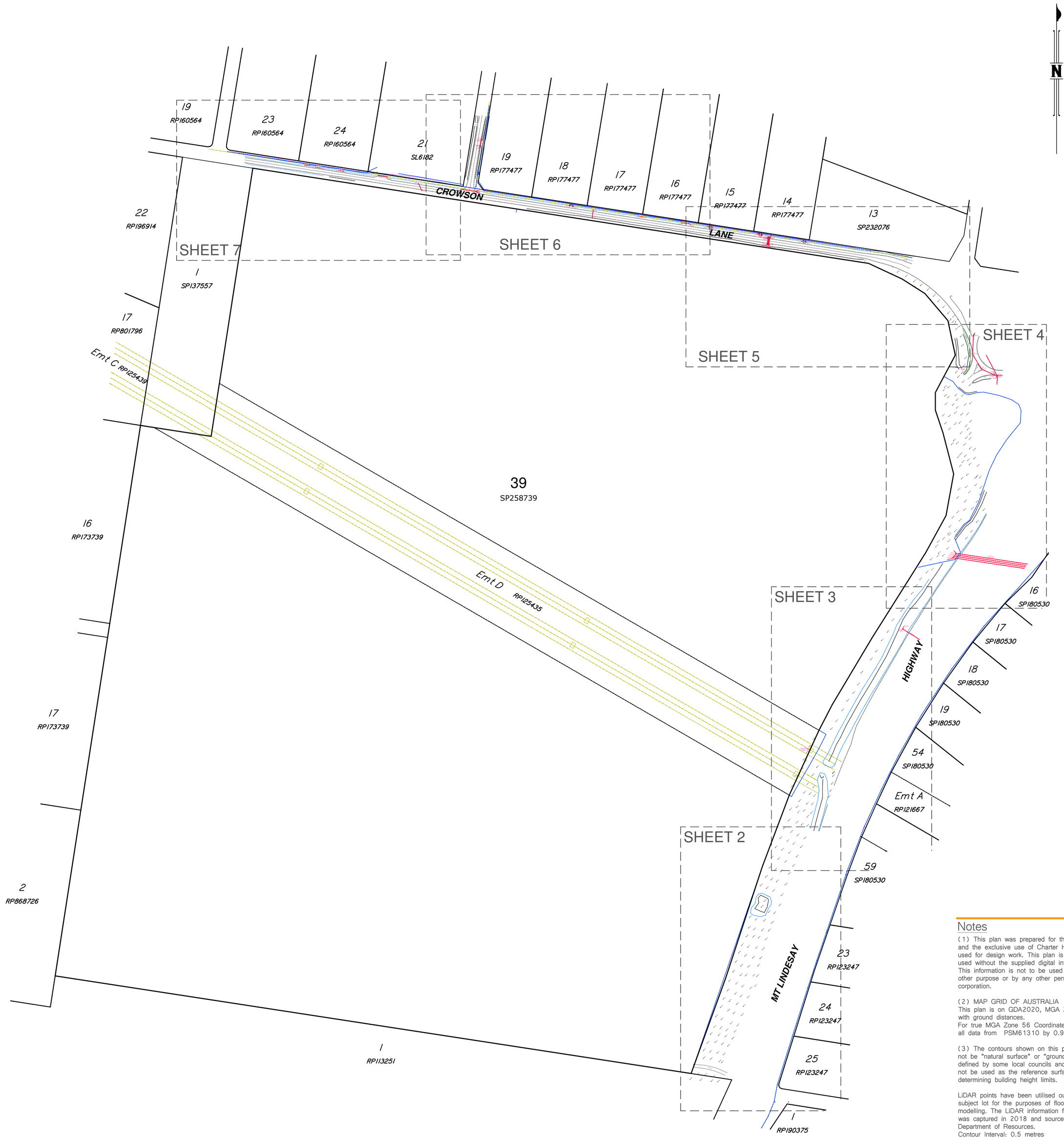
INSTITUTE OF PUBLIC WORKS ENGINEERING AUSTRALASIA

STANDARD DRAWINGS

LARGE BIORETENTION SEDIMENT FOREBAY

DS–075

Rv. A



Notes

(1) This plan was prepared for the purpose and the exclusive use of Charter Hall, to be used for design work. This plan is not to be used without the supplied digital information. This information is not to be used for any other purpose or by any other person or corporation.

(2) MAP GRID OF AUSTRALIA
This plan is on GDA2020, MGA Zone 56 with ground distances.
For true MGA Zone 56 Coordinates, scale all data from PSM61310 by 0.9995896.

(3) The contours shown on this plan may not be "natural surface" or "ground level" as defined by some local councils and should not be used as the reference surface when determining building height limits.

LiDAR points have been utilised outside the subject lot for the purposes of flood modelling. The LiDAR information for this site was captured in 2018 and sourced from the Department of Resources.
Contour Interval: 0.5 metres

(4) Property Boundaries
The subject lot boundaries and dimensions shown on this plan are compiled from original survey records SP258739, SP137557 & RC232077 and plotted with a surveying methodology that gives these boundaries a positional uncertainty of 200 millimetres and must not be used for detailed design. Boundaries of all adjoining lots have been sourced from DCDB to assist with visualising boundaries only. These boundaries are approximate with unknown accuracy.
A Cadastral Survey as defined by the Surveying and Mapping Infrastructure Act 2003 and Surveyors Act 2003 is required for accurate boundary positions and dimensions.

(5) Only visible features of underground services were located. Positions of stormwater mains, sewer mains & water mains that have been plotted are indicative only and as such should not be relied upon for detailed engineering design and construction. Contact relevant authorities before any excavation.

(6) UNDERGROUND SERVICES

This plan generally complies with Australian Standard 5488—2013: Classification of Subsurface Utility Information (SUI).

Definitions:
Quality Level A (QL-A): Features or points on alignments that have been positively identified, measured directly and have a Horizontal and Vertical Positional Uncertainty of 50mm or less. QL-A Features in this data include surface fittings and surveyed inverts
Quality Level B (QL-B): Points on alignments that have been remotely detected by Pensar, these points have a horizontal Positional Uncertainty of 300mm or less.
Quality Level C (QL-C): Alignments are service provider's records with their positioning enhanced by QL-A or QL-B points. All alignments in this data should be considered QL-C unless otherwise noted.
Quality Level D (QL-D): Alignments that have been scaled or digitized from service provider's records.

Only information with Quality Level A should be relied upon for detailed design. For more information see AS5488—2013.

(7) This plan may not be copied unless this note is included.

Scale 1:3000 – Lengths are in metres.

50 0 50 100 150 200 250 300 350 400

WOLTER consulting group

Planning Urban Design Landscape Environment Surveying

Contour and Detail Survey

2-140 Crowson Lane, North Maclean

Local Authority: North Maclean
Description: Lot 39 on SP258739
Level Datum: PM61310 - RL24.798
Origin: AHD
Co-ord System: GDA2020, MGA Zone 56

Rev.	Reason for Issue or Amendment	Date	Surveyed	Drawn	Approved
A	Original Issue	02-03-2022	J.Townend	J.Cowell	G.Hanton

DRAWING NO.
21-0432S-01

SHEET NO. 1 of 7

VERSION A

SEE SHEET 3

N

39
SP258739

HIGHWAY

MT LINDESAY

ST ALDWYN RD

59
SP180530

23
RP123247

24
RP123247

25
RP123247

1
RP113251

Driveway

Notes

(1) This plan was prepared for the purpose and the exclusive use of Charter Hall, to be used for design work. This plan is not to be used without the supplied digital information. This information is not to be used for any other purpose or by any other person or corporation.

(2) MAP GRID OF AUSTRALIA
This plan is on GDA2020, MGA Zone 56 with ground distances.
For true MGA Zone 56 Coordinates, scale all data from PSM61310 by 0.9995896.

(3) The contours shown on this plan may not be "natural surface" or "ground level" as defined by some local councils and should not be used as the reference surface when determining building height limits.

LiDAR points have been utilised outside the subject lot for the purposes of flood modelling. The LiDAR information for this site was captured in 2018 and sourced from the Department of Resources.
Contour Interval: 0.5 metres

(4) Property Boundaries
The subject lot boundaries and dimensions shown on this plan are compiled from original survey records SP258739, SP137557 & RC232077 and plotted with a surveying methodology that gives these boundaries a positional uncertainty of 200 millimetres and must not be used for detailed design.
Boundaries of all adjoining lots have been sourced from DCDB to assist with visualising boundaries only. These boundaries are approximate with unknown accuracy.
A Cadastral Survey as defined by the Surveying and Mapping
Infrastructure Act 2003 and Surveyors Act 2003 is required for
accurate boundary positions and dimensions.

(5) Only visible features of underground services were located. Positions of stormwater mains, sewer mains & water mains that have been plotted are indicative only and as such should not be relied upon for detailed engineering design and construction. Contact relevant authorities before any excavation.

(6) UNDERGROUND SERVICES

This plan generally complies with Australian Standard 5488—2013: Classification of Subsurface Utility Information (SUI).

Definitions:
Quality Level A (QL-A): Features or points on alignments that have been positively identified, measured directly and have a Horizontal and Vertical Positional Uncertainty of 50mm or less. QL-A Features in this data include surface fittings and surveyed inverts
Quality Level B (QL-B): Points on alignments that have been remotely detected by Pensar, these points have a horizontal Positional Uncertainty of 300mm or less.
Quality Level C (QL-C): Alignments are service provider's records with their positioning enhanced by QL-A or QL-B points. All alignments in this data should be considered QL-C unless otherwise noted.
Quality Level D (QL-D): Alignments that have been scaled or digitized from service provider's records.

Only information with Quality Level A should be relied upon for detailed design. For more information see AS5488—2013.

(7) This plan may not be copied unless this note is included.

Linework

- Electrical OverHead
- Fence Line
- Road Crown
- Road Driveway
- Road Bitumen Edge
- Road Kerb Back
- Road Kerb Invert
- Road Kerb Lip
- Storm Located - Quality Level 'A'
- Storm Located - Quality Level 'D'
- Telecomms Located - Quality Level 'C'
- Topo Bank Bottom
- Topo Bank Top
- Topo Change of Grade
- Topo Concrete
- Traffic Barrier
- Water Located - Quality Level 'C'
- Water Located - Quality Level 'D'

Symbols

- Electrical Light Pole
- Electrical Pit
- Electrical Pole
- Storm Headwall
- Storm Invert
- Storm Manhole
- Storm Gully Trap
- Survey Benchmark
- Telecomms Pillar
- Telecomms Pit
- Topo Surface Level
- Water Booster Cabinet
- Water Valve
- Water Fire Hydrant

Scale 1:500 – Lengths are in metres.

5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70

WOLTER consulting group

Planning Urban Design Landscape Environment Surveying

Contour and Detail Survey

2-140 Crowson Lane, North Maclean

Local Authority: North Maclean
Level Datum: PM61310 - RL24.798
Co-ord System: GDA2020, MGA Zone 56
Description: Lot 39 on SP258739
Origin: AHD

Rev.	Reason for Issue or Amendment	Date	Surveyed	Drawn	Approved
A	Original Issue	02-03-2022	J.Townend	J.Cowell	G.Hanton

DRAWING NO.
21-0432S-01

SHEET NO. 2 of 7

VERSION A

SEE SHEET 4

39
SP258739

HIGHWAY

MT LINDESAY

Benchmark
PSM61310
RL24.798

DSIL22.42
Headwall
SIL22.90
450Ø RCP

Emt D
RP125435

Emt A
RP121667

19
SP180530

54
SP180530

59
SP180530

SEE SHEET 2

Scale 1:500 – Lengths are in metres.
5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70

Notes

(1) This plan was prepared for the purpose and the exclusive use of Charter Hall, to be used for design work. This plan is not to be used without the supplied digital information. This information is not to be used for any other purpose or by any other person or corporation.

(2) MAP GRID OF AUSTRALIA
This plan is on GDA2020, MGA Zone 56 with ground distances.
For true MGA Zone 56 Coordinates, scale all data from PSM61310 by 0.9995896.

(3) The contours shown on this plan may not be "natural surface" or "ground level" as defined by some local councils and should not be used as the reference surface when determining building height limits.

LiDAR points have been utilised outside the subject lot for the purposes of flood modelling. The LiDAR information for this site was captured in 2018 and sourced from the Department of Resources.
Contour Interval: 0.5 metres

(4) Property Boundaries
The subject lot boundaries and dimensions shown on this plan are compiled from original survey records SP258739, SP137557 & RC232077 and plotted with a surveying methodology that gives these boundaries a positional uncertainty of 200 millimetres and must not be used for detailed design.
Boundaries of all adjoining lots have been sourced from DCDB to assist with visualising boundaries only. These boundaries are approximate with unknown accuracy.
A Cadastral Survey as defined by the Surveying and Mapping Infrastructure Act 2003 and Surveyors Act 2003 is required for accurate boundary positions and dimensions.

(5) Only visible features of underground services were located. Positions of stormwater mains, sewer mains & water mains that have been plotted are indicative only and as such should not be relied upon for detailed engineering design and construction. Contact relevant authorities before any excavation.

(6) UNDERGROUND SERVICES

This plan generally complies with Australian Standard 5488—2013: Classification of Subsurface Utility Information (SUI).

Definitions:
Quality Level A (QL-A): Features or points on alignments that have been positively identified, measured directly and have a Horizontal and Vertical Positional Uncertainty of 50mm or less. QL-A Features in this data include surface fittings and surveyed inverts
Quality Level B (QL-B): Points on alignments that have been remotely detected by Pensar, these points have a horizontal Positional Uncertainty of 300mm or less.
Quality Level C (QL-C): Alignments are service provider's records with their positioning enhanced by QL-A or QL-B points. All alignments in this data should be considered QL-C unless otherwise noted.
Quality Level D (QL-D): Alignments that have been scaled or digitized from service provider's records.

Only information with Quality Level A should be relied upon for detailed design. For more information see AS5488—2013.

(7) This plan may not be copied unless this note is included.

Linework

- Electrical OverHead
- Fence Line
- Road Crown
- Road Driveway
- Road Bitumen Edge
- Road Kerb Back
- Road Kerb Invert
- Road Kerb Lip
- Storm Located - Quality Level 'A'
- Storm Located - Quality Level 'D'
- Telecomms Located - Quality Level 'C'
- Topo Bank Bottom
- Topo Bank Top
- Topo Change of Grade
- Topo Concrete
- Traffic Barrier
- Water Located - Quality Level 'C'
- Water Located - Quality Level 'D'

Symbols

- Electrical Light Pole
- Electrical Pit
- Electrical Pole
- Storm Headwall
- Storm Invert
- Storm Manhole
- Storm Gully Trap
- Survey Benchmark
- Telecomms Pillar
- Telecomms Pit
- Topo Surface Level
- Water Booster Cabinet
- Water Valve
- Water Fire Hydrant

WOLTER consulting group
Planning Urban Design Landscape Environment Surveying

Contour and Detail Survey

2-140 Crowson Lane, North Maclean

Local Authority: North Maclean
Description: Lot 39 on SP258739
Level Datum: PM61310 - RL24.798
Origin: AHD
Co-ord System: GDA2020, MGA Zone 56

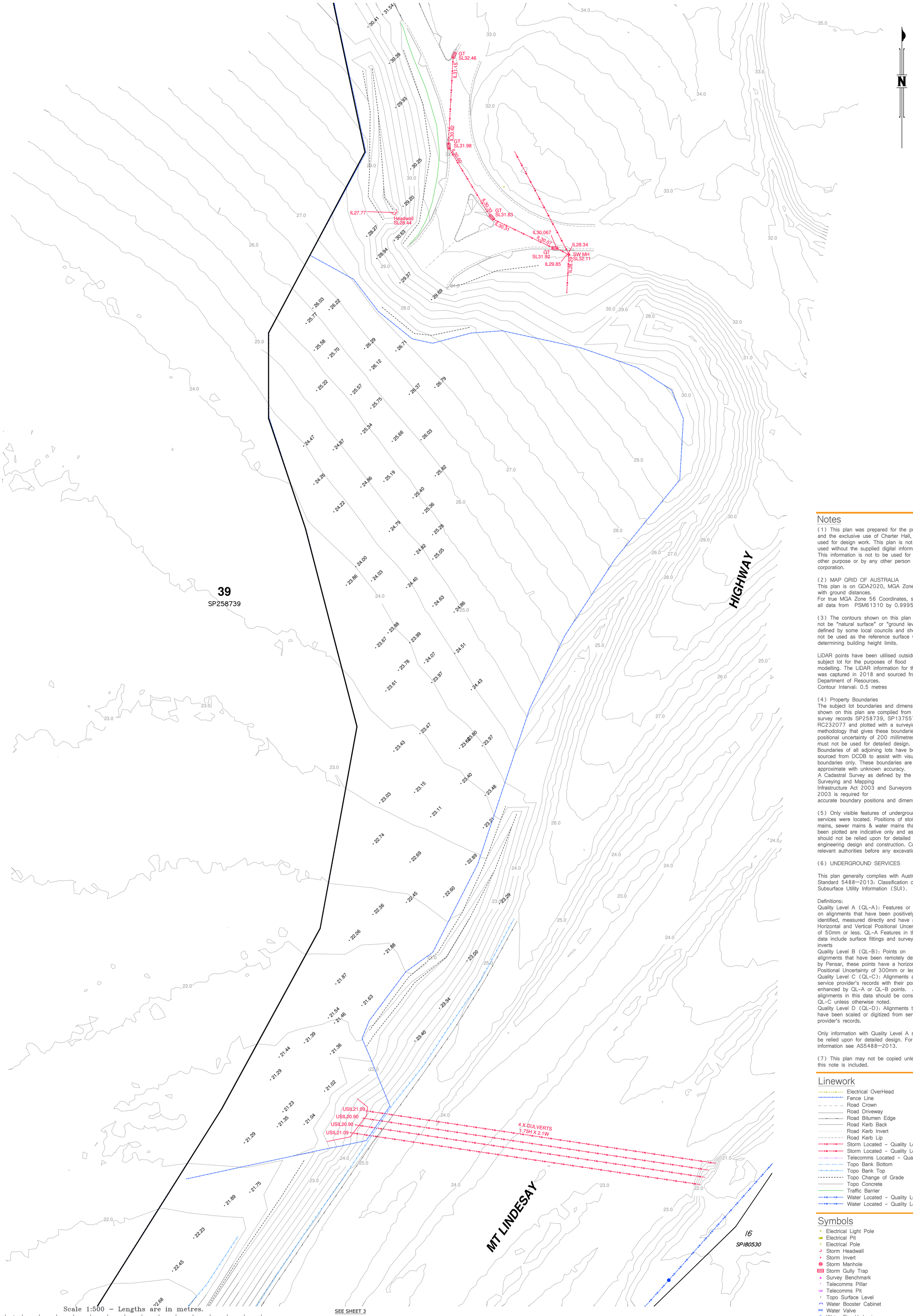
Rev.	Reason for Issue or Amendment	Date	Surveyed	Drawn	Approved
A	Original Issue	02-03-2022	J.Townend	J.Cowell	G.Hanton

DRAWING NO.
21-0432S-01

SHEET NO.
3 of 7

VERSION
A

SEE SHEET 5



Scale 1:500 – Lengths are in metres.

5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70

Notes

(1) This plan was prepared for the purpose and the exclusive use of Charter Hall, to be used for design work. This plan is not to be used without the supplied digital information. This information is not to be used for any other purpose or by any other person or corporation.

(2) MAP GRID OF AUSTRALIA
This plan is on GDA2020, MGA Zone 56 with ground distances.
For true MGA Zone 56 Coordinates, scale all data from PSM61310 by 0.9995896.

(3) The contours shown on this plan may not be "natural surface" or "ground level" as defined by some local councils and should not be used as the reference surface when determining building height limits.

LiDAR points have been utilised outside the subject lot for the purposes of flood modelling. The LiDAR information for this site was captured in 2018 and sourced from the Department of Resources.
Contour Interval: 0.5 metres

(4) Property Boundaries
The subject lot boundaries and dimensions shown on this plan are compiled from original survey records SP258739, SP137557 & RC232077 and plotted with a surveying methodology that gives these boundaries a positional uncertainty of 200 millimetres and must not be used for detailed design.
Boundaries of all adjoining lots have been sourced from DCDB to assist with visualising boundaries only. These boundaries are approximate with unknown accuracy.
A Cadastral Survey as defined by the Surveying and Mapping Infrastructure Act 2003 and Surveyors Act 2003 is required for accurate boundary positions and dimensions.

(5) Only visible features of underground services were located. Positions of stormwater mains, sewer mains & water mains that have been plotted are indicative only and as such should not be relied upon for detailed engineering design and construction. Contact relevant authorities before any excavation.

(6) UNDERGROUND SERVICES

This plan generally complies with Australian Standard 5488—2013: Classification of Subsurface Utility Information (SUI).

Definitions:
Quality Level A (QL-A): Features or points on alignments that have been positively identified, measured directly and have a Horizontal and Vertical Positional Uncertainty of 50mm or less. QL-A Features in this data include surface fittings and surveyed inverts
Quality Level B (QL-B): Points on alignments that have been remotely detected by Pensar, these points have a horizontal Positional Uncertainty of 300mm or less.
Quality Level C (QL-C): Alignments are service provider's records with their positioning enhanced by QL-A or QL-B points. All alignments in this data should be considered QL-C unless otherwise noted.
Quality Level D (QL-D): Alignments that have been scaled or digitized from service provider's records.

Only information with Quality Level A should be relied upon for detailed design. For more information see AS5488—2013.

(7) This plan may not be copied unless this note is included.

Linework

- Electrical OverHead
- Fence Line
- Road Crown
- Road Driveway
- Road Bitumen Edge
- Road Kerb Back
- Road Kerb Invert
- Road Kerb Lip
- Storm Located - Quality Level 'A'
- Storm Located - Quality Level 'D'
- Telecomms Located - Quality Level 'C'
- Topo Bank Bottom
- Topo Bank Top
- Topo Change of Grade
- Topo Concrete
- Traffic Barrier
- Water Located - Quality Level 'C'
- Water Located - Quality Level 'D'

Symbols

- Electrical Light Pole
- Electrical Pit
- Electrical Pole
- Storm Headwall
- Storm Invert
- Storm Manhole
- Storm Gully Trap
- Survey Benchmark
- Telecomms Pillar
- Telecomms Pit
- Topo Surface Level
- Water Booster Cabinet
- Water Valve
- Water Fire Hydrant

WOLTER consulting group
Planning Urban Design Landscape Environment Surveying

Contour and Detail Survey

2-140 Crowson Lane, North Maclean

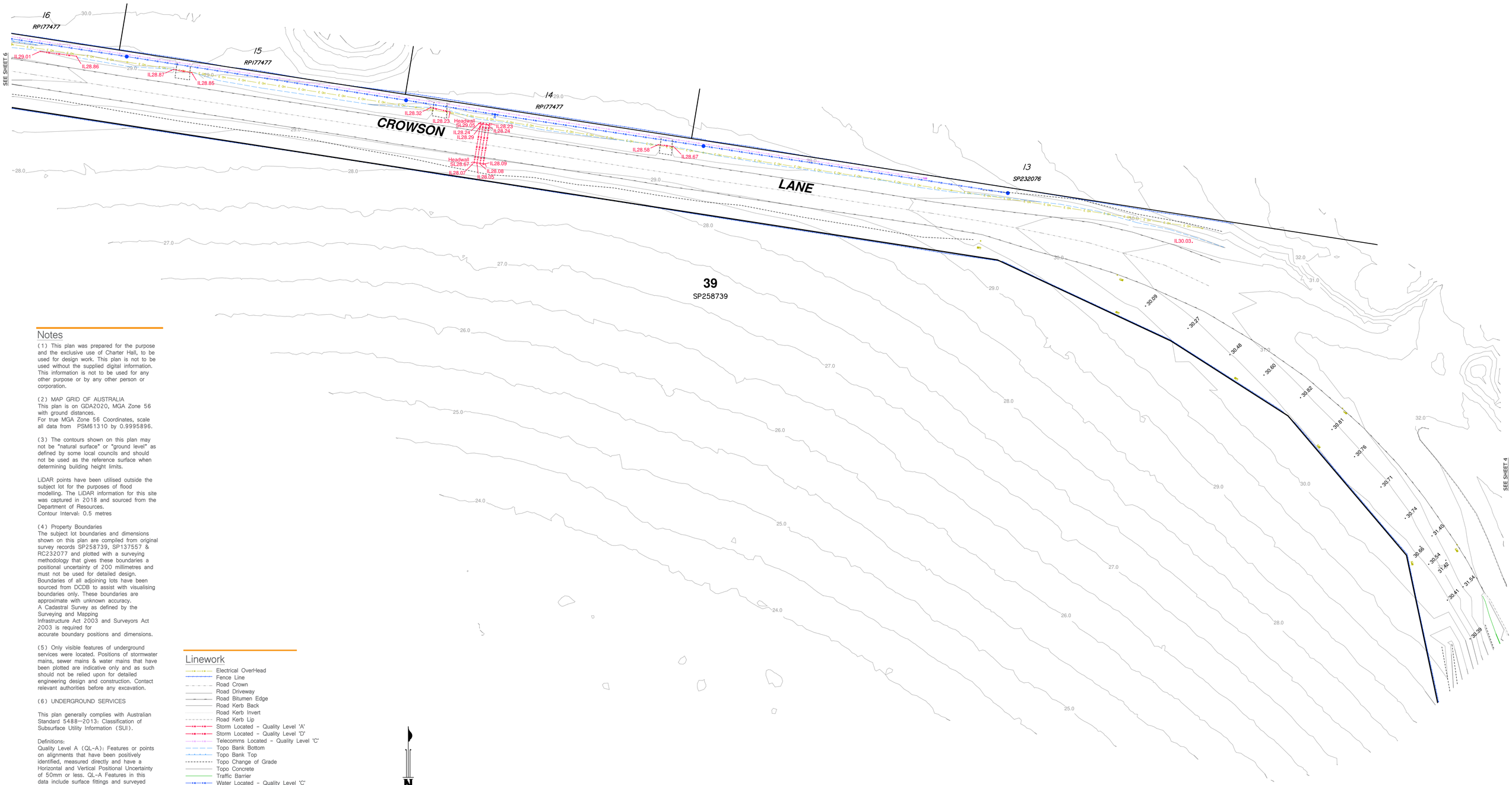
Local Authority: North Maclean
Description: Lot 39 on SP258739
Level Datum: PM61310 - RL24.798
Origin: AHD
Co-ord System: GDA2020, MGA Zone 56

Rev.	Reason for Issue or Amendment	Date	Surveyed	Drawn	Approved
A	Original Issue	02-03-2022	J.Townend	J.Cowell	G.Hanton

DRAWING NO.
21-0432S-01

SHEET NO.
4 of 7

VERSION
A



Notes

(1) This plan was prepared for the purpose and the exclusive use of Charter Hall, to be used for design work. This plan is not to be used without the supplied digital information. This information is not to be used for any other purpose or by any other person or corporation.

(2) MAP GRID OF AUSTRALIA
This plan is on GDA2020, MGA Zone 56 with ground distances.
For true MGA Zone 56 Coordinates, scale all data from PSM61310 by 0.9995896.

(3) The contours shown on this plan may not be "natural surface" or "ground level" as defined by some local councils and should not be used as the reference surface when determining building height limits.

LiDAR points have been utilised outside the subject lot for the purposes of flood modelling. The LiDAR information for this site was captured in 2018 and sourced from the Department of Resources.
Contour Interval: 0.5 metres

(4) Property Boundaries
The subject lot boundaries and dimensions shown on this plan are compiled from original survey records SP258739, SP137557 & RC232077 and plotted with a surveying methodology that gives these boundaries a positional uncertainty of 200 millimetres and must not be used for detailed design.
Boundaries of all adjoining lots have been sourced from DCDB to assist with visualising boundaries only. These boundaries are approximate with unknown accuracy.
A Cadastral Survey as defined by the Surveying and Mapping Infrastructure Act 2003 and Surveyors Act 2003 is required for accurate boundary positions and dimensions.

(5) Only visible features of underground services were located. Positions of stormwater mains, sewer mains & water mains that have been plotted are indicative only and as such should not be relied upon for detailed engineering design and construction. Contact relevant authorities before any excavation.

(6) UNDERGROUND SERVICES

This plan generally complies with Australian Standard 5488—2013: Classification of Subsurface Utility Information (SUI).

Definitions:
Quality Level A (QL-A): Features or points on alignments that have been positively identified, measured directly and have a Horizontal and Vertical Positional Uncertainty of 50mm or less. QL-A Features in this data include surface fittings and surveyed inverts
Quality Level B (QL-B): Points on alignments that have been remotely detected by Pensar, these points have a horizontal Positional Uncertainty of 300mm or less.
Quality Level C (QL-C): Alignments are service provider's records with their positioning enhanced by QL-A or QL-B points. All alignments in this data should be considered QL-C unless otherwise noted.
Quality Level D (QL-D): Alignments that have been scaled or digitized from service provider's records.

Only information with Quality Level A should be relied upon for detailed design. For more information see AS5488—2013.

(7) This plan may not be copied unless this note is included.

Linework

- Electrical OverHead
- Fence Line
- Road Crown
- Road Driveway
- Road Bitumen Edge
- Road Kerb Back
- Road Kerb Invert
- Road Kerb Lip
- Storm Located - Quality Level 'A'
- Storm Located - Quality Level 'D'
- Telecomms Located - Quality Level 'C'
- Topo Bank Bottom
- Topo Bank Top
- Topo Change of Grade
- Topo Concrete
- Traffic Barrier
- Water Located - Quality Level 'C'
- Water Located - Quality Level 'D'

Symbols

- Electrical Light Pole
- Electrical Pit
- Electrical Pole
- Storm Headwall
- Storm Invert
- Storm Manhole
- Storm Gully Trap
- Survey Benchmark
- Telecomms Pillar
- Telecomms Pit
- Topo Surface Level
- Water Booster Cabinet
- Water Valve
- Water Fire Hydrant

WOLTER consulting group
Planning Urban Design Landscape Environment Surveying

Scale 1:500 - Lengths are in metres.
5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70

Contour and Detail Survey

2-140 Crowson Lane, North Maclean

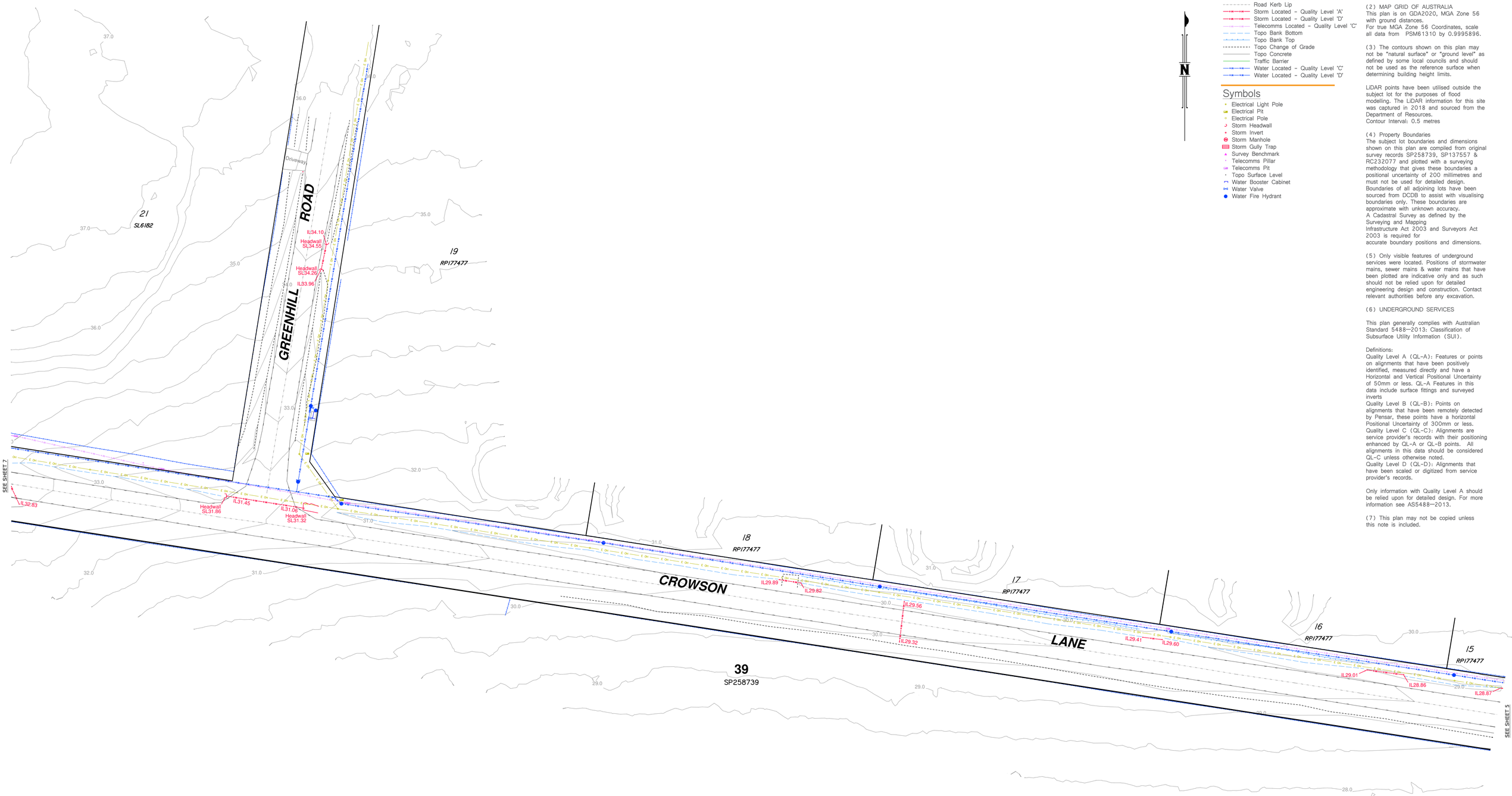
Local Authority: North Maclean
Level Datum: PM61310 - RL24.798
Co-ord System: GDA2020, MGA Zone 56
Description: Lot 39 on SP258739
Origin: AHD

Rev.	Reason for Issue or Amendment	Date	Surveyed	Drawn	Approved
A	Original Issue	02-03-2022	J.Townend	J.Cowell	G.Hanton

DRAWING NO.
21-0432S-01

SHEET NO.
5 of 7

VERSION
A



Linework

- Electrical OverHead
- Fence Line
- Road Crown
- Road Driveway
- Road Bitumen Edge
- Road Kerb Back
- Road Kerb Invert
- Road Kerb Lip
- Storm Located - Quality Level 'A'
- Storm Located - Quality Level 'D'
- Telecomms Located - Quality Level 'C'
- Topo Bank Bottom
- Topo Bank Top
- Topo Change of Grade
- Topo Concrete
- Traffic Barrier
- Water Located - Quality Level 'C'
- Water Located - Quality Level 'D'

Symbols

- Electrical Light Pole
- Electrical Pit
- Electrical Pole
- Storm Headwall
- Storm Invert
- Storm Manhole
- Storm Gully Trap
- Survey Benchmark
- Telecomms Pillar
- Telecomms Pit
- Topo Surface Level
- Water Booster Cabinet
- Water Valve
- Water Fire Hydrant

Notes

(1) This plan was prepared for the purpose and the exclusive use of Charter Hall, to be used for design work. This plan is not to be used without the supplied digital information. This information is not to be used for any other purpose or by any other person or corporation.

(2) MAP GRID OF AUSTRALIA
This plan is on GDA2020, MGA Zone 56 with ground distances.
For true MGA Zone 56 Coordinates, scale all data from PSM61310 by 0.9995896.

(3) The contours shown on this plan may not be "natural surface" or "ground level" as defined by some local councils and should not be used as the reference surface when determining building height limits.

LiDAR points have been utilised outside the subject lot for the purposes of flood modelling. The LiDAR information for this site was captured in 2018 and sourced from the Department of Resources.
Contour Interval: 0.5 metres

(4) Property Boundaries
The subject lot boundaries and dimensions shown on this plan are compiled from original survey records SP258739, SP137557 & RC232077 and plotted with a surveying methodology that gives these boundaries a positional uncertainty of 200 millimetres and must not be used for detailed design. Boundaries of all adjoining lots have been sourced from DCDB to assist with visualising boundaries only. These boundaries are approximate with unknown accuracy.
A Cadastral Survey as defined by the Surveying and Mapping Infrastructure Act 2003 and Surveyors Act 2003 is required for accurate boundary positions and dimensions.

(5) Only visible features of underground services were located. Positions of stormwater mains, sewer mains & water mains that have been plotted are indicative only and as such should not be relied upon for detailed engineering design and construction. Contact relevant authorities before any excavation.

(6) UNDERGROUND SERVICES

This plan generally complies with Australian Standard 5488—2013: Classification of Subsurface Utility Information (SUI).

Definitions:
Quality Level A (QL-A): Features or points on alignments that have been positively identified, measured directly and have a Horizontal and Vertical Positional Uncertainty of 50mm or less. QL-A Features in this data include surface fittings and surveyed inverts
Quality Level B (QL-B): Points on alignments that have been remotely detected by Pensar, these points have a horizontal Positional Uncertainty of 300mm or less.
Quality Level C (QL-C): Alignments are service provider's records with their positioning enhanced by QL-A or QL-B points. All alignments in this data should be considered QL-C unless otherwise noted.
Quality Level D (QL-D): Alignments that have been scaled or digitized from service provider's records.

Only information with Quality Level A should be relied upon for detailed design. For more information see AS5488—2013.

(7) This plan may not be copied unless this note is included.

WOLTER consulting group
Planning Urban Design Landscape Environment Surveying

Scale 1:500 – Lengths are in metres.
5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70

Contour and Detail Survey

2-140 Crowson Lane, North Maclean

Local Authority: North Maclean
Level Datum: PM61310 - RL24.798
Co-ord System: GDA2020, MGA Zone 56
Description: Lot 39 on SP258739
Origin: AHD

Rev.	Reason for Issue or Amendment	Date	Surveyed	Drawn	Approved
A	Original Issue	02-03-2022	J.Townend	J.Cowell	G.Hanton

DRAWING NO.
21-0432S-01

SHEET NO.
6 of 7

VERSION
A

Notes

(1) This plan was prepared for the purpose and the exclusive use of Charter Hall, to be used for design work. This plan is not to be used without the supplied digital information. This information is not to be used for any other purpose or by any other person or corporation.

(2) MAP GRID OF AUSTRALIA
This plan is on GDA2020, MGA Zone 56 with ground distances.
For true MGA Zone 56 Coordinates, scale all data from PSM61310 by 0.9995896.

(3) The contours shown on this plan may not be "natural surface" or "ground level" as defined by some local councils and should not be used as the reference surface when determining building height limits.

LiDAR points have been utilised outside the subject lot for the purposes of flood modelling. The LiDAR information for this site was captured in 2018 and sourced from the Department of Resources.
Contour Interval: 0.5 metres

(4) Property Boundaries
The subject lot boundaries and dimensions shown on this plan are compiled from original survey records SP258739, SP137557 & RC232077 and plotted with a surveying methodology that gives these boundaries a positional uncertainty of 200 millimetres and must not be used for detailed design.
Boundaries of all adjoining lots have been sourced from DCDB to assist with visualising boundaries only. These boundaries are approximate with unknown accuracy.
A Cadastral Survey as defined by the Surveying and Mapping Infrastructure Act 2003 and Surveyors Act 2003 is required for accurate boundary positions and dimensions.

(5) Only visible features of underground services were located. Positions of stormwater mains, sewer mains & water mains that have been plotted are indicative only and as such should not be relied upon for detailed engineering design and construction. Contact relevant authorities before any excavation.

(6) UNDERGROUND SERVICES

This plan generally complies with Australian Standard 5488—2013: Classification of Subsurface Utility Information (SUI).

Definitions:
Quality Level A (QL-A): Features or points on alignments that have been positively identified, measured directly and have a Horizontal and Vertical Positional Uncertainty of 50mm or less. QL-A Features in this data include surface fittings and surveyed inverts
Quality Level B (QL-B): Points on alignments that have been remotely detected by Pensar, these points have a horizontal Positional Uncertainty of 300mm or less.
Quality Level C (QL-C): Alignments are service provider's records with their positioning enhanced by QL-A or QL-B points. All alignments in this data should be considered QL-C unless otherwise noted.
Quality Level D (QL-D): Alignments that have been scaled or digitized from service provider's records.

Only information with Quality Level A should be relied upon for detailed design. For more information see AS5488—2013.

(7) This plan may not be copied unless this note is included.

Linework

- Electrical OverHead
- Fence Line
- Road Crown
- Road Driveway
- Road Bitumen Edge
- Road Kerb Back
- Road Kerb Invert
- Road Kerb Lip
- Storm Located - Quality Level 'A'
- Storm Located - Quality Level 'D'
- Telecomms Located - Quality Level 'C'
- Topo Bank Bottom
- Topo Bank Top
- Topo Change of Grade
- Topo Concrete
- Traffic Barrier
- Water Located - Quality Level 'C'
- Water Located - Quality Level 'D'

Symbols

- Electrical Light Pole
- Electrical Pit
- Electrical Pole
- Storm Headwall
- Storm Invert
- Storm Manhole
- Storm Gully Trap
- Survey Benchmark
- Telecomms Pillar
- Telecomms Pit
- Topo Surface Level
- Water Booster Cabinet
- Water Valve
- Water Fire Hydrant

N

WOLTER consulting group

Planning Urban Design Landscape Environment Surveying

Scale 1:500 - Lengths are in metres.

5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70

Contour and Detail Survey

2-140 Crowson Lane, North Maclean

Local Authority: North Maclean
Level Datum: PM61310 - RL24.798
Co-ord System: GDA2020, MGA Zone 56
Description: Lot 39 on SP258739
Origin: AHD

Rev.	Reason for Issue or Amendment	Date	Surveyed	Drawn	Approved
A	Original Issue	02-03-2022	J.Townend	J.Cowell	G.Hanton

DRAWING NO.
21-0432S-01

SHEET NO. 7 of 7

VERSION A

APPENDIX C

Existing Approval Decision Notice

APPENDIX D

Construction and Establishment Guidelines – Swales, Bioretention Systems and Wetlands.

Queensland Government

Department of
State Development, Infrastructure, Local Government and Planning

Our ref: DEV2018/961

10 September 2021

Wearco Pty Ltd
C/- Reel Planning Pty Ltd
Att: Ms Amy Adamson
PO Box 2088
MILTON QLD 4064

Email: amy@reelplanning.com

Dear Amy

S89(1)(a) Approval of PDA development application
PDA Development Permit for reconfiguring a lot – 1 lot into 4 lots, plus roads and open space at 4499-4651 Mount Lindesay Highway, North Maclean described as Lot 39 on RP253739

On 10 September 2021, pursuant to s.85(4)(b) of the *Economic Development Act 2012,* the Minister for Economic Development Queensland (MEDQ) decided to grant **all** of the PDA development application applied for, in accordance with the attached PDA decision notice.

The PDA decision notice and approved plans / documents can also be viewed in the MEDQ Development Approvals Register via the Department website at www.dsdilgp.qld.gov.au/pda-da-applications.

If you require any further information, please contact Mr Brandon Bouda, Manager, Development Assessment, in Economic Development Queensland, by telephone on (07) 3452 7422 or at brandon.bouda@dsdilgp.qld.gov.au, who will be pleased to assist.

Yours sincerely

Jeanine Stone
Director
Development Assessment
Economic Development Queensland

Economic Development Queensland
GPO Box 2202
Brisbane Queensland 4001 Australia
Website www.edq.qld.gov.au
ABN 76 590 288 697

PDA Decision Notice

Site information		
Name of priority development area (PDA)	Greater Flagstone	
Site address	4499 – 4651 Mount Lindesay Highway, North Maclean	
Lot on plan description	Lot number	Plan description
	39	SP258739

PDA development application details	
DEV reference number	DEV2018/961
'Properly made' date	19 October 2018
Type of application	☒ PDA development application for: ☐ Material change of use ☐ Preliminary approval ☐ Development permit ☒ Reconfiguring a lot ☐ Preliminary approval ☒ Development permit ☐ Operational work ☐ Preliminary approval ☐ Development permit ☐ Application to change PDA development approval ☐ Application to extend currency period
Proposed development	1 into 4 lots, with road, open space and a context plan

PDA development approval details	
Decision of the MEDQ	The MEDQ has decided to grant **all** of the PDA development approval applied for, **subject to** PDA development conditions forming part of this decision notice. The approval is for: • 1 into 4 lots, with road, open space and a context plan
Decision date	10 September 2021
Currency period	6 years from the date of the decision

Economic Development Queensland
GPO Box 2202
Brisbane Queensland 4001 Australia
Website www.edq.qld.gov.au
ABN 76 590 288 697

Approved plans and documents			
The plans and documents approved by the MEDQ and referred to in the PDA development conditions for the PDA development approval are detailed below.			
Approved plans and documents		**Number**	**Date**
1.	Proposed Development Layout Plan	TIEL2020159.CIV.DA 010, Issue H	07/07/21 (as amended in red dated 08/09/2021)
2.	Staging Plan	TIELK202159.CIV.DA, Dwg No. 16, Issue C	07/07/2021 (as amended in red date 03/09/2021)
3.	Concept Earthworks Layout Plan	TIEL202159.CIV.DA, Dwg No. 015, Issue G	07/07/21
4.	Concept Water Reticulation Layout Plan	TIEL202159.CIV.DA, Dwg No. 014, Issue G	07/07/21
5.	Concept Sewer Reticulation Layout Plan	TIEL202159.CIV.DA, Dwg No. 012, Issue G	07/07/21 (as amended in red dated 03/09/2021)
6.	Concept Stormwater Drainage Layout Plan	TIEL202159.CIV.DA, Dwg No. 013, Issue H	07/07/21
7.	Concept Catchment Layout Plan	TIEL202159.CIV.DA, Dwg No. 008, Issue I	07/07/21
8.	Swale Cross Section	TIEL202159.CIV.DA.DWG No 019, Issue C	07/07/21
9.	Swale Longitudinal Section	TIEL202159.CIV.DA, Dwg No 018, Issue B	07/07/21
10.	Traffic Impact Assessment	16378, Version 3	01/03/19
11.	Bushfire Management Plan	Report 16014, Final V3	13 July 2018
12.	Addendum to the bushfire management plan for the proposed development at 4499-4651 Mount Lindsay Highway, North Maclean		18 February 2019
13.	North Maclean Enterprise Precinct (4499-4651 Mount Lindesay Highway, North Maclean) – Progression of Ecological Issues		31 March 2017

Supporting Plans and Documents

To remove any doubt, the following documents are not approved documents for the purposes of this PDA development approval, but rather are supporting documents.

	Supporting plans, reports and specifications	**Number** *(if applicable)*	**Date** *(if applicable)*
Endorsed Context Plan			
1.	North Maclean Enterprise Context Plan Land Use and Road Network		12/07/2021 (as amended in red dated 03/09/2021)
2.	North Maclean Enterprise Context Plan Land Use and Road Network (Wider Locality)		12/07/2021
3.	North Maclean Enterprise Context Plan Ultimate Water and Sewer Network		12/07/2021
4.	North Maclean Enterprise Context Plan Ultimate Stormwater Network		12/07/2021 (as amended in red dated 03/09/2021)
Supporting Plans, Reports and Specifications			
5.	Site Based Stormwater Management Plan	TEL202159, Issue A	08 July 2021
6.	Engineering Services Report	TEL202159, Issue A	06/07/21.

PDA development conditions

PREAMBLE AND ABBREVIATIONS

PREAMBLE

For the purpose of interpreting this PDA Development Approval, including the PDA Development Conditions, the following applies:

Compliance assessment

Where a condition of this approval requires Compliance Assessment, Compliance Assessment is required in accordance with the following:

a) The applicant must:

   i) pay to MEDQ at the time of submission the relevant fee for Compliance Assessment, including any third party peer review costs which will be charged on a 100% cost recovery basis. The Compliance Assessment fees are set out in EDQ Development Assessment Fees and Charges Schedule[1] (as amended from time to time).
   ii) submit to EDQ DA a duly completed Compliance Assessment form[2].

   iii) submit to EDQ DA the documentation as required under the relevant condition.

b) Where EDQ is satisfied the documentation submitted for Compliance Assessment meets the requirements of the relevant condition (or element of the condition), EDQ will endorse the documentation and advise by written notice.

[1] The EDQ Development Assessment Fees and Charges Schedule is available at EDQ's website.

[2] The Compliance Assessment form is available at EDQ's website. It sets out how to submit documentation for Compliance Assessment and how to pay Compliance Assessment fees.

c) Compliance Assessment and endorsement can be repeated where a different design or solution, to that already endorsed, is sought.

d) The process and timeframes that apply to Compliance Assessment are as follows:

i) applicant submits items required under a) above to EDQ DA for Compliance Assessment.

ii) **within 30 business days** – EDQ assesses the documentation and:
1. if satisfied, endorses the documentation; or
2. if not satisfied, notifies the applicant accordingly.

iii) if the applicant is notified under ii.2. above, revised documentation must be submitted **within 30 business days** from the date of notification.

iv) **within 30 business days** – EDQ assesses the revised documentation and:
1. if satisfied, endorses the revised documentation; or
2. if not satisfied, notifies the applicant accordingly.

v) where EDQ notifies the applicant as stated under iv.2. above, repeat steps iii. and iv. above. If either party is not satisfied by the outcome of this process, that party can elect to enter into a mediation process with an independent mediator agreed to by both parties.

Despite note v. above, the condition (or element of the condition) is determined to have been met only when EDQ endorses relevant documentation.

SUBMITTING DOCUMENTATION TO EDQ:

Where a condition of this approval requires documentation to be submitted to either EDQ DA or EDQ TS, submit the documentation to:

a) EDQ DA at: pdadevelopmentassessment@dsdmip.qld.gov.au.

b) EDQ TS at: EDQ_PrePostConstruction@dsdmip.qld.gov.au.

ABBREVIATIONS

For the purposes of interpreting the PDA Development Conditions, the following is a list of abbreviations utilised:

1. **AILA** means a Landscape Architect registered Australian Institute Landscape Architect.

2. **Certification Procedures Manual** means the document titled *Certification Procedures Manual*, prepared by the Department of Infrastructure, Local Government and Planning, dated 16 October 2017 (as amended from time to time).

3. **Contributed Asset** means an asset constructed under a PDA development approval or Infrastructure Agreement that will become the responsibility of an External Authority. For the purposes of operational works for a Contributed Asset, the following definitions apply:
   a. **External Authority** means a public-sector entity other than the MEDQ;
   b. **Parkland** means carrying out operational work related to the provision of parkland infrastructure;

c. **Roadworks** means carrying out any operational work within existing or proposed road(s), to a depth of 1.5m measured from the top of kerb, and includes Streetscape Works;
d. **Sewer Works** means carrying out any operational work related to the provision of wastewater infrastructure;
e. **Streetscape Works** means carrying out any operational work within the verge of a road, including footpath surface treatments, street furniture, street lighting and landscaping;
f. **Stormwater Works** means carrying out any operational work related to the provision of stormwater infrastructure; and
g. **Water Works** means carrying out any operational work related to the provision of water infrastructure.

4. **Council** means Logan City Council.

5. **DSDILGP** means The Department of State Development, Infrastructure, Local Government and Planning

6. **EDQ** means Economic Development Queensland

7. **EDQ DA** means Economic Development Queensland's – Development Assessment team.

8. **EDQ TS** means Economic Development Queensland's – Technical Services team.

9. **IFF** means Infrastructure Funding Framework.

10. **MEDQ** means The Minister of Economic Development Queensland.

11. **PDA** means Priority Development Area.

12. **RPEQ** means Registered Professional Engineer of Queensland

No.	Condition	Timing
General		
1.	**Carry out the approved development** Carry out the approved development generally in accordance with the approved plans and documents; and any other documentation endorsed via Compliance Assessment as required by these conditions.	Prior to survey plan endorsement for the relevant stage
2.	**Street naming** Submit to EDQ DA a schedule of street names approved by Council.	Prior to survey plan endorsement for the relevant stage
Construction		
3.	**Hours of work - construction** Unless otherwise endorsed, via Compliance Assessment for out of hours work, construction hours for the approved development are limited to Monday to Saturday between 6:30am to 6:30pm, excluding public holidays.	During construction unless otherwise endorsed

4.	**Out of hours work - Compliance Assessment** Where out of hours work is proposed, submit to EDQ DA, for Compliance Assessment, an out of hours work request. The out of hours work request must include a duly completed out of hours work request form[3].	Minimum of 10 business days prior to proposed out of hours work commencement date
5.	**Certification of Operational Work** Carry out all Operational Work under this approval in accordance with the *Certification Procedures Manual.*	At all times
6.	**Construction management plan** a) Submit to EDQ TS a site-based Construction Management Plan (CMP), prepared by the principal site contractor and reviewed by a suitably qualified and experienced person responsible for overseeing the site works, to manage construction impacts, including: i) noise and dust in accordance with the EP Act; ii) stormwater flows around and through the site without increasing the concentration of total suspended solids or Prescribed Water Contaminants (as defined in the EP Act), causing erosion, creating any ponding and causing any actionable nuisance to upstream and downstream properties; iii) contaminated land, where required under a site suitability statement prepared in accordance with section 389 of the EP Act; iv) complaints procedures; v) site management: 1. for the provision of safe and functional alternative pedestrian routes, past, through or around the site; 2. to mitigate impacts to public sector entity assets, including street trees, on or external to the site; 3. for safe and functional temporary vehicular access points and frequency of use; 4. for the safe and functional loading and unloading of materials including the location of any remote loading sites; 5. for the location of materials, structures, plant and equipment; 6. of waste generated by construction activities; 7. detailing how materials are to be loaded/unloaded; 8. of proposed external hoardings and gantries (with clearances to street furniture and other public sector entity assets); 9. of employee and visitor parking areas; 10. of anticipated staging and programming; 11. for the provision of safe and functional emergency exit routes; and 12. any out of hours work as endorsed via Compliance Assessment. b) A copy of the CMP submitted under part a) of this condition must be current and available on site.	a) Prior to commencing work for the relevant stage b) During construction

[3] The out of hours work request form is available at EDQ's website.

	c) Carry out all construction work generally in accordance with the CMP submitted under part a) of this condition.	c) During construction
7.	**Erosion and sediment management** a) Submit to EDQ TS an Erosion and Sediment Control Plan (ESCP), certified by a RPEQ or an accredited professional in erosion and sediment control, and prepared generally in accordance with the following: **i)** construction phase stormwater management design objectives of the *State Planning Policy 2017* (Appendix 2 Table A); **ii)** *Healthy Land and Water Technical Note: Complying with the SPP – Sediment Management on Construction Sites*. b) Implement the certified ESCP submitted under part a) of this condition.	a) Prior to commencing work for the relevant stage b) During construction
8.	**Dispersive soil management** a) Submit to EDQ TS a Dispersive Soil Management Plan, prepared by a soil science/soil chemistry specialist that details for the design, construction, and operational phases of the development including: i. the suite of methods required to identify and address potential issues associated with the exposure and re-use of dispersive soils, ii. details of the areas where dispersive soils will be disturbed and treated/rehabilitated. b) Implement and monitor the actions identified in the Dispersive Soil Management Plan as required under part a) of this condition.	a) Prior to commencing site works b) At all times during construction
9.	**Traffic Management Plan** a) Submit to EDQ TS a Traffic Management Plan (TMP), certified by a person holding a current Traffic Management Design qualification. The TMP must include the following: i) provision for the safe and functional management of traffic around and through the site during and outside of construction work hours; ii) provision for the safe and functional management of pedestrian traffic, including alternative pedestrian routes past, through or around the site; iii) provision of parking for workers and materials delivery; iv) risk identification, assessment and identification of mitigation measures; v) ongoing monitoring, management review and certified updates (as required); and vi) traffic control plans and/or traffic control diagrams, prepared in accordance with *Austroads Guide to Temporary Traffic Management*, for any temporary part or full road closures. b) Carry out all construction work generally in accordance with the certified TMP submitted under part a) of this condition, which is to be current and available on site.	a) Prior to commencing work for the relevant stage b) During construction

	***Advice Note**: Operational traffic changes, such as temporary and permanent lane modifications, relaxation of clearway zone hours or footpath closures may require authorisation from Council or DTMR as road manager. It is recommended that applicants engage directly with the applicable road manager.*	
10.	**Public infrastructure (damage, repairs and relocation)** a) Repair any damage to existing public infrastructure caused by works carried out in association with the approved development. b) Where existing public infrastructure require repair or relocation, due to the approved development and/or works associated with the approved development, repair and/or relocate the public infrastructure at no cost to others and in accordance with statutory requirements and adopted design standards. ***Advice Note**: It is recommended applicants record their own dated photographic evidence of the condition of relevant existing public infrastructure both before and after works carried out in association with the approved development.*	a) Prior to survey plan endorsement for the relevant stage b) Prior to survey plan endorsement for the relevant stage
Earthworks and retaining walls		
11.	**Compliance Assessment - Earthworks** a) Submit to EDQ DA for Compliance Assessment detailed earthworks plans, certified by a RPEQ, and designed generally in accordance with: i) Australian Standard AS3798 – 2007 Guidelines on Earthworks for Commercial and Residential Developments and ii) the approved Concept Earthworks Layout Plan, Plan No. TIEL202159.CIV.DA, Dwg No. 015, Issue G, Prepared by Telford Civil, dated 07/07/21. The certified earthworks plans are to: i) include a geotechnical soils assessment of the site; ii) accord with the Erosion and Sediment Control Plan, as required by condition 7 – Erosion and sediment management; iii) accord with the Dispersive Soil Management Plan, as required by condition 8 – Dispersive soil management; iv) include the location and finished surface levels of any cut and/or fill; v) provide details of any areas where surplus soils are to be stockpiled; vi) detail protection measures to: 1. ensure adjoining properties and roads are not impacted by ponding or nuisance stormwater resulting from earthworks associated with the approved development; 2. preserve all drainage structures from structural loading impacts resulting from earthworks associated with the approved development.	a) Prior to commencing earthworks for the relevant stage

	b) Carry out earthworks generally in accordance with the certified plans endorsed by EDQ through part a) of this condition. c) Submit to EDQ TS RPEQ certification that: i) all earthworks have been carried out generally in accordance with the certified plans submitted under part a) of this condition; and ii) any unsuitable material encountered has been treated or replaced with suitable material.	b) Prior to survey plan endorsement for the relevant stage c) Prior to survey plan endorsement for the relevant stage
12.	**Retaining walls (excluding the western boundary retaining wall)** a) Submit to EDQ TS detailed engineering plans, certified by a RPEQ, of all retaining walls 1m or greater in height. Retaining walls must be: i) certified to achieve a minimum 50 year design life; ii) designed generally in accordance with *AS4678 – Earth Retaining Structures* and relevant material standards (e.g. *AS3600 – Concrete Structures*); b) Construct retaining walls generally in accordance with the certified plans required under part a) of this condition. c) Submit to EDQ TS certification from an RPEQ that all retaining wall works 1.0m or greater in height have been constructed generally in accordance with the certified plans submitted under part a) of this condition.	a) Prior to commencing earthworks for the relevant stage b) Prior to survey plan endorsement for the relevant stage c) Prior to survey plan endorsement for the relevant stage
13.	**Compliance Assessment – Western boundary retaining wall** a) Submit to EDQ DA for Compliance Assessment preliminary engineering plans, certified by a RPEQ, of the proposed western boundary retaining wall adjoining the swale. The retaining wall must be: i) fully contained, including footings, within the private lots; ii) designed based on a professional geotechnical advice; iii) take into consideration scour and flood impacts from the adjoining swale; and iv) appropriately fenced (fauna exclusion). b) Submit to EDQ TS detailed engineering plans, certified by a RPEQ, of the proposed retaining wall along the western swale, generally in accordance with the endorsed plans required under part a) of this condition. The retaining wall must be: i) certified to achieve a minimum 100 year design life; ii) designed generally in accordance with *AS4678 – Earth Retaining Structures* and relevant material standards (e.g. *AS3600 – Concrete Structures*); c) Construct retaining walls generally in accordance with the certified plans required under part b) of this condition.	a) Prior to commencing earthworks for Stage 2 b) Prior to survey plan endorsement for Stage 2 c) Prior to survey plan endorsement for Stage 2

	d) Submit to EDQ TS: i) 'as-constructed' plans, certified by a RPEQ, demonstrating that the retaining wall has been constructed generally in accordance with the certified plans submitted under part a) of this condition. ii) A survey plan identifying the location of wall and footings to the property boundary.	d) Prior to survey plan endorsement for Stage 2
Roadworks, urban servicing and stormwater management		
14.	**Compliance Assessment - Road 1, Road 3 and Road 4**	
	a) Submit to EDQ DA for Compliance Assessment functional layout plans, certified by a RPEQ, for Road 1, Road 3 and Road 4 generally in accordance with: i) PDA Guideline No. 13 Engineering standards; and ii) Proposed Development Layout Plan, Plan No. TIEL202159.CIV.DA, Dwg No. 010, Issue H, prepared by Telford Civil and dated 07/07/21 iii) Industrial Connector Street Cross-Section as identified in the Engineering Services Report prepared by Telford Civil and dated 06/07/21. The roads are to be designed to allow for the use of heavy vehicles (B-doubles).	a) Prior to commencing site works
	b) Submit to EDQ TS detailed engineering plans, certified by a RPEQ, for roadworks for Road 1, Road 3 and Road 4, including parking bays, traffic devices and footpaths generally in accordance with: i) PDA Guideline No. 13 Engineering standards; and ii) functional layout plans endorsed under part a) of this condition.	b) Prior to commencing roadworks for the relevant stage
	c) Construct roadworks generally in accordance with the certified plans submitted under part b) of this condition.	c) Prior to survey plan endorsement for the relevant stage
	d) Submit to EDQ TS: i) certification from a RPEQ that all roadworks have been constructed generally in accordance with the certified plans submitted under part a) of this condition; and ii) all documentation as required by the *Certification Procedures Manual*. iii) as-constructed drawings, asset register and test results, certified by a RPEQ, in a format acceptable to the end asset owners for all roadworks constructed under this condition.	d) Prior to survey plan endorsement for the relevant stage
15.	**Compliance assessment – Crowson Lane and Greenhill Road intersection interim layout** Unless ultimate intersection works are already delivered by Council as part of the Crowson Lane augmentation project:	
	a) Submit to EDQ DA for Compliance Assessment engineering design and construction drawings, certified by a RPEQ, for the auxiliary left-turn treatment and channelised right turn lane	a) Prior to commencing intersection works

	treatment at the Crowson Lane/Greenhill Road intersection, generally in accordance with the following plans/documents: i. PDA Guideline No. 13 Engineering standards; and ii. Traffic Impact Assessment, Report No. 16378, Version 3 prepared by Rytenskild Traffic Engineering and dated 1 March 2019. b) Construct the works generally in accordance with the endorsed plans submitted under part a) of this condition. c) Submit to EDQ TS: i) certification from a RPEQ that the intersection works have been constructed generally in accordance with the certified plans submitted under part b) of this condition; and ii) all documentation as required by the Certification Procedures Manual. iii) as-constructed drawings, asset register and test results, certified by a RPEQ, in a format acceptable to the end asset owners for all roadworks constructed under this condition.	b) Prior to survey plan endorsement for the first stage c) Prior to survey plan endorsement for the first stage
16.	**Mount Lindesay Highway Service Road (Road 2)** a) Submit to EDQ TS, approval from the Department of Transport and Main Roads for the Mount Lindesay Highway service lane, identified as Road 2 on Proposed Development Layout Plan, Plan No. TIEL202159.CIV.DA, Dwg No. 010, Issue H, prepared by Telford Civil and dated 07/07/21 The service lane is to be designed to allow for the use of heavy vehicles (B-doubles). b) Construct the extent of Road 2 as shown on Proposed Development Layout Plan, Plan No. TIEL202159.CIV.DA, Dwg No. 010, Issue H, prepared by Telford Civil and dated 07/07/21 from the intersection with Road 1 to the Crowson Lane Interchange with the first stage of development in accordance with the approval from DTMR as required under part a) c) Construct the extent of Road 2 as shown on Proposed Development Layout Plan, Plan No. TIEL202159.CIV.DA, Dwg No. 010, Issue H, prepared by Telford Civil and dated 07/07/21 from the intersection with Road 3 to the intersection of Road 1 with the second stage of development in accordance with the approval from DTMR as required under part a). d) Submit to EDQ TS, certification from a RPEQ that all roadworks have been constructed generally in accordance part a) of this condition. ***Advice Note****: Construction of this service lane in accordance with the Industrial Connector cross-section or as alternatively agreed to by EDQ and meets EDQ's minimum requirements for offsetable infrastructure, can be considered offsetable.*	a) Prior to commencing works for Stage 1 b) As indicated c) As indicated d) Prior to survey plan endorsement for the relevant stage

17.	**Street lighting** Comply with either parts a) and c) or parts b) and c) of this condition.	
	a) Design and install a Rate 2 street lighting system, certified by a RPEQ, to all roads, including footpaths/bikeways within road reserves. The design of the street lighting system must: i) meet the relevant standards of Energex; ii) be endorsed by Energex as 'Rate 2 Public Lighting'; iii) be endorsed by Council as the Energex 'billable customer'; iv) be generally in accordance with *Australian Standards AS1158 – 'Lighting for Roads and Public Spaces*.	a) Prior to survey plan endorsement for the relevant stage
	b) Design and install a Rate 3 street lighting system, certified by a suitably qualified and experienced RPEQ, to all roads, including footpaths/bikeways within road reserves. The design of the street lighting system must: i) be in accordance with *Australian Standards AS1158 – 'Lighting for Roads and Public Spaces'* ii) meet the requirements of AS3000 – '*SAA Wiring Rules'.* iii) meet the requirements of Energex for unmetered supply iv) be endorsed by the relevant ownership authority.	b) Prior to survey plan endorsement for the relevant stage
	c) Submit to EDQ TS 'as-constructed' plans and test documentation, certified by a RPEQ, in a format acceptable to Council.	c) Prior to survey plan endorsement for the relevant stage
18.	**Compliance Assessment - Water reticulation**	
	a) Submit to EDQ DA for Compliance Assessment a detailed water network plan, supported by hydraulic analysis, certified by RPEQ. The water network plan shall be prepared in accordance with: i) *SEQ Water Supply and Sewerage Design and Construction Code*; and ii) Concept Water Reticulation Layout Plan, Plan no. TIEL202159.CIV.DA, Dwg No 014, Issue G, prepared by Telford Civil and dated 07/07/21.	a) Prior to commencing works for Stage 1
	b) Submit to EDQ TS detailed water reticulation design plans, certified by a RPEQ. The certified water reticulation design plans must be designed generally in accordance with: i) *SEQ Water Supply and Sewerage Design and Construction Code*; and ii) the endorsed water network analysis required under part a) of this condition.	b) Prior commencing water reticulation work for the relevant stage
	c) Construct water reticulation works generally in accordance with the certified plans submitted under part a) of this condition.	c) Prior to survey plan endorsement for the relevant stage

	d) Submit to EDQ TS 'as constructed' plans, certified by a RPEQ, of all water reticulation infrastructure constructed in accordance with this condition, including an asset register, pressure and bacterial test results in accordance with: i) SEQ Water Supply and Sewerage Design and Construction Code - Asset Information.	d) Prior to survey plan endorsement for the relevant stage
19.	**Compliance Assessment – Internal Sewer reticulation**	
	a) Submit to EDQ DA for Compliance Assessment a detailed internal sewerage network plan, supported by hydraulic analysis, certified by RPEQ. The internal sewer network plan shall be prepared in accordance with: i) *SEQ Water Supply and Sewerage Design and Construction Code*; and ii) Concept Sewer Reticulation Layout Plan, Plan No. TIEL202159.CIV.DA, Dwg No 012, Issue G, prepared by Telford Civil and dated 07/07/21. The sewerage network plan shall include the extension of the internal sewer reticulation to the southern boundary to service the external catchment falling to the site.	a) Prior to commencing works for the relevant stage
	b) Submit to EDQ TS detailed sewer reticulation design plans, certified by a RPEQ. The certified sewer reticulation design plans must be designed generally in accordance with: i) *SEQ Water Supply and Sewerage Design and Construction Code;* and ii) the endorsed sewer network plan required under part a) of this condition	b) Prior to commencing works for the relevant stage
	c) Construct the internal sewer reticulation works generally in accordance with the certified plans submitted under part b) of this condition.	c) Prior to survey plan endorsement for the relevant stage
	d) Submit to EDQ TS 'as constructed' plans, certified by an RPEQ, of all internal sewer reticulation infrastructure constructed in accordance with this condition, including an asset register, pressure and CCTV results in accordance with: *i) SEQ Water Supply and Sewerage Design and Construction Code - Asset Information.* **Advice Note:** *The Sub-Regional sewerage pump station NM1 and external sewer rising main will be constructed and put in operation by Council.*	d) Prior to survey plan endorsement for the relevant stage
20.	**Temporary sewage tankering of wastewater** Unless the Sub-Regional sewerage pump station NM1 and external rising main is completed and in operation by Council:	
	a) Enter into a tankering agreement with Council for the collection and disposal of wastewater for any lots created; and	a) Prior to survey plan endorsement for the first stage
	b) Maintain the tankering agreement required by part a) of this condition until Sub-Regional sewerage pump station NM1 is commissioned.	b) As indicated

21.	**Compliance Assessment – Updated Site Based Stormwater Management Plan** Submit to EDQ DA for Compliance Assessment an updated Site Base Stormwater Management Plan (SBSMP), certified by a RPEQ, for the management of stormwater within the site to ensure non-worsening to downstream properties, including Mt Lindesay Highway, generally in accordance with *PDA Guideline No. 13 Engineering standards, Stormwater Quantity and Stormwater Quality*. The updated SBSMP shall include the following: i) Confirmation that the subject site is not impacted by flooding. This confirmation is to be provided through the undertaking of a site based flood model. If impacted by flood, provide further details on the Q100 line and the type of inundation – conveyance and/or storage Or Demonstrate that the updated current solution identified in the SBSMP ensures that there is no worsening at lawful point of discharge based on Council's nominated 1% AEP flood level at Mt Lindesay Highway. ii) he on-site detention/bio-retention basins form part of the overall solution. Provide an engineering and legal strategy/mechanism (e.g. Easement) to ensure that these devices can continue to perform as designed into the future. iii) Demonstrate that the design of the road stormwater system will convey runoff from the road reserve and the pre-developed lots to the proposed detention / bio-retention basin. iv) Demonstrate that the configuration, sizing and operation of the proposed detention / bio-retention basin system will accommodate runoff from the road stormwater system as per part (iii) above and result in no net worsening downstream of the site. v) Conveyance of existing external flows to the existing lawful point of discharge, ensuring no-net worsening downstream of the site.	Prior to commencing works
22.	**Stormwater Conveyance System** a) Submit to EDQ TS detailed engineering drawings and hydraulic calculations, certified by a RPEQ, for the stormwater conveyance system designed generally in accordance with: i) *PDA Guideline No. 13 Engineering standards* – Stormwater quantity; and ii) Updated Site Based Stormwater Management Plan, required by Condition 21 of this approval. b) Construct stormwater network generally in accordance with the certified plans submitted under part a) of this condition.	a) Prior to commencing works for the relevant stage b) Prior to survey plan endorsement for the relevant stage

	c) Submit to EDQ TS "as constructed" plans, certified by a RPEQ including an asset register in a format acceptable to Council.	c) Prior to survey plan endorsement for the relevant stage
23.	**Compliance Assessment - Stormwater detention/bio-retention basin** a) Submit to EDQ DA for Compliance Assessment detailed engineering drawings and hydraulic calculations, certified by a RPEQ, for the proposed detention/bio-retention basin designed generally in accordance with: i) PDA Guideline No. 13 Engineering standards – Stormwater Quantity and Stormwater Quality; and ii) Updated Site Based Stormwater Management Plan, required by Condition 21 of this approval. b) Construct the basin generally in accordance with the endorsed plans required under part a) of this condition. c) Submit to EDQ TS "as constructed" plans, certified by a RPEQ including an asset register in a format acceptable to Council. **Advice Note:** *The proposed industrial allotments will have lot-based on-site stormwater detention and water quality treatment measures in the post-development phase. These treatment devices will be installed by the future lot owner with their size and location being allocated to suit the end use. Maintenance of these devices will be the responsibility of the future lot owners.*	a) Prior to commencing works b) Prior to survey plan endorsement for the first stage c) Prior to survey plan endorsement for the first stage
24.	**Compliance Assessment – Swale** a) Submit to EDQ DA for Compliance Assessment detailed engineering drawings and hydraulic calculations, certified by a RPEQ, for the stormwater swale on the western boundary of the land designed generally in accordance with: i) PDA Guideline No. 13 Engineering standards – Stormwater quantity and: ii) Concept Catchment Layout Plan, Plan No. TIEL202159.CIV.DA, Dwg No. 008 Issue I, Prepared by Telford Civil and dated 07/07/2021 iii) Swale Longitudinal Section, Plan No. TIEL202159.CIV.DA, Dwg No 018 Issue B, Prepared by Telford Civil and dated 07/07/2021 iv) Swale Cross Sections, Plan No. TIEL202159.CIV.DA, Dwg No 019 Issue C, Prepared by Telford Civil and dated 07/07/2021 The detailed design shall ensure that the swale: i) has adequate capacity to convey overland flow up to including the 1 in 100year event with appropriate freeboard ii) is free flowing with no ponding iii) is provided with an adjacent track to allow future maintenance iv) maintain a depth*velocity product not exceeding 0.6 up to including 1 in 100year event unless agreed in writing by Council	a) Prior to commencing works

	v) is appropriately fenced (fauna exclusion) along the eastern side of the swale.	
	b) Construct the swale generally in accordance with the endorsed plans required under part a) of this condition.	b) Prior to survey plan endorsement for Stage 2
	c) Submit to EDQ TS swale "as constructed" plans, certified by a RPEQ including an asset register in a format acceptable to Council.	c) Prior to survey plan endorsement for Stage 2
25.	**Electricity**	
	a) Submit to EDQ TS a Certificate of Electricity Supply from ENERGEX for the provision of electricity supply to the approved development.	a) Prior to survey plan endorsement for the relevant stage
	b) Connect the approved development in accordance with the Certificate of Electricity Supply submitted under part a) of this condition.	b) Prior to survey plan endorsement for the relevant stage
26.	**Telecommunications**	
	a) Submit to EDQ TS documentation from an authorised telecommunication service provider confirming that an agreement has been entered into for the provision of underground telecommunication services to the approved development.	a) Prior to survey plan endorsement for the relevant stage
	b) Connect the approved development in accordance with the documentation submitted under part a) of this condition.	b) Prior to survey plan endorsement for the relevant stage
27.	**Broadband**	
	a) Submit to EDQ TS written agreement, from an authorised telecommunications service provider, confirming that fibre-ready pit and pipe infrastructure designed to service the approved development can accommodate services compliant with *Industry Guideline G645:2017 Fibre-Ready Pit and Pipe Specification for Real Estate Development Projects*.	a) Prior to survey plan endorsement for the relevant stage
	b) Construct the fibre-ready pit and pipe infrastructure specified in the agreement submitted under part a) of this condition.	b) Prior to survey plan endorsement for the relevant stage
28.	**Gas**	
	a) Submit to EDQ TS, documentation from an authorised gas service provider, confirming that an agreement has been entered into for the provision of underground gas services to the proposed development.	a) Prior to survey plan endorsement for the relevant stage
	b) Connect the development to underground gas services in accordance with the agreement mentioned in part a) of this condition.	b) Prior to survey plan endorsement for the relevant stage

Landscape and environment		
29.	**Streetscape works – Compliance Assessment** a) Submit to EDQ DA, for Compliance Assessment, detailed streetscape works drawings, certified by an AILA, for proposed streetscape works of Roads 1, 3 and 4, including a schedule of proposed standard and non-standard Contributed Assets to be transferred to Council. The certified drawings are to include, where relevant: 1. location and type of street lighting in accordance with AS1158 –*'Lighting for Roads and Public Spaces';* 2. footpath treatments; 3. location and specifications of streetscape furniture; 4. location and size of stormwater treatment devices; and 5. street trees and plants, including species, size and location generally in accordance with Council's adopted planting schedules and guidelines. b) Construct streetscape works generally in accordance with the streetscape plans endorsed under part a) of this condition. c) Submit to EDQ TS 'as constructed' plans, certified by an AILA, and asset register in a format acceptable to Council.	a) Prior to commencing streetscape work for the relevant stage b) Prior to survey plan endorsement for the relevant stage c) Prior to survey plan endorsement for the relevant stage
30.	**Vegetation Clearing** a) Submit to EDQ TS a vegetation clearing plan prepared by an ecologist for each stage that excludes the 25m buffer corridor and lot identified for open space. b) Undertake vegetation clearing generally in accordance with the plan submitted under part a) of this condition. The clearing is to be undertaken with the stage to be developed. c) Vegetation clearing is to be supervised by an Ecologist. d) Submit to EDQ TS written certification from an Ecologist that vegetation clearing has been carried out generally in accordance with part b) of this condition.	a) Prior to commencement of clearing for relevant stage b) At all times c) At all times d) Within 3 months of completion of clearing of the relevant stage
31.	**Fauna Spotter** a) A licensed Wildlife Spotter/Catcher under the N*ature Conservation Act 1992* is to undertake a survey of the site to identify any fauna or habitat features (e.g. nests, tree hollows) and certify that any necessary fauna protection measures or relocation procedures have been implemented. b) A licensed Wildlife Spotter/Catcher must be present during the vegetation clearing.	a) Prior to commencement of vegetation clearing for the relevant stage b) At all times during vegetation clearing

	c) Submit to EDQ TS certification from the licensed Wildlife Spotter/Catcher that vegetation clearing and fauna protection measures was carried out generally in accordance with the conditions of approval. **Advice Note:** *Where an Environmental Protection and Biodiversity Conservation Act 1999 (EPBC) approval has been granted and includes fauna spotter requirements, the fauna spotter requirements under this condition will not be applicable for the same matters under the EPBC approval*.	c) Within 3 months of the completion of vegetation clearing of the relevant stage
32.	**Vegetation – Compensatory Planting**	
	a) Submit to EDQ TS a planting plan certified by an ecologist showing the extent of compensatory planting to be undertaken in lot identified as 'Open Space' on Proposed Development Layout Plan, Plan No. TIEL2020159.CIV.DA, Dwg 10, Issue H dated 07/07/2021, excluding the minimum 25m buffer on the western boundary, including, type and extent of planting, as set out in the EDQ Guideline 17: Remnant Vegetation and Koala Habitat Obligations in Greater Flagstone and Yarrabilba PDAs dated May 2015.	a) Prior to commencement of vegetation clearing for the relevant stage
	b) Undertake compensatory planting in accordance with a) of this condition.	b) Within 3 months of commencement of vegetation clearing
	c) Once compensatory planting has been undertaken, submit to EDQ TS confirmation from a qualified arborist (AQF Level 5) or ecologist that the compensatory planting has been undertaken in accordance with b) of this condition.	c) Within 12 months of commencement of vegetation clearing of the relevant stage
33.	**Bushfire management**	
	a) Carry out bushfire management works in accordance with: (i) Section 6 of the approved Bushfire Management Plan, Report 16014, Final V3, dated 13 July 2018 (ii) Addendum to the Bushfire Management Plan for the proposed development at 4499-4651 Mount Lindsay Highway, North Maclean dated 18 February 2021.	a) Prior to survey plan endorsement for the relevant stage
	b) Submit to EDQ TS verification from a suitably qualified professional that the works required for bushfire management and mitigation within the relevant stages have been carried out generally in accordance with the relevant approved plans and documents. **Advice Note**: *If the adjoining landowner obtains approval for vegetation clearing that reduces bushfire impact, then this can be articulated though an updated context plan supported by a new bushfire advice.*	b) Prior to survey plan endorsement for the relevant stage

Surveying, land transfers and easements		
34.	**Land transfers - contaminated land** Submit to EDQ TS a copy of a site suitability statement, as required under the EP Act, confirming that all land conditioned to be transferred to a trustee is suitable for the intended purpose(s). The site suitability statement must be prepared by a suitably qualified person and be certified by an approved auditor in accordance with the EP Act. *NOTES:* *For the purpose of this condition a suitably qualified person is defined in the EP Act.* *A list of approved auditors can be found at the following website:* https://www.qld.gov.au/environment/pollution/management/contaminated-land/auditor-engagement.	Prior to survey plan endorsement for the relevant stage
35.	**Land transfers – drainage and offset area** Transfer, in fee simple, to Council as trustee, the Lot identified as Open Space as shown on the approved plans for drainage and offset open space purposes.	At registration of survey plan for Stage 2
36.	**Land transfers – Sewerage pump station** a) Submit to EDQ TS, confirmation from Council on the size and location of the Sewer pump station site. b) Transfer in fee simple, to Council as trustee, land for the proposed sub-regional pump station generally in accordance as shown on: i) Concept Sewer Reticulation Layout Plan, Plan No. TIEL202159.CIV.DA, Dwg No. 012, Issue G, prepared by Teleford Civil and dated 07/07/21. The land metes and bounds must be to the satisfaction of the Chief Executive Officer of the authority. ***Advice Note**: This land forms part of the sub-regional sewer infrastructure to be delivered by Council. Offsets for the land may be available.*	a) Prior to survey plan endorsement of the first stage b) At registration of survey plan for the first stage
37.	**Rising main easement** Provide a 6m wide easement, in favour of and at no cost to the Council, along the southern boundary for the proposed sub-regional sewerage rising main generally in accordance as shown on: i) Concept Sewer Reticulation Layout Plan, Plan No. TIEL202159.CIV.DA, Dwg No. 012, Issue G, prepared by Teleford Civil and dated 07/07/21. The terms of public utility easements are to be to the satisfaction of the Chief Executive Officer of the authority which is to accept and maintain the Contributed Assets. ***Advice Note:** If an alternative route for the rising main is pursued, the easement can be cancelled at the agreement of Council.*	At registration of survey plan for the first stage

38.	**Easements over infrastructure** Provide public utility easements, in favour of and at no cost to the grantee, over infrastructure located in land (other than road) for Contributed Assets. . The terms of public utility easements are to be to the satisfaction of the Chief Executive Officer of the authority which is to accept and maintain the Contributed Assets.	At registration of survey plan for the relevant stage

STANDARD ADVICE

Please note that to lawfully undertake development, it may be necessary to obtain approvals other than this PDA development approval. For advice on other approvals that may be necessary in relation to your proposal, it is recommended that you seek professional advice.

**** End of Package ****

APPENDIX E

Water by Design “Maintaining Vegetated Assets”

Table 3.6: Summary of Staged Construction and Establishment Methods

	OPTION 1: SURFACE PROTECTION	OPTION 2: BYPASS AND EARLY ESTABLISHMENT	OPTION 3: SEDIMENT BASIN AND BIORETENTION FUNCTION	OPTION 4: LEAVE AS SEDIMENT BASIN
Description	Construct the civil infrastructure, including under-drainage and media, for the bioretention system. Install protective layers on the surface of the filter media, allowing it to operate as a shallow sediment basin during the building phase. Surface protection options are: - filter cloth, topsoil and turf - coarse sand, topsoil and turf When 80–90% of building in the catchment is complete, remove the protective layers and establish vegetation in the bioretention system.	Construct the civil infrastructure for the bioretention system. Bypass stormwater around the bioretention system or isolate it from stormwater using a temporary bund. This allows the surface of the bioretention system to be planted out and established immediately. Vegetation is fully established by the end of the building phase. When 80–90% of building in the catchment is complete, the bypass systems can be removed and the bioretention system allowed to function.	The approach combines Option 1 (surface protection) with a sediment basin upstream of the bioretention system. Outflow from the sediment basin is discharged to the bioretention system for further treatment before discharging to the receiving environment. The sediment basin should be designed to capture either coarse sediment only (125um) or as a Type C, D or F sediment basin. Refer to a suitable erosion and sediment control guide, for example the *Best Practice Erosion and Sediment Control* (IECA, 2008) for design requirements of sediment basin. When building in the catchment is 80–90% complete, the sediment basin is cleaned or removed and the protective layers on the bioretention system are removed and vegetation is established.	Install the hydraulic structures and bulk out the system. Allow it to operate as a sediment basin (Type C, D or F) during the building phase. Refer to a suitable erosion and sediment control guide, for example the*Best Practice Erosion and Sediment Control* (IECA, 2008) for design requirements of sediment basin. When building in the catchment is 80–90% complete, the bioretention system can be cleaned and profiled, the under-drainage and bioretention media installed, and the vegetation planted and established.
Order of construction	PFollow the procedures in Section 3.9 from Step 1 to Step 40.	Follow the procedures in Section 3.9 from Step 1 to Step 40.	Follow the procedures in Section 3.9 from Step 1 to Step 40.	Follow the procedures in Section 3.10.
Environmental benefit — the level of water quality management during the building phase	Moderate	Low	High	High

	OPTION 1: SURFACE PROTECTION	OPTION 2: BYPASS AND EARLY ESTABLISHMENT	OPTION 3: SEDIMENT BASIN AND BIORETENTION FUNCTION	OPTION 4: LEAVE AS SEDIMENT BASIN
Landscape amenity	Moderate to high	High	Moderate	Low
Timeframe*	24-36 mo.	12-24 mo.	24-36 mo.	24-36 mo.
Advantages	Protects filter media. Very little maintenance during building phase. Moderate amenity.	Protects filter media. Early establishment of vegetation. High amenity. Simple and early handover of asset.	Protects filter media. High level of protection to receiving environment. Amenity should be moderate to high, provided construction and establishment is successful.	Bioretention system not constructed until after building, therefore no sediment issues. High level of protection to receiving environment.
Disadvantages	Moderate protection to receiving environment (only manages coarse sediment down to 125um). Vegetation established after completion of building phase. Delayed handover of asset.	Low protection to the receiving environment during the building phase. If Option 2 is adopted, it should be combined with strict erosion and sediment control on the building sites or sediment basins at the discharge point of the drainage system (i.e. downstream of the bioretention systems). Establishment of plants requires water or novel irrigation methods	Additional space is required for the sediment basin. A high level of management of sediment basin required, particularly if it is a Type F sediment basin.	Poor landscape amenity. Delay of construction results in a long period before asset handover. A high level of management of sediment basin required, particularly if it is a Type F sediment basin.
Preferred construction and establishment method based on scale:				
Streetscape	✓	✓	X	X
Parkland in high profile location	✓	✓	✓	X
Parkland in low profile location	✓	✓	✓	✓

* Timing dictated by the Building Phase period. (this timing assumes 18-24 moth Building Phase)

3.8.1 Option 1: Surface protection

To minimise the risk of damage and the cost of any re-establishment, the civil works for bioretention systems can be undertaken and temporary protective measures installed to prevent clogging of the filter media during the building phase (see Figure 3.9). Option 1 involves:

- Stage 1 Civil Works — Civil construction and installation of the functional elements of the bioretention system should be undertaken in accordance with Section 3.9.1.
- Stage 2 Building Phase Protection
  - Sediment fences should be installed around the perimeter of the filter media and the top of the batter to prevent sediment from being carried into the system by overland flow. The fences clearly show that construction traffic should not enter the system.
  - Covering the surface of the filtration media with a temporary filter cloth or coarse sand (25 mm) and laying 25 mm of topsoil and turf over it will protect the bioretention system during the construction and building phases.
  - During the building phase, the extended detention acts as a shallow sediment basin.
- Stage 3 Landscape Establishment — When the building phase is 80–90% complete, the temporary measures protecting the bioretention systems and the accumulated sediment can be removed. The bioretention system can be planted and established according to Section 3.9.3.

As illustrated in Figure 3.10, for Option 1, the system will be in the Building Phase Protection mode for up to 24 months, followed by a 12-month period of landscape establishment.Advantages of Option 1 are:

- the bioretention system is comprehensively protected during the building phase
- very little maintenance or irrigation is required during building phase.

Disadvantages of Option 1 include:

- the landscape is not established until after the building is complete and plants will not be fully established until 6–12 months after the building phase
- the filter cloth used to protect the surface of the filter media has blocked in some situations, therefore, the use of coarse sand is also supported.

Figure 3.9: Illustration of Option 1: Protect the bioretention system during the building phase

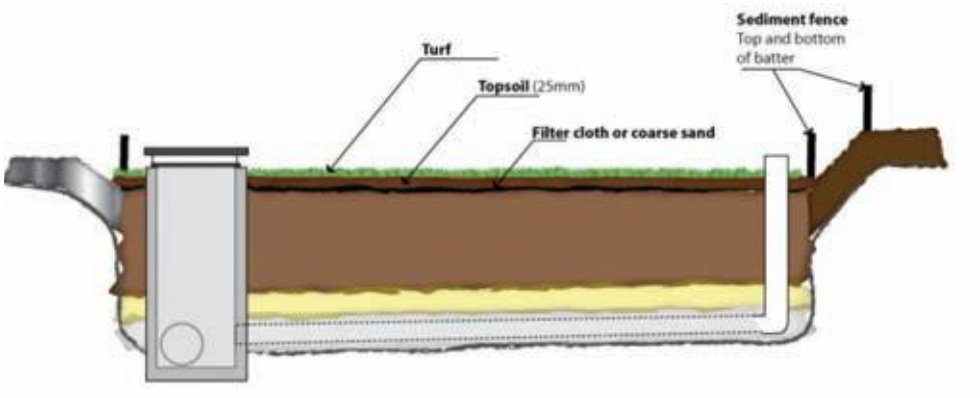
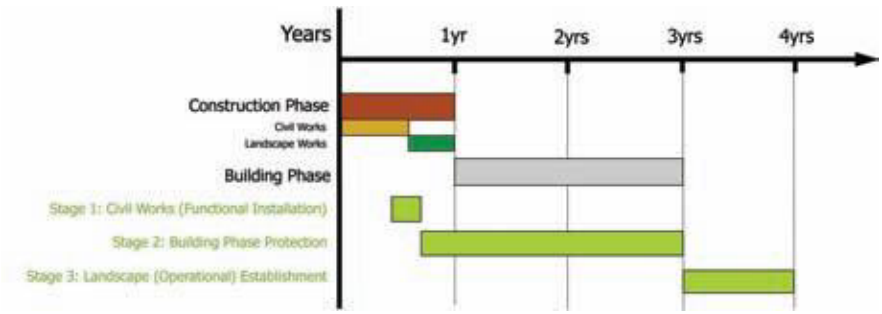


Figure 3.10: Stages of construction associated with Option 1: Surface protection (amended from Leinster, 2006)



3.9 Step-by-step sequence — Options 1, 2 and 3

The following sections provide a step-by-step sequence for civil construction, building phase protection and landscape establishment for the Staged Construction and Establishment Options 1, 2 and 3. Detailed descriptions and, where available, photos are provided for each step in tabular format. It is envisaged the tables will be laminated and used as an on-site reference during construction and establishment.

3.9.1 Stage 1 – Civil construction

The recommended civil construction sequence for bioretention systems is summarised in Table 3.7. The construction sequence should be read in combination with the Bioretention Construction and Establishment Sign-Off Forms.

Table 3.7: Civil construction (Stage 1) step-by-step sequence — Options 1, 2 and 3

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 1: Pre-start meeting	Hold a pre-start meeting with the bioretention designer, civil engineer, landscape architect, site superintendent, civil contractor, landscape contractor and, where required, the Council compliance officer to: - explain the function of the bioretention system - highlight issues and risks associated with construction and establishment - talk through a preferred construction and establishment approach for the site - explain the as-constructed survey or drawing, inspection and sign-off requirements - confirm sources of bioretention media and certification requirements.		
STEP 2: Preparation	Prepare for construction at least 10 days before starting on site. Preparation includes organising the correct equipment to achieve required tolerances (Section 3.4.2), sourcing the bioretention media, ensuring the supplier of the filter media is completing the correct testing (Section 3.5), ordering materials and identifying construction timing and rain contingency plans (Section 3.3).		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 3: Install overflow pit and outlet pipe	Install the overflow pit and ensure the crest of the pit is at design level. The crest of the pit can be used as a datum from which other levels within the system are measured. The pit requires holes for under-drainage pipe connections. These holes should be drilled at this stage or plastic stubs should be installed at the time of casting the pit. Construct outflow headwalls and install sections of stormwater outlet pipe. If the outlet pipe is below the receiving environment levels (Section 3.3.4) consult the superintendent and designers to resolve a change in the design. Design levels and tolerances (+25 mm) must be achieved (Section 3.4.2).		
STEP 4: Bulking out	Undertake bulk earthworks, including construction of bunds surrounding system. The bunds and batters surrounding the system should have 200 mm of topsoil applied following earthworks. Design levels for the top of the bund are inclusive of this 200 mm layer of topsoil, so that bulk earthworks should leave the top of bund 200 mm below the design level. Excavate the surrounding landform to design subsoil levels. This will reduce the need for earthworks adjacent to the systems after they have been constructed. If adopting Construction and Establishment Method Option 3, the upstream sediment basin should be constructed and commissioned prior to bulking out the bioretention system.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 5: Trimming and profiling	Undertake detailed excavation, trimming and profiling of bunds, embankments, batters, sides and base of system, ensuring the base has a minimum 0.5% grade towards pit, unless the design specifies a flat base and design levels achieve (+ 50 mm). If the design has a flat base and does not contain the 0.5% grade, confirm with the designer and refer to these guidelines or the *WSUD Technical Design Guidelines for SEQ* (SEQHWP, 2006). Ensure base of system is free from debris and meets the tolerances (Section 3.4.2).		
STEP 6: Construct overflow weir if required	Where an overflow weir is part of the system design, it should be constructed at this stage and appropriately 'keyed' into the bunds to avoid potential scour at the edges of the weir. Design levels and tolerances must be achieved (+25 mm).		
STEP 7: As-constructed survey	Undertake an as-constructed survey of the system at this stage to confirm design and tolerances (Section 3.4.2) are achieved, including: - overflow pit crest level, invert level and under-drainage connections invert and diameter - outlet pipe upstream and downstream invert levels - overflow weir - base of bioretention system to illustrate the level and the 0.5% grade.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 8: HOLD POINT Inspection and sign-off (Form A)	Following collection of the as-constructed survey, the site superintendent and bioretention designer will inspect the system with the contractor, review the as-constructed survey and take photos. If the construction meets the tolerances outlined Section 3.4.2 and conforms with the design, complete Sign-Off Form A attaching the as-constructed survey and photos.		
STEP 9: Filter cloth Lining	Line system with filter cloth, ensuring the filter cloth extends a minimum of 500 mm beyond the top of the bioretention system side walls.		
STEP 10: Install under-drainage	Install slotted rigid under-drainage pipes and ag-pipes and rigid collector pipes in the specified layout outlined in Section 3.3.6. Ensure all pipes are laid at a minimum 0.5% slope with no localised depressions verified using levels or string lines. Ensure levels are achieved (+25 mm). Seal junctions and connections using sufficient sealant to prevent sand, gravel or soil passing into drainage network. The same drainage layer material (aggregate) may be required to raise pipe in section to adhere to design grade (0.5%).		
STEP 11: Install cleanouts	Connect clean-out points ensuring top of clean-out points will ultimately sit at least 50 mm (preferably 150 mm) above the bioretention surface. The caps on the clean-out points should be screwed in place to secure against vandalism.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 12: HOLD POINT Inspection and sign-off (Form B)	Following installation of the liner and under-drainage, either the site superintendent or bioretention designer will inspect the system with the contractor and take photos. If the lining and under-drainage meets the design and construction requirements, they will complete Sign-Off Form B and attach photos.		
STEP 13: Source drainage layer, transition layer and filter media material	Testing and sourcing the drainage, transition and filter media layers should have commenced as part of Step 2. By Step13, the material can be delivered and stockpiled on site ready for installation.	 2	 4
STEP 14: Install drainage layer	Install 200–250 mm deep gravel drainage layer to cover the slotted under-drainage pipe network. The preferred approach is to use an excavator (long-arm if required) or conveyor belt (see Section 3.4.7) positioned on the edge of the system to place gravel into the system. Contractors can then spread and flatten the gravel to the specified depth using spreader bars. The exact procedure for constructing the drainage layer is determined through consultation with the contractor. It may differ from the procedure described in Section 3.4.7. The site superintendent or bioretention designer should inspect the drainage layer to ensure the correct depth (200–250 mm) and tolerances (+25 mm) have been achieved and that the surface is flat.		
STEP 15: HOLD POINT Inspection of drainage layer	The site superintendent or bioretention designer should inspect the drainage layer to ensure the correct depths (200–250 mm) and grades (typically 0.5%) have been achieved and the surface is flat. The relevant sections of Sign-Off Form C must be completed and photos taken. There is no need to stop construction for this inspection unless specifically required. The site superintendent or designer should undertake the inspection as construction occurs.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 16: Install transition layer	Install a 100 mm deep coarse sand transition layer on top of the gravel drainage layer using the same approach outlined in Step 14 to achieve the correct tolerances (+25 mm) and to ensure the surface is flat.		
STEP 17: Inspection of transition layer	The site superintendent or bioretention designer should inspect the transition layer to ensure the correct depths (100 mm) and grade (typically 0.5%) have been achieved and that the surface is flat. The relevant sections of Sign-Off Form C should be completed and photos taken. The site superintendent or designer can undertake the inspection as construction occurs.		
STEP 18: Install filter media	Place the bioretention filter media to the designed the surface level of the bioretention system in two separate lifts, where required, with each lift lightly compacted as outlined in Section 3.4.6. At the completion of the section lift and compaction, use a spreader bar to flatten the surface of the filter media. Ultimately, the surface of the filter media must be at the design level (+25 mm) and free from local depressions.		
STEP 19: Install sediment fences	Immediately after installing the filter media, install sediment fences around the filter media and at the top of the batter to prevent sediment from entering the batters and to keep construction vehicles off the system.		
STEP 20: Lay protective filter cloth, where required	If there is a delay between Step 18 and Steps 25 and 29, the surface and batters of the bioretention system should be covered with a temporary layer of filter cloth to protect against sediment-laden runoff. Some or all of this filter cloth will be left in place as part of Steps 25 to 28.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 21: As constructed survey	Undertake an as-constructed survey of the system surface and surrounding bunds, picking at least four spots on the surface of the small bioretention systems (<100 m²), one spot level per 100 m² on the surface of large bioretention systems and at least one spot level every 10 m along the top of the bunds as well as any low points.		
STEP 22: HOLD POINT Inspection and sign-off (Forms C and D)	Following collection of the as-constructed survey, the site superintendent and bioretention designer will inspect the system, review the as-constructed survey and take photos. If the construction meets the tolerances outlined in Section 3.4.2 and conforms to the design, Sign-Off Forms C and D will be completed and signed and the as-constructed survey and photos attached.		
STEP 23: Install coarse sediment forebay	Construct the coarse sediment forebay in accordance with the design and advice provided in Section 3.4.9. Concrete is preferred with surface treatment as directed by the design.		
STEP 24: Inspection and sign-off (Form E) PRACTICAL COMPLETION	The site superintendent or bioretention designer should inspect the coarse sediment forebay to ensure consistency with design. The relevant sections of Sign-Off Form E should be completed and photos are taken before either Building Phase Protection works or Landscape Works start.		
CONTINUE TO STEP 25 (Building Phase Protection) if there is building or works in the catchment that will cause damage to the bioretention system or the accumulation of sediment in the system. CONTINUE TO STEP 29 (Landscape Works) if there is no building or works proposed in the catchment that are likely to cause damage to the bioretention system or the accumulation of sediment in the system.			

3.9.2 Stage 2 — Building phase protection

Steps 25–28 provide the construction and establishment sequence for the Building Phase Protection (Stage 2) for Option 1, 2 and 3.

Table 3.8: Building phase protection (Stage 2) step-by-step sequence — Options 1 and 3

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 25: Install sediment fences	If not installed as part of Step 19, sediment fences should be installed around the filter media and at the top of the batter to prevent sediment entering from the batters and to keep construction vehicles off the system.		
STEP 26: Install protective layers on surface of filter media (filter cloth and turf)	Cover the surface of filter media with filter cloth or 25–50 mm of coarse sand and place 25 mm topsoil and turf over the filter cloth or coarse sand. Filter cloth has been known to block in some situations. Coarse sand (25–50 mm) can be used if there is concern with the filter cloth.		
STEP 27: HOLD POINT Inspection and sign-off (Form F)	Following installation of protective layers, the site superintendent and bioretention designer will inspect the system with the contractor. If approved, Sign-Off Form F can be completed and signed and photos attached.		
STEP 28: Building phase operation	During the building phase, which may be as long as 2–4 years, the bioretention system will operate as a shallow sediment basin, and protect the filter media from sediment and clogging. When 80–90% of the building in the catchment is complete, Stage 3: Landscape Works can start (Step 29).		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 25: Install sediment fences	If not already installed as part of STEP 19, sediment fences should be installed around the filter media and at the top of the batter to prevent sediment entering from the batters and to keep construction vehicles off the system.		
STEP 26A: Install bypass system (temporary protective bunds)	The majority of the bioretention system should be isolated from sediment-laden inflows. This can be achieved by: - completely bypassing pipe flows during the building phase and connecting the pipe system to the bioretention system following the building phase - partitioning (bunding) the majority of the bioretention system to isolate flows to the outlet and inlet of the system. Where partitioning (bunding) is used: - it should be designed so that flows are directed into either the overflow pit or overflow weir rather than entering the bioretention system preventing sediment-laden runoff from spreading across the bioretention surface - in small bioretention systems, the protective bund can be created using form ply with all joints overlaid and sealed - in larger bioretention system, the protective bunds can be created using the filter media wrapped in filter cloth - the crest of the bund should be higher than both the overflow pit and the surrounding embankments to ensure no sediment-laden flow enters the bioretention system and the bund should be keyed into the batters to avoid scouring around the edges causing water to enter the system.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 26B: Install protective layers on surface of filter media (filter cloth and turf)	Install temporary protective covering over the bioretention surface located within bunded area adjacent to the coarse sediment forebay. Cover the surface of filtration media with filter cloth (or coarse sand) and place 25 mm topsoil and turf over the filter cloth.		
STEP 27: HOLD POINT Inspection and sign-off (Form F)	Following collection of the as-constructed survey, the site superintendent and bioretention designer will inspect the system, review the as-constructed survey and take photos. If the construction meets the tolerances outlined in Section 3.4.2 and conforms to the design, Sign-Off Forms C and D will be completed and signed and the as-constructed survey and photos attached.		
STEP 28: Building phase operation	During the building phase, which may be up to 2–4 years, landscape can be established on the majority of the bioretention system surfaces in accordance with Stage 3: Landscape Works (Step 29 onwards). The small, protected part of the bioretention system will operate as a sediment basin, while protecting the filter media from sediment and clogging. When 80–90% of the building in the catchment is complete, the bund and protective layers can be removed and appropriate landscaping applied.		

3.9.3 Stage 3 — Landscape establishment

Once the building phase is finished, the protected portions of the bioretention system are cleaned and any accumulated is removed in readiness for establishing the landscape. The recommended landscape establishment sequence for the bioretention systems is shown in Table 3.10. The construction sequence should be read in combination with the Bioretention Construction and Establishment Sign-Off Forms.

Table 3.9: Landscape establishment (Stage 3) step-by-step sequence — Options 1, 2 and 3

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 29: Pre-start and plant set-out meeting	Before starting landscape preparation, hold a pre-start and plant set-out meeting with the bioretention designers, including an ecologist, site superintendent and landscape contractors. The meeting should confirm design and planting establishment and set out the planting to ensure the correct plants are installed in the correct locations.		
STEP 30: Preparation	Prepare for the landscape establishment up to six months before starting, including ordering and inspecting plants at the nursery, ordering and receiving organic mulch and matting and organising a source of irrigation water.		
STEP 31: Remove building phase protection and flushing of under-drainage (where required)	Remove the building phase protective measures such as bunds, filter cloth, coarse sand, turf and accumulated sediment. Care should be taken to avoid damaging the clean-out points for the under-drainage. The under-drainage should be flushed out with potable water to remove any accumulated sediment. If adopting Option 1, the protective measures will remain in place while landscape is being establishment. Protective measures are removed when building is 80–90% complete.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 32: Flatten surface	After the protective layers are removed, flatten the surface of the filter media using a spreader bar. Additional filter media may be required to fill in any over-excavated zones. Care should be taken to not over-compact the filter media (refer Sections 3.4.6 and 3.4.7).		
STEP 33: Mulching	Mulch the filter media surface in accordance with Section 3.6.4. Create holes in the mulch for planting. Ensure the holes have 50 mm separation from stem of the plant to the mulch.		
STEP 34: Soil preparation	Dig planting holes by hand and apply the prescribed amount of slow-release native fertiliser detailed in Section 3.6.3. Pre-soaked wetting agents are recommended in this step.		
STEP 35: Planting	Plant tubestock ensuring the root ball is covered with filter media and the stem is sitting above the filter media. Clear away any mulch from the step to 50 mm (refer Section 3.6.5).	 	 

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 36: Inspection and sign-off (Form G) PRACTICAL COMPLETION	After installing the mulch and plants, the site superintendent and bioretention designer will inspect the system and Sign-Off Form G is completed and photos attached.		
STEP 37: Watering	Water the plants according to Section 3.6.6: Week 1–6 5 waterings per week Week 6–103 waterings per week Week 11–152 waterings per week If there is no rain, each plant should receive 2.5–5.0 litres of water per week during establishment in the first six weeks (40 mm per week).	 	
STEP 38: Weeding	Inspect bioretention plants fortnightly during establishment,removing any weeds by hand.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 39: On-going inspections and final landscape establishment	Monitor the establishment of plants until they are robust and self-sustaining. An established bioretention is measured by (Section 3.6.7): 1. survival of more than 90% of plants 2. 80% coverage of bioretention surface 3. more than one species per macrophyte zone 4. at least 5 plants per m2 and preferably 6–10 plants/m2 5. an increase in plant height of at least 50% measured through markers or stakes 6. propagation of more than 2–3 stems and there is seeding 7. no weeds. Record growth and maturity through three-monthly photo logs every 500m2.		 
STEP 40: Inspection and sign-off (Form H)	After plants are established, the site superintendent and bioretention designer will inspect the system and complete Sign-Off Form H with attached photos.		

3.10.3 Stage 3 — Civil construction and landscape establishment

Once the building phase is complete, the bioretention system is cleaned out of accumulated sediment, civil works are finalised and landscape established in accordance with the sequence provided in Table 3.12. The construction and establishment sequence should be read in combination with the Bioretention System Construction and Establishment Sign-Off Forms.

Table 3.11: Civil construction and landscape establishment step-by-step sequence — Option 3

CONSTRUCTION STEP	ACTIVITY	PHOTOS (LARGE BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 7: Pre-start meeting	Hold a pre-start meeting with the bioretention designer, civil engineer, landscape architect, site superintendent, civil contractor, landscape contractor and, where required, the Council compliance officer to: - explain the function of the bioretention system - highlight issues and risks associated with construction and establishment - talk through a preferred construction and establishment approach for the site - explain the as-constructed survey or drawing, inspection and sign-off requirements - confirm sources of bioretention media and certification requirements.		
STEP 8: Preparation	Prepare for construction at least 10 days before starting on site. Preparation includes organising the correct equipment to achieve required tolerances (Section 3.4.2), sourcing the bioretention media ensuring the supplier of the filter media is completing the correct testing (Section 3.5), ordering materials and identifying construction timing and rain contingency plans (Section 3.3).		
STEP 9: Clean out the bioretention system	Drain the bioretention system and remove accumulated sediment, gross litter and any lining installed for sediment basin operation.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 10: Check the hydraulic structures	The hydraulic structures should be inspected for damage or movement.		
STEP 11: Trimming and profiling	Undertake detailed excavation, trimming and profiling of bunds, embankments, batters, sides and base of system, ensuring base has minimum 0.5% grade towards pit, unless the design specifies a flat base and design levels achieve (+ 50 mm). If the design has a flat base, confirm with the designer and refer to these guidelines or the *WSUD Technical Guidelines for South East Queensland* (SEQHWP, 2006)if the designer does not understand the purposes of the 0.5% grade. Ensure base of system is free from debris and meets the tolerances (Section 3.4.2).		
STEP 12: Construct overflow weir if required	Where an overflow weir is part of the system design, it should be constructed at this stage and appropriately 'keyed' into the bunds to avoid potential scour at the edges of the weir. Design levels and tolerances must be achieved (+25 mm).		
STEP 13: As-constructed survey	An as-constructed survey of the system is required at this stage to confirm design and tolerances (Section 3.4.2) are achieved, including: - overflow pit crest level, invert level and under-drainage connections invert and diameter - outlet pipe upstream and downstream invert levels - overflow weir - base of bioretention system to illustrate the level and the 0.5% grade.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 14: HOLD POINT Inspection and sign-off (Form A)	Following collection of the as-constructed survey, the site superintendent and bioretention designer will inspect the system with the contractor, review the as-constructed survey and take photos. If the construction meets the tolerances outlined Section 3.4.2 and conforms with the design, complete Sign-Off Form A attaching the as-constructed survey and photos.		
STEP 15: Filter cloth lining	Line system with filter cloth, ensuring filter cloth extends a minimum of 500 mm beyond the top of the bioretention system's side walls.		
STEP 16: Install under-drainage	Install slotted rigid under-drainage pipes or ag-pipe and rigid collector pipes in the specified layout outlined in Section 3.4.5. Ensure all pipes are laid at a minimum 0.5% slope with no localised depressions verified using levels or string lines. Ensure levels are achieved (+25 mm). Seal junctions and connections using sufficient sealant to prevent sand, gravel or soil passing into drainage network. The same drainage layer material (aggregate) can be used to adjust the under drainage grade of the pipe to 0.5%.		
STEP 17: Install cleanouts	Connect clean out points ensuring the top of clean out points will ultimately sit at least 50 mm (preferably 150 mm) above the bioretention surface. Clean out caps should be screwed in place to secure against vandalism.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 18: HOLD POINT Inspection and sign-off (Form B)	Following collection of the as-constructed survey, the site superintendent and bioretention designer will inspect the system with the contractor, review the as-constructed survey and take photos. If the construction meets the tolerances outlined Section 3.4.2 and conforms with the design, complete Sign-Off Form A attaching the as-constructed survey and photos.		
STEP 19: Source drainage layer, transition layer and filter media material	Testing and sourcing of the drainage, transition and filter media layers should have commenced as part of Step 2. By Step 19, the material can be delivered and stockpiled on site ready for installation.		
STEP 20: Install drainage layer	Install 200–250 mm deep gravel drainage layer to cover the slotted under-drainage pipe network. The preferred approach is to use an excavator (long-arm if required) or conveyor belt (see Section 3.4.7) positioned on the edge of the system to place gravel into the system. Contractors can then spread and flatten the gravel to the specified depth using spreader bars. The exact procedure for constructing the drainage layer is determined through consultation with the contractor. It may differ from the procedure described in Section 3.4.7. The site superintendent or bioretention designer should inspect the drainage layer to ensure the correct depth (200–250 mm) and tolerances (+25 mm) have been achieved and that the surface is flat.		
STEP 21: HOLD POINT Inspection of drainage layer	The site superintendent or bioretention designer should inspect the drainage layer to ensure the correct depths (200–250 mm) and grade (typically 0.5%) have been achieved and the surface is flat. The relevant sections of Sign-Off Form C must completed and photos taken. There is no need to stop construction for this inspection unless specifically required. The site superintendent or designer should undertake the inspection as construction occurs.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 22: Install transition layer	Install a 100 mm deep coarse sand transition layer on top of the gravel drainage layer using the same approach outlined in Step 14 to achieve the correct tolerances (+25 mm) and to ensure the surface is flat.		
STEP 23: Inspection of transition layer	The site superintendent or bioretention designer should inspect the transition layer to ensure the correct depths (100 mm) and grade (typically 0.5%) have been achieved and that the surface is flat. The relevant sections of Sign-Off Form C should be completed and photos taken. There is no need to stop construction for this inspection, unless specifically required. The site superintendent or designer should undertake the inspection as construction occurs.		
STEP 24: Install filter media	Place the bioretention filter media to the designed the surface level of the bioretention system, in two separate lifts where required, with each lift lightly compacted as outlined in Section 3.4.6. At the completion of the section lift and compaction, use a spreader bar to flatten the surface of the filter media. Ultimately, the surface of the filter media must be level at the design level (+25 mm) and free from local depressions.		
STEP 25: Install sediment fences	Immediately after installing the filter media, install sediment fences around filter media and at the top of the batter to prevent sediment from entering the batters and to keep construction vehicles off the system.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 26: Lay protective filter cloth, where required	If there will be delay between Step 34 and Step 35 (handover from civil contractor to landscape contractor), the surface and batters of the bioretention system should be covered with a temporary layer of filter cloth to protect against sediment-laden runoff. The filter cloth will be removed prior to installation and establishment of the landscape.		
STEP 27: As constructed survey	Undertake an as-constructed survey of the system surface and surrounding bunds, choosing at least four spots on the surface of the small bioretention systems (<100 m^2), one spot level per 100 m^2 on the surface of large bioretention systems and at least one spot level every 10 m along the top of the bunds as well as any low points.		
STEP 28: HOLD POINT Inspection and sign-off (Forms C and D)	Following collection of the as-constructed survey, the site superintendent and bioretention designer will inspect the system, review the as-constructed survey and take photos. If the construction meets the tolerances outlined Section 3.4.2 and conforms with the design, Sign-Off Forms C and D will be completed and signed and the as-constructed survey and photos attached.		
STEP 29: Install coarse sediment forebay	Construct coarse sediment forebay in accordance with the design and advice provided in Section 3.4.9. Concrete is preferred with surface treatment as directed by the design.		
STEP 30: Inspection and sign-off (Form E) PRACTICAL COMPLETION	The site superintendent or bioretention designer should inspect the coarse sediment forebay to ensure consistency with design. The relevant sections of Sign-Off Form E should be completed and photos taken before either Building Phase Protection works or Landscape Works start.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
CONTINUE TO STEP 31 (Landscape Works) immediately. This will involve a rapid handover from the civil contractor to the landscape contractor.			
Landscape works STEP 31: Pre-start and plant set-out meeting	Before starting landscape preparation, hold a pre-start and plant set-out meeting with the bioretention designers, including an ecologist, site superintendent and landscape contractors. The meeting should confirm design and planting establishment and set out the planting to ensure the correct plants are installed in the correct locations.		
STEP 32: Preparation	Prepare for the landscape establishment up to six months before starting, including ordering and inspecting plants at the nursery, ordering and receiving organic mulch and matting and organising a source of irrigation water. For bioretention systems, recycled water for irrigation is generally not recommended.	 3	 3
STEP 33: Remove temporary protection	If temporary protective filter cloth was installed at STEP 26, this should be removed at this stage. Care should be taken to avoid damaging the clean-out points for the under-drainage.		
STEP 34: Flatten surface	After the protective layers are removed, flatten the surface of the filter media using a spreader bar. Additional filter media may be required to fill in any over-excavated zones. Care should be taken to not over-compact the filter media (refer Sections 3.4.6 and 3.4.7).		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 35: Mulching	Mulch the filter media surface in accordance with Section 3.6.4. Create holes in the mulch for planting. Ensure the holes have 50 mm separation from stem of the plant to the mulch.		
STEP 36: Soil preparation	Dig planting holes by hand and apply the prescribed amount of slow-release native fertiliser detailed in Section 3.6.3. Pre-soaked wetting agents are recommended in this step.		
STEP 37: Planting	Plant tubestock ensuring the root ball is covered with filter media and the stem is sitting above the filter media. Clear away any mulch from the step to 50 mm (refer Section 3.6.5).	 	 
STEP 38: Inspection and sign-off (Form G) PRACTICAL COMPLETION	After installing the mulch and plants, the site superintendent and bioretention designer will inspect the system and Sign-Off Form G is completed and photos attached.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 39: Watering	Water the plants according to Section 3.6.6: Week 1–6 5 waterings per week Week 6–10 3 waterings per week Week 11–15 2 waterings per week If there is no rain, each plant should receive 2.5–5.0 litres of water per week during establishment in the first six weeks (40 mm per week).		
STEP 40: Weeding	Inspect bioretention plants fortnightly during establishment, removing any weeds by hand.		
STEP 41: On-going inspections and final landscape establishment	Monitor the establishment of plants until they are robust and self-sustaining.An established bioretention is measured by (Section 3.6.7): 1. survival of more than 90% of plants 2. 80% coverage of bioretention surface 3. more than one species per macrophyte zone 4. at least 5 plants per m2 and preferably 6–10 plants/m2 5. an increase in plant height of at least 50% measured through markers or stakes 6. propagation of more than 2–3 stems and there is seeding 7. no weeds. Record growth and maturity through three-monthly photo logs every 500m^2.		 

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 42: Inspection and sign-off (Form H)	After plants are established, the site superintendent and bioretention designer will inspect the system and complete Sign-Off Form H with photos attached.		

3.11 Potential failure and rectification

Constructing and establishing any civil or landscape asset requires refinement and repair of defects to ensure compliance with the design. Table 3.13 outlines potential construction and establishment failures or defects for bioretention systems and suggests ways to rectify the problems. The table focuses on construction and establishment defects and on functional failures that can occur following the completion of construction and provides rectification actions. The table is not exhaustive and will be updated in future revisions of this guideline. The bioretention designer or external expert should be consulted when the following failures occur to confirm rectification actions.

Table 3.12: Potential failure scenarios for bioretention systems and rectification actions

DEFECT OR FAILURE	CAUSES	RECTIFICATION
Ponding water on surface or reduce filtration rate	Blinding or blockage of filter media surface with sediment.  	Confirm surface blinding or blockage by scraping back the surface sediment to reach the bioretention filter media filling the void with water to see if the water drains. In-situ hydraulic conductivity testing should be undertaken at the surface, middle and bottom of the filter media profile in accordance with *Practice Note 1: In-Situ Measurement of Hydraulic Conductivity* (Hatt and Le Coustumer, 2008). More detailed assessment may be required by: - collecting samples at the surface and at depth at a number of locations in the system - testing samples for particle size distribution and saturated hydraulic conductivity in accordance with the *Guideline Specifications for Soil Media in Bioretention Systems* (FAWB, 2008). Rectification of the system is required if: - the in-situ hydraulic conductivity testing confirms low conductivity at the surface and high conductivity at depth - the particle distribution size analysis finds finer material at the surface.

DEFECT OR FAILURE	CAUSES	RECTIFICATION
Ponding water on surface or reduce filtration rate (cont).		Rectification options include: - identifying the source of the sediment and rectifying - removing the surface layer of sediment and re-installing the filter media to achieve the design surface level, then mulching and replanting - planting with rushes, grasses and trees to increase plant and root density to break up the surface. The bioretention system must drain according to design requirements within 12 months. If it does not drain, remove the surface sediment and re-mulch and replant the system.
	Structural collapse as a result of using incorrect media or poor installation. Structural collapse means the soil's structure is unable to hold fine soil in place so the fines move to a certain location in the profile of the filter media, therefore blocking the movement of water.  3	Confirm structural collapse by: - collecting samples at the surface, middle and bottom of the filter media at a number of locations in the system - testing the samples for particle size distribution and saturated hydraulic conductivity in accordance with the *Guideline Specifications for Soil Media in Bioretention Systems* (FAWB, 2008) - completing in-situ hydraulic conductivity testing at the surface, middle and bottom of the filter media profile in accordance with *Practice Note 1: In-Situ Measurement of Hydraulic Conductivity* (Hatt and Le Coustumer, 2008). If the testing finds the filter media has structurally collapsed, rectification is required. Rectification options include: - removing the filter media and installing new media that meets the specifications, mulch and replant (preferred) - planting with rushes, grasses and trees to break-up the surface (alternative). The bioretention system must drain according to the design requirements within 12 months. If it does not drain, remove the surface sediment and re-mulch and replant the system.

DEFECT OR FAILURE	CAUSES	RECTIFICATION
Ponding water on surface or reduce filtration rate (cont).	Blockage of transition or drainage layer with sediment.	To confirm if the transition layer or drainage layer is blocked with sediment, a geotech specialist can create boreholes at a number of locations in the bioretention system to allow the collection of samples for particle size distribution analysis. Permeability testing should also be undertaken at the transition layer and drainage layer to confirm hydraulic conductivity. If the transition layer or drainage layer is blocked with sediment (i.e. contains significant fine soils), remove the bioretention media and refill the system with filter media and plant out in accordance with these guidelines.
	Filter cloth around under-drainage or between the filter media and transition layer/ drainage layer is clogged with fine sediment.	Filter cloth should not be installed around the under-drain or between any of the bioretention media layers. The Sign-Off Forms and photos will confirm that filter cloth has not be used. If filter cloth has been used and is clogged with fine sediment, remove the filter cloth and the bioretention media. Refill the bioretention system with filter media and plant out in accordance with these guidelines.
	Blockage of under-drains.	Clean out under-drains with standard plumbing equipment. The bioretention system should drain after cleaning. If system does not drain, then investigate blockage of the transition or drainage layers, blinding of filter media, or structural collapse of the filter media.
Scour and short-circuiting of flows at outlet pit	Under-drains that are not sealed into outlet pit can result in flow short-circuiting down the side of pit and scouring the filter media, the transition layer and the drainage layer.  	To rectify (Figure 3.16): - seal the under-drainage pipes into the pit - dig out the eroded sections of the bioretention profile including the filter media, transition layer and drainage layer well beyond the bounds of the scour - replace the drainage layer, transition layer and filter media and compact the layers - install a layer of filter cloth to the pit and extend it down the side of the pit into the filter media to a depth of300 mm, extending the filter cloth horizontally out into the filter media by 300–500 mm as shown in the sketch to minimises the risk of scour down the side of the pit.

DEFECT OR FAILURE	CAUSES	RECTIFICATION
	Scour will eventually occur around any apron or concrete spill on the outlet pit as it impossible to compact filter media up under the apron or spill.  2	To rectify: - dig out the eroded sections of the bioretention profile including the filter media, transition layer and drainage layer well beyond the bounds the scour - remove the concrete apron or spill - install a layer of filter cloth to the pit and extend it down the side of the pit into the filter media to a depth of 300 mm, extending the filter cloth horizontally out into the filter media by 300–500 mm as shown in the sketch to minimises the risk of scour down the side of the pit - replace the drainage layer, transition layer and filter media and compact the layers.
Scour and short-circuiting at the edge of bioretention system	Erosion of the bioretention batters. Filter cloth is not extended up to the batters of the bioretention system resulting in scour down the outside edge of the filter cloth.	To rectify: - dig out the eroded sections of the bioretention profile including the filter media, transition layer and drainage layer well beyond the bounds the scour - install new filter cloth from the base of the bioretention up the edge to extend at least 500 mm up the batters and pin in place - replace the drainage layer, transition layer and filter media and compact the layers - place topsoil over the filter cloth on the batters.
Scour and short-circuiting at bioretention walls	In many situations, the conceptual design of bioretention systems does not allow space for batters and designers are forced to use vertical walls. Where the walls extend down the side of the filter media there is a risk of flow scouring the filter media at the interface with the wall. This is a particular concern with rock walls or walls without a flat vertical surface.	To rectify: Option 1 (Figure 3.17) - place filter fabric on the wall and extend at least 1 m onto filter media - install filter media or top soil over the filter cloth to create a batter against the wall, extending the top of the batter well above the likely flood level - wrap the filter cloth back over the top of the batter and place more topsoil on the surface - compact, mulch and plant.

DEFECT OR FAILURE	CAUSES	RECTIFICATION
Scour and short-circuiting at bioretention walls (cont).		Option 2 (Figure 3.18) - dig out the eroded sections of the bioretention profile including the filter media, transition layer and drainage layer to at least 0.5 m away from the wall - install clay within the 0.5 m space, from the edge of the filter media to the wall - compact the clay to ensure there is no potential flow connection from the wall to the drainage layers of the bioretention system - install filter fabric up the vertical edge of clay and across flat surface - install the drainage layer, transition layer and filter media and compact the layers - mulch and plant out.
Scour around the high-flow weir	If the weir crest and grouted rock protection is not extended up the batters of the bioretention system, scour may occur around the edge of the weir as flows will skirt the weir.	Extend the concrete weir crest and grouted rock batters up the batters to at least 500 mm above the weir invert.
Scour of bioretention batters	Lateral surface flows enter the bioretention system from a small catchment directly adjacent to the bioretention.	Direct the lateral flows to small rock-lined channels that feed down the batters to the bioretention system. Plant out scoured zones. Where required, organic mesh or netting may be required to avoid erosion of the batters.
Failure of the bioretention bunds	Failure of bioretention bunds can occur through scours and overflows. The bunds can also fail if they are constructed too low.	Rectify scour and ensure geotech certification of the bund for stability and capacity. If necessary, raise the bund well above the top of the potential flood levels in the bioretention system and provide rock protection in high velocity locations.
Damaged to clean-out or missing inspection caps	The systems may be vandalised, for example, inspection caps may be removed.	Replace inspection caps and ensure they are secured with screws to reduce the risk of vandalism.

DEFECT OR FAILURE	CAUSES	RECTIFICATION
Failure of plants	Plants may fail to thrive if the filter media does not meet specifications, particularly for water-hold capacity and organic content.	Review Bioretention Construction and Establishment Sign-Off Form C to confirm the media meets the specifications outlined in Section 3.5. Collect samples within the bioretention system at the surface, middle and base of the filter media approximately every 250 m^2. Complete the FAWB tests on the samples in accordance with Section 3.5 and compare the results with the specification. If the installed media does not meet the specifications, seek advice from laboratory on how to ensure the specifications are met. In-situ amelioration may be possible; however, if not the filter media will need to be removed and replaced.
	Inappropriate watering during establishment of plants.	If plants are alive, irrigate according to the recommendations in Section 3.6.6 or install a riser at the outlet pit to raise water levels in the bioretention system to just below the root of the plants. If the plants have died, mulch, replant and irrigate according to Section 3.6.6 or install a riser to raise water levels in the bioretention system.
	Lack of mulch or fertiliser during establishment of plants.	If plants are alive, apply small quantity of liquid fertiliser and apply much. If plants have died, mix compost or organics into the top 50–100 mm of the filter media, mulch and replant.
	Poor plant cover of less than five to six plants per m2.	Review species selection in consultation with the bioretention designer and select an alternative species that is better suited to the subject site.
	Excessive weed cover.	Remove weeds manually to protect native plants. Avoid weed seed set by pro-actively maintaining and reducing weeds from the edge of the bioretention system.

BIORETENTION SYSTEM CONSTRUCTION & ESTABLISHMENT SIGN-OFF FORMS			
Asset I.D.		DA No.	
System location:			
Area:	Catchment Area (ha):	Bioretention Area (ha):	
Civil drawing no.			
Landscape drawing no.			
ROLE/STAKEHOLDER	**COMPANY**	**CONTACT NAME**	**CONTACT DETAILS**
Developer			
Site superintendent (civil)			
Site superintendent (landscape)			
Bioretention designer			
Civil engineer			
Landscape architect			
Civil contractor			
Landscape contractor			
Council compliance officer			

CHECKLIST OF SIGN-OFF FORMS			
SIGN-OFF FORM	**DATE COMPLETED**	**NAME OF SIGNATORY & ROLE (E.G. SUPERINTENDENT)**	**SIGNATURE**
Pre-Start Meeting			
Form A — Earthworks & Functional Structures			
Form B — Under-Drainage			
Form C — Bioretention Media			
Form D — Finished Levels			
Form E — Coarse Sediment Forebay			
Form F — Protective Measures			
Form G — Landscape Installation			
Form H — Landscape Establishment			

PRE-START MEETING

List pre-start meeting attendees who are to sign indicating they have attended the meeting and understand the design intent, construction and establishment process.

Location			
Date			
ROLE/STAKEHOLDER	**COMPANY**	**CONTACT NAME**	**CONTACT DETAILS**
Developer			
Site superintendent (civil)			
Site superintendent(landscape)			
Bioretention designer			
Civil engineer			
Landscape architect			
Civil contractor			
Landscape contractor			
Other			
Other			
Other			
Comments (attach and refer to additional pages if necessary)			

Actions (attach and refer to additional pages if necessary)

FORM A — EARTHWORKS AND FUNCTIONAL (HYDRAULIC) STRUCTURES

Purpose: To ensure earthworks bulking out, trimming and profiling and the key levels of functional (hydraulic) structures are in accordance with design drawings and specifications. The earthworks and structures dictate the movement of stormwater through the bioretention system and are a critical element in the function of the system.

ITEMS	CHECKED	SATISFACTORY	ACTION (IF UNSATISFACTORY)	INITIAL
As constructed survey completed and attached to this form				
Photos taken and attached to this form				
Set-out of system is correct				
Base levels are at correct elevation (±50 mm)				
Base at correct grading (0.5%)				
Punch out holes in overflow pit are correct size, correct level and above invert level of outlet pipe (+25 mm)				
Overflow pit is correct size and crest and invert is at correct level (±25 mm)				
Outlet pipe invert levels are correct (upstream and downstream) (±25 mm)				
Outlet pipe is free draining				
Overflow weir (if required) is correct length and at correct level ±25 mm)				
Overflow weir (if required) is keyed into bund				
Bunds/embankments surrounding the system are at correct levels or above				
HOLD POINT: Superintendent and bioretention designer inspection and sign-off before proceeding.				
Comments (attach and refer to additional pages if necessary)				

NB: As constructed survey and drawings and photos attached.

Signed by superintendent:

Print name:

Date:

Signed by bioretention designer:

Print name:

Date:

FORM B — UNDER-DRAINAGE

Purpose: To ensure under-drainage is installed correctly before the bioretention media is installed.

ITEMS	CHECKED	SATISFACTORY	ACTION (IF UNSATISFACTORY)	INITIAL
Base of system free from debris				
Liner (typically filter cloth) correctly installed				
There is no fabric 'sock' around the under-drainage				
Correct under-drainage has been supplied and slotted at 2 mm or smaller				
Under-drainage pipes are laid at the correct spacing (small bioretention system 1.5 m, large system 2 m) Required grade (verified using level or string line)				
Under-drainage pipes laid at required grade (verified using level or string line to achieve design level ±25 mm and 0.5% grade)				
All junctions and connections have been appropriately sealed				
Top of clean out points at design level (i.e. approximately 50–150 mm above filter media surface)				
HOLD POINT: Superintendent and bioretention designer inspection and sign-off before proceeding.				
Comments (attach and refer to additional pages if necessary)				

NB: As constructed survey and drawings and photos attached.

Signed by superintendent:

Print name:

Date:

Signed by bioretention designer:

Print name:

Date:

FORM C — BIORETENTION MEDIA

Purpose: To ensure that the media placed in the system meets the required specifications and that there is a record of the media being delivered to site.

To ensure media layers are installed correctly and meet the design and specification requirements.

SOURCING, TESTING AND SUPPLYING BIORETENTION MEDIA

DRAINAGE LAYER	CHECKED	SATISFACTORY	ACTION (IF UNSATISFACTORY)	INITIAL
Meets the specifications				
Meets the required hydraulic conductivity (4,000 mm/hr)				
Delivery supply docket certifies that the material delivered is the material tested (delivery docket attached)				
TRANSITION LAYER SUPPLY				
Meets the specifications				
Supplier certification provided (certification attached)				
Delivery supply docket certifies that the material delivered is the material tested (delivery docket attached)				
FILTER MEDIA SUPPLY				
Meets the FAWB's *Guideline Specifications for Soil Media in Bioretention Systems* (2008)				
Meets the required hydraulic conductivity (100–500 mm/hr, 750 mm/hr maximum)				
Frequency of laboratory testing completed in accordance with Section 3.5 (results of testing attached)				
Supplier certification provided (certification attached)				
Delivery supply docket certifies that the material delivered is the material tested (delivery docket attached)				
HOLD POINT: Superintendent or bioretention designer inspection and review of test results and certifications before proceeding.				
Comments (attach and refer to additional pages if necessary)				

FORM C — BIORETENTION MEDIA (CONT.)

INSTALLATION OF BIORETENTION MEDIA

	CHECKED	SATISFACTORY	ACTION (IF UNSATISFACTORY)	INITIAL
Base of system free from debris				
Drainage layer (fine gravel) installed to correct depth (± 25 mm)				
Transition layer (coarse sand) installed to correct depth (± 25 mm)				
Placement of filter media completed to avoid compaction of media and using at least two lifts				
Filter media installed to correct depth				
Light, even compaction applied to remove air gaps (e.g. light roller or single pass with a 'pozitrack' bobcat)				
Spreader bar used to flatten surface of filter media				
Sediment fences in place				

INSPECTION: Superintendent and bioretention designer inspection and sign-off to occur while installation of media is occurring. Photos must be taken by the superintendent, the bioretention designer or the contractor.

Comments (attach and refer to additional pages if necessary)

NB: Laboratory test results, certification, delivery dockets and photos attached.

Signed by superintendent:

Print name:

Date:

Signed by bioretention designer:

Print name:

Date:

FORM D — FINISHED LEVELS

Purpose: To ensure finished levels of system surface and bunds are correct and meet the design.

ITEMS	CHECKED	SATISFACTORY	ACTION (IF UNSATISFACTORY)	INITIAL
Landscaping topsoil applied to surrounding bunds to achieve design levels				
As-constructed survey of system surface and surrounding bunds completed				
Final constructed levels are consistent with design levels				
Under-drainage clean-outs extended 50–150 mm above filter media				
Under-drainage pipes flushed to remove initial ingress of material				
HOLD POINT: Superintendent and bioretention designer inspection and sign-off before proceeding.				
Comments (attach and refer to additional pages if necessary)				

NB: As constructed survey and drawings and photos attached.

Signed by superintendent:

Print name:

Date:

Signed by bioretention designer:

Print name:

Date:

FORM E — COARSE SEDIMENT FOREBAY

Purpose: To ensure the coarse sediment forebay is constructed correctly.

ITEMS	CHECKED	SATISFACTORY	ACTION (IF UNSATISFACTORY)	INITIAL
Extent of coarse sediment forebay correctly set out				
Rocks to be used to line base of forebay are correct size and shape				
Base of constructed forebay is flat and set at the correct level below the surface of the filter media				
Rocks placed for energy dissipation are of appropriate size and are in correct location				
Interface between forebay and filter media is structurally sound and not prone to collapse				
HOLD POINT: Superintendent or bioretention designer inspection and sign-off before proceeding.				
Comments (attach and refer to additional pages if necessary)				

NB: As constructed survey and drawings and photos attached.

Signed by superintendent:

Print name:

Date:

Signed by bioretention designer:

Print name:

Date:

FORM F — PROTECTIVE MEASURES

Purpose: To ensure protective measures are correctly installed to protect the bioretention system while building is occurring in the catchment.

Protection option adopted (Option 1, 2 or 3)				
OPTION 1 — SURFACE PROTECTION DURING BUILDING PHASE	**CHECKED**	**SATISFACTORY**	**ACTION (IF UNSATISFACTORY)**	**INITIAL**
Continuous sediment fences installed around perimeter of filter media and top of batter.				
Where landscape works are not to commence immediately then cover batters with filter cloth.				
Protective covering (filter cloth + 25 mm topsoil + turf) installed across entire filter media area of system.				
OPTION 2 — BYPASS AND EARLY ESTABLISHMENT	**CHECKED**	**SATISFACTORY**	**ACTION (IF UNSATISFACTORY)**	**INITIAL**
Continuous sediment fences installed around perimeter of filter media and top of batter.				
Where landscape works are not to commence immediately then cover batters with filter cloth.				
Temporary bund installed (where required) to prevent stormwater runoff from entering bulk of system. Bund keyed into batters of bioretention and crest level higher than pits and weirs.				
Temporary protective covering (filter cloth + 25 mm topsoil + turf) installed within bunded area.				
OPTION 3 – SEDIMENT BASIN AND BIORETENTION FUNCTION	**CHECKED**	**SATISFACTORY**	**ACTION (IF UNSATISFACTORY)**	**INITIAL**
Continuous sediment fences installed around perimeter of filter media and top of batter				
Sediment basin installed upstream of bioretention in accordance with either (including hydraulic structures): • WSUD Technical Design Guidelines for SEQ (SEQHWP) • Local erosion and sediment control guidelines or Best Practice Erosion and Sediment Control (IECA, 2008)				
Suitable access provided to sediment basin for clean out				
Bioretention system installed downstream of sediment basin				
Protective covering (filter cloth + 25mm topsoil + turf) installed across entire filter media area of basin.				
HOLD POINT: Superintendent and bioretention designer inspection and sign-off before proceeding.				
Comments (attach and refer to additional pages if necessary)				

NB: Photos attached.

Signed by superintendent:

Print name:

Date:

Signed by bioretention designer:

Print name:

Date:

FORM G — LANDSCAPE INSTALLATION

Purpose: To ensure the correct plants are supplied, installed and established.

ITEMS	CHECKED	SATISFACTORY	ACTION (IF UNSATISFACTORY)	INITIAL
Correct mulch has been supplied				
Mulch applied to correct depth and secured				
Supplied plants are correct species				
Supplied plants are in correct pot sizes and maturity (300 mm min)				
Plants have been installed at correct planting density (min 6 plants/m^2)				
As constructed drawings marked up with final plant species and densities				
Mulch is clear of plant stems by approximately 50 mm				
HOLD POINT: Superintendent AND bioretention designer inspection and sign-off before proceeding.				
Comments (attach and refer to additional pages if necessary)				

NB: As constructed drawings and photos attached.

Signed by superintendent:

Print name:

Date:

Signed by bioretention designer:

Print name:

Date:

FORM H — LANDSCAPE ESTABLISHMENT

Purpose: To ensure the correct plants are supplied, installed and established.

ITEMS	CHECKED	SATISFACTORY	ACTION (IF UNSATISFACTORY)	INITIAL
PLANT ESTABLISHMENT				
Weeds being removed as required				
Watering occurring as required				
Replanting occurred as required to replace failed plants				
Plants successfully established plants propagation is occurring. Measure of successful establishment 1. Survivorship greater than 90% 2. 80% coverage of system 3. Preferably more than one species per macrophyte zone 4. At least 5 plants/m2 (preferably 6–10 plants/m2) 5. Plant height of at least 50%. This can be measures through the use of marker or stakes through the bioretention 6. Propagation is occurring (more than 2–3 stems, seeding) 7. No weeds. Growth and maturity should be recorded through three-monthly photo logs every 500 m2.				
HOLD POINT: Superintendent AND bioretention designer inspection and sign-off.				
Comments (attach and refer to additional pages if necessary)				

NB: As constructed drawings and photos attached.

Signed by superintendent:

Print name:

Date:

Signed by bioretention designer:

Print name:

Date:

APPENDIX E

Water by Design “Maintaining Vegetated Assets”

Maintenance activities for swales, bioretention systems, constructed wetlands, and sediment basins include:

- repairing erosion (Section 3.1)
- unblocking inlets and outlets (Section 3.2)
- removing sediment (Section 3.3)
- removing litter and debris (Section 3.4)
- managing mosquitoes (Section 3.5)
- managing birds (Section 3.6)
- managing high or low water levels in a wetland (Section 3.7)
- responding to a paint or fuel-spill (Section 3.8)
- replanting (Section 3.9)
- controlling weeds (Section 3.10)
- managing excessive algae in sediment basins and constructed wetlands (Section 3.11)
- managing algal or moss growth on bioretention systems (Section 3.12)

The need for maintenance can be identified by comparing the state of the asset against the performance indicators in the checklists in Section 4.

3.1 Repairing erosion

ISSUE

Erosion in and around vegetated stormwater assets is generally because of fast flows, poor soil placement or compaction, inadequate vegetation cover, or dispersive soils. The most common areas for erosion are:

- at the base of a swale or on the surface of a bioretention system
- on the batter slopes, usually due to lateral inflows to the asset or where there is poor vegetation
- around inlet structures, due to high velocities
- at the interface of concrete and soil surfaces, due to water preferentially flowing along the concrete surface

Figure 14 and Figure 15 show examples of erosion in vegetated stormwater assets.

Minor erosion can extend and turn into a larger problem, including undermining structures, channelling of flows, and affecting vegetation health.

Figure 14 Erosion at the transition between a swale and bioretention system causing ripping of the jute mat

Photo: Paul Dubowski, Healthy Waterways

Figure 15 Erosion at the transition between wetland cells

Photos: Jason Sonneman, DesignFlow

ACTIONS

If the erosion poses a risk to public safety or the structural integrity of the asset, or is likely to worsen if left unattended, undertake repairs immediately.

If the erosion is minor, re-profile using hand tools or light machinery to limit damage to adjacent vegetation. Re-plant using replacements from other parts of the asset or bring in new stock.

Larger washouts may require large machinery and new fill material and plant stock to be imported. When using large machinery, take care not to compact the filter media of a bioretention system. If imported fill is used, it must meet the design specifications (particularly for bioretention systems). If the design specifications are not known, consult the *Technical Design Guidelines*. Re-plant once the earthworks are finished.

If an investigation into the source of the erosion is needed (e.g. the erosion is severe or recurring), refer to *Rectifying Vegetated Stormwater Assets*.

3.2 Unblocking inlets and outlets

ISSUE

The inlets and outlets are the main hydraulic controls. If they are blocked or not flowing freely:

- the asset may pose a risk to flooding, particularly if there is no alternative high-flow path
- the vegetation will be at risk (the plants may drown eventually)
- the volume of water that can be treated will be restricted as inflow will not enter the asset when it is full, causing flows to overflow or to pass downstream untreated

Figure 16 Litter blocking outlet pits

Photos: Paul Dubowski, Healthy Waterways and Robin Allison, DesignFlow

Figure 16 shows examples of blocked outlet pits that are restricting flows.

ACTIONS

Remove litter and debris by hand or with hand tools, such as shovels, forks, and tongs. Special opening tools (e.g. grate/gatic openers) are required for some outlets.

For sediment basins and wetlands, waders or a boat may be required to access the water body.

In extreme cases, machinery may be required.

If blocking persists, refer to *Rectifying Vegetated Stormwater Assets*. An alternative grate may be required or upstream measures may need to be investigated e.g. checking or installing gross pollutant traps.

3.3 Removing sediment

ISSUE

Sediment build-up in swales, bioretention systems (Figure 17), constructed wetlands, and sediment basins can:

- smother vegetation
- change the surface profile of the asset, which influences flow patterns
- form an impermeable layer on the surface of bioretention systems and prevent infiltration

If infiltration in a bioretention system is reduced or not occurring (see Figure 18), stormwater will bypass untreated into the overflow and the media may become boggy. A lack of water will affect the health of the vegetation and boggy conditions can attract mosquitoes, as well as generate unpleasant odours.

Figure 17 Sediment accumulated at an inlet

Photo: Paul Dubowski, Healthy Waterways

Figure 18 Examples of a bioretention surface that has been blinded with clay-like sediment deposition

Photos: Alan Hoban, Healthy Waterways and Andrew O'Neill, DesignFlow

ACTIONS

If an asset requires cleaning out at an unacceptable or unsustainable frequency, refer to *Rectifying Vegetated Stormwater Assets*.

Bioretention systems – coarse sediment forebay

Coarse sediment forebays are placed at the inflow location to bioretention systems to capture very coarse sediment (>1 mm). The forebays will typically be constructed of rock or concrete and should be designed to be cleaned out once a year[1] . When the sediment forebay is 75% full or greater, remove the sediment.

Removing sediment should be a straightforward task that can be done by hand or mechanically. Because the forebay captures coarse sediment only, it should not be contaminated, and because the forebay is shallow and mostly dry, dewatering should not be needed.

Bioretention systems – surface

Remove sediment in dry weather and ideally at the end of the dry season.

To maintain the integrity of the vegetation and prevent compaction of the filter media, remove sediment by hand (if possible) using flat shovels.

If machinery is used, remove sediment via an excavator located on the edge of the bioretention system or via a pozitrack bobcat to avoid compaction of the filter media. Minimise the number of times the bobcat passes over the bioretention surface. Reprofile and replant the area as required.

The equipment required for cleaning the coarse sediment forebay and the surface of the bioretention system includes:

- shovel and wheelbarrow for small assets
- bobcat or small excavator for large assets
- tipper truck if sediment disposal cannot occur locally

Sediment basins

Sediment basins are normally designed to be cleaned out at least once every five years[1]. Clean out a sediment basin when there is less than 1 m of water above the accumulated sediment. Complete the works in dry weather, ideally at the end of the dry season.

When removing sediment:

- Complete a sediment contamination and disposal assessment as outlined in Appendix A. In most cases, sediment contamination should not be a concern. If the sediment is contaminated, engage a licensed waste removal contractor as transporting and disposing of the sediment is subject to local and state regulations.
- Get necessary approvals for the works, including permission to de-water if necessary. Approval to drain the asset may be required for sediment basins and wetlands.
- Lower the water level with a maintenance valve or de-water the asset with a pump in accordance with the procedures of the relevant authority. Divert inflows away from the asset. In some cases, install a plug in the inlet pipe, pump the water, and clean the asset while holding the water upstream. Dewatering can take 1–2 days depending on the size of the asset and the capacity of the drain or pump. Ensure the dewatering has no adverse environmental affects.
- Remove and store plants that will be disturbed, in order to replant them after removing the sediment.
- Remove the sediment using appropriate machinery (see below).
- Remove sediment from the bottom of the asset. Sediment basins may have a hard base (such as concrete, rocks, or gravel), which indicates the bottom. The design drawings should identify this.
- If a drying (de-watering) area is available, place the sediment in this area to dry, ensuring it has silt control, and leave it until it is dry enough to remove. Clean sediment (no pollutants, needles etc.) may be re-used in earthworks or landscaping activities subject to relevant testing. Otherwise, place the sediment in a truck and transport to an approved recycling or disposal facility.
- If a drying area is not available, place the sediment in a sealed truck for transport to an approved waste disposal facility. It is worth investigating if a drying area can be created nearby to reduce transport and disposal costs.
- Clean the sediment basin and reinstate the dewatering area and sediment pond edges as required, including replanting.

The equipment required to maintain sediment basins includes:

- pump to dewater the basin if maintenance valves do not completely drain it
- method of stopping inflows to the basin e.g. sand bags for small inflows
- if sediment needs to be collected from the edge of the basin, an excavator (possibly with a long-reach) or a heavy vacuum loader unit with a 6 inch hose
- if there are reinforced access tracks, a backhoe or excavator can enter the asset
- drying pad or a sealed truck to transport the saturated sediment
- if the dry sediment if it cannot be reused on site, a truck
- hand tools or small machinery to reinstate the disturbed area

Constructed wetlands

Removing sediment from wetlands is similar to removing it from sediment basins, with the following additional tasks:

- Ensure the wetland is off-line, diverting flows around the wetland if possible. Always have sediment controls in place in case of flows into the wetland.
- Access the wetland from the edge to avoid damaging vegetation.
- Replant all disturbed areas after removing the sediment.

1 This clean out frequency is after construction activity in the catchment has finished.

3.4 Removing litter and debris

ISSUE

While litter and debris are mainly an aesthetic issue, they can smother vegetation, provide habitat for mosquito breeding, be a source of pollutants, block inlet and outlet structures, and pose a risk to public safety. If litter is able to enter downstream waterways it can cause environmental harm.

ACTIONS

Remove litter and excessive debris, by hand or with hand tools such as shovels, forks, and tongs.

For sediment basins and wetlands, waders or a boat may be required to access the water body.

In extreme cases, small machinery such as bobcats may be required.

3.5 Managing mosquitoes

ISSUE

Shallow, isolated pools of water that exist for several days in constructed wetlands, sediment basins, or water-logged areas of swales and bioretention systems can provide habitat for mosquitoes. Permanent water bodies are less likely to cause mosquito issues because they support predator species that can keep mosquito populations under control.

ACTIONS

Fill and reprofile isolated pools of water and re-plant if necessary.

If there are excessive numbers of mosquitoes or the problem is recurring, refer to *Rectifying Vegetated Stormwater Assets*.

3.6 Managing birds

ISSUE

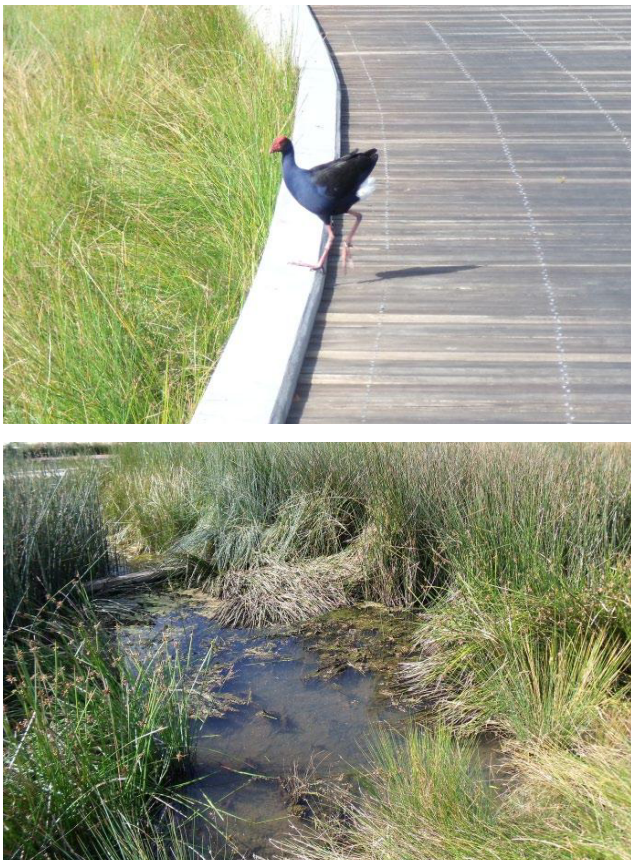
While fauna is generally welcomed in vegetated stormwater assets, large populations of some fauna can be a nuisance and can affect how an asset functions. In particular, birds can be a problem in and around constructed wetlands because they can eat or trample vegetation. For example, plant death can result from swamp hens trampling vegetation (see Figure 20). Faeces of other birds that gather in high numbers can affect water quality. Common problem species are ibises and ducks.

ACTIONS

Manage the preferred habitat. For example, remove islands or provide a predator bridge. Wetlands should not have islands as these encourage birds to nest and roost safe from predators. Other options are using signs to encourage visitors not to feed the birds or dropping the water level before and during breeding time to encourage the birds to leave the area, particularly for swamp hens. If the wetland does not have an outlet control pit (refer to *Technical Design Guidelines*), it is recommended that one is installed. If the wetland cannot be drained under gravity, pumping will be required.

If excessive numbers of birds are causing significant or repeated damage to an asset, refer to *Rectifying Vegetated Stormwater Assets*.

Figure 19 Swamp hen and associated damage



Photos: Andrew O'Neill, DesignFlow

3.7 Managing high or low water levels in a wetland

ISSUE

The water level in a constructed wetland will vary according to climatic conditions. During rainfall it will rise up to 0.5 m above the normal water level and during drought conditions it may lower by up to 0.3 m. The wetland plants will tolerate this variation and most will thrive. However, persistently high or low water levels (Figure 20) will have a negative impact on the plants and will need to be fixed.

Figure 20 Example of a wetland with persistently low water levels

Photo: Robin Allison, DesignFlow

ACTIONS

If it has not rained for three days and water levels remain high, the outlet may be blocked or there may be high water downstream that is preventing the wetland from drawing down. If an outlet or riser orifice is blocked, see Section 3.2. If there are no blockages, consult *Rectifying Vegetated Stormwater Assets*.

If the water level is much lower than the normal water level, inflows may have reduced or there may be a leak in the wetland. Consult *Rectifying Vegetated Stormwater Assets*.

3.8 Responding to paint or fuel spills

ISSUE

Pollutants from paint or fuel spills can get into stormwater and into a vegetated stormwater asset. Action is required to reduce the impacts, particularly on wetlands.

ACTIONS

Ensure designated staff and equipment are available in the case of a pollution-related incident.

Stop polluted material from moving through a wetland and reaching downstream environments using floating booms and by shutting off the outlet area (if possible).

Record all incidents on the inspection and maintenance checklist.

3.9 Replanting

ISSUE

Vegetated stormwater assets should have dense, evenly distributed vegetation across all planted areas. Maintaining vegetation is crucial to the performance of vegetated stormwater assets because it:

- assists to spread and slow water, which maximises the amount of vegetation in contact with the stormwater
- helps to reduce erosion
- minimises the establishment of weeds by shading and competing for nutrients
- preserves hydraulic conductivity in bioretention systems
- traps coarse litter
- acts as a deterrent to public access

Some water plant species will dieback (senesce) each winter: this does not equate to dead vegetation.

Figure 21 shows an example of uneven vegetation in a wetland. It is important to quickly re-establish vegetation in bare areas before weeds establish.

Figure 21 Uneven vegetation cover in a wetland and after transplanting

Photos: Robin Allison, DesignFlow

ACTIONS

If the asset does not meet the performance indicators for vegetation, re-establish the vegetation using new stock or (for constructed wetlands) using stock transplanted from elsewhere within the asset.

If replanting with new stock, use the plant species that are growing well in other parts of the asset. (For wetlands, looks for plants growing in similar depths of water.) Otherwise, refer to the *Technical Design Guidelines* or a person with a good understanding of aquatic vegetation. Plant at a density of between 6–10 plants per m2 and use a minimum of two species.

In constructed wetlands, dividing and relocating existing vegetation is a simple and cost-effective way of replacing vegetation. Mature water plants from a similar depth zone can be removed and the plant divided by splitting it through the base. Directly plant the new sections into the re-establishment area, taking care of the root system. Water plants with rhizomatous root systems (underground stems with multiple shoots off them) are ideal candidates for division and relocation, as each rhizome can be cut into multiple sections.

In wetlands with grazing waterbirds (particularly Purple Swamp Hens) or where the water level cannot be maintained at a constant low level (10 cm), replant using larger seedlings or plants. This is because swamp hens tend to pull seedlings out and high water levels often drown the seedlings. In areas with few birds and good water level control, use seedlings to revegetate as they are usually more cost-effective.

Use specialist aquatic plant contractors when large areas need replanting. A small boat may be required.

Refer to the *Construction and Establishment Guidelines* for detailed advice on planting procedures for vegetated stormwater assets.

If the lack of vegetation cover is severe or recurring or the replanted vegetation fails to establish, consult *Rectifying Vegetated Stormwater Assets*.

3.10 Controlling weeds

A weed is a plant that is growing where it is not wanted. Plants are considered weeds because they: compete with or displace native plant species; reduce biodiversity; impact ecosystem function; alter natural habitats; restrict natural processes; reduce amenity; and cause blockages to hydraulic structures. While this definition is generally applied to introduced plant species, some native plant species are also classified as weeds when they grow out of their natural range. Appendix B contains detailed information on common weeds encountered in vegetated stormwater assets.

ISSUE

Identifying and controlling weeds is important to preserve the function of a vegetated stormwater asset.

Assets are particularly vulnerable to weed invasions when the desirable plants are stressed, such as during the dry season or at the end of the wet season.

Swales and bioretention systems

Common terrestrial weeds readily grow within bioretention systems and swales (Table B-1). The growth of weeds within bioretention systems can reduce vegetation health, cover, and diversity, and result in an excessive organic layer accumulating on the surface of the filter material. Dense weeds within swales can reduce the flow capacity of the asset and increase the risk of flooding.

Sediment basins and wetlands

Enriched nutrient conditions and open water provides ideal habitat for aquatic weeds within sediment basins and constructed wetlands. Emergent aquatic plants (i.e. Cumbungi) and semi-aquatic weeds (i.e. para grass) colonise and grow well within the planted marsh zones and ephemeral margins (Table B-1). Common terrestrial weeds readily grow on the batters (Table B-1).

ACTIONS

Ideally, remove or control all weed species within an asset as part of a regular maintenance program. This is mandatory for declared weeds. A low level of undeclared weed cover may be okay if it does not hinder the functioning of an asset. However, early detection and action should cost less and result in higher success rates for managing weeds.

The main aspects of controlling weeds in vegetated stormwater assets are:

- recognise that some weed growth is inevitable because stormwater conveys weed seeds from the catchment
- know which weeds cause problems
- regularly inspect for weeds

Persistent weed ingress or excessive weed cover may mean that maintenance activities are not sufficient to manage the weeds. In this case, increase the maintenance frequency for a growing season (6–12 months). If this does not satisfactorily manage weeds, refer to *Rectifying Vegetated Stormwater Assets*.

When managing weeds, consider the following factors:

- the cause of the weed infestation
- the biology and ecology of the weed species
- methods to remove weeds, including their costs and benefits

Determining the source or cause of weeds will help to determine the most appropriate weed control strategy.

Understanding a weed's biology or ecology may influence the timing of the control method. For example, it may be beneficial to control a particular weed before it seeds to prevent further spread of the infestation.

There is a range of methods commonly used to control weeds within vegetated stormwater assets (see below). An integrated approach, where a number of control methods are used in a co-ordinated manner, is often the most effective long-term strategy. For example, a weed may initially be removed by hand, with any remaining weeds controlled using chemicals.

Many aquatic weed species are able to re-grow from small plant fragments and seeds. Take extreme care when physically removing and disposing of the plant material. Thoroughly clean all equipment used with or near aquatic weeds before moving the equipment to another waterway. This includes hand equipment, boats, booms, excavators, harvesters, and transport vehicles.

Control methods

PHYSICAL REMOVAL OF WEEDS

Hand pulling: A labour-intensive method that is extremely effective for controlling isolated weed infestations. This method is particularly useful for removing shallow-rooted weed species. Take care to remove all root material, particularly when removing deep-rooted perennial weed species.

Hand raking: A labour-intensive method used to remove small aquatic weed infestations. This method involves using a long-handled rake to remove floating or submerged aquatic weeds from sediment basins and constructed wetlands.

Grubbing: This method uses tools such as shovels and mattocks to remove weeds. Grubbing is a useful method for removing deep-rooted, woody weed species.

Mechanical removal: Use this method to remove large infestations of floating or submerged aquatic weeds from sediment basins and constructed wetlands.

Specialised floating harvesters can remove floating aquatic weeds or cut and remove weed biomass at a fixed depth below the water surface. Floating harvesters can manage weed biomass. Weed harvesting needs to be regularly repeated.

An excavator can remove floating and submerged aquatic weeds from open water areas. This normally involves scooping plants from the water with a bucket. If using excavators, use floating booms to concentrate floating aquatic weeds.

Long-reach draglines, such as chains or nets, can remove floating or submerged aquatic weeds. This involves pulling the chain or net through the water using a tractor. Only use this method when other methods of weed control are unfeasible as draglines can damage desirable macrophytes.

While using floating harvesters, excavators, or draglines to remove aquatic weeds is unlikely to eradicate them, this may provide an effective strategy for short-term control.

Floating booms: Floating booms are an effective method to control the spread of free-floating aquatic weeds within sediment basins and constructed wetlands. Floating booms are particularly useful for confining small, isolated weed infestations to particular areas of the asset, at which point plants may be physically removed or other control methods used, such as herbicides.

SLASHING

Slashing is an effective strategy to prevent weeds from flowering and seeding. Slashing is particularly useful for controlling isolated weed infestations but is not an effective method for eradicating weeds. Slashing can be undertaken using either a hand-held brush-cutting machine or a tractor equipped with a slashing implement.

BIOLOGICAL

Biological control uses insects and disease to control the spread of particular weed species. Biological control does not eradicate weeds. Biological control is a long-term strategy that reduces the health of a weed population, in order to control it easily with other methods. Biological control can be a cost-effective and environmentally sensitive method of weed control. A number of aquatic weed species within Australia have been successfully targeted using this method.

WATER LEVEL MANAGEMENT

Lowering the water level in sediment basins and wetlands can help to control floating and submerged aquatic weeds. The draw-down of water levels will dry out the vegetative material. Drying out sediment basins and wetlands is most effective during the dry season, when there is little or no stormwater runoff.

HERBICIDES

Herbicides are a common method used to control weeds growing in vegetated stormwater assets. Chemical weed control is often more cost-effective than mechanical methods and is particularly effective at controlling large weed infestations.

Major risks associated with using herbicides include the potential impacts on desirable plants and the environmental effects due to chemical residues accumulating within sediments and soils.

When treating aquatic weeds within sediment basins and constructed wetlands, take care to ensure that herbicides are registered or permitted for use around aquatic areas. Use herbicides in accordance with the registered labels and the relevant legislation (e.g. *Chemical Usage (Agricultural and Veterinary) Control Act 1988* in Queensland). Seek advice from the relevant government department if considering uses other than prescribed on labels. Note that all staff using herbicides should have completed Chemcert Training or its equivalent. Special licences may be required to use herbicides within a water body.

Herbicides are commonly applied to weeds using either foliar spray or rope-wick applicator methods. Cut stump and stem injection (drill and fill) are suitable methods for applying herbicides to woody weeds.

Foliar spray: Apply foliar herbicides using spot spraying techniques with hand-held sprayers. Spot spraying reduces the amount of herbicide used, which minimises the cost of application and damage to non-target plants. Take care to minimise the amount of herbicide that makes contact with the water. Using booms to confine isolated aquatic weeds may help to minimise non-target application of the herbicide.

Rope-wick applicators: Consists of a handle with a wick or rope attached to the end that is soaked with herbicide. Use the wetted wick or rope to brush herbicide over the surface of the weed. Rope-wick applicators are suitable for herbaceous weeds and young regrowth. This method ensures minimal damage to non-target plants.

Cut stump: This method involves cutting the stump of the weed approximately 15 cm from the ground using a cane knife or secateurs and applying herbicide immediately to the cut surface of the stump using a paintbrush or spray bottle.

Stem injection: This method involves making a 45-degree incision in the bark of the weed's stem using a small axe or machete and filling the pocket with a herbicide mixture. The incision must penetrate through the sapwood. Incisions are required every 7.5 cm around the circumference of the trunk.

All herbicides are potentially hazardous to humans. Protective clothing is essential when handling or spraying most herbicides. The minimum personal protection required is: rubber boots; long pants or overalls; rubber or plastic apron or coat covering the tops of the boots; rubber or plastic gloves; face shield; and waterproof hat or hood.

STEAMING

The direct application of heated steam can control weeds. Applying steam removes the plant's outer, waxy coating and breaks cellular structures, resulting in discoloration and death within a few days. While

steaming is an effective method for controlling annual weeds, regrowth of perennial weeds often occurs unless repeated treatments are undertaken.

3.11 Managing excessive algae in sediment basins and constructed wetlands

ISSUE

Algae occurs naturally in sediment basins and constructed wetlands due to the nutrient concentrations in stormwater inflows and the nutrients released from sediment and decomposing organic matter.

Generally, algal growth is either planktonic or filamentous.

Planktonic algae comprise individual, free floating cells that often turn the water green, which is also known as an 'algal bloom'. Planktonic algae include many blue-green algal species that produce toxins and pose a potential public health risk.

Planktonic algae typically grow in open water areas, particularly in sediment basins characterised by highly enriched conditions. Algal blooms will not affect the functional performance of either sediment basins or constructed wetlands.

Filamentous algae comprise single algal cells that form visible chains and often appear as floating or submerged algal mats that are bright green. Filamentous algae feel slimy when handled and individual filaments can often be recognised.

Filamentous algae grow in shallow vegetated zones and open water areas. A combination of high nutrient concentrations, light, and warm shallow water often results in excessive filamentous algal biomass.

Excessive filamentous algal biomass may severely affect the functional performance of sediment basins and constructed wetlands. Filamentous algae can block hydraulic structures, resulting in altered water regimes, and can potentially damage vegetation health, cover, and diversity. Filamentous algal biomass in constructed wetlands can smother the vegetation and be displaced by stormwater inflow. This can severely reduce plant health and the overall vegetation cover within the wetland. The death and decay of filamentous algal biomass can lead to oxygen depletion and result in poor water quality and fish kills.

ACTIONS

Planktonic algae

If access to sediment basins and constructed wetlands is restricted and there are minimal public health risks, it is not necessary to take any further action regarding planktonic algae.

Where sediment basins or constructed wetlands are accessible to the public or located within prominent public locations, the presence of blue-green algae requires further investigation. Refer to *Rectifying Vegetated Stormwater Assets*.

Filamentous algae

If filamentous algal biomass is observed within a sediment basin or wetland, it is generally not necessary to take any further action. However, in high amenity areas it may be desirable to remove filamentous algal biomass from areas of open water. Filamentous algal biomass can be physically removed using rakes, or through mechanical removal with specialist machinery (e.g. that used for removing wet sediment).

If the filamentous algal mat covers more than 10% of the sediment basin or constructed wetland area on two consecutive inspections, refer to *Rectifying Vegetated Stormwater Assets*.

3.12 Managing algal or moss growth on bioretention systems

ISSUE

Constant wetting of the filter surface of a bioretention system may result in the growth of algal or moss. Algae can be identified as a green/brown coloured coating or biofilm on the surface of the filter media, as shown in Figure 22. Filamentous algae may also appear on the surface of the filter media and often appears as a dense mat of fine green filaments (see Section 3.11). Moss is easy to identify because it looks like a thick green carpet as shown in Figure 23.

In most circumstances, minor algal and moss growth on the surface of a bioretention system will not be detrimental to infiltration rates. However, excessive algal growth or moss can clog the filter surface and prevent infiltration, and indicate that either base flows are entering the asset or there are problems with the infiltration rate. If infiltration in a bioretention system is reduced or not occurring (see Figure 18), stormwater will bypass untreated into the overflow and the media may become boggy. A lack of water will affect the health of

the vegetation and boggy conditions can attract mosquitoes, as well as generate unpleasant odours.

ACTIONS

If the cover of algal and moss growth is more than 10% of the filter media surface, refer to *Rectifying Vegetated Stormwater Assets*.

Figure 22 Algae growing on the filter media surface

Photo: Leon Rowlands, Sunshine Coast Council

Figure 23 Moss growing on the filter bed surface

Photo: Paul Dubowski, Healthy Waterways

APPENDIX F

Water by Design – Inspection and Maintenance Checklist for Bioretention Systems

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	

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

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

What to look for	Performance Indicator (PI)	Condition rating*	Maintenance undertaken**	Additional work needed
Algal or moss growth	Maximum 10% of surface covered in algae			
	No moss growth			
OUTLET (OVERFLOW WEIR, PIPE, OR OUTFALL)				
Erosion	Outlet is structurally sound and there is no evidence of erosion or subsidence/settlement, including around edges of rock protection or toe of weir for large systems			
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			
Outlet freely draining to receiving drainage or waterway	No downstream impediments to the release of water, no erosion or damage to the outfall structure, and no evidence of malfunction (e.g. excessive sediment accumulated)			

* 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

*** Presence of *Typha* is an indicator of poorly draining filter media