Whitehead & Associates
Environmental Consultants

Stormwater Management Advice for a proposed biochar processing facility

11 Markwell Road, Bulahdelah NSW

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Document Control Sheet

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Author:	Connor Morton
Project Manager:	Mark Saunders
Date of Issue:	08/05/2025
Job Reference:	3855_SW letter_003
Synopsis:	This document presents the On-site Detention (OSD) and discharge measures required to ensure compliance with MidCoast Council guidelines.
Client Details	
Client:	BioCarbon Pty Ltd
Primary Contact:	John Mellowes

Document Distribution

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Document Verification

Checked by: *Mark Saunders*	***Issued by:*** *Connor Morton*

Disclaimer

The information contained in this document is based on independent research undertaken by Whitehead & Associates Environmental Consultants Pty Ltd (W&A). To our knowledge, it does not contain any false, misleading or incomplete information.

Recommendations are based on an appraisal of the Site conditions subject to the limited scope and resources available for this project, and follow relevant industry standards. The work performed by W&A included a Site walkover and investigation on 29 October 2021; with further assessment by desktop review. The conclusions made in this report are based on the information gained and the assumptions as outlined. Under no circumstances, can it be considered that these results represent the actual state of the Site at all points as subsurface and temporal conditions are inherently variable.

Copyright Note

1 Introduction

Whitehead & Associates Environmental Consultants Pty Ltd (W&A) were engaged by BioCarbon Pty Ltd (the Client) to provide stormwater management advice for a proposed development at 11 Markwell Road, Bulahdelah NSW (the Site). The Site, identified as Lot 322 in DP1309245, is approximately 7.1ha in area is zoned RU5 (Village) and RU2 (Rural Landscape) under the Great Lakes LEP 2014.

It is understood that the Client is working with the property owner (Relfs Mill Pty Ltd) to examine the opportunity for a proposed biochar processing facility at the Site. The proposal intends to take waste material (wood chips) from the existing timber mill operation and process the material to create 'biochar'. The operation will occur in a newly constructed shed in the northeast of the Site. The proposed shed has a roof area of 1,600m^2 and includes roof water collection and storage in four (4) 20kL rainwater tanks. A paved area of 400m^2 is proposed adjacent to the shed, which is to be covered by metal 'lean-to' roof.

A Development Application (DA) pre-lodgement meeting with MidCoast Council (MCC or Council) notes that the proposal is permitted with consent, subject to stormwater considerations; specifically, compliance with On-site Detention (OSD) and stormwater discharge requirements as outlined in the MCC Site Stormwater Drainage Guidelines (MCC, 2024).

1.1 Water Sensitive Urban Design

DA pre-lodgement meeting notes indicate that the proposed development may require the preparation of a Water Sensitive Design (WSD) strategy. However, Section 11.2 of the MCC Development Control Plan (2014) states that alterations and additions to properties with existing development are exempt to WSD requirements where "an increase to the overall impervious surface is less than 10%".

Under pre-development conditions, the controlled drainage area in the east of the property (comprising the original Mill yard) consists almost exclusively (>90%) of compacted clay drive aisles; road-base storage areas and roofed structures (refer Figure 2, Appendix A). These areas are considered 'impervious', consistent with definitions described in MCC DCP (2014) and MCC (2024), in that they generate stormwater run-off volumes during rain events with negligible to very low infiltration.

As the proposal will occur within an existing development footprint with 100% impervious surface (compacted clay), no nett increase in impervious surface area is anticipated. On this basis, W&A consider the proposal <u>exempt from WSD requirements</u>.

2 Site Context

The locality and layout of the Site is shown in Figure 1 of Appendix A.

2.1 Climate

The following table summarises climatic conditions for the Site. Rainfall data has been obtained from the Bulahdelah Post Office [060002] Bureau of Meteorology (BoM) Station, with evaporation sourced from SILO Point Data (-32.41, 152.21).

Parameter	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Median Rainfall (mm)	101.4	107.7	128.0	106.1	89.4	90.9	65.8	50.0	50.7	62.1	82.1	87.2	1,329.6
Mean Evaporation (mm)	176.4	140.1	123.6	92.0	68.6	57.7	66.4	91.8	120.7	147.8	158.6	183.4	1,427.2
Rainfall - Evaporation (mm)	-75.0	-32.4	4.4	14.1	20.8	33.2	-0.6	-41.8	-70.0	-85.7	-76.5	-96.2	-97.6

Data shows that the Site experiences a 'temperate' climate typical of the lower Hunter region. Average annual evaporation exceeds rainfall; however, surplus rainfall periods occur March to June in the typical climate year.

2.2 Locality and Receiving Environment

The Site is located to the northwest of Bulahdelah town centre. Markwell Road is adjacent the eastern Site boundary and includes a constructed table drain to direct surface water flows approximately 195m north, where they connect with a natural drainage channel and road culvert.

Surrounding land use includes open pasture in the north and remnant forest and open-grassed areas to the west. Land to the south is residential / industrial in nature, consisting of dwellings to the south east and an old lumber mill to the south west. There are multiple intermittent drainage channels to the north and west, draining to the Myall River approximately 500m to the west of the Site.

2.3 Site Characteristics

The character of the Site is informed by site investigation on 29 October 2021, along with a recent desktop assessment of publicly available information (aerial imagery, LiDAR and hydro line data etc.).

The Site has a total area of ~70,640m^2, with ~43,000m^2 (61%) of the property in the east and south disturbed for development (hardstand / road-base and structures). The remaining ~27,640m^2 (39%) of the Site in the west consists of remnant forest and open grass pasture (refer Figure 2, Appendix A). Site slope ranges from 3% – 5%, with a general northerly aspect.

2.4 Existing Development

Existing improvements comprise multiple large buildings serving as areas for machinery operation (sawmills, kilns, conveyers, silos etc.); storage for timber milling products (logs, planks) and by-products (saw-dust, wood chips), and post-processing facilities (laminating shed). A majority of the developed area of property consists of impervious surface.

2.5 Proposed Development

The proposed biochar processing operation will be housed within a new 1,600m^2 metal shed to be constructed in the northeast of the Site (see Figure 1, Appendix A). The shed is an 'L' shaped configuration, with dimensions of 40m (width), 60m (length) and 9.3m (height). Four (4) 20kL of rainwater storage tanks are proposed north of the shed to collect runoff from the new roof area. An open, paved courtyard area of 400m^2 is proposed adjacent the shed, where the pyrolysis equipment will be located. Therefore, a total development footprint of <u>2,000m^2</u> is proposed to facilitate the biochar operation.

The development footprint currently consists of hardstand / road-base and is used for heavy vehicle storage (trucks). Slopes in the vicinity of the proposed development footprint are ~3%, falling gently to the north.

3 Stormwater Flows

The proposal is seen as an 'ancillary' use to the existing mill development. To avoid any increase in flows to the existing stormwater management system, it is proposed that stormwater flows generated from the processing shed are to be managed separately from the existing arrangements at the Site. Therefore, this assessment <u>only</u> considers stormwater flows from the proposed development footprint.

As per Table 1 of MCC (2024), OSD and discharge requirements for industrial developments are to be determined via the Time Area Hydrograph method (preferably using 'DRAINS' modelling).

However, given the unique nature of the proposal including small catchment area, limited routing and independent stormwater system, the utility of the DRAINS model is limited.

3.1 Model Selection

The assessment and advice presented here uses the “OSD for VIPs” model (the Model), developed by Cleanstormwater Pty Ltd[1].

The Model is a web-based Time Area Hydrograph tool that performs OSD and discharge calculations using the Swinburne, Rational, Modified Rational or Boyd methods. The Swinburne (OSD4W) methodology was used for this assessment. The Model obtains Intensity-Frequency-Duration (IFD) data from the BOM Design Rainfall Data System (2016) for the location, which is then applied in the calculations. Outputs from the modelling are provided in a standard report format.

An assessment of the Permissible Site Discharge (PSD) and Site Storage Requirement (or OSD) for the low recurrence interval (20% AEP), medium recurrence interval (10% AEP) and upper value limit (1% AEP) are provided, as per Section 5.3 of MCC (2024). The Model was also used to define discharge orifice diameters for the 20% AEP and 1% AEP storm outflows.

Model output reports for each scenario are provided at Appendix B.

3.2 Model Inputs

Time of Concentration (TOC) is required to calculate peak discharge from the connected catchment area of the proposal. The Model uses both Time of Catchment (TCS) and Time of Site to Outlet (TSO) values to calculate TOC. As per Section 5.3 of MCC (2024), this may be calculated using the Friends Equation, as follows.

$$t = (107 \times n \times L^{0.333}) / S^{0.2}$$

Where:

t = Overland sheet flow travel time (minutes)[2];

L = Overland sheet flow path length (m);

N = Horton’s surface roughness factor[3]; and

S = Slope of surface (%).

Stormwater flows from the development footprint are shown conceptually in Figure 3, Appendix A. The following inputs were used for the derivation of TCS and TSO.

Parameter	Value	Comment / Reference
TCS		
L (m)	40	Longest downslope length of development footprint
N	0.028	Conservative value, based on ‘Bare soil surface’, rounded
S (%)	3	Slope of surface area (refer Section 2.5)
t (minutes)	8.21	$(107 \times 0.028 \times 40^{0.333}) / 3^{0.2}$, rounded
TSO		
L (m)	79	Furthest travel path to street drainage

[1] MUSIC Models & WSUD reports - Compliant with MUSIC Modelling and Guidelines
[2] A minimum time of concentration of 5-minutes must be applied, as per Section 5.3 of MCC (2024)
[3] Table 4.6 of Soil Conservation Guidelines for Queensland (2015)

Parameter	Value	Comment / Reference
N	0.015	Conservative value, based on ‘Paved surface’
S (%)	1.5	Slope across contour to Site discharge location
t (minutes)	6.34	(107 x 0.015 x $79^{0.333}$) / $1.5^{0.2}$, rounded

Therefore, a design TOC of 14.55 minutes (8.21 + 6.34 minutes) is calculated.

The proposed development footprint of 2,000m^2 (1,600m^2 + 400m^2) was used as the total catchment area for both pre-development and post-development conditions, with varying run-off coefficients applied to reflect the change in surface characteristics.

A run-off coefficient of 0.9 was applied for the pre-development condition, reflecting an impervious area with minor infiltration (hardstand / road-base). A value of 1.0 was applied for the post-development condition, representative of a ‘zero’ infiltration surface (metal roof) and paved courtyard.

The ‘Height of Storage Above Orifice (m)’ value is used to calculate the required discharge orifice diameters for the 20% AEP and 1% AEP storm overflows. Based on commercially available tanks of the proposed volume (20kL), it is estimated that each rainwater tank will have dimensions of 3.4m (diameter) and 2.25m (height). With the installation of inter-tank connections and a maximum capacity overflow pipe, it is estimated that a working height of 1.95m will be available within each tank. Therefore, a value of 1.75m was applied for the 20% AEP storm event, with a value of 1.25m applied for the 1% AEP storm event.

The Model was run to calculate the PSD and OSD for the all storm events outlined in Section 3. Overflow orifice features were determined for the 1% AEP and 20% AEP storm events. Design requirements are provided in the following section.

3.3 Model Outputs

The following table summarises the PSD, OSD and orifice sizing outputs from the Model, with further detail provided in Appendix B.

Parameter	Storm Event		
	20% AEP	10% AEP	1% AEP
PSD (L/second)	53.78	65.71	109.84
OSD (m^3)	17.28	21.11	35.23
Height of Storage Above Orifice (m)	1.75	n/a	1.25
Orifice Opening (mm)	137.34	n/a	213.5

3.3.1 PSD

As shown, PSD for the pre-development condition ranges from 54L/second for the low recurrence interval event (20% AEP) and up to 110L/second for the peak event (1% AEP) at the Site.

3.3.2 OSD

The proposal will install 80kL of rainwater tanks to collect roof run-off from the processing shed, with the available volume deployed for OSD. The recommended configuration will see Tank 1 used to receive the ‘first-flush’ and the moderation of storm surges. The three (3) remaining tanks (Tanks 2-4) will be configured as a single volume and utilised exclusively for OSD.

Based on the post-development calculations, OSD volumes of 18m^3 (rounded) and 35m^3 (rounded) are required to manage the low recurrence interval (20% AEP) and peak event (1% AEP) flows, respectively.

Based on the proposed tank configuration (refer Section 4), approximately 45kL will be available for OSD; therefore, the required OSD volumes can be achieved.

To maintain the required OSD volumes, the calculated storage height (m) above the discharge offtake for each OSD volume is 1.25m (1% AEP) and 1.75m (20% AEP).

3.3.3 Discharge Orifice Sizing

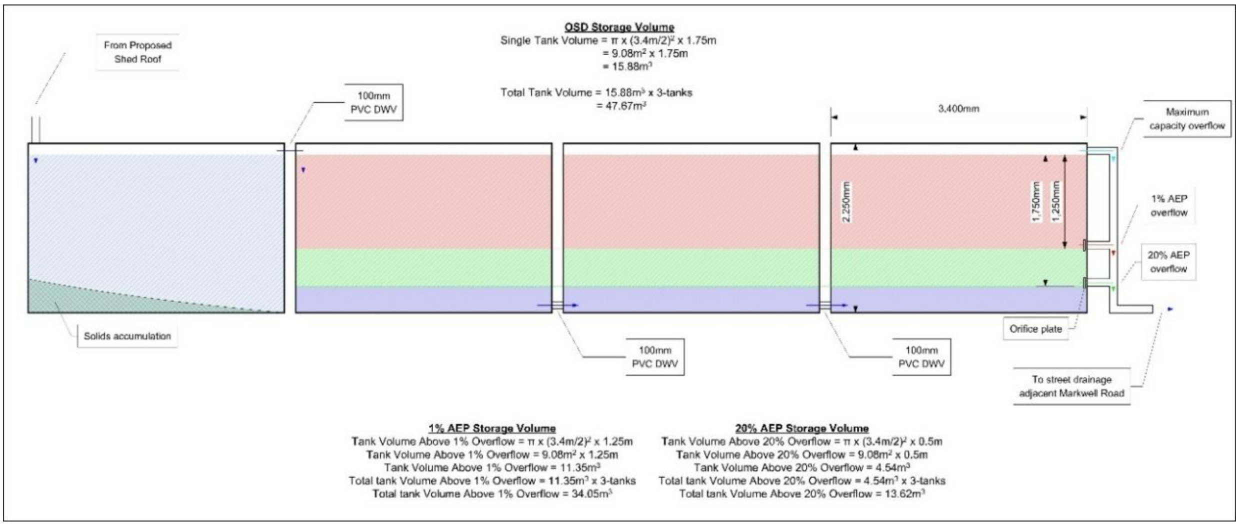
To maintain Site discharge velocity below the pre-development condition, orifice opening sizes of 215mm (rounded) and 140mm (rounded) are required for 1% AEP and 20% AEP storm event discharge, respectively.

4 OSD Configuration

As per plans provided by the Client, four (4) 20kL rainwater tanks will collect stormwater run-off from the roof of proposed shed. All stormwater from the roof area is to be directed to the OSD system via roof guttering. Stormwater from the proposed paved courtyard area must also be directed to the OSD system to comply with Section 5.1 of MCC (2024) for industrial developments.

This will likely require the installation of a sump pit, with pump transfer, to the OSD tank inlet. Care must also be taken to ensure stormwater from upslope areas of the Site are not directed to the OSD system.

The proposed OSD arrangement is presented in the following graphic.



The first tank is to be used to manage storm surges and collect any solids entering the system, with the remaining tanks used for OSD volume. The first and second tank will be 'top-connected', allowing displacement between the two. All remaining tanks (Tanks 2-4) will be cross-connected (50-100mm from the base) to allow them to act as a single volume.

A 'high' overflow will be installed ~100mm below the top of the final tank to allow extreme event volumes to discharge from the OSD system. The invert of the 1% AEP discharge offtake pipe will be installed (minimum) 1.25m below the high overflow, while the 20% AEP discharge offtake will be installed 1.75m below the high overflow level.

No plans have been advised; however, retained volumes within the OSD (below 20% AEP discharge offtake) tanks may also be reused on-site (i.e. landscape watering).

As described, orifice plates will be installed on both the 1% and 20% AEP discharge offtakes to restrict post-event flows to PSD. Further details on orifice requirements can be found in Section 6.2.1 of MCC (2024).

OSD marker plates are to be fixed to the rainwater tanks to indicate the vicinity of the OSD system. Details on the requirements of OSD marker plates can be found in Section 6.5 of MCC (2024).

4.1 Off-site Discharge

OSD overflow volumes are to be directed to the roadside drainage channel adjacent Markwell Road to the east. Overflow pipes are to be composed of PVC DWV (nominally >200mm). Pipework is to be buried 300mm below the ground surface to protect from structural damage.

As per Section 2.3 of MCC (2024), discharge pipes are to be made of reinforced concrete (RCP) and connections to stormwater channels must be via a single point, adjacent to the channel. The invert of the discharge pipe must be installed at (minimum) 150mm above the channel invert at that location. The channel must be protected against erosion at the point of discharge.

W&A propose the installation of a durable rock apron and energy dissipater within the property boundary and connecting to an existing discharge swale from the main stormwater basin. The approximate location and form of the connection is shown in Figure 3, Appendix A.

A standard drawing for a rock pad outlet structure (OS-01) is also provided in Appendix A.

5 Conclusion

To comply with the MCC Stormwater Drainage Guidelines (2024), the following OSD and stormwater discharge requirements are recommended for the proposed ‘biochar’ processing facility at 11 Markwell Road, Bulahdelah:

- Stormwater from the proposed 2,000m^2 development footprint (shed roof and paved courtyard area) is to be collected in an OSD system comprising four (4) 20kL rainwater tanks (total 80kL);
- The 20% AEP discharge offtake is to be installed to allow for 1.75m of storage height above the offtake invert, with an orifice plate opening of 140mm;
- The 1% AEP discharge offtake is to be installed to allow for 1.25m of storage height above the offtake invert, with an orifice plate opening of 215mm;
- Overflow volumes from the tanks are to be directed to the roadside drainage channel adjacent Markwell Road in the east;
- The invert of the discharge pipe must be installed at 150mm above the channel invert;
- A durable rock apron and energy dissipator is to be installed, connecting to an existing discharge swale from the main stormwater basin; and
- Pipework is to be buried 300mm below the ground surface, increasing to 500mm in trafficked areas.

Yours Sincerely

CMorton

Connor Morton

Environmental Consultant
Whitehead & Associates Environmental Consultants Pty Ltd

Appendix A

Figures

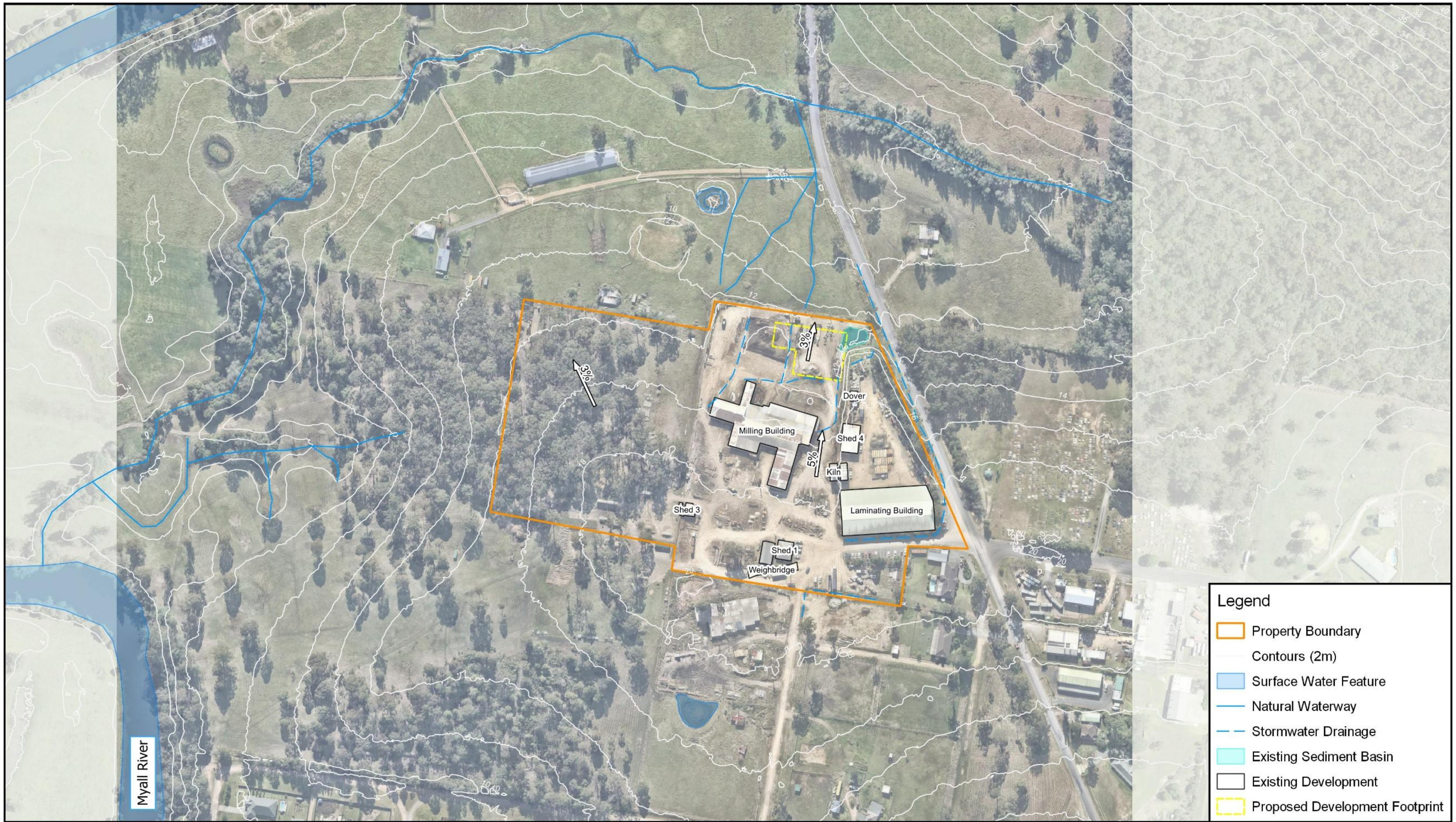


Figure 1: Site Plan Showing Layout and Surrounding Environment

Job 3855: 11 Markwell Road, Bulahdelah

Whitehead & Associates Environmental Consultants

0 100 200 300 400 500 600 700 m (Approx Scale)

N

Revision	002
Drawn	CM
Approved	MS

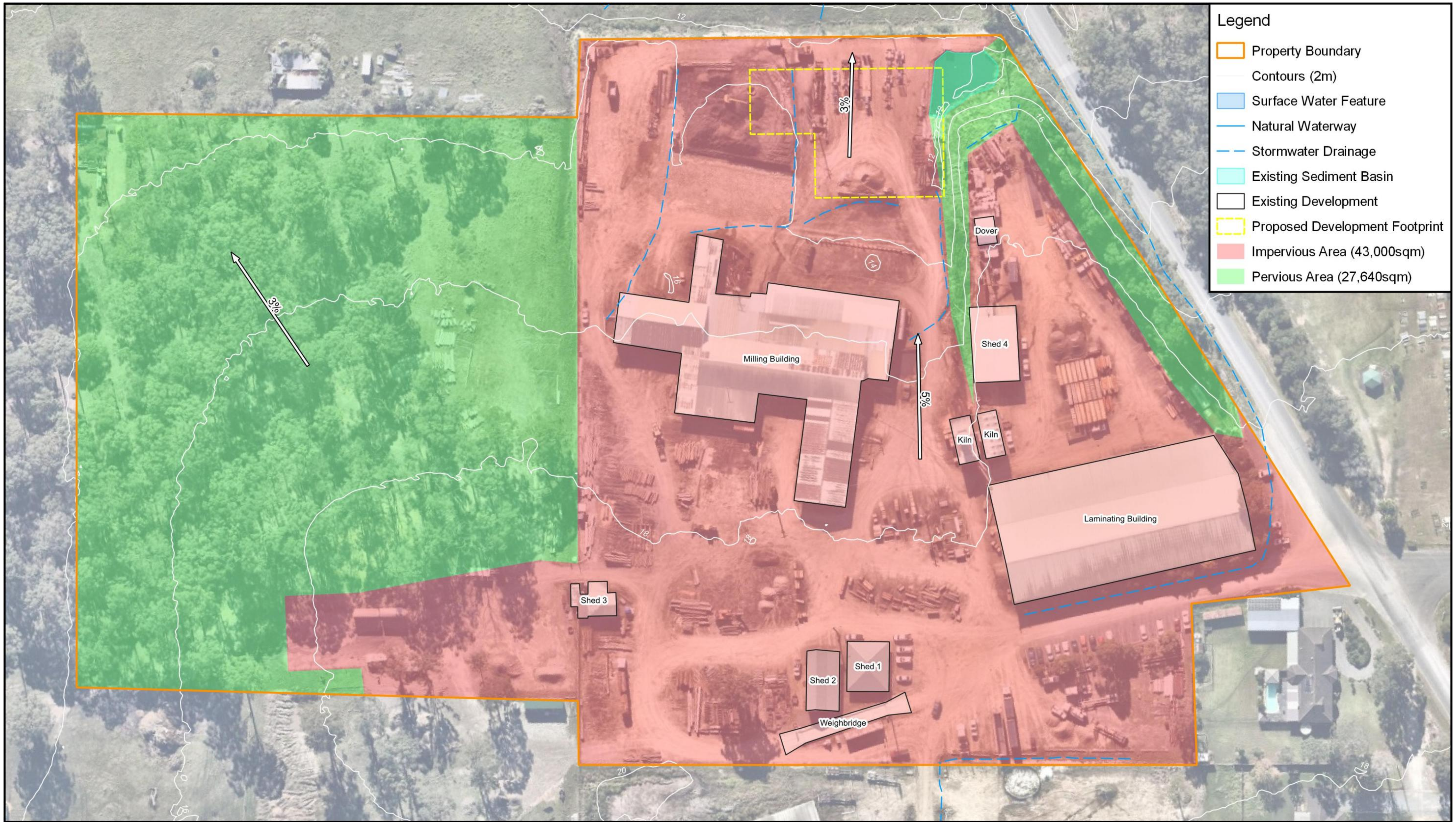


Figure 2: Site Plan Showing Impervious Land

Job 3855: 11 Markwell Road, Bulahdelah

Whitehead & Associates Environmental Consultants

0 50 100 150 200 250 m

(Approx Scale)

N

Revision	002
Drawn	CM
Approved	MS

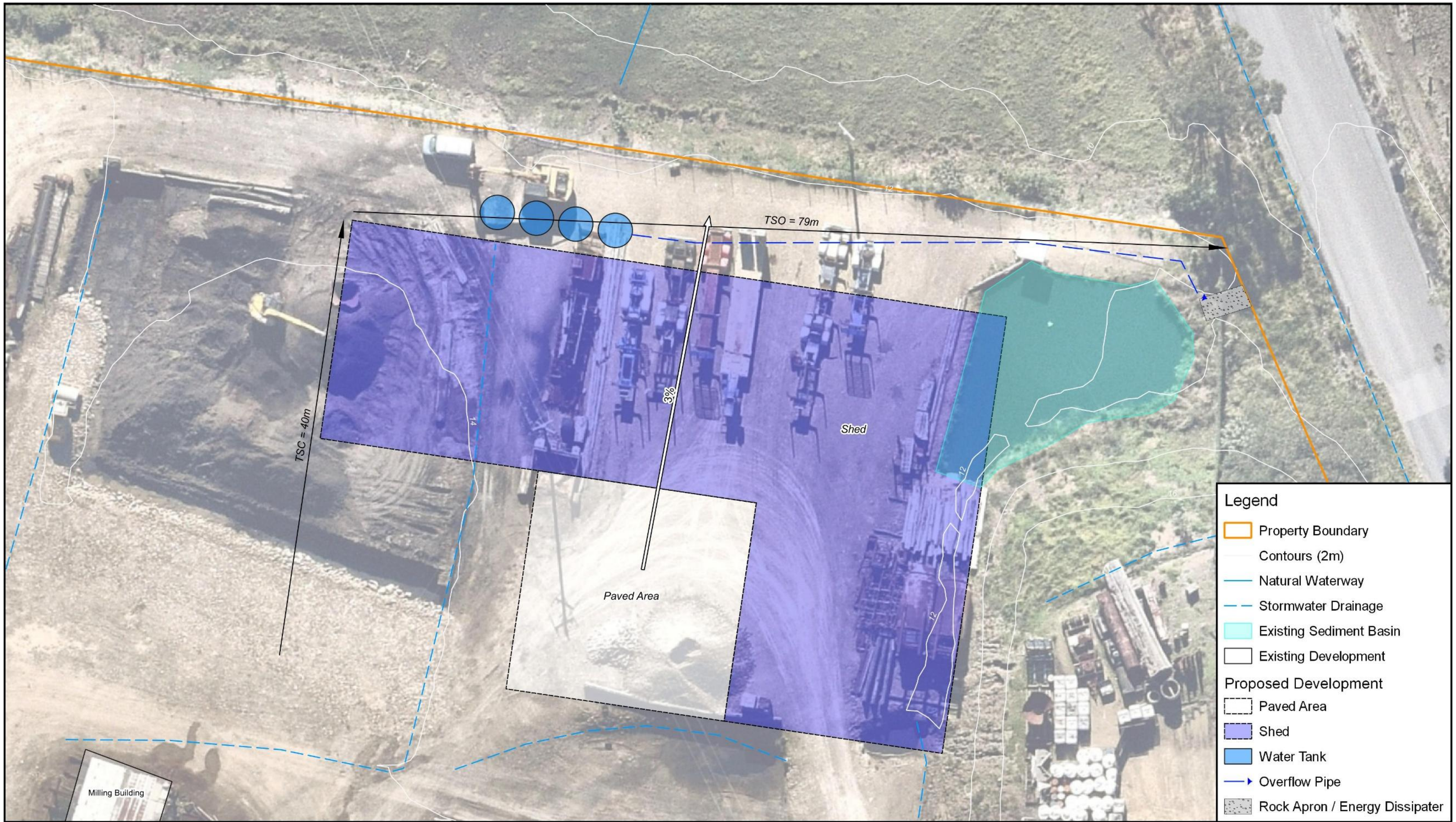
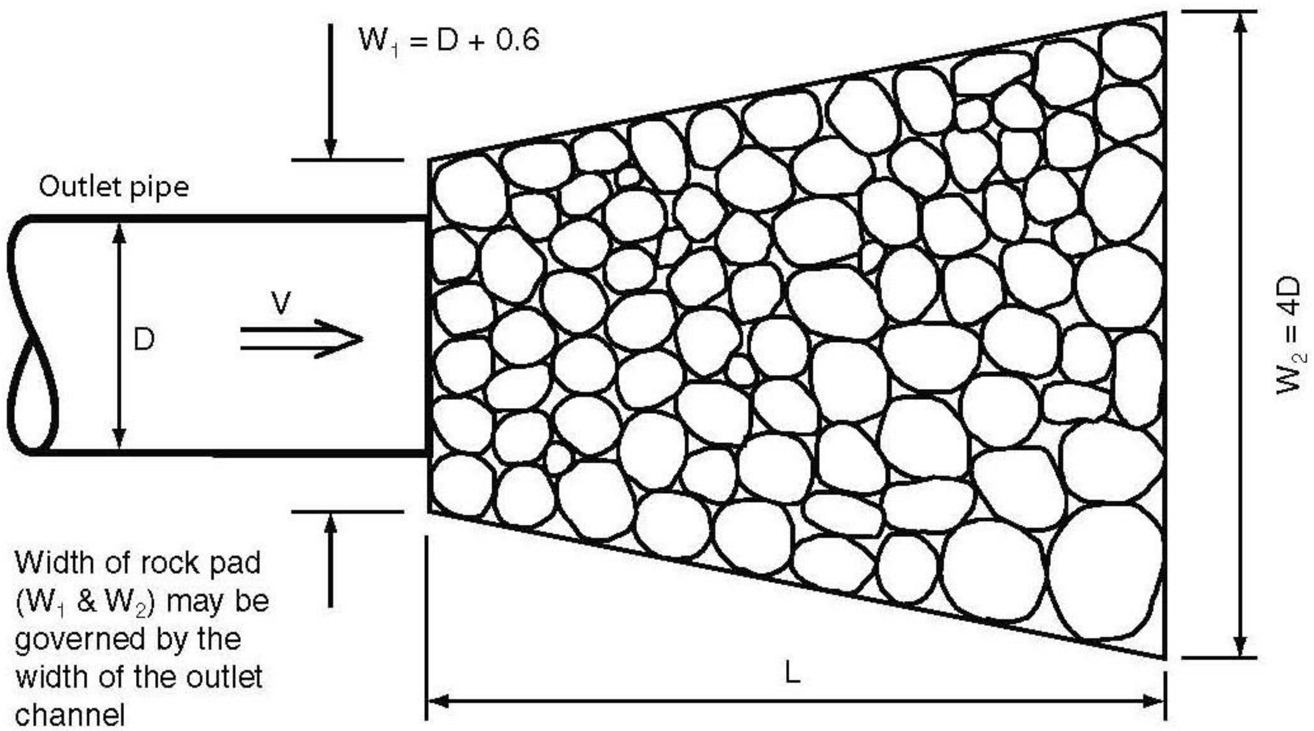


Figure 3: Site Plan Showing Proposed OSD and Overflow

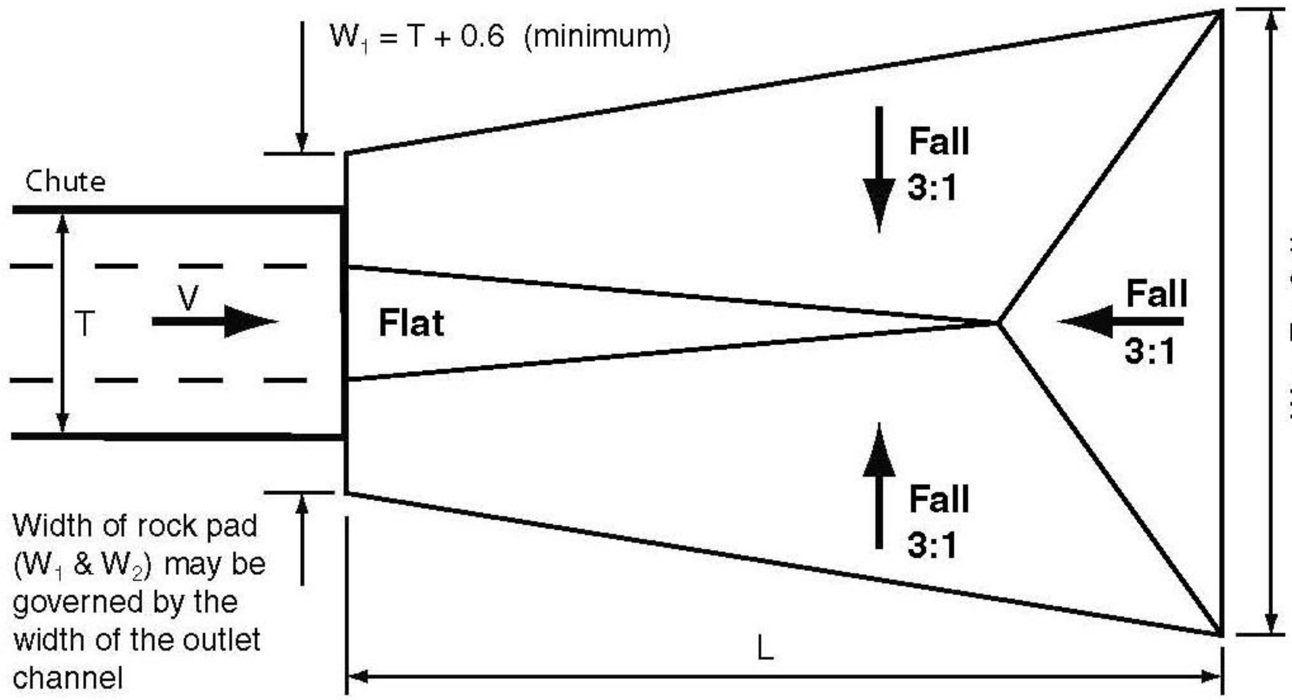
Job 3855: 11 Markwell Road, Bulahdelah

Whitehead & Associates
Environmental Consultants

Revision	002
Drawn	CM
Approved	MS

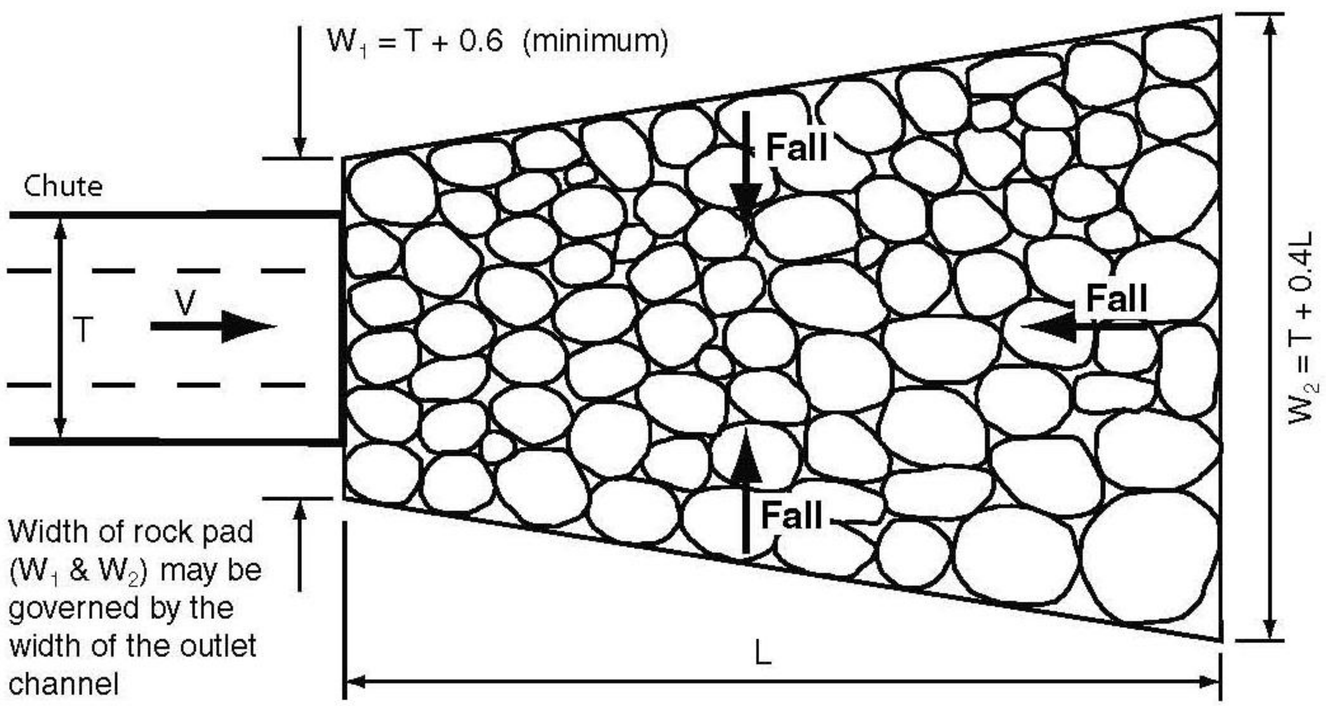


(a) Typical layout of a rock pad outlet structure for a pipe outlet

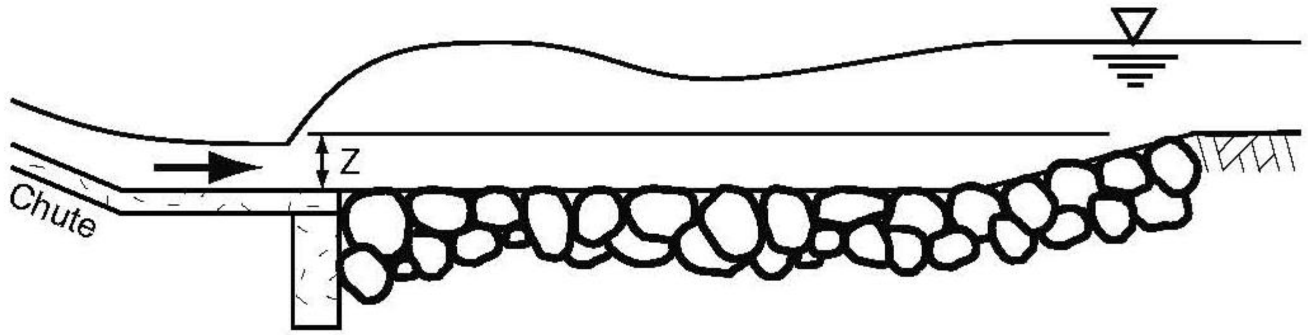


T = Maximum top width of flow at base of chute

(b) Typical form of a rock pad outlet structure for a drainage chute



(c) Typical layout of a rock pad outlet structure for a drainage chute



(d) Typical profile of a rock pad outlet structure for a drainage chute

Notes:

1. Drawings applicable to temporary drainage chutes and slope drains.
2. Rock pad outlet structures for slope drains usually are not required to be recessed below natural ground level as is the case for chute outlets (see Figure B).

Drawn: GMW	Date: Dec-09	Outlet Structures	OS-01

Appendix B

Stormwater Flow Assessment

On Site Detention Report

Basic Information:

Date: 6-5-2025

Assessor Name:	Connor
Assessor Email:	connormorton@whiteheadenvironmental.com.au
City Council:	Mid-Coast Council
Address Line 1:	1 Markwell Rd, Bulahdelah NSW 2423, Australia
Address Line 2:	Bulahdelah, NSW 2423
Development Type:	Industrial
Planning Permit No:	N/A

Project Details:

LAT: -32.3976135, LNG: 152.2070617

OSD Design Summary Report

Method for OSD calculations: SWINBURNE METHOD OSD4W

Device Name: Typical OSD RWT

Device Type: Steel - Above Ground Storage

Pre-Development Site Details	Area (m²)	Runoff Coefficient	Uncontrolled Area (m²)
Shed	1600	0.9	N/A
Hardstand	400	0.9	N/A

Post-Development Site Details	Area (m²)	Runoff Coefficient	Uncontrolled Area (m²)
Shed	1600	1	0
Hardstand	400	1	0

Section IFD:

IFD data used in the calculations is as follows:

IFD 2016 (no Climate Adjustment)

Storm Details

AEP for PSD Calc (%)	20
AEP for Storage Calc (%)	20
Intensity For PSD Calc (mm/hr)	102.81
Intensity For Storage Calc (mm/hr)	110.61

C-Value

Pre Dev	0.9
Post Dev Controlled	1
Post Dev Uncontrolled	0

Flow and Volume

Time of Concentration of catchment to site outlet (Tcs):	8.21 mins
Time of Concentration of site outlet to catchment outlet (Tso):	6.34 mins
Time of Concentration of catchment (Tc):	14.55 mins
Pre-Dev peak site inflow, Qp (L/s):	51.4
Permissible Site Discharge, PSD (L/s):	53.78
Post-Dev Peak Site Inflow for PSD, Qa (L/s):	114.23
Critical Duration, Td (min):	12.4
Post-Dev Peak Site Inflow Based for Storage, Qa' (L/s):	122.9
Required Storage Volume (m^3)	17.28
Adjusted Required Storage Volume (m^3):	17.28
Height of storage above orifice (m):	1.75
Required Orifice Diameter (mm):	137.34

OSD Design Calculation Details

About Swinburne Method (OSD4W variation)

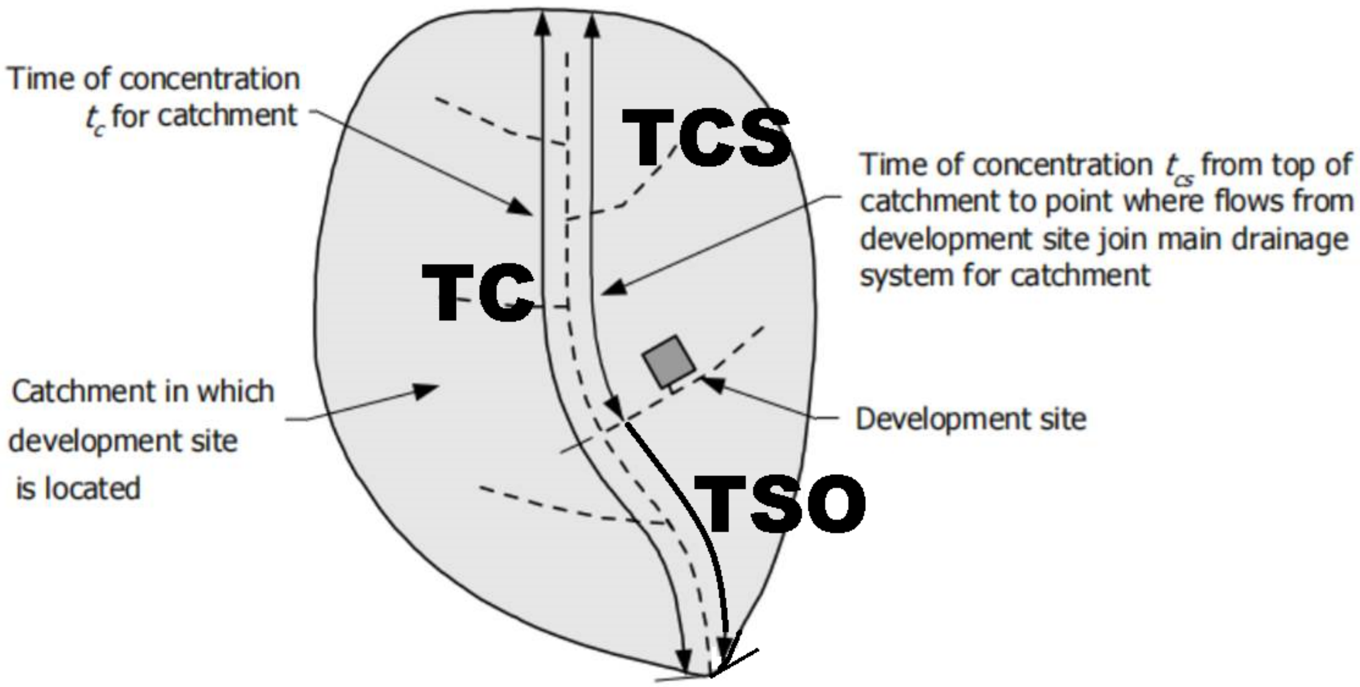
The Swinburne Method is outlined by Dr. Donald Ian Phillips in this paper published in 1995. Further analysis shows calculation methods for 3 different storage types which are used to generate results in this report. The calculation methods have been compared and validated against the OSD4w software (legacy tool used for Swinburne calculations in Victoria, Australia). It is important to clarify:

> OSD4w software developers have introduced a "safety parameter" in the calculations, therefore the results produced by OSD4w are not the same as the results produced using the standard Swinburne method devised by Dr. Phillips.

OSD4w software has been used for a long time and, unfortunately, the developer has passed. This legacy software uses 1987 IFD data and is not inline (no longer maintained) with latest AR&R guidance to use 2016 IFD data. The following calculations in this report are generated by OSDs For VIPs' Swinburne method (OSD4w variation). The calculations use 2016 IFD data as per AR&R guidance. Calculation details are outlined in the following sections.

Section 1: Determine catchment time of concentration (Tc), time of catchment to site (Tcs) & time of site to outlet (Tso)

Swinburne Method uses the position of the development site within a larger catchment to determine permissible discharge. This is different from other methods, as for the Swinburne method the time of concentration on the site for both "pre-development" and "post-development" site condition is not relevant This requires establishment of Tc, Tcs & Tso for the catchment in which the development is located, as in below figure:



Please note Site size or time of concentration is irrelevant. Also irrelevant distance from site to main drainage system

Figure 19.2 Relationship Between t_c and t_{cs} for the Swinburne Method

Time of Concentration are calculated as follows:

Tc = 8.21 minutes (specified by engineer)

Tso = 6.34 minutes (specified by engineer)

Catchment Time of Concentration (Tc):

Tc = Tcs + Tso = 8.21 + 6.34 = 14.55

Section 2: Determine Catchment Pre Development Flow, Qp

Catchment Pre development flow is determined using Rational Method where:

A (Total Catchment Area, m²)

Catchment Name	Area (m²)
Shed	1600
Hardstand	400
Total Catchment Area (m²)	2000

I (Design Storm Intensity, mm/hr)

Intensity is obtained as per Section IFD above.
The IFD 2016 data used for calculations was downloaded from Bureau Of Meteorology at:

Latitude, degrees	Longitude, degrees
-32.4	152.21

Intensity used for PSD calculations is determined as follows:

Catchment Time of Concentration, min	14.55
AEP,%	20
Design Storm Intensity from 2016 BOM IFD, mm/hr	102.81
Climate Change Adjustment Applied *	No
Design Storm Intensity used for OSD calculations, mm/hr	102.81

*Note: Climate change adjusted intensities are calculated using method outline in AR&R Book1 AR&R Book1 Chapter 6.

C (Total Weighted C - Value)

Catchment Name	Area (m²)	C - Value (1)	Weighted C - Value (e)
Shed	1600	0.9	0.72
Hardstand	400	0.9	0.18
Total Weighted C-Value (f):			0.9

Pre Development Flow Calculation

Pre Development Flow (Qp), L/s = C * I * A / 3600

A (Total Catchment Area, m²)	I (Design Storm Intensity, mm/hr)	C (Total Weighted C - Value)	Qp, L/s
2000	102.81	0.9	51.4

Section 3: Determine Catchment Post Development Flow, Qa

Catchment Post development flow is determined using Rational Method where:

A (Total Catchment Area, m²)

Catchment Name	Area (m²)
Shed	1600
Hardstand	400
Total Catchment Area (m²)	2000

I (Design Storm Intensity, mm/hr)

Intensity is obtained as per Section IFD above.
The IFD 2016 data used for calculations was downloaded from Bureau Of Meteorology at:

Latitude, degrees	Longitude, degrees
-32.4	152.21

Intensity used for OSD calculations is determined as follows:

Catchment Time of Concentration, min	14.55
AEP,%	20
Design Storm Intensity from 2016 BOM IFD, mm/hr	102.81
Climate Change Adjustment Applied *	No
Design Storm Intensity used for OSD calculations, mm/hr	102.81

*Note: Climate change adjusted intensities are calculated using method outline in AR&R Book1 AR&R Book1 Chapter 6.

C (Total Weighted C - Value)

Catchment Name	Area (m²)	C - Value (1)	Weighted C - Value (e)
Shed	1600	1	0.8
Hardstand	400	1	0.2
Total Weighted C-Value (f):			1

Post Development Flow Calculation

Post Development Flow (Qa), L/s = 2 * C * I * A / 3600

*Note: The "2" is the safety factor introduced in OSD4w as discussed in "About Swinburne Method" section.

A (Total Catchment Area, m²)	I (Design Storm Intensity, mm/hr)	C (Total Weighted C - Value)	Qa, L/s
2000	102.81	1	114.23

Note: Qa is only used in calculation of PSD. For calculation of storage, the term Qa' is used and varies depending on duration & intensity used for each iteration (C and A is kept constant, similar to Qa calculations). More details in Section 5.

Section 4: Determine Permissible Site Discharge (PSD)

PSD is determined by solving Swinburne Method equation for Above Ground Storage

$$PSD = \frac{-b-\left(b^2-4c\right)^{\frac{1}{2}}}{2}$$

$$b = -\frac{2Q_a}{tc}\left(\frac{0.667t_cQ_p}{Q_a} + 0.75t_c + 0.25t_{cs}\right)$$

$$c = 2Q_aQ_p$$

Where:

PSD = Permissible site discharge

Qp = Pre development flow

Qa = Post Development flow

Tcs = Time from catchment to site

Tc = Time of concentration for catchment

*See parameter values in OSD Design Summary Report (Page 2)

Section 5: Determine Storage Volume Required

Storage volume is determined by solving Swinburne Method equation for Above Ground Storage using various trials of duration Td to find max volume required (see section 7 & 8 for iterations).

$$V_s = \left(0.5 Q_a' t_d - \left[\left(0.875 \text{PSD}\, t_d \right) \left(1 - 0.917 \frac{\text{PSD}}{Q_a'} \right) + \left(0.427 t_d \frac{\text{PSD}^2}{Q_a'} \right) \right] \right) \left(\frac{60}{10^3} \right) \left(m^3 \right)$$

Where:

PSD = Permissible site discharge (From section 4)

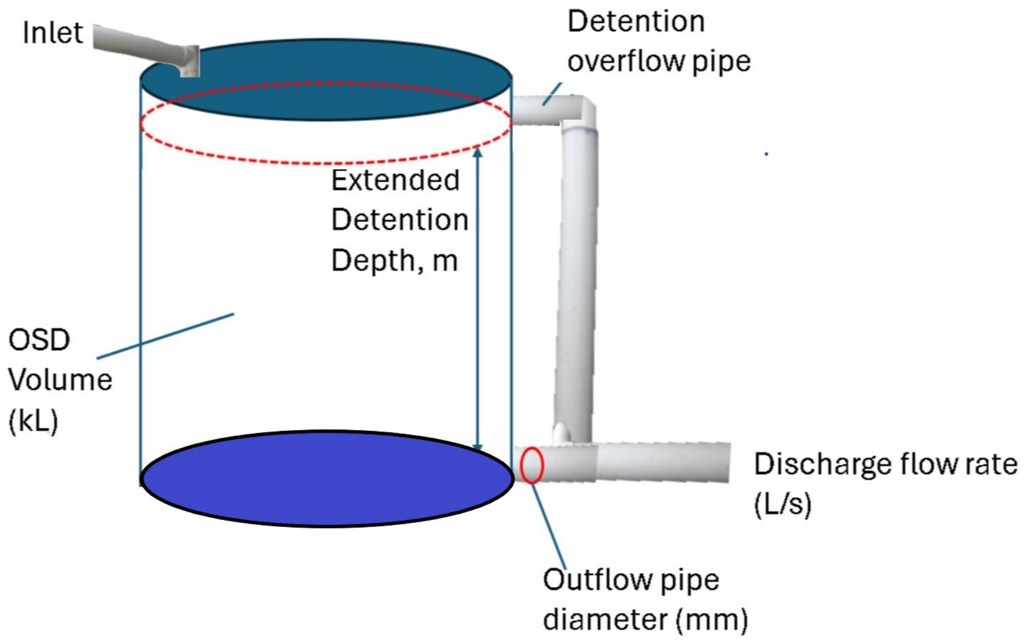
Qa' = Post Development flow for storage calculaions

Td = Storm duration

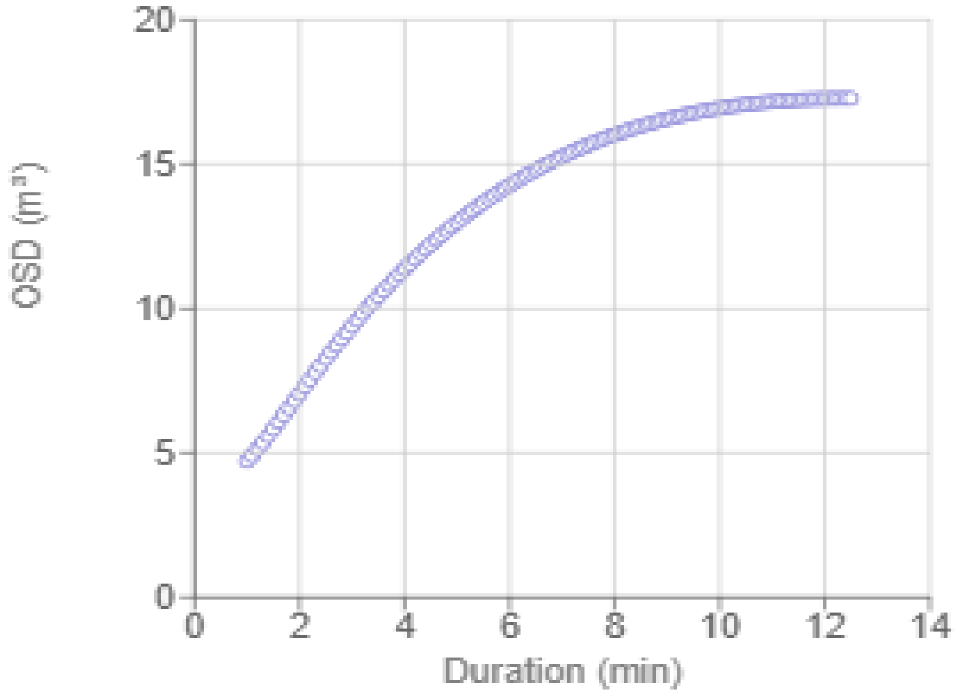
Vs = Storage Volume Required

* See parameter values in OSD Design Summary Report (Page 2)

Section 6: Standard Drawing and Specification - Typical OSD RWT



Section 7: Range of Durations used to Determine Max volume Required



Section 8: Range of Durations Calculated to Determine Critical Duration

Td, min	I, mm/hr	Adopted PSD	Quncontrolled, L/s	Qa', l/s	Volume Required, (m3)
1.0	218.3945	53.7796	0.0000	242.6606	4.7248
1.1	210.5071	53.7796	0.0000	233.8968	4.9192
1.2	204.3808	53.7796	0.0000	227.0898	5.1313
1.3	199.4855	53.7796	0.0000	221.6505	5.3560
1.4	195.4762	53.7796	0.0000	217.1958	5.5893
1.5	192.1204	53.7796	0.0000	213.4671	5.8286
1.6	189.2564	53.7796	0.0000	210.2848	6.0718
1.7	186.7690	53.7796	0.0000	207.5211	6.3174
1.8	184.5747	53.7796	0.0000	205.0830	6.5640
1.9	182.6113	53.7796	0.0000	202.9014	6.8108
2.0	180.8322	53.7796	0.0000	200.9246	7.0570
2.1	179.2017	53.7796	0.0000	199.1130	7.3019
2.2	177.6924	53.7796	0.0000	197.4361	7.5451
2.3	176.2829	53.7796	0.0000	195.8699	7.7860
2.4	174.9562	53.7796	0.0000	194.3957	8.0245
2.5	173.6988	53.7796	0.0000	192.9986	8.2601
2.6	172.5000	53.7796	0.0000	191.6666	8.4927
2.7	171.3511	53.7796	0.0000	190.3901	8.7221
2.8	170.2450	53.7796	0.0000	189.1611	8.9482
2.9	169.1760	53.7796	0.0000	187.9733	9.1707

Section 8: Range of Durations Calculated to Determine Critical Duration

Td, min	I, mm/hr	Adopted PSD	Quncontrolled, L/s	Qa', l/s	Volume Required, (m3)
3.0	168.1393	53.7796	0.0000	186.8215	9.3897
3.1	167.1311	53.7796	0.0000	185.7012	9.6050
3.2	166.1480	53.7796	0.0000	184.6089	9.8166
3.3	165.1874	53.7796	0.0000	183.5415	10.0245
3.4	164.2470	53.7796	0.0000	182.4966	10.2286
3.5	163.3248	53.7796	0.0000	181.4720	10.4289
3.6	162.4194	53.7796	0.0000	180.4660	10.6254
3.7	161.5293	53.7796	0.0000	179.4770	10.8182
3.8	160.6533	53.7796	0.0000	178.5037	11.0071
3.9	159.7905	53.7796	0.0000	177.5450	11.1923
4.0	158.9400	53.7796	0.0000	176.6000	11.3737
4.1	158.1011	53.7796	0.0000	175.6679	11.5514
4.2	157.2731	53.7796	0.0000	174.7479	11.7255
4.3	156.4556	53.7796	0.0000	173.8396	11.8958
4.4	155.6480	53.7796	0.0000	172.9422	12.0626
4.5	154.8498	53.7796	0.0000	172.0554	12.2258
4.6	154.0609	53.7796	0.0000	171.1787	12.3854
4.7	153.2807	53.7796	0.0000	170.3119	12.5415
4.8	152.5090	53.7796	0.0000	169.4545	12.6942
4.9	151.7456	53.7796	0.0000	168.6063	12.8434

Section 8: Range of Durations Calculated to Determine Critical Duration

Td, min	I, mm/hr	Adopted PSD	Quncontrolled, L/s	Qa', l/s	Volume Required, (m3)
5.0	150.9903	53.7796	0.0000	167.7670	12.9893
5.1	150.2427	53.7796	0.0000	166.9364	13.1319
5.2	149.5028	53.7796	0.0000	166.1142	13.2711
5.3	148.7704	53.7796	0.0000	165.3004	13.4072
5.4	148.0452	53.7796	0.0000	164.4947	13.5400
5.5	147.3272	53.7796	0.0000	163.6969	13.6698
5.6	146.6163	53.7796	0.0000	162.9070	13.7964
5.7	145.9122	53.7796	0.0000	162.1247	13.9200
5.8	145.2149	53.7796	0.0000	161.3499	14.0406
5.9	144.5243	53.7796	0.0000	160.5826	14.1582
6.0	143.8403	53.7796	0.0000	159.8225	14.2730
6.1	143.1627	53.7796	0.0000	159.0696	14.3848
6.2	142.4915	53.7796	0.0000	158.3239	14.4939
6.3	141.8265	53.7796	0.0000	157.5851	14.6002
6.4	141.1678	53.7796	0.0000	156.8531	14.7037
6.5	140.5152	53.7796	0.0000	156.1280	14.8046
6.6	139.8686	53.7796	0.0000	155.4096	14.9029
6.7	139.2280	53.7796	0.0000	154.6978	14.9985
6.8	138.5933	53.7796	0.0000	153.9925	15.0916
6.9	137.9643	53.7796	0.0000	153.2937	15.1822

Section 8: Range of Durations Calculated to Determine Critical Duration

Td, min	I, mm/hr	Adopted PSD	Quncontrolled, L/s	Qa', l/s	Volume Required, (m3)
7.0	137.3411	53.7796	0.0000	152.6013	15.2703
7.1	136.7236	53.7796	0.0000	151.9151	15.3560
7.2	136.1117	53.7796	0.0000	151.2352	15.4393
7.3	135.5053	53.7796	0.0000	150.5614	15.5203
7.4	134.9043	53.7796	0.0000	149.8937	15.5989
7.5	134.3088	53.7796	0.0000	149.2320	15.6753
7.6	133.7186	53.7796	0.0000	148.5762	15.7494
7.7	133.1337	53.7796	0.0000	147.9263	15.8213
7.8	132.5540	53.7796	0.0000	147.2822	15.8911
7.9	131.9794	53.7796	0.0000	146.6438	15.9587
8.0	131.4099	53.7796	0.0000	146.0110	16.0243
8.1	130.8455	53.7796	0.0000	145.3839	16.0878
8.2	130.2860	53.7796	0.0000	144.7623	16.1493
8.3	129.7315	53.7796	0.0000	144.1461	16.2087
8.4	129.1818	53.7796	0.0000	143.5353	16.2663
8.5	128.6369	53.7796	0.0000	142.9299	16.3219
8.6	128.0968	53.7796	0.0000	142.3298	16.3756
8.7	127.5614	53.7796	0.0000	141.7349	16.4274
8.8	127.0306	53.7796	0.0000	141.1451	16.4774
8.9	126.5044	53.7796	0.0000	140.5604	16.5257

Section 8: Range of Durations Calculated to Determine Critical Duration

Td, min	I, mm/hr	Adopted PSD	Quncontrolled, L/s	Qa', l/s	Volume Required, (m3)
9.0	125.9827	53.7796	0.0000	139.9808	16.5721
9.1	125.4655	53.7796	0.0000	139.4061	16.6168
9.2	124.9527	53.7796	0.0000	138.8364	16.6598
9.3	124.4444	53.7796	0.0000	138.2715	16.7011
9.4	123.9403	53.7796	0.0000	137.7115	16.7408
9.5	123.4406	53.7796	0.0000	137.1562	16.7788
9.6	122.9450	53.7796	0.0000	136.6056	16.8153
9.7	122.4537	53.7796	0.0000	136.0596	16.8501
9.8	121.9665	53.7796	0.0000	135.5183	16.8834
9.9	121.4833	53.7796	0.0000	134.9815	16.9152
10.0	121.0043	53.7796	0.0000	134.4492	16.9455
10.1	120.5292	53.7796	0.0000	133.9213	16.9742
10.2	120.0580	53.7796	0.0000	133.3978	17.0016
10.3	119.5908	53.7796	0.0000	132.8787	17.0275
10.4	119.1275	53.7796	0.0000	132.3638	17.0520
10.5	118.6679	53.7796	0.0000	131.8532	17.0752
10.6	118.2121	53.7796	0.0000	131.3468	17.0969
10.7	117.7601	53.7796	0.0000	130.8445	17.1174
10.8	117.3117	53.7796	0.0000	130.3464	17.1365
10.9	116.8670	53.7796	0.0000	129.8522	17.1543

Section 8: Range of Durations Calculated to Determine Critical Duration

Td, min	I, mm/hr	Adopted PSD	Quncontrolled, L/s	Qa', l/s	Volume Required, (m3)
11.0	116.4259	53.7796	0.0000	129.3621	17.1708
11.1	115.9884	53.7796	0.0000	128.8760	17.1861
11.2	115.5544	53.7796	0.0000	128.3937	17.2002
11.3	115.1238	53.7796	0.0000	127.9154	17.2130
11.4	114.6967	53.7796	0.0000	127.4408	17.2247
11.5	114.2731	53.7796	0.0000	126.9701	17.2352
11.6	113.8528	53.7796	0.0000	126.5031	17.2445
11.7	113.4358	53.7796	0.0000	126.0398	17.2527
11.8	113.0221	53.7796	0.0000	125.5801	17.2598
11.9	112.6117	53.7796	0.0000	125.1241	17.2657
12.0	112.2045	53.7796	0.0000	124.6717	17.2706
12.1	111.8005	53.7796	0.0000	124.2228	17.2744
12.2	111.3996	53.7796	0.0000	123.7773	17.2772
12.3	111.0019	53.7796	0.0000	123.3354	17.2789
12.4	110.6072	53.7796	0.0000	122.8969	17.2796
12.5	110.2156	53.7796	0.0000	122.4617	17.2794

On Site Detention Report

Basic Information:

Date: 6-5-2025

Assessor Name:	Connor
Assessor Email:	connormorton@whiteheadenvironmental.com.au
City Council:	Mid-Coast Council
Address Line 1:	1 Markwell Rd, Bulahdelah NSW 2423, Australia
Address Line 2:	Bulahdelah, NSW 2423
Development Type:	Industrial
Planning Permit No:	N/A

Project Details:

LAT: -32.3976135, LNG: 152.2070617

OSD Design Summary Report

Method for OSD calculations: SWINBURNE METHOD OSD4W

Device Name: Typical OSD RWT

Device Type: Steel - Above Ground Storage

Pre-Development Site Details	Area (m²)	Runoff Coefficient	Uncontrolled Area (m²)
Shed	1600	0.9	N/A
Hardstand	400	0.9	N/A

Post-Development Site Details	Area (m²)	Runoff Coefficient	Uncontrolled Area (m²)
Shed	1600	1	0
Hardstand	400	1	0

Section IFD:

IFD data used in the calculations is as follows:

IFD 2016 (no Climate Adjustment)

Storm Details

AEP for PSD Calc (%)	10
AEP for Storage Calc (%)	10
Intensity For PSD Calc (mm/hr)	125.62
Intensity For Storage Calc (mm/hr)	135.13

C-Value

Pre Dev	0.9
Post Dev Controlled	1
Post Dev Uncontrolled	0

Flow and Volume

Time of Concentration of catchment to site outlet (Tcs):	8.21 mins
Time of Concentration of site outlet to catchment outlet (Tso):	6.34 mins
Time of Concentration of catchment (Tc):	14.55 mins
Pre-Dev peak site inflow, Qp (L/s):	62.81
Permissible Site Discharge, PSD (L/s):	65.71
Post-Dev Peak Site Inflow for PSD, Qa (L/s):	139.58
Critical Duration, Td (min):	12.4
Post-Dev Peak Site Inflow Based for Storage, Qa' (L/s):	150.14
Required Storage Volume (m^3)	21.11
Adjusted Required Storage Volume (m^3):	21.11

OSD Design Calculation Details

About Swinburne Method (OSD4W variation)

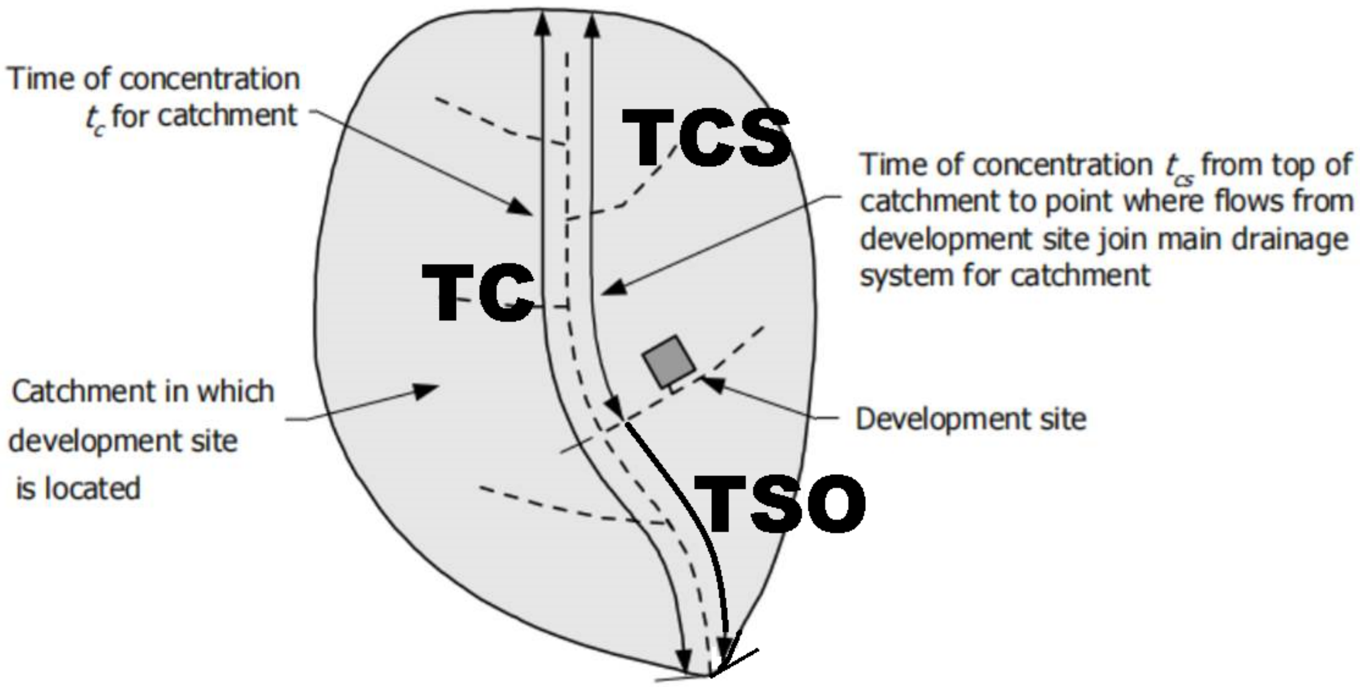
The Swinburne Method is outlined by Dr. Donald Ian Phillips in this paper published in 1995. Further analysis shows calculation methods for 3 different storage types which are used to generate results in this report. The calculation methods have been compared and validated against the OSD4w software (legacy tool used for Swinburne calculations in Victoria, Australia). It is important to clarify:

> OSD4w software developers have introduced a “safety parameter” in the calculations, therefore the results produced by OSD4w are not the same as the results produced using the standard Swinburne method devised by Dr. Phillips.

OSD4w software has been used for a long time and, unfortunately, the developer has passed. This legacy software uses 1987 IFD data and is not inline (no longer maintained) with latest AR&R guidance to use 2016 IFD data. The following calculations in this report are generated by OSDs For VIPs’ Swinburne method (OSD4w variation). The calculations use 2016 IFD data as per AR&R guidance. Calculation details are outlined in the following sections.

Section 1: Determine catchment time of concentration (Tc), time of catchment to site (Tcs) & time of site to outlet (Tso)

Swinburne Method uses the position of the development site within a larger catchment to determine permissible discharge. This is different from other methods, as for the Swinburne method the time of concentration on the site for both “pre-development” and “post-development” site condition is not relevant This requires establishment of Tc, Tcs & Tso for the catchment in which the development is located, as in below figure:



Please note Site size or time of concentration is irrelevant. Also irrelevant distance from site to main drainage system

Figure 19.2 Relationship Between t_c and t_{cs} for the Swinburne Method

Time of Concentration are calculated as follows:

Tc = 8.21 minutes (specified by engineer)

Tso = 6.34 minutes (specified by engineer)

Catchment Time of Concentration (Tc):

Tc = Tcs + Tso = 8.21 + 6.34 = 14.55

Section 2: Determine Catchment Pre Development Flow, Qp

Catchment Pre development flow is determined using Rational Method where:

A (Total Catchment Area, m²)

Catchment Name	Area (m²)
Shed	1600
Hardstand	400
Total Catchment Area (m²)	2000

I (Design Storm Intensity, mm/hr)

Intensity is obtained as per Section IFD above.
The IFD 2016 data used for calculations was downloaded from Bureau Of Meteorology at:

Latitude, degrees	Longitude, degrees
-32.4	152.21

Intensity used for PSD calculations is determined as follows:

Catchment Time of Concentration, min	14.55
AEP,%	10
Design Storm Intensity from 2016 BOM IFD, mm/hr	125.62
Climate Change Adjustment Applied *	No
Design Storm Intensity used for OSD calculations, mm/hr	125.62

*Note: Climate change adjusted intensities are calculated using method outline in AR&R Book1 AR&R Book1 Chapter 6.

C (Total Weighted C - Value)

Catchment Name	Area (m²)	C - Value (1)	Weighted C - Value (e)
Shed	1600	0.9	0.72
Hardstand	400	0.9	0.18
Total Weighted C-Value (f):			0.9

Pre Development Flow Calculation

Pre Development Flow (Qp), L/s = C * I * A / 3600

A (Total Catchment Area, m²)	I (Design Storm Intensity, mm/hr)	C (Total Weighted C - Value)	Qp, L/s
2000	125.62	0.9	62.81

Section 3: Determine Catchment Post Development Flow, Qa

Catchment Post development flow is determined using Rational Method where:

A (Total Catchment Area, m²)

Catchment Name	Area (m²)
Shed	1600
Hardstand	400
Total Catchment Area (m²)	2000

I (Design Storm Intensity, mm/hr)

Intensity is obtained as per Section IFD above.
The IFD 2016 data used for calculations was downloaded from Bureau Of Meteorology at:

Latitude, degrees	Longitude, degrees
-32.4	152.21

Intensity used for OSD calculations is determined as follows:

Catchment Time of Concentration, min	14.55
AEP,%	10
Design Storm Intensity from 2016 BOM IFD, mm/hr	125.62
Climate Change Adjustment Applied *	No
Design Storm Intensity used for OSD calculations, mm/hr	125.62

*Note: Climate change adjusted intensities are calculated using method outline in AR&R Book1 AR&R Book1 Chapter 6.

C (Total Weighted C - Value)

Catchment Name	Area (m²)	C - Value (1)	Weighted C - Value (e)
Shed	1600	1	0.8
Hardstand	400	1	0.2
Total Weighted C-Value (f):			1

Post Development Flow Calculation

Post Development Flow (Qa), L/s = 2 * C * I * A / 3600

*Note: The "2" is the safety factor introduced in OSD4w as discussed in "About Swinburne Method" section.

A (Total Catchment Area, m²)	I (Design Storm Intensity, mm/hr)	C (Total Weighted C - Value)	Qa, L/s
2000	125.62	1	139.58

Note: Qa is only used in calculation of PSD. For calculation of storage, the term Qa' is used and varies depending on duration & intensity used for each iteration (C and A is kept constant, similar to Qa calculations). More details in Section 5.

Section 4: Determine Permissible Site Discharge (PSD)

PSD is determined by solving Swinburne Method equation for Above Ground Storage

$$PSD = \frac{-b - \left(b^2 - 4c\right)^{\frac{1}{2}}}{2}$$

$$b = -\frac{2Q_a}{tc}\left(\frac{0.667 t_c Q_p}{Q_a} + 0.75 t_c + 0.25 t_{cs}\right)$$

$$c = 2Q_a Q_p$$

Where:

PSD = Permissible site discharge

Qp = Pre development flow

Qa = Post Development flow

Tcs = Time from catchment to site

Tc = Time of concentration for catchment

*See parameter values in OSD Design Summary Report (Page 2)

Section 5: Determine Storage Volume Required

Storage volume is determined by solving Swinburne Method equation for Above Ground Storage using various trials of duration Td to find max volume required (see section 7 & 8 for iterations).

$$V_s = \left(0.5Q_a't_d - \left[\left(0.875\,\mathrm{PSD}\,t_d\right)\left(1 - 0.917\frac{\mathrm{PSD}}{Q_a'}\right) + \left(0.427\,t_d\frac{\mathrm{PSD}^2}{Q_a'}\right)\right]\right)\left(\frac{60}{10^3}\right)\left(m^3\right)$$

Where:

PSD = Permissible site discharge (From section 4)

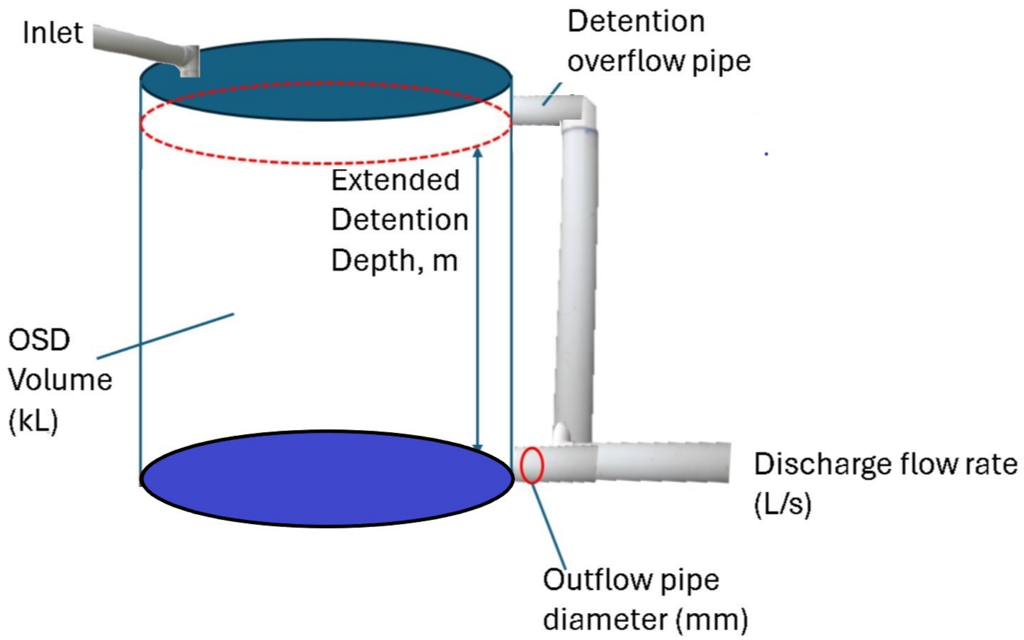
Qa' = Post Development flow for storage calculaions

Td = Storm duration

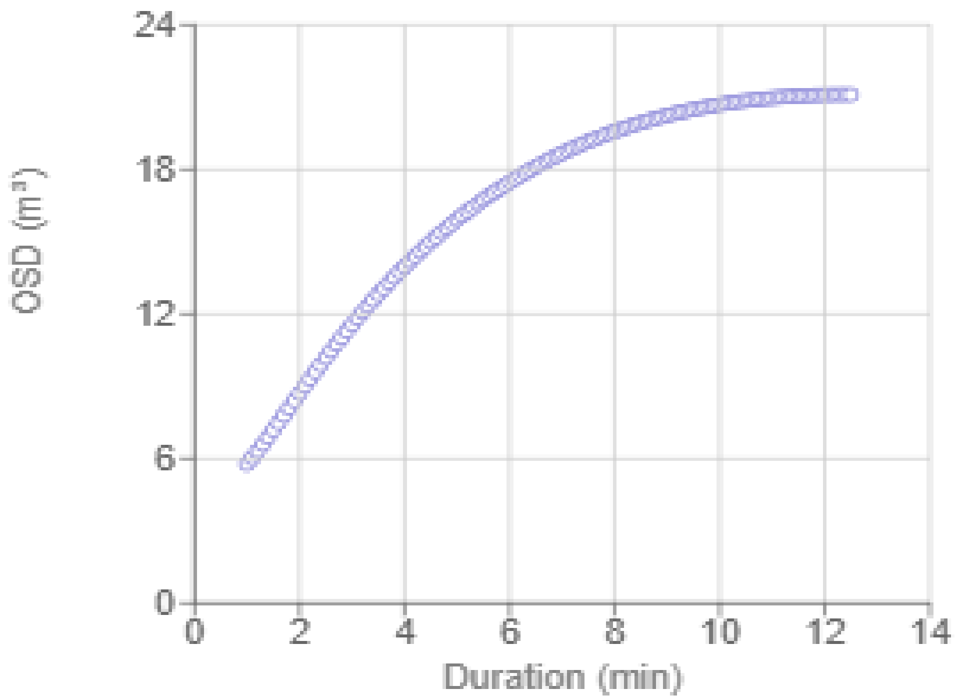
Vs = Storage Volume Required

* See parameter values in OSD Design Summary Report (Page 2)

Section 6: Standard Drawing and Specification - Typical OSD RWT



Section 7: Range of Durations used to Determine Max volume Required



Section 8: Range of Durations Calculated to Determine Critical Duration

Td, min	I, mm/hr	Adopted PSD	Quncontrolled, L/s	Qa', l/s	Volume Required, (m3)
1.0	267.1023	65.7144	0.0000	296.7803	5.7811
1.1	257.9206	65.7144	0.0000	286.5785	6.0354
1.2	250.7318	65.7144	0.0000	278.5909	6.3082
1.3	244.9424	65.7144	0.0000	272.1583	6.5937
1.4	240.1648	65.7144	0.0000	266.8498	6.8879
1.5	236.1363	65.7144	0.0000	262.3736	7.1878
1.6	232.6739	65.7144	0.0000	258.5265	7.4912
1.7	229.6469	65.7144	0.0000	255.1632	7.7963
1.8	226.9599	65.7144	0.0000	252.1777	8.1018
1.9	224.5423	65.7144	0.0000	249.4914	8.4067
2.0	222.3405	65.7144	0.0000	247.0450	8.7101
2.1	220.3138	65.7144	0.0000	244.7931	9.0113
2.2	218.4305	65.7144	0.0000	242.7006	9.3099
2.3	216.6659	65.7144	0.0000	240.7399	9.6053
2.4	215.0006	65.7144	0.0000	238.8895	9.8972
2.5	213.4188	65.7144	0.0000	237.1320	10.1853
2.6	211.9081	65.7144	0.0000	235.4534	10.4694
2.7	210.4584	65.7144	0.0000	233.8427	10.7492
2.8	209.0614	65.7144	0.0000	232.2905	11.0247
2.9	207.7104	65.7144	0.0000	230.7894	11.2958

Section 8: Range of Durations Calculated to Determine Critical Duration

Td, min	I, mm/hr	Adopted PSD	Quncontrolled, L/s	Qa', l/s	Volume Required, (m3)
3.0	206.3998	65.7144	0.0000	229.3331	11.5623
3.1	205.1250	65.7144	0.0000	227.9167	11.8241
3.2	203.8821	65.7144	0.0000	226.5356	12.0813
3.3	202.6678	65.7144	0.0000	225.1865	12.3337
3.4	201.4796	65.7144	0.0000	223.8662	12.5815
3.5	200.3150	65.7144	0.0000	222.5722	12.8245
3.6	199.1721	65.7144	0.0000	221.3023	13.0628
3.7	198.0493	65.7144	0.0000	220.0548	13.2964
3.8	196.9451	65.7144	0.0000	218.8279	13.5253
3.9	195.8583	65.7144	0.0000	217.6203	13.7496
4.0	194.7878	65.7144	0.0000	216.4309	13.9692
4.1	193.7328	65.7144	0.0000	215.2586	14.1843
4.2	192.6923	65.7144	0.0000	214.1026	14.3948
4.3	191.6658	65.7144	0.0000	212.9620	14.6009
4.4	190.6525	65.7144	0.0000	211.8362	14.8025
4.5	189.6520	65.7144	0.0000	210.7245	14.9998
4.6	188.6638	65.7144	0.0000	209.6264	15.1927
4.7	187.6873	65.7144	0.0000	208.5414	15.3813
4.8	186.7222	65.7144	0.0000	207.4692	15.5657
4.9	185.7683	65.7144	0.0000	206.4092	15.7460

Section 8: Range of Durations Calculated to Determine Critical Duration

Td, min	I, mm/hr	Adopted PSD	Quncontrolled, L/s	Qa', l/s	Volume Required, (m3)
5.0	184.8251	65.7144	0.0000	205.3612	15.9222
5.1	183.8923	65.7144	0.0000	204.3248	16.0943
5.2	182.9697	65.7144	0.0000	203.2997	16.2625
5.3	182.0571	65.7144	0.0000	202.2857	16.4267
5.4	181.1542	65.7144	0.0000	201.2824	16.5870
5.5	180.2608	65.7144	0.0000	200.2898	16.7436
5.6	179.3768	65.7144	0.0000	199.3075	16.8964
5.7	178.5018	65.7144	0.0000	198.3354	17.0455
5.8	177.6359	65.7144	0.0000	197.3732	17.1910
5.9	176.7787	65.7144	0.0000	196.4208	17.3329
6.0	175.9302	65.7144	0.0000	195.4780	17.4713
6.1	175.0902	65.7144	0.0000	194.5447	17.6063
6.2	174.2586	65.7144	0.0000	193.6206	17.7378
6.3	173.4352	65.7144	0.0000	192.7057	17.8660
6.4	172.6199	65.7144	0.0000	191.7998	17.9909
6.5	171.8125	65.7144	0.0000	190.9028	18.1126
6.6	171.0131	65.7144	0.0000	190.0145	18.2311
6.7	170.2213	65.7144	0.0000	189.1348	18.3465
6.8	169.4373	65.7144	0.0000	188.2636	18.4587
6.9	168.6607	65.7144	0.0000	187.4008	18.5680

Section 8: Range of Durations Calculated to Determine Critical Duration

Td, min	I, mm/hr	Adopted PSD	Quncontrolled, L/s	Qa', l/s	Volume Required, (m3)
7.0	167.8915	65.7144	0.0000	186.5462	18.6743
7.1	167.1297	65.7144	0.0000	185.6997	18.7776
7.2	166.3751	65.7144	0.0000	184.8612	18.8781
7.3	165.6276	65.7144	0.0000	184.0307	18.9757
7.4	164.8872	65.7144	0.0000	183.2079	19.0706
7.5	164.1536	65.7144	0.0000	182.3929	19.1627
7.6	163.4269	65.7144	0.0000	181.5855	19.2521
7.7	162.7070	65.7144	0.0000	180.7855	19.3389
7.8	161.9937	65.7144	0.0000	179.9930	19.4231
7.9	161.2870	65.7144	0.0000	179.2078	19.5047
8.0	160.5868	65.7144	0.0000	178.4298	19.5838
8.1	159.8930	65.7144	0.0000	177.6589	19.6605
8.2	159.2055	65.7144	0.0000	176.8950	19.7347
8.3	158.5243	65.7144	0.0000	176.1381	19.8065
8.4	157.8492	65.7144	0.0000	175.3880	19.8759
8.5	157.1802	65.7144	0.0000	174.6447	19.9430
8.6	156.5173	65.7144	0.0000	173.9081	20.0079
8.7	155.8602	65.7144	0.0000	173.1780	20.0705
8.8	155.2091	65.7144	0.0000	172.4545	20.1309
8.9	154.5637	65.7144	0.0000	171.7374	20.1892

Section 8: Range of Durations Calculated to Determine Critical Duration

Td, min	I, mm/hr	Adopted PSD	Quncontrolled, L/s	Qa', l/s	Volume Required, (m3)
9.0	153.9240	65.7144	0.0000	171.0267	20.2453
9.1	153.2900	65.7144	0.0000	170.3223	20.2994
9.2	152.6616	65.7144	0.0000	169.6240	20.3513
9.3	152.0387	65.7144	0.0000	168.9319	20.4013
9.4	151.4212	65.7144	0.0000	168.2458	20.4493
9.5	150.8091	65.7144	0.0000	167.5657	20.4953
9.6	150.2023	65.7144	0.0000	166.8914	20.5393
9.7	149.6007	65.7144	0.0000	166.2230	20.5815
9.8	149.0044	65.7144	0.0000	165.5604	20.6218
9.9	148.4131	65.7144	0.0000	164.9035	20.6603
10.0	147.8269	65.7144	0.0000	164.2521	20.6970
10.1	147.2457	65.7144	0.0000	163.6063	20.7319
10.2	146.6694	65.7144	0.0000	162.9660	20.7651
10.3	146.0980	65.7144	0.0000	162.3311	20.7965
10.4	145.5314	65.7144	0.0000	161.7016	20.8263
10.5	144.9696	65.7144	0.0000	161.0774	20.8543
10.6	144.4125	65.7144	0.0000	160.4583	20.8808
10.7	143.8600	65.7144	0.0000	159.8445	20.9056
10.8	143.3121	65.7144	0.0000	159.2357	20.9289
10.9	142.7688	65.7144	0.0000	158.6320	20.9506

Section 8: Range of Durations Calculated to Determine Critical Duration

Td, min	I, mm/hr	Adopted PSD	Quncontrolled, L/s	Qa', l/s	Volume Required, (m3)
11.0	142.2299	65.7144	0.0000	158.0332	20.9708
11.1	141.6954	65.7144	0.0000	157.4394	20.9894
11.2	141.1654	65.7144	0.0000	156.8504	21.0066
11.3	140.6396	65.7144	0.0000	156.2662	21.0223
11.4	140.1181	65.7144	0.0000	155.6868	21.0366
11.5	139.6009	65.7144	0.0000	155.1121	21.0495
11.6	139.0878	65.7144	0.0000	154.5420	21.0610
11.7	138.5789	65.7144	0.0000	153.9765	21.0711
11.8	138.0740	65.7144	0.0000	153.4155	21.0799
11.9	137.5731	65.7144	0.0000	152.8590	21.0873
12.0	137.0763	65.7144	0.0000	152.3070	21.0934
12.1	136.5834	65.7144	0.0000	151.7593	21.0983
12.2	136.0943	65.7144	0.0000	151.2159	21.1019
12.3	135.6091	65.7144	0.0000	150.6768	21.1042
12.4	135.1278	65.7144	0.0000	150.1420	21.1053
12.5	134.6502	65.7144	0.0000	149.6113	21.1053

On Site Detention Report

Basic Information:

Date: 6-5-2025

Assessor Name:	Connor
Assessor Email:	connormorton@whiteheadenvironmental.com.au
City Council:	Mid-Coast Council
Address Line 1:	1 Markwell Rd, Bulahdelah NSW 2423, Australia
Address Line 2:	Bulahdelah, NSW 2423
Development Type:	Industrial
Planning Permit No:	N/A

Project Details:

LAT: -32.3976135, LNG: 152.2070617

OSD Design Summary Report

Method for OSD calculations: SWINBURNE METHOD OSD4W

Device Name: Typical OSD RWT

Device Type: Steel - Above Ground Storage

Pre-Development Site Details	Area (m²)	Runoff Coefficient	Uncontrolled Area (m²)
Shed	1600	0.9	N/A
Hardstand	400	0.9	N/A

Post-Development Site Details	Area (m²)	Runoff Coefficient	Uncontrolled Area (m²)
Shed	1600	1	0
Hardstand	400	1	0

Section IFD:

IFD data used in the calculations is as follows:

IFD 2016 (no Climate Adjustment)

Storm Details

AEP for PSD Calc (%)	1
AEP for Storage Calc (%)	1
Intensity For PSD Calc (mm/hr)	209.97
Intensity For Storage Calc (mm/hr)	224.94

C-Value

Pre Dev	0.9
Post Dev Controlled	1
Post Dev Uncontrolled	0

Flow and Volume

Time of Concentration of catchment to site outlet (Tcs):	8.21 mins
Time of Concentration of site outlet to catchment outlet (Tso):	6.34 mins
Time of Concentration of catchment (Tc):	14.55 mins
Pre-Dev peak site inflow, Qp (L/s):	104.98
Permissible Site Discharge, PSD (L/s):	109.84
Post-Dev Peak Site Inflow for PSD, Qa (L/s):	233.3
Critical Duration, Td (min):	12.5
Post-Dev Peak Site Inflow Based for Storage, Qa' (L/s):	249.93
Required Storage Volume (m^3)	35.23
Adjusted Required Storage Volume (m^3):	35.23
Height of storage above orifice (m):	1.25
Required Orifice Diameter (mm):	213.5

OSD Design Calculation Details

About Swinburne Method (OSD4W variation)

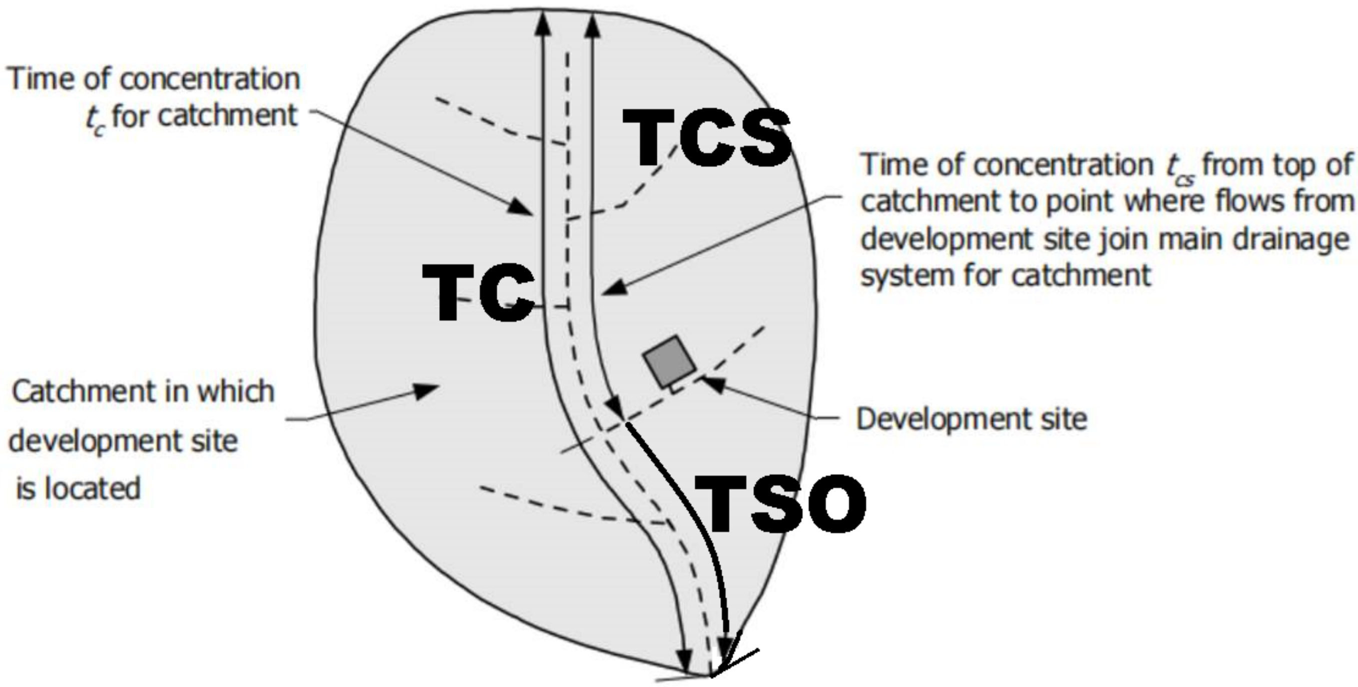
The Swinburne Method is outlined by Dr. Donald Ian Phillips in this paper published in 1995. Further analysis shows calculation methods for 3 different storage types which are used to generate results in this report. The calculation methods have been compared and validated against the OSD4w software (legacy tool used for Swinburne calculations in Victoria, Australia). It is important to clarify:

> OSD4w software developers have introduced a “safety parameter” in the calculations, therefore the results produced by OSD4w are not the same as the results produced using the standard Swinburne method devised by Dr. Phillips.

OSD4w software has been used for a long time and, unfortunately, the developer has passed. This legacy software uses 1987 IFD data and is not inline (no longer maintained) with latest AR&R guidance to use 2016 IFD data. The following calculations in this report are generated by OSDs For VIPs’ Swinburne method (OSD4w variation). The calculations use 2016 IFD data as per AR&R guidance. Calculation details are outlined in the following sections.

Section 1: Determine catchment time of concentration (Tc), time of catchment to site (Tcs) & time of site to outlet (Tso)

Swinburne Method uses the position of the development site within a larger catchment to determine permissible discharge. This is different from other methods, as for the Swinburne method the time of concentration on the site for both “pre-development” and “post-development” site condition is not relevant This requires establishment of Tc, Tcs & Tso for the catchment in which the development is located, as in below figure:



Please note Site size or time of concentration is irrelevant. Also irrelevant distance from site to main drainage system

Figure 19.2 Relationship Between t_c and t_{cs} for the Swinburne Method

Time of Concentration are calculated as follows:

Tc = 8.21 minutes (specified by engineer)

Tso = 6.34 minutes (specified by engineer)

Catchment Time of Concentration (Tc):

Tc = Tcs + Tso = 8.21 + 6.34 = 14.55

Section 2: Determine Catchment Pre Development Flow, Qp

Catchment Pre development flow is determined using Rational Method where:

A (Total Catchment Area, m²)

Catchment Name	Area (m²)
Shed	1600
Hardstand	400
Total Catchment Area (m²)	2000

I (Design Storm Intensity, mm/hr)

Intensity is obtained as per Section IFD above.
The IFD 2016 data used for calculations was downloaded from Bureau Of Meteorology at:

Latitude, degrees	Longitude, degrees
-32.4	152.21

Intensity used for PSD calculations is determined as follows:

Catchment Time of Concentration, min	14.55
AEP,%	1
Design Storm Intensity from 2016 BOM IFD, mm/hr	209.97
Climate Change Adjustment Applied *	No
Design Storm Intensity used for OSD calculations, mm/hr	209.97

*Note: Climate change adjusted intensities are calculated using method outline in AR&R Book1 AR&R Book1 Chapter 6.

C (Total Weighted C - Value)

Catchment Name	Area (m²)	C - Value (1)	Weighted C - Value (e)
Shed	1600	0.9	0.72
Hardstand	400	0.9	0.18
Total Weighted C-Value (f):			0.9

Pre Development Flow Calculation

Pre Development Flow (Qp), L/s = C * I * A / 3600

A (Total Catchment Area, m²)	I (Design Storm Intensity, mm/hr)	C (Total Weighted C - Value)	Qp, L/s
2000	209.97	0.9	104.98

Section 3: Determine Catchment Post Development Flow, Qa

Catchment Post development flow is determined using Rational Method where:

A (Total Catchment Area, m²)

Catchment Name	Area (m²)
Shed	1600
Hardstand	400
Total Catchment Area (m²)	2000

I (Design Storm Intensity, mm/hr)

Intensity is obtained as per Section IFD above.
The IFD 2016 data used for calculations was downloaded from Bureau Of Meteorology at:

Latitude, degrees	Longitude, degrees
-32.4	152.21

Intensity used for OSD calculations is determined as follows:

Catchment Time of Concentration, min	14.55
AEP,%	1
Design Storm Intensity from 2016 BOM IFD, mm/hr	209.97
Climate Change Adjustment Applied *	No
Design Storm Intensity used for OSD calculations, mm/hr	209.97

*Note: Climate change adjusted intensities are calculated using method outline in AR&R Book1 AR&R Book1 Chapter 6.

C (Total Weighted C - Value)

Catchment Name	Area (m²)	C - Value (1)	Weighted C - Value (e)
Shed	1600	1	0.8
Hardstand	400	1	0.2
Total Weighted C-Value (f):			1

Post Development Flow Calculation

Post Development Flow (Qa), L/s = 2 * C * I * A / 3600

*Note: The "2" is the safety factor introduced in OSD4w as discussed in "About Swinburne Method" section.

A (Total Catchment Area, m²)	I (Design Storm Intensity, mm/hr)	C (Total Weighted C - Value)	Qa, L/s
2000	209.97	1	233.3

Note: Qa is only used in calculation of PSD. For calculation of storage, the term Qa' is used and varies depending on duration & intensity used for each iteration (C and A is kept constant, similar to Qa calculations). More details in Section 5.

Section 4: Determine Permissible Site Discharge (PSD)

PSD is determined by solving Swinburne Method equation for Above Ground Storage

$$PSD = \frac{-b - \left(b^2 - 4c\right)^{\frac{1}{2}}}{2}$$

$$b = -\frac{2Q_a}{tc}\left(\frac{0.667 t_c Q_p}{Q_a} + 0.75 t_c + 0.25 t_{cs}\right)$$

$$c = 2 Q_a Q_p$$

Where:

PSD = Permissible site discharge

Qp = Pre development flow

Qa = Post Development flow

Tcs = Time from catchment to site

Tc = Time of concentration for catchment

*See parameter values in OSD Design Summary Report (Page 2)

Section 5: Determine Storage Volume Required

Storage volume is determined by solving Swinburne Method equation for Above Ground Storage using various trials of duration Td to find max volume required (see section 7 & 8 for iterations).

$$V_s = \left(0.5Q_a' t_d - \left[\left(0.875 \text{PSD}\, t_d \right) \left(1 - 0.917 \frac{\text{PSD}}{Q_a'} \right) + \left(0.427 t_d \frac{\text{PSD}^2}{Q_a'} \right) \right] \right) \left(\frac{60}{10^3} \right) \left(m^3 \right)$$

Where:

PSD = Permissible site discharge (From section 4)

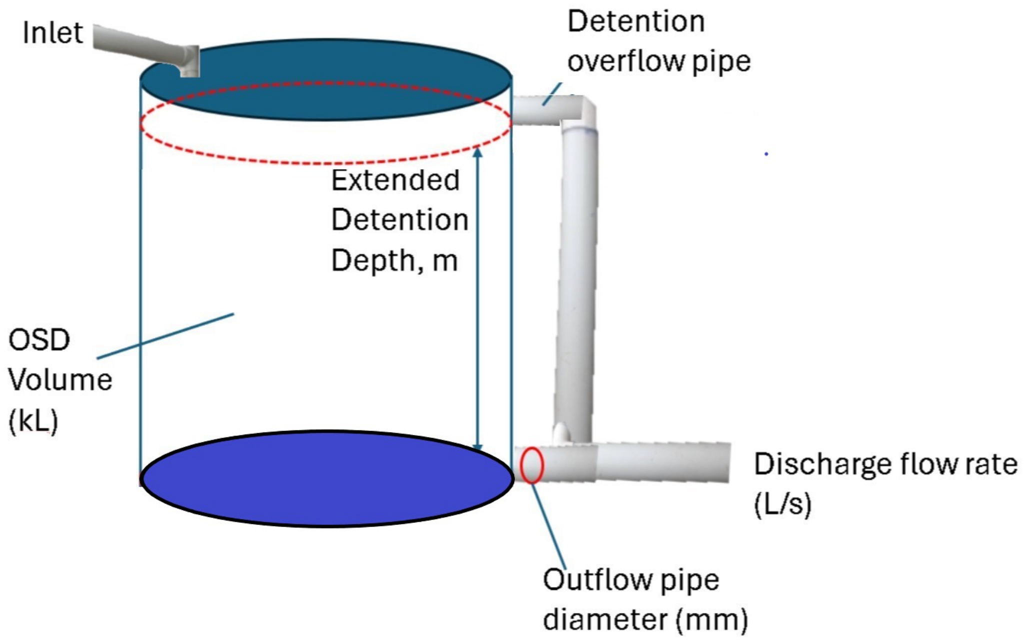
Qa' = Post Development flow for storage calculaions

Td = Storm duration

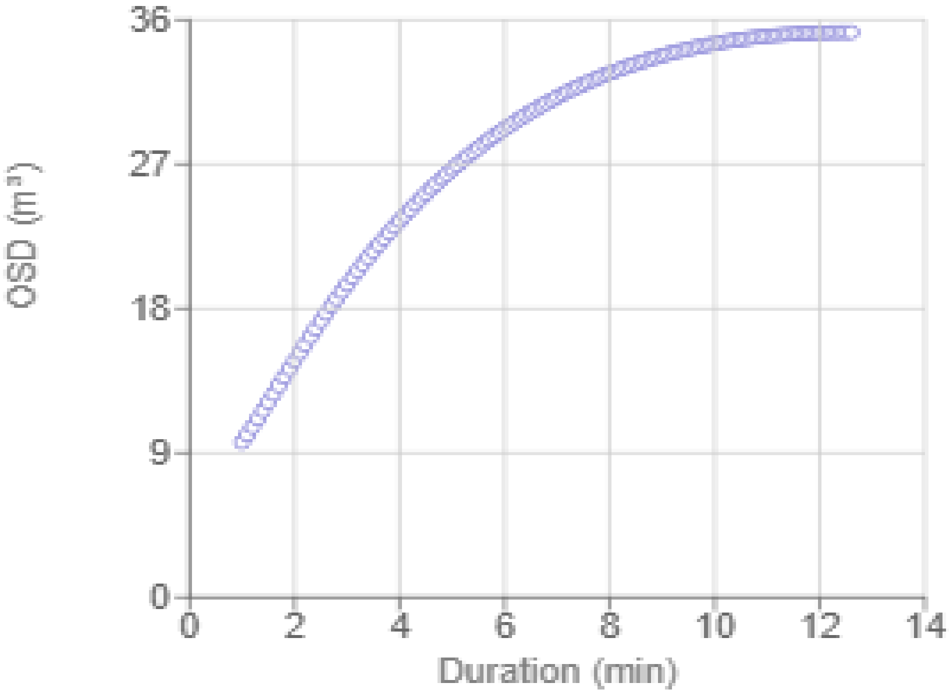
Vs = Storage Volume Required

* See parameter values in OSD Design Summary Report (Page 2)

Section 6: Standard Drawing and Specification - Typical OSD RWT



Section 7: Range of Durations used to Determine Max volume Required



Section 8: Range of Durations Calculated to Determine Critical Duration

Td, min	I, mm/hr	Adopted PSD	Quncontrolled, L/s	Qa', l/s	Volume Required, (m3)
1.0	446.8570	109.8369	0.0000	496.5077	9.6760
1.1	432.6609	109.8369	0.0000	480.7343	10.1429
1.2	421.3856	109.8369	0.0000	468.2062	10.6321
1.3	412.1799	109.8369	0.0000	457.9777	11.1360
1.4	404.4827	109.8369	0.0000	449.4253	11.6493
1.5	397.9117	109.8369	0.0000	442.1241	12.1678
1.6	392.1985	109.8369	0.0000	435.7761	12.6886
1.7	387.1504	109.8369	0.0000	430.1671	13.2094
1.8	382.6263	109.8369	0.0000	425.1404	13.7284
1.9	378.5207	109.8369	0.0000	420.5786	14.2442
2.0	374.7538	109.8369	0.0000	416.3931	14.7558
2.1	371.2641	109.8369	0.0000	412.5156	15.2622
2.2	368.0038	109.8369	0.0000	408.8931	15.7627
2.3	364.9355	109.8369	0.0000	405.4839	16.2568
2.4	362.0293	109.8369	0.0000	402.2547	16.7440
2.5	359.2612	109.8369	0.0000	399.1791	17.2241
2.6	356.6121	109.8369	0.0000	396.2356	17.6966
2.7	354.0660	109.8369	0.0000	393.4067	18.1614
2.8	351.6103	109.8369	0.0000	390.6781	18.6183
2.9	349.2341	109.8369	0.0000	388.0379	19.0673

Section 8: Range of Durations Calculated to Determine Critical Duration

Td, min	I, mm/hr	Adopted PSD	Quncontrolled, L/s	Qa', l/s	Volume Required, (m3)
3.0	346.9286	109.8369	0.0000	385.4762	19.5082
3.1	344.6864	109.8369	0.0000	382.9849	19.9410
3.2	342.5014	109.8369	0.0000	380.5571	20.3657
3.3	340.3682	109.8369	0.0000	378.1869	20.7822
3.4	338.2824	109.8369	0.0000	375.8693	21.1906
3.5	336.2401	109.8369	0.0000	373.6001	21.5910
3.6	334.2381	109.8369	0.0000	371.3757	21.9833
3.7	332.2735	109.8369	0.0000	369.1928	22.3677
3.8	330.3439	109.8369	0.0000	367.0488	22.7441
3.9	328.4472	109.8369	0.0000	364.9413	23.1128
4.0	326.5814	109.8369	0.0000	362.8682	23.4736
4.1	324.7449	109.8369	0.0000	360.8277	23.8268
4.2	322.9363	109.8369	0.0000	358.8181	24.1725
4.3	321.1543	109.8369	0.0000	356.8381	24.5107
4.4	319.3976	109.8369	0.0000	354.8862	24.8415
4.5	317.6653	109.8369	0.0000	352.9615	25.1650
4.6	315.9565	109.8369	0.0000	351.0628	25.4814
4.7	314.2703	109.8369	0.0000	349.1892	25.7906
4.8	312.6059	109.8369	0.0000	347.3399	26.0930
4.9	310.9626	109.8369	0.0000	345.5140	26.3884

Section 8: Range of Durations Calculated to Determine Critical Duration

Td, min	I, mm/hr	Adopted PSD	Quncontrolled, L/s	Qa', l/s	Volume Required, (m3)
5.0	309.3398	109.8369	0.0000	343.7109	26.6771
5.1	307.7369	109.8369	0.0000	341.9299	26.9592
5.2	306.1534	109.8369	0.0000	340.1704	27.2347
5.3	304.5887	109.8369	0.0000	338.4318	27.5037
5.4	303.0423	109.8369	0.0000	336.7137	27.7664
5.5	301.5139	109.8369	0.0000	335.0154	28.0229
5.6	300.0030	109.8369	0.0000	333.3366	28.2733
5.7	298.5092	109.8369	0.0000	331.6769	28.5176
5.8	297.0321	109.8369	0.0000	330.0357	28.7560
5.9	295.5715	109.8369	0.0000	328.4127	28.9885
6.0	294.1269	109.8369	0.0000	326.8077	29.2153
6.1	292.6981	109.8369	0.0000	325.2201	29.4364
6.2	291.2847	109.8369	0.0000	323.6496	29.6520
6.3	289.8865	109.8369	0.0000	322.0961	29.8622
6.4	288.5031	109.8369	0.0000	320.5590	30.0670
6.5	287.1344	109.8369	0.0000	319.0382	30.2665
6.6	285.7800	109.8369	0.0000	317.5334	30.4608
6.7	284.4398	109.8369	0.0000	316.0442	30.6500
6.8	283.1134	109.8369	0.0000	314.5705	30.8342
6.9	281.8007	109.8369	0.0000	313.1119	31.0135

Section 8: Range of Durations Calculated to Determine Critical Duration

Td, min	I, mm/hr	Adopted PSD	Quncontrolled, L/s	Qa', l/s	Volume Required, (m3)
7.0	280.5014	109.8369	0.0000	311.6682	31.1879
7.1	279.2153	109.8369	0.0000	310.2392	31.3576
7.2	277.9422	109.8369	0.0000	308.8246	31.5226
7.3	276.6818	109.8369	0.0000	307.4242	31.6830
7.4	275.4341	109.8369	0.0000	306.0379	31.8388
7.5	274.1987	109.8369	0.0000	304.6652	31.9903
7.6	272.9756	109.8369	0.0000	303.3062	32.1373
7.7	271.7644	109.8369	0.0000	301.9605	32.2800
7.8	270.5651	109.8369	0.0000	300.6279	32.4186
7.9	269.3775	109.8369	0.0000	299.3083	32.5529
8.0	268.2013	109.8369	0.0000	298.0015	32.6832
8.1	267.0365	109.8369	0.0000	296.7072	32.8094
8.2	265.8828	109.8369	0.0000	295.4253	32.9317
8.3	264.7401	109.8369	0.0000	294.1557	33.0501
8.4	263.6083	109.8369	0.0000	292.8981	33.1647
8.5	262.4871	109.8369	0.0000	291.6523	33.2756
8.6	261.3765	109.8369	0.0000	290.4183	33.3827
8.7	260.2762	109.8369	0.0000	289.1958	33.4862
8.8	259.1862	109.8369	0.0000	287.9847	33.5862
8.9	258.1063	109.8369	0.0000	286.7848	33.6826

Section 8: Range of Durations Calculated to Determine Critical Duration

Td, min	I, mm/hr	Adopted PSD	Quncontrolled, L/s	Qa', l/s	Volume Required, (m3)
9.0	257.0363	109.8369	0.0000	285.5959	33.7755
9.1	255.9762	109.8369	0.0000	284.4180	33.8651
9.2	254.9257	109.8369	0.0000	283.2508	33.9513
9.3	253.8848	109.8369	0.0000	282.0942	34.0342
9.4	252.8533	109.8369	0.0000	280.9481	34.1139
9.5	251.8311	109.8369	0.0000	279.8124	34.1905
9.6	250.8181	109.8369	0.0000	278.6868	34.2638
9.7	249.8141	109.8369	0.0000	277.5713	34.3341
9.8	248.8191	109.8369	0.0000	276.4657	34.4014
9.9	247.8329	109.8369	0.0000	275.3699	34.4657
10.0	246.8553	109.8369	0.0000	274.2837	34.5271
10.1	245.8864	109.8369	0.0000	273.2071	34.5856
10.2	244.9259	109.8369	0.0000	272.1398	34.6412
10.3	243.9737	109.8369	0.0000	271.0819	34.6941
10.4	243.0298	109.8369	0.0000	270.0331	34.7442
10.5	242.0941	109.8369	0.0000	268.9934	34.7916
10.6	241.1663	109.8369	0.0000	267.9626	34.8363
10.7	240.2465	109.8369	0.0000	266.9406	34.8784
10.8	239.3346	109.8369	0.0000	265.9273	34.9180
10.9	238.4304	109.8369	0.0000	264.9226	34.9550

Section 8: Range of Durations Calculated to Determine Critical Duration

Td, min	I, mm/hr	Adopted PSD	Quncontrolled, L/s	Qa', l/s	Volume Required, (m3)
11.0	237.5338	109.8369	0.0000	263.9264	34.9895
11.1	236.6447	109.8369	0.0000	262.9386	35.0216
11.2	235.7631	109.8369	0.0000	261.9590	35.0512
11.3	234.8888	109.8369	0.0000	260.9876	35.0785
11.4	234.0218	109.8369	0.0000	260.0243	35.1035
11.5	233.1620	109.8369	0.0000	259.0689	35.1261
11.6	232.3092	109.8369	0.0000	258.1214	35.1465
11.7	231.4635	109.8369	0.0000	257.1816	35.1646
11.8	230.6246	109.8369	0.0000	256.2496	35.1805
11.9	229.7926	109.8369	0.0000	255.3251	35.1943
12.0	228.9672	109.8369	0.0000	254.4081	35.2060
12.1	228.1486	109.8369	0.0000	253.4984	35.2156
12.2	227.3365	109.8369	0.0000	252.5961	35.2231
12.3	226.5309	109.8369	0.0000	251.7010	35.2285
12.4	225.7318	109.8369	0.0000	250.8131	35.2320
12.5	224.9390	109.8369	0.0000	249.9322	35.2335
12.6	224.1524	109.8369	0.0000	249.0582	35.2331