Huntingfield Master Plan Stormwater Management System

Detailed Design Report

Department of Communities Tasmania

15 December 2022

→ The Power of Commitment

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1. Introduction

1.1 Overview

The Department of Communities Tasmania (DCT) has engaged GHD to undertake the master planning and design of the engineering services for a concept design and detailed design for the Huntingfield residential subdivision of land at Huntingfield, in the Kingborough Council local government area, Tasmania. It provides an assessment of the proposed development with respect to stormwater quantity and quality management.

In accordance with Kingborough Interim Planning Scheme 2015, new developments must consider the impact of increased stormwater runoff due to an increase in impervious fraction. Hence, in refining the previous Stormwater Management Plan (GHD 2021), a stormwater management system is designed as part of the Developer's Application submission to Kingborough Council.

The proposed stormwater quality and quantity treatment devices consist of 5 kL household rainwater tanks distributed across the subdivision site, an end-of-line treatment train consisting of a 1,202 m^2 sediment basin, and 4,891 m^2 combined wetland/ OSD basin, and a proprietary gross pollutant trap (GPT) to treat the portion of the developed catchment that drains to the north. The proposed end-of-line treatment train is to be located within the footprint of a proposed on-site detention basin situated at the southern point of the development, see Figure 1. While acknowledging the challenging terrain (i.e., on a hillslope) and the boundary against Peter Murrell State Reserve to the east, this is the natural choice as most of the stormwater runoff are directed to this location due to the topography and proposed drainage.

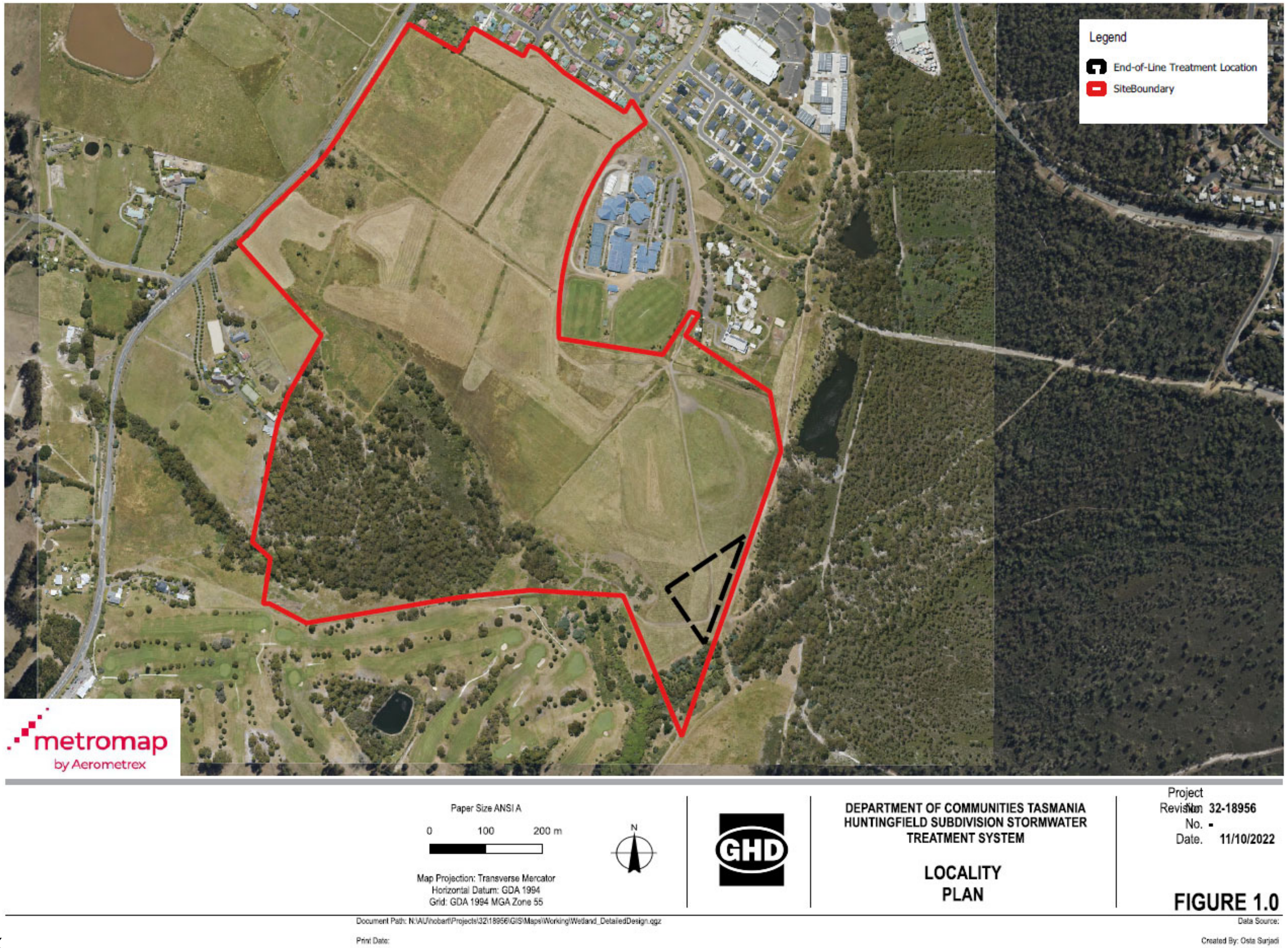

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Figure 1 Site location and proposed location of end-of-line treatment train

1.2 Purpose of this report

The purpose of this report is to document the detailed design of the proposed stormwater quality and quantity treatment systems for the Huntingfield subdivision. This document should be read in conjunction with the Huntingfield Development Stage 1I drawings by GHD 32-18956-C2000 to C2083.

1.3 Relevant planning controls and design principals

The following planning and engineering controls and design principles have been used:

- Kingborough Interim Planning Scheme 2015 (the Planning Scheme) (Kingborough Council 2015).
- Tasmanian Subdivision Guidelines 2013[1]
- Australian Rainfall and Runoff, Engineers Australia 2019 (ARR)[2]
- MUSIC Guidelines, Melbourne Water 2018 (Melbourne Water 2018)
- Wetland Design Manual, Melbourne Water 2020 (Melbourne Water 2020)

1.4 Scope and limitations

This report: has been prepared by GHD for Department of Communities Tasmania and may only be used and relied on by Department of Communities Tasmania for the purpose agreed between GHD and Department of Communities Tasmania as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Department of Communities Tasmania arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section(s) 11 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

Accessibility of documents

If this report is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.

GHD has prepared the DRAINS and MUSIC models ("Models") for, and for the benefit and sole use of, Department of Communities Tasmania to support stormwater quality and quantity treatment systems detailed design and must not be used for any other purpose or by any other person.

The Models are a representation only and does not reflect reality in every aspect. The Models contain simplified assumptions to derive a modelled outcome. The actual variables will inevitably be different to those used to prepare the Models. Accordingly, the outputs of the Models cannot be relied upon to represent actual conditions without due consideration of the inherent and expected inaccuracies. Such considerations are beyond GHD's scope.

The information, data and assumptions ("Inputs") used as inputs into the Models are from publicly available sources or provided by or on behalf of the Department of Communities Tasmania, (including possibly through stakeholder engagements). GHD has not independently verified or checked Inputs beyond its agreed scope of work. GHD's scope of work does not include review or update of the Models as further Inputs becomes available.

The Models are limited by the mathematical rules and assumptions that are set out in the Report or included in the Models and by the software environment in which the Models are developed.

The Models are customised models and not intended to be amended in any form or extracted to other software for amending. Any change made to the Models, other than by GHD, is undertaken on the express understanding that GHD is not responsible, and has no liability, for the changed Models including any outputs.

[1] https://www.lgat.tas.gov.au/__data/assets/pdf_file/0020/322616/Subdivision-Guidelines-21-10-13-with-coverpage.pdf
[2] https://arr.ga.gov.au/arr-guideline

GHD has prepared the preliminary cost estimate set out in section 10 of this report ("Cost Estimate") using information reasonably available to the GHD employee(s) who prepared this report; and based on assumptions and judgments made by GHD (e.g., Rawlinsons Australian Construction Handbook 2022).

The Cost Estimate has been prepared for the purpose of estimating a price for the proposed stormwater treatment system and must not be used for any other purpose.

The Cost Estimate is a preliminary estimate only. Actual prices, costs and other variables may be different to those used to prepare the Cost Estimate and may change. Unless as otherwise specified in this report, no detailed quotation has been obtained for actions identified in this report. GHD does not represent, warrant or guarantee that the [works/project] can or will be undertaken at a cost which is the same or less than the Cost Estimate.

Where estimates of potential costs are provided with an indicated level of confidence, notwithstanding the conservatism of the level of confidence selected as the planning level, there remains a chance that the cost will be greater than the planning estimate, and any funding would not be adequate. The confidence level considered to be most appropriate for planning purposes will vary depending on the conservatism of the user and the nature of the project. The user should therefore select appropriate confidence levels to suit their particular risk profile.

1.5 Assumptions

The assumptions listed below were adopted as part of the detailed design.

- Melbourne Water guidelines and standards have been used to design the stormwater treatment system with the understanding and agreement of the client
- While in agreement, GHD has not verified the suitability of using Melbourne based standards and guidelines for stormwater treatment system designs in Tasmania
  - Notably, Melbourne Water are normally owners of stormwater assets in large catchments (> 60 ha). As such, their design guidelines may relate to stormwater management for much bigger catchments than the Huntingfield subdivision

2. Site Description

2.1 Pre-development (existing) site condition

The existing site upon which the development is proposed, is largely open pasture used for grazing livestock in the past. The surface is pervious with surface runoff directed toward unnamed tributaries of Coffee Creek to the northeast and southeast of the development site, with slopes between 5 - 12 %. Features of the existing site are noted in the following sections.

2.1.1 Site geology

The site geotechnical investigation (noted in the *'Huntingfield Master Plan and Civil Design Preliminary Subdivision Geotechnical Investigation' report GHD, July 2020*) identified that most of the proposed subdivision is underlain with medium to very high strength basalt rock. The extent of weathering of the basalt varied from residual soil typically comprised high plasticity clay and clayey sand, that is overlain by a thin layer of topsoil, to moderately weathered.

The depth to basalt was generally shallow in the north and north-west of the site (from 0.5 to 1.5 m below ground level), and slightly deeper (between 1.3 m to at least 2.4 m below ground level) in the east to southeast of the site.

Highly weathered, very low strength sandstone was encountered in the south-west of the site (on the northern bank of the unnamed tributary of Coffee Creek, at a depth of 1.9 m.

2.1.2 Site groundwater

The '*Huntingfield Master Plan and Civil Design Preliminary Subdivision Geotechnical Investigation*' *report GHD, July 2020* also noted that groundwater was not encountered in any of the test pits during the geotechnical investigation. It should be noted however that test pits were immediately backfilled upon completion meaning that any slow seepages of groundwater into the test pits would not be observed. It should also be noted that groundwater levels can fluctuate, and higher water table or perched groundwater may be encountered during wetter periods of the year. Surface seepage was noted at the eastern site boundary during a previous site inspection on 12 July 2018 (refer to Figure 2).

Figure 2 ***Seepage observed at the site eastern boundary on 12 July 2018***

2.1.3 Stormwater from upslope external catchment

A portion of flows from the roundabout access at the intersection of Channel Highway and the Huntingfield subdivision site, will be captured and conveyed through the development via pits and pipes and trunk drainage channels to the proposed combined wetland/ OSD basin, and eventually discharged to Coffee Creek.

2.1.4 Stormwater directed off-site

2.1.4.1 Site runoff directed toward St Aloysius Catholic College

The surface slope toward the north-east is interrupted by the St Aloysius Catholic College buildings and playing fields. No existing stormwater drainage system is apparent to prevent run-off onto school grounds from the development site. The surface in this area slopes slightly more north and south with the school infrastructure sitting upon a crest. This topography encourages surface flow around the school rather than through it.

2.1.4.2 Site runoff directed east toward Coffee Creek

The eastern side extent of the site flattens to around 3% slope between the eastern boundary of the development and the top bank of Coffee Creek. The surface takes the form of a shallow linear depression here creating a slightly sloping watercourse. This area has been noted to show sub-surface flow reaching the surface and running overland to Coffee Creek following rainfall, possibly linked to a raised water table exfiltrating through the local gravels below the topsoil discovered during geotechnical investigation.

Runoff from upslope contributing catchments will be captured within drainage infrastructure and directed to a combined wetland/ OSD basin as the ultimate stormwater feature. The combined basin is located between the eastern boundary of the development and the top bank of Coffee Creek. It will detain stormwater flows to pre-development levels in the peak 5% AEP storm. Low flows from the basin will be intercepted by an open channel and directed south to Coffee Creek via a 20m long level spreader. Runoff volumes exceeding the basin capacity shall overtop the spillway and discharged over the level spreader and into Coffee Creek. Outlet headwall and armouring/velocity dissipation will be provided at the discharging point to promote discharges with reduced risk of scour downstream of the outlet.

3. Stormwater quantity assessment

3.1 Stormwater quantity objectives

Stormwater quantity management is to comply with the objective of Kingborough Interim Planning Scheme 2015, which are:

- Stormwater run-off from the development will be no greater than the pre-existing run-off during the minor storm event.
- The design events considered are:
  - Minor storm event – 5% Annual Event Probability (AEP) storm (approximate 20-year Average Recurrence Interval (ARI)); and
  - Major storm event – 1% AEP (approximate 100-year ARI) plus 30% increase in rainfall intensity allowance for climate change.

3.2 Modelling methodology

3.2.1 Overview

This assessment has been completed to determine on-site detention (OSD) requirements for the proposed subdivision. DRAINS modelling package (version 2021.02 - 4 Aug 2021), uses the IL/CL method was used to perform hydrological and hydraulic analysis.

3.3 Hydrology

3.3.1 Model set-up

Hydrology parameters were obtained from the Australian rainfall and runoff Data Hub (ARR Hub). Losses were adopted as follows:

IL/CL method:

- Impervious area initial loss – 1 mm
- Impervious area continuing loss – 0 mm/hr
- Pervious area initial losses – 28 mm
- Pervious area continuing loss – 3.4 mm/hr

3.3.2 Intensity-Frequency-Duration (IFD)

Rainfall intensities were adopted from the ARR Data Hub and the Bureau of Meteorology (BOM). The Intensity Frequency Duration (IFD) 2019 data is provided in Appendix A.

3.3.3 Temporal patterns

ARR 2019 ensemble temporal patterns were used for this assessment.

3.3.4 Pre-burst rainfall

Pre-burst rainfall depths were obtained from the ARR Data Hub and have been adopted in the DRAINS model to determine OSD basin requirements. The pre-burst is subtracted from the initial loss.

3.3.5 Catchments analysis

Identification and analysis of catchments contributing to, and within, the subdivision site was conducted using lidar information and survey of the existing ground surface, the development layout and the proposed stormwater infrastructure.

3.3.6 Catchment Impervious fraction

Existing site impervious fraction

The existing site comprises of grassed field with very little impervious area.

0% impervious area was adopted in hydrologic calculation for the existing case.

Developed site impervious fraction

Catchment areas were subdivided into areas corresponding to lots and roads areas, based on the proposed subdivision layout. Catchment area details are provided in Appendix B.

Typical impervious fractions have been adopted as:

- Low density residential land. 60% impervious
- Standard density residential land. 75% impervious
- Medium density residential land. 75% impervious
- High density residential land. 85% impervious
- Commercial land. 90% impervious
- Open space reserves. 10% impervious
- Road catchments. 80% impervious

Road catchments defined as space between residential lots that excludes already defined land uses such as open spaces. This includes nature strips, road surfaces with varying imperviousness, and road batters.

3.3.7 Allowance for climate change

An additional allowance for climate change of 30% has been added to rainfall intensities derived for the major event only, in accordance with the requirements of Kingborough Council (as directed at a pre-design meeting with Councils Stormwater Engineer). We note that this is in accordance with predictions stated in the Kingborough Local Climate Profile, as part of the 'Regional Councils Climate Adaptation Project' presented by the Antarctic Climate and Ecosystems Cooperative Research Centre for the Department of Premier and Cabinet[3].

3.4 Stormwater detention structures

A combined wetland/OSD basin has been designed to ensure stormwater flows from the proposed development do not exceed the peak flow rate under existing conditions for 5% AEP storm event. The OSD is located on a relatively flat area between the eastern boundary of the development and the top bank of Coffee Creek. The location of the combined basin is shown on drawing 32-18956 C2020 (refer to Appendix C).

The design features of the OSD are listed in Table 1.

[3] http://www.dpac.tas.gov.au/divisions/climatechange/what_you_can_do/local_government/local_government_area_climate_profiles

Table 1 OSD dimensions and levels

Dimension or level	Value
5% AEP OSD volume	4300 m^3
5% AEP top water level	R.L. 33.33
Peak 5% AEP flow into basin	6.27 m^3/s
Peak 5% AEP flow out of basin	2.43 m^3/s
Minimum depth to spillway (R.L. 33.34)	0.64 m
1% AEP plus climate change top water level	R.L. 33.64
1% AEP plus climate change freeboard to overflow weir (R.L. 34.15)	0.51 m

A comparison of pre-development site discharge flows, against post development flows is summarised in Table 2.

Table 2 Comparison of pre-development to post-development site discharge flows

Storm Event	Existing Peak Discharge (m^3/s)	Post Development Peak Discharge	Change (m^3/s)	Complies with Council's requirement
5% AEP	2.85	2.80	0.05	Yes

The comparison of flow volumes made in Table 2 shows that the proposed flow arriving at the site discharge point is no greater than the existing run-off during the minor storm event.

4. Stormwater quality assessment

4.1 Objectives and design criteria

4.1.1 Objectives

GHD was advised by the client that the objectives set out for the proposed stormwater treatment system is based on the Planning Scheme's design objectives. Furthermore, Melbourne Water's wetland design manual is used to achieve an acceptable wetland design. Note that some design assumptions outlined in documents authored and/or referred to by Melbourne Water may not be appropriate due to the location of the site being outside of Melbourne, Victoria and may need to be confirmed before the next stage of the project. The design objectives set out include:

– To mitigate and manage the environmental impacts caused by stormwater runoff on receiving watercourses and catchments downstream of the proposed Huntingfield development
– To assess the performance of a stormwater treatment system in achieving stormwater treatment objectives in accordance with the Planning Scheme given the spatial constraints of the allocated site
– To design a stormwater treatment system that satisfies the Planning Scheme and Melbourne Water design requirements

4.2 Design criteria

Like the design objectives outlined above, the following design criteria, based on Melbourne Water's design criteria, has been established for the proposed stormwater treatment system:

– Adherence to Melbourne Water's wetland design manual deemed-to-comply design criteria (Melbourne Water 2020)
– Quantitative performance objectives for urban stormwater in accordance with the Planning Scheme

4.2.1 Melbourne Water wetland design manual deemed-to-comply criteria

Melbourne Water, in their role, has published numerous standard guidelines including a wetland design manual. Within this manual is a “deemed-to-comply” criteria which mandates key design parameters and considerations for the design of a sediment pond and wetland macrophyte zone to be accepted. The criteria are designed to ensure effective functionality while promoting safety in design for the stormwater assets. The criteria also outline the maintenance needs and activities to ensure the design will work as intended.

In this detailed design process, we have extracted the criteria and used it as a checklist. Refer to Appendix D for the criteria checklist.

4.2.2 Kingborough Interim Planning Scheme 2015

The Interim Planning Scheme sets out the requirements for use or development of land in accordance with the Land Use Planning and Approvals Act 1993.

The quantitative performance objectives can be viewed into two categories: pollutant management and runoff volume management. In this section of the report, we focus on the pollutant management objectives which are listed in Table 3.

Table 3 Quantitative performance objectives for urban stormwater

Pollutant	Objective
Total suspended solids (TSS)	80% reduction in mean annual load
Total phosphorus (TP)	45% reduction in mean annual load
Total nitrogen (TN)	45% reduction in mean annual load
Gross pollutants (GP) or litter	70% reduction in mean annual load

4.3 Hydrologic and hydraulic modelling

4.4 Catchment hydrology

The Huntingfield development catchment can be divided into two sub catchments, one draining to the south and the other to the north, see Appendix E. The sub-catchment draining to the south will enter the proposed stormwater treatment train while the sub-catchment to the north will bypass the southern treatment train but is to be treated with a proprietary GPT. The total catchment size is approximately 48 ha. The treatment train is sized to service its contributing sub-catchment only which is approximately 42 ha. The flow paths within the development is shown in Figure 3.

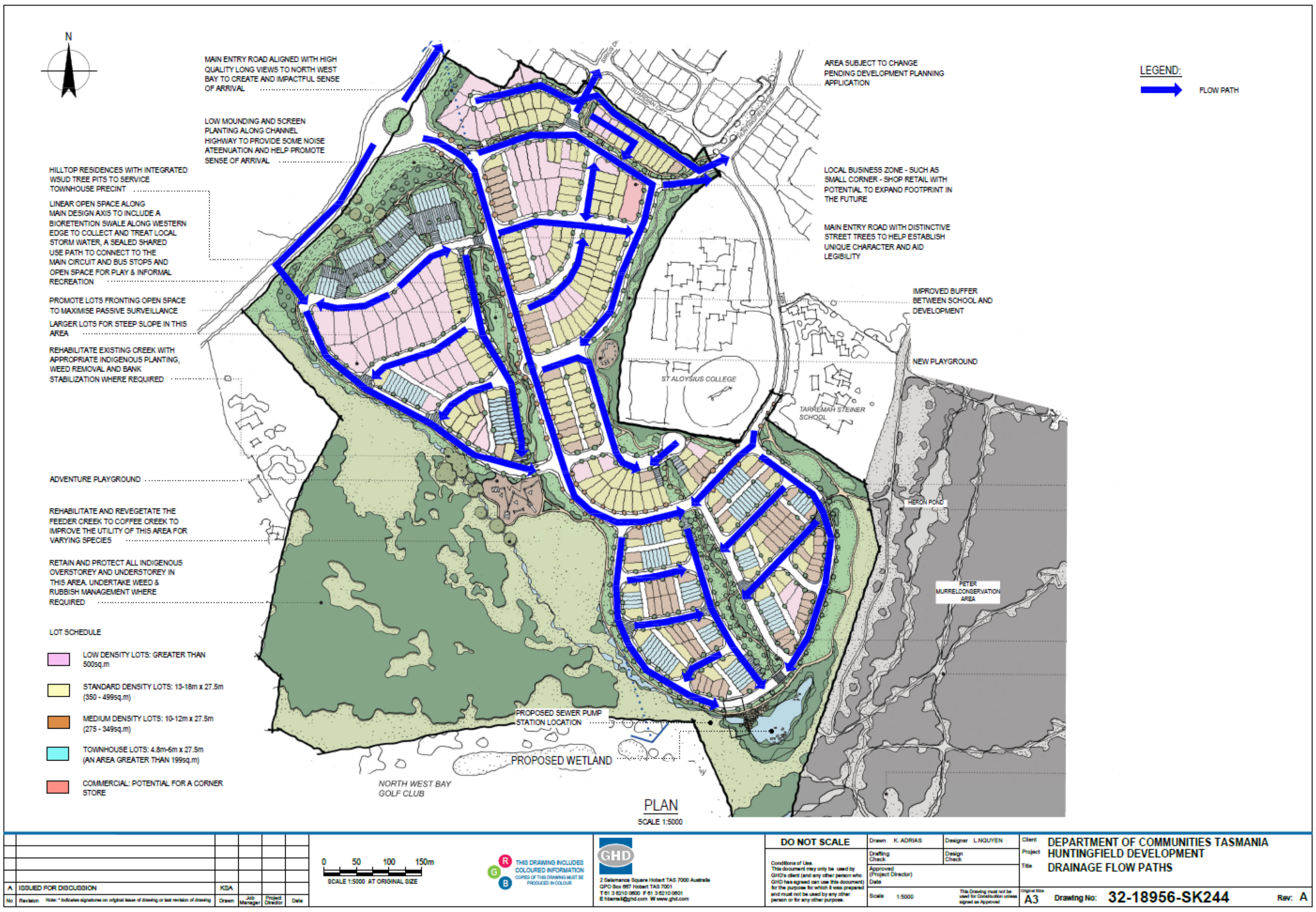

Figure 3 Drainage flow paths

Based on the sub-catchment size, impervious fraction and estimated time of concentration, an estimate of the 4 EY (98.17%), 63.21% AEP (1-year ARI), 10% AEP (10-year ARI), 5% AEP (20-year ARI), and 1% AEP (100-year ARI) peak design flow rates were made in by using DRAINS model (IL/CL method); these are summarised in Table 4.

Table 4 Estimated peak design flow rates

EY, AEP (%)	Area (ha)	Impervious Fraction (%)	Estimated Flow (m^3/s)
4 EY	41.9	62%	1.6
63.21% AEP	41.9	62%	2.8
10% AEP	41.9	62%	5.4
5% AEP	41.9	62%	6.4
1% AEP	41.9	62%	8.8

4.5 Coffee Creek

The treatment train is proposed to discharge into Coffee Creek which is east of the development and outlets into Stinkpot Bay to the south. A previous flood study (WMA Water 2021) on Coffee Creek reported flood levels around the proposed wetland discharge location for a range of AEP, these are summarised in Table 5. It is concluded that there are insignificant tail water impacts from Coffee Creek on the treatment train's capacity to discharge into Coffee Creek.

Table 5 *Coffee Creek flood levels in existing conditions around the proposed wetland discharge location*

AEP	AEP (1 in X)	Flood level (mAHD)	Depth (m)
5%	1 in 20	15.37	2.07
1%	1 in 100	15.63	2.33

4.6 On-site detention basin

The proposed treatment train is located within a proposed on-site detention basin which has a capacity to attenuate a 5% AEP. The treatment train's hydraulic controls are designed to incorporate the on-site detention basin's hydraulic controls. The objective is to minimise the period in which the macrophyte zone plants are inundated and are at risk. To do this, the stage-storage-discharge relationship of the on-site detention basin is incorporated into the wetland's stage-storage-discharge relationship (Table 6).

Table 6 OSD stage storage discharge relationship

Elevation (m)	Surface Area (m^2)	Storage (m^3)	Discharge (m^3/s)
32.7	6,038	0	0.00
32.8	6,268	615	0.00
32.9	6,511	1,254	0.00
33	6,755	1,917	0.00
33.1	7,000	2,605	0.36
33.2	7,276	3,319	1.85
33.3	7,563	4,061	3.75
33.4	7,833	4,831	6.53
33.5	8,118	5,628	9.93
33.6	8,419	6,455	13.13
33.7	8,720	7,312	16.94
33.8	9,018	8,199	19.98
33.9	9,340	9,116	22.75
34	9,684	10,067	25.77

A bypass channel which conveys a 63.21% AEP (1 in 1 AEP) peak design flow is included in the design to protect the macrophyte zone from undesirable flows in accordance with Melbourne Water's wetland design manual.

Details on the on-site detention basin's design can be found in Section 2.

5. Treatment system design

5.1 Catchment area

The sub-catchment area draining serviced by the treatment train is approximately 42 ha consisting primarily of residential development. An average impervious fraction of 62% is assumed based on the Masterplan's lot layout. A full breakdown of the catchment land use is shown in Appendix E.

5.2 Design flows

The treatment train is designed to have a capacity to treat flows up to 1.6 m^3/s, corresponding to a 4 EY peak design flow. This is achieved via a 3,600 x 3,600 mm diversion pit and 600 mm reinforced concrete pipe (RCP) fitted to the on-site detention basin's twin pipe inlet (1,350 mm) which has a maximum capacity of 6.36 m^3/s, corresponding to a 5% AEP peak design flow. Flows from the site (<= 1.6 m^3/s) will be diverted to the sediment basin prior to discharging to the wetland. Once the pipe capacity is exceeded, flows unable to drain to the sediment basin (> 1.6 m^3/s) will surcharge at the bubble-up pit and bypass channel via a twin 1,200 mm pipe. Once the rain ceases, water still contained in the twin 1,200 mm pipe will flow back into the sediment basin.

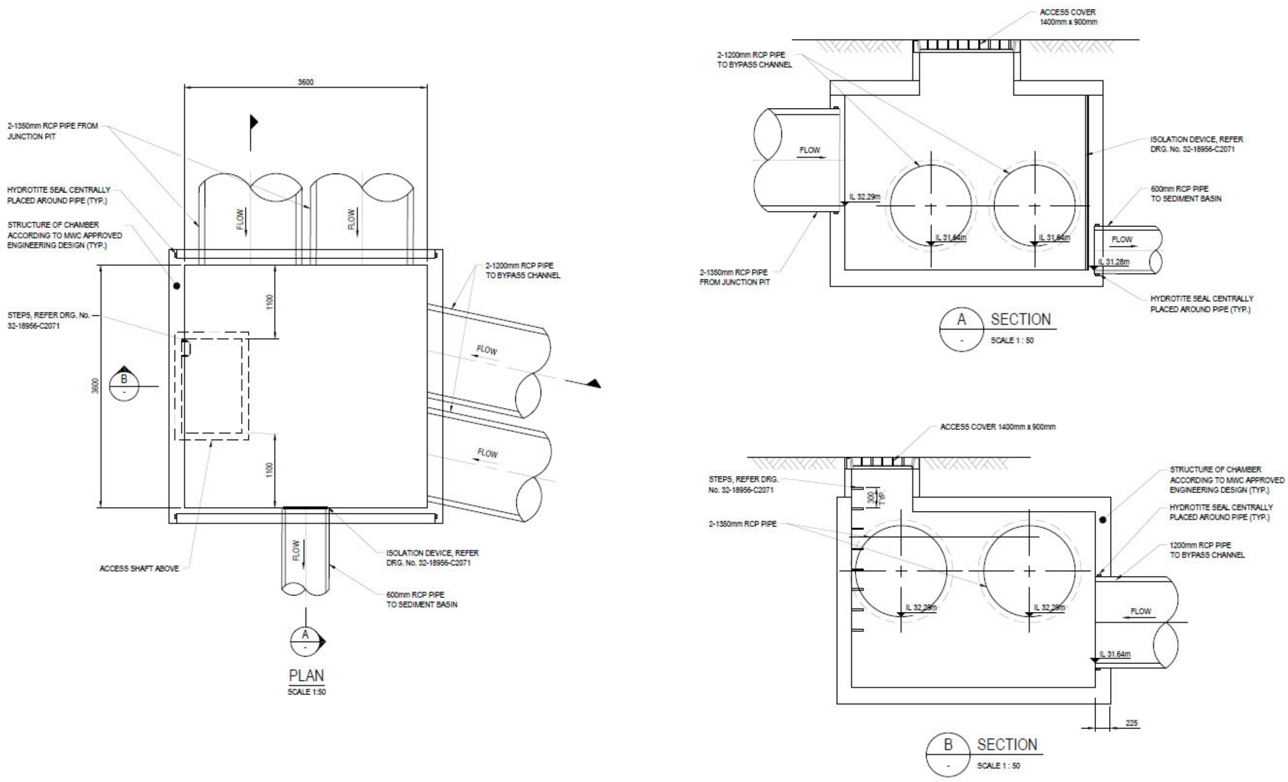

Figure 4 Diversion pit

5.3 Rainwater tanks

Rainwater tanks are proposed as part of the stormwater management system. 5 kL rainwater tanks are assumed at each residential household. In accordance with the approved planning permit (Kingborough Council 2021), 2,150 L of each 5 kL tank is designated for detention and the rest is used for harvesting and re-use. While the smaller tanks are cheaper, these 5 kL tanks are proposed to aid in reducing the volume of runoff draining into the wetland system which consequently reduce the required footprint in the already limited designated space for the end-of-line treatment train.

The total number of rainwater tanks projected for the ultimate development of Huntingfield is 434. The rainwater tanks are designed to be used for household irrigation only. In accordance with the WSUD Engineering Procedures, chapter 12, the average irrigation demand per household is 32 kL/person/year. Assuming an average of three people per household, the total irrigation demand is 96 kL/house/year. Based on the three stages of the development, the annual irrigation demand for each stage is as follows:

– Stage 1 = 18,240 kL/year
– Stage 2 = 7,296 kL/year
– Stage 3 = 16,128 kL/year
– Stage 1, bypassing the end-of-line treatment train = 2,688 kL/year
– Stage 2, bypassing the end-of-line treatment train = 576 kL/year

5.4 Treatment train arrangement

The proposed end-of-line treatment train consists of a sediment basin and a series of macrophyte marshes (i.e., wetland) of varying depths and open water zones. Note that approximately 6 ha of the developed catchment bypasses the treatment train. To meet the stormwater treatment objectives for the entire development, the treatment train infrastructure is oversized to compensate for the bypassing flow and pollutant loads.

5.4.1 Sediment basin

Design flows

The sediment basin receives flows from the diversion pipe at a maximum rate of 1.6 m3/s, corresponding to a 4 EY peak design flow. The sediment basin is designed to dissipate inflows to velocities which encourages sediments to settle, this minimises sediments from entering the macrophyte zones which preserves the wetland's ability to treat and attenuate flows.

Bathymetry

The sediment basin will approximately have a surface area of 1,202 m^2 at the normal water level (NWL) of 32.8 mAHD and a permanent depth of 1.6 m. When operating as intended, the sediment basin can deposit up to 95% of sediments, with a nominal particle size that is bigger than or equal to 125 μm, in a 4 EY flow. The sediment basin is designed to have a minimum cleanout frequency of five years. The stage-storage-area relationship of the sediment basin is shown in Table 7. Note that this does not include the on-site detention basin's stage-storage-area relationship.

Table 7 Sediment basin stage-storage-area relationship

Water level (mAHD)	Water depth above NWL (m)	Storage (m^3/s)	Surface area (m^2)
31.2	-1.6	0	594
31.4	-1.4	125	657
31.6	-1.2	263	723
31.8	-1.0	414	792
32.0	-0.8	580	864
32.2	-0.6	760	939
32.4	-0.4	956	1,017
32.6	-0.2	1,168	1,105
32.8	0.0	1,399	1,202
32.85	0.05	1,458	1,234
32.9	0.1	1,521	1,267
32.95	0.15	1,585	1,299
33.0	0.2	1,650	1,332
33.05	0.25	1,718	1,364
33.1	0.3	1,787	1,396
33.15	0.35	1,858	1,434

Macrophyte zone connection

The connection between the sediment basin and the macrophyte zone is a transfer pit (1,400 x 900 mm) and pipe (900 mm) arrangement. The NWL of the sediment basin is set to be 100 mm higher than the macrophyte zone's NWL. This will allow independent drawdown of the basin and macrophyte zone for maintenance purposes. The stage-discharge relationship of the sediment basin is pit controlled and is shown in Table 8.

Table 8 Sediment basin stage-discharge relationship

Water level (mAHD)	Water depth above NWL (m)	Discharge (m^3/s)
32.8	0	0.00
32.85	0.05	0.09
32.9	0.1	0.27
32.95	0.15	0.49
33.0	0.2	0.76
33.05	0.25	1.06
33.1	0.3	1.39
33.15	0.35	1.75

5.4.2 Macrophyte zone

Design flows

The macrophyte zone is designed to receive a maximum flow equivalent to a 4 EY event (1.6 m^3/s) via the pit and pipe arrangement from the sediment basin.

Bathymetry

The macrophyte zone will approximately have a surface area of 4,891 m^2 at the NWL of 32.7 mAHD (i.e., 100 mm lower than the sediment basin NWL). A 350 mm extended detention depth is to be maintained to allow for stormwater constituents to be effectively treated within the macrophyte zone before discharging into the receiving Coffee Creek. The marshes and open water zones are divided into the following depth bands and area to aid in the biological removal of pollutants:

– Shallow marsh, 100 mm – 150 mm below NWL, approximately 1,983 m^2 (41%)
– Deep marsh, 150 mm – 350 mm below NWL, approximately 1,872 m^2 (38%)
– Submerged marsh, 350 mm – 700 mm below NWL, approximately 782 m^2 (16%)
– Open water, deeper than 700 mm below NWL, approximately 254 m^2 (5%)

In accordance with Melbourne Water guidelines, the edges of the proposed water bodies will have relatively flat slopes (1 vertical to 8 horizontal) and are planted with selected macrophytes and wetland plants. Plant selection is shown further in the report in Section 8. Deeper zones are battered with 1 vertical to 3 horizontal slopes.

The stage-storage-area relationship of the macrophyte zone is shown in . Note that this does not include the on-site detention basin's stage-storage-area relationship.

Table 9 Wetland stage-storage-area relationship

Water level (mAHD)	Water depth above NWL (m)	Storage (m^3/s)	Surface area (m^2)
32.7	0.0	3,133	4,891
32.75	0.05	3,379	4,977
32.8	0.1	3,631	5,069
32.85	0.15	3,886	5,160
32.9	0.2	4,147	5,252
32.95	0.25	4,411	5,343
33.0	0.3	4,681	5,434
33.05	0.35	4,955	5,526
33.1	0.4	5,233	5,617

Water level (mAHD)	Water depth above NWL (m)	Storage (m^3/s)	Surface area (m^2)
33.15	0.45	5,517	5,710

Water level and outlet control

The wetland's placement within an on-site detention basin can cause the wetland plants to be underwater for longer than the desired period. Therefore, a flexible outlet for the wetland was chosen which can work independently but also set to work in tandem with the on-site detention basin's outlet in rainfall events greater than a 4 EY. In ideal operation, the wetland water level can return to the NWL by discharging the extended detention volume into Coffee Creek over a maximum period of 72 hours or 3 days.

The proposed outlet is a grated twin chamber pit with a rectangular slot (50 x 350 mm) cut into a metallic plate fitted, see Figure 5. The use of a metallic plate can be replaced in the future should the rectangular slot size needs adjusting depending on circumstance, for example, increased development in upstream catchments.

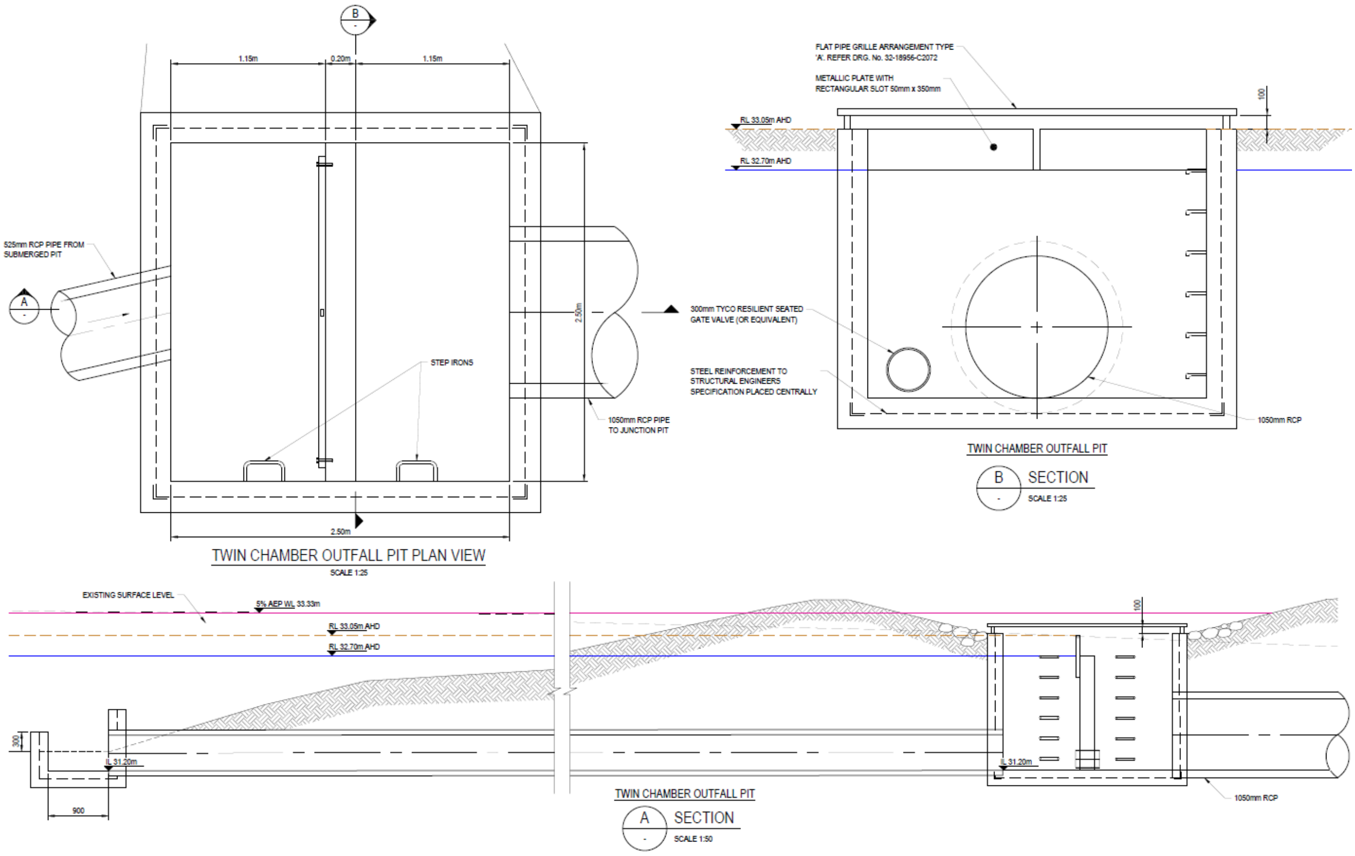

Figure 5 Twin chamber pit with rectangular slot outlet

Note that the width of the rectangular slot is slightly oversized to allow for blockage which may occur naturally. The stage-discharge relationship for the wetland outlet under ideal operating conditions is shown in Table 10. In MUSIC, this stage-discharge relationship is configured in the custom outflow relationship for the wetland node's pipe.

Table 10 Wetland outlet stage-discharge relationship under ideal operating conditions

Water level (mAHD)	Water depth above NWL (m)	Flow through rectangular slot (m^3/s)
32.7	0	0.000
32.75	0.05	0.001
32.8	0.1	0.003
32.85	0.15	0.006

Water level (mAHD)	Water depth above NWL (m)	Flow through rectangular slot (m^3/s)
32.9	0.2	0.009
32.95	0.25	0.012
33.0	0.3	0.016
33.05	0.35	0.020

Connection with bypass channel

The bypass channel is intended to drain into the wetland's grated twin chamber outlet pit. This will allow for a combined outlet arrangement with a discharging pipe (1,050 mm) which is sized to convey a maximum flow rate corresponding to the difference between a 1 in 1 AEP and 4 EY peak design flows (1.2 m^3/s). The stage-discharge relationship for the 1,050 mm discharge pipe is shown in Table 11. In MUSIC, this stage-discharge relationship is configured in the custom outflow relationship for the wetland node's weir.

Table 11 Discharge pipe outlet stage-discharge relationship

Water level (mAHD)	Water depth above NWL (m)	Flow through grated pit (m^3/s)
32.7	0	0
32.75	0.05	0
32.8	0.1	0
32.85	0.15	0
32.9	0.2	0
32.95	0.25	0
33	0.3	0
33.05	0.35	0
33.1	0.4	0.55
33.15	0.45	1.55
33.2	0.5	2.86
33.25	0.55	4.07
33.3	0.6	5.78
33.35	0.65	7.69
33.4	0.7	9.57
33.45	0.75	11.53
33.5	0.8	13.65
33.55	0.85	15.54
33.6	0.9	17.14
33.65	0.95	18.65
33.7	1	20.19
33.75	1.05	21.75
33.8	1.1	23.35
33.85	1.15	24.97
33.9	1.2	26.44
33.95	1.25	28.11
34	1.3	29.81

5.4.3 Gross pollutant trap

A proposed underground GPT such as a Rocla CDS unit could be located below ground adjacent to the proposed road leading to the north east of the development to treat stormwater runoff generated from the bypassing Stage 1 sub-catchment to the north, see Figure 6. The GPT should be sized in accordance with the size of the catchment it is servicing.

For the bypassing Stage 1 sub-catchment of approximately 5 ha, a P1009 Rocla CDS unit or similar would be appropriate. This will increase the overall stormwater treatment performance for the development. Refer to Appendix H for GPT sizing details. Maintenance for the GPT can be done from the adjacent road or nature strip.

The maintenance frequency of the underground device can be altered to suit Council’s long-term requirements. According to Rocla, a cleaning frequency of three times per year is typical.

The limitation of the underground GPT is that the treatment flow rate is restricted to an estimated 0.1 m^3/s, resulting in an estimate reduction of gross pollutants of 98% and total suspended solids of 69% for the bypassing Stage 1 catchment. This assumes that the GPT is appropriately maintained.

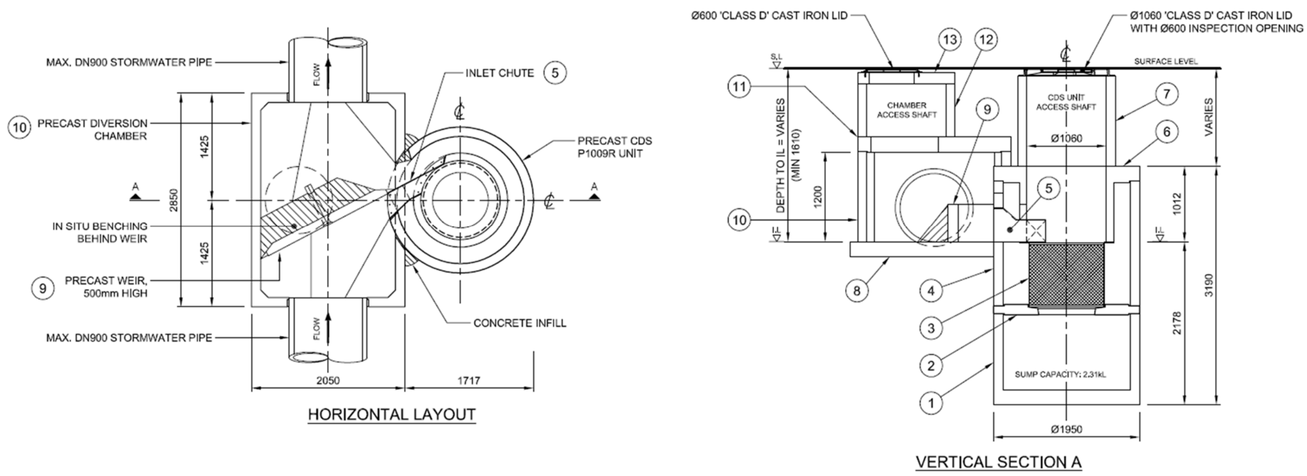

Figure 6 The P1009 Rocla CDS unit to be located at the road leading northeast of the development

6. Terrain modelling of wetlands

Existing ground and design terrain model

Existing ground survey information was used to develop a digital terrain model (DTM) for the existing surface. A design DTM was compared with the existing surface to estimate the volume of earthworks required to establish the stormwater treatment infrastructure including the on-site detention basin. Based on this comparison, there will be a need to import more material to the site to establish the required embankments around the on-site detention basin, see Table 12. This volume estimate does not make an allowance for:

– Preparation of the sub-grade
– Placement of rock
– Boxing quantities and topsoil stripping/placement as required as part of the detailed design; and
– Bulking factors required as part of the earthworks

Table 12 Estimated earthwork volumes

Total cut (m^3)	Total fill (m^3)	Balance (m^3)
8,374	5,251	3,123

7. Stormwater treatment effectiveness

To assess the stormwater treatment train's performance, a water balance model of the treatment system was developed using eWater's Model for Urban Stormwater Improvement Conceptualisation (MUSIC). MUSIC is Australia's leading tool for water sensitive urban design.

7.1 MUSIC model

MUSIC (version 6.2) was used to estimate the pollutant load and treatment performance of the proposed stormwater treatment train system.

7.2 Climate data

Climate data for the model was obtained from the Hobart Airport West rainfall station data (station number 94008) provided by eWater. The period assessed in the MUSIC model is a ten-year period from January 1996 to December 2005 with a 6-minute time step, in accordance with MUSIC modelling guidelines.

7.3 Model configuration

The proposed Huntingfield development has been modelled in MUSIC as shown in Figure 7.

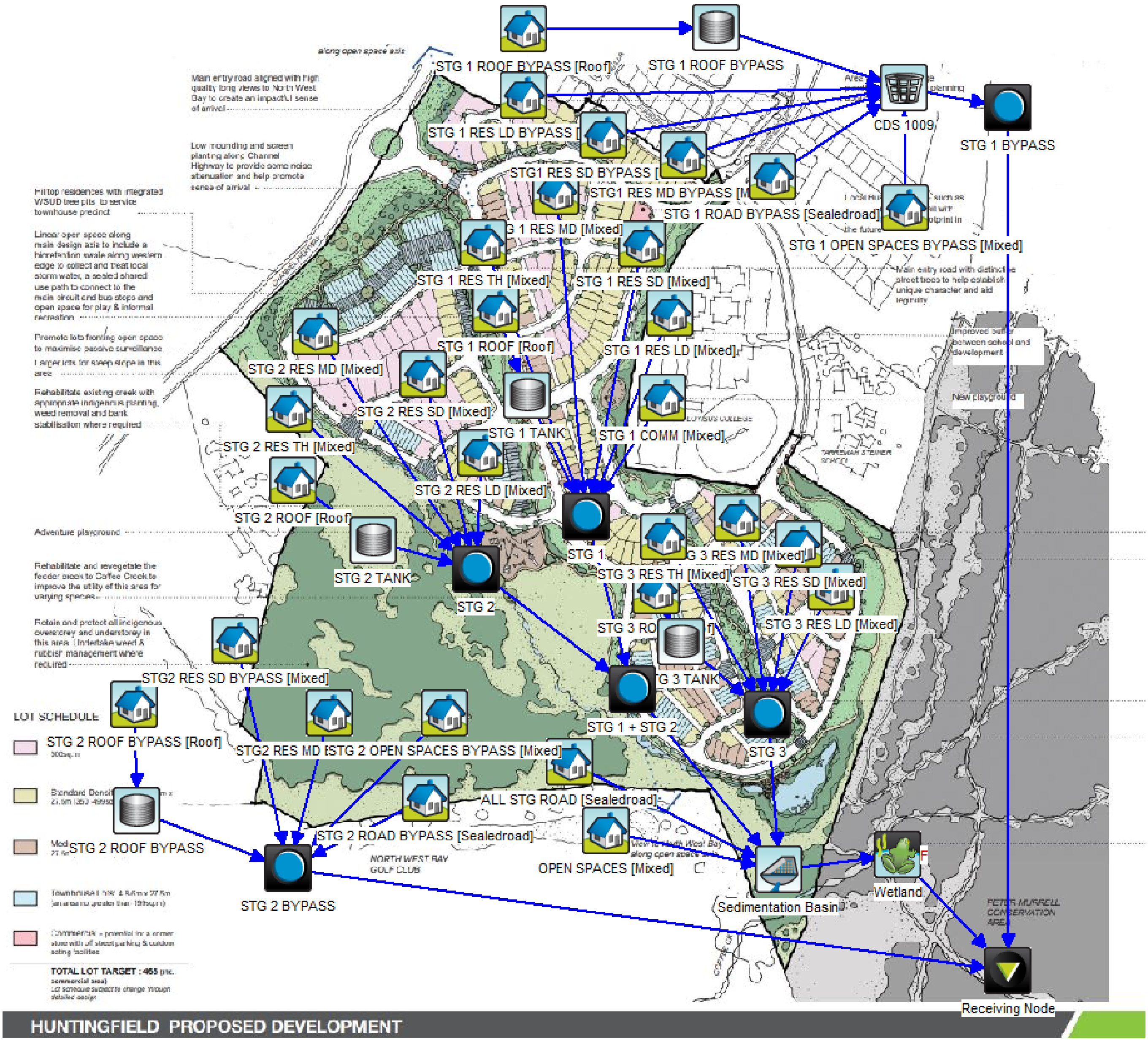

Figure 7 MUSIC model representation of the proposed Huntingfield development

7.4 Source node parameters

Each source node used in the model adopted the default pollutant generation parameters for a 'mixed' land use and adopts the stochastic generation of pollutants approach. Based on Melbourne Water's MUSIC guidelines, the default pervious area properties for the following were edited:

– Soil storage capacity = 120 mm
– Field capacity = 50 mm

A summary of each source node in the model is shown in Table 13.

Table 13 Source node parameters – area and impervious fraction

Source node	Area (ha)	Impervious fraction (%)
Roads (draining into treatment train)	15.78	80
Open spaces (draining into treatment train	10.70	10
Stage 1 commercial	0.16	90

Source node	Area (ha)	Impervious fraction (%)
Stage 1 open spaces (bypass)	1.00	10
Stage 1 residential – low density	1.27	60
Stage 1 residential – low density (bypass)	0.51	60
Stage 1 residential – medium density	0.44	75
Stage 1 residential – medium density (bypass)	0.02	75
Stage 1 residential – standard density	2.89	75
Stage 1 residential – standard density (bypass)	0.50	75
Stage 1 residential – townhouses	0.50	85
Stage 1 road (bypass)	1.36	80
Stage 1 roof	2.03	100
Stage 1 roof (bypass)	0.34	100
Stage 2 open spaces (bypass)	0.67	10
Stage 2 residential – low density	2.23	60
Stage 2 residential – medium density	0.04	75
Stage 2 residential – medium density (bypass)	0.05	75
Stage 2 residential – standard density	0.59	75
Stage 2 residential – standard density (bypass)	0.12	75
Stage 2 residential – townhouses	0.18	85
Stage 2 road (bypass)	0.91	80
Stage 2 roof	0.84	100
Stage 2 roof (bypass)	0.07	100
Stage 3 residential – low density	0.12	60
Stage 3 residential – medium density	1.12	75
Stage 3 residential – standard density	0.86	75
Stage 3 residential – townhouses	0.68	85
Stage 3 roof	1.46	100

7.5 Treatment node parameters

As mentioned, the stormwater management system includes rainwater tanks to reduce runoff volume generated by the catchment by harvesting rainwater for household irrigation, a sediment basin to capture large sediment particles, a wetland to remove suspended solids and nutrient, and a GPT to remove litter and suspended solids from a portion of the bypassing catchment.

7.5.1 Rainwater tank nodes

Multiple rainwater tanks can be represented in a single rainwater tank node in MUSIC if each of the tanks have equivalent properties. It is assumed that the design of each household rainwater tank is the same across the development.

Each rainwater tank node is then allocated to a source node which represents the total roof area for a given residential stage (e.g., Stage 1 and Stage 1 Bypass). The individual tank properties input is based on the Orion polyethylene rainwater tanks series[4]:

[4] https://www.orionproducts.com.au/5000-ltr-slimline-tank

– Volume below overflow pipe = 2.85 kL
– Depth above overflow = 0.43 m
– Surface area = 5.0 m^2
– Initial volume = 2.85 kL
– Overflow pipe diameter = 90 mm

Each rainwater tank node's reuse function is set to the total irrigation demand for their respective residential stage, see Table 14. The annual irrigation demand pattern adopted is 'PET – Rain', which apportions the irrigation demand based on the amount of rainfall at each time step of the simulation.

Table 14 Rainwater tank reuse parameters

Rainwater tank node	Number of tanks in residential stage	Annual reuse / irrigation volume (kL/year)
Stage 1	190	18,240
Stage 2	76	7,296
Stage 3	168	16,128
Stage 1 bypass	28	2,688
Stage 2 bypass	6	576

7.5.2 Sediment basin node

The sediment basin parameters for the MUSIC model are detailed in Table 15. The stage-discharge-storage relationship detailed in Table 7 and Table 8 is configured in the custom outflow and storage relationship in the model.

Table 15 Sediment basin node parameters in MUSIC

Parameter	Values
High flow bypass (m^3/s)	1.6
Surface area (m^2)	1,202
Extended detention depth (m)	0.35
Permanent pool volume (m^3)	1,399
Initial volume (m^3)	1,399
Exfiltration rate (mm/hr)	0
Evaporative loss as % of PET	75

7.5.3 Wetland node (macrophyte zone)

The wetland parameters for the MUSIC model are detailed in Table 16. The stage- storage- discharge relationships for the macrophyte zone and the OSD detailed in , , Table 10 and Table 11 are configured in the custom outflow and storage relationship in the model.

Table 16 Wetland node parameters in MUSIC

Parameter	Values
High flow bypass (m^3/s)	1.6
Surface area (m^2)	4,886
Extended detention depth (m)	0.35
Permanent pool volume (m^3)	3,133
Initial volume (m^3)	3,133

Parameter	Values
Exfiltration rate (mm/hr)	0
Evaporative loss as % of PET	125

7.5.4 Gross pollutant trap node

Rocla has made MUSIC nodes representing their CDS GPT units available for download from their website. The CDS P1009 MUSIC node was used in the MUSIC model. This GPT has a high flow bypass of 0.1 m^3/s. Its transfer functions are based on a concentration-based capture efficiency, these are detailed in Table 17.

Table 17 GPT node transfer functions in MUSIC

Parameter	Input	Output	Reduction (%)
Total suspended solids (mg/L)	100	30	70
Total phosphorus (mg/L)	100	70	30
Total nitrogen (mg/L)	50	50	0
Gross pollutant (kg/ML)	100	2	98

7.6 Stormwater treatment results

7.6.1 MUSIC model results

Based on the proposed stormwater management system, the MUSIC model estimates that the system can achieve the required pollutant reductions to meet the Planning Scheme for the entire development. The results observed at the receiving node / downstream of the development / discharge point in the model is shown in Table 18.

Table 18 Stormwater treatment results

Pollutant	Pollution generation	Residual load	Reduction	Reduction targets
Total suspended solids (kg/yr)	25,600	4,540	82%	80%
Total phosphorus (kg/yr)	46	13	71%	45%
Total nitrogen (kg/yr)	262	135	49%	45%
Gross pollutant (kg/yr)	4,310	122	97%	70%

7.6.2 MUSIC auditor results

Daily flux results extracted from the wetland node are used as input to the MUSIC auditor online tool[5]. This tool determines whether the wetland outlet configuration will satisfy Deemed to Comply requirements by assessing the wetland depths relative to plant heights and the wetland residence time.

Inundation frequency

The inundation frequency of the wetland is shown in Figure 8.

[5] https://www.musicauditor.com.au/wetlandanalysistool

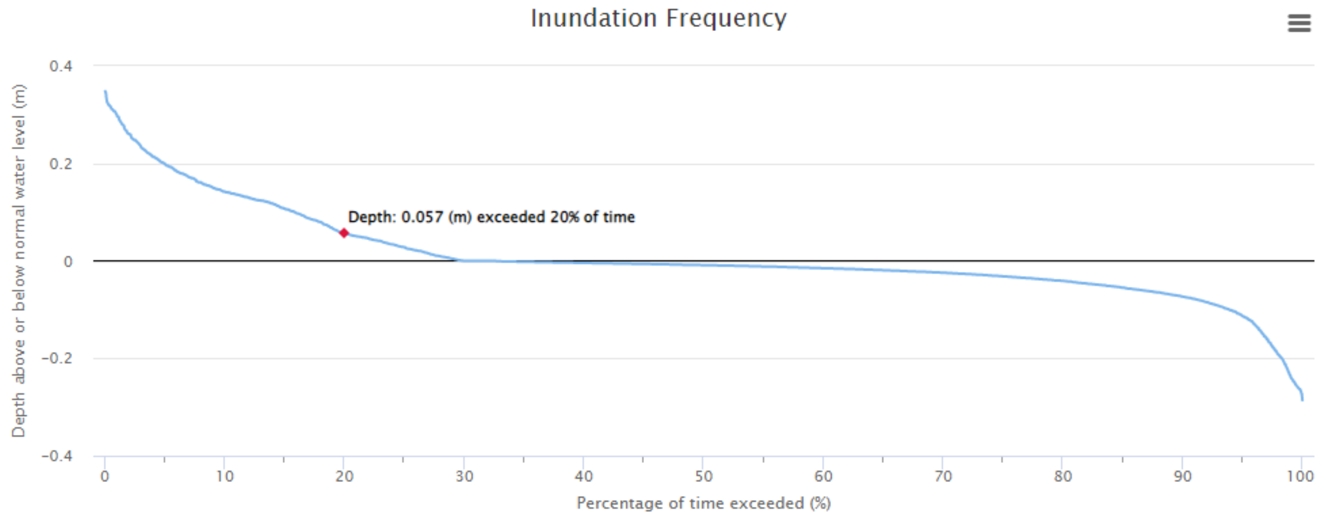

Figure 8 Wetland inundation frequency

In choosing the plants shown in Table 19, MUSIC auditor determined that the shallow and deep marsh zones meet the Deemed to Comply criteria. Other results displayed by MUSIC auditor include:

– Water level exceeded for 20% of time: 0.057 m
– Water level exceeded for 50% of time: - 0.0088 m
– Effective water level is within 50 mm of NWL and is acceptable.
– 90th Percentile Residence Time: 2 days

Table 19 Selected plants in MUSIC auditor to assess Deemed to Comply requirements

Shallow marsh plants	Deep marsh plants
Common Spike-rush (Eleocharis acuta)	Marsh Club-rush (Bolboschoenus medianus)
Sea Club-rush (Bolboschoenus caldwellii)	Water Ribbons (Triglochin procerum)
Water Ribbons (Triglochin procerum)	Tall Spike-rush (Eleocharis sphacelate)

Spells analysis

Melbourne Water suggests that shallow marsh plants are unlikely to persist with water levels 300 mm above NWL for greater than 10 days occurring repeatedly. The spell analysis should show the frequency of exceedances of depths greater than 300 mm above NWL greater than 10 days is no more than once in ten years.

The spells analysis for the wetland is shown in Figure 9. The results from MUSIC auditor showed that the wetland is inundated in depths greater than 300 mm for three days at most.

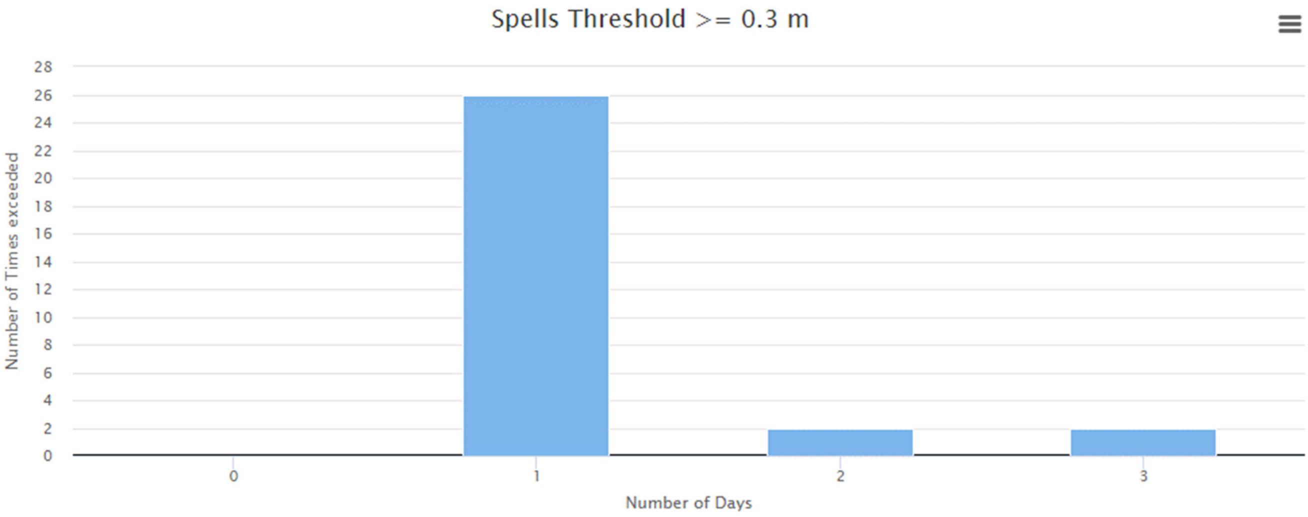

Figure 9 Wetland spells analysis

8. Planting and landscape design

8.1 Landscape issues

The broad landscape issues have been identified as:

– Integration of the proposed works to reflect the local landscape character populated with local plant species
– Planting of the wetland system to achieve the expected water quality outcomes
– Enrichment of wildlife habitat values
– Provide an open space asset that offers the local community active and passive recreation opportunities

8.2 Existing site conditions

8.2.1 Surface conditions

The 53.5 hectare Huntingfield site is located in a semi-rural area, immediately South West of Kingston. The proposed subdivision is comprised of moderately undulating pasture, generally sloping towards the south-east at between 5 and 14°. A localised region of increased slope angle (up to 18°) exists to the west of the overall site.

The majority of the subdivision site is vegetated by grasses, with blackberry, gorse and brush frequently observed along the remains of paddock fences. An area of bushland is present beyond the south-west side of the proposed subdivision, characterised by large trees and ferns

Basalt exposed at surface was observed infrequently at the site, generally in the north and north-west of the proposed subdivision and in areas where the grass had been slashed. The observations typically comprised isolated cobbles or small exposures. Basalt outcrop was previously identified in the former quarry in the southern corner of the site

It was observed that a small pond (approximately 4 m wide by 10 m long) had formed across an access track in the south corner of the site (in vicinity of a proposed detention basin and lowest point of the subdivision). The general area of the proposed detention basin was observed to be waterlogged and vegetated with sedges.

The proposed wetland is located between the northwest of the Peter Murrell Reserve and south of the proposed Huntingfield Stage 3 development and St Aloysius Catholic School College/Tarremah Steiner School.

8.2.2 Aboriginal Heritage

Cultural Heritage Management Australia (CHMA) were previously engaged by DCT to undertake an archaeological investigation within the Huntingfield site and to more accurately determine the extent and nature of Aboriginal heritage resources within the study area. The outcomes from this investigation are summarised in the report, *Huntingfield Aboriginal Heritage Assessment: Stage 2a Ploughing and Survey Assessment (2012).*

In November 2019, GHD and DCT presented to the Aboriginal Heritage Council (AHC) highlighting the background and design methodology while taking into consideration known artefacts. GHD and DCT have incorporated the key findings from CHMA's report and the feedback from the AHC meeting into the development of the Master Plan while minimising the impacts to known artefacts.

All Aboriginal sites including the various sections of TASI 7734 identified during the site investigations have high cultural significance for today's Aboriginal community.

GHD has made significant efforts to ensure the proposed Master Plan does not impact the core components of site TASI 7734 which contain the higher artefact densities.

8.3 Proposed wetland development

All wetland areas will be completely planted with native aquatic species except those areas designated as sediment basin and open water, which will have perimeter fringe planting only.

Wetland planting and species composition will vary according to the depth of standing water within the various depth zones, which comprise each cell.

Typical proposed plants (Department of Primary Industries, Parks, Water and Environment 2012) are shown in Table 20.

Table 20 Typical wetland planting species

Botanical name	Common name	Minimum density (plants/m^2)	Average plant height (m)
Ephemeral batter plant list (NWL to 350 mm above NWL)			
Blechnum minus	Soft Water Fern	4 – 6	0.5 – 1.2
Cyperus gunnii	Flecked Flat Sedge	6 – 8	0.6 – 1
Juncus amabilis	-	8 – 10	0.2 – 1.2
Juncus pallidus	Pale Rush	8 – 10	0.5 – 2.3
Lepidosperma longitudinale	Common Sword Sedge	6	0.15 – 0.5
Melaleuca ericifolia	Swamp Paperbark	2 – 4	2 – 9
Shallow marsh (100 – 150 mm below NWL)			
Carex fasicularis	Tassel Sedge	6 – 8	0.5 – 1.5
Carex gaudichadiana	Tufted Sedge	6 – 8	0.1 – 0.6
Cyperus lucidus	Leafy Flat Sedge	6	0.6 – 1.5
Eleocharis acuta	Common Spike-rush	6 – 8	0.3 – 0.9
Gahnia grandis	Giant Saw Sedge	4 – 6	> 1
Gahnia trifida	Cutting Sedge	4 – 6	> 1
Isolepis inundata	Swamp Club-rush	6 – 8	0.05 – 0.3
Isolepis cernua	Slender Club-rush	6 – 8	0.3
Isolepis fluitans	Floating Club-rush	-	0.3
Isolepis nodosa	Knobby Club-rush	6 – 8	0.5 – 1
Juncus kraussii	Sea Rush	6 – 10	0.6 – 2.3

Botanical name	Common name	Minimum density (plants/m^2)	Average plant height (m)
Juncus subsecundus	Finger Rush	6 – 10	0.5 – 1
Leptocarpus brownii	Coarse Wire Rush	-	> 0.4
Leptocarpus tenax	Slender Wire Rush	-	> 0.4
Nymphoides exigua	Tasmanian Marshwort	1	-
Phragmites australis	Common reed	-	> 1.5
Schoenus lepidosperma	-	6 – 8	0.1 – 0.6
Villarsia exaltata	Yellow Marsh Flower	6 – 8	0.3
Deep marsh (150 – 350 mm below NWL)			
Baumea articulata	Jointed Twig-rush	4	1 – 2
Eleocharis sphacelata	Tall Spike-rush	6	0.5 – 2
Schoenoplectus validus	Lake Club-rush	4	0.8 – 2
Submerged marsh (350 – 700 mm below NWL)			
Myriophyllum pedunculatum	Mat Water-milfoil	1	prostrate
Potamogeton crispus	Curly Pondweed	1	Stems to 4.5
Potamogeton ochreatus	Blunt Pondweed	1	Stems to 4.5
Potamogeton pectinatus	Fennel Pondweed	1	Stems to 3
Potamogeton tricarinatus	Floating Pondweed	1	Stems to 2.7
Vallisneria gigantea	Ribbonweed	1	Stems to 3

All aquatic and semi-aquatic plants should be supplied in Viro cells or standard tubes, or as divisions. Eucalyptus and Melaleuca species should be supplied in standard tubes.

The whole of the area for aquatic and semi-aquatic planting should be topsoiled with a 150 – 200 mm thick layer of local soil with high organic content, having a pH of 6.5 – 8.5.

8.4 Landscaped areas above wetland zones

Beyond the wetland zones, all bare earth surfaces created by construction works shall be established by topsoiling, planting, and grassing to provide suitable ground cover. Ideally normal pasture or parkland grasses should be separated from semi-aquatic plant species by a buffer strip of native grasses such as local Danthonia, Poa and Themeda species, planted as Viro cells into mulched beds.

The use of clumping native grasses should also be encouraged so to minimise the need for mowing of the wetland. It has been observed that maintenance mowing of the wetland perimeter area has a detrimental impact on fauna such as frogs, reptiles and turtles that may reside within wetland fringes.

8.5 Tree and shrub planting

The plan proposes tree and shrub planting around the perimeter of each wetland cell and beside the bypass channel. This planting should be undertaken for the following reasons:

- To compensate for vegetation lost in construction of the wetlands
- To augment the existing vegetation and compensate for the lack of natural regeneration
- To enrich wildlife habitat values
- To provide wind protection for the wetlands
- To create a buffer between other land uses and the wetlands
- To aid the visual integration of the wetlands with the broader landscape

For this planting, the major species (Department of Primary Industries, Parks, Water and Environment 2012) should comprise:

Table 21 Typical major tree species for landscaping

Scientific name	Common name
Leptospermum scoparium	Prickly Tea-tree
Leptospermum lanigerum	Woolly Tea-tree
Leucopogon australis	Spike Beard Heath
Melaleuca squarrosa	Scented Paperbark
Pimelea glauca	Smooth Rice- flower
Pultenaea daphnoides	Large-leaf Bush-pea

As noted for wetland species, all trees and shrubs should be propagated from local provenance seed or cuttings. Plantings should be grouped into mulched beds and should consist of tube stock protected by plastic guards.

8.6 Maintenance

Consistent, regular monitoring and maintenance of all plant material is vital to the success of the project, with weed suppression being of prime concern. Particular attention should be given to weed control prior to planting and during the plant establishment phase.

Additional maintenance tasks should include monitoring for disease or pest attack, replacement of dead plant stock as required, and topping up of mulch as required.

9. Establishment, maintenance, and lifecycles issues

9.1 Wetland establishment

The typical process to plant out the wetland is to begin with planting the deeper areas first and manipulate the water levels upwards as the other planting bands are established. While the seated gate valve fitted to the twin chamber outlet pit can provide partial drawdown to manipulate the wetland's water level during planting, a mechanical pump may be required should the gate valve fail to achieve the desired outcome.

The following process to control the water levels is recommended for establishment and ongoing maintenance;

- Initially, allow the wetland to fill above the nominated levels
- Once achieved, drain the wetland down to the level required; this can be achieved by opening the gate valve at the twin chamber outlet pit or by a mechanical pump
- To prevent inflows to the wetland when maintenance is occurring, the sluice gate located in the diversion put should be closed and the gate on the main line opened. This will allow runoff to continue flowing downstream of the wetland through the bypass channel during the establishment and maintenance period.

9.2 Sediment basin maintenance

The maintenance of the sediment basin would be like that of the wetland with the effluent pumped from the sediment basin. Note that a mechanical pump would be required to drain the sediment basin as there are no maintenance drain fitted to the sediment basin. The sluice gate in the diversion pit should be closed to prevent inflow into the sediment basin during the maintenance period. A dewatering area of approximately 640 m^2 is provided to the west of the sediment basin. A step-by-step guide to dewatering and resetting a sediment basin can be found in Melbourne Water's website[6].

9.3 Ongoing maintenance

There are items in the proposed stormwater management system that will require ongoing attention and maintenance. The responsibility of maintaining the rainwater tanks is assumed to fall on the household owners. The key maintenance and expected lifecycle issues are listed in Table 22

Table 22 Maintenance requirements

Description	Asset	Maintenance activities	Frequency of maintenance activities
Gross pollutant trap	Underground GPT	Removal of captured litter	Litter removal typically three times per year
Wetland	Wetland and associated water bodies including aquatic planting zones and planting areas up to the top water level	Removal of litter	Litter removal typically a minimum of twice a year or as required
	Aquatic plants	Macrophyte harvesting	As required
		Weed removal	A minimum of 4 times a year
Sediment basin		Removal of litter	Litter removal as required
		Removal of sediment	A minimum of once every 5 years or when sediment has accumulated to 500 mm below the NWL
		Weed control	Typically, 4 times a year or as required
		Nuisance species management (including algae, exotic fish, etc.)	As required
Grassed areas	All grass areas	Mowing	Monthly
		Removal of litter	As required
		Broad leaf weed spray	A minimum of 4 times a year
Flow control structures	Inlet structures	Inspect and clear blockages in diversion pit upstream of sediment basin	Inspection to be done monthly Clearing as required and during sediment basin maintenance
	Transfer pit and pipe structures	Inspect and clear blockages in transfer pit and pipe connection between sediment basin and macrophyte zones	Inspection to be done monthly Clearing as required and during sediment basin maintenance
	Outlet structures	Inspect and clear blockages in offtake pit in the last macrophyte zone cell and grated twin chamber outlet pit	Inspection to be done monthly Clearing as required and during wetland maintenance
Bypass channel	Constructed channel	Removal of litter	As required
		Broad leaf weed spray	A minimum of 4 times a year

[6] https://www.melbournewater.com.au/building-and-works/stormwater-management/options-treating-stormwater/sediment-basins

Description	Asset	Maintenance activities	Frequency of maintenance activities
Access	Maintenance access tracks	Replacement of surface material	Inspect annually and replace as required
		Broad leaf weed spray	As required
Landscape furniture	Signage	Repair of vandalised components	As required
Fencing	Post and wire fence and tube fencing	Maintenances and replacement	As required to ensure that fence continues to serve the intended function

During construction phase of the project, the site will need to be managed to minimise the generation of pollutants and to trap pollutants prior to discharge into receiving waters (e.g., Coffee Creek). Minimisation of exposed soils, and the use of temporary filter zones, hay bales, silt fence and sediment traps will be required. Staging of works needs to be planned to provide for the trapping of sediments and monitoring of site practices.

10. Cost estimates

A preliminary cost estimate has been prepared for the construction of the Huntingfield stormwater management system as outlined in Table 23. The total estimated cost for the civil construction of the system is $2.1 - $3.2 M with 30% to 100% contingencies. The total estimated annual operation and maintenance costs of the system (excl. rainwater tanks) is $34 - $52 K with 30% to 100% contingencies. The cost estimate breakdown is shown in Appendix F.

The cost estimates presented are based on extrapolation of recent similar project pricing, quotes for some equipment items, industry unit rates and GHD experience. A contingency of 30% has been applied on the cost estimate.

Table 23 Cost estimate summary

	Capital costs		Cost
1	On-site detention basin		$522,390.00
2	GPT		$20,400.00
3	Sediment basin		$30,000.00
4	Macrophyte zone		$37,000.00
5	Bypass channel		$9,600.00
6	Rainwater tanks		$954,800.00
	Annual operation and maintenance cost		**Cost**
7	On-ste detention basin		$18,312.00
8	GPT		$6,000.00
9	Sediment basin		$1,000.00
	Totals		
	Total CAPEX		$1,575,000.00
	Total OPEX		$26,000.00
	Contingency	**30% contingency**	**100% contingency**
	Total CAPEX + Contingency	$2,048,000.00	$3,150,000.00
	Total OPEX + Contingency	$34,000.00	$52,000.00
	Total + Contingency	$2,082,000.00	$3,202,000.00

11. Conclusion

A stormwater management system has been designed for the Huntingfield development to achieve stormwater treatment objectives as outlined in the Kingborough Interim Planning Scheme. The objectives were achieved by the uptake of 5 kL household rainwater tanks, a GPT, and an end-of-line treatment system consisting of a sediment basin and wetland.

The end-of-line treatment train is located within an on-site detention basin which is designed to contain a 1 in 20 AEP event. By itself, the stormwater treatment objectives for the development are not met due to some of the developed catchment bypassing the treatment train. An underground GPT is proposed to treat a portion of the bypassing sub-catchment to boost the development's stormwater treatment performance. The overall stormwater treatment performance include:

– A reduction in total suspended solids by 84% on average annually
– A reduction in total phosphorus by 72% on average annually
– A reduction in total nitrogen by 50% on average annually
– A reduction in gross pollutants by 97% on average annually

The wetland system is designed such that extended detention is limited to 3 days at most by fitting an easily modified plate attachment with a rectangular slot onto the twin chamber outlet pit.

The estimated capital cost of the stormwater management system is $2.1 - $3.2 M with 30% to 100% contingencies. The total estimated annual operation and maintenance costs of the system (excl. rainwater tanks) is $34 - $52 K with 30% to 100% contingencies

12. References

The following references were used:

Department of Primary Industries, Parks, Water and Environment. 2012. “Water Sensitive Urban Design.” Tasmania.

GHD. 2021. “Huntingfield Master Plan and Civil Design Channel Highway Roundabout - Stormwater Management Plan.” Hobart.

Kingborough Council. 2015. “Kingborough Interim Planning Scheme.” Kingston.

Kingborough Council. 2021. “Planning Permit for Subdivision Stage 1 Huntingfield.” Kingston.

Melbourne Water. 2018. *MUSIC Guidelines - Input parameters and modelling approaches for MUSIC users in Melbourne Water's service area.* Melbourne, Victoria: Melbourne Water.

Melbourne Water. 2020. “Wetland Design Manual.” Melbourne.

WMA Water. 2021. “Coffee Creek Hydraulic & Erosion Assessment.” Final Report, Newtown.

Appendices

Appendix A

Rainfall intensity data

Australian Government
Bureau of Meteorology

Location

Label: Not provided

Latitude: -42.998 [Nearest grid cell: 42.9875 (S)]

Longitude: 147.285 [Nearest grid cell: 147.2875 (E)]

IFD Design Rainfall Intensity (mm/h)

Issued: 13 August 2020

Rainfall intensity for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
FAQ for New ARR probability terminology

	Annual Exceedance Probability (AEP)						
Duration	**63.2%**	**50%#**	**20%***	**10%**	**5%**	**2%**	**1%**
1 min	62.6	71.1	100.0	121	143	175	201
2 min	53.8	60.8	83.0	98.4	114	134	149
3 min	47.6	53.9	74.2	88.5	103	122	137
4 min	42.9	48.7	67.6	81.1	94.8	114	129
5 min	39.2	44.5	62.2	75.0	88.2	107	122
10 min	28.3	32.2	45.6	55.5	66.0	81.3	93.9
15 min	22.9	26.1	36.8	44.9	53.5	65.9	76.3
20 min	19.6	22.3	31.4	38.2	45.4	55.8	64.5
25 min	17.3	19.7	27.6	33.6	39.8	48.8	56.2
30 min	15.7	17.8	24.9	30.2	35.7	43.5	50.0
45 min	12.5	14.2	19.8	23.8	28.0	33.8	38.5
1 hour	10.8	12.2	16.9	20.3	23.7	28.4	32.1
1.5 hour	8.70	9.88	13.7	16.3	18.9	22.4	25.2
2 hour	7.52	8.55	11.8	14.1	16.3	19.2	21.4
3 hour	6.14	7.02	9.73	11.6	13.3	15.7	17.4
4.5 hour	5.03	5.77	8.07	9.61	11.1	13.0	14.5
6 hour	4.36	5.02	7.08	8.44	9.76	11.5	12.8
9 hour	3.54	4.10	5.84	7.01	8.15	9.66	10.8
12 hour	3.03	3.52	5.06	6.10	7.12	8.48	9.54
18 hour	2.39	2.79	4.05	4.91	5.76	6.93	7.84
24 hour	2.00	2.33	3.39	4.13	4.87	5.88	6.68
30 hour	1.72	2.00	2.92	3.56	4.21	5.10	5.81
36 hour	1.51	1.76	2.57	3.13	3.70	4.49	5.13
48 hour	1.22	1.42	2.06	2.51	2.97	3.60	4.12
72 hour	0.888	1.03	1.47	1.78	2.10	2.54	2.89
96 hour	0.701	0.805	1.14	1.38	1.62	1.94	2.20
120 hour	0.582	0.667	0.938	1.13	1.31	1.57	1.77

Appendix B

DRAINS catchment area

Table B.1: Pre-development DRAINS catchments

DRAINS ID	Description	Area (ha)	% Impervious
1E_CAT_01	Existing catchment	47.40	0
	Total area	47.40	100% of total area
	Total impervious area	0	0% of total area
	Total pervious area	47.40	100% of total area

Table B.2: Post development DRAINS catchments

DRAINS ID	Description	Area (ha)	% Impervious
1D_CAT_00	RAB catchment to wetland	3.53	33
1D_CAT_01	Catchment to wetland	38.44	65
1D_CAT_02	Northern catchment bypassing wetland	3.72	65
1D_CAT_03	Southern catchment 1 bypassing wetland	0.66	0
1D_CAT_04	Southern catchment 2 bypassing wetland	0.91	40
1D_CAT_05	Eastern catchment bypassing wetland	0.48	22
	Total area	47.75	100% of total area
	Total impervious area	29.04	61% of total area
	Total pervious area	18.71	39% of total area

Appendix C

Stormwater plan drawings (included as Appendix C of the Development Application Report)

Appendix D

Melbourne Water Wetland Design Manual

Deemed-to-comply criteria

3. Deemed to Comply Criteria

3.1 General

			Proposed Design
GN1	The treatment and flow regime performance of the wetland must be modelled in MUSIC, or similar conceptual modelling software as approved by Melbourne Water.	**Concept** **Functional** **Detailed**	MUSIC model was used to model the treatment and flow regime of the wetland
GN2	The meteorological data in the conceptual modelling data or software (i.e. MUSIC) must be: • Based on at least 10 years of historical records • Recorded at six minutes intervals • Sourced from a pluviographic station as close as possible to the wetland site • Have a mean annual rainfall depth within 10% of the long term rainfall depth at the rainfall station closest to the wetland site	**Concept** **Functional** **Detailed**	Meteorological data referring to 94008 Hobart Airport. 1/1/1996 - 31/12/2005
GN3	The system configuration shown on the design plans must be consistent with the conceptual modelling parameters (e.g. MUSIC) (including the stage/discharge relationship) and sediment pond calculator/calculations.	**Concept** **Functional** **Detailed**	Design plans and MUSIC model parameters are confirmed. Refer to Sections 4 and 6 of the Wetland Detailed Design report
GN4	Peak design flows must be estimated in accordance with methods in Australian Rainfall and Runoff.	**Concept** **Functional** **Detailed**	Peak design flows were estimated using the DRAINS software. Refer to Section 3 of the Wetland Detailed Design report

3.2 Maintenance Provisions

			Proposed Design
MN1	Sediment ponds must be able to be drained whilst maintaining the macrophyte zone water level at normal water level. This is achieved by having the sediment pond transfer pit RL 100mm higher than the inlet pool NWL. Refer Standard Drawing 7251/12/001.	**Functional** **Detailed**	Inlet pond transfer pit RL is set to 100 mm higher than the macrophyte zone.
MN2	All parts of the base of a sediment pond must be accessible: • Within seven metres of a designated hard stand area for excavation vehicles ("edge cleaned") OR • Via a maintenance access ramp into the base of the sediment pond. Refer Standard Drawing 7251/12/013	**Functional** **Detailed**	A maintenance access ramp into the base of the basin is provided. See drawing C2063
MN3	The sediment pond base material must extend vertically up the batter by 300 mm and comprise of: • Steel reinforced concrete – steel reinforced, minimum 150 mm thick; OR • 400 mm compacted rock. Approximately 50% 300mm in size. The remaining 50% made up of 0-100mm graded rock, premixed with 300 dia rocks and spread and tracked so as to form a compacted base. Refer Standard Drawing 7251/12/012	**Detailed**	Pond base material designed as per criteria. See drawings C2060 and C2063
MN4	'Edge cleaned' sediment ponds must have hardstand areas (e.g. crushed rock) for excavation vehicles. A maintenance track must be provided around the entire perimeter of the sediment pond. Refer Standard Drawing 7251/12/013	**Detailed**	Sediment basin is not edge cleaned. A maintenance access track is provided into the base of the sediment pond instead. See drawing C2063.
MN5	Maintenance access ramps are required on all sediment ponds that cannot be 'edge cleaned'. The maintenance access ramp into a sediment pond must: • Extend from the base of the sediment pond to at least 0.5 metres above TEDD, • Be at least 4 metres wide, • Be no steeper than 1:5, (1:12 cross fall or flatter) • Be capable of supporting a 20 tonne excavator, • Constructed of compacted 200 mm deep layer of rock: -Bottom layer is 100mm depth of 0-100mm FCR; top layer is 100mm of 0-40mm NDCR (6% cement stabilised below NWL), • Have a barrier to prevent unauthorised vehicle access (e.g. gate, bollard and/or fence). Refer Standard Drawing 7251/12/013	**Functional** **Detailed**	See drawing C2063
MN6	A maintenance access track must be provided to the sediment pond maintenance access ramp and to enable maintenance vehicles to safely access and exit the site. The maintenance access track must: • Be at least 4 metres wide, Comprise of compacted 200 mm deep layer of rock. Bottom layer is 100mm depth of 0-100mm FCR; top layer is 100mm of 0-40mm NDCR, • Be reinforced to take a 20 tonne vehicle, • At the road edge, have an industrial crossover to Council standard and rolled kerb adjoining it, • Have a barrier to prevent unauthorised vehicle access (e.g. gate, bollard and/or fence). Refer Standard Drawing 7251/12/013	**Concept** **Functional** **Detailed**	See drawing C2063
MN7	A hardstand area with a minimum turning circle appropriate to the types of maintenance vehicles to be used must be provided adjacent to the sediment pond maintenance access ramp to enable maintenance vehicles to safely reverse and exit the sediment loading area. (Designers should seek advice from Melbourne Water on the types of maintenance vehicles that will be used.) **Note:** The turning circle must be in accordance with the Austroads Design Vehicles and Turning Path Templates Guide.	**Concept** **Functional** **Detailed**	See drawings C2030 and C2063
MN8	Intersections between pedestrian pathways and site maintenance access tracks should be reinforced to take a 20 tonne vehicle.	**Detailed**	This is specified in the design plans. See drawing C2030.
MN9	Dedicated sediment dewatering areas must be provided and: • Be accessible from the maintenance ramp/track, • Have a length to width ratio no narrower than 10:1, • 1:12 cross fall or flatter. • Be able to contain all sediment removed from the sediment accumulation volume spread out at a maximum of 500 mm depth, • Be located above the peak 10 year ARI water level and within 25 metres of each sediment pond, • Be located at least 15 metres from residential areas, public access spaces (playgrounds, sports fields etc.), and consider potential odour and visual issues for local residents, • Address public safety and potential impacts on public access to open space areas, • Be free from above ground obstructions (e.g. light poles) and be an area that Melbourne Water has legal or approved access to for the purpose of dewatering sediment. Refer resetting sediment ponds best practice guideline for additional information.	**Concept** **Functional** **Detailed**	Approximately 640 m2 dewatering area is provided to the west of the sediment basin and is accessible via the maintenance access track. See drawing C2030.
MN10	The wetland must be configured to enable maintenance vehicles to drive around at least 50% of the wetland perimeter. Note: This can be achieved via subdivisional road networks. Vehicular access must be provided as close as possible to wetland structures that may catch debris (e.g. provide access to the closest bank where structures are within the water body).	**Concept** **Functional** **Detailed**	Due to limited space the maintenance access is limited to the northern side of the wetland. See drawing C2030.

3.3 Sediment Pond

			Proposed Design
SP1	Sediment ponds must be located offline of waterways[1] but online to the pipe or lined channel they are treating water from. Refer to **Part A3** of this Manual for guidance on offline configurations.	**Concept** **Functional** **Detailed**	Sediment basin receives diverted stormwater up to a 4EY peak design flow from the main drain. See drawings C2070 and C2071 for diversion pit and pipe and sediment basin inlet arrangement.
SP2	Sediment ponds must be located at each point stormwater enters the "wetland system" unless: • The catchment of the incoming stormwater is < 5% of the total wetland catchment OR • The incoming stormwater has already passed through a bioretention system or wetland immediately upstream	**Concept** **Functional** **Detailed**	Sediment basin located upstream of macrophyte zone. See drawing C2030.

[1] A waterway is defined as either a natural or constructed waterway. Melbourne Water's Development Services Schemes define a 'Constructed Waterway' as reaches of a waterway that are required to be fully or partially constructed to service new development.

SP3	Sediment ponds must be sized to: • Capture 95% of coarse particles ≥ 125 µm diameter for the peak three month ARI • ≤ than 1.6m deep • Provide adequate sediment storage volume to store five years of sediment. The top of the sediment accumulation zone must be assumed to be 500 mm below NWL (refer to Figure 1). • Ensure that velocity through the sediment pond during the peak 100 year ARI event is ≤ 0.5 m/s. (The flow area must be assumed to be the EDD multiplied by the narrowest width of the sediment pond, at NWL, between the inlet and overflow outlet) Sediment ponds must be ≤ 120% of the size needed to meet the limiting of the above three criteria. Compliance with the above criteria must be demonstrated using the methods described in WSUD Engineering Procedures: Stormwater (Melbourne Water, 2005). Alternatively, the velocity criteria can be checked using a hydraulic model such as HEC-RAS. Refer to **Part D** of this Manual for guidance on undertaking velocity checks).	**Functional** **Detailed**	See design calculations in Appendix G.
SP4	The sediment pond EDD must be ≤ 350 mm.	**Concept** **Functional** **Detailed**	Sediment basin EDD set to 350 mm (RL 33.15 mAHD). This is set by the transfer pit size.

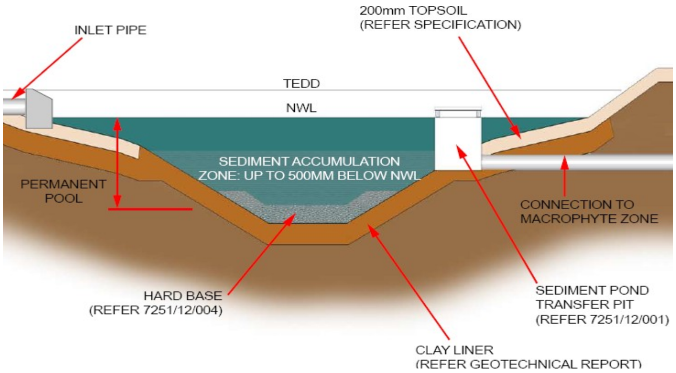

Figure 1: Sediment pond storage.

3.4 Macrophyte Zone

			Proposed Design
MZ1	At least 80% of the area of the macrophyte zone at NWL must be ≤ 350 mm deep to support shallow and deep marsh vegetation. The wetland bathymetry should provide approximately equal amounts of shallow marsh (100mm - 150 mm deep) and deep marsh (150 mm to 350 mm deep).	**Functional** **Detailed**	Macrophyte zones are distributed as follows: Shallow marsh, approximately 1,983 m2 (41%) Deep marsh, approximately 1,872 m2 (38%) Submerged marsh, approximately 782 m2 (16%) Open water, approximately 254 m2 (5%)
MZ2	The macrophyte zone EDD must be ≤ 350 mm.	**Concept** **Functional** **Detailed**	Macrophyte zone EDD set to 350 mm (RL 33.05 mAHD). This is set by the rectangular slot outlet size.
MZ3	Macrophyte zones must be located offline from all waterways and drains (i.e. there must be a bypass route around the macrophyte zone).	**Concept** **Functional** **Detailed**	A bypass channel convey flows greater than the macrophyte zone's design flow which correspond to a 4EY peak flow around the wetland system .
MZ4	The length of the macrophyte zone must be ≥ four times the average width of the macrophyte zone.	**Concept** **Functional** **Detailed**	The length of the macrophyte zone is approximately 168 m and the average width is approximately 30 m.
MZ5	The macrophyte zone outlet must be located at the opposite end of the macrophyte zone to the inlet(s).	**Concept** **Functional** **Detailed**	Outlet is located at the opposite end of the macrophyte zone relative to the inlet
MZ6	The macrophyte zone must have a sequence and mix of submerged, shallow and deep marsh zones arranged in a banded manner perpendicular to the direction of flow. Refer Figure 2).	**Functional** **Detailed**	See drawings C2030-C2032 and C2040-C2046 for plan and sectional views
MZ7	Inlet and outlet pools must be ≤ 1.5 m depth.	**Functional** **Detailed**	Inlet and outlet pools are 1.5m deep.
MZ8	Intermediate pools (between the inlet and outlet pool) must be ≤ 1.2 m deep.	**Functional** **Detailed**	Intermediate pools are 1.2m deep.
MZ9	Velocities in the macrophyte zone must be: • less than 0.5 m/s for the peak 100 year ARI flow • less than 0.05 m/s for the peak three month ARI Compliance with the above criteria must be demonstrated using the methods described in WSUD Engineering Procedures: Stormwater (Melbourne Water, 2005) or using a hydraulic model such as HEC- RAS or TUFLOW. Refer to **Part D** of this Manual for guidance on undertaking velocity checks.	**Functional** **Detailed**	Estimated peak velocity for 1% AEP = 0.5 m/s Estimated peak velocity for 4EY AEP = 0.15 m/s Macrophyte zone width is limited due to available space. Greater consideration should be provided in establishing macrophytes to avoid deterioration. We note that the velocity for 4EY AEP is still relatively low.
MZ10	The macrophyte zone must provide a 90th percentile residence time of 72 hours (assuming plug flow between inlet and outlet through the EDD and 50% of the permanent pool volume). Refer to the Melbourne Water online tool and Part D of this Manual for guidance on determining residence time and wet spells analysis. Note: This residence time is required to ensure settling of suspended particles and pollutant removal. Criteria VG10, which relates to ensuring water levels do not drown plants, must also be met.	**Functional** **Detailed**	MUSIC Auditor results shown in report Section 6.6.2
MZ11	A grade of between 1:150 and 1:400 must be provided between marsh zones (longitudinally through the macrophyte zone) to enable the wetland to freely drain. Intermediate pools will generally be needed to transition between marsh zones.	**Functional** **Detailed**	Average slope between zones is approximately 1 in 700
MZ12	A marker must be used to show wetland water level relative to NWL and EDD. The marker must be able to be read from the bank and attached to the wall of the submerged outlet pit. Refer to Standard Drawings 7251/12/005 and 7251/12/011.	**Detailed**	Marker shown in drawing C2074
MZ13	Melbourne Water will not accept islands within wetlands as are difficult to maintain (need a canoe or boat) and can become easily overgrown with weeds.	**Concept** **Functional** **Detailed**	No islands in design

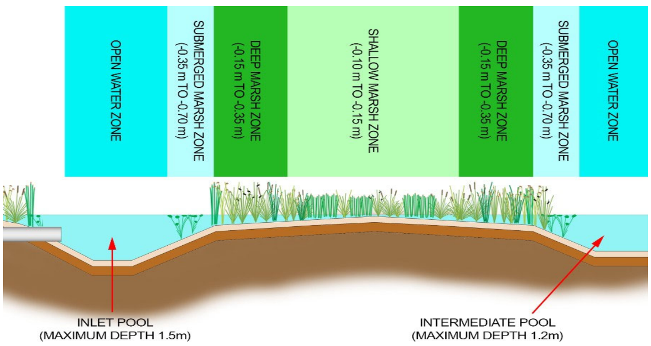

Figure 2: Macrophyte zone planting bands.

3.5 Bypass

			Proposed Design
BY1	The bypass route must be sized to convey the maximum overflow from the sediment pond that will occur during the peak 100 year ARI event. Where a sediment pond is located within a retarding basin, the bypass must convey at least the peak one year ARI flow.	**Concept** **Functional** **Detailed**	The sediment basin is located in a retarding basin, therefore bypass channel is designed to convey the difference between 1 in 1 AEP and 4 EY peak flows. See design calculations in Appendix G

3.6 Inlets and Outlets

			Proposed Design
IO1	All pits, grilles and structures must conform to Melbourne Water's standards as shown in the Land Development Manual and Standard Drawings.	**Detailed**	Standard structures are based on Melbourne Water's standard drawings.
IO2	Outlet structures must be easily identifiable and maintainable. They must be accessible from the bank. The edge of the outlet structure closest to the bank (maintenance access point) must be located in < 350 mm water depth. Refer Standard Drawing 7251/12/4003	**Detailed**	Twin chamber outlet pit located at the end of the bypass channel and will be accessible by foot. See drawing C2030, C2073-C2075
IO3	The Twin Chamber Outfall pit (containing the side winding penstock and gate valves) must have a grilled or grated lid to allow visual inspection and valve operation from the surface (e.g. through the grate/grille). Refer Standard Drawing 7251/12/005 and 7251/12/006 **Note:** Melbourne Water will be installing a hydraulic level sensor and data logger on all Development Services Scheme wetlands to ensure the wetland is meeting the required hydraulic performance target	**Detailed**	Twin chamber outlet pit shown in drawings C2073-C2075
IO4	The connection between the sediment pond and macrophyte zone inlet pool (sediment pond transfer pit) must be sized such that: • All flows ≤ the peak three month ARI event are transferred into the macrophyte zone (refer Figure 4), AND • 60% of the peak 1 year ARI flow overflows from the sediment pond into the bypass channel/pipe when the water level in the macrophyte zone is at TEDD (and not enter the macrophyte zone) (refer Figure 5), AND • The velocity through the macrophyte zone is ≤ 0.5 m/s during the peak 100 year ARI event: i. Assuming the macrophyte zone is at TEDD if the wetland is not within a retarding basin or flood plain ii. Assuming the water level is at the peak 10 year ARI water level if the wetland is within a	**Functional** **Detailed**	See design calculations in Appendix G.
IO5	The submerged offtake pit connecting into the twin chamber outfall pit must be submerged to minimise blocking from floating debris. Refer to Standard Drawings 7251/12/4003 and 7251/12/035.	**Detailed**	See drawing C2073
IO6	The twin chamber outfall pit must contain both a side winding penstock valve & a gate valve so that: • When the penstock is fully open the wetland draws down to NWL quickly assisting with plant growth during the first 12 months of plant establishment. • The penstock can be fully opened or closed to assist with maintenance of the wetland. • The stage/discharge rate can be adjusted if required to achieve suitable residence times and/or inundation patterns Refer Standard Drawing 7251/12/005 & 7251/12/006 The gate valve allows full or partial draw down of the wetland to assist with maintenance.	**Functional** **Detailed**	Side winding penstock valve is not standard in Tasmania. Instead a metal plate with a rectangular slot sized appropriately is fixed onto the twin chamber outlet pit to achieve the 3 day residence time. See drawing C2073-C2075
IO7	Balance pipes must be placed between all open water zones (inlet, intermediate and outlet pools) to enable water levels to be drawn down for maintenance or water level management purposes. Refer Standard Drawings 7251/12/015 & 7251/12/035. Balance pipes must be 300mm dia RCP with the RL of the submerged offtake pit (notch cut out) no more than 300 mm above the base of the deepest point of the pool to maximise draw down and minimise blockage potential. Refer Standard Drawing 7251/12/035 for details.	**Functional** **Detailed**	See drawing C2030, and C2076-C2077

Figure 3: Hydraulic level sensor & data logger

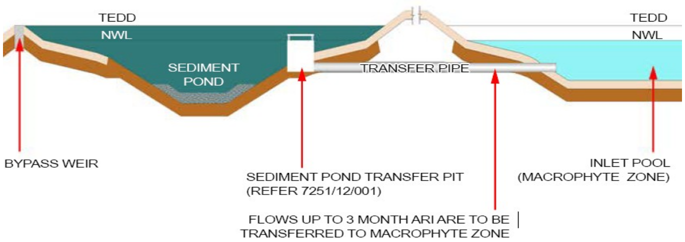

Figure 4: Connection between sediment pond and macrophyte zone – three month ARI flow check (refer to Melbourne Water Standard Drawing 7251/12/001 for more details on the connection between sediment pond and macrophyte zone).

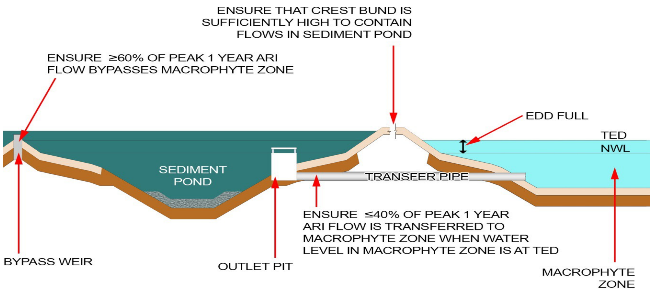

Figure 5: Figure 6 Connection between sediment pond and macrophyte zone – one year ARI flow check (Refer to Melbourne Water Standard Drawings 7251/12/001 for more details on the connection between sediment pond and macrophyte zone).

3.7 Vegetation & Landscape

Proposed Design

VG1	The macrophyte zone must contain a minimum of 80% cover of emergent macrophytes comprising of shallow and deep marsh zones. Open water areas (maximum 20% of the wetland area) must include submerged marsh vegetation.	**Functional** **Detailed**	Macrophyte zones are distributed as follows: Shallow marsh, approximately 1,983 m2 (41%) Deep marsh, approximately 1,872 m2 (38%)
VG2	Any open water areas in excess of 20% of the macrophyte zone area (at NWL) must be located as a separate water body. These separate water bodies are not considered by Melbourne Water to be wetlands for the purpose of treating stormwater, and are therefore beyond the scope of this document. For further information, refer to **Part A3** for open water, landscape design and amenity design considerations and the Planning and Building website for ownership and maintenance responsibilities. Conceptual models of wetlands and other parts of the treatment train (e.g. MUSIC) must assume there is no reduction in pollutant loads within these separate waterbodies.	**Concept** **Functional** **Detailed**	No excess open water area in design
VG3	Ephemeral batters (NWL to 350 mm above NWL) of the wetland macrophyte zone and sediment pond must be densely planted with plants at 6 plants per sqm suited to intermittent wetting. 80% of the plants used in the ephemeral batters must be in accordance with the species and densities shown in Table 1.	**Functional** **Detailed**	Plant schedule selection is provided in report Section 7.3
VG4	The ephemeral batters must be planted at an average density of 6 plants per sqm with individual plants grown in individual pots or tray cells that are a minimum of 90 cm^3 in volume (V93 hiko cell equivalent), however 200cm^3 (forestry tubes) are preferred.	**Detailed**	Plant schedule selection is provided in report Section 7.3
VG5	The shallow marsh (≤100 - 150mm below NWL) of the macrophyte zone and sediment pond must be densely planted with 2 pots per sqm (≥550cm^3 containers). 90% of the plants used in the shallow marsh must be in accordance with the species and densities shown in Table 2. A minimum of three species must be specified for the shallow marsh zone.	**Functional** **Detailed**	Plant schedule selection is provided in report Section 7.3
VG6	The deep marsh (150 to 350 mm below NWL) of the macrophyte zone must be densely planted with 2 pots per sqm (≥550 cm^3 containers). 90% of the plants used in the deep marsh must be in accordance with the species and densities shown in Table 3. A minimum of three species must be specified for the deep marsh zone.	**Functional** **Detailed**	Plant schedule selection is provided in report Section 7.3
VG7	The submerged marsh (350 to 700 mm below NWL) of the macrophyte zone must be planted with 1 pot per sqm (≥550 cm3 containers). 90% of the plants used in the submerged marsh must be in accordance with the species and densities shown in Table 4.	**Functional** **Detailed**	Plant schedule selection is provided in report Section 7.3
VG8	Emergent and submerged macrophyte seedlings must be grown in individual container/pots with a minimum volume of: • ≥550cm^3 (200cm^3 forestry tubes are not acceptable) Note: Seedlings sourced from bare-root divisions from tub/tray grown stock or stock harvested	**Detailed**	Plant schedule selection is provided in report Section 7.3
VG9	Seedlings grown in ≥550cm^3 pots must have: • minimum stem height of 500 mm (except *Triglochin procerum* and *Eleocharis acuta* – minimum stem height of 400 mm) • total stem area must cover at least 50% of the pot surface area • well developed, healthy root system that occupies the full pot volume (i.e. the growing media must remain intact when the plant is removed from the pot) • Not have a pot depth exceeding 150mm. **Note:** The minimum stem height criteria specified for ≥550 cm3 pots does not apply to submerged macrophyte species.	**Detailed**	Plant schedule selection is provided in report Section 7.3
VG10	The effective water depth (permanent pool depth plus TEDD) must not exceed half of the average plant height for more than 20% of the time. This must be demonstrated using inundation frequency analysis assuming the plants heights are in accordance with those shown in Table 2 to Table 4. Refer to online tool and **Part D** of this Manual for guidance on the inundation frequency analysis.	**Functional** **Detailed**	MUSIC auditor results shown in report Section 6.6.2
VG11	For stormwater harvesting requirements please refer to the below guidelines. **Note:** the harvested water can only be extracted from the downstream chamber of the twin chamber outfall pit. Stormwater harvesting guidelines Stormwater harvesting technical guidelines Standard Drawings - Stormwater Harvesting Note: a diversion licence is required to harvest water from Melbourne Water assets.	**Concept** **Functional** **Detailed**	No stormwater harvesting in design
VG12	The wetland must have an appropriately sized outfall to ensure the planting wont drown and for Melbourne Water to accept ownership of the asset at completion of the defects period. **Note:** The developer and or their consultant is to negotiate with any downstream property owners with regard to outfall design and construction (temporary or permanent), not Melbourne Water. The developer must own and maintain any temporary outfalls until the permanent asset is constructed, not Melbourne Water.	**Functional** **Detailed**	Spells analysis as part of MUSIC auditor results are shown in report Section 6.6.2
VG13	Any grassed areas that Melbourne Water must maintain are to meet one of the below options. Councils batter grade requirements should be sought for areas they are to maintain as each council has a different requirement: 1. 1 in 5 or flatter with a 3m run out area at the bottom of the slope is to be provided so MW can mow up and down if necessary. Run out area is to be a maximum grade of 1:12 and be clear of rocks, trees, fences etc. 2. Maximum grade of 1:12 to allow for safe grass cutting (horizontal and vertical cutting method). No run out area is required, area must be clear of rocks, trees, fences, drops etc. Note: For mowing around vegetation MW requires a 3m gap between vegetation to allow mower access. Overhanging vegetation can be an access issue. Slopes steeper than 1 in 5 to be densely vegetated.	**Functional** **Detailed**	Grassed areas to be maintained according to Kingborough Council requirements
VG14	No mulch to be placed below Q100 or frequently inundated areas. Jute mat required to be installed between NWL & TEDD, and jute mat to be used above TEDD where deemed necessary. Jute mat must be installed to the manufacturer's specifications, including fasteners.	**Functional** **Detailed**	Retarding basin only attenuates 1 in 20 AEP. Mulch will not be placed in any frequently inundated areas (i.e., in wetland system)

Table 1: Ephemeral batter plant list (NWL to 350mm above NWL)

Botanical name	Common name	Minimum density (>90cm^3
Baumea rubiginosa	Soft Twig-rush	6
Carex appressa	Tall Sedge	6
Carex tereticaulis	Basket Sedge	6
Cyperus lucidus	Leafy Flat-sedge	6
Juncus amabilis	Hollow Rush	6
Juncus flavidus	Yellow Rush	6
Juncus krausii	Sea Rush	6
Juncus pallidus	Pale Rush	6
Poa labillardierei	Common Tussock	6
Lomandra longifolia	Spiny-headed Matt-rush	6

Table 2: Shallow marsh plant list (100 to 150mm below NWL)

Botanical name	Common name	Minimum density (plants/m^2) ≥550cm^3 pot	Average plant height (m)
Baumea articulata	Jointed Club-rush	2	1.8
Bolboschoenus caldwellii	Sea Club-rush	2	1.0
Botanical name	**Common name**	**Minimum density (plants/m^2)** ≥550cm^3 pot	**Average plant height (m)**
Bolboschoenus fluviatilis	Tall Club-rush	2	1.8
Bolboschoenus medianus	Marsh Club-rush	2	1.5
Cladium procerum	Leafy Twig-rush	2	2.0
Eleocharis acuta	Common Spike-rush	2	0.5
Schoenoplectus tabernaemontani	River Club-rush	2	1.8
Cycnogeton procerum	Water Ribbons	2	1.0

Table 3: Deep marsh plant list (150 to 350mm below NWL)

Botanical name	Common name	Minimum density (plants/m^2) ≥550cm^3 pot	Average plant height (m)
Baumea articulata	Jointed Club-rush	2	1.8
Bolboschoenus caldwellii	Sea Club-rush	2	1.0
Bolboschoenus fluviatilis	Tall Club-rush	2	1.8
Bolboschoenus medianus	Marsh Club-rush	2	1.5
Cladium procerum	Leafy Twig-rush	2	2.0
Eleocharis sphacelata	Tall Spike Rush	2	1.8

Schoenoplectus tabernaemontani	River Club-rush	2	1.8
Cycnogeton procerum	Water Ribbons	2	1.0

Table 4: Submerged marsh plant list (350 to 700mm below NWL)

`Botanical name	Common name	Minimum density (plants/m²) ≥550cm³ pot
Myriophyllum crispatum	Upright Water-milfoil	1
Potamogeton ochreatus	Blunt Pondweed	1
Vallisneria australis	Eel-grass	1

3.8 Liner and Topsoil

			Proposed Design
LN1	The exfiltration rate from the base and the sides of the wetland must be accurately represented in the conceptual modelling software analysis (e.g. MUSIC). Wetlands with a permanent NWL must have a compacted clay liner made from site soils and/or imported material where site soils are unsuitable based on the recommendations from the site geotechnical report.	**Concept** **Functional** **Detailed**	Zero exfiltration assumed due to impermeable clay lining for wetland system.
LN2	Impermeable liners (based on the recommendations from the site geotechnical report) must be used where the groundwater table is likely to interact with the wetland or where there are saline in-situ soils.	**Detailed**	Clay lining to be established for wetland system as per criterion
LN3	At least 200mm of topsoil must be provided in all areas of the macrophyte zone; and in sediment ponds to 500mm below NWL in accordance with Melbourne Waters Topsoil specification	**Functional** **Detailed**	Topsoil to be established in the wetland system as per criterion
LN4	Topsoils used within the wetland (in situ or imported) must comply with Melbourne Waters Topsoil specification which is sub set of AS 4419 Soils for landscaping and garden use[2]. Testing must be carried out by a NATA accredited laboratory. If required, amelioration to the topsoil must be undertaken to achieve compliance with Melbourne Waters Topsoil specification	**Detailed**	Topsoil to be established in the wetland system as per criterion

3.9 Landscape Design Structures

			Proposed Design
LDS1	All boardwalks, piers, bridges and/or structurally treated edges installed and maintained by others are to meet Melbourne Waters below guideline requirements and also have heights and/or railings in accordance with relevant design codes and satisfy inundation and safety criteria. - Constructing waterway crossings guideline - Shared pathways guideline - Maintenance Agreements Refer to Part A3 of this Manual for design consideration and guidance on landscape design features.	**Detailed**	No bridges or boarwalks are proposed in the design to date.

[2] The AS 4419 requirement for % organic matter content does not apply. Topsoils used in wetlands must have a minimum of 5% organic matter content.

LDS2	Boardwalks and/or viewing platforms are not permitted over sediment ponds, pipes & pits, weirs, rock chutes and EDD control structures for maintenance access reasons.	**Concept** **Functional** **Detailed**	No bridges or boarwalks are proposed in the design to date.
LDS3	Vehicle exclusion bollards are required around entire wetland reserve to prevent unauthorised access and illegal rubbish dumping. Refer Standard Drawings 7251/8/204, 7251/8/205, 7251/8/207	**Functional** **Detailed**	Vehicle exclusion bollards to be placed where required.

3.10 Edge Treatment

			Proposed Design
ET1	The edge of any deep open water should not be hidden or obscured by embankments or terrestrial planting unless measures are taken to preclude access. Public access to structures, the top of weirs, orifice pits and outlet structures must be restricted by appropriate safety fences and other barriers. Permanent fencing is required adjacent to potentially unsafe structures (i.e. deep water zones, steep drops, top of weirs, outlet structures etc.).	**Functional** **Detailed**	Barriers are established where required.
ET2	All wetland edges must have: • Vegetated approach batters no steeper than 1:5, a 2.8 metre wide vegetated safety bench at 1:8 between NWL and 350 mm below NWL and a maximum 1:3 slope beyond 350 mm below NWL (refer • Figure 6). OR • The batter from TEDD to 350mm below NWL must contain dense impenetrable planting that is a minimum of 2.8 metres wide and 1.2 metres high (refer Figure 7 and Figure 8).	**Functional** **Detailed**	Vegetated approach have a 1:4 batter (limit for mowing). A 1:8 safety bench is provided and a maximum slope of 1:3 is set below NWL. Planting selection is provided in Section 7.3 of the report.
ET3	A minimum offset of 15 metres must be provided from the wetland's NWL to any allotment or road reserve (not including shared pathways). A safety design audit may be required for any proposal that does not achieve this condition. Refer to **Part A3** of this Manual for design consideration and guidance on safety in design.	**Concept** **Functional** **Detailed**	Limited space is available to fit an appropriately sized wetland system. Vehicle exclusion and access barriers will be established where necessary to induce safety around the wetland system.

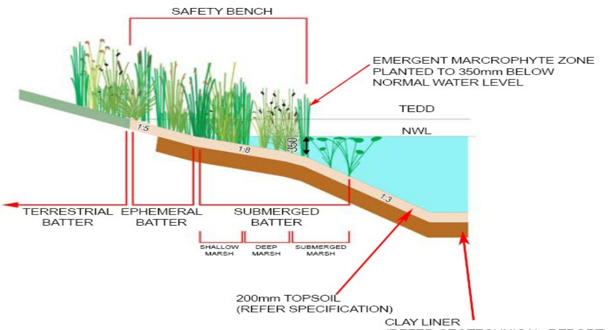

Figure 6: Indicative cross-section of vegetated wetland edge with safety bench (Refer to Melbourne Water Standard Drawing 7251/12/010 for more details).

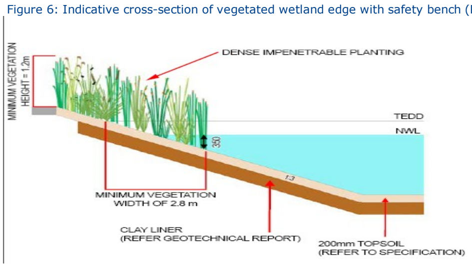

Figure 7 Indicative cross-section of vegetated wetland edge with impenetrable planting.


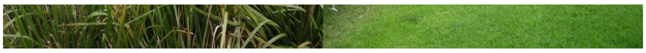

Figure 8: Photos showing examples of wetland edges with dense impenetrable planting

3.11 Landscape Contractor Selection, Plant Supply, Installation & Maintenance

The landscape consultant must be engaged by the developer to supervise and approve the entire landscape construction process from the pre-commencement meeting through to achieving the end of defects period (a minimum of 27 months), ensuring the fellow requirements are met:

LC1	The landscape contractor awarded the wetland project is suitably qualified and experienced and has	Construction
LC2	The landscape contractor awarded the wetland project must be the contractor undertaking the plant	**Construction**
LC3	The landscape contractor awarded the wetland project must be the contractor maintaining the	**Construction**
LC4	The landscape contractor awarded the wetland project must order stock from an accredited nursery	**Construction**
LC5	Check the planting contractor’s delivery dockets to ensure the number of plants and format of	**Construction**
LC6	Audit the quality of stock delivered to site prior to the installation occurring accepting and/or	**Construction**
LC7	Ensure the contractor is undertaking regular weed runs (aquatic, ephemeral and terrestrial) of the	**Construction**
LC8	Undertake random audits of the accredited nursery’s they regularly source stock from to ensure the	**Construction**
LC9	Make Melbourne Water aware of any accredited nursey’s growing and supplying poor quality stock	**Construction**
LC10	Make Melbourne Water aware of any landscape contractor not sourcing, installing and maintain	**Construction**
LC11	Make Melbourne Water aware of any topsoil installation that doesn’t meet the requirements of	**Construction**
LC12	Make Melbourne Water aware of wetland bathymetry that doesn’t meet the requirements of this	**Construction**

Note: Should Melbourne Water feel the quality of sourced plants delivered to and installed on site don’t meet the requirements of this manual, we reserve the right to engage an independent auditor to assess and make a recommendation as to the quality of the landscape planting. Any required rectification works resulting from this audit would be at the expense of the developer, not Melbourne Water.

Appendix E

Catchment delineation and land use breakdown

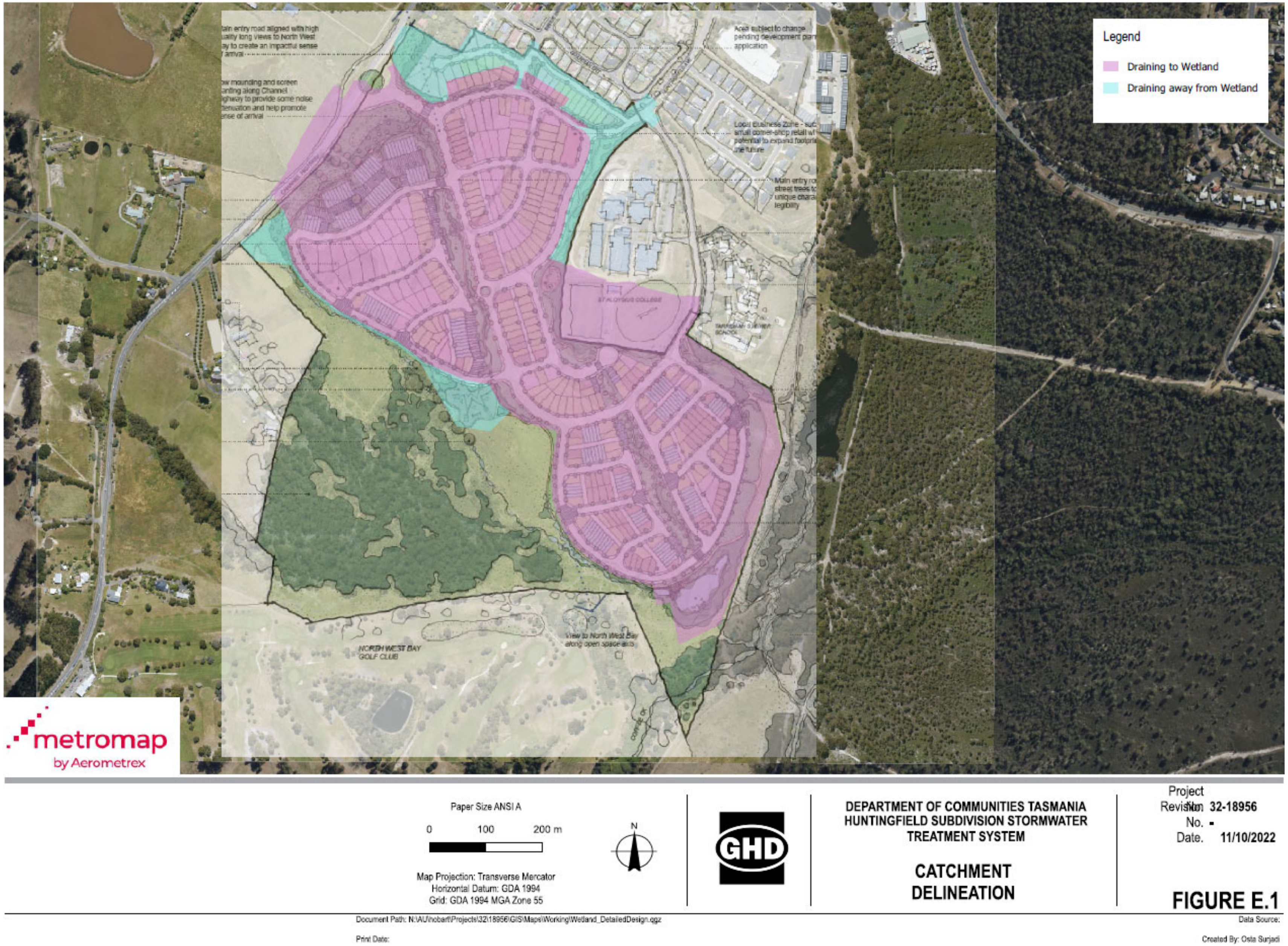

Figure E.1 Catchment delineation

Table E.1 Catchment land use breakdown

Land use	Area draining into treatment train (ha)	Area bypassing the treatment train (ha)	Impervious fraction (Melbourne Water MUSIC guidelines 2020)
Residential (excl. roof area) – Low density	3.6	0.5	0.6
Residential (excl. roof area) – Standard density	4.3	0.6	0.75
Residential (excl. roof area) – Medium density	1.6	0.1	0.75
Residential (excl. roof area) – Townhouse	1.4	-	0.85
Residential (roof area) – Low density	0.7	0.1	1.0
Residential (roof area) – Standard density	1.6	0.3	1.0
Residential (roof area) – Medium density	0.8	0.04	1.0
Residential (roof area) – Townhouse	1.3	-	1.0
Commercial	0.2	-	0.9
Open space	10.7	1.7	0.1
Road	15.8	2.0	0.8

Appendix F

Cost estimate breakdown

		Rate			Quantity	
	Option 1	**Rate**			**Quantity**	
	Capital costs					
1	On-site detention basin					
1.1	Bulk excavation	$	30.00	cum	8,594	$ 257,820.00
1.2	General fill (embankment formation, lining, top soil, etc.)	$	20.00	cum	4,806	$ 96,120.00
1.3	Excess fill disposal	$	50.00	cum	3,788	$ 189,400.00
1.3	Outllet weir formation	$	10,000.00	item	1	$ 10,000.00
2	GPT					
2.1	Earthworks (excavation, backfilling, and surface treatment)	$	30.00	cum	7	$ 223.56
2.2	Supply, install and connect to pipes	$	20,000.00	item	1	$ 20,000.00
3	Sediment basin					
3.1	Supply and install inlet diversion pit (900 x 900 mm) and pipe (DN600)	$	10,000.00	item	1	$ 10,000.00
3.2	Supply and install outlet pit (900 x 900 mm) and pipe (DN600)	$	10,000.00	item	1	$ 10,000.00
4	Macrophyte zone					
4.1	Supply and install offtake pit (900 x 900 mm) and pipe (DN525), twin chamber pit (900 x 900 mm), metallic plate with rectangular slot (40 x 350 mm), and outlet pipe (DN750)	$	15,000.00	item	1	$ 15,000.00
4.2	Macrophyte planting	$	10.00	m2	1,200	$ 12,000.00
5	Bypass channel					
5.1	Rock formation	$	80.00	cum	120	$ 9,600.00
6	Rainwater tanks					
6.1	Supply 5kL rainwater tanks	$	2,000.00	item	434	$ 868,000.00
6.2	Installation	$	200.00	item	434	$ 86,800.00
	Annual operation and maintenance cost					
7	On-ste detention basin					
7.1	Ongoing maintenance		5%	year	1	$ 18,197.00
8	GPT					
8.1	Ongoing maintenance	$	2,000.00	year	3	$ 6,000.00
9	Sediment basin					
9.1	Major maintenance	$	5,000.00	5 yr	0.2	$ 1,000.00

Total CAPEX	$ 1,585,000.00	
Total OPEX	$ 26,000.00	
	30% contingency	100% contingency
Total CAPEX	$ 2,061,000.00	$ 3,170,000.00
Total OPEX	$ 34,000.00	$ 52,000.00
Total	$ 2,095,000.00	$ 3,222,000.00

Summary table

	Capital costs	Rate	Quantity	Cost Method 1
1	On-site detention basin			$ 553,340.00
2	GPT			$ 20,200.00
3	Sediment basin			$ 20,000.00
4	Macrophyte zone			$ 27,000.00
5	Bypass channel			$ 9,600.00
6	Rainwater tanks			$ 954,800.00
	Annual operation and maintenance cost			
7	On-ste detention basin			$ 18,197.00
8	GPT			$ 6,000.00
9	Sediment basin			$ 1,000.00

Total CAPEX	$ 1,585,000.00	
Total OPEX	$ 26,000.00	
	30% contingency	100% contingency
Total CAPEX	$ 2,061,000.00	$ 3,170,000.00
Total OPEX	$ 34,000.00	$ 52,000.00
Total	$ 2,095,000.00	$ 3,222,000.00

Appendix G

Sediment basin and wetland design calculations

G-1 Sediment basin calculations

G-1-1 Sediment basin sizing

Target sediment retention = 95%

Target sediment particle diameter >= 125 µm

Target AEP = 4 EY (1 in 3 months)

Sediment removal efficiency equation (Wetland Design Manual, Melbourne Water 2020):

$$R = 1 - \left[1 + \frac{1}{n} \times \frac{v_s}{Q/A} \times \frac{(d_e + d_p)}{(d_e + d^*)}\right]^{-n}$$

R = Fraction of target sediment removed = 0.95

d_e = Extended detention depth = 0.35 m

d_p (empty basin) = Permanent depth = 1.5 m

d* (empty basin) = Permanent pool level – target sediment depth (lesser of 1 and d_p) = 1 m

v_s = Settling velocity = 11 mm/s

λ = Hydraulic efficiency (pond shape) = 0.4

n = Turbulence/short-circuiting parameter = 1.666666667

Q = 4 EY peak flow = 1.60 m^3/s

$(d_e+d_p)/(d_e+d^*)$ = 1.37

Estimated surface area = 890.00 m^2

Estimated volume = 1335.00 m^3

Estimated sediment storage volume = 890.00 m^3

Adopted surface area (adjusted to 12d modelling) = 1202.00 m^2

Adopted volume (adjusted to 12d modelling) = 1398.80 m^3

Sediment storage volume (adjusted to 12d modelling) = 1202.00 m^3

G-1-2 Sediment storage requirement check

Target cleaning frequency = 5 years

Sediment removal frequency (Wetland Design Manual, Melbourne Water 2020):

$$S_t = C_a \times R \times L_0 \times F_r$$

C_a = Contributing catchment area = 41.88 ha

R = Fraction of target sediment removed = 0.95

L_0 = Sediment loading rate, from Wetland Design Manual = 1.6 m^3/ha/yr

F_r = Cleanout frequency = 5 years

S_t = Volume of storage required between base and 0.5 m below normal water level = 318.288 m^3

Estimated F_r for adopted storage volume = 18.9 years

G-1-3 Sediment basin inlet (diversion pit and pipe)

Pipe size determined using 12D ILSEX method. The analysis determined that the diversion pipe will be under pressure during a 4 EY event.

Adopted standard pipe internal diameter = 600 mm

Flow capacity = 0.4 m3/s

Actual flow during 4 EY = 1.6 m^3/s

Capacity velocity = 1.5 m/s

Actual velocity = 5.5 m/s

Pipe slope = 1 in 200 (0.5%)

Diversion pit size determined by size of stormwater main (twin RCP 1,350 mm inlet and twin RCP 1,200 mm outlet) and adopted diversion pipe (RCP 600 mm)

Adopted pit size = 3,600 mm x 3,600 mm

G-1-4 Sediment basin outlet (transfer pit and pipe)

Pipe size determined using trial and error or 'Goal Seek' function in Microsoft Excel. Goal seek function used to find target flow (1.6 m/s)

Manning's flow velocity equation

$$v = (k_n / n)\, R_h^{2/3}\, S^{1/2}$$

$$Q = v \times A = v \times (\pi D^2/4)$$

v = Pipe full flow velocity (ideally between 1 m/s and 6 m/s for self-cleaning and minimising wear according to Melbourne Water[8])

k_n = 1 (for SI units)

n = Manning coefficient of roughness = 0.013

R_h = Hydraulic radius = D/4

S = Assumed pipe slope (1 in S) = 100

Q = Q_{4EY} = 1.6 m^3/s

D = Pipe internal diameter = 0.89 m

Adopted standard pipe internal diameter = 900 mm

Pit size determined using weir flow equation (perimeter of pit = weir length)

$$Q = B * C * L * h^{1.5}$$

B = Blockage factor, assume no blockage = 1

C = Discharge coefficient for weirs = 1.84

H = Max height of water above pit, EDD = 0.35 m

L = Perimeter of pit to allow Q_{4EY} into macrophyte zone = 4.2 m

Adopted pit perimeter = 4.6 m

Adopted 1400 mm x 900 mm to fit pipe diameter

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8 https://www.melbournewater.com.au/building-and-works/developer-guides-and-resources/standards-and-specifications/hydrologic-and

G-2 Macrophyte zone calculations

G-2-1 Macrophyte zone sizing for optimal pollutant removal

Method is based on chapter 2 and 4 of the WSUD Engineering Procedures: Stormwater by Melbourne Water (2005).

C_{imp} = Impervious area of catchment = 25.9 ha

$C_{\%}$ = Percentage of impervious area recommended = Recommended proportion of impervious area to remove pollutants (45ssuming TN is the limiting pollutant) = 2.40%

F = Hydrologic region adjustment factor (based on the region of south coast of Victoria) = 0.428 + (0.737 x MAR)

> MAR = Mean annual rainfall = 441.51 mm (based on rainfall data used in MUSIC model from the Hobart Airport rainfall station, station number 094008)
>
> F = 0.75

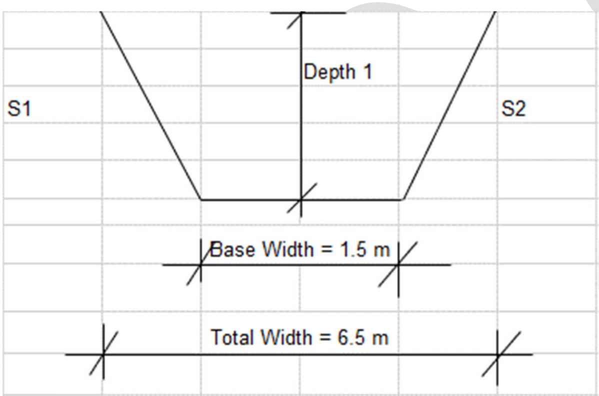
Required wetland area = C_{imp} x $C_{\%}$ x F = 0.47 ha

Adopted wetland area (based on 12D modelling) = 4891.00 m^2

G-2-2 Macrophyte zone bypass channel

Bypass channel design based on a trapezoidal channel cross-section. Channel capacity should be greater than the peak flow in a 1 in 1 year AEP event (= 2.8 m^3/s). In a 1 in 1 year AEP event, a portion of the peak flow is diverted into the sediment basin (= 1.60 m^3/s).

Hence, the channel should have a conveyance greater than 2.80 – 1.60 = 1.20 m^3/s.



Base Width = 1.5 m

Side Slope 1 (1V:xH) = 5

Side Slope 2 (1V:xH) = 5

Channel Depth = 0.50 m

Manning's (n) = 0.045

Longitudinal Slope (%) = 0.5

Waterway Area = 2 m^2

Wetted Perimeter (P_w) = 6.60 m

Hydraulic Radius (R_h) = P_w/A = 0.30 m

Velocity (Manning's flow velocity equation) = 0.71 m/s

Discharge (velocity x waterway area) = 1.42 m^3/s

G-2-3 Macrophyte zone outlet

The designed outlet is housed in a twin chamber pit which draws water from the outlet pool through a submerged offtake pit and flows through a fixed rectangular slot and ultimately outlets via a discharge pipe.

Flow through a rectangular slot (Wetland Design Manual, Melbourne Water 2005):

$$Q = C_d*(2/3)*((2*g)^{0.5})*b*h^{1.5}$$

$$C_d = 0.562+11.354/Re^{0.5}$$

Rectangular slot dimensions are determined through trial and error or the ‘Goal Seek’ function in Microsoft Excel. Goal seek function used to find flow that results in a 3 days residence time estimated using the MUSIC Auditor online tool.

H = Water depth (maximum depth = EDD) = 0.35 m

R_h = Hydraulic radius = bh/(b+2h) = 0.023333333

v = Q/(bh) = Design flow velocity for target discharge = 0.47 m/s

R_e = v x R/kinematic viscosity = Assume kinematic viscosity = 1mm^2/s for water = 10969.91

C_d = Discharge coefficient = 0.67

g = Gravitational constant = 9.80 m/s^2

Q = Discharge = 0.020485463 m3/s

b = Slot width = 0.050 m

Discharge pipe size determined using trial and error or ‘Goal Seek’ function in Microsoft Excel. Goal seek function used to find target flow equal to a full 1 in 1 year AEP peak flow (2.80 m^3/s).

Manning’s flow velocity equation

$$v = (k_n / n)\ R_h^{2/3}\ S^{1/2}$$

$$Q = v \times A = v \times (\pi D^2/4)$$

v = Pipe full flow velocity (ideally between 1 m/s and 6 m/s for self-cleaning and minimising wear according to Melbourne Water[9])

k_n = 1 (for SI units)

n = Manning coefficient of roughness = 0.013

R_h = Hydraulic radius = D/4

S = Assumed pipe slope (1 in S) = 100

Q = Q_1 = 2.8 m^3/s

D = Pipe internal diameter = 1.06 m

Adopted standard pipe internal diameter = 1,050 mm

Twin chamber pit is located within the bypass channel and its size is determined using weir flow equation (perimeter of pit = weir length) but checked with DRAINS modelling to consider the required OSD discharge.

$$Q = B * C * L * h^{1.5}$$

B = Blockage factor, assume no blockage = 1

C = Discharge coefficient for weirs = 1.84

[9] https://www.melbournewater.com.au/building-and-works/developer-guides-and-resources/standards-and-specifications/hydrologic-and

H = Max height of water above pit, depth of bypass channel = 0.5 m

L = Perimeter of pit to allow Q_{4EY} into macrophyte zone = 4.2 m

Adopted pit perimeter to allow required OSD discharge = 10 m

Adopted 2500 mm x 2500 mm

G-2-4 Macrophyte zone maintenance drain

Maintenance drain to be sized such that permanent volume of wetland can be drained manually in 12 hours. Maintenance drain is fitted into the twin chamber outlet pit underneath the rectangular slot outlet.

Target flow is estimated using the flow through an orifice equation.

$$A_o = \frac{Q}{C_d\sqrt{2gh}}$$

Permanent wetland pool volume (based on 12D model) = 3133.00 m^3

Target drain time = 12 hours = 43200 seconds

Q = Discharge rate to empty wetland in target drain time = 0.08 m^3/s

h = Macrophyte zone outlet pool depth = 1.5 m

g = 9.8 m/s^2

C_d = Orifice discharge coefficient = 0.67

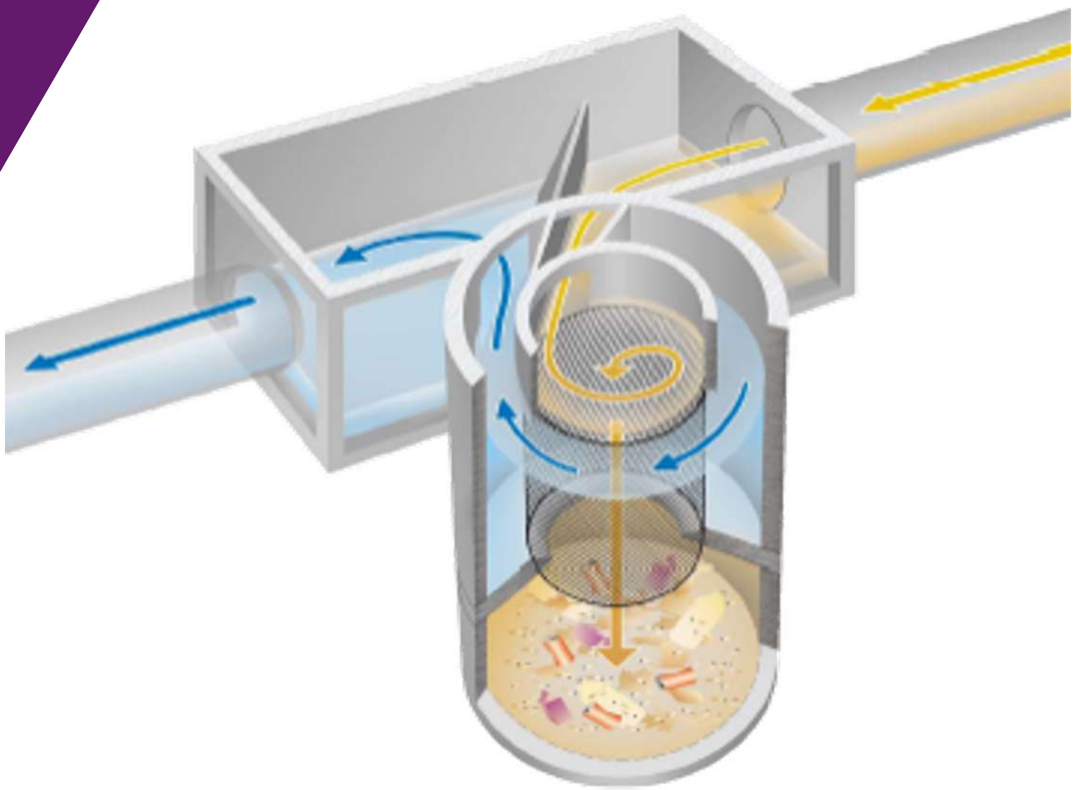
A_o = 0.022021227 m2

d_o = Orifice diameter = 0.167446402 m = 168 mm

Adopted orifice diameter = Minimum diameter = 300 mm

Appendix H

Gross Pollutant Trap details



CDS® 1.8m width Diversion Chamber

Product Installation Guide

(July 2021)

Disclaimer

The information in this document is provided as a guide to assist contractors installing a CDS® GPT. It is the purchaser's responsibility to ensure that installation work is carried out by competent tradespeople.

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- Confirms whether the product to be installed has non-standard components. If so, seek guidance from Rocla as items may not be covered within this guide
- Completes a **DIAL BEFORE YOU DIG** of the installation site prior to any excavation works.
- Determines the presence of groundwater. If groundwater is present, a suitable de-watering system is put in place for excavation and installation.

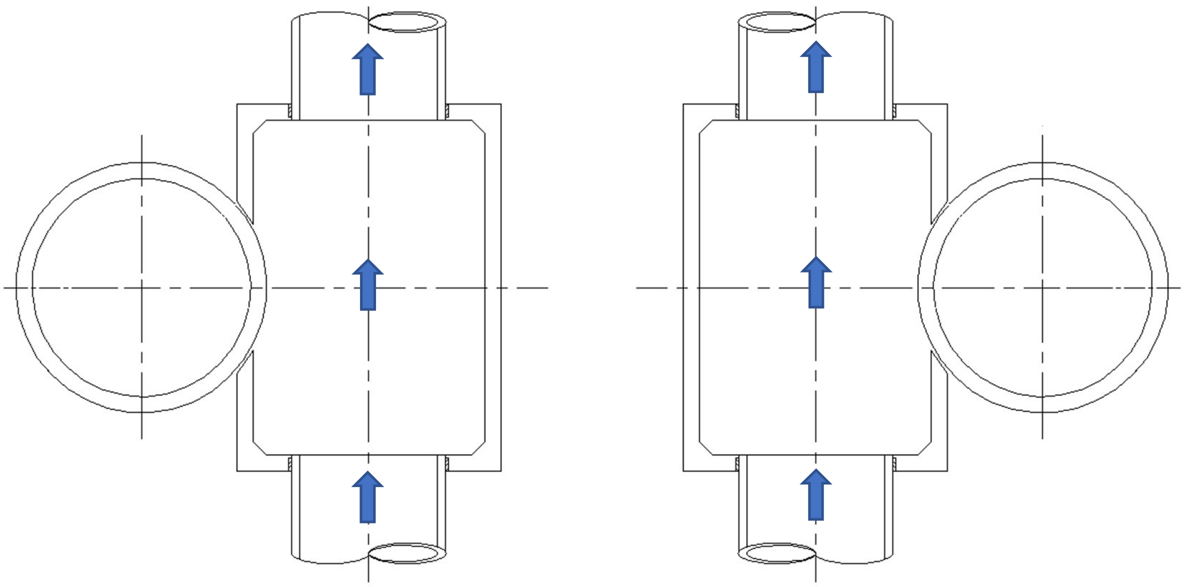
Understanding CDS® Diversion Chambers

Diversion Chambers for CDS® units are split into 3 distinct designs, all referenced to by the chamber's **internal width**.

	CDS Series					
Chamber Width	P0506	P0708	P1000	P1500	P2000	P3000
1.8m	N/A	N/A	✓✓	✓	✗	✗
2.4m – 3.6m	N/A	N/A	✓	✓✓	✓✓	✓✓
4.2m	N/A	N/A	✓	✓	✓	✓

✓✓ = Common chamber design

Unit Orientation – When looking along the pipeline towards the downstream end, a GPT placed on the left of the pipeline is a Left Hand unit, and Right Hand units are placed on the right side of the pipeline. 'Twin Units' typically consist of one of each type of unit, placed on both sides of the pipeline.



LEFT HAND UNIT **RIGHT HAND UNIT**

Required Installation Guides

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As well as this Diversion Chamber guide, make sure you also have a copy of the correct CDS® unit installation guide.

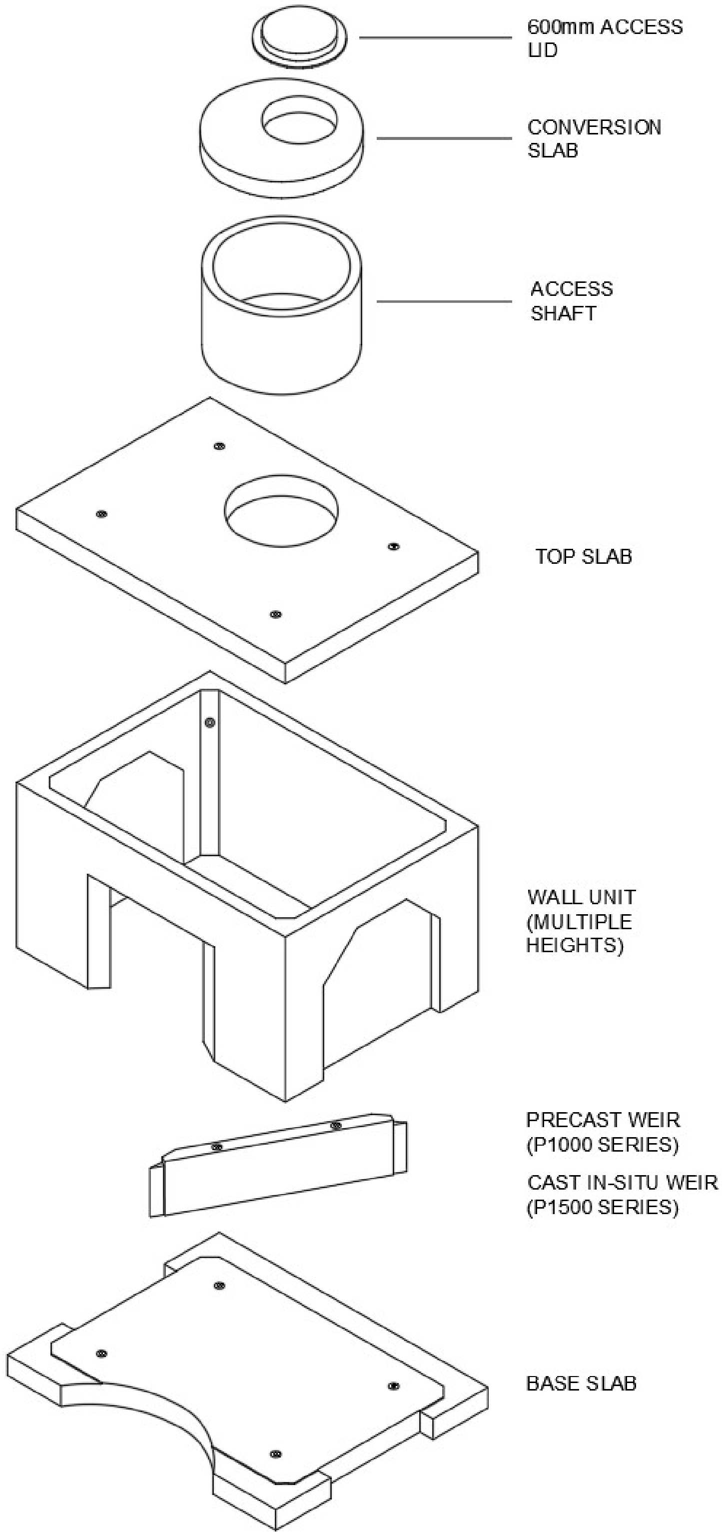
The installer should refer to the site-specific Rocla project drawings, and/or contact Rocla, to understand the guides required for each installation.

The following table generally describes the work procedures covered.

ORDER	WORK PROCEDURE	
1	SITE WORKS AND SET OUT	CDS® UNIT GUIDE
2	EXCAVATE FOR DEVICE	
3	CONSTRUCT DEVICE	
4	FITTING OUT	
5	OIL BAFFLE (OPTIONAL)	
6	EXCAVATE FOR DIVERSION CHAMBER	THIS GUIDE
7	CONSTRUCT DIVERSION CHAMBER	
8	BACKFILLING AND LIDS	BOTH GUIDES

Guide Contents

A. CDS® 1.8m Diversion Chamber Arrangement



DIVERSION CHAMBER ASSEMBLY

B. CDS® 1.8m Diversion Chamber Component List

The below component list is for a standard unit for an average depth installation. Actual delivered component quantities may vary slightly due to optional components selected, or units for deeper or shallower installations.

COMPONENT	MATERIAL	QTY	MASS (kg) *	Swiftlift / QTY
Base Slab	Concrete	1	2830	2.5T / 4
Wall Unit	Concrete	1	2720 (1200mm height) 3600 (1500mm height) 4480 (1800mm height)	5T / 4
Diversion Weir (P1000 Series only)	Concrete	1	400	2.5T / 2
Roof Slab	Concrete	1	2560	2.5T / 4
Access Shaft(s)	Concrete	Varies	470 per m	Lifting Holes
Conversion Slab	Concrete	1	600	1.3T / 2
Access Lid	Cast Iron	1	70	Soft Slings
N16 Threaded Dowel, 400mm	Mild Steel	6	ONLY SUPPLIED FOR CHAMBERS FIXED TO CDS P1000 UNITS	
N12 Reo Bar, 1000mm	Mild Steel	1		
Angle Brackets (100 x 100)	Galv. Steel	5	ONLY THREE (3) SUPPLIED FOR CHAMBERS FIXED TO CDS P1500 UNITS	
Dynabolt, M12 x 80mm	Galv. Steel	11	ONLY SEVEN (7) SUPPLIED FOR CHAMBERS FIXED TO CDS P1500 UNITS	
Weir Bypass Pipe & Cap	PVC	1		
Dynabolt, M8 x 65mm	S / Steel	3		
M8 Washer, large	S / Steel	3		
Rocla Primer, 1 litre	-	2		
Mastic (3.6m length)	-	6		
Sikaflex 11FC	-	4		

* Nominal mass – all precast components will be branded with mass.

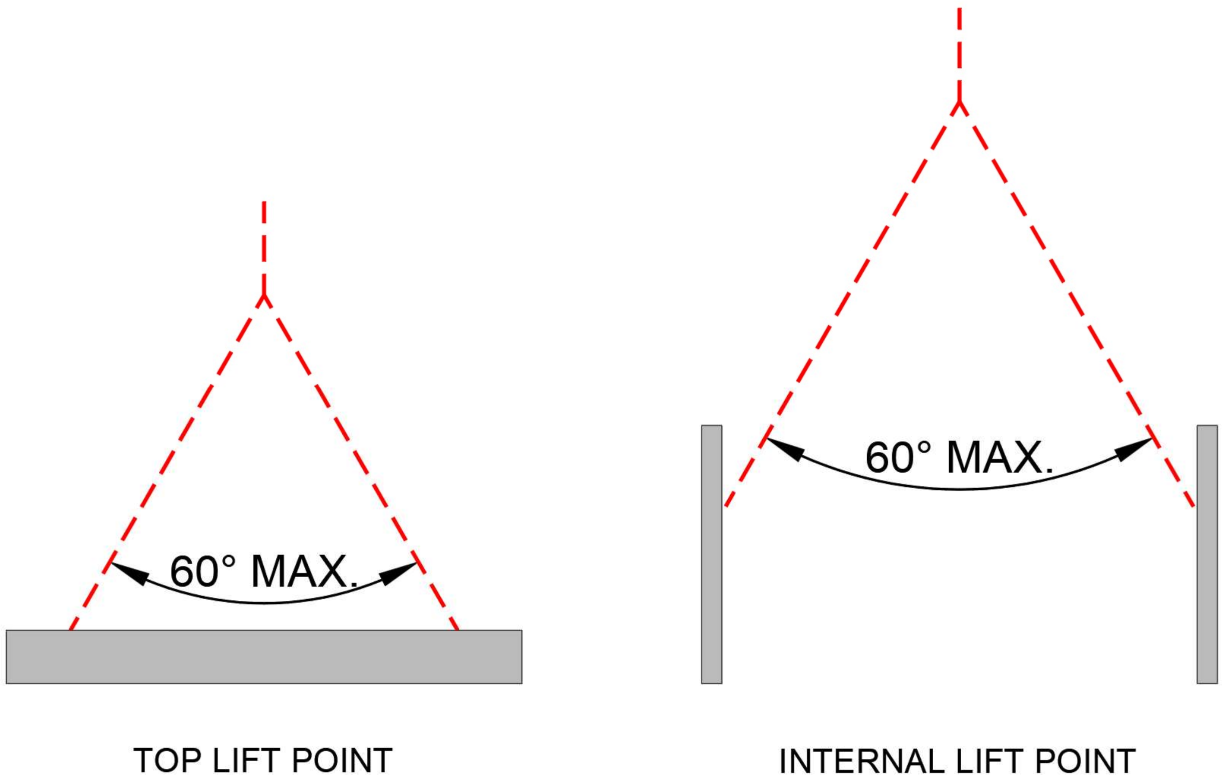
C. Component Lifting & Handling

The components within this CDS® Diversion Chamber use the following lifting types :

- Internal lift points (cylindrical component)
- Top Lifting Points (flat component)

Refer to the Components List (Section B) in this guide for Swiftlift capacity and quantity for each components

<u>Details below are diagrammatic only – do not scale.</u>



1. Chamber Setout

By the time the Diversion Chamber is ready to be installed, the majority of the CDS® device has already been placed. The outer diameter of the device will control the set-out of the Diversion Chamber, as the Chamber Base Slab will have a curved rebate that will match the device's outer diameter.

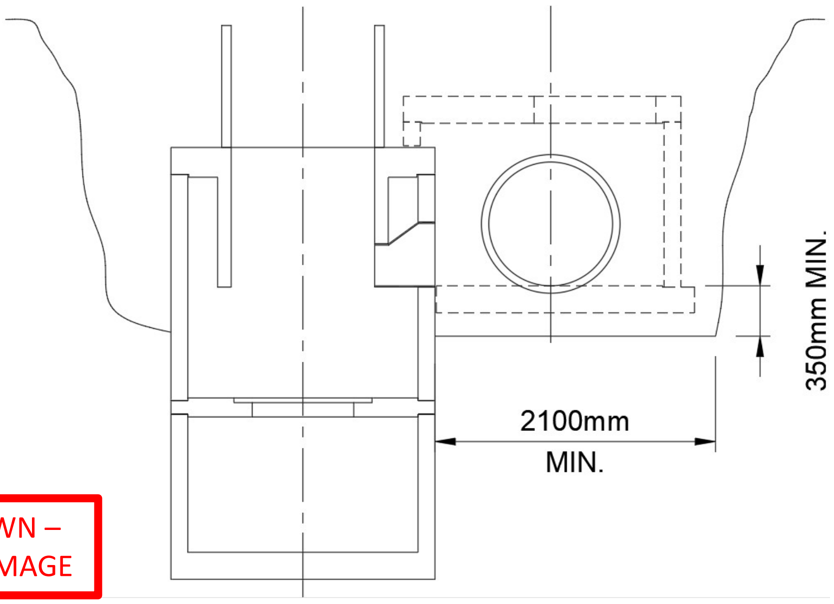
In a perfect installation, the floor of the Chamber should match both the bottom inside surface of the CDS® Inlet Chute, and the invert level of the pipeline at the **chamber outlet.** If these points do not match, the Chamber should be installed so that the floor level matches whichever is the **higher of these two points.**

The Chamber should always be installed level (no grade). On installations with steeply graded pipelines, this will create a small 'fall' from the inlet pipe into the Diversion Chamber, which is acceptable.

2. Chamber Excavation

Refer to the site specific project drawings for overall Diversion Chamber footprint dimensions. The size of the excavation should be sufficient for the Chamber, as well as man access around the Chamber.

The Base Slab thickness of the 1.8m wide Diversion Chamber is 200mm. Adding 150mm for compacted bedding material, the excavation for the Diversion Chamber should be 350mm lower than either the device Inlet Chute or the outlet pipeline (whichever is the higher of the two).



LEFT HAND UNIT SHOWN – RH UNIT IS A MIRROR IMAGE

3. Chamber Assembly

This Diversion Chamber comprises both precast and in-situ concrete, steel and PVC components assembled in-situ. Careful preparation of joint surfaces and having correct tools and equipment will minimise delays.

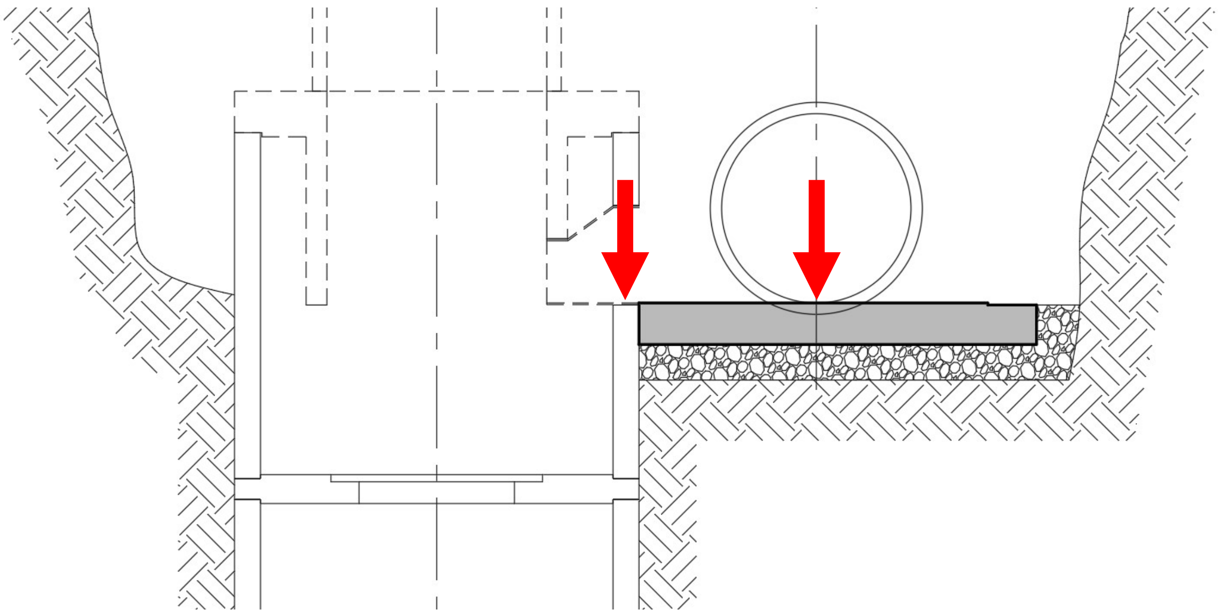
Any reinforcement exposed by cutting during the installation process must be coated with epoxy resin.

Prior to component installation, place suitable bedding material, such as small aggregate (10mm) or crusher dust (7mm) to a minimum **compacted depth** of 150mm. Compaction must be in accordance with project specifications.

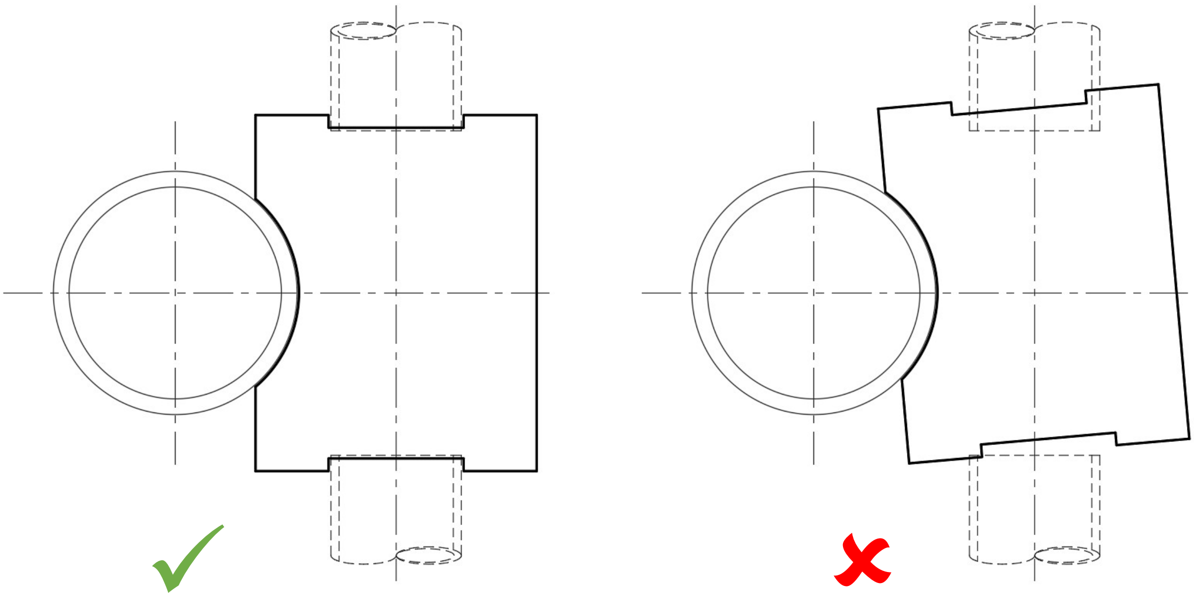
3.1 BASE SLAB (4 x 2.5T swift-lifts required)

When installing the Base Slab, extreme care must be taken to ensure the component is placed in the **correct position and is level.**

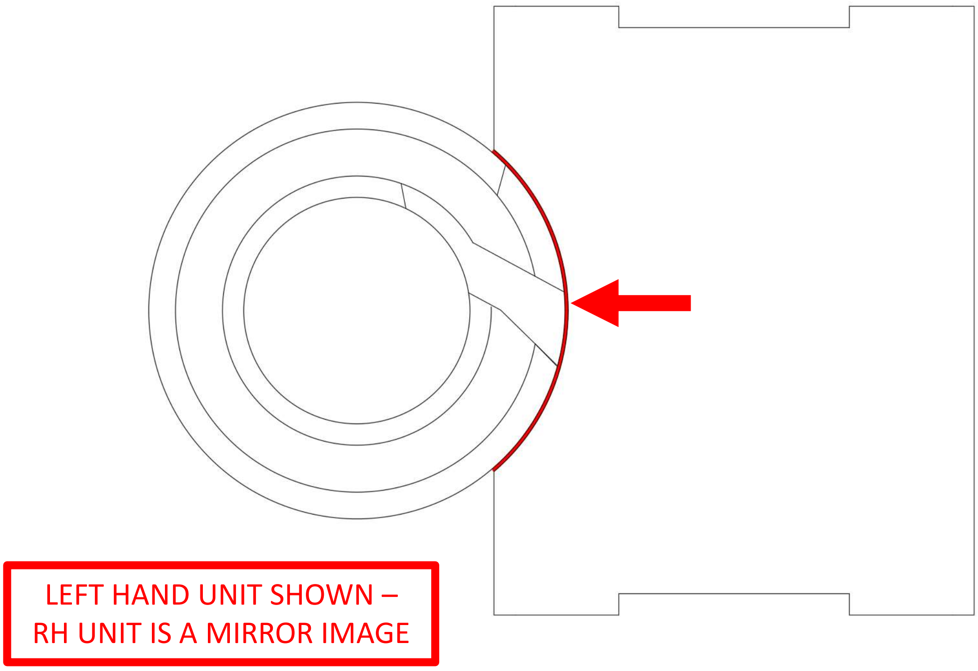
After placement, take the level at several positions or use a spirit level to ensure the Base Slab is level and at the correct depth. As noted previously, the top face of the Base Slab (Chamber floor level) should precisely match the bottom inside face of the CDS® Inlet Chute and the outlet pipeline invert level (**RED ARROWS**), or whichever of the two is higher.



Ensure that the placement of the Base Slab is aligned (or closely parallel) with the centreline of the pipeline.



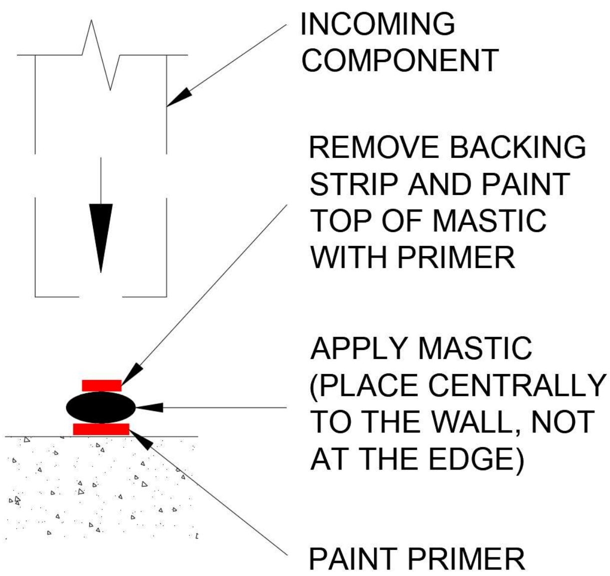
The scalloped rebate in the Base Slab is 15mm larger than the outer diameter of the CDS® device. This gap (**RED ARROW**) must be filled with sand/cement or non-shrink grout and if required topped with Sikaflex 11FC to ensure water tightness.



3.3 JOINTING OF COMPONENTS

For jointing between components, follow the below process :

- Brush clean both contacting faces of the joining components
- Rocla Primer is then painted onto the bottom components joint surface
- Rocla Black Mastic strip (supplied in 3.6m rolls) is then placed over the primer, centrally to the wall thickness. Ends of the Rocla Black Mastic must be overlapped **200mm minimum**
- Remove the paper backing strip after the mastic is placed and apply Primer to the top surface of the Black Mastic (this process effectively applies Primer to the bottom face of incoming component without personnel being under a suspended load)
- Position the incoming component



3.3 WALL UNIT (4 x 5T swift-lifts required)

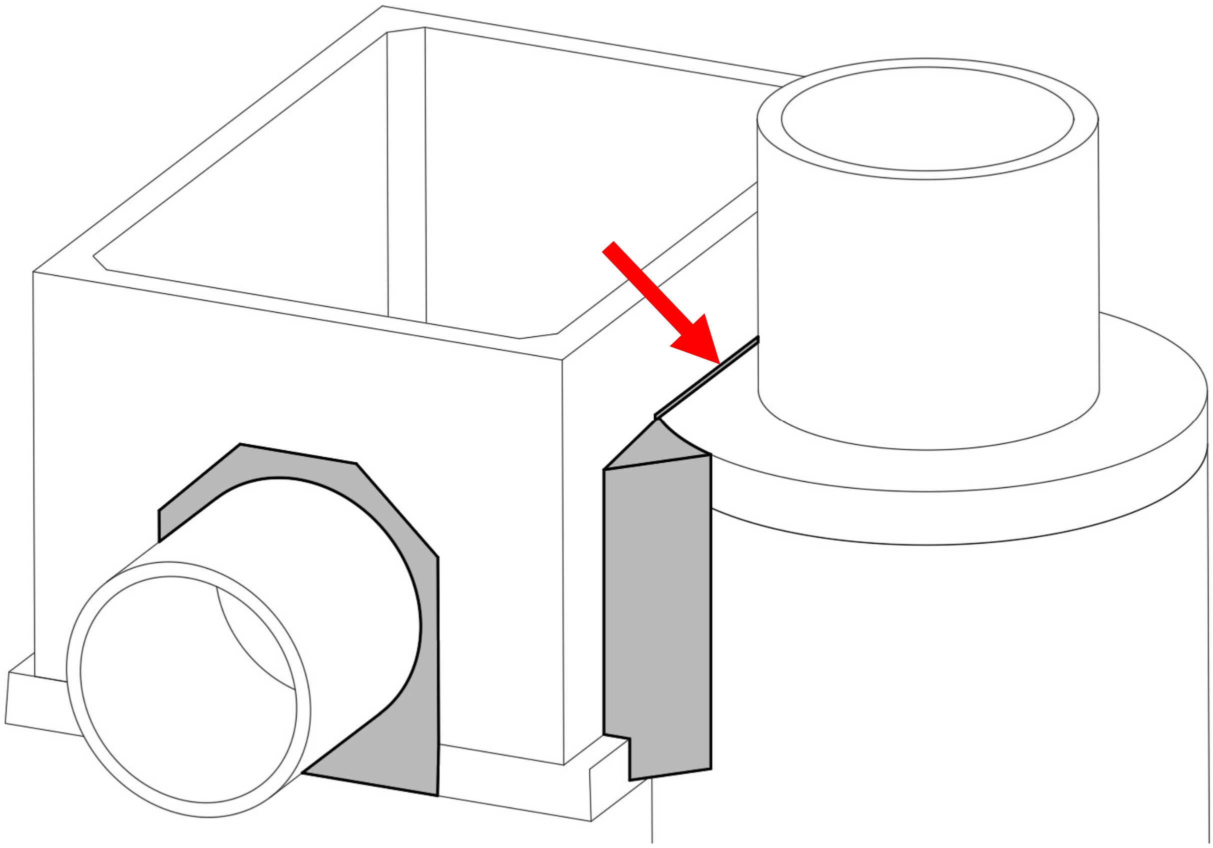
Wall units are available in 3 heights; 1200mm, 1500mm and 1800mm nominal.

1200mm and 1500mm Wall Units will not have complete openings for the inlet and outlet pipes, but a shallow depth rebate leaving a skin of concrete. This skin must be knocked-out prior to placement of the wall unit.

TIP : Only remove enough of the skin to fit over the pipes, as remaining skin effectively becomes the inside formwork for the in-situ bandage around the pipe on the external face of the Chamber.

Once the Wall Unit has been placed, complete the joints between the Diversion Chamber and inlet/outlet pipes, and between the Diversion Chamber and CDS® unit, via in-situ pouring of sand/cement (or a non-shrink grout) paying particular attention to adequately filling the gap over the CDS® unit (**RED ARROW**)

Internal fit-out of the Diversion Chamber can now proceed.



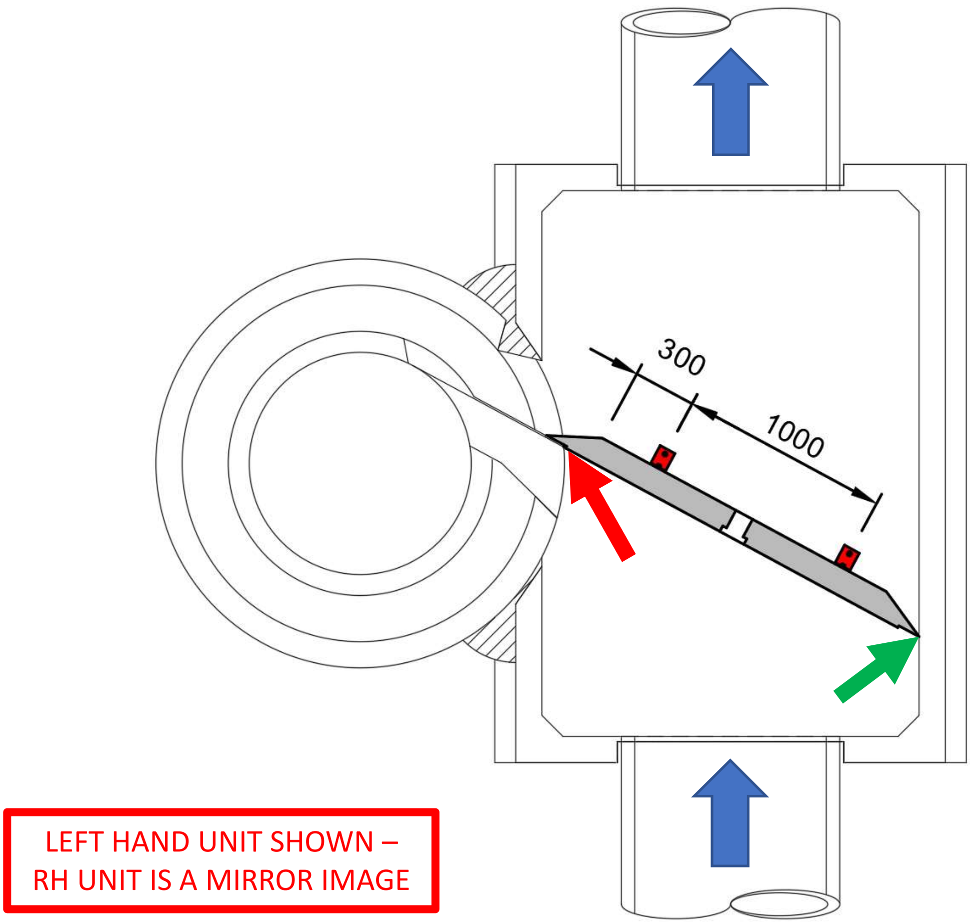
3.4 PRECAST WEIR (2 x 2.5T swift-lifts required)

This Section refers to standard-height precast Weirs, supplied with Diversion Chambers when combined with CDS® P1000 Series devices. For weirs for CDS® P1500 Series devices, or non-standard height Weirs, refer to Section 3.7

Firstly, rest the Diversion Weir on the Base Slab, without detaching lifting points. Using the crane to take the component weight, carefully position the Weir tight against the CDS® unit and Inlet Chute (**RED ARROW**), taking great care not to damage the Chute. Then rotate the Weir until it is hard against the outer wall of the Wall Unit (**GREEN ARROW**).

When correctly placed, the front face of the Weir, and the internal side face of the Inlet Chute should be consistent.

Place two of the supplied Angle Brackets as per the below detail, and fix to both the Chamber Base Slab and Weir with the supplied **M12 x 80mm** dynabolts.

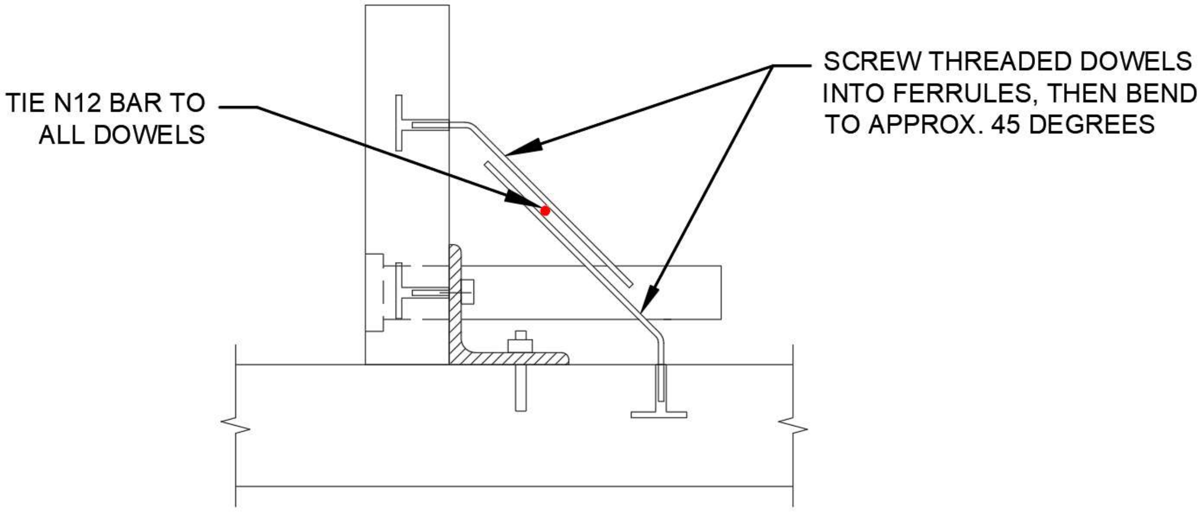


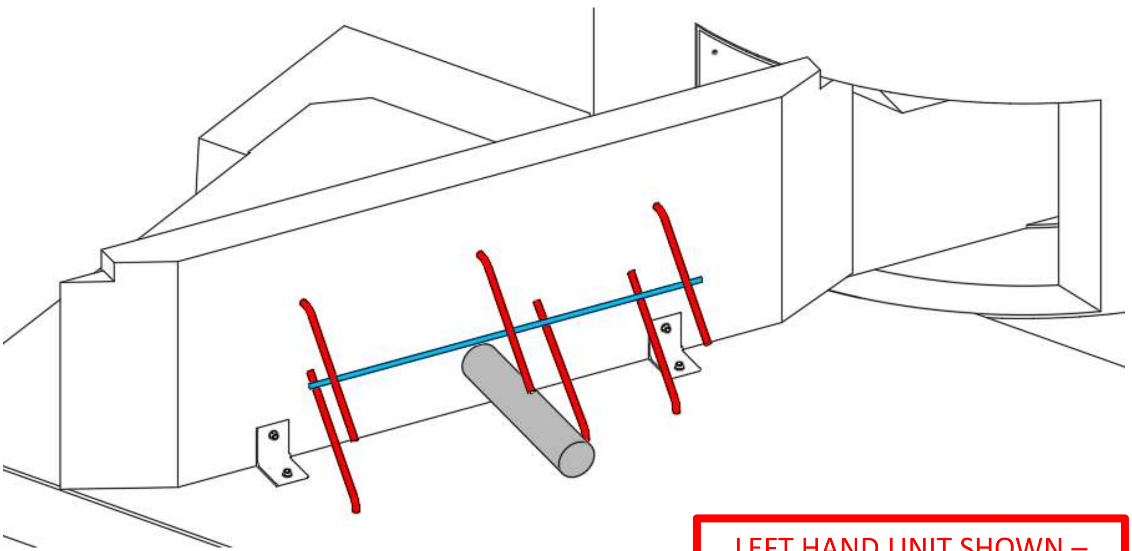
3.5 PRECAST WEIR REINFORCEMENT

Place the PVC Bypass Pipe, capped at the front face of the Weir, into place.

Screw six supplied dowels, three into the Base Slab and three into the rear face of the weir, into place, then bend to approx. 45 degrees. The centre dowel from the weir may also need to be angled to avoid contact with the PVC Bypass Pipe.

Tie the N12 Trimmer bar to the dowels as per the below details.



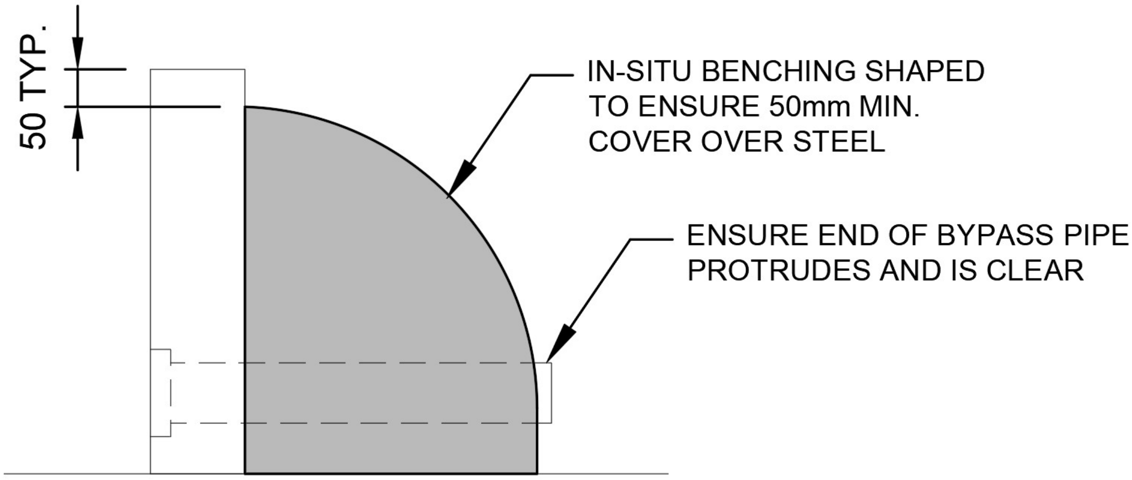


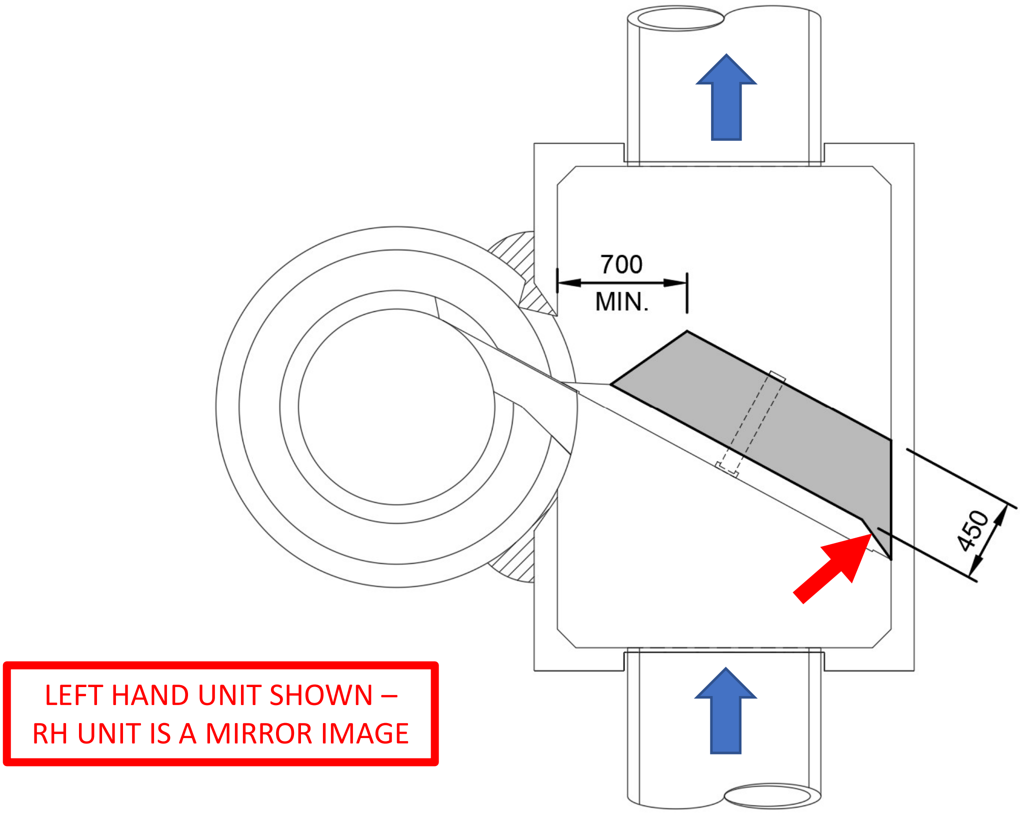
LEFT HAND UNIT SHOWN – RH UNIT IS A MIRROR IMAGE

3.6 PRECAST WEIR BENCHING (IN-SITU)

Pour in-situ benching (25MPa min) as detailed below, ensuring that the rear end of the PVC Bypass Pipe is protruding and is clear internally, and that Weir reinforcement has minimum 50mm concrete cover.

As the Precast Weir is designed to be used on both left and right Hand configurations, ensure that the step-down at the far end of the weir is built up to match the top surface of the Weir (**RED ARROW**)





3.7 IN-SITU DIVERSION WEIR

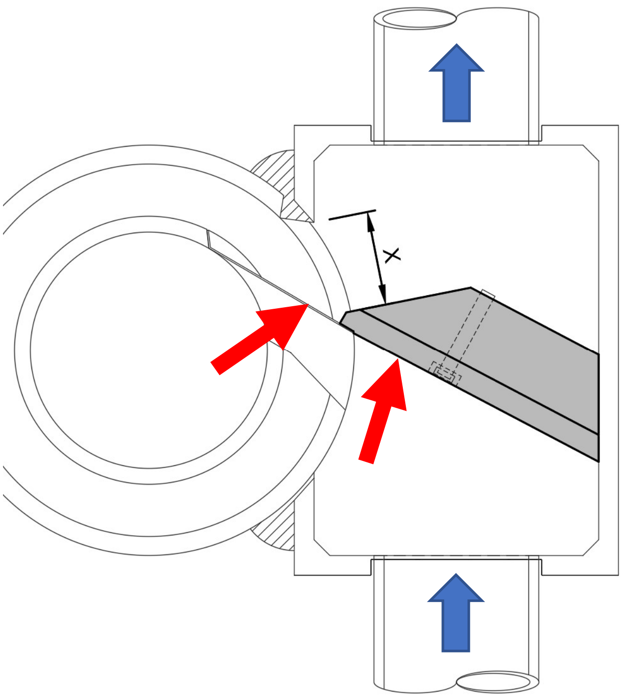
This Section refers to in-situ Weirs, either for Diversion Chambers when combined with CDS® P1500 Series devices, or for non-standard heights. For standard height Weir details for CDS® P1000 Series devices, refer to Section 3.4

Carefully form and cast the in-situ weir as per the details & dimensions below, ensuring that the front face of the weir aligns with the inside face of the CDS® unit's Inlet Chute (**RED ARROWS**)

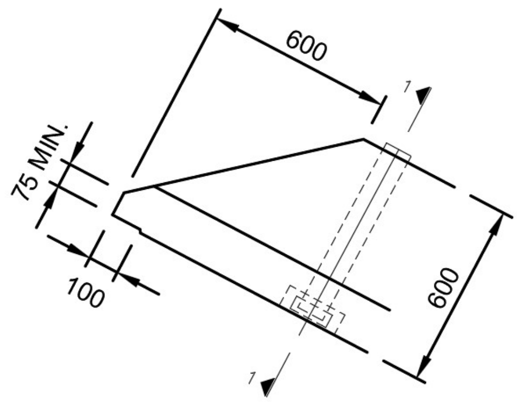
Ensure the PVC Bypass Pipe is placed correctly, capped at the upstream end. The Bypass pipe should be rebated at the front face of the weir, as the pipe protruding will create a catch point for debree. The rebate should be large enough for the pipe to be uncapped by hand (approx. 200 x 200 x 75 deep)

The outlet width (refer dimension X) and Weir Height (dimension Y) will be nominated on the project drawings.

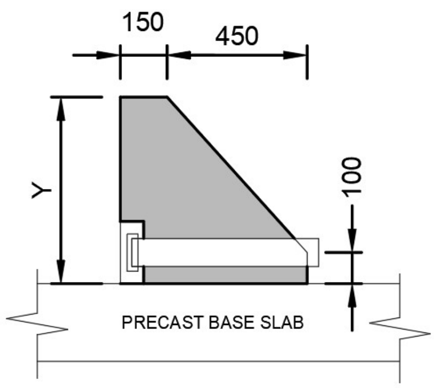
Refer to reinforcement detail on the next page.



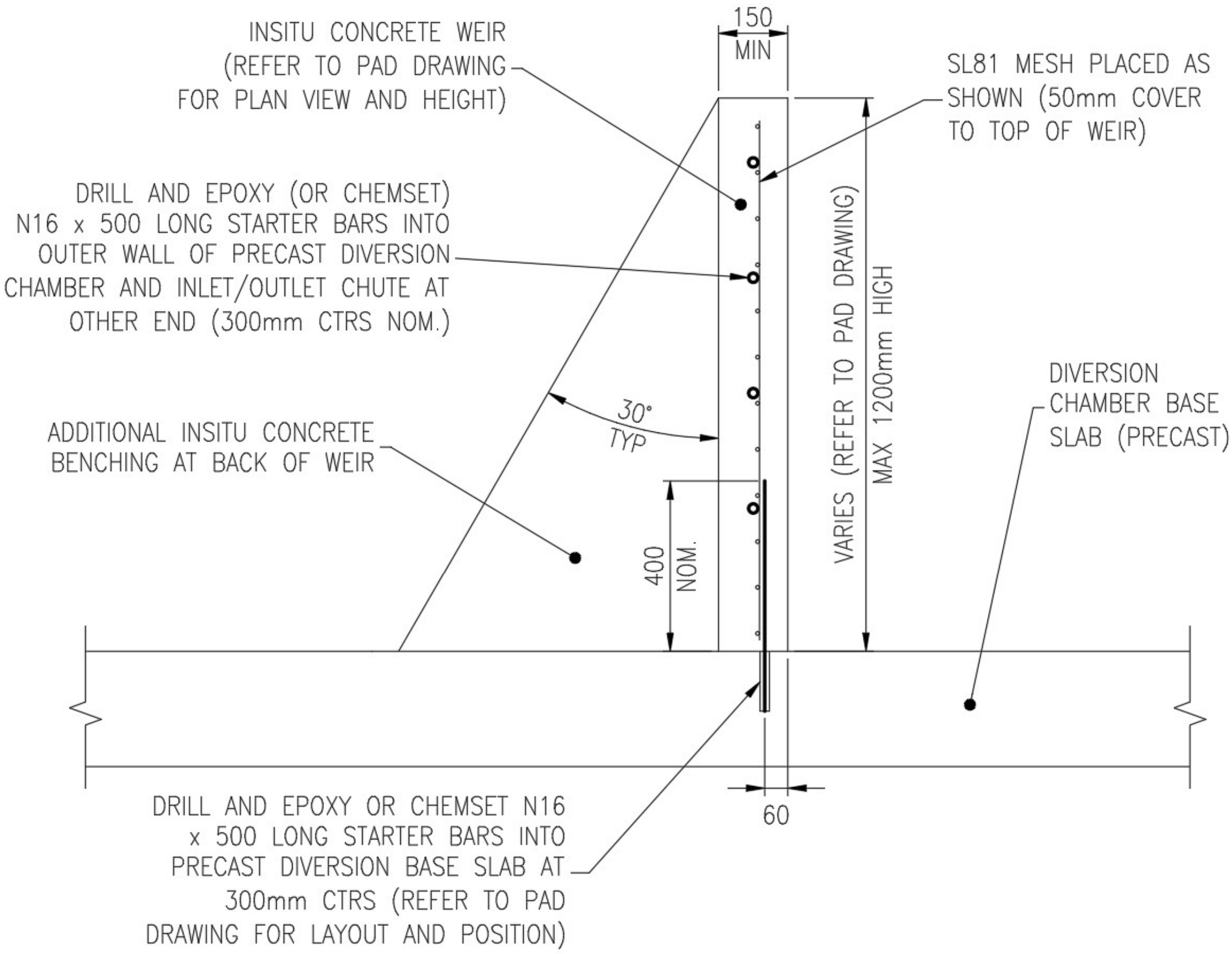
LEFT HAND UNIT SHOWN –
RH UNIT IS A MIRROR IMAGE



WEIR DETAIL



WEIR SECTION 1



WEIR REINFORCEMENT DETAILS

(FOR PRECAST BASE SLAB)

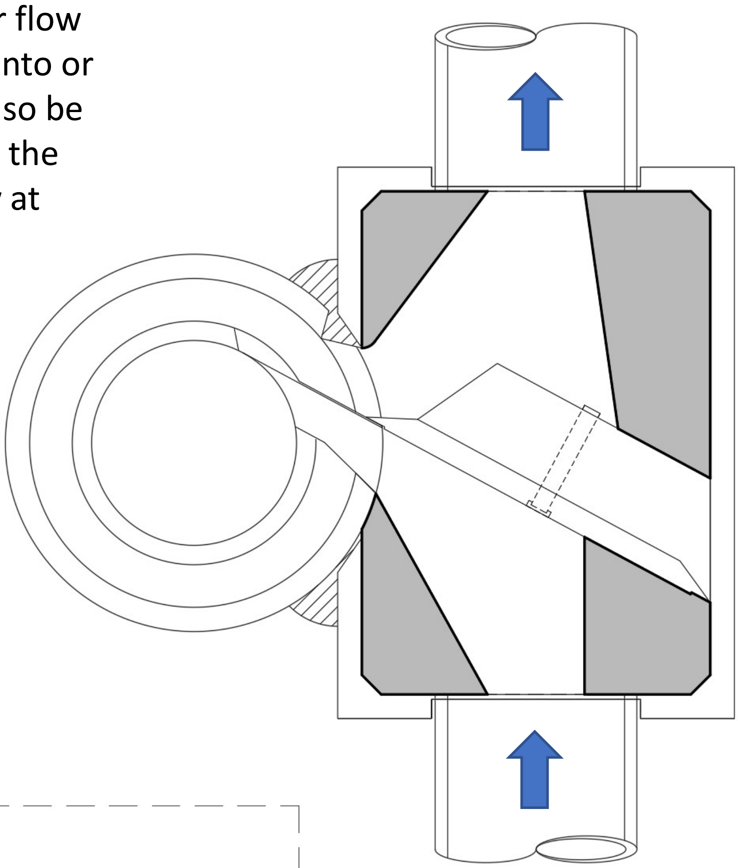
Secondary Weir

Some units require a Secondary Weir, which partially blocks the outlet from the CDS® unit. Check the site specific Rocla project drawings to confirm if it is required. If required, construct generally as per the main Diversion Weir, with weir height as per the project drawings.

3.8 MASS CONCRETE BENCHING

The final internal item to complete is the placement of mass in-situ concrete benching. The mass concrete (15MPa minimum) should be a minimum of 75mm thick to avoid breakaway at the edges, with a 5-10 degree sloping top surface to ensure no build-up of sediments in the corners of the Diversion Chamber.

Benching should not block water flow into or out of the Chamber, nor into or out of the CDS® unit. It should also be clear of the Bypass Pipe through the Weir, to allow bypass water flow at times of maintenance.



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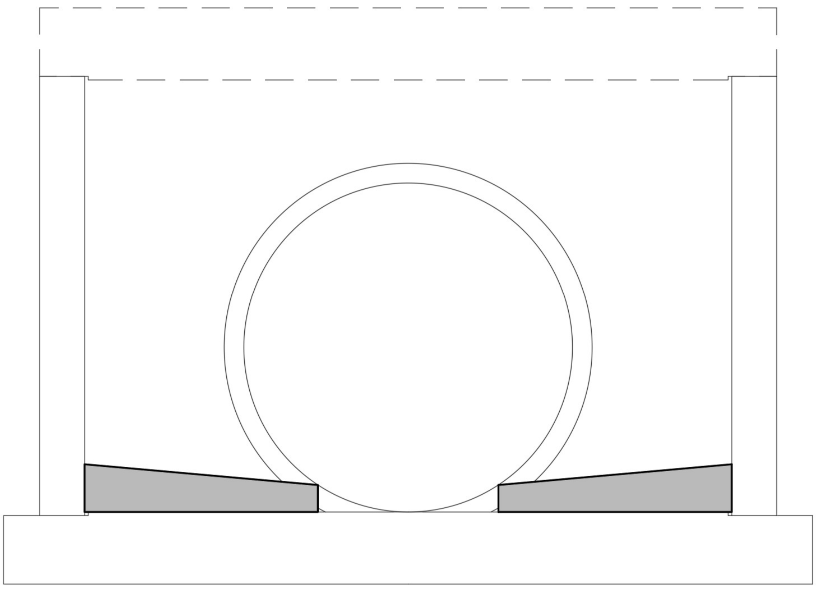


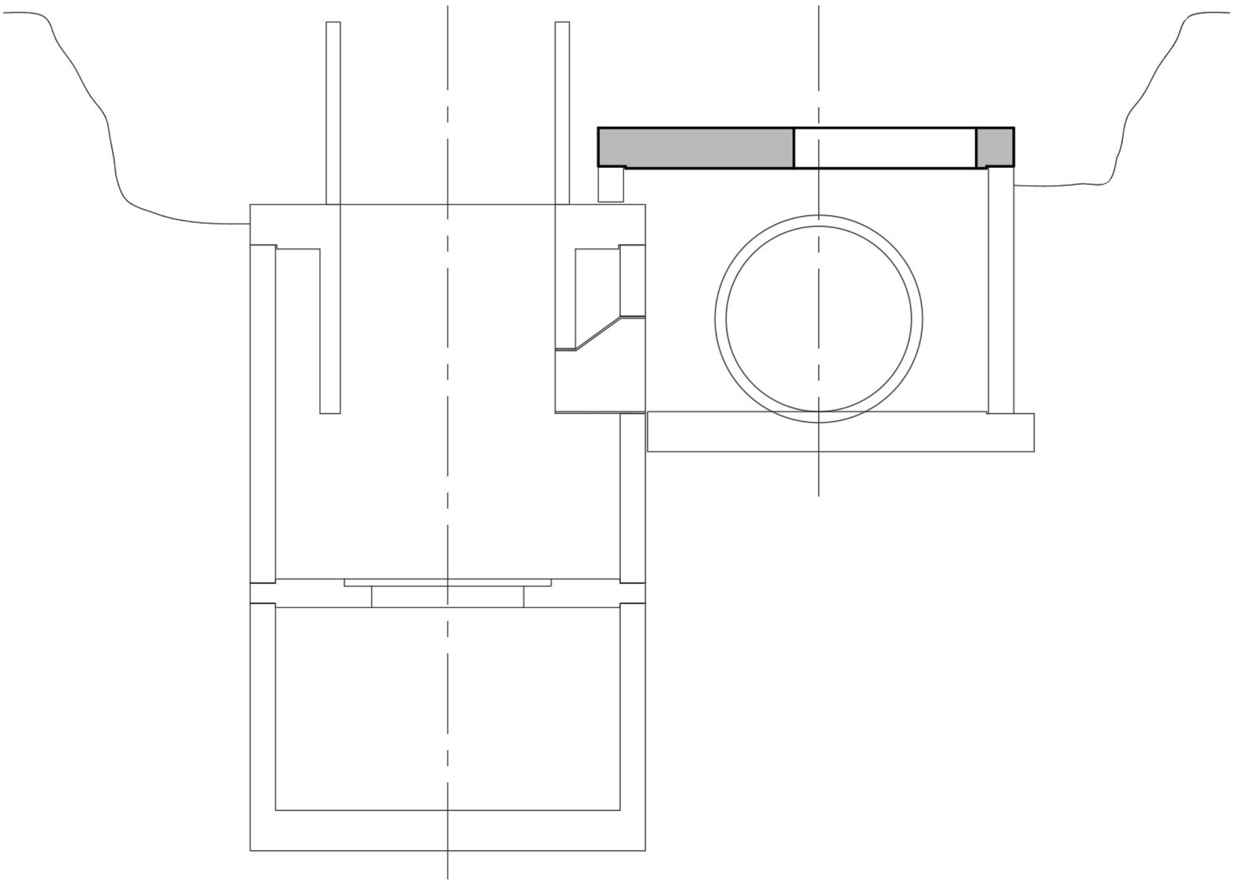
3.9 ROOF SLAB (4 x 2.5T swift-lifts required)

Before placement of the Diversion Chamber Roof Slab, complete the jointing process as per Section 3.3 of this guide.

Assuming the CDS® Access Riser has been installed, as all internal works in the Diversion Chamber have been completed, backfilling up to the Chamber roof slab could now occur, if desired.

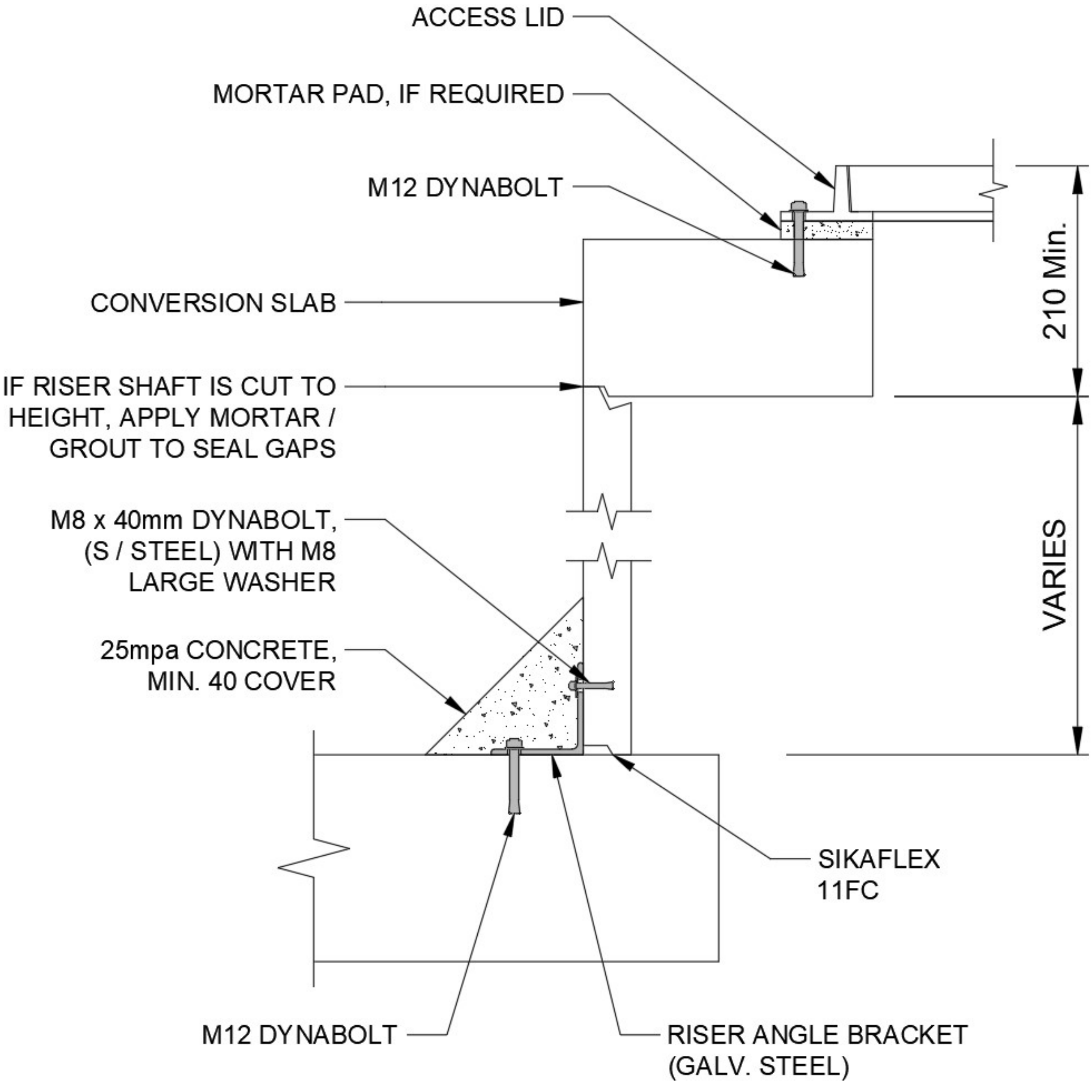
The Roof Slab can be placed in two orientations, depending on the preferred location of the Chamber's access point. Typically, the access point is on the far side of the Chamber (see detail below) as this locates the access point behind the weir, allowing easy access into the Chamber.

For some CDS® units with very high diversion weirs, a dual access Roof Slab may be supplied to allow access to both the upstream and downstream sides of the Weir. For these units, additional access and lid components will be supplied.



3.10 ACCESS RISERS & LIDS

See below connection detail for Access Risers, Conversion Slab & Access Lid. If multiple riser sections are required, seal the joins with Sikaflex 11FC.



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CDS® 1.8m Diversion Chamber Install Guide (JUN 20)

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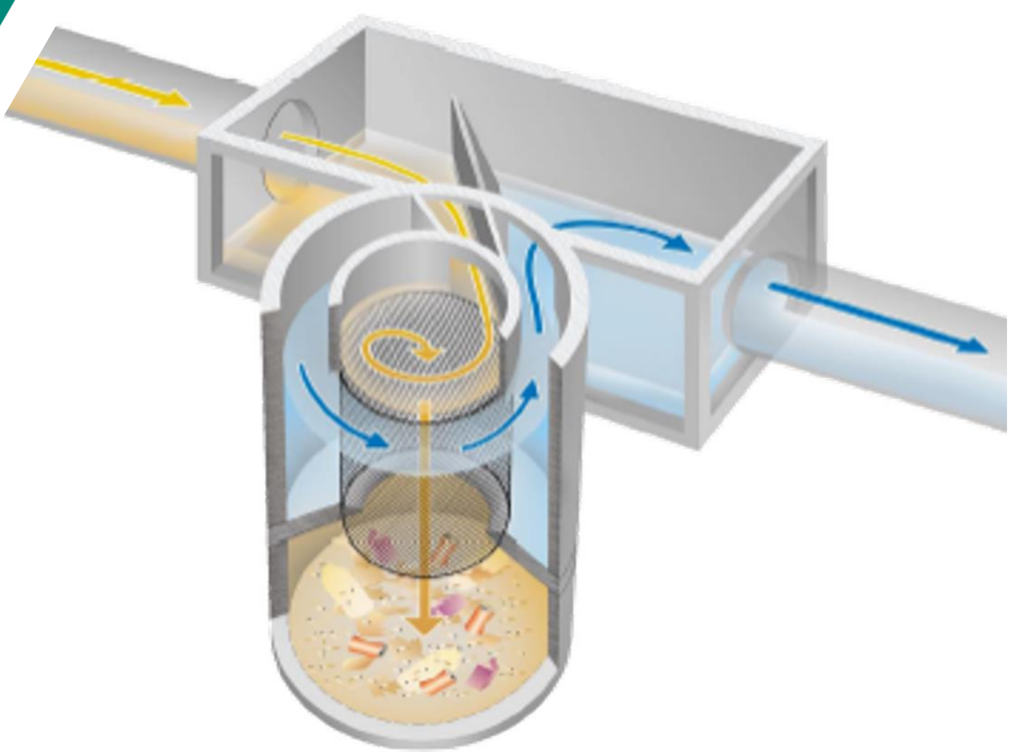

CDS® P1000 Series (Right Hand)

Product Installation Guide

(June 2020)

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- Checks that all components listed in the kitting/parts lists have been delivered, and that all delivered components have been checked for damage. **Any damaged or missing components must be reported to Rocla on the day of delivery**. If this does not occur, the supply of any replacement components (due to loss or damage) may result in additional charges from Rocla.

- Confirms that the installation contractor has a copy of the Rocla site-specific drawings, this installation guide and all relevant associated installation guides

- Confirms whether the product to be installed has non-standard components. If so, seek guidance from Rocla as items may not be covered within this guide

- Completes a **DIAL BEFORE YOU DIG** of the installation site prior to any excavation works.

- Determines the presence of groundwater. If groundwater is present, a suitable de-watering system is put in place for excavation and installation.

Understanding CDS® Models

The full range of CDS® GPT Models includes :

Small GPT Range	P1000 Series	P1500 Series	P2000 Series	P3000 Series
PL0506 (Nipper)	P1009	P1512	P2018	P3018
P0708	P1012	P1518	P2028	P3024
P0708 Maxi	P1015			P3030

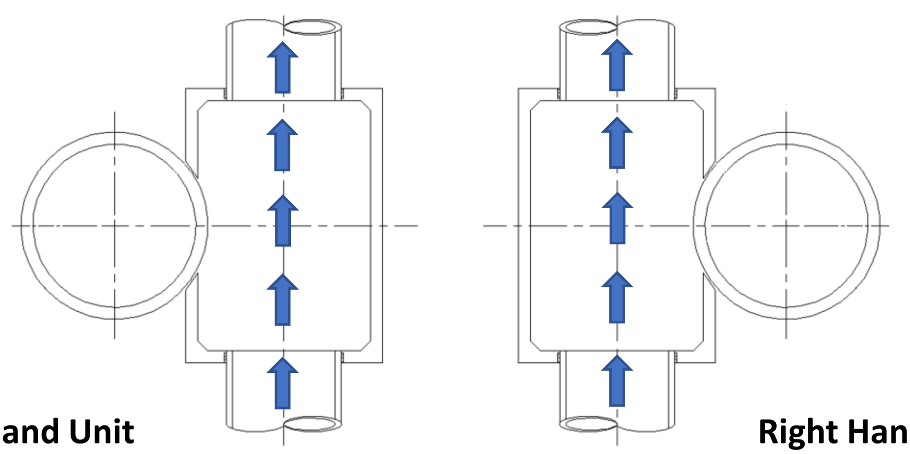
All CDS® GPT model names follow a standard format. See example below

P1009L

- P**10** – Nominal Screen Diameter
- **09** – Nominal Screen Height
- **L** – Unit Orientation

Unit Orientation – When looking along the pipeline towards the downstream end, a GPT placed on the left of the pipeline is a Left Hand unit, and Right Hand units are placed on the right side of the pipeline. 'Twin Units' typically consist of one of each type of unit, placed on both sides of the pipeline.

Note that Small GPT Range units are only made in right hand orientation.



Left Hand Unit **Right Hand Unit**

Required Installation Guides

Installation instructions for every model of CDS® product is covered within the range of published installation guides. Make sure you have the correct guide for the model being installed.

As well as the correct CDS® unit installation guide, a Diversion Chamber installation guide is also required if the unit being installed is within the P1000, P1500, P2000 or P3000 series.

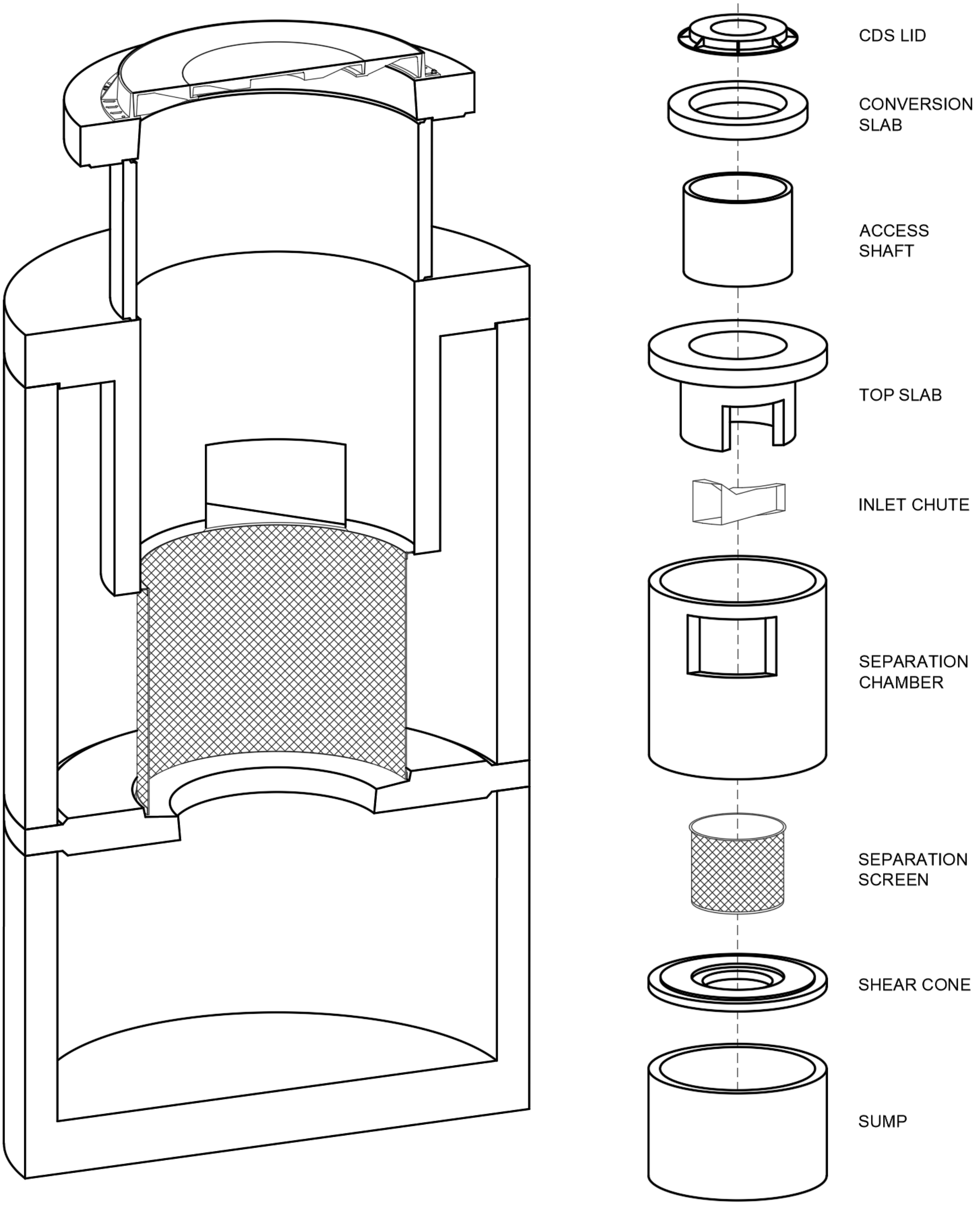
The installation contractor should refer to the site specific product drawings, and/or contact Rocla, to understand the guides required for each installation

The following table generally describes the work procedures covered

<table>
<tr><th>ORDER</th><th>WORK PROCEDURE</th><th></th></tr>
<tr><td>1</td><td>SITE WORKS AND SET OUT</td><td rowspan="5">THIS GUIDE</td></tr>
<tr><td>2</td><td>EXCAVATE FOR DEVICE</td></tr>
<tr><td>3</td><td>CONSTRUCT DEVICE</td></tr>
<tr><td>4</td><td>FITTING OUT</td></tr>
<tr><td>5</td><td>OIL BAFFLE (OPTIONAL)</td></tr>
<tr><td>6</td><td>EXCAVATE FOR DIVERSION CHAMBER</td><td rowspan="2">DIVERSION CHAMBER GUIDE</td></tr>
<tr><td>7</td><td>CONSTRUCT DIVERSION CHAMBER</td></tr>
<tr><td>8</td><td>BACKFILLING AND LIDS</td><td>BOTH GUIDES</td></tr>
</table>

Guide Contents

A. CDS® P1000 Series Arrangement



CDS P1000 UNIT ASSEMBLY

B. CDS® P1000 Series Component List

The below component list is for a standard unit for an average depth installation. Actual delivered component quantities may vary slightly due to optional components selected, or units for deeper or shallower installations.

<table>
<tr><th>COMPONENT</th><th>MATERIAL</th><th>QTY</th><th>Mass (kg) *</th><th>Swiftlift / QTY</th></tr>
<tr><td>Sump</td><td>Concrete</td><td>1</td><td>3300</td><td>5T / 3</td></tr>
<tr><td>Sump Extension (Optional)</td><td>Concrete</td><td>1</td><td>1800 per m</td><td>5T / 3</td></tr>
<tr><td>Shear Cone</td><td>Concrete</td><td>1</td><td>800</td><td>2.5T / 3</td></tr>
<tr><td>Separation Chamber</td><td>Concrete</td><td>1</td><td>2900 (P1009)
3400 (P1012)
3900 (P1015)</td><td>5T / 3</td></tr>
<tr><td>Top Slab</td><td>Concrete</td><td>1</td><td>1800</td><td>2.5T / 3</td></tr>
<tr><td>Inlet Chute</td><td>Fibreglass</td><td>1</td><td>15</td><td>-</td></tr>
<tr><td>Oil Baffle (optional)</td><td>PVC</td><td>1</td><td>5</td><td>-</td></tr>
<tr><td>Separation Screen</td><td>S / Steel</td><td>1</td><td>35</td><td>-</td></tr>
<tr><td>Screen Keeper Ring</td><td>S / Steel</td><td>1</td><td>5</td><td>-</td></tr>
<tr><td>Access Shaft(s)</td><td>Concrete</td><td>Varies</td><td>470 per m</td><td>Lifting Holes</td></tr>
<tr><td>Conversion Slab</td><td>Concrete</td><td>1</td><td>350</td><td>1.3T / 2</td></tr>
<tr><td>Access Lid</td><td>Cast Iron</td><td>1</td><td>200</td><td>Soft Slings</td></tr>
<tr><td>Angle Brackets (100 x 100)</td><td>Galv. Steel</td><td>3</td><td colspan="2" rowspan="12">ITEMS FOUND WITHIN THE SUPPLIED CRATE</td></tr>
<tr><td>Screen Lug Bracket</td><td>S / Steel</td><td>6</td></tr>
<tr><td>Dynabolt, M12 x 80mm</td><td>Galv. Steel</td><td>8</td></tr>
<tr><td>Dynabolt, M8 x 65mm</td><td>S / Steel</td><td>14</td></tr>
<tr><td>Dynabolt, M8 x 40mm</td><td>S / Steel</td><td>3</td></tr>
<tr><td>M12 x 35mm Bolt & Washer</td><td>S / Steel</td><td>6</td></tr>
<tr><td>M8 x 35mm Bolt & Washer</td><td>S / Steel</td><td>6</td></tr>
<tr><td>M8 Washer, large</td><td>S / Steel</td><td>3</td></tr>
<tr><td>Inlet Chute Packers</td><td>Plastic</td><td>10</td></tr>
<tr><td>Rocla Primer, 1 litre</td><td>-</td><td>2</td></tr>
<tr><td>Mastic (3.6m length)</td><td>-</td><td>6</td></tr>
<tr><td>Sikaflex 11FC</td><td>-</td><td>4</td></tr>
</table>

* Nominal mass – all precast components will be branded with mass.

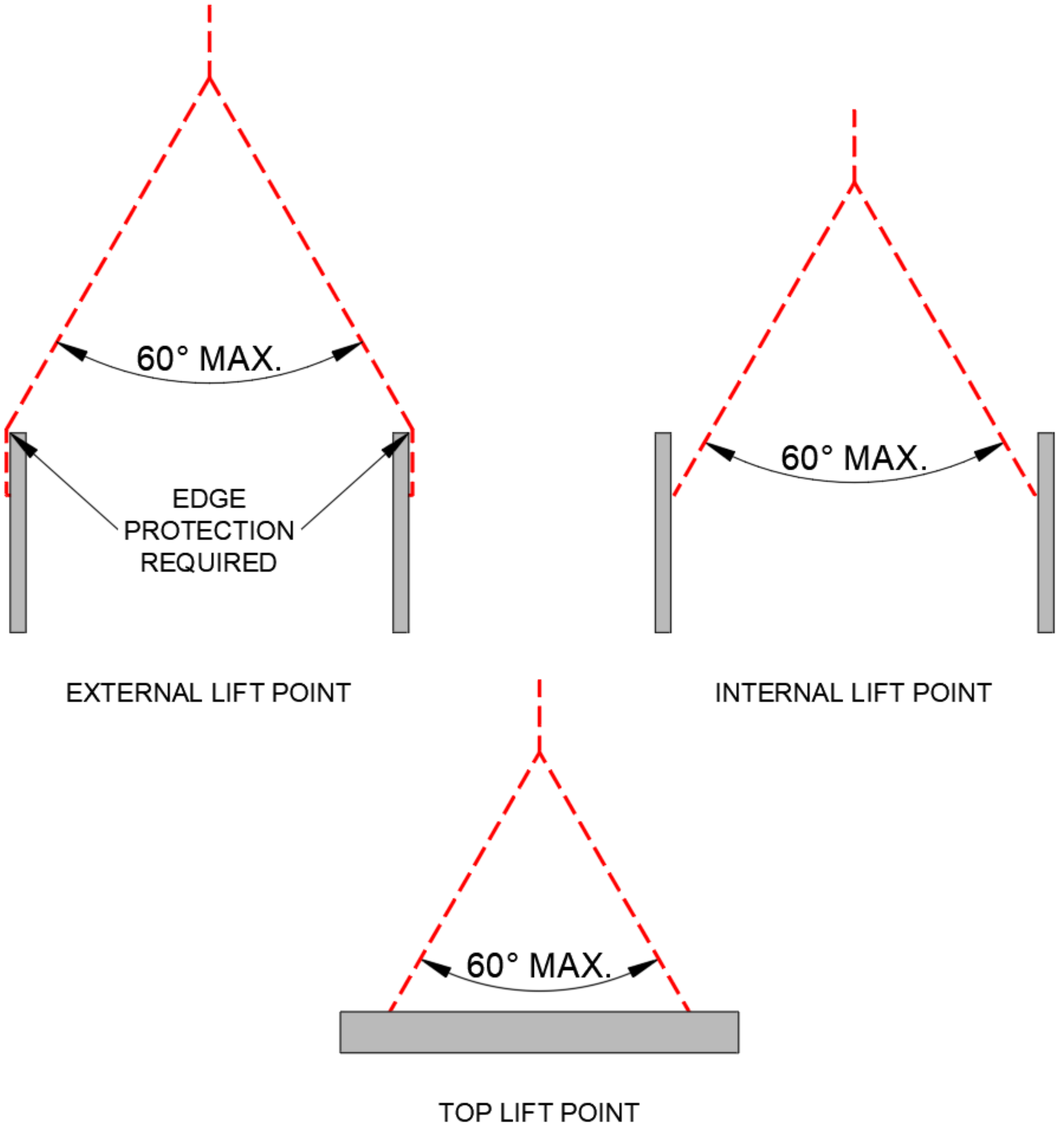
C. Component Lifting & Handling

The components within this CDS® unit use the following lifting types :

- External lift points (cylindrical component)
- Internal lift points (cylindrical component)
- Top Lifting Points (flat component)

Refer to the Components List (Section B) in this guide for Swiftlift capacity and quantity for each components

Details below are diagrammatic only – do not scale.



1. Device Setout

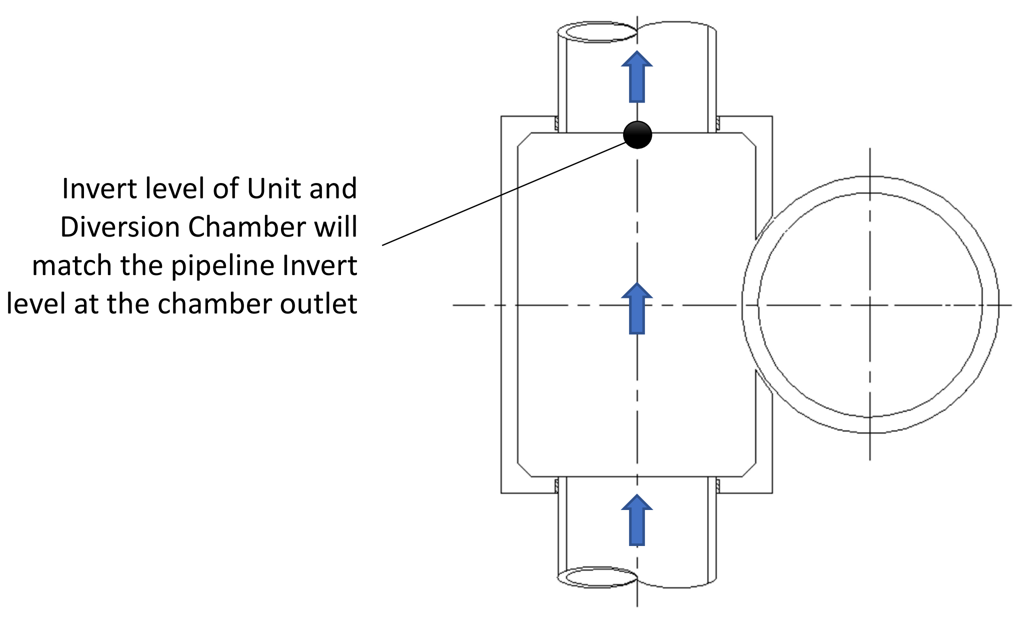
Determining GPT / Diversion Chamber Invert Level

It is most important to make sure that the device is set out to match the line and level of the drainage system to which it is being fitted. The invert level of the CDS® unit, and chamber, should match the invert level of the pipeline at the location of the chamber outlet **(BLACK DOT IN IMAGE BELOW)**.

Installations on new pipelines : For installations on un-built pipelines, determine the proposed centreline of the pipeline on which the device is being fitted. Determine the invert level of the pipeline at the point in which the GPT diversion chamber outlet will be. This level will be the GPT and Diversion Chamber invert.

Retrofit installations : Locate the pipeline and punch a hole in the top at the point where the outlet of the Diversion Chamber will be located. Insert a staff ensuring there is no debris under the staff and record the invert level. This level will be the GPT and Diversion Chamber invert.

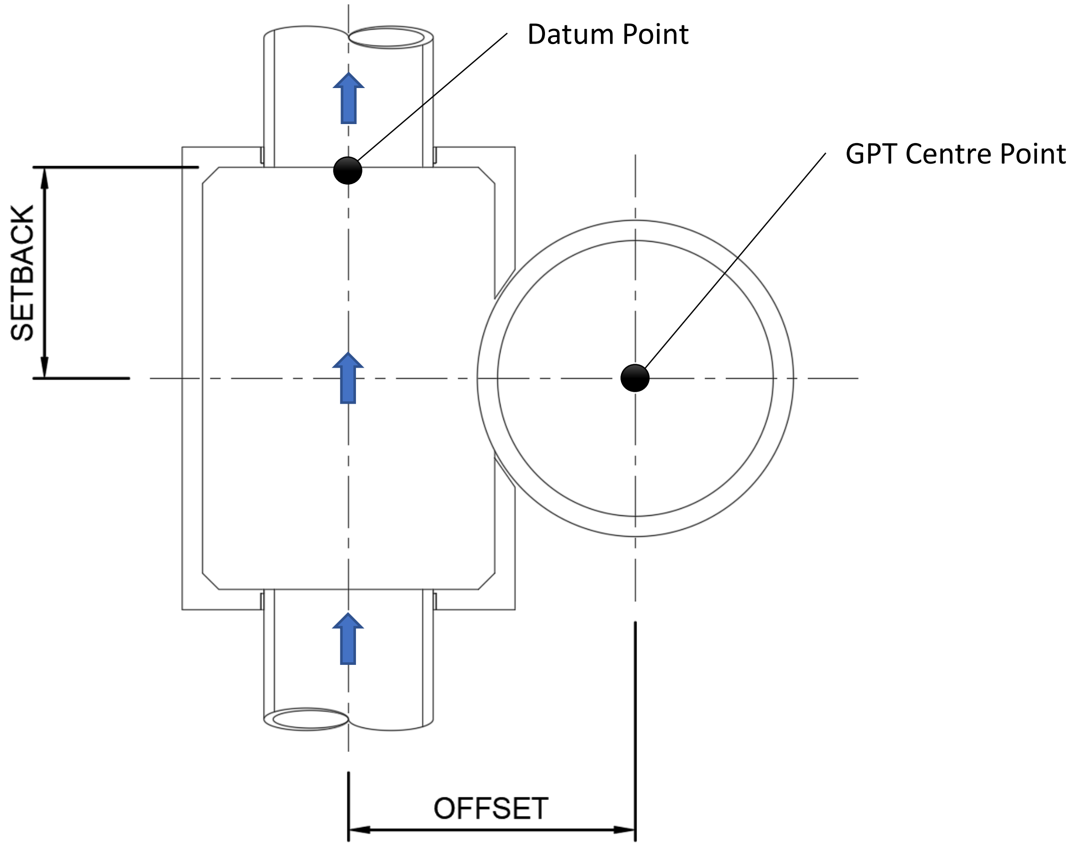
This location becomes the **datum point** for the excavation - all excavation dimensions are taken from this **datum point**.



Determining GPT Centre Location

To determine the centre point of the device, take the location of the datum point (previous page of this guide) and use the **Setback** and **Offset** dimensions to located the GPT centre point.

<u>The Setback and Offset dimensions will vary on each project. You must refer to the site specific drawings for the correct dimensions.</u>



It is important to establish the main centre lines with recovery pegs. Locations can then be identified with plumbs from stringlines once excavation is underway.

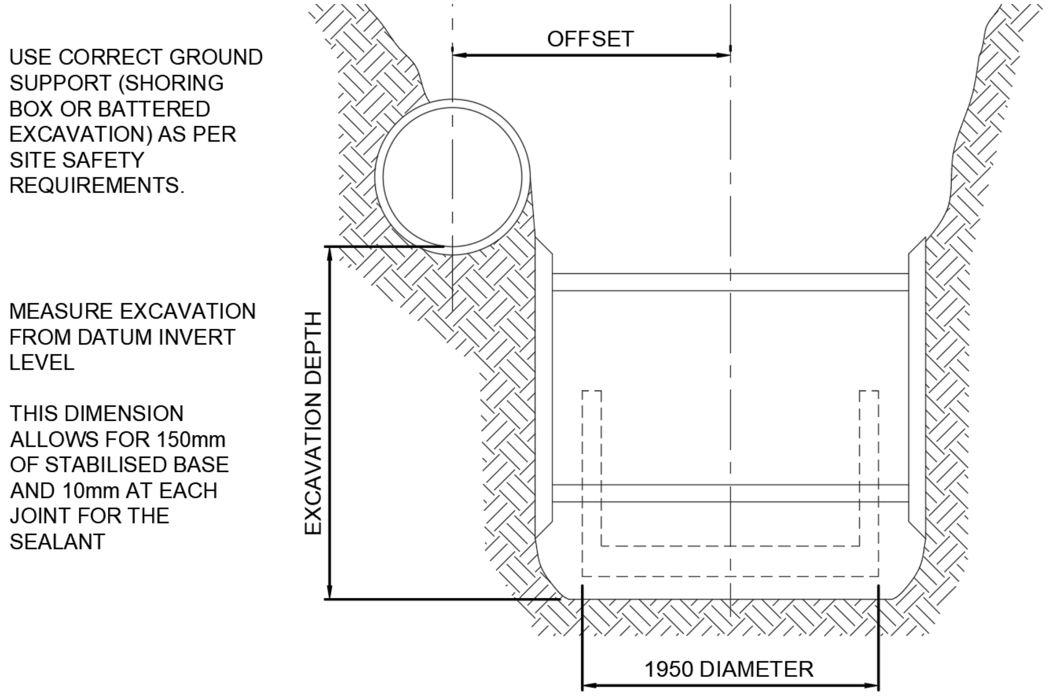
Use offset recovery pegs to maintain the centreline locations of the unit until the excavation is completed and the first component (Sump) is positioned.

2. Excavation

Confirm whether the unit uses the standard sump, or whether an optional extended depth sump is to be installed, which must be allowed for when determining depth calculations (add component height + 10mm)

Measure each component and compare to the measurements below, and to the project drawings. **Whilst assembly drawings will show individual component heights, they will not allow for the 10mm nominal gap at each joint**

The below diagram and table **only allow for the standard sized Sump**



Dimensional tolerance of +10mm / -0mm is acceptable

	CDS UNIT (STANDARD SUMP)		
	P1009	**P1012**	**P1015**
BASE MATERIAL	150 mm	150 mm	150 mm
SUMP	1220 mm	1220 mm	1220 mm
SHEAR CONE	100 mm	100 mm	100 mm
SEPARATION CHAMBER	**860 mm**	**1160 mm**	**1460 mm**
10mm NOM PER JOIN (2 JOINS)	20 mm	20 mm	20 mm
EXCAVATION DEPTH	**2350 mm**	**2650 mm**	**2950 mm**

3. Device Assembly

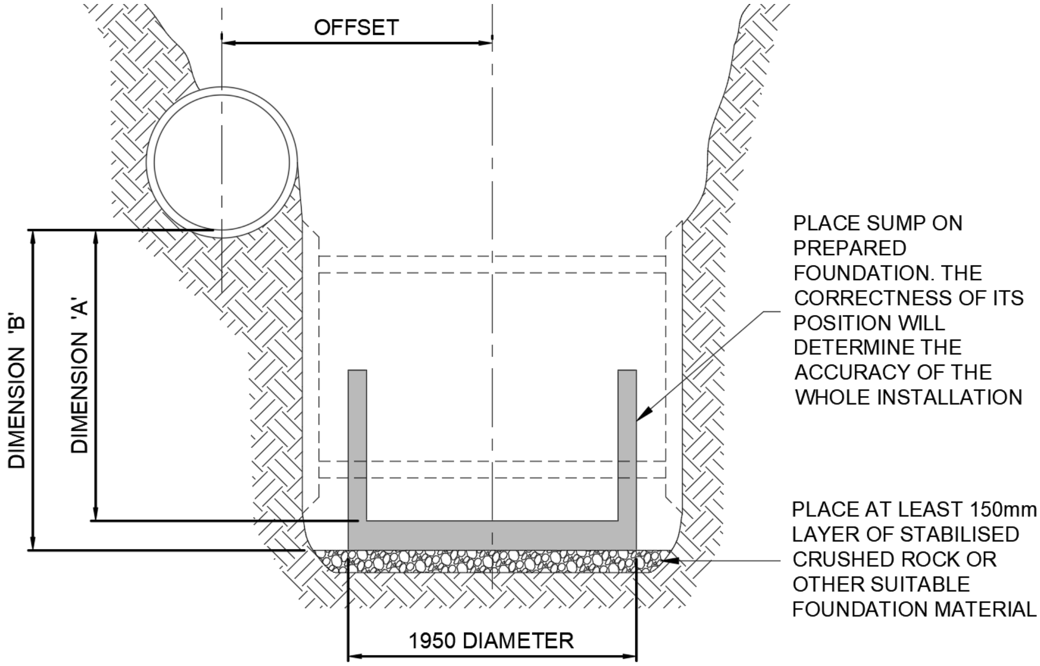
This CDS® model comprises precast concrete, stainless steel and fibreglass components assembled in-situ. Careful preparation of joint surfaces and having correct tools and equipment will minimise delays.

Prior to component installation, place suitable bedding material, such as small aggregate (10mm) or crusher dust (7mm) to a **minimum compacted depth** of 150mm. Compaction must be in accordance with project specifications.

3.1 SUMP (3 x 5T swift-lifts required)

The Sump is not placed in any specific rotation, but extreme care must be taken to ensure the component is placed in the **correct position and is level.**

After placement, take the level at several positions or use a spirit level to ensure the sump is level and at the correct depth from pipeline invert.



Dimensional tolerance of +10mm / -0mm is acceptable	**CDS UNIT (STANDARD SUMP)**		
	P1009	**P1012**	**P1015**
Dimension A	2000 mm	2300 mm	2600 mm
Dimension B	2200 mm	2500 mm	2800 mm

3.2 OPTIONAL SUMP EXTENSION (3 x 5T swift-lifts required)

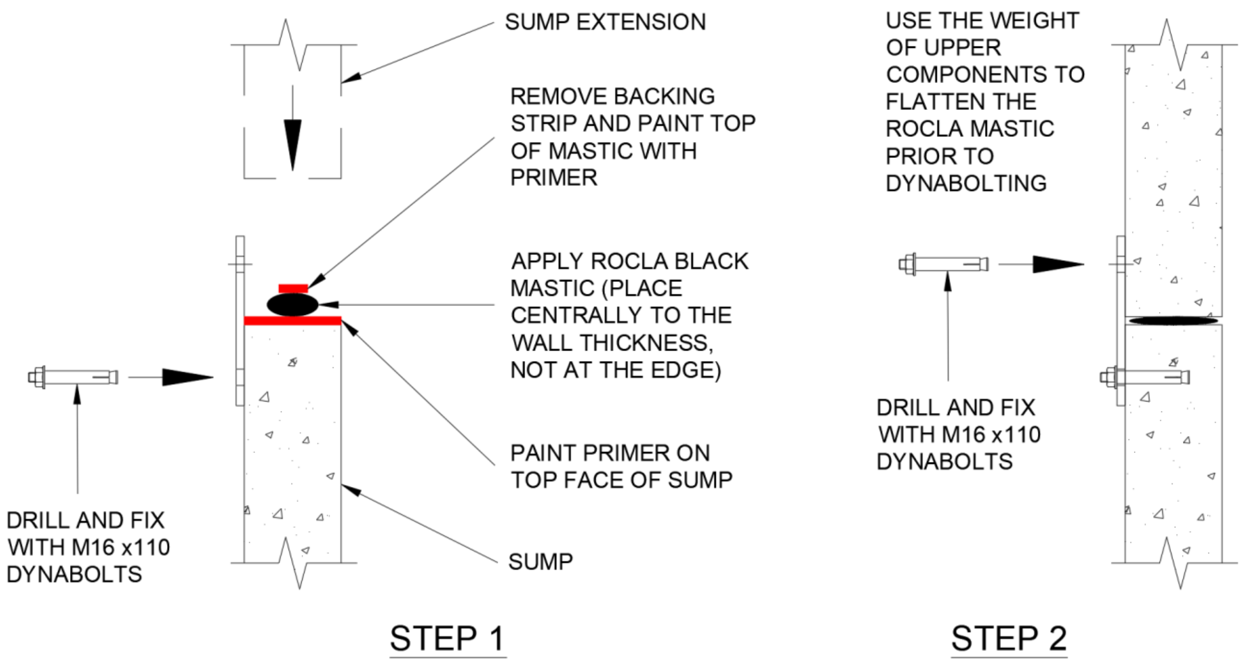
If a Sump Extension is specified, a number of factors are effected, including overall excavation depths, increased risk of groundwater, and that the shoring box size may need to increase in size to allow man access around the sump.

The Sump Extension height can vary, therefore refer to the site specific drawings and measure the component on site, then allowed for in depth calculations.

When Sump Extensions are supplied, three Connector Plates (210 x 75), six M16 x 110 Dynabolts and additional primer and mastic will be supplied.

Follow the below connection detail to connect the Sump to the Sump Extension.

It may beneficial to trial assemble the Sump and Sump Extension, and then drill and fix the Connector Plates to the Sump before Sump installation, however it is **strictly forbidden to attempt to lift / move both components together.**

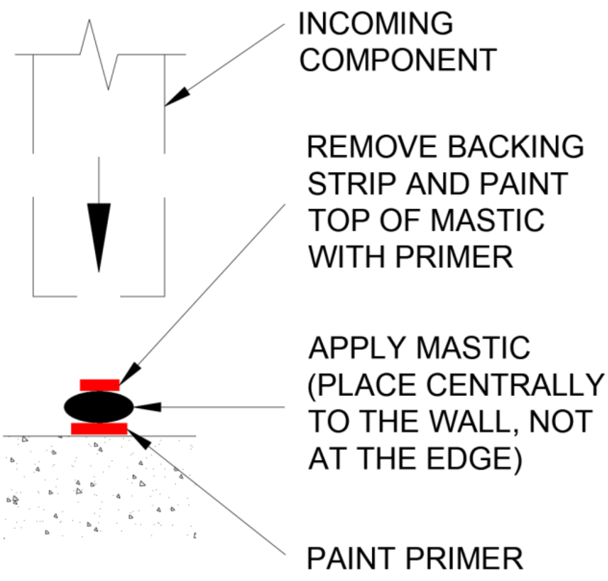


3.3 JOINTING OF COMPONENTS

Numerous components in this CDS® unit require a dry trial run initial placement. Make sure that the trial run has been completed prior to following the process below :

For each join between components, follow the below process :

- Brush clean both contacting faces of the joining components
- Rocla Primer is then painted onto the bottom components joint surface
- Rocla Black Mastic strip (supplied in 3.6m rolls) is then placed centrally around the top surface. Ends of the Rocla Black Mastic must be overlapped **200mm minimum**
- Remove the paper backing strip after the mastic is placed and apply Primer to the top surface of the Black Mastic (this process effectively applies Primer to the bottom face of incoming component without personnel being under a suspended load)
- Position the incoming component



3.4 SHEAR CONE (3 x 2.5T swift-lifts required)

The Shear Cone is NOT placed in rotational orientation but after placement, mark the centreline of the CDS® unit at 90 degrees to the pipeline centreline on the outside face of the Shear Cone.

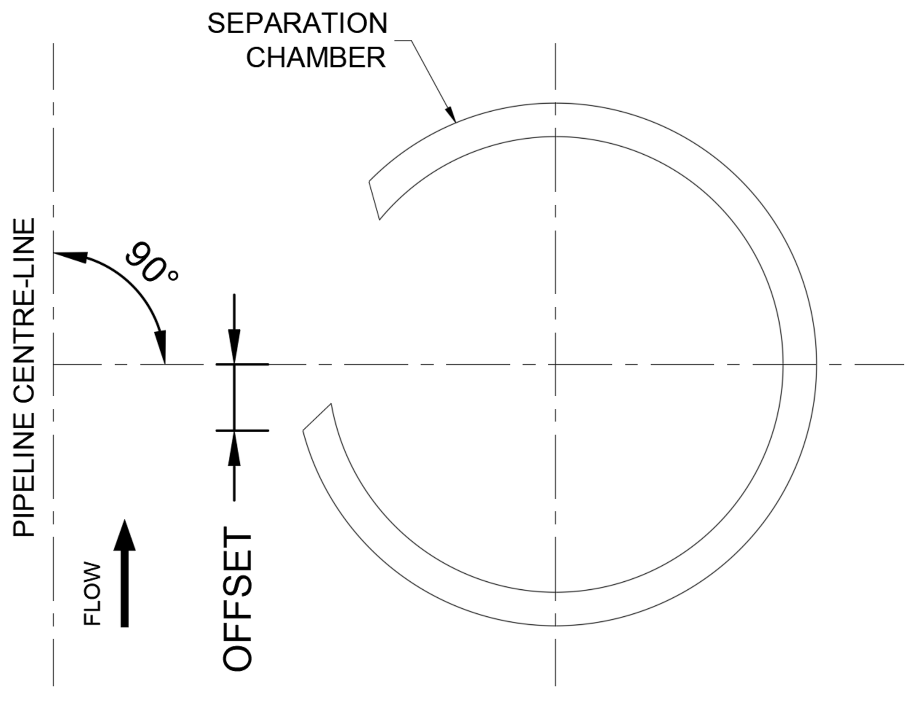
DO NOT repeat the jointing process prior to placement of the next component (Separation Chamber), as this components first placement is a dry trial run.

3.5 SEPARATION CHAMBER (3 x 5T swift-lifts required)

The Separation Chamber placement requires more attention, because it must be fitted in the correct rotational orientation. As the P1000 series CDS® unit can be mated with varying Diversion Chambers, always refer to the site specific drawings for the correct **OFFSET** dimension.

Complete a dry trial placement of the Separation Chamber, ensuring the correct rotation via the correct Offset dimension.

See further instructions on the next page.



Refer to the above image, noting the pipeline centreline and perpendicular line to the centreline of the CDS® unit (**YELLOW dashed lines**). The pipe in the background is the inlet pipe.

Before trial placement, the component should be marked with lines indicating the correct offset (**BLACK lines and arrows**)

The OFFSET line on the unit, and centreline should align (**RED ARROW**)

When correctly aligned, create a witness mark across both the Separation Chamber and Shear Cone, to ensure correct alignment on the final placement.

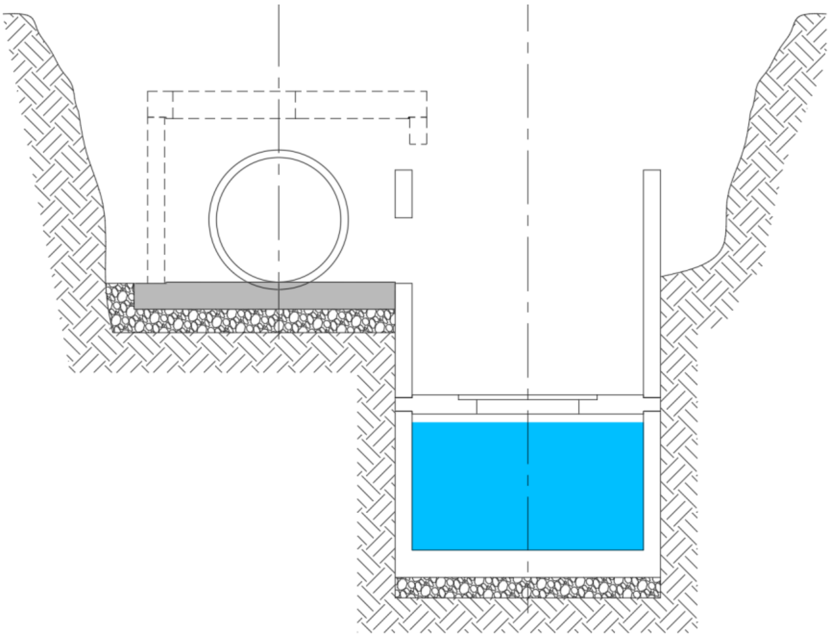
Remove the Separation Chamber, then complete the jointing process as per Section 3.3, before re-placing the Separation Chamber at the correct alignment.

The unit can then be backfilled and compacted up to the bottom of the compacted base required for the Diversion Chamber.

Also, as a safeguard against floatation, **the Sump must now be filled with water.**

3.6 DIVERSION CHAMBER BASE SLAB

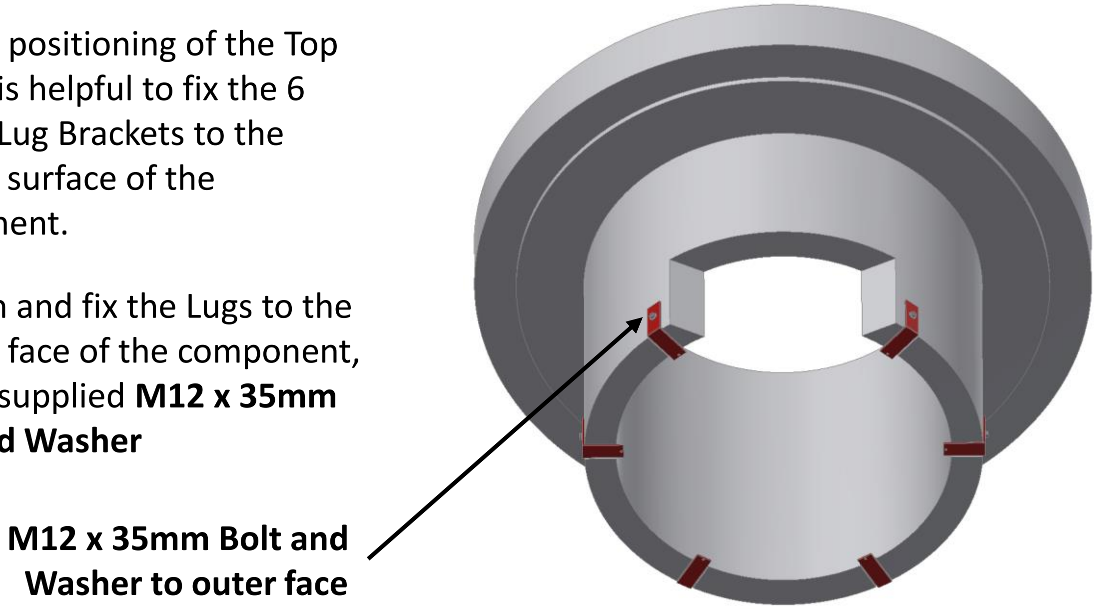
It is helpful at this stage to place compacted bedding material and the Diversion Chamber Base Slab in position. Refer to the correct installation guide for the Diversion Chamber, as various chambers can be used in combination with the P1000 series CDS® unit.



3.7 SCREEN FIXINGS

Prior to positioning of the Top Slab, it is helpful to fix the 6 Screen Lug Brackets to the bottom surface of the component.

Position and fix the Lugs to the outside face of the component, via the supplied **M12 x 35mm Bolt and Washer**



3.8 TOP HAT SLAB (3 x 2.5T swift-lifts required)

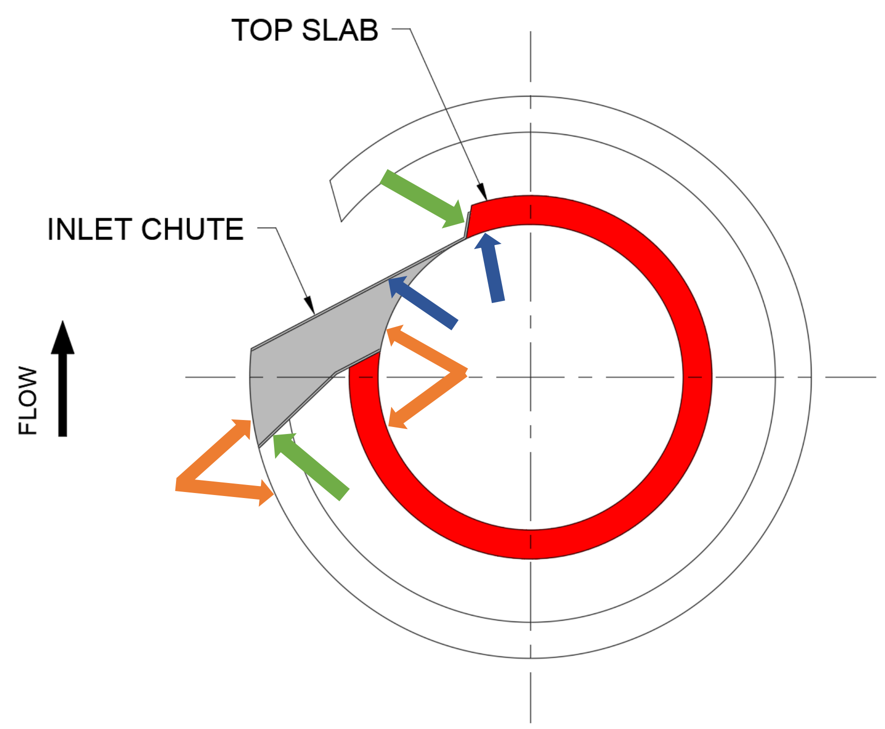
Note : If the device being installed requires the fitting of the optional Oil Baffle, this must be placed loosely inside the Separation Chamber (with the mounting place facing upwards) prior to the placement of the Top Hat Slab.

The last major component of the main CDS® structure is the Top Slab. Like the Separation Chamber, it has an opening which must be aligned correctly to enable the fibreglass Inlet Chute to be properly positioned.

Again, first placement is a dry trial run to determine correct rotation. The Inlet Chute must be temporarily placed in position to check that the Top Slab has been correctly positioned in rotation.

The following must be correct, in order of importance :

1. The inner face of the Chute **must** align with the inside surface of the Top Hat (**BLUE ARROWS**) to ensure a smooth flow of water through the Inlet Chute and into the centre of the Top Slab.
2. The Chute **must** be fitted tightly against concrete (**GREEN ARROWS**)
3. The Chute should closely match the inner and outer radius of the concrete components. (**ORANGE ARROWS**)



Once correct orientation has been determined, paint witness marks on the outside of the unit, across the edge of the Top Slab and Separation Chamber.

Remove the Top Slab, then complete the jointing process as per Section 3.3, before re-placing the Top Slab at the correct alignment.

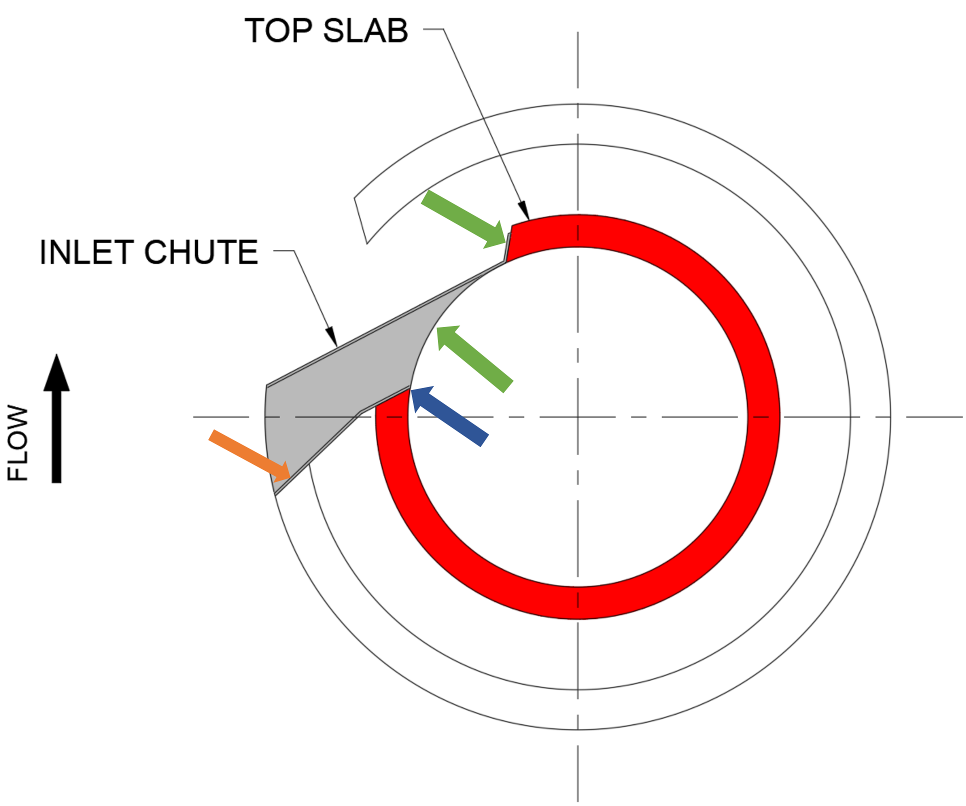
3.9 INLET CHUTE

If the Top Slab has been correctly aligned and fitted, the Inlet Chute should fit easily back into position. See below and next page.

With the supplied M8 x 65mm Dynabolts, fix the Inlet Chute to the Top Slab (**GREEN ARROWS**) across the top and sides.

Fix the Inlet Chute to the Separation Chamber (**ORANGE ARROW**) across the bottom, sides and top.

Seal any gaps between the Inlet Chute and Top Slab, and the Inlet Chute and Separation Chamber, with Sikaflex 11FC, paying particularly attention to the gap between the Inlet Chute and Top Slab on the inner face (**BLUE ARROW**)

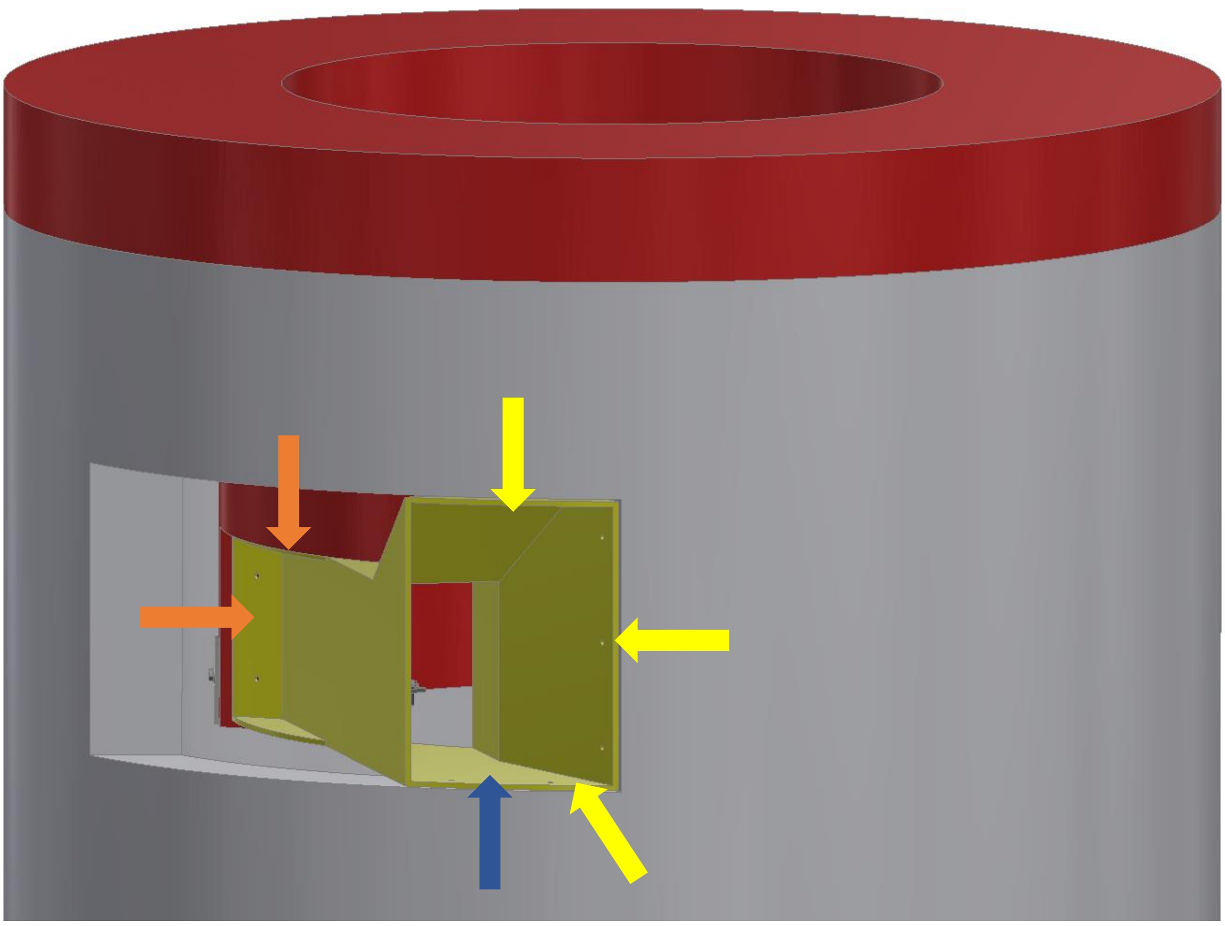


When fixing the Inlet Chute, the inside bottom face (**BLUE ARROW**) should match the level of the Diversion Chamber floor. If required, use the supplied plastic packers to raise the Chute to match the level.

As per the instruction on the previous page, fix the Inlet Chute to the Top Slab (**ORANGE ARROWS**), and the Separation Chamber (**YELLOW ARROWS**).

The Chute should be tight against the opening in the Separation Chamber on the side. If there is a gap at the top of the Chute, use the supplied plastic packers at the Dynabolt locations.

Seal any gaps between the Inlet Chute and Top Slab, and the Inlet Chute and Separation Chamber, with Sikaflex 11FC



3.10 OIL BAFFLE (OPTIONAL)

If an oil baffle is specified in the design, this must be fitted after final placement of the Top Slab, and before the fitment of the Separation Screen.

If an Oil Baffle has been supplied, five additional **M8 x 65mm** Dynabolts and additional Sikaflex 11FC will also be supplied.

STEP 1

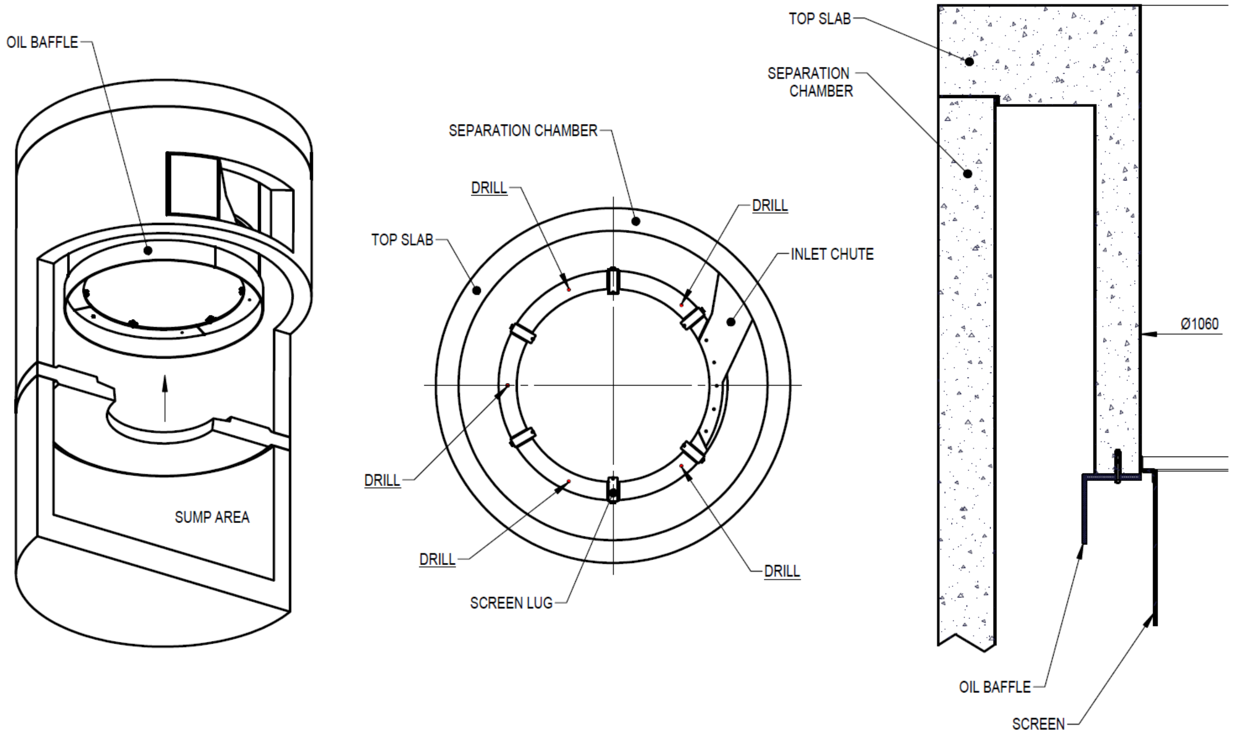
Complete a dry trial placement of the Oil Baffle, marking the drill locations under the bottom face of the Top Slab. Drill locations should be between the Screen Mounting Lugs. **Do not drill into the Inlet Chute.**

STEP 2

Drill the fixing points into the Top Slab, and then coat the entire bottom surface with Sikaflex 11FC.

STEP 3

Re-place the Oil Baffle and secure to the Top Slab.



3.11 SEPARATION SCREEN

The Separation Screen can now be installed. The screen uses a Keeper Ring, which is typically taped to Screen for transport. Remove this from the Screen.

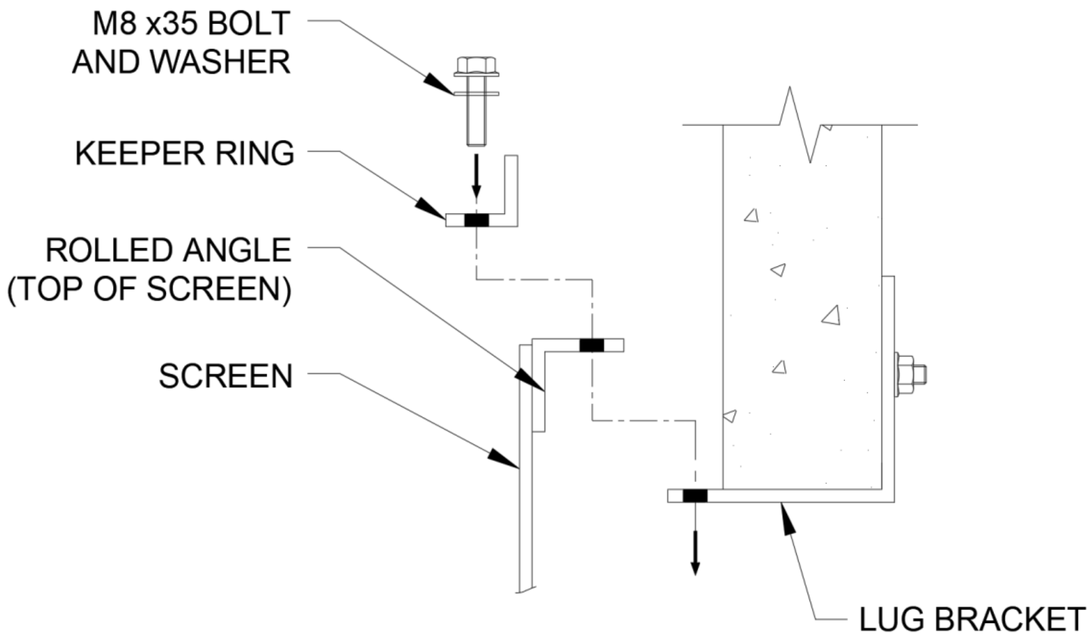
The top of the Screen is identifiable via the rolled angle at the top. When correctly orientated, on the inside of the screen, the screen mesh should feel smooth when wiping your hand across it in a **CLOCKWISE DIRECTION**, and rough in the other direction.

Manoeuvre the screen down until it sits on the steel Lug Brackets. Rotate the screen until the slotted holes in the top stiffener ring line up with the threaded holes in the Lug Brackets.

Place the Keeper Ring on the top of the screen, one face of the Keeper Ring on the Screen and the other on the inside face of the concrete.

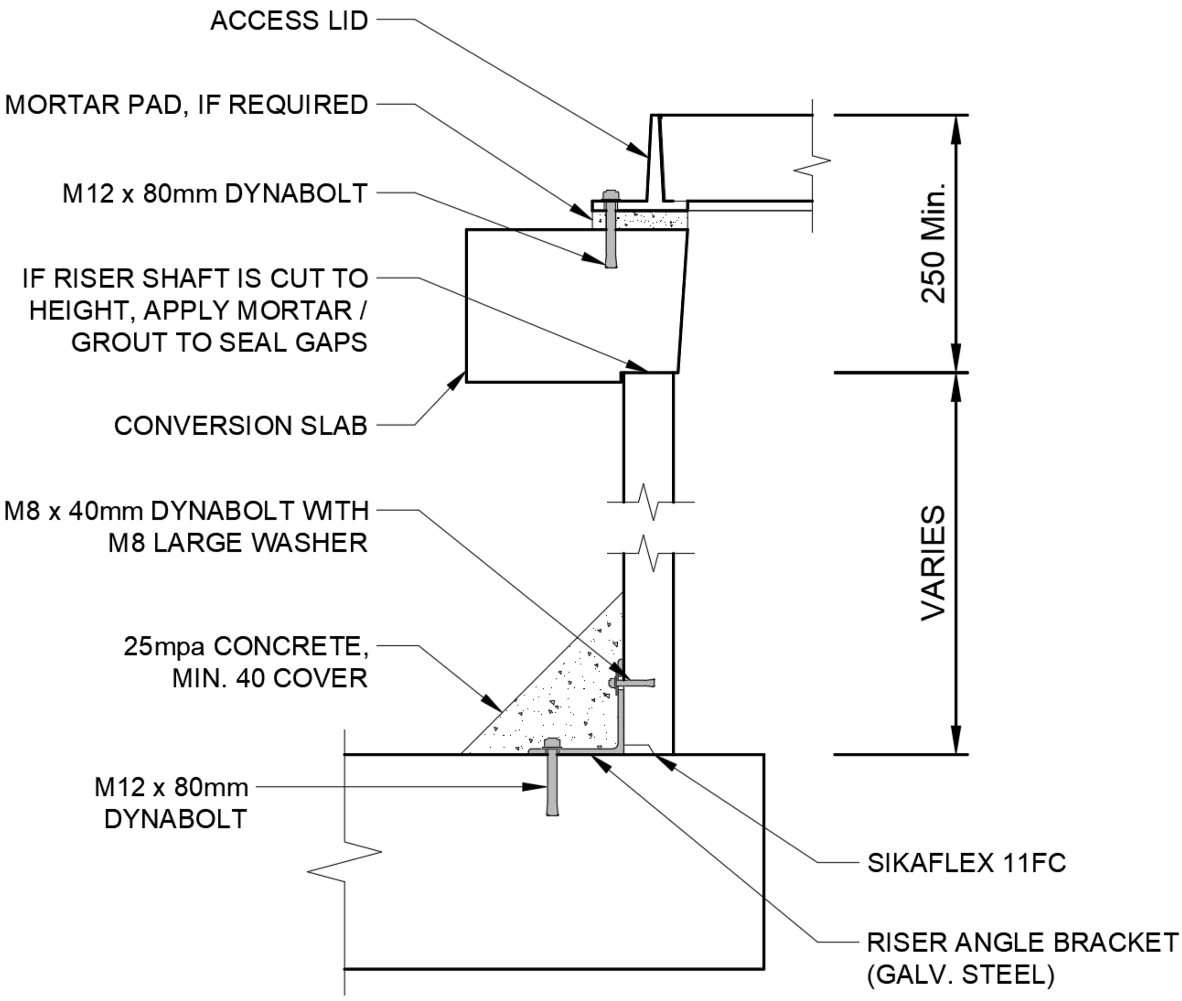
Fix the Keeper Ring and Screen to the Lug Brackets with the supplied **M8 x 35mm** bolt and washer.

As the Screen 'hangs' from the top, there will be a gap at the base of the Screen (where it seats into the Shear Cone). If the gap is minor, seal the gap with SikaFlex 11FC. If the gap is larger, sand and cement grout (or an alternative filler) must be used to ensure there are no gaps.



3.12 ACCESS RISERS & LIDS

See below connection detail for Access Risers, Conversion Slab & Access Lid. If multiple riser sections are required, seal the joins with Sikaflex 11FC.



4. FOOTNOTE

Any reinforcement exposed by cutting during the installation process must be coated with epoxy resin.

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Certified System

Quality ISO 9001

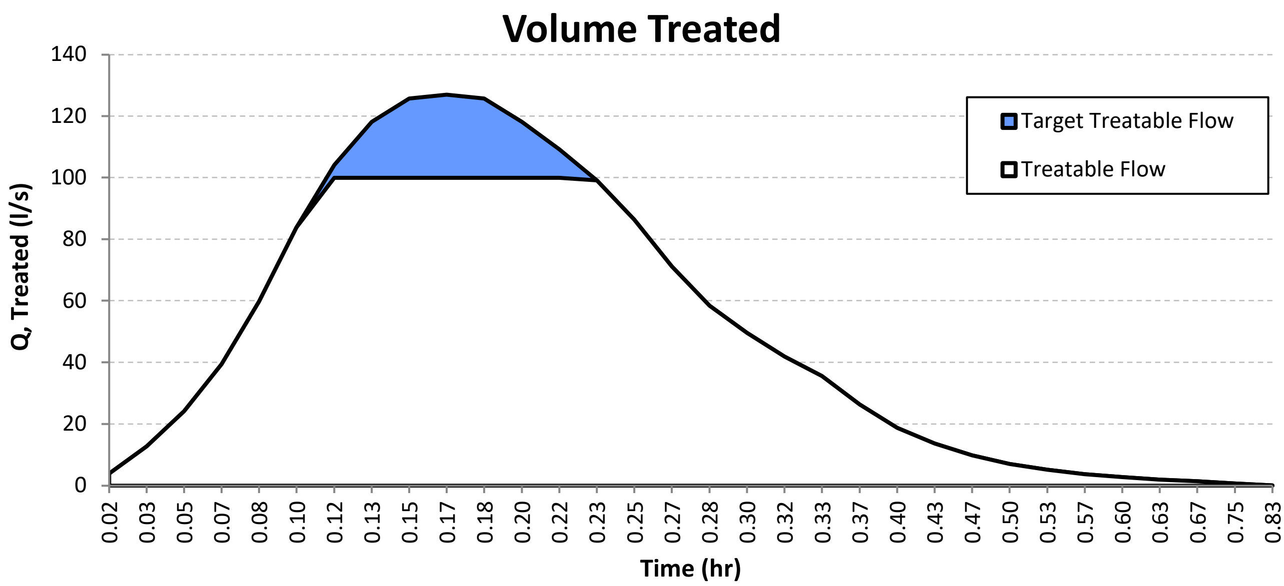
9 Sep 2022

CDS Sizing Report

Executive Summary	
Rocla Reference Number	2504
Client GPT Reference Number	GPT
Selected CDS Model	P1009 Model (To be confirmed)
Recommended Diversion Chamber	1.8W x 1.2H x 2.6L CDS Precast Chamber
Treatment flowrate requested by client (m^3/s)	not provided
Treatment Flowrate used for analysis (m^3/s)	0.127
Weir Type & Height	Precast Weir - 0.5m High
Project Specific Designer Note 1	Unknow location, we assumed a rainfall data for this site. Subject is TBC.
Project Specific Designer Note 2	This is a preliminary sizing. Details of catchment area and in/out pipes and levels and DTI are to be confirmed for DC sizing.
Project Specific Designer Note 3	
Project Specific Designer Note 4	

Project and Client Inputs		
Project Name		No Name
Site / Location		Unknow
Client Name		Osta Surjadi
Consultant Name		GHD
Rocla Sales Representative		Andrew Clifton
Rocla Reference Number		2504
Client GPT Reference Number		GPT
Catchment Area	ha	5
Equivalent Impervious Area	%	60
Local Authority		Unknow
Land-use		Residential
Inlet Pipe Details	mm	TBC
Outlet Pipe Details	mm	TBC
Pipe Grade	%	1 (assumed value - input not supplied by client)
I.L	m	TBC
S.L	m	TBC
D.T.I.	m	TBC
ARI requested by client		3mt
Treatment flowrate requested by client	m^3/s	not provided
Maximum flowrate at GPT	m^3/s	0.635 (assumed value by Rocla)
Is Volute Pipe Requested ?		No
Is Oil Baffle Requested ?		No
Is there Backwater / Standing Water ?		No

SWATT Analysis and Output		
Estimated removal of G.P. (> 5mm)	91.4%	457 kg removed per annum
Estimated removal of TSS (d50 = 106µm)	62.7%	1751 kg removed per annum
Estimated removal of Phosphorous	30.0%	8 kg removed per annum
Estimated number of cleanouts per year	3	



CDS Model Selection Data	
Recommended Rocla CDS® Model	P1009 Model
Orientation	To be confirmed
Diversion Structure Type	CDS Precast Chamber
Diversion Structure Size	1800W x 1200H x 2600L
Weir Type & Height	0.5m Precast weir
Volute Pipe Required?	Not Used
Secondary Weir Height for Volute	Not Used
Oil Baffle Required?	No
Treatment Flowrate used for analysis	0.127 m3/s
CDS Bypass Flowrate	0.635 m3/s

Treatment flow used in this design has been assumed by P.A.D.

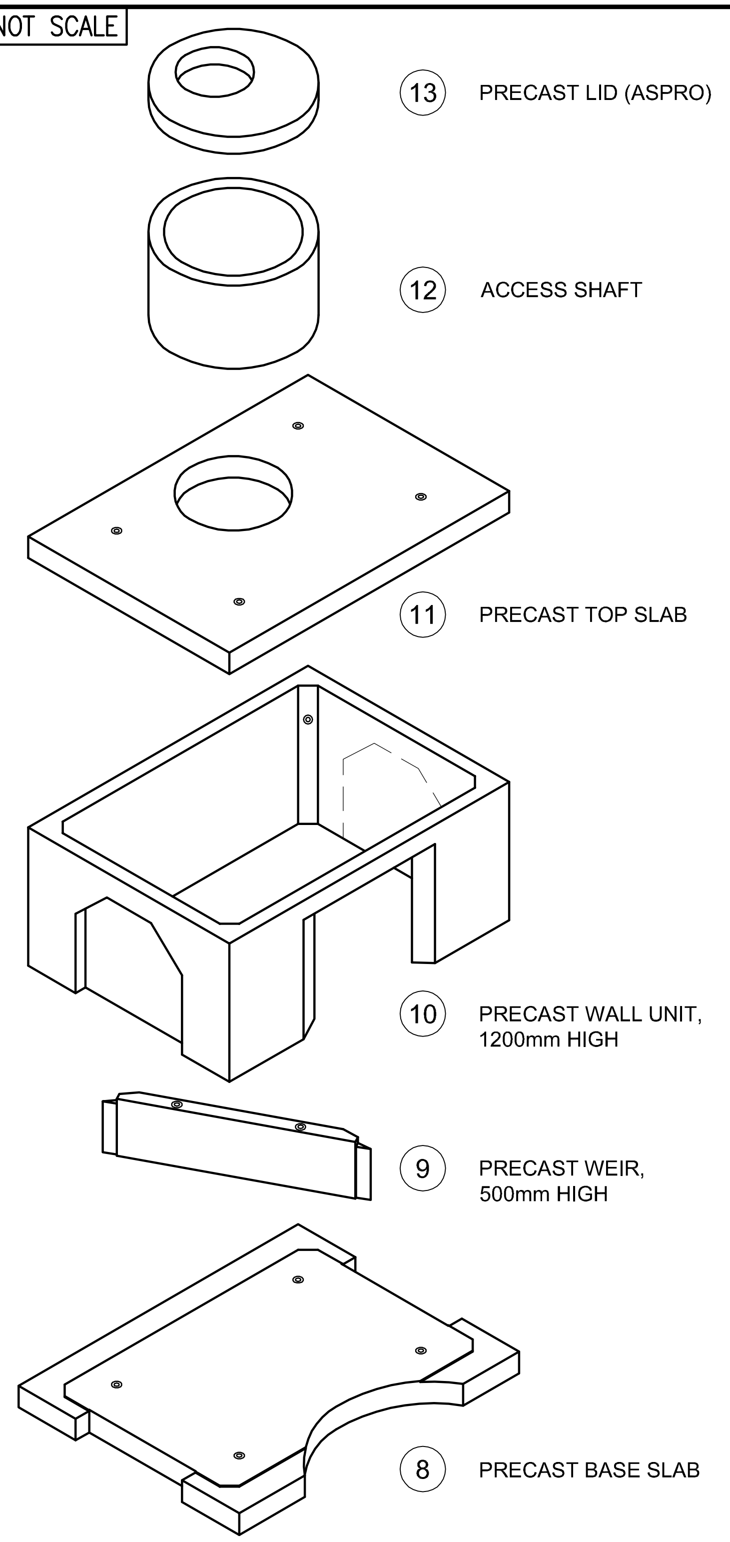
Bypass flow used in this design has been assumed by P.A.D.

Notes/Comments:

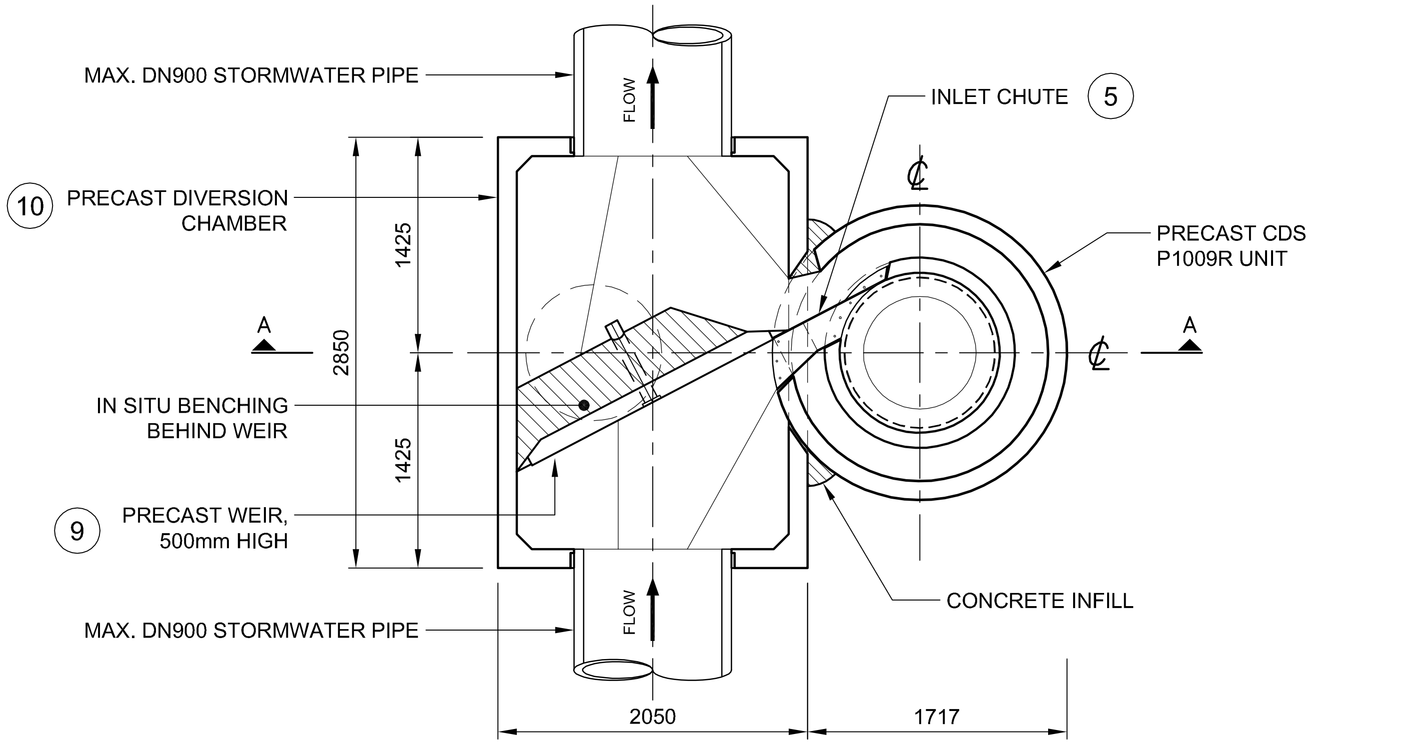
1. Recommended CDS® model and diversion chamber are based on details provided. If the details change then the information in the above tables may not be accurate and a new sizing request will be required.
2. Performance of the CDS® system is based on achieving the minimum cleaning frequency.
3. A site specific CDS product drawing can be produced by our P.A.D. department once all information is finalised and agreed.
4. Some CDS® units will involve some insitu work (to be detailed by others). This will be noted on the drawings.
5. A model specific installation guide and maintenance can be provided on request for each project. Note that any changes will require a new revision to the drawing and sign-off by the client prior to proceeding to manufacture.
6. All components, including hardware, will be delivered to site free on truck. It is the responsibility of the contractor to offload and store components prior to installation.

Report prepared by **Tony Nguyen**
BEng(Hons.) MSc(Civil) MIEAust C.WEM CEng
Senior Design Engineer
Product Application Design, Rocla

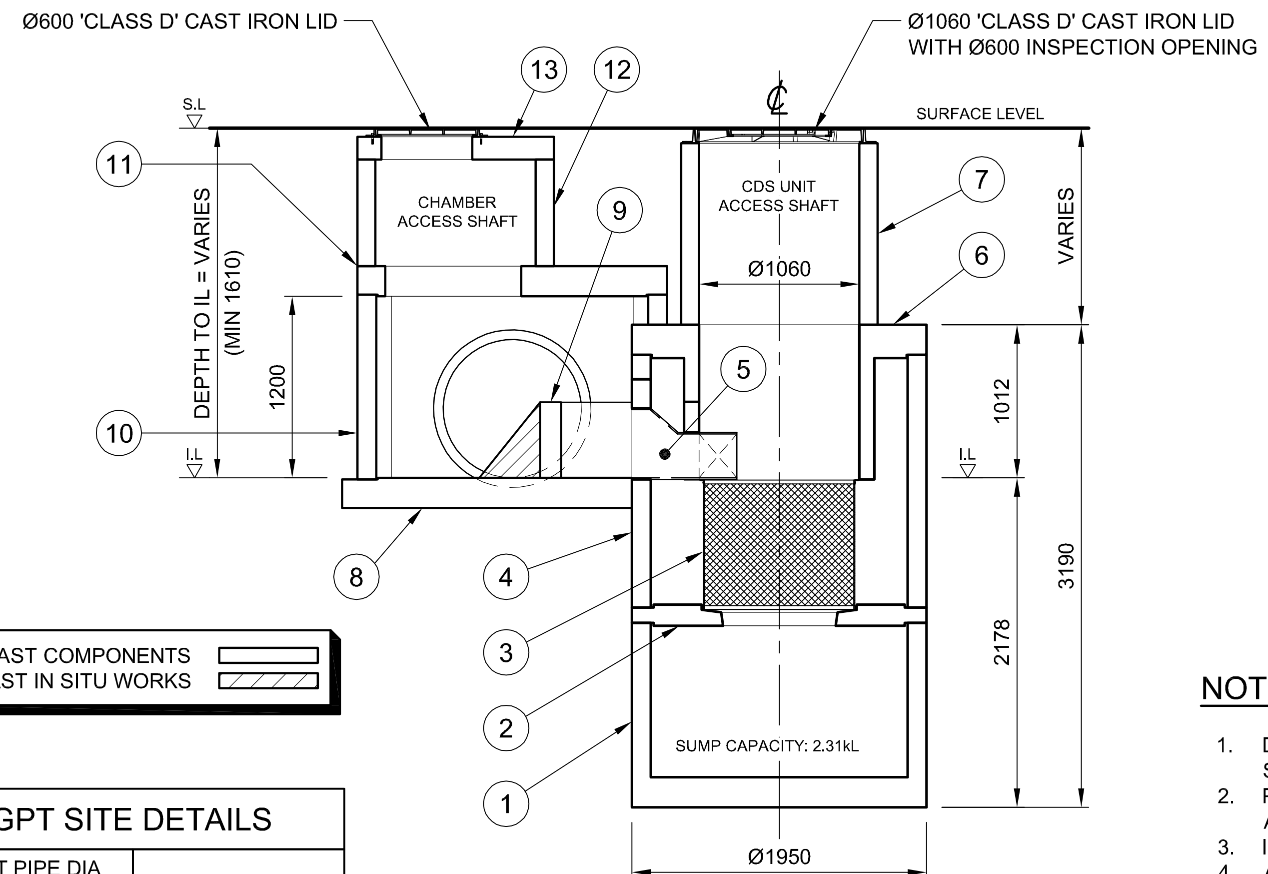
DO NOT SCALE



DIVERSION CHAMBER ASSEMBLY

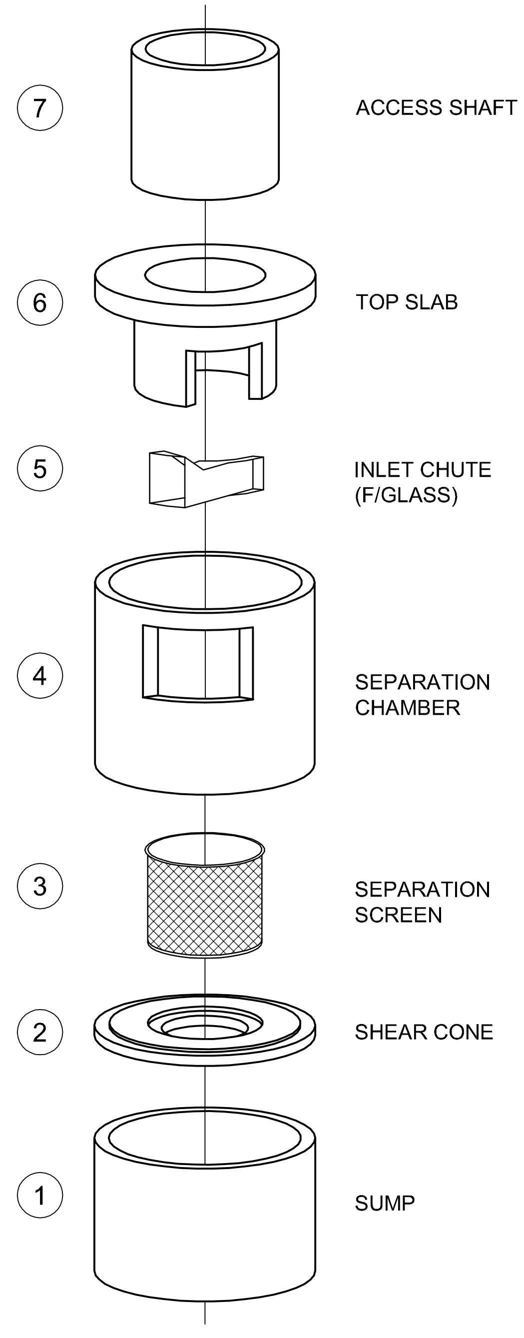


HORIZONTAL LAYOUT



PRECAST COMPONENTS	
CAST IN SITU WORKS	

VERTICAL SECTION A



CDS UNIT ASSEMBLY

NOTES:

1. DIMENSIONS SHOWN ARE FOR CONCRETE COMPONENTS ONLY. SEALANTS BETWEEN COMPONENTS (APPROX 10mm PER JOIN).
2. PRECAST RISER SHAFTS MAY NOT MATCH SURFACE LEVELS AND CAST INSITU FINISHING MAY BE REQUIRED.
3. INSITU CONCRETE DESIGN BY CLIENT, U.N.O (40mpa MIN.)
4. ALL LEVELS TO BE CONFIRMED PRIOR TO INSTALLATION.
5. GPT SHALL BE INSTALLED IN ACCORDANCE WITH PROJECT SPECIFICATIONS AND/OR AS.3725-2007, AND ROCLA PRODUCT INSTALLATION GUIDES.

DRAWING APPROVAL

I/WE HAVE REVIEWED ALL DRAWINGS AND ARE SATISFIED THAT ALL INFORMATION SHOWN IS CORRECT

NAME OF PERSON AUTHORISED BY CUSTOMER ______ SIGNATURE ______ DATE __/__/__

GPT SITE DETAILS	
INLET PIPE DIA	
OUTLET PIPE DIA	
D.T.I (OUTLET)	

RV	DRN	CKD	APR	DESCRIPTION	DATE
E					
D					
C					
B	DRC	DRC	SDB	ISSUED FOR INFORMATION	15.06.09
A	SB	LH	PW	ISSUED FOR INFORMATION	29.06.07

CDS® TECHNOLOGIES

Rocla® Water Quality

ROCLA CDS
P1009R GPT
1800W x 1200H CHAMBER
GENERAL ARRANGEMENT

RWQ No.	SALES
JOB No.	
SHEET	1 OF 1
SCALE	DO NOT SCALE
D	205344

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