STORMWATER AUDIT (STAGE 1)

JBA Project Code	2022s0125
Contract	Stage 1 SWA – Brennanstown Road
Client	Cairn Homes PLC
Prepared by	Michael O'Donoghue
Subject	Stormwater Audit Stage 1 Report

Revision History

Issue	Date	Status	Issued to
S3-P01	07/04/2022	First issue	Waterman Moylan

1 Introduction

JBA Consulting have been contracted by Cairn Homes PLC to undertake a Stage 1 SW Audit of the surface water drainage design prepared by Waterman Moylan Consulting Engineers for the proposed SHD at the Brennanstown Road, Dublin. The audit has been completed in accordance with Dún Laoghaire Rathdown County Council's (DLRCC) Stormwater Audit Procedure (Rev 0, Jan 2012) as set out below.

The subject of this Stage 1 stormwater audit is to review the proposed surface water drainage design and sustainable urban drainage system (SuDS) proposals for the proposed development. This audit was undertaken in advance of a Strategic Housing Development (SHD) planning submission to An Bord Pleanála.

Stage 1 – Pre-Planning Stage: *A Stage 1 audit shall be carried out of the Stormwater Impact Assessment (SIA) prepared by the applicant. The audit will focus on the SUDS management train and whether the applicant has carefully considered all known SUDS techniques and applied the most appropriate type(s) for the site that will ensure improved water quality, biodiversity and volume control.*

1.1 Report Structure

The Feedback Form in Appendix A identifies queries raised in this report which are to be answered by the Design Engineers. Once an 'Acceptable' status is achieved for each query the audit is deemed to be closed out.

The results of the audit are set out hereunder, where items raised in the feedback form are shown in bold within this report, cross-referenced with the numbering convention used in the Feedback From (FFXX).

1.2 Relevant Studies and Documents

The following documents were considered as part of this surface water audit:

- Greater Dublin Strategic Drainage Strategy (GDSDS);
- Greater Dublin Regional Code of Practice for Drainage Works;
- The SUDs Manual (CIRIA C753).
- DLRCC County Development Plan 2016-2022
- DLRCC Green Roof Guidance Document (Appendix 16 of the County Development Plan 2016-202
- BRE Digest 365

1.3 Key Considerations and Benefits of SuDS

The key benefits and objectives of SuDS considered as part of this audit and listed below include:

- Water Quantity
- Water Quality
- Amenity
- Biodiversity

Which can be achieved by;

- Storing runoff and releasing it slowly (attenuation)
- Harvesting and using the rain close to where it falls
- Allowing water to soak into the ground (infiltration)
- Slowly transporting (conveying) water on the surface
- Filtering out pollutants
- Allowing sediments to settle out by controlling the flow of the water

1.3.1 SuDs Management Train

A SuDs Management Train is a robust pollutant removal strategy. The treatment train can comprise four stages:

1. *Prevention*
2. *Source Control*
3. *Site Control*
4. *Regional control*

2 Proposed Development (SHD) at Brennanstown Road

The development is proposed to be constructed on a site in Cabinteely, Co. Dublin. It is bound to the north by Brennanstown Road, to the south by Carrickmines River and the Brennanstown Luas stop and to the west by Brennanstown Vale. The location of the site is shown in Figure 1 below.

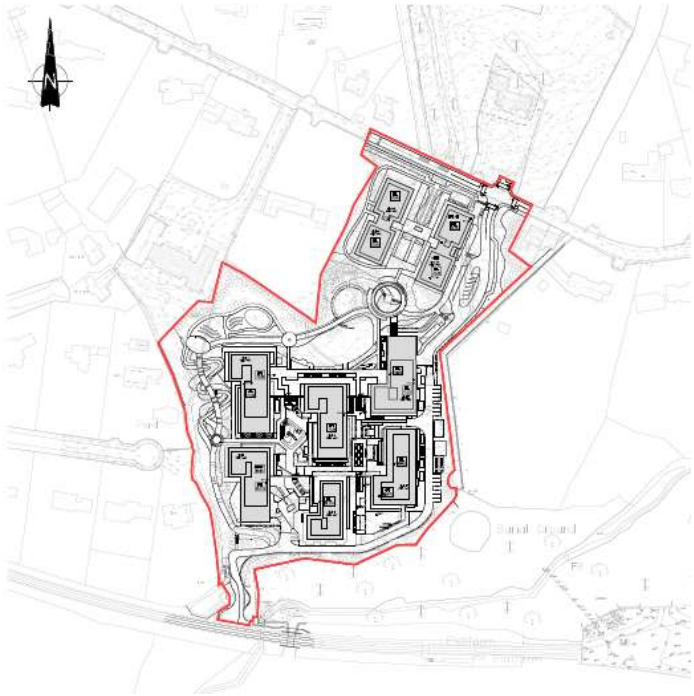


Figure 1- Site Location

The total site area is approximately 3.81 hectares, of which 2.3Ha is hardstanding. There are two existing houses on the site which will be demolished as part of the development and the Barrington Tower which will be retained. The remainder of the site is currently greenfield. The proposed 'Build-to-Rent' (BTR) development will consist of the construction of 8 no. blocks in heights up to 10 storeys comprising 534

residential units, a creche, a retail unit, residential support facilities and residential services and amenities. The proposal also includes car and cycle parking, public and communal open spaces, landscaping, bin stores, plant areas, substations, switch rooms, and all associated site development works and services provision.

2.1 Review of SW Drainage Proposals

This review is based on the following documents provided by Waterman Moylan on 09/03/2022 (First submission).

- 20-040r.004 Engineering Assessment Report_app
- BRR-WM-ZZ-00-DR-C-P010 Site Location Plan
- BRR-WM-ZZ-00-DR-C-P200 Proposed Drainage Layout
- BRR-WM-ZZ-00-DR-C-P202 Proposed Basement - 2 Drainage Layout
- BRR-WM-ZZ-00-DR-C-P203 Proposed SUDS Drainage Layout
- BRR-WM-ZZ-00-DR-C-P204 - SUDS Drainage Details
- BRR-WM-ZZ-00-DR-C-P205 Overland Flow Route
- BRR-WM-ZZ-00-DR-C-P206 Catchment Layout
- BRR-WM-ZZ-00-DR-C-P214 - Attenuation Details Sheet 1 of 2
- BRR-WM-ZZ-00-DR-C-P215 - Attenuation Details Sheet 2 of 2
- BRR-WM-ZZ-XX-DR-C-P210 - Public Surface Water Drainage Details
- BRR-WM-ZZ-XX-DR-C-P211 - Private Surface Water Drainage Details
- BRR-WM-ZZ-XX-DR-C-P213 - Proposed Petrol Interceptor & Hydrobrake Details

Any subsequent documents requested as part of the audit process are referenced within the Feedback Form as required.

2.1.1 Pre-Planning Meeting(s)

Reference is made within the Engineering Report (Section 4.1) to a meeting between the consultants and DLRCC as part of the Stage 2 pre-planning process. It is noted all items raised by DLRCC Drainage Department were closed out with agreement from Johanne Codd and John Cunniffee. The list of queries isn't included within the report.

2.1.2 Site Characteristics

The site is predominantly greenfield, with a natural average slope of 1:22 across the site. The site is characterised as Soil Type 1 according to GSI mapping. However, following the undertaking of 2 no. site investigations, the consultants have proposed to classify the soil type as Type 3. Soakaways test carried out in August 2020 found that the subsoil is not suitable for the use of infiltration techniques as the 4 No. soakaways tests held water and therefore failed.

FF 1a. No reference to groundwater is made within the report. WM should provide referenced site investigation reports to allow assessment of impact of ground conditions on proposed drainage design.

2.2 Design Parameters

Rainfall parameters can be estimated using Met Eireann data, using the Flood Studies Report (FSR) values or the values in the GDSDS. The Met Eireann method can be more representative of a site if selected correctly. The design values used by WM and considered by JBA are shown below:

Rainfall parameters	Designer values	JBA Comment
M5_60	16.4	16.6mm on our records - OK
Ratio R	0.272	OK
SAAR (mm)	892	OK – Met Éireann
Qbar l/s	8.8l/s	OK
Climate Change	20%*	OK – 10% required in GDSDS

The total impermeable area of the catchment including roads, car parking and roofs is approx. 2.3Ha, which equates correctly to 8.8l/s, based on the data used above. This calculation is found within Appendix D of the engineering report.

***Note that a revised set of calculations were submitted as part of the final return of comments (see FF 7a). These calculations were revised to adjust the impact of climate change to a factor of 30%. FF 7a has been accepted on the Feedback Form.**

2.3 Surface Water Drainage Strategy

2.3.1 Adjacent lands/existing drainage

The existing site drains surface water, unrestricted, to Carrickmines River to the south of the site. The existing site has an impermeable area of approx. 0.057Ha. An estimate for Q100 flow rates into the Carrickmines River are provided within the report, estimated at 42.08l/s. This suggests a significant improvement post-development in the flow rates from the site entering the Carrickmines River.

2.3.2 Site Drainage Strategy

The drainage for the proposed development and attenuation systems has been divided into 5 sub-catchments, with flow restriction at each of the sub-catchment attenuation structures.

Causeway Flow software was used to model the stormwater network. The network was analysed for a 1 in 5-year event with a surcharged outfall. The attenuation for the 1 in 100-year event.

No surface flooding occurs in the 1 in 100-year event, but is retained on site, therefore complying with the GDSDS requirements.

No infiltration has been allowed for in the design.

FF1g. The surcharged outfall does not appear to correlate with any anticipated flood level in the Carrickmines river. Rationale for the choice of this should be provided.

FF1h. No surface run-off factors have been identified within the engineering report.

2.3.3 SuDS Measures Considered

SuDS Technology	Comments
Green/Blue Roofs	Green roofs have been used throughout the site, covering 67.5% of roof area, satisfying Appendix 16 of DLRCC County Development Plan.
Swale, Filter Drain, Infiltration Trench	Dry swales are used adjacent to the access roads for surface water treatment. Filter drains are provided for the footpath and podium level surface water treatment.
Tree Pits, Bioretention Areas, Rain Gardens	None proposed
Permeable Paving	Permeable paving will be utilised for the surface level carparking area to provide treatment and storage to rainwater falling on these areas. The permeable paving will be lined with a permeable geotextile membrane which will allow any surface water that can soakaway into the ground to do so. Permeable paving will be provided for the footpaths within the podium area.
Soakaways	None proposed as the soil is not suitable for infiltration.
Detention Basins,	None proposed

Retention Ponds, Stormwater Wetlands	
Rainwater Harvesting	None proposed
Petrol Interceptor	Petrol interceptors will be installed upstream of the proposed attenuation tanks as a final treatment level before discharging to the attenuation tank.
Attenuation	4 no. geocell attenuation tanks are proposed within the sub-catchments, along with 1 no. RC tank beneath the podium. A stone filled area will be connected into a swale upstream of the final outfall to provide further attenuation. This attenuation is incorporated into the proposed permeable paving.
Other	N/A

2.3.4 Review of drainage drawings and SuDS drawings;

The SuDS drawings show a range of SuDS measures proposed throughout the site including permeable paving, green roofs and bioretention areas. Details of the attenuation structures are provided for each type of attenuation structure proposed. The set of drawings proposed is robust, and substantially covers the level of required for a Stage 1 audit. A number of discrepancies were identified and are referenced below.

FF 2a. The extent of permeable paving differs from the drainage layout and the SuDS layout.

FF 2b. One of the filter drains is shown to be discharging into the foul network.

FF 2d. The filter drains are adjacent to roadways with falls exceeding 1:100, a gradient where interception will no longer be provided. This should be addressed if WM are to consider these as interception measures.

FF 3a. The swale filter layer appears to have a topsoil surface in contradiction with CIRIA C753 18.9.

FF 3b. The permeable paving details differ across the drawings.

FF 3c. The attenuation detail on drawing P204 doesn't seem to reflect what has been considered in the calculations.

FF 4a. The swale within Catchment D appears to be contributing to Catchment E, therefore incorrectly distributed across the sub-catchments.

FF 5a. The swale detail within P210 differs from P204.

2.3.5 Review of Hydraulic Model

The network was analysed using Causeway Flow Software.

- 20% climate change allowed for the network design and in the simulation 100-year storm which is analysed for the range of durations and is satisfactory.
- Maximum rainfall intensity is limited to 50 mm/hr. Results for the 1 in 5 yr, 1 in 30 yr & 1 in 100 yr are provided. A surcharged outfall of 1.5m head is applied to the network.
- Summer and winter CVs of 0.75 & 0.84 are applied to the network.
- The calculations present results for the proposed attenuation structures, but do not include the design details of the attenuation structures themselves.
- A significant volume of flooding occurs in the 1 in 100 yr event, with no clear evidence that this volume is retained on the site.
- There are a number of pipe runs with extremely steep falls, thus not fully availing of the storage within the network.
- Tank C has a ToE of 4 minutes for 1.4Ha, which seems overly conservative.

WM should consider/clarify the following:

FF 1c. The invert of Tank D is not consistent across the documents.

FF 1d. The hydrobrakes at Tank A & B don't correlate with their attenuation tank soffit levels.

FF 1e. The porosity of 0.4 used for the permeable paving seems high and should be reviewed.

FF 1f. Consider steps across manholes where excessively steep pipe runs are proposed.

FF 1i. Revisit Tank C to determine whether savings can be made on the scale of the volume required.

2.3.6 Interception/Treatment

Interception of runoff is intended to prevent any runoff for small rainfall events which are less than 5mm (and up to 10mm if possible). Treatment of 15mm is required if interception is not provided.

Table 24.6 of the CIRIA manual provides indication of deemed to satisfy criteria and it is considered that this should be complied with. All sources of runoff should also be intercepted where possible. A high level of Interception provided for some parts of the site is not to be considered as adequate compensation for a low degree of interception provision for other locations. Compliance is required for the whole site, or at least for road/paved areas, for it to be considered effective. Interception mechanisms are based on runoff retention. This can be achieved using rainwater harvesting or using soil storage and evaporation. Either infiltration or transpiration rates can dispose of the runoff from minor events to enable the next event to be captured.

A substantial breakdown of interception calculations is provided within the engineering report. The calculations do assume, however, that all interception measures are fully utilised.

FF 1j. WM should confirm that all interception measures are fully utilised and the extent of catchments allocated to each measure is maximised.

2.3.7 Exceedance Flows

No reference to exceedance flows are made within the report. Given the topography, overland flows would flow towards the Carrickmines River to the south.

2.4 Health & Safety and Maintenance Issues

The proposed drainage system comprises SuDS devices, traditional road gullies, manholes, attenuation systems, petrol interceptors, swales and underground pipes. These elements are considered acceptable from a Health & Safety perspective once supplier/manufacturers guides are followed and complied with during the detailed design, construction and operation.

Optimum performance of the SUDs treatment train is subject to the frequency of maintenance provided. A full maintenance regime is set out in Section 5 of the engineering report.

It is recommended that the petrol interceptors be fitted with an audible high-level silt and oil alarm for maintenance and safety purposes. Regular inspection and maintenance is recommended for the petrol interceptor.

Please note that silt and debris removed from the petrol interceptor during maintenance will be classified as contaminated material and should only be handled and transported by a suitably licensed contractor and haulier and disposed of at a suitably licensed landfill only.

2.5 Items to be considered at Detailed Design Stage

The following should be considered at detailed design stage.

- As the groundwater level fluctuates considerably across the site, it is recommended the need for lining of attenuation structures be considered to ensure the risk of cross-contamination of groundwater is mitigated against. As infiltration is not considered as part of the hydraulic design, this will have no

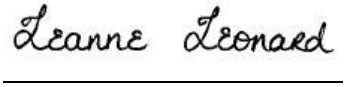
impact on the capacity of the network, nor have any impact on the application of the SuDS measures proposed.

2.6 Audit Report sign Off

Audit Report Prepared by:

Michael O'Donoghue BEng (Hons) CEng MIEI
Associate Director

Approved by:



Leanne Leonard BEng (Hons) MIEI
Design Engineer

Note:

JBA Consulting Engineers & Scientists Ltd. role on this project is as an independent reviewer/auditor. JBA Consulting Engineers & Scientists hold no design responsibility on this project. All issues raised and comments made by JBA are for the consideration of the Design Engineer. Final design, construction supervision, with sign-off and/or commissioning of the surface water system so that the final product is fit for purpose with a suitable design, capacity and life-span, remains the responsibility of the Design Engineers.

Appendix A – Audit Feedback Form

JBA Consulting Stormwater Audit - Stage 1 Feedback Form	
Project:	St1 SWA Barrington Road
Date:	21/03/2022
JBA Reviewers	Michael O'Donoghue
Project Number:	2022s0125

Item No.	JBA Review Comment	Comment/Clarification Request/Suggested Mitigation	Response from Client/Client Representative	Acceptable / Not Acceptable
P01	**21/03/2022**	**21/03/2022**		
Reference Docs	20-040r.004 Engineering Assessment Report_app BRR-WM-ZZ-00-DR-C-P010 Site Location Plan BRR-WM-ZZ-00-DR-C-P200 Proposed Drainage Layout BRR-WM-ZZ-00-DR-C-P202 Proposed Basement - 2 Drainage Layout BRR-WM-ZZ-00-DR-C-P203 Proposed SUDS Drainage Layout BRR-WM-ZZ-00-DR-C-P204 - SUDS Drainage Details BRR-WM-ZZ-00-DR-C-P205 Overland Flow Route BRR-WM-ZZ-00-DR-C-P206 Catchment Layout BRR-WM-ZZ-00-DR-C-P214 - Attenuation Details Sheet 1 of 2 BRR-WM-ZZ-00-DR-C-P215 - Attenuation Details Sheet 2 of 2 BRR-WM-ZZ-XX-DR-C-P210 - Public Surface Water Drainage Details BRR-WM-ZZ-XX-DR-C-P211 - Private Surface Water Drainage Details BRR-WM-ZZ-XX-DR-C-P213 - Proposed Petrol Interceptor & Hydrobrake Details			
1	**20-040r.004 Engineering Assessment Report_app**			
a	Reference is made to two site investigations, but the results of neither have been included. It is not clear whether infiltration tests were undertaken.	Please provide site investigation reports.	Please refer to attached Site Investigation Reports carried out in November 2020 and in May 2021. 4 No Soakaways tests were completed in 2020 suggesting the soils are unsuitable for infiltration.	See Note 6
b	Each of Tank A, B & D have porosity values of 1 included in the calculations. This doesn't seem to be reflective of the proposed structures.	Review porosity of pluvial attenuation structures A, B & D. It would also be useful to include volumes of each of the tanks on the Proposed Drainage Layout.	Pluvial tanks have been amended in the Flow model to reflect a porosity of 96%. Please find attached with this reponse the updated drainage layouts showing the attenuated volumes for each tank.	Acceptable
c	The invert of Tank D in the calculations does not match that in the Drainage Layout	Ensure consistency across all documents.	Please find attached with this reponse the updated drainage layouts.	Acceptable
d	The design head for the hydrobrake at Tank A does not correlate with the attenuation depth. Similarly Tank B has a depth of 1.6m but a hydrobrake design head of 1.35m.	Review depths of attenuation structures/hydrobrakes.	Please find attached flow results with amended depths matching the tanks.	Acceptable
e	The porosity of the permeable paving is set at 0.4. This seems high and may not be achievable.	Confirm how a porosity of 0.4 will be achieved within the attenuation medium.	The current market has stone material which can achieve 40% porosity as we have done in previous sites. However, we have changed to a porosity of 30% which is a more standard practice. As shown in the details drawing, this porosity will be achieve through 4/20mm Coarse graded aggregate to BS 13242:2002.	Acceptable
f	There are a number of pipe runs with extremely steep falls. Whilst not a problem in itself it does result in increased flows during flood events, thus increasing the requirements of the attenuation structures.	Consider introducing steps across manholes to reduce the gradients on the stormwater runs, thus better availing of the volume provided by the network itself.	Noted. However, the flow modeL is designed with step gradients during the 1 in 100 year storm plus 20% climate change and not flooding occurs on site.	Acceptable
g	It is noted that a surcharged height of 1.5m has been applied to the outfall to represent a coinciding fluvial event in the Carrickmines River. Has this figure been applied with reference to an FRA or taken as an estimate? If it is the former, what joint probability was applied?	Clarify what informs the surcharged outfall level.	At the time of writing there is not a water level monitoring study. However, the river water level was measured inmediately after a week of intense rains and at the outfall location the invert level of the river was 57.3m and the top of water level was 57.66 indicating only a 300mm water level. An assumption of 1.5m water level has been assumed as worst-case scenario.	See Note 7
h	Surface run-off factors have not been provided. It is noted however that a Cv of 1 is provided in the Causeway Simulation calcs.	Clarify run-off coefficients used, if any.	A Summer Cv of 0.750 and a winter Cv of 0.840 have been used in the model.	Acceptable
i	Tank C (denoted Node 17_Tank C) receives 1.386Ha of run-off with a ToE of 4 minutes. This isn't a fair reflection of how the network will work and is likely resulting in an over-design of the tank.	There may be a means of reducing the size of Tank C by breaking down the contributing 1.386Ha into a number of sub-catchments, with the application of suitable run-off factors.	At planning stage, the locations of rainwater pipes from the roofs and podium have not yet been decided. A conservative approach has been taken to design the attenuation tank at basement level.	Acceptable
j	The calculations provided on Table 4-16 assume that all interception measures are fully utilised. This may not always be the case depending on proposed site levels and falls.	Can you confirm that the contributing areas to the proposed interception measures ensure full use of the capacity of each?	Interception measures are fully utilised. Only the available hardstanding area discharging into each of the SUDS measures has been accounted for interception storage.	Acceptable
2	**BRR-WM-ZZ-00-DR-C-P200 Proposed Drainage Layout**			
a	The extent of permeable paving differs from this drawing and P203.	Clarify extent of permeable paving.	Please refer to updated drawings showing same extent of permeable paving.	Acceptable
b	There appears to be a filter drain connection at F MH 20.	Amend drawing to remove cross-connection.	Noted and amended.	Acceptable
c	A petrol interceptor is located upstream of Tank A. The upstream catchment does not appear to have any run-off from carriageway or parking surfaces. Therefore it may be possible to remove the interceptor.	Clarify purpose of interceptor upstream of Tank A.	The are upstream of the petrol interceptor is currently use for fire tender purposes. Should the fire tender strategy changed at detailed design stage, petrol interceptor in Catchment A may be removed as not vehicles are allowed to drive in this area.	Acceptable
d	Given the steepness of the proposed drainage, it is likely that the filter drains will be installed at similar gradients. Should they be installed at steeper gradients than 1:100 they can not be deemed to be providing interception.	Provide gradients for filter drains and swales.	Please refer to drawing P204 which shows a longitudinal sections to be used for filter strips and swales when the footpath/road levels have steeper gradients than 1:100. Therefore, all proposed swales and filter strips on site will provide interception.	Acceptable
3	**BRR-WM-ZZ-00-DR-C-P204 - SUDS Drainage Details**			

Item No.	JBA Review Comment	Comment/Clarification Request/Suggested Mitigation	Response from Client/Client Representative	Acceptable / Not Acceptable
a	The swale filter layer should be specified in line with the reccommendations set out in CIRIA C753 Chapter 18.9. The topsoil surfacing material should be carefully considered so that waterlogging doesn't occur.	Provide landscape spec. as referenced in dwg P204 for the swale surfacing material.	A specification for the top soil material of the swale will be provided at detailed design stage to be in compliance with Section 18.9 of CIRIA C753.	Acceptable
b	There are two separate permeable paving proposals included on the drawing. One has a 200 gauge impermeable membrane, one has 2000 gauge. It is assumed the 200 gauge is a misprint. In either case, a 2000 gauge polythene is not impermeable under hydrostatic pressure, but only suitable for resistance against capillary action.	Clarify whether the permeable paving is to be lined, and ensure material proposed is suitable.	To avoid the risk of groundwater entering the SUDS features, permeable paving will be lined with an impermeable geomembrane. Please refer to updated drawing reflecting this change. In addition, pluvial cube attenuation tanks will also be lined where the distance between the tank and the structure is less than 5m.	Acceptable
c	The attenuation detail in Section A-A does not reflect what has been used in the calculations. In order to avail of the attenuation volume, the design head would need to be greater than the proposed max design head of 62.937mAOD. The detail has no dimensions to allow an accurate assessment. However, the soffit of the volume available is 130mm below the surface, and this should be reflected in how the structure is modelled.	Ensure the design parameters in the calculations transfer to the design drawings. Amend attenuation detail to provide clarity on dimensions and invert levels.	As indicated in the flow model and attached image showing the results for the 1 in 100 year storm event for the permeable paving located to the south, the volume of water to be stored within this permeable paving and stone beneath is very small, being 1.3 c.m . The depth of stone provided is required for the structural build up and will also provide interception treatment. Flow model shows only 0.075 depth of permeable paving being utilised for storage. CL an IL of the permeable paving area will vary with the road levels. Depths of the build up is shown in drawing P204 and reflected in the flow model with a 300mm depth of 30% voids coarse graded stone where water will be stored should it need to. This area provides interception for Catchment E and hydrobrake in MH33 allows for all rainwater on site being attenuated prior to discharge.	Acceptable
4	**BRR-WM-ZZ-00-DR-C-P206 Catchment Layout**			
a	The swale that runs to the south of the road within Catchment D (southern section) discharges into the attenuation tank beneath the permeable paving at IC2, thus is contributing to Catchment E.	Amend catchment distribution to reflect SUDS proposals and amend attenuation capacities as necessary.	Refer to updated drainage drawing. Two separate swales run along the southern main road. Each of them discharges into a different catchment.	Acceptable
5	**BRR-WM-ZZ-XX-DR-C-P210 - Public Surface Water Drainage Details**			
a	The typical swale detail shown on this drawing differs from that on P204.	Delete swale detail from one of the drawings.	Typical Swale detail has been removed from Drawing P210.	Acceptable
P02	31/03/2022	31/03/2022		
6	**20-040r.004 Engineering Assessment Report**			
a	Whilst its noted that very little groundwater was encountered and that infiltration isn't relied on, it will be important at detailed design stage to consider any impact of groundwater on the attenuation structures. This appears only to be relevant to Tank A, to the north of the site.	Will Tank A be lined to prevent risk of cross-contamination of groundwater?	Groundwater monitoring works will be carried out prior to construction. The pluvial cube tanks will be wrapped with a permeable geotextile which will allow any surface water that can soakway into the ground to do so. Should the tank be 5.0m of a building or 1.0m (vertically) of groundwater, an impermeable geomembrane will be used.	Acceptable
7				
a	Has a site specific flood risk assessment been undertaken for the site? This would give a greater indication of flood levels within the river. CFRAM mapping suggests an upstream 1% level exceeding 60m AOD which would be greater than the 1.5m allowed for.	Provide site specific FRA and comment on CFRAM levels within proposed site location.	A site specific FRA has been undertaken for the site and is attached with this response. However, the river was not modelled as part of the Flood Risk Assessment as the site is not at risk of flooding from the river. As can be seen in the topographical survey in drawing BRR-WM-ZZ-00-DR-C-P011 Proposed Road Levels, the river bank levels surrounding the outfall are between 58.63 and 57.72 AOD. The pipe IL at the headwall is 57.92m (subject to further water levels monitoring at design stage) and a 1.5m surcharged outfall has been applied, therefore assuming a maximum water level of 59.42m AOD. Should a surcharge event occur, combining a 1 in 100 year + 30% cc event and high water river level, the water would first spill over the embankment of the river as opposed to surcharging the pipe outfall therefore the assumption of a 1.5m surcharged outfall is actually worse than the worst possible case scenario as in reality the water in the river cannot reach this level.	Acceptable