STORMWATER AUDIT (STAGE 1)

JBA Project Code	2020s1191
Contract	Residential Development– Holybanks, Swords, Co. Dublin
Client	Cairn Homes Properties Ltd.
Date	05th October 2020
Author	Jamie Cullen
Subject	**Stormwater Audit - Stage 1 Report**

1 Proposed Residential Development, Holybanks, Swords, Co. Dublin.

1.1 Introduction

JBA Consulting have been contracted by Cairn Homes Properties Ltd. C/O Waterman Moylan Consulting Engineers (WMCE) to undertake a Stage 1 audit of the surface water drainage design for the proposed residential development at Holybanks, Swords, Co. Dublin. The surface water audit was undertaken in advance of a planning submission.

The audit has been completed in accordance with Dún Laoghaire Rathdown County Council's (DLRCC) Stormwater Audit Procedure (Rev 0, Jan 2012). The results of the audit are set out in the table below.

1.2 Stage 1 Audit

Design Parameter	Audit Result
Proposed Development	The subject site is located at Holybanks, Swords, Co. Dublin and is currently a green field site, shown below in Figure 1-1.  *Figure 1-1 Site Location & Boundary* The proposed development will consist of the provision of 635 no. residential units comprising a mix of housing typologies, duplexes and apartments along with ancillary childcare facility and a range of residential amenity facilities including gym, concierge and 2 no's multipurposed rooms. The total site area is stated to be 13.4 hectares (ha) although the net site area drained as part of the subject development is 10.83ha with a total impermeable area arising from the proposed development of 4.81ha. The subject of this Stage 1 stormwater audit is to review the proposed surface water drainage design and sustainable urban drainage system proposals for the proposed development.
Relevant Studies/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 Green Roof Guidance Document (September 2011) • The audit is based on the WMCE Engineering Assessment Report dated September 2020 (Issue No.3) and associated drawings.

Key Considerations & Benefits of SUDs	The key benefits and objectives of SUDs considered as part of this audit and listed below include: • Reduction of run-off rates; • Provision of volume storage; • Volume treatment provided; • Reduction in volume run-off; • Water quality improvement; • Biodiversity.
Site Characteristics	**Soil:** Soil has been indicated as being type 2 (SPR = 0.3), refer section 4.2 of Engineering Assessment Report, which was obtained from site investigations which were carried out. WMCE state in their report that it was also found from the Site Investigation that the water table is high across the site therefore the proposed SuDS features will be fully lined in an impermeable membrane in order to prevent the ingress of groundwater, therefore infiltration will not be possible on site. However, the drawings of the soakaway structure and as confirmed by WMCE indicate that the soakaway will be unlined with infiltration possible at this location. The operation of this soakaway may need to be confirmed at detailed design stage to ensure there will no ingress of groundwater. No infiltration has been taken into account in the calculations for attenuation. It should be noted that no impermeable membrane is indicated on the SuDS detail drawings. **Rainfall (basis for surface water pipeline network design):** 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. A comparison of values estimated by WMCE and JBA is shown below: **WMCE value** / **JBA Value** Rainfall model: Met Éireann / Met Éireann M5-60 (mm): 15.10mm / 15.10mm Ratio R: 0.300 / 0.273 **Greenfield Runoff Rate (basis of surface water attenuation design):** The Estuary West Masterplan stipulates that the post-development run-off rates are limited to 2 l/s/ha for the site. Therefore, the proposed design is based on an outflow of 21.6 l/s. **WMCE value** / **JBA value** QBAR: 21.6 l/s / 21.6 l/s No variation therefore acceptable. **FLOW Calculations** The FLOW model submitted for the storm sewer calculations account for 10.83ha which coincides with the net site area indicated within Table 3 Section 4.2 of the Engineering Assessment Report. The design of the storm network is indicated as 100 years return period which is deemed acceptable. 20% has also been added for climate change purposes. **Gradient:** There is a topographical fall across the site in a northern direction from a high of c. 14m at the south-west to a low of c. 5.6m at the north-east at Broadmeadow

	River. The adopted finished floor levels together with final site levels would allow for most SuDS technologies being feasible for the site.
SuDS Measures Considered	WMCE confirmed the following SuDS measures were considered and conclusions reached:

SUDS Technology	Comments
Green / Blue Roofs	A green roof is proposed for all 3 apartment blocks covering 60% of each of the roof area.
Swale/ Filter Drain / Infiltration trench	No infiltration is possible on-site with all SuDS treatment systems to be fully lined bar the soakaway structure. 5nr. swales are proposed to provide some access road surface water treatment before conveying the stormwater to a downstream detention basin and soakaway.
Permeable Paving	Permeable paving systems are proposed for the surface carparking areas.
Soakaways	A soakaway is proposed to the south of the site to deal with flows from Catchment A before discharging via a hydro-brake to the public sewer at 2 l/s.
Petrol Interceptor	It is proposed to include a petrol interceptor upstream of the 2 proposed detention basins and upstream of the soakaway to the south of the site.
Detention Basins, Retention Ponds, Stormwater Wetlands	It is proposed to use a central detention basin to deal with stormwater flow from Catchment B. This stormwater will be discharged using a hydro-brake into the storm network where a final detention basin is located to the north of the site. This provides the final bit of treatment/attenuation for all the flows from Catchment B & C before discharging at a controlled rate into the Broadmeadow River.
Rainwater Harvesting	For all individual dwellings rainwater 'butts' are to be provided. Rainwater Harvesting is being considered for the apartment blocks.
Other Sediment Management	No other Sediment Management systems are proposed for the site.
Surface Water Attenuation	Attenuation Storage will be provided to ensure that there is adequate attenuation storage for the required limited discharge of surface water volumes. The site has been divided into sub catchments to reduce flows, volumes and provide treatment run-off, as part of the surface water management train. Attenuation will be provided for events up to, and including, the 1.0% AEP rainfall event of each sub-catchment (+ CC).
Site Run-off Rates	WMCE propose to limit discharge to the equivalent of 2 l/s/ha (21.6 l/s) for all storm events.
Tree Root Structural Cell	Not included in design.

	Systems, Bio-retention, rain garden
Surface Water Drainage Design	All surface water flows generated by the proposed development will be attenuated and discharged at the controlled rate of 21.6 l/sec as per the GDSDS requirements and as highlighted within this storm water audit. No storm network pipes proposed are less than 225mm diameter for the site that may be taken in charge as per DLRCC requirements.
SUDs Management Train	**Source Control** and **Site Control** are addressed by the use of conveyance of stormwater flows to swales and detention basins with run-off within the curtilage of the property boundary passing through at least one SuDS component (detention basin) prior to discharging from site and run-off from public areas passing through at least two SuDS components (green roofs, swales, permeable paving, soakaway, detention basins). A petrol interceptor is also incorporated into the design to treat surface water run-off prior to it entering the detention basins. It is noted that not all impermeable areas are intercepted but the stormwater flows through the detention basins and interception volumes are provided in the catchment areas. **Regional Control** does not apply at the level of this development. As recommended with the SUDs Manual (Table 3.3) assuming effective pre-treatment is in place the following number of treatment train components are recommended:

	No. of treatment train components recommended	Comment/Proposals
Roof areas (apartments)	1	Green roof's, detention basins
Residential roads, parking areas, commercial zones	2	Permeable paving, swales, detention basins
Refuse collection, industrial areas, loading bays, lorry parks and highways.	3	No recycling centre detailed on drawings.

	Generally, site proposals meet the treatment train recommendations within the SuDS Manual.
Climate Change	An allowance of 20% increase in flows has been included for climate change, both for the storm sewer calculations provided and for the rainfall intensities for the purposes of sizing the attenuation structures. This is in compliance with Section 6.3.2.4 of the GDSDS.
Discharge Rate / Flow Control	From the IH124 method, the QBAR discharge rate, using the FSR growth curves, from the development site is 21.2 l/s. Post-development run-off rates are limited to QBAR or 2 l/s/ha whichever is

	greater. It is proposed by WMCE and as discussed with DLRCC that surface water run-off from the site will be attenuated to 2 l/s/ha (21.6 l/s) using a Hydro-brake flow control device, while providing surface water attenuation for the full 1 in 100-year event (plus climate change) within the proposed stormwater design / attenuation system(s). To the south of the site from Catchment A the hydro-brake will limit flow to the existing storm water network at 2 l/s, while to the north of the site Catchment B & C run-off will be limited to 19.6 l/s entering the Broadmeadow River. Following the geotechnical site investigations, it is likely that some run-off will occur from landscaped areas and the design has allowed for a 30% runoff factor (SPR = 0.3) for such areas which is deemed acceptable. It is proposed that no Hydro-brake device will have a clear passage of less than 100mm therefore, blockage of the device is less likely to happen compared to if they were less than 75mm. The minimum freeboard requirements of 500mm as set out in the GDSDS has not been provided for the northern detention basin as the FFL of adjacent properties is only 100mm above the TWL in the basin. Similarly, the central detention basin insufficient freeboard appears to have been provided to surrounding FFL's. Flooding at ground level is indicated in the FLOW output for the 100-year storm plus 20% climate change. The flooding occurs at 3 manhole locations on site as picked up by WMCE in their report (Section 4.6 Catchment C). However, at SWMH49 19m^3 of flooding will occur and it is proposed to allow this to flow into the public park and into the watercourse. This is not acceptable to GDSDS to allow unattenuated flows into a watercourse. To reduce the flood volumes at the three manholes and prevent the flow of unattenuated stormwater into the watercourse JBA have requested WMCE to review and advise on the flooding issues which can be found in the Feedback Form at the end of this report.
Volume Storage	WMCE have provided calculations for the proposed attenuation volumes. Currently, WMCE are proposing an attenuation volume of 21.6m^3 in the soakaway for run-off from Catchment A, an attenuation volume of 800m^3 in the central detention basin for run-off from Catchment B and a final attenuation volume of 2900m^3 for the final run-off from Catchment B & C. These attenuation volumes were sized for the 100-year return period + climate change and is based on Criterion 4.3, Table 6.3 of the GDSDS for all attenuation storage.
Volume Run-off	Greenfield run-off is currently conveyed to the northern boundary of the site following the natural topography of the site. Whereas, the volume may ultimately be increased due to the increased paved area, SuDS measures have been maximised and the discharge from the site is limited to 2 l/s/ha for all storm events as per the requirements of the GDSDS.
Treatment Volume / Water Quality Improvement	At least 5mm of interception storage currently proposed in accordance with Table 24.6 of CIRIA C753. It is noted that not all impermeable areas are intercepted but the stormwater flows through the detention basins and interception volumes are provided in the catchment areas.
Biodiversity	Not deemed viable to enhance biodiversity any further given current proposals incorporate green roofs, swales and detention basins.
Return Period	A 100-year return period plus 20% for climate change has been used in the design for the attenuation systems.

Health & Safety and Maintenance Issues	The proposed drainage system comprises traditional road gullies, manholes, petrol interceptors, swales, detention basins, 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. At detailed design stage, it is recommended that a maintenance regime be adopted. Particular consideration is required at detailed design stage to the design, maintenance requirements and whole life plan (and replacement) of the soakaways and permeable paving. Regular maintenance of the hydro-brake and open grated manhole in the final detention basin will be required to remove any blockages, particularly in the wake of heavy rainfall events or local floods. It is recommended that the petrol interceptor 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.
Design Review Process	Upon review of WMCE initial drainage design, JBA Consulting provided feedback, resulting in some modifications, namely; • Provide sufficient freeboard of 500mm for FFL's against TWL's of detention basins. • The volume of the detention basin needs to be re-examined as the flood levels during the 1% and 0.1% at the point of discharge are much greater than the IL of the outfall to the Broadmeadow River. • Reducing or eliminate the volume of flooding that will occur at 3 no. manholes. • Consider other local SuDS measures to provide local interception of all hardstanding surfaces. • Clearer relationship between the FLOW output information and what is shown on the drawings. A summary of comments and responses are included in the attached Audit Feedback Form. Based on this being at preliminary design stage and a Stage 1 Surface Water Audit, JBA Consulting's comments have all been satisfactorily addressed or sufficient commitment provided that details will be confirmed at detailed design stage.
Audit Result	JBA Consulting considers that the surface water drainage design for the proposed development is acceptable and meets the requirements of the Stage 1 Stormwater Audit.

Audit Report Prepared by:	Jamie Cullen BEng (Hons) MSc. Assistant Engineer
Approved by:	Chris Wason BEng CEng MICE Principal 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 (*Waterman Moylan*). 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:	Residential Development at Holybanks, Swords, Co. Dublin
Date:	05/10/2020
JBA Reviewers	Jamie Cullen - Assistant Engineer
Project Number:	2020s1191

Item No.	JBA Review Comment	Comment/Clarification Request/Suggested Mitigation	Response from Client/Client Representative	Acceptable / Not Acceptable
	05/10/2020		**13/01/2021**	
	Reference Documents - 17-088-P001-Site Location Plan - 17-088-P002-Proposed Roads Layout & Levels (Sheet 1 of 2) - 17-088-P003-Proposed Roads Layout & Levels (Sheet 2 of 2) - 17-088-P200-Proposed Drainage Layout (Sheet 1 of 2) - 17-088-P201-Proposed Drainage Layout (Sheet 2 of 2) - 17-088-P203-SUDS Drainage Layout (Sheet 1 of 2) - 17-088-P204-SUDS Drainage Layout (Sheet 2 of 2) - 17-088-P205-Overland Flood Route (Sheet 1 of 2) - 17-088-P206-Overland Flood Route (Sheet 2 of 2) - 17-088-P207-Catchment Layout - 17-088r.010 EAR_DRAFT - Surface Water Results - BLA-JBAI-XX-XX-RP-HM-0001-S3-P02_Holybank FRA			
1	JBA Flood Risk Assessment The JBA Flood Risk Assessment indicates that the 1% and 0.1% AEP flood levels from the Broadmeadow River at the point of discharge is 6.2mOD and 6.48mOD respectively. This indicates that a gravity discharge from the proposed detention basin is not available at all times which impacts on volume calculations.	Waterman Moylan to consider the implications of a surcharged outfall on the volume requirements of the detention basin for the 1 in 100 year rainfall event and the joint probability of successive rainfall events.	**An analysis has been run for the 1% AEP Flood assuming a level of 6.2mOD on the Broadmeadow River at the point of discharge. It has been designed a peak storm of 3 hours long. Results show that for the 1440 min winter storm the required volume in the detention basin is 3000 m3, which the detention basin has. The model accounts for a maximum level of water in the detention basin of 6.9m. It is proposed to provide 0.3m of freeboard at the north Detention basin being the top side slopes at a level of 7.2. Furthermore, a 0.5m freeboard is provided between the top level of water in the detention basin and the closer FFL of 7.4m. In case of a joint probability of successive rainfall events, the development will have a 30m wide riparian buffer strip from top of bank where not dwellings are proposed. Please see attached amended drawings and Surface water results for a surcharged outfall.**	Acceptable
2	JBA Flood Risk Assessment The JBA Flood Risk Assessment indicates that the 1% and 0.1% AEP flood levels from the Broadmeadow River at the point of discharge is 6.2mOD and 6.48mOD respectively. This indicates that a flood route exists back into the detention basin and the residential development without the provision of a non-return valve on the proposed outfall.	Waterman Moylan to review	**Refer to updated drawings 17-088-P200 and P201 where a non-return valve is located at the point of discharge.**	Acceptable
3	JBA Flood Risk Assessment As per Section 5.2.1 of the FRA, a minimum of 150mm freeboard should be provided between FFL's and external ground levels. It is noted that such freeboard is not provided throughout the development, for example the 3nr apartment blocks towards the north-west of the site.	Waterman Moylan to review	**FFl's have been reviewed and amended in order to provide a minimum of 150mm freeboard.**	Acceptable
4	Drainage Drawing Nr P201 It is noted that the invert level of the northern detention basin is 6.1m with an overall flood depth of 0.8m giving a top water level of 6.9m. However, this only provides 100mm freeboard above the proposed FFL's of 7m and as per the GDSDS, this should be a minimum of 0.5m. In addition, the top water level is the same level as the top of the side slopes around the basin with no freeboard provided.	Waterman Moylan to review	**Refer to updated drawings 17-088-P201 and P211. A minimum 0.5m is now proposed between the flood top level and the FFL's of Duplex blocks I and H. Additionally, a 0.3m freeboard is proposed for the North Detention Basin.**	Acceptable
5	Drainage Drawing Nr P201 Further to item 4 above, there are no details provided to indicate the top water level within the central detention basin. Proposed levels would suggest insufficient freeboard is provided given the proposed apartment block with a FFL of 7m to the north-east corner of the detention basin.	Waterman Moylan to review	**Central detention basin has been amended and will store 620 m3 for the 100 year storm + 20% Climate change. The total storage of this basin is approximately of 900m3, allowing for a total freeboard of 230mm in line with section 6.3.2.1 of GDSDS.**	See Note 20
6	Drainage Drawing Nr P201 The proposed levels to the central detention basin would suggest storm manhole SW55 is exposed.	Waterman Moylan to review	**Manhole cover level amended. Please refer to updated drawing 17-088-P201.**	Acceptable

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7	Waterman Moylan Engineering Assessment Report In section 4.6 of the report, Catchment C it is noted that there is a substantial flood (19m^3) occuring at SWMH49 during an extreme event and it is proposed to let this flood water drain overland and enter the Broadmeadow River. This is not acceptable to the GDSDS as unattenuated flows are not to be discharged into a waterbody.	Waterman Moylan to review and advise.	**Flooding occurring at SWMH49 will flood back to the North Detention Basin where flow will be attenuated prior to discharge to the BroadMeadow River.**	See Note 21
8	Waterman Moylan Engineering Assessment Report In section 4.6 of the report, flooding is shown to occur at SWMH52 & SWMH45 but at much smaller volumes compared to SWMH49 (1.29m^3 & 3.1m^3 respectively) which presents a flood risk to adjacent properties, refer item 3 above re minimum freeboard to be provided.	Waterman Moylan to review and advise.	**Flood volumes from Manholes SWMH52 and SWMH45 will be contained within the kerb levels. Additionally, FFl's of adjacent properties are 150 mm above road levels.**	See Note 22
9	Calculations In the FLOW output a Ratio R value of 0.3 is provided. From the Met Eireann Rainfall Data for the site a M5-60 value of 15.1mm and M5-2day value of 55.4mm were obtained which gives a Ratio R value of 0.273. Is there a reason for the discrepency considering in the FLOW output the M5-60 value are the same?	Waterman Moylan to review and advise.	**Ratio R value of 0.273 has been included in the model.**	Acceptable
10	The FLOW output shows negative values for velocity and outflow at certain node locations for the 30yr and 100yr storm event. Please clarify why this is as it would suggest that the network is not providing the design standard of protection at these locations?	Waterman Moylan to review and advise.	**The negative flow and velocity is back flow in the network caused by the hydro-brake, this is required for the attenuation system to function properly and restrict and store storm water, this is not an issue to the network and is industry design standard, there is no possible way to restrict flow without this happening, if the network was modelled without the hydrobrake, there would be no back flow at this point and pipes flow by gravity.**	Acceptable
11	In the FLOW output the Hydro-brake invert levels do not match the invert levels shown on drawing P200 & P201. There is also 4 Hydro-brakes within the calculations compared 3 displayed on the drawings.	Waterman Moylan to review and advise.	**Hydrobreaks have been amended. There is a 4th Hydrobreak in the model in order to model an additional 2l/s flow from the future school.**	Acceptable
12	5nr swales are shown on the drawings throughout the site for road interception. However, as no road gullies are shown, it is unclear if the subject road(s) have a cross fall towards the swales where no kerb is provided.	Waterman Moylan to review and advise.	**We can confirm that at the location of the swales the roads will be constructed with a road fall towards the swales as can be seen in the details drawing 17-088-P211 and 174-088-P190.**	Acceptable
13	Interception Whereas some access roads are intercepted by the provision of swales, other access roads are not.	Waterman Moylan to review and consider other local SuDS measures to provide local interception of all hardstanding surfaces.	**Where swales are not provided, gullies and permeable paving will redirect water into the system. Refer to attached updated drawings 17-088-P200/P201.**	See Note 23
14	Cover levels and invert levels of multiple manholes on the drawing do not match those in the FLOW outputs. Also some of the nodes in the FLOW output can not be located on the drawings.	Waterman Moylan to review and amend as necessary.	**Refer to attached updated drawings. Nodes 66,67 and 101 in the flow model are auxiliary elements that help model swales. Similarly, some nodes are not included in the Flow model in order to simplified the model and the computational time.**	Acceptable - At detailed design stage all nodes and areas are to be included in the model.
15	In the FLOW output no information is provided on the pipe runs (Links). Information such as the time of travel, time of concentration, associated rainfall intensity and cumulative area contributing to each pipe run should be provided.	Waterman Moylan to review and amend calculations as necessary.	**Please refer to the Surface Water Results which include the information required.**	Acceptable
16	For the simulation settings in the FLOW output there is no climate change factor added to the 30yr storm calculations.	Waterman Moylan to review and amend.	**The Surface Water Management Plan (SWMP) for the Estuary West Masterplan states that a 20% Climate change shall be included for the 1 in 100 year storm.**	Acceptable - At detailed design stage a check should be carried out for the 30yr storm + 10% CC to ensure no surface flooding will occur.
17	For the 1 in 100yr storm event + 20% climate change the FLOW output shows that a number of manholes are under flood risk. What threshold has been set for the onset of flood risk?	Waterman Moylan to review and advise.	**Threshold for flood risk is set at 0.3m.**	Acceptable

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18	Open Grated Manhole Overflow to detention basin is noted to be via an open grated manhole on the bed of the detention basin which, pending on the size of ope etc, will restrict the overflow rate from the storm sewer with likely backing up of flows in the storm network. The backing-up may impact on upstream SuDS features.	Waterman Moylan to review and advise.	**Open Grated Manhole will be sufficient capacity to cater for the inflow and will not affect upstreams SUDS features.**	Acceptable
19	Open Grated Manhole The proposed grated manhole has the potential to be blocked and together with item 18 above, impact on the conveyance of flood flows. In this regard, an operation and maintenance procedure will need to be developed at detailed design stage. Alternatively, reconsider a design detail similar to the central detention basin.	Waterman Moylan to review and advise.	**The open grated manhole will be maintained as part of the Detention Basin Maintenance schedule. An operation and maintenance procedure will be developed at detailed design stage.**	Acceptable
	25/01/2021			
20	Section 6.3.2.1 of the GDSDS on the Storage Pond Flooding states that *"Storage pond water levels are designed specifically, and therefore there is less uncertainty than for river flood water levels. However, property floor levels must be provided with a safety freeboard and it is recommended that this is 500mm."* *"The design of overflow structures for a 200 year event and still providing a freeboard of at least 200mm."* The minimum freeboard from TWL to FFL should be a minimum of 500mm not 200mm.	Waterman Moylan to review and advise.	**Central detention basin - Top of storage level in detention basin - 8.305m OD Malin - Lowest FFL - 8.60m OD Malin, we would note this detention basin does not have the required seperation distance of 500mm however, the unit in question is adjacent to a road at gradient of 1/20, this will direct water flow away from the unit before it ever reaches a level of 8.60m, the adjacent road is at alevel of 7.6m on the northern boundary of the unit in question, 1m lower than the unit level therefore risk of flooding from this detention basin into said unit is extremely unlieky and not an issue.** **North detention basin - Top of storage level in detention basin - 6.824m OD Malin - Lowest FLL - 7.4m OD Malin**	Acceptable
21	From the FLOW results a flood volume of 14.6270m^3 will occur at SWMH49 during the 1 in 100-yr + 20% CC event. By taking an average flood depth of 0.1m an area of 146.27m^2 is required to contain this volume of flood water before it re-enters the system. When taking the 1 in 100-yr + 20% CC event with the surcharged outfall the flood volume increases to 15.8521m^3. Taking the same depth of 0.1m, the area required to store the flood volume is 158.521m^2. How is it proposed to contain the flood water that will occur at SWMH49 and have it flood back into the system and to the northern detention basin?	Waterman Moylan to review and advise.	**This question has been put forward in 2 parts both of which will not occur at same time. If the water is contained on the road, it will not need to flood overland to the detention basin. The intention would be that the water reamins on the road and would re-enter the sytem when the water levels drop and storm passed. This way it would travel through the drainage network by gravity to detention basin. I would note that drainage pipe networks are not required to be desinged for 1 in 100 year storm, this volume is only required to be stored on site and this is covered within the design. We have updated the drainage design to move SWMH49 to end of the road and increased road level to 8.50m. No flooding occurs now at SWMH49.**	Acceptable
22	SWMH52 flood will cover an area of between 2.012m^2 and 2.069m^2 (1 in 100-yr + 20% CC and the surcharged volume) for a flood depth of 0.1m which can be contained within the kerb levels. However, for SWMH45 this flood area would be between 30.607m^2 and 30.047m^2. Is there enough area within the roadway to contain the flood volume in this location and considering the FFL of Duplex Block C is only 50mm above the CL of SWMH45 the FFL should be a minimum 150mm above surrounding ground levels.	Waterman Moylan to review and advise.	**SWMH52 is not contained on a road area but in landsacape, the surcharged volume can drain to landsacped areas from where it will drain naturally to ground or back into netwrok when the storm has passed. SWMH45 is also not contained within the road area but in landscape, the surcharged volume can drain to landscape areas which is quite large surrounding the proposed manhole where it will drain naturally to ground or back to the network once the storm has passed. The area availible for overflow is over 1000m2, the landscape areas in this area has been further reviewed and levels dropped by 100mm to ensure 150mm separation, the flood volume is now 21m3 for MH 45 which can be accomdated within surrounding landscape areas.**	Acceptable

Item No.	JBA Review Comment	Comment/Clarification Request/Suggested Mitigation	Response from Client/Client Representative	Acceptable / Not Acceptable
23	Where impermeable road areas are not intercepted by the swales localised interception through SuDS units should be provided before the stormwater flows enter the drainage network. The permeable pavement areas will only intercept the stormwater which falls directly onto these areas and it is assumed that these areas will also drain the impermeable roof areas therefore no additional area can be drained to this SuDS feature for it to comply with interception requirements as set out in the CIRIA manual. If the permeable pavement is lined the permeable pavement can not drain any additional area other than it's own surface area. The detention basin will not provide interception of the roadway as according to the CIRIA manual "*Areas of the site drained to detention basins with a flat unlined base (without specific provision for routing low flows directly to the outlet) can be assumed to comply, where the drained impermeable surface area is less than 5 times the vegetated surface area receiving the runoff for any soil tupe. The area of the basin that is assumed to contribute to interception of runoff should be below the outlet level of the basin.*" The outlet levels of the basin are lower than the invert levels of the basins therefore, interception is not provided.	Waterman Moylan to review and advise.	**Catchment A, B & C are shown on WM Drg No. 17-088-P207.** **Catchment A has a hardstanding area of 1100m2. Assuming 80% runoff from connected paved surfaces and 0% from pervious surface, the area for purpose of calculations is 880m2, taking 5mm of rainfall, an interception volume of 4.4m3 is required.** **Initial Swale Detail** **A swale of 55m length is provided for this catchment, the swale is 0.6m wide with 0.2m of stone below collection pipe and a void ratio of 0.4 therefore the interception volume is as follows:** **55m x 0.6m x 0.2m x 0.4 = 2.64m3** **Updated Swale Detail** **A swale of 55m length is provided for this catchment, the swale is 1.0m wide with 0.2m of stone below collection pipe and a void ratio of 0.4 therefore the interception volume is as follows:** **55m x 1.0m x 0.2m x 0.4 = 4.4m3** **See attached updated Drawing No. 17-088-P212 SuDS Drainage Detail which reflects swale with correct cross sectional area.** **Catchment B has a hardstanding area of 25000m2. Assuming 80% runoff from connected paved surfaces and 0% from pervious surface, the area for purpose of calculations is 20000m2, taking 5mm of rainfall, an interception volume of 100m3 is required.** **Swales** **Swales of 238m length is provided for this catchment, the swale is 1.0m wide with 0.2m of stone below collection pipe and a void ratio of 0.4 therefore the interception volume is as follows:** **238m x 1.0m x 0.2m x 0.4 = 19.04m3** **Permeable Paving** **3350m2 of permeable paving is provided with Catchment B, the preamble paving detail has been updated so that there is 100mm of storage provided beneath the permeable paving spaces, outlet is 100mm above base. This storage is also with a void ratio of 0.4 therefore:** **3350m2 x 0.1m x 0.4 = 134m3 of interception volume** **There are additional SuDS measures but volume is achieved between swales and permeable paving, see attached updated drawing No. 17-088-P212 for details of updated swale detail** **Catchment C has a hardstanding area of 22000m2. Assuming 80% runoff from connected paved surfaces and 0% from pervious surface, the area for purpose of calculations is 17600m2, taking 5mm of rainfall, an interception volume of 88m3 is required.** **Swales** **Swales of 73m length is provided for this catchment, the swale is 1.0m wide with 0.2m of stone below collection pipe and a void ratio of 0.4 therefore the interception volume is as follows:** **73m x 1.0m x 0.2m x 0.4 = 5.84m3** **Permeable Paving** **2950m2 of permeable paving is provided with Catchment B, the preamble paving detail has been updated so that there is 100mm of storage provided beneath the permeable paving spaces, outlet is 100mm above base. This storage is also with a void ratio of 0.4 therefore:** **2950m2 x 0.1m x 0.4 = 118m3 of interception volume** **There are additional SuDS measures but volume is achieved between swales and permeable paving.**	**Acceptable** **Note: Not all impermeable areas are intercepted but the stormwater flows through the detention basins and interception volumes are provided in the catchments. - Subject to Local Authority Approval**