

Cyfarthfa Retail Park, Costa Drive Thru

TECHNICAL NOTE

Drainage Strategy

DOCUMENT CONTROL SHEET

Issued by: Burrows Graham Limited
5 Ambassador Place
Stockport Road
Altrincham
Cheshire
WA15 8DB

Tel: +44 (0)161 804 8046

Client: Corona Vulcan Merthyr Limited

Project: Cyfarthfa Retail Park, Costa Drive Thru

Document No: 30106-BGL-XX-XX-TN-X-00002

Title: Drainage Strategy

Status: P01

Date: 02/08/2024

Prepared By: Jack Williams CEng MICE MCIHT – Civils Director

Document Revision Record

Version Number	Date	Revision Details
P01	02/08/2024	First Issue

Burrows Graham Limited has prepared this report in accordance with the instructions of the above-named Client for their sole and specific use. Any third parties who may use the information contained herein do so at their own risk.

Introduction

Burrows Graham Ltd. have been appointed by Corona Vulcan Myrtha Limited. To produce a detailed design for planning and SAB submission for the drainage strategy of a Costa Drive-Thru.

The following is the calculations for the permeable paving areas for an EV charging car park at the Cyfarthfa Retail Park in Merthyr Tydfil. Postcode – CF48 1HY, OS – 303970E 206375N.

It is for the end use situation and doesn't include for any temporary / short-term measures / requirements during construction phase.

Drainage Design

The method for removal of surface water from the site has been selected in accordance with the hierarchy outlined in Building Regulations Part H as summarised below:

- Infiltration to the ground
- Discharge to a watercourse
- Connection to a surface water sewer
- Connection to a combined sewer

Based on the site investigation carried out by Ground Investigation Specialists Limited, the site is underlain by a thick layer of made ground associated with the spoil from the Cyfarthfa ironworks (including varying amounts of slag, cinder, coal, ash, pottery, clinker and brick), mixed with suspected spoil from nearby coal and ironstone mining operations (namely argillaceous siltstone, shale and mudstone).

As colliery waste is regarded as hazardous waste use of infiltration on the development has been discounted.

There are no watercourse or public surface water sewers in the vicinity of the site which discounts these as options for discharge.

As such, it is proposed to discharge to the combined sewer to the south of the site within Pantycelyn at a restricted rates of 0.9 l/s. Due to the protection provided by the permeable construction a 25mm orifice from the car park is proposed.

Sustainable Drainage Systems

Sustainable Drainage Systems (SuDS) will be utilised in line with The SuDS Manual (C753) guidance and aim to minimise the impact a development has on the runoff quantity and quality and maximise amenity and biodiversity opportunities.

The management train approach is a fundamental principle of SuDS, it aims to primarily reduce pollution, flow rates and volume of runoff from the site. The main objective is to treat the runoff as close to the source as possible and it is imperative that at least two of the following should be included within the drainage strategy.

- **Prevention** – The use of good site design and rainwater re-use measures to prevent runoff.
- **Source Control** – Controlling the runoff as close to source as possible by using; green roofs, porous pavements and soakaways.
- **Site Control** – Use of water management techniques within local area, i.e. detention basins and geo-cellular storage.
- **Regional Control** – Management of water from a number of sites in a specific location, i.e. balancing ponds and wetlands.

The drainage strategy for this development will incorporate source control using permeable paving in carparking bays and site control measures through the use of attenuation and flow control device which are incorporated to control storm water for all rainfall events.

The design will follow BS: 7533 -13:2009 Pavements constructed with Clay, natural stone or concrete pavers - Guide for the design of permeable pavements constructed with concrete paving blocks and flags, natural stone slabs and setts and clay pavers. The design below outlined in this technical note covers both the structural and then the hydraulic needs of the site.

Should the proposals use porous asphalt surfacing courses the subbase / reservoir will remain the same depth with just the top layers being replaced.

Treatment

The design follows the mitigation indices approach set out in CIRIA C753 and shall specifically achieve the mitigation required as set out below and in Chapter 26.

Table 26.2 classifies this site as a low pollution hazard as below with the following pollution indices for Total Suspended Solids (TSS), Metals and Hydrocarbons.

Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
--	-----	-----	-----	-----

It is proposed that the highest risk car park areas will pass through permeable paving, which in line with Table 26.3 has the required mitigation for a low risk site.

Permeable pavement	0.7	0.6	0.7
--------------------	-----	-----	-----

It is proposed that for the areas that do not pass through the permeable paving, these will be treated via a proprietary SPEL Stormceptor or similar which achieves the required mitigation for low risk sites as below.

SPEL Smartceptor

Certified Mitigation Index

TSS	0.5
Metals	0.4
Hydrocarbons	0.5

As such, we consider the proposed mitigation suitable for this application.

Permeable Pavement Design

Structural Design

Currently the extent and form of permeable / porous paving hasn't been determined with options including:

- Concrete Block Permeable Paving to bays and impermeable asphalt to the aisles.
- Concrete Block Permeable Paving to aisles and impermeable asphalt to the bays.
- CBPP everywhere.
- Porous Asphalt everywhere.

For these calculations it is assumed that the whole parking surface is permeable and the requirements / methodology on BS 7533-13 (2009) will be followed but with some noted variation.

Subgrade:

Ground is to be compacted to provide a CBR $\geq 5\%$ with a 150mm capping layer to support the System C. Should the CBR be lower than 5% the capping layer will be thickened in line with BS 7533-13 Table 10.

Traffic:

Extract of BS 7533-13 Table 6 - Loading categories

B/car parking	100	Emergency vehicles only	• Car parking bays and aisles • Railway station platforms • External car showrooms • Sports stadium pedestrian routes • Footways with occasion overrun • Private drives • Footway crossover
---------------	-----	-------------------------	---

The final use is considered to be a Category B.

From BS 7533-13 Table 8 the pavement course material course and thickness is:

Table 8 System C – selection of pavement course material and thickness

Category/application	Block/laying course mm	Hydraulically bound base mm	Course graded material mm	Capping layer mm
A/domestic	80/50	—	250	150
B/car parking	80/50	—	350	150
C/pedestrian	80/50	125	150	150

Therefore, the structural design proposal would be:

- 80mm minimum thickness of block paving laid in a herringbone pattern OR 50mm nominal thickness of laying course, on
- 350mm of course graded material wrapped with an impermeable liner, on
- 150mm Capping.

Hydraulic Design

Permeable pavement thickness:

The hydraulic characteristics of the site have been taken as:

M5-60: 20	R: 0.2	SAAR: 1600
Hydraulic region: 9	SOIL: 5	SPR: 0.53

From BS 7533-13 Table 4 the sub-base thickness for a System C:

Table 4 Sub-base thickness for System C

Rainfall data	r ^{A)}	Required sub-base thickness mm		
		1 in 30 year event	1 in 100 year event	1 in 100 year event plus 20% climate change
M60 ^{B)} = 20 mm	0.4	120	160	210
	0.3	140	190	240
	0.2	180	250	310
M60 = 17 mm	0.4	100	140	190
	0.3	120	160	210
	0.2	150	210	270
M60 = 14 mm	0.4	—	—	—
	0.3	90	130	170
	0.2	120	160	220

^{A)} Ratio of a 60-minute storm rainfall depth to the depth of the 2-day maximum rainfall depth.

^{B)} 60-minute storm recurring every 5 years.

The sub-base thickness for the site for the 1 in 30-year event would be 180mm but the access road is impermeable and falls into the site and needs consideration.

BS 7533-13 Table 5 includes for impermeable contributing to permeable and gives a depth of 260mm for the site on the 1in30-year event.

Table 5 Sub-base thickness for System C collecting impermeable area

Rainfall data	r^A	Required sub-base thickness mm		
		1 in 30 year event	1 in 100 year event	1 in 100 year event plus 20% climate change
$M_5-60 = 20 \text{ mm}$	0.4	230	340	450
	0.3	240	390	480
	0.2	260	400	530
$M_5-60 = 17 \text{ mm}$	0.4	190	270	360
	0.3	190	280	380
	0.2	200	320	440
$M_5-60 = 14 \text{ mm}$	0.4	—	—	—
	0.3	140	210	290
	0.2	140	230	330

NOTE Thickness assumes sub-base has a voids ratio of 30%.

Infiltration rate greater than $1 \times 10^{-5} \text{ m/s}$.

Maximum ratio of impermeable to permeable is 2:1.

A) Ratio of a 60-minute storm rainfall depth to the depth of the 2-day maximum rainfall depth.

To ensure there is no flooding offsite from the 100 year event a depth of sub-base of 400mm should be considered. This coupled with the attenuation tank on site will provide adequate protection to the site in the 100 year plus 20% event.

Conclusion

As the thickness for the hydraulic design requirements is greater than the strength design the final construction is based on the hydraulic design.

The design is based on the end usage with a BS 7533-13 Traffic Category B / Car parking with emergency vehicles only.

Hydraulic calculations using Causeway Flow have been undertaken using a Car Park storage structure with a depth of 0.40m at a cover of 0.15m, so excluding the volume in the surfacing, using a 0.3 porosity for the void ratio of the stone.

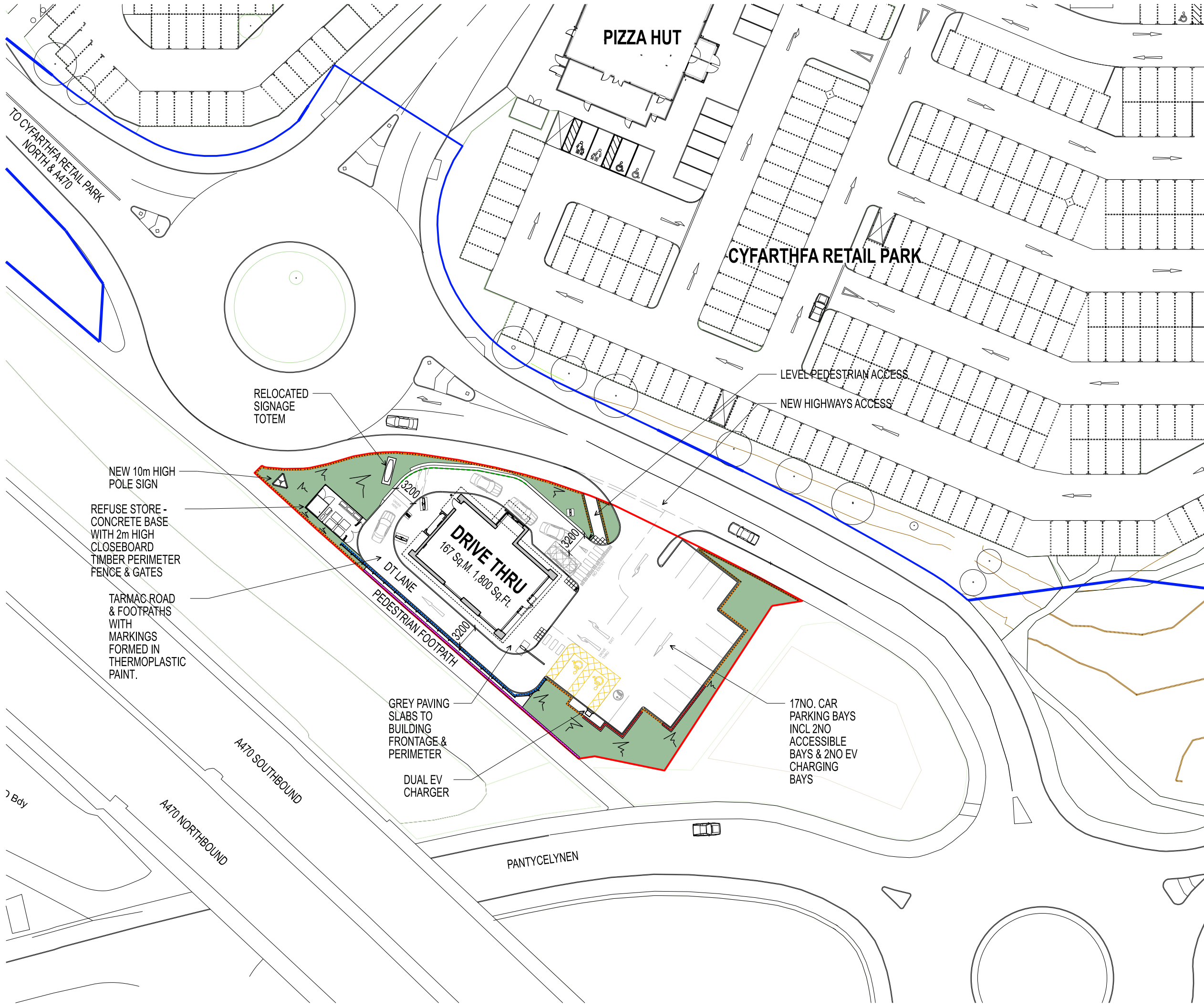
There is no flooding for the 1 in 30 year + 20% climate change or the 100 year + 20% climate change.

The 1 in 100year +40% climate change has been checked for sensitivity and there is no flooding in this event.

The calculations are appending to the end of this note.

APPENDIX A – PROPOSED SITE LAYOUT

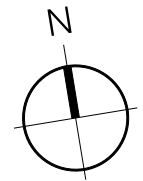
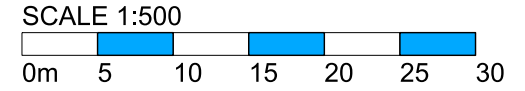
chrisjoneson 23/07/2024 14:51:38 P:\0000011000\11400-11499\114281-Sheets\11428-DT-FL-L02.dgn Costa Unit, Cyfarthfa South, Merthyr Tydfil



THIS DRAWING IS PROTECTED BY COPYRIGHT AND MUST NOT BE COPIED OR REPRODUCED WITHOUT THE WRITTEN CONSENT OF R G PARTNERSHIP LIMITED. NO DIMENSIONS ARE TO BE SCALED FROM THIS DRAWING. ALL DIMENSIONS AND SIZES TO BE CHECKED ON SITE, NORTH POINTS SHOWN ARE INDICATIVE. ©

SITE SPECIFIC HAZARDS

IN ACCORDANCE WITH THE REQUIREMENTS OF THE CDM REGULATIONS 2015 THE FOLLOWING SIGNIFICANT RESIDUAL HAZARDS HAVE NOT BEEN DESIGNED OUT OF THIS PROJECT AND MUST BE TAKEN INTO CONSIDERATION BY CONTRACTORS PLANNING TO UNDERTAKE THE WORKS SHOWN ON THIS DRAWING:



NOTES

EXTERNAL LIGHTING DESIGN TO BE CONFIRMED.
REFER TO LANDSCAPE DESIGNER'S INFORMATION FOR DETAILS OF SOFT LANDSCAPING.

KEY

- : GREY STONE FACED RETAINING STRUCTURE
- : 450mm HIGH TIMBER KNEE RAIL
- : 1100mm HIGH TIMBER POST & RAIL GUARDING
- : GREY STONE FACE RETAINING STRUCTURE WITH TIMBER POST & RAIL GUARDING TO HEIGHT OF 1100mm ABOVE CAR PARK LEVEL.
- : 1100mm HIGH TIMBER CLAD VEHICLE CONTAINMENT SYSTEM WITH INTEGRATED HANDRAIL / PEDESTRIAN GUARDING
- : DOUBLE STACKED TRIEF KERB RETAINING STRUCTURE

REV.	DATE	NOTES	INIT.
------	------	-------	-------

CLIENT / PROJECT
BROOKFIELD PROPERTIES
PROPOSED DRIVE THRU, LAND TO SOUTH OF CYFARTHFA RETAIL PARK

DRAWING TITLE
PROPOSED SITE PLAN

STATUS
PLANNING

DATE	DRAWN	SCALE @ A3
JULY 2024	CMP	1:500

PROJECT NUMBER	UNIT / BLOCK	CI / SFB CODE	TYPE & NUMBER	REVISION LETTER
----------------	--------------	---------------	---------------	-----------------

DRAWING NO.	11428	DT	PL	L02	-
-------------	-------	----	----	-----	---

Site Location Plans	L	GA Plans	P	Elevations	E
Sections	S	Details	D	Prefix: Colour	C

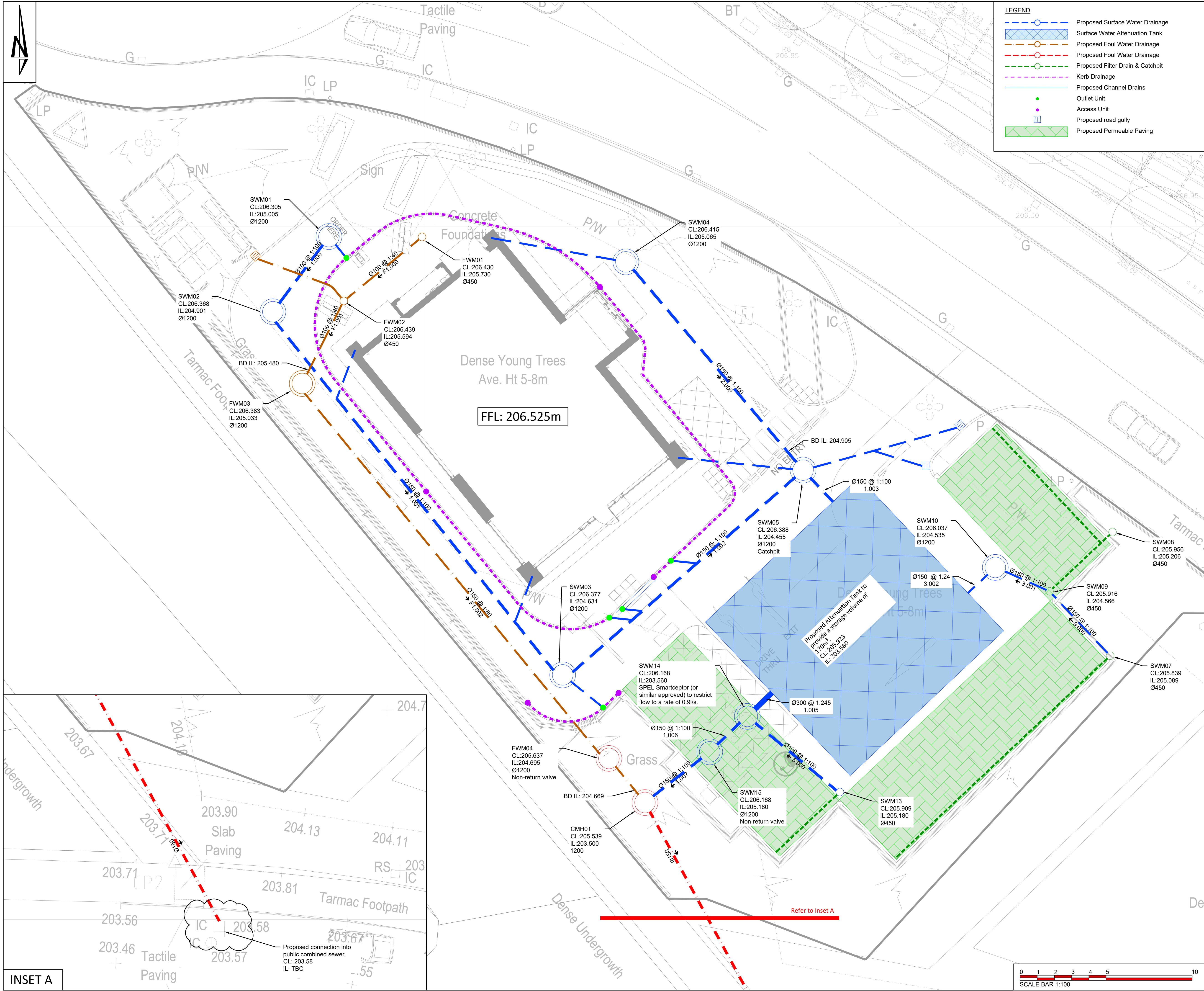
THE RATCLIFFE GROVES PARTNERSHIP

MANCHESTER
105 MANCHESTER ROAD
BURY LANCASHIRE BL9 0TD
T. 0161 797 6000 E. manchester@rgp.uk.com
www.rgp.uk.com

LONDON
19 BEDFORD ROW
LONDON WC1R 4EB
T. 020 7600 6666 E. london@rgp.uk.com



APPENDIX B – PROPOSED DRAINAGE STRATEGY



THIS DRAWING IS THE COPYRIGHT OF BURROWS GRAHAM LIMITED.

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING

CONSTRUCTION

MAINTENANCE

DEMOLITION

IT IS ASSUMED THAT ALL WORKS WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROVED METHOD STATEMENT

GENERAL NOTES:

1. This drawing shall be read in conjunction with all the relevant architects, engineers' and service engineers drawings & specifications.

2. All units in millimeters U.O.N. on the drawing. Do not scale off the drawing.

3. All temporary works for formwork, excavations etc. to be the design responsibility of the Contractor.

4. The Contractor shall allow for the protection, temporary and permanent support and diversion works as necessary, to all existing services to the satisfaction of the soil owners.

5. The Contractor shall allow for dealing with surface water run-off into excavations and from groundwater by means of sumps, pumping and dewatering as appropriate, in order to keep the excavation as reasonably dry as possible during the construction of the works.

6. The Contractor is responsible for obtaining all required permits and licenses.

7. All private drainage within the site is to comply with the requirements of the relevant British/European Standard, (including BS EN 752, BS EN 650, BS EN 295, BS EN 1917, BS EN 11, BS EN 11, BS EN 124), and the Building Regulations Part H.

8. Any adoptable drainage is to be in accordance with the requirements of the adopting authority. If in doubt seek clarification.

9. All pipework within chambers are to be laid soffit to soffit (U.O.N). All chamber invert levels are for the outgoing pipe levels. Backdrop pipework shall be connected at soffit to soffit with the backdrop / adding access level specified.

10. Catchpit invert levels are for the outgoing pipe, pipes to be soffit level, sump level specified separately. All Catchpits are to be built with a 300 sump (U.O.N).

11. Any gradients of drains indicated are indicative only and the Contractor shall install the drains to the specified levels shown for each chamber (U.O.N).

12. Cover levels of the access points are provisional and subject to adjustment on site to suit the finished ground levels.

13. Positions and sizes of above ground foul and surface water drainage connections ("pop-ups") are indicative only. Setting out and confirmation of the internal requirements is the responsibility of the Architect. Contractor to confirm requirement prior to construction.

14. Ø of PCC manholes varies with pipe size, number of connections, depth etc. Minimum sizes are shown on the Burrows Graham Standard Details drawings. Sizes shown on drainage layout and/or manhole schedules take precedence over minimum sizes.

15. Flow control chambers should be built in accordance with the requirement of the manufacturer. Allowance should be made for a 600 sump and double covers and frames on the chambers.

16. Initial concrete grades to be as stated on the drawings. Design chemical class for all precast concrete products shall be C40 unless agreed otherwise.

17. All separators shall be in accordance with Building Regulations Part H3-A and with BS EN 858 and be site-marked / CL marked in accordance. The oil alarm system is to be in accordance with Client's requirements. Separators to be installed in accordance with manufacturer's recommendations / requirements (venting, protection etc)

18. All below ground plastic/GRP tanks shall be installed in accordance with the manufacturers instructions / requirements. They shall be provided with sufficient concrete surround to counter floatation and shall have a wall thickness adequate to resist the highest ground water level which could be encountered at their location.

19. All existing drainage/structures to be abandoned shall be broken out and removed from site, the excavation shall be backfilled with a suitable granular material to the required level. Alternatively, deep drains may be cleaned and grouted with a 1:10 cementitious grout, with structures broken down to 1m below proposed finished ground level and infilled with a suitable granular material. Abandoned gullies are to be removed from site and abandoned tails are to be sealed with a 300 thick concrete plug at a depth of 1.0m below proposed finished ground level.

20. Where utility/land drainage trenches etc cross over drainage trenches, the Contractor shall construct an impermeable barrier to prevent groundwater infiltrating into the drainage trench.

21. Design assumes that no sewerage authority sewers or other drainage systems require modification, diversion or abandoning (U.O.N on the drawings). Unless otherwise agreed, all outfalls to ponds and watercourses to be proprietary PCC units. Where applicable, headwall details are to be approved by the relevant authority (i.e. Internal Drainage Board / Lead Local Flood Authority / Environment Agency / Highway Authority).

22. All headwalls to have guardrail and headwalls with pipes greater than Ø375 to have a trash screen/grating fitted.

23. All manholes less than 1.5m deep are considered as none man entry and shall be maintained from ground level.

24. Upon completion of the works, the Contractor shall clean all drainage by jetting, removing all debris from site and the system is to be CCTV surveyed. No debris shall be permitted to enter the existing drainage system.

25. No deep rooting trees/vegetation should be planted within 5.0m of any drainage works.

26. The storage and installation of all proprietary drainage items used are to be strictly in accordance with the manufacturers instructions / requirements.

27. Any works within the public highway to be reinstated to highway authority requirements. All relevant permits/licenses must be sought by the contractor prior to the works being undertaken.

28. Peristocks, where indicated, shall be electronically operated complete with power supply and connection (refer to service engineers drawings for cable and ducting etc.)

29. Statutory Undertakers information, where shown, is indicative only based on supplied records. The contractor shall verify the depth position and nature of the services as necessary in order to construct the works.

30. Drainage channels are to be ACO Omix in service yards and ACO Multidrain in car parks, or similar approved. Channels are to be sized by the supplier and approved by the Engineer in writing prior to ordering. Drainage channels to be installed to manufacturers' requirements. Design of channels shall be based on a 1 in 30 year storm return period, 15 minute duration. Outlet units on channel drains to include silt traps.

31. All RWPs, gully and channel connections shall be Ø150 U.O.N. Waste/soil stack connections shall be Ø100mm U.O.N. and shall have internal above ground rodding eyes or large access fittings in accordance with Building Regulations.

32. All WPC, SWP's and RWPs are shown indicatively. Locations shall be confirmed by others.

33. Siphonic break chambers (i.e. with SWP entering) to be constructed with open grated manhole covers. ("Waterway 2000" or similar approved).

34. All sprinkler drain, gully locations and flow rates to be confirmed by the sprinkler Contractor. Potential local storage manholes for sprinkler discharge are to be confirmed following definition of system requirements. It is assumed that future sprinkler installation points will be located close to foul water drainage runs.

35. Below ground drainage connections to be provided to all canopy downpipes.

36.1. Ø150mm with concrete bed and surround U.O.N.

36.2. All rising mains to be laid at minimum gradients of 1:500 rising and 1:300 falling. Air valves and washout valves may be required at high and low points respectively.

P02	09.08.24	JB	Issued for Information	JW
P01	02.08.24	JB	Issued for Information	JW
REV	DATE	BY	DESCRIPTION	CHKD

Burrows Graham

North Office:
5 Ambassador Place, Stockport Road,
Altrincham WA15 8DB
Tel: +44 (0)161 804 8046
South Office:
Buckland House, Dower Mews,
High Street, Berkhamsted HP4 2BL
Tel: +44 (0)1442 508 402

CLIENT
BROOKFIELD

PROJECT
CYFARTHFA RETAIL PARK
COSTA COFFEE DRIVE THRU

DRAWING TITLE
PROPOSED DRAINAGE STRATEGY

BGL PROJECT NUMBER 30106	DRAWING STATUS PRELIMINARY	OFFICE NORTH
SCALE @ A1 1:100	DATE 02.08.2024	DRAWN BY JB
DRAWING No 30106-BGL-XX-XX-DR-C-00250	CHECKED BY JW	REV P02

APPENDIX C – SURFACE WATER HYDRAULIC CALCULATIONS



Design Settings

Rainfall Methodology	FEH-13	Minimum Velocity (m/s)	1.00
Return Period (years)	30	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	0.750	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	x
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Depth (m)
1	0.021	5.00	206.305	1200	1.300
2	0.003	5.00	206.368	1200	1.467
3	0.021	5.00	206.377	1200	1.746
4	0.018	5.00	206.415	1200	1.350
5	0.008	5.00	206.388	1200	1.933
6			206.366		1.936
7	0.035	5.00	205.839	450	0.750
8		5.00	205.956	450	0.750
9	0.005	5.00	205.916	450	1.350
10	0.005	5.00	206.037	1200	1.502
11			206.041		1.665
Attenuation Tank	0.035	5.00	206.169		2.589
13	0.010	5.00	205.909	450	0.729
14	0.010	5.00	206.168	1200	2.600
CMH01			205.539	1200	2.049
EXMH01			203.580	1200	1.350
15			206.168	1200	2.630

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	1	2	5.444	0.600	205.005	204.951	0.054	100.0	100	5.12	50.0
1.001	2	3	26.974	0.600	204.901	204.631	0.270	100.0	150	5.57	50.0
1.002	3	5	17.599	0.600	204.631	204.455	0.176	100.0	150	5.86	50.0
2.000	4	5	15.984	0.600	205.065	204.905	0.160	100.0	150	5.27	50.0
1.003	5	6	2.515	0.600	204.455	204.430	0.025	100.0	150	5.90	50.0
1.004	6	Attenuation Tank	10.164	0.600	204.430	203.580	0.850	12.0	150	5.96	50.0
3.000	7	9	5.178	0.600	205.089	204.566	0.523	9.9	150	5.03	50.0
4.000	8	9	5.025	0.600	205.206	204.566	0.640	7.9	150	5.02	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	0.769	6.0	2.8	1.200	1.317	0.021	0.0	48	0.756
1.001	1.005	17.8	3.2	1.317	1.596	0.024	0.0	43	0.763
1.002	1.005	17.8	6.1	1.596	1.783	0.045	0.0	61	0.912
2.000	1.005	17.8	2.5	1.200	1.333	0.018	0.0	38	0.709
1.003	1.005	17.8	9.6	1.783	1.786	0.071	0.0	79	1.025
1.004	2.929	51.8	9.6	1.786	2.439	0.071	0.0	44	2.247
3.000	3.220	56.9	4.7	0.600	1.200	0.035	0.0	29	1.953
4.000	3.618	63.9	0.0	0.600	1.200	0.000	0.0	0	0.000

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
3.001	9	10	3.134	0.600	204.566	204.535	0.031	100.0	150	5.08	50.0
3.002	10	11	2.481	0.600	204.535	204.430	0.105	23.6	150	5.10	50.0
3.003	11	Attenuation Tank	12.764	0.600	204.376	203.580	0.796	16.0	150	5.18	50.0
1.005	Attenuation Tank	14	3.007	0.600	203.580	203.568	0.012	245.0	300	6.01	50.0
5.000	13	14	6.938	0.600	205.180	205.111	0.069	100.0	100	5.15	50.0
1.008	CMH01	EXMH01	18.904	0.600	203.500	202.230	1.270	14.9	150	6.26	50.0
1.006	14	15	2.999	0.600	203.568	203.538	0.030	100.0	150	6.06	50.0
1.007	15	CMH01	4.774	0.600	203.538	203.490	0.048	99.5	150	6.14	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
3.001	1.005	17.8	5.4	1.200	1.352	0.040	0.0	57	0.881
3.002	2.080	36.8	6.0	1.352	1.461	0.045	0.0	41	1.547
3.003	2.528	44.7	6.0	1.515	2.439	0.045	0.0	37	1.773
1.005	1.000	70.7	20.4	2.289	2.300	0.151	0.0	110	0.867
5.000	0.769	6.0	1.4	0.629	0.957	0.010	0.0	32	0.621
1.008	2.624	46.4	23.1	1.889	1.200	0.170	0.0	75	2.620
1.006	1.005	17.8	23.1	2.450	2.480	0.170	0.0	150	1.024
1.007	1.007	17.8	23.1	2.480	1.899	0.170	0.0	150	1.026

Simulation Settings

Rainfall Methodology	FEH-13	Analysis Speed	Normal	Additional Storage (m³/ha)	20.0
Summer CV	0.750	Skip Steady State	x	Check Discharge Rate(s)	x
Winter CV	0.840	Drain Down Time (mins)	240	Check Discharge Volume	x

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440
----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	------

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0
30	20	0	0
100	20	0	0
100	40	0	0

Node 14 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	203.568	Product Number	CTL-SHE-0039-9000-1700-9000
Design Depth (m)	1.700	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	0.9	Min Node Diameter (mm)	1200

Node Attenuation Tank Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	203.580
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)
0.000	150.0	0.0	1.200	150.0	0.0	1.201	0.0	0.0

Node 13 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	205.180	Slope (1:X)	30.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	0	Depth (m)	0.400
Safety Factor	2.0	Width (m)	4.800	Inf Depth (m)	
Porosity	0.30	Length (m)	13.300		

Node 7 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	205.089	Slope (1:X)	300.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	0	Depth (m)	0.400
Safety Factor	2.0	Width (m)	4.800	Inf Depth (m)	
Porosity	0.30	Length (m)	16.800		

Node 9 Carpark Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Invert Level (m)	204.566	Slope (1:X)	30.0
Side Inf Coefficient (m/hr)	0.00000	Time to half empty (mins)	480	Depth (m)	0.400
Safety Factor	2.0	Width (m)	4.800	Inf Depth (m)	
Porosity	0.30	Length (m)	9.600		

Results for 2 year Critical Storm Duration. Lowest mass balance: 99.36%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	10	205.051	0.046	2.4	0.0666	0.0000	OK
15 minute winter	2	11	204.940	0.039	2.6	0.0454	0.0000	OK
15 minute winter	3	11	204.685	0.054	4.9	0.0745	0.0000	OK
15 minute winter	4	10	205.100	0.035	2.1	0.0490	0.0000	OK
15 minute winter	5	11	204.525	0.070	7.9	0.0848	0.0000	OK
15 minute winter	6	10	204.472	0.042	7.9	0.0000	0.0000	OK
15 minute winter	7	11	205.116	0.027	4.0	0.1827	0.0000	OK
15 minute summer	8	1	205.206	0.000	0.0	0.0000	0.0000	OK
15 minute winter	9	11	204.621	0.055	4.4	0.0831	0.0000	OK
15 minute winter	10	11	204.574	0.039	4.9	0.0469	0.0000	OK
15 minute winter	11	10	204.411	0.035	4.9	0.0000	0.0000	OK
1440 minute winter	Attenuation Tank	1320	203.964	0.384	2.4	54.7926	0.0000	SURCHARGED
15 minute winter	13	11	205.210	0.030	1.1	0.0333	0.0000	OK
1440 minute winter	14	1350	203.963	0.395	0.6	0.4758	0.0000	SURCHARGED
120 minute winter	CMH01	94	203.512	0.022	0.5	0.0244	0.0000	OK
120 minute winter	EXMH01	94	202.242	0.011	0.5	0.0000	0.0000	OK
120 minute winter	15	92	203.556	0.018	0.5	0.0205	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	1	1.000	2	2.3	0.690	0.384	0.0183	
15 minute winter	2	1.001	3	2.6	0.562	0.147	0.1259	
15 minute winter	3	1.002	5	4.9	0.719	0.278	0.1211	
15 minute winter	4	2.000	5	2.0	0.665	0.115	0.0490	
15 minute winter	5	1.003	6	7.9	1.319	0.443	0.0152	
15 minute winter	6	1.004	Attenuation Tank	7.9	2.807	0.153	0.0380	
15 minute winter	7	3.000	9	3.8	1.002	0.068	0.0205	
15 minute summer	8	4.000	9	0.0	0.000	0.000	0.0141	
15 minute winter	9	3.001	10	4.4	0.922	0.246	0.0149	
15 minute winter	10	3.002	11	4.9	1.383	0.132	0.0087	
15 minute winter	11	3.003	Attenuation Tank	4.9	2.071	0.110	0.0452	
1440 minute winter	Attenuation Tank	1.005	14	0.5	0.097	0.007	0.2118	
15 minute winter	13	5.000	14	1.1	0.572	0.182	0.0133	
1440 minute winter	14	Hydro-Brake®	15	0.5				
120 minute winter	CMH01	1.008	EXMH01	0.5	0.877	0.012	0.0116	10.3
120 minute winter	15	1.007	CMH01	0.5	0.393	0.030	0.0066	

Results for 30 year +20% CC Critical Storm Duration. Lowest mass balance: 99.36%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	11	205.128	0.123	7.2	0.1787	0.0000	SURCHARGED
15 minute winter	2	11	204.971	0.070	7.8	0.0814	0.0000	OK
15 minute winter	3	11	204.741	0.109	14.9	0.1504	0.0000	OK
15 minute winter	4	10	205.128	0.063	6.3	0.0887	0.0000	OK
15 minute winter	5	11	204.596	0.141	23.5	0.1715	0.0000	OK
15 minute winter	6	10	204.501	0.071	23.6	0.0000	0.0000	OK
15 minute winter	7	11	205.135	0.046	12.1	0.5096	0.0000	OK
15 minute summer	8	1	205.206	0.000	0.0	0.0000	0.0000	OK
15 minute winter	9	11	204.671	0.105	13.2	0.2693	0.0000	OK
15 minute winter	10	11	204.609	0.074	14.7	0.0879	0.0000	OK
1440 minute winter	11	1350	204.475	0.099	1.4	0.0000	0.0000	OK
1440 minute winter	Attenuation Tank	1350	204.475	0.895	4.6	127.7500	0.0000	SURCHARGED
15 minute winter	13	11	205.237	0.057	3.5	0.0931	0.0000	OK
1440 minute winter	14	1350	204.474	0.906	1.0	1.0914	0.0000	SURCHARGED
1440 minute winter	CMH01	1350	203.513	0.023	0.7	0.0259	0.0000	OK
1440 minute winter	EXMH01	1350	202.243	0.013	0.7	0.0000	0.0000	OK
1440 minute winter	15	1350	203.559	0.021	0.7	0.0232	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	1	1.000	2	6.9	0.892	1.147	0.0405	
15 minute winter	2	1.001	3	7.9	0.716	0.442	0.2936	
15 minute winter	3	1.002	5	14.8	0.942	0.835	0.2726	
15 minute winter	4	2.000	5	6.1	0.895	0.346	0.1098	
15 minute winter	5	1.003	6	23.6	1.786	1.329	0.0318	
15 minute winter	6	1.004	Attenuation Tank	23.2	3.163	0.447	0.1202	
15 minute winter	7	3.000	9	11.6	1.332	0.204	0.0458	
15 minute summer	8	4.000	9	0.0	0.000	0.000	0.0319	
15 minute winter	9	3.001	10	13.2	1.206	0.741	0.0340	
15 minute winter	10	3.002	11	14.6	1.825	0.398	0.0199	
1440 minute winter	11	3.003	Attenuation Tank	1.4	0.733	0.031	0.1909	
1440 minute winter	Attenuation Tank	1.005	14	0.8	0.099	0.012	0.2118	
15 minute winter	13	5.000	14	3.4	0.762	0.559	0.0307	
1440 minute winter	14	Hydro-Brake®	15	0.7				
1440 minute winter	CMH01	1.008	EXMH01	0.7	0.945	0.015	0.0137	54.4
1440 minute winter	15	1.007	CMH01	0.7	0.436	0.038	0.0075	

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 99.36%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	11	205.187	0.182	9.0	0.2633	0.0000	SURCHARGED
15 minute winter	2	11	204.980	0.079	9.8	0.0927	0.0000	OK
15 minute winter	3	11	204.820	0.189	18.6	0.2595	0.0000	SURCHARGED
15 minute winter	4	10	205.137	0.072	7.9	0.1013	0.0000	OK
1440 minute winter	5	1380	204.640	0.185	2.4	0.2241	0.0000	SURCHARGED
1440 minute winter	6	1380	204.640	0.210	2.4	0.0000	0.0000	SURCHARGED
15 minute winter	7	11	205.141	0.052	15.2	0.6380	0.0000	OK
15 minute summer	8	1	205.206	0.000	0.0	0.0000	0.0000	OK
15 minute winter	9	11	204.688	0.122	16.5	0.3611	0.0000	OK
1440 minute winter	10	1380	204.640	0.105	1.6	0.1246	0.0000	OK
1440 minute winter	11	1380	204.640	0.264	3.4	0.0000	0.0000	SURCHARGED
1440 minute winter	Attenuation Tank	1380	204.640	1.060	5.3	151.2694	0.0000	SURCHARGED
15 minute winter	13	11	205.246	0.066	4.3	0.1185	0.0000	OK
1440 minute winter	14	1380	204.639	1.071	0.9	1.2894	0.0000	SURCHARGED
1440 minute winter	CMH01	1380	203.513	0.023	0.7	0.0264	0.0000	OK
1440 minute winter	EXMH01	1380	202.244	0.013	0.7	0.0000	0.0000	OK
1440 minute winter	15	1380	203.559	0.021	0.7	0.0241	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	1	1.000	2	8.6	1.098	1.422	0.0417	
15 minute winter	2	1.001	3	9.8	0.712	0.552	0.3647	
15 minute winter	3	1.002	5	17.7	1.028	0.996	0.3098	
15 minute winter	4	2.000	5	7.7	0.947	0.435	0.1303	
1440 minute winter	5	1.003	6	2.4	0.972	0.135	0.0443	
1440 minute winter	6	1.004	Attenuation Tank	2.4	1.244	0.046	0.1789	
15 minute winter	7	3.000	9	14.5	1.402	0.256	0.0537	
15 minute summer	8	4.000	9	0.0	0.000	0.000	0.0375	
15 minute winter	9	3.001	10	16.4	1.267	0.926	0.0402	
1440 minute winter	10	3.002	11	3.4	1.017	0.094	0.0381	
1440 minute winter	11	3.003	Attenuation Tank	1.6	0.733	0.036	0.2247	
1440 minute winter	Attenuation Tank	1.005	14	0.7	0.105	0.010	0.2118	
15 minute winter	13	5.000	14	4.2	0.797	0.691	0.0363	
1440 minute winter	14	Hydro-Brake®	15	0.7				
1440 minute winter	CMH01	1.008	EXMH01	0.7	0.967	0.016	0.0144	57.8
1440 minute winter	15	1.007	CMH01	0.7	0.450	0.041	0.0078	

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.36%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	11	205.242	0.237	10.5	0.3431	0.0000	SURCHARGED
1440 minute winter	2	1380	205.232	0.331	0.9	0.3876	0.0000	SURCHARGED
1440 minute winter	3	1380	205.231	0.600	1.8	0.8249	0.0000	SURCHARGED
1440 minute winter	4	1380	205.232	0.167	0.7	0.2334	0.0000	SURCHARGED
1440 minute winter	5	1380	205.233	0.778	2.8	0.9443	0.0000	SURCHARGED
1440 minute winter	6	1380	205.233	0.803	2.8	0.0000	0.0000	SURCHARGED
1440 minute winter	7	1380	205.232	0.143	1.4	2.9335	0.0000	OK
1440 minute winter	8	1380	205.230	0.024	0.1	0.0039	0.0000	OK
1440 minute winter	9	1380	205.232	0.666	1.6	3.4958	0.0000	SURCHARGED
1440 minute winter	10	1380	205.232	0.697	1.8	0.8312	0.0000	SURCHARGED
1440 minute winter	11	1380	205.232	0.856	4.3	0.0000	0.0000	SURCHARGED
1440 minute winter	Attenuation Tank	1380	205.231	1.651	6.1	171.5169	0.0000	SURCHARGED
15 minute winter	13	11	205.254	0.074	5.1	0.1459	0.0000	OK
1440 minute winter	14	1380	205.231	1.662	3.4	2.0016	0.0000	SURCHARGED
1440 minute winter	CMH01	1380	203.515	0.025	0.9	0.0278	0.0000	OK
1440 minute winter	EXMH01	1380	202.245	0.015	0.9	0.0000	0.0000	OK
1440 minute winter	15	1380	203.562	0.024	0.9	0.0267	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	1	1.000	2	10.0	1.276	1.654	0.0421	
1440 minute winter	2	1.001	3	0.9	0.416	0.051	0.4749	
1440 minute winter	3	1.002	5	1.8	0.550	0.101	0.3098	
1440 minute winter	4	2.000	5	0.7	0.488	0.039	0.2814	
1440 minute winter	5	1.003	6	2.8	1.020	0.158	0.0443	
1440 minute winter	6	1.004	Attenuation Tank	2.8	1.244	0.054	0.1789	
1440 minute winter	7	3.000	9	1.4	0.752	0.025	0.0904	
1440 minute winter	8	4.000	9	-0.1	-0.008	-0.001	0.0489	
1440 minute winter	9	3.001	10	1.6	0.707	0.090	0.0552	
1440 minute winter	10	3.002	11	4.3	1.053	0.116	0.0437	
1440 minute winter	11	3.003	Attenuation Tank	1.8	0.733	0.040	0.2247	
1440 minute winter	Attenuation Tank	1.005	14	3.4	0.048	0.048	0.2118	
15 minute winter	13	5.000	14	4.9	0.821	0.811	0.0413	
1440 minute winter	14	Hydro-Brake®	15	0.9				
1440 minute winter	CMH01	1.008	EXMH01	0.9	1.023	0.019	0.0165	64.4
1440 minute winter	15	1.007	CMH01	0.9	0.489	0.050	0.0087	