Alveston Hill

Basis of Design and Drainage Strategy

South Gloucestershire Council

02 October 2023

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This document has 18 pages including the cover.

Technical Note

Project:	Alveston Hill		
Subject:	Highway Drainage – Basis of Design and Drainage Strategy		
Date:	02/10/2023	Project No.:	5220316

Document history

Document title: Basis of Design and Drainage Strategy

Document reference: WECA_SGC-ATK-HDG-5220316-RP-CD-000001

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
C01	First Issue	AP	VV	HV	MM	02/10/23

Client signoff

Client	South Gloucestershire Council
Project	Alveston Hill
Project No.	5220316
Client signature / date	

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- See Bound Document "Alveston Hill Appendices for Basis of Design and Drainage Strategy"

1. Introduction

1.1. Scope

AtkinsRéalis, was commissioned by South Gloucestershire Council (SGC).This Basis of Design sets out the design parameters, requirements, and methodology to be adopted for the highway drainage design associated with the Alveston Hill in South Gloucestershire.

2. Existing Site Information

2.1. Site Description

The Alveston Hill cycle scheme is located near the B4061 highway between the village of Alveston and town of Thornbury, north of Bristol. The proposed cycle path alignment joins the A38 in the south of the site and will run along the western side of the existing Alveston Hill road (B4061) for approximately 485 m before crossing to the eastern side for approximately 180 m and entering fields. The cycleway crosses through fields to the east of the B4061 for approximately 600 m until Thornbury leisure centre where the cycleway follows Vilner Lane off road via an existing pathway through Vilner Wood and across Midland Way. The cycleway ends on Streamleaze road in the town of Thornbury where the cycleway ties in with an existing footpath.

The extent of the scheme is shown on Figure 2-1 below with reference from the Google Map tool. The scheme extent is described in accordance with the following drawings:

- WECA_SGC-ATK-HGN-5220316-DR-CH-000001
- WECA_SGC-ATK-HGN-5220316-DR-CH-000002
- WECA_SGC-ATK-HGN-5220316-DR-CH-000003
- WECA_SGC-ATK-HGN-5220316-DR-CH-000004
- WECA_SGC-ATK-HGN-5220316-DR-CH-000005
- WECA_SGC-ATK-HGN-5220316-DR-CH-000006

Figure 2.1 - Site Extents Alveston Hill (not to scale)

2.2. Existing Drainage and Water Features

The following data has been reviewed to identify the existing drainage systems.:

- Topographical survey information (Drawing number: WECA_SGC-ATK-VTO-5220316-M2-CH-000001).
- Existing Utilities and Search Report (Drawing number: WECA_SGC-ATK-VUT-5220316-M2-CU-000001, Utility Search Report-200174-Alveston Hill - V1.zip)
- Ordnance Survey Mapping (Drawing number: WECA_SGC-ATK-VOS-5220316-M2-CH-000001)

2.3. Existing Drainage Condition

2.4. Ground Conditions

The below information is based on GI Report: WECA_SGC-ATK-HGT-5220316-SP-CE-000001

The following text provides a summary of the anticipated geology and ground conditions as inferred from review of published information. No assurance is given to its accuracy.

The geology varies across the site and therefore three different sequences of stratigraphy have been proposed for the expected ground conditions, these are displayed in Figure 4. All three ground models indicate Topsoil overlying bedrock. Ground Model 1 comprises Limestones / Mudstones from the Clifton Down Mudstone, Gully Oolite Formation and Black Rock Limestone subgroup. Ground Model 2 comprises the Mercia Mudstone Group (Marginal Facies) and Ground Model 3, the Tintern Sandstone Formation is anticipated. A map1 indicating the areas each Ground Model covers is displayed in Figure 4.

Table 2.1 - Ground Model 1

FORMATION	GENERAL DESCRIPTION	EXPECTED TOP OF STRATA (m bgl)
Topsoil	Firm medium brown very sandy slightly soily clay	0.0 m bgl
Limestone/Mudstone	Weathered Limestone / weathered Mudstone with bands of ironstone	0.5 to 1.0 m bgl
Unweathered Limestone / Mudstone	Circa 1.0 m bgl	

Table 2.2 - Ground Model 2

FORMATION	GENERAL DESCRIPTION	EXPECTED DEPTHS (m bgl)
Topsoil	Firm medium brown very sandy slightly soily clay	0.0 m bgl
Mercia Mudstone Group (Marginal Facies)	Conglomerate composed of limestone and dolomitized matrix.	Circa 0.5 m bgl

Table 2.3 - Ground Model 3

FORMATION	GENERAL DESCRIPTION	EXPECTED DEPTHS (m bgl)
Topsoil	Very sandy clayey soil	0.00 m bgl
Tintern Sandstone	Hard yellow, red sandstone	Circa 0.30 m bgl

[1] BGS Geology Viewer (BETA)

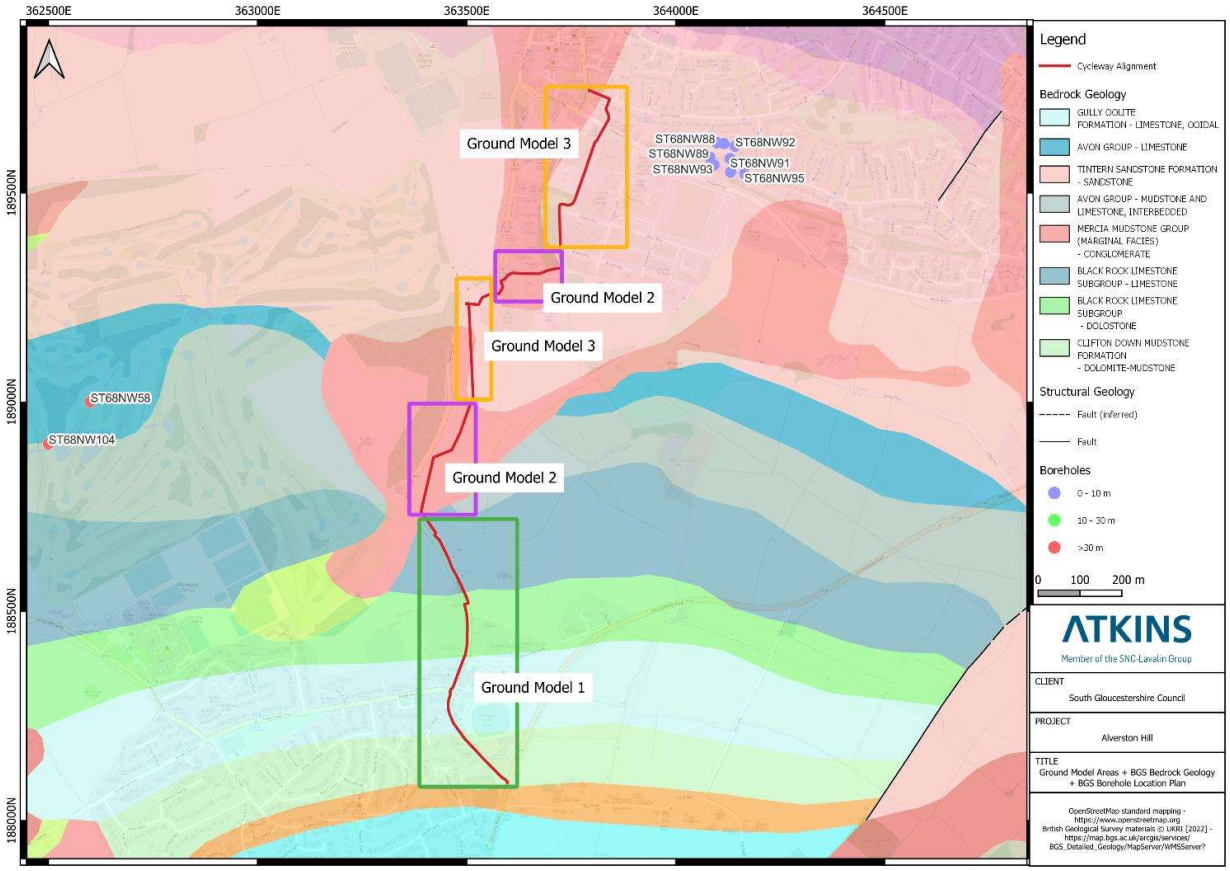

Figure 2.2 – Ground Condition

2.5. Groundwater

The below information is based on GI Report: WECA_SGC-ATK-HGT-5220316-SP-CE-000001

The groundwater underlying the site in the Principal and Secondary aquifers (A and B) is of high vulnerability due to the absence of superficial geology and high leaching potential of soils. The site is also within a soluble rock risk zone. The high vulnerability classification is defined as “areas able to easily transmit pollution to groundwater. They are likely to be characterised by high leaching soils and the absence of low permeability superficial deposits.”

The site is not located within a Source Protection Zone (SPZ) and there are no active or historical groundwater abstraction licenses within 250 m of the site.

2.6. Topography

The below information is based on GI Report: WECA_SGC-ATK-HGT-5220316-SP-CE-000001

The elevation generally increases from north to south, the section of cycleway around Thornbury Leisure Centre is at the lowest elevation of 52 m AOD and the highest elevation is 100 m AOD at the southern extent of the site.

2.7. Flood Risk

The Environment Agency (EA)[2] flood map for planning shown in Figure 2.3 indicates that the Alveston Hill lies in Flood zone 2 & 3 [3] (land assessed as having a greater than 1 in 100 annual probabilities of flooding (>1%)), and thus is at a high risk of flooding.

This assessment of flood risk FRA has presented an assessment of flood risk to the Alveston Hill cycleway (refer: 5220316-ATK-HYD-ZZ-REP-H-0001 FRA p0.4.docx). The Scheme is at flood risk from the minor watercourse flowing north near Westerleigh Road, with the risk based only on the published Environment Agency data and reinforced by high-level flood modelling.

Table 1 – Sources of flood risk summary

FLOOD RISK	BASELINE RISK	COMMENTARY
Fluvial	High	Flood risk from the Oldbury Pill and its tributaries.
Surface Water (Pluvial)	High	Surface water flood risk arising from runoff from the south, draining into the Oldbury Pill and its tributaries.
Groundwater	Low	Based on geology the risk of groundwater flooding is low.

This FRA has presented an assessment of flood risk to the Alveston Hill cycleway. The Scheme is at risk from flood sources as summarised below, with the risk based only on the published Environment Agency data and reinforced by the high-level flood modelling.

Table 2 - Summary of flood risk

FLOOD RISK SOURCE	RELEVANT SOURCE OF FLOODING	RISK	REQUIRES FURTHER ASSESSMENT?
Fluvial	Yes	High	Yes – the impact of the Scheme on flood risk elsewhere needs to be considered.
Surface water (Pluvial)	Yes	High	
Groundwater	Yes	Low	No

CONCLUSION:

In conclusion, the site at Alveston is at risk of flooding from fluvial and pluvial sources. There is a risk that the cycleway infrastructure will be inundated by the 1% annual exceedance probability event (1 in 100-year return period) over a combined distance of some 200m. However, much of the site will also remain flood free.

Flood levels across the site are predicted to increase with future climate change, with an uplift of 26% applied to surface flows, and/or 20% on peak rainfall intensity.

[2] https://www.gov.uk/guidance/flood-risk-assessment-standing-advice

[3] Flood risk assessment in flood zones 2 and 3 - GOV.UK (www.gov.uk)

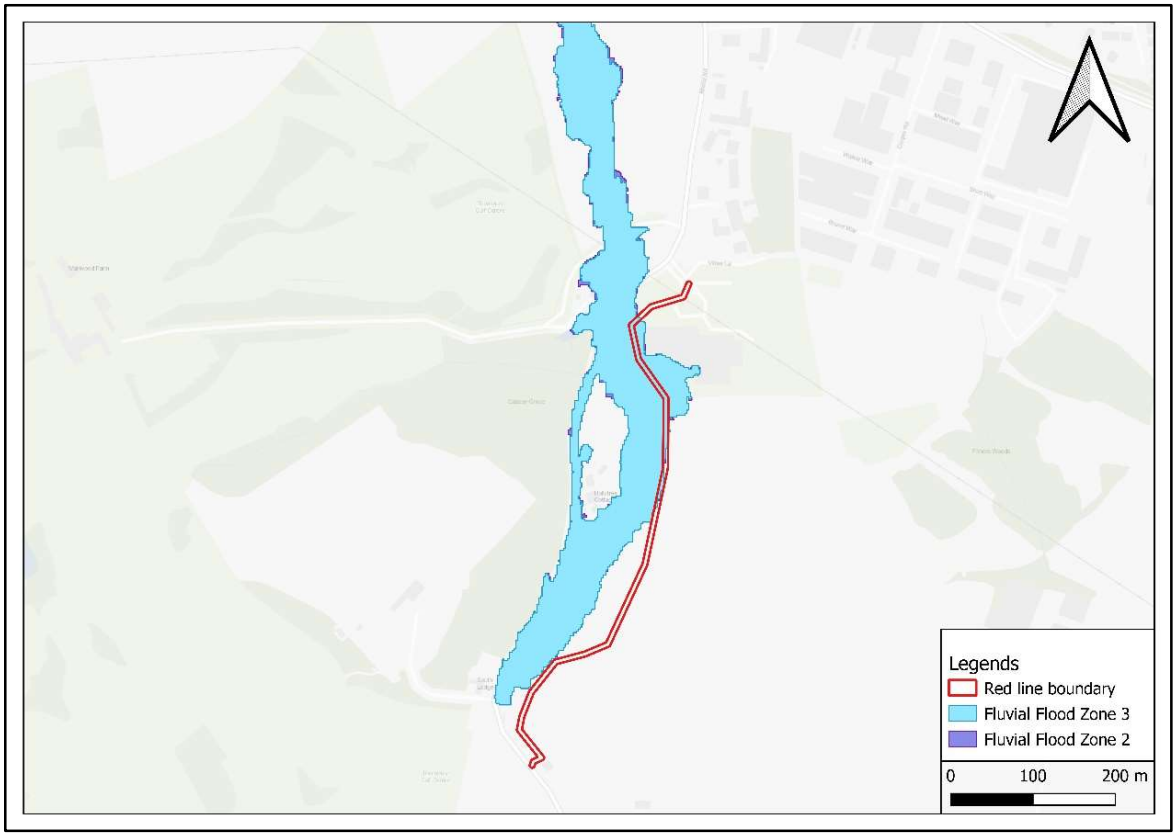

Figure 2.3 - EA flood map for planning for Alveston Hill

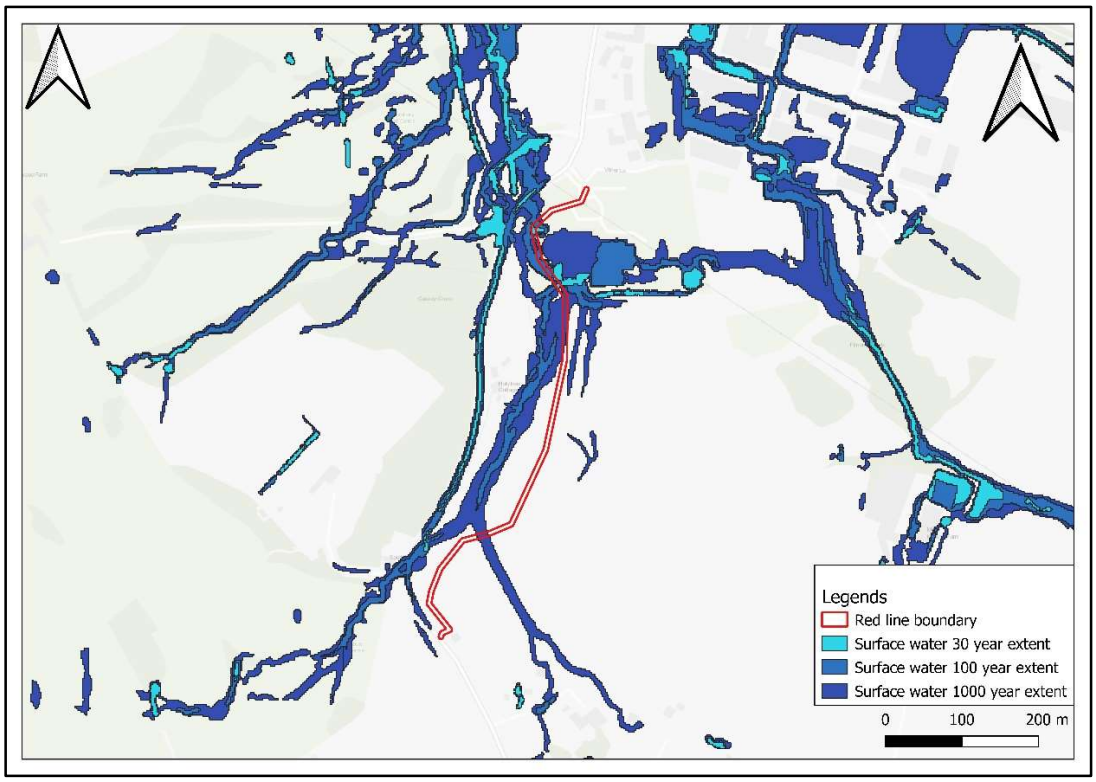

Figure 2.4 - EA Risk of surface water flooding map for Alveston Hill

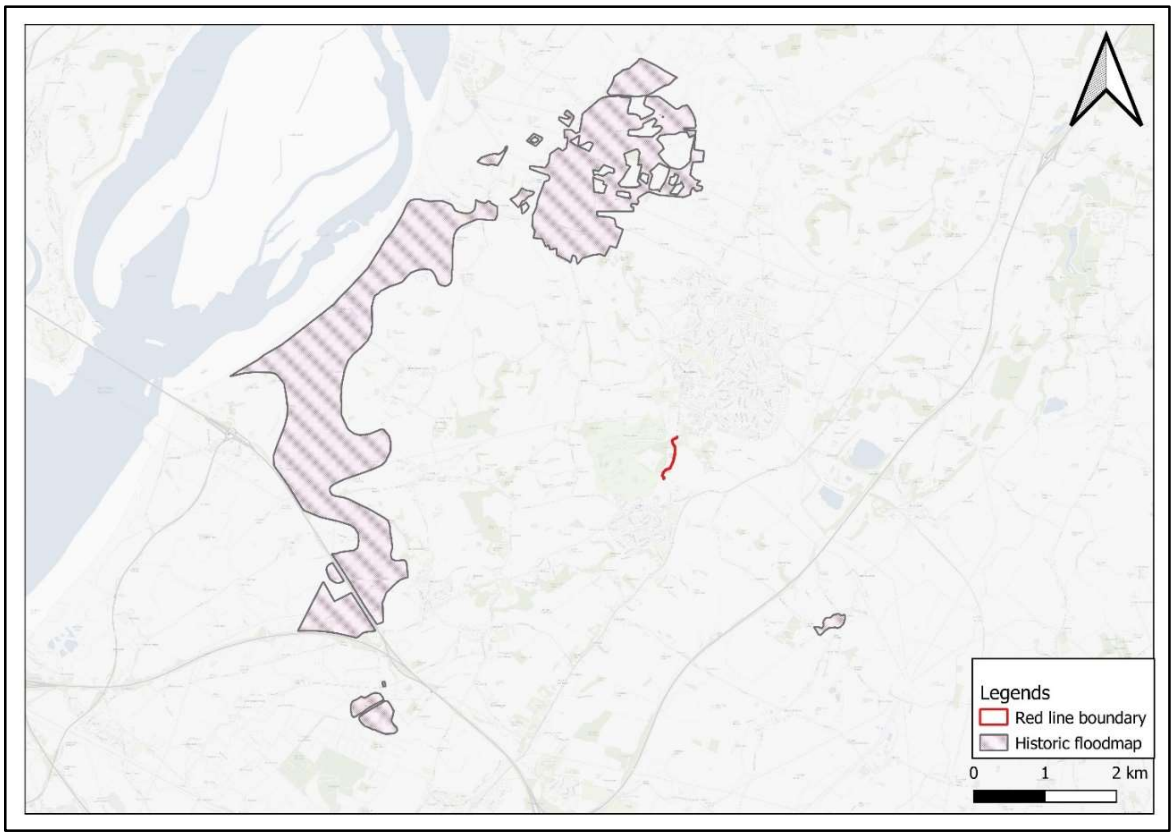

Figure 2.5 - Historic flooding map for Alveston Hill

3. Highway Drainage Basis of Design

3.1. Collection System

Project is divided into different sections based on percentage increase in impermeable area i.e., more than 7% or less than 7% in the area. If area's increase due to work on Alveston Hill is less than 7%, then hydraulic modelling is not required as it won't affect the current drainage much. Whereas if the percentage increase in the impermeable area is more than 7% in proposed scenario, then hydraulic analysis is required to control extra flow at the existing flow rate and large diameter pipes will be provided for attenuation. In the detailed design phase, the scope of work is to move the existing drainage collection systems that collect rainwater to the new kerb lines and add more drains based on the maximum areas they can cover. Whenever possible, reuse of the existing collection system and outlet pipes will be proposed, adjusting them to fit the new kerb lines. More detailed information is mentioned in Table 4.1 about our drainage strategy.

3.2. Relevant Policy and Design Criteria

The hydraulic design parameters for the scheme are adopted as following:

- 1 in 1 year storm event – no surcharging of the drainage system shall occur.
- 1 in 5 years storm event – no flooding from the drainage system shall occur.
- 1 in 30 years + 20% climate change storm event – attenuation storage will be sized to control the peak discharge rates from the scheme to the existing peak discharge rates generated from the site. Attenuation storage will be provided up to the 30-year event for only the increased impermeable area within the scheme boundary.
- 1 in 100 years + 25% climate change – assess the consequences of exceedance (i.e., flows are not routed onto third-party land or to critical infrastructure e.g., substations, water supply pumping stations, hospitals etc).

There should also be no increase in the peak discharge rates during the 1 in 1 year, 1 in 5 year and 1 in 30 year storm events compared with existing peak discharge rates.

3.3. Water Quality

Given the small traffic volumes predicted for the scheme the risk of runoff from the carriageway containing harmful levels of pollutants and risk of spillages occurring is considered low. Notwithstanding this, drainage from the scheme will incorporate a combination of trapped gullies and open grated catchpits to trap silts and pollutants. Hence, the risk of pollution to local surface water receptors will be low. This approach is in line with LA 113 ‘Road Drainage and the Water Environment’ and CIRIA C753 ‘The SuDs Manual’.

3.4. Design Parameters

The summary of design parameters applied in the design is shown in table 3-1 and table 3-2.

Table 3-1 - Summary of Design Parameters

Sl. No.	Particulars	Value
1.	Rainfall Method	Flood Studies Report (FSR)
2.	M5-60	20.00 mm
3.	Ratio R	0.35
4.	Global time of entry	5 mins
5.	Maximum rainfall	250 mm/hr
6.	Minimum Velocity	0.75 m/sec
7.	Minimum Pipe Diameter	150 mm
8.	Minimum Chamber Diameter	1050 mm
9.	Pipe Roughness Coefficients for carrier drains	0.60
10.	Time of Entry	Gully – 5 mins
11.	Cover	Min 1.20 m on carriageway 0.9m on verge where feasible
12.	Maximum Allowable Flow Width	0.75 m
Percentage Runoff		
1.	Carriageways, Footways	1.00 (100% of impermeable area)
2.	Verge	0.15 (15% of impermeable area)

Table 3-2 - Summary of Design Parameters

Pipes and Chambers		
1	Pipes and Chambers	For the purposes of assessment, outline conveyance pipework will generally be developed in accordance with CG 501 'Design of Highway Drainage Systems', section 3. Pipes shall be designed for the 1in 1-year return period without surcharge and 1in 5-year return period with no flooding. Catchpits (Type 8) with open gratings • Diameter=600mm F series (MCHW VOL3.SECTION 1) • Grated covers for Type-8 catch-pits shall be Durey Castings the Peloton (600x 600 mm) product or similar approved products.
2.	Surface Water Collection System	Surface water collection system like top entry gully, CKD units, Catchpits with grated cover are proposed to collect the runoff from carriageway and landscape area.
Kerb and Gully system		
1	Gully Grating	R (As per CD526)
2	Return Period	5 years
3	Manning's Coefficient	0.017 (asphalt, average condition)
4	2MinM5	3mm
5	Critical storm duration	5 minutes
Combined Drainage Kerb units		
1	Product	ACO Kerb Drain
2	Return Period	5 years
3	Access units	To be provided at 25-30m spacings.
4	Climate change	20% (for any additional paved area)
5	Outlet unit	Multifunctional end cap

3.5. Design Standards

The drainage design adhered in accordance with Design Manual for Roads and Bridges (DMRB) guidelines and other best practice guidance as listed below:

- DMRB CG 501 Design of Highway Drainage Systems.
- DMRB CD 522 Drainage of runoff from natural catchments.
- DMRB CD 526 Spacing of Road Gullies.
- DMRB CD 534 Chamber tops and gully tops for road drainage and services.
- DMRB CD 535 Drainage asset data and risk management.
- DMRB LA113 Road Drainage and the water environment.
- CIRIA C753 The SuDS Manual.
- GCC Technical Specification for New Streets – 2nd Edition, February 2020.
- GCC & Atkins Standard Drawings, Appendix – E.

4. Proposed Drainage Strategy

The proposed drainage strategy for the scheme is summarised in Table 1 below**.** The proposed drainage layout is shown in the below mentioned drawings:

Table 4.1 – Proposed Drainage Strategy

Location	Chainage	Proposed Highway Development	Proposed Drainage Strategy
B4061 – Alveston Hill Road	Ch +0.0m to Ch +43.0m	No Highway changes with existing kerb lines and catchments retained.	No change in kerb line and existing area. Retain the existing drainage system.
B4061 – Alveston Hill Road	Ch +43.0m to Ch +150.0m	**The road space is to be reallocated to provide a footway (2.5m wide) on the southbound and shared use path (3m wide) on the northbound of the carriageway.**	There is increase in impermeable area. Increase % = 6.7% Northbound – After capacity assessment of the existing collection system, the location where the kerb line is being modified will require the abandonment of the existing collection system. New collection system will be installed at the proposed kerb line location, which will include additional gullies and kerb outlets as per proposed condition suitability. This new drainage system aims to effectively gather the increased runoff from modified area and will be connected to the existing conveyance system. Southbound – The locations where the kerb-line is changing existing collection system to be abandoned and new collection system with additional gullies and kerb-outlets to be installed at the proposed kerb-line location to collect the runoff and will be connected to existing conveyance system.
Down Road Junction	Ch +150.0m to Ch +287.0m	The road space is to be reallocated to provide a footway (2m wide), cycleway (3m wide) and shared use path (3m wide) on the northbound of the carriageway. No development in southbound of carriageway.	There is increase in impermeable area. Increase % = 16.5% Northbound – As the percentage increase in the impermeable area is more than 7%. The flows in the proposed scenario will be controlled at the existing flow rate and large diameter pipes will be provided for attenuation. After capacity assessment of the existing collection system, the location where the kerb line is being modified will require the abandonment of the existing collection system. New collection system will be installed at the proposed kerb line location, which will include additional gullies and kerb outlets as per proposed condition suitability. This new drainage system aims to effectively gather the

			increased runoff from modified area and will be connected to the existing conveyance system. Southbound - Since there is no development in the southbound of the carriage way and the existing kerb is retained, therefore we have proposed to retain the existing drainage infrastructure without undertaking capacity assessments of the existing assets and we will not assess the need for additional gullies.
B4061 – Alveston Hill Road	Ch +287.0m to Ch +447.0m	The verge area is converted to provide a footway (1.5-2 m wide) and cycleway (3m wide) on the northbound of the carriageway. And the existing carriageway kerb is retained. No development in southbound of carriageway.	There is increase in impermeable area. Increase % = 28.3% Northbound - As the percentage increase in the impermeable area is more than 7%, the flows in the proposed scenario will be controlled at the existing flow rate and large diameter pipes will be provided for attenuation. after capacity assessment of the existing collection system, new collection system will be installed at the kerb line location, which will include additional gullies and kerb outlets as per proposed condition suitability. This new drainage system aims to effectively gather the increased runoff from modified area and will be connected to the existing conveyance system. Southbound - Since there is no development in the southbound of the carriage way and the existing kerb is retained, therefore we have proposed to retain the existing drainage infrastructure without undertaking capacity assessments of the existing assets and we will not assess the need for additional gullies.
B4061 – Alveston Hill Road	Ch +447.0m to Ch +638.0m	The existing footway is converted to shared use path (3m wide) on the southbound of the carriageway. New kerbs are proposed at the carriageway ends but the existing carriageway pavement is retained. No development in northbound of carriageway.	There is increase in impermeable area. Increase % = 6.82% Southbound – After capacity assessment of the existing collection system, the location where the kerb line is being modified will require the abandonment of the existing collection system. New collection system will be installed at the proposed kerb line location and will be connected to the existing conveyance system. Northbound - Since there is no development in the Northbound of the carriage way and the existing kerb is retained, therefore we have proposed to retain the existing drainage infrastructure without undertaking capacity assessments of the existing assets and we will not assess the need for additional gullies.

B4061 – Alveston Hill Road	Ch +638.0m to Ch +690.0m	The existing footway is converted to shared use path (3m wide) on the southbound of the carriageway. No development in northbound of carriageway.	There is increase in impermeable area. Increase % = 56.42% but the area of increase is 57m^2. As there is no major development in the Northbound and Southbound of the carriage way and the existing kerb is retained, therefore we have proposed to retain the existing drainage infrastructure without undertaking capacity assessments of the existing assets and we will not assess the need for additional gullies.
Greenfield Area	Ch +0.0m to Ch +336.0m	The planned new cycle path, measuring 3 meters in width, and the footpath, 2 meters wide, will be constructed within the greenfield area. They will run alongside the existing road, with a balanced section.	On the east side of the greenfield area next to the planned 2-meter-wide footpath, the land slopes downward toward the footpath itself. To manage the rainwater from this greenfield area and the footpath, a trapezoidal ditch is proposed, that's 0.5 meters deep, 0.3 meters wide at the base, and with side slope of 1:2. This ditch runs alongside the footpath and connects to an existing ditch downstream. Before the water flows into the existing ditch, a pond is proposed to attenuate the drainage water. To control the water flow and prevent extra water from going into the existing ditch, an orifice is used as flow control device before outfall. Additionally, the 3-meter-wide cycleway on the northbound of cycle track, slopes in western direction. A trapezoidal ditch is proposed, that's 0.5 meters deep, 0.3 meters wide at the base, and with side slope of 1:2. This ditch runs alongside the cycle track and connects to an existing ditch downstream at approximately ch +336.0 meters. To control the water flow and prevent extra water from going into the existing ditch, an orifice is used as flow control device.
Greenfield Area	Ch +336.0m to Ch +510.0m	The planned new cycle path, measuring 3 meters in width, and the footpath, 2 meters wide, will be constructed within the greenfield area. They will run alongside the existing road, with a balanced section.	The greenfield area on the east side of the planned footpath slopes downward toward the footpath itself. To manage drainage water from this sloping green area, a trapezoidal ditch of 0.5 meters deep, 0.3 meters wide at the base, and with 1:2 side slope is proposed. This ditch connects to a proposed pond before the water flows into an existing ditch downstream. On the other side, the 3-meter-wide cycle path in the proposed development slopes toward the west side for which ditch is proposed, that's 0.5 meters deep, 0.3 meters wide at the base, and with side slope of 1:2. A pond is proposed to attenuate the water and to control the water flow and prevent extra water from going into the existing ditch, an orifice is used as flow control device and a

			pipe is proposed on the downstream side of pond which is discharging to the existing ditch at controlled flow rate.
Vilner Lane	Ch +0.0m to Ch +200.0m	Proposed new cycleway (3m wide) and footway (2m wide) in the existing footway.	There is increase in impermeable area. Increase % = 112% As the percentage increase in the impermeable area is more than 7%, the flows in the proposed scenario will be controlled at the existing flow rate and large diameter pipes will be provided for attenuation. After capacity assessment of the existing collection system, the location where the kerb line is being modified will require the abandonment of the existing collection system. New collection system will be installed at the proposed kerb line location, which will include additional gullies and kerb outlets as per proposed condition suitability. This new drainage system aims to effectively gather the increased runoff from modified area and will be connected to the existing conveyance system.
Vilner Wood to Midway Lane	Ch +0.0m to Ch +580.0m	Proposed shared use path (3m wide).	There is increase in impermeable area. Increase % = 1% As the percentage increase in the impermeable area is less than 5%, So there is no major development in the Northbound and Southbound of the shared use path and the existing kerb is retained, therefore we have proposed to retain the existing drainage infrastructure without undertaking capacity assessments of the existing assets and we will not assess the need for additional gullies.

The existing drainage flow from the greenfield area on the westbound side of the B4061 Alveston Hill road is calculated, and the following are the existing flow rate achieved for various rainfall event as the following,

Table 4.2 - Qbar value for the east side greenfield area using Source Control (Ch. +0.0m and Ch. +336.0m)

Qbar	1 in 1 year (l/s)	1 in 30 year (l/s)	1 in 100 year (l/s)
Source Control (MD)	25.9	61.1	80.1

Table 4.3 - Qbar value for the east side greenfield area using Source Control (Ch. +336.0m and Ch. +510.0m)

Qbar	1 in 1 year (l/s)	1 in 30 year (l/s)	1 in 100 year (l/s)
Source Control (MD)	9.3	22	28.8

Based on the above Qbar value the discharge to the existing ditch is controlled on the proposed development using attenuation structures (ponds) and flow control (orifice) to allow the restricted discharge to the existing ditch based on the above Qbar values.

5. Recommendations

It is recommended that the following is undertaken and developed during the detailed design stage:

- Undertake topographical surveys to establish the location, level, size and connectivity of existing public sewer and highway drainage assets where this information is currently not available.
- Undertake CCTV survey of some of the existing drainage which may not be covered in the survey information to identify problems that may need to be rectified prior to the connection of new collection system into the existing highway drainage.
- Where existing watercourse crossings are to be extended undertake CCTV surveys to establish the condition of the crossing structure.
- Submit a developer enquiry to Severn Trent Water if required, to agree the outfall locations and rates and any modifications required to the public sewer network.
- On receiving the required survey information, hydraulic models will be developed for the existing and proposed drainage systems to confirm the sizes of the proposed highway collections and carrier drains.
- Agree with the Environment Agency requirements for the design of the extension of main river watercourse crossings and any compensatory floodplain storage required.
- On the receipt of the required survey develop hydraulic models of the existing and proposed drainage systems to inform preliminary sizing of the proposed highway collection and carrier drainage, attenuation storage features and any compensatory floodplain storage required.
- Investigate further anecdotal evidence of flooding occurring at the tributary of existing watercourse crossing.