

Kilnwood Vale

Remaining Infrastructure Drainage Strategy

For
Crest Strategic Projects

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1.0 INTRODUCTION

- 1.1.1. This report has been prepared by CampbellReith to provide the detailed design and calculations for the primary drainage infrastructure that is to be constructed within the Remaining Infrastructure phase of works, a part of the wider Kilnwood Vale site in Crawley, RH12 0AQ. The site wide drainage strategy report by CampbellReith (revision D5, December 2016) defined the high-level strategy, and readers of this report should be acquainted with this document.
- 1.1.2. The Remaining Infrastructure phase will complete the primary drainage and highways infrastructure associated with Phases 2 & 3 of the Kilnwood Vale site and provide infrastructure connections into Phases 4 & 5 land north of the railway line. In this report and on the accompanying drawings the Remaining Infrastructure package is referred to as 'RI'. These works encompass a large network of highways, connecting previously approved phases including:
- High Street – planning ref. DC/18/0670
 - Phase 3C SRE – planning ref. DC/19/0906
 - Phase 3A/3B – planning ref. DC/17/0936
- 1.1.3. The highways also pass over the diverted Bewbush Brook, approved under planning ref. DC/18/0959. This planning application also included the culverting of the brook in two locations, under Road 37 (Primary Street) and East Brook (Secondary Street). Both of these stretches of highway are included within the Remaining Infrastructure phase; however, the culvert and associated design information are not included within this report as they have been previously approved under the land drainage consent for the diversion of the Bewbush Brook and all detail remains the same.
- 1.1.4. The RI infrastructure phase has been designed to serve the residential Phases 3D, 3E, 3F, 3G, 3H, 3I and 3J. The drainage infrastructure design will also include outfalls from the roads to appropriate discharge points i.e., to Bewbush Brook for the surface water drainage and a Thames Water sewer for foul drainage. The on-plot drainage designs for Plots 3D, 3E, 3F, 3G, 3H, 3I and 3J will be designed by others (Ardent Consulting Engineers) and their designed infrastructure will connect to the primary drainage covered by this report.
- 1.1.5. The detailed drainage design for RI has been developed based on the drainage strategy for the Phases 2 & 3 site detailed in the CampbellReith report titled 'Kilnwood Vale site wide drainage strategy report' that was presented as a part of the information used in discharging condition 22 of planning application reference DC/15/2813.

2.0 REMAINING INFRASTRUCTURE DEVELOPMENT

2.1. Infrastructure Design

- 2.1.1. Refer to Figure 1 below and drawing 11950-CRH-RI-XX-DR-C-4050 in Appendix A, for a site location plan indicating RI in context of the full site-wide Kilnwood Vale development.

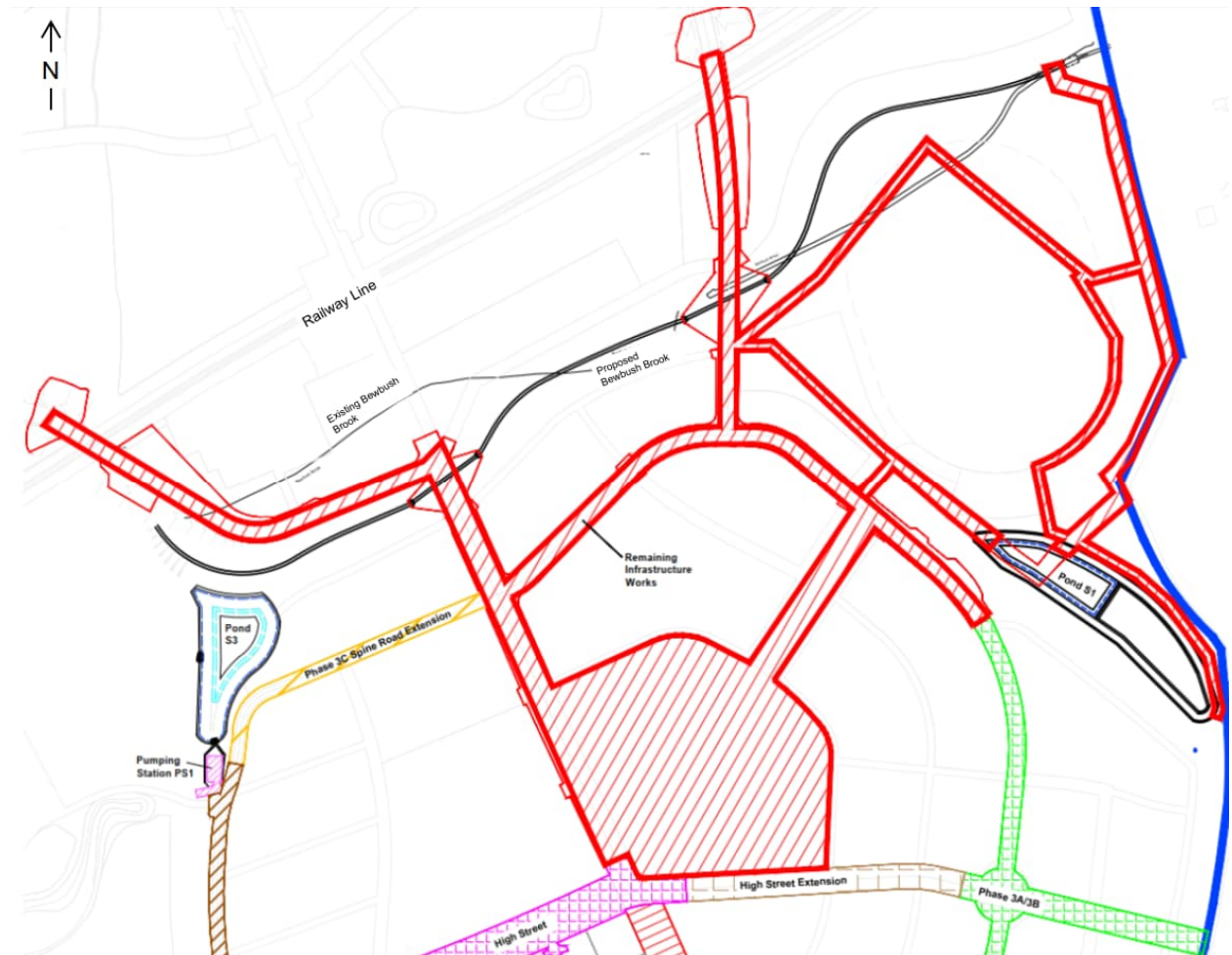


Figure 1: Remaining Infrastructure Location Plan in relation to previous CampbellReith designed phases

- 2.1.2. The overall Kilnwood Phase 2&3 site foul and surface drainage strategy plans extracted from the CampbellReith report titled 'Kilnwood Vale Site Wide Drainage Strategy Report' are included in Appendix B.
- 2.1.3. The RI proposed highway layout is shown on drawings 11950-CRH-RI-XX-DR-C-5000 – 5007 in Appendix C. The total length of road will be approximately 1600m, with varying carriageway widths – predominantly 5.5m wide with a 6.1m width along the Road 37 Primary Street. Throughout the phase, there is a varying combination of verge widths (0m, 2m or 3m) and footway widths (0m, 2m or 3m if a shared footway/cycleway). Along East Brook, a 4m bridleway runs alongside the highway corridor as it heads northwards into the future Phase 4 & 5 over the Eastern Bridge.

2.2. Surface Water Drainage

- 2.2.1. RI is predominantly within surface water drainage Catchment A of the Phase 2 & 3 site, which drains directly into Pond S1 (refer to Figure 2). After being attenuated in Pond S1, surface water from Catchment A will be discharged into the Bewbush Brook via a flow control. Parts of RI also drain flows from Catchment B and Catchment C, which discharge into Pond S3 and directly into the Bewbush Brook respectively. The total area within the RI red-line boundary is 6.066 ha. The area contained by the 3DEFG green-line boundary is 6.713 ha. Phases 3HIJ total 5.471 ha. The impermeable areas of these are distributed among the main catchment areas as follows:

Region	Remaining Infrastructure	3DEFG, 3H, 3I and 3J
Catchment A	1.882 ha impermeable	3.896 ha impermeable
Catchment B	0.109 ha impermeable	0.479 ha impermeable
Catchment C	0.352 ha impermeable	4.024 ha impermeable
Green Space (including temporary batter slopes to bulk earthworks)	3.758 ha	1.668 ha

Table 1: Breakdown of Impermeable Areas by catchment and boundary region

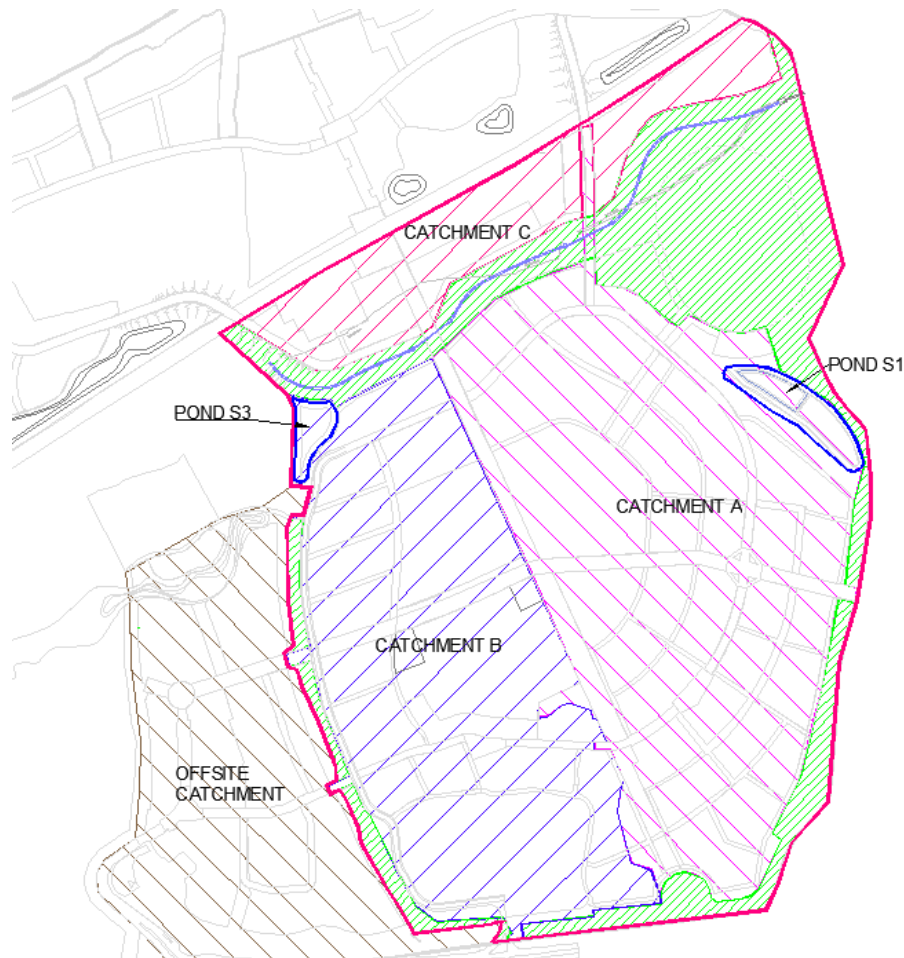


Figure 2: Kilnwood Vale Phase 2 & 3 Surface Water Catchments

- 2.2.2. The extent of the drainage design covered by this report is shown by the red line boundary in Figure 1 and drawings 11950-CRH-RI-XX-DR-C-5050 in Appendix D.

- 2.2.3. The surface water drainage infrastructure to be constructed within Remaining Infrastructure will include all the necessary infrastructure to allow the phase to discharge as per the site wide strategy, as well as connecting upstream phases that have already been constructed into their respective discharge points. Any temporary drainage measures that have been put in place in the interim will be removed in such a way that does not inhibit the discharge of surface water in a controlled manner.
- 2.2.4. The areas to be served by the RI surface water drainage infrastructure are:
- a) Highway Infrastructure – 1.699 ha impermeable area
 - b) Public Realm Area – 0.582 ha impermeable area (sports pitch and MUGA drainage)
 - c) Phase 3E – 0.580 ha impermeable area
 - d) Phase 3D(2) & 3G(1) – 0.661 ha impermeable area
 - e) Phase 3F & 3G(2) – 1.476 ha impermeable area
 - f) Phase 3G(3) – 0.174 ha impermeable area
 - g) Phase 3J - 1.060 ha impermeable area

2.3. Foul Water Drainage

- 2.3.1. The foul water infrastructure to be constructed within RI will provide a gravity connection capable of discharging the entire site's sewage into the existing Thames Water sewers, located to the east of Phase 2/3 of Kilnwood Vale in the Public Open Space (Kilnwood Vale Park) area. Spurs will also be provided across the two bridges so that up to 2no. future rising mains can discharge flows from Phase 4/5 to the Thames Water sewers to the east within Phase 2/3.
- 2.3.2. The areas to be served by the RI foul water drainage infrastructure are:
- a) 3D(2) – 22 dwellings
 - b) part of 3(E) – 32 dwellings
 - c) 3G(1), 3G(2), 3G(3) – 60 dwellings
 - d) Pumping Station PS1 – 1305 dwellings + 2.64 ha commercial/employment area
 - e) Pumping Station PS3 – estimated 317 dwellings from Phase 4/5
 - f) Pumping Station PS4 – 266 dwellings + 1.11 ha employment area
 - g) Pumping Station PS6 – estimated 389 dwellings from Phase 4/5
- 2.3.3. Although no new pumping stations are to be constructed as a part of these works, a series of rising main spurs and connections will be installed to allow for future development and construction. In total 3no. rising mains will be laid as a part of these works, with the intention that the following pumping stations will in future discharge flows into the RI foul water infrastructure.
- Pumping Station PS3 – proposed to the north of the rail, located in the western half of Phase 4 & 5. It is estimated that 317 dwellings will drain to this pumping station.

- Pumping Station PS4 – to be located immediately south of the rail, near to the East Bridge (East Brook road), to take flows from all residential and commercial/industrial areas between the Bewbush Brook and the rail (phases 3I, 3J and 3H) totalling 266 dwellings + 1.11 ha of employment area.
 - Pumping Station PS6 - proposed to be north of the rail, located in the eastern half of Phase 4 & 5. It is estimated that 389 dwellings will drain to this pumping station.
- 2.3.4. The previously approved rising main connection from PS1 into gravity sewers will be constructed within the highways boundary associated with the RI works, however the design of the rising main is not discussed in this report. Instead, readers should refer to the CampbellReith Phase 3C SRE Drainage Report, dated May 2019 for further information.
- 2.3.5. The highways within RI are to be offered for adoption to West Sussex County Council under a Section 38 Agreement. It is also proposed that the foul and surface water sewers within the package (including the foul water rising mains) will be offered for adoption to Thames Water under a Section 104 Agreement.

2.4. Geotechnical Investigations and Design

- 2.4.1. RI is located across several of the Kilnwood Vale earthworks phases; listed below alongside relevant site investigation reports.
- a) Phase 2.4 - 'Ground Investigation: Kilnwood Vale, Phase 2.4, Bewbush, West Sussex' by Hydrock
 - b) Phase 2.5 - 'Ground Investigation: Kilnwood Vale, Phase 2.5, Bewbush, West Sussex' by Hydrock
 - c) Phase 2.6 - 'Ground Investigation: Kilnwood Vale, Phase 2.6, Bewbush, West Sussex' by Hydrock
- 2.4.2. These reports indicate that RI is underlain by natural Weald Clay, with a varying depth of made ground sitting on top of the natural Weald Clay material. In some areas (primarily adjacent to the Bewbush Brook), the presence of Alluvium is indicated, along with River Terrace Deposits.
- 2.4.3. In undertaking the bulk earthworks for development, where the depth of made ground is shallow it will be dug out and replaced with engineered fill. Where the depth of made ground is deep, surcharge treatment will be carried out. Drawing 11950-RI-CE100 (Appendix H) shows RI in relation to earthworks phases and surcharge treatment areas.
- 2.4.4. For detailed earthworks treatment for the area, refer to the CampbellReith specification "Kilnwood Vale Phase 2.4-2.6 Earthworks Specification 2017".

3.0 DETAILED DRAINAGE DESIGN FOR THE ROAD INFRASTRUCTURE

This section of the report covers the detailed design of the foul and surface water drainage infrastructure that will be constructed within the Remaining Infrastructure area.

The RI drainage layouts (11950-CRH-RI-XX-DR-C-5051 - 5059) are included in Appendix D.

3.1. RI - Surface Water Drainage

3.1.1. Collection and Conveyance

Surface water from the highways within RI will be collected in trapped gullies and conveyed to main sewers by branch connections. Surface water from nearby residential and commercial developments will discharge into the surface water infrastructure via spurs. Surface water that passes through RI will discharge via one of three outfalls, depending on the catchment.

3.1.2. Drainage Catchments

The three catchments that are to be served by the RI surface water infrastructure total 11.906 ha (7.732 ha of impermeable area), of which 1.699 ha is from the highways within the red-line boundary. The areas are split up as follows:

- Catchment A sewers collect from 5.778 ha of impermeable area (9.732 ha total area, mix of 10-100% impermeable)
- Catchment B sewers collect 0.075 ha of impermeable area (0.075 ha total area, 100% impermeable)
- Catchment C sewers collect 1.906 ha of impermeable area (2.099 ha total area, mainly 100% impermeable with some areas 70%).

The contributing catchment areas are shown in drawing 11950-RI-CD108 in Appendix E.

The gullies located within the RI highways have a maximum catchment of 180m², in line with WSCC standards. Refer to drawings 11950-CRH-RI-XX-DR-C-5061 to 5068 in Appendix E for the gully catchment plan.

3.1.3. Design Parameters

The surface water drainage design has been based on the FSR rainfall-runoff method with an M5-60 of 20mm and Ratio R of 0.349.

3.1.4. Pipe Gradients and Pipe Sizing

The proposed pipe diameters/sizes are included on the drainage layout drawings 11950-CRH-RI-XX-DR-C-5051 - 5059 in Appendix D.

The surface roughness (Ks) value used in the design of surface water sewers is 0.6mm as stipulated in Sewers for Adoption.

Portions of the RI drainage are to be constructed within an area that requires ground treatment via surcharge (see drawing 11950-RI-CE100 in Appendix H). It has therefore been designed with a gradient no flatter than 1:75 (whilst also maintaining a minimum pipe flow velocity of 1m/s), to

avoid the risk of backfalls due to potential residual ground settlement following surcharge treatment of the ground.

The pipe diameters and the corresponding gradients are designed to also ensure that there is no surcharging in the 1 in 1 year flows in most of the pipes and that there is no flooding for the 1 in 30 year storm events.

The surface water drainage calculations undertaken in MicroDrainage for the Remaining Infrastructure Surface Water Sewers are included in Appendix E. These results show that no flooding is expected in the sewers for rainfall events up to the 1 in 100 years.

Under a 1 in 100 year (+30% climate change), there are 4 manholes that flood under intense rainfall. Of these 4no. flooded sewers, 3no. are spurs leading into future phases of development. As such, it is the expectation that the installation of sewers and manholes within these phases will provide the storage necessary to avoid flooding of the system at these points. The surface water from the other flooded sewers will be directed at very shallow depths in road corridors as shown by the flood routes on drawing 11950-RI-CD110 in Appendix E. The overland flow generated is to be directed to a low point of the site, where it will sit until a point where it can be drained through. All overland flows that run through RI will end up in Pond S1, Pond S3 or the Bewbush Brook, depending on which catchment they fall.

3.1.5. Pipe Bedding

The majority of drainage within the RI works is located within an area subject to surcharge treatment, either through surcharge mounding or through pre-loaded surcharge (i.e. the existing ground is considered to have acted as surcharge). In this area, the pipe bedding shall be as per the detail in Appendix G. This bedding detail has been developed to mitigate potential differential settlement within the “surcharge ground treatment areas”. Refer to Ground Treatment Plan in Appendix H for the location of surcharged areas in relation to the RI boundary.

In areas subject to dig and replace treatment settlement is not considered a significant risk, therefore standard Class S or Class Z pipe bedding shall be used.

3.1.6. Pipe Materials

For surface water pipes 375mm in diameter and greater, it is proposed that concrete pipes of strength class 120 are used. For surface water pipes smaller than 375mm, vitrified clay pipes are proposed.

3.2. RI– Foul Water Gravity Drainage

3.2.1. Design Parameters

For all dwellings, the assumed discharge rate per person is 222 litres/day, with a peaking factor of 6 and assumed occupancy of 3 people per dwelling, in line with guidance from SfA 7th Edition.

For commercial and retail areas, an assumed discharge rate of 0.6 litres/sec/ha is to be used, in line with guidance from SfA 7th Edition.

3.2.2. Proposed Foul Water Catchment

The proposed foul water catchments served by the RI foul sewers are included in Appendix F (11950-RI-CD111).

The RI foul water sewers serve almost the entire site catchment, with the installation of a gravity connection into the Thames Water manhole located to the east of the Public Open Space area of Kilnwood Vale Park. Eventually, the vast majority of foul water from the site will drain to this point, via the connection of gravity sewers or rising mains that serve varying phases across Kilnwood Vale.

Once complete there will be up to 2372 dwellings and 3.75 ha of additional area, classed as a mixture of industrial, commercial & employment space, that will drain to the RI sewers, either directly or via rising mains from pumping stations that serve various catchments.

3.2.3. Pipe Gradients and Pipe Sizing

The pipes have been sized to convey the peak foul water flow generated by the proposed development within the foul sewer catchment. All pipe gradients have been designed to achieve a self-cleansing velocity of 0.75m/s at one-third design flow or to satisfy the criterion of Sewers for Adoption which states that:

- a) a 150 mm nominal internal diameter gravity sewer is laid to a gradient not flatter than 1:150 where there are at least ten dwelling units connected; or,*
- b) a sewer or lateral drain with a nominal internal diameter of 100 mm, or lateral drain serving ten or less properties is laid to a gradient not flatter than 1:80, where there is at least one WC connected and 1:40 if there is no WC connected.*

In areas subject to surcharge ground treatment of the ground, the pipes have been designed with a minimum gradient of 1:75 to avoid the risk of backfalls due to potential residual ground settlement.

As with the surface water sewers, in “dig and replace” areas, Sewers for Adoption 7th Edition limits on gradients (1:75) will be used whilst ensuring self-cleansing velocities of 0.75m/s are maintained.

MicroDrainage calculations are included in Appendix F. The calculations show that the pipes designed can convey the peak flows and they also either achieve the required self-cleansing velocity or satisfy the criterion of Sewers for Adoption.

3.2.4. Pipe Bedding

As with section 3.1.5, the majority of drainage within the RI works is located within an area subject to surcharge treatment – either through surcharge mounding or through pre-loaded surcharge (i.e. the existing ground is considered to have acted as surcharge). In this area, the pipe bedding shall be as per the detail in Appendix G. This bedding detail has been developed to mitigate potential differential settlement within the “surcharge ground treatment areas”. Refer to Ground Treatment Plan in Appendix H for the location of surcharged areas in relation to the RI boundary.

In areas subject to dig and replace treatment, settlement is not considered a significant risk, therefore standard Class S or Class Z pipe bedding shall be used.

3.2.5. Pipe Materials

For foul water pipes that are 375mm in diameter and greater, it is proposed that concrete pipes of strength class 120 are used. For foul water pipes smaller than 375mm, vitrified clay pipes are proposed.

3.3. RI – Foul Water Pumped Drainage

3.3.1. Proposed Pumping Station Requirements

As the RI works will effectively complete the key infrastructure within Phases 2 & 3 of Kilnwood Vale (excluding individual residential and industrial/commercial/employment parcels), it is important to ensure that all future phases have the ability to discharge foul water flows into RI sewers. In order to provide Phases 3H, 3I, 3J, and 4 & 5 with adequate provision for foul water drainage, the assumption has been made that 3no. rising mains will be required. As Phase 4 & 5 are to the north of the rail, any collected foul flows will be required to be pumped over the rail in the build-up of the bridge(s). Phase 3H, 3I and 3J, adjacent to the rail, form a low spot which requires a pumping station in order to properly drain the parcel without requiring excessively deep gravity sewers throughout the rest of the site.

As discussed in section 3.2.2, the foul sewers within Phase 3C SRE will discharge to the pumping station PS1. This pumping station, located to the west of the Phase 3C SRE, has a significant catchment area. Refer to 2.3.2 and drawing 11950-3C-SRE-CD102 in Appendix F. The rising main from PS1 will also cross into the RI boundary. Refer to the Phase 3C SRE Drainage Report prepared by CampbellReith, dated May 2019, for detailed design information.

The pumping station PS2 permanent rising main is also proposed to cross into the RI boundary. This pumping station serves a significant catchment, serving all dwellings to the east of the site's high point. As with the PS1 rising main, the pumping station PS2 and rising main have been designed under a separate cover. Refer to the CampbellReith report Phase 3A-3B Drainage Strategy Report, dated April 2017, for further design information on PS2.

3.3.2. Pumping Station Design

Although there will be an allowance for 3no. rising mains within this phase of works, there are no pumping stations to be installed as a part of these works, and therefore no detailed design has been undertaken for the pumping stations themselves.

3.3.3. Rising Main Design

A total of 5no. rising main spurs will be installed as a part of the works for this phase, with 2no. being designed under previous covers (refer to Section 3.3.1), and the remaining 3no. each leading to a potential future pumping station. Based on preliminary calculations and estimates of housing numbers/industrial area draining to each of the potential pumping stations, the rising mains have been sized. This will form a constraint to the future design of the pumping stations.

The rising main from future pumping station PS3 has been preliminarily sized based on an estimated 317 dwellings from Phase 4/5. For a catchment such as this, the expected pumping rate has been calculated as 7.45 litres/sec, with a rising main OD160mm, SDR11. Air valves have been located at high points along the rising main and wash-out chambers located at low points, as shown on the drainage layout drawings in Appendix D.

The rising main from future pumping station PS4 has been preliminarily sized based on an estimated 266 dwellings and 1.11 ha of employment area from Phases 3I, 3J and 3H. For a catchment such as this, the expected pumping rate has been calculated as 6.49 litres/sec, with a

rising main OD160mm, SDR11. Air valves have been located at high points along the rising main and wash-out chambers located at low points, as shown on the drainage layout drawings in Appendix D.

The rising main from future pumping station PS6 has been preliminarily sized based on an estimated 389 dwellings from Phase 4/5. For a catchment such as this, the expected pumping rate has been calculated as 9.15 litres/sec, with a rising main OD180mm, SDR11. Air valves have been located at high points along the rising main and wash-out chambers located at low points, as shown on the drainage layout drawings in Appendix D.

Prior to discharge into gravity sewers, the rising mains will flow downhill. This will ensure that the flows into the break chamber are controlled. An air valve chamber is required to ensure that no air pockets will be formed at the high points along the rising mains.

The rising mains are to be located with a minimum cover of 1.2m to the pipe soffit and will be located within the proposed highway corridor for the entire length.

The rising mains are to be bedded to the detail in 11950-CD155 (included in Appendix G), where sited within an area treated by surcharge. Outside of the surcharged area, a standard Class S bedding type shall be used.

Throughout the length of the rising mains, marker tape is to be installed as a part of the bedding detail to ensure that the mains can be tracked and located for any future maintenance works.

3.3.4. Emergency Storage

As with 3.3.2, no detailed design has been undertaken for emergency storage requirements in lieu of detailed design information for Phase 3H, 3I, 3J, and Phase 4 & 5.

4.0 SUSTAINABLE DRAINAGE SYSTEMS

- 4.1.1. Sustainable drainage systems are incorporated to enhance biodiversity, limit flows, provide amenity value and provide water quality improvements from the surface water flows generated by the proposed RI works before discharging at a controlled rate into the Bewbush Brook via one of 3 outfalls.
- 4.1.2. Pond S1 will serve areas of Catchment A that fall within the Remaining Infrastructure works (along with upstream areas that discharge into RI sewers). The pond will be a wet pond with constant depth of 0.6m, with planting and will contribute positively to improve water quality, enhance biodiversity, and provide amenity value through the provision of footways and cycleways adjacent to the pond.
- 4.1.3. Pond S3, located north west of the site, will attenuate a small portion of flows from the Remaining Infrastructure works within Catchment B. The pond will be a wet pond with constant depth of 0.75m, with planting and will contribute positively to improve water quality, enhance biodiversity, and provide amenity value through the provision of footways and cycleways directly adjacent to the pond.
- 4.1.4. The ponds were designed and sized as a part of the Kilnwood Vale Site-Wide Drainage Strategy. The details for the ponds were approved under planning application DC/17/0943.
- 4.1.5. Catchment C, to the north of the brook, will discharge directly into the Bewbush Brook via 3 outfalls, of which only the one serving Plot 3J is to be constructed as a part of these works. A flow control chamber will constrain flows, and future attenuation is to be provided by the developers of Phase 3J. Phases 3H and 3I will construct their own outfalls to the Bewbush brook. The plots will all provide a suitable volume of attenuation storage within their boundary, due to their isolation from the main system of attenuation ponds.
- 4.1.6. Water quality control has been reviewed in line with CIRIA C753 (Chapter 26), and the relevant pollution indices. Guidance suggests that the water quality control measures put in place on the site through the combination of various SuDS are sufficient in mitigating against an increase in pollution, as set out in Chapter 7 of the Sitewide Drainage Strategy Report prepared by CampbellReith, dated December 2016.

5.0 SCHEDULE OF MAINTENANCE

5.1. Introduction

- 5.1.1. All elements of the drainage infrastructure within RI are to be publicly adopted (by either West Sussex County Council or Thames Water), and as such the individual maintenance of the system will fall under the relevant bodies routine maintenance schedule.
- 5.1.2. Any surface water flows discharging into the RI infrastructure via spurs from areas of residential or commercial development are encouraged to further consider the use of SuDS as a part of the on-plot designs. SuDS that are recommended for use within the individual phases are typically permeable paving or proprietary treatment systems.
- 5.1.3. The maintenance of SuDS features is vital ensuring that they work as efficiently as they were set out to do. Maintenance activities can be broadly defined as:
- Regular maintenance – basic tasks carried out regularly.
 - Occasional maintenance – tasks that are required periodically but on a much less frequent basis.
 - Remedial maintenance – tasks required when a fault needs rectifying and often includes unforeseen events.
- 5.1.4. During construction, it is the responsibility of the Principal Contractor to ensure the relevant management and maintenance requirements outlined below are implemented. The principal contractor will retain responsibility during construction up to the handing over.
- 5.1.5. Typical maintenance requirements, as per CIRIA C753: The SuDS Manual, for recommended SuDS are detailed below. The operations and maintenance requirements for Pond S1 & Pond S3, are also included.

5.2. Permeable Paving

Construction

- 5.2.1. Construction vehicles and equipment not directly involved in the construction of the pervious pavements will be kept away from these areas. Silt fences, staged excavation works and temporary drainage swales/bunds to divert runoff away from exposed areas will be utilised, as appropriate, to manage the risks associated with, and to intercept the discharge of sediment laden runoff. Landscaping activities will be carefully designed and carried out to prevent deposition of topsoil, turf and other materials on the surface of the pavement. Infiltration surfaces will not be compacted and will be protected at all times. Excavations for the pervious pavement installation should aim to be undertaken in times of dry weather, when possible, to prevent mobilisation of sediments from exposed surfaces during rainfall events. Surfaces exposed as part of the pervious paving installation works should be stabilised as soon as possible. Perimeter controls should be installed prior to construction to protect watercourses.

Maintenance Schedule

Table 2 shows the operation and maintenance requirements for the pervious pavements which are in accordance with the CIRIA C753 SuDS Manual.

Maintenance Schedule	Required Action	Typical Frequency
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations - pay particular attention to areas where water runs onto pervious surfaces from adjacent impervious areas as these areas are most likely to collect the most sediment
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using Glyphosate applied directly onto the weeds by an applicator rather than spraying	As required - once per year on less frequently used pavements
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth - if required, take remedial action	Three-monthly, 48 hrs after large storms in first six months
	Assess silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

Table 2: Operation and maintenance requirements for pervious pavements (CIRIA C753, 2015)

5.3. Ponds

Construction

- 5.3.1. Construction vehicles and equipment not directly involved in the construction of the ponds are to be kept away from these areas. Silt fences, staged excavation works and temporary drainage swales/bunds to divert runoff away from exposed areas will be utilised, as appropriate, to manage the risks associated with, and to intercept the discharge of, sediment laden runoff prior to its discharge into Bewbush Brook. Excavations for the ponds should be undertaken in times

of dry weather, when possible, to prevent mobilisation of sediments during rainfall events. Surfaces exposed as part of the pond construction should be stabilised as soon as possible, by the use of hydroseeding or an alternative approved approach. Care should be taken to ensure that the impermeable liner is not damaged during construction. Perimeter controls should be installed prior to construction to protect the existing water bodies.

Maintenance Schedule

- 5.3.2. The following Table 3 shows the operation and maintenance requirements for the detention basins, adopted from the SuDS Manual C753.

Maintenance Schedule	Required Action	Typical frequency
Regular maintenance	Remove litter and debris	Monthly (or as required)
	Cut the grass	Monthly (during growing season)
	Inspect marginal and bankside vegetation and remove nuisance plants (for first 3 years)	Monthly (at start, then as required)
	Inspect inlets, outlets, banksides, structures, pipework for evidence of blockage and/or physical damage	Monthly
	Inspect water body for signs of poor water quality	Monthly (May – October only)
	Inspect silt accumulation rates in the detention basin and establish appropriate removal frequencies; undertake contamination testing once some build-up has occurred, to inform management and disposal options	Half yearly
	Check any mechanical devices	Half yearly
	Hand cut submerged and emergent aquatic plants (at minimum of 0.1m above pond base; include maximum 25% of pond surface)	Annually
	Remove 25% of bankside vegetation from water's edge to a minimum of 1m above water level	Annually
	Tidy all dead growth (scrub clearance) before start of growing season	Annually
Occasional maintenance	Remove sediment build-up	As required
Remedial actions	Repair erosion or other damage	As required
	Replant, where necessary	As required
	Aerate pond when signs of eutrophication are detected	As required
	Repair/rehabilitate inlets, outlets, and overflows.	As required

Table 3: Operation and maintenance requirements for ponds (CIRIA C753, 2015)

5.4. Proprietary Treatment Systems

- 5.4.1. The proprietary treatment systems include conventional pipework, gullies, catchpits, manholes, channels, and headwalls.

Construction

- 5.4.2. During construction, the principal contractor must ensure that preventative measures have been put in place as to not allow the construction runoff to drain into the system. Measures must be taken to ensure debris from the construction site does not block the components. Routine inspections should be undertaken ensuring that the drainage is functioning properly. Outfalls must be constructed to the correct level and all joints must be correctly sealed. During construction backfill should be correctly installed as specified and as per the manufactures' recommendations.

Maintenance Schedule

- 5.4.3. The maintenance schedule for the aforementioned SuDS components has been adopted from the SuDS Manual C753 and are summarised in Table 4.

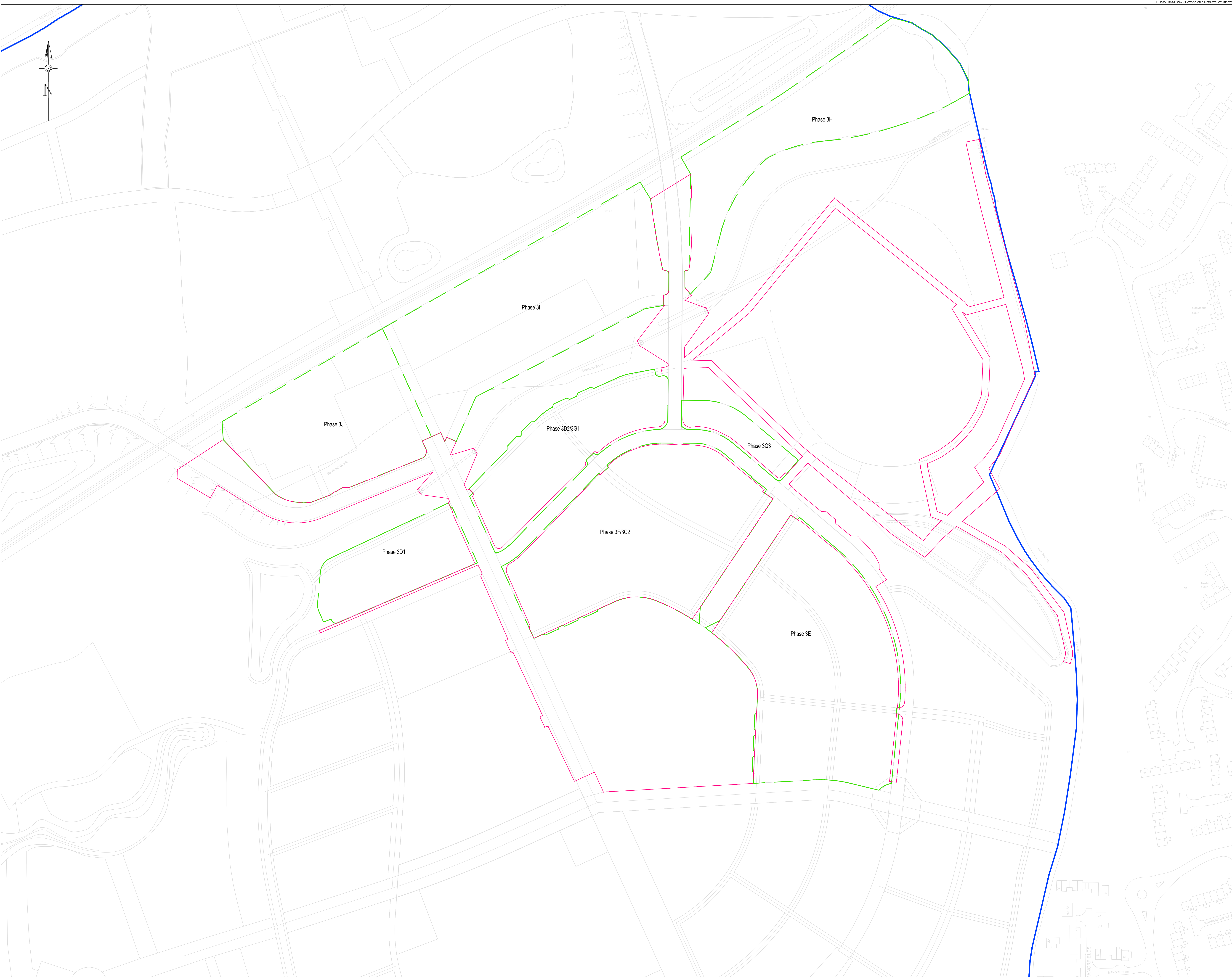
Maintenance Schedule	Required Action	Typical Frequency
Regular maintenance	Remove litter and debris	Monthly (or as required)
	Monitoring	Inspect monthly
Occasional maintenance	Sediment management	Annually or as required
Remedial maintenance	Structure rehabilitation/repair	As required

Table 4: Operation and maintenance Requirements for Proprietary Treatment Systems

6.0 CONCLUSION

- 6.1.1. CampbellReith have designed the foul and surface water networks in accordance with Sewers for Adoption 7th Edition. The detailed foul water calculations show that the Remaining Infrastructure sewers have the capacity to convey the peak flows whilst achieving a self-cleansing velocity of 0.75m/s at one-third design flow or satisfying the criteria of Sewers for Adoption.
- 6.1.2. The surface water calculations show there is no surcharging within the Remaining Infrastructure surface water sewers for the 1 in 1 year storm events. The results also show that there is no flooding from the designed sewers, for rainfall events up to the 1 in 100 year events. The results also show that there will be flooding in some of the sewers upstream of the Spine Road Extension for events up to the 1 in 100 year +30% climate change allowance, but the road infrastructure will act as flood routes conveying the flooding surface water, at shallow depths, to Attenuation Ponds S1 & S3 or the Bewbush Brook, depending on the catchment.
- 6.1.3. The future development works to Kilnwood Vale are likely to require up to 3no. future pumping stations which will need to discharge flows through the Remaining Infrastructure package. In addition, 2 previously approved pumping stations will discharge flows through rising mains that run, in part, through the RI boundary. As such, 5no. rising mains will be constructed as a part of these works and based on existing designs where possible – if flows are unconfirmed, they have been preliminarily sized based on information available at this time. Detailed design of the future pumping stations and emergency storage requirements will be carried out when more information is available. Pumping stations PS1 & PS2 have been designed and detailed under separate designs, and readers should refer to the Phase 3C SRE and Phase 3A-3B Drainage Strategy Reports respectively for further design information.
- 6.1.4. The existing site ground conditions have also been considered in preparing the detailed designs for the foul and surface water sewer to be offered for adoption. The Remaining Infrastructure sewers will be constructed partly within an area where the existing ground will have been surcharged to minimise future ground settlements. Sewers in this area have been designed with flattest gradients of 1:75 and with the bedding detail shown on drawing 11950-CD-155 in Appendix H to minimise the impact of any residual settlement. Drainage outside of the surcharged area (i.e., within “dig and replace” areas) is subject to the requirements of Sewers for Adoption 7th Edition.
- 6.1.5. Vitrified Clay and Concrete pipes are proposed for gravity mains subject to pipe size. For the rising mains, a HDPE pipe is proposed.

Appendix A: Remaining Infrastructure Location Plan



Notes

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3. Read this drawing with all Architect's, Service Engineer's and CampbellReith's relevant details, specifications and drawings.
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5. Drawn as follows:

P: Preliminary	Evolving drawings for approvals, tenders, billings etc.
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C: Contractual Drawings authorized and approved for stage completion i.e. Stage-Tender or Stage 5-Construction.

6. Drawing status:

Work in progress

S1 - Suitable for coordination, **S2** - Suitable for information, **S3** - Suitable for review and comment, **S4** - Suitable for stage approval

Published (For contractors purposes)

B1, Bn etc - Partial sign-off (with comments)

CR - As constructed record document (Final Construction ONLY). Any deviations to that which is on site is not the liability of CampbellReith)

7. Work Stages:

2 - Concept, 3 - Definition, 4 - Design, 5 - Build & commission, 6 - Handover

8. Only drawings with revision Cn and status A5 to be used for Construction.

9. This drawing is to be read in conjunction with others in the CampbellReith 11950-RI series.

Legend

— Kilnwood Vale Overall Site Boundary

— Remaining Infrastructure Planning Boundary

— — Housing Phase Boundaries

P1	Issued for Information	27.04.23	NB
Rev	Description	Date	By

CampbellReith
consulting engineers

London	020 7340 1700	☐	☐	Manchester	0161 819 3060
Surrey	01737 784 500	☐	☐	Birmingham	01675 467 484
Bristol	0117 916 1066	☒	☐	Dubai	00 971 4345 7088

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Job Title Kilnwood Vale, Crawley

Client	Ridewood Vale, Crawley
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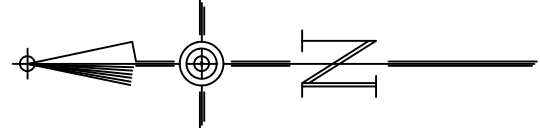
Crest Nicholson

Remaining Infrastructure Block Plan

Drawn by	Date made	Scale @ A0	Checked by	Suitability	CR Project
NB	05.04.23	1:1000		S2	11950

Project No.	Originator	Volume	Lvl/Loc	Type	Role	Number	Rev
11950	CPH	B1	XX	DB	C	1050	B1

Appendix B: Extract from “Kilnwood Vale Site Wide Drainage Strategy Report”



OVERSIZE PIPE/UNDERGROUND TANKS TO ATTENUATE FLOW PRIOR TO OUTFALL

ATTENUATION POND S1

OUTFALL FOR POND S1

OVERSIZE PIPE/UNDERGROUND TANKS TO ATTENUATE FLOW PRIOR TO OUTFALL

ATTENUATION POND S3

OUTFALL FOR POND S3

Grove

Bewash Brook

notes

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DRAWING STATUS

S - SCHEME

D - DESIGN DEVELOPMENT

C - CONSTRUCTION

Outline/Scheme drawings for proposals, budgets etc.

Existing final design drawings for approvals, tenders, etc.

Fully developed drawings issued under instruction for construction.

ONLY STATUS C DRAWINGS TO BE USED FOR CONSTRUCTION.

6. For manhole information please refer to excel spreadsheet "SR MANHOLE SCHEDULE OVERALL SITE".

LEGEND

BULK EARTHWORK PLATFORMS

PROP B/E CONTOURS (MAJOR)

PROP B/E CONTOURS (MINOR)

STORMWATER PIPE & MANHOLE

EXISTING CULVERT TO BE RETAINED

SUDS OUTFALL CONNECTIVITY

PHASE 2 AND 3 BOUNDARY

CLIENT OWNERSHIP BOUNDARY

S8	DRAINAGE NETWORK REVISED	12.12.16	NEJ
S7	MANHOLE REF REVISED	04.04.16	HM
S6	DRAINAGE REVISED	02.03.16	HM
S5	ROAD 16 DRAINAGE ADDED, REFS. REVISED	04.02.16	HM
S4	DRAINAGE REVISED	13.01.16	HM
S3	DRAINAGE REVISED TO SUIT MASTERPLAN	11.01.16	HM
S2	ISSUED FOR INFORMATION	30.01.15	NEJ
S1	ISSUED FOR INFORMATION	27.01.15	NEJ

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DUBAI 00 971 4345 7088

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Job Title

KILNWOOD VALE, CRAWLEY

Client

CREST NICHOLSON

DRAINAGE STRATEGY

STORMWATER LAYOUT

OVERALL SITE

drawn

NEJ

date

30.01.2015

scale

1:1250@A0

C1 checked

CAD filename

11950SK20

Job No.

11950

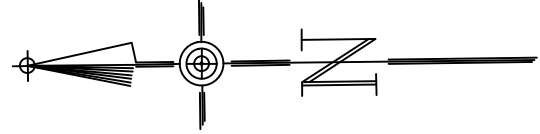
Dwg No.

SK20

Data/Revision

S8

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MAIN PUMPING STATION COMPOUND
PUMPING STATION A (DESIGN TEC)
185 HOUSES
EMERGENCY STORAGE = 750M³

PUMPING STATION B
494 HOUSES
1.9HA COMMERCIAL SPACE
EMERGENCY STORAGE = 104M³

PUMPING STATION 2
489 HOUSES
0.625 COMMERCIAL SPACE
EMERGENCY STORAGE = 87.94M³

PUMPING STATION 1
967 HOUSES
2.64HA COMMERCIAL SPACE
1000 SCHOOL PUPILS & TEACHERS
EMERGENCY STORAGE = 227.7M³
88M³ PROVIDED BY PHASE 1 CONTRACT
139.7M³ TO BE CONSTRUCTED AS PART OF
PHASE 2 & 3

PS3
287 HOUSES
EMERGENCY STORAGE = 79.8M³

CONNECTION FOR PHASE 4/5

CONNECTION FOR PHASE 4/5

ATTENUATION
POND S1

ATTENUATION
POND S3

Remaining infrastructure

notes

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Outline/Scheme drawings for proposals, budgets etc.

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Fully developed drawings issued under instruction for construction.

ONLY STATUS C DRAWINGS TO BE USED FOR CONSTRUCTION.

6. For manhole information please refer to excel spreadsheet "FW MANHOLE SCHEDULES OVERALL SITE"

LEGEND

BULK EARTHWORK PLATFORMS

75.00 PROP B/E CONTOURS (MAJOR)

75.00 PROP B/E CONTOURS (MINOR)

FOUL WATER PIPE & MANHOLE

PHASE 2 AND 3 BOUNDARY

CLIENT OWNERSHIP BOUNDARY

FOUL RISING MAIN

S10	DRAINAGE NETWORK REVISED	12.12.16	NEJ
S9	PIPE SIZES AMENDED	03.11.16	NEJ
S8	RISING MAIN ADDED, PIPES RENUMBERED, CLOUSED PIPES AMENDED, PUMPING STATION INFORMATION ADDED	22.07.16	NEJ
S7	DRAINAGE RENUMBERED	18.04.16	NEJ
S6	DRAINAGE REVISED	04.04.16	HM
S5	DRAINAGE REVISED	02.03.16	HM
S4	ROAD 16 DRAINAGE ADDED, REFS REVISED	04.02.16	HM
S3	DRAINAGE REVISED TO SUIT MASTERPLAN	11.01.16	HM
S2	ISSUED FOR INFORMATION	30.01.15	NEJ
S1	ISSUED FOR INFORMATION	27.01.15	NEJ

Status	Description	Date	By

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Job Title

KILNWOOD VALE, CRAWLEY

Client

CREST NICHOLSON

DRAINAGE STRATEGY
FOUL WATER LAYOUT
OVERALL SITE

drawn	date	scale	C1 checked	CAC Name
NEJ	30.01.2015	1:1250@A0		11950SK21

job No.	Dwg No.	Status/Revision
11950	SK21	S10

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Appendix C: Remaining Infrastructure Road Layout



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Drawings authorized and approved for stage completion i.e. Stage-Tender or Stage 5-Construction.

6. Drawing status:

Work in progress

S0 - Initial status

Shared (Non-contractual)

S1 - Suitable for coordination, S2 - Suitable for information, S3 - Suitable for review and comment, S4 - Suitable for stage approval

Published (For contractors purposes)

A1: An etc - Authorised and accepted ('Y' relates to work stages)

S1, Bn etc - Partial sign-off (with comments)

CR - As constructed record document (Final Construction ONLY, Any deviations to that which is on site is not the liability of CampbellReith)

7. Work Stages:

2 - Concept, 3 - Definition, 4 - Design, 5 - Build & commission, 6 - Handover

8. Only drawings with revision Cn and status A5 to be used for Construction.

9. This drawing is to be read in conjunction with others in the CampbellReith 11950-RI series.

10. All adoptable highway works to be carried out in accordance with DfT specification for highway works or as amended by West Sussex County Council S278/38 standard details.

11. Temporary terminations of carriageway to be retained by sacrificial kerb laid flush with surface.

12. Design CBR values taken as 3%, contractor to confirm cbr values on site. If design CBR value is not achieved sub base to be increased in accordance with WSCC standard detail S278/38/21.

13. Any soft spots within the proposed highway shall be dug out and the void backfilled in layers up to formation level with selected granular fill as directed and to the satisfaction of the highways inspector.

14. Tactile paving to comply with the 'Guidance on the use of tactile paving surfaces' 1998. Refer to standard detail S278/38/18.

15. Topsoil to be removed prior to commencement of any construction work.

16. Engineering fill material to be placed, compared and tested in accordance with specification.

17. Detailed information is available in the following drawings:

Pavement makeup: CampbellReith, 11950-CRH-RI-XX-DR-C-5001 to 5007

Horizontal Alignments: CampbellReith, 11950-CRH-RI-XX-DR-C-5101 to 5107

Visibility Splays: CampbellReith, 11950-CRH-RI-XX-DR-C-5121 to 5137

Vertical Alignments: CampbellReith, 11950-CRH-RI-XX-DR-C-5141 to 5143

Signs & Marking: CampbellReith, 11950-CRH-RI-XX-DR-C-6101 to 6107

Lighting columns: SSE / Enerveo, EVO320759-LD-001 to 003 and EVO20017547-LD-001

Vehicle Tracking: CampbellReith, 11950-CRH-RI-XX-DR-C-6111 to 6117

Legend

Remaining Infrastructure Planning Boundary

Housing Phase Boundaries

P2	Lighting columns added, drawing notes added	16.06.23	NB
P1	Issued for information	27.04.23	NB

Rev	Description	Date	By

CampbellReith

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London

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Surrey

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Birmingham

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Job Title

Kilnwood Vale, Crawley

Client

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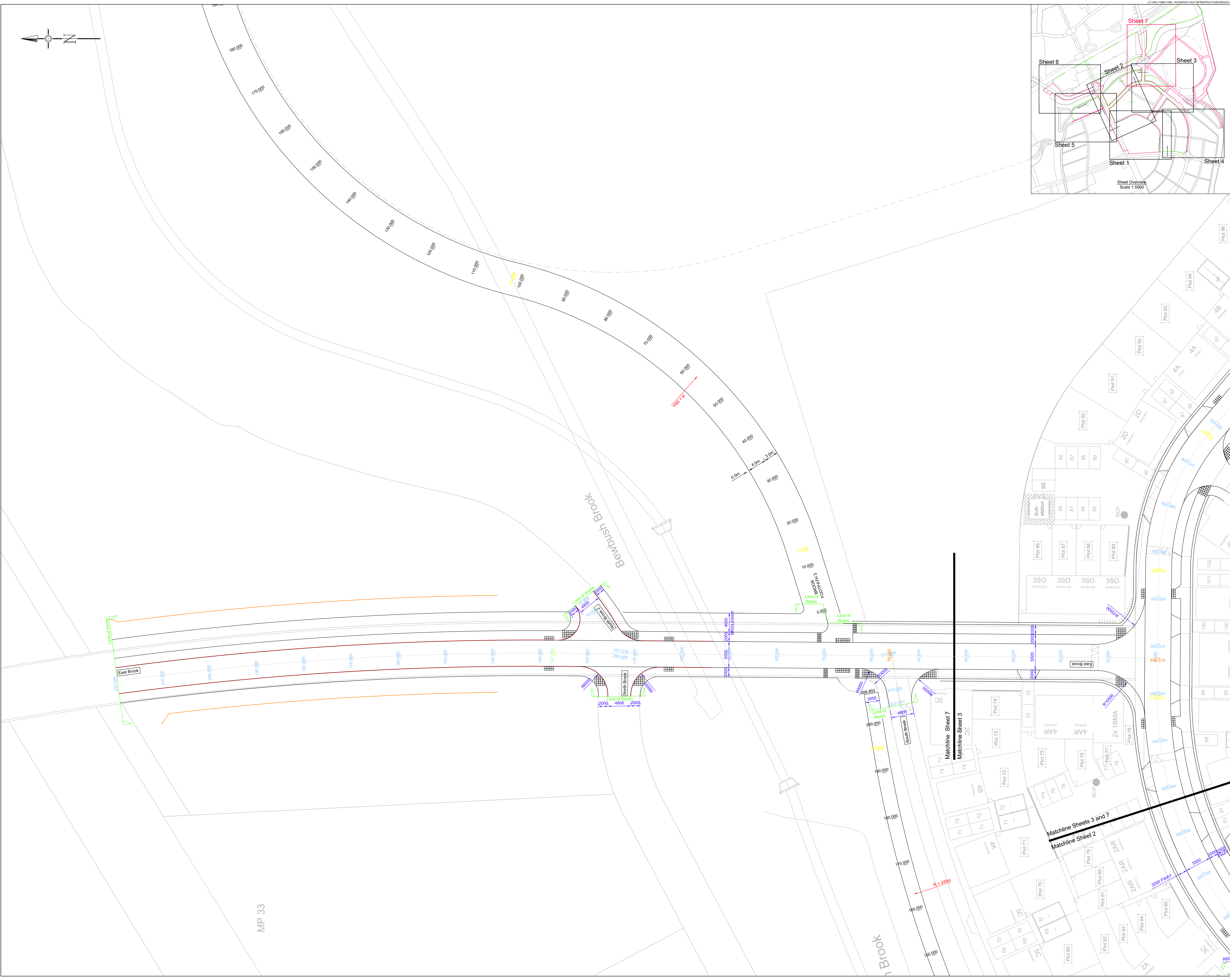
Remaining Infrastructure

Overall Highways Layout

Drawn by	Date made	Scale @ A0	Checked by	Suitability	CR Project
NB	05.04.23	1:1000		S2	11950

Project No.	Originator	Volume	Lvl/Loc	Type	Role	Number	Rev
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4. All work is to be done in accordance with the relevant specifications issued by CampbellReith, British Standard Codes of Practice, Statutory Requirements and the Contract Documents.

5. Drawing revision:

P:Preliminary

C:Contractual

Evolving drawings for approvals, tenders, billings etc.

Drawings authorized and approved for stage completion i.e. Stage-Tender or Stage 5-Construction.

6. Drawing status:

Work in progress

S0 - Initial status

Shared (Non-contractual)

S1 - Suitable for coordination, S2 - Suitable for information, S3 - Suitable for review and comment, S4 - Suitable for stage approval.

Published (For contractors purposes)

A1, A1n etc - Authorised and accepted ('Y' relates to work stages)

S1, S1n etc - Partial sign-off (with comments)

CR - As constructed record document (Final Construction ONLY, Any deviations to that which is on site is not the liability of CampbellReith)

7. Work Stages:

2 - Concept, 3 - Definition, 4 - Design, 5 - Build & commission, 6 - Handover

8. Only drawings with revision Cn and status A5 to be used for Construction.

9. This drawing is to be read in conjunction with others in the CampbellReith 11950-CRH-RI series.

10. All adoptable highway works to be carried out in accordance with DIT specification for highway works or as amended by West Sussex County Council S278/38 standard details.

11. Temporary terminations of carriageway to be retained by sacrificial kerb laid flush with surface.

12. Design CBR values taken as 3%, contractor to confirm cbr values on site. If design CBR value is not achieved sub base to be increased in accordance with WSCC standard detail S278/38/21.

13. Any soft spots within the proposed highway shall be dug out and the void backfilled in layers up to formation level with selected granular fill as directed and to the satisfaction of the highways inspector.

14. Tactile paving to comply with the 'Guidance on the use of tactile paving surfaces' 1998. Refer to standard detail S278/38/18.

15. Topsoil to be removed prior to commencement of any construction work.

16. Engineering fill material to be placed, compared and tested in accordance with specification.

Rev

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27.04.23

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Job Title

Kilwood Vale, Crawley

Client

Crest Nicholson

Remaining Infrastructure

Horizontal Alignments

Sheet 7 of 7

Drawn by

Date made

Scale @ A0

Checked by

Suitability

CR Project

NB

04.04.23

1:250

S2

11950

Project No

Originator

Volume

Lvl/Loc

Type

Role

Number

Rev

11950

CRH

RI

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5107

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