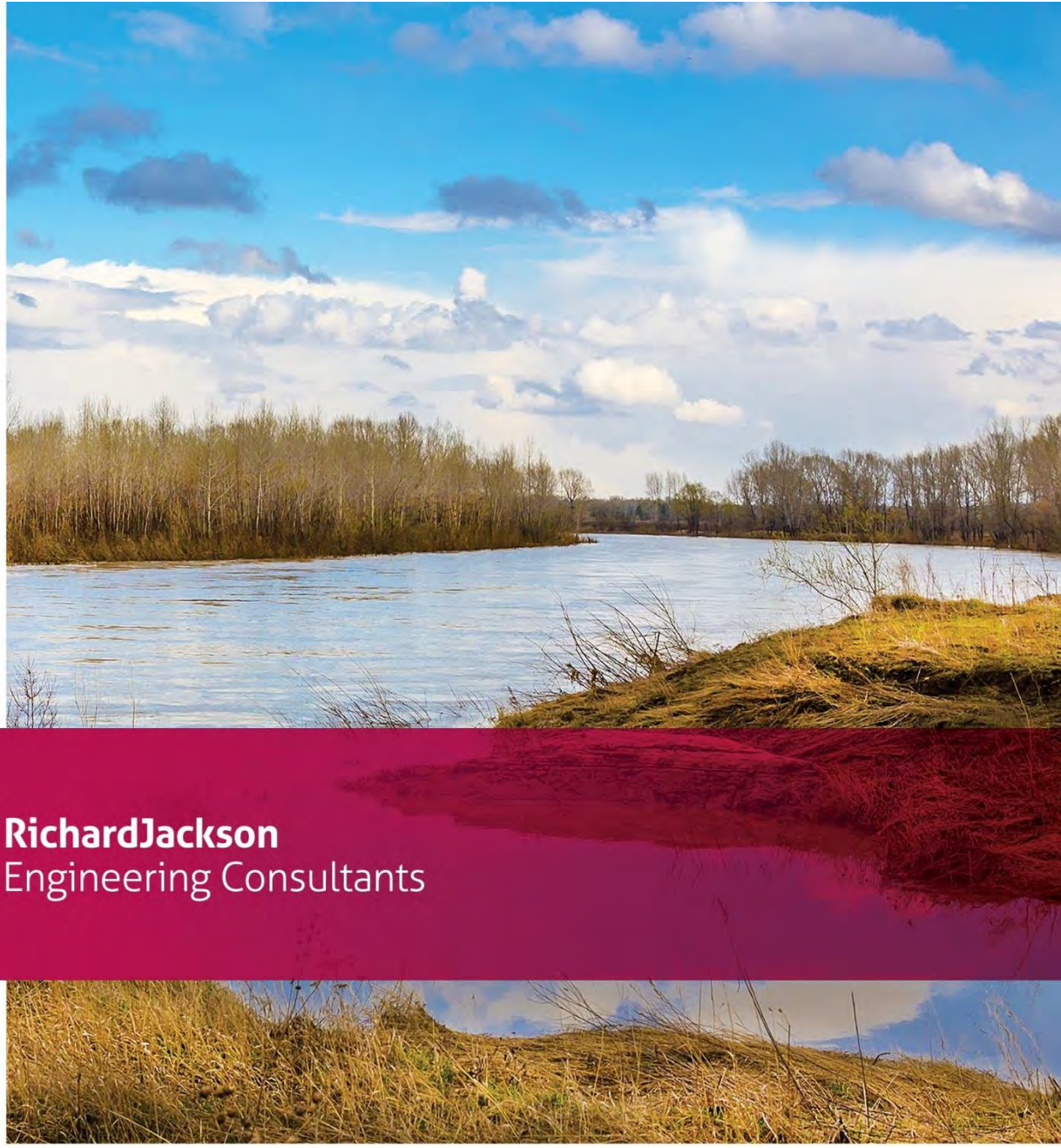

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SITE SPECIFIC FLOOD RISK ASSESSMENT

Land off Howlett Way, Trimley St Martin

Client(s): Trinity College, Cambridge

December 2019

Project no: 48055

RichardJackson
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Appendices

1. Introduction

1.1. Richard Jackson Limited have been instructed by Trinity College, Cambridge to consider the flood and surface water drainage elements for Land off Howlett Way, Trimley St Martin in support of an outline planning application for up to 340 dwellings with open space, a new Early Years Facility, new roundabout access from Howlett Way, a foul water pumping station and associated landscaping. The site is allocated as Policy 'FPP7' within the Felixstowe Peninsula Action Plan (2017).

1.2. The site is shown on Figure 1. This report is to consider an overview of a surface water drainage strategy to mitigate and address the potential for a new residential development and associated facilities, against flood risk in the surrounding area. Access to the development will be off Howlett Way on the northwest boundary via a new roundabout access. The current use of the site is for agricultural land which there are very little impermeable surfaces.

1.3. The site is shown on the Governments' Indicative Flood Mapping for planning to be in Flood Zone 1 (very low risk – less than 0.1% annual probability event), therefore suitable for the land uses proposed.

1.4. East Suffolk District Council (ESDC) Development Management Policy DM28 – Flood Risk - will be considered:

Policy DM28: '*Within all areas at high risk from flooding the proposal must be accompanied by a Flood Risk Assessment which shows that the proposal:*

i) Is unlikely to impede materially the flow or storage of flood water or increase the risk of flooding elsewhere (for example, due to additional water runoff); and

ii) Would not increase the number of people or properties at risk from flooding, by including appropriate mitigation measures to prevent this occurring.

1.5. Whilst the proposed site is not within an area of high risk from flooding, the general principle of development of an undeveloped area increases the impermeable area and surface water runoff. This Flood Risk Assessment (FRA) identifies the proposed surface water drainage strategy and how the risk to onsite properties and offsite is minimised.

1.6. The flood risk and drainage strategy is carried out in accordance with the National Planning Policy Framework (NPPF) – Planning Practice Guidance (PPG) on Flood Risk & Coastal Change, published by the Department for Communities and Local Government (DCLG). Reference is also made to the Suffolk County Council as the Local Lead Flood Authority (LLFA) guidance document 'Sustainable Drainage Systems (SuDS) a Local Design Guide – Appendix A to the Suffolk Flood Risk Management Strategy (May 2018).

1.7. The copyright of this report is vested in Richard Jackson Limited. The Consortium or their appointed representatives may copy this report for the purposes in connection with the development described herein. It shall not be copied or distributed in any other form by any other party or used for any other purpose without the written consent of Richard Jackson Limited.

2. Development Description and Location

2.1. The site is located to the northwest of Felixstowe (in the village of Trimley St Martin) and west of the A14 Trunk Road and east of High Road. The approximate OS grid reference for the centre of the site is 627730, 237330 and postcode IP11 0SW. The location and its environs can be seen on Figure 1, which shows the site boundary indicatively.

2.2. The topography of the site falls in an easterly direction at approximate gradients ranging between 1 in 155 and 1 in 25. To the north of the site is Howlett Way. To the east of the site boundary is the A14. To the south of the site lies private dwellings and further agricultural land. To the immediate west of the site lies private dwellings and the High Road. The topographical survey drawings are shown in Appendix A.

2.3. The site is 100% greenfield and permeable and likely discharges into the ground. There are no local watercourses in the area that the site would drain too currently. The site area is approximately 23.19ha in total.

2.4. An extract of the relevant Flood Estimation Handbook (FEH) rainfall data for the site is also presented in Appendix B.

2.5. A copy of the illustrative development masterplan is shown within Appendix C and referenced (7845-SK02-D) – December 2019. This indicates the layout for up to 340 dwellings and an 'early years centre' as well as approximate locations for principle surface water drainage features.

2.6. Published geological records from the British Geological Survey (BGS) show that the site is likely to be underlain by primarily sands and gravels. This superficial formation is underlain with the Kesgrave Catchment subgroup, which is in turn likely to be underlain with Red Crag formation. Refer to the infiltration testing and soil logs of the site in Appendix D for further detail. In summary, the site is suitable for infiltration generally across the site. This will form the principle basis for the surface water drainage strategy.

2.7. The on-site infiltration testing identifies the area to have a minimum 2.5m of silty sands geology and no groundwater was encountered to a depth of 2.5m at the lowest point on the site (eastern corner).

3. Definition of a Flood Hazard

3.1. When assessing any development site, there are five potential sources of flooding which need to be considered both in terms of their effect on the

development itself and its end users and that caused to others. The main sources of flooding that need to be considered are as follows:

- Fluvial and/or tidal flooding;
- Ground water;
- Overloading of the existing drainage network;
- Artificial sources, i.e. reservoirs; and
- Surface water flooding

Fluvial and tidal sources of flooding

3.2. From investigation of the existing watercourses and the Government long term risk online mapping, the site is in Flood Risk Zone (FRZ) 1. The nearest source of fluvial/tidal flooding is from the River Orwell to the southwest of the site, approximately 2.6km away. Fluvial and/or tidal flooding is not considered to be a risk on this development.

3.3. The sequential and exception test are not relevant to this development proposal as the area of the site to be developed lies outside the 0.1% annual probability event flood zone. Refer to Figure 2.

Groundwater Flooding

3.4. The Environment Agency (EA) defines groundwater vulnerability mapping of the Site, see Figure 3 and shows that the Site is located on a minor aquifer with high vulnerability. On this basis, any water that flows back into the ground must be managed to protect the groundwater through suitable Sustainable Drainage Systems (SuDS).

3.5. The on-site infiltration testing identifies the area to have a minimum 2.5m of sands and no groundwater was encountered to a depth of 2.5m at the lowest point on the site (eastern corner). It is not considered that groundwater flooding is a risk to this site.

Existing Drainage Network

3.6. Flooding can occur when the drainage capacity of the network is exceeded or fails. This can be due to the design capacity of the network being less than the return period of the rainfall event of the development proposals. Otherwise, it can be when the network does not perform to the design capacity due to blockage or damage within the network.

3.7. Available records from Anglian Water have been analysed together with the results of a full topographical survey to establish the existing drainage arrangements. The Anglian Water records show that there are no surface water sewers that exist on or near to the Site. As the site is suitable for infiltration, the use of surface water sewers is not required. Existing Anglian Water records can be seen in the Foul Water & Utilities Assessment submitted as part of this planning application.

3.8. The existing Anglian Water records indicate local foul water sewers in High Road to the west of the site, therefore a pumped foul water drainage

strategy for the site is required. This allows the pumped rate to be controlled and also accommodates 24-hour storage of foul water, should it be required, minimising risk to the existing foul water network and to the occupiers of this development should the pumping station fail.

Artificial Sources of Flooding

3.9. The Government long term flood risk online mapping identifies the site has no risk of reservoir flooding. Therefore, this is not considered further.

Surface Water Flooding

3.10. Further investigation into the existing ground conditions and suitability of the use of soakaways and SuDS is examined later in this report.

3.11. An assessment of the likelihood of flooding from overland surface water can be assessed by using the Governments' long-term flood risk online surface water flooding maps which are shown on Figures 4 and 5. Figure 5 shows the greater than 0.1% annual probability event (low risk) (1 in 1000-year event). Figure 4 shows the greater than 3.3% annual probability (high risk) and the greater than 1.0% annual probability event (medium risk) event.

3.12. The site does not suffer from overland surface water flooding. The government online flood risk mapping shows that there is some limited surface water flooding along the eastern boundary in 0.1% annual probability event, however, in the 1.0% annual probability event ('medium risk') there is no surface water flooding in this area.

3.13. The rainfall landing on the existing ground would principally infiltrate into the ground with only minor overland flow to the eastern site boundary as the levels lowest of the site. The water from the proposed development will therefore be captured through a new SuDS scheme, whilst allowing infiltration where possible – at source, but would allow surface water run-off to be directed to the lowest points of the land parcels, attenuated and then discharged into the ground.

3.14. The NPPF indicates that a site-specific flood risk assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall. The assessment of surface water run-off and reduction of flood risk is assessed in Chapter 6 of this report.

4. Probability of Flooding

4.1. The site area to be developed is located in FRZ 1, which is assessed as having less than a 0.1% annual probability of river or sea flooding in any year (very low risk). On this basis, the site is very unlikely to flood from fluvial / tidal areas and from the assessment of groundwater, artificial flooding, or overland surface water flooding and is very unlikely to cause

any risk to dwellings or life. Thus, the development site is acceptable in this location for residential and early education uses.

4.2. High Road to the west of the site, forms a natural highpoint of topography in the wider area of Trimley St Martin. To the west of High Road, the land falls to the west towards the River Orwell, therefore there is no exceedance surface water runoff likely to pass across the site and does not needs to be considered further.

5. Climate Change

5.1. Climate change over the next 100 years or so is predicted to cause an increase in the probability of surface water flooding, as peak rainfall is predicted to significantly increase. Therefore, the design of the surface water drainage strategy considers a factor of 20% climate change allowance; in accordance with the LLFA advice for development with a design life of 100 years should be used when designing new surface water infrastructure or SuDS. A sensitivity check for a climate change allowance of 40% has also been undertaken. As there are no rivers affecting the site, no additional assessment of climate change is required.

6. Flood Risk Impact

6.1. It has been determined using the Ordnance Survey and topographical survey level information available, that surface water runoff from the site will occur in an easterly direction with most of the rainfall falling across the existing site infiltrating into the soils of the site given the current permeable surfaces and geology.

6.2. To determine the rainfall data for the site, the Flood Estimation Handbook (FEH) data has been used, see Appendix B. The FEH data for rainfall is suggested to be used where the critical rainfall scenario is greater than 1 hour.

Soil Types and SuDS Suitability

6.3. The NPPF and associated LLFA guidance indicates that the FRA should identify the risks of flooding and manage those risks to ensure the site remains safe. One way to manage the flood risk is to incorporate SuDS within proposals for new sites. There is a general requirement that SuDS be installed where appropriate, in order to limit the amount of surface water runoff entering existing drainage systems/watercourses and to return surface water into the ground to follow its natural drainage path. This advice is also replicated in the SuDS Manual C753 (2015).

6.4. A site investigation has been undertaken which included infiltration testing to BRE Digest 365 at the site, see Appendix D. On the basis of the data, it is therefore considered that the ground conditions will be suitable for typical infiltration methods, due to the presence of appropriate geology. The infiltration rate varies across the site and this has been indicated on the plans provided in Appendix D. Table 6.1 indicates the summary of suitable infiltration rates for the various areas across the site.

Table 6.1 – Permeability Rates

Area	Lowest Suitable Permeability Rate			
	Shallow (circa 0.7m depth)	Trial Pit Ref.	Deep (circa 2.5m depth)	Trial Pit Ref.
South	1.1×10^{-5} m/s	TP8	5.0×10^{-6} m/s	TP9
East	1.5×10^{-5} m/s	TP4	1.0×10^{-5} m/s	TP3
West	5.4×10^{-6} m/s	TP6	N/A	TP7
North	9.4×10^{-6} m/s	TP5	1.6×10^{-5} m/s	TP1

* N/A identifies localised infiltration is unlikely to be suitable.

6.5. From this data, infiltration SuDS features could be considered at this site. For example, surface water from car parking areas could be drained via appropriately designed porous surfaces such as 'Hydropave' or 'Aquaflow block' and allowed to infiltrate. The permeable paving can be laid near to the building and soakaways and large SuDS features should be 5m away from structures and highway kerbs. Pervious surfaces act as an effective way to store surface water prior to discharge into the ground and have also been shown to act as a filter and retainer for pollutants, in particular oil.

6.6. Advice on pollution control is given in the SuDS Manual C753 (2015). To provide data that indicates sufficient pollution protection to improve water quality, an assessment of the 'Water Quality Risk Management' has been undertaken in accordance with Chapter 26 of the CIRIA C753 SuDS Manual 2015. Table 26.2 of the SuDS Manual identifies the pollution hazard indices for different land use classifications. The pollution levels for this site are indicated below as taken from Chapter 26, Table 26.2, for property driveways, roofs and the highways.

TABLE 26.2 Pollution hazard indices for different land use classifications

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
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
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways[1]	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured, industrial sites, trunk roads and motorways[1]	High	0.8[2]	0.8[2]	0.9[2]

Notes

1 Motorways and trunk roads should follow the guidance and risk assessment process set out in Highways Agency (2009)

2 These should only be used if considered appropriate as part of a detailed risk assessment – required for all these land use types (Table 4.3). When dealing with high hazard sites, the environmental regulator should first be consulted for pre-permitting advice. This will help determine the most appropriate approach to the development of a design solution

Table 26.2 – CIRIA C753 (2015)

6.7. The highest pollution hazard level for the majority of the site is 'low' for the drives, low trafficked highways and the indices for Total Suspended Solids (TSS) is 0.5, Metals 0.4 and Hydrocarbons of 0.4. For the proposed main link road, this is likely to be trafficked by more than 300 vehicles per day and therefore the pollution hazard level is 'medium' that has indices of TSS 0.7, Metals 0.6 and Hydrocarbons of 0.7. To mitigate the pollution indices an assessment of which SuDS features are applicable when discharging to groundwater, Table 26.4 and Table 26.3 for discharging to surface waters from SuDS Manual C753 (2015) has been consulted.

TABLE 26.3 Indicative SuDS mitigation indices for discharges to surface waters

	Mitigation indices[1]		
Type of SuDS component	**TSS**	**Metals**	**Hydrocarbons**
Filter strip	0.4	0.4	0.5
Filter drain	0.4[2]	0.4	0.4
Swale	0.5	0.6	0.6
Bioretention system	0.8	0.8	0.8
Permeable pavement	0.7	0.6	0.7
Detention basin	0.5	0.5	0.6
Pond[4]	0.7[3]	0.7	0.5
Wetland	0.8[3]	0.8	0.8
Proprietary treatment systems[5,6]	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

Notes

1 SuDS components only deliver these indices if they follow design guidance with respect to hydraulics and treatment set out in the relevant technical component chapters.

2 Filter drains can remove coarse sediments, but their use for this purpose will have significant implications with respect to maintenance requirements, and this should be taken into account in the design and Maintenance Plan.

3 Ponds and wetlands can remove coarse sediments, but their use for this purpose will have significant implications with respect to the maintenance requirements and amenity value of the system. Sediment should normally be removed upstream, unless they are specifically designed to retain sediment in a separate part of the component, where it cannot easily migrate to the main body of water.

4 Where a wetland is not specifically designed to provide significantly enhanced treatment, it should be considered as having the same mitigation indices as a pond.

5 See Chapter 14 for approaches to demonstrate product performance. A British Water/Environment Agency assessment code of practice is currently under development that will allow manufacturers to complete an agreed test protocol for systems intended to treat contaminated surface water runoff. Full details can be found at: **http://tinyurl.com/qf7yuj7**

6 SEPA only considers proprietary treatment systems as appropriate in exceptional circumstances where other types of SuDS component are not practicable. Proprietary treatment systems may also be considered appropriate for existing sites that are causing pollution where there is a requirement to retrofit treatment. SEPA (2014) also provides a flowchart with a summary of checks on suitability of a proprietary system.

Table 26.3 – CIRIA C753 (2015)

TABLE 26.4 Indicative SuDS mitigation indices for discharges to groundwater

Characteristics of the material overlying the proposed infiltration surface, through which the runoff percolates[1]	TSS	Metals	Hydrocarbons
A layer of dense vegetation underlain by a soil with good contaminant attenuation potential[2] of at least 300 mm in depth[3]	0.6[4]	0.5	0.6
A soil with good contaminant attenuation potential[2] of at least 300 mm in depth[3]	0.4[4]	0.3	0.3
Infiltration trench (where a suitable depth of filtration material is included that provides treatment, ie graded gravel with sufficient smaller particles but not single size coarse aggregate such as 20 mm gravel) underlain by a soil with good contaminant attenuation potential[2] of at least 300 mm in depth[3]	0.4[4]	0.4	0.4
Constructed permeable pavement (where a suitable filtration layer is included that provides treatment, and including a geotextile at the base separating the foundation from the subgrade) underlain by a soil with good contaminant attenuation potential[2] of at least 300 mm in depth[3]	0.7	0.6	0.7
Bioretention underlain by a soil with good contaminant attenuation potential[2] of at least 300 mm in depth[3]	0.8[4]	0.8	0.8
Proprietary treatment systems[5,6]	These must demonstrate that they can address each of the contaminant types to acceptable levels for inflow concentrations relevant to the contributing drainage area.		

Notes

1. All designs must include a minimum of 1 m unsaturated depth of aquifer material between the infiltration surface and the maximum likely groundwater level (as required in infiltration design – Chapter 25)
2. For example as recommended in Sniffer (2008a and 2008b), Scott Wilson (2010) or other appropriate guidance.
3. Alternative depths may be considered where it can be demonstrated that the combination of the proposed depth and soil characteristics will provide equivalent protection to the underlying groundwater – see note 1.
4. If significant volumes of sediment are allowed to enter an infiltration system, there will be a high risk of rapid clogging and subsequent system failure.
5. See Chapter 14 for approaches to demonstrate product performance. Note: a British Water/Environment Agency assessment code of practice is currently under development that will allow manufacturers to complete an agreed test protocol for systems intended to treat contaminated surface water runoff. Full details can be found at: **www.britishwater.co.uk/Publications/codes-of-practise.aspx**
6. SEPA only considers proprietary treatment systems as appropriate in exceptional circumstances where other types of SuDS component are not practicable. Proprietary treatment systems may also be considered appropriate for existing sites that are causing pollution, where there is a requirement to retrofit treatment. WAT-RM-08 (SEPA, 2014) also provides a flowchart with a summary of checks on suitability of a proprietary system.

Table 26.4 – CIRIA C753 (2015)

6.8. To ascertain which SuDS features are applicable, the comparison Table 6.2 indicates the acceptability given the pollution indices for Private Drive and residential roof water and the main highways.

Table 6.2 – SuDS Selection

Type of SuDS	Private Drives TSS=0.5; Metal = 0.4; Hcarbons = 0.4.	Private Roofs TSS=0.2; Metal = 0.2; Hcarbons = 0.05	Highways TSS=0.5; Metal = 0.4; Hcarbons = 0.4	Main Highways TSS=0.7; Metal = 0.6; Hcarbons = 0.7
Filter Strip		✓		
Filter Drain		✓		
Swale	✓	✓	✓	
Permeable Paving	✓	✓	✓	N/A
Detention Basin	✓	✓	✓	
Pond	✓	✓	✓	
Wetland	✓	✓	✓	✓
Soakaway		✓		
Infiltration Trench		✓		
Proprietary Product	✓		✓	✓

6.9. As set out in the SuDS Manual, where a single SuDS feature can't achieve the pollution mitigation indices alone then additional features can be added. The pollution mitigation of these secondary or tertiary treatment stages can be applied albeit subject to a factor of 0.5, therefore creating a treatment train.

6.10. Using the table above which is derived from Table 26.3 and 26.4 of CIRIA C753 then it can be concluded that the better SuDS' choices for the site are as set out below;

Adoptable main link road - Dry swales / infiltration trench and then to an infiltration detention basin.

Adoptable estate roads - Highway drainage to infiltration detention basin.

Private Drives / Roads - Permeable paving.

Residential Roofs - Permeable paving.

Early Years Centre - Geocellular soakaway and permeable paving.

6.11. As this planning application is for outline planning approval, the current layout for the development could be amended as part of a reserved matters planning application to suit the Developers future layout, therefore impermeable areas are likely to change which will affect the preliminary surface water drainage strategy when it is developed in detail. To take into account 'Urban Creep' a further additional 10% of impermeable area has been taken into account on dwellings and private drives. Adopted highways do not require the addition of an urban creep factor. The remainder of the site is assumed to be permeable areas like Public Open Space and gardens.

6.12. For the large open infiltration detention basins that accommodate surface water runoff from the adopted highways, to be robust, it is assumed that all surface water run-off is directed to the principal SuDS feature has been sized accordingly to accommodate the 1 in 100 year storm event plus an allowance for climate change on rainfall intensity. However, it is likely that some roads could use swale features that could allow infiltration to occur closer to the point of source. This would reduce the amount of surface water flowing direct to the principle SuDS feature but has not been taken into account for drainage modelling at this time. A Factor of Safety of 5 has been applied to the likely infiltration rate for the depth of the SuDS feature of $1.0x10^{-5}$m/s (36mm/hr) to account for any potential maintenance issues of the detention basins. However, as these basins would be highway detention basins they would be well maintained, therefore it is considered this is a robust assessment of the required size of detention basins.

6.13. A reserved matters application (post planning approval) will be required for the surface water drainage strategy that will be based on a detailed layout of the development and accurate area of impermeability. This will more accurately ascertain the requirements for the principle SuDS features. This robust drainage strategy therefore ensures the deliverability of the proposed development and maximum space requirements for SuDS.

6.14. A SuDS strategy is therefore proposed to utilise permeable paving for private drives and parking areas, which allows roof water to also filter through to provide the relevant pollution control requirements. For on-site minor highway areas, the surface water run-off will be directed via highway drainage to infiltration basins. More heavily trafficked roads would require a further surface water treatment such as a swale feature to reduce pollution contaminants entering the detention basin. The basin and swale act together to achieve the required pollution control mitigation indices for a main road. The infiltration detention basin can also be designed to include a permeable berm at the base of the feature to contain TSS to a localised area reducing maintenance issues across the whole basin. The highway infiltration detention basins will allow the water to infiltrate through appropriate soil with good contaminant attenuation of at least 300mm depth.

6.15. The basins required for the site have been designed for events up to the 1 in 100-year storm plus a climate change factor of 20% with no flooding onsite, with a sensitivity check on a climate change factor of 40%. The permeable paving depths required for the residential dwellings and external areas have been designed for events up to the 1 in 100-year storm plus a climate change factor of 20% with no flooding onsite. The early years centres' surface water drainage strategy will consist of permeable paving for the car park and geocellular soakaway in the rear garden area. This has been designed to the 1 in 100 year plus a climate change factor of 20%. As infiltration drainage is to be used across the site, Factors of Safety from Table 4.6 of CIRIA Report 156 have been considered relative to the risk of reduced infiltration over time of the area being drained.

7. Flood Risk Management

7.1. Having determined that the site possesses sufficient capacity for infiltration techniques to dispose of surface water from the site, a drainage strategy has been devised. The soakage rates from the infiltration testing in May 2018 have been used and the site split into zones. These infiltration rates have been indicated previously in Table 6.1. For permeable paving calculations the lowest recorded shallow infiltration rate recorded has been used to be robust, which was 5.4 x 10^{-6}m/s (19.4mm/hr). For the infiltration basins an infiltration rate of 1.0 x 10^{-5}m/s (36.0mm/hr) i.e. Trial Pit 3 as this is representative of the depth of geology that the basins area proposed.

7.2. When considering surface water drainage from impermeable areas, it is often assumed that there will be 100% runoff, thus, providing the most onerous calculation. For the purpose of this report, we have assumed the worst-case scenario that there will be 100% runoff from the proposed impervious surfaces.

7.3. To determine the appropriate use of the SuDS features, the pollution indices were used to determine the type of SuDS to be used. These are set out in Chapter 6. The proposed masterplan, has been used to create the proposed drainage strategy for Drawing 48055/PP/SK01 which shows the surface water drainage strategy based on the current Architects Masterplan provided in Appendix C which provides approximate impermeable areas.

Drainage for Dwellings

7.4. The tables below (Table 7.1 & 7.2) show a typical type of each private residential area where the area being drained varies and therefore as does the Factor of Safety. As the house areas will be reasonably standard across the site and we have been robust in the use of the lowest shallow infiltration rate recorded, the assessment of a general house type for a single property is considered reasonable as this planning application is for outline planning approval. Should a dwelling be larger than expected, the drive area and permeable area is also likely to increase, otherwise the depth of the material could be increased to accommodate the small increase in surface water runoff. Drainage calculations are contained in Appendix E.

Table 7.1 – Detail of a Typical Dwelling**s'** Permeable Paving

	Typical House Area (m2)*	Typical Drive Area (m2)*	Factor of Safety	Depth of material under paving (m)	Max depth of surface water in 1 in 100 year event plus climate change (m)
Dwelling	55	40	1.5	0.600	0.675

* includes urban creep factor of 10%

Table 7.2 – Detail of a Typical a Large Communal Permeable Paving Area

	Typical Dwelling Area (m2)*	Typical Drive / Road Area (m2)	Factor of Safety	Depth of material under paving (m)	Max depth of surface water in 1 in 100 year event plus climate change (m)
Dwelling	1117	1253	5.0	0.600	0.705

* includes urban creep factor of 10%

7.5. Although the drainage calculations show that for the large communal areas' permeable paving may have some slight flooding (<1m^3) in the 1 in 100-year storm event with the 40% climate change factor, when using the 20% climate change factor this does not occur. For the typical private dwelling, there is no flooding in the 1 in 100-year event with a 40% climate change factor.

7.6. The minor amount of flooding on large areas of permeable paving can be accommodated by slightly increasing the material beneath the permeable paving or due to the shallow gradients of the road the water could be temporarily stored in the car park area.

Drainage for Main Highways

7.7. Adopted highways (except the main link road area) will drain to the infiltration / detention basins via highway drainage. The main link roads or roads with a high traffic volume in excess of 300 movements per day will require a further upstream treatment such as a swale.

7.8. A drainage design has been made for the 1 in 100-year storm event including a climate change factor of 20% and these calculations are in Appendix F and summarised in the Tables 7.3 & 7.4 below. A sensitivity check for a climate change factor of 40% has also been undertaken, with the modelling results shown included in Appendix F, however, the basins do not show any flooding in either climate change scenario.

Table 7.3 – Central Highway Infiltration Detention Basin

	Area of Adopted Highway (ha)	Factor of Safety	Depth of Basin (m)	Max depth of surface water in 1 in 100 year event plus 20% climate change (m)	Max depth of surface water in 1 in 100 year event plus 40% climate change (m)
Central Basin	0.933	5.0	1.8	1.464	1.625

Table 7.4 – Eastern Highway Infiltration Detention Basin

	Area of Adopted Highway (ha)	Factor of Safety	Depth of Basin (m)	Depth of surface water in 1 in 100 year event plus 20% climate change (m)	Depth of surface water in 1 in 100 year event plus 40% climate change (m)
Eastern Basin	0.858	5.0	1.8	1.543	1.694

7.9. As it can be seen the depth of water for the 1 in 100-year event plus 20% for climate change is approximately 1.5m, therefore a 1.5m wide 'wet bench', 600mm from the bottom of the basin, is included in the design of the basins for safety purposes. As the basin is 1.8m in depth in total, there is at least a 150mm freeboard from the maximum depth of water to the top of the basin. A 3.0m wide dry bench is also provided around the top of the basin, which can also act as a maintenance strip. Access to the basins is directly from the main highway.

7.10. The design, location and exceedance flow routes for the drainage are shown on drawing 48055/PP/SK01. The road layouts are designed to

allow surface water runoff in an exceedance event to be directed towards the low point of the site (the eastern highway infiltration detention basin), which is the eastern boundary of the site where a small swale feature could be designed to collect any exceedance runoff from the highway and direct back to the eastern basin.

Drainage for Early Years Centre

7.11. The proposed car park area (185m^2) can be simply constructed of permeable paving of a similar depth of material of 0.6m to accommodate the surface water from the car park. For the early years centre building (185m^2 Gross External Area) this is proposed to have a geocellular soakaway in the rear green space of the facility. Based on the infiltration rate recorded in this location of 5.0x10^{-6}m/s (18mm/hr), a total crate size of 4.0x6.0x0.8m(H) would be required. It would be recommended there is an upstream manhole or silt trap installed to remove sediment entering the crates and reduce maintenance requirements.

7.12. The location of the geocellular soakaway is approximately shown on drawing 48055/PP/SK01. Drainage calculations of the geocellular crates are included in Appendix G for reference. The drainage calculations show that in the 1 in 100-year storm event plus climate change there is still a 10% depth capacity, as required by SCC as the LLFA.

8. Flood Risk Management Measures

8.1. The finished floor levels of the dwellings will be sufficient to raise the dwellings well above the level up to the 1 in 100-year storm event with an allowance of 40% for climate change with surface water volumes, contained in the drainage, infiltration / detention basins or permeable paving in accordance with the NPPF. Access and egress to the site will not be impeded during these events. It is recommended that all dwellings have finished floor levels which are at least 300mm above the nearest SuDS features' maximum expected surface water level.

8.2. The site layout and surface water drainage system will be designed to cope with events that exceed the drainage capacity of the system which accommodates up to the 1 in 100 year storm event plus 20% climate change and will be safely stored without adverse impacts on or off site, as indicated on Drawing 48055/PP/SK01. The surface water would then infiltrate accordingly across the site as close to source as possible.

9. Management and Maintenance Plan

9.1. Sustainable Drainage System management requires a clear understanding of who is responsible for maintenance, particularly on a self-contained private development and also for adopted areas. There are distinct areas of SuDS maintenance:

- Maintenance of the first category of feature (for example green roofs, water butts, and permeable driveways) is the responsibility of the land or property owner(s).
- Maintenance of the second category (for example communal permeable pavements, bio-retention areas and some collector swales) in this case will be the homeowner(s) or the social housing landlord or highway authority.
- The third category (for example basins, crates, ponds and wetlands with linking swales and control structures) will in this case will be the responsibility of the highway authority.

9.2. The maintenance regime will be such that the work to maintain the storage in the permeable paving (Table 26.15 of Chapter 20 of SuDS Manual 2015) and infiltration / detention basins (Table 22.1 of Chapter 22 of SuDS Manual 2015), regular checks will be as indicated below, extracted from the CIRIA SuDS Manual (2015).

Operation and maintenance requirements for pervious pavements

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 surface from adjacent impermeable areas as this area is 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 into the weeds by an applicator rather than spraying	As required – once per year or 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 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

Operation and maintenance requirements for detention basins		
Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter and debris	Monthly
	Cut grass – for spillways and access routes	Monthly (during growing season), or as required
	Cut grass – meadow grass in and around basin	Half yearly (spring – before nesting season, and autumn)
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Inspect inlets, outlets and overflows for blockages, and clear if required.	Monthly
	Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies.	Monthly (for first year), then annually or as required
	Check any penstocks and other mechanical devices	Annually
	Tidy all dead growth before start of growing season	Annually
	Remove sediment from inlets, outlet and forebay	Annually (or as required)
	Manage wetland plants in outlet pool – where provided	Annually (as set out in Chapter 23)
Occasional maintenance	Reseed areas of poor vegetation growth	As required
	Prune and trim any trees and remove cuttings	Every 2 years, or as required
	Remove sediment from inlets, outlets, forebay and main basin when required	Every 5 years, or as required (likely to be minimal requirements where effective upstream source control is provided)
Remedial actions	Repair erosion or other damage by reseeding or re-turfing	As required
	Realignment of rip-rap	As required
	Repair/rehabilitation of inlets, outlets and overflows	As required
	Relevel uneven surfaces and reinstate design levels	As required

9.3. A detailed maintenance schedule can be conditioned on any subsequent planning approval as part of the reserved matters planning application to which a detailed surface water drainage strategy will be provided for the approval of the Local Authority. An asset collection sheet can also be provided as part of the reserved matters planning application to identify accurately the location (once a masterplan is further developed and a detailed drainage strategy developed) of the infiltration / detention basins as part of the SCC LLFA Flood Risk Asset Register.

9.4. A copy of the Surface Water Drainage Proforma has been completed for the proposed preliminary drainage strategy for an outline planning application and this is included in Appendix H.

10. Residual Risks

10.1. The residual risk is usually taken to refer to the portion of overall risk that remains once risk mitigation measures have been implemented. There is always the very low risk potential for storm events greater than a 1 in 100-year storm event. Principal SuDS features are located at key areas of topography to allow overflow of surface water would fall towards the SuDS features and away from the residential areas. The residual risk to the development is therefore considered to be extremely low.

10.2. In the unlikely event that groundwater flooding could occur, there is no proposed basement development, SuDS features will be no more than 1.8m deep and the floor levels will be raised above all storm events. As previously stated, groundwater flooding can cause disruption, but the slow onset of this type of flooding mean that it is unlikely to cause a danger to life or property. The topography of the land would direct water away from dwellings and principle infrastructure.

10.3. As required by SCC LLFA, a Health and Safety Risk Assessment based on the proforma set by the CIRIA SuDS Manual (2015) for the infiltration detention basins is included in Appendix I.

11. Conclusions

11.1. The development is situated in flood zone 1 and is appropriate development for that zone according to the Planning Practice Guidance of the NPPF and that of the LLFA.

11.2. Increased surface water flows at the site will be treated and attenuated by using SuDS storage prior to discharging into the ground to mimic that of the existing use of the site with minimal risk off-site or to the new potential occupiers of the Site, should development proceed.

12. Limitations

12.1. This report has been produced for the sole use of Trinity College, Cambridge for the construction of residential accommodation and associated works on land off Howlett Way, Trimley St Martin. Its contents should not be relied upon by others without the written authority of Richard Jackson Limited. If any unauthorised third party makes use of this report, they do so at their own risk and Richard Jackson Limited owes them no duty of care or skill.

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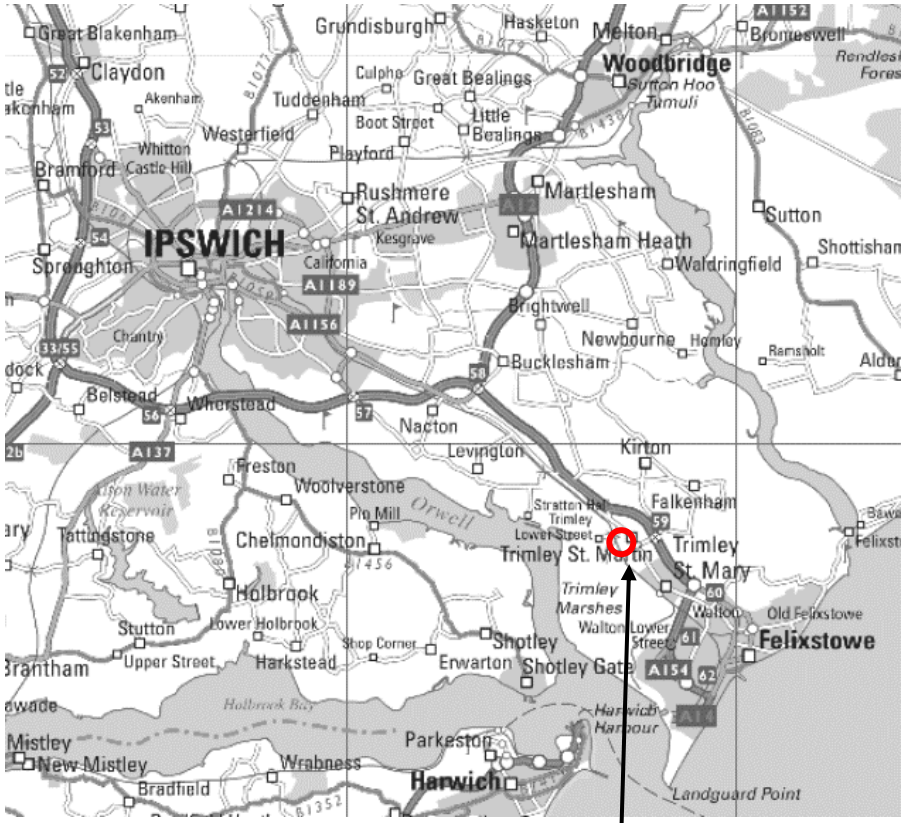
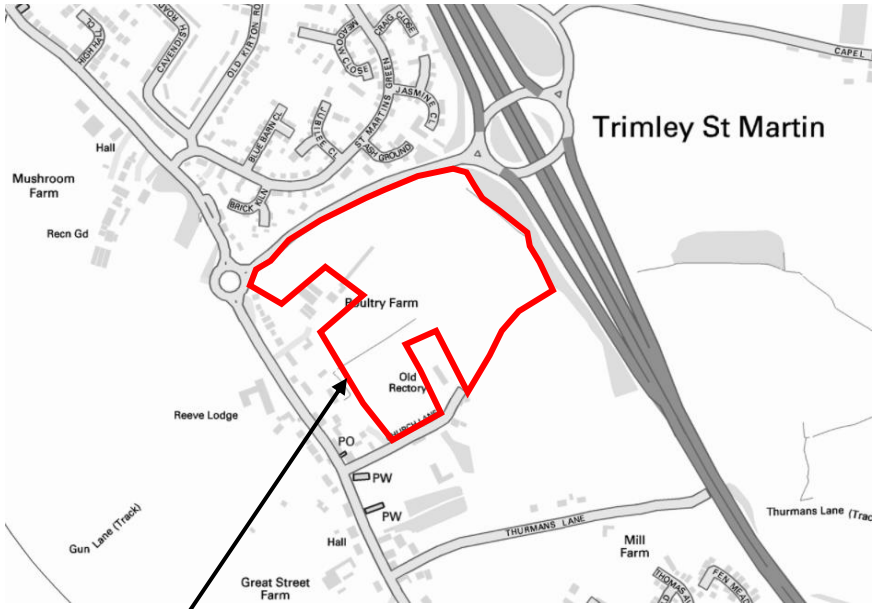
FIGURES/DRAWINGS



SITE LOCATION



SITE LOCATION

Howlett Way, Trimley St Martin Site Location Grid Reference 627730, 237330 and Postcode IP11 0SW

Client:	Drawing Title:		
Trinity College, Cambridge	Site Location Plan		
Job Title:	Date:	Job No:	Dwg No:
Land off Howlett Way, Trimley St Martin	10.12.19	48055	Fig. 1

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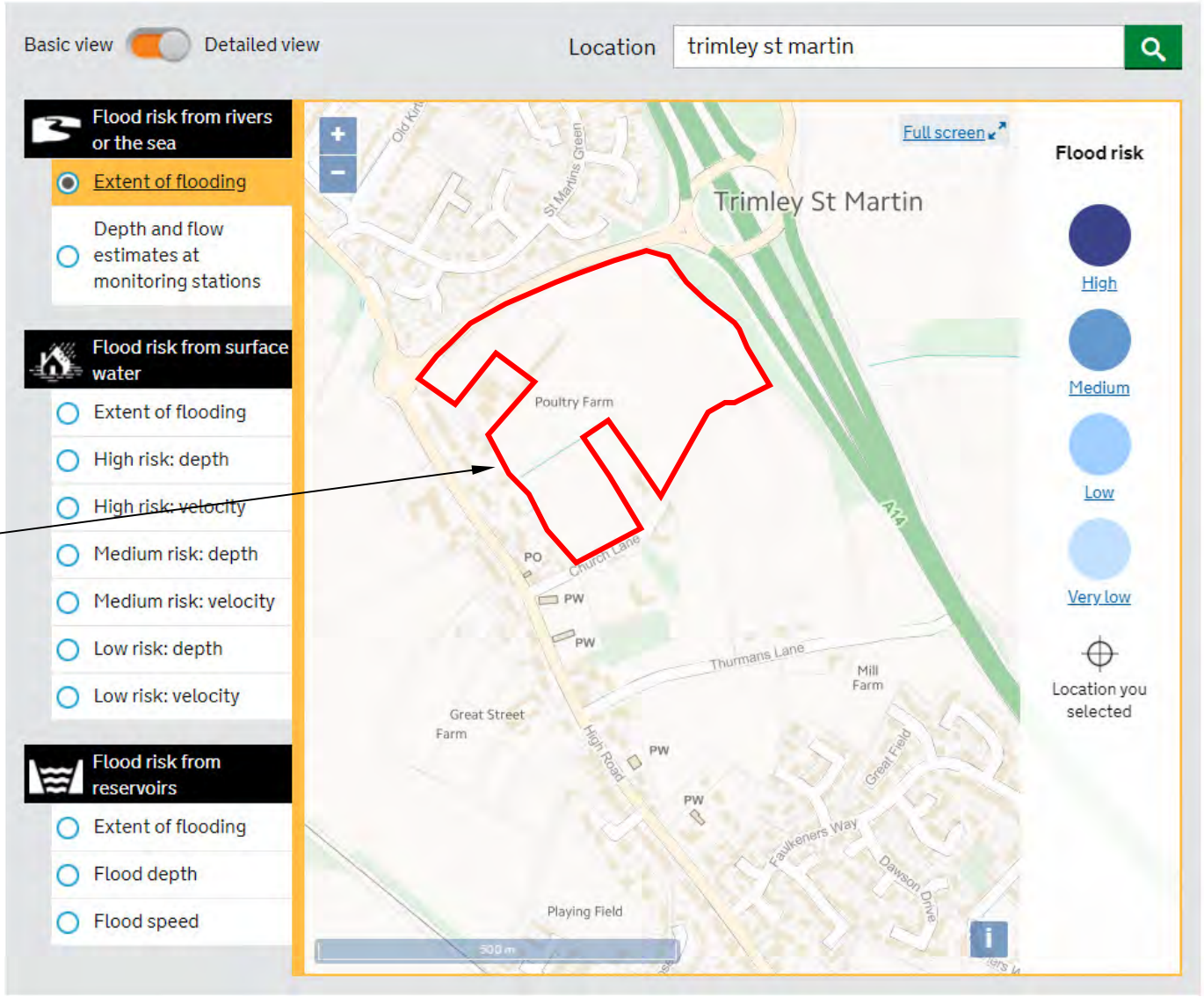

THE SITE

Site location grid reference 627730, 237330 and postcode IP11 0SW

Client:	Drawing Title:		
Trinity College, Cambridge	**Flood Risk Plan (Rivers and Sea)**		
Job Title:	Date:	Job No:	Dwg No:
Land off Howlett Way, Trimley St Martin	**10.12.19**	**48055**	**Fig. 2 (NTS)**

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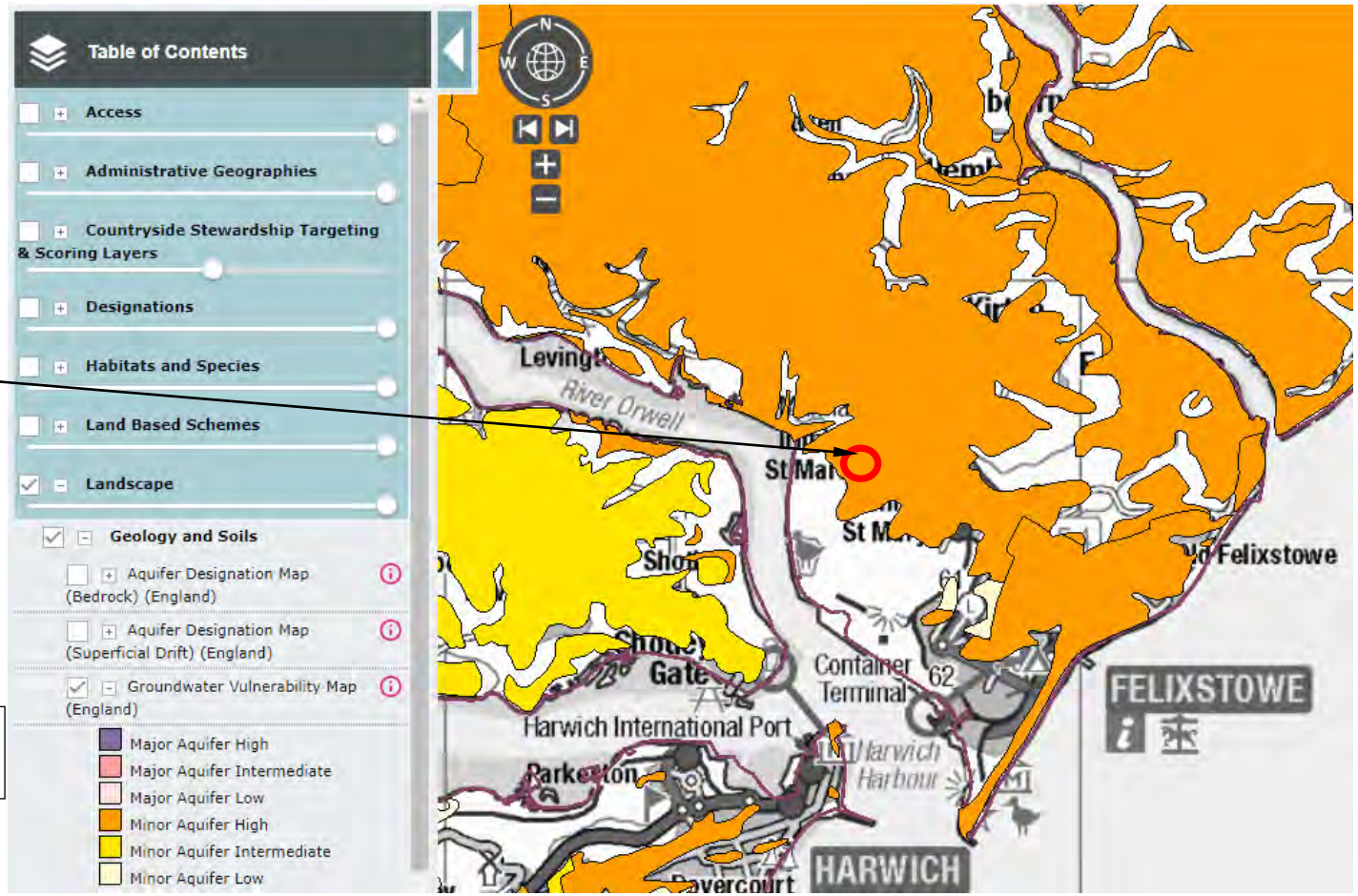

Site location grid reference 627730, 237330 and postcode IP11 0SW

Client:	Drawing Title:		
Trinity College, Cambridge	Groundwater Vulnerability Map		
Job Title:	Date:	Job No:	Dwg No:
Land off Howlett Way, Trimley St Martin	10.12.19	48055	Fig. 3 (NTS)

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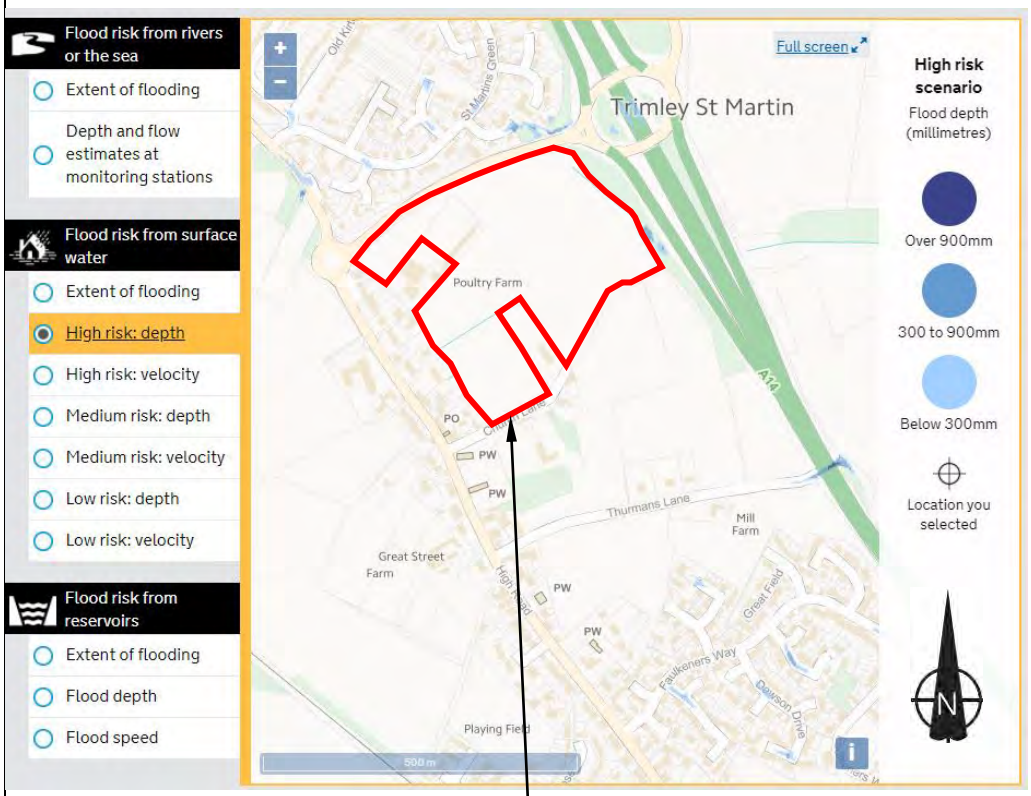
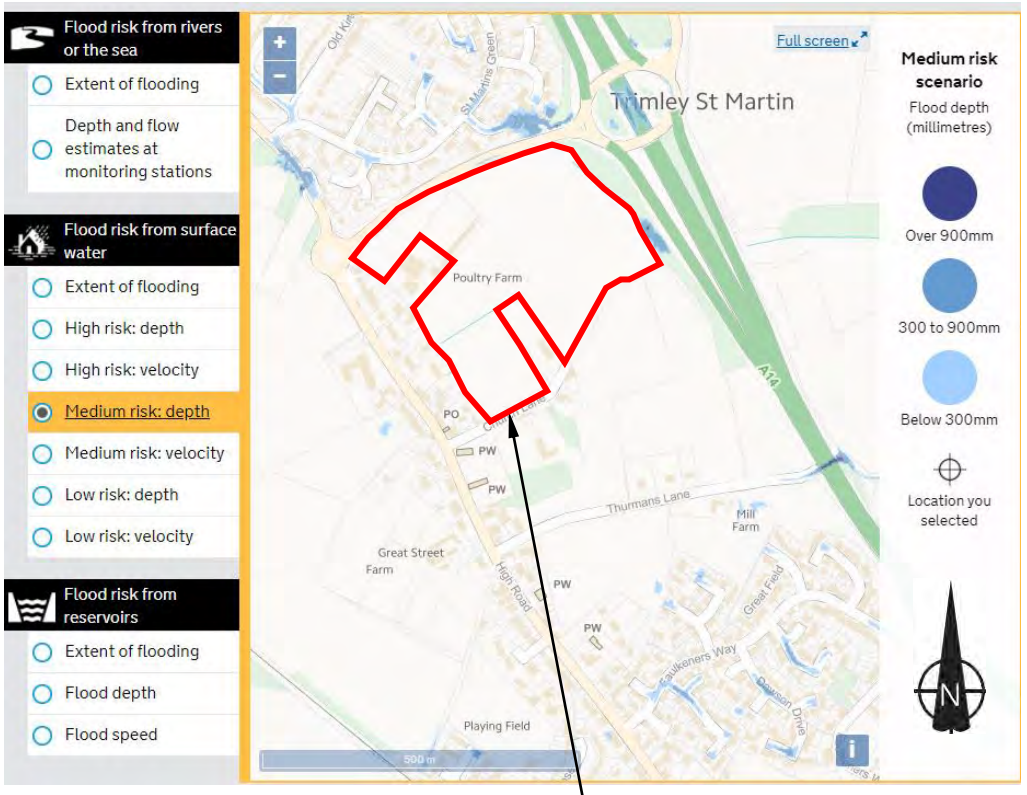


THE SITE
(Flood risk greater than 3.3% annual probability)



THE SITE
(Flood risk greater than 1.0% annual probability)

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Client:	Drawing Title:		
Trinity College, Cambridge	Surface Water Flood Mapping (High & Medium Risk)		
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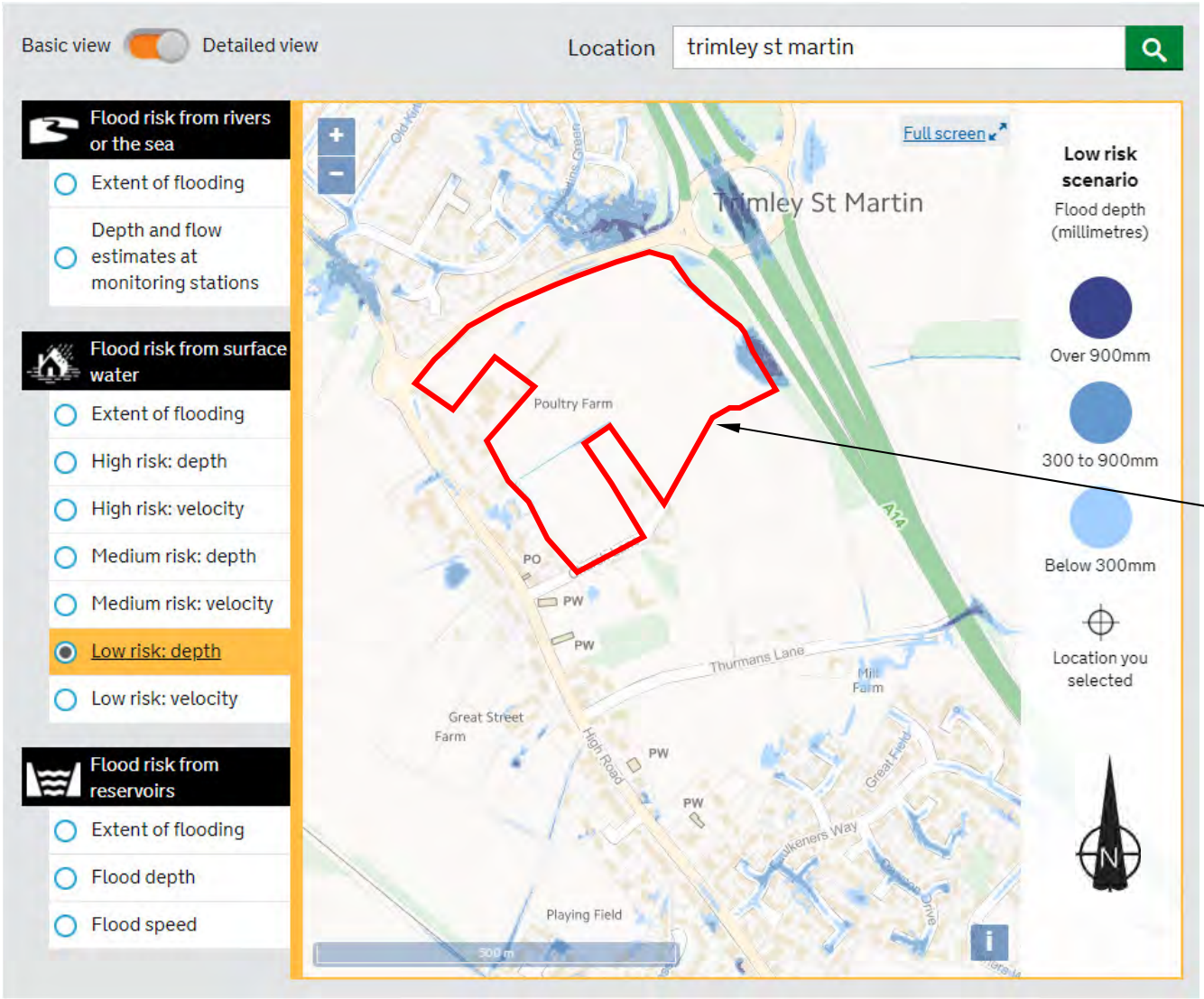

THE SITE
(Flood risk greater than 0.1% annual probability)

Site location grid reference 627730, 237330 and postcode IP11 0SW

Client:	Drawing Title:		
Trinity College, Cambridge	**Surface Water Flood Mapping (Low Risk)**		
Job Title:	Date:	Job No:	Dwg No:
Land off Howlett Way, Trimley St Martin	**10.12.19**	**48055**	**Fig. 5 (NTS)**

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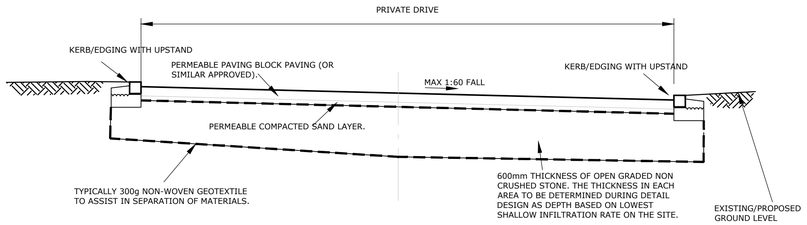
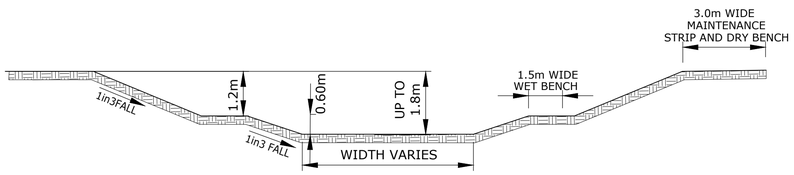


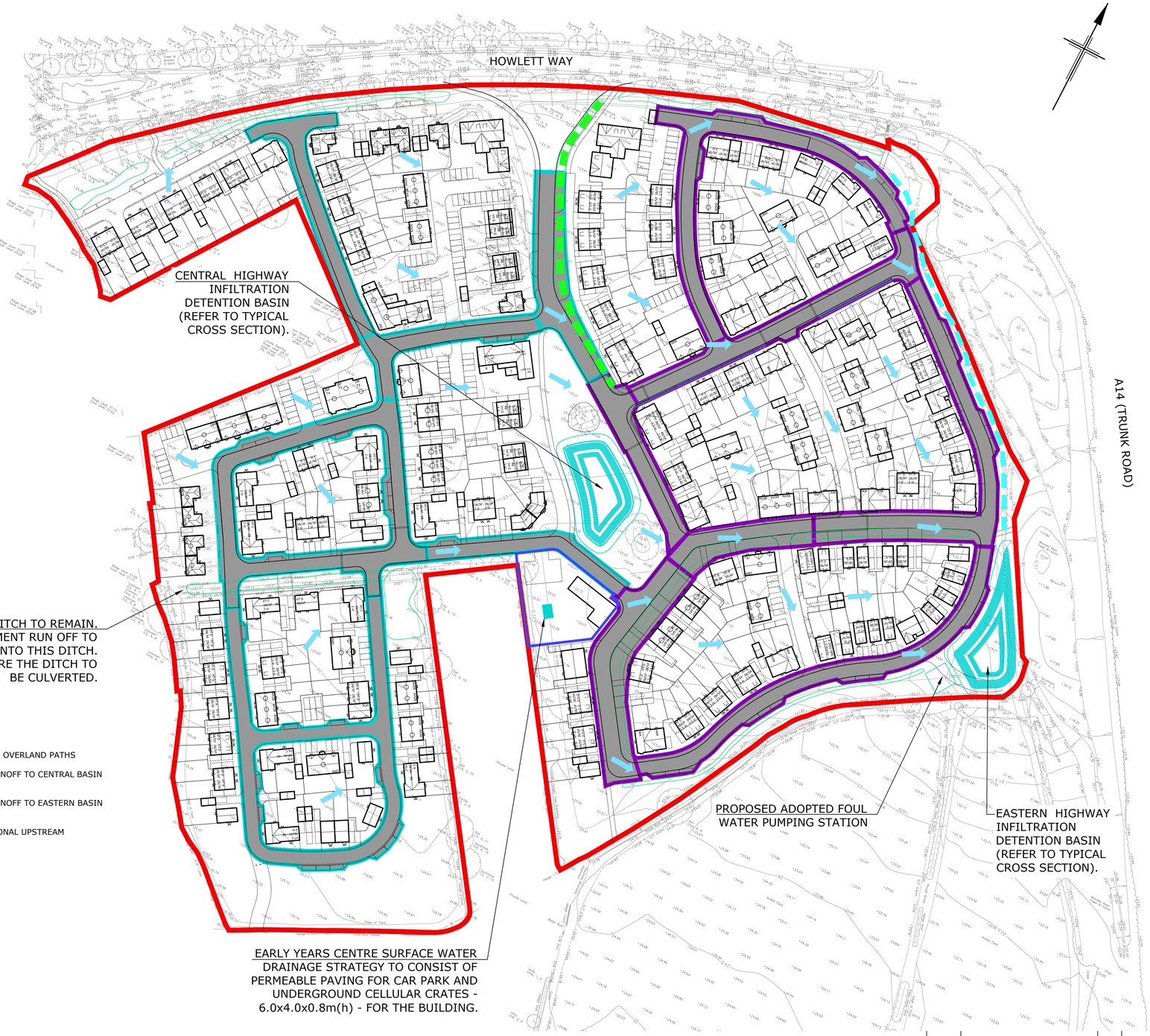
TYPICAL CROSS SECTION OF THE RESIDENTIAL AREAS - PRIVATE DRIVE AND COMMUNAL PERMEABLE PAVING

SCALE NTS



TYPICAL INFILTRATION DETENTION HIGHWAY BASIN CROSS SECTION

SCALE N.T.S



GENERAL NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS INDICATED OTHERWISE.
2. ALL LEVELS ARE IN METRES AND RELATE TO ORDNANCE SURVEY DATUM.
3. DO NOT SCALE FROM THIS DRAWING.
4. ALL TREES ARE TO BE REMOVED WITHIN 5m OF PROPOSED DRAINAGE INFRASTRUCTURE, UNLESS OTHERWISE AGREED.
5. THIS SURVEY INFORMATION HAS BEEN SUPPLIED BY RANDALL SURVEYS LLP, DRAWING NUMBER 14780/GN/1 & 14780/GN/2 DATED JANUARY 2018 AND RICHARD JACKSON LTD ACCEPT NO RESPONSIBILITY FOR ERROR OR OMISSION.
6. PRELIMINARY SURFACE WATER DRAINAGE STRATEGY BASED ON ARCHITECTS MASTERPLAN DRAWING 7845 SK02 (D) DATED 02.12.19
7. REFER TO RICHARD JACKSON LTD FLOOD RISK ASSESSMENT DATED DECEMBER 2019 FOR SUPPORTING DRAINAGE MODELLING CALCULATIONS AND DESIGN ASSUMPTIONS. DRAINAGE DESIGN IS SUBJECT TO AMENDMENT BASED ON CURRENT LEAD LOCAL FLOOD AUTHORITY GUIDANCE AND REVIEW. PLANNING APPLICATION IS FOR OUTLINE PERMISSION, THEREFORE THE DRAINAGE STRATEGY IS SUBJECT TO AMENDMENT TO SUIT DEVELOPER(S) MASTERPLAN.
8. ALL PERMEABLE PAVING HAS BEEN DESIGN TO ACCOMMODATE THE 1 IN 100 YEAR STORM EVENT PLUS CLIMATE CHANGE AND AN ADDITIONAL 10% URBAN CREEP APPLIED TO IMPERMEABLE DWELLING/DRIVE AREAS.
9. INFILTRATION DETENTION BASINS ONLY ACCOMMODATE ADOPTABLE HIGHWAY SURFACE WATER RUNOFF AS INDICATED IN THE KEY. BASINS ARE DESIGNED TO ACCOMMODATE THE 1 IN 100 YEAR STORM PLUS CLIMATE CHANGE WITHOUT FLOODING. NO ALLOWANCE FOR STORAGE WITHIN ANY UPSTREAM DRAINAGE IS ALLOWED FOR FOR ROBUST ANALYSIS OF STORAGE VOLUME.
10. ADOPTABLE HIGHWAY SURFACE WATER RUNOFF AREAS FOR EACH BASIN ARE INDICATED IN THE KEY. ALL OTHER AREAS ARE ASSUMED TO BE PRIVATE DRIVES / ROADS / COMMUNAL PARKING AREAS. THESE AREAS ARE TO BE CONSTRUCTED OF PERMEABLE PAVING AND ACCOMMODATE ROOF SURFACE WATER AND WATER LANDING ON PAVING.
11. FOR MAIN ROADS WHERE LIKELY DAILY TRAFFIC IS IN EXCESS OF 300 VEHICLE MOVEMENTS PER DAY, HIGHWAY SWALES TO BE PROVIDED AS INDICATED.

KEY

- EXCEEDENCE SURFACE WATER OVERLAND PATHS
- HIGHWAY SURFACE WATER RUNOFF TO CENTRAL BASIN (0.933ha TOTAL AREA)
- HIGHWAY SURFACE WATER RUNOFF TO EASTERN BASIN (0.858ha TOTAL AREA)
- HIGHWAY SWALE FOR ADDITIONAL UPSTREAM POLLUTION CONTROL
- EXCEEDENCE SWALE FEATURE

PRELIMINARY

REV	DATE	DESCRIPTION	DRAWN	CHKD

REVISIONS

Project: LAND OFF HOWLETT WAY TRIMLEY ST MARTIN SUFFOLK	Title: PRELIMINARY SURFACE WATER DRAINAGE STRATEGY	Client: TRINITY COLLEGE CAMBRIDGE	Drawn: RNL; Date: 10.12.2019 Job Manager: R LONG; Checked: MJD Approved: MJD; Scale: 1:1000 @ A1

This drawing is to be read in conjunction with all other Engineer's drawings and all other project information. Any discrepancy between the Engineer's drawings and other project information is to be reported to the Engineer immediately.

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Drawing No.: 48055/PP/SK01 — Revision:

Drawing Status: ☒ INFORMATION ☐ APPROVAL ☐ COSTING ☐ TENDER ☐ CONSTRUCTION ☐ AS CONSTRUCTED

A1