RichardJackson
Engineering Consultants

Our Ref: 48130/MJD/SEC (Rev A)
Your Ref:

25 August 2017

Consortium of Taylor Wimpey
Persimmon Homes & Hopkins Homes
c/o Ms R Rejzek
Bidwells
16 Upper King Street
Norwich
NR3 1HA

Email Only

Dear Ms Fowler

Re: **'White Land' –** Phase 3 **–** Sprowston -
Flood Risk and Surface Water Drainage Strategy

I refer to our instructions to assess the preliminary surface and foul water drainage strategy for the above site as indicated on Drawing 48130/PP/SK01, for the Phases 3a to 3f, herein to be known as the 'Site'. The land known as 'GT20' or Phase 2, will be considered separately for the purposes of surface water drainage but could both be promoted together for foul water disposal to ensure adequate infrastructure is in place for Phase 3, whilst Phase 2 is progressing. Consideration for the Foul Water Drainage Strategy for the Site has been undertaken separately to this technical assessment.

The Site is mainly arable farm land and is situated to the east of Mallard Way (the new spine road for current Phase 1 development south of Wroxham Road) and north of Salhouse Road. The land boundary to the west is made up of the Phase 2 land parcel proposed for residential use. To the north and east, the Site is bounded by a golf course and woodland respectively. Salhouse Rd forms the boundary to the south.

The flood risk and drainage strategy has been carried out with reference to the National Planning Policy Framework (NPPF) – Planning Practice Guidance on Flood Risk and Coastal Change, published by the Department for Communities and Local Government (DCLG). Reference is also made to the Norfolk County Council, Lead Local Flood Authority (LLFA) Guidance, dated November 2016.

The Sites' topography is such that the highest point is to the eastern boundary of the Site and it falls in a northwest to westerly direction. The high points are at about 34.0m AOD and the northwest corner is at about 21.8m AOD, which is a fall of about 1 in 110, from the southeast to the northwest of the Site. At the northern end of the Site the fall to the west is a little steeper at about 1 in 56.

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Proposed Development

The Site is proposed for residential development and the total area the site boundary covers is approximately 69Ha. In normal circumstances, the Site could potentially deliver approximately 1500 dwellings. The woodland area in the southeast corner is assumed to be retained and a green corridor is to be created from Mallard Way, south of White House Farm and eastwards to the existing woodland.

On the basis of the above it is assumed, for drainage purposes only, the site area may be reduced by 7.5ha to approximately 61.5ha to account for existing woodland to be retained in the southeast corner of the Site. Further to this, it is identified on the indicative masterplan that approximately 20ha will be specified as open space. For the purposes of establishing the likely drainage parameters for the Site, the remaining site area of 41.5ha, will be used to provide a robust range of necessary water attenuation and/or storage.

It is proposed at this stage to split the development site into Phases 'a' to 'f'. The phases of the Site are indicated on the enclosed drainage strategy drawing 48130/PP/SK01.

Existing Flood Sources

When assessing any development site, there are four potential sources of flooding which need to be considered both in terms of their effect on the development itself and its end users as well as that caused to others in the local area. The main sources of flooding that need to be considered are as follows:

- Fluvial and/or tidal flooding;
- Groundwater;
- Overloading of the existing drainage network;
- Surface water flooding.

Fluvial and Tidal Sources of Flooding

From investigation of the existing watercourses and the Environment Agency (EA) floodplain maps, there are no identified influences of fluvial or tidal flooding at the Site and the Site is in Flood Risk Zone 1. The nearest flood plain (Flood Zone 2 & 3) is located approximately 3.6km south of the Site, therefore this has not been investigated further.

Groundwater Vulnerability

The local ground investigations for the Phase 1 site to the west of Mallard Way found that under the topsoil (approximately 0.4m below ground level [bgl]) were underlying 'Cover Silt Deposits' with some clay. Beneath the silt deposits is the Corton Formation Deposits which comprise of coarse sands and sandy silty clay. The extent of the more permeable sand layer varies in depth below ground level and thickness, thus, on Phase 3 the type of infiltration required will need to be adapted, based on expanded geological assessment. The soil data considered above comes from the development land (Phase 1) immediately to the west of the proposed Site and is of a similar topography, therefore the ground conditions are likely be similar to Phase 1.

Groundwater in the neighbouring site was recorded at a depth of 3.0m bgl in only a small number of sample windows, with the remainder of sample windows being recorded as dry, which were also taken to a depth of 3.0m. These were undertaken at low ground levels on the site and therefore would likely consist of locally perched

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water tables, with little influence on general base flow with groundwater likely to be lower than 3.0m bgl.

The EA defines groundwater Source Protection Zones (SPZ) around all major groundwater abstraction points. SPZs are defined to protect areas of groundwater that are used for potable supply, including public/private potable supply, (including mineral and bottled water) or for use in the production of commercial food and drinks. There is a SPZ 3 that lies across the Site. For the EA groundwater vulnerability mapping of the Site, see Figure 1. Figure 1 shows that the Site is within a Catchment Zone 3 which is an area covered by the total catchment of a source of water abstraction. On this basis, any water that flows back into the ground must be managed to protect the groundwater through suitable Sustainable Drainage Systems (SuDS).

In addition, the Groundwater Vulnerability Zone Maps show that the Site is covered by a 'Major Aquifer High'. This designation has been superseded by the newer Environment Agency Groundwater Protection Policy (GP3) and the Water Framework Directive and as a consequence, the Site is deemed to be a 'Secondary A' aquifer. This type of aquifer is created in permeable layers capable of supporting water supplies on a local rather than strategic scale. Therefore, protection and management of water from a development is to be maintained to protect the underlying groundwater, which could be completed using a range of SuDS features.

Existing Surface Water System and Ground Conditions

Records from Anglian Water have been analysed and it is unlikely any surface water sewers exist across the Site. It is understood that the surface water drainage strategy for the Phase 1 land, west of Mallard Way, is principally to discharge surface water to the watercourse in the northern corner of Phase 2 land. The surface water discharge is restricted to the Internal Drainage Board requirement of 1.0 L/sec/developed hectare runoff rates and attenuation is via an offline infiltration/balancing lagoon. Highways are directed to independent infiltration basins near to Mallard Way. Surface water drainage is designed to the 1 in 100 year event with an allowance for climate change.

The watercourse (running between Phase 2 and 3) continues to flow in a northerly/northeast direction (via the golf course) beyond the Site boundary for approximately 3.8km and is under riparian and Council control up to this point, where it then becomes under the overall control of the Norfolk Rivers and Broads Internal Drainage Board.

Using the parameters above to establish the existing soil parameters, an investigation into the potential ground conditions has been undertaken. The likely parameters of infiltration for Phase 1, based on the testing of existing soil type, suggests permeability of soils ranging from 2.2×10^{-4} m/s to 1.9×10^{-5} m/s. The ground investigation to the west of Mallard Way in 2007 provided data indicating one localised ground water strike at 3.0m, but as mentioned previously, this would still allow for medium to shallow depth soakaways to be utilised on the Site.

The existing surface water flooding has been investigated and this is shown on Figure 2. There is some minor surface water flooding indicated on the western boundary of the Site and this is for the 1 in 1000 year event with little to no flooding occurring for the 1 in 30 and 1 in 100 year events.

Any new systems of drainage for development should consider the flow from the Site and adjacent sites and suitable SuDS to accommodate storage before discharging into the ground/watercourse.

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Flood Risk Impact

It has been determined using the Ordnance Survey and topographical survey level information available, that surface water runoff from the Site will occur in a generally westerly direction. A proportion of rainfall falling across the existing Site will also infiltrate into the soils of the Site given the current ground conditions. A proportion of this infiltrating surface water will also contribute to any groundwater recharge. Ground permeability has been checked for the adjacent committed site as mentioned.

To determine the rainfall data for the Site, the Flood Estimation Handbook (FEH) data has been established from the FEH CD Rom, see data attached. 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

The NPPF and appropriate guidance indicates that any 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 drainage systems 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).

The details of the ground conditions have yet to be determined through a full ground investigation but advice provided for Phase 1 on the use of SuDS/soakaways is such that they could be used. The permeability of the Site has been determined as being between 2.2 x 10^{-4} m/s and 1.9 x 10^{-5} m/s based on the soil type. To be robust for the purposes of this assessment, it has been assumed that this Site would have the lowest recorded infiltration rate (1.9 x 10^{-5} m/s).

SuDS Assessment

The suitability of the use of SuDS on the Site is based on the criteria as set out in the Ciria document C753 dated November 2015, where in Chapter 26 the appropriateness of SuDS can be established. The table below suggests the potential appropriate SuDS selection for Highways and Private Drives and also for Private Roofs to deal with pollutants.

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Table A – SuDS Selection

Type of SuDS	Highways & Private Drives TSS=0.5 Metal=0.4 Hydrocarbons=0.4	Private Roofs TSS=0.2 Metals=0.2 Hydrocarbons=0.05
Filter Strip		✓
Filter Drain		✓
Swale	✓	✓
Permeable Paving	✓	✓
Detention Basin	✓	✓
Pond	✓	✓
Wetland	✓	✓
Soakaway (surrounded with infiltration materials)		✓
Infiltration Trench		✓

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;

Private Drives – Permeable paving and/or soakaway, or infiltration lagoon.

Residential Roofs – To permeable paving or soakaway, or infiltration lagoon.

Adoptable Highways – To Swales and/or Infiltration Basin.

A surface water strategy could therefore be proposed to utilise permeable paving and soakaways (with or without infiltration lagoons) for the drives and private roof areas and separate swales and/or infiltration basins for the adopted highway water for events up to the 1 in 100 year storm event, plus climate change currently set at 40%. This is based on the SuDS management train and also the favourable soakage rates as previously indicated.

As the overall flow for the Site generally falls to the local watercourse in the northwest corner, it could also be proposed, in a similar format to that used for Phase 1, that for events of over 1 in 30 years the surface water be directed to the watercourse and restricted to 1.0 L/sec/developed hectare with the excess water being attenuated on site, where areas are subject to poor infiltration. If applied to the Phase 3 land the total outfall rate could be up to 20.75 L/s based on the IDB restricted runoff rate requirements. This restricted rate is higher than the greenfield runoff rate determined using MicroDrainage, which is approximately 14.7 L/s. This approach would only be recommended to be utilised for land north of White House Farm and the green corridor. To land south of this green corridor it is recommended that just infiltration SuDS are utilised as this area of land is generally higher and more likely to have favourable infiltration rates.

Flood Risk Management

Having determined that the soils across the Site likely possesses sufficient infiltration capacity for the use of infiltration devices, the methods of surface water disposal have been investigated, to determine the feasibility of discharging and treating the water prior to it entering the ground.

To determine the appropriate use of the SuDS features, the pollution indices were used to determine the type of SuDS to be used. For design purposes, upon which the Site has yet to be detailed and is only at master plan stage, a selection of likely solutions have been prepared for different house types, drive areas and widths of highway.

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The private drives can provide permeable paving to act as a pollution treatment and then the water can be collected and drain towards the soakaway proposed for the private dwelling or discharge straight into the ground. Suggested sizes for the private dwelling drainage are indicated on Table B below, with permeability rates of $1.9x10^{-5}$ m/s or 0.0684 m/hr:

Table B – Indicative SuDS Storage Sizes – Private Houses

Dwelling Type	Dwelling Area (m^2)	Garage Area (m^2)	Private Drive Area (m^2)	Total Area (m^2)*	1 in 30 year plus 40% CC Soakaway** (LxWxH)m	1 in 100 year plus 40% CC Soakaway** (LxWxH)m
A	35	N/A	27	68	2.3 x 2.3 x 1.6 Vol = 2.5m^3	2.75 x 2.75 x 1.6 Vol = 3.6m^3
B	57	N/A	27	92	2.6 x 2.6 x 1.6 Vol = 3.2m^3	3.1 x 3.1 x 1.6 Vol = 4.6m^3
C	85	44	30	175	3.2 x 3.2 x 2.1 Vol = 4.9m^3	4 x 4 x 2.1 Vol = 10.0m^3
D	131	44	86	286	2No.(2.9x2.9x2.1) Vol = 10.6m^3	2No.(3.5x3.5x2.1) Vol = 15.4m^3
E	82	44	92	240	2No.(2.6x2.6x2.1) Vol = 8.5m^3	2No.(3.2x3.2x2.1) Vol = 12.9m^3

* includes 10% increase for urban creep as recommended in Ciria C753
** Soakaway based on granular fill

Efficiencies in soakaway sizes can be found in utilising communal soakaways between dwellings, soakaway specification (i.e. cellular soakaway instead of granular) and/or allowing permeable paving to infiltrate directly into the ground. To potentially reduce the amount of total size of lagoon, private soakaways could be utilised and the respective volume above could be deducted from the total lagoon size. It should be noted that soakaways will be required to be a minimum of 5m away from any structure. See Table C below for the sizes required for cellular crate soakaways which are 90% porosity in comparison to 30% porosity for granular fill, albeit are a more expensive solution.

Table C – Alternative Designs for Soakaways – for Dwelling Type C, D and E.

Dwelling Type	Dwelling Area (m^2)	Garage Area (m^2)	Private Drive Area (m^2)	Total Area (m^2)*	1 in 30 year plus 40% CC Soakaway** (LxWxH)m	1 in 100 year plus 40% CC Soakaway** (LxWxH)m
C	85	44	30	175	3.2 x 2.5 x 1.2 Vol = 8.1m^3	3.0 x 2.5 x 1.6 Vol = 10.8m^3
D	131	44	86	286	3.0 x 3.0 x 1.6 Vol = 13.0m^3	3.0 x 4.0 x 1.6 Vol = 17.3m^3
E	82	44	92	240	3.0 x 3.0 x 1.2 Vol = 9.7m^3	3.0 x 3.5 x 1.6 Vol = 15.1m^3

* includes 10% increase for urban creep as recommended in Ciria C753.
** Soakaway based on cellular crates.

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The highway water is recommended to be directed towards swales which are to be positioned adjacent to the highway or in the Public Open Space. The size will be determined by the exact dimensions of the roads and footways going to the swales/infiltration basin but an indication of the sizes are given in Table D. For purposes of being robust, the lower permeability rate of 1.9×10^{-5} m/s or 0.0684m/hr will be used. For an estimated SuDS sizing see Table D below:

Table D – Highway Swale/Infiltration Design

Overall Highway Width (m)*	Length of Highway (m)	Swale Profile	1 in 30 year storm plus 40% CC		1 in100 year storm plus 40% CC	
			Depth (m)	Volume (m^3)	Depth (m)	Volume (m^3)
6.0	10m	Side Slope = 1 in 3 Base Width = 0.3m	0.30	2.1	0.35	3.2
9.5	10m	Side Slope = 1 in 3 Base Width = 0.5m	0.40	3.8	0.45	5.5
12.0	10m	Side Slope = 1 in 3 Base Width = 0.5m	0.40	4.6	0.45	6.7

* includes footways/cycleways

Should it be decided that individual soakaways / permeable paving for private houses / roads / parking area are not a preferred option of SuDS, an alternative robust assumption has been made by discharging private surface water only using infiltration basins.

As mentioned previously, the development masterplan is likely to be split into two by a green corridor between woodland areas. The two land parcels are therefore considered to be dealt with separately and are as proposed:

- Northern land parcel – approximately 30.0ha (Phases 3c to 3e) – discharge to five infiltration basins.
- Southern land parcel (Phases 3a and 3b) – approximately 8.9ha – discharge to two infiltration basins.
- Proposed school – approximately 2.57ha – discharge to cellular soakaway beneath playing field or car parking.

Based on the above parameters and an assumed impermeable area of 50% for the 1 in 100 year event, with an allowance of 40% for climate change and an infiltration rate of 1.9×10^{-5} m/s, the following attenuation volumes are required.

Table E – Infiltration Basin Design

Phase	Impermeable Area (ha)	Outfall rate (l/s)	Side Slope (min)	Depth	Area at invert level	Volume required
3a	2.43	N/A	1:4	1.5m	850m^2	1720m^3
3b	2.02	N/A	1:4	1.5m	700m^2	1416m^3
3c	3.02	N/A	1:4	1.5m	1075m^2	2167m^3
3d1	0.75	N/A	1:4	1.5m	180m^2	501m^3
3d2	1.58	N/A	1:4	1.5m	500m^2	1095m^3
3e/f	9.62	N/A	1:4	1.5m	*1900m^2	*3501m^3

* Phase 3e/f – requires two lagoons of size shown.

The locations of the infiltration lagoons can be seen on drawing 48130/PP/SK01. Efficiencies in the design and size of the proposed SuDS can be found in accurate infiltration rates, utilising other infiltration SuDS for private roads/parking areas such as permeable paving and using swales for the adopted highway. It has been assumed from indicative masterplan provided the area of a green belt and public open space is approximately 20ha and this has been excluded from the above calculations.

For the proposed school, it is again estimated that the impermeable area is approximately 50% of the land parcel area (2.57ha), which equates to 1.285ha. The use of cellular storage beneath playing fields, car parking or playgrounds could be used. Initial calculations for cellular infiltration storage indicates a required volume of 850m^3. This could be achieved by providing a 35.0 x 32.0 x 0.8m (h) cellular storage volume based on the infiltration rates indicated previously.

Summary and Conclusions

There are minimal risks of existing natural surface water flooding of the Site and the ground investigations of the adjacent land known as Phase 1 has shown that the ground is likely to be suitable for infiltration techniques following the design processes set by the SuDS Manual and Lead Local Flood Authority. Detailed infiltration testing will be required of the Site for a Flood Risk Assessment supporting a planning application.

Individual properties and private drives could be provided with individual or communal private soakaways, which the sizes of can be determined once impermeable areas and infiltration rates are confirmed but do not represent a viability issue. Adopted highway land is recommended to be directed to open swales for discharging of surface water. An alternative and more robust solution would be to discharge all surface water runoff from the dwellings and hardstanding to a few open infiltration basins located at low points on the Site. Given the land availability and layout of the site it is not considered that this affects the viability of the development Site.

As can be seen, even in a robust indicative assessment of the flood risk of the Site, it shows that there is negligible risk to the Site or others in the local area. The various SuDS requirements can be easily accommodated on the Site and can achieve

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the pollution control requirements set by the SuDS Manual (2015) and can be wholly accommodated on Site.

We trust that the above technical assessment of the surface water drainage and flood risk of a potential development of 1500 dwellings on this Site demonstrates the scheme is viable and supports the proposal through the Local Plan allocations.

Yours sincerely,

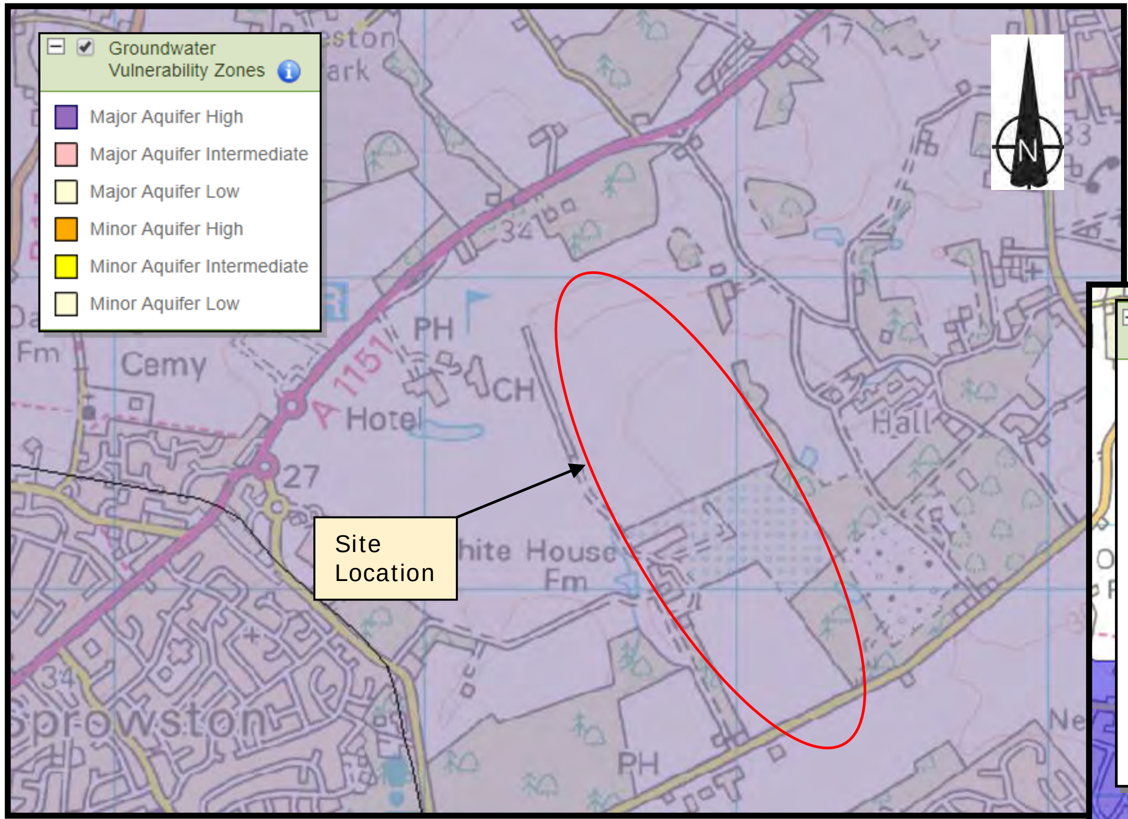
Raymond Long BSc (Hons) IEng MCIHT MICE
Senior Engineer
on behalf of Richard Jackson Limited

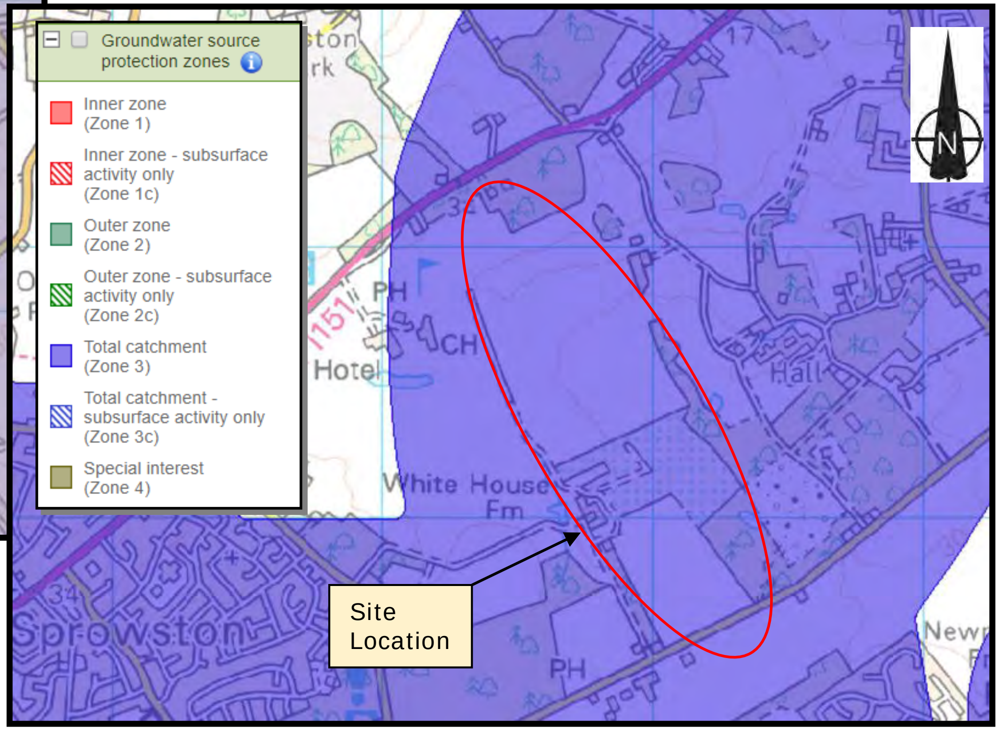
Checked by

Martin Doughty BEng (Hons) CEng FCIHT FICE MAPM
Director
On behalf of Richard Jackson Limited.

Encs. Figures 1 & 2
Drawing 48130/PP/SK01 – Indicative Surface Water Drainage Strategy.

c.c. Mr T Hewett – Taylor Wimpey
Ms L Townes – Persimmon Homes
Mr R Eburne – Hopkins Homes





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Site Location Grid Reference 626400, 312360
and Postcode NR7 8RN

Client:	Drawing Title:		
Developer Consortium	Environment Agency Flood Plan (Groundwater)		
Job Title:	**Date:**	**Job No:**	**Dwg No:**
Phase 3, White House Farm, Sprowston	26.06.17	48130	Figure. 1

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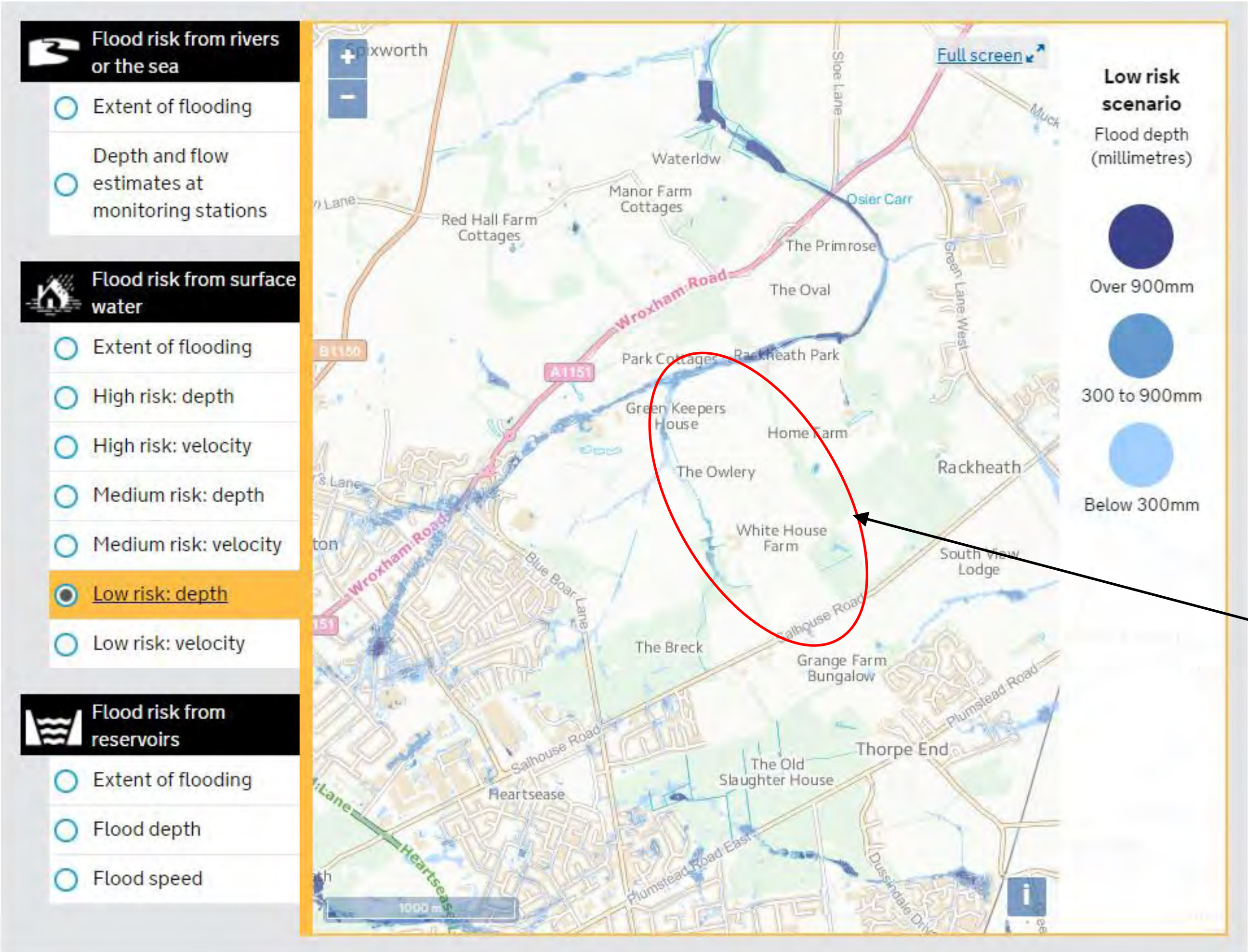

Site Location

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Site Location Grid Reference 626400, 312360 and Postcode NR7 8RN

Client:	Drawing Title:		
Developer Consortium	Surface Water Flood Mapping		
Job Title:	**Date:**	**Job No:**	**Dwg No:**
Phase 3, White House Farm, Sprowstom	26.06.17	48130	Figure. 2

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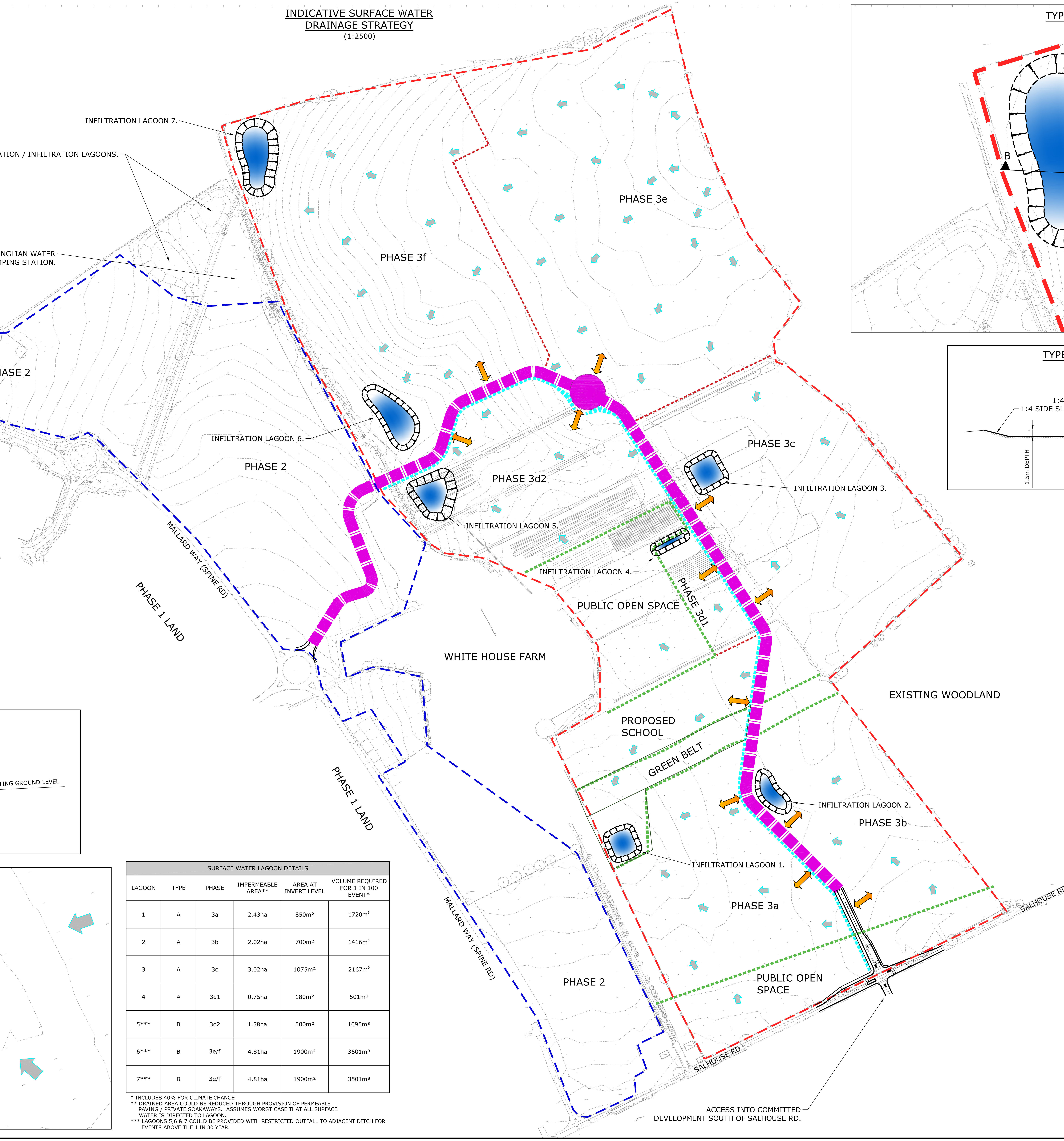
DO NOT SCALE

INDICATIVE SURFACE WATER DRAINAGE STRATEGY

(1:2500)



KEY:

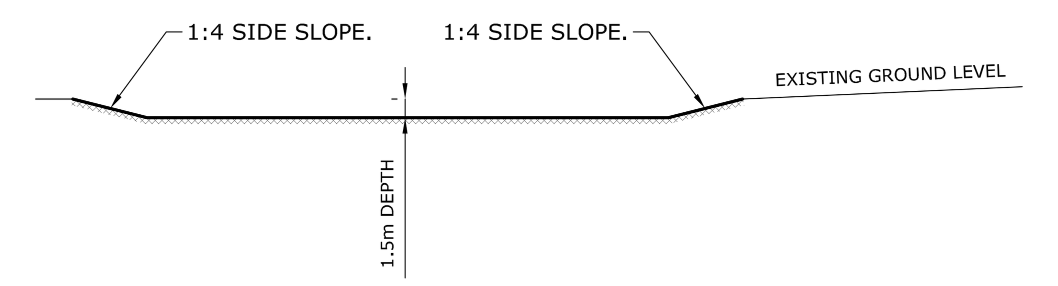
- OVERLAND FLOW ROUTES
- PHASE 2 INDICATIVE BOUNDARY
- PHASE 3 INDICATIVE BOUNDARY
- MAIN SPINE ROAD SWALE (0.45m DEPTH; BASE WIDTH 0.5m; 1 IN 3 SIDE SLOPES)
- RESIDENTIAL ESTATE ROAD
- LINK ROAD

NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE STATED. PLAN IS BASED ON TOPOGRAPHICAL SURVEY INFORMATION.
2. LAGOONS BASED ON INFILTRATION RATES DETERMINED FOR PHASE 1. NEW INFILTRATION TESTING REQUIRED AT AREAS INDICATED FOR LAGOONS.
3. ROAD ALIGNMENT IS INDICATIVE. MAIN SPINE ROAD TO HAVE SWALE TO DRAIN SURFACE WATER RUNOFF FROM HIGHWAY.

TYPE A LAGOON SECTION A-A

(N.T.S)



TYPE A LAGOON

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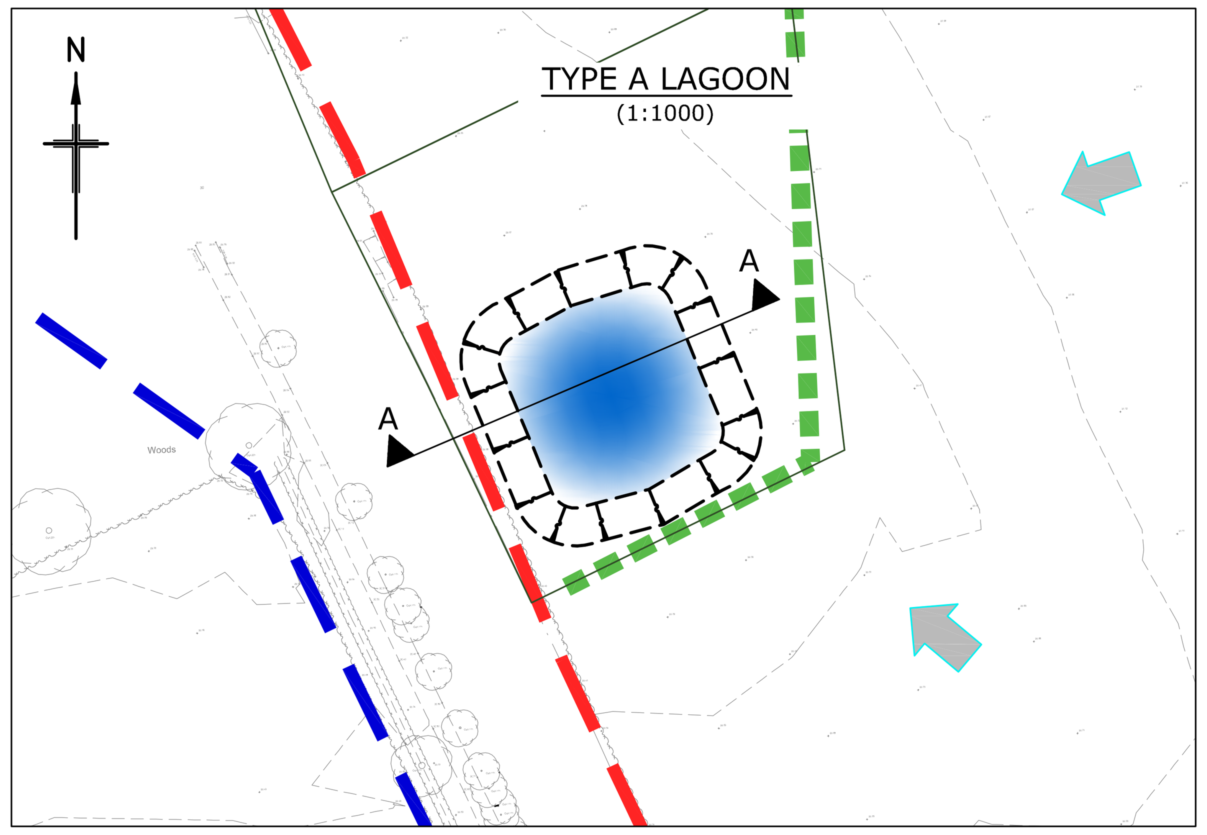


SURFACE WATER LAGOON DETAILS					
LAGOON	TYPE	PHASE	IMPERMEABLE AREA**	AREA AT INVERT LEVEL	VOLUME REQUIRED FOR 1 IN 100 EVENT*
1	A	3a	2.43ha	850m²	1720m³
2	A	3b	2.02ha	700m²	1416m³
3	A	3c	3.02ha	1075m²	2167m³
4	A	3d1	0.75ha	180m²	501m³
5***	B	3d2	1.58ha	500m²	1095m³
6***	B	3e/f	4.81ha	1900m²	3501m³
7***	B	3e/f	4.81ha	1900m²	3501m³

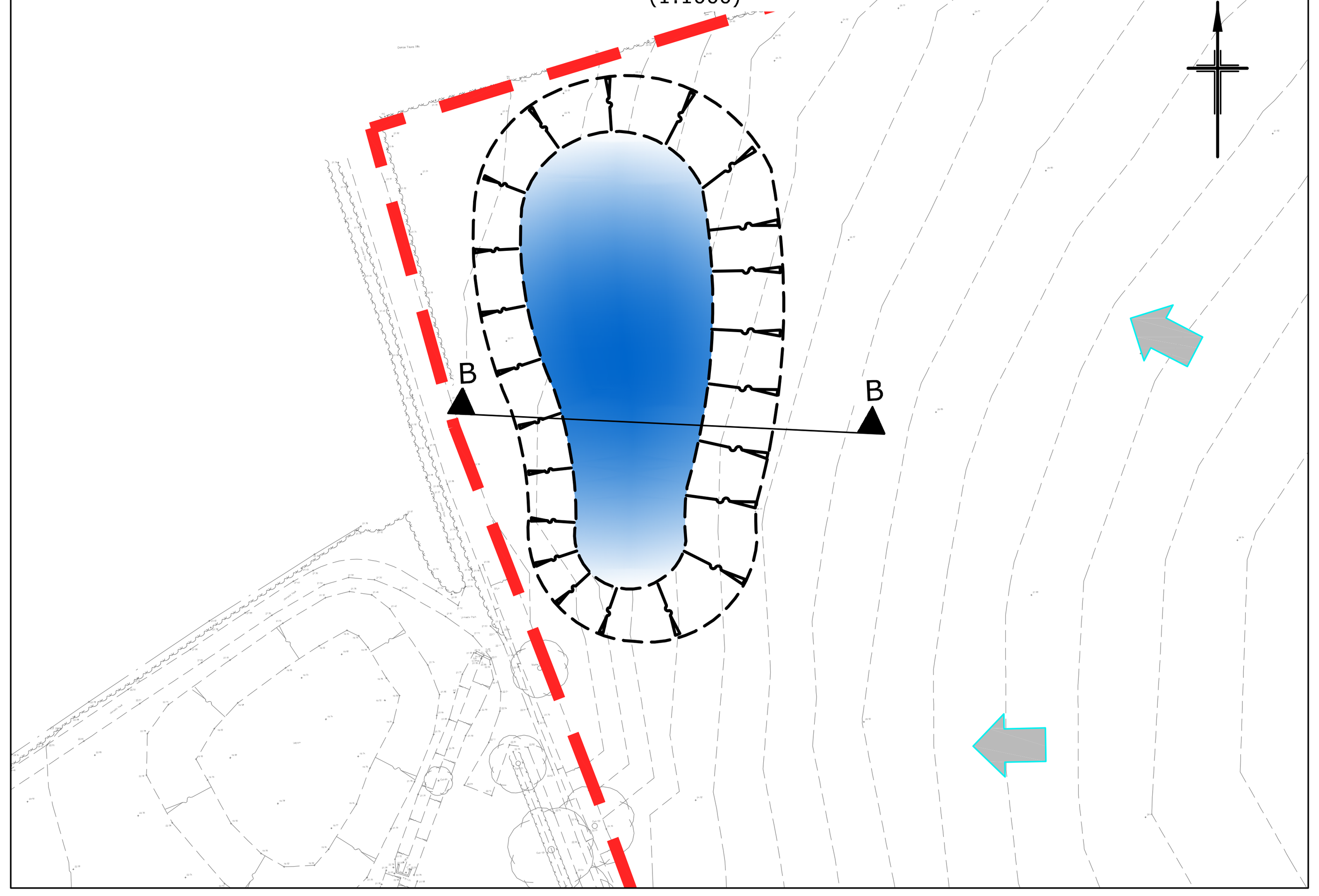
* INCLUDES 40% FOR CLIMATE CHANGE

** DRAINED AREA COULD BE REDUCED THROUGH PROVISION OF PERMEABLE PAVING / PRIVATE SOAKAWAYS. ASSUMES WORST CASE THAT ALL SURFACE WATER IS DIRECTED TO LAGOON.

*** LAGOONS 5,6 & 7 COULD BE PROVIDED WITH RESTRICTED OUTFALL TO ADJACENT DITCH FOR EVENTS ABOVE THE 1 IN 30 YEAR.

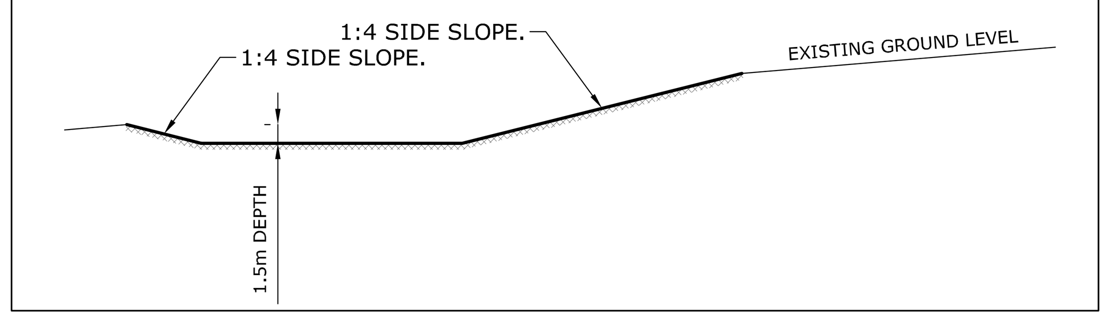
TYPE B LAGOON

(1:1000)



TYPE B LAGOON SECTION B-B

(N.T.S)



REV	DATE	DESCRIPTION	DRAWN	CHKD
B	25.08.17	AMENDED SPINE ROAD, BOUNDARIES, TABLE LAGOON SIZES.	RNL	JP
A	19.07.17	AMENDED KEY AND LAGOON SHAPE.	RNL	MJD

REVISIONS

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.

Project
'WHITE LAND' - PHASE 3
SPROWSTON
LOCAL PLAN REPRESENTATION

Title
INDICATIVE SURFACE WATER DRAINAGE STRATEGY

Client
CONSORTIUM OF TAYLOR WIMPEY, PERSIMMON HOMES & HOPKINS HOMES

Scale	Drawn	Date
AS SHOWN @ A1	R. LONG	10/07/17
Job Manager	Checked	Approved
R. LONG	MJD	MJD

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Email Address: mail@rj.uk.com Website: http://www.rj.uk.com

Drawing No. 48130/PP/SK01 Revision B

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

A1

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