LAND WEST OF CHESTERTON

FLOOD RISK ASSESSMENT

FOR

TAYLOR WIMPEY UK LTD

September 2014

Our Ref: RCEF29420-002R

RPS Health, Safety & Environment
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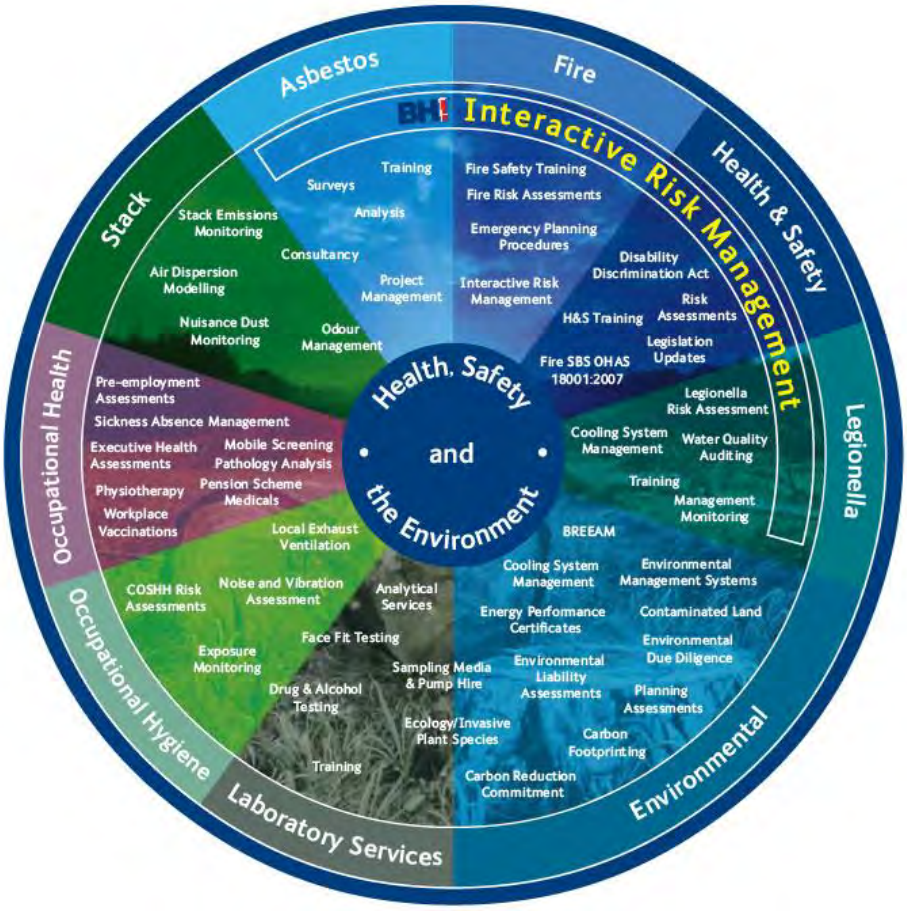

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General Notes

1. The following notes should be read in conjunction with the report:

2. This report contains only that available factual data for the site, which was obtained from the sources, described in the text. These data were related to the site on the basis of the location information made available to RPS by the client.

3. The assessment of the site is based on information supplied by the client. Relevant information was also obtained from other sources.

4. The report reflects both the information provided to RPS in documents made available for review and the results of observations and consultations by RPS staff.

5. Where data have been supplied by the client or other sources, including that from previous site audits or investigations, it has been assumed that the information is correct but no warranty is given to that effect. While reasonable care and skill has been applied in review of this data no responsibility can be accepted by RPS for inaccuracies in the data supplied.

6. This report is prepared and written in the context of the proposals stated in the introduction to this report and its contents should not be used out of context. Furthermore new information, changed practices and changes in legislation may necessitate revised interpretation of the report after its original submission.

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CONTENTS

1 INTRODUCTION

1.1 RPS was commissioned to undertake a Flood Risk Assessment of land situated North of Green Lane, Chesterton in relation to the outline planning application for the development of residential properties.

1.2 The aim of the Flood Risk Assessment is to outline the potential for the site to be impacted by flooding, the impacts of the proposed development on flooding in the vicinity of the site, and the proposed measures which could be incorporated into the development to mitigate the identified risk. The report has been produced in accordance with the guidance detailed in the National Planning Policy Framework (NPPF). Reference has also been made to the CIRIA SUDS manual (C697), BRE Digest 365 Soakaway Design, the Cherwell and West Oxfordshire Strategic Flood Risk Assessment (SFRA).

1.3 This report has been produced in consultation with the Sustainable Places Team at the Environment Agency. The site is not located within an Internal Drainage Board (IDB) District.

1.4 This report is not intended to provide formal details of the final drainage design for the development. It provides information regarding the capabilities of the conceptual surface water drainage strategy to meet the requirements of the NPPF.

1.5 The desk study was undertaken by reference to information provided / published by the following bodies:

- Environment Agency
- Centre for Ecology and Hydrology
- British Geological Survey
- Ordnance Survey
- Thames Water

1.6 A site visit was conducted on 25th March 2014.

2 PLANNING POLICY CONTEXT

National Planning Policy

2.1 The National Planning Policy Framework (NPPF) released in March 2012, advises of the requirements for a site specific Flood Risk Assessment (FRA) for any of the following cases:

- All proposals (including minor development and change of use) located within the Environmental Agency designated floodplain, recognised as either Flood Zone 2 (medium probability) or Flood Zone 3 (high probability);
- All proposals greater than 1ha in area located in Flood Zone 1 (low probability);
- All proposals within an area which has critical drainage problems (as notified to the Local Planning Authority by the Environment Agency); and
- Where proposed development may be subject to other sources of flooding.

Local Planning Policy

2.2 The adopted Cherwell Local Plan (1996) does not contain any policies relating to flood risk and drainage.

2.3 The proposed new Cherwell Local Plan (2006-2031) was submitted to the Secretary of State for Communities and Local Government for formal Examination on 31st January 2014. The proposed new Cherwell Local Plan contains the following Policies relating to flood risk and drainage:

Policy ESD 6 - Sustainable Flood Risk Management

The Council will manage and reduce flood risk in the district through using a sequential approach to development; locating vulnerable developments in areas at lower risk of flooding. Development proposals will be assessed according to the sequential approach and where necessary the exceptions test as set out in the NPPF. Development will only be permitted in areas of flood risk when there are no reasonably available sites in areas of lower flood risk and the benefits of the development outweigh the risks from flooding.

In addition to safeguarding floodplains from development, opportunities will be sought to restore natural river flows and floodplains, increasing their amenity and biodiversity value. Building over or culverting of watercourses should be avoided and the removal of existing culverts will be encouraged.

Existing flood defences will be protected from damaging development and where development is considered appropriate in areas protected by such defences it must allow for the maintenance and management of the defences and be designed to be resilient to flooding.

Site specific flood risk assessments will be required to accompany development proposals in the following situations:

- *All development proposals located in flood zones 2 or 3*
- *Development proposals of 1 hectare or more located in flood zone 1*
- *Development sites located in an area known to have experienced flooding problems*
- *Development sites located within 9m of any watercourses.*

Flood risk assessments should assess all sources of flood risk and demonstrate that:

- *There will be no increase in surface water discharge rates or volumes during storm events up to and including the 1 in 100 year storm event with an allowance for climate change (the design storm event)*
- *Developments will not flood from surface water up to and including the design storm event or any surface water flooding beyond the 1 in 30 year storm event, up to and including the design storm event will be safely contained on site.*

Development should be safe and remain operational (where necessary) and proposals should demonstrate that surface water will be managed effectively on site and that the development will not increase flood risk elsewhere, including sewer flooding.

Policy ESD 7 - Sustainable Drainage Systems (SuDS)

All development will be required to use sustainable drainage systems (SuDS) for the management of surface water run-off.

Where site specific Flood Risk Assessments are required in association with development proposals, they should be used to determine how SuDS can be used on particular sites and to design appropriate systems.

In considering SuDS solutions, the need to protect ground water quality must be taken into account, especially where infiltration techniques are proposed. Where possible, SuDS should seek to reduce flood risk, reduce pollution and provide landscape and wildlife benefits. SuDS will require the approval of Oxfordshire County Council as LLFA and SuDS Approval Body, and proposals must include an agreement on the future management, maintenance and replacement of the SuDS features.

Policy ESD 9 - Protection of the Oxford Meadows SAC

Developers will be required to demonstrate that:

- *During construction of the development there will be no adverse effects on the water quality or quantity of any adjacent or nearby watercourse*
- *During operation of the development any run-off of water into adjacent or surrounding watercourses will meet Environmental Quality Standards (and where necessary oil interceptors, silt traps and Sustainable Drainage Systems will be included)*
- *New development will not significantly alter groundwater flows and that the hydrological regime of the Oxford Meadows SAC is maintained in terms of water quantity and quality*
- *Run-off rates of surface water from the development will be maintained at Greenfield rates.*

2.4 The Cherwell and West Oxfordshire Strategic Flood Risk Assessment (SFRA) identifies and maps flood risk from all sources at a borough-wide scale as well as providing guidance on producing site specific FRAs. Relevant information from the SFRA has been referenced throughout this Flood Risk Assessment report.

3 CONSULTATION

3.1 The Flood Risk Assessment has been produced in consultation with the Sustainable Places Team at the Environment Agency. The Environment Agency advised that for sites located within Flood Zone 1 greenfield run-off rates need to be maintained post development. Where possible, greenfield rates should be improved (i.e. through the use of soakaways).

3.2 The site is not located within an Internal Drainage Board (IDB) District.

3.3 The public sewer network within the vicinity of the site is operated by Thames Water. The sewer network within the vicinity of the site is discussed within Section 8 of this report.

3.4 A pre-development enquiry has been undertaken as part of the preparation of the Flood Risk Assessment. Thames Water have advised that a network modelling study will be required and at this stage the preliminary works are being undertaken.

3.5 The site is within the administrative boundary of Cherwell District Council. The Lead Local Flood Authority is Oxfordshire County Council. Oxfordshire County Council's Draft Local Flood Risk Management Strategy is currently open for consultation between 30th June 2014 and 19th September 2014.

4 SITE DESCRIPTION

Site Description

4.1 The site is located off Green Lane, Chesterton approximately 2.5 km to the southwest of Bicester town centre at National Grid Reference SP 55761 21449. It is rectangular in shape, occupying an area of approximately 2.79 hectares. A site location plan is provided in Figure 1.

4.2 The majority of the site is currently utilised as arable farm land, however, there are several sheds and a gravel area to the north of the site.

4.3 Vehicular and pedestrian access to the site is currently gained via the single track road which forms the north western boundary.

Surrounding Land Uses

4.4 The site is situated within an area dominated by agricultural and residential land uses. The site is bound to the north by allotments to the northeast by residential properties to the south west by agricultural land and to the north west by a single track road beyond which lies Bicester Hotel, Golf and Spa.

4.5 The site is not situated within or in close proximity to either a Special Area of Conservation (SAC) or Special Protection Area (SPA).

Topography

4.6 A topographic survey has been undertaken by RPS (Drainage Ref. JKK8123_1, Dated 21st March 2014) on the site and is included in Appendix A. The site generally slopes gently downwards in a south easterly direction from a topographic high point of approximately 78.38 m AOD in the northern corner to a topographic low point of approximately 75.00 m AOD in the southern corner.

4.7 The topographic survey identifies that levels along the single track road which form the north western boundary of generally fall from north to south with levels at the northern end of the site at approximately 78.83 m AOD and levels at the southern end at approximately 78.03 m AOD. The levels on the part of the single track road close to the northern boundary of the site are generally up to 0.5 m higher than on the site.

4.8 Reference to OS Mapping contours identifies that site is located within a wider area where levels are generally sloping downwards in a south easterly direction. Ground to the north west of the site is generally higher than the site and ground to the south east of the site is generally lower.

5 PROPOSED DEVELOPMENT

5.1 This planning application seeks outline planning approval with means of access for consideration (layout, scale, appearance and landscaping reserved for subsequent approval) for the erection of up to 45 dwellings served via a new vehicular and pedestrian access; public open space and associated earthworks to facilitate surface water drainage; and all other ancillary and enabling works.

5.2 Illustrative masterplans are shown in Appendix B.

5.3 Vehicular and pedestrian access will be provided via a newly constructed access road which will lead off the single track road located to the north west of the site.

5.4 Finished floor levels for the proposed buildings will be raised slightly above existing site levels.

5.5 The proposed area of hardstanding following development of the site will comprise approximately 1.3 Ha and the remaining area will be soft landscaping and public open space.

5.6 The proposed use of the site is classified as ôMore Vulnerableôwithin the NPPF.

5.7 An indicative drainage layout has been designed for the site. It is anticipated that surface water runoff will pass to a surface water drain situated within The Woodlands to the south of the site. The acceptable discharge rate to the existing mains sewer will need to be agreed with Thames Water in consultation with the Environment Agency. However, based on the existing greenfield nature of the site, greenfield rates will need to be maintained post development.

5.8 The potential to provide surface water attenuation, including the use of SuDS, has been considered as part of the preliminary design process (see Section 10 ï Surface Water Management).

6 HYDROLOGICAL SETTING

Nearby Watercourses

6.1 Reference to Ordnance Survey Mapping indicates that the nearest surface water feature is Gagle Brook which is situated approximately 350 m to the east, beyond Chesterton town centre. The brook is indicated to flow to the south, ultimately discharging to the River Ray approximately 4.6 km from the site.

6.2 A total of thirteen ponds are shown to be located within the grounds of the Bicester Hotel, Golf and Spa to the north west of the site.

6.3 No artificial watercourses / features (e.g. canals, reservoirs) have been identified within 1km of the site.

Flood Risk Classification

6.4 The Environment Agency's indicative floodplain map indicates that the site is located wholly within Flood Zone 1 which is classified as being at a low risk of fluvial flooding (less than 1 in 1000 annual probability). The Environment Agency indicative floodplain map is included as Figure 2.

6.5 The Environment Agency's indicative floodplain map indicates that the nearest floodplain to the site is located approximately 350 m to the east and is associated with Gagle Brook. Reference to Ordnance Survey Mapping indicates that the site is situated at least 75 m AOD whilst Gagle Brook is situated at approximately 70 m AOD, therefore the site is at least 5 m above the identified floodplain.

6.6 Reference to the Environment Agency's online risk of flooding from surface water map indicates that the proposed site is not at risk of surface water flooding.

6.7 The Environment Agency's reservoir flooding map indicates that the site is not in an area at risk of inundation from reservoir flooding.

6.8 No other sources of flooding have been identified within close proximity to the site.

7 HYDROGEOLOGICAL SETTING

7.1 Reference to the British Geological Survey online mapping (1:50,000 scale) indicates that no superficial deposits underlie the site. The underlying bedrock is indicated to consist of the Cornbrash Formation a member of the Great Oolite Group. This is described as poorly bedded, medium- to fine-grained limestone.

7.2 According to the Environment Agencyôs online Groundwater Vulnerability Mapping, the bedrock consisting of the Cornbrash Formation is classified as a Secondary A Aquifer. Secondary A Aquifers are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

7.3 Soilscapes online mapping describes the underlying soil on the site as, ôFreely draining lime-rich loamy soilsô

7.4 Reference to the Environment Agencyôs online groundwater Source Protection Zone maps indicates that the site is not located within a groundwater Source Protection Zone.

8 EXISTING DRAINAGE / WATER MAINS

8.1 At present the site is currently undeveloped and therefore there is no formal surface water system draining the site.

8.2 Reference to Thames Water plans of public sewers (shown in Appendix C) indicates that a 225 mm diameter surface water sewer and a 150 mm diameter foul water sewer are situated within the Woodlands to the south of the site. Both sewers are indicated to flow southward before diverting eastward along Green Lane.

8.3 Reference to water network plans provided by Thames Water indicates that there is a 90mm distribution main located in The Woodlands to the south of the site.

9 FLOOD RISK AND MITIGATION

9.1 The key sources of flooding that could potentially impact the site are discussed below:

Fluvial / Tidal Flooding

9.2 The Environment Agency's indicative floodplain map indicates that the site is located wholly within Flood Zone 1 which is classified as being at a low risk of fluvial flooding (less than 1 in 1000 annual probability). The Environment Agency indicative floodplain map is included as Figure 2.

9.3 Given the distance of the nearest floodplain to the site (350 m) and the elevation of the site above the watercourse (approximately 5 m) the risk of fluvial flooding to the site is considered to be low.

9.4 The access road included in the proposed development which leads off the single track road, is located within Flood Zone 1 therefore safe access/egress is available for the site.

9.5 Given that the site and immediate surrounding area is within Flood Zone 1, the proposed development will not result in any modification to fluvial flood flows nor is there any loss in floodplain storage; therefore floodplain compensation is not required for the proposed development.

Proposed Mitigation

9.6 No mitigation measures are required.

Flooding from sewers

9.7 Sewer flooding can occur during periods of heavy rainfall when a sewer becomes blocked or is of inadequate capacity. At present the site is currently undeveloped and therefore there is no formal surface water system draining the site, however there are sewers situated to the south of the site serving the neighbouring residential properties which are detailed in Section 8.

9.8 Given the topography of the site and the surrounding area it is likely that in the event of sewer surcharging it is water would be retained within the road by the roadside kerbs, and would flow along the Woodlands to the south and east and away from the site.

9.9 The SFRA has taken historical sewer flooding records provided from Thames Water and Anglian Water Services DG5 databases detailing the total number of flood events recorded to have affected both internal and external property over a 10 year period. The number of recorded sewer flooding events provided from the DG5 register is provided on a 5 figure grid reference basis and does not pin-point specific areas. The site is not identified as being within an area where sewer flooding has been recorded.

9.10 The discharge rate to the existing sewer will be agreed with Thames Water to ensure that there is capacity to receive discharge from the site without significantly increasing flood risk.

Proposed Mitigation

9.11 The residential dwellings on site will need to be raised above the road network in order to mitigate the potential for flooding from the onsite drainage network.

Surface water flooding (overland flow)

9.12 This can occur during intense rainfall events, when water cannot soak into the ground or enter drainage systems.

9.13 Reference to the Environment Agencyôs online risk of flooding from surface water map indicates that the site is not at risk from surface water flooding.

9.14 Reference to OS Mapping contours identifies that the site is located within a wider area where levels are generally sloping downwards in a southerly easterly direction. Ground to the north west of the site is generally higher than the site and ground to the south east of the site is generally lower. There is therefore potential for surface water overland flow to migrate onto the site from off-site areas to the north and north west of the site. In such instances, flows would migrate across the site in a south easterly direction following the topographic gradient towards Hazelhurst Road.

9.15 Surface water flooding from on-site sources is considered in Section 10 of this report.

Proposed Mitigation

9.16 Floor levels of the buildings on site will be raised a minimum of 150 mm above surrounding ground levels thereby preventing ingress of any overland flows from off-site sources into the buildings on the site.

Groundwater flooding

9.17 This can occur in low-lying areas when groundwater levels rise above surface levels, or within underground structures. BGS mapping indicates that the site is underlain by bedrock consisting of the Cornbrash Formation a member of the Great Oolite Group. There is potential for shallow groundwater to exist beneath the site, although it is unlikely to be present in significant quantities. At this stage no site specific information is available for groundwater levels beneath the site.

9.18 The SFRA states that, ô*No historical flooding records or information were identified for the SW quadrant of Bicester*.ô

9.19 Soilscapes online mapping describes the underlying soil on the site as, ôFreely draining lime-rich loamy soilsô

9.20 The proposed buildings on the site do not include basement levels.

9.21 The risk of groundwater flooding is considered to be low.

Proposed Mitigation

9.22 No mitigation required

Other Sources

9.23 The risk of flooding associated with reservoirs, canals and other artificial structures is considered to be low given the absence of any such features within close proximity of the site.

9.24 The Environment Agency's indicative Reservoir Flooding map indicates that the site is not in an area at risk of inundation from reservoir flooding.

9.25 There will be no increase in flood risk from sources such as water mains, canals or other artificial water bodies as a result of the development.

Proposed Mitigation

9.26 Raising floor levels of the buildings on site a minimum of 150 mm above surrounding ground levels will reduce the risk of ingress of any sewer flows into the buildings on the site.

Event Exceedence and Residual Risk

9.27 The mitigation measures proposed as part of the development scheme are considered appropriate to mitigate against any residual risks or event exceedence scenarios.

10 SURFACE WATER MANAGEMENT

Introduction

10.1 At present, the site is undeveloped and therefore, there will be an increase in the amount of hardstanding in the form of roads, residential buildings and driveways. Consultation with the Environment Agency has determined that greenfield run-off rates need to be maintained post development.

10.2 The IoH 124 Method has been used to calculate the greenfield run-off rate for the site. The calculation sheet is included at Appendix D. The QBAR greenfield run-off rate has been calculated as 2.14 l/s which is approximately 6.0 l/s/ha for the site.

10.3 The proposed development comprises the construction of residential properties. Generally, this type of development is considered to have a design life of 100 years. Therefore, for the purposes of this assessment, taking into account the recommended national precautionary sensitivity ranges for peak rainfall intensity (Table 5 in the NPPF), a 30% increase in peak rainfall intensity has been included as climate change allowance, which caters up to the year 2115.

Consideration of Sustainable Drainage Systems

10.4 The potential for the use of Sustainable Drainage Systems (SuDS) has been considered at this stage.

Swales, detention basins and ponds

10.5 The use of detention basins or ponds within the site is a potential method for surface water attenuation due to the availability of open areas within the proposed development. Detention basin 1 (North Pond) will provide a storage volume of 335.7 m^3 with a freeboard of approximately 0.492 m. Detention basin 2 (South Pond) will provide a storage volume of 530.2 m^3 with a freeboard of approximately 0.483 m. The ponds have the potential to be used as infiltration basins subject to soakaway tests prior to the detailed drainage design.

Soakaways

10.6 Reference to BGS mapping indicates that the site is underlain by no superficial deposits. The underlying bedrock is indicated to consist of the Cornbrash Formation which is likely to be of a relatively high permeability. The soils are described as ôFreely draining lime-rich loamy soilsô

10.7 Given the reported geological conditions beneath the site, it is considered that soakaways could provide a feasible method for the disposal of surface water runoff from the site. The attenuation basins could be included as attenuation basins (and potentially reduced in size as necessary) or soakaway chambers could be used within the site subject to infiltration testing.

Rainwater Harvesting

10.8 The attenuation benefits provided through the use of rainwater harvesting are considered to be limited, and would only be realised when the tanks were not full.

Green Roofs

10.9 Green roofs are considered unsuitable given the nature of the development.

Porous / Permeable Paving

10.10 The use of porous / permeable paving would be suitable for the construction of hardstanding areas of the site including turning heads, and driveways, totalling an area of 2,680 m^2.

10.11 Storage would be provided within the sub-grade material to a depth of 300 mm with a 30% void ratio prior to controlled discharge to the receiving surface water sewer or infiltration into the underlying strata. This could provide up to 241 m^3 of storage for the site.

Conceptual Surface Water Attenuation Scheme

10.12 The proposed surface water attenuation scheme comprises drainage of surface water from the site into surface water attenuation basins. The conceptual surface and foul water drainage scheme is shown in appendix E. Micro drainage calculation sheets are provided at Appendix F. Detailed drainage design will be required at the detailed design stage.

10.13 Surface Water Attenuation Basin no. 1, located towards the eastern boundary of the site, will drain the proposed residential buildings located west of the basin. The basin will provide a storage volume of 335.7 m^3 for a 1 in 100 year plus 30% climate change event. The water depth has been calculated as 1.158m. A freeboard of approximately 0.492 m will be provided.

10.14 Surface Water Attenuation Basin no. 2 which is located within the southern corner of the site will provide a storage volume of 530.2 m^3 for a 1 in 100 year plus 30% climate change event. Depth of water within the basin has been calculated as 1.167 m. A freeboard of 0.483 m is provided.

10.15 The outflow from the basins is controlled by a flow control. The outflow from Attenuation Basin 1 is set at a rate of 3.0 litres/sec. The outflow from Attenuation Basin 2 is set at a rate of 6.0 litres/sec (greenfield run-off rate for the site) and will discharge into Woodlands via a gravity sewer.

10.16 This provides significant betterment than the existing situation as all events above the QBAR rate will be maintained on site up to the 1 in 100 year plus 30% allowance for climate change event. It should be noted that subject to infiltration testing the attenuation basins may be replaced by infiltration basins. This will be confirmed at the detailed design stage.

10.17 The foul water drainage features two northeast to southwest flowing foul sewers which drain into a foul sewer running along the southwestern boundary of the site and subsequently around attenuation basin 2. This then discharges into an existing foul sewer located in The Woodlands.

10.18 The final discharge will require requisition of sewers in The Woodlands. Thames Water has advised that a network modelling study will be required and at this stage the preliminary works are being undertaken.

Event Exceedence

10.19 The proposed indicative surface water drainage concept provides storage up to the 1 in 100 year plus 30% climate change event. In an event exceeding this magnitude, detailed drainage design will identify mitigation measures to ensure that the resulting above-ground flooding will be confined to temporary shallow flooding of the on-site road network and will not affect the buildings on site or significantly increase flood risk to off-site locations.

10.20 Event exceedence planning will be undertaken as part of the final design process. Suitable mitigation measures will be incorporated into the development to ensure water is retained on-site should surcharging of on-site drains occur during extreme rainfall events.

11 SEQUENTIAL TEST AND EXCEPTION TEST

Sequential Test

11.1 The NPPF requires the Local Authority to apply the Sequential Test in consideration of new development. The aim of the Test is to steer new development to areas at the lowest probability of flooding. The proposed use of the site is classified as ómore vulnerableôwithin the NPPF.

11.2 More vulnerable developments are deemed appropriate for Flood Zone 1 and therefore the proposed development of the site meets the requirements of the Sequential Test.

The Exception Test

11.3 According to Table 3 of the NPPF, ómore vulnerableôdevelopments are considered appropriate within Flood Zone 1 without the requirement to apply the Exception Test. Therefore, application of the Exception Test is not required for the proposed development.

12 SUMMARY AND CONCLUSIONS

12.1 The aim of the Flood Risk Assessment is to outline the potential for the site to be impacted by flooding, the potential impacts of the development on flooding both onsite and in the vicinity, and the proposed measures which can be incorporated into the development to mitigate the identified risks. The report has been produced in accordance with the guidance detailed in the NPPF. Reference has also been made to the CIRIA SuDS manual (C697), the Strategic Flood Risk Assessment and following consultation with the Environment Agency's Sustainable Places Team.

12.2 The potential flood risks to the site, and the measures proposed to mitigate the identified risks, are summarised in the table below:

Source of flooding	Identified Risk			Mitigation proposed	Residual risk		
	L	M	H		L	M	H
Fluvial	✓			No mitigation required.	✓		
Tidal	✓			No mitigation required.	✓		
Sewers	✓			Residential dwellings raised above road network.	✓		
Surface Water		✓		Floor levels of the buildings raised a minimum of 150mm above surrounding ground levels.	✓		
Groundwater	✓			No mitigation required	✓		
Other Sources (e.g. reservoirs, water mains)	✓			Raise floor levels of the buildings onsite a minimum of 150mm above surrounding ground levels.	✓		

12.3 The site is located with the Environment Agency's Flood Zone 1, therefore is considered to have a low risk of fluvial flooding.

12.4 Based on the site's location within Flood Zone 1, the site meets the requirements of the Sequential Test incorporated within the NPPF.

12.5 The conceptual foul and surface water drainage plan, described in Section 10, will maintain greenfield run-of rates for the site through a series of gravity sewers. Attenuation is provided in the form of two attenuation basins before discharge into Woodlands to Thames Water sewers. There is potential that infiltration will be incorporated into the basins at the detailed design stage.

12.6 Overall, it has been demonstrated that the development would be safe, without increasing flood risk elsewhere, and that a positive reduction in flood risk would be achieved through the proposed surface water management.

Figure 1

SITE LOCATION PLAN

RPS
Unit 12, Watersedge Business Park, Modwen Road, Salford Quays, M5 3EZ
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Client: Taylor Wimpey Oxfordshire	Date: 27/08/2014 Scale: NTS
Project: Green Lane, Chesterton	Figure: 01 Rev: 00
Title: Site Location Plan	Job Ref: RCEF29420

Figure 2

ENVIRONMENT AGENCY FLOOD MAP

RPS
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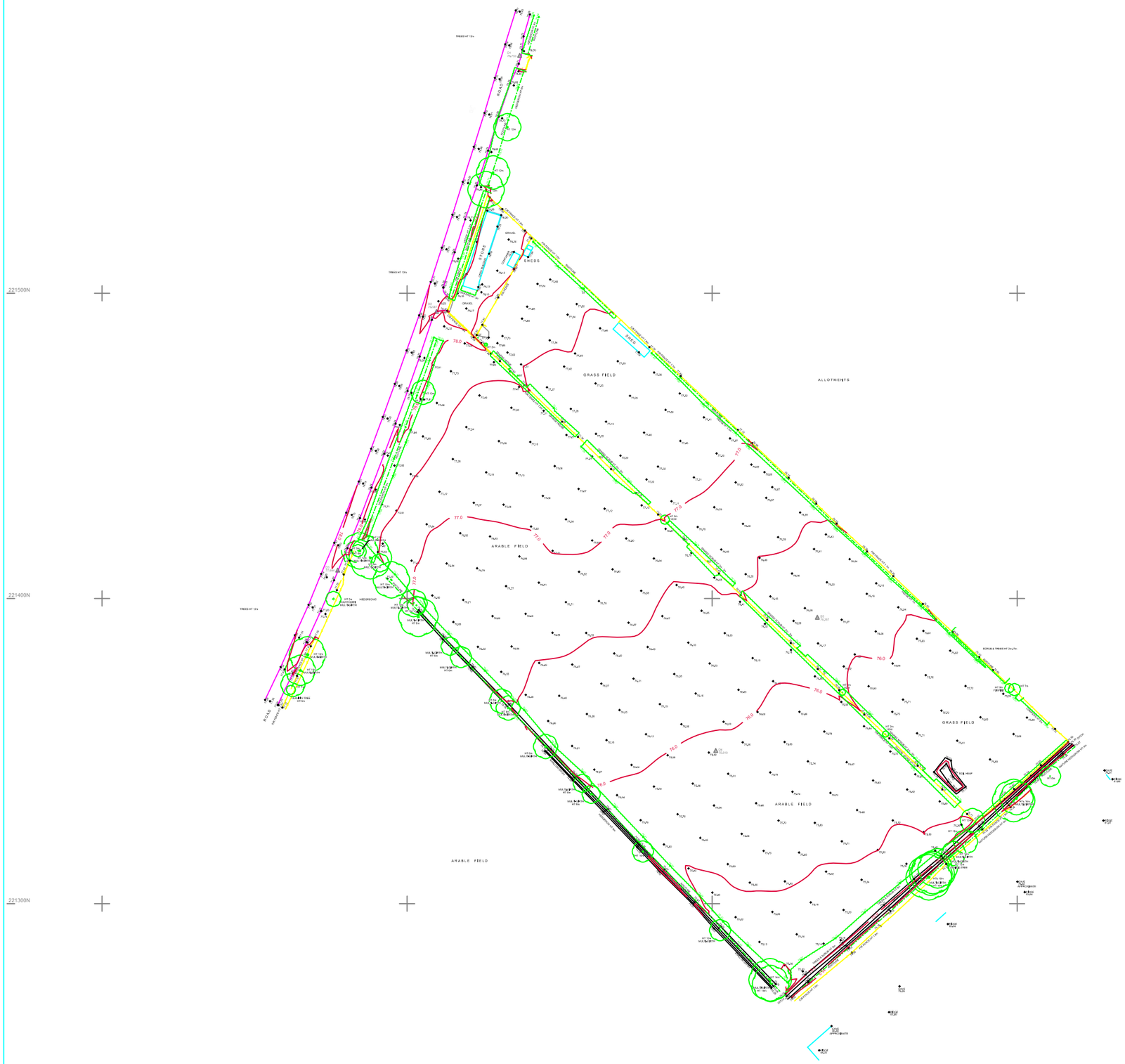
Client: Taylor Wimpey Oxfordshire	Date: 27/08/2014 Scale: NTS
Project: Green Lane, Chesterton	Figure: 02 Rev: 00
Title: Environment Agency Flood Map	Job Ref: RCEF29420

Appendix A

TOPOGRAPHIC SURVEY



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SURVEY KEY

AV	AIR VALVE	BR	BACK RAIL
BL	BOLLARD	BO	BORE OUTLET
BM	BENCH MARK	LB	LETTER BOX
BN	BEACON	LP	LAMP POST
BS	BUS STOP SIGN	LA	LANDS LAY
BT	BRITISH TELECOM COVER	MH	MANHOLE
B/W	BARBED WIRE	MK	MARKER POST
CB	CONTROL BOX	MW	MONITORING WELL
CCTV	CLOSED CIRCUIT TV	NP	NAME PLATE
CL	COVER LEVEL	P	POST
C/I	CORRUGATED IRON	PM	PARKING METER
C/L	CHAIN LINK	P/R	POST AND RAIL
CONC	CONCRETE	P/W	POST AND WIRE
CPS	CONCRETE PAVING SLABS	RE	RODDING EYE
CR	CULVERT	RS	ROAD SIGN
C/B	CLOSE BOARDED	RWP	RAIN WATER PIPE
C/F	CHESTNUT PALING	SC	STOP COCK
C/P	CONCRETE PANEL	SF	SOFFIT LEVEL
CTV	CABLE TV	SP	SIGN POST
D	TRUNK DIAMETER	S/R	STEEL RAILING
DP	DOWN PIPE	ST	STUMP
EBS	ELECTRICITY BOX - DOUBLE	SW	SOIL VENT PIPE
EB	ELECTRICITY BOX	TW	TEMPORARY WATER
EC	ELECTRICITY COVER	TC	TACTILE PAVING
EP	ELECTRICITY POLE	TCB	TELEPHONE CALL BOX
ER	EARTH ROD	TL	TRAFFIC LIGHT
EU	EUCALYPTUS	TLC	TRAFFIC LIGHT SERVICE COVER
FL	FINISHED FLOOR LEVEL	TP	TELEPHONE POLE
FH	FIRE HYDRANT	TW	TOP OF WALL LEVEL
FV	FOUL INVERT	UL	UNABLE TO LIFT
GL	GROUND LIGHT	VC	VERGEMARK VALVE COVER
GM	GAS METER	VP	VENT PIPE
GP	GATE POST	WCL	WINDOW CILL LEVEL
GV	GAS VALVE	WHL	WINDOW HEAD LEVEL
GY	GULLY	WL	WATER LEVEL
HCH	HORSE CHESTNUT	WM	WATER METER
IC	INSPECTION COVER	WN	WIRE NETTING
IL	INVERT LEVEL	W/O	WIRE WORK
MH	SIGN INVERT LEVEL	WO	WASH OUT VALVE

1. UNDERGROUND DRAINAGE INFORMATION HAS BEEN MEASURED FROM SURFACE INSPECTION ONLY AND SHOULD BE CONFIRMED BY SPECIALISTS IF CRITICAL.
2. TREE AND HEDGE SPECIES HAVE BEEN IDENTIFIED AS ACCURATELY AS POSSIBLE BUT SHOULD BE CONFIRMED BY SPECIALISTS IF CRITICAL.
3. SURVEY GRID & LEVELS RELATED TO ORDNANCE SURVEY NATIONAL GRID, OBTAINED THROUGH RTK TIME GPS OBSERVATIONS. BASED ON STATION D4 (455801.189E, 221349.983N). NO SCALE FACTOR HAS BEEN USED.
4. NORTH ARROW APPROXIMATE ONLY

Station	Easting	Northing	Level
D1	455736.915	221577.756	78.753
D2	455709.661	221493.829	78.587
D3	455677.244	221409.074	77.984
D4	455801.189	221349.983	75.910
D5	455834.508	221393.631	76.357

Rev	Description	By	Ckd	Date

For guidance only. Do not scale off this drawing

1:25 @ A1: 0 200mm 400mm 600mm 800mm 1000 1200 1400 1600 1800 2000
1:50 @ A3: 0 1m 2m 3m 4m 5m 6m 7m 8m 9m 10m
1:100 @ A1: 0 1m 2m 3m 4m 5m
1:200 @ A3: 0 2m 4m 6m 8m 10m

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Client

Project LAND AT GREEN LANE, CHESTERTON, OXFORDSHIRE.

Title TOPOGRAPHICAL SURVEY

Status	Scale	Date Created
Final	1:500 @A0	21st March 2014
Project Leader	Drawn By	Checked by
AP	DJR	ST

Drawing Number	Rev
JKK8123 _1	A

rpsgroup.com

Appendix B

ILLUSTRATIVE MASTERPLAN

- Proposed New Access
- Proposed Footpath
- Illustrative Paths
- Existing Vegetation
- Proposed Planting
- Infrastructure
- Development
- Front Gardens / Footpaths
- Buildings
- Potential Location for Play Area
- Water Balancing Facility

0m 20 40 60m

scale 1:1000

APPROXIMATE TRUE NORTH

75.6m

LAND AT CHESTERTON, OXFORDSHIRE - ILLUSTRATIVE MASTERPLAN - (1:1000 A3)

September 2014

Taylor Wimpey

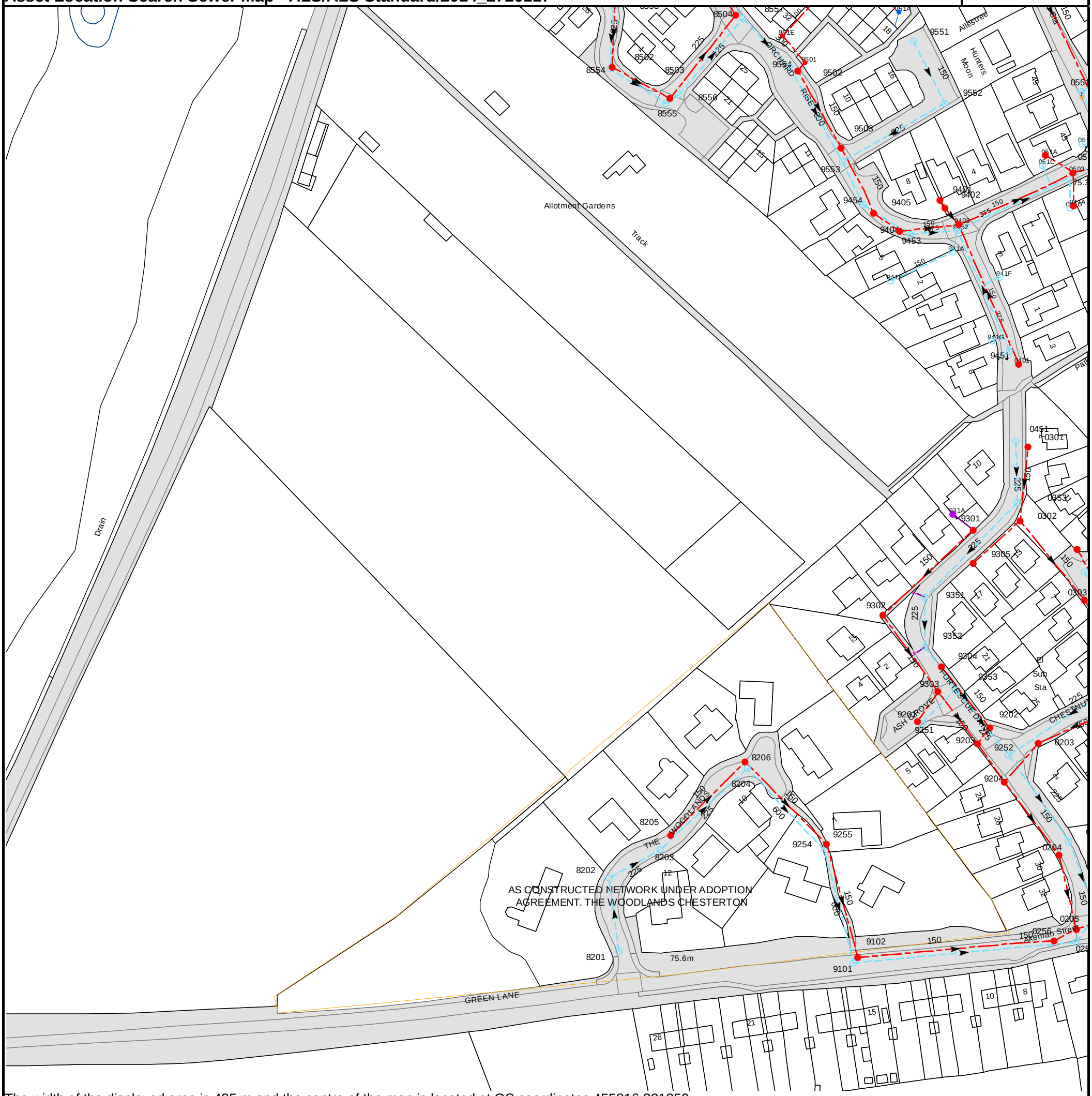
Life Space Design Studio

UNIT 1 PRESTON LODGE COURT | PRESTON DEANERY | NORTHAMPTON | NN7 2DS | T: 01604 871199 | W: www.lsdev.co.uk | E: info@lsdev.co.uk

Appendix C

THAMES WATER SEWER PLANS

Asset Location Search Sewer Map - ALS/ALS Standard/2014_2726117



The width of the displayed area is 425 m and the centre of the map is located at OS coordinates 455816,221359

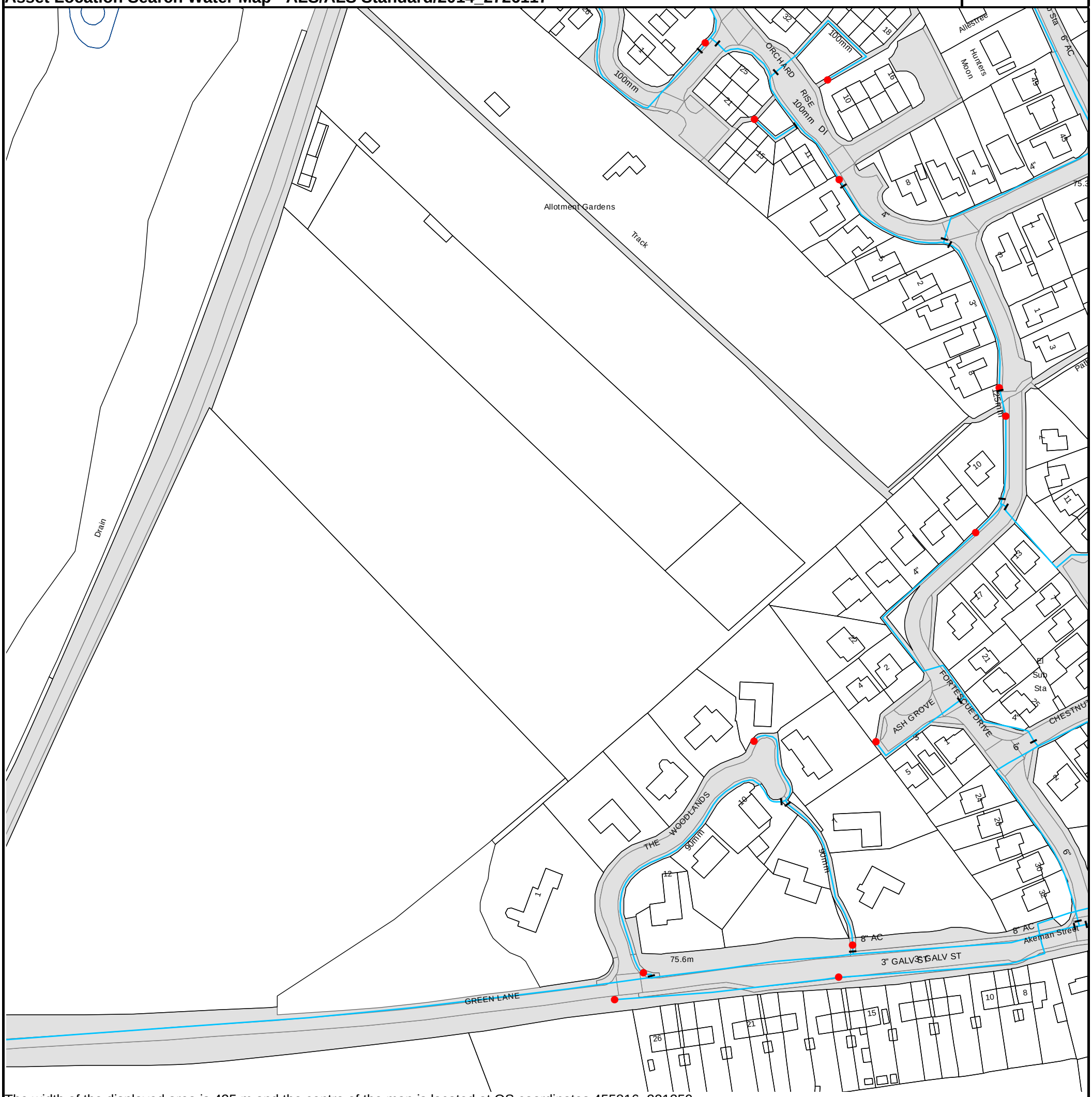
The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
8204	74.73	73.16
8206	74.73	73.55

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

Asset Location Search Water Map - ALS/ALS Standard/2014_2726117



The width of the displayed area is 425 m and the centre of the map is located at OS coordinates 455816, 221359.

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

Appendix D

IoH 124 METHOD GREENFIELD CALCULATION

CALCULATIONS

Sheet No: 1 of 1

Project: Green Lane **Ref:** RCEF29420

Calc Details: IOH124, Greenfield Run-off Calculation

Prepared by: MB **Date:** 01/04/2014

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Modwen Road, Salford Quays,
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The IOH124 method is the preferred approach for calculating Greenfield run-off. This should however be compared to the ADAS method on steep sites.

Calculation

NB This spreadsheet considers the run-off from small rural catchments
where the catchment area is less than 50Ha, the QBAR calc is completed for 50Ha and scaled down accordingly

AREA 0.01 km^2
1 Ha

SAAR 656 mm
Take from FEH CD

SOIL 0.335

Winter Rain Acceptance Potential (FSR, Fig I.4.18) or refer to: http://www.landis.org.uk/soilscapes/

Soil Class		% of catchment
Very High	S1	
High	S2	50%
Moderate	S3	50%
Low	S4	
Very Low	S5	

QBAR 0.002 m^3/s
2.15 l/s

QBAR = 0.00108*AREA$^{0.89}$*SAAR$^{1.17}$*SOIL$^{2.17}$

Region 6

Hydrological areas

Peak Run-off

Return Period	Flow (m^3/s)	Flow (l/s)
2yr	0.002	1.9
5yr	0.003	2.7
10yr	0.003	3.5
30yr	0.005	4.9
50yr	0.006	5.6
100yr	0.007	6.8
100yr + 20%	0.008	8.2
100yr + 30%	0.009	8.9
500yr	0.010	9.6
1000yr	0.011	11.1

Growth Factors

Hydrometric Area	Return Period							
	2	5	10	30	50	100	500	1000
1	0.9	1.2	1.45	1.88	2.12	2.48	3.25	3.63
2	0.91	1.11	1.42	1.9	2.17	2.63	3.45	3.85
3	0.94	1.25	1.45	1.75	1.9	2.08	2.73	3.04
4	0.89	1.23	1.49	1.95	2.2	2.57	3.62	4.16
5	0.89	1.29	1.65	2.39	2.83	3.56	5.02	5.76
6	0.88	1.28	1.62	2.26	2.62	3.19	4.49	5.16
7	0.88	1.28	1.62	2.26	2.62	3.19	4.49	5.16
8	0.88	1.23	1.49	1.91	2.12	2.42	3.41	3.91
9	0.93	1.21	1.42	1.77	1.94	2.18	2.86	3.19
10	0.93	1.19	1.38	1.7	1.85	2.08	2.73	3.04
Ireland	0.95	1.2	1.37	1.64	1.77	1.96	2.4	2.6

Appendix E

CONCEPTUAL SURFACE WATER DRAINAFE ATTENUATION PLAN

Notes

1. This drawing has been prepared in accordance with the scope of RPS's appointment with its client and is subject to the terms and conditions of that appointment. RPS accepts no liability for any use of this document other than by its client and only for the purposes for which it was prepared and provided.
2. If received electronically it is the recipients responsibility to print to correct scale. Only written dimensions should be used.

This drawing illustrates a sketch proposal only and as such is subject to detailed site investigation including ground conditions/contaminants, drainage, design and planning/density negotiations. The layout maybe based upon an enlargement of an OS sheet or other small scale plans and its accuracy will need to be verified by survey. Full risk analysis under the CDM Regulations has not been undertaken.

PRELIMINARY

Rev	Description	Date	Initial	Checked
B	Drainage Concept updated in line with latest layout.	11.09.14	OP	
A	Surface water attenuation shown in two ponds, indicative main drainage concept detailed.	22.08.14	AG	

For guidance only. Do not scale off this drawing

1:20 - 0 200mm 400mm 600mm 800mm 1000 1200 1400 1600 1800 2000
1:100 - 0 1m 2m 3m 4m 5m 6m 7m 8m 9m 10m
1:50 - 0 1m 100mm 2m 200mm 3m 300mm 4m 400mm 5m 500mm
1:5 - 0

Surface Water Attenuation Basin No. 1
Storage Volume of 335.7m³
for 1 in 100 yr + 30% event.
Water Depth 1.158m
Freeboard Approx 0.492m

Surface Water Attenuation Basin No. 2
Storage Volume of 530.2m³
for 1 in 100 yr + 30% event.
Water Depth 1.167m
Freeboard Approx 0.483m

Flow Control
3.0 litres/sec
IL74.600

Flow Control
6.0 litres/sec
IL73.850

Bed Level
74.65m

Bed Level
73.90m

Top of Bank
75.55m

Top of Bank
74.65m

IL in 4 banks
banks 6.6m wide

2.5m easement from existing plot required. Outfall subject to Thames Water confirmation of connection and sewer requisition.

Approximated IL of existing foul water Mh 8205 in Woodlands = 73.90m

Approximated IL of existing surface water Mh 8203 in Woodlands = 73.50m

2.4m x 215m visibility splay (actual)

Drain

GREEN LANE

Allotment Gardens

Track

ALLOTMENTS

GRASS FIELD

ARABLE FIELD

SHEDS

STORE

STYED

APPROXIMATE TRUE NORTH

ARABLE FIELD

THE WOODLANDS

ASH GROVE

RPS

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Client Taylor Wimpey

Project Green Lane, Chesterton

Title Proposed Foul and Surface Water Drainage Concept Including Surface Water Attenuation Ponds

Status	Drawn By	PM/Checked by
PRELIMINARY	A.Rodwell	A.Granger
Job Ref	Scale @ A1	Date Created
	1:500	14/04/2014

Drawing Number SK1

Rev B

rpsgroup.com

Appendix F

MICRO DRAINAGE WINDES MODELLING ASSESSMENT

Cascade Summary of Results for Pond 1.srcx

Upstream Structures	Outflow To	Overflow To
(None)	Pond 2.srcx	Pond 2.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	75.416	0.766	2.5	164.8	O K
30 min Summer	75.483	0.833	2.5	190.0	O K
60 min Summer	75.552	0.902	2.6	217.5	O K
120 min Summer	75.619	0.969	2.7	246.1	O K
180 min Summer	75.655	1.005	2.8	262.2	O K
240 min Summer	75.678	1.028	2.8	272.4	O K
360 min Summer	75.703	1.053	2.8	284.2	O K
480 min Summer	75.714	1.064	2.9	289.4	O K
600 min Summer	75.717	1.067	2.9	290.8	O K
720 min Summer	75.715	1.065	2.9	289.7	O K
960 min Summer	75.711	1.061	2.9	287.6	O K
1440 min Summer	75.694	1.044	2.8	280.1	O K
2160 min Summer	75.664	1.014	2.8	266.0	O K
2880 min Summer	75.635	0.985	2.8	253.2	O K
4320 min Summer	75.553	0.903	2.6	218.1	O K
5760 min Summer	75.481	0.831	2.5	189.1	O K
7200 min Summer	75.415	0.765	2.4	164.4	O K
8640 min Summer	75.354	0.704	2.4	143.3	O K
10080 min Summer	75.298	0.648	2.3	124.9	O K
15 min Winter	75.470	0.820	2.5	184.9	O K
30 min Winter	75.542	0.892	2.6	213.3	O K
60 min Winter	75.616	0.966	2.7	244.6	O K
120 min Winter	75.689	1.039	2.8	277.5	O K
180 min Winter	75.729	1.079	2.9	296.4	O K
240 min Winter	75.755	1.105	2.9	308.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	168.904	0.0	165.3	27
30 min Summer	98.010	0.0	175.8	41
60 min Summer	56.872	0.0	226.0	70
120 min Summer	33.001	0.0	262.4	130
180 min Summer	24.003	0.0	286.2	188
240 min Summer	19.150	0.0	304.4	248
360 min Summer	13.928	0.0	332.1	366
480 min Summer	11.112	0.0	353.3	484
600 min Summer	9.326	0.0	370.6	602
720 min Summer	8.082	0.0	379.3	720
960 min Summer	6.491	0.0	387.9	828
1440 min Summer	4.765	0.0	394.2	1080
2160 min Summer	3.498	0.0	500.5	1480
2880 min Summer	2.810	0.0	536.1	1904
4320 min Summer	1.991	0.0	569.8	2724
5760 min Summer	1.560	0.0	595.1	3512
7200 min Summer	1.290	0.0	615.5	4264
8640 min Summer	1.105	0.0	632.6	5024
10080 min Summer	0.970	0.0	647.5	5760
15 min Winter	168.904	0.0	173.0	26
30 min Winter	98.010	0.0	186.1	41
60 min Winter	56.872	0.0	253.2	70
120 min Winter	33.001	0.0	293.8	126
180 min Winter	24.003	0.0	320.5	184
240 min Winter	19.150	0.0	341.0	242

Cascade Summary of Results for Pond 1.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
360 min Winter	75.785	1.135	3.0	323.8	O K
480 min Winter	75.800	1.150	3.0	331.5	O K
600 min Winter	75.807	1.157	3.0	334.9	O K
720 min Winter	75.808	1.158	3.0	335.7	O K
960 min Winter	75.807	1.157	3.0	335.2	O K
1440 min Winter	75.790	1.140	3.0	326.3	O K
2160 min Winter	75.753	1.103	2.9	308.1	O K
2880 min Winter	75.711	1.061	2.9	287.9	O K
4320 min Winter	75.601	0.951	2.7	238.1	O K
5760 min Winter	75.501	0.851	2.6	196.8	O K
7200 min Winter	75.410	0.760	2.4	162.5	O K
8640 min Winter	75.326	0.676	2.3	134.0	O K
10080 min Winter	75.251	0.601	2.2	110.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
360 min Winter	13.928	0.0	372.1	358
480 min Winter	11.112	0.0	390.3	474
600 min Winter	9.326	0.0	397.4	586
720 min Winter	8.082	0.0	403.7	696
960 min Winter	6.491	0.0	412.2	910
1440 min Winter	4.765	0.0	415.1	1142
2160 min Winter	3.498	0.0	560.7	1604
2880 min Winter	2.810	0.0	600.3	2056
4320 min Winter	1.991	0.0	638.2	2940
5760 min Winter	1.560	0.0	666.4	3752
7200 min Winter	1.290	0.0	689.4	4544
8640 min Winter	1.105	0.0	708.5	5288
10080 min Winter	0.970	0.0	725.2	6056

Cascade Rainfall Details for Pond 1.srcx

Rainfall Model	FEH	D3 (1km)	0.252	Cv (Winter)	0.840
Return Period (years)	100	E (1km)	0.289	Shortest Storm (mins)	15
Site Location	Chesterton	F (1km)	2.449	Longest Storm (mins)	10080
C (1km)	-0.022	Summer Storms	Yes	Climate Change %	+30
D1 (1km)	0.316	Winter Storms	Yes		
D2 (1km)	0.339	Cv (Summer)	0.750		

Time Area Diagram

Total Area (ha) 0.530

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.170	4	8	0.190	8	12	0.170

Cascade Model Details for Pond 1.srcx

Storage is Online Cover Level (m) 76.450

Tank or Pond Structure

Invert Level (m) 74.650

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	70.0	0.600	298.0	1.200	526.0	1.800	754.0	2.400	754.0
0.100	108.0	0.700	336.0	1.300	564.0	1.900	754.0	2.500	754.0
0.200	146.0	0.800	374.0	1.400	602.0	2.000	754.0		
0.300	184.0	0.900	412.0	1.500	640.0	2.100	754.0		
0.400	222.0	1.000	450.0	1.600	678.0	2.200	754.0		
0.500	260.0	1.100	488.0	1.700	716.0	2.300	754.0		

Hydro-Brake® Outflow Control

Design Head (m) 1.200 Hydro-Brake® Type Md4 Invert Level (m) 74.600
Design Flow (l/s) 3.0 Diameter (mm) 59

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.6	0.800	2.4	2.000	3.8	4.000	5.4	7.000	7.2
0.200	1.4	1.000	2.7	2.200	4.0	4.500	5.8	7.500	7.4
0.300	1.5	1.200	3.0	2.400	4.2	5.000	6.1	8.000	7.7
0.400	1.7	1.400	3.2	2.600	4.4	5.500	6.4	8.500	7.9
0.500	1.9	1.600	3.4	3.000	4.7	6.000	6.6	9.000	8.1
0.600	2.1	1.800	3.6	3.500	5.1	6.500	6.9	9.500	8.4

Cascade Summary of Results for Pond 2.srcx

	Upstream Structures	Outflow To	Overflow To
	Pond 1.srcx	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	74.548	0.648	4.5	235.2	O K
30 min Summer	74.622	0.722	4.7	271.8	O K
60 min Summer	74.701	0.801	5.0	312.5	O K
120 min Summer	74.782	0.882	5.2	356.6	O K
180 min Summer	74.829	0.929	5.3	383.0	O K
240 min Summer	74.860	0.960	5.4	401.1	O K
360 min Summer	74.900	1.000	5.5	424.8	O K
480 min Summer	74.923	1.023	5.6	439.0	O K
600 min Summer	74.937	1.037	5.6	447.5	O K
720 min Summer	74.945	1.045	5.6	452.3	O K
960 min Summer	74.955	1.055	5.6	458.3	O K
1440 min Summer	74.948	1.048	5.6	454.0	O K
2160 min Summer	74.928	1.028	5.6	441.8	O K
2880 min Summer	74.907	1.007	5.5	428.9	O K
4320 min Summer	74.834	0.934	5.3	385.9	O K
5760 min Summer	74.770	0.870	5.1	349.8	O K
7200 min Summer	74.710	0.810	5.0	317.4	O K
8640 min Summer	74.654	0.754	4.8	288.0	O K
10080 min Summer	74.601	0.701	4.7	261.0	O K
15 min Winter	74.606	0.706	4.7	263.6	O K
30 min Winter	74.686	0.786	4.9	304.8	O K
60 min Winter	74.772	0.872	5.2	350.9	O K
120 min Winter	74.860	0.960	5.4	401.1	O K
180 min Winter	74.911	1.011	5.5	431.5	O K
240 min Winter	74.946	1.046	5.6	452.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	168.904	0.0	330.4	27
30 min Summer	98.010	0.0	351.4	41
60 min Summer	56.872	0.0	545.8	72
120 min Summer	33.001	0.0	633.5	130
180 min Summer	24.003	0.0	691.2	190
240 min Summer	19.150	0.0	730.9	248
360 min Summer	13.928	0.0	759.9	368
480 min Summer	11.112	0.0	776.2	486
600 min Summer	9.326	0.0	789.8	606
720 min Summer	8.082	0.0	799.2	724
960 min Summer	6.491	0.0	812.3	962
1440 min Summer	4.765	0.0	815.9	1286
2160 min Summer	3.498	0.0	1209.0	1656
2880 min Summer	2.810	0.0	1294.6	2048
4320 min Summer	1.991	0.0	1348.5	2860
5760 min Summer	1.560	0.0	1437.2	3688
7200 min Summer	1.290	0.0	1486.2	4472
8640 min Summer	1.105	0.0	1527.9	5280
10080 min Summer	0.970	0.0	1563.7	6056
15 min Winter	168.904	0.0	346.6	27
30 min Winter	98.010	0.0	369.8	41
60 min Winter	56.872	0.0	611.4	70
120 min Winter	33.001	0.0	709.5	128
180 min Winter	24.003	0.0	758.4	186
240 min Winter	19.150	0.0	774.4	244

Cascade Summary of Results for Pond 2.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
360 min Winter	74.991	1.091	5.7	481.2	O K
480 min Winter	75.019	1.119	5.8	498.9	O K
600 min Winter	75.037	1.137	5.8	510.4	O K
720 min Winter	75.048	1.148	5.9	517.8	O K
960 min Winter	75.065	1.165	5.9	528.5	O K
1440 min Winter	75.067	1.167	5.9	530.2	O K
2160 min Winter	75.044	1.144	5.9	514.9	O K
2880 min Winter	75.018	1.118	5.8	498.2	O K
4320 min Winter	74.923	1.023	5.6	438.5	O K
5760 min Winter	74.834	0.934	5.3	386.1	O K
7200 min Winter	74.750	0.850	5.1	338.9	O K
8640 min Winter	74.671	0.771	4.9	296.5	O K
10080 min Winter	74.595	0.695	4.6	258.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
360 min Winter	13.928	0.0	803.1	362
480 min Winter	11.112	0.0	822.7	478
600 min Winter	9.326	0.0	835.6	594
720 min Winter	8.082	0.0	844.2	708
960 min Winter	6.491	0.0	855.1	934
1440 min Winter	4.765	0.0	854.4	1370
2160 min Winter	3.498	0.0	1354.0	1732
2880 min Winter	2.810	0.0	1449.8	2188
4320 min Winter	1.991	0.0	1445.2	3080
5760 min Winter	1.560	0.0	1609.5	3976
7200 min Winter	1.290	0.0	1664.6	4824
8640 min Winter	1.105	0.0	1711.0	5624
10080 min Winter	0.970	0.0	1751.3	6456

Cascade Rainfall Details for Pond 2.srcx

Rainfall Model	FEH	D3 (1km)	0.252	Cv (Winter)	0.840
Return Period (years)	100	E (1km)	0.289	Shortest Storm (mins)	15
Site Location	Chesterton	F (1km)	2.449	Longest Storm (mins)	10080
C (1km)	-0.022	Summer Storms	Yes	Climate Change %	+30
D1 (1km)	0.316	Winter Storms	Yes		
D2 (1km)	0.339	Cv (Summer)	0.750		

Time Area Diagram

Total Area (ha) 0.750

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.250	4	8	0.250	8	12	0.250

Cascade Model Details for Pond 2.srcx

Storage is Online Cover Level (m) 75.700

Tank or Pond Structure

Invert Level (m) 73.900

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	250.0	0.600	460.0	1.200	670.0	1.800	880.0	2.400	880.0
0.100	285.0	0.700	495.0	1.300	705.0	1.900	880.0	2.500	880.0
0.200	320.0	0.800	530.0	1.400	740.0	2.000	880.0		
0.300	355.0	0.900	565.0	1.500	778.0	2.100	880.0		
0.400	390.0	1.000	600.0	1.600	810.0	2.200	880.0		
0.500	425.0	1.100	635.0	1.700	845.0	2.300	880.0		

Hydro-Brake® Outflow Control

Design Head (m) 1.200 Hydro-Brake® Type Md4 Invert Level (m) 73.850
Design Flow (l/s) 6.0 Diameter (mm) 83

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.5	0.800	4.8	2.000	7.6	4.000	10.7	7.000	14.2
0.200	3.9	1.000	5.4	2.200	8.0	4.500	11.4	7.500	14.7
0.300	3.3	1.200	5.9	2.400	8.3	5.000	12.0	8.000	15.2
0.400	3.4	1.400	6.4	2.600	8.7	5.500	12.6	8.500	15.7
0.500	3.8	1.600	6.8	3.000	9.3	6.000	13.1	9.000	16.1
0.600	4.2	1.800	7.2	3.500	10.0	6.500	13.7	9.500	16.5