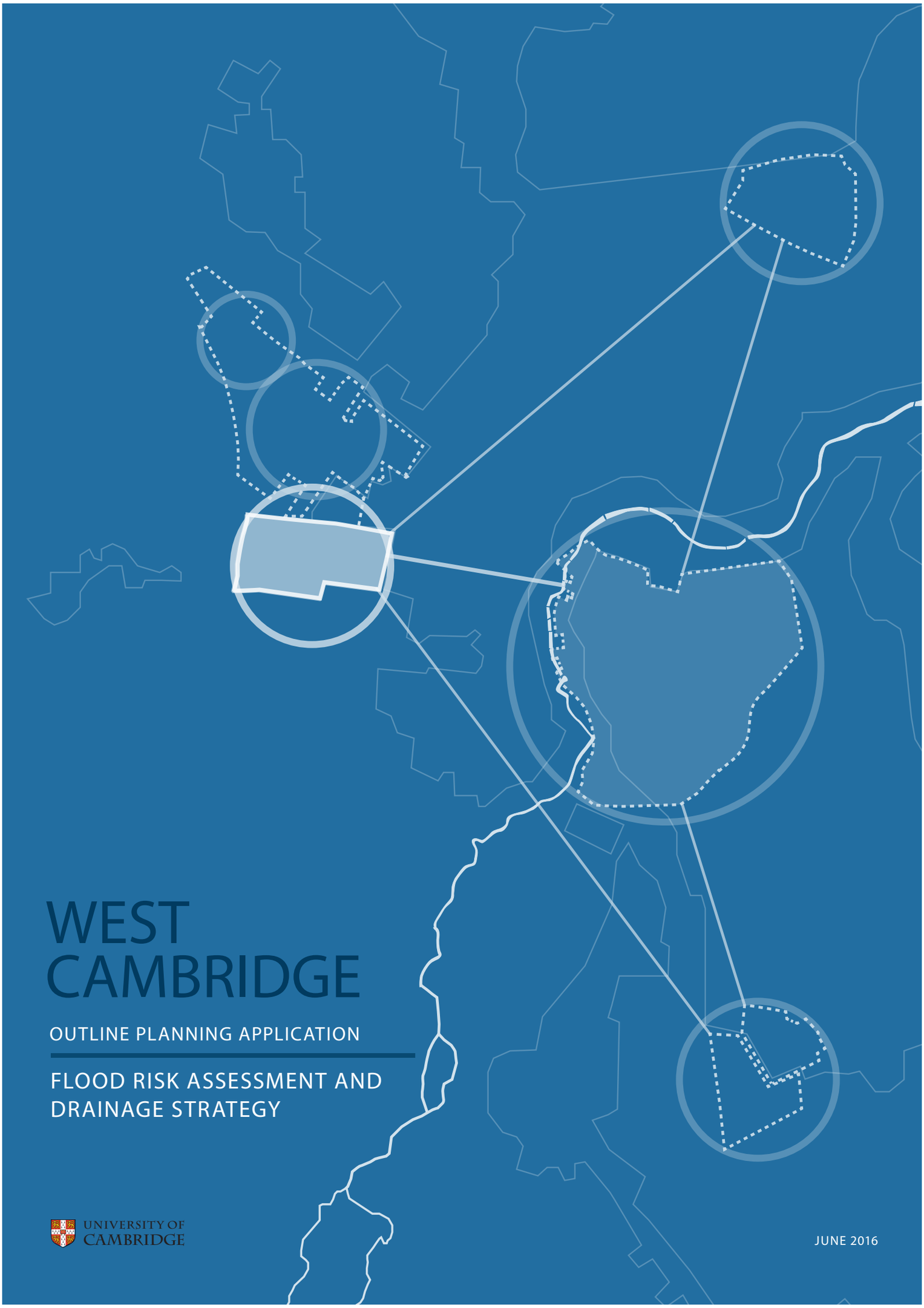

WEST CAMBRIDGE

OUTLINE PLANNING APPLICATION

FLOOD RISK ASSESSMENT AND DRAINAGE STRATEGY

UNIVERSITY OF CAMBRIDGE

JUNE 2016

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1 Executive Summary

1.1 Executive Summary

1.1.1 The National Planning Policy Framework (CLG, 2012) requires an FRA to be provided for development proposals greater than 1 hectare. This assessment aims to inform the local planning authority of the expected changes in flood risk and vulnerability that could result from the development. Priority is given in the National Planning Policy Framework (NPPF) to the use of sustainable drainage systems (SuDS) as the means for safely managing any residual post development flood risk.

1.1.2 This Flood Risk Assessment (FRA) supports an outline planning application for additional development at the University of Cambridge's West Cambridge site.

1.1.3 The majority of the 1999 Master Plan has been built with primary highway and drainage infrastructure constructed to service the current mix of commercial and academic land use.

1.1.4 Development proposals, whilst providing significant economic benefits, could increase flood risk to both the development and downstream catchments from increased rates and volumes of surface water. Development will also place a greater demand on potable water, resulting in increased waste water discharges to the public sewer network.

1.1.5 It is recognised that both the Coton Brook and Wash Pit Brook are sensitive watercourses in both ecological and hydrological terms. Mitigation measures will be necessary to ensure there is no adverse impact on water quality.

1.1.6 The Environment Agency (EA) flood map shows the site is outside the 0.1% annual probability flood extent. For planning purposes the site is within Flood Zone 1 and is considered at a low probability of flooding. Flood Zone 1 is land assessed as having less than 0.1% annual probability (1 in 1000 year) of flooding from fluvial sources.

1.1.7 As required by the NPPF, all forms of potential flooding have been considered. The greatest post-development flood risk is that associated with increased rates and volumes of rainfall run off.

1.1.8 There are physical and spatial constraints associated with integrating new development and infrastructure with existing. The drainage strategy has been developed to minimise impact on existing infrastructure and utilities where possible.

1.1.9 The drainage strategy, set out in the following FRA, has been developed to optimise the existing drainage infrastructure as much as possible, whilst acknowledging the requirements of the NPPF and Lead Local Flood Authority, Cambridgeshire County Council, particularly with regard to recent increases to climate change allowances and long-term surface water storage requirements.

1.1.10 The proposed construction phasing has also been considered in the development of the drainage strategy. Additional strategic storage will be provided within the lake, canal and south eastern pond, with discharges restricted to the 1 in 1 year Greenfield run off rate. This will enable existing underground storage to be removed and facilitate phased development, without increasing flood risk elsewhere.

1.1.11 Whilst existing strategic green infrastructure has been optimised as much as possible to provide attenuation, it will be necessary for some development plots to utilise on plot storage. Whilst the exact details of plot development are currently unknown, the provision of attenuation will require innovative solutions utilising best practice set out in CIRIA C 753 The SuDS Manual.

1.1.12 It is envisaged that future Reserved Matters applications will incorporate techniques such as:

- Green Roofs
- Blue Roofs

- Tanked Permeable Paving
- Rills / Swales
- Roadside Bio-retention areas

This list is not exhaustive.

1.1.13 The proposed drainage strategy has been developed to integrate into landscaping proposals. This includes significant improvements to the lake, canal and south eastern pond which will promote biodiversity and assist in water treatment.

1.1.14 Where utilities permit, bio-retention systems will be installed, which would assist in the treatment and conveyance of road run off.

1.1.15 The drainage strategy proposes to reduce the overall site discharge, following development, by 10% from previously consented Greenfield run off rates. This will result in lower discharges to both the Coton Brook and Washpit Brook and represents significant betterment for the downstream catchments.

1.1.16 Reinforcement of the private foul sewer located in Coton footpath will be necessary through the formal sewer requisition process. Anglian Water has confirmed connections to the public sewer network can be made following reinforcement.

1.1.17 The Flood Risk Assessment concludes that the development proposals are considered appropriate subject to the above measures being implemented on site.

2 Introduction

2.1 Introduction

2.1.1 Peter Brett Associates LLP (PBA) has been appointed by the University of Cambridge to prepare a Flood Risk Assessment (FRA) to support an outline planning application for additional mixed use development at the West Cambridge site located south of Madingley Road, Cambridge.

2.1.2 The existing site is predominantly brownfield and benefits from a site wide drainage infrastructure, built out to service the consented 1999 masterplan. Under the proposals, significant additional development will be delivered. Details of proposed development are set out in Section 4.

2.1.3 The drainage strategy proposes to re-engineer existing drainage assets and implement additional measures which reflect current best practice, with due consideration to the technical and environmental constraints facing development.

The objective of the FRA is to provide the following:

i. Liaise with relevant stakeholders to understand capacity constraints of on site/offsite drainage relating to flood risk;

ii. Evaluate the level of flood risk from all potential sources of flooding on the site and the surrounding area;

iii. Identify the extent to which mitigation measures are required to manage flood risk from all sources;

iv. Establish the evidence base for sustainable mitigation measures for managing post development surface water discharges and flood risk on-site, so that these proposals can be incorporated within the scheme layout, without adverse impact on people, or property;

v. Demonstrate that in flood risk terms, the site is suitable for mixed use development.

vi. Demonstrate that the measures set out in the drainage strategy are sustainable, innovative and provide betterment to existing downstream catchments.

PBA have prepared this FRA in accordance with Section 10 of the Planning Practice Guidance (PPG) on ‘Flood Risk and Coastal Change’ document.

3 Existing Site

3.1 Site Location and Existing Use

3.1.1 The site is bordered to the North by Madingley Road, to the West by M11, to the East by Clerk Maxwell Road and to the South by Coton footpath. The total site area is approximately 66.5ha. A site location plan can be found in **Appendix A**. The site is centred on or near National Grid Reference:542496E, 259085N (NGR TL42496, 59085).

3.1.2 The majority of the site has been developed in line with the original consented 1999 Masterplan. However, the Paddocks associated with the Vet School remain Greenfield.

3.1.3 Since 1999, Reserved Matters planning applications have been approved for a number of plots. Many of the plots have been constructed or are in the process of completion. Currently, the amount of development area represents approximately 34.60ha of the site.

3.2 Topography

3.2.1 A site wide topographical survey was completed in 2014 and is included in **Appendix B**. The northern boundary with Madingley Road falls from approximately 19.50m AOD to 16.80m AOD west to east and the southern boundary of the site falls from approximately 17.50m AOD to 12.70m AOD West to East. Within the site there is a ridge that falls eastwards from 19.70m AOD to 14.70m AOD, broadly through the upper third of the site. This watershed splits the site into two catchments, with approximately one third of the site draining Northwards and the remainder draining to the South East. The watershed catchments and respective outfalls are shown in **Appendix C.**

The two most prominent drainage features within the site are the lake located west of the Sports Centre, the South Eastern pond (adjacent to Coton Footpath) and the interlinking ditch, which is known as the Canal.

3.3 Current Drainage Regime

3.3.1 There are two main outfalls from the site into which all site flows eventually drain. Discharges from the northern catchment drain via a piped network to a series of ditches and culverts, before eventually out falling to the Washpit Brook, located north east of Madingley Road.

Runoff from the remainder of the site is collected and conveyed via a piped network to the existing attenuation features located along the southern boundary. The lake, canal and South Eastern pond attenuate flows before discharging off-site at restricted rate via the 450mm diameter culvert located to the South East and adjacent to Coton Footpath.

Flows from the site are restricted by three-stage flow controls to Greenfield run off rates previously agreed with the Environment Agency, as part of the Consented 1999 FRA. These are set out in Section 8 “Surface and Foul Water Drainage Strategy” and permit a discharge up to and including the 1 in 100 year Greenfield run off rate.

Appendix D also provides details on the existing off-site sewer provisions for both surface and foul water. **Appendix B** includes a site wide utilities plan.

Based upon the existing watershed, foul flows drain to a 300mm diameter public sewer located in Madingley Road, or to the private foul sewer, located adjacent to Coton Footpath, which gravitates eastwards before discharging into a 225mm diameter public sewer located in Wilberforce Road. Details of the arrangements are shown on the Anglian Water sewer plans (**Appendix D**).

3.3.2 Coton Brook is located along the South Eastern boundary of the site. Coton Brook drains eastwards before draining into a 450mm diameter culvert which passes under the Emmanuel College Sports Grounds and Wilberforce Road before re-emerging into an open watercourse, The Bin Brook, located eastwards. An unnamed watercourse drains North Westward before discharging to the Washpit Brook located westwards.

Drainage infrastructure to deliver the 1999 Masterplan has been built out in four phases. Primary sewers have been installed with spurs provided to each of the plots shown on the consented masterplan. The majority of the central and North Western / South Western areas drain to the lake, where flows are attenuated before discharging via a three stage flow control to the Canal. These areas enjoy an unrestricted discharge with the Lake providing strategic attenuation.

3.3.3 The North Eastern and South Eastern areas were delivered under the earliest phases of build out and, therefore, the majority of storage is provided by underground tanks. Discharges to the Canal and South Eastern Pond are restricted by flow controls. The existing arrangements are shown in **Appendix C**.

3.3.4 The primary sewers, whilst not offered for adoption to Anglian Water, were designed in accordance with Sewers for Adoption.

In order to establish the condition, capacity and connectivity of the existing primary foul and surface water sewer network, Peter Brett Associates commissioned a CCTV survey on behalf of the University of Cambridge.

In general, the existing sewer network was in good condition. However, a number of pipes were encountered where debris / detritus has reduced the cross-sectional pipe area by up to 20%. The majority of material encountered within the pipework appears to be debris from construction. Clearly, any reduction in pipe capacity could increase flood risk. This can be mitigated by the measures discussed in Section 8.0.

Selected extracts from the CCTV survey showing the worst effected pipes are included in **Appendix E**. The complete survey is available for inspection at the offices of PBA Cambridge.

3.3.5 Within the site there is a ridge that falls in elevation eastwards. This essentially splits the site into two catchments; with approximately one third of the site area draining northwards and the remainder draining south east. The ridge and catchments are shown in **Appendix C**.

3.3.6 The northern catchment is approximately 14.80ha representing 23% of the total site area. The southern catchment is 50.20ha and represents 77% of the total site area. Of the total site area, approximately 27ha (41%) consists of impervious areas (roofs hard standings and roads etc)

3.3.7 Approximately half of the northern catchment drains surface water via a network of pipes and ditches to Washpit Brook located to the North West of Madingley Road. The remainder of the northern catchment is conveyed eastwards via a 300mm diameter public surface water sewer, which ultimately outfalls into Bin Brook located East of the Emmanuel College sports ground.

The entire Southern catchment drains by gravity to the South Eastern corner of the site where it discharges into Coton Brook.

3.3.8 Foul water is also split into two catchments as described above. The northern catchment of the site discharges foul flows to a public foul sewer of 300mm diameter located in Madingley Road that gravitates eastwards connecting into the public sewer network in Queens Road. The Whittle Laboratory located to the north east of the site also drains into the Madingley Road sewer. The Southern part of the site discharges to a private foul sewer of 300mm diameter located in Coton footpath that gravitates eastwards to the public sewer network in Wilberforce Road.

3.4 Ground Conditions

3.4.1 There have been numerous ground investigations undertaken since 1999 to inform the design of the primary infrastructure (lake, ponds, drainage and roads). In addition, consented plot development required ground investigations to inform detailed design.

As part of our appointment, PBA undertook a desktop review of the reports available. The technical note summarising ground conditions is included in **Appendix F**, and confirms that the underlying soils generally comprise Gault Clay and Mudstone. A review of existing British Geological Survey borehole confirms the drift deposits are predominantly clay.

3.4.2 The British Geological Surveys (BGS) extracts showing the site's geology are included in **Appendix G**. The site is underlain by the Gault Formation comprising Mudstone. There are limited few boreholes within the West and North parts of the site.

The boreholes located within the western part of the site describe the ground as consisting of "Firm brownish grey silty clay with a little fine rounded gravel". Review of the Soilscapes website of Cranfield University show the site has "Lime-rich loamy and clayey soils with impeded drainage".

3.4.3 The cohesive nature of the underlying soils suggests infiltration into the underlying ground is very unlikely.

3.4.4 The EA map shows that the site is not within a Source Protection Zone (see Figure 1 below). The EA map indicates the site is not above a bedrock aquifer. The topography of the site, and nature of the underlying soils, indicates groundwater is likely to be encountered at depth.

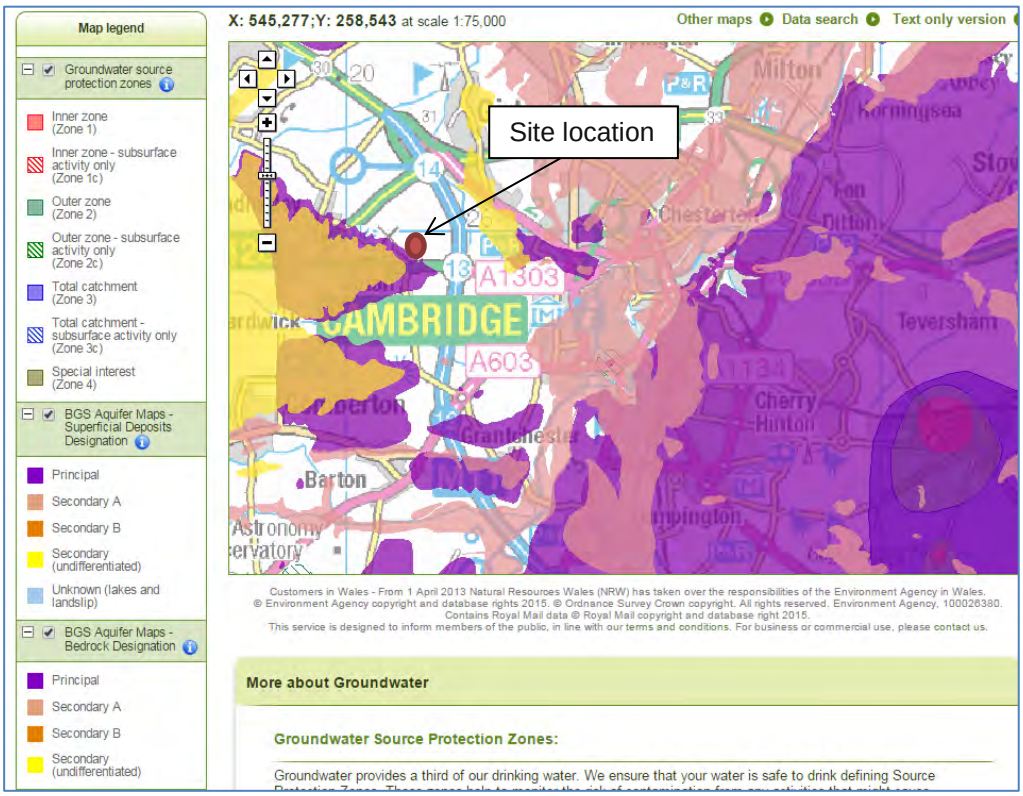

Figure 1: Groundwater source protection zones (EA, 2016)

4 Development Proposals

4.1 Development Proposals

4.1.1 Development proposals include the following land uses:

- Academic research
- Commercial research
- Nursery
- Shops, Café, restaurant/public house
- Assembly and Leisure
- Ancillary Infrastructure (Energy Centre)

The majority of the 1999 consented masterplan has been built out providing approximately 164,550m^2 of floor space. Approximately 70,887m^2 of consented floor space has not been implemented.

4.1.2 Densification of the West Cambridge site will result in a substantial increase of impervious surfaces (car parking, roads, hard standings and roofs), which will increase the rate of surface water runoff and potentially the volume, though the potential for infiltration is limited on the site. Unless sustainable mitigation measures are implemented, there is a risk that densification could increase flood risk to the development itself and impact upon downstream catchments.

The existing site benefits from significant drainage infrastructure, which is to be modified and incorporated into the site-wide drainage strategy. To enable flood risk associated with the 1 in 100 year annual probability event, including climate change, to be mitigated and managed in a sustainable manner, a wide range of SuDs techniques have been identified. These are discussed in Section 8.

Development will be delivered in three phases, with the majority of the primary drainage infrastructure delivered in phase 1.

Development will entail demolition of some existing buildings, and replacement with modern facilities.

The proposed developable areas by phase are summarised in the following table.

Phase	Total GEA (m²)
Existing (including buildings to be demolished)	153,869
Built in Phase 1	177,364
Built in Phase 2	177,846
Built in Phase 3	99,307
Total (Existing and Built)	608,386
Total (Existing and Built – demolished)	**559,196**

Table 1 Development Areas by Phase

A detailed breakdown of these areas by use is included in the development schedule included in **Appendix H**.

4.1.3 The total impervious areas, post development, will be approximately 45.65ha which represents 68% of the entire site area (66.50ha).

The remainder of the site area will consist of landscaped public realm and open spaces.

The plot plan indicating phasing, including public realm areas is included in **Appendix I**. (Development Schedule Version 5 AECOM Feb 2016).

5 Reference Documents

5.1 Policy Context

PBA have prepared this FRA in accordance with the relevant national, regional and local planning policy guidance as follows:

- National policy regarding flood risk as contained within the National Planning Policy Framework (NPPF) and the Technical Guidance to the NPPF, both issued by the Communities and Local Government (CLG, 2012) in March 2012 and the 'Flood Risk and Coastal Change' document released in March 2014 (CLG, 2014). Table 4 of the EA document 'Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities' implies that an increase of 40% over the 1961-1990 peak rainfall intensity should be used as a suitable allowance for the potential impact of climate change on storm events from 2070 onwards.

- A collection and review of available flood risk information within the city of Cambridge is presented within the 'Cambridge and Cambridgeshire Level 1 Strategic Flood Risk Assessment dated September 2010 (WSP, 2010). Extracts from the Assessment are included in **Appendix J**.

- The Cambridge Local Plan 2006 sets out policies and proposals for future development and land use to 2016. The plan contains a policy on Flood Risk but was deleted in 2009 as it was covered in National and Regional Policy. Site 7.06 West Cambridge, South of Madingley Road is identified as a major allocation site. Cambridge City Proposals Map identifies the site as a "Proposal Site". Details of the policies are shown in **Appendix K**.

- The Cambridge Local Plan 2014: Proposed Submission sets out the planning strategy for future growth up to 2031 but the plan is not expected to be adopted until 2017 and is currently subject to examination by the Secretary of State. Policy 18: West Cambridge Area of Major Change states that development in this area will be permitted in line with the existing planning permissions. Policy 31: Integrated water management and water cycle requires SuDS to be integrated into developments where possible and Policy 32: Flood Risk. Policy 40: Development and expansion of business space encourages the West Cambridge site to be developed. Policy 43: University faculty development identifies the West Cambridge site as an opportunity to enhance faculty and research facilities. Details of the policies are shown in **Appendix K**.

- Cambridge and Milton Surface Water Management Plan (SWMP) dated November 2011 (Hyder Consulting & Edenvale Young, 2011) outlines the predicted risk and preferred surface water management strategy for the Cambridge area. Relevant Information from SWMP is included in this assessment in **Appendix J**.

- Department for Environment, Food & Rural Affairs and Environment Agency Flood Risk Assessment for Planning Applications Advice April 2012 'All development in Flood Zones 1 where development is more than 1 hectare (ha)' requires a Flood Risk Assessment.

- The Flood and Water Management Act (2010) gives the EA a strategic overview role for flood risk, and gives local authorities responsibility for preparing and putting in place strategies for managing flood risk from groundwater, surface water and ordinary watercourses in their areas as Lead Local Flood Authorities (LLFA).

- On 24th March 2015, the Government laid a statutory instrument making Lead Local Flood Authorities a statutory consultee by adding the consultation requirement to Schedule 4 of the Development Management Procedure Order. LLFAs are now statutory consultees to LPAs for major developments (10 dwellings or more) for surface water drainage.

- A Preliminary Flood Risk Assessment (PFRA) dated January 2011 (Hyder Consulting, 2011) was produced for Cambridge County Council to fulfil its statutory requirements under the Flood Risk Regulations, which implement the requirements of the European Floods Directive. PFRAs provide evidence to help LLFAs manage local flood risk through their local flood risk management strategies.

6 Methodology

The following key methods and design standards have been followed in the preparation of this FRA:

- The latest method for incorporating climate change allowances into new development is included within *'Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities'* prepared by the Environment Agency in 2016. Within the East Anglian Region, this document stipulates a "central" or "upper" limit for climate change should be made of 20% and 40% respectively dependent upon site characteristic and severity of flooding impact. In accordance with this document, an allowance of 40% in increase in rainfall intensity has been included in the modelling work and output drainage calculations provided (**Appendix L)**.

- The order in which disposing of surface water from development sites should be undertaken is stipulated within **the Building Regulations Requirement Part H3**. This stipulates that desirably, all run off should be disposed of via infiltration. Where this is not reasonably practicable to do so then to a watercourse and when this not practicable, a sewer. All surface water disposal mechanisms contained within this FRA will be in accordance with this approach.

- Good practice sustainable drainage systems design advice is given in **The SuDS Manual** (C753) released by CIRIA in 2015. This manual defines SuDS as "Drainage systems which are considered to be environmentally beneficial, causing minimal or no long term detrimental impact". SuDS can be in a variety of forms, including detention basins, soakaways, swales and permeable surfaces. The design of new SuDS systems used for this development site as well as their proposed treatment efficiencies and long term storage provisions will be in full accordance with the SuDS Manual approach.

- Pipe networks for both the surface and foul water will be designed in full accordance with Sewers for Adoption 7th Edition. This includes;

  - Surface water pipes sized to surcharge in 1:30 year storm event with flooding permissible only during 1:100 year storm events (in the event of flooding, flood water will always be a minimum 300mm below finished floor levels)

  - Minimum self-cleansing velocities of 1.0 m/s and 0.75 m/s for surface and foul water pipes respectively

  - Endeavouring to provide a minimum of 1.2m cover to all pipework within hard landscaped areas.

  - All pipes to make soffit to soffit connections will typically no sump allowance made in manholes.

- All SuDS storage features and pipe networks implemented as part of this development will be fully modelled in Microdrainage hydraulic design software using continuous rainfall series for the critical storm duration.

- All existing pipe alignments, gradients and levels have been established from the CCTV and topographical survey.

- Further specific design measures and consideration are contained within Section 8 of this FRA.

- In addition, PBA have held meetings with the LLFA to discuss and agree the principles of the strategy set out in this report. A copy of the correspondence is included in **Appendix M**.

7 Flood Risk

7.1 Environment Agency Flood Zone

7.1.1 The EA Flood Zone Map, enclosed in **Appendix N** shows the site to be located within Flood Zone 1: Low Probability, having a less than 1 in 1000 annual probability of river or sea flooding (<0.1%) in any year). The risk of fluvial flooding is therefore low. All land uses are deemed appropriate within this zone.

7.2 Surface Water Flooding

7.2.1 The site falls within the 'Bin Brook Wet Spot', an area considered to be at risk of surface water flooding. It has been identified in the SWMP (Surface Water Management Plan) as one of a number of areas within the City which have a history of localised surface water flooding. These areas are identified as 'Wet Spots' in the report.

7.2.2 Although the site is within the Bin Brook Wet Spot, the Stage 1 SWMP modelling results show that the depth of flooding at the lowest elevation of the site is very low (0.1m-0.30m) during a 1 in 200 year rainfall event. Results from the SWMP take precedence over the EA and SFRA surface water maps. Taking the above into consideration, the risk of surface water flooding is considered to be low.

7.3 Groundwater Flooding

7.3.1 A review of historical Ground Investigation reports and BGS borehole records has indicated groundwater flooding is unlikely. The site is underlain by drift deposits of clay above mudstone and hence the rate and quantity of groundwater recharge will be limited. The risk of groundwater flooding is therefore considered to be low. The EA also confirms that the site is underlain by the Gault Formation which is designated as unproductive strata.

7.4 Sewer Flooding

7.4.1 Anglian Water have no records of flooding in the vicinity that can be attributed to capacity limitations in the public sewerage system.

7.5 Reservoir Flooding

7.5.1 The site is not in an area which is at risk of flooding from a reservoir (as indicated on EA on-line data).

7.6 Historical Flooding

7.6.1 The SFRA indicates the site has no flood history. No data relating to historical flooding episodes were identified by Cambridgeshire County Council (CCC).

7.7 Vulnerability

7.7.1 The proposed development will provide a mixed use. The most vulnerable classification is the student halls of residence that are classified as 'More Vulnerable' in Table 2 of the PPG 'Flood Risk and Coastal Change'. Table 3 of the same section states that this classification is appropriate for development within Flood Zone 1.

7.8 Sequential and Exception Tests

7.8.1 The site is located within Flood Zone 1 and therefore the sequential and exception tests are not required.

8 Surface & Foul Water Drainage Strategy

8.1 Introduction and Design Approach

The drainage strategy set out in the following sections, has been developed in accordance with current best practice, planning policy and with due regard to the known technical and environmental considerations.

8.1.1 This section outlines how surface water run-off from the development is managed in accordance with National and Regional policy requirements, and best practice guidance. The design aims to mitigate the risk of surface water flooding on the site and to avoid increasing flood risk to development or elsewhere. The following sections assess off site capacity issues associated with waste water discharges and sets out an effective mitigation strategy.

8.1.2 The existing site benefits from drainage infrastructure constructed over the past 16 years. The significant amount of development that has been delivered since consent of the 1999 master plan, means there are physical constraints (levels, service easements, building clearances etc) to consider and these have shaped development of the drainage strategy.

8.1.3 It is acknowledged that other considerations, such as proposed development phasing and removal/modification of existing drainage infrastructure to facilitate construction, are factors which have also influenced evolution of the mitigation measures proposed

8.1.4 Best practice associated with design of drainage infrastructure has evolved significantly since 1999. This is reflected both in industry standards, such as The SuDs Manual C753 (2015) and national/local planning policies, particularly with regard to maintenance of sustainable drainage systems and increased allowances in storage volumes to cater for climate change effects.

8.1.5 Where opportunities exist to improve the sustainable management and mitigation of flood risk they have been implemented as part of the strategy.

8.1.6 Densification will increase the rate and volume of post development surface water runoff. This must be controlled and mitigated effectively to ensure no increase in flood risk to the development or downstream catchments. This places significant constraints on development as discharge rates will be restricted to the 1 in 1 year Greenfield run off rate, with significant additional storage volumes provided.

8.1.7 An important element of the proposed drainage strategy is the re-use of as much of the existing drainage infrastructure as possible and to implement measures which will provide other benefits, apart from flood risk mitigation, such as treatment of water quality, promotion of bio-diversity and providing improved green areas through integration with landscaping proposals.

8.1.8 Due to the proposed phasing of development, much of the underground storage located in the Eastern and Central areas of the site will be removed.

8.1.9 In order to mitigate the temporary loss of this storage, it is proposed that enabling works are undertaken to the Lake, Canal and South Eastern ponds to replace the storage loss. This enabling work will need to be implemented before any plot development commences. The Construction Phasing is shown in **Appendix O**.

8.2 Surface Water Drainage Strategy

8.2.1 The proposed drainage strategy is shown in **Appendix P**. This details the modifications required to the surface and foul water piped networks. The drainage strategy plans show the proposed foul and surface water discharge rates, together with the storage volumes required. The drawings should be read in conjunction with the MicroDrainage simulation results contained in **Appendix L**. Details of the proposed catchments are also included.

8.3 Method of Surface Water Discharge

8.3.1 Further to the preferred surface water disposal hierarchy set out in The Building Regulations (Part H), each option has been assessed to ascertain suitability for this development, based upon known constraints.

8.4 Infiltration

8.4.1 The preferred method for disposal of surface water in the Building Regulations hierarchy is through infiltration to the ground. However, the underlying geology of this site indicates that infiltration drainage is not viable due to the cohesive nature of the soils. Infiltration has therefore been ruled out. This limits the options for surface water disposal.

8.5 Watercourse

8.5.1 The next preferred method of surface water disposal is to discharge to a nearby watercourse or lake. Where sufficient fall allows a gravity connection to a watercourse whilst maintaining adequate pipe self-cleansing and cover. This option is the preferred method underpinning the drainage strategy and utilises the existing drainage regime.

8.6 Public Sewer

8.6.1 The least preferred option is to discharge post development flows to a public sewer. While it is not proposed to discharge surface water directly to the public sewer network, foul flows will be discharged to public sewers located in Madingley Road (300mm diameter) or the 300mm diameter sewer located in Coton footpath, which, whilst private, ultimately discharges into the public sewer in Wilberforce Road.

8.7 Proposed Discharge Rates

8.7.1 Existing Greenfield Run off Rates

The existing Greenfield run off rates have been calculated in accordance with the IoH124 Methodology. These rates closely match those previously agreed with the EA to support the original FRA for the consented 1999 Masterplan.

1 year rate	2.88 l/s/ha
30 year rate	7.96 l/s/ha
100 year rate	11.79 l/s/ha

Table 2 Existing Greenfield Rates

8.7.2 Proposed Discharge Rates

It is acknowledged that the Bin Brook and Washpit Brook Catchments are sensitive to any increase in discharges. Therefore in order to reduce the discharge it is proposed that discharges are limited to the 1 in 1 year Greenfield rate, which is less than previously agreed. Furthermore, a 10% reduction has been applied to provide additional betterment. Table 3 below shows these reduced rates. Calculations are shown in **Appendix Q**.

1 year rate	**2.592 l/s/ha**
30 year rate	7.164 l/s/ha
100 year rate	10.211 l/s/ha

Table 3 Proposed Greenfield Rates

8.7.3 It should be noted that whilst the rates shown within Table 3 include for the 1, 30 and 100 year storm events. It is proposed the whole site will discharge at the 1 in 1 year Greenfield rate for

all storm events up to and including the 100year + 40% climate change event. Thus a significant betterment in discharge rate is promoted.

8.8 Surface Water Attenuation Requirements

8.8.1 A reduction in the run off rate, to less than the predevelopment rate, will require additional attenuation storage to be provided throughout the site.

8.8.2 The volume of all attenuation storage has been assessed to accommodate the 1 in 1 year Greenfield run-off rate discharge rate for the 100year + 40% climate change event. A minimum of 0.3m freeboard from maximum water level to storage cover level will be provided at all times. Calculations are included in **Appendix L**.

8.8.3 The way in which individual plots attenuate surface water flows varies and is dependent upon the location within the development. In general terms, the central and western areas of the development have an unrestricted discharge to the lake. Discharges from the lake to the Canal and outfall will be restricted by a flow control limiting discharge to the 1 in 1 year Greenfield rate. The eastern areas of the development will be required to provide on plot attenuation with discharges limited to the 1 in 1 year Greenfield rate.

8.8.4 Attenuation for plots utilising free flow connections are provided by larger communal storage structures located within public realm areas. The 2 main storage structures will be the re-engineered South Eastern pond and Western lake. The Canal will also be reprofiled to provide additional attenuation, with outflow restricted by a flow control.

8.8.5 The South Eastern pond will attenuate flows from 2.090ha of eastern development area. This pond will release flows to Coton Brook watercourse at 5.42 l/s (1 year rate) via a hydro-brake flow control.

8.8.6 This existing lake will provide attenuation for Western and Central development areas. These areas total 20.465ha. This will be achieved by lowering the existing flow control by 400mm to 14.300m AOD. This will provide 19,000m3 of storage in total. This allows inflow to be released at 53.05 l/s (1 year rate) from the lake via a hydro-brake flow control.

8.8.7 Flows from the lake enter the canal, drain along the full length, approximately 425m, before flowing through another hydro-brake flow control located at the Canal outfall, before discharging at 54.76 l/s. This secondary flow control is necessary because the Canal also receives run off from a development area of 0.658ha. It is intended that the Canal will be re-profiled, with the bed depth lowered by 400mm.

8.9 On-Plot Surface Water Storage

8.9.1 In order to ensure the 1 in 1 year Greenfield run off rate is not exceeded for the Eastern plots, it is envisaged a variety of SuDs features and techniques will be implemented to provide on plot attenuation. The tight constraints of the strategy will help to promote innovation solutions to plot attenuation that meet the LLFA objectives. The following systems should be incorporated into on-plot attenuation strategies;

- Tanked permeable pavements
- Lined swales and filter drains
- Detention basins
- Green roofs
- Blue roofs
- Rills
- Bio Retention areas

8.9.2 The application of a 10% reduction to the 1 in 1 year Greenfield run off rate means smaller plots which are generally less than 0.40ha in area will have low discharge rates. Due to the blockage risks associated with small orifice sizes, it is proposed that the smallest orifice size will be 50mm, with a minimum flow rate of 1 l/s.

8.9.3 In order to protect against blockage risk, the following measures will be put in place for all attenuation systems;

- Treatment of storm water prior to entering flow controls reducing the presence of sediments and suspended solids entering control
- Monthly inspection of flow controls and regular cyclic maintenance
- Implementation of overflow provision by directing overland flow along roads and using public realm areas for exceedance events

8.10 Surface Water Volume Control (Long Term Storage)

8.10.1 As set out in CIRIA C753 the SuDs Manual, the volume of surface water run off leaving a development site 12 hours after a 100 year, 6 hour storm event has occurred should be less than or equal to the green-field volume that would result from that same event.

8.10.2 It is proposed that all attenuation structures, including those situated on the eastern development plot will release flows at the 1 in 1 year run off rate. This ensures that the volume of surface water leaving both the Coton Brook and Madingley Road catchments is less after a 12 hour period than it was before densification took place. This will result in reduced flood risk to downstream catchment and will provide significant betterment. Calculations confirming volumes required are included in **Appendix L**.

8.11 Sustainable Drainage Systems (SuDS)

8.11.1 Due to the impermeable nature of the soils there is no potential for infiltration. The spatial constraints associated with existing buildings, roads and surface corridors further limits the opportunity to provide communal SuDs storage facilities within the site.

8.11.2 Notwithstanding these challenges and constraints, it is proposed a number of SuDS elements be integrated into proposals.

8.12 Western Lake and South Eastern Pond

8.12.1 It is proposed these existing structures will be enlarged as part of the overall drainage strategy and integrated into the landscaping proposals.

8.13 Dry Swale

8.13.1 It is proposed that a dry swale will run along the full length of the proposed footway / cycleway within the central landscaped Green Cone area. Run off entering the swale will be from the footway / cycleway only, which equates to a total impermeable area of 0.30ha. Approximately 0.128ha of impermeable will outfall to the western lake catchment area and will not be restricted. The remaining 0.172ha will outfall to the pink catchment zone (refer to Appendix P), and will require plot flows to be attenuated. A flow control will restrict all run off to a rate of 1 l/s before entering the pipe network.

8.14 Road Side Bio Retention Areas

8.14.1 Where service corridors and existing trees permit, road side bio retention areas could be installed. These would collect highway run off and treat flows before discharging back to the existing surface water system.

8.14.2 As well as providing water quality treatment, they would also promote bio diversity and provide temporary above ground storage during exceedance events.

8.14.3 Cast iron inlet gullies will be positioned along the kerb face and will direct run off into bio retention areas. These areas will slow run off and provide treatment. Residue volume will be conveyed via perforated pipes running along the invert of the structures and directed into surface water carrier drains. Areas where these features could be installed are shown in **Appendix %**. Further investigation will be required as the design detail evolves.

8.14.4 It is envisaged on plot SuDs features will be implemented by individual plot developers. Innovative SuDs techniques and solutions will play a leading role in ensuring development aspirations can be met as plots move forward to their respective Reserved Matters Applications. The permitted plot discharges and storage requirements are detailed on the drainage strategy drawings.

8.15 Pollution Control

8.15.1 Appropriate pollution control measures will be included in the surface water drainage system to minimise the risk of contamination or pollution entering the ground or waterbodies from surface water runoff.

8.15.2 In order to mitigate and / or reduce pollution risk, the drainage systems will be designed to comply with the treatment requirements set out within CIRIA 753 'The SuDs Manual'. Pollution Hazard levels area assessed based on the land use gathering run off. These areas are shown in table 26.2 of C753 which is reproduced below.

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]

Figure 2: Pollution hazard Indices for different land use classifications

8.15.3 The highest hazard level is that associated with treatment of run off from the roads. This can be mitigated by installation of the bio retention areas previously described. In all other cases the hazard levels are likely to range from low to very low.

8.15.4 The treatment of highway run off using the bio retention areas will be effective. Table 26.3 (CIRIA C753) shows the mitigation indices associated with bio retention systems to be 0.8 for treatment of metals, hydrocarbons and total suspended solids.

The two main attenuation features, Western lake and South Eastern pond, will include fore bays, and will be planted with suitable aquatic plant species. These areas along with the interlinking Canal will form a wetland environment through which the majority of development flows will pass. The exception being the catchment which discharges to the Washpit Brook. The Schlumberger building currently discharges to Washpit Brook, via a planted pond located to the North. It is envisaged this feature could be enlarged to provide the required level of

attenuation. Discharges would be restricted to the 1 in 1 year Greenfield rate by a flow control. This pond would provide effective treatment of flows.

It is promoted that plot designs will incorporate innovative tertiary treatment measures such as:

- Tanked permeable paving
- Green roofs

External parking areas could also incorporate features such as swales, filter drains, bio retention systems, rills and filter strips which could be integrated into a SuDs system for the plot, and provide effective water treatment.

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.		

Figure 3: Indicative SuDS mitigation Indices for discharges to surface waters

8.16 Exceedance

8.16.1 Proposed site levels are largely governed by existing building and road levels. In an exceedance event (above the 1 in 100 year plus climate change) flows will be routed away from buildings. This will be achieved by ensuring that site levels are designed to direct flows away from the buildings and towards the roads and public realm areas where temporary flooding can occur. The proposed depression areas will provide a retention volume for larger storm events in excess of the 1 in 100 year plus climate change rainfall event. The natural topography of the site routes this floodwater towards the widened boulevard of Charles Babbage Road or SuDS features.

8.17 Adoption and Maintenance

8.17.1 It is anticipated that the University's Estates department will undertake regular maintenance of the strategic drainage infrastructure.

8.17.2 A maintenance schedule will need to be produced to support the Reserved Matters applications as they come forward.

8.17.3 Table 1 below summarises considerations relating to the maintenance of the SuDS features on site.

Pond	
Regular Maintenance	**Frequency**
Litter removal. Inspect control structures to/from pond. Grass cutting on slopes around pond above temporary water level – amenity grass.	Monthly
Occasional Tasks	**Frequency**
Scrub clearance from bankside. Cut 25% to 30% wetland vegetation and remove to site wildlife piles.	Once a year
Remedial Work	**Frequency**
Remove planting and silt from 25% to 30% of base and place in site piles.	Once per 5 years

Table 4: Proposed maintenance requirements for ponds

Swales, filter strips and bio retention areas	
Regular Maintenance	**Frequency**
Litter removal. Inspect control structures to/from swale. Grass cutting in swale – amenity grass.	Monthly
Occasional Tasks	**Frequency**
Scrub clearance from bankside. Cut 25% to 30% wetland vegetation and remove to site wildlife piles.	Once a year
Remedial Work	**Frequency**
Remove planting and silt from 25% to 30% of base and place in site piles.	As required

Table 5 Proposed maintenance requirements for swales, filter strips and rain gardens

8.18 Foul Water Drainage

Existing Foul Water Drainage

8.18.1 It is proposed that post development foul water flows will discharge into the public foul sewers, subject to formal agreement with Anglian Water.

The site is well serviced by existing foul sewers. Public sewers are located along Madingley Road, (North of the site) and Wilberforce Road located East of the site.

The area North of the existing watershed currently drains to the 300mm sewer in Madingley Road. The area South of the existing watershed gravitates to the 300mm diameter foul sewer located alongside the Coton Footpath. Anglian Water has confirmed that this sewer remains private and discharges into a 225mm diameter public sewer in Wilberforce Road, which has capacity constraints.

Based upon predicted population rates the estimated dry weather flow is 43l/s. Anglian Water were consulted on development proposals and undertook hydraulic modelling of the offsite foul water network to establish if there was sufficient capacity to accommodate flows.

To take account of potential variances in flow (a conservative approach as the details of development are unknown) a peak factor of 3 was applied. This provided a theoretical peak flow of 129 l/s.

Using this flow rate, Anglian Water confirmed:

- 3 l/s (DWF) can be discharged to the public foul sewer in Madingley Road.
- 40 l/s (DWF) can be discharged to the 600mm diameter public sewer in Wilberforce Road.

A copy of the 'Addendum to the Pre Planning Assessment Report – 24 December 2015', is included in **Appendix S**.

8.19 Proposed Foul Water Drainage

8.19.1 The proposed foul drainage seeks to use as much of the existing infrastructure as possible. However, diversions and upsizing will be required. The proposed network arrangements are shown on the drainage strategy plans (**Appendix P**).

8.20 Proposed on-site mitigation measures

On-site Foul Drainage System

8.20.1 All development flows can be drained by gravity without the need to pump. Should plot developments incorporate basements, pumping may be necessary.

8.20.2 Although the on-site sewers will not be offered for adoption, they have been designed in accordance with Sewers for Adoption. The permitted discharge rates for each plot are shown on the drainage strategy plans. It is envisaged that each plot will be provided with a connection spur.

8.20.3 The foul water drainage infrastructure will be constructed in three phases, with the majority provided in Phase 1 and 2.

8.21 Proposed off-site measures

Off-site Foul Drainage

8.21.1 Anglian Water has advised that the existing 225 mm diameter sewer in Wilberforce Road, which receives current development flows, has limited capacity. The consented connection point for post development flows is the 600mm sewer located further north along Wilberforce Road. This connection point is shown on the drainage strategy plan.

In order to minimise disruption to the existing facilities, it is proposed to provide a new 300mm diameter sewer, parallel to the existing located along Coton footpath, and connect directly to the consented connection point which does have capacity. The land, through which the current private sewer passes, is owned by St John's and construction of the existing sewer was made possible by a Deed of Easement.

Anglian Water has advised that the construction of a new sewer through this land could be undertaken through a Section 98 (Water Industry Act) Sewer Requisition agreement.

Proposed discharges to the foul sewer in Madingley Road would be subject to a Section 106 (Water Industry Act) application

.

8.22 Residual Risks

8.22.1 The greatest residual flood risk risks relate to the potential lack of maintenance to proposed and existing infrastructure.

The CCTV survey has identified some sections of pipework where sedimentation has occurred. This can potentially reduce the capacity of the pipes and increase flood risk. This can be mitigated by pressure jetting of retained pipework. The inclusion of fore bays into the lake and pond will also facilitate maintenance and help preserve storage volumes.

Due to the low discharge rates and proposed flow control, regular inspections and maintenance will be required in accordance with the inspection /maintenance schedule to ensure they continue to operate effectively.

Regular cleaning of trash screens associated with the culverts draining to Washpit Brook and Coton Brook is essential, if this infrastructure is to operate effectively.

9 Conclusions and Recommendations

9.1.1 The site is located within Flood Zone 1 and is not vulnerable to fluvial flood risk. Other sources present a low flood risks than can be readily managed.

9.1.2 The scale of proposed development will increase both the rate and, although limited given the permeability of the soil, the volume of surface water runoff. The latest guidance requires that attenuation volumes are sufficiently large to cater for a predicted increase in volumes of up to 40% as a result of climate change on increased rainfall intensities.

9.1.3 Both the Washpit Brook to the North West and Coton Brook to the South East are sensitive to any increase in discharge resulting from development. Both of these catchments are shown at risk of pluvial flooding.

9.1.4 Results of the investigations undertaken by Peter Brett Associates have identified defects in the existing on site drainage network, and capacity constraints associated with both the off-site surface water culverts and foul public sewers.

9.1.5 In the case of the surface water systems, this is attributable to lack of maintenance resulting in sedimentation and blockages of pipes and trash screens. However, this can be mitigated through the implementation of the cyclic inspection and maintenance programme.

9.1.6 Opportunities to implement new open attenuation features are limited by topography and spatial constraints associated with existing buildings, utilities and highway infrastructure.

9.1.7 This has required an innovative approach to implementing sustainable drainage systems by making best use of existing drainage assets, whilst seeking opportunities to promote bio diversity and reduce flood risk.

9.1.8 Under the proposed drainage strategy, discharges to both the Washpit Brook and Coton Brook will be reduced by 10% from the previously consented Greenfield run off rates. Furthermore, the proposed surface water discharges from the entire site will be limited to the 1 in 1 year Greenfield run off rate. This ensures a conservative approach with sufficient storage provided by modification of existing attenuation features in conjunction with installation of additional systems.

9.1.9 The existing green drainage infrastructure will be integrated into landscaping proposals. The incorporation of pollution measures, such a forebays into the lake and pond, together with selected planting will promote bio diversity and assist in maintaining water quality.

9.1.10 Where physical constraints permit, other systems such as swales and bio retention zones will be installed to treat highway run off.

9.1.11 Whilst the lake, canal and pond will provide the majority of attenuation required, the central/eastern areas of the site will require on plot storage to be provided. This will require plot developers to be innovative in how they meet this requirement.

9.1.12 There are known capacity constraints associated with the off site public foul sewers, and reinforcement will be necessary. This will entail a new foul sewer to be constructed along Coton footpath, and secured through a formal sewer requisition agreement with Anglian Water.

9.1.13 The removal of existing underground storage, as part of the first phase of the development, can be mitigated by ensuring the modifications to the lake, canal and pond are undertaken in advance of plot construction. In this way, the required volumes of storage can be maintained during the construction phases, mitigating flood risk.

9.1.14 Although there are significant technical and environmental constraints facing development, implementation of the drainage strategy set out in this report will not only ensure flood risk can be mitigated sustainably, it will also provide betterment to downstream catchments by reducing the overall discharges from the site and mitigating post development flood risk.

9.1.15 The FRA therefore considers this site appropriate for development in accordance with NPPF.

10 References

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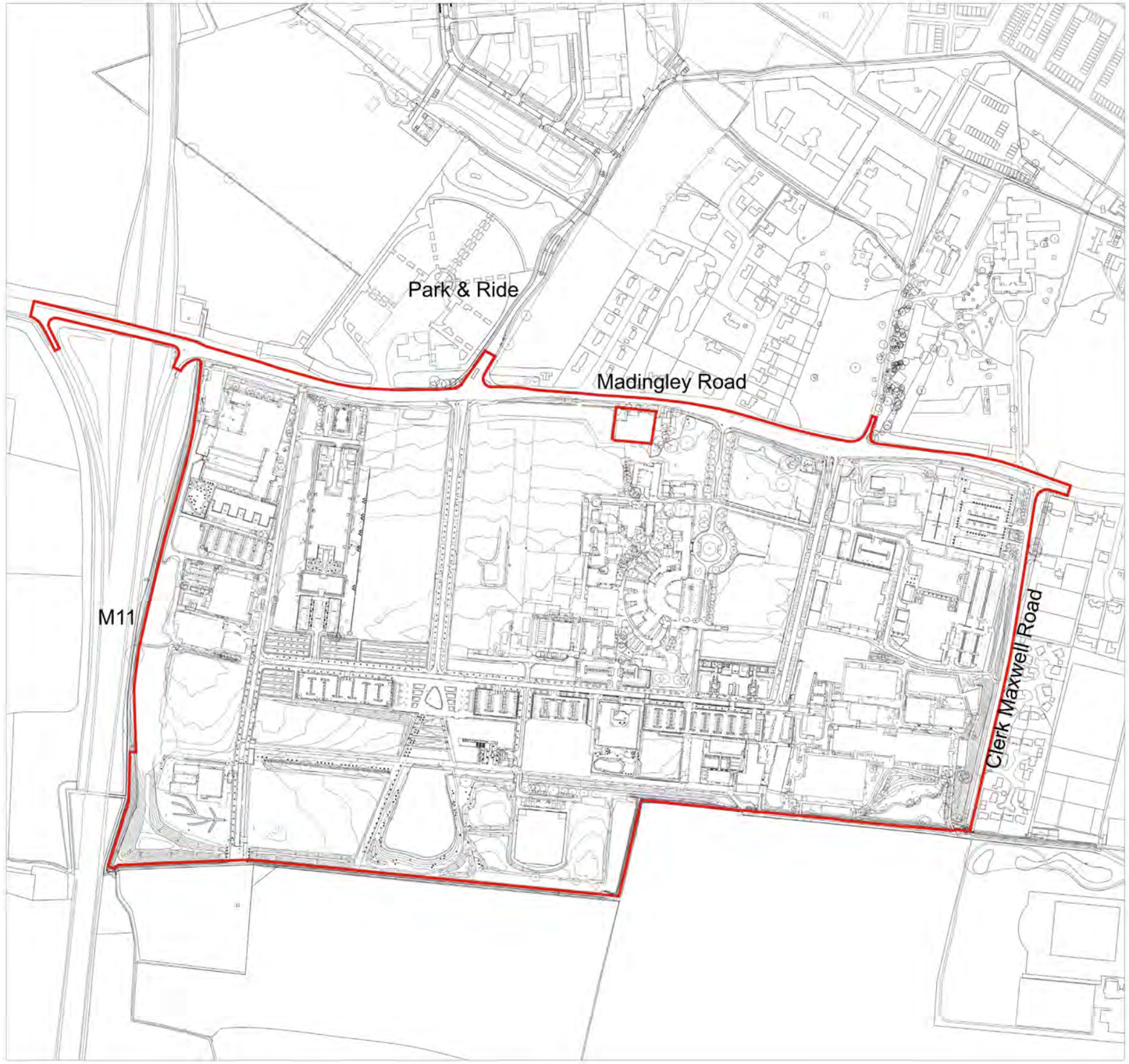
Appendix A West Cambridge Application Site Boundary



KEY

For Approval:

Application site boundary

All information other than that identified as being for approval is shown for contextual purposes only.

West Cambridge

WC/OPA/APP/01 - Plan for Approval:
Application Site Boundary

February 2016

UNIVERSITY OF CAMBRIDGE

0 10 50 100m
Scale 1:2500@A1

01. Application Site Boundary, Submitted for Approval

Appendix B Topographic Survey and Utilities Plan

N

Station Information:

Station	Easting (m)	Northing (m)	Level (m)	Station	Easting (m)	Northing (m)	Level (m)
GH1	543006.505	259213.445	17.785	GH40	542964.042	258869.046	16.596
GH2	542985.113	259126.853	18.745	GH41	542809.368	258883.530	18.021
GH3	542961.607	258990.094	19.320	GH42	542711.173	258892.147	18.441
GH4	542927.494	258872.642	18.177	GH43	542588.276	258901.398	19.362
GH5	542922.513	258830.631	17.114	GH44	542469.893	258912.142	20.475
GH6	542914.383	258757.245	15.483	GH45	542229.232	258945.162	20.992
GH7	542909.663	258732.008	14.561	GH410	542806.881	258838.088	17.610
GH8	542961.812	258726.887	14.106	GH430	542581.912	258791.079	16.307
GH9	543186.967	258702.677	12.595	GH431	542422.135	258805.396	16.298
GH10	543213.545	258808.313	14.068	GH432	542699.470	258779.547	15.396
GH11	543235.907	258903.146	14.696	GH433	542804.162	258769.975	14.517
GH12	543258.187	259022.610	14.757	GH440	542449.463	258870.498	21.554
GH13	543281.514	259187.679	18.319	GH441	542494.359	259097.539	21.534
GH20	543108.683	259094.039	16.746	GH442	542506.596	259281.863	19.493
GH21	542843.042	259154.013	19.045	GH443	542670.611	259302.205	19.593
GH30	543072.712	258963.109	16.896	RD1	543105.644	259218.804	18.705
GH31	542830.212	258980.614	19.248	RD2	542868.189	259266.784	18.468

OS Note:

Some services may have been omitted due to parked vehicles. The Ordnance Survey tile is to be used as a guide only.

OS Buildings (grey) *Surveyed Buildings* (yellow)

This survey has been orientated to the Ordnance Survey (O.S) National Grid (OSGB36) via Global Navigational Satellite Systems (GNSS) and the O.S. Active Network (OS Net).

A true OSGB36 coordinate has been established near to the site centre via a transformation using the OSTN02 & OSGM02 transformation models.
The survey has been correlated to this point and a further one or more OSGB36 points established to create a true O.S. bearing for angle orientation.

No scale factor has been applied to the survey therefore the coordinates shown are arbitrary & not true O.S. Coordinates which have a scale factor applied.

Please refer to Survey Station Table to enable establishment of the on-site grid and datum.

Legend:

Buildings
Wall
Kerb line
Line marking
Drop kerb
Centre line
Overhead Cable
Concrete edge
Tarmac edge
Grass verge
Canopy/Overhang
Verge
1 Station and Name
100.000 Station Level
Tree / Bush / Sapling
Area of Undergrowth
Woodland
R: Ridge Level
E: Eaves Level
F: Flat Roof Level
Gate

Fence types:
I\W Interwoven
I\R Iron Railings
W\M Wire Mesh
P\R Post & Rail
P\W Post & Wire
C\L Chain Link
W\P Wooden Panels
C\P Concrete Panels
S\P Steel Palisade

IC	Inspection chamber	Boll	Bollard
PInv	Pipe invert	IB	Illuminated bollard
Gy	Gully	Bin	Rubbish bin
Bg	Back gully	Vp	Vent pipe
Dp	Down pipe	Grl	Ground light
Pipe	Pipe above ground	Lbox	Letter box
MH	Manhole	Ldr	Ladder
WL	Water level	Sty	Stile
Fl	Flood light	IFL	Internal floor level
Lp	Lamp post	THL	Threshold level
Tp	Telegraph post	Sp	Sign post
Ep	Electricity post	TH	Trialhole
Tl	Traffic light	BH	Borehole
Bus	Bus stop	ELC	Electric
Sv	Stop valve	BT	British Telecom
St	Stop tap	C.Box	Control box
Er	Earth rod	TT	Tactile
Wm	Water meter	BP	Brick paved
Gas	Gas valve	CPS	Concrete paving slabs
Av	Air valve	CVR	Cover
ICU	Undentified inspection	IC	Inspection chamber
Wo	Wash out	R/wall	Retaining wall
Re	Rodding eye	UTL	Unable to lift
BB	Belisha beacon	TCL	Tree canopy level
CTV	Cable tv	G:	Girth
Mkr	Marker post	MG	Multi girth
Gmkr	Gas marker post	Stmp	Tree Stump
So	Soffit	CL:	Cover level
AC	Air Conditioning Units	IL:	Invert level

Rev	Date	Description	Drawn	Q. Ref.

greenhatch group

Topographical Surveys
Site Engineering
Utility / CCTV Surveys
Measured Building Surveys
3D Laser Scanning
Revit & BIM Models

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CLIENT

Peter Brett Associates

PROJECT

University of West Cambridge Madingley Road, Cambridge

TITLE

Topographical Survey

SCALE	DATE
A0@ 1: 1250	17.11.14-30.01.15
DRAWN	QUALITY REF
CS/DR/LM	F1035

Level datum	See OS Note
Grid orientation	See OS Note
Job number	21144

Drawing No.	Rev.
21144 OGL	0

Comments
This plan should only be used for its original purpose. Greenhatch Group accepts no responsibility for this plan if supplied to any party other than the original client.

All dimensions should be checked on site prior to design and construction.

Drainage information (where applicable) has been visually inspected from the surface and therefore should be treated as approximate only.

Notes:

UTILITIES & UNDERGROUND INVESTIGATIONS

ABBREVIATIONS & SYMBOLS

10 SC	1 Duct 5 Cables	CPC	Circ Plastic Chamber	EOT	End Of Trace
Ø	Diameter	CS	Crown Level	IBD	Internal Backdrop
AR	Assumed Route	DCI	Depth To Crown	IL	Invert Level
BL	Base Level	DI	Depth To Invert	RBC	Rectangular Brick Chamber
CB	Concrete Benching	DS	Depth To Surcharge	RCC	Rectangular Conc Chamber
CBC	Circular Brick Chamber	DTB	Depth To Base	SL	Silt Level
CCC	Circular Conc Chamber	DTW	Depth To Water	SvL	Surchegde Level
CL	Crown Level	DTS	Depth To Silt	UTC	Unable To CCTV

BT	BT CABLE(S)	UTL	Unable To Lift
FO	FIBRE OPTIC CABLE(S)	UTT	Unable To Trace
COMMUNICATIONS CABLE(S)			
CTV	CABLE TV CABLE(S)	TFR	Taken From Records
E	ELECTRIC CABLE(S)	EBD	External Backdrop
OHE	OVERHEAD ELECTRIC CABLE(S)		
TC	TRAFFIC CABLE(S)		
GM	GAS MAIN		
GS	GAS SERVICE		
GPR	GROUND PENETRATING RADAR (GPR) TRACE		
HW	HOT WATER PIPE		
ST	STORM WATER		
SC	SECURITY CABLING		
UT	UNIDENTIFIED TRACE	MH CL 46.60	UTILITIES COMMENT BOX
WM	WATER MAIN		
WS	WATER SERVICE	SMH 0.63	DEPTH TO SERVICE
FW	FOUL WATER SEWER		
FS	FOUL SEWER		
R	RISING MAIN		
SW	SURFACE WATER SEWER		
	UTILITIES INVESTIGATION EXTENTS		

NORTH Indicative

DRAWING NOTES

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AVAILABILITY OF UTILITY RECORD DRAWINGS

UTILITY	AVAILABILITY	UTILITY	AVAILABILITY	UTILITY	AVAILABILITY
SEWER	SITE	BT	PUBLIC	OIL PIPES	SITE
WATER MAIN	SITE	CABLE TV	SITE	OTHERS	NO
GAS MAIN	PUBLIC	ELECTRICITY	SITE		

REV	DESCRIPTION	DRAWN	APPR	DATE

SURVEY SOLUTIONS

Ipswich Coventry Yeovil Norwich Perth Nottingham Brentwood

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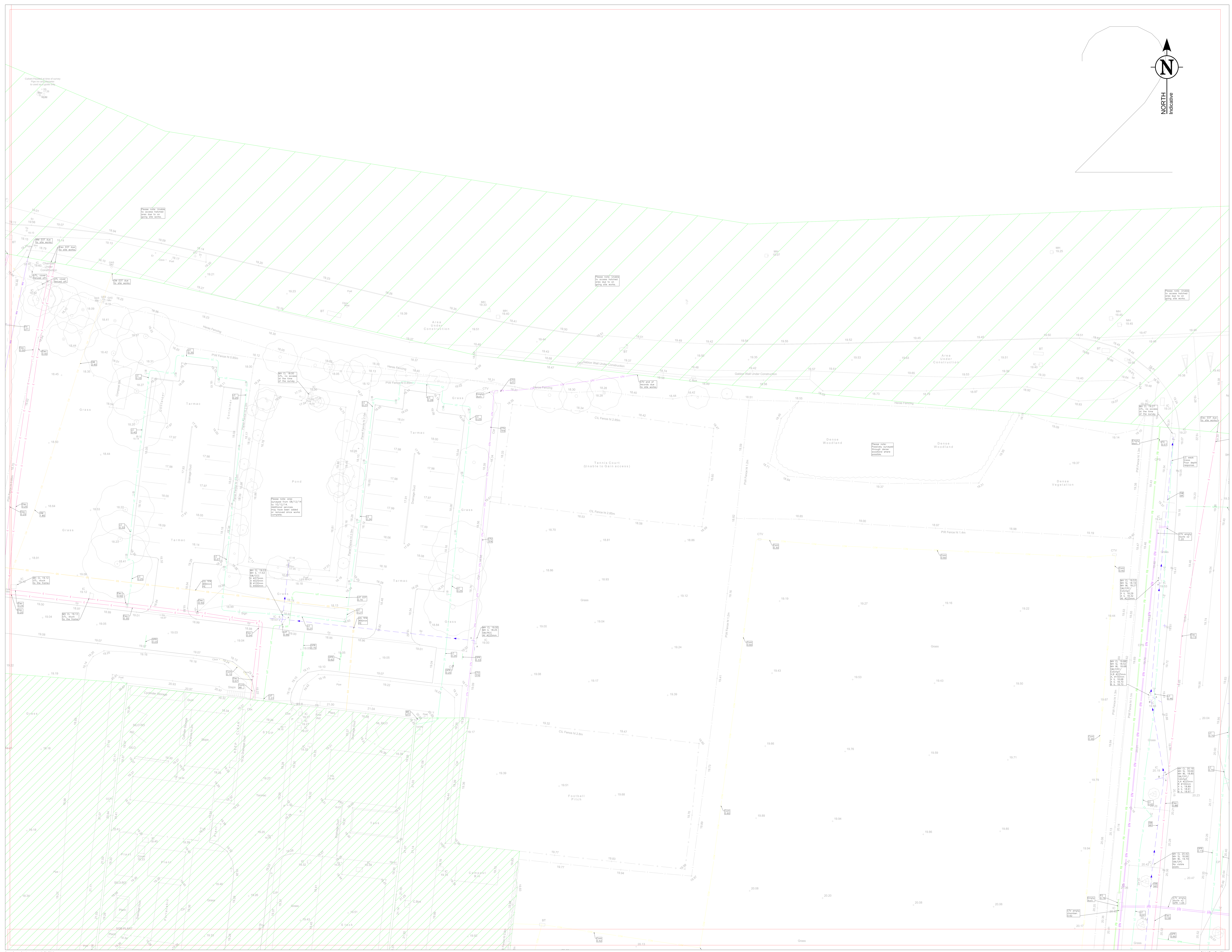
www.survey-solutions.co.uk enquiries@survey-solutions.co.uk

LAND SURVEYING BUILDING SURVEYING UNDERGROUND SURVEYING

PROJECT TITLE
WEST CAMBRIDGE DENSIFICATION SCHEME
MADINGLEY ROAD, CB3 0EL

DRAWING DETAIL
UTILITIES AND DRAINAGE INVESTIGATION
SHEET 1 OF 29

CLIENT			SCALE
PETER BRETT ASSOCIATES			1:200
SURVEYOR	SURVEY DATE	CHECKED BY	APPROVED BY	DWG STATUS
DW/RP/PI	03/11/2014	JTM	RAG	FINAL
DRAWING NUMBER		REVISION	ISSUE DATE
15415UG-01			APR 2015



UTILITIES & UNDERGROUND INVESTIGATIONS

ABBREVIATIONS & SYMBOLS

1D 5C	1 Duct 5 Cables	CPC	Circ Plastic Chamber	EOT	End Of Trace
Ø	Diameter	CrL	Crown Level	IBD	Internal Backdrop
AR	Assumed Route	DCr	Depth To Crown	IL	Invert Level
BL	Base Level	DI	Depth To Invert	RBC	Rectangular Brick Chamber
CB	Concrete Benching	DS	Depth To Surcharge	RCC	Rectangular Conc Chamber
CBC	Circular Brick Chamber	DTB	Depth To Base	SL	Silt Level
CCC	Circular Conc Chamber	DTW	Depth To Water	SuL	Surcharge Level
CL	Cover Level	DTS	Depth To Silt	UTC	Unable To CCTV
				UTL	Unable To Lift
				UTT	Unable To Trace
				TFR	Taken From Records
				EBD	External Backdrop

BT — BT CABLE(S)
O/BT — OVERHEAD BT CABLE(S)
COM — COMMUNICATIONS CABLE(S)
CTV — CABLE TV CABLE(S)
E — ELECTRIC CABLE(S)
O/E — OVERHEAD ELECTRIC CABLE(S)
FO — FIBREOPTIC CABLE(S)
GM — GAS MAIN
GS — GAS SERVICE
GPR — GROUND PENETRATING RADAR (GPR) TRACE
HW — HOT WATER PIPE
LC — LIGHTING CIRCUIT
SEC — SECURITY CABLING
UIT — UNIDENTIFIED TRACE
WM — WATER MAIN
WS — WATER SERVICE
COMBINED SEWER
FOUL SEWER
RISING MAIN
SURFACE WATER SEWER
UTILITIES INVESTIGATION EXTENTS

MH CL 48.93 — UTILITIES COMMENT BOX
WM 0.61 — DEPTH TO SERVICE

DRAWING NOTES

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UTILITY	AVAILABILITY	UTILITY	AVAILABILITY	UTILITY	AVAILABILITY
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WATER MAIN	SITE	CABLE TV	SITE	OTHERS	NO
GAS MAIN	PUBLIC	ELECTRICITY	SITE		

REV	DESCRIPTION	DRAWN	APPR	DATE

SURVEY SOLUTIONS
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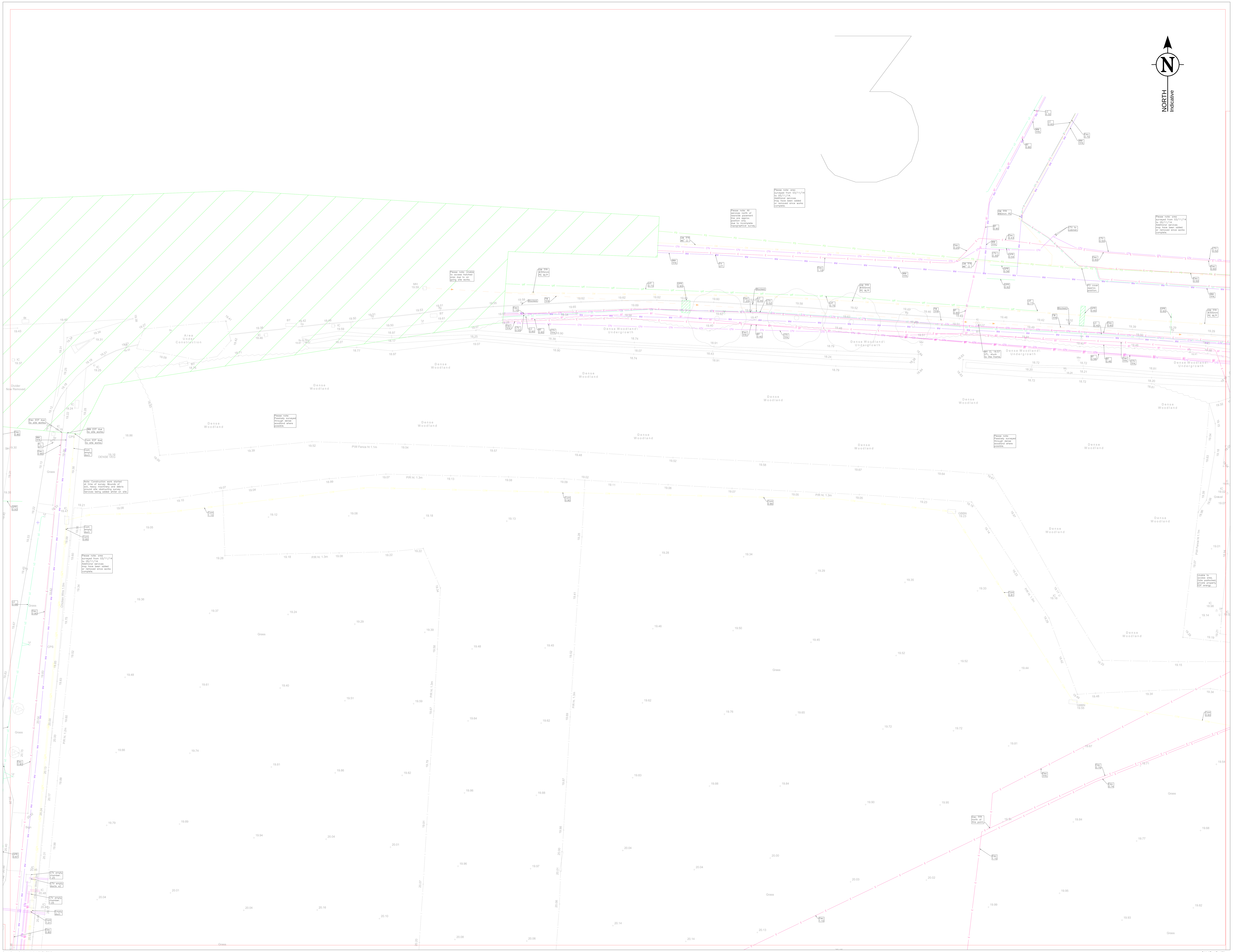
LAND SURVEYING BUILDING SURVEYING UNDERGROUND SURVEYING

PROJECT TITLE
WEST CAMBRIDGE DENSIFICATION SCHEME
MADINGLEY ROAD, CB3 0EL

DRAWING DETAIL
UTILITIES AND DRAINAGE INVESTIGATION
SHEET 2 OF 29

CLIENT				SCALE
PETER BRETT ASSOCIATES				1:200
SURVEYOR	SURVEY DATE	CHECKED BY	APPROVED BY	DWG STATUS
DWR/PI	03/11/2014	JTM	RAG	FINAL
DRAWING NUMBER			REVISION	ISSUE DATE
15415UG-02				APR 2015



UTILITIES & UNDERGROUND INVESTIGATIONS

ABBREVIATIONS & SYMBOLS

1D 5C	1 Duct 5 Cables	CPC	Circ Plastic Chamber	EOT	End Of Trace
Ø	Diameter	CrL	Crown Level	IBD	Internal Backdrop
AR	Assumed Route	DCr	Depth To Crown	IL	Invert Level
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- HW — HOT WATER PIPE
- LC — LIGHTING CIRCUIT
- SEC — SECURITY CABLING
- UIT — UNIDENTIFIED TRACE
- WM — WATER MAIN
- WS — WATER SERVICE
- COMBINED SEWER
- FOUL SEWER
- RISING MAIN
- SURFACE WATER SEWER
- UTILITIES INVESTIGATION EXTENTS

MH CL 48.93 — UTILITIES COMMENT BOX

WM 0.61 — DEPTH TO SERVICE

DRAWING NOTES

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SEWER	SITE	BT	PUBLIC	OIL PIPES	SITE
WATER MAIN	SITE	CABLE TV	SITE	OTHERS	NO
GAS MAIN	PUBLIC	ELECTRICITY	SITE		

REV	DESCRIPTION	DRAWN	APPR	DATE

SURVEY SOLUTIONS

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LAND SURVEYING BUILDING SURVEYING UNDERGROUND SURVEYING

PROJECT TITLE WEST CAMBRIDGE DENSIFICATION SCHEME MADINGLEY ROAD, CB3 0EL				
DRAWING DETAIL UTILITIES AND DRAINAGE INVESTIGATION SHEET 3 OF 29				
CLIENT PETER BRETT ASSOCIATES				SCALE 1:200
SURVEYOR DWR/PI	SURVEY DATE 03/11/2014	CHECKED BY JTM	APPROVED BY RAG	DWG STATUS FINAL
DRAWING NUMBER 15415UG-03			REVISION	ISSUE DATE APR 2015

Original Sheet Size A0H

UTILITIES & UNDERGROUND INVESTIGATIONS

ABBREVIATIONS & SYMBOLS

1D SC	1 Duct 5 Cables	CPC	Circ Plastic Chamber	EOT	End Of Trace
Ø	Diameter	CS	Crown Level	IBD	Internal Backdrop
AR	Assumed Route	DCI	Depth To Crown	IL	Invert Level
BL	Base Level	DI	Depth To Invert	RBC	Rectangular Brick Chamber
CB	Concrete Benching	DS	Depth To Surcharge	RCC	Rectangular Conc Chamber
CBC	Circular Brick Chamber	DTB	Depth To Base	SL	Silt Level
CCC	Circular Conc Chamber	DTW	Depth To Water	SwL	Surcharge Level
CL	Crown Level	DTS	Depth To Silt	UTC	Unable To CCTV
BT	BT CABLE(S)			UTL	Unable To Lift
CW	COMMUNICATIONS CABLE(S)			UTT	Unable To Trace
CTV	CABLE TV CABLE(S)			TPR	Taken From Records
E	ELECTRIC CABLE(S)			EBD	External Backdrop
OHE	OVERHEAD ELECTRIC CABLE(S)				
TL	TRAFFIC LIGHT CABLE(S)				
GM	GAS MAIN				
GS	GAS SERVICE				
GPR	GROUND PENETRATING RADAR (GPR) TRACE				
HW	HOT WATER PIPE				
LP	LIGHTING COLUMN				
SC	SECURITY CABLING				
UT	UNIDENTIFIED TRACE			MH CL 48.60	UTILITIES COMMENT BOX
WM	WATER MAIN				
WS	WATER SERVICE			DMH 0.63	DEPTH TO SERVICE
FW	FOUL SEWER				
FM	FOUL MAIN				
R	RISING MAIN				
SW	SURFACE WATER SEWER				
	UTILITIES INVESTIGATION EXTENTS				

DRAWING NOTES

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WATER MAIN	SITE	CABLE TV	SITE	OTHERS	NO
GAS MAIN	PUBLIC	ELECTRICITY	SITE		

NORTH
Indicative

REV	DESCRIPTION	DRAWN	APPR	DATE

SURVEY SOLUTIONS

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LAND SURVEYING BUILDING SURVEYING UNDERGROUND SURVEYING

PROJECT TITLE	WEST CAMBRIDGE DENSIFICATION SCHEME MADINGLEY ROAD, CB3 0EL		
DRAWING DETAIL	UTILITIES AND DRAINAGE INVESTIGATION SHEET 4 OF 29		
CLIENT	PETER BRETT ASSOCIATES		SCALE 1:200
SURVEYOR	SURVEY DATE	CHECKED BY	APPROVED BY	DWG STATUS
DWR/PJ	03/11/2014	JTM	RAG	FINAL
DRAWING NUMBER		REVISION	ISSUE DATE
15415UG-04			APR 2015

Original Sheet Size A0H

Original Sheet Size A0H

UTILITIES & UNDERGROUND INVESTIGATIONS

ABBREVIATIONS & SYMBOLS

1D 5C	1 Duct 5 Cables	CPC	Circ Plastic Chamber	EOT	End Of Trace
Ø	Diameter	CrL	Crown Level	IBD	Internal Backdrop
AR	Assumed Route	DCr	Depth To Crown	IL	Invert Level
BL	Base Level	DI	Depth To Invert	RBC	Rectangular Brick Chamber
CB	Concrete Benching	DS	Depth To Surcharge	RCC	Rectangular Conc Chamber
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CCC	Circular Conc Chamber	DTW	Depth To Water	SuL	Surcharge Level
CL	Cover Level	DTS	Depth To Silt	UTC	Unable To CCTV
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UTILITIES INVESTIGATION EXTENTS

MH CL 48.93 — UTILITIES COMMENT BOX
WM 0.61 — DEPTH TO SERVICE

DRAWING NOTES

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WATER MAIN	SITE	CABLE TV	SITE	OTHERS	NO
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REV	DESCRIPTION	DRAWN	APPR	DATE

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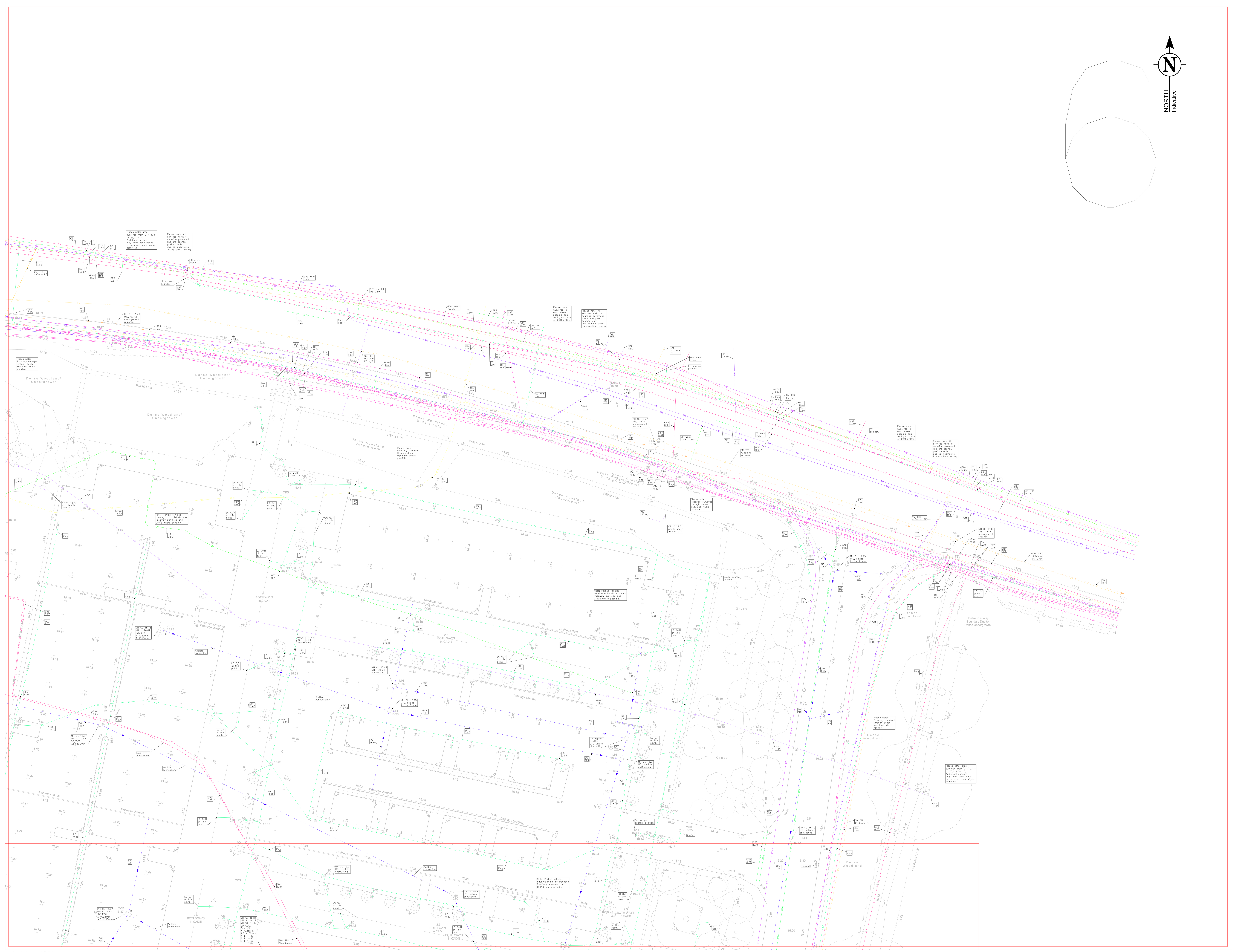
LAND SURVEYING BUILDING SURVEYING UNDERGROUND SURVEYING

PROJECT TITLE
WEST CAMBRIDGE DENSIFICATION SCHEME
MADINGLEY ROAD, CB3 0EL

DRAWING DETAIL
UTILITIES AND DRAINAGE INVESTIGATION
SHEET 5 OF 29

CLIENT				SCALE
PETER BRETT ASSOCIATES				1:200
SURVEYOR	SURVEY DATE	CHECKED BY	APPROVED BY	DWG STATUS
DWR/PI	03/11/2014	JTM	RAG	FINAL
DRAWING NUMBER			REVISION	ISSUE DATE
15415UG-05				APR 2015



Original Sheet Size A0H

UTILITIES & UNDERGROUND INVESTIGATIONS

ABBREVIATIONS & SYMBOLS

1D 5C	1 Duct 5 Cables	CPC	Circ Plastic Chamber	EOT	End Of Trace
Ø	Diameter	CrL	Crown Level	IBD	Internal Backdrop
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WM 0.61 — DEPTH TO SERVICE

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All critical dimensions and measurements should be checked and verified with any errors or discrepancies notified to Survey Solutions immediately. The accuracy of the digital data is the same as the plotting scale implies. All dimensions are in metres unless otherwise stated.

The contractor must check and verify all site and building dimensions, levels, utilities and drainage details and connections prior to commencing work.

Do not scale from this drawing.

AVAILABILITY OF UTILITY RECORD DRAWINGS

UTILITY	AVAILABILITY	UTILITY	AVAILABILITY	UTILITY	AVAILABILITY
SEWER	SITE	BT	PUBLIC	OIL PIPES	SITE
WATER MAIN	SITE	CABLE TV	SITE	OTHERS	NO
GAS MAIN	PUBLIC	ELECTRICITY	SITE		

REV	DESCRIPTION	DRAWN	APPR	DATE

SURVEY SOLUTIONS
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LAND SURVEYING BUILDING SURVEYING UNDERGROUND SURVEYING

PROJECT TITLE
WEST CAMBRIDGE DENSIFICATION SCHEME
MADINGLEY ROAD, CB3 0EL

DRAWING DETAIL
UTILITIES AND DRAINAGE INVESTIGATION
SHEET 6 OF 29

CLIENT				SCALE
PETER BRETT ASSOCIATES				1:200
SURVEYOR	SURVEY DATE	CHECKED BY	APPROVED BY	DWG STATUS
DWR/PI	03/11/2014	JTM	RAG	FINAL
DRAWING NUMBER			REVISION	ISSUE DATE
15415UG-06				APR 2015