Anfield Road Stand, Liverpool

Flood Risk Assessment

1 March 2021

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Contents

Executive summary 1

1 Introduction 2

2 Site Description 4
2.1 Site Location 4
2.2 Site Description 4
2.3 Topography 4
2.4 Geology and Hydrogeology 5
2.4.1 Geology 5
2.4.2 Hydrogeology 5
2.5 Hydrology 5
2.6 Existing Drainage 6
2.6.1 Public Sewers 6
2.6.2 Private Drainage 6
2.6.3 Highway Drainage 7
2.7 Development Proposal 7

3 Flood Risk Assessment 8
3.1 Flood Risk Summary 8
3.2 Natural Drainage 8
3.2.1 Fluvial Flooding 8
3.2.2 Pluvial Flooding and Overland Flow 9
3.2.3 Groundwater Flooding 10
3.3 Artificial drainage 11
3.3.1 Public Sewers 11
3.3.2 Private Drainage Systems 11
3.3.3 Highway Drainage 11
3.3.4 Reservoirs 12
3.3.5 Development Drainage 12

4 Sequential Test 14

5 Drainage Strategy 15
5.1 Control of Surface Water Run-off 15
5.1.1 Infiltration Based System 15
5.1.2 Watercourses 15
5.1.3 Public Sewers 15
5.2 Climate Change 16
5.3 Allowable Surface Water Discharge Rate 16

5.3.1 Existing Surface Water Runoff Rate 16
5.3.2 Proposed Surface Water Runoff Rate 17
5.4 Surface Water Attenuation 17
5.5 Sustainable Drainage Systems (SuDS) and Water Quality 18
5.5.1 Living or Green Roofs 19
5.5.2 Ponds and Basins 19
5.5.3 Filter Strips and Swales 20
5.5.4 Rain Gardens and Bioretention Areas 20
5.5.5 Permeable Paving 20
5.5.6 Tanked Systems 21
5.5.7 Surface Storage 22
5.6 Surface Water Design Proposal 22
5.7 Foul Water Design Proposal 23
5.7.1 Existing Foul Water Flow Rates 23
5.7.2 Proposed Foul Water Flow Rates 23
5.7.3 Foul Water Drainage Strategy 24
5.8 Design Standards and Consents 24
5.9 Flood Routing 24
5.10 Maintenance 24

6 Conclusion 26

A. Topographical Survey 27

B. Public Sewer Records 31

C. Private Drainage Survey 33

D. Proposed Landscape Masterplan 35

E. Surface Water Attenuation Volume Calculations 37

F. Foul Water Calculations 54

Executive summary

Mott MacDonald was commissioned by Liverpool Football Club and Athletics Group Ltd (LFC) to carry out a Flood Risk Assessment (FRA) and drainage assessment for the proposed expansion of the Anfield Road Stand at Anfield Stadium, Liverpool.

This report is to support a Planning Application for this site.

The site is to be assessed with regard to the requirements of the Planning Practice Guidance (PPG) and the associated Technical Guidance to determine the suitability of the proposed development on the site.

As well as fluvial flood risk the report will also assess the risk posed locally by the development itself and the runoff it may generate.

This element will include a general overview of the suitability of Sustainable Drainage Systems (SuDS) type systems.

If required, mitigation measures and recommendations will be made that will enable the site to be suitably developed while actively seeking to reduce flood risk locally.

The following guidelines and references have been used in the preparation of this report:

- Planning Practice Guidance – Technical Guidance (PPG-TG)[1]
- Environment Agency Flood Risk Standing Advice for England[2]
- LFC archive drawings

The report is also based on additional information received from the Environment Agency (EA), United Utilities (UU) and the Lead Local Flood Authority, Liverpool City Council (LCC).

The report concludes that the development is suitable for this location and can be safely developed to manage and control all identified long-term residual flood risks in the area. The provision of a new positive drainage system on the site may also contribute to a reduction in flood risk locally.

Furthermore, it is demonstrated that the layout may be developed to incorporate a SuDS based system that will not only provide adequate run-off protection but also provide and improvements in the run-off quality and biodiversity of the area.

[1] http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/
[2] https://www.gov.uk/flood-risk-assessment-local-planning-authorities

1 Introduction

It is proposed that the existing Anfield Road Stand at Anfield Stadium, Liverpool is expanded to increase the capacity of the stadium. The proposed scheme includes construction of the new Anfield Road Stand and redevelopment of the associated external areas. This development will need to be assessed to determine if it is at risk from existing sources of flooding or if the development will increase material flood risk outside the development site.

The Government has placed increasing priority on the need to take full account of the risks associated with flooding at all stages of the planning and development process, to reduce future damage to property and loss of life. The PPG identifies how the use of flooding is dealt with in the drafting of planning policy and the consideration of planning applications.

The purpose of this report is to assist our client and the Local Planning Authority to make an informed decision on the flood risk associated with the site development.

Local Planning Authorities have the powers to control development in accordance with the guidelines contained in PPG-TG, and are expected to apply a risk-based approach to development with the Sequential Test. This sets out a sequential characterisation of flood risk in terms of annual probability of river, tidal and coastal flooding. In accordance with the Sequential Tests in the technical guidance, sites are to be classed as follows:

Table 1.1: Flood Zones – PPG-TG Table 1&2

Flood Zone	Appropriate Uses
Flood Zone 1 – Low Probability This zone comprises land having less than 1 in 1000-year annual probability of river or sea flooding (<0.1%)	All uses of land are appropriate in this zone
Flood Zone 2 – Medium Probability This zone comprises land having between 1 in 100 and 1 in 1000-year annual probability of river flooding (1%-0.1%) or between 1 in 200 and 1 in 1000-year annual probability of sea flooding (0.5%-0.1%) in any year	The water compatible, less vulnerable, and more vulnerable uses of land and essential infrastructure in Table D.2 are appropriate in this Zone. Subject to the Sequential Test being applied, the highly vulnerable used in Table D.2 are only appropriate in this Zone if the Exception Test is passed.
Flood Zone 3a – High Probability This zone comprises land having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of sea flooding (>0.5%) in any year	The water compatible and less vulnerable uses of land in Table D.2 are appropriate in this Zone. The highly vulnerable uses in Table D.2 should not be permitted in this Zone. The more vulnerable and essential infrastructure uses in Table D.2 should only be permitted in this Zone if the Exception Test is passed. Essential infrastructure permitted in this should be designed and constructed to remain operational and safe for users in time of flood.
Flood Zone 3b – Functional Floodplain This zone comprises land where water has to flow or be stored in times of flood. SFRA's should identify this Flood Zone (land which would flood with annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in extreme (0.1%) flood, or at another probability to be agreed between the LPA and the EA, including water conveyance routes).	Only water compatible uses and the essential infrastructure listed in Table D.2 that has to be there should be permitted in this Zone. It should be designed and constructed to: Remain operational and safe for users in times of flood; Result in no net loss of floodplain storage; Not impede water flows; and Not increase flood risk elsewhere. Essential infrastructure in the Zone should pass the Exception Test.

Source: https://www.gov.uk/guidance/flood-risk-and-coastal-change#flood-zone-and-flood-risk-tables

Mott MacDonald has followed accepted procedures in providing our services however, given the residual risk associated with any prediction and the variability which can be experienced in flood conditions, we take no liability for and give no warranty against actual flooding of any property (client's or third party) or the consequences of flooding in relation to the performance of the service. This report has been prepared for the purposes of Planning Approval only and is intended to assist our client and the Local Planning Authority in making an informed decision on the flood risks associated with the proposed development of the site.

Allowance for the effects of climate change has been made in accordance with government recommendations in place and statistical data available at the time of writing this report. These recommendations may become more onerous and the statistical data may be revised in the future; we will not make any estimate of what changes may result from this. Please be aware that this, and other issues over which Mott MacDonald has no control, may affect future flood risk at the proposed development site and may require further work to be undertaken for which we accept no liability.

2 Site Description

2.1 Site Location

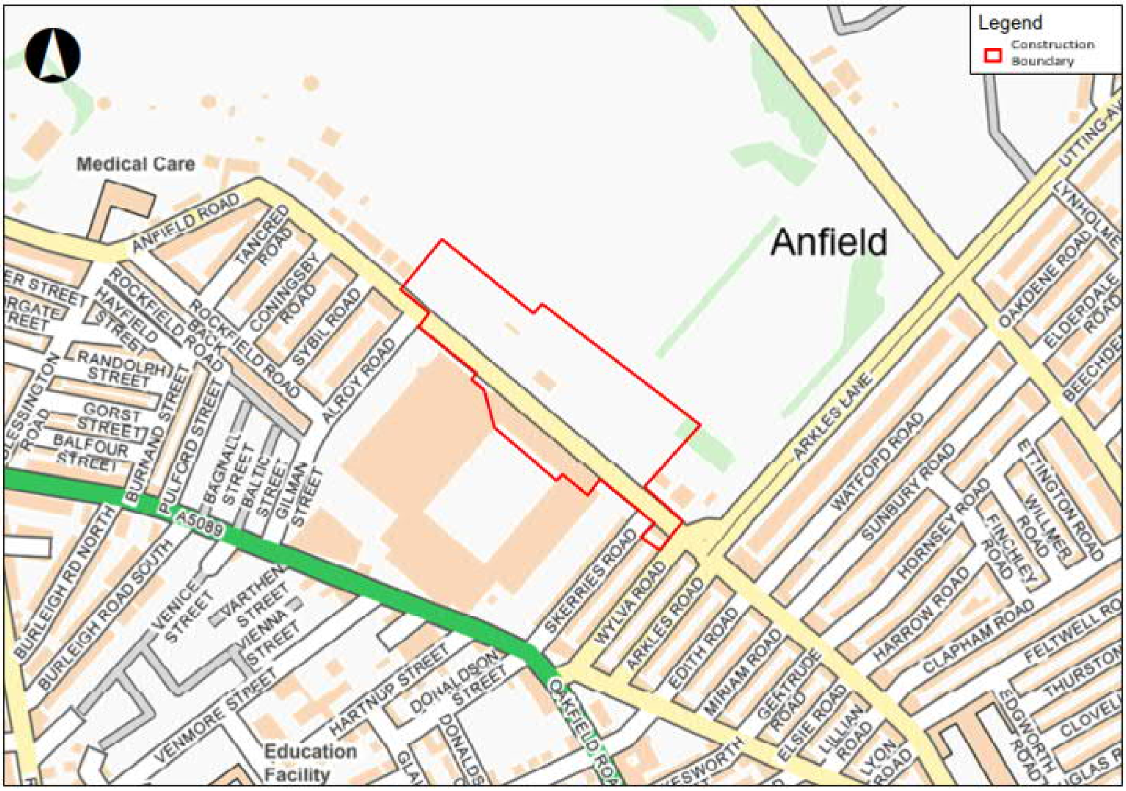
The proposed development site is Anfield Stadium, Anfield, Liverpool and is situated approximately 2.5km to the northeast of Liverpool city centre. The approximate National Grid reference (NGR) is 336210, 393140. This co-ordinate is to the middle of the proposed development site.

2.2 Site Description

The Site, which extends to approximately 2.6ha covers the Anfield Road Stand (the northernmost stand), Anfield Road and, areas of hardstanding to the rear of the stand including a pedestrian footway into Stanley Park, an outside broadcast area, a fan zone and car park.

Figure 2.1 shows the general layout of the Site.

Figure 2.1: Site Layout



Source: Mott MacDonald, 2020

The wider Anfield Stadium (comprising the other stands and pitch) is located directly south/southwest of the Site. Skerries Road and Alroy Road are located to the southeast and west respectively. Stanley Park bounds the Site to the north; it is part of a wider expanse of open space, including Anfield Cemetery, extending to approximately 101ha.

The wider area surrounding the Site to the south, east and west is predominantly residential in character. The Walton Breck Road high street, which contains a mix of commercial, residential and community uses, lies immediately to the south of the Anfield Stadium.

2.3 Topography

A topographical survey of the site was undertaken in September 2019 by Survey Operations and plans are included in Appendix A for reference.

The topography along Anfield Road has a gradient of approximately 1v:75h from the north-west to the south-east. The high point of the area being 59.8mAOD on the western boundary and the low point being 55.7mAOD on the eastern boundary.

There is a general crossfall from Stanley Park towards Anfield Road of approximately 1v:80h from the north-east to the south-west.

2.4 Geology and Hydrogeology

Mott MacDonald has produced a Geotechnical Review for Anfield Road Stand (issued separately as document 405016_GEO_01) in December 2019 which reviewed preliminary and historical ground investigation data and established baseline ground conditions at the site. The report was written prior to intrusive ground investigations being undertaken for the development and the key findings of that report are outlined below.

2.4.1 Geology

The British Geological Survey (BGS) published maps indicate that there are no superficial deposits at the site. The mapping indicates that the bedrock underlying the site is the Chester Formation Sandstone which is part of the Sherwood Sandstone Group. The lithology is described to be fine to coarse grained sandstone commonly pebbly, with conglomerates and sporadic siltstones.

The site is located in an urban area, with much development having occurred historically, on that basis it is highly likely that Made Ground will be encountered beneath the site.

Borehole logs available from ground investigations in 2002-2003 and 2007 have confirmed that on the site there is a layer of up to 2m Made Ground underlain with Sandstone to depths in excess of 30m BGL.

2.4.2 Hydrogeology

The Chester Pebbles Beds Formation underlying the site is designated as a Principal Aquifer by the Environmental Agency, which layers of rock or drift deposits have high intergranular and/or fracture permeability meaning they usually provide a high-level of water. They may support water supply and/or river base flow on a strategic scale.

The site in not within any Source Protection Zones (SPZ) and no sensitive groundwater abstractions are located within 1km of the site.

There is one licensed groundwater abstraction listed within 1 km of the site, which is associated with abstraction from Stanley Park Lake, operated by Liverpool City Council (LCC).

2.5 Hydrology

The nearest main river to the site is the River Mersey which located approximately 2.5km to the west of the site.

No ordinary watercourses have been identified within the vicinity of the site.

The Leeds and Liverpool Canal which is located approximately 1.8km to the west of the site.

There are a number of surface water bodies in the vicinity of the site, including Stanley Lake located 550m to the north-west in Stanley Park.

2.6 Existing Drainage

2.6.1 Public Sewers

Sewer records obtained from united Utilities (UU) are included in Appendix B for reference.

These records show that the area in the vicinity of the site is served by a combined public sewer network.

There is 375mm combined public sewer located within Anfield Road which flows in a south-easterly direction.

There is a 910x1520mm combined public sewer located beneath the Kop Stand, to the south of the stadium, and flows in a north-westerly direction.

2.6.2 Private Drainage

A drainage survey was undertaken by Invek in December 2019 to confirm the extents and condition of the existing private drainage network on site, a plan of the existing drainage has been included in Appendix C for reference.

2.6.2.1 Surface Water

The Anfield Road Stand roof drainage was confirmed to discharge into two networks. The northern-half of the stand roof drains into the 375mm combined public sewer in Anfield Road via a 300mm diameter connection. The southern-half of the stand roof discharges into a private 225mm diameter surface water drainage system located in the car park to the rear of the Sir Kenny Dalglish Stand. From here the surface water drain flows in a southerly direction and increases in size to a 450mm diameter drain as it receives additional surface water flows from the Sir Kenny Dalglish Stand and car park. The surface water drain eventually discharges via a private 600mm combined connection into the 910x1520mm combined public sewer which flows under the Kop Stand.

There were limited surface water drainage features identified within the car park area. A small area of the car park was found to drain into three road gullies which were connected into a surface water drain which discharges into a soakaway system. The rest of the car park was found to fall towards the road gullies located in Anfield Road.

Surface water runoff from the footpath linking Anfield Road and Stanley Park is drained via a slot drain which connects into the 300mm diameter Outside Broadcast Area surface water drainage system. The surface water drainage within the Outside Broadcast Area discharges into the 375mm diameter combined public sewer in Anfield Road via a 150mm diameter connection.

The surface water runoff from the existing fan zone is found to drain to a soakaway located to the north of the area.

2.6.2.2 Foul Water

The drainage survey confirmed that all of the toilets and foul discharging units in the Anfield Road Stand discharge into a private 150mm diameter foul drainage system located beneath the stand. The foul drain flows west to east towards the car park to the rear of the Sir Kenny Dalglish Stand. From here the foul drain flows in a southerly direction and increases in size to a 300mm diameter drain as it receives additional foul flows from the Sir Kenny Dalglish Stand. The foul drain eventually discharges via a private 600mm combined connection into the 910x1520mm combined public sewer which flows under the Kop Stand.

The foul drainage from the existing fan zone drains via a private pump station (the existing pump rate is unknown) into the 375mm diameter combined public sewer in Anfield Road.

2.6.3 Highway Drainage

The drainage survey confirmed that the road gullies within Anfield Road all discharged directly into the 375mm diameter combined public sewer within the road. There was no separate highway drainage system identified.

2.7 Development Proposal

The proposed scheme seeks to increase the fan capacity at the Anfield Road Stand through the provision of a new stand increasing seating from 8,962 to approximately 16,000, along with the provision of new associated facilities. The existing uses on Anfield Road (the highway, car park, fan zone, outside broadcast area and access to Stanley Park) will be impacted to some extent by the proposed scheme.

The main features of the proposed scheme are:

- Anfield Road Stand extended;
- Anfield Road realigned around the new Anfield Road Stand;
- Public realm area provided around the new Anfield Road Stand;
- Existing car park area removed;
- Fan Zone relocated to within the new Anfield Road Stand and public realm spaces; and
- Outside broadcast area to be retained.

A landscape masterplan of the propose scheme is included in Appendix D.

3 Flood Risk Assessment

3.1 Flood Risk Summary

Table 3.1 summarises the sources and extent of flood risk to the site, the risks are explored further in this section.

Table 3.1: Summary of source and extent of flooding

Potential Source of Flooding	Is there an existing flood risk to the development site?	Pre-mitigation flood risk to the development site	Post mitigation flood risk to the development site
Fluvial flooding	No	Low	Site is located in Flood Zone 1
Pluvial flooding and overland flow	Yes	Low	A section of Anfield Road within the site boundary is shown to be at 'low' risk of surface water flooding
Groundwater flooding	No	Low	No evidence identified – extensive existing drainage systems in place
Adopted drainage	No	Low	Site is elevated above adjacent UU assets
Private drainage	Yes	Low	Cannot confirm what design standards the existing private drainage was designed to
Highway drainage	No	Low	Site is elevated above adjacent roads
Reservoir flooding	No	Low	Not in the flood envelope for reservoirs
Development drainage	No	Low	Development drainage to be designed to relevant standards

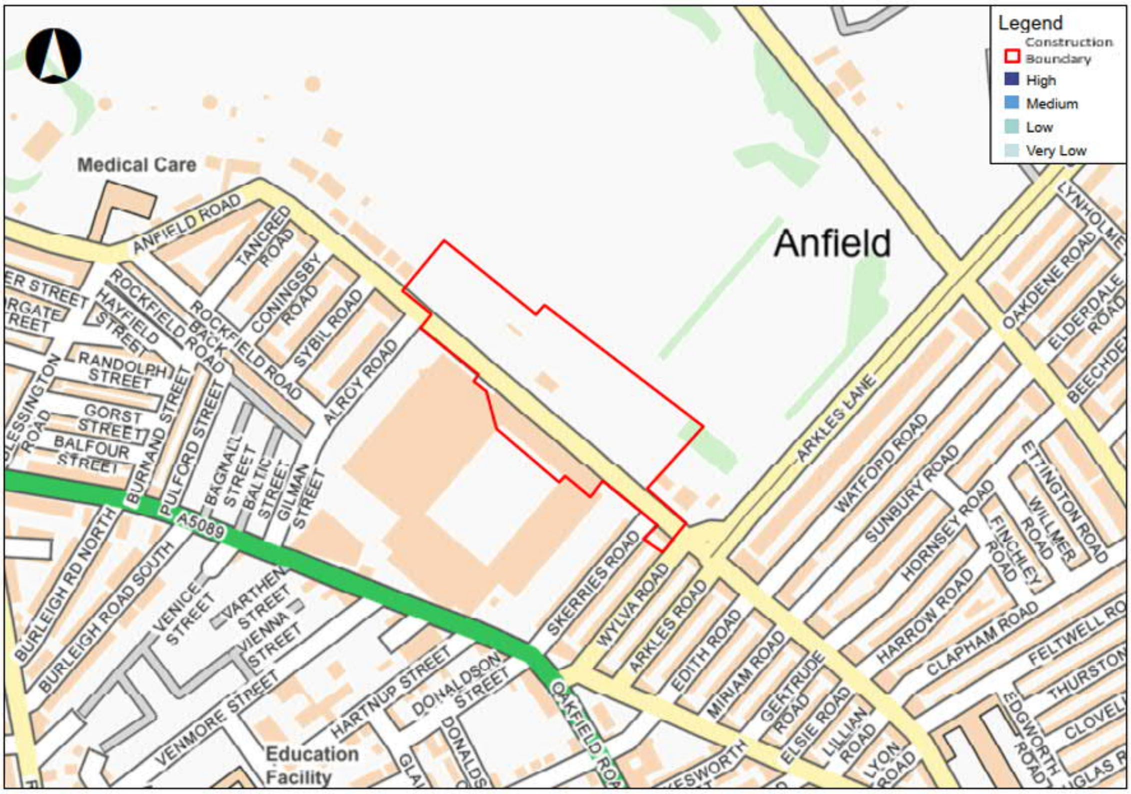
Source: Flood Risk Assessment

3.2 Natural Drainage

3.2.1 Fluvial Flooding

With reference to the EA's Indicative Flood Map (see Figure 3.1 below), the site is shown to be in Flood Zone 1, which comprises land having less than a 1 in 1000-year annual probability of river or sea flooding (<0.1%).

Figure 3.1: Environment Agency Indicative Fluvial Flood Map



Source: Environment Agency website: maps.environment-agency.gov.uk. Downloaded 2020.

Due to the site being located within Flood Zone 1 the risk of flooding to the development from fluvial sources is therefore considered to be low and acceptable.

3.2.2 Pluvial Flooding and Overland Flow

With reference to the EA's indicative flood maps, data related to the risk of potential surface water inundation is provided. The overall site is shown to be predominantly in an area generally of very low risk see Figure 3.2.

There is an area of Anfield Road within the development boundary which is shown to be at low risk of flooding, meaning that this area has an has a chance of flooding of less than 1 in 1000-year (0.1% AEP) event. The flood extents during the 1 in 1000-year event are contained within the curtilage of Anfield Road and flow south down Skerries Road.

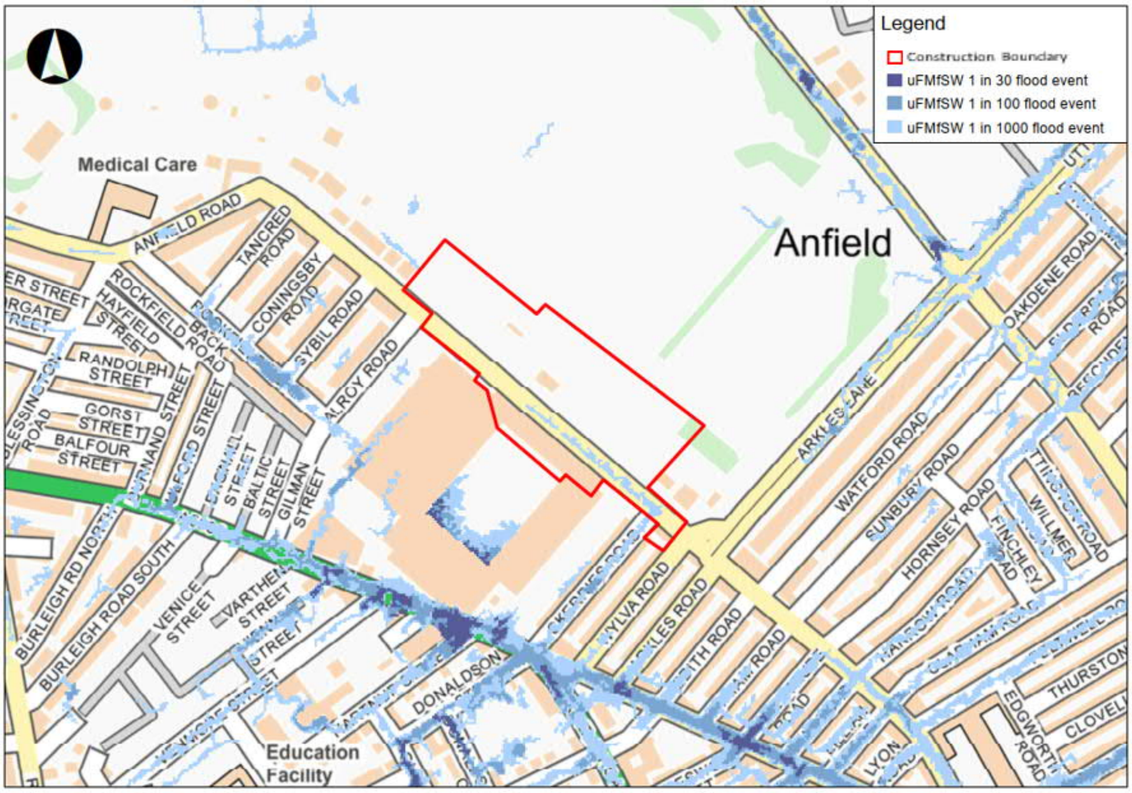
It should be noted that the EA Risk of Flooding from Surface Water Flood Map assumes that any existing drainage system is full. As the road currently benefits from a positive drainage system which is maintained by LCC and UU it is considered that the risk of flooding to the site from pluvial flooding is low and acceptable.

Overland flow is generated by adjacent impermeable developments and/or infrastructure and can be a source of flood risk in times of extreme rainfall, when the drainage systems are operating beyond their hydraulic design conditions, or if they fail by collapse or blockage.

In this location, the local topography falls from northwest to southeast and any overland flows would follow the fall of the land and be contained within the curtilage of the carriageway.

The proposed development will require a new surface water drainage system which will be designed to contain surface water run-off resulting from 1 in 100-year rainfall event including an allowance for climate change. The risk of the development causing an increase in pluvial flooding and overland flows is therefore considered to be low and acceptable.

Figure 3.2: Environment Agency Surface Water Flooding Map



Source: Environment Agency website: maps.environment-agency.gov.uk. Downloaded 2020.

3.2.3 Groundwater Flooding

In the absence of any recorded flood risk or existing ground water features on site. The general locale is heavily urbanised and incorporates extensive drainage infrastructure. It is considered that the site is not at risk from groundwater flooding.

It is recommended that groundwater levels are measured and monitored as part of any future ground investigations. If the ground water levels are found to be high, then it may present a risk to the development during construction. To mitigate this risk, appropriate construction techniques such as utilising dewatering pumps may be required.

The risk of the development contributing to an increase in local groundwater levels is considered negligible. The risk of the development causing increased groundwater flooding elsewhere is therefore considered low and acceptable.

3.3 Artificial drainage

3.3.1 Public Sewers

The public sewer network in the vicinity of the site is stated in Section 2.6.1 and shown on the asset records included in Appendix B.

There are no reported incidents of sewer flooding at the site and the LCC Preliminary Flood Risk Assessment (2017) does not indicate any historic information of sewer flooding at the site.

If there were to be a catastrophic failure of the public sewer system, the flows from the public sewer manholes would remain within the curtilage of the carriageway and follow the topography of the road flowing away from the site. Therefore, the risk of flooding to the site from the existing public sewer system is therefore considered to be low.

It is proposed that the existing combined public sewer located in Anfield Road will either be divested or abandoned as part of the proposed development. Given that the proposed drainage systems for the site will be designed to meet the latest flood performance standards in accordance with Part H of the Building Regulations (2015) and Sewers for Adoption (7^{th} Edition), future flood risk from the drainage systems serving the development is therefore considered to be low.

3.3.2 Private Drainage Systems

The private drainage system serving the site is described in Section 2.6.2 and shown on the existing drainage plans included in Appendix C.

There are no reported incidents of flooding from the private drainage network. The private drainage system is owned and maintained by LFC therefore the risk of flooding to the site from the existing private drainage system is considered to be low.

Given that the proposed drainage systems for the site will be designed to meet the latest flood performance standards in accordance with Part H of the Building Regulations (2015) and Sewers for Adoption (7^{th} Edition), future flood risk from the drainage systems serving the development is therefore considered to be low.

3.3.3 Highway Drainage

Anfield Road carriageway is drained via road gullies which discharge directly into the combined public sewer system in Anfield Road. Any flooding from the road gullies would be contained within the curtilage of the carriageway and follow the topography of the road flowing away from the site. Therefore, the risk of flooding to the site from the existing highway drainage system is therefore considered to be low.

Anfield Road is being diverted as part of the proposed development and any drainage from the realigned road will discharge into the proposed site drainage network. The surface water drainage for the development will be designed in accordance with appropriate legislation and guidance. Assuming the drainage system is constructed to the above standards and is correctly maintained then the risk of flooding to or from the highway drainage system from the proposed development is considered to be low and acceptable.

3.3.4 Reservoirs

The EA publish a Risk of Flooding from Reservoirs Map which indicates the area which could be flooded in the event of reservoir failure. The map currently indicates that the site is outside and at least 1 km away from the influence of any local reservoir flooding or inundation.

Flooding due to a reservoir failure is very unlikely to occur. There has been no loss of life in the UK from reservoir flooding since 1925. All large reservoirs must be inspected and supervised by reservoir panel engineers. The enforcement authority for the Reservoirs Act 1975 in England is the EA, they ensure that reservoirs are inspected regularly, and essential safety work is carried out.

No other significant artificial waterbodies that could cause flooding have been identified in the vicinity of the site.

From the above it is concluded that due to the very low probability of a reservoir failure and given that the development site is outside of the flooding extents, the risk of flooding to the proposed development from reservoirs is low and acceptable.

3.3.5 Development Drainage

The proposed development will see a small increase in the overall impermeable area and ultimately an increase the post-development run-off from the site, if not mitigated.

This run-off will itself pose a flood risk to both the development site and the areas downstream of this point. The new impermeable development will alter the existing run-off profile of the site with a commensurate increase in run-off potential. As such, the management of surface water will be important so as not to pose a significant flood risk.

It is demonstrated in Section 5 that safe discharge of surface water from the site is possible, with the implementation of appropriate attenuation and storage, and use of SuDS where practicable. The current proposal for the site offers good scope to be able to deliver these requirements in conjunction with the landscape and urban design functions, to provide safe and effective management of surface water which is integral to the design of the site. In addition to providing effective management of surface water to reduce flood risk, appropriate SuDS components can also offer potential opportunities and benefits in terms of amenity value, biodiversity, and water quality.

The surface water drainage for the development will be designed in accordance with appropriate legislation and guidance. Assuming the drainage system is constructed to the above standards and is correctly maintained then the risk of flooding from the proposed drainage system on site is considered to be low and acceptable.

3.3.5.1 Safe Exceedance Planning

The development layout and associated drainage strategy should include provision for the safe exceedance of the drainage systems during extreme events.

If considered early in the development process mitigation can be designed into the layout, with little economic impact, to prevent overland flows from the site either entering habitable areas or leaving the site in an uncontrolled manner.

3.3.5.2 Flood Resilience and Resistance

Design development of the site layout should always consider that it is potentially at risk from flooding during an extreme rainfall event and as such, the proposed development should incorporate measures that address flood resilience and resistance.

Relatively simple measures for incorporating flood resilience into any proposed development could include raising utility entry points, using first floor or ceiling down electrical circuits and sloping landscaping away from buildings can be easily and economically incorporated into the development of the site at the design stage.

Flood resistant construction techniques could include the use of solid floors, sealed door and window cavities, locating IT infrastructure at high level and utility shut-off points.

More information can be found in the Communities and Local Government publication' Improving the Flood Performance of New Buildings[3].

[3] http://www.planningportal.gov.uk/uploads/br/flood_performance.pdf

4 Sequential Test

As the development is shown to be wholly within Flood Zone 1 and outside the influence of any other local flood risk elements, in accordance with Table 3 of the PPG-TG it is concluded that the development is suitable for this location and the Sequential Test is deemed to have been passed.

5 Drainage Strategy

5.1 Control of Surface Water Run-off

It should be acknowledged that the satisfactory collection, control and discharge of surface water is now a principal planning and design consideration. This is reflected in the non-statutory National Sustainable Drainage System (SuDS) Standards.

Part H of the Building Regulations 2015 recommends that surface water run-off from developments shall discharge to one of the following, listed in order of priority:

- An adequate soakaway or other adequate infiltration system, or where that is not reasonably practicable;
- A watercourse, or where that is not reasonably practicable;
- A surface water sewer or drain, or where that is not reasonably practicable;
- A combined water sewer.

It is necessary to identify the appropriate methods of controlling and discharging surface water from the site. Where possible, surface water run-off from the developed site will be drained in such a way as to mimic the natural drainage system and thereby implement a SuDS approach. The design should seek to improve the local run-off profile using systems that can either attenuate run-off and reduce peak flow rates or positively impact on the existing flood profile.

5.1.1 Infiltration Based System

As outlined in Section 2.4.1, the ground conditions on site have been proven to be Made Ground underlain with Sandstone. Given these observations of the known geology there is a possibility that an infiltration-based system may potentially be viable in the Sandstone strata.

Useable infiltration may be achievable on site and if this is confirmed via in-situ, site specific infiltration testing, in accordance with BRE365 then infiltration should be the primary focus for the disposal of surface water runoff from the site. Infiltration rates around 5×10^{-6} ms^{-1} may be expected in fractured sandstone.

It should be noted that the site is located on a Principal Aquifer. Given this designation it will be necessary for all discharges to ground water to be adequately controlled and treated. However, infiltration should be encouraged as a means of recharge for the aquifer.

It should be noted that the depth of Made Ground encountered on the site may be in excess of 2m depth which would reduce the viability of using infiltration in a shallow drainage system.

5.1.2 Watercourses

There are no watercourses in the vicinity of the site so discharging surface water directly to a watercourse by gravity is not considered to be a viable solution.

5.1.3 Public Sewers

If discharging surface water from the site by infiltration is not deemed viable then a secondary option would be to discharges into the UU public sewer network. The public sewer network in the vicinity of the site is discussed in Section 2.6.1.

It is proposed that the surface water from the site discharges into the 375mm diameter combined public sewer located in Anfield Road, this will need to be agreed with UU.

5.2 Climate Change

The Environment Agency requires, in accordance with the Government's PPG-TG document, that there should be no increase in the rate of surface water emanating from a newly developed site above that of any previous development. Furthermore, it is the joint aim of the Environment Agency and Local Planning Authorities, to actively encourage a reduction in the discharge of storm water as a condition of Approval for new developments. In addition, all drainage systems should be sized to accommodate the runoff arising from a 1 in 100-year rainfall event and should include a further allowance to account for the further effects of climate change.

Table 5.1 below, shows the anticipated increases in rainfall intensities with time, and has been reproduced in part from Table 4 of PPG-TG.

Table 5.1: Peak Rainfall Intensity Allowance

Parameter	Allowance Category	2015 to 2039	2040 to 2069	2070 to 2115
Peak Rainfall Intensity	Central	5%	10%	20%
Peak Rainfall Intensity	Upper	10%	20%	40%

Source: PPG-TG

The development has a proposed design life of 50 years, which if constructed this year will be until 2070. Therefore, a climate change value for rainfall intensity of 20% climate change will be used for design, and 40% for checking.

This is in line with the LLFA guidance which requires that any new non-residential development should designed with a 20% increase in rainfall intensity due to climate change.

5.3 Allowable Surface Water Discharge Rate

5.3.1 Existing Surface Water Runoff Rate

As the existing site is classified as brownfield, the existing surface water runoff rate from the site has been calculated using the Rational Method and the Lloyd Davis equation for direct runoff.

$$Q = 2.78CiA$$

Where:
Q = maximum flow rate (l/s)
C = runoff coefficient (dimensionless)
i = rainfall intensity (mm/hr)
A = catchment area (ha)

For all of the areas which have been identified by the drainage survey (see Section 2.6.2) as discharging to the public sewer network the runoff coefficient has been set as 1, which does not account for any infiltration or loss of surface water.

The rainfall intensity that has been used to calculate the existing runoff rate is 40mm/hr which is approximately equivalent to the 1 in 2-year critical rainfall event, as specified by LCC.

The contributing impermeable area for each area of the existing site has been taken-off existing site plans and verified during the drainage survey.

The total brownfield runoff rate for the existing site and the breakdown of into which public sewer network each area drains is outlined in Table 5.2.

Table 5.2: Existing Brownfield Runoff Rates

Area of Site	Impermeable Area (Ha)	Existing Brownfield Runoff Rate (l/s)	Receiving Downstream Network
Footpath	0.045	5.00	Anfield Road combined sewer
Outside Broadcast Area	0.242	26.91	Anfield Road combined sewer
Fan Zone	0.222	N/A	To soakaway
Car Park	0.142	15.79	Anfield Road combined sewer
Anfield Road	0.263	29.25	Anfield Road combined sewer
Anfield Road Stand Roof (Northern Half)	0.135	15.01	Anfield Road combined sewer
Anfield Road Stand Roof (Southern Half)	0.135	15.01	Kop Stand combined sewer
Total	1.184	106.97	

Source: Flood Risk Assessment

The total peak surface water runoff rate from the existing site into the public sewer networks has been calculated as 107l/s.

5.3.2 Proposed Surface Water Runoff Rate

If infiltration is proven to be viable then the surface water discharge rate from the site would be limited to the infiltration rate of the ground. Infiltration rates around 5 x 10^{-6} ms^{-1} may be achievable.

If infiltration is not viable then surface water runoff will need to discharge into the public sewer network. LCC planning guidance requires that the maximum allowed surface water discharge rate from a new development should be limited to the existing 1 in 2-year critical rainfall event with a 30% reduction applied to reduce the risk of flooding downstream. UU have also requested a 30% betterment in existing surface water discharge rates into the public sewer network.

The proposed surface water runoff rate from the entire site will therefore be limited to 75l/s as outlined in Table 5.3.

Table 5.3: Proposed Surface Water Runoff Rates

Receiving Downstream Network	Existing Brownfield Runoff Rate (l/s)	Proposed Brownfield Runoff Rate (30% betterment) (l/s)
Anfield Road Combined Sewer	92	64.5
Kop Stand Combined Sewer	15	10.5
Total Site	107	75

Source: Flood Risk Assessment

5.4 Surface Water Attenuation

The provision of suitable attenuation on-site to mitigate flood risk resulting from the proposed development will be a key factor in the evolution of the site development layout.

The provision of large volumes of attenuation, as is likely in this case, can be achieved by a number of methods; however, not all systems can be assessed in direct comparison.

One of the aims of PPG is to provide not only flood risk mitigation but also maximise additional gains such as improvements in runoff quality and provision of amenity and biodiversity. Systems incorporating these features are often termed Sustainable Drainage Systems (SuDS) and it is a requirement of PPG that these are considered as the primary means of collection, control and disposal for storm water as close to source as possible.

The volume of attenuation required for the development has been estimated using the hydraulic design software MicroDrainage. The proposed impermeable areas taken from the current layout have been used to evaluate the runoff response of the site during varying rainfall events.

For the purposed of this assessment an orifice plate flow control device has been used. The software uses the FSR characteristics of M5-60= 18.800 mm and ratio R= 0.400.

The MicroDrainage outputs are included in Appendix E and summarised in Table 5.4 below.

Table 5.4: Summary of Anticipated Attenuation Volume

Method of Disposal	Impermeable Area (Ha)	Unrestricted Run-off (l/s)	Flow Restriction (m/s and l/s)	Estimated Attenuation Volume (1:100yr +20%) (m^3)	Estimated Attenuation Volume (1:100yr +40%) (m^3)
Discharge to Ground	1.60	177.92	5×10^{-6}	930	1085
Discharge to Public Sewer	1.60	177.92	75	472	586

Source: MicroDrainage Calculation

This assessment is for the whole proposed impermeable area discharging to a single system such as an infiltration blanket or below ground geocellular storage system. Undeveloped areas within the site boundary have not been considered as it is assumed that drainage of these areas will be as existing.

5.5 Sustainable Drainage Systems (SuDS) and Water Quality

With the required volume of storage estimated it is necessary to determine appropriate forms of attenuation that may be used. In accordance with the 'SuDS Manual' CIRIA report C753 there are four main categories of benefits that can be achieved by SuDS:

- Water quantity – control the quantity of run-off to reduce flood risk and maintain and protect the natural water cycle
- Water quality – manage the quality of the run-off to prevent pollution
- Amenity – create and sustain better places for people
- Biodiversity – create and sustain better places for nature

The SuDS Manual and EA guidance applies a sustainability hierarchy to the various types of SuDS systems, this is summarised in Table 5.5. Systems at the top of the hierarchy provide a greater combination of the four main benefits and are deemed the most sustainable options.

Table 5.5: SuDS Hierarchy

Component Type	Water Quantity	Water Quality	Amenity	Biodiversity
Living or Green Roofs	✓	✓	✓	✓
Basins and Ponds	✓	✓	✓	✓
Filter Strips and Swales	✓	✓	✓	✓
Rain Gardens and Bioretention Areas	✓	✓	✓	✓
Pervious Paving	✓	✓		
Tanked Systems	✓			
Surface Storage	✓			

Source: SuDS Manual C753

SuDS can take many forms, both above and below ground and most SuDS schemes use a combination of SuDS components to achieve the overall design objectives for the site, known as the SuDS Management Train. The use of a sequence of different SuDS components can collectively provide the necessary processes to control the frequency of run-off, the flow rates, and the volumes of run-off, and to reduce the concentration of contaminants to acceptable levels.

There are always specific scenarios where some SuDS systems are more suitable than others for a particular site. Outlined below are summaries of some of the main types of SuDS systems that may be applied to the development outlining the main benefits and constraints to their application and suitability for this development.

5.5.1 Living or Green Roofs

Larger areas of roof may be designated as living or green roofs to provide both point water treatment and significant enhancement of local biodiversity. The assessment gains are such that these systems are the preferred EA option for the provision of SuDS.

If considered at the outset of the design of a unit, a green roof can be integrated within the provision of a roof terrace area to multiply the benefits, amenity, a maintained roof can be installed that may require specialist access.

There are numerous proprietary systems available on the market to suit various specific applications and it is recommended that is these systems are being considered discussion with several suppliers is instigated as soon as possible.

While a useful system, the application of a green roof for the proposed stadium roof on this site is limited due to on-going maintenance and access requirements of any system. The use of green roofs will therefore not be considered further.

5.5.2 Ponds and Basins

The nature of these systems is such that the run-off from the development can be treated by biological action and stilling to significantly improve the quality of water discharge from the system.

Basins also provide large areas of open space that can be developed for recreational uses or as new habitat for wildlife.

Both systems do, however, take up developable land and have residual maintenance and liability issues attached to their implementation.

In this case, the special constraints of the site restrict the use of ponds or basins as a means of attenuation is not viable. The use of ponds or basins will therefore not be considered further at the detailed design stage.

5.5.3 Filter Strips and Swales

Often used adjacent to roads and footpaths, swales and filter strips can be used to collect water directly from linear features, percolate flow, attenuate and then discharge the flow to either a traditional system or a secondary SuDS device.

The use of these systems is more suited to linear applications such as roads as the typical cross section is relatively small and longer runs are required to provided attenuation volume.

Filter strips will be smaller in plan area than a swale although the swale can be landscaped to be incorporated into the verge of the carriageway, combining two functions.

Land take can be relatively small in comparison to other systems and both types perform well in improving water quality. They are also ideally suited for disposal of water via secondary infiltration. However, due to the expected ground conditions any filter strips of swales would have to be used primarily as a form of conveyance.

It is likely that the site layout would not provide sufficient space adjacent to the carriageways to allow for the use of filter strips or swales. The use of filter strips or swales will therefore not be considered further at the detailed design stage.

5.5.4 Rain Gardens and Bioretention Areas

Bioretention systems including rain gardens are shallow landscaped depressions that can reduce runoff rates and volumes and treat pollution through the use of engineered soils and vegetation. They are flexible surface water management components that can be integrated into a wide variety of development landscapes using different shapes, material planting and dimensions.

Bioretention areas are generally applied to small catchments and the maximum recommended area that should drain to a bioretention system is 0.8ha.

Bioretention areas are designed for intermittent flow and the surface should be designed to drain and re-aerate between rainfall events.

There are some planted areas proposed along the boundary with Stanley Park where bioretention areas could be utilised for draining localised parts of the site. The use of bioretention areas will therefore be considered further at the detailed design stage.

5.5.5 Permeable Paving

Large areas of paved hardstanding can easily be converted to provide significant volumes of storage. These systems also encourage biological treatment of flow and extraction of oils and heavy metals from the run-off.

Land take is reduced as storage is located under the car parking areas. However, maintenance is potentially a long-term issue and the possibility of the paving being damaged, dug up and not properly reinstated or not regularly swept could lead to compromising the future capacity and efficiency and asset life of the system.

This system could reduce the use of a separate collection system such as kerbs and gullies and potentially could negate the use of an oil separator. It could also assist in reducing the flood profile of the site by detaining run-off from the development within the sub-base material.

There is no specific amenity provided by the system other than enabling other areas to be utilised for development rather than potentially sterilising areas with an easement for a sewer or stand off for a pond or basin.

These systems may be incorporated into normal car parking areas and driveways but may not be suitable for areas accessed by larger vehicles. Some areas of the proposed external landscaping may be suitable for the use of permeable paving surfaces.

Currently it is considered that this method would be of limited benefit from an infiltration perspective due to the underlying ground conditions, however, the system could still be used and the sub-base utilised as a form of attenuation which could make a small reduction to the overall run-off and storage requirement for the site. This system will therefore be considered further at the detailed design stage.

5.5.6 Tanked Systems

5.5.6.1 Cellular Storage

Large volumes of storage can be provided under grassed and lightly trafficked areas by using proprietary plastic cellular systems. This will maximise the developable area of the site.

There is no specific mechanism within the system designed to treat flow, but extended detention times will allow sedimentation, reducing the suspended solids within the discharge.

There is no creation of amenity or biodiversity by the installation of these types of systems, indeed by maintaining access to the system small areas may need to be reserved.

If the developable footprint is constrained then these systems may be advantageous, however, to ensure adoptability it is recommended that the use of these systems is discussed with the adopting authority as they are not always preferred. As some of the drainage on this site is to be private this is not believed to be an issue.

The use of geocellular storage will therefore be considered further at the detailed design stage.

5.5.6.2 Tank or Culvert Storage

Hard engineered tank storage systems have traditionally been used for attenuation structures for the past decade and area often specified where large volumes of storage are required (>200m^3) and available space is an issue.

These systems have no inherent water treatment properties except potential sedimentation of the attenuated flow and offer no additional amenity benefits. In some cases, the easement to the tank or culvert is such that a significant portion of land area is sterilised from development.

There are also significant costs associated with these systems in production, transportation, and installation. However, once installed the long-term maintenance requirement of the system is relatively low.

With a proven record of successful installation, tanks and culverts are regularly adopted by water companies across the country, albeit with a large associated easement that will sterilise that portion of the site. Tanks or culverts should generally be laid contours than across them minimise excavation depths.

The use of below ground tanks or culvert storage will therefore be considered further at the detailed design stage.

5.5.6.3 Oversized Pipework

It is often possible to provide the required volume of storage within the existing collection pipework of the proposed system. This may be incorporated by using oversized pipework designed to act as inline storage.

As the diameter of the larger pipes readily available is limited the applicability of these types of systems is more suited to <200m^3 of attenuation. Above this volume the length of pipe required is excessive and difficult to fit into a normal site layout.

There is no intrinsic amenity provided by the use of this system neither is there any specific level of run-off treatment over and above that of a standard pipe and gully system.

However, due to their traditional nature, the adoption of these types of systems by water companies is straightforward and does not require and specialist input. The pipes are generally available direct from suppliers with little or no lead in time and the satisfactory long-term performance of these systems is well documented.

Oversized pipework maybe required as a form of attenuation within some areas of the site, this will be considered further at the detailed design stage.

5.5.7 Surface Storage

The use of roads, public areas and even landscaped areas as additional storage for an extreme rainfall event is becoming a widely accepted form of attenuation.

Water spilling from drainage systems can be collected via roads and kerbs and channelled to lower lying areas where it would be stored until the capacity in the existing system returns.

These systems have the advantage of requiring little additional infrastructure merely detailing of the proposed roads and grassed areas.

As these systems will only be used in extreme events when the adopted drainage system is exceeded (>1 in 30-years), they provide a very efficient way of catering for these events rather than providing permanent capacity.

There is no inherent water treatment capability in this system nor any particular increase in amenity, however, the costs associated with this provision are relatively small.

As there is a defined slope across the site from northwest to southeast, the safe management of flows on the surface and the mobilisation of sufficient attenuation volumes would be impractical on a site wide basis. However, it may be possible to utilise these systems on a smaller scale in small areas of the site, this will be reviewed at the detailed design stage when the proposed external levels are finalised.

5.6 Surface Water Design Proposal

If infiltration is deemed viable on site, then it is proposed that surface water runoff will discharge to ground. Infiltration rates of around 5×10^{-6} ms^{-1} may be achievable which would result in an estimated attenuation volume of 930m^3 to ensure no flooding from the surface water drainage system for events up to and including the 1 in 100-year event including 20% for climate change.

The infiltration blanket could be located in the pedestrian plaza area to the southeast of the new Anfield Road Stand. A significant depth of excavation would be required to provide the attenuation volume.

If the infiltration rates of the ground are found to be too low to efficiently utilise infiltration as a means of surface water disposal then it is proposed that surface water from the Site discharges into the UU owned 375mm diameter combined public sewer in Anfield Road.

It is proposed that the surface water discharge rate will be limited to 75l/s, providing a 30% reduction in the existing surface water discharge rate to the overall public sewer network. As outlined in Table 5.4 a total approximate attenuation volume of 472m^3 will be required to ensure no flooding from the surface water drainage system for events up to and including the 1 in 100-year event including 20% for climate change.

Due to the limited available space on site it is proposed that the majority of the required attenuation volume is provided in the form of geocellular storage located in the pedestrian plaza area to the southeast of the new Anfield Road Stand. At the detailed design stage, the potential use of permeable paving and bioretention areas will be explored to try and optimise the volume of geocellular storage.

Discussions are currently on going with UU regarding the point of connection and proposed discharge rate for the surface water drainage and will be confirmed at the detailed design stage.

5.7 Foul Water Design Proposal

5.7.1 Existing Foul Water Flow Rates

The existing foul flow rates from the Anfield Road Stand have been calculated using the discharge unit method as outlined in BS EN 12056-2:2000 (Gravity Drainage Systems Inside Buildings). The equation below is used to calculate the expected flowrate of foul water from the whole Site.

$$Q = K\sqrt{\sum DU}$$

Where: Q = peak foul flowrate (l/s)

K = frequency factor (dimensionless)

ΣDU = sum of discharging units

A frequency factor of 1.0 has been used allowing for congested use.

The total number of discharging units from the existing stand have been calculated as 173.50 based in the existing floor plans. The existing peak flow rate for the site has been calculated as 13.17l/s. Calculations of the existing foul discharge rates are included in Appendix F.

5.7.2 Proposed Foul Water Flow Rates

The proposed foul flow rates from the redeveloped Anfield Road Stand have been calculated using the same method as outlined above.

The total number of discharging units from the proposed stand have been calculated as 460.10 based in the proposed floor plans. The proposed peak flow rate for the site has therefore been calculated as 21.45l/s. This represents an increase in the peak foul discharge rate from the site of 8.28l/s.

Calculations of the proposed foul discharge rates are included in Appendix F.

5.7.3 Foul Water Drainage Strategy

It is proposed that the foul flows from the redeveloped Anfield Road Stand will all discharge via the existing foul drainage network on site into the 910x1520mm combined public sewer to the south of the stadium, which flows under the Kop Stand.

The existing private foul drainage network will need to be modelled to confirm there is sufficient capacity to accept the additional foul flows and that any additional drainage can discharge into this network via gravity. If there is not sufficient capacity in the existing private foul drainage network or gravity connections are not viable then discharging some of the additional foul flows into the 375mm diameter combined public sewer in Anfield Road should be explored.

Discussions are currently on going with UU regarding the point of connection and proposed additional flows for the foul water drainage and will be confirmed at the detailed design stage.

5.8 Design Standards and Consents

The foul and surface water drainage networks on site will remain separate systems.

All new private foul and surface water drainage systems on site will be developed and be designed in accordance to the requirements set out in Building Regulations Part H.

All new foul and surface water drainage to be adopted will be designed in accordance to the requirements set out in Sewers for Adoption (7^{th} Edition) and UU specific guidelines.

Formal consent will be required from UU to confirm the location of connection and proposed discharge rates into the existing public sewer networks at the detailed design stage.

5.9 Flood Routing

The performance of the system during extreme events (>1 in 100 years) should also be considered at this stage.

The routing of potential storm water run-off, should the capacity of the proposed site drainage system be exceeded, needs to be built into the layout of the site such that the residual risk of flooding from this element can be easily mitigated.

All proposed manholes are to be located external to the building so if there was a blockage of the drainage system and flooding were to occur the flood water would emanate within the curtilage realigned Anfield Road or the Plaza Area. Due to the topography of the site, flood water would flow along the realigned Anfield Road towards the southeast and then along Skerries Road as indicated by the EA surface water flooding map in Figure 3.2. Any flood water would be contained with the curtilage of the carriageway and collected by the highway drainage system.

Due to the topography of the site there is limited potential for overland storage within the site boundary.

5.10 Maintenance

The proposed foul and surface water drainage networks will be privately owned, and the maintenance will be the responsibly of the landowner, LFC.

Discussions are currently underway with UU regarding the potential to either divest or abandon the existing 375mm diameter combined public sewer in Anfield Road, where it will be under the footprint of the proposed redeveloped Anfield Road Stand. The point to which the public sewer will be divested or abandoned will need to be confirmed with UU. Downstream of this point the public sewers will remain under the ownership and maintenance responsibility of UU.

It is currently proposed that the section of Anfield Road where is passes through the site comes under the ownership of LFC so any highway drainage will be privately owned by LFC.

It is recommended that a maintenance schedule such as that outlined in Table 5.6 is followed to ensure the required level of performance of the drainage system is maintained and the operational life if the system optimised.

Table 5.6: Proposed Maintenance Schedule Overview

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspect and identify any areas of the drainage system that are not operating correctly. If required, take remedial action.	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance).	Monthly
	Remove sediment from pre-treatment structures (road gullies, channel drain silt traps, catchpits etc).	Annually or as required
	Remove sediment from within attenuation structure (gully sucker)	Annually or as required
Remedial Actions	Repair/replace any damaged surface drainage features (manhole covers, gully gratings, outlets etc)	Reactive, as required
Monitoring	Inspect all surface drainage components to ensure they are in good condition and operating as designed.	Annually
	Survey inside of below ground drainage piped network for structural damage and sediment build-up.	Every 5 years or as required
	Survey inside of attenuation structure for structural damage and sediment build-up.	Every 5 years or as required

Source: The SuDs Manual, CIRIA C753 (2015)

6 Conclusion

Following this assessment, it is considered that the site can be classified as being within Flood Zone 1, an area with low fluvial flood risk as determined by Table 1 of PPG-TG.

The site has been shown to be outside of the flood envelope of all other identified sources of flood potential and as such the development type is deemed to be suitable for this location.

The management of storm water generated by the development itself will be the principal flood risk to the development and the area overall.

The ground conditions on site suggest that infiltration may be possible, with infiltration rates around 5×10^{-6} ms^{-1} potentially achievable. Therefore, infiltration tests are being undertaken to BRE365 as part of the intrusive ground investigations. If infiltration is not deemed to be feasible and as there are no watercourses in the vicinity of the site, it would be proposed that surface water will discharge to the UU owned combined public sewer network in Anfield Road.

The allowable site discharge rate has been determined based on the existing brownfield runoff rate with a 30% betterment. The surface water discharge rate from the proposed site to a public sewer will therefore be limited to 75l/s.

Based on the indicative proposed layout the required attenuation for the 1 in 100-year +20% event is approximately 930m^3, if discharging via infiltration or 472m^3, if discharging to the public sewer network. An appropriate method of providing this volume of attenuation is deemed to be either an infiltration blanket or geocellular storage, due to the overall space restrictions on the site. Further storage options will be considered at the detailed design stage.

Foul drainage from the site will discharge into the UU owned combined public sewer network. The proposed development will see an increase in peak foul flows of approximately 8.28l/s at peak times.

Approval from UU is required at the detailed design stage for both the proposed foul and surface water drainage discharges into the combined public sewer network.

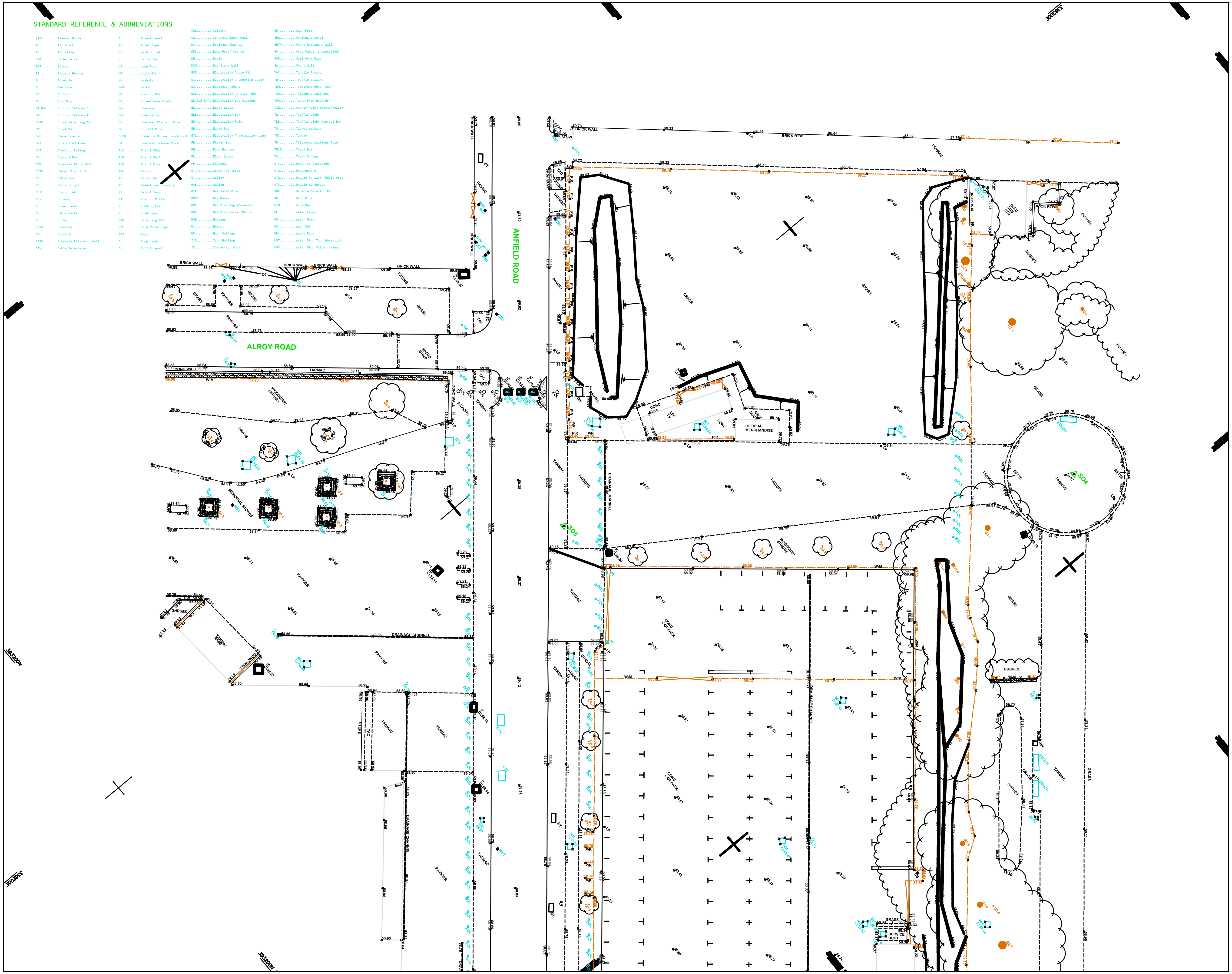
Flood routing should also be considered during the detailed design of the storm water systems to further improve the run-off profile of the proposed development and provide flood resilience to the development. Ensuring that finished floor levels of buildings are a minimum of 150mm above the proposed levels of external areas will help to mitigate again residual risks of flooding caused due to blockages or failure of the proposed drainage system. Additional flood resilient measures that could be incorporated to commercial properties include raising any meters or vital equipment 600mm above the finished floor level.

A. Topographical Survey

A.1 19H298/001

A.2 19H298/002

A.3 19H298/003

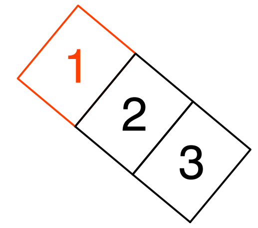


Note:

The survey is plotted on a plane local Grid. Orientation to National Grid.
All levels relate to Ordnance Datum, achieved using the OS National GPS Network.

Survey Control Markers established for Mapping purposes only and should not be used for Construction without the written approval of Survey Operations Ltd.

SURVEY STATIONS			
Name	Easting	Northing	Height
S01	336369.65	393096.09	56.09
S02	336417.55	393160.58	55.96
S03	336326.23	393237.90	58.02
S04	336242.34	393307.01	59.68
S05	336209.56	393258.33	59.30
S06	336353.24	393140.93	56.88



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Client: Legends International

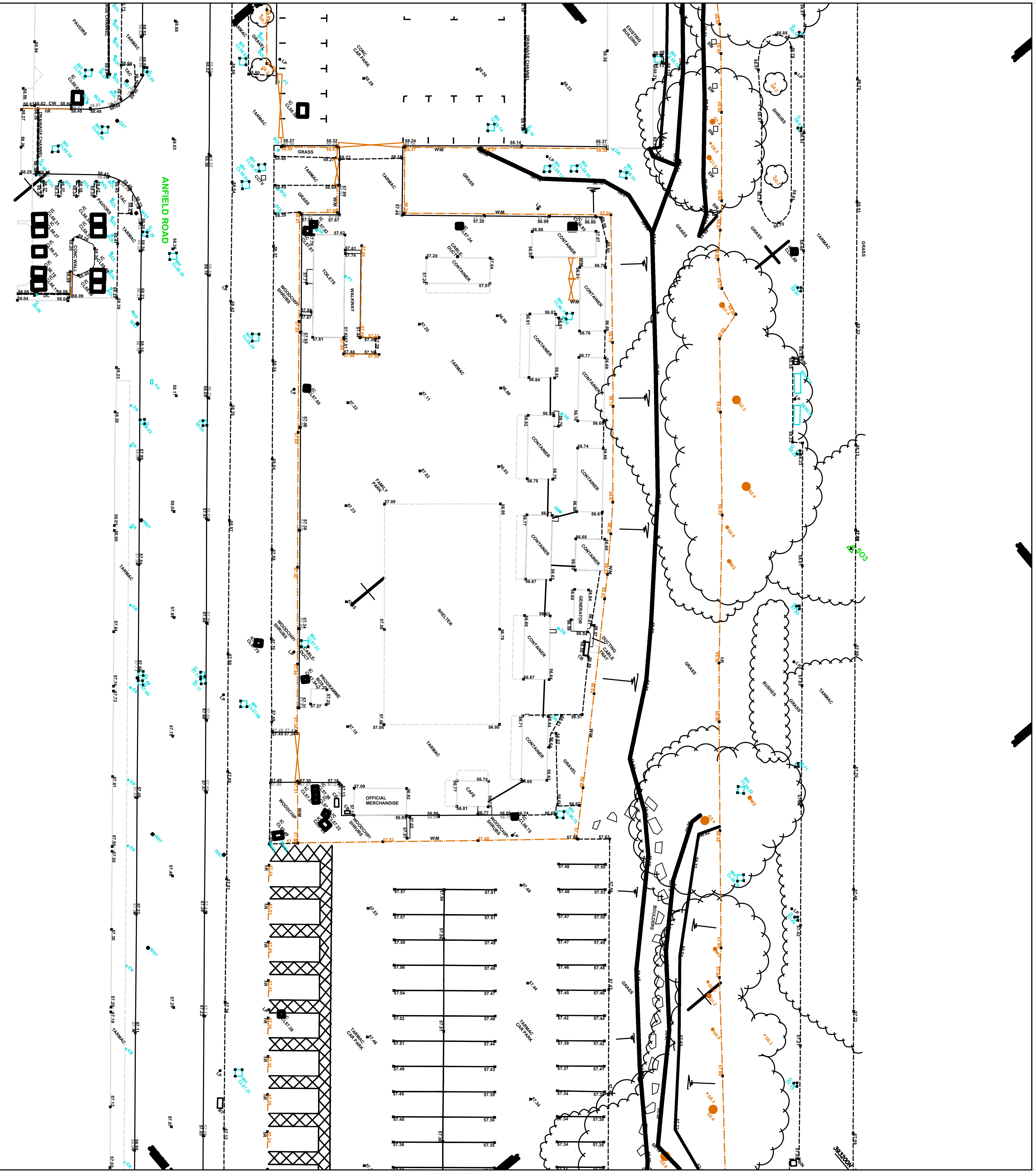
Drawing Title:
Topographical Survey of Land at:
Liverpool Revit Model
Liverpool
Sheet 1 of 3

Scale(s)	1:200	Surveyor	CA
Date	SEP 19	Drawn	CD
Job Number	19H298	Checked	TP

Sheet Size & Drg Number & Revision: A1 19H298/001

STANDARD REFERENCE & ABBREVIATIONS

(AR)........Assumed Route
AB..........Air Brick
AV..........Air Valve
B/W.........Barbed Wire
BAR.........Barrier
BB..........Belisha Beacon
BH..........Borehole
BL..........Bed Level
BOL.........Bollard
BS..........Bus Stop
BT Box......British Telecom Box
BT..........British Telecom IC
BRTW........Brick Retaining Wall
BW..........Brick Wall
C/B.........Close Boarded
C/I.........Corrugated Iron
C/P.........Chestnut Paling
CB..........Control Box
CBW.........Concrete Block Wall
CCTV........Closed Circuit TV
CD..........Cable Duct
CEL.........Cellar Light
CH/L........Chain Link
CHY.........Chimney
CL..........Cover Level
CM..........Cable Marker
COL.........Column
CONC........Concrete
CP..........Catch Pit
CRTW........Concrete Retaining Wall
CTV.........Cable Television
IL..........Invert Level
IP..........Inlet Pipe
KO..........Kerb Outlet
LB..........Letter Box
LP..........Lamp Post
MG..........Multi-Girth
MH..........Manhole
MKR.........Marker
MP..........Mooring Point
NP..........Street Name Plate
O/H.........Overhead
O/P.........Open Paling
OE..........Overhead Electric Wire
OP..........Outfall Pipe
OSBM........Ordnance Survey Bench Mark
OT..........Overhead Telecom Wire
P/C.........Post & Chain
P/R.........Post & Rail
P/W.........Post & Wire
PAV.........Paving
PB..........Pillar Box
PC..........Pedestrian Crossing
PP..........Petrol Pump
PT..........Post or Pillar
RE..........Rodding Eye
RS..........Road Sign
RTW.........Retaining Wall
RWP.........Rain Water Pipe
SAP.........Sapling
SL..........Sump Level
SoL.........Soffit Level
CUL.........Culvert
CW..........Concrete Block Wall
DC..........Drainage Channel
DPC.........Damp Proof Course
DR..........Drain
DSW.........Dry Stone Wall
ECP.........Electricity Cable Pit
EIC.........Electricity Inspection Cover
EJ..........Expansion Joint
EJB.........Electricity Junction Box
EL SUB STN..Electricity Sub Station
EL..........Eaves Level
ELB.........Electricity Box
EP..........Electricity Pole
ER..........Earth Rod
ETL.........Electricity Transmission Line
FB..........Flower Bed
FH..........Fire Hydrant
FL..........Floor Level
FP..........Flagpole
G*.*........Girth (of tree)
G...........Gulley
GAB.........Gabion
GIP.........Gas Inlet Pipe
GMKR........Gas Marker
GST.........Gas Stop Tap (Domestic)
GSV.........Gas Stop Valve (Mains)
HSE.........Housing
Ht..........Height
HV..........High Voltage
I/R.........Iron Railing
IC..........Inspection Cover
SP..........Sign Post
SPL.........Springing Level
SRTW........Stone Retaining Wall
SV..........Stop Valve (unspecified)
SVP.........Soil Vent Pipe
SW..........Stone Wall
TAC.........Tactile Paving
TB..........Traffic Bollard
TBM.........Temporary Bench Mark
TCB.........Telephone Call Box
TFR.........Taken From Records
TIE.........Anchor Point (Masts/Poles)
TL..........Traffic Light
TLB.........Traffic Light Control Box
TM..........Ticket Machine
TMC.........Tarmac
TP..........Telecommunications Pole
TPIT........Trial Pit
TS..........Trash Screen
U/C.........Under Construction
U/G.........Underground
UTL.........Unable to Lift (MH,IC etc)
UTS.........Unable to Survey
VDP.........Vehicle Detector Pad
VP..........Vent Pipe
W/M.........Wire Mesh
WL..........Water Level
WM..........Water Meter
WO..........Wash Out
WP..........Waste Pipe
WST.........Water Stop Tap (domestic)
WSV.........Water Stop Valve (mains)



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SURVEY STATIONS			
Name	Easting	Northing	Height
SO1	336369.65	393096.09	56.09
SO2	336417.55	393160.58	55.96
SO3	336326.23	393237.90	58.02
SO4	336242.34	393307.01	59.68
SO5	336209.56	393258.33	59.30
SO6	336353.24	393140.93	56.88

1 2 3

SurveY OPERATIONS

Smith Street, Skelmersdale, Lancs. WN8 8LN
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Email: mail@survops.co.uk – www.survops.co.uk

Client
Legends International

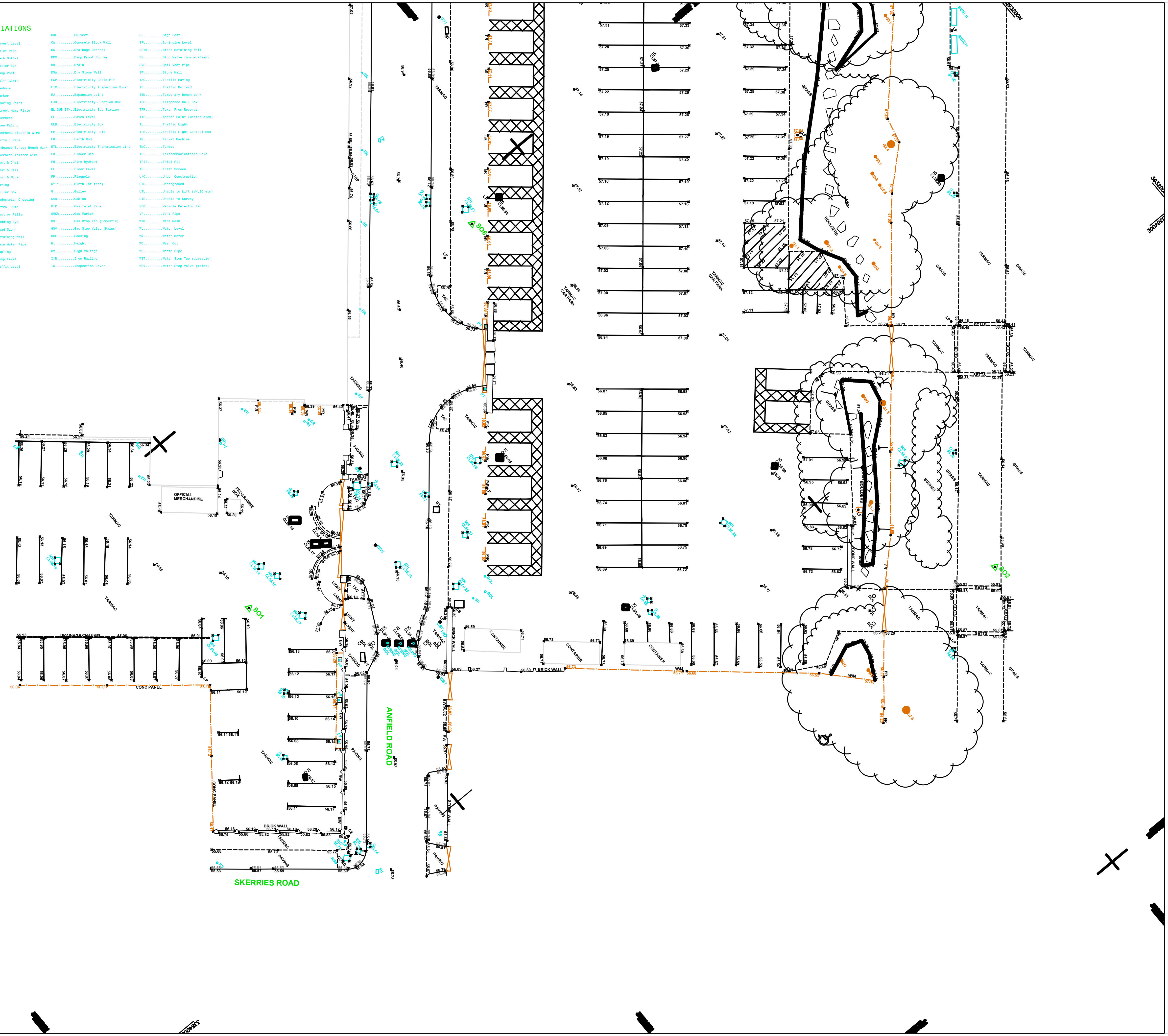
Drawing Title
Topographical Survey of Land at:
Liverpool Revit Model
Liverpool
Sheet 2 of 3

Scale(s)	1:200	Surveyor	CA
Date	SEP 19	Drawn	CD
Job Number	19H298	Checked	TP

Sheet Size & Drg Number & Revision
A1 19H298/002

STANDARD REFERENCE & ABBREVIATIONS

(AR)........Assumed Route	IL.........Invert Level	CUL.........Culvert	SP.........Sign Post
AB.........Air Brick	IP.........Inlet Pipe	CW.........Concrete Block Wall	SPL.........Springing Level
AV.........Air Valve	KO.........Kerb Outlet	DC.........Drainage Channel	SRTW........Stone Retaining Wall
B/W.........Barbed Wire	LB.........Letter Box	DPC.........Damp Proof Course	SV.........Stop Valve (unspecified)
BAR.........Barrier	LP.........Lamp Post	DR.........Drain	SVP.........Soil Vent Pipe
BB.........Belisha Beacon	MG.........Multi-Girth	DSW.........Dry Stone Wall	SW.........Stone Wall
BH.........Borehole	MH.........Manhole	ECP.........Electricity Cable Pit	TAC.........Tactile Paving
BL.........Bed Level	MKR.........Marker	EIC.........Electricity Inspection Cover	TB.........Traffic Bollard
BOL.........Bollard	MP.........Mooring Point	EJ.........Expansion Joint	TBM.........Temporary Bench Mark
BS.........Bus Stop	NP.........Street Name Plate	EJB.........Electricity Junction Box	TCB.........Telephone Call Box
BT Box......British Telecom Box	O/H.........Overhead	EL SUB STN..Electricity Sub Station	TFR.........Taken From Records
BT.........British Telecom IC	O/P.........Open Paling	EL.........Eaves Level	TIE.........Anchor Point (Masts/Poles)
BRTW........Brick Retaining Wall	OE.........Overhead Electric Wire	ELB.........Electricity Box	TL.........Traffic Light
BW.........Brick Wall	OP.........Outfall Pipe	EP.........Electricity Pole	TLB.........Traffic Light Control Box
C/B.........Close Boarded	OSBM........Ordnance Survey Bench Mark	ER.........Earth Rod	TM.........Ticket Machine
C/I.........Corrugated Iron	OT.........Overhead Telecom Wire	ETL.........Electricity Transmission Line	TMC.........Tarmac
C/P.........Chestnut Paling	P/C.........Post & Chain	FB.........Flower Bed	TP.........Telecommunications Pole
CB.........Control Box	P/R.........Post & Rail	FH.........Fire Hydrant	TPIT........Trial Pit
CBW.........Concrete Block Wall	P/W.........Post & Wire	FL.........Floor Level	TS.........Trash Screen
CCTV........Closed Circuit TV	PAV.........Paving	FP.........Flagpole	U/C.........Under Construction
CD.........Cable Duct	PB.........Pillar Box	G*.*........Girth (of tree)	U/G.........Underground
CEL.........Cellar Light	PC.........Pedestrian Crossing	G..........Gulley	UTL.........Unable to Lift (MH,IC etc)
CH/L........Chain Link	PP.........Petrol Pump	GAB.........Gabion	UTS.........Unable to Survey
CHY.........Chimney	PT.........Post or Pillar	GIP.........Gas Inlet Pipe	VDP.........Vehicle Detector Pad
CL.........Cover Level	RE.........Rodding Eye	GMKR........Gas Marker	VP.........Vent Pipe
CM.........Cable Marker	RS.........Road Sign	GST.........Gas Stop Tap (Domestic)	W/M.........Wire Mesh
COL.........Column	RTW.........Retaining Wall	GSV.........Gas Stop Valve (Mains)	WL.........Water Level
CONC........Concrete	RWP.........Rain Water Pipe	HSE.........Housing	WM.........Water Meter
CP.........Catch Pit	SAP.........Sapling	Ht.........Height	WO.........Wash Out
CRTW........Concrete Retaining Wall	SL.........Sump Level	HV.........High Voltage	WP.........Waste Pipe
CTV.........Cable Television	SoL.........Soffit Level	I/R.........Iron Railing	WST.........Water Stop Tap (domestic)
		IC.........Inspection Cover	WSV.........Water Stop Valve (mains)



Note:

The survey is plotted on a plane local Grid. Orientation to National Grid. All levels relate to Ordnance Datum, achieved using the OS National GPS Network.

Survey Control Markers established for Mapping purposes only and should not be used for Construction without the written approval of Survey Operations Ltd.

SURVEY STATIONS

Name	Easting	Northing	Height
SO1	336369.65	393096.09	56.09
SO2	336417.55	393160.58	55.96
SO3	336326.23	393237.90	58.02
SO4	336242.34	393307.01	59.68
SO5	336209.56	393258.33	59.30
SO6	336353.24	393140.93	56.88

1 2 3

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Email: mail@survops.co.uk – www.survops.co.uk

Client: Legends International

Drawing Title: Topographical Survey of Land at: Liverpool Revit Model, Liverpool, Sheet 3 of 3

Scale(s): 1:200	Surveyor: CA
Date: SEP 19	Drawn: CD
Job Number: 19H298	Checked: TP

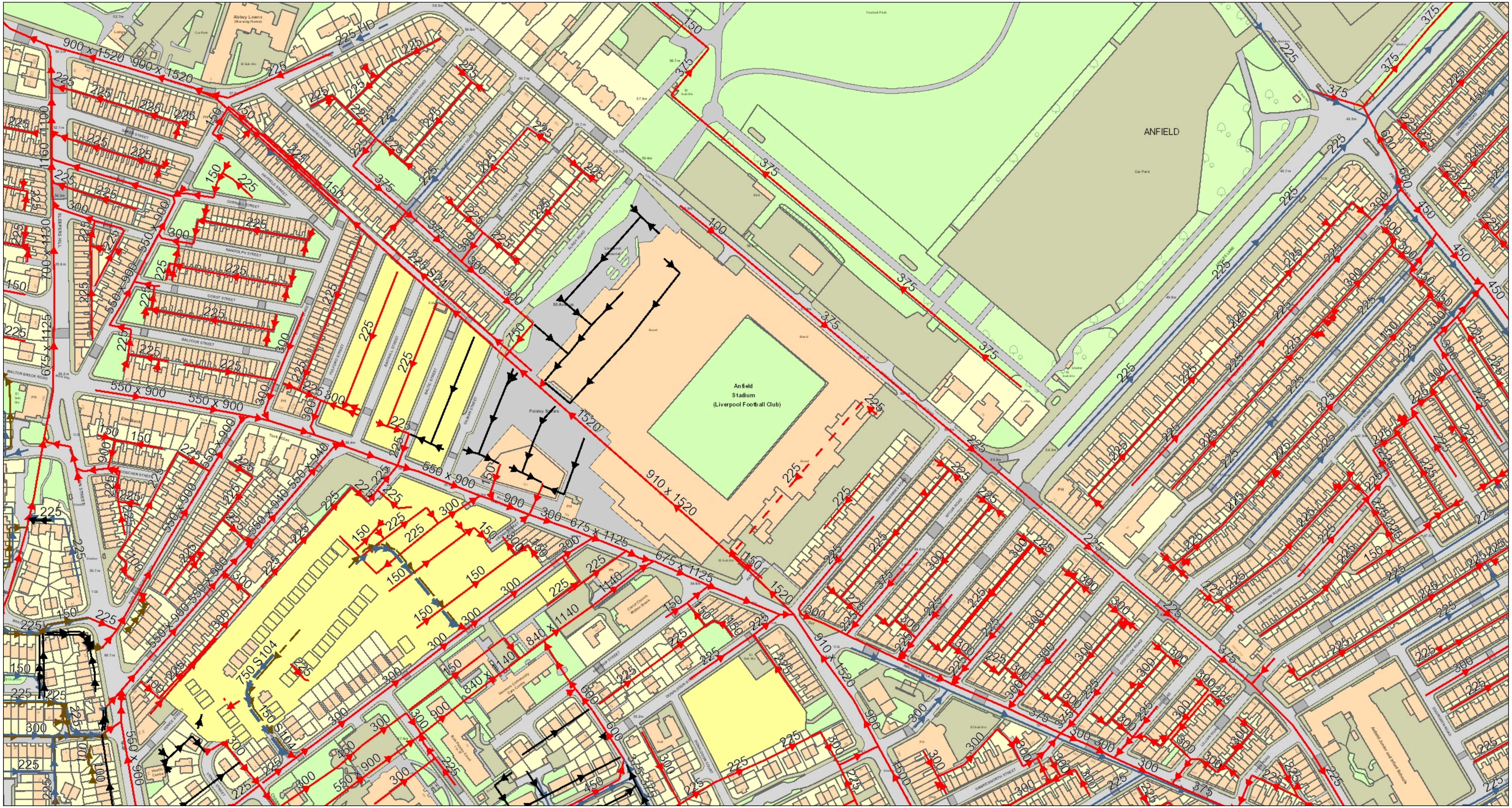
Sheet Size & Drg Number & Revision: A1 19H298/003

B. United Utilities Sewer Records

United Utilities Maps for SafeDig

UserName: MOTTMACNRT

Centre : X : 336271 Y : 393104	**Date :** 05/03/2020 14:11:17	**Scale Approx :** 2500



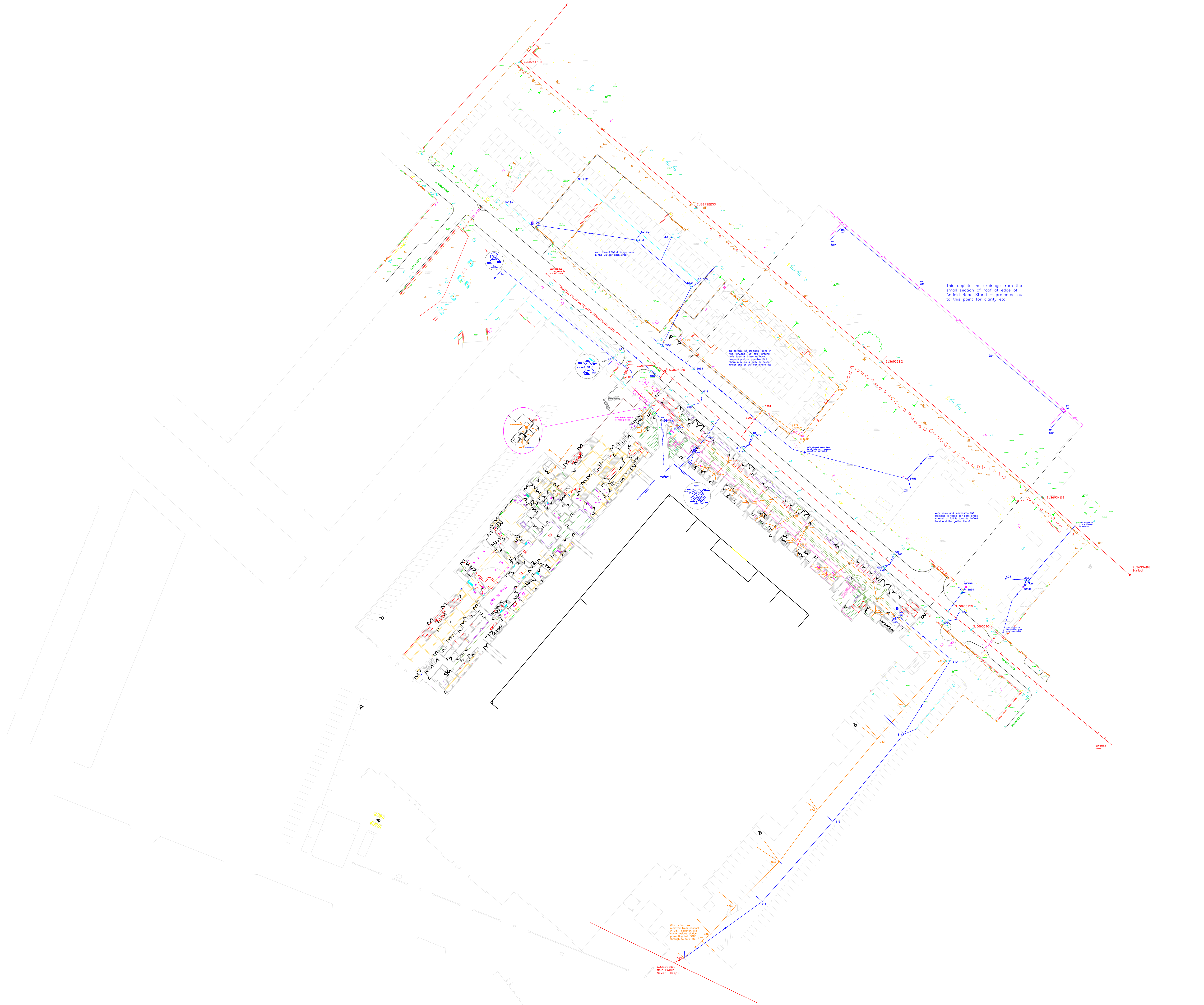
Extract from maps of United Utilities' Underground Assets

The position of the underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available. The actual positions may be different from those shown on the plan and private service pipes may be shown by a blue broken line. United Utilities Water will not accept liability for any damage caused by the actual position being different from those shown.

United Utilities helping life flow smoothly

C. Private Drainage Survey

C.1 1584/01 Rev 01



N

Legend/Notes:

- Combined Sewer
- Foul Sewer
- SW Sewer
- Assumed Sewer (Not Proven)
- Rising Main
- Highway Drainage
- Culvert Sewer
- Open Water Course
- Overflow Line
- Treated Line
- RWD Rain Water Down Pipe
- FDP Foul Down Pipe
- CDP Combined Down Pipe
- GDP Grey Water Down Pipe
- Highway Gully
- Septic Tanks
- Direction of overland flows
- +48.591 Spot levels
- Air Valve
- Hatchbox
- Capped End
- Penstock

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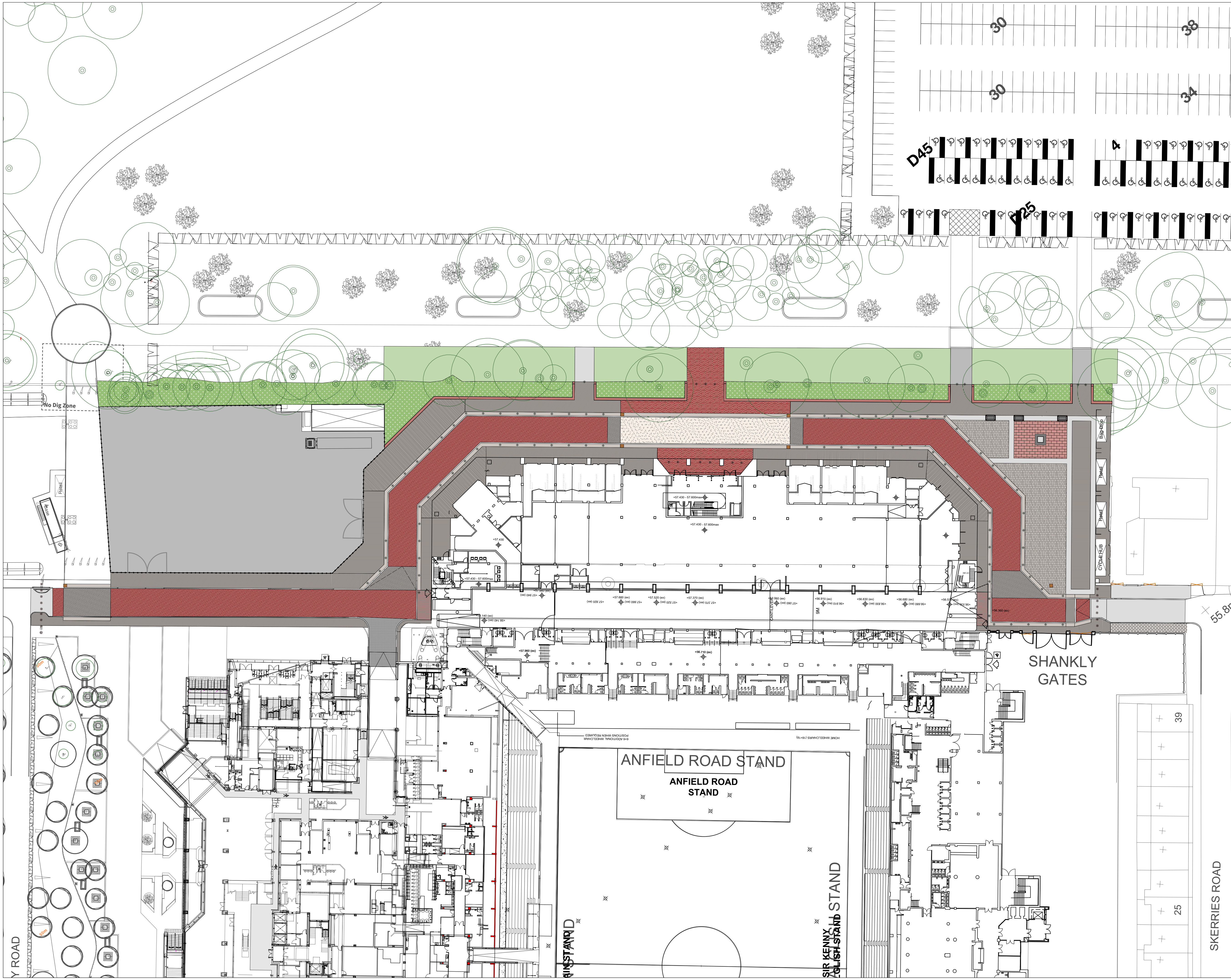
Client	Mott MacDonald
Drawing Title	LFC Combined Drainage Layout
Scale(s)	N.T.S
Drawn	PW
Date	19.12.19
Checked	RD
Job Number	1584
Approved	KN
Sheet Size, Drawing Number & Revision	A1_1584/01_Rev_01

D. Proposed Landscape Masterplan

D.1 ARS-PLA-XX-XX-DR-L-0012



NOTES:
1. Do not scale from this drawing.
2. Always work to noted dimensions.
3. All dimensions are in millimetres unless otherwise stated.
4. All setting out, levels and dimensions to be agreed on site.
5. The dimensions of all materials must be checked on site before being laid out.
6. This drawing must be read with the relevant specification clauses and detail drawings.
7. Order of construction and setting out to be agreed on site.

Revision	Date	Description	Drawn	Apprvd.
S1-P02	24.01.20	FOR COMMENT	AT	GB
S1-P01	21.01.20	FOR COMMENT	AT	GB

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Client Liverpool FC

Project Anfield Road Stand Expansion

Drg Title Public realm general arrangement

Created on	Created by	Approved by
21.01.20	AT	GB

Scale	Size	Workstage
1:400	A1	RIBA 02

Drg No.	Suitability	Revision
ARS-PLA-XX-XX-DR-L-0012	S1	P02

E. Surface Water Attenuation Volume Calculations

Summary of Results for 100 year Return Period (+20%)

Half Drain Time : 1717 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	0.599	0.599	4.6	327.7	O K
30 min Summer	0.783	0.783	4.6	428.3	O K
60 min Summer	0.971	0.971	4.6	531.3	O K
120 min Summer	1.156	1.156	4.6	632.3	O K
180 min Summer	1.255	1.255	4.6	686.8	O K
240 min Summer	1.318	1.318	4.6	721.2	O K
360 min Summer	1.388	1.388	4.6	759.7	O K
480 min Summer	1.430	1.430	4.6	782.4	O K
600 min Summer	1.452	1.452	4.6	794.7	O K
720 min Summer	1.462	1.462	4.6	800.1	O K
960 min Summer	1.459	1.459	4.6	798.1	O K
1440 min Summer	1.401	1.401	4.6	766.6	O K
2160 min Summer	1.309	1.309	4.6	716.5	O K
2880 min Summer	1.235	1.235	4.6	675.8	O K
4320 min Summer	1.104	1.104	4.6	603.9	O K
5760 min Summer	0.981	0.981	4.6	537.1	O K
7200 min Summer	0.866	0.866	4.6	473.8	O K
8640 min Summer	0.757	0.757	4.6	414.4	O K
10080 min Summer	0.656	0.656	4.6	359.0	O K
15 min Winter	0.672	0.672	4.6	367.5	O K
30 min Winter	0.878	0.878	4.6	480.7	O K
60 min Winter	1.091	1.091	4.6	597.0	O K
120 min Winter	1.302	1.302	4.6	712.6	O K
180 min Winter	1.418	1.418	4.6	775.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	110.648	0.0	19
30 min Summer	72.727	0.0	34
60 min Summer	45.589	0.0	64
120 min Summer	27.651	0.0	124
180 min Summer	20.382	0.0	184
240 min Summer	16.326	0.0	242
360 min Summer	11.852	0.0	362
480 min Summer	9.449	0.0	482
600 min Summer	7.921	0.0	602
720 min Summer	6.855	0.0	722
960 min Summer	5.452	0.0	960
1440 min Summer	3.943	0.0	1370
2160 min Summer	2.847	0.0	1692
2880 min Summer	2.257	0.0	2072
4320 min Summer	1.625	0.0	2856
5760 min Summer	1.286	0.0	3688
7200 min Summer	1.072	0.0	4472
8640 min Summer	0.923	0.0	5272
10080 min Summer	0.814	0.0	6048
15 min Winter	110.648	0.0	19
30 min Winter	72.727	0.0	34
60 min Winter	45.589	0.0	64
120 min Winter	27.651	0.0	122
180 min Winter	20.382	0.0	180

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
240 min Winter	1.492	1.492	4.6	816.6	O K
360 min Winter	1.579	1.579	4.6	864.1	O K
480 min Winter	1.634	1.634	4.6	893.9	O K
600 min Winter	1.667	1.667	4.6	912.1	O K
720 min Winter	1.686	1.686	4.6	922.8	O K
960 min Winter	1.699	1.699	4.6	929.6	O K
1440 min Winter	1.664	1.664	4.6	910.6	O K
2160 min Winter	1.548	1.548	4.6	847.3	O K
2880 min Winter	1.449	1.449	4.6	793.1	O K
4320 min Winter	1.263	1.263	4.6	690.9	O K
5760 min Winter	1.078	1.078	4.6	589.9	O K
7200 min Winter	0.902	0.902	4.6	493.7	O K
8640 min Winter	0.738	0.738	4.6	403.8	O K
10080 min Winter	0.587	0.587	4.6	321.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
240 min Winter	16.326	0.0	240
360 min Winter	11.852	0.0	358
480 min Winter	9.449	0.0	474
600 min Winter	7.921	0.0	590
720 min Winter	6.855	0.0	708
960 min Winter	5.452	0.0	934
1440 min Winter	3.943	0.0	1384
2160 min Winter	2.847	0.0	1984
2880 min Winter	2.257	0.0	2224
4320 min Winter	1.625	0.0	3152
5760 min Winter	1.286	0.0	4032
7200 min Winter	1.072	0.0	4832
8640 min Winter	0.923	0.0	5624
10080 min Winter	0.814	0.0	6360

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.800	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 1.600

Time From:	**(mins) To:**	**Area (ha)**
0	4	1.600

Model Details

Storage is Online Cover Level (m) 2.000

Infiltration Blanket Structure

Infiltration Coefficient Base (m/hr)	0.01800	Diameter/Width (m)	45.6
Safety Factor	2.0	Length (m)	40.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000		

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 1717 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	0.599	0.599	5.3	382.3	O K
30 min Summer	0.783	0.783	5.3	499.7	O K
60 min Summer	0.971	0.971	5.3	619.9	O K
120 min Summer	1.156	1.156	5.3	737.7	O K
180 min Summer	1.255	1.255	5.3	801.3	O K
240 min Summer	1.318	1.318	5.3	841.4	O K
360 min Summer	1.388	1.388	5.3	886.3	O K
480 min Summer	1.430	1.430	5.3	912.8	O K
600 min Summer	1.452	1.452	5.3	927.1	O K
720 min Summer	1.462	1.462	5.3	933.5	O K
960 min Summer	1.459	1.459	5.3	931.1	O K
1440 min Summer	1.401	1.401	5.3	894.4	O K
2160 min Summer	1.309	1.309	5.3	835.9	O K
2880 min Summer	1.235	1.235	5.3	788.4	O K
4320 min Summer	1.104	1.104	5.3	704.5	O K
5760 min Summer	0.981	0.981	5.3	626.6	O K
7200 min Summer	0.866	0.866	5.3	552.8	O K
8640 min Summer	0.757	0.757	5.3	483.5	O K
10080 min Summer	0.656	0.656	5.3	418.9	O K
15 min Winter	0.672	0.672	5.3	428.8	O K
30 min Winter	0.878	0.878	5.3	560.8	O K
60 min Winter	1.091	1.091	5.3	696.5	O K
120 min Winter	1.302	1.302	5.3	831.3	O K
180 min Winter	1.418	1.418	5.3	905.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	129.089	0.0	19
30 min Summer	84.848	0.0	34
60 min Summer	53.188	0.0	64
120 min Summer	32.259	0.0	124
180 min Summer	23.779	0.0	184
240 min Summer	19.047	0.0	242
360 min Summer	13.827	0.0	362
480 min Summer	11.024	0.0	482
600 min Summer	9.241	0.0	602
720 min Summer	7.997	0.0	722
960 min Summer	6.361	0.0	960
1440 min Summer	4.600	0.0	1370
2160 min Summer	3.321	0.0	1692
2880 min Summer	2.633	0.0	2072
4320 min Summer	1.896	0.0	2856
5760 min Summer	1.500	0.0	3688
7200 min Summer	1.251	0.0	4472
8640 min Summer	1.077	0.0	5272
10080 min Summer	0.949	0.0	6048
15 min Winter	129.089	0.0	19
30 min Winter	84.848	0.0	34
60 min Winter	53.188	0.0	64
120 min Winter	32.259	0.0	122
180 min Winter	23.779	0.0	180

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
240 min Winter	1.492	1.492	5.3	952.6	O K
360 min Winter	1.579	1.579	5.3	1008.1	O K
480 min Winter	1.634	1.634	5.3	1042.8	O K
600 min Winter	1.667	1.667	5.3	1064.1	O K
720 min Winter	1.686	1.686	5.3	1076.6	O K
960 min Winter	1.699	1.699	5.3	1084.5	O K
1440 min Winter	1.664	1.664	5.3	1062.4	O K
2160 min Winter	1.548	1.548	5.3	988.5	O K
2880 min Winter	1.449	1.449	5.3	925.3	O K
4320 min Winter	1.263	1.263	5.3	806.0	O K
5760 min Winter	1.078	1.078	5.3	688.2	O K
7200 min Winter	0.902	0.902	5.3	576.0	O K
8640 min Winter	0.738	0.738	5.3	471.1	O K
10080 min Winter	0.587	0.587	5.3	375.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
240 min Winter	19.047	0.0	240
360 min Winter	13.827	0.0	358
480 min Winter	11.024	0.0	474
600 min Winter	9.241	0.0	590
720 min Winter	7.997	0.0	708
960 min Winter	6.361	0.0	934
1440 min Winter	4.600	0.0	1384
2160 min Winter	3.321	0.0	1984
2880 min Winter	2.633	0.0	2224
4320 min Winter	1.896	0.0	3152
5760 min Winter	1.500	0.0	4032
7200 min Winter	1.251	0.0	4832
8640 min Winter	1.077	0.0	5624
10080 min Winter	0.949	0.0	6360

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.800	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 1.600

Time (mins) From:	To:	Area (ha)
0	4	1.600

Model Details

Storage is Online Cover Level (m) 2.000

Infiltration Blanket Structure

Infiltration Coefficient Base (m/hr)	0.01800	Diameter/Width (m)	53.2
Safety Factor	2.0	Length (m)	40.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	0.000		

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.633	0.633	57.5	299.9	O K
30 min Summer	0.779	0.779	64.9	369.0	O K
60 min Summer	0.866	0.866	68.9	410.1	O K
120 min Summer	0.899	0.899	70.4	425.7	O K
180 min Summer	0.879	0.879	69.5	416.3	O K
240 min Summer	0.843	0.843	67.8	398.9	O K
360 min Summer	0.759	0.759	63.9	359.2	O K
480 min Summer	0.685	0.685	60.2	324.2	O K
600 min Summer	0.621	0.621	56.9	294.1	O K
720 min Summer	0.567	0.567	53.9	268.6	O K
960 min Summer	0.482	0.482	48.8	228.2	O K
1440 min Summer	0.371	0.371	41.1	175.4	O K
2160 min Summer	0.282	0.282	33.8	133.6	O K
2880 min Summer	0.244	0.244	27.9	115.6	O K
4320 min Summer	0.201	0.201	20.7	94.9	O K
5760 min Summer	0.175	0.175	16.6	82.7	O K
7200 min Summer	0.158	0.158	13.9	74.6	O K
8640 min Summer	0.142	0.142	12.0	67.3	O K
10080 min Summer	0.130	0.130	10.6	61.6	O K
15 min Winter	0.713	0.713	61.6	337.5	O K
30 min Winter	0.881	0.881	69.5	416.8	O K
60 min Winter	0.977	0.977	73.7	462.6	O K
120 min Winter	0.997	0.997	74.5	472.2	O K
180 min Winter	0.954	0.954	72.7	451.7	O K
240 min Winter	0.894	0.894	70.1	423.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	110.648	0.0	328.3	17
30 min Summer	72.727	0.0	432.6	31
60 min Summer	45.589	0.0	545.4	50
120 min Summer	27.651	0.0	661.9	84
180 min Summer	20.382	0.0	732.0	118
240 min Summer	16.326	0.0	781.8	152
360 min Summer	11.852	0.0	851.4	218
480 min Summer	9.449	0.0	905.1	282
600 min Summer	7.921	0.0	948.4	344
720 min Summer	6.855	0.0	984.8	406
960 min Summer	5.452	0.0	1044.3	528
1440 min Summer	3.943	0.0	1132.3	766
2160 min Summer	2.847	0.0	1228.8	1120
2880 min Summer	2.257	0.0	1298.6	1472
4320 min Summer	1.625	0.0	1401.0	2204
5760 min Summer	1.286	0.0	1481.1	2936
7200 min Summer	1.072	0.0	1542.9	3672
8640 min Summer	0.923	0.0	1594.2	4408
10080 min Summer	0.814	0.0	1637.7	5136
15 min Winter	110.648	0.0	368.1	17
30 min Winter	72.727	0.0	484.9	31
60 min Winter	45.589	0.0	611.0	56
120 min Winter	27.651	0.0	741.5	90
180 min Winter	20.382	0.0	820.0	128
240 min Winter	16.326	0.0	875.9	162

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m^3)	Status
360 min Winter	0.770	0.770	64.4	364.5	O K
480 min Winter	0.667	0.667	59.3	315.9	O K
600 min Winter	0.583	0.583	54.8	276.1	O K
720 min Winter	0.515	0.515	50.8	243.7	O K
960 min Winter	0.413	0.413	44.2	195.7	O K
1440 min Winter	0.297	0.297	35.1	140.5	O K
2160 min Winter	0.235	0.235	26.3	111.2	O K
2880 min Winter	0.203	0.203	21.1	95.9	O K
4320 min Winter	0.166	0.166	15.2	78.8	O K
5760 min Winter	0.143	0.143	12.1	67.8	O K
7200 min Winter	0.126	0.126	10.1	59.7	O K
8640 min Winter	0.114	0.114	8.7	54.0	O K
10080 min Winter	0.107	0.107	7.7	50.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m^3)	Discharge Volume (m^3)	Time-Peak (mins)
360 min Winter	11.852	0.0	953.8	232
480 min Winter	9.449	0.0	1014.0	298
600 min Winter	7.921	0.0	1062.5	362
720 min Winter	6.855	0.0	1103.3	422
960 min Winter	5.452	0.0	1170.0	542
1440 min Winter	3.943	0.0	1268.6	776
2160 min Winter	2.847	0.0	1376.4	1124
2880 min Winter	2.257	0.0	1454.6	1472
4320 min Winter	1.625	0.0	1569.6	2204
5760 min Winter	1.286	0.0	1658.9	2944
7200 min Winter	1.072	0.0	1728.1	3672
8640 min Winter	0.923	0.0	1785.8	4392
10080 min Winter	0.814	0.0	1834.8	5136

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.800	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 1.600

Time From:	**(mins) To:**	**Area (ha)**
0	4	1.600

Model Details

Storage is Online Cover Level (m) 2.000

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	473.4	1.000	473.4	1.001	0.0

Orifice Outflow Control

Diameter (m) 0.194 Discharge Coefficient 0.600 Invert Level (m) 0.000

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.605	0.605	56.0	355.7	O K
30 min Summer	0.753	0.753	63.6	442.8	O K
60 min Summer	0.848	0.848	68.1	498.8	O K
120 min Summer	0.892	0.892	70.0	524.4	O K
180 min Summer	0.885	0.885	69.7	520.3	O K
240 min Summer	0.859	0.859	68.6	505.4	O K
360 min Summer	0.792	0.792	65.5	465.6	O K
480 min Summer	0.728	0.728	62.4	427.9	O K
600 min Summer	0.670	0.670	59.5	393.7	O K
720 min Summer	0.618	0.618	56.7	363.6	O K
960 min Summer	0.534	0.534	51.9	314.3	O K
1440 min Summer	0.419	0.419	44.6	246.3	O K
2160 min Summer	0.319	0.319	37.0	187.5	O K
2880 min Summer	0.268	0.268	31.8	157.5	O K
4320 min Summer	0.220	0.220	23.9	129.1	O K
5760 min Summer	0.191	0.191	19.2	112.3	O K
7200 min Summer	0.172	0.172	16.1	101.1	O K
8640 min Summer	0.158	0.158	13.9	92.8	O K
10080 min Summer	0.145	0.145	12.2	85.2	O K
15 min Winter	0.680	0.680	60.0	400.0	O K
30 min Winter	0.850	0.850	68.2	499.7	O K
60 min Winter	0.962	0.962	73.1	565.9	O K
120 min Winter	0.996	0.996	74.5	585.9	O K
180 min Winter	0.972	0.972	73.5	571.8	O K
240 min Winter	0.927	0.927	71.6	545.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	129.089	0.0	381.5	18
30 min Summer	84.848	0.0	503.2	31
60 min Summer	53.188	0.0	635.4	54
120 min Summer	32.259	0.0	771.3	86
180 min Summer	23.779	0.0	853.1	120
240 min Summer	19.047	0.0	911.3	156
360 min Summer	13.827	0.0	992.4	222
480 min Summer	11.024	0.0	1055.1	288
600 min Summer	9.241	0.0	1105.6	350
720 min Summer	7.997	0.0	1148.1	414
960 min Summer	6.361	0.0	1217.5	538
1440 min Summer	4.600	0.0	1319.8	780
2160 min Summer	3.321	0.0	1432.9	1128
2880 min Summer	2.633	0.0	1514.3	1472
4320 min Summer	1.896	0.0	1633.4	2204
5760 min Summer	1.500	0.0	1727.6	2936
7200 min Summer	1.251	0.0	1799.5	3672
8640 min Summer	1.077	0.0	1859.2	4408
10080 min Summer	0.949	0.0	1909.7	5136
15 min Winter	129.089	0.0	427.9	17
30 min Winter	84.848	0.0	564.2	31
60 min Winter	53.188	0.0	712.0	58
120 min Winter	32.259	0.0	864.2	92
180 min Winter	23.779	0.0	955.8	130
240 min Winter	19.047	0.0	1021.0	168

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
360 min Winter	0.823	0.823	66.9	484.1	O K
480 min Winter	0.731	0.731	62.5	429.6	O K
600 min Winter	0.651	0.651	58.5	382.7	O K
720 min Winter	0.583	0.583	54.8	342.9	O K
960 min Winter	0.478	0.478	48.5	280.8	O K
1440 min Winter	0.346	0.346	39.2	203.6	O K
2160 min Winter	0.260	0.260	30.5	152.7	O K
2880 min Winter	0.223	0.223	24.4	131.2	O K
4320 min Winter	0.182	0.182	17.8	107.1	O K
5760 min Winter	0.159	0.159	14.1	93.5	O K
7200 min Winter	0.140	0.140	11.7	82.6	O K
8640 min Winter	0.127	0.127	10.2	74.4	O K
10080 min Winter	0.116	0.116	9.0	68.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
360 min Winter	13.827	0.0	1111.9	238
480 min Winter	11.024	0.0	1182.1	304
600 min Winter	9.241	0.0	1238.7	370
720 min Winter	7.997	0.0	1286.3	434
960 min Winter	6.361	0.0	1364.0	558
1440 min Winter	4.600	0.0	1478.9	794
2160 min Winter	3.321	0.0	1605.1	1128
2880 min Winter	2.633	0.0	1696.3	1496
4320 min Winter	1.896	0.0	1830.1	2208
5760 min Winter	1.500	0.0	1935.1	2936
7200 min Winter	1.251	0.0	2015.7	3680
8640 min Winter	1.077	0.0	2082.7	4408
10080 min Winter	0.949	0.0	2139.7	5136

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.800	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 1.600

Time From:	**(mins) To:**	**Area (ha)**
0	4	1.600

Model Details

Storage is Online Cover Level (m) 2.000

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	588.1	1.000	588.1	1.001	0.0

Orifice Outflow Control

Diameter (m) 0.194 Discharge Coefficient 0.600 Invert Level (m) 0.000

F. Foul Water Calculations

Project Anfield Road Stand Expansion			MOTT MACDONALD
Calculations for: Foul Water Drainage	**Divn/Dept** WST/BNI	**Job Nr/File No** 405016 / CAL / C / 0001	
	Calculated by: KC	**Date: 05/12/2019**	**Sheet Nr 1 of 1**
	Checked by: AS	**Date: 05/12/2019**	

Aim

This calculation aims to determine the existing peak foul flow rates from the existing Anfield Road Stand based on existing floor plans and the proposed peak foul flow rates from the proposed extended Anfield Road Stand, based on proposed floor plans.

References

The peak foul flow rates will be calculated using the discharge unit method outlined in Gravity drainage systems inside buildings – Part 2 Sanitary pipework, layout and calculation (BS EN 12056-2-2000).

Calculation

Existing Anfield Road Stand Foul Flow Rates						
	WC	WHB	Sink	UR	Dishwasher	Sum of DU's
Discharge Units (DU)	1.7	0.3	1.3	0.2	0.2	
Ground Floor	50	44	2	90	0	
First Floor	0	0	0	0	0	
Second Floor	24	18	1	36	0	
Total	74	62	3	126	0	
Sum of Discharge Units	125.80	18.60	3.90	25.20	0.00	173.50

Peak Existing Foul Flow Rate	13.17	l/s

Proposed Anfield Road Stand Foul Flow Rates						
	WC	WHB	Sink	UR	Dishwasher	Sum of DU's
Discharge Units (DU)	1.7	0.3	1.3	0.2	0.2	
Existing Stand (to be retained)	53	51	5	90	0	
Proposed Expansion	144	119	15	145	6	
Total	197	170	20	235	6	
Sum of Discharge Units	334.90	51.00	26.00	47.00	1.20	460.10

Peak Proposed Foul Flow Rate	21.45	l/s

The peak foul flow rates have been calculated based on a frequency factor (K) of 1 (congested use)

Conclusion

Therefore, the proposed expansion of the Anfield Road Stand will result in an increase in the peak foul discharge rate of 8.28l/s.

It is proposed that the foul flows from the proposed Anfield Road Stand will continue to discharge via the existing foul drainage network on site into the 910x1520mm combined public sewer to the south of the stadium, which flows under the Kop Stand.

The existing private network will need to be modelled to confirm there is sufficient capacity to accept the additional foul flows.

This additional discharge rate will need to be agreed with UU.

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