FLOOD RISK ASSESSMENT

FOR

DORMITARY ERADICATION AT EDWARD STREET HOSPITAL (DE-ESH)

FOR

BLACK COUNTRY HEALTHCARE NHS FOUNDATION TRUST

Prepared by Couch Consulting Engineers

FEBRUARY 2022

Rev. No.	Date	Revision	Rev. By
P01	07/02/2022	Initial Issue.	OJB
P02	21/03/2022	Architect's and Drainage Layouts amended. 2.2.1 amended.	OJB
P03	24/03/2022	Conclusion amended for clarity. Site boundary on figures amended.	OJB

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1. DEVELOPMENT DESCRIPTION AND LOCATION

This Flood Risk Assessment report has been commissioned to support a planning application for a proposed single room accommodation wards redevelopment on land currently occupied by an existing dormitory style wards located of Edward Street, West Bromwich.

The purpose of this report is to assess flood risk at the site in relation to the proposed development and provide a suitable surface water scheme for the site which does not increase flood risk on the site or to adjacent land.

For the purposes of this study, the following have been considered:-

- Environment Agency Flood Mapping
- Preliminary Ground Investigation information provided by Geo Environmental Group in February 2022.
- Topographical Survey undertaken by RGI Surveys in October 2021.
- Proposed site layout prepared by Gilling Dod Architects in December 2021.

1.1. Existing Site

The 0.283 ha site is currently occupied by dormitory style wards, made up of a single building with the rest of the site covered in landscaping and hardstanding area. The site is nestled within the Edwards Street Hospital complex.

The location of the site is shown in Figure 1.1.

Figure 1.1: Development Location

The site is generally level around the existing buildings, with the whole buildings sitting slightly higher than the surrounding landscaped areas. Within the site boundary itself levels fall away from the existing buildings towards the carriageway to the north, with a building FFL of 167.787mAOD towards carriageways highest level of 166.62mAOD and the lowest at 166.050mAOD. The landscaped area to south falls away from the building towards the railway embankment from the buildings FFL of 167.787mAOD to 167.25mAOD at the brick boundary wall to the south of the site. Levels then fall towards the access drive located between the buildings on the east side of the site.

A copy of the topographical survey undertaken by RGI Surveys in October 2021 is included in Appendix A.

1.2. Site Geology

At the time of writing this report, a full S.I. Report was not available.

In reference to preliminary geo-environmental works undertaken by Geo Environmental Group in February 2022, some initial investigation works were undertaken.

The site area is shown on maps published by the British Geological Survey to be underlain by both Superficial and Bedrock geology. The Superficial layer is Glaciofluvial Deposits from the Devensian Period. Bedrock is the Alveley Member – Sandstone Sedimentary Bedrock of the Carboniferous Period.

The Alveley Member comprises fine to medium grained mudstone and sandstones with thin limestone beds. The upper boundary is defined by a base of pebbly sandstones, clast, limestone, and chert. The lower boundary contains a transitional-gradational boundary of red mudstone into grey mudstone of the Halesowen Formation. The EA records the Alveley Member as a Bedrock Secondary A of Medium-Low to Low Vulnerability.

Superficial Layers located within the site belong to the Glaciofluvial Deposits, which mainly consist of sands and gravels.

The closet surface water feature is the Birmingham Canal which is located 1.71km to the west of the site. Ponds can also be located 1.2km to the east within Dartmouth Park.

The site then falls away from the existing buildings towards Edwards Street to the east, and the railway embankment to the south. An existing storm water network is location around the existing building, which is believed to eventually discharge into sewer located in Edwards Street.

2. FLOOD HAZARD AND PROBABILITY

2.1 Possible Flooding Mechanisms

Table 1: Possible Flooding Mechanisms

Source/Pathway	Level of Risk	Comment/Reason
Fluvial	Low	The site is shown to lie within Flood Zone 1, outside of both the 1 in 100 year and 1 in 1000 year floodplain extents.
Tidal/Coastal	N/A	The site does not lie within close proximity to the sea.
Canals	N/A	The site does not lie within close proximity to any canals.
Reservoirs and Waterbodies	Low	The site is not shown to be affected by flooding from reservoirs. A few small ponds lie within relatively close proximity to the site but any risk to the site would be negligible.
Pluvial (surface water)	Low / Very Low	EA Surface Water Flood Maps has highlighted that the site lies within an area at risk of low to very low flood risk during high rainfall events.
Groundwater	Low	Groundwater was recorded at depth of 2.46m BGL..
Overland flow	Low	There is a significant fall away from the existing building towards the site boundaries.

The main potential sources of flood risk is considered to be surface water runoff from the site towards the boundary.

According to the Environment Agency Flood Maps the site lies within Flood Zone 1 (outside of both the 1 in 100 year and 1 in 1000 year floodplain).

2.2 Fluvial Flooding Risk

The annual probability of a flood event occurring at a site can be defined from the Environment Agency's Flood Zone map (Figure 2.2).

Figure 2.2: Fluvial Flood Map

Source: watermaps.environment-agency.gov.uk/

The proposed development site lies in **Flood Zone 1 (FZ1)**. According to 'Guidance – Flood Risk and Coastal Change', this zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%). This assigns the probability as defined on the government web site 'Guidance – Flood Risk and Coastal Change', Table 1: Flood Zones (https://www.gov.uk/guidance/flood-risk-and-coastal-change#Table-1-Flood-Zones).

2.2.1 Suitability of the Site for Hospital Development

The probability of flooding at a location area defined on the government web site 'Guidance – Flood Risk and Coastal Change', Table 3: Flood risk vulnerability and flood zone 'compatibility' (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/575184/Table_3_-_Flood_risk_vulnerability_and_flood_zone__compatibility_.pdf). Any developments are appropriate in this Flood Zone. as shown in Table 3.1.

Table 3.1 Flood Risk Vulnerability and Flood Zone 'Compatibility' (Guidance on Flood Risk and Coast Change, Table 3)

Flood Risk Vulnerability		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	Zone 1	✔	✔	✔	✔	✔
	Zone 2	✔	✔	Exception test required	✔	✔
	Zone 3a	Exception test required	✔	✕	Exception test required	✔
	Zone 3b	Exception test required	✔	✕	✕	✕

✔ - Development is appropriate ✕ – Development should not be permitted

The Indicative Flood Plain Map contained within Figure 2.2 confirms that the whole site is within Flood Zone 1 'low probability'. NPPF Technical Guidance Table 2 shows the hospital site is within the Flood Risk Vulnerability classification of "more vulnerable" (this includes buildings used for; hospitals, dwelling houses, student halls of residence, non-residential uses for nurseries and educational establishments). Therefore, based on the EA flood zone classification of the development, Table 3 in NPPF 'Technical Guidance' (see Table 3.1 above), indicates that development is 'appropriate'.

The risk of fluvial flooding is Low.

2.3 Reservoir and Waterbodies Flood Risk

Figure 2.3: Reservoir Flood Map

Source: watermaps.environment-agency.gov.uk/

The development location is shown to be not at risk of flooding from reservoirs and other waterbodies.

The risk of flooding from reservoirs and other waterbodies is Low.

2.4 Pluvial / Surface Water Flooding

According to the Surface Water Flood Map from the Environment Agency's website (see Figure 2.4) The site is shown to be at high risk of surface water flooding.

Figure 2.4: Pluvial Flood Map

Source: watermaps.environment-agency.gov.uk/

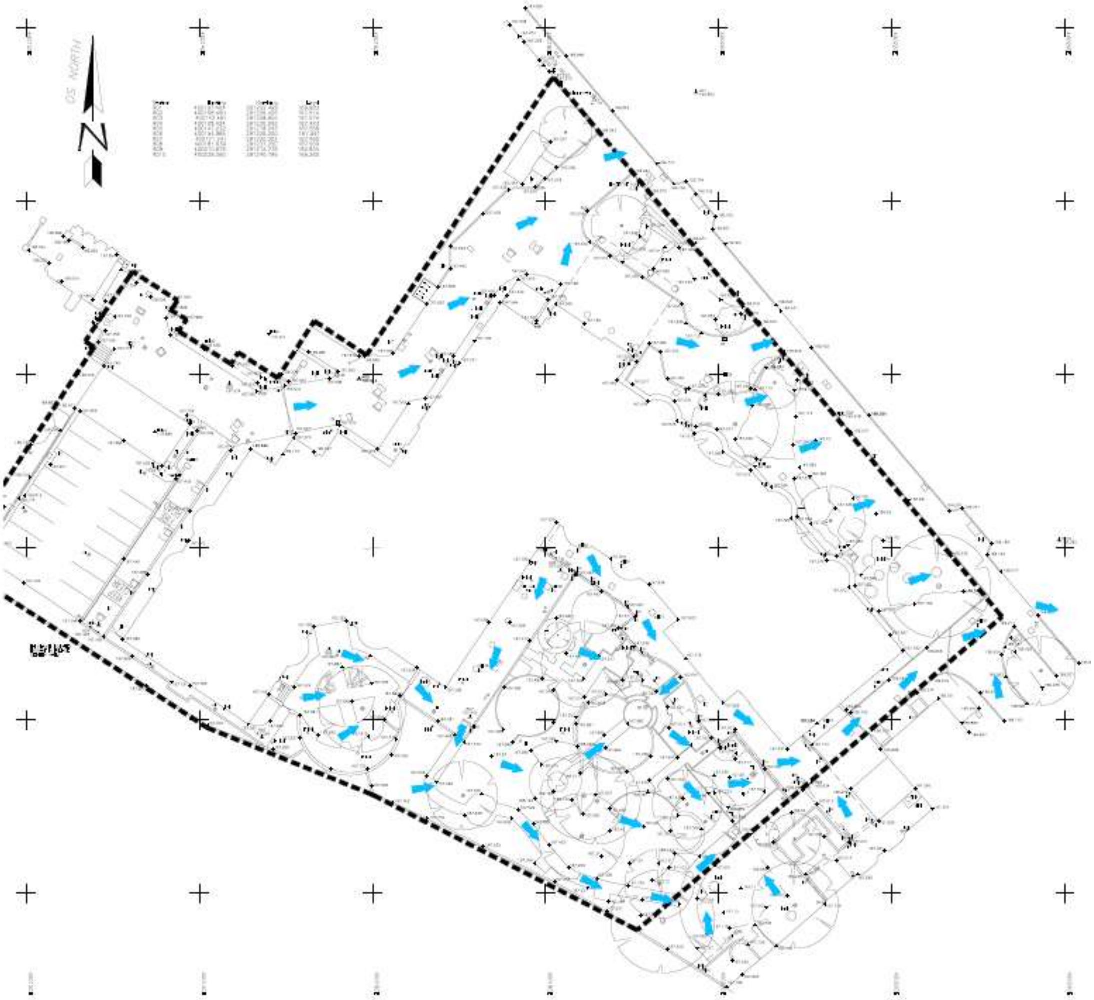
The map shows that the development will not be at risk from pluvial flooding. Pluvial flooding occurs outside the site along Edwards Street and the railway.

The risk of flooding from pluvial flooding is Low.

2.5 Overland Flow

As discussed, ground levels from the entrance of the site fall relatively steeply towards the site as shown by the topographical survey and as shown in Figure 2.5 below.

Figure 2.5: Overland Flow Route



At present any overland flow would follow through the landscaped area towards the gap between the existing buildings to the south end of the site, routing through the existing driveway, and out into the carriageway. Levels at the front of the site generally fall away form the existing build, towards the carriageway.

In summary the existing levels around the site direct any overland flows, generated during extreme rainfall events, away from the existing building and towards Edwards Street.

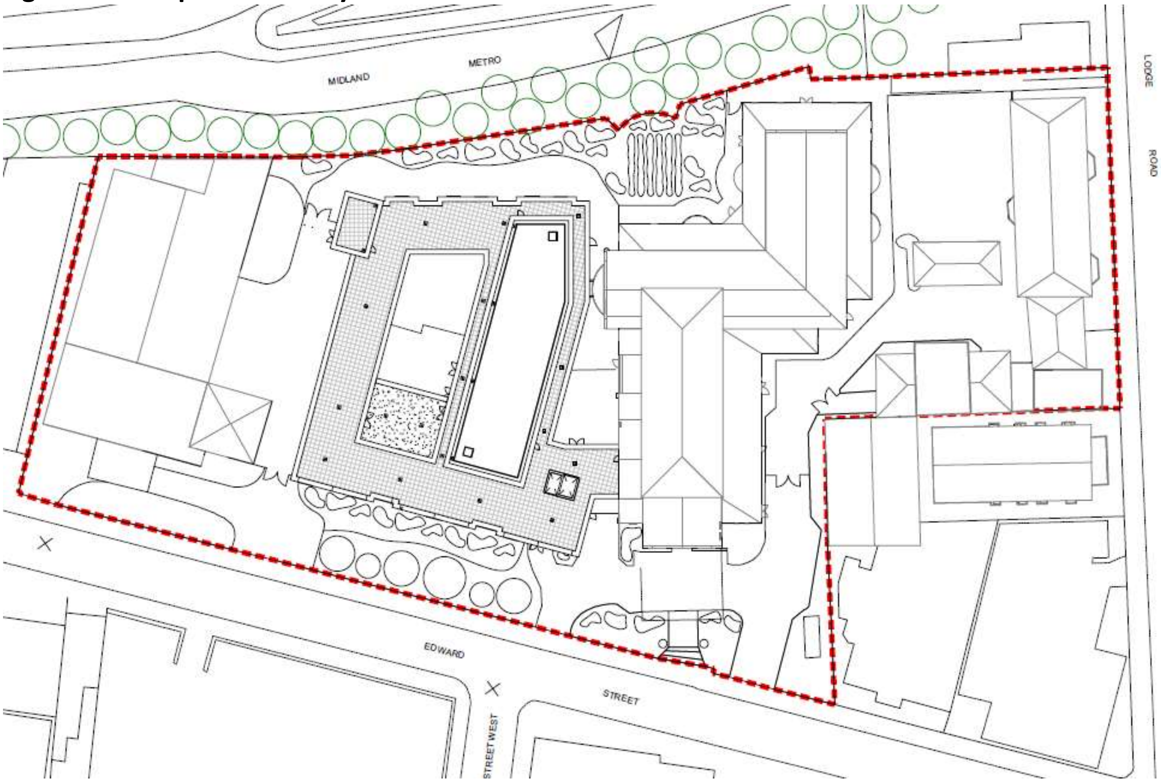
3. DEVELOPMENT PROPOSALS, FLOOD RISK MANAGEMENT & OFF-SITE IMPACTS

3.1. Development Location and Proposals

The proposal includes the demolition of the existing dormitory style ward building and construction of a new single occupancy room ward building with associated hard landscaped areas and courtyard. Access to the site from Edwards Street is to be retained and is to lead into the new private access drive.

A copy of the proposed site layout produced by Gilling Dod Architects in Jan 2021 is included in Figure 3.1 below with a larger scale plan provided in Appendix B.

Figure 3.1: Proposed Site Layout



Source: Gilling Dod Architects

The development site has been shown to lie outside the fluvial floodplain, as well as very low risk of flooding from other sources, being surface water runoff and overland flow.

In terms of the risk from flooding due to overland flow post-development, the proposed building will maintain the existing building FFL, as the existing building was significantly higher than surrounding ground levels to force the fluvial flooding around the property during extreme rainfall events. Due to the reduction of the landscaped areas to the rear of the site, the new, large areas of paving surrounding, and within the courtyard of the proposed building will require a drainage solution to intercept any overland flows and avoid unnecessary ponding.

3.2. Access / Egress

Although the main access in and out of the site will have no flooding, due the overland flows being predominately restricted to Edwards Street, as indicated on the EA's pluvial flood mapping. In the event that the route is not passable the immediate area around the property will be out of the path of the overland flow.

3.3. Surface Water Drainage & Foul Water Drainage

The proposals at the site show the amount of impermeable area will increase compared to the existing site, from 0.143 ha (54% of the total site area) to 0.239 ha (91% of the total site area); with the amount and rate of surface water runoff would therefore also increasing.

A surface water drainage strategy has been prepared and proposes to pipe the surface water runoff from the roof area, driveways, and paved areas to a cellular storage tank located in the landscaped area between the proposed building and the carriageway. The surface water within the storm drainage network is then discharged into the existing Storm Water Sewer located in Edwards Street at a restricted discharge rate of 5.0 L/s, as stated in the Developer Enquiry response received from STW.

At the time of writing this document a Site Investigation was in progress, however the soakaway results and the report were not available.

In terms of site foul water drainage, it has been established that there is an existing STW foul water sewer is located in Edwards Street. An existing manhole will be used to discharge the properties foul water.

A copy of the drainage strategy is provided in Appendix C.

3.3.1. Potential SUDS Option on Site

The following represents considerations on suitable SUDS options appropriate to this site. CIRIA C753 The SUDS manual was consulted to examine the use of SUDS on this site. Our conclusions are based on the assessment of the site and the evaluation of the relevant design requirements.

Due to the site arrangement, there is no scope to incorporate a soakaway due to the requirements in CIRIA SuDS Manual that states soakaways need to located at least 5 metres from any building, highway, and boundary line.

<u>Attenuation Storage Tanks</u>
Attenuation storage tanks are used to create a below-ground void space for the temporary storage of surface water before infiltration, controlled release, or use. Due to the flexibility in size and shape of the storage system they can retain larger volumes of water (compared to aggregate filled structures). Most types of attenuation tanks can also be installed under roads and car parks as well as any recreational areas or public open space.

Attenuation Storage Tank is proposed.

3.4. Overland Flow

As stated on the EA's pluvial flood mapping, the site is in an area of very low flood risk. In order to protect the proposed building from overland flow during extreme rainfall events, the proposed buildings FFL should be set to match the existing buildings FFL. Surrounding ground levels should be directed away from buildings with drainage to intercept as much of the flow as possible.

A plan showing the location of the proposed drainage strategy is also included in Appendix C.

3.5. SUDS Maintenance & Management Plans

The scope/nature of inspection and maintenance is such that various facilities and structures are inspected and maintained at regular intervals, as well as after or during heavy storms, in order to ensure that these perform effectively. This shall include the storage and pipework so that the system fully maintains its functionality throughout.

A suitably appointed private management company will be responsible for maintaining the private site entities such as the manholes, gullies, and the respective SUDS facilities etc.

It is anticipated that the maintenance schedule will generally comprise the following activities in accordance with the CIRIA publication C753 (The SuDS Manual).

Refer to the following tables for proposed site maintenance & management strategies.

ATTENUATION STORAGE TANKS		
Maintenance Schedule	**Required Action**	**Typical Frequency**
Regular maintenance	Inspect and identify any areas 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
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae, or other matter, remove and replace surface infiltration medium as necessary	Annually
	Remove sediment from pre-treatment structures and/ or internal forebays	Annually, or as required
Remedial Actions	Repair/rehabilitate inlets, outlet, overflows, and vents	As required
Monitoring	Inspect/check all inlets, outlets, vents, and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required

4. RESIDUAL RISKS

The assessment has shown the site to be located within Flood Zone 1, and at very low risk of flooding from all other sources.

To ensure the development does not pose a flood risk to the surrounding area, overland flows should be directed away from the proposed and existing buildings as much as reasonability feasible.

5. CONCLUSIONS

This report has been written in accordance with the requirements set out in the National Planning Policy Framework for a proposed hospital redevelopment on land currently occupied by a dormitory style ward at Edwards Street Hospital, Edwards Street, West Bromwich.

Based on the information obtained the site has been shown to lie within Flood Zone 1 and therefore at low risk of flooding from fluvial sources. The site has also been shown to lie at very low risk of flooding from other sources.

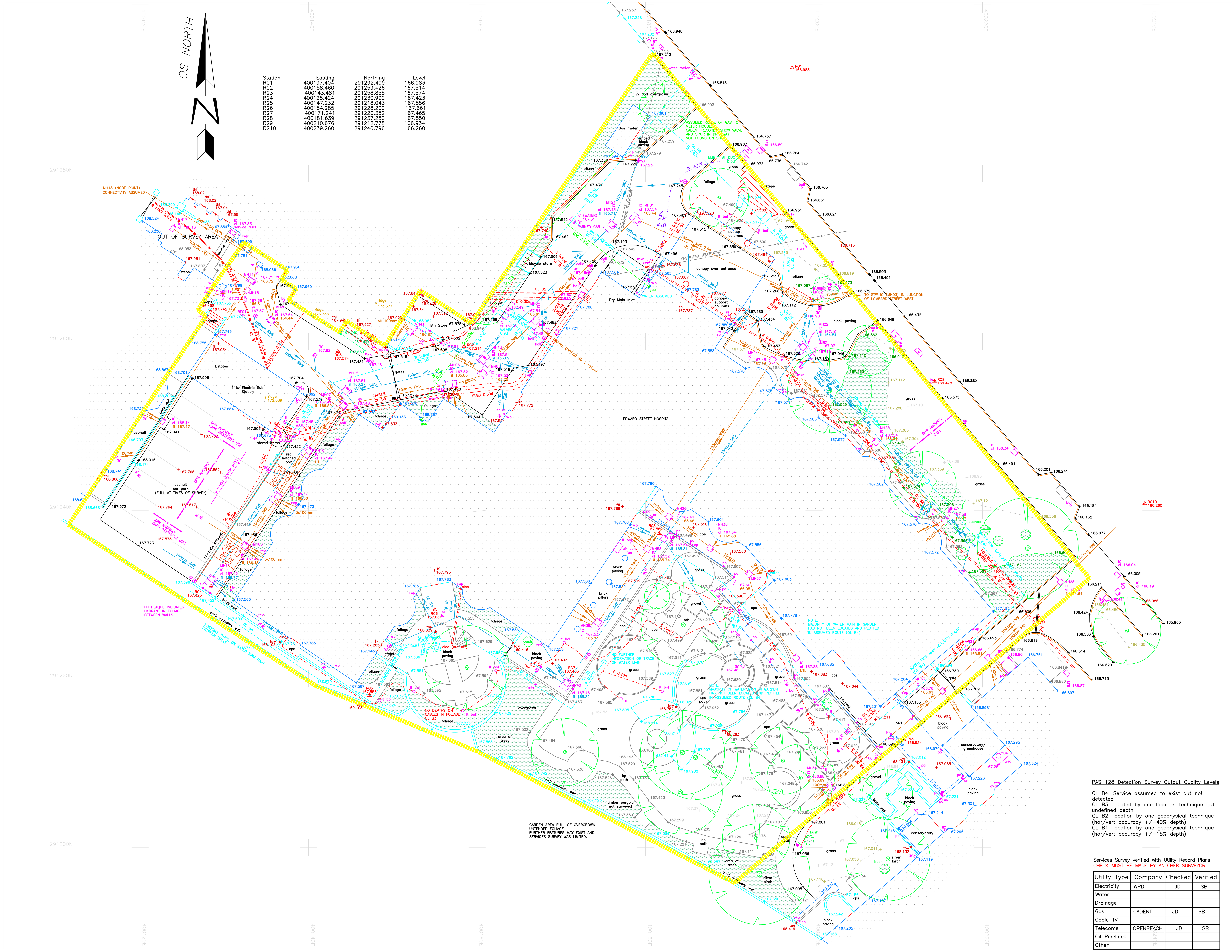
- The proposed site layout shows finished floor levels to be set to match the existing build, which sits above the surrounding ground levels to mitigate against any possible overland flows flooding the new building, during rainfall event that are in excess of 1:100yr +40% additional rainfall for climate change. Site levels should also be designed to fall away from the building to ensure storm water is directed away from external doors.

- As indicated on the Pluvial Flood Map from the EA (Figure 2.4), there is a risk that during heavy rainfall events (exceeding the 1:100yr rainfall event), or due to poor highway drainage maintenance, Edwards Street may become flooded, making dry access / egress from the building difficult. However this flooding does not impose a risk to the building.

- In terms of the risk of flooding from pluvial sources from the site a surface water drainage strategy has been prepared which intercepts the runoff from the roof and paved areas of the proposed building, via a piped storm water network. The surface water is then drained into an Attenuation Tank located in the landscaped area, inside the new buildings courtyard, and between the building and Edwards Street, which has sufficient storage for all storm events up to and including the 1:100 year rainfall event plus 40% additional rainfall for climate change.

Providing the mitigation measures discussed in this report or similar measures are implemented it is considered that the risk of flooding to the site and adjacent land will be greatly reduced.

APPENDIX A – TOPOGRAPHICAL SURVEY



Station	Easting	Northing	Level
RG1	400197.404	291292.499	166.983
RG2	400158.460	291259.426	167.514
RG3	400143.481	291258.855	167.574
RG4	400128.424	291230.992	167.423
RG5	400147.232	291218.043	167.556
RG6	400154.985	291228.200	167.661
RG7	400171.241	291220.352	167.465
RG8	400181.639	291237.250	167.550
RG9	400210.676	291212.778	166.934
RG10	400239.260	291240.796	166.260

Topographic Legend

Drainage abbreviations

- bd Back drop
- lh Lamp hole
- re Rodding eye
- of Overflow
- ww Wash water

Level prefix descriptions

- ah Arch level
- bl Bed level
- cl Cover level
- el Eaves level
- ffl Finished Floor level
- il Invert level
- pl Parapet level
- rl Roof/Ridge level
- sfl Soffit level
- tow Top of wall level
- twl Top water level
- wl Water level

Please note surveyed boundaries may not represent the extent of legal ownership of the land.

Contractor should check crucial dimensions on site before commencement of any work.

Grid Orientation and Level Datum:

A true OSGB36 coordinate has been established near to the site centre via a transformation using the OSTN15 and OSGM15 transformation models.
The survey has been correlated to this point and a further one or more OSGB36 points established to create a true O.S. bearing for angle orientation. No scale factor applied.

Services Survey Key

HV ELECTRIC CABLES
LV ELECTRIC CABLES
TELEPHONE
CABLE TV
DATA CABLES
GAS MAINS
WATER MAINS
UNIDENTIFIED
FOUL WATER SEWERS
COMBINED WATER SEWERS
STORM WATER SEWERS
RISING MAIN
ABANDONED SERVICE
OVERHEAD SERVICE
OTHER SERVICES
END OF TRACE (EOT)

Services Survey Notes

Services detection including electromagnetic location (EML) and ground probing radar (GPR) have been used to locate underground services. RGI Surveys have successfully used these methods since our establishment in 1989. identification of services is only possible through confirmation with record drawings & with surveyor's experience in the field. please be aware that results are not flawless and where critical we advise confirmation of services by trial excavations.
The services survey should be read in conjunction with utility record drawings. single cable lines may represent multiple cables and ducts.
Statutory utility records can be obtained through Linesearch.org. although all efforts are made to provide a complete & comprehensive survey as possible, Rugby Ground Information LTD cannot guarantee the completeness of the survey.
Only BT contractors are allowed to access BT covers therefore our survey for BT cables may be restricted. we advise contacting Openreach to arrange telecoms location by openreach engineers prior to any excavation.
Additional services may exist within the survey area.
depths to services (eg 1.00d) are provided as a guidance only and are not infallible. Where critical we advice confirmation by trial excavations to determine location, depth and identity.
Drainage depths are inverts from cover level.
drainage surveys have been carried out by non—man entry means, unless otherwise stated. pipe sizes & depths are as accurate as possible when surveyed from the surface.
Where survey includes services and anomalies determined utilising GPR on a realtime basis with a single frequency system. Please note GPR results are open to interpretation and dependant upon ground conditions. Results are to the best of our abilities.
Services not electronically located are annotated as follows:
GPR GROUND PROBING RADAR
NL—A NOT LOCATED — plotted in an assumed position
NL—I NOT LOCATED — plotted from on site information
NL—R NOT LOCATED — taken from records
NL—TS NOT LOCATED — plotted from visible trench scars

PAS 128 Detection Survey Output Quality Levels

QL B4: Service assumed to exist but not detected
QL B3: located by one location technique but undefined depth
QL B2: location by one geophysical technique (hor/vert accuracy +/−40% depth)
QL B1: location by one geophysical technique (hor/vert accuracy +/−15% depth)

Services Survey verified with Utility Record Plans
CHECK MUST BE MADE BY ANOTHER SURVEYOR

Utility Type	Company	Checked	Verified
Electricity	WPD	JD	SB
Water			
Drainage			
Gas	CADENT	JD	SB
Cable TV			
Telecoms	OPENREACH	JD	SB
Oil Pipelines			
Other			

Rev Details
rev1 9—12—21
Drainage ref numbers added from cctv
Drainage details from cctv

Client
Sir Robert McAlpine

Project Title
Topographic Survey
Location and Mapping of Underground Services and Drainage
Edward Street Hospital
West Bromwich

drawing no. 9600 Edward St
date 22nd Oct 2021
surveyed JD OM — drawn RGI — chkd SB — scale 1:200 — plot A1

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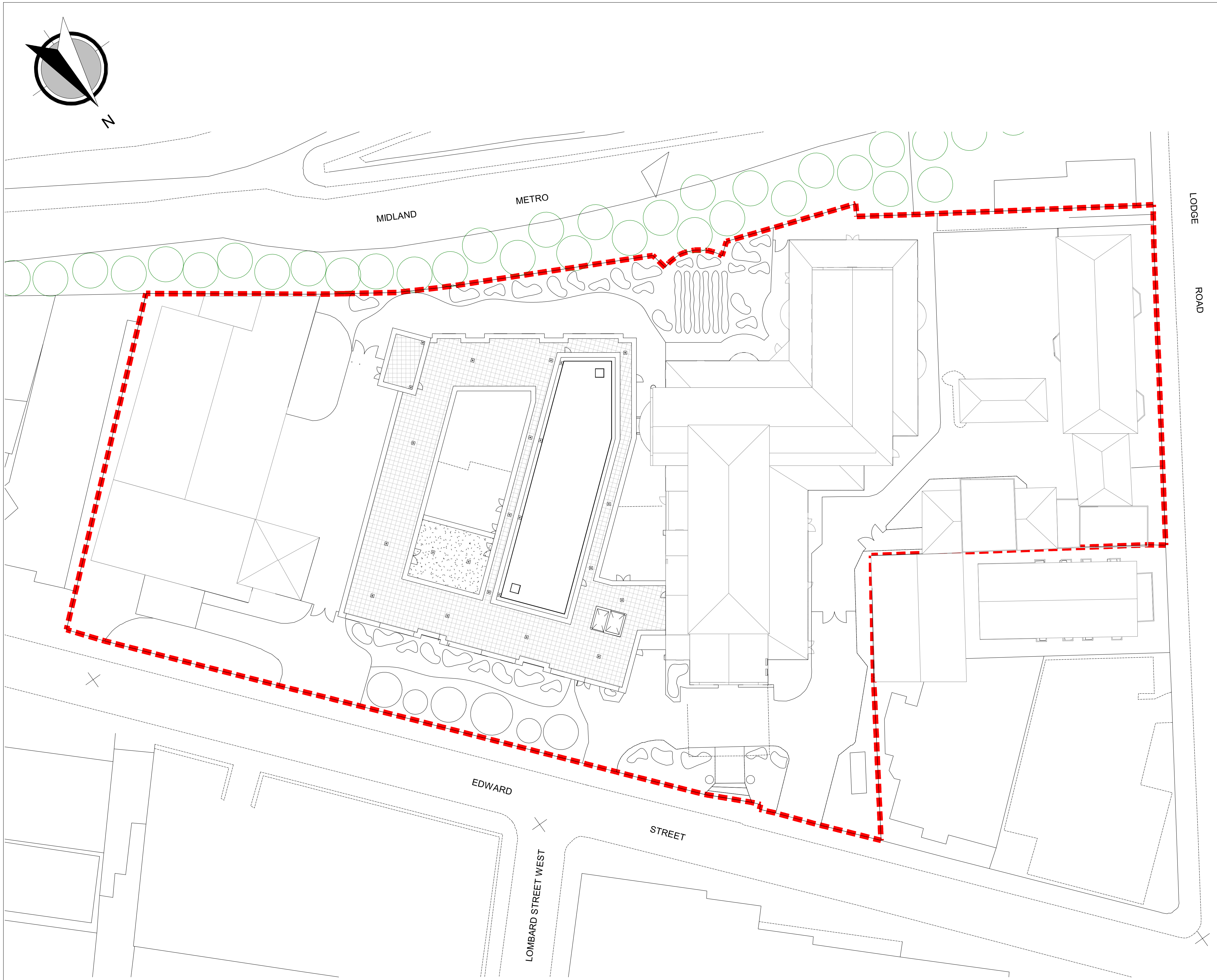
APPENDIX B – PROPOSED SITE LAYOUT



0102 - Proposed Site Plan

1:500

SITE BOUNDARY

Rev	By	Description	Date
P01	KO	Draft Planning Issue	11/02/22

gilling dod architects
The Cruck Barn, Duxbury Park, Chorley, Lancashire. PR7 4AT
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Client Name:
Black Country Healthcare NHS Foundation Trust

Site Name:
Edward Street Hospital

Project Name:
Dormitory Eradication at Edward Street Hospital

Drawing Title:
Proposed - Site Plan

Project No:	Sheet Size:	Scale:	
RB0002	A3	As indicated	
Drawn by: NB	Checked by: KO	Approved by: AA	Revision: P01

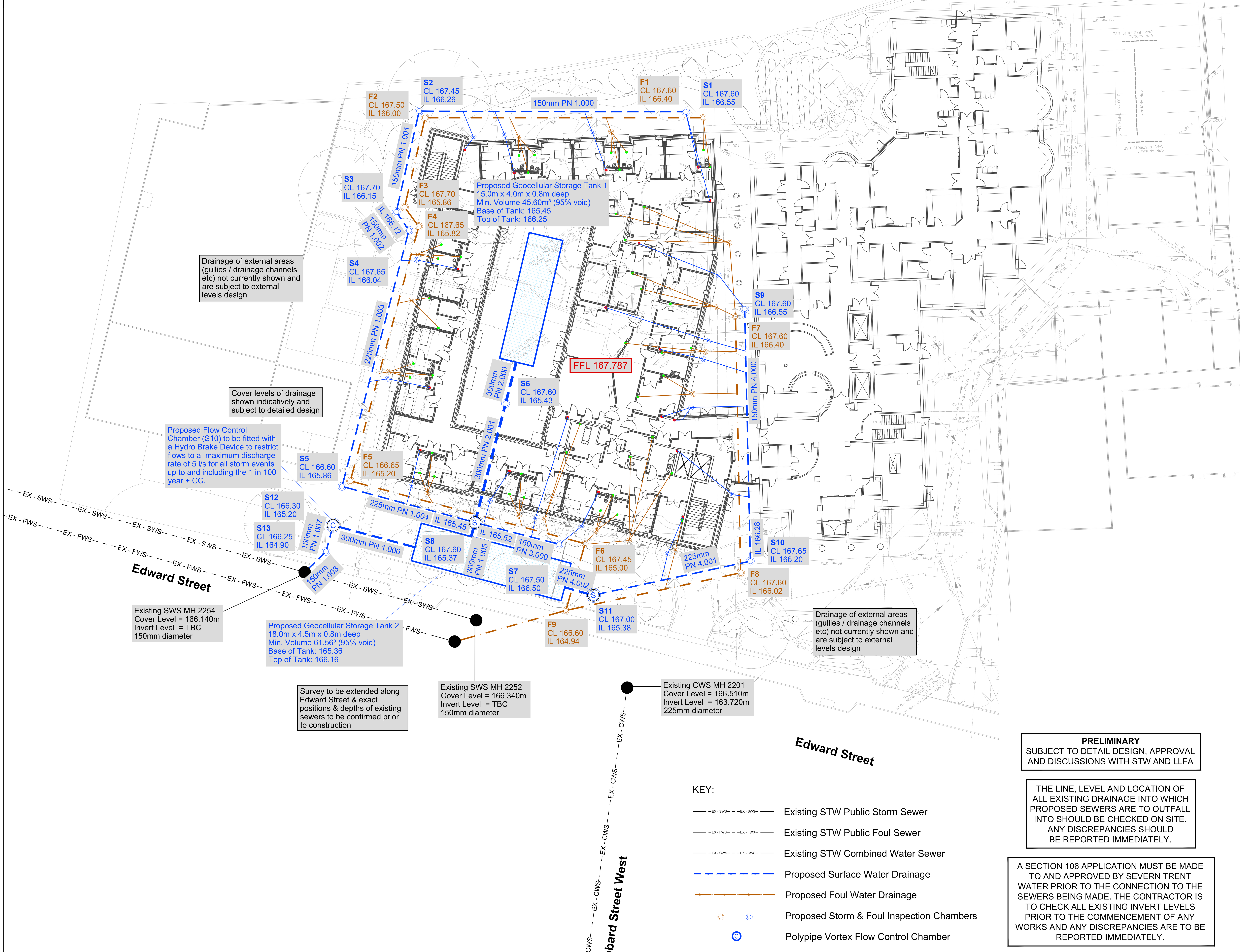
Suitability: COMMENT & APPROVAL

Status: S3

Drawing Number:
RB0002-GDAC-V1-ZZ-DR-A-0140

APPENDIX C – SITE DRAINAGE STRATEGY

ALL DIMENSIONS TO BE CHECKED BY CONTRACTOR



REV	AMENDMENT	BY	DATE
P02	UPDATED TO SUIT LATEST SITE LAYOUT AND INTERNAL DRAINAGE ARRANGEMENTS & FOLLOWING HYDRAULIC MODELLING	ODP	11.02.2022
P01	UPDATED TO INCLUDE DRAINAGE LEVELS & TO SUIT 3D MODEL. CHANGED SCALE FROM 1:250 TO 1:200	ODP	11.02.2022

PROJECT EXECUTION CLASS: N/A

All materials supplied in relations to those specified on this drawing are to be CE marked in accordance with the European Union Declaration of conformity

PURPOSE OF ISSUE

PRELIMINARY

COUCH
Consulting Engineers
Civil & Structural

The Old Forge, Priory, London Road, Canwell, Sutton Coldfield. B75 5SH Tel: 0121 308 7557
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info@cceng.co.uk www.cceng.co.uk

CLIENT
BLACK COUNTRY HEALTHCARE NHS FOUNDATION TRUST

PROJECT
DORMITORY ERADICATION AT EDWARD STREET HOSPITAL

DRAWING TITLE
DRAINAGE LAYOUT

SHEET SIZE	SCALE	DATE	DRAWN	CHECKED	STATUS
A1	1:200@A1	03.11.21	SN	JG	S3

CCE PROJECT No.	DRAWING No.	REV
7976	RB0002-CCEN-V1-XX-DR-C-0105	P02

APPENDIX D – Prelim SWS Calcs

Design Settings

Rainfall Methodology	FSR
Return Period (years)	100
Additional Flow (%)	0
FSR Region	England and Wales
M5-60 (mm)	20.000
Ratio-R	0.400
CV	0.750
Time of Entry (mins)	5.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Height (m)	0.200
Preferred Cover Depth (m)	1.200
Include Intermediate Ground	✓
Enforce best practice design rules	✓

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Depth (m)
S1	0.046	5.00	167.600	600	1.050
S2	0.000		167.450	600	1.190
S3	0.000		167.700	600	1.550
S4	0.060	5.00	167.650	600	1.610
S5	0.028	5.00	166.600	600	0.740
Tank 1	0.028	5.00	167.600	1	2.150
S6			167.600	1200	2.170
S7	0.015	5.00	167.500	600	1.000
S8	0.000		167.600	1200	2.230
S9	0.061	5.00	167.600	600	1.050
S10	0.015	5.00	167.650	600	1.850
S11	0.000		167.000	600	1.620
Tank 2	0.000		166.700	1	1.340
S12	0.000		166.300	1200	1.100
S13	0.000		166.250	1200	1.350

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	S1	S2	30.943	0.600	166.550	166.260	0.290	106.7	150	5.53	50.0
1.001	S2	S3	12.000	0.600	166.260	166.150	0.110	109.1	150	5.74	50.0
1.002	S3	S4	2.590	0.600	166.150	166.120	0.030	86.3	150	5.78	50.0
1.003	S4	S5	30.720	0.600	166.040	165.860	0.180	170.7	225	6.29	50.0
1.004	S5	S8	16.000	0.600	165.860	165.450	0.410	39.0	225	6.42	50.0
2.000	Tank 1	S6	4.950	0.600	165.450	165.430	0.020	247.5	300	5.08	50.0
2.001	S6	S8	14.260	0.600	165.430	165.370	0.060	237.7	300	5.32	50.0
3.000	S7	S8	10.090	0.600	166.500	165.520	0.980	10.3	150	5.05	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)
1.000	0.972	17.2	6.2	0.900	1.040	0.046	0.0
1.001	0.961	17.0	6.2	1.040	1.400	0.046	0.0
1.002	1.082	19.1	6.2	1.400	1.380	0.046	0.0
1.003	0.998	39.7	14.4	1.385	0.515	0.106	0.0
1.004	2.100	83.5	18.2	0.515	1.925	0.134	0.0
2.000	0.995	70.3	3.8	1.850	1.870	0.028	0.0
2.001	1.015	71.8	3.8	1.870	1.930	0.028	0.0
3.000	3.158	55.8	2.0	0.850	1.930	0.015	0.0

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.005	S8	Tank 2	1.670	0.600	165.370	165.360	0.010	167.0	300	6.44	50.0
4.000	S9	S10	29.314	0.600	166.550	165.880	0.670	43.8	150	5.32	50.0
4.001	S10	S11	18.640	0.600	165.800	165.380	0.420	44.4	225	5.48	50.0
4.002	S11	Tank 2	3.467	0.600	165.380	165.360	0.020	173.4	225	5.54	50.0
1.006	Tank 2	S12	9.830	0.600	165.360	165.200	0.160	61.4	300	6.52	50.0
1.007	S12	S13	3.130	0.600	165.200	164.900	0.300	10.4	150	6.54	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)
1.005	1.214	85.8	24.0	1.930	1.040	0.177	0.0
4.000	1.525	27.0	8.3	0.900	1.620	0.061	0.0
4.001	1.969	78.3	10.3	1.625	1.395	0.076	0.0
4.002	0.990	39.4	10.3	1.395	1.115	0.076	0.0
1.006	2.009	142.0	34.3	1.040	0.800	0.253	0.0
1.007	3.137	55.4	34.3	0.950	1.200	0.253	0.0

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	30.943	106.7	150	Circular	167.600	166.550	0.900	167.450	166.260	1.040
1.001	12.000	109.1	150	Circular	167.450	166.260	1.040	167.700	166.150	1.400
1.002	2.590	86.3	150	Circular	167.700	166.150	1.400	167.650	166.120	1.380
1.003	30.720	170.7	225	Circular	167.650	166.040	1.385	166.600	165.860	0.515
1.004	16.000	39.0	225	Circular	166.600	165.860	0.515	167.600	165.450	1.925
2.000	4.950	247.5	300	Circular	167.600	165.450	1.850	167.600	165.430	1.870
2.001	14.260	237.7	300	Circular	167.600	165.430	1.870	167.600	165.370	1.930
3.000	10.090	10.3	150	Circular	167.500	166.500	0.850	167.600	165.520	1.930
1.005	1.670	167.0	300	Circular	167.600	165.370	1.930	166.700	165.360	1.040
4.000	29.314	43.8	150	Circular	167.600	166.550	0.900	167.650	165.880	1.620
4.001	18.640	44.4	225	Circular	167.650	165.800	1.625	167.000	165.380	1.395
4.002	3.467	173.4	225	Circular	167.000	165.380	1.395	166.700	165.360	1.115
1.006	9.830	61.4	300	Circular	166.700	165.360	1.040	166.300	165.200	0.800
1.007	3.130	10.4	150	Circular	166.300	165.200	0.950	166.250	164.900	1.200

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	S1	600	Manhole	Adoptable	S2	600	Manhole	Adoptable
1.001	S2	600	Manhole	Adoptable	S3	600	Manhole	Adoptable
1.002	S3	600	Manhole	Adoptable	S4	600	Manhole	Adoptable
1.003	S4	600	Manhole	Adoptable	S5	600	Manhole	Adoptable
1.004	S5	600	Manhole	Adoptable	S8	1200	Manhole	Adoptable
2.000	Tank 1	1	Manhole	Adoptable	S6	1200	Manhole	Adoptable
2.001	S6	1200	Manhole	Adoptable	S8	1200	Manhole	Adoptable
3.000	S7	600	Manhole	Adoptable	S8	1200	Manhole	Adoptable
1.005	S8	1200	Manhole	Adoptable	Tank 2	1	Manhole	Adoptable
4.000	S9	600	Manhole	Adoptable	S10	600	Manhole	Adoptable
4.001	S10	600	Manhole	Adoptable	S11	600	Manhole	Adoptable
4.002	S11	600	Manhole	Adoptable	Tank 2	1	Manhole	Adoptable
1.006	Tank 2	1	Manhole	Adoptable	S12	1200	Manhole	Adoptable
1.007	S12	1200	Manhole	Adoptable	S13	1200	Manhole	Adoptable

Manhole Schedule

Node	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
S1	167.600	1.050	600	0	1.000	166.550	150
S2	167.450	1.190	600	1	1.000	166.260	150
				0	1.001	166.260	150
S3	167.700	1.550	600	1	1.001	166.150	150
				0	1.002	166.150	150
S4	167.650	1.610	600	1	1.002	166.120	150
				0	1.003	166.040	225
S5	166.600	0.740	600	1	1.003	165.860	225
				0	1.004	165.860	225
Tank 1	167.600	2.150	1	0	2.000	165.450	300
S6	167.600	2.170	1200	1	2.000	165.430	300
				0	2.001	165.430	300
S7	167.500	1.000	600	0	3.000	166.500	150
S8	167.600	2.230	1200	1	3.000	165.520	150
				2	2.001	165.370	300
				3	1.004	165.450	225
				0	1.005	165.370	300
S9	167.600	1.050	600	0	4.000	166.550	150
S10	167.650	1.850	600	1	4.000	165.880	150
				0	4.001	165.800	225
S11	167.000	1.620	600	1	4.001	165.380	225
				0	4.002	165.380	225
Tank 2	166.700	1.340	1	1	4.002	165.360	225
				2	1.005	165.360	300
				0	1.006	165.360	300

Manhole Schedule

Node	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
S12	166.300	1.100	1200	1	1.006	165.200	300
				0	1.007	165.200	150
S13	166.250	1.350	1200	1	1.007	164.900	150

Simulation Settings

Rainfall Methodology	FSR	Analysis Speed	Detailed
FSR Region	England and Wales	Skip Steady State	x
M5-60 (mm)	20.000	Drain Down Time (mins)	240
Ratio-R	0.400	Additional Storage (m³/ha)	0.0
Summer CV	0.750	Check Discharge Rate(s)	x
Winter CV	0.840	Check Discharge Volume	x

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
30	0	0	0
100	40	0	0

Node S12 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	165.200	Product Number	CTL-SHE-0100-5000-1400-5000
Design Depth (m)	1.400	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	5.0	Min Node Diameter (mm)	1200

Node Tank 2 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	165.360
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	256

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	81.0	0.0	0.800	81.0	0.0	0.801	0.0	0.0

Node S6 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	165.430
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	204

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	60.0	0.0	0.800	60.0	0.0	0.801	0.0	0.0

Results for 1 year Critical Storm Duration. Lowest mass balance: 99.52%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S1	10	166.614	0.064	6.5	0.0182	0.0000	OK
15 minute winter	S2	11	166.326	0.066	6.4	0.0188	0.0000	OK
15 minute winter	S3	11	166.218	0.068	6.4	0.0193	0.0000	OK
15 minute winter	S4	11	166.138	0.098	14.5	0.0276	0.0000	OK
15 minute winter	S5	11	165.935	0.075	18.2	0.0212	0.0000	OK
15 minute summer	Tank 1	9	165.501	0.051	3.8	0.0000	0.0000	OK
60 minute winter	S6	47	165.496	0.066	4.3	3.8490	0.0000	OK
15 minute winter	S7	10	166.520	0.020	2.1	0.0057	0.0000	OK
60 minute winter	S8	50	165.499	0.129	10.9	0.1463	0.0000	OK
15 minute winter	S9	10	166.609	0.059	8.6	0.0167	0.0000	OK
15 minute winter	S10	10	165.855	0.055	10.5	0.0156	0.0000	OK
60 minute winter	S11	49	165.498	0.118	5.6	0.0334	0.0000	OK
60 minute winter	Tank 2	48	165.497	0.137	30.0	10.5083	0.0000	OK
60 minute winter	S12	44	165.550	0.350	25.4	0.3961	0.0000	SURCHARGED
15 minute summer	S13	1	164.900	0.000	5.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	S1	1.000	S2	6.4	0.872	0.372	0.2265	
15 minute winter	S2	1.001	S3	6.4	0.830	0.374	0.0919	
15 minute winter	S3	1.002	S4	6.4	0.892	0.333	0.0185	
15 minute winter	S4	1.003	S5	14.5	1.035	0.365	0.4308	
15 minute winter	S5	1.004	S8	18.3	1.638	0.219	0.1785	
15 minute summer	Tank 1	2.000	S6	3.8	0.965	0.054	0.0223	
60 minute winter	S6	2.001	S8	-2.9	0.229	-0.040	0.2890	
15 minute winter	S7	3.000	S8	2.1	1.492	0.037	0.0141	
60 minute winter	S8	1.005	Tank 2	9.8	0.895	0.114	0.0503	
15 minute winter	S9	4.000	S10	8.4	1.332	0.312	0.1853	
15 minute winter	S10	4.001	S11	10.4	1.044	0.133	0.1949	
60 minute winter	S11	4.002	Tank 2	5.8	0.755	0.147	0.0796	
60 minute winter	Tank 2	1.006	S12	25.4	0.565	0.179	0.4969	
60 minute winter	S12	Hydro-Brake®	S13	5.0				26.7

Results for 30 year Critical Storm Duration. Lowest mass balance: 99.52%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S1	10	166.667	0.117	15.9	0.0331	0.0000	OK
15 minute winter	S2	11	166.386	0.126	15.6	0.0357	0.0000	OK
15 minute winter	S3	11	166.272	0.122	15.5	0.0346	0.0000	OK
15 minute winter	S4	11	166.210	0.170	35.5	0.0482	0.0000	OK
15 minute winter	S5	11	165.988	0.128	44.5	0.0361	0.0000	OK
60 minute winter	Tank 1	61	165.729	0.279	4.9	0.0000	0.0000	OK
60 minute winter	S6	61	165.729	0.299	19.1	17.3616	0.0000	OK
15 minute winter	S7	10	166.532	0.032	5.2	0.0090	0.0000	OK
60 minute winter	S8	61	165.729	0.359	26.2	0.4055	0.0000	SURCHARGED
15 minute winter	S9	10	166.653	0.103	21.1	0.0292	0.0000	OK
15 minute winter	S10	10	165.888	0.088	25.9	0.0250	0.0000	OK
60 minute winter	S11	61	165.728	0.348	13.4	0.0986	0.0000	SURCHARGED
60 minute winter	Tank 2	61	165.728	0.368	33.5	28.3513	0.0000	SURCHARGED
60 minute winter	S12	61	165.728	0.528	20.6	0.5973	0.0000	SURCHARGED
15 minute summer	S13	1	164.900	0.000	5.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	S1	1.000	S2	15.6	1.037	0.910	0.4664	
15 minute winter	S2	1.001	S3	15.5	0.996	0.914	0.1873	
15 minute winter	S3	1.002	S4	15.5	1.099	0.813	0.0365	
15 minute winter	S4	1.003	S5	35.3	1.268	0.891	0.8512	
15 minute winter	S5	1.004	S8	44.7	2.037	0.536	0.3565	
60 minute winter	Tank 1	2.000	S6	4.5	0.706	0.064	0.3430	
60 minute winter	S6	2.001	S8	-14.9	-0.386	-0.208	1.0037	
15 minute winter	S7	3.000	S8	5.2	1.936	0.093	0.0714	
60 minute winter	S8	1.005	Tank 2	15.2	1.115	0.177	0.1176	
15 minute winter	S9	4.000	S10	20.7	1.644	0.768	0.3691	
15 minute winter	S10	4.001	S11	25.8	1.285	0.329	0.4741	
60 minute winter	S11	4.002	Tank 2	13.4	0.949	0.340	0.1379	
60 minute winter	Tank 2	1.006	S12	20.6	0.528	0.145	0.6922	
60 minute winter	S12	Hydro-Brake®	S13	5.0				64.7

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.52%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S1	11	167.588	1.038	28.9	0.2939	0.0000	FLOOD RISK
15 minute winter	S2	12	166.878	0.618	25.4	0.1748	0.0000	SURCHARGED
15 minute winter	S3	11	166.570	0.420	25.2	0.1189	0.0000	SURCHARGED
15 minute winter	S4	11	166.476	0.436	58.9	0.1235	0.0000	SURCHARGED
180 minute winter	S5	176	166.191	0.331	19.6	0.0937	0.0000	SURCHARGED
180 minute winter	Tank 1	176	166.187	0.737	4.1	0.0000	0.0000	SURCHARGED
180 minute winter	S6	176	166.187	0.757	13.2	44.0243	0.0000	SURCHARGED
15 minute winter	S7	10	166.542	0.042	9.4	0.0118	0.0000	OK
180 minute winter	S8	176	166.189	0.819	21.8	0.9260	0.0000	SURCHARGED
15 minute winter	S9	11	167.354	0.804	38.3	0.2276	0.0000	FLOOD RISK
180 minute winter	S10	172	166.185	0.385	11.1	0.1090	0.0000	SURCHARGED
180 minute winter	S11	176	166.188	0.808	11.1	0.2287	0.0000	SURCHARGED
180 minute winter	Tank 2	176	166.189	0.829	25.1	61.5985	0.0000	SURCHARGED
180 minute winter	S12	176	166.189	0.989	25.4	1.1183	0.0000	FLOOD RISK
15 minute summer	S13	1	164.900	0.000	5.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	S1	1.000	S2	25.4	1.441	1.476	0.5447	
15 minute winter	S2	1.001	S3	25.2	1.434	1.486	0.2113	
15 minute winter	S3	1.002	S4	26.5	1.505	1.386	0.0456	
15 minute winter	S4	1.003	S5	58.4	1.477	1.473	1.1688	
180 minute winter	S5	1.004	S8	19.6	1.353	0.235	0.6363	
180 minute winter	Tank 1	2.000	S6	3.9	0.571	0.055	0.3486	
180 minute winter	S6	2.001	S8	-9.3	-0.195	-0.130	1.0042	
15 minute winter	S7	3.000	S8	9.4	2.117	0.168	0.1081	
180 minute winter	S8	1.005	Tank 2	12.0	0.908	0.139	0.1176	
15 minute winter	S9	4.000	S10	36.0	2.045	1.336	0.5126	
180 minute winter	S10	4.001	S11	11.1	0.621	0.142	0.7413	
180 minute winter	S11	4.002	Tank 2	10.6	0.792	0.271	0.1379	
180 minute winter	Tank 2	1.006	S12	25.4	0.557	0.179	0.6922	
180 minute winter	S12	Hydro-Brake®	S13	5.0				107.4