

FLOOD RISK ASSESSMENT
&
SUDS / DRAINAGE ASSESSMENT
FOR PLANNING

AT

**9 UPPER CROWN STREET,
READING, RG1 2SS**

August 2021

Ark Environmental Consultancy Ltd

Table of Contents

1.0	Scope	1
2.0	Introduction	1
3.0	Existing Site Status and Setting	1
3.1	Site Location and Status	1
3.2	Geology	1
3.3	Existing Drainage: Connections & Inverts	2
3.4	Flood Risk Sources and Pathways Summary	2
4.0	Assessment of Proposed Development	5
4.1	Proposed Development	5
4.2	Foul Drainage	5
4.3	Surface Water Drainage.....	5
4.4	SUDS Storage Calculations	6
4.5	SUDS Design	6
4.6	SUDS Specifications: SUDS Hierarchy Compliant	7
4.7	Connections & Inverts	8
4.9	Pipe Sizes / Manholes / Pipe Runs	8
4.10	Maintenance	8

1.0 Scope

This report contains the details of a FRA & SUDS Drainage Strategy for planning carried out by Ark Environmental Consulting Limited ("ARK Ltd") at 9 UPPER CROWN STREET, READING, RG1 2SS, henceforth referred to as "the site" in this report.

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2.0 Introduction

The information source used to undertake this FRA has been collected from the following sources:

- British Geological Survey Website and iGeology Website
- EA Website
- Reading SFRA
- Reading as the LLFA SUDS Policies and Guidance
- Internet mapping and searches

3.0 Existing Site Status and Setting

3.1 Site Location and Status

The site is Brownfield and has a gross area of approx. 0.29 ha. The site location is indicated in red on the site location plan included within Appendix A.

The overall site comprises the existing building and hardstanding.

The site is ~100% impermeable. The existing layout is also provided in Appendix A.

3.2 Geology

Geology

Based on BGS mapping and boreholes (and known conditions of the majority of this area of Bromley):

- Bedrock: Lambeth Group - Clay, Silt And Sand
- Superficial deposits: either none or potential for Taplow Gravel Member - Sand And Gravel

There are no lost / underground rivers documented at the site or near the site nor identifiable by the local geology mapping.

Why is infiltration not being used?

Given the geology and the setting: the SUDS strategy necessarily needs to be storage on site with restricted discharge to existing separate surface water sewer.

No infiltration testing is required at this stage and it is an appropriate risk management strategy to design the SUDS as if infiltration were not feasible in order to oversize the SUDS storage.

3.3 Existing Drainage: Connections & Inverts

All foul water from the site is discharged to the foul sewers via the existing separate connection.

All surface water is discharged to the surface water sewers via the existing separate connection.

Based on the evidence available, there are no existing SUDS.

The site currently discharges all roof and hard surfaces to the sewer 100% unattenuated.

An assessment of the Greenfield equivalent discharge for the site has been carried out.

This has confirmed an average discharge rate (QBAR) of less than 0.5 l/s.

This low rate is due to the relatively small nature of the site.

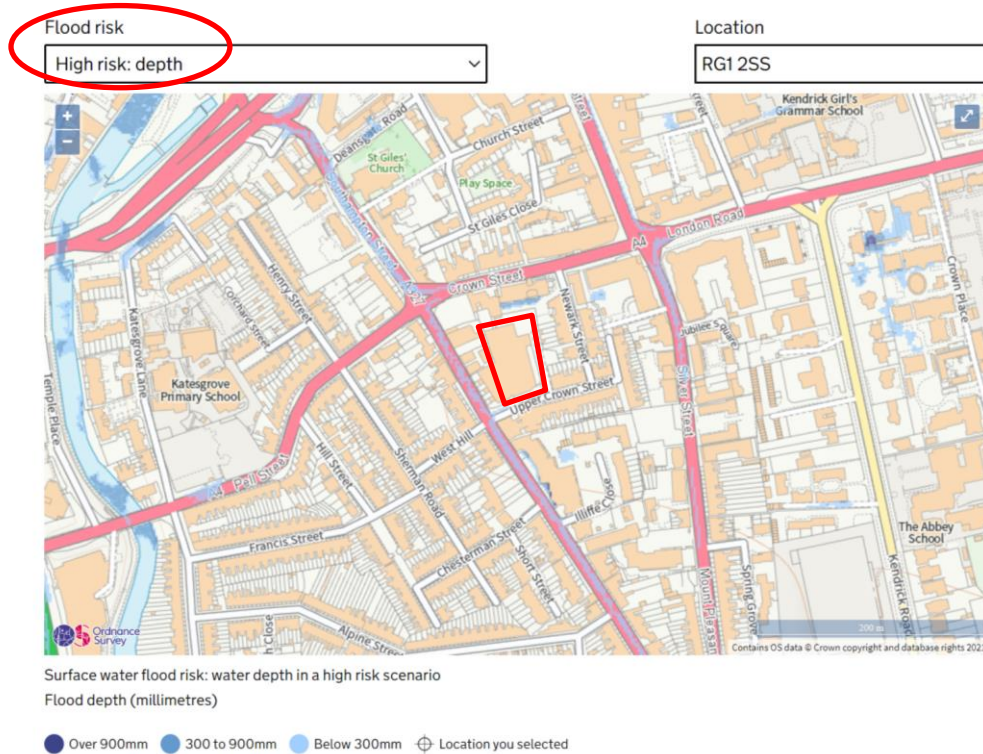
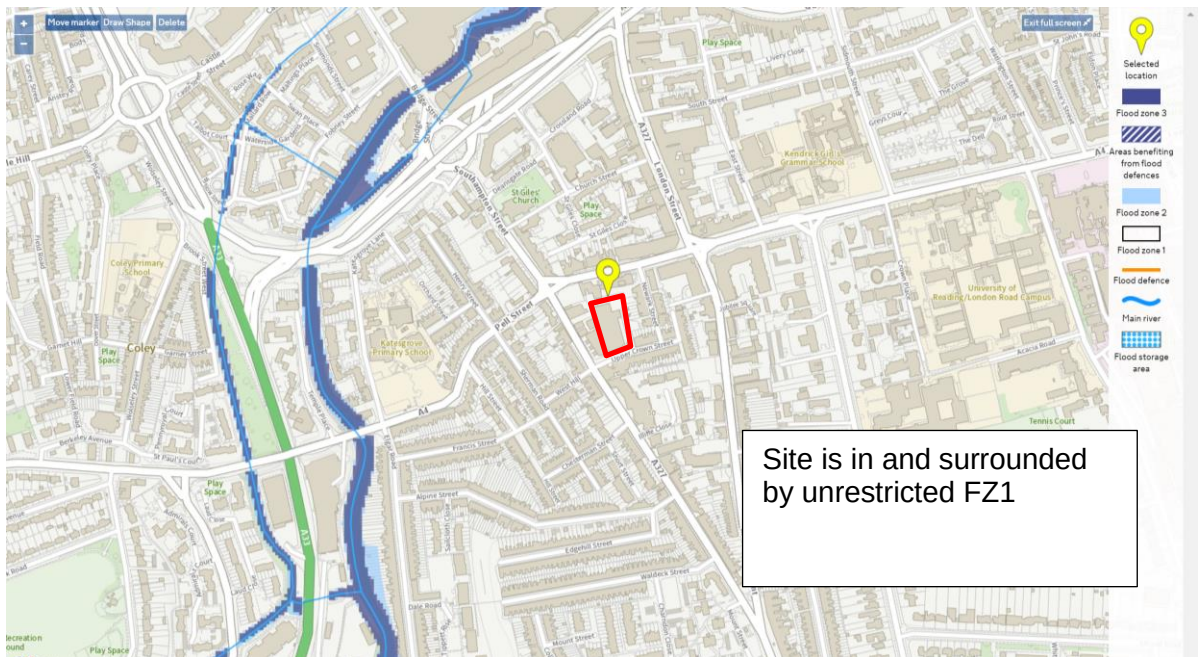
Important:

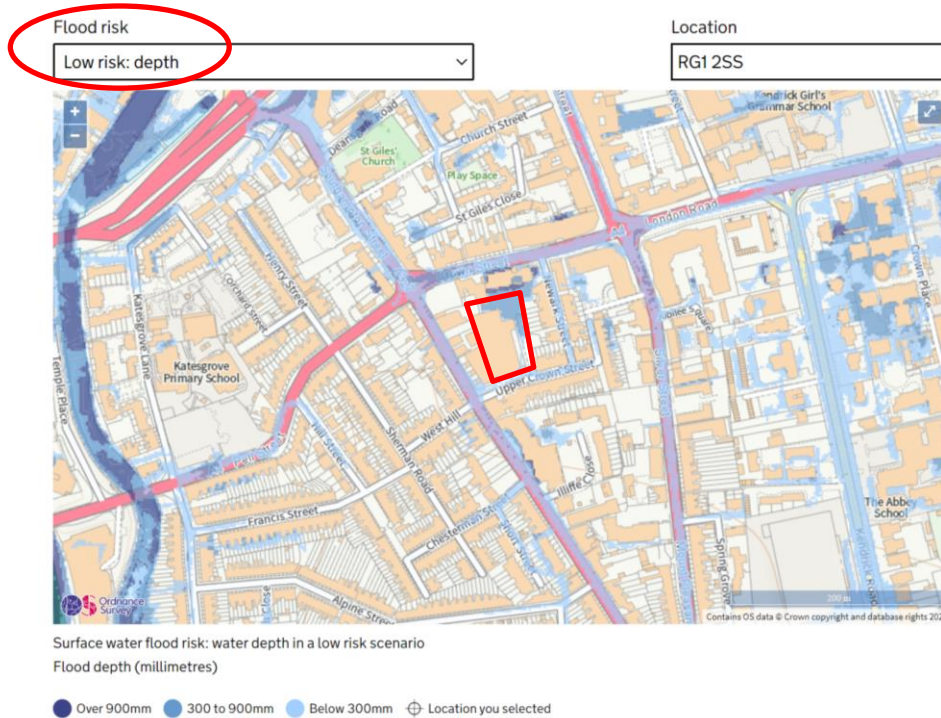
Critical Invert for new design:

The available manholes in Upper Crown Street are known to have a minimum 1.20m depth of invert.

3.4 Flood Risk Sources and Pathways Summary

Flood Sources	Site Status	Comment on flood risk posed to / from the development
Fluvial / Tidal	Site is in Flood Zone FZ1 EA official VERY LOW hazard	This is the zone where residential development is to be encouraged as per the NPPF in flood risk terms Scheme results in better protected and flood future-proofed property than existing
Groundwater	SFRA mapping indicates site not in area of groundwater flooding.	The proposed development will not increase the risk of groundwater flooding Low Risk
Artificial Sources	No artificial sources within 250m	Low Risk
Surface Water / Sewer Flooding	Site is in majority NO hazard in all the EA scenarios; small patchy area of low hazard in the EA LOW risk scenario: scheme addresses by new SUDS scheme on the site Condition, depth and location of surrounding infrastructure uncertain	New formal SUDS scheme to meet Reading SPD New modern flood resilience / resistance Development will utilise existing connection to sewers, gravity drainage and non-return valves Low Risk: Scheme results in reduction in flood risk overall with new SUDS storage for existing 100% unattenuated site
Climate Change & new allowances	Included in the flood modelling extents Site not within climate change flood extent area	Development will not significantly increase the peak flow and volume of discharge from the site Low risk posed to and from the development





4.0 Assessment of Proposed Development

4.1 Proposed Development

The proposed development is (Appendix B) comprises:

- Demolish existing structures and remove all impermeable areas and faulty / poor condition infrastructure
- Existing basement excavation area to be used to form new car park and enable “suspended” ground level above
- Erect a residential flats development above a basement car park with maximised porous and permeable areas, rain gardens / integrated storage planters, parking and communal landscaping
 - Maximisation of highest forms of SUDS
 - Restricting discharge on a previously 100% unattenuated site
 - To meet Reading Sustainability Policies and NPPF

4.2 Foul Drainage

Based on the proposed residential development, the maximum peak foul discharge generated is not considered to be unacceptable.

Given the existing property drains using gravity connections and the scheme does not propose any lower structures that would require significantly lower inverts: it is considered that gravity connections will be feasible for the proposed scheme.

Subject to exact connections and specifications confirmation as part of detailed drainage designs, Thames Water approvals and setting out by contractor.

4.3 Surface Water Drainage

In accordance with the NPPF, PPG and LLFA policy requirements, sustainable drainage systems (SUDS) should be incorporated wherever possible to reduce positive surface water run-off and flood risk to other areas.

SUDS techniques are to be restricted to the use of the highest forms of SUDS feasible i.e. surface storage rain gardens / planters with integrated storage, with also permeable paving and shallow underground storage, storing for the full 1in100year+40% climate change, with a residual positive discharge rate being smaller than the lowest possible restriction, discharging to the adjacent drainage sewer.

4.4 SUDS Storage Calculations

Calculations have been prepared based on the Micro Drainage software package to assess the size of structure require, based on the following design criteria.

FEH: given the size of the site and our approach to fully oversize the storage to ensure the site can accommodate more SUDS than is required of policy, we use the smaller site calculations i.e. IH124 and also use the greenfield rates / Qbar for the sizing of storage, which again overestimates the total storage required.

- Existing impermeable areas: 2,900.00m² (100% of the site)
- The calculations for SUDS storage use the required 50% reduction including for 40% climate change
 - This is considered appropriate for this existing constrained site which already has the excavated basement area
 - This will be the most sustainable approach
- Design event for storage - 100 year (with climate change; see below)
- Climate change allowance - 40%
 - It is not advised by guidance to restrict to lower than 3l/s as having a smaller than 100mm diameter restriction causes a flood risk in itself
- **Calculations use 3.0 l/s for the storage calculations purely to oversize the storage**
 - Lowest suitable discharge rate for sizing the storage
- The calculation output is included within Appendix C.
 - Oversized storage required: 87.0m³

4.5 SUDS Design

The SUDS measures have been incorporated as part of the designs, to meet the constraints of the site and setting.

The highest forms of SUDS have been prioritised.

The scheme has been designed in accordance with the relevant up to date SUDS Guidance.

We have used industry best practice, our 18 years experience, together with the lessons learned and the same approach as per many similar and more complex Reading and UK wide schemes.

There are particular constraints to this site:

- Surrounded on all sides by properties except the south access point
- Existing full site area basement
 - Reutilising is sustainable but minimises the ability to incorporate a suitable depth of stratum that can classify areas as truly porous / permeable for the ground floor being in effect a “suspended slab”
- Existing infrastructure that can be retained i.e. sewer connections which is a more sustainable approach
- Inner urban location: density appropriate for an apartments development

4.6 SUDS Specifications: SUDS Hierarchy Compliant

Formal SUDS Type	Source Control	Dimensions	Storage Volume
Porous amenity areas and Permeable Access / Parking and Planting	Yes	Total area of c. 300m ² The full “external” areas is greater, but this figure takes into account that some areas are not fully “porous / permeable” for the purposes of SUDS calculations.	n/a Natural Interception and Source Control
Surface Storage Rain Gardens: with raised planter edges or sunken (detailed design stage to confirm exact specification)	Yes	Planted communal amenity areas adjacent to new footprint / designed also to take overland flow from access areas Total of 210.0m ² . Use minimum of 200mm height / depth = 42.0m ² (Refer to Appendix D for location of these areas within the site)	42.00m ³
Permeable / Porous access and communal areas with underground lined geocellular storage	YES Permeable paving takes roof runoff	<u>Communal / access area nearest to Upper Crown Street</u> Area equivalent as verified by scaled drawing to be c. 55.0m ² Use 0.4m geocellular depth (this still works for the invert and drop to the main manhole) = 22.00m ³	22.0m ³
Sedum / Green roof area (mixed in with the solar arrays / plant at roof level)	YES	<u>Rooftops</u> Likely area available given solar arrays and other plant: c. 340.0m ² . Use 0.05m reservoir tray system = 17.0m ³ <u>Green roof on bin store</u> 36.75m ² Use 0.5m depth geocellular storage = 18.38m ³	35.38m ³
		Total	99.38m ³ Greater than the already oversized 87.00m ³ required
Attenuation in basement (if required as backup)	n/a	Area of 108m ² with 1.6m high concrete tanked = 172.8m ³ See AppD for basement locations	

The indicative layout plan included within Appendix D shows locations for the SUDS structures.

4.7 Connections & Inverts

It is proposed to connect the now restricted discharge from the rain gardens / green roof and permeable paving + geocellular storage directly to the sewer.

The scheme unequivocally reduces flood risk to and from the sewer.

The SUDS used are deliberately at height or shallow specifications given the invert required for connection is known.

4.9 Pipe Sizes / Manholes / Pipe Runs

These will be confirmed as part of detailed designs; specifications of landscaping and drainage products need to be confirmed through planning and at a later date.

This is not required at this stage to demonstrate scheme can accommodate the surface water flows or meet LLFA requirements.

Further Enhancements

Whilst internal rainwater harvesting is not proposed, it is recommended that rainwater pipes are fitted with water butts wherever feasible. Whilst the use of water butts won't reduce the design criteria of the receiving sewer, their use will reduce the time of entry and provide a supply of water for irrigation.

It will be necessary for the surface water drainage system to comply with the Environment Agency's pollution prevention guidance. Roof run-off is classified as uncontaminated and, in accordance with EA pollution prevention guidance, will not require any treatment. Any surface water run-off draining through permeable paving / rain gardens will also receive an adequate level of filtration through the associated substrate.

4.10 Maintenance

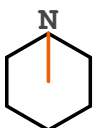
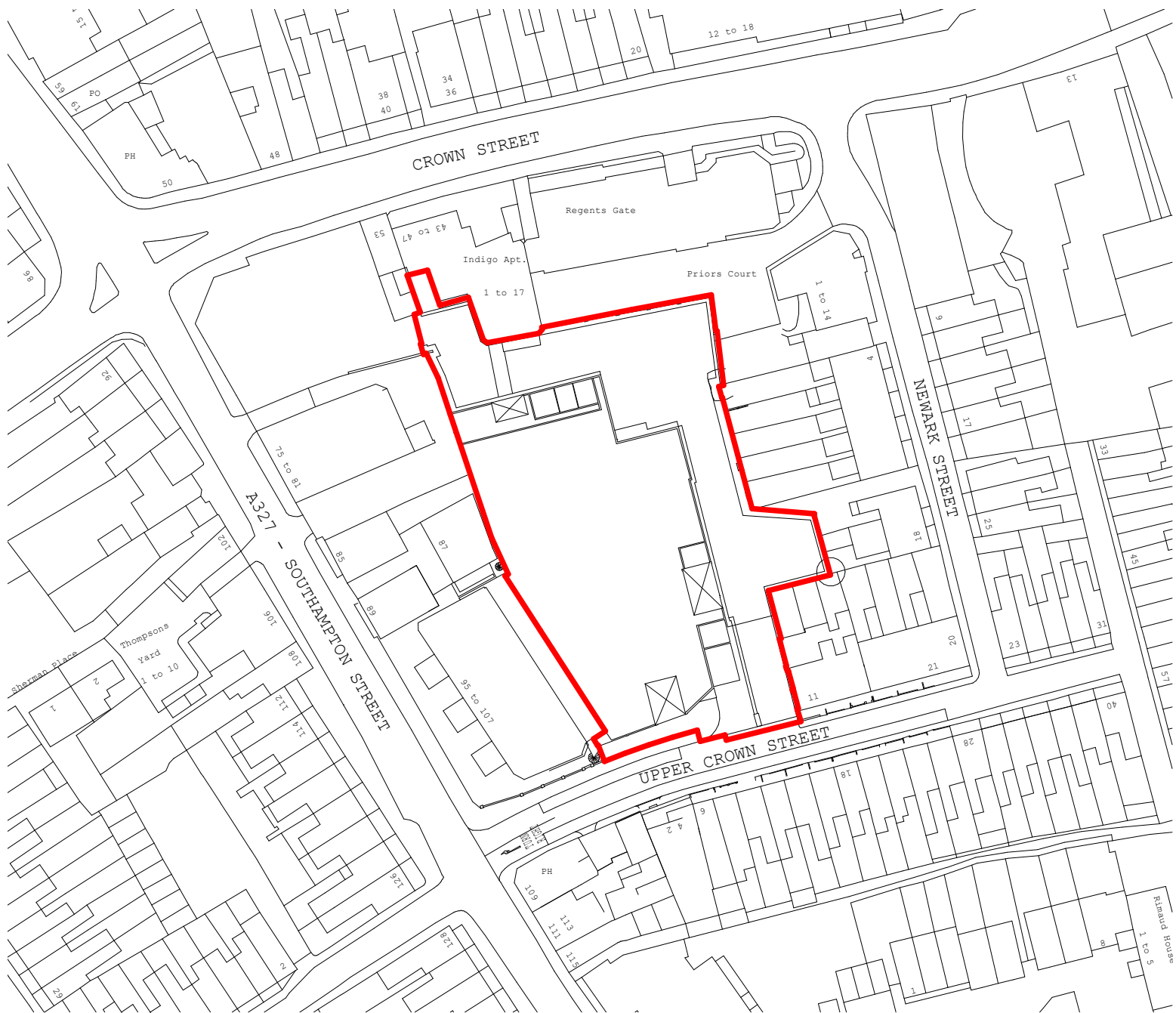
With respect to maintenance, the proposed SUDS techniques should be maintained in accordance with the appropriate regimes set out within the SUDS manual and will be the responsibility of the owner / management company.

- The specifications have been deliberately chosen to be low maintenance, resilient and easy to access inspect & clean.

A SUDS maintenance schedule is included within Appendix E.

APPENDICES

APPENDIX A



Collaborating with:
Edward Richardson

Job: 222 Drawing: P001 Revision: A

Project:
**9 Upper Crown Street
Reading, RG1 2SS**
Drawing:
Site Location Plan

Date:
Mar '21 Status:
Planning
Drawn By:
MC Checked By:
ED

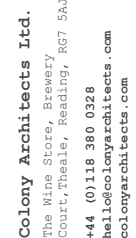


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APPENDIX B



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Project:
9 Upper Crown Street
Reading, RG1 2SS

Drawing:
SitePlan

Date:
Mar '21

Status:
Planning

Drawn By:
MC

Checked By:
ED

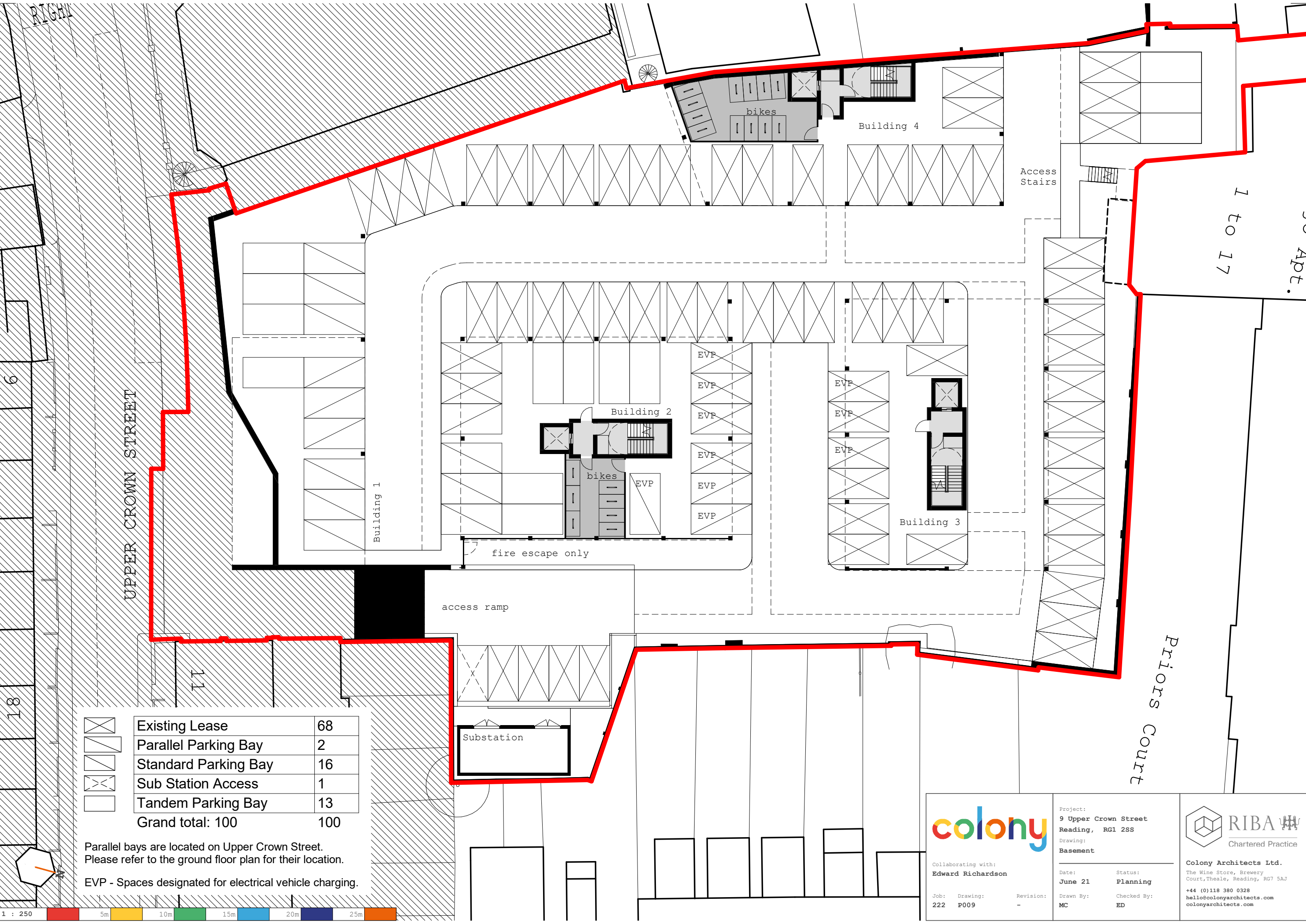
**colony**

Collaborating with:
Edward Richardson

Job:
222

Drawing:
P008

Revision:
A



	Existing Lease	68
	Parallel Parking Bay	2
	Standard Parking Bay	16
	Sub Station Access	1
	Tandem Parking Bay	13
Grand total: 100		100

Parallel bays are located on Upper Crown Street.
Please refer to the ground floor plan for their location.

EVP - Spaces designated for electrical vehicle charging.

Collaborating with:
Edward Richardson

Job: 222 Drawing: P009 Revision: -

Project:
9 Upper Crown Street
Reading, RG1 2SS

Drawing:
Basement

Date:
June 21

Status:
Planning

Drawn By:
MC

Checked By:
ED

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UPPER CROWN STREET

Priors Court



Collaborating with:
Edward Richardson

Job: 222 Drawing: P010 Revision: -

Project:
9 Upper Crown Street
Reading, RG1 2SS
Drawing:
Ground Floor

Date: June 21 Status: Planning
Drawn By: MC Checked By: ED



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UPPER CROWN STREET

Priors Court

RIGHT



1 : 250 5m 10m 15m 20m 25m



Collaborating with:
Edward Richardson

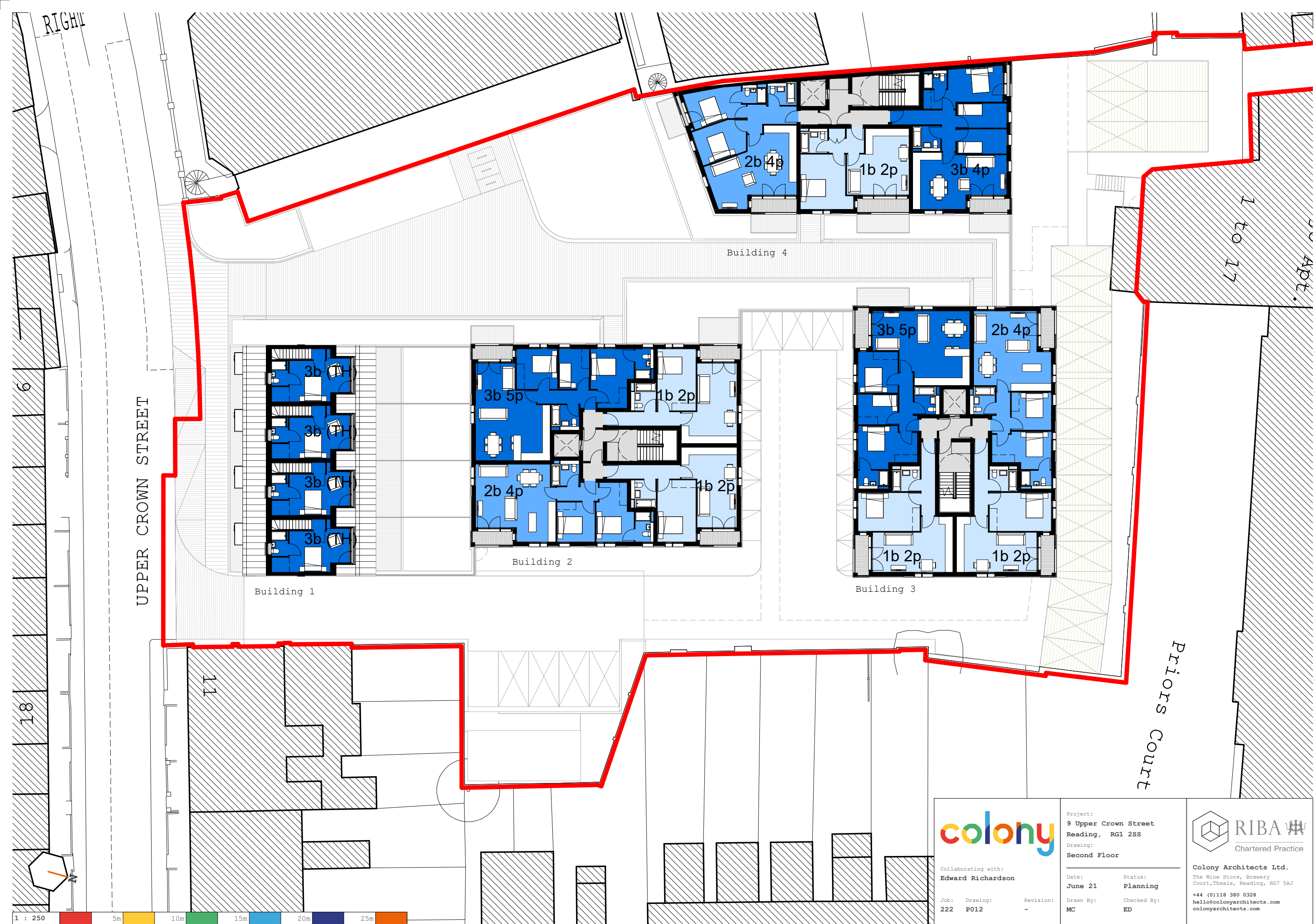
Job: 222 Drawing: P011 Revision: -

Project:
9 Upper Crown Street
Reading, RG1 2SS
Drawing:
First Floor

Date:
June 21
Status:
Planning
Drawn By:
MC
Checked By:
ED



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UPPER CROWN STREET

Priors Court

RIGHT

6

18

11

1 to 17

APT.

1 : 250 5m 10m 15m 20m 25m

Building 4

Building 2

Building 3



Collaborating with:
Edward Richardson

Job: 222 Drawing: P013 Revision: -

Project:
9 Upper Crown Street
Reading, RG1 2SS

Drawing:
Third Floor

Date:
June 21

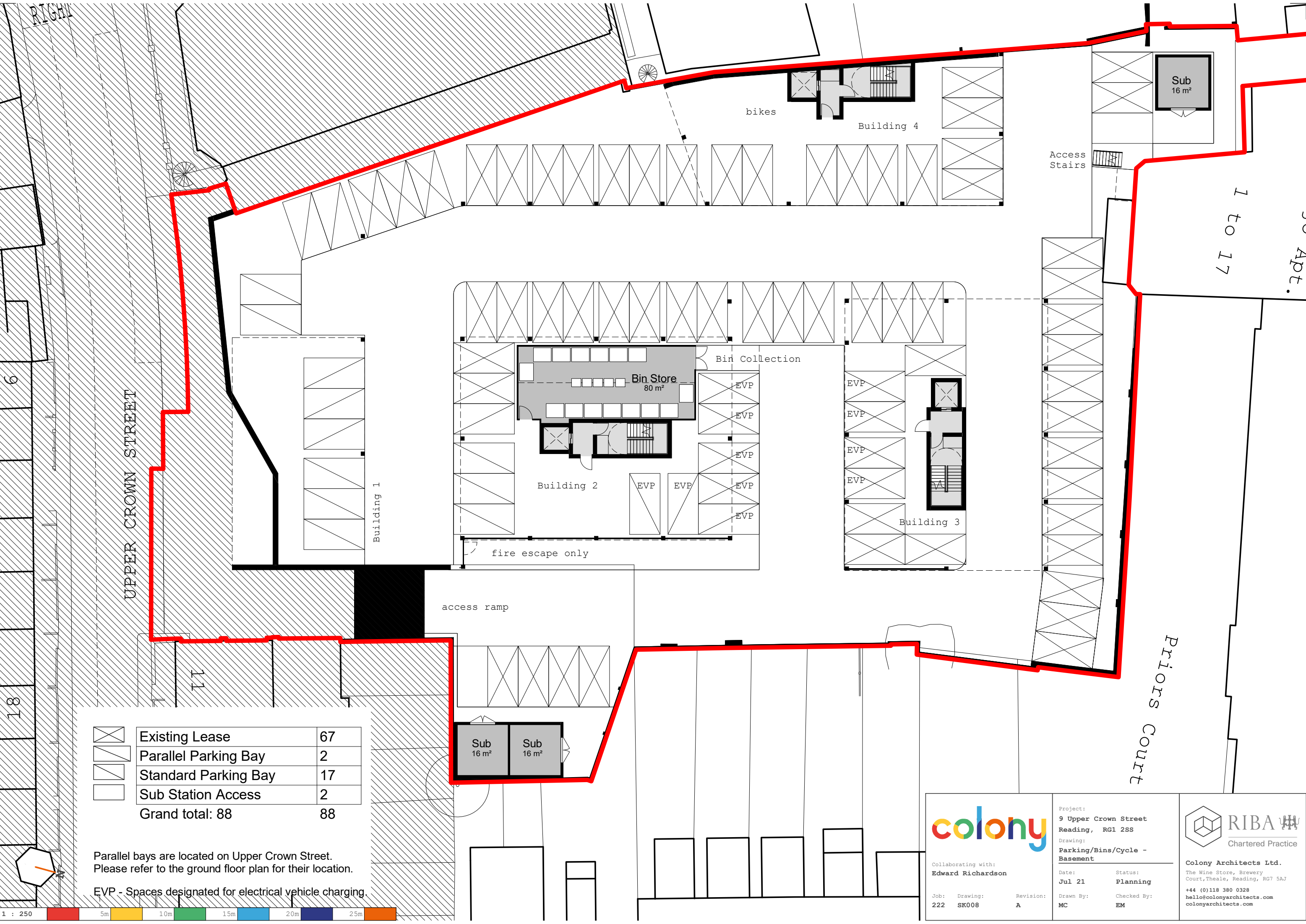
Status:
Planning

Drawn By:
MC

Checked By:
ED



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	Existing Lease	67
	Parallel Parking Bay	2
	Standard Parking Bay	17
	Sub Station Access	2
Grand total: 88		88

Parallel bays are located on Upper Crown Street.
Please refer to the ground floor plan for their location.

EVP - Spaces designated for electrical vehicle charging.



Collaborating with:
Edward Richardson

Job: 222 Drawing: SK008 Revision: A

Project:
**9 Upper Crown Street
Reading, RG1 2SS**

Drawing:
**Parking/Bins/Cycle -
Basement**

Date:
Jul 21

Drawn By:
MC

Status:
Planning

Checked By:
EM

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APPENDIX C



Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:

Site name:

Site location:

Site Details

Latitude:

Longitude:

Reference:

Date:

This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the design of the drainage scheme.

Site characteristics

Total site area (ha):	0.29
Significant public open space (ha):	0
Area positively drained (ha):	0.29
Impermeable area (ha):	0.1450
Percentage of drained area that is impermeable (%):	50
Impervious area drained via infiltration (ha):	0
Return period for infiltration system design (year):	10
Impervious area drained to rainwater harvesting (ha):	0
Return period for rainwater harvesting system (year):	10
Compliance factor for rainwater harvesting system (%):	66
Net site area for storage volume design (ha):	0.29
Net impermeable area for storage volume design (ha):	0.16
Pervious area contribution to runoff (%):	30

* where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50% of the 'area positively drained', the 'net site area' and the estimates of Q_{BAR} and other flow rates will have been reduced accordingly.

Design criteria

Climate change allowance factor:

Urban creep allowance factor:

Volume control approach:

Interception rainfall depth (mm):

Minimum flow rate (l/s):

Methodology

esti

Q_{BAR} estimation method:

SPR estimation method:

Soil characteristics

	Default	Edited
SOIL type:	2	2
SPR:	0.3	0.3

Hydrological characteristics

	Default	Edited
Rainfall 100 yrs 6 hrs:	--	55
Rainfall 100 yrs 12 hrs:	--	74.34
FEH / FSR conversion factor:	1.18	1.18
SAAR (mm):	640	640
M5-60 Rainfall Depth (mm):	17	17
'r' Ratio M5-60/M5-2 day:	0.4	0.4
Hydrological region:	6	6
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 10 year:	1.62	1.62
Growth curve factor 30 year:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Q_{BAR} for total site area (l/s):	0.48	0.48
Q_{BAR} for net site area (l/s):	0.48	0.48

Site discharge rates

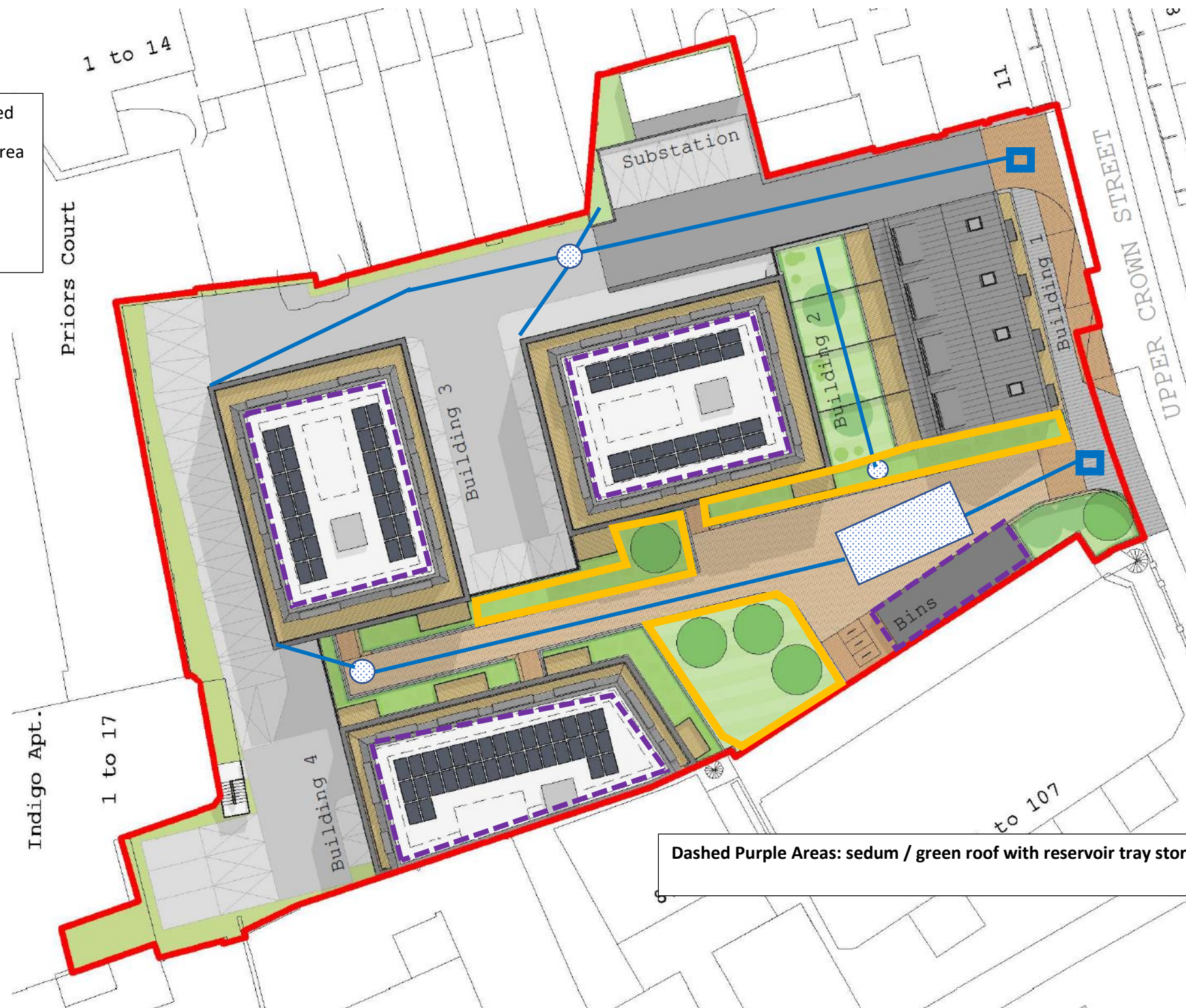
	Default	Edited
1 in 1 year (l/s):	2	2
1 in 30 years (l/s):	2	2
1 in 100 year (l/s):	2	2

Estimated storage volumes

	Default	Edited
Attenuation storage 1/100 years (m^3):	87	87
Long term storage 1/100 years (m^3):	0	0
Total storage 1/100 years (m^3):	87	87

This report was produced using the storage estimation tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement, which can both be found at <http://www.uksuds.com/terms-and-conditions.htm>. The outputs from this tool have been used to estimate storage volume requirements. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of these data in the design or operational characteristics of any drainage scheme.

APPENDIX D



Exact connection to be confirmed
Either within new ground slab area
or under slab (depending on
requirement for attenuation in
basement area)

MANHOLE TYPES

A: PC MANHOLE UNITS TO BS 5911 PART 200 KITE MARKED

B: POLYPROPYLENE INSPECTION CHAMBER-450 dia

POLYPROPYLENE INSPECTION CHAMBERS TO BE MANUFACTURED BY
HEPWORTH OR SIMILAR APPROVED

All downpipes and gulleys to be roddable

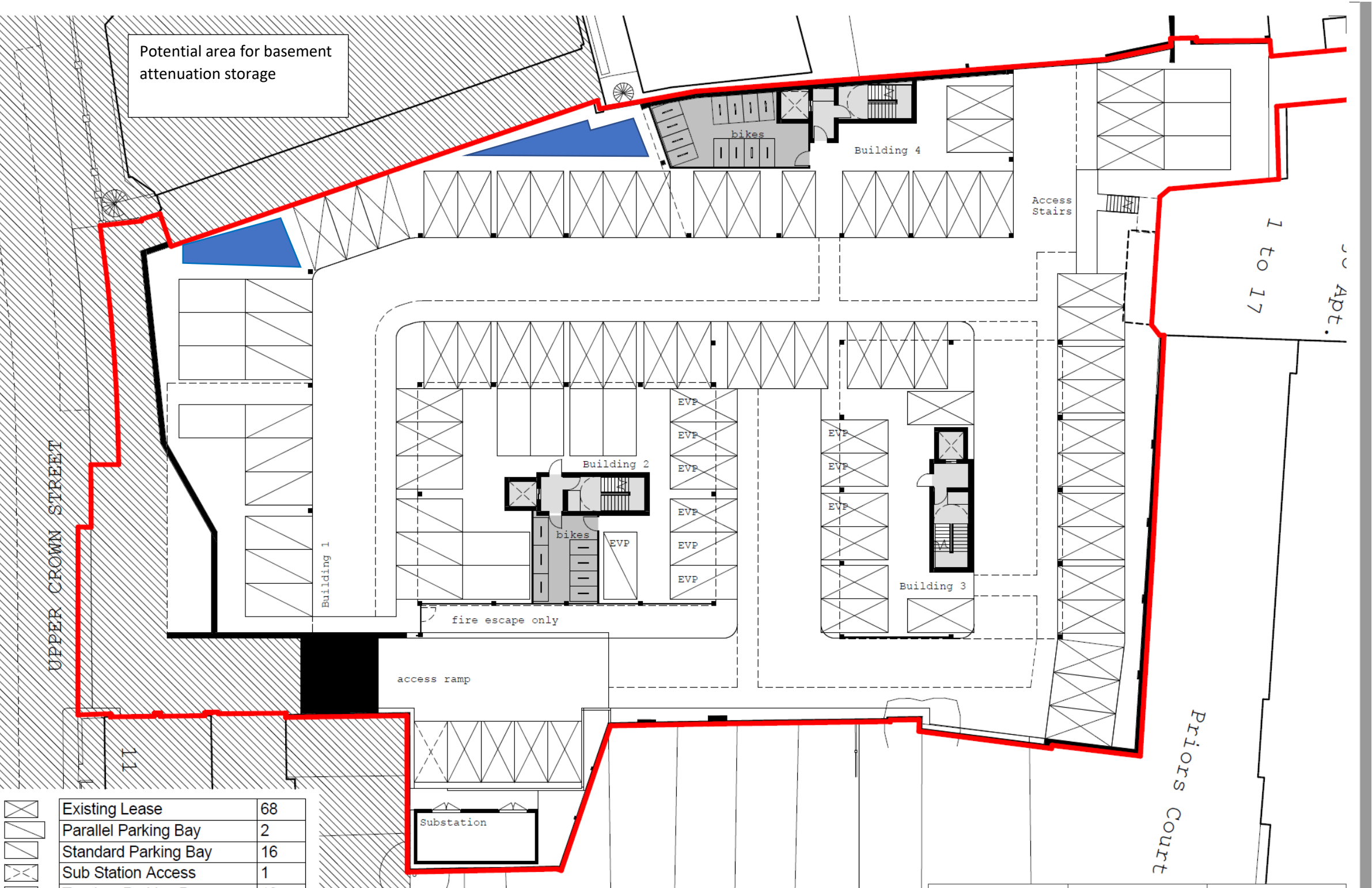
Note: separate surface and foul water manholes
existing connection inverts to be confirmed so levels
can be finalised

Existing separate surface water
manhole to be used / re-built with
existing outfall to sewer

Verified by CCTV survey

Dashed Purple Areas: sedum / green roof with reservoir tray storage / deeper stratum if structural integrity permits

Dotted Blue Areas: Online angular granular shallow depth storage to contractor design and installation; bedded, surrounded and backfilled as recommend by industry standard specifications and EA specification – follow all maintenance instructions.



APPENDIX E

SUDS Maintenance Schedule

Installation	Maintenance Required	Frequency	Responsibility
Rain Garden and Planters with integrated storage Splayed ends to rainwater downpipes	Inspection / Grass cutting / weeding / jetting	De-silting and jetting if required to be part of maintenance plan	Estate/Building Management Company
Pipe network / inspection chambers	Inspection, sediment removal and jetting	Annually or as per supplier's recommendations	Supplier (via a maintenance/service package) or Estate Management Company
Permeable Paving (incl. associated distribution pipework and sump chambers) Geocellular Storage	Inspection, sediment removal, debris removal and jetting: flush of system after extreme events	Typically, inspection is recommended annually or after a severe or significant storm event, with any jetting/cleaning being carried out as necessary.	Estate/Building Management Company