

**FLOOD RISK ASSESSMENT & SUDS REPORT FOR
WARREN CREEK, THE WARREN, CAVERSHAM,
RG4 7TQ**

DOCUMENT NUMBER: C3007-R2-REV-A

PREPARED BY



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1. SITE DETAILS

Site Name	Warren Creek
Site Address	Warren Creek, The Warren, Caversham, RG4 7TQ
Purpose of Development	Residential
Existing Land Use	Brownfield
OS NGR	469863E, 175084N
Country	England
Local Planning Authority	Reading Borough Council

1.1 Site Location

The location of the project site is shown in Figure 1 below.



Figure 1- Location of Project Site (Source: OS Opendata).

1.2 Proposed Development

This report is to support the application for a permitted development of this existing dwelling to provide a ground floor side extension to the existing dwelling. With first floor sleeping accommodation to be provided, which will be above the modelled floor level.

2. PLANNING POLICIES

2.1 National Planning Policies

- NPPF's Technical Guidance States:

"The effect of development is generally to reduce the permeability of at least part of the site. This markedly changes the sites response to rainfall. Without specific measures, the volume of water that runs off the site and the peak run-off flow rate is likely to increase. Inadequate surface water drainage arrangements in new development can threaten the development itself and increase the risk of flooding others."

2.2 Local Planning Policy

The report has been written in conjunction with the following local planning policies:

- Reading Borough Council Strategic Flood Risk Assessment Report

3. FLOOD RISK

The probable causes of flooding set out in NPPF are considered in this section in relation to flood risk to the site itself and the effects of the development of the site on the flood risk elsewhere.

3.1. Flood Zones

As described by the Flood risk and coastal change Technical Guidance to the National Planning Policy Framework, “inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere.”

The document defines areas at risk of flooding as meaning “land within Flood Zones 2 and 3; or land within Flood Zone 1 which has critical drainage problems, and which has been notified to the local planning authority by the Environment Agency”.

The document describes flood risk as meaning “risk from all sources of flooding – including from rivers and the sea, directly from rainfall on the ground surface and rising groundwater, overwhelmed sewers and drainage systems, and from reservoirs, canals and lakes and other artificial sources.”

Flood zones for planning purposes refer to the probability of flooding from the sea and rivers only.

Table 1 summarises the flood zones used in the Flood risk and coastal change Technical Guidance:

Flood Zone	Description
Zone 1 – low probability	Land assessed as having a less than 1 in 1,000 annual probabilities of river or sea flooding (<0.1%).
Zone 2 – medium probability	Land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% - 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% - 0.1%) in any year.
Zone 3a – high probability	Land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
Zone 3b – the functional floodplain	Land where water has to flow or be stored in times of flood, as identified by local planning authorities in their Strategic Flood Risk Assessments, in agreement with the Environment Agency.

Table 1- Flood risk and coastal change Flood Zone Guidance

3.2. Vulnerability Classification

The Flood risk and coastal change guidance outlines flood risk vulnerability classifications for a range of development types.

The document describes the classification as being “based partly on Department for Environment, Food and Rural Affairs and Environment Agency research on Flood Risks to People (FD2321/TR2) and on the need of some uses to keep functioning during flooding.

Based on the Flood risk and coastal change guidance, Table 2 summarises the vulnerability classification of the proposed site:

Site Use	Vulnerability Classification
• Hospitals • Residential institutions such as residential care homes, children's homes, social services homes, prisons, and hostels. • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs, and hotels. • Non-residential uses for health services, nurseries, and educational establishments. • Landfill* and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.	More Vulnerable

Table 2- Flood risk and coastal change guidance, Flood Risk Vulnerability Classification (More Vulnerable).

3.3. Development Planning Background and Environment Agency Data

Figure 4 overleaf, shows the indicative flood map for flood risk from rivers or the sea, which was downloaded from the Environment Agency's website, June 2024.

This indicative map suggests the site is located within Flood Zone 3. Flood Zone 3 is an area where there is a 0.5% chance of occurring in any year for flooding from the sea, or a 1% chance of occurring for fluvial (river) flooding.

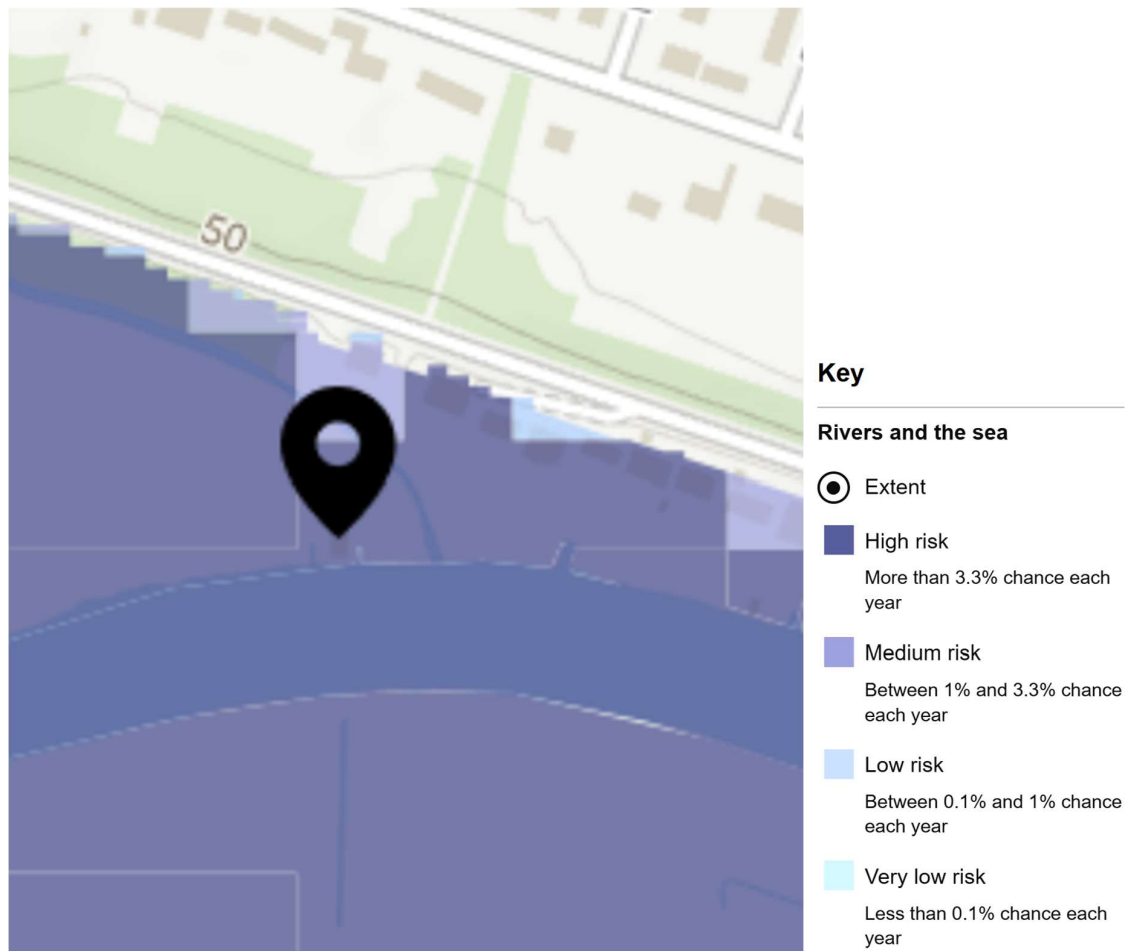


Figure 4 – Environment Agency Flood Map for flooding extent from rivers and sea for the proposed development

The Environment Agency were contacted to obtain site specific modelled flood levels, in order to ascertain the risk of flooding from the Rivers and the Sea to the site.

These modelled flood levels show that the proposed development site is within a Flood Zone 3, with a 1 in 100 annual probability of fluvial flooding in any year.

The site is not protected by flood defences, and there is a history of fluvial flooding at the site. That said the client is applying for a permitted development for an extension

at a dwelling where they reside, with existing sleeping accommodation to be moved to the first floor of this existing dwelling.

Flood point data was provided at the location of the proposed replacement dwelling with a modelled flood level for the 1 in 100 years plus 70% climate change event of 39.52mAOD.

Therefore, the ground floor of this dwelling has a finished floor level of 38.220mAOD, and will be at risk of flooding to a depth of 1.3 m, and due to the proposals being for an extension to an existing dwelling, there is no scope to raise the finished floor level of the proposed ground floor extension.

However various mitigation and resilience measures further on in this report, and the first floor will be above the modelled flood level, therefore a safe area of refuge will be provided. There will be issues with access and egress to the building during an extreme flooding event, which will be discussed further on in this report.

It should also be noted that, no flood storage compensation will be required, as the area of the extension equates to 59.4m², and there are buildings to be removed which equate to 40.88m², as well as 10m² of front porch which will be open and allow flood water to flow through this. Drawings showing the buildings to be removed, and the extension area have been provided in Appendix A.

3.4 Flooding from Land (Overland Flow)

The existing dwelling and area for this proposed extension is at a very low risk of surface water flooding, and although there are areas within the client's site boundary showing a low risk of surface water flooding, the depths of flooding at these areas will be less than 300mm.

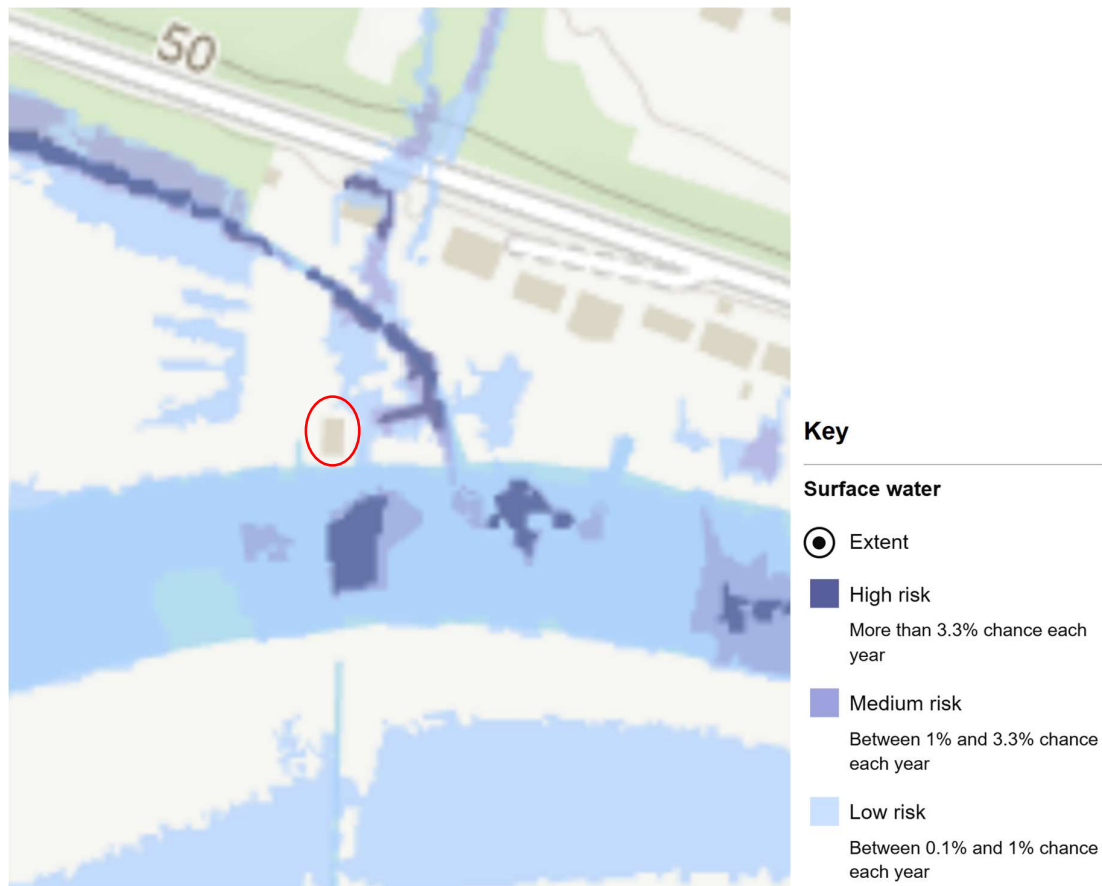


Figure 5 – Environment Agency Surface Water Flood Map for the proposed development.

3.5 Flooding from Groundwater

The Environment Agency's website confirms that groundwater flooding is unlikely in this area.

3.6 Flooding from Sewers

There is no risk of flooding from any sewers at the proposed development site, and there has been no history of sewer flooding at the proposed development site.

3.7 Flooding from Reservoirs, Canals, or Other Artificial Sources

The Environment Agency's Flood map shown in Figure 6 overleaf, shows the site to be at risk of any reservoir, however flood warnings are in place, and there has been no loss of life from reservoir flooding.

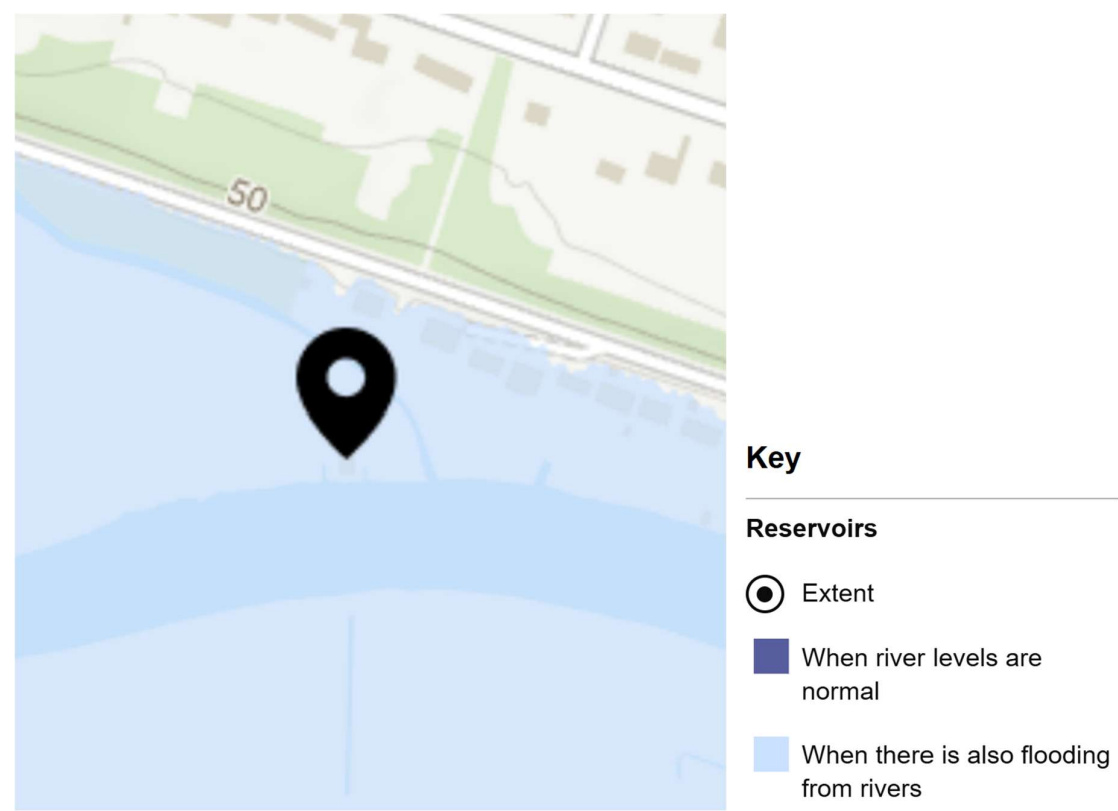


Figure 6 – Environment Agency Flood Map from reservoirs for the proposed development

4 RESIDUAL RISK AND MITIGATION MEASURES

4.1. Residual Risks

As discussed in this report, the site is located within the Environment Agency's fluvial Flood Zone 3, which comprises land assessed as having a 1% (1 in 100) annual probability of fluvial flooding in any year.

As discussed previously in this report, the ground floor of the existing building, and the proposed ground floor extension will be at risk of fluvial flooding, however the first floor and sleeping accommodation of this existing dwelling is above the modelled flood level for the 1 in 100 year plus 70% event.

Therefore, a safe area of refuge is available on the first floor, and the owners of the dwellings will be asked to sign up to Flood Warnings direct, which they are currently signed up to, so that the residents can seek refuge on this floor once a flood warning has been received.

4.2. Mitigation Measures

The existing ground floor and ground floor extension is at risk of fluvial flooding, therefore various resilience measures will be incorporated into the fabric of the ground floor extension, as well as flood proof windows and doors to be provided for the existing dwelling, at ground floor level also. Fixtures and fittings will be put in place to ensure that if any flood water does enter the ground floor during a flood event, the

impact of floodwater on the property will be minimal. These measures will ensure drying and cleaning is simpler, and that the structural integrity of the building is not compromised, and ultimately, they will reduce the time required until the property can be re-occupied.

The resilience measures to be adopted, are as follows:

- Air vents to be located as high as possible.
- Flood warning alarm system.
- Using Floodproof windows and doors for the ground floor.
- Electricity consumer unit and to be located as high as possible, with all feeds to go down the building from the ceiling.
- Non return valves to be used in drainage design to prevent back up of flow.
- Adequate sealing of joints between the internal units in the garage is required to prevent any penetration of water behind fittings.
- Any proposed heating systems such as boiler units and ancillary devices to be installed as high as possible.

- Walls will have closed-cell cavity insulation and a damp proof course up to the first-floor level, for the proposed extension.

4.3. Safe Access and Egress

As discussed, access and egress to the site will not be feasible during an extreme fluvial event, and the occupants would be advised to sign up to flood warning direct in order to receive a flood warning and seek refuge in the first floor of the dwelling and stay there until the flooding stops. Unless they are informed otherwise by the emergency services

The owners of the dwellings would receive a copy of this report as a part of their deeds and therefore would be also asked to keep an emergency supply bag of tinned and dry food in the event of an extreme flood event where they cannot leave this building. Should a flood warning be received whilst they are away from their building, they will be advised to remain away until told otherwise by the Environment Agency.

5. SUSTAINABLE URBAN DRAINAGE SYSTEMS

The total area of the proposed extension is 59.4m², with there being an additional 70.5m² of additional hardstanding areas.

Surface water arising from a developed site should, as far as practicable, be managed in a sustainable manner to mimic the surface water flows arising from the site prior to the proposed development, while reducing the flood risk to the site itself and elsewhere, taking climate change into account.

Reducing the rate of surface water discharge from Urban Sites is one of the most effective ways of reducing and managing flood risk.

Traditional piped surface water systems work by removing the surface water from our developments as quickly as possible, however this can cause various adverse impacts:

- Increased downstream flooding, and sudden rises in flow rates and water levels in local water courses.
- Reduction in groundwater levels dry weather flows in watercourses.
- Reduce amenity and adversely affect biodiversity due to the surface water runoff containing contaminants such as oil, organic matter, and toxic materials.

SuDS are defined as a sequence of management principles and control structures designed to drain surface water in a more sustainable fashion than conventional piped drainage techniques. SuDS should utilise the environmental, ecological and social benefits.

These include:

- Protection and enhancement of water quality – As well as providing on-site attenuation, SuDS treat the water, resulting in an improved quality of water leaving the site. This is achieved when the water passes through the fine soils and the roots of specially selected plants, pollutants washed off the hard landscaping by rainfall will be safely removed before the water reaches the natural water course.
- A sympathetic approach to the environmental setting by providing the opportunities to create habitats for flora and fauna in urban watercourses and open spaces.
- Meeting the amenity and social needs of the local community and residents in the creation of attractive green spaces.

The various types of SuDS include:

Permeable paving	
Soakaways	
Swales and basins	
Bioretention/ rain gardens	
Green roofs and rainwater re-use	
Infiltration trenches and filter drains	
Ponds and wetlands	

Preferably a combination of these techniques should be used as part of the surface water management train, and it is important for all stakeholders, such as developers, architects, landscape architects and engineers, to work together at the planning stage in order to determine a feasible solution.

The SuDS management train is shown in Figure 7 below, this has been followed when proposing the proposed Sustainable Urban Drainage Systems for this site.

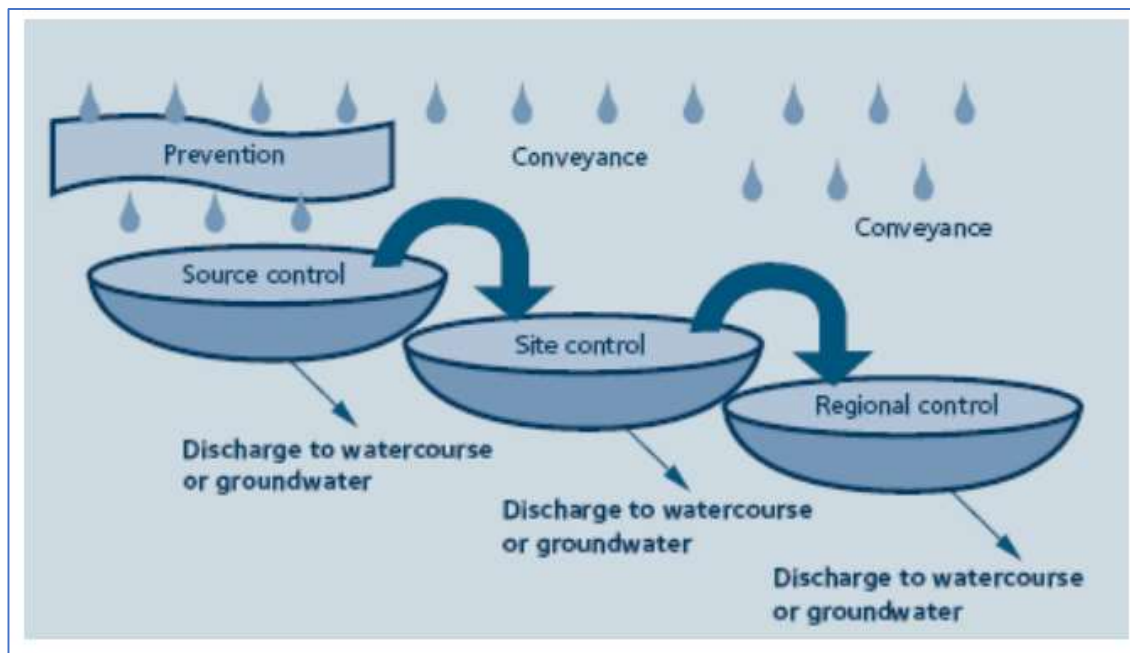


Figure 7 – SuDS Management Train

6. PROPOSED SuDS SOLUTION

In order to ensure that the SuDS management train has been followed, two wall mounted rainwater harvesting tanks will be provided at the dwelling, and one at the garage. The proposed extension roofs is pitched, therefore green or sedum roofing could not be provided.

All proposed hardstanding areas will be formed of porous surfacing, with the surface water runoff from any sloped areas to be caught by slot drains.

The preferred method of dealing with remaining surface water from the above SuDS components would be to treat and deal with it at source using soakaways, however due to the geological makeup of the soils these are not possible on this site.

Therefore, the remaining surface water runoff will be conveyed into one, below ground crate system attenuation tank with restricted flow leaving the site and discharging into the creek at a rate of 1 l/s, in order to avoid blockages, as per the calculations provided in Appendix C.

Hydrograph storage calculations were carried out for the 1 in 100-year storm event plus 45% climate change event. These show that, 4m³ of storage is required within the site, with the restricted discharge to be conveyed by gravity to the river. The proposed outline SuDS solution is provided in Appendix A.

7. SuDS PROPOSALS FOR DEVELOPMENT

In accordance with the CIRIA SuDS Manual C753, the SuDS hierarchy has been considered in relation to the site-specific constraints and its surroundings. Table 3 below outlines the hierarchical approach considered for the development at Warren Creek, The Warren, Caversham, RG4 7TQ.

Sustainable Drainage Proposal	Description	Constraints/Comments	Appropriate
Rainwater Use as a Resource	Use of rainwater runoff for reuse, e.g. Rainwater harvesting tanks, Blue Roofs for irrigation	Two wall mounted rainwater harvesting tanks will be provided at the new buildings.	Yes
Rainwater Full Infiltration to Ground (Source Control)	Infiltration devices and/or soakaways. Surface water runoff stored on site and gradually percolating into receiving ground	Due to the geological makeup of the ground Infiltration on this site is not an option.	No
Rainwater Partial Infiltration to Ground (Source Control)	Installation of permeable/porous surfacing	Porous paving has been proposed at all new hardstanding areas to deal with surface water run off for low storm event	Yes
Rainwater attenuation in green infrastructure features for gradual release	The onsite storage of all surface water runoff which can then be gradually conveyed to a nearby watercourse, sewer, or infiltration into the ground. Forms of green infrastructure features: Green	The proposed extension roofs will be pitched therefore green, or sedum roofing cannot be provided and due to the site levels, any discharge from ponds would have to be pumped, therefore we have proposed an underground tank	No

	Roofs, Raingardens, Ponds, Swales, Detention basins, Infiltration Trenches, and Raingarden Planters		
Rainwater discharge direct to a watercourse	All surface water runoff on site discharged at a restricted rate to a nearby watercourse	The remaining surface water runoff will be attenuated and discharged into the adjacent river at restricted rate of 1 l/s.	Yes
Controlled rainwater discharge to a surface water sewer or drain	All surface water runoff on site is discharged at a restricted rate to a nearby surface water sewer or drain, all rainwater runoff stored in below ground attenuation features. E.g. oversized pipes or geo-cellular tanks	N/A	N/A
Controlled rainwater discharge to a combined sewer	All surface water runoff on site discharged at a restricted rate to a nearby surface water sewer all rainwater runoff stored in below ground attenuation features. E.g. oversized pipes or geo-cellular tanks	N/A	N/A

Table 3: SuDS hierarchy

8. TIMESCALE AND MAINTENANCE OF DRAINAGE WORKS

All drainage works shall be completed prior to first occupation and there shall be no adoption of any of the drainage works within the site, and the homeowner will be responsible to oversee the long-term maintenance of the communal drains.

The following outline maintenance strategy sets out recommended timescales for maintenance of the proposed drainage works, in line with CIRIA SuDS Design Guide:

- Regular inspection will comprise the inspection and cleaning of catchment, gutters, filters, and tanks to reduce the likelihood of contamination, this is recommended to be carried out every 3 to 6 months.
- The catch pit chamber to the attenuation should be checked and emptied regularly to ensure there is no silting up of the system.
- Regular jet-washing of permeable block paving can be used to keep joints and voids clear; this should be carried out every 3 to 6 months.

The following table outlines the maintenance requirements for the porous paving:

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations, or clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this is the most likely to collect the most sediment
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphosate applied directly into the weeds by an applicator rather than spraying	As required
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving.	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material.	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48hr after large storms in six months
	Inspect slit accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

Table 4: Operation and maintenance requirements for pervious pavements.

The following table outlines the maintenance requirements for the Attenuation Tank:

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 blockages 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

Table 5: Operation and maintenance requirements for attenuation storage tanks.

The following table outlines the maintenance requirements for the rainwater harvesting systems:

Maintenance schedule	Required action	Typical Frequency
Regular maintenance	Inspection of the tank for debris and sediment build-up, inlets/outlets/withdraw devices, overflow areas, pumps, filters.	Annually (and following poor performance)
	Cleaning of tank, inlets, outlets, gutters. Withdrawal devices and roof drain filters of silts and other debris	Annually (and following poor performance)
Occasional maintenance	Cleaning and/ or replacement of any filters	Three monthly (or as required)
Remedial actions	Repair of overflow erosion damage or damage to tank	As required
	Pump repairs	As required

Table 6: Operation and maintenance requirement for RWH systems.

The following table outlines the maintenance requirements for the flow control chambers:

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspect from surface and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then 6 monthly intervals
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	Orifice plates within plastic chambers or vortex controls to be jetted from the surface after heavy rainfall events to remove any debris or silt	As required
	Empty catchpits upstream of SuDS features to ensure no debris is passed downstream	3 months or as required
Remedial actions*	In the event of a blockage, a vortex flow control can be removed from the chamber via the lifting cabled located at the access, this will be cleaned at surface level and reinstalled into its original location	As required
	In the event of a blockage, the orifice plate should be jetted from surface, and if blockage is not cleared the orifice plate can be removed by removing fixing bolts. These fixing bolts should be checked and replaced if needed.	As required
Monitoring	Following installation, it is important that any extraneous materials i.e. building materials: granular backfill, in-situ pour concrete etc are removed from the unit and the new flow control chamber is fully jetted down	Upon installation
	Inspect/check chamber channel for any debris or silt build-up. Upstream chambers should be checked at the same time as these monitoring works to ensure network is operating at full capacity.	Annually

Table 7: Operation and maintenance requirement for flow control chambers

*All Remedial Works should be carried out by a competent and certified contractor, with no entry or removal of parts to be undertaken by landowner.

If upstream network of flow control chamber is regularly maintained, little maintenance is required within the chamber as there are no moving part.

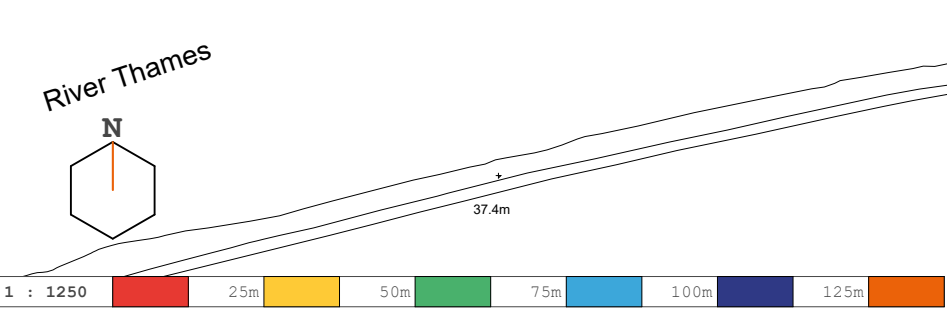
9. CONCLUSIONS

This report has been produced to demonstrate that the proposed development will not increase risk to life and will not increase flood risk to the site itself or areas adjacent to the site.

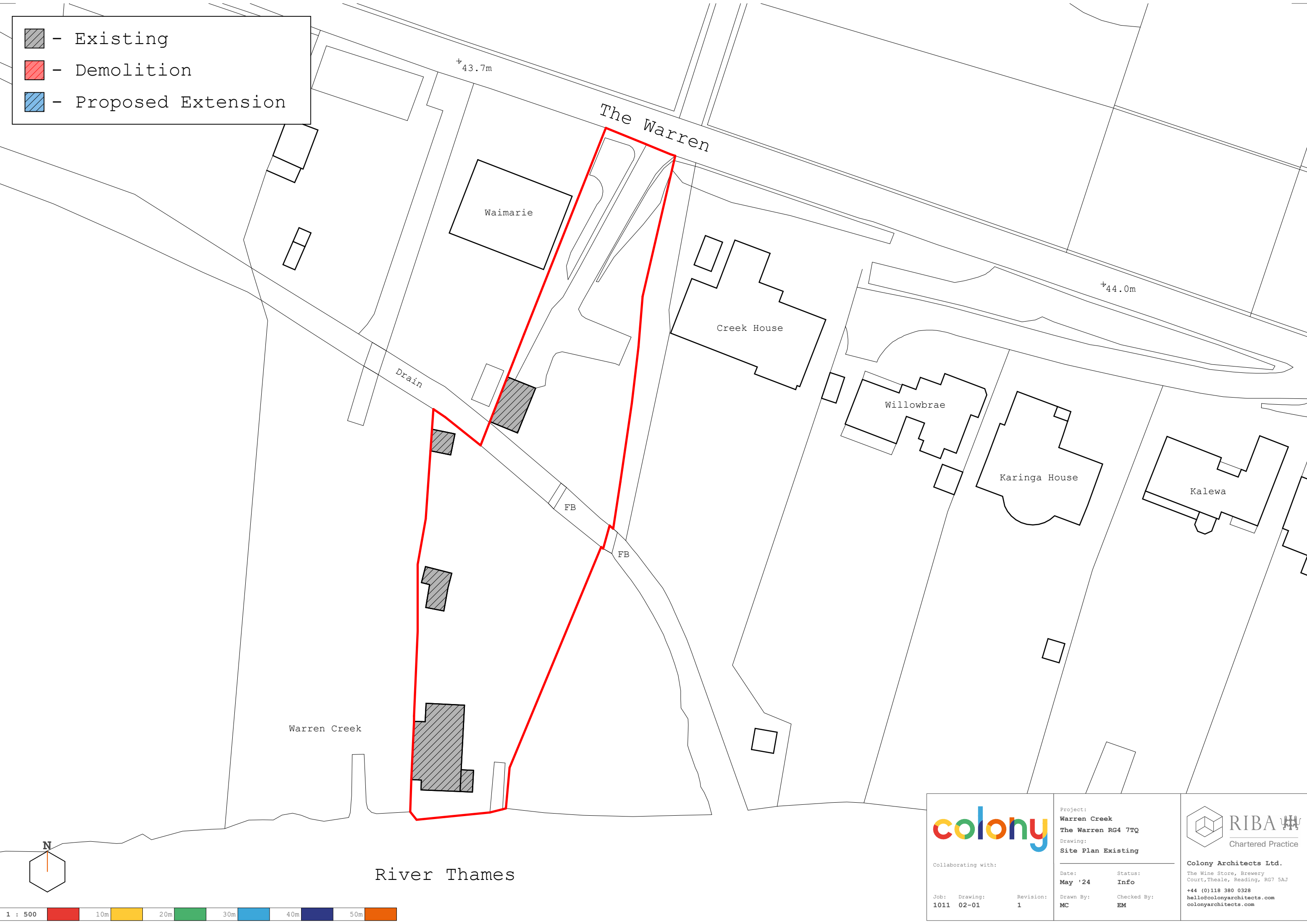
There is a risk of fluvial flooding, to the site, however sleeping accommodation is provided on the first floor and various mitigation and resilience measures have been proposed.

A suitable Sustainable Urban Drainage systems solution has been proposed which follows the SuDS hierarchy.

APPENDIX A – DRAWINGS



 Collaborating with:			Project: Warren Creek The Warren RG4 7TQ Drawing: Site Location Plan		 Chartered Practice Colony Architects Ltd. The Wine Store, Brewery Court, Theale, Reading, RG7 5AJ +44 (0)118 380 0328 hello@colonyarchitects.com colonyarchitects.com
Date: May '24 Status: Info			Drawn By: MC Checked By: EM		
Job: 1011 Drawing: 01-01 Revision: 1					



- Existing

- Demolition

- Proposed Extension

colony

Collaborating with:

Job: 1011

Drawing: 02-01

Revision: 1

Project: Warren Creek
The Warren RG4 7TQ

Drawing: Site Plan Existing

Date: May '24

Status: Info

Drawn By: MC

Checked By: EM

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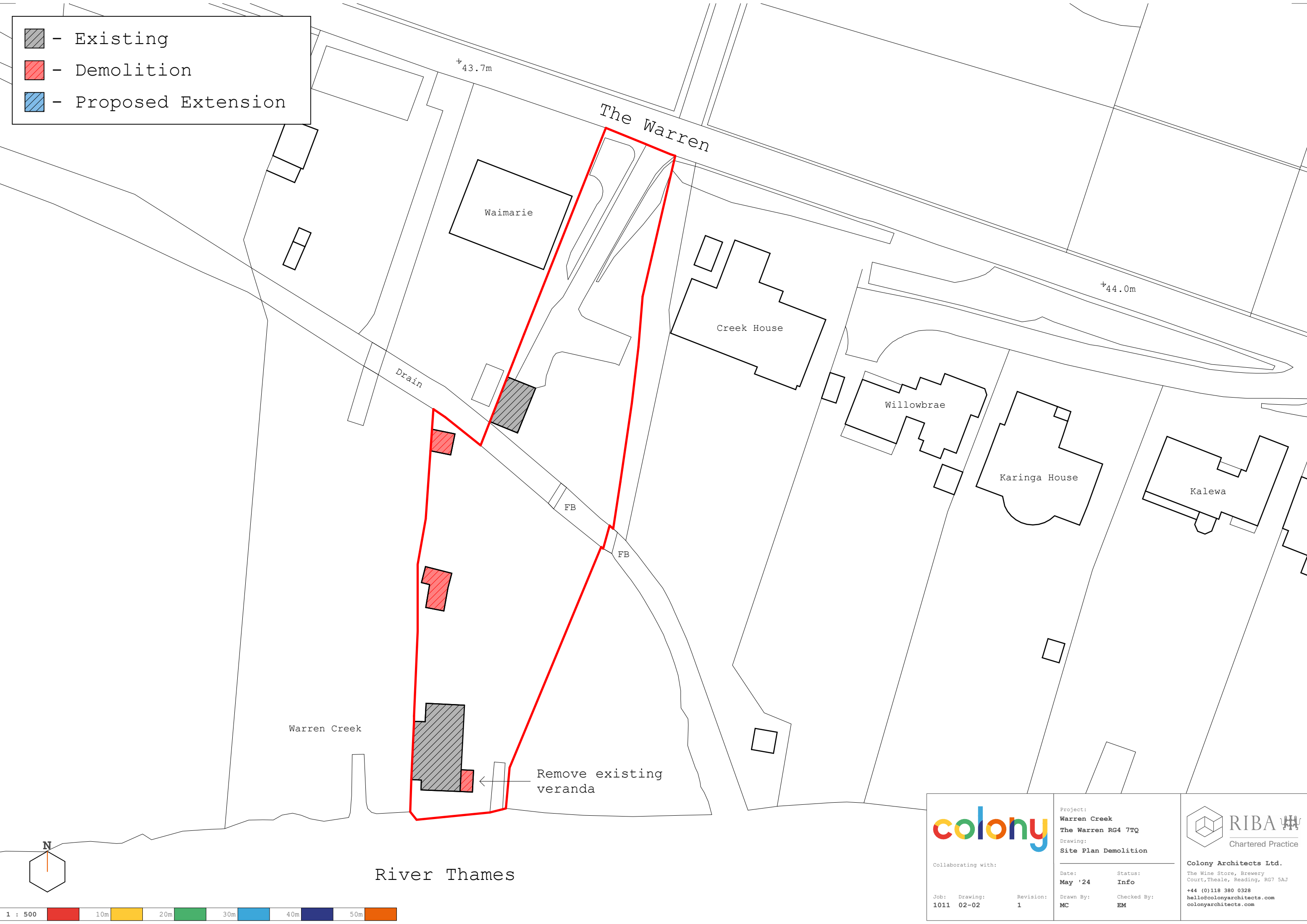
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- Existing

- Demolition

- Proposed Extension

N

1 : 500

10m

20m

30m

40m

50m

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Collaborating with:

Project:

Warren Creek
The Warren RG4 7TQ

Drawing:

Site Plan Demolition

Job:

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Status:

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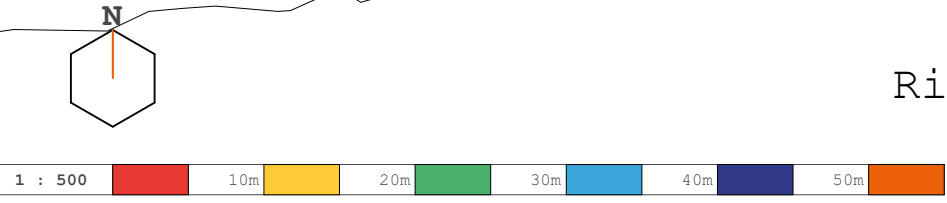
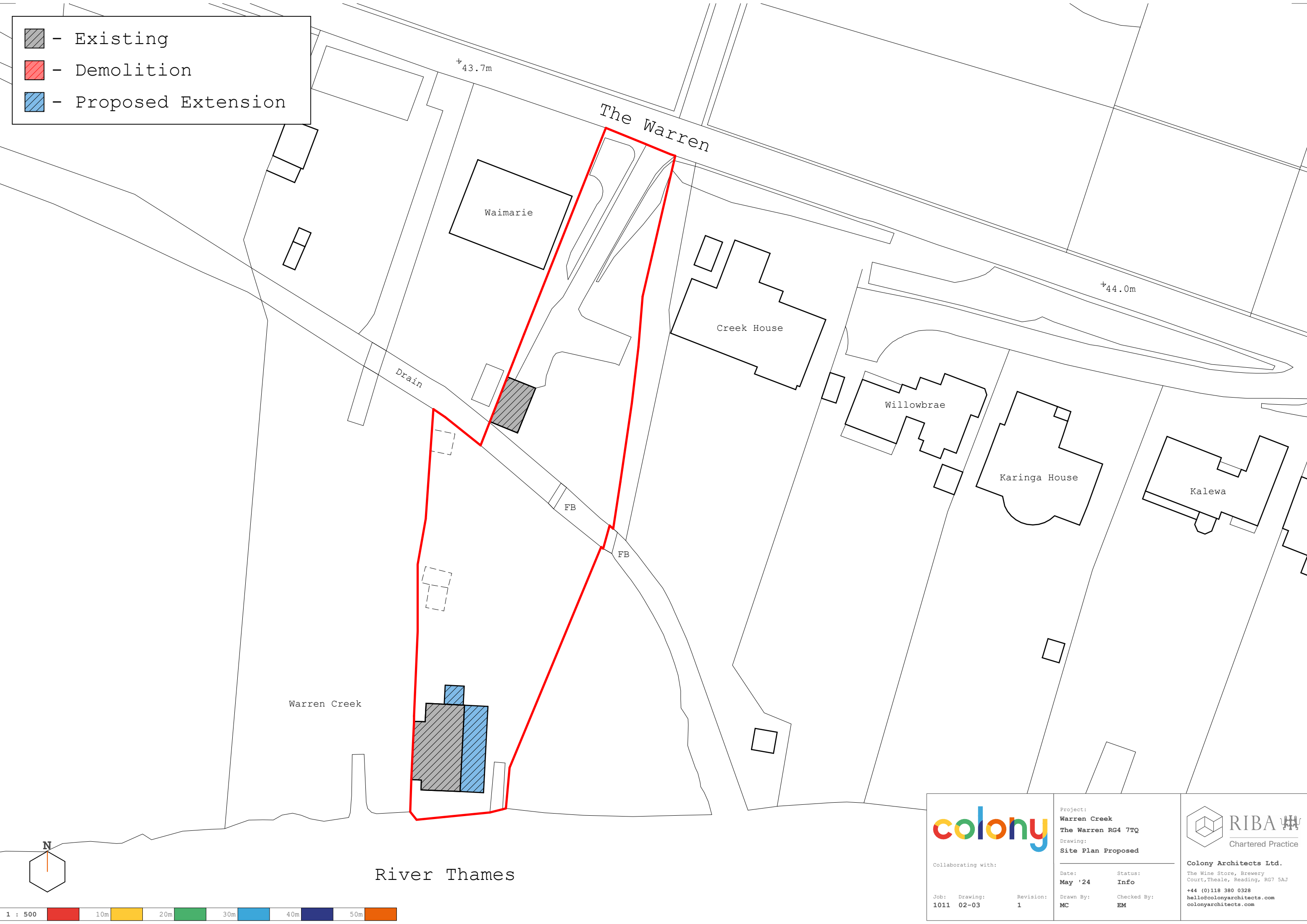
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Project:
Warren Creek
The Warren RG4 7TQ

Drawing:
Site Plan Proposed

Date:
May '24

Status:
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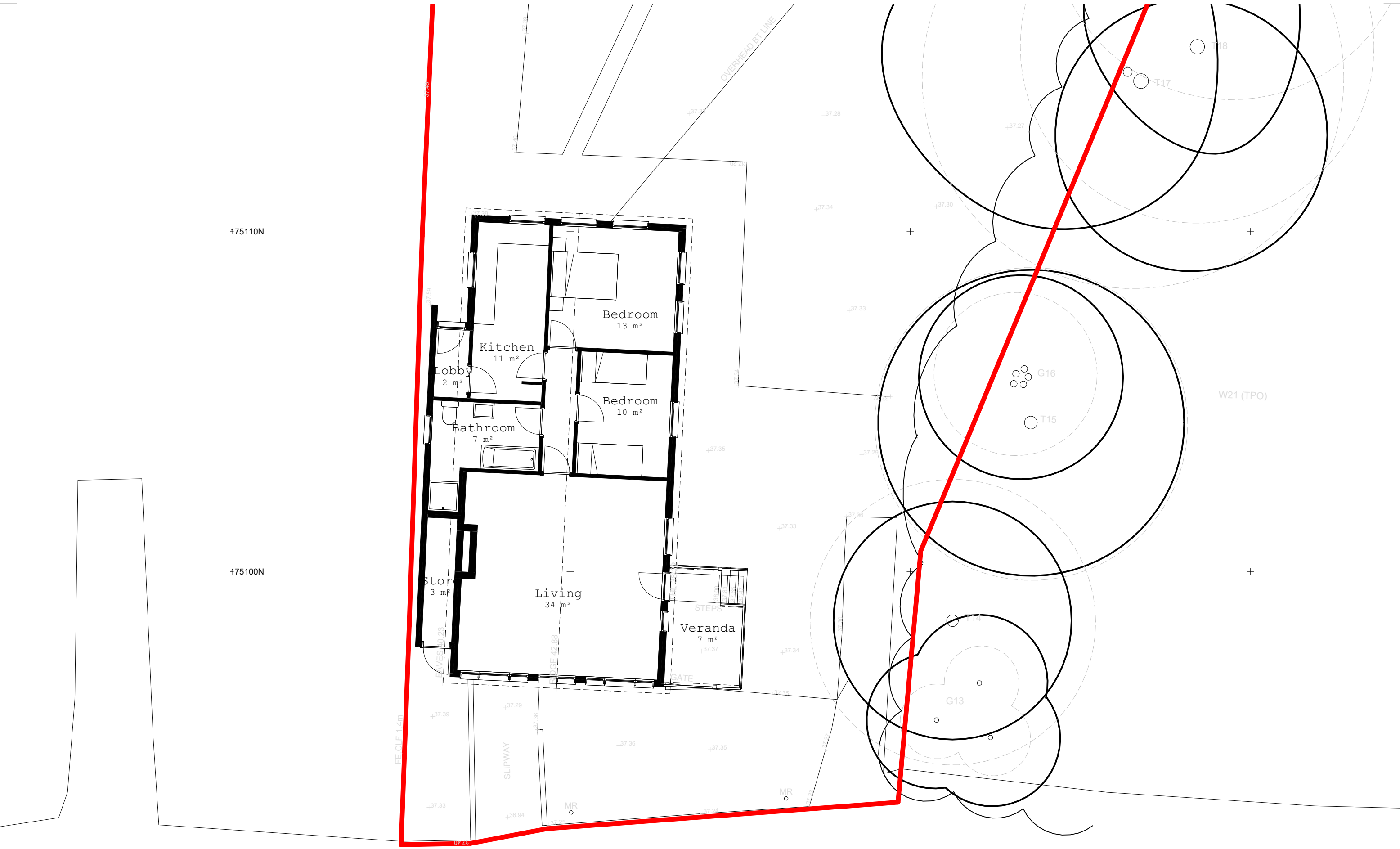
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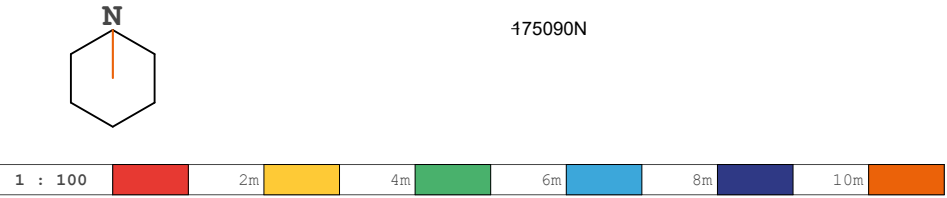


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River Thames



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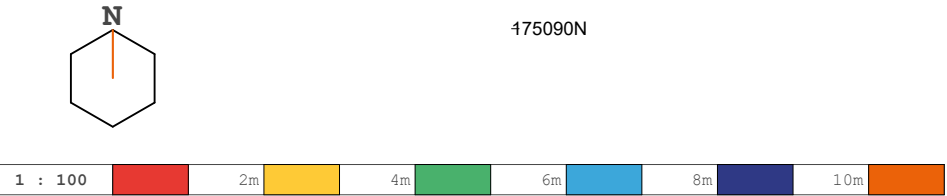
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The Warren RG4 7TQ
Drawing:
Existing Ground Floor

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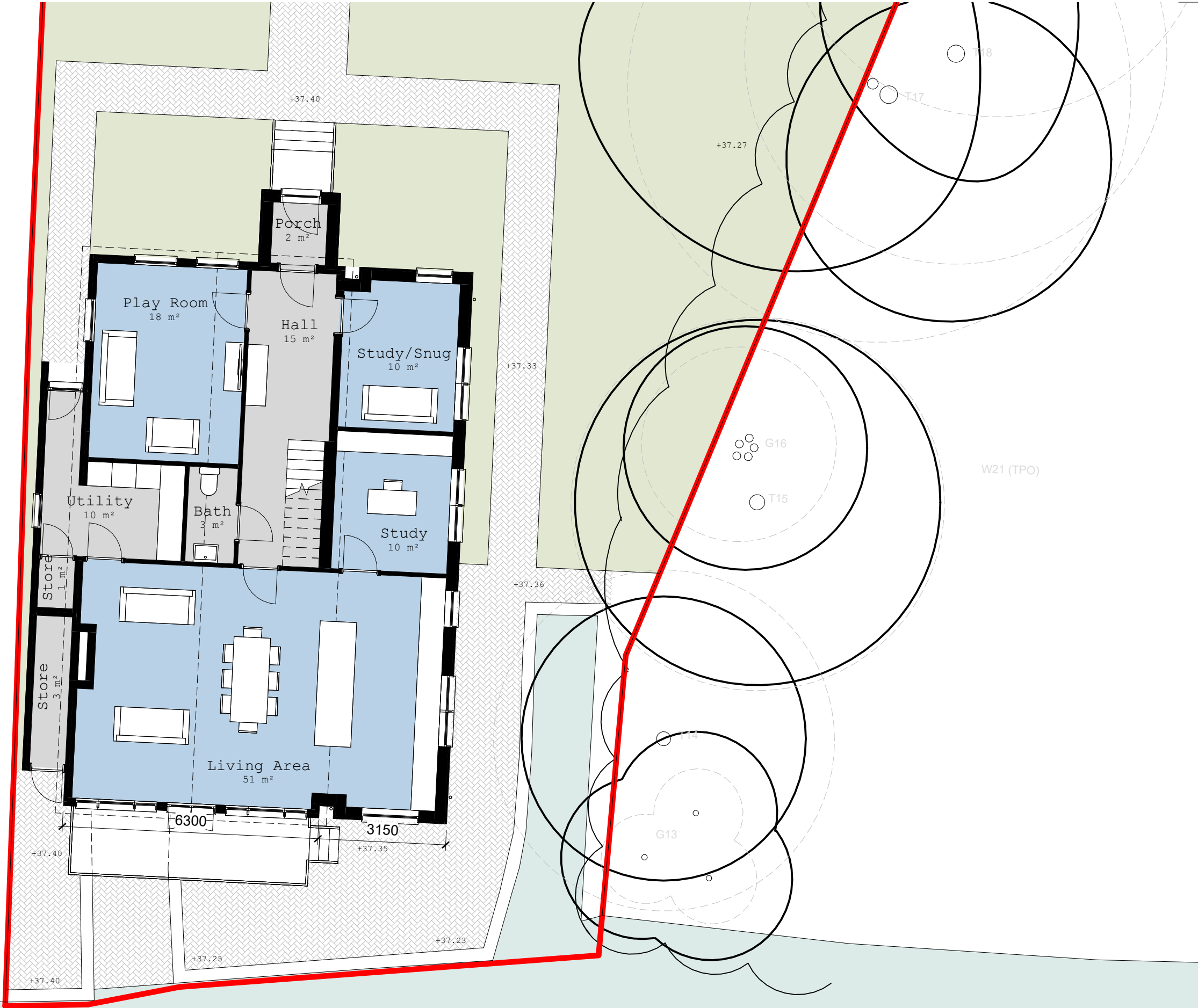
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1011	03-02	1

Date:	Status:
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Drawn By:	Checked By:
MC	EM



Notes

- 1. Flood level +39.52m
- 2. Loft for safe refuge
- 3. Remove the existing out buildings
- 4. Voided floor
- 5. Flood-proof doors/windows
- 6. Improve tanking, to make the building water tight
- 7. Try and put bedrooms upstairs
- 8. Flood warning alarm system - Audio-visual alarm, triggered on a level breach



River Thames



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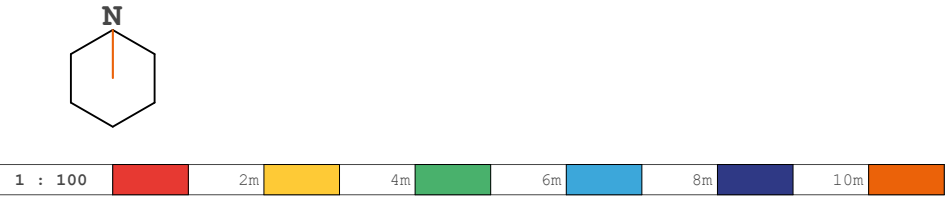
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Project: Warren Creek The Warren RG4 7TQ
Drawing: Proposed Ground Floor Plan

Date: May '24 Status: Info
Drawn By: MC Checked By: EM



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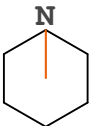
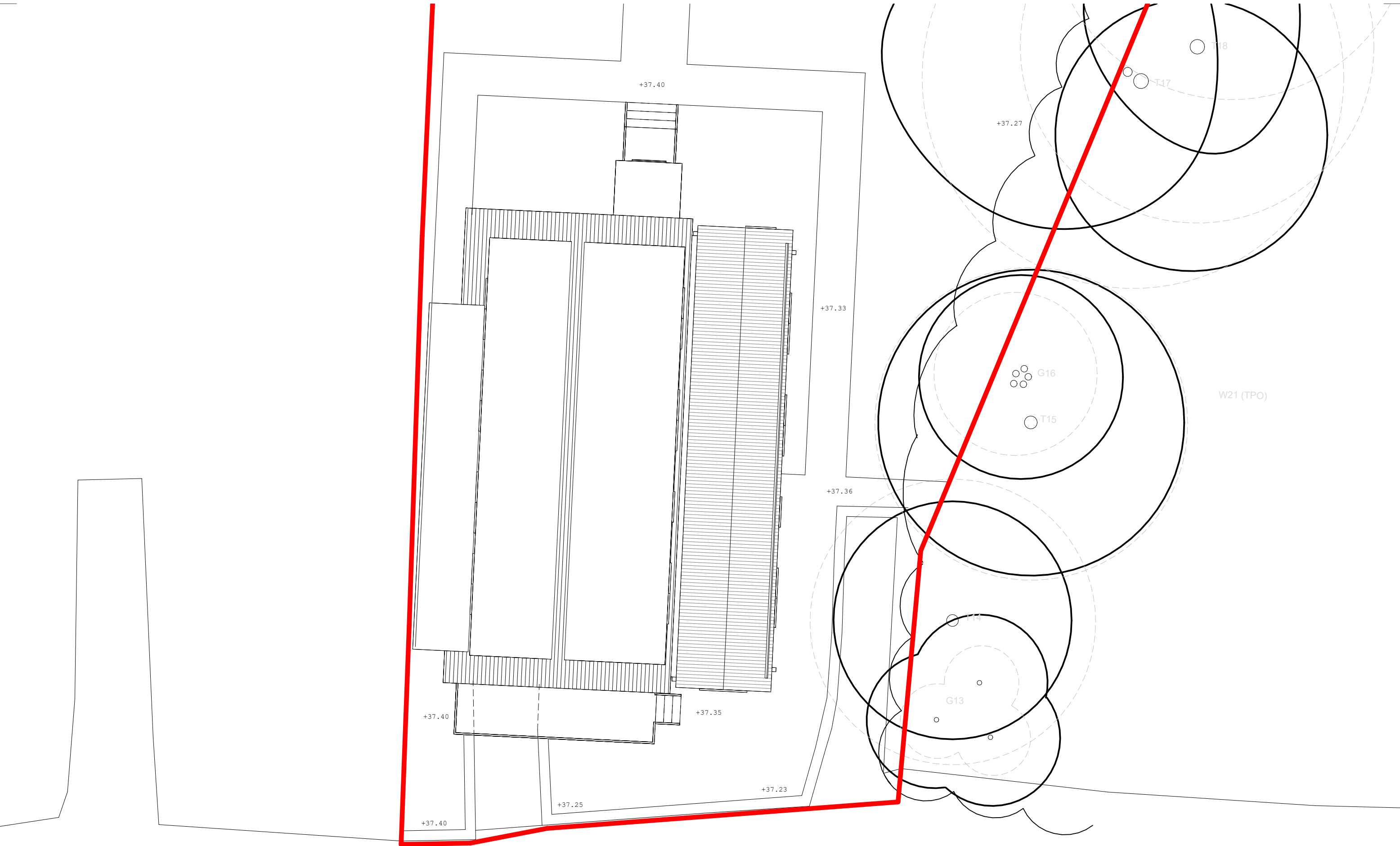
Job: 1011
Drawing: 03-04
Revision: 2

Project:
Warren Creek
The Warren RG4 7TQ
Drawing:
Proposed First Floor Plan

Date:
May '24
Status:
Info
Drawn By:
MC
Checked By:
EM



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Collaborating with:

Job: 1011
Drawing: 03-05
Revision: 2

Project:
Warren Creek
The Warren RG4 7TQ
Drawing:
Proposed Roof Plan

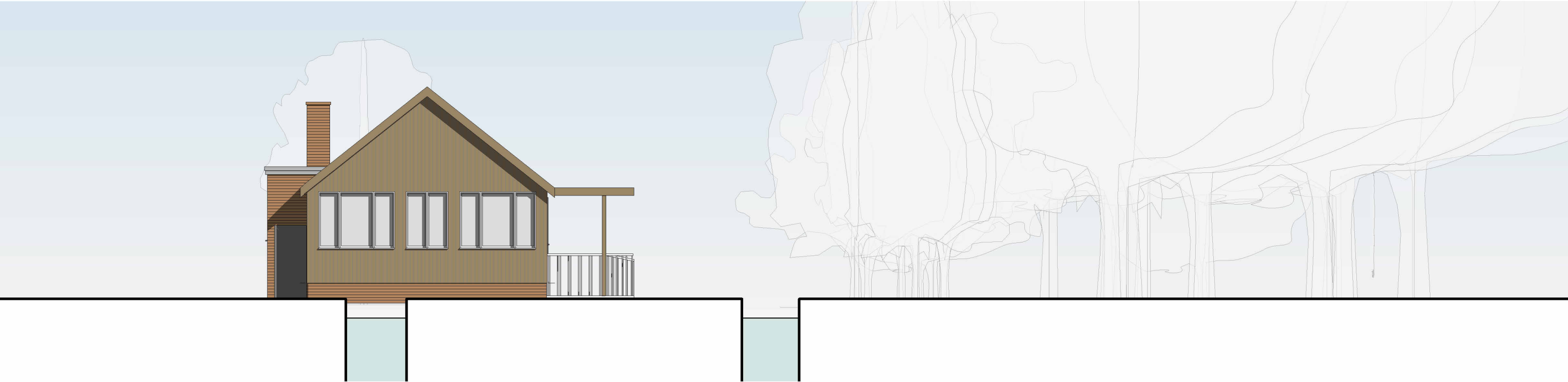
Date:
May '24
Status:
Info
Drawn By:
MC
Checked By:
EM



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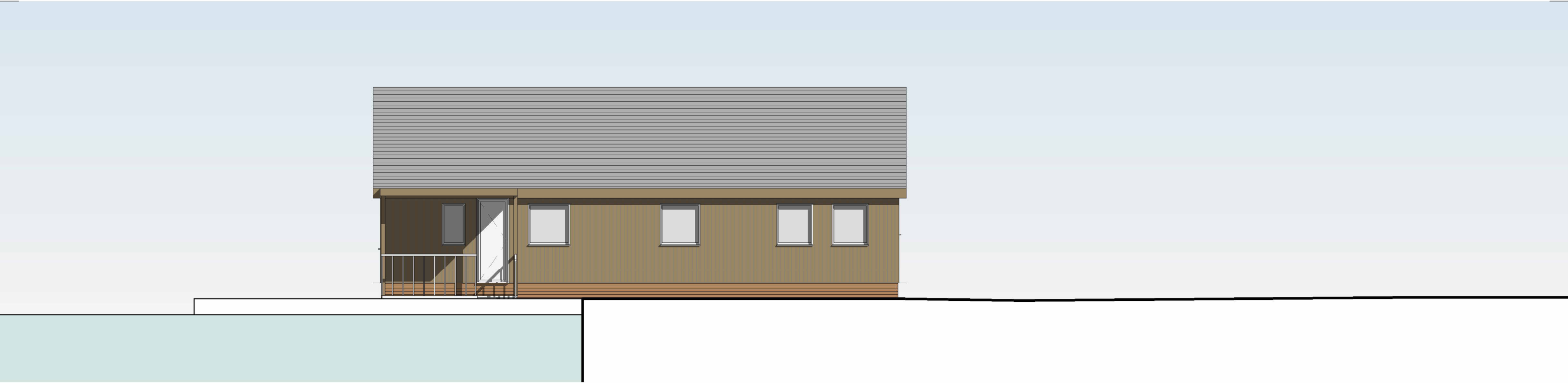
1 North
1 : 100



2 South
1 : 100



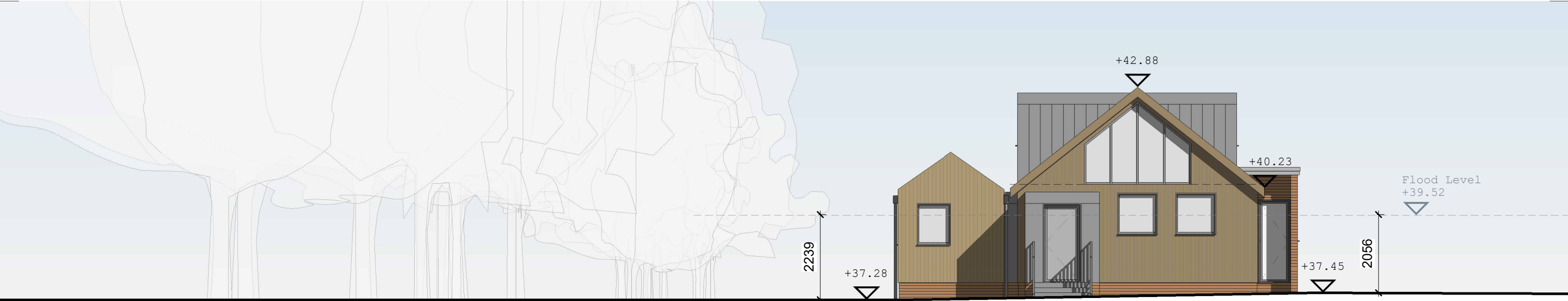
			Project: Warren Creek The Warren RG4 7TQ Drawing: Existing Elevations Sheet 1 of 2		 RIBA  Chartered Practice Colony Architects Ltd. The Wine Store, Brewery Court, Theale, Reading, RG7 5AJ +44 (0)118 380 0328 hello@colonyarchitects.com colonyarchitects.com
Collaborating with:			Date: May '24 Status: Info		
Job: 1011	Drawing: 05-01	Revision: 1	Drawn By: MC Checked By: EM		



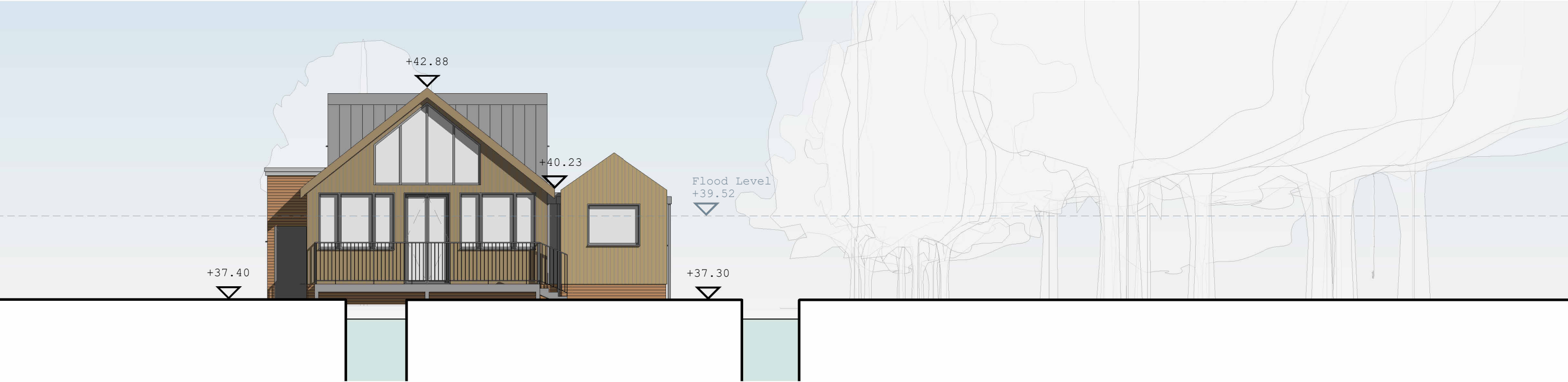
1 East
1 : 100



2 West
1 : 100



1 North
1 : 100

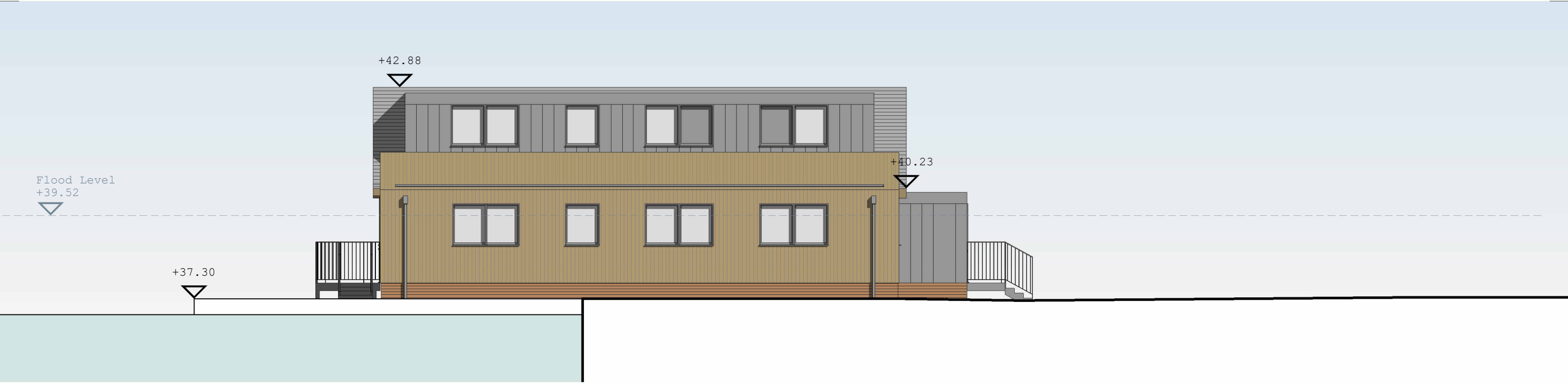


2 South
1 : 100

Option 2



			Project: Warren Creek The Warren RG4 7TQ Drawing: Proposed Elevations Sheet 1 of 2 Date: May '24 Job: 1011 Drawing: 05-03 Revision: 2		Status: Info Drawn By: MC Checked By: EM		 RIBA Chartered Practice Colony Architects Ltd. The Wine Store, Brewery Court, Theale, Reading, RG7 5AJ +44 (0)118 380 0328 hello@colonyarchitects.com colonyarchitects.com
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1 East
1 : 100



2 West
1 : 100

Option 2





Collaborating with:

Job:	Drawing:	Revision:
1011	05-04	2

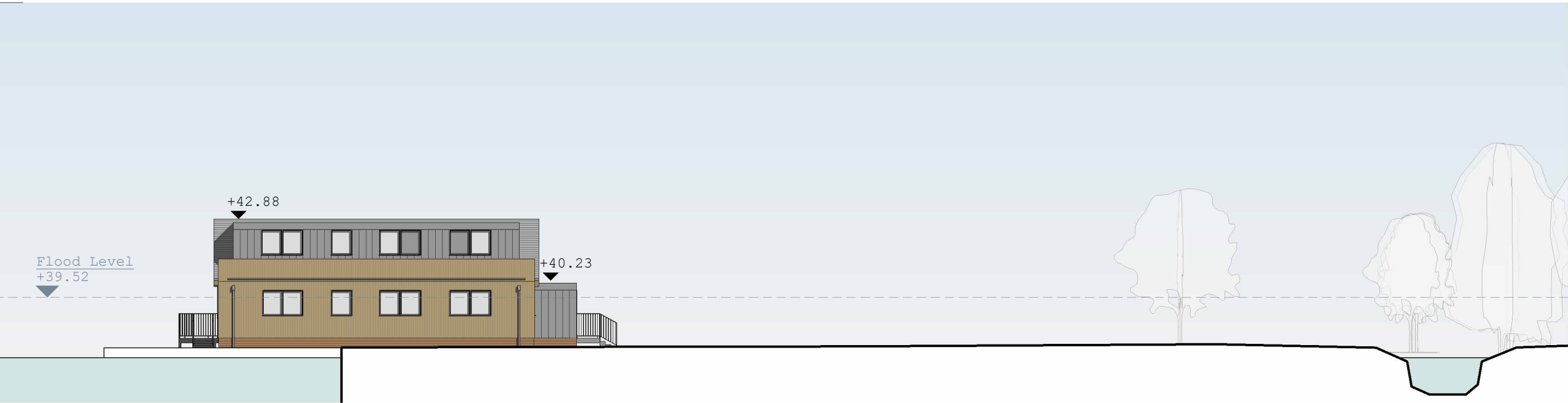
Project:
Warren Creek
The Warren RG4 7TQ

Drawing:
Proposed Elevations Sheet
2 of 2

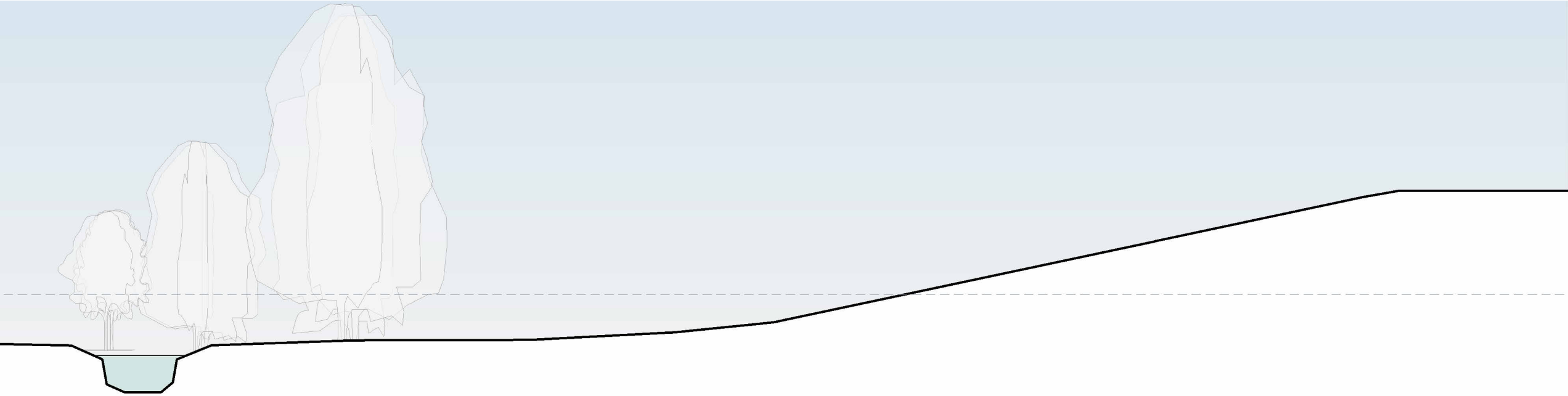
Date:	Status:
May '24	Info
Drawn By:	Checked By:
MC	EM



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1 Part 1
1 : 200



2 Part 2
1 : 200

Option 2



			Project: Warren Creek The Warren RG4 7TQ		 Chartered Practice
Collaborating with:			Drawing: Long Site Elevation		
Job: 1011	Drawing: 05-05	Revision: 2	Date: May '24	Status: Info	Colony Architects Ltd. The Wine Store, Brewery Court, Theale, Reading, RG7 5AJ +44 (0)118 380 0328 hello@colonyarchitects.com colonyarchitects.com
			Drawn By: MC	Checked By: EM	

APPENDIX B – MODELLED FLOOD LEVELS FROM THE ENVIRONMENT AGENCY

Product 4 (Detailed Flood Risk) for Warren Creek, The Warren, Caversham, Reading, RG4 7TQ

Our Ref: THM311206

Product 4 is designed for developers where Flood Risk Standing Advice FRA (Flood Risk Assessment) Guidance Note 3 Applies. This is:

- i) "all applications in Flood Zone 3, other than non-domestic extensions less than 250 sq metres; and all domestic extensions", and
- ii) "all applications with a site area greater than 1 ha" in Flood Zone 2.

Product 4 includes the following information:

Ordnance Survey 1:25k colour raster base mapping;
Flood Zone 2 and Flood Zone 3;
Relevant model node locations and unique identifiers (for cross referencing to the water levels, depths and flows table);
Model extents showing *defended* scenarios;
FRA site boundary (where a suitable GIS layer is supplied);
Flood defence locations (where available/relevant) and unique identifiers; (supplied separately)
Flood Map flood storage areas (where available/relevant);
Historic flood events outlines (where available/relevant, not the Historic Flood Map) and unique identifiers;

Statutory (Sealed) Main River (where available within map extents);

A table showing:

- i) Model node X/Y coordinate locations, unique identifiers, and levels and flows for *defended* scenarios.
- ii) Flood defence locations unique identifiers and attributes; (supplied separately)
- iii) Historic flood events outlines unique identifiers and attributes; and
- iv) Local flood history data (where available/relevant).

Please note:

If you will be carrying out computer modelling as part of your Flood Risk Assessment, please request our guidance which sets out the requirements and best practice for computer river modelling.

This information is based on that currently available as of the date of this letter. You may feel it is appropriate to contact our office at regular intervals, to check whether any amendments/ improvements have been made. Should you re-contact us after a period of time, please quote the above reference in order to help us deal with your query.

This information is provided subject to the enclosed notice which you should read.

This letter is not a Flood Risk Assessment. The information supplied can be used to form part of your Flood Risk Assessment. Further advice and guidance regarding Flood Risk Assessments can be found on our website at:

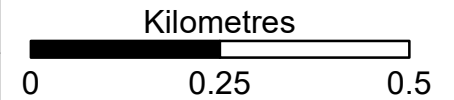
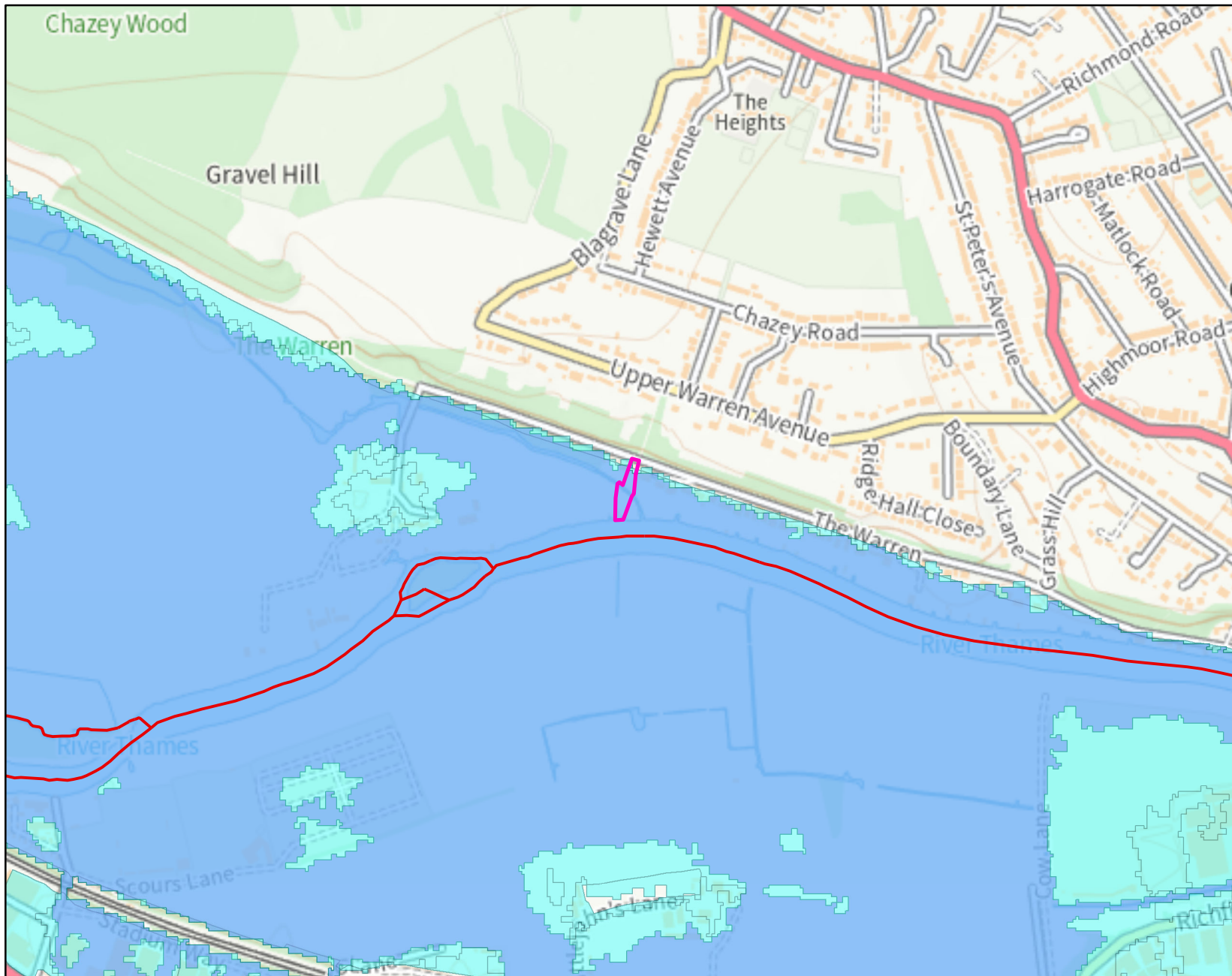
<https://www.gov.uk/guidance/flood-risk-assessment-local-planning-authorities>

If you would like advice from us regarding your development proposals you can complete our pre application enquiry form which can be found at:

<https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion>

Flood Map for Planning centred on Warren Creek, The Warren, Caversham, Reading, RG4 7TQ

Created on 06/06/23 REF: THM311206



Legend

- Site Boundary
- Main River
- Flood Map - Flood defences
- Flood Map - Flood Storage Areas
- Flooding from rivers or sea (FZ3)
- Extent of extreme flood (FZ2)

Flooding from rivers or sea without defences (Flood Zone 3) shows the area that could be affected by flooding:

- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

The Extent of an extreme flood (Flood Zone 2) shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

Defence information

Defence Location: No defences on Main River

Description: This location is not currently protected by any formal defences and we do not currently have any flood alleviation works planned for the area. However we continue to maintain certain watercourses and the schedule of these can be found on our internet pages.

Model information

THM311206

Model: Thames (Pangbourne to Sonning) 2019

Description: The information provided is taken from the Reading and Caversham Flood Alleviation Scheme: Baseline Modelling Report - Final undertaken by Jacobs, dated 07 May 2021. The study was carried out using 1D-2D modelling software (Flood Modeller Pro-TUFLOW). This model study was undertaken as part of the technical studies stage for developing scheme options for the Reading and Caversham Flood Alleviation Scheme: in February 2022 it was announced that this scheme will not go ahead, however the modelling is still viable and can be used internally and externally to inform flood risk. The whole model covers 28 km of the River Thames from Whitchurch Lock to Henley-on-Thames, however the Environment Agency are only using this model up to Sonning: downstream of this location, please refer to the Thames (Sonning to Hurley) 2019 model.

Model design runs:

1 in 2 / 50% AEP; 1 in 5 / 20% AEP; 1 in 10 / 10% AEP; 1 in 20 / 5% AEP; 1 in 30 / 3.3% AEP; 1 in 50 / 2% AEP; 1 in 75 / 1.33% AEP; 1 in 100 / 1% AEP; 1 in 100+25% / 1% AEP with 25% climate change; 1 in 100+35% / 1% AEP with 35% climate change; 1 in 100+70% / 1% AEP with 70% climate change; 1 in 200 / 0.5% AEP; and 1 in 1000 / 0.1% AEP.

Mapped outputs:

1 in 2 / 50% AEP; 1 in 5 / 20% AEP; 1 in 10 / 10% AEP; 1 in 20 / 5% AEP; 1 in 30 / 3.3% AEP; 1 in 50 / 2% AEP; 1 in 75 / 1.33% AEP; 1 in 100 / 1% AEP; 1 in 100+25% / 1% AEP with 25% climate change; 1 in 100+35% / 1% AEP with 35% climate change; 1 in 100+70% / 1% AEP with 70% climate change; 1 in 200 / 0.5% AEP; and 1 in 1000 / 0.1% AEP.

Modelled in-channel flood flows and levels

THM311206

The modelled flood levels and flows for the closest most appropriate model node points for your site that are within the river channel are provided below:

				Flood Levels (mAOD)											
Node label	Model	Easting	Northing	20% AEP	5% AEP	3.3% AEP	1% AEP	1% AEP (+10% increase in flows)	1% AEP (+15% increase in flows)	1% AEP (+20% increase in flows)	1% AEP (+25% increase in flows)	1% AEP (+35% increase in flows)	1% AEP (+70% increase in flows)	0.1% AEP	
061_00_2019_36.08	Thames (Pangbourne to Sonning) 2019	468914	174783	37.90	38.30	38.40	38.71				39.07	39.20	39.59	39.30	
061_00_2019_36.079	Thames (Pangbourne to Sonning) 2019	469052	174835	37.85	38.26	38.36	38.68				39.05	39.18	39.57	39.28	
061_00_2019_36.071	Thames (Pangbourne to Sonning) 2019	469179	174939	37.75	38.17	38.29	38.62				39.01	39.14	39.54	39.24	
061_00_2019_36.071A	Thames (Pangbourne to Sonning) 2019	469333	175011	37.70	38.12	38.24	38.59				38.99	39.12	39.52	39.23	
061_00_2019_36.071AIn1	Thames (Pangbourne to Sonning) 2019	469620	175062	37.67	38.10	38.22	38.57				38.96	39.10	39.51	39.20	
061_00_2019_36.06	Thames (Pangbourne to Sonning) 2019	469865	175003	37.61	38.06	38.18	38.54				38.94	39.07	39.47	39.18	
061_00_2019_36.060In1	Thames (Pangbourne to Sonning) 2019	470134	174893	37.56	38.01	38.13	38.50				38.90	39.04	39.45	39.15	

				Flood Flows (m3/s)											
Node label	Model	Easting	Northing	20% AEP	5% AEP	3.3% AEP	1% AEP	1% AEP (+10% increase in flows)	1% AEP (+15% increase in flows)	1% AEP (+20% increase in flows)	1% AEP (+25% increase in flows)	1% AEP (+35% increase in flows)	1% AEP (+70% increase in flows)	0.1% AEP	
061_00_2019_36.08	Thames (Pangbourne to Sonning) 2019	468914	174783	213.57	252.68	259.98	273.61				278.75	278.96	293.00	279.10	
061_00_2019_36.079	Thames (Pangbourne to Sonning) 2019	469052	174835	215.25	249.22	256.63	265.50				270.33	271.77	287.68	273.86	
061_00_2019_36.071	Thames (Pangbourne to Sonning) 2019	469179	174939	216.29	244.76	250.22	256.85				259.38	260.96	274.54	262.47	
061_00_2019_36.071A	Thames (Pangbourne to Sonning) 2019	469333	175011	215.58	247.73	251.61	255.34				255.67	257.34	271.12	258.93	
061_00_2019_36.071AIn1	Thames (Pangbourne to Sonning) 2019	469620	175062	212.81	245.64	248.93	257.61				268.77	273.16	293.24	276.92	
061_00_2019_36.06	Thames (Pangbourne to Sonning) 2019	469865	175003	212.75	238.54	243.06	259.79				276.95	283.36	308.80	288.66	
061_00_2019_36.060In1	Thames (Pangbourne to Sonning) 2019	470134	174893	213.23	240.40	245.72	263.08				278.85	284.68	308.69	289.59	

Note:
Due to changes in guidance on the allowances for climate change, the percentage increase in river flows above should no longer to be used for development design purposes. The data included in this Product can be used for interpolation of levels as part of an intermediate level assessment.

For further advice on the new allowances please visit
<https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

Modelled floodplain flood levels

THM311206

The modelled flood levels for the closest most appropriate model grid cells for your site are provided below:

2D grid cell reference	Model	Easting	Northing	flood levels (mAOD)										
				20% AEP	5% AEP	3.3 AEP	1% AEP	1% AEP (+10% increase in flows)	1% AEP (+15% increase in flows)	1% AEP (+20% increase in flows)	1% AEP (+25% increase in flows)	1% AEP (+35% increase in flows)	1% AEP (+70% increase in flows)	0.1% AEP
Flood Point 1	Thames (Pangbourne to Sonning) 2019	469576	175109	37.65	38.09	38.22	38.59				39.00	39.13	39.52	39.23
Flood Point 2	Thames (Pangbourne to Sonning) 2019	469593	175163	37.65	38.09	38.22	38.59				38.99	39.13	39.52	39.23
Flood Point 3	Thames (Pangbourne to Sonning) 2019	469484	175144	37.67	38.10	38.22	38.60				39.00	39.14	39.53	39.24
Flood Point 4	Thames (Pangbourne to Sonning) 2019	469662	175126	37.65	38.08	38.21	38.59				38.99	39.13	39.51	39.22
Flood Point 5	Thames (Pangbourne to Sonning) 2019	469546	174978	37.66	38.09	38.22	38.59				39.00	39.13	39.52	39.23

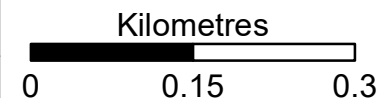
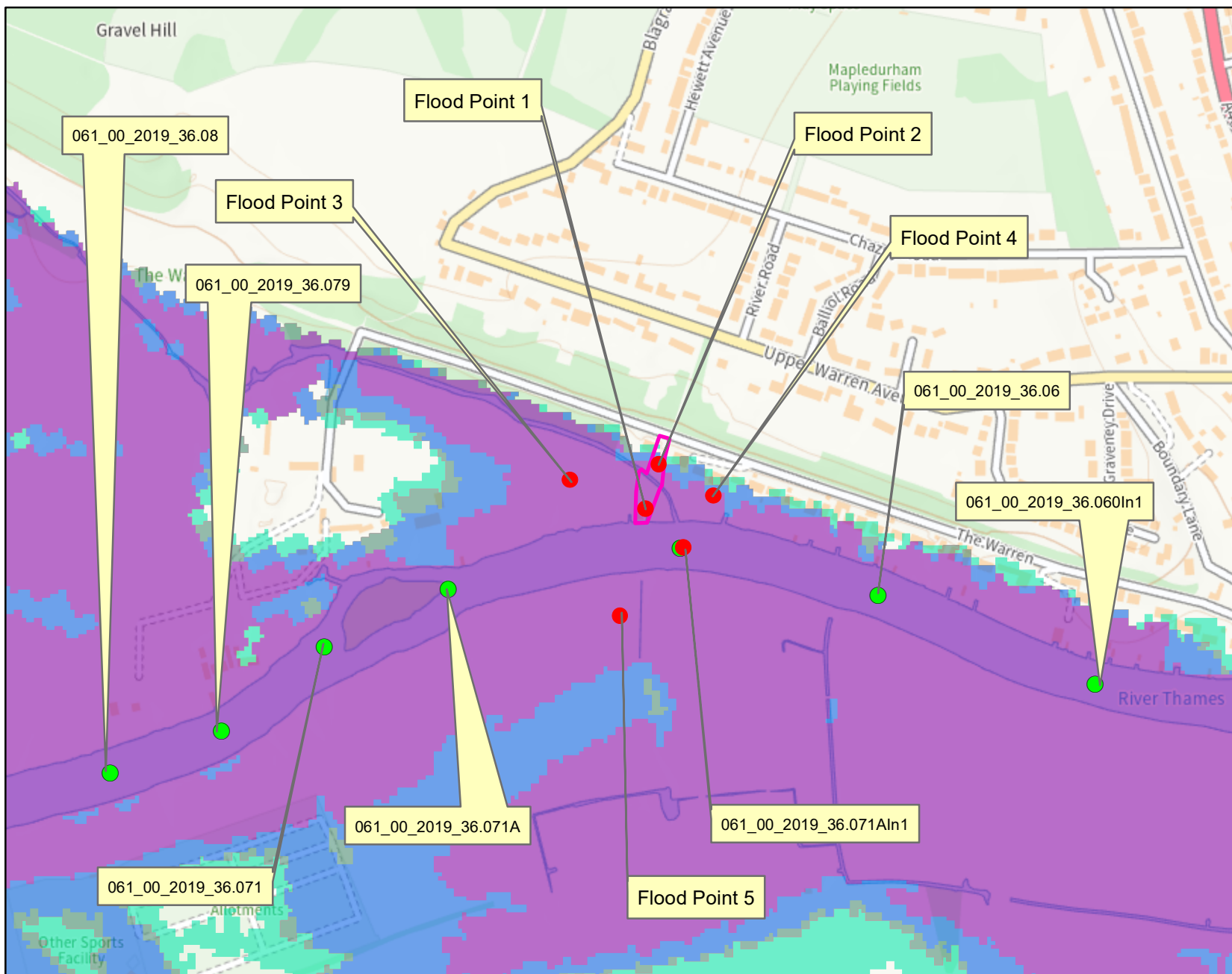
This flood model has represented the floodplain as a grid.
The flood water levels have been calculated for each grid cell.

Note:
Due to changes in guidance on the allowances for climate change, the percentage increase in river flows above should no longer to be used for development design purposes. The data included in this Product can be used for interpolation of levels as part of an intermediate level assessment.

For further advice on the new allowances please visit
<https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

Detailed FRA Map #1 centred on Warren Creek, The Warren, Caversham, Reading, RG4 7TQ

Created on 06/06/23 REF: THM311206



Legend

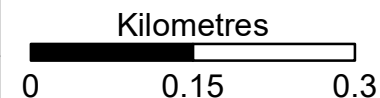
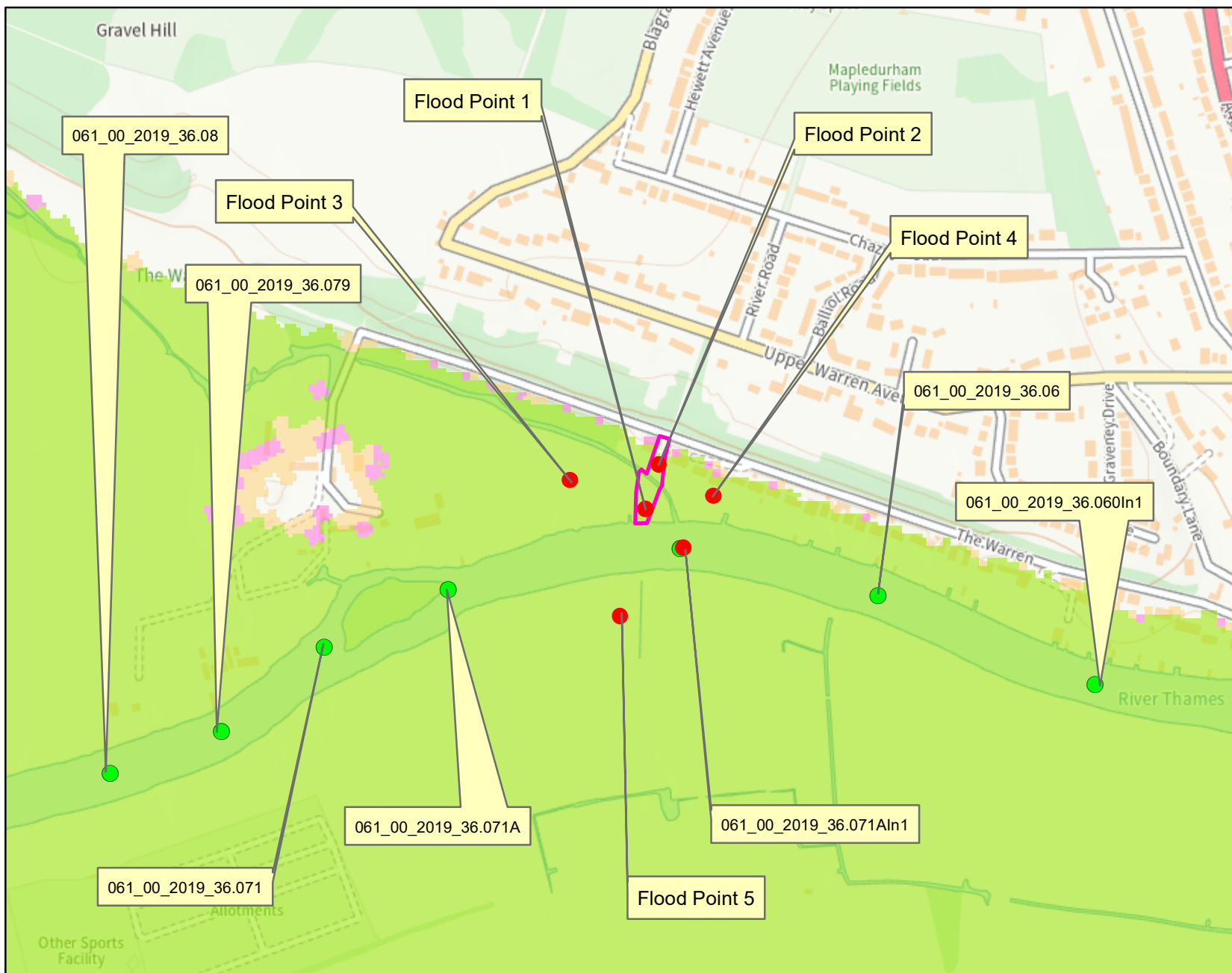
- Site Boundary
- Model Nodes
- 20% AEP Flood Outline
- 5% AEP Flood Outline
- 3.3% AEP Flood Outline
- 1% AEP Flood Outline
- Floodplain Node

AEP = Annual Exceedance Probability
The probability of a flood of a particular magnitude, or greater, occurring in any given year

Where available climate change extents have been calculated with an additional flow added to an AEP event. An example of how this is written is 1%+20% AEP.

Detailed FRA Map #2 centred on Warren Creek, The Warren, Caversham, Reading, RG4 7TQ

Created on 06/06/23 REF: THM311206



Legend

- Site Boundary
- Model Nodes
- 1%+25% CC AEP Flood Outline
- 1%+35% CC AEP Flood Outline
- 1%+70% CC AEP Flood Outline
- 0.1% AEP Flood Outline
- Floodplain Node

AEP = Annual Exceedance Probability
The probability of a flood of a particular magnitude, or greater, occurring in any given year

Where available climate change extents have been calculated with an additional flow added to an AEP event. An example of how this is written is 1%+20% AEP.

Historic flood data

THM311206

Our records show that the area of your site has been affected by flooding.
Information on the floods that have affected your site is provided in the table below:

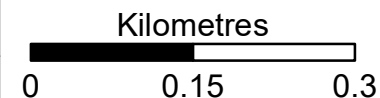
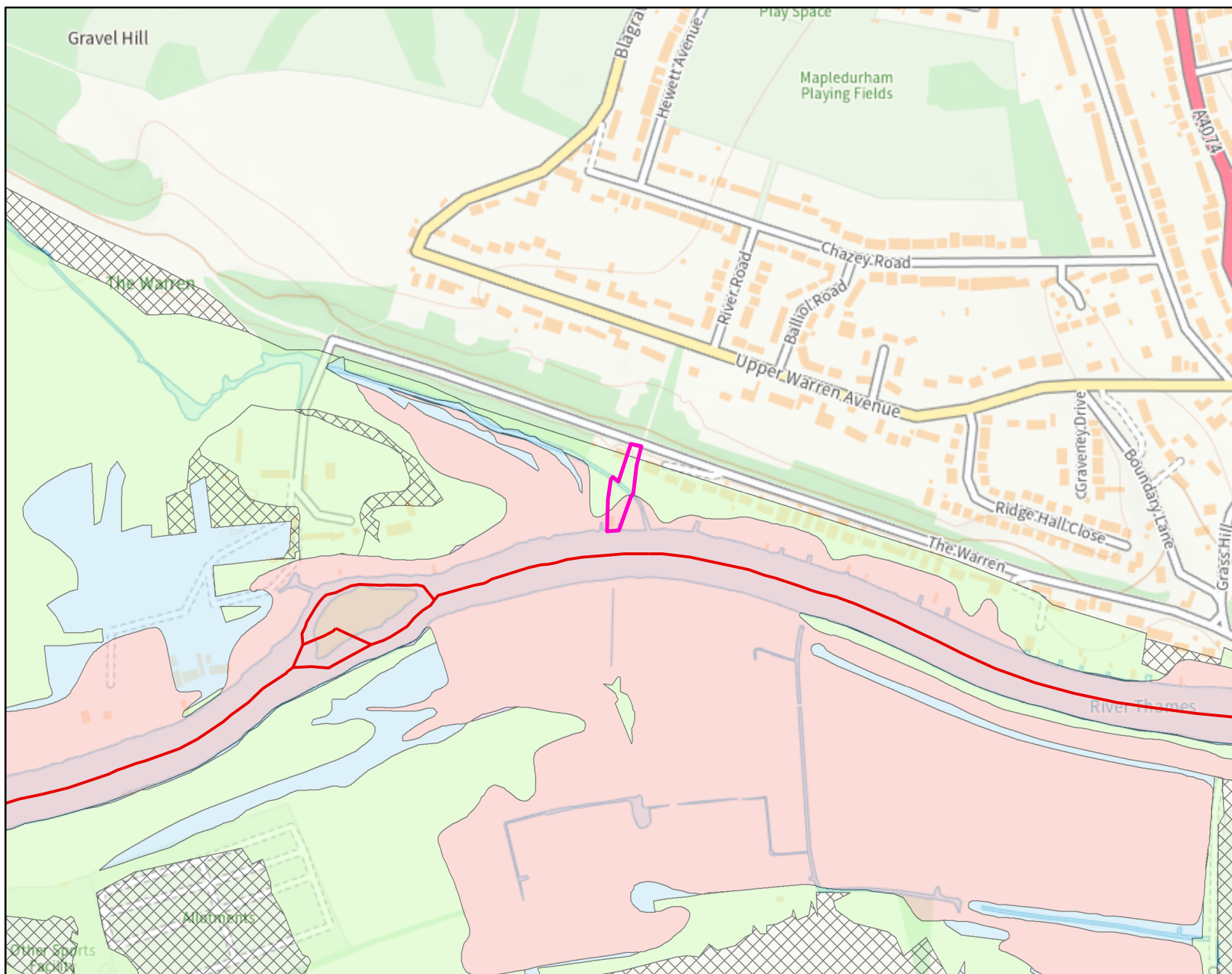
Flood Event Code	Flood Event Name	Start Date	End Date	Source of Flooding	Cause of Flooding
EA0619470300103	06MarchSpring1947	01/01/1947	12/12/1947	main river	channel capacity exceeded (no raised defences)
EA0619770800316	06AugustSummer1977	01/01/1977	12/12/1977	other	local drainage/surface water
EA0620001200982	06DecemberWinter2000	01/01/2000	12/12/2000	main river	channel capacity exceeded (no raised defences)
EA0620030101899	06JanuaryNewYear2003	23/12/2002	12/01/2003	main river	channel capacity exceeded (no raised defences)
ea061231504	Reading_Fluvial Water	19/07/2007	29/07/2007	main river	channel capacity exceeded (no raised defences)

Please note the Environment Agency maps flooding to land not individual properties. Floodplain extents are an indication of the geographical extent of a historic flood. They do not provide information regarding levels of individual properties, nor do they imply that a property has flooded internally.

Start and End Dates shown above may represent a wider range where the exact dates are not available.

Historic Flood Map centred on Warren Creek, The Warren, Caversham, Reading, RG4 7TQ

Created on 06/06/23 REF: THM311206



Legend

Site Boundary

Main River

Year

1947

1977

2000

2002/3

2007

Flooding from rivers or sea without defences (Flood Zone 3) shows the area that could be affected by flooding:

- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

The Extent of an extreme flood (Flood Zone 2) shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

APPENDIX C – SURFACE WATER RUNOFF CALCULATIONS



MasterDrain
SW

Nimbus Engineering Consultants Ltd

www.nimbusengineering.co.uk

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London, EC1V 2NX
Mob:0772 339 3155
email: info@nimbusengineering.co.uk

Job No. C3007		
Sheet no. 1		
Date 12/06/24		
By SL	Checked	Reviewed

Project **Warren Creek, The Warren, Caversham, RG4 7TQ**

Title **Hydrograph storage calcs - Extension**

Data:-

Location = READING
M5-60 (mm) = 18
Soil index = 0.30
Return period = 100
UCWI = 0.0

Grid reference = SU7272
r = 0.40
SAAR (mm/yr) = 650
WRAP = 2
Climate change = 45%

- i) Very permeable soils with shallow ground water;
- ii) Permeable soils over rock or fragipan, commonly on slopes in western Britain associated with smaller areas of less permeable wet soils; The layer is low in organic matter, mottled and (fragipan - a natural subsurface horizon having a higher bulk density than the solum above. Seemingly cemented when dry but showing moderate to weak brittleness when moist. Slowly or very slowly permeable to water. It is found in profiles of either cultivated or virgin soils but not in calcareous material).
- iii) Moderately permeable soils, some with slowly permeable subsoils.

Pipeline storage = 0.0 m³
Offline storage = 0.0 m³

Available MH storage = 0.0 m³

Percentage runoff = 100.0% (manual setting)

Imperv. area = 130 m²
Total area = 130 m²
Total runoff = 6.8 m³
Storage (m³) = 4.0 m³ (Sum of all balance quantities)
Total rainfall depth = 52.6 mm

Pervious area = 0 m²
Equiv area = 130 m² (Tot. area x % runoff).
Discharge rate = 1.000 l/s

Calculations :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.010	20.0	10.5	0.014	0.036	0.000	0.000
0.020	20.0	10.5	0.014	0.036	0.000	0.000
0.030	21.0	11.1	0.014	0.036	0.000	0.000
0.040	21.0	11.1	0.014	0.036	0.000	0.000
0.050	22.0	11.6	0.015	0.036	0.000	0.000
0.060	23.0	12.1	0.016	0.036	0.000	0.000
0.070	24.0	12.6	0.016	0.036	0.000	0.000
0.080	26.0	13.7	0.018	0.036	0.000	0.000
0.090	27.0	14.2	0.018	0.036	0.000	0.000
0.100	29.0	15.3	0.020	0.036	0.000	0.000
0.110	31.0	16.3	0.021	0.036	0.000	0.000
0.120	32.0	16.8	0.022	0.036	0.000	0.000
0.130	33.0	17.4	0.023	0.036	0.000	0.000
0.140	34.0	17.9	0.023	0.036	0.000	0.000
0.150	36.0	18.9	0.025	0.036	0.000	0.000
0.160	38.0	20.0	0.026	0.036	0.000	0.000
0.170	39.0	20.5	0.027	0.036	0.000	0.000
0.180	40.0	21.1	0.027	0.036	0.000	0.000
0.190	42.0	22.1	0.029	0.036	0.000	0.000
0.200	45.0	23.7	0.031	0.036	0.000	0.000
0.210	49.0	25.8	0.034	0.036	0.000	0.000
0.220	53.0	27.9	0.036	0.036	0.000	0.000
0.230	57.0	30.0	0.039	0.036	0.003	0.003
0.240	62.0	32.6	0.042	0.036	0.006	0.010
0.250	66.0	34.7	0.045	0.036	0.009	0.019
0.260	71.0	37.4	0.049	0.036	0.013	0.031
0.270	77.0	40.5	0.053	0.036	0.017	0.048
0.280	84.0	44.2	0.057	0.036	0.021	0.070
0.290	91.0	47.9	0.062	0.036	0.026	0.096
0.300	98.0	51.6	0.067	0.036	0.031	0.127
0.310	105.0	55.3	0.072	0.036	0.036	0.163
0.320	114.0	60.0	0.078	0.036	0.042	0.205
0.330	125.0	65.8	0.086	0.036	0.050	0.254



MasterDrain
SW

Nimbus Engineering Consultants Ltd

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Job No. C3007			
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Project Warren Creek, The Warren, Caversham, RG4 7TQ			
Title Hydrograph storage calcs - Extension			

Calculations (cont.) :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.410	204.0	107.4	0.140	0.036	0.104	0.890
0.420	212.0	111.6	0.145	0.036	0.109	0.999
0.430	219.0	115.3	0.150	0.036	0.114	1.113
0.440	226.0	118.9	0.155	0.036	0.119	1.231
0.450	233.0	122.6	0.159	0.036	0.123	1.355
0.460	239.0	125.8	0.164	0.036	0.128	1.482
0.470	244.0	128.4	0.167	0.036	0.131	1.613
0.480	248.0	130.5	0.170	0.036	0.134	1.747
0.490	249.0	131.0	0.170	0.036	0.134	1.881
0.500	250.0	131.6	0.171	0.036	0.135	2.016
0.510	250.0	131.6	0.171	0.036	0.135	2.151
0.520	249.0	131.0	0.170	0.036	0.134	2.286
0.530	248.0	130.5	0.170	0.036	0.134	2.419
0.540	244.0	128.4	0.167	0.036	0.131	2.550
0.550	239.0	125.8	0.164	0.036	0.128	2.678
0.560	233.0	122.6	0.159	0.036	0.123	2.801
0.570	226.0	118.9	0.155	0.036	0.119	2.920
0.580	219.0	115.3	0.150	0.036	0.114	3.034
0.590	212.0	111.6	0.145	0.036	0.109	3.143
0.600	204.0	107.4	0.140	0.036	0.104	3.246
0.610	194.0	102.1	0.133	0.036	0.097	3.343
0.620	183.0	96.3	0.125	0.036	0.089	3.432
0.630	173.0	91.0	0.118	0.036	0.082	3.514
0.640	164.0	86.3	0.112	0.036	0.076	3.591
0.650	154.0	81.0	0.105	0.036	0.069	3.660
0.660	143.0	75.3	0.098	0.036	0.062	3.722
0.670	135.0	71.0	0.092	0.036	0.056	3.778
0.680	125.0	65.8	0.086	0.036	0.050	3.828
0.690	114.0	60.0	0.078	0.036	0.042	3.870
0.700	105.0	55.3	0.072	0.036	0.036	3.906
0.710	98.0	51.6	0.067	0.036	0.031	3.937
0.720	91.0	47.9	0.062	0.036	0.026	3.963
0.730	84.0	44.2	0.057	0.036	0.021	3.984
0.740	77.0	40.5	0.053	0.036	0.017	4.001
0.750	71.0	37.4	0.049	0.036	0.013	4.014
0.760	66.0	34.7	0.045	0.036	0.009	4.023
0.770	62.0	32.6	0.042	0.036	0.006	4.029
0.780	57.0	30.0	0.039	0.036	0.003	4.032
0.790	53.0	27.9	0.036	0.036	0.000	4.032
0.800	49.0	25.8	0.034	0.036	0.000	4.030
0.810	45.0	23.7	0.031	0.036	0.000	4.025
0.820	42.0	22.1	0.029	0.036	0.000	4.017
0.830	40.0	21.1	0.027	0.036	0.000	4.009
0.840	39.0	20.5	0.027	0.036	0.000	3.999
0.850	38.0	20.0	0.026	0.036	0.000	3.989
0.860	36.0	18.9	0.025	0.036	0.000	3.978
0.870	34.0	17.9	0.023	0.036	0.000	3.965
0.880	33.0	17.4	0.023	0.036	0.000	3.952
0.890	32.0	16.8	0.022	0.036	0.000	3.938
0.900	31.0	16.3	0.021	0.036	0.000	3.923
0.910	29.0	15.3	0.020	0.036	0.000	3.907
0.920	27.0	14.2	0.018	0.036	0.000	3.889
0.930	26.0	13.7	0.018	0.036	0.000	3.871
0.940	24.0	12.6	0.016	0.036	0.000	3.852
0.950	23.0	12.1	0.016	0.036	0.000	3.831
0.960	22.0	11.6	0.015	0.036	0.000	3.810
0.970	21.0	11.1	0.014	0.036	0.000	3.789
0.980	21.0	11.1	0.014	0.036	0.000	3.767
0.990	20.0	10.5	0.014	0.036	0.000	3.745
1.000	20.0	10.5	0.014	0.036	0.000	3.722

Storage volume (m³) = 4.0 m³ (Sum of all balance quantities)



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Date **12/06/24**

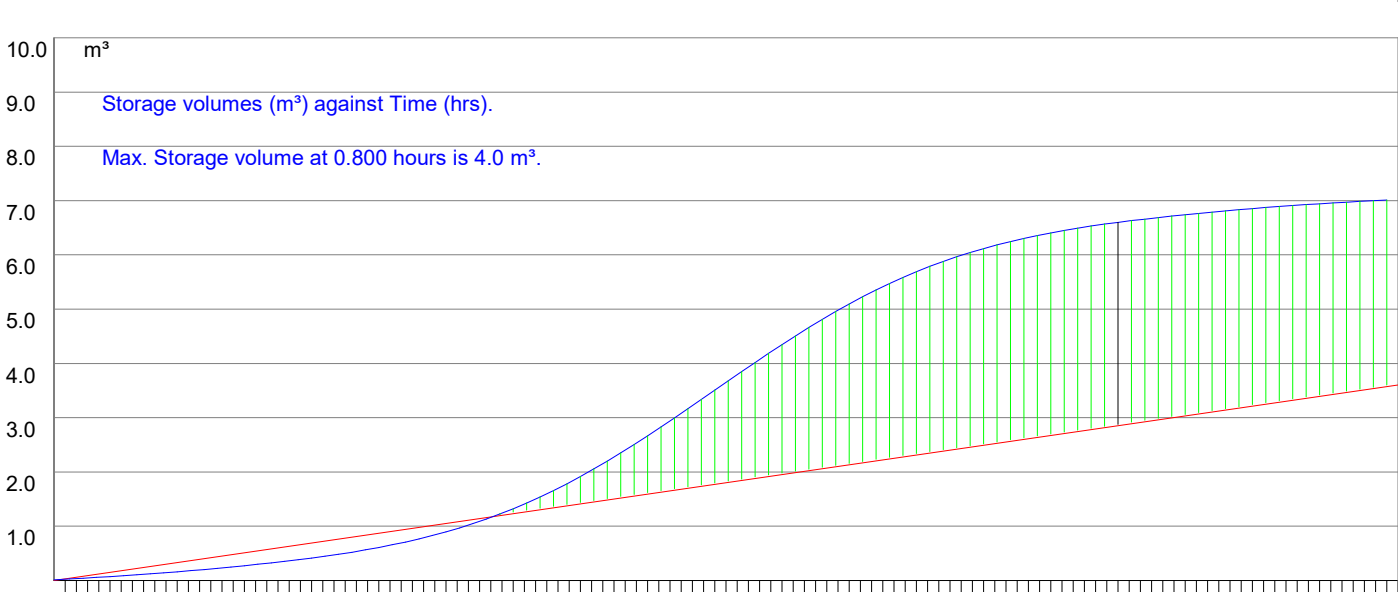
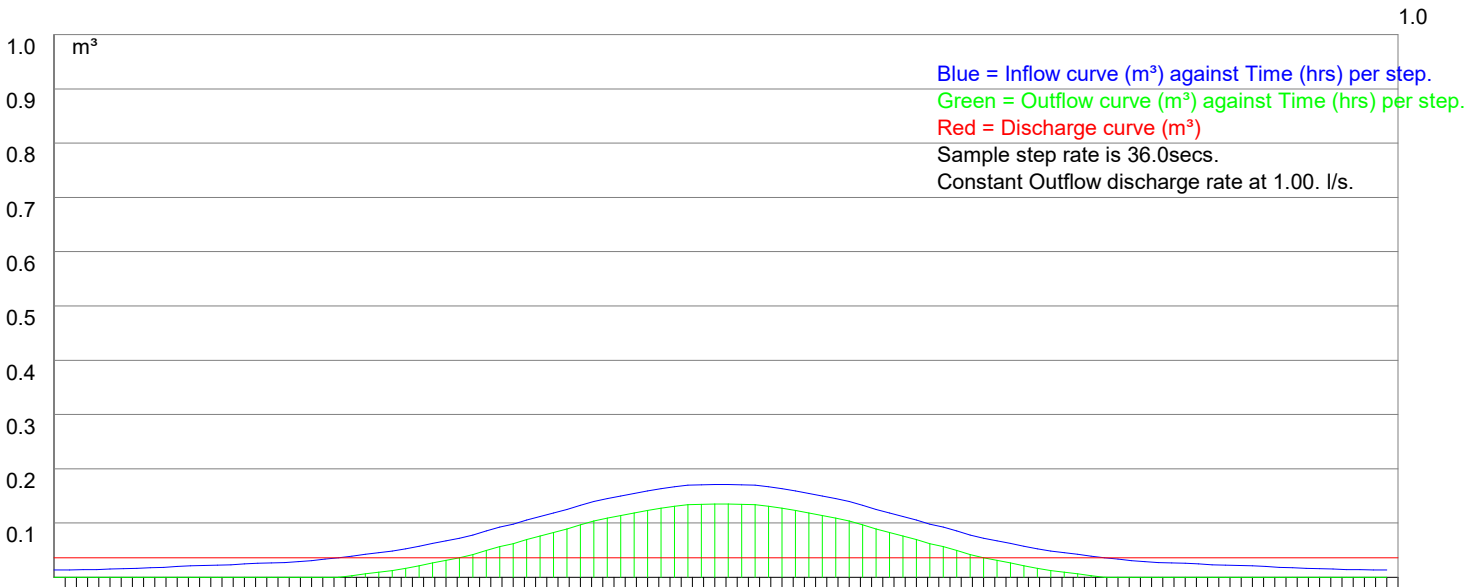
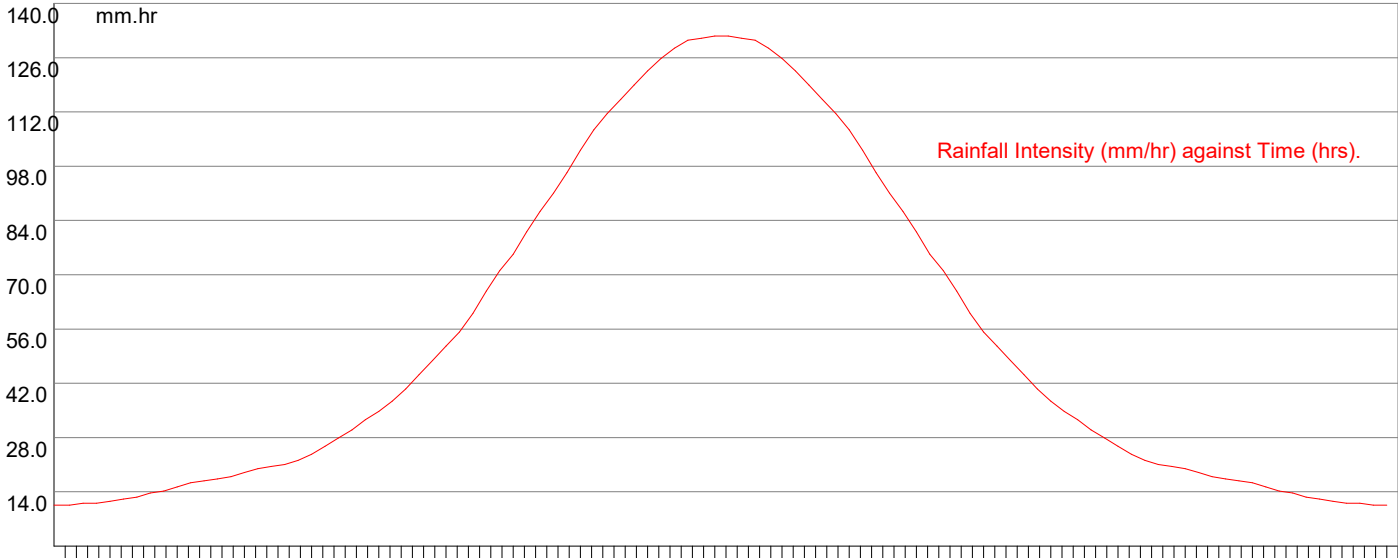
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Title **Hydrograph storage calcs - Extension**

Maximum storage volumes for varying duration storms.

Storm length (hrs)	Max. Vol (m ³)	Max. Vol time	Mean intens (mm/hr)	Step time. (mins)	Peak found
0.25	3.35	0.25	127.47	0.2	
0.5	3.89	0.50	83.83	0.3	
1	4.03	1.00	52.63	0.6	Peak found
2	3.49	---	32.00	1.2	
3	2.74	---	23.64	1.8	
4	1.98	---	18.98	2.4	
5	1.28	---	15.95	3.0	
6	0.69	---	13.82	3.6	
7	0.23	---	12.21	4.2	
8	0.00	---	11.00	4.8	
9	0.00	---	10.02	5.4	
10	0.00	---	9.22	6.0	
12	0.00	---	7.98	7.2	
15	0.00	---	6.69	9.0	
18	0.00	---	5.78	10.8	
20	0.00	---	5.32	12.0	
24	0.00	---	4.60	14.4	
30	0.00	---	3.84	18.0	
36	0.00	---	3.32	21.6	
42	0.00	---	2.93	25.2	
48	0.00	---	2.63	28.8	
54	0.00	---	2.40	32.4	
60	0.00	---	2.20	36.0	
66	0.00	---	2.04	39.6	
72	0.00	---	1.90	43.2	
84	0.00	---	1.67	50.4	
96	0.00	---	1.50	57.6	
120	0.00	---	1.25	72.0	
150	0.00	---	1.04	90.0	
175	0.00	---	0.92	105.0	
200	0.00	---	0.82	120.0	
250	0.00	---	0.69	150.0	
300	0.00	---	0.59	180.0	
375	0.00	---	0.49	225.0	
500	0.00	---	0.39	300.0	
750	0.00	---	0.28	450.0	
1000	0.00	---	0.22	600.0	
1250	0.00	---	0.18	750.0	
1500	0.00	---	0.16	900.0	
1570	0.00	---	0.15	942.0	
2000	0.00	---	0.13	1200.0	
2500	0.00	---	0.11	1500.0	
3000	0.00	---	0.09	1800.0	
3500	0.00	---	0.08	2100.0	
4000	0.00	---	0.07	2400.0	



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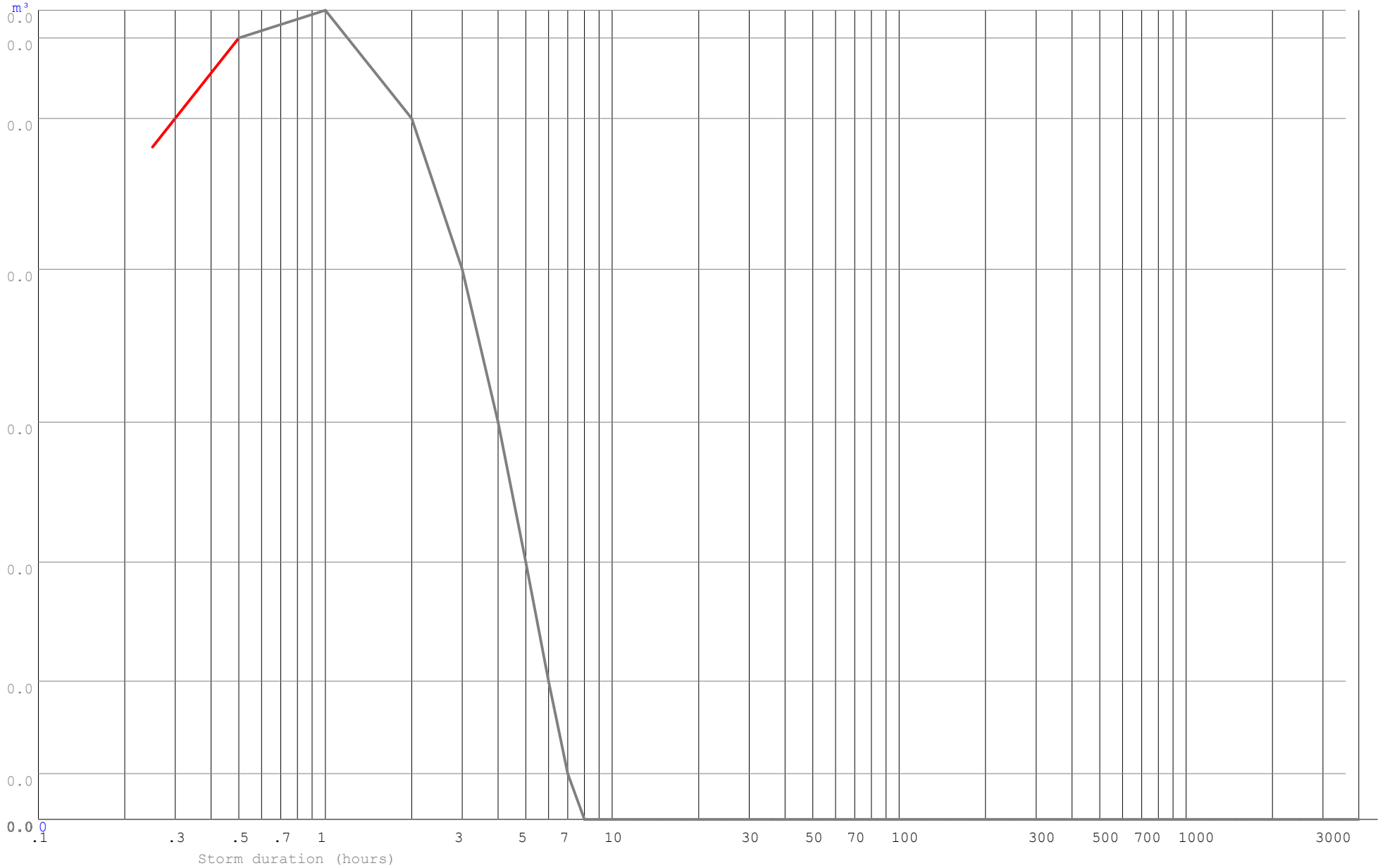
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Sequential storage volume at specific storm durations.





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Explanatory notes for Peak Flow Storage

- 1) This system uses the rainfall intensity/ duration curve calculated using either the Wallingford or FEH method as selected.
- 2) The balance is calculated from the inflow minus the outflow.
- 3) The storage volume is the maximum value of the balance curve.
- 4) This method was described by Davis (1963) - see Butler & Davies, 2nd edition, p294
- 5) References to 'storm duration' relate only to the hydrograph method (qv).
- 6) There are always 600 steps in the calculation process, thus a 'run' time of 10 hours will be sampled every minute,

Explanatory notes for Hydrograph Storage

- 1) The user has the choice of Summer or Winter curves
- 2) The mean intensity varies with the duration of the storm curve
- 3) There are always 120 steps in the calculation process, irrespective of storm duration.
- 4) The balance is calculated from the inflow minus the outflow.
- 5) The storage volume is the sum of the balance values for each step.
- 6) Varying durations should be tried to find the maximum storage value - this can be narrowed down very closely.

*Modelling using the flow characteristics of the restrictor is available using Vortex Control modelling function. Please be aware that this function needs the full design data file to function.

Why do the two methods give different results?

The rainfall characteristics for each method are very different.

The Peak flow (using the Intensity/Duration/Frequency curve) does not model the actual rainfall. This curve is joined points which represent the mean intensity of a storm at a given duration i.e. a value of 19.5 mm/hr for a 60 minute storm indicates that over the sixty minute period, the mean intensity was 19.5 mm/hr. The calculation method samples the IDF curve for a given location and frequency (Return Period) and calculates the storage for that rate and duration less the outflow volume. The maximum value is displayed as the 'worst case' storage.

The hydrograph method uses a standard curve for either Winter or Summer storms. Traditionally these are symmetrical about the central peak. UK rainfall does not fit into this convenient curve, so the calculations are dealing with a stylised set of data. The mean intensity for the storm is calculated from the IDF curve and applied to the curve data, calculating the storage for that step less the outflow volume. The final storage volume is the sum of the storage for all the steps.

It can be seen that these two methods are very different, and the user may have the choice of which result to use. This is not an exact science, though is often treated as such by those that do not understand the principles of the calculations.