Flood Resilient Property

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Acknowledgments

The Flood Resilient Property project was funded by Defra. The Flood Resilient Property project seeks to improve future delivery of flood resistant and resilience building scale measures, by promoting innovative approaches that contribute towards the development of new way of common building for developments in areas at risk of floods.

This project has been led by BRE in collaboration with Baca Architects and Aquobex.

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Disclaimer

The Flood Resilient Property Handbook is for information only. The authors and Flood Resilient Property Handbook project team take no responsibility for the subsequent use of this information, nor for any errors or omissions it may contain. Professional advice should be sought when considering any development, particularly where flood risk may be present.

Cover image

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July 2014

Executive Summary

The Flood Resilient Property is the proposed design for a new house to be built on the BRE Innovation Park to demonstrate resilience to flooding. The house will be part of a larger building that will be partially set within a raised tank. This could be artificially flooded to show various construction techniques and materials that are either resistant to water or resilient to the effects of being inundated.

Different materials and technologies which could help create a Flood Resilient Property have been identified, collated and assessed, and the specification for the Flood Resilient Property has been created from this catalogue of elements.

The specification focuses on the foundations, ground floor, walls and partitions, services and technologies. This includes consideration of other building elements required to meet current building regulations, particularly thermal performance.

The property is designed with a hybrid of resilient and resistant technologies and details. The property will be resistant to flooding to a depth of 600mm. Once water levels exceed 600mm the water is allowed to enter into the property through predetermined entry points. The inside of the house is designed to be flood resilient up to a notional flood level.

New buildings should follow Planning and Environment Agency guidance and ideally be located away from flood risk and if this is not possible raised above the design flood level (typically 1% AEP + allowance for climate change).

The Flood Resilient Property is therefore seen as a way of managing residual flood risk, or for use in more extreme flood levels, or in unusual circumstances, and as a way of improving (and establishing) flood resilient construction standards.

Specification and standards have been adopted from a range of sources, particularly waterproofing standards for basements. There is a need to bring together these standards into one location. The design includes a full specification, set of drawings, cost plan and build plan.

Contents

BRE Innovation Park *© BACA Architects*

The Flood Resilient Property is a proposed new house to be built on the BRE Innovation Park to demonstrate resilience to flooding. The house will be a showcase of flood resilient approaches that will be tested in-situ. The demonstration will illustrate the performance of up to date technology in flood resilience.

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> Design

- **Proposed Design**
- **Floor Plans**
- **Section**

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Proposed Design

Concept

The Flood Resilient Property (FRP) is intended to be located in the BRE Innovation Park at Watford. The FRP is a building design to demonstrate technologies and flood protection systems on a single residential unit. It has been developed to represent a Typical Terrace House design. The dwelling has been designed as a 3 bed two storey property.

Siting

The proposed location is on the existing car park, to better integrate with the existing Innovation Park.

Particular attention has been placed on the connection with the existing SUDS next to the Visitors Centre (on the site plan opposite). A drainage channel has been designed as a water feature to enhance the landscape. Adjacent sites to the proposed development allow for possible future developments and a new entrance alley.

The FRP design is such that both housing and commercial low rise properties can be developed. The performance demonstrated at the IP will be applicable across a wide range of building types.

Features

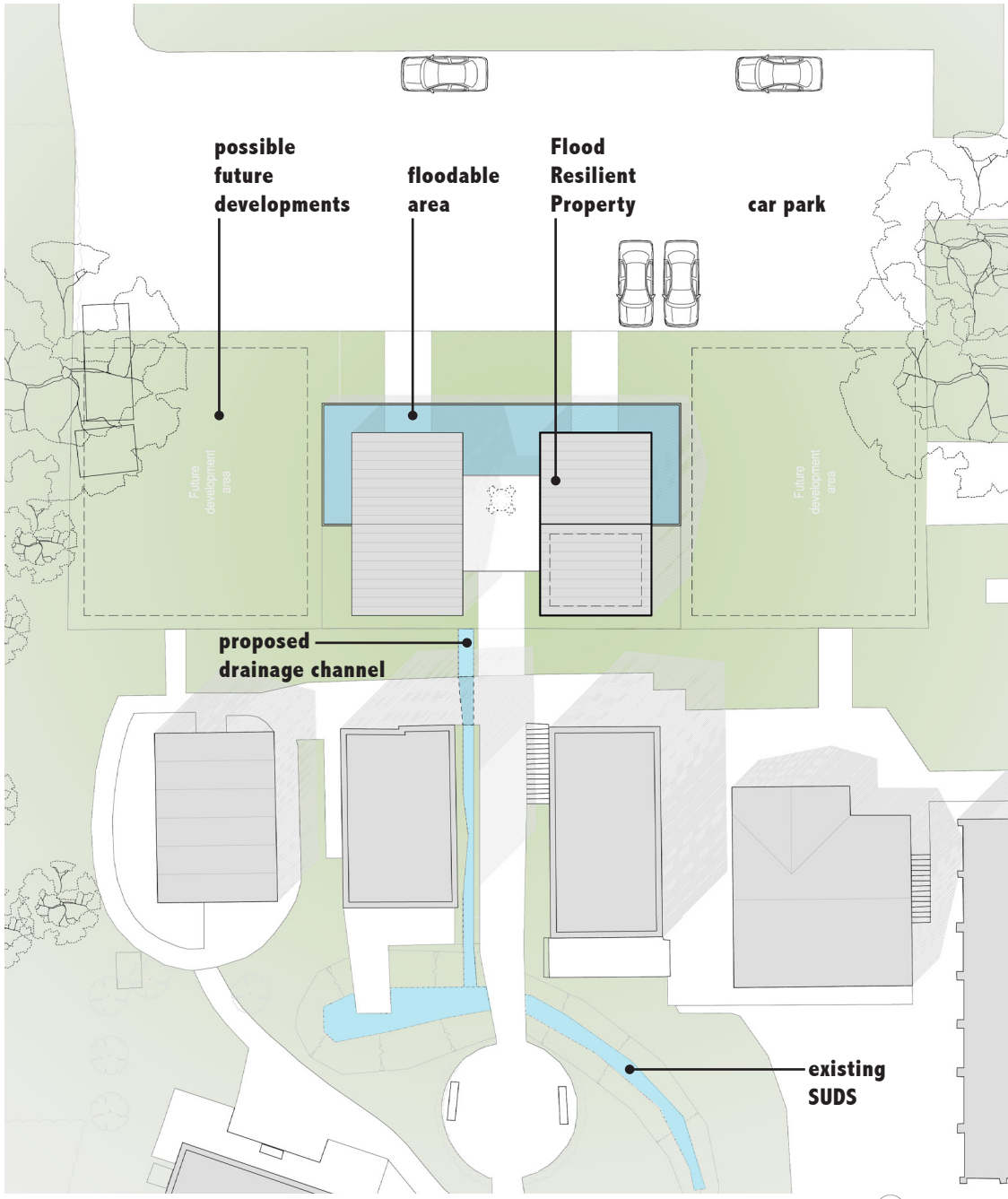
The house will be constructed with traditional brick and block masonry cavity walls, concrete slab and foundations and timber first floor and roof. All of which are enhanced to provide resistance and/or resilience to flooding.

The house is designed to resist water up to 600mm in depth after which water is allowed to enter into the property to reduce pressure on the structure.

Automatic opening window panels (flood vents) triggered by localised sensors will allow a controlled inundation flood into the property. A series of water sensors will be located outside the property and on entry points, linked to an internal remote alarm.

Emergency rescue locations are designed at ground and first floor levels.

A Mechanical Ventilation Heat Recovery system is installed as part of good modern building practice and to aid the drying out after a flood. All service entry points will be sealed. All electrics will be raised above the design flood level and within the Building Regulations Part M maximum height of 1.2m above finished floor level.



Site Plan

Floor Plans

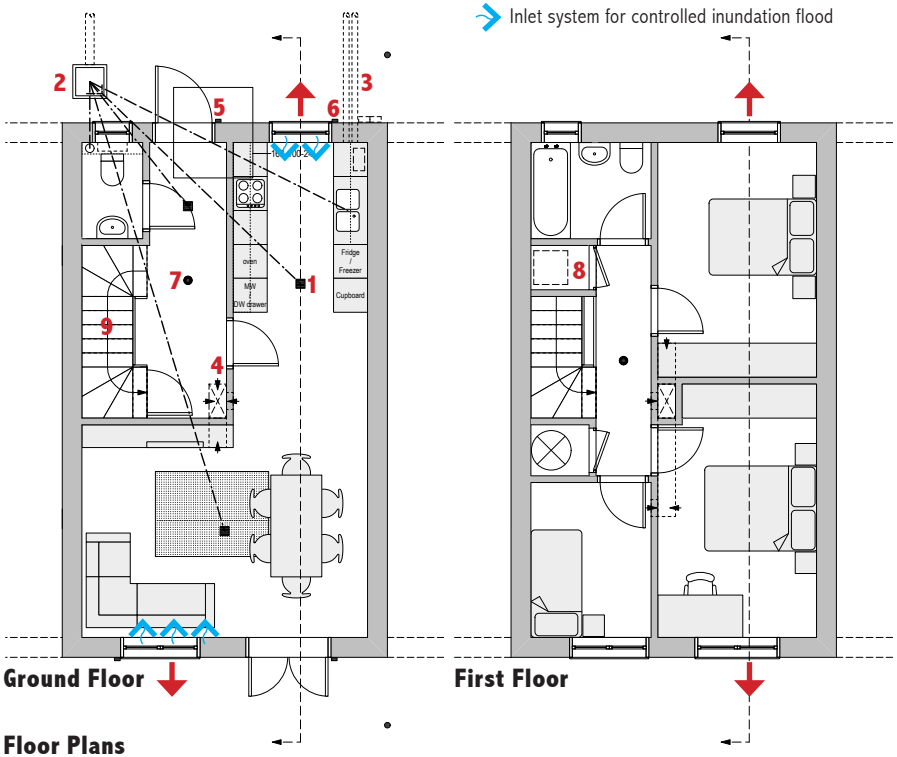
The house reflects a typical 3bedrooms/5persons terraced house. Kitchen, dining and living area are located on the ground floor with toilet, while the bedrooms and the main bathroom are located on the first floor. The design integrates all the devices and technologies within this typical layout, trying to preserve the livability and the character of the dwelling.

Key

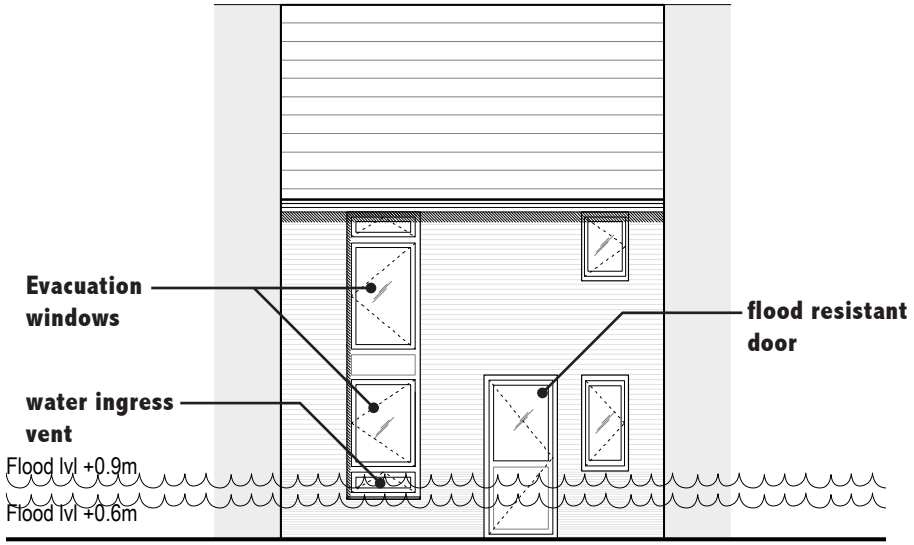
1. Floor drain trap with integral non-return valve
2. Bespoke sealed manhole with non-return valve
3. Incoming services with gas & electricity meters located above maximum flood level
4. MVHR system
5. Flood proof door with visual/audible door sensor and water inlet panel
6. Flood inlet/escape window with automatic water sensor
7. Flood sensor linked to internal sounder
8. Electrical distribution board, flood emergency kit & water pump
9. Stairwell dimensions to allow larger furniture items to be moved

Escape routes

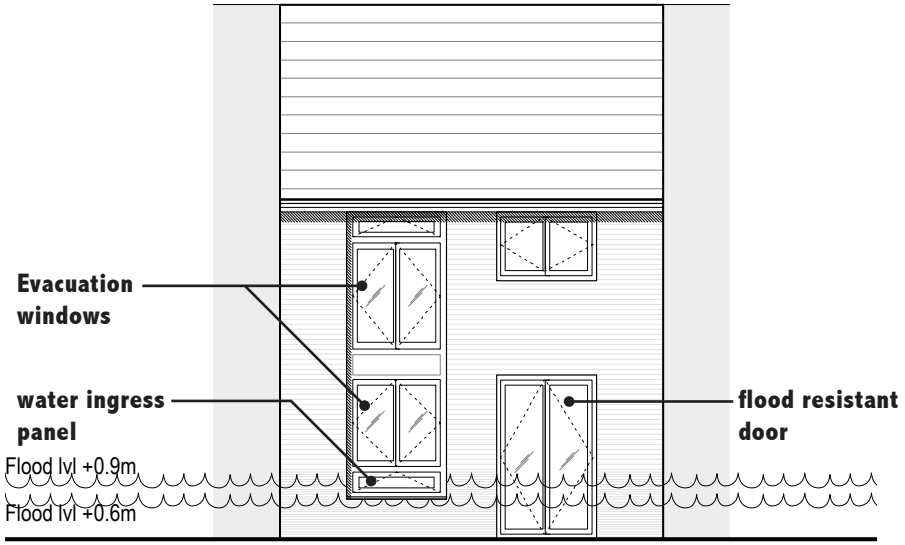
Inlet system for controlled inundation flood



Floor Plans

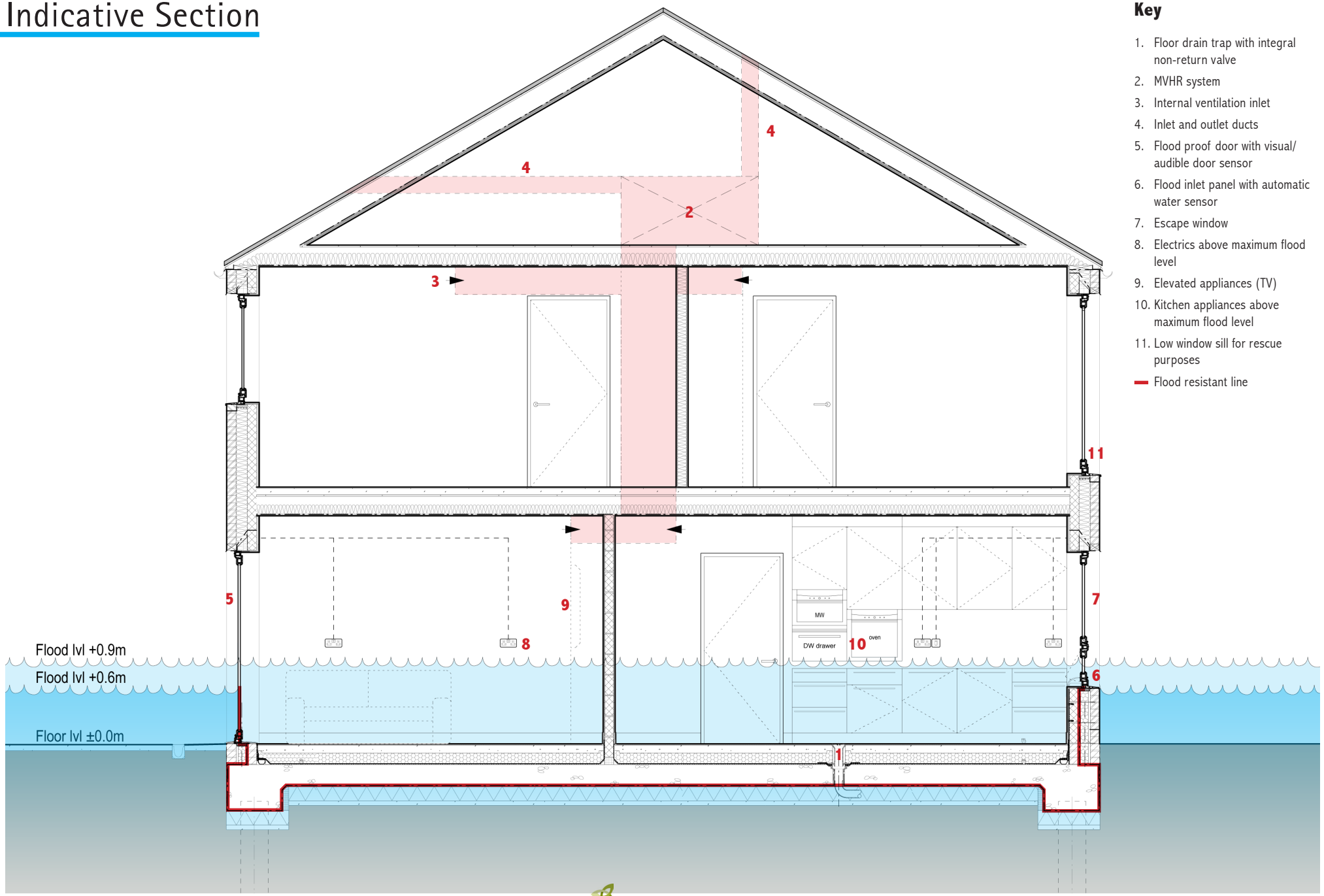


East (front) Elevation



West (rear) Elevation

Indicative Section



Key

1. Floor drain trap with integral non-return valve
2. MVHR system
3. Internal ventilation inlet
4. Inlet and outlet ducts
5. Flood proof door with visual/ audible door sensor
6. Flood inlet panel with automatic water sensor
7. Escape window
8. Electrics above maximum flood level
9. Elevated appliances (TV)
10. Kitchen appliances above maximum flood level
11. Low window sill for rescue purposes

Flood resistant line

> Construction Details

- **Wall to Floor (Option A)**
- **Wall to Floor (Option B)**
- **Doors**
- **Windows**
- **Internal Partitions**

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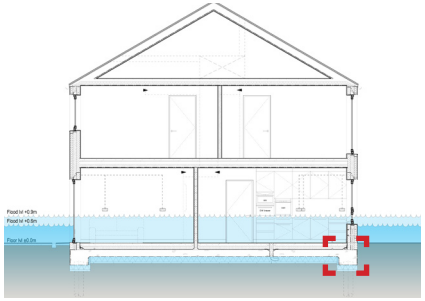
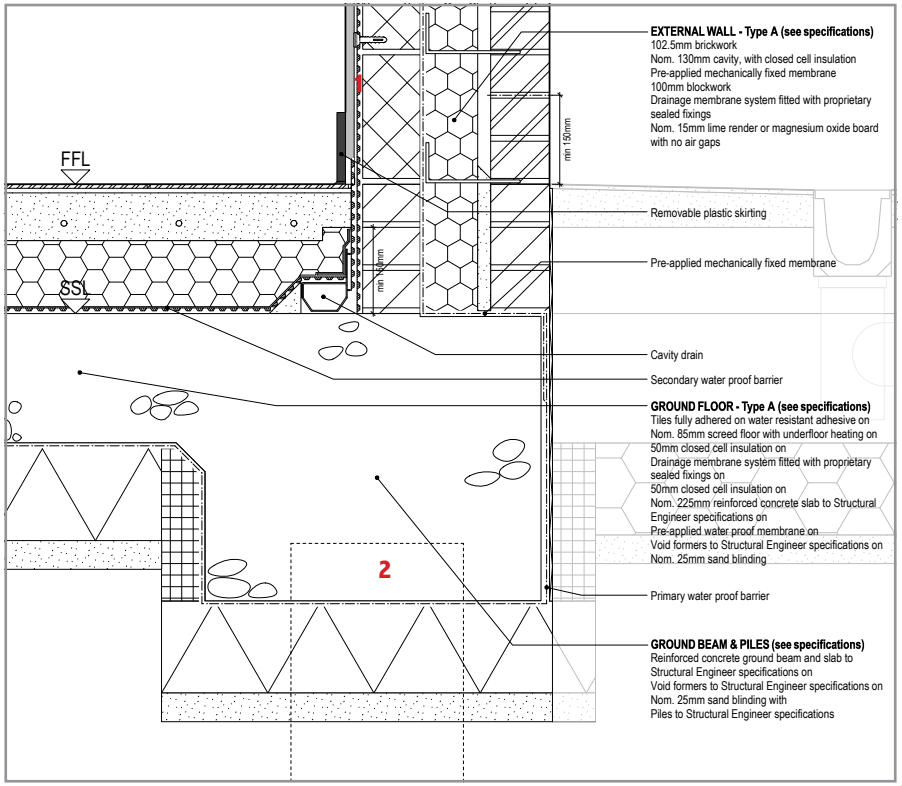
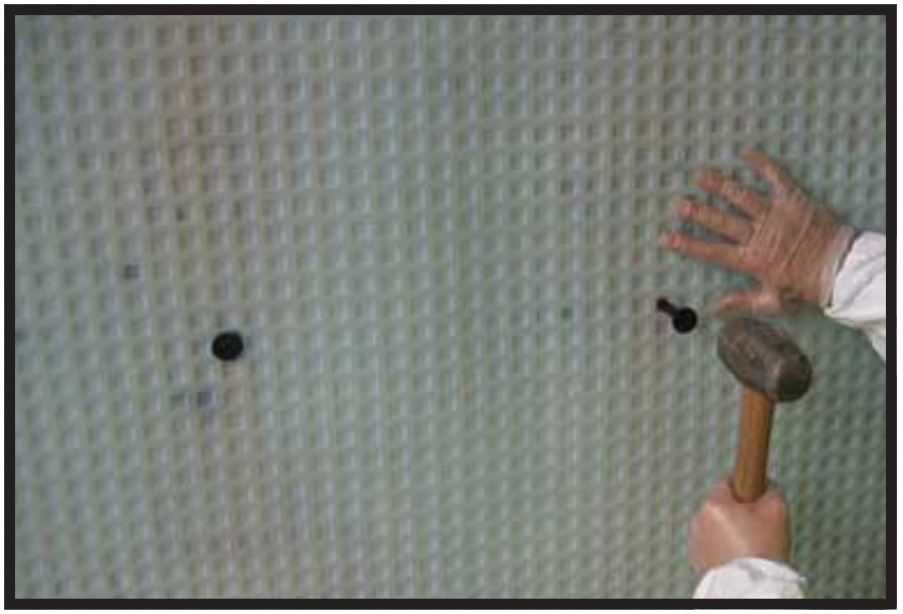
Wall to Floor (Option A)

As structural connections are a potential point of water entry, a primary and a secondary layer of waterproofing has been designed:

- Water tanking below slab to resist water pressure (primary layer)
- Pile foundations for problematic soil conditions
- Cavity drainage for water collection after flood (secondary layer)







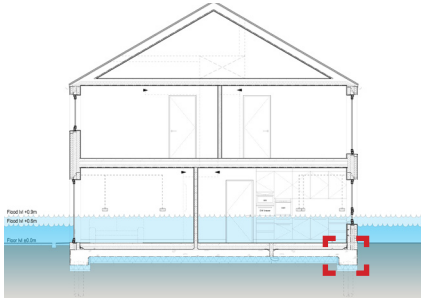
Cavity damp proof membrane (1) *© Triton Systems*

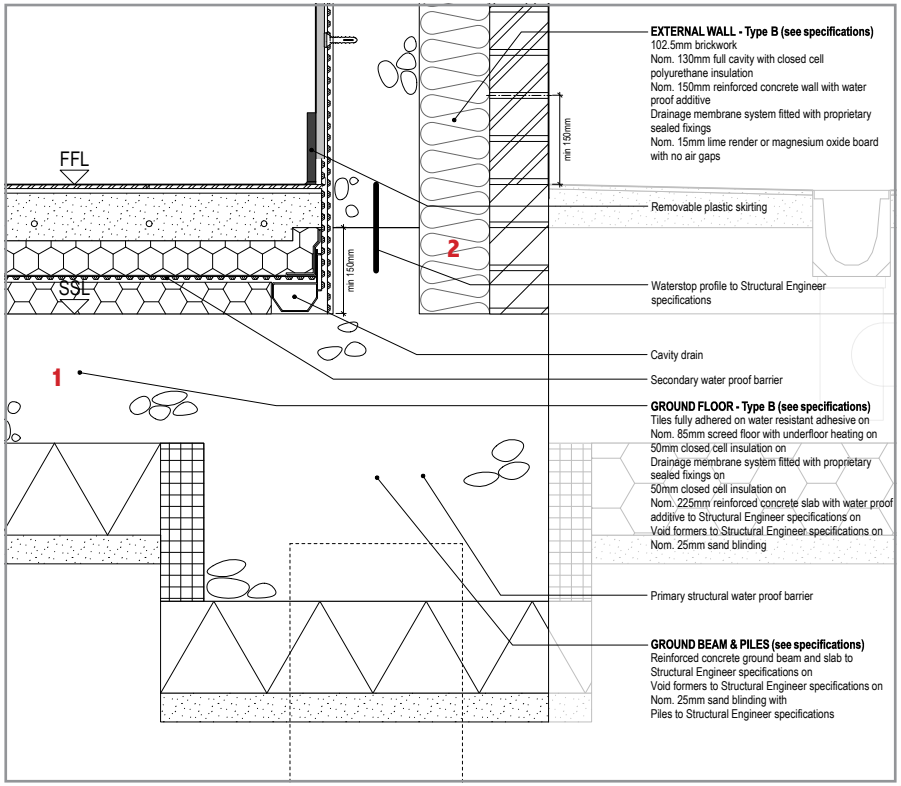
Beams and piles foundation (2) *source: Max Frank Limited*

Wall to Floor (Option B)

Water proof concrete could be utilised in lieu of a water proof membrane . A primary and a secondary layer of waterproofing has been designed:

- Concrete slab and wall with water resistant additive (primary layer)
- Full cavity waterproof insulation
- Cavity drainage for water collection after flood (secondary layer)





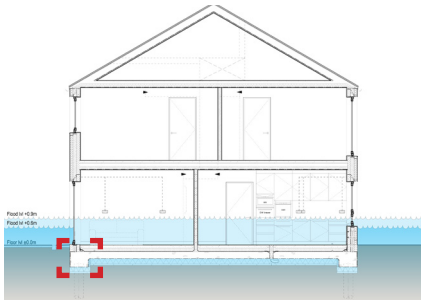
Water resistant reinforced concrete slab (1) *source: BayForm Ltd*

Closed cell polyurethane cavity wall insulation, injection process (2)
© Isothane Limited

Doors

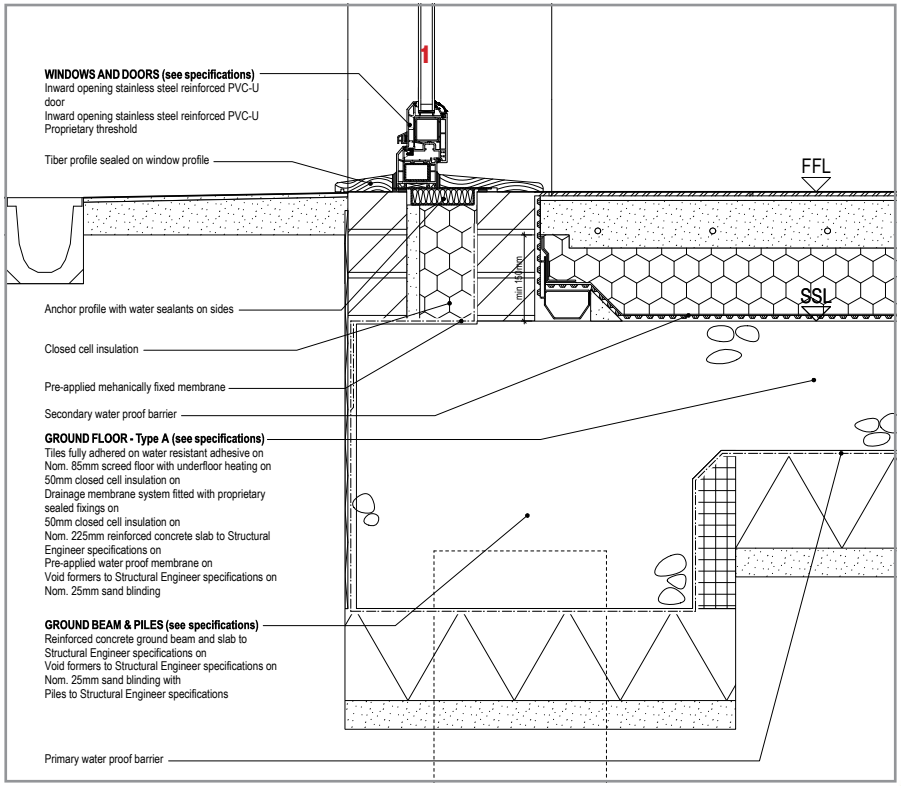
Flood resistant doors have been used to resist water penetration up to 600mm above floor level:

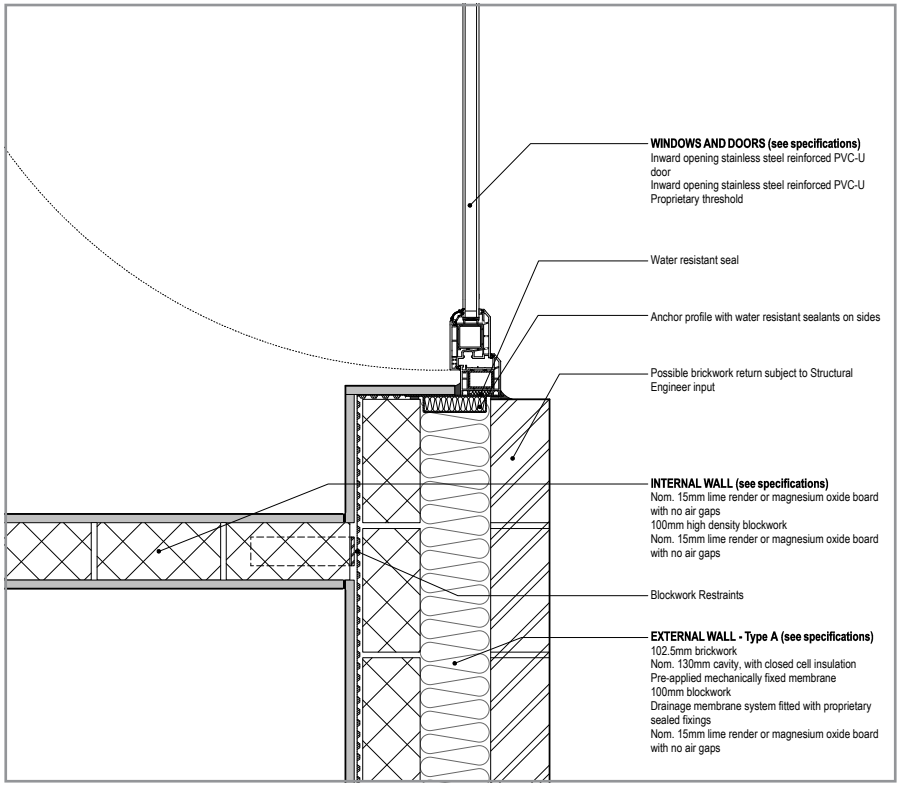
- Door threshold to be disabled accessible
- Door profile to be connected and sealed with main waterproof membrane
- PVC-U profile with stainless steel reinforcement



Flood resistant PVC-U door *© Aquobex*

Flood resistant PVC-U french door *© Aquobex*

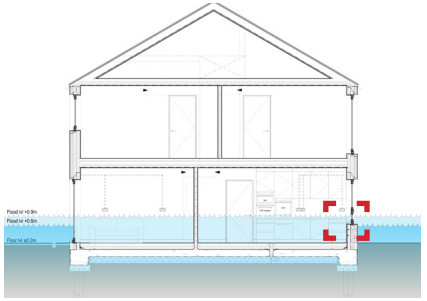


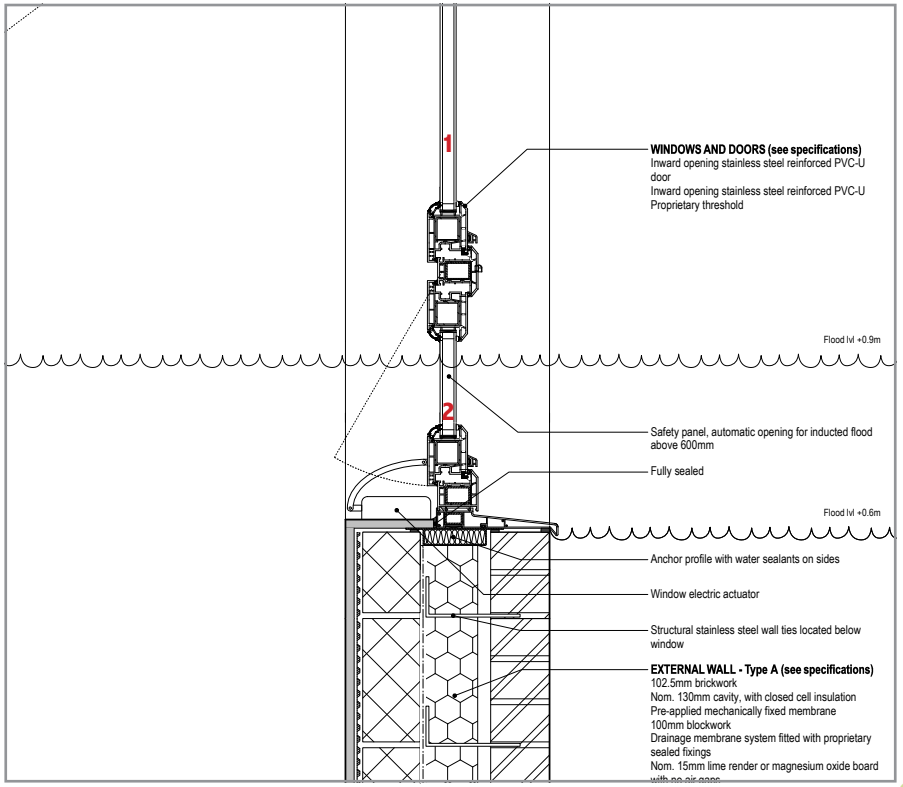


Windows

Windows will incorporate different technologies to allow water control and safe egress:

- PVC-U profile with stainless steel reinforcement
- Automatic opening panel at maximum flood resistance level to allow water in
- Escape routes are at both the front and rear of the property to guarantee safe escape





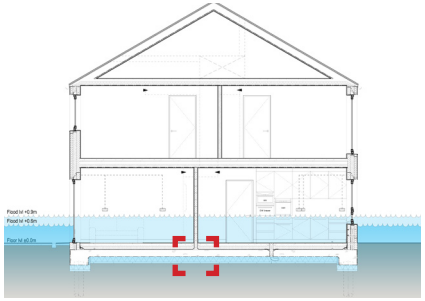
Flood resistant PVC-U window (1) *© Flood Control International*

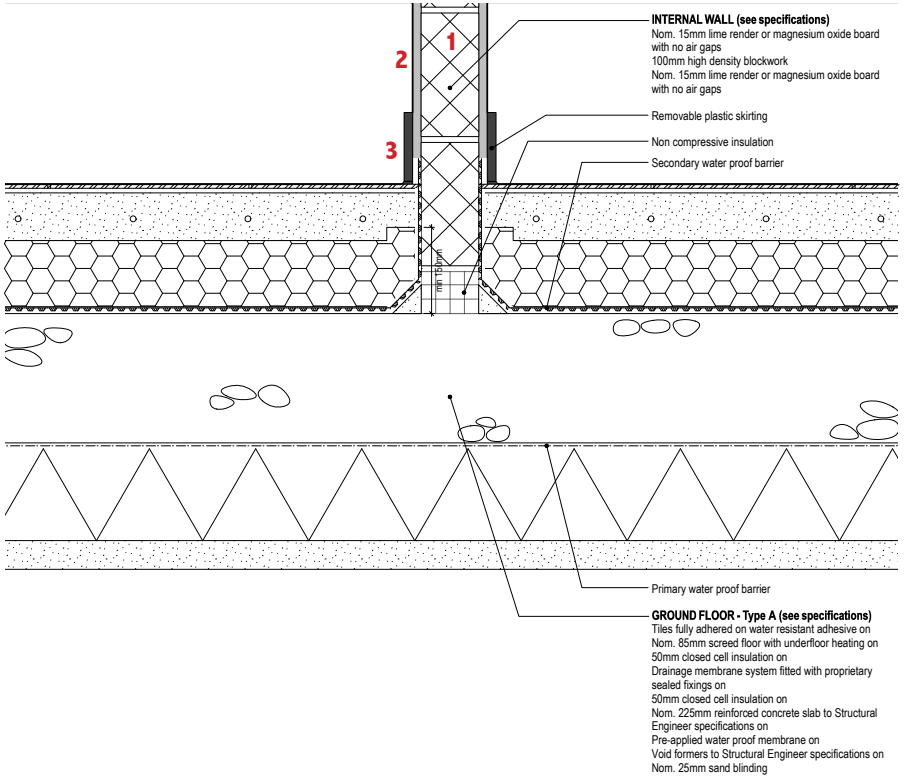
Automated opening system for water inlet (2) *© BRE*

Internal Partitions

Internal walls are to be water resilient and built with materials that allow fast drying recovery:

- Concrete block partition wall
- Lime plaster or magnesium oxide board as finishing
- Skirting to be sealed with internal cavity membrane





Concrete block internal wall (1) *© UWE Bristol*

Magnesium oxide board (2)
© Supertec Ceilings and Board (Pty) Ltd

PVC-U skirting profile (3)
source: Eurocell

> Services and Technology

- **Incoming Services**
- **Electrical & Mechanical**
- **Fittings & Appliances**
- **Warning Systems & Automation**
- **Drainage**
- **Floor Drainage**
- **Flood Emergency Kit**
- **Conclusions**

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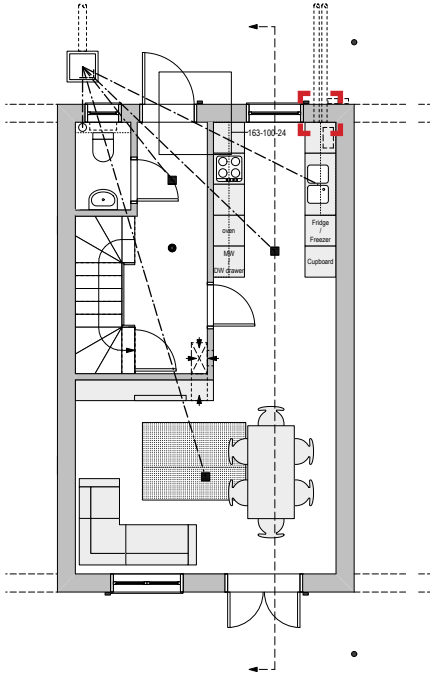
Incoming Services

The incoming services are a potential point of water entry, therefore all penetrations through the building fabric need to be well sealed.

Key points are:

- Seal all incoming services such as gas, electric, water, data, telecom, cable TV and any duct at the entry point into the building
- Safety valve system on water, electricity and gas pipes, to be disconnected from the main distribution grid in case of flood, to avoid losses and increasing of danger
- If services are all installed before the Close Cell Polyurethane insulation application, the insulation should expand to fill and seal all gaps



Duct sealing system *© Aquobex*

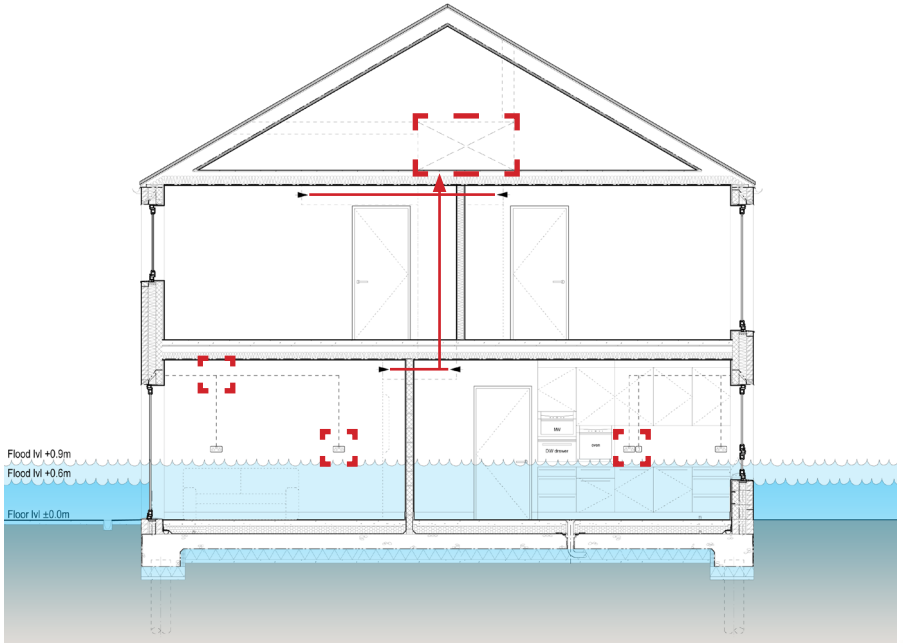
Cable duct seal *© Aquobex*

Electrical & Mechanical

Water must not come in contact with electrical power. Therefore, as a rule of best practice, all systems supported by electricity should be located above the maximum flood level.

Key points are:

- Electricity meter, distribution board, sockets and cables should be located above the maximum flood level
- Underfloor heating manifolds should be located above flood level
- Ventilation ducts should be located above flood level
- Natural ventilation will be possible, to maintain air circulation in the event of a loss of electricity
- MVHR unit located on the soffit



Elevated electrics and sockets *© Huntingdonshire District Council*

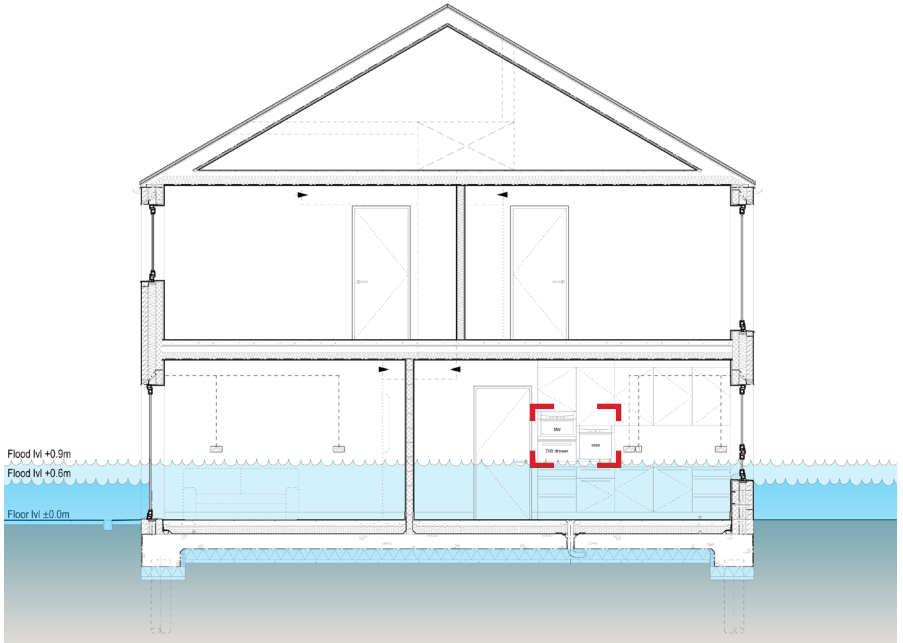
MVHR unit on attic *"http://www.sustainablebuildingsolutions.co.uk/products/renewable-technologies"*

Fittings & Appliances

As a rule of best practice, all the systems supported by electricity should be located above the maximum flood level.

Key points are:

- All appliances to be placed above flood level
- Kitchen units below flood level to be of waterproof material
- Plastic or stainless steel hardware.
- Kitchen units doors and drawers to be sealed
- Elevated dishwasher



Water resistant kitchen modules *source: StoryBlog.us*

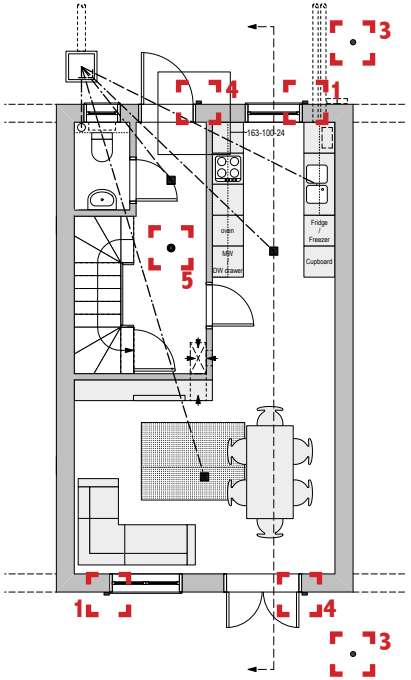
Elevated appliances *© BACA Architects*

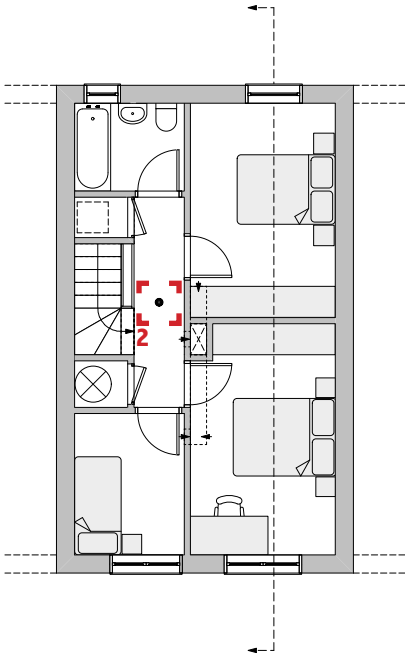
Warning Systems & Automation

Automation is essential to allow the various technologies to work in synergy and provide early warning, emergency contact and automatic safety measures.

Key points are:

- Wireless sensors located externally on the ground to alert in case of flood (3)
- External sensors on windows to allow automatic opening of the flood inlet panels (1)
- External door sensors to advise in case of water rising (4)
- Internal ground sensor to advise for eventual presence of water inside the building (4)
- All sensors to be connected to a main sounder to give acoustic and visual warning (2)
- Possibility of connecting the main sounder to an automated call system to emergency authorities





Audio / visual sounder (1) *© BACA Architects*

External wireless window sensor (2)
© BRE

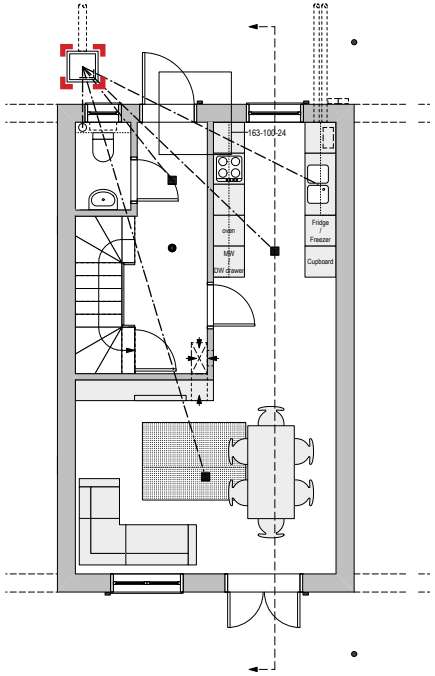
Automated emergency call
© BRANDFIT Ltd

Drainage

Foul drainage can be a potential entry point for flood water, therefore non-return valves need to be fitted to prevent sewage back flowing into the property during a flood.

Key points are:

- Sewage system needs to have a non-return valve system
- Pipe to be sealed on passage through the “flood proof tanking”
- Inspection chamber to be fitted with anti-lift lid
- Drainage pipes need to be covered and locked with concrete to resist lower ground water pressure and help prevent damage



Non return valve with automatic flusher system *© Aquobex*

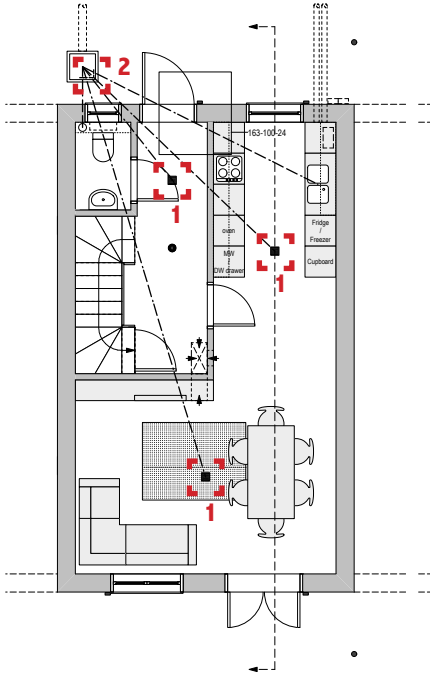
Sealed manhole cover *© Aquobex*

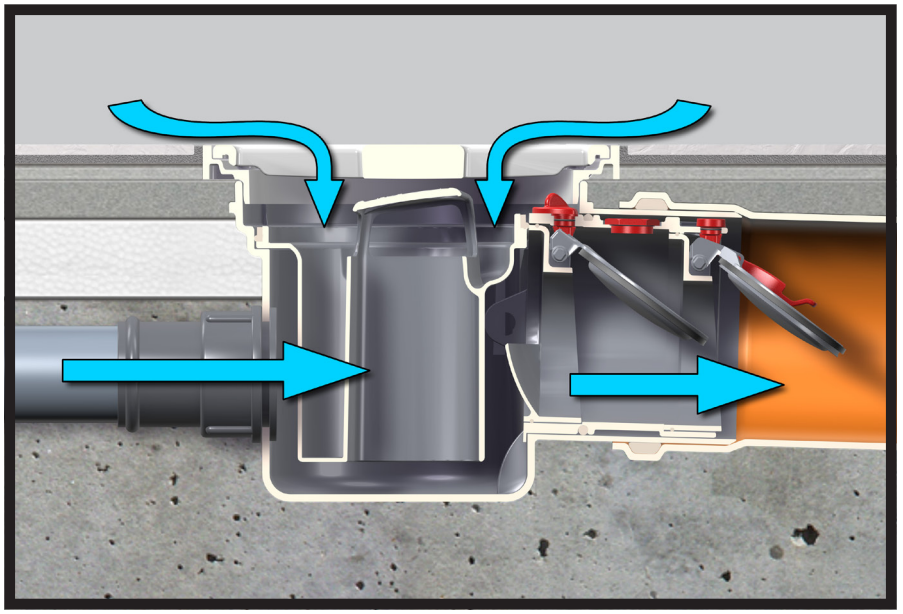
Floor Drainage

In order to allow fast recovery after a flood occurring inside the building, internal drains need to be provided to facilitate water outflow.

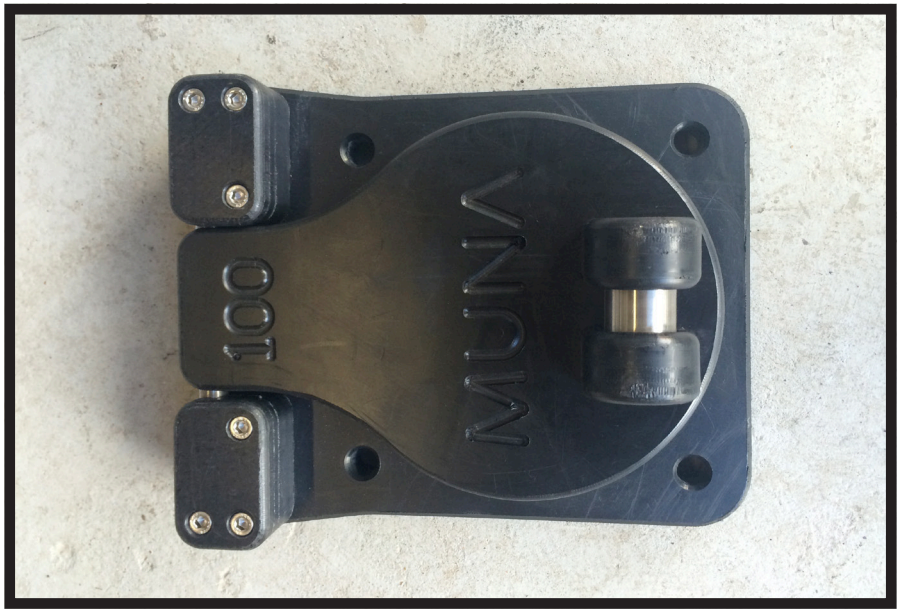
Key points are:

- Distributed to facilitate water drainage after a flood event
- Drain connections into man hole to be fitted with non-return valve and anti-lift lid
- Pipes with non-return flaps before manhole to avoid back-flow of sewage





Section of internal drain with non-return system (1) *© ACO Passavant GmbH*



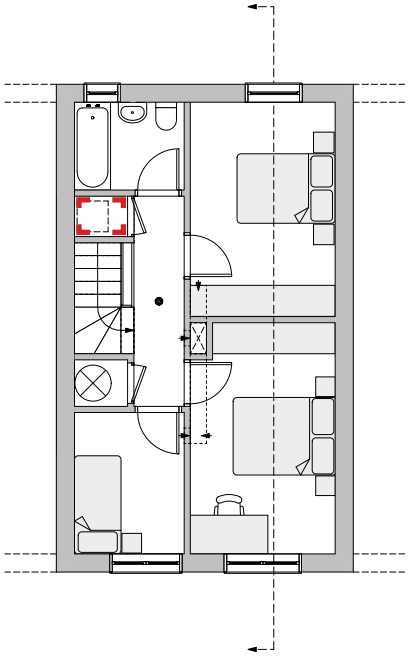
Non-return flap (2) *© MUNA UK Ltd*

Flood Emergency Kit

To prevent emergency situations, a flood emergency kit needs to be available in a safe area of the house. To reduce recovery time, an immersion pump needs to be included as well.

Key points are:

- Located at first floor
- First aid, documents, radio, etc. to be stored in a sealed package (see kit from EA)
- Immersion motor pump to help ground floor drainage after a flood event
- Possibly use solar PV energy to power the immersion pump in case of general electric disruption



Immersion motor pump *© EBARA Pumps Europe S.p.A.*

Flood Emergency Kit *source: Gloucester Council*

Conclusions

The Flood Resilient Property aims to use a combination of flood resistant and resilient measures in order to resist flood emergency situations and in the aftermath, to be able to recover as quickly as possible from the consequences of a major flood.

The main key points have been:

- The house has to be sealed up to a certain height (600mm) to demonstrate resistance
- Two waterproofing systems have been designed in order to seal the house. The primary system should guarantee prevention against water penetration. The second system is necessary to guarantee further protection in the advent of potential primary system failure and also to protect the structure if the building's interiors becomes inundated
- Water entry points are necessary to allow water into the building to reduce water pressure on the building's fabric to prevent potential structural failure. The entrance points have been designed in opposite locations of the perimeter to ensure at least one entrance can be used as an emergency escape route
- Escape routes have been provided on opposite sides and above maximum flood levels to facilitate emergency escape and rescues during flood events
- Integrated technology is an important part of the flood resistant/resilient design. In order to guarantee the proper functionality of the different systems, automation will ensure forced water penetration above the limit level and early warning through wireless sensors around the perimeter of the house and on the main resistant elements (doors and windows). The integration of these systems with the property alarm and emergency alert system is fundamental to notify the emergency services, to monitor the situation and to provide rescue in the case of danger