

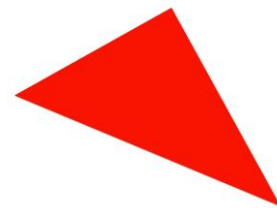
**FLOOD RISK ASSESSMENT AND DRAINAGE STRATEGY REPORT**  
**ISLAND SITE, EAST LANCASHIRE PAPER MILL**  
**SPRING LANE**  
**RADCLIFFE**  
**MANCHESTER M26 2QU**  
**for**  
**GREAT PLACES HOUSING GROUP**



| 20.B.12866 REPORT REVISIONS |                                                                        |
|-----------------------------|------------------------------------------------------------------------|
| - APRIL '21                 | Original report.                                                       |
| A – MARCH '22               | General revisions following proposed development/ site layout changes. |

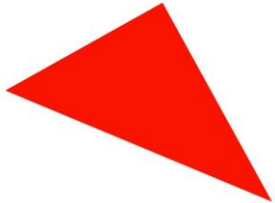
**20-B-12866/ELPM**

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| EXECUTIVE SUMMARY      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Site Parameters        | Site Area – 4360m <sup>2</sup><br>Present Impermeable Area - 1550m <sup>2</sup><br>Post Development Impermeable Area – 1220m <sup>2</sup><br>DECREASE in Impermeable Area – 330m <sup>2</sup><br>NGR – 379021 (E); 407407 (N)<br>Nearest Post Code – M26 2QU                                                                                                                                                                                                                                                                                                                                                                                                          |
| Flooding               | This report has considered flooding from a variety of sources in accordance with NPPF guidelines. The site, although relatively small falls into Flood Zones (FZ) 1, 2 & 3 as a result of the flood risk from Crow Trees Farm Brook (CTFB) which passes beneath the site in a culvert, outfalling to the River Irwell to the south. The report demonstrates how the site can be safely developed by constructing new property above “worst case” flood levels & also by providing additional flood storage on site to mitigate for storage volume lost due to the development.                                                                                        |
| Surface Water Drainage | There is a surface water sewer adjacent to the site in Cunliffe Street, which connects to a combined sewer in Cock Clod Street. There is also a culverted watercourse (CTFB) flowing in a southerly direction crossing the site. Whilst the SuDS drainage hierarchy indicates that ground infiltration should always be the first choice, preliminary investigations indicate a layer of impermeable clay & contaminated made ground covering the site so infiltration looks unlikely to be achievable or desirable. Therefore, connection of the site surface water to CTFB is proposed with discharge not to exceed the existing $Q_{BAR}$ greenfield run-off rate. |
| Foul Drainage          | There are combined sewers in Howard Street, Pollitt Street & Cock Clod Street. United Utilities indicate that their preferred connection point would be to the 300 dia combined sewer in Howard Street at an uncontrolled rate. UU also indicate that connection to the combined system would be considered at any other convenient position.                                                                                                                                                                                                                                                                                                                         |





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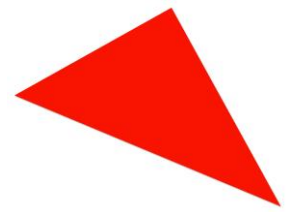
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## **1.0 INTRODUCTION**

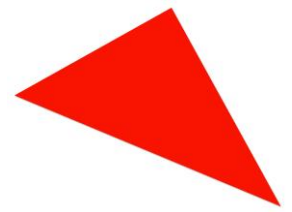
- 1.1 Carley Daines and Partners Limited have been commissioned by Great Places Housing Group to undertake a Flood Risk Assessment (FRA) and Drainage Strategy Report for this site in accordance with the requirements of National Planning Policy Guidelines (NPPG), published in 2016 & as since updated.
- 1.2 It is understood that the site has been acquired by Homes England & has the benefit of Outline Planning Permission granted by Bury Council reference 62969 & dated 19 December 2018. The site is allocated for development with affordable housing and is locally known as “The Island Site”.
- 1.3 The site falls with FZ’s 1, 2 & 3.
- 1.4 The report will demonstrate how the development proposals will:
  - Comply with current SuDS Guidelines
  - Restrict surface water run-off to current greenfield run-off rates
  - Set new property levels above critical flood levels
  - Provide additional on-site flood storage significantly greater than that lost by the development, ensuring that flood water is not displaced elsewhere.

## **2.0 PREVIOUS REPORTS**

- 2.1 Reports prepared by WYG have been made available to us and are reviewed and summarised below.

### **2.2 WYG FLOOD RISK AND DRAINAGE BRIEFING NOTE DATED 2 NOVEMBER 2020**

- The report confirms OPP granted by Bury Council
- Details site topography and that levels vary significantly across the site, falling towards the south.
- Confirms that the site falls within FZ’s 1, 2 & 3.
- Indicates that flood risk to the site results from CTFB rather from the River Irwell.
- Details the culvert survey of CTFB undertaken in 2012.
- Details UU sewer infrastructure in the area.
- Discusses the Sequential Test and advises that any re-modelling of site levels must demonstrate that this does not have an adverse impact on other nearby off-site areas.



- Advises the following:

The modelling of Crow Trees Farm Brook commissioned by Homes England is expected to reduce the footprint of FZs 2 and 3 and therefore if all new proposed residential buildings are located on land within FZ 1 the Sequential Test will be satisfactorily addressed.

As part of the ELPM application there were extensive discussions with the EA. In the submitted FRA Addendum (November 2018) Section 2.2 states:

*"Cost recoverable" advice was sought from the EA in order to obtain further clarification on the risk of flooding from the (Crow Trees Farm) Brook and any detailed modelling requirements. It was indicated in the meeting that although the EA Product 4 data imply that a considerable number of existing properties may be subject to flooding on a 1 in 20 year event, since telemetry and screening at the upstream culvert entry were introduced, there have not been reports of flooding (due to Crow Trees Farm Brook).*

*It was agreed with the EA that further detailed modelling of the culvert is not required if no modifications to the existing culvert are proposed and finished floor levels (and resilience measures if appropriate) are provided for any properties within the zone of influence of flooding from Crow Trees Farm Brook based on the relevant EA model data'.*

If it is proposed to significantly amend levels in the site to alter the shape of the Flood Zone 2 and 3 areas, it will be necessary to demonstrate that this does not have an adverse impact on other adjacent areas by either further river modelling or a methodology to be agreed with the EA.

- Makes the following recommendations:

Following a 'cost recoverable' meeting with the EA and the associated discussions the confirmed position in terms of future finished floor levels (FFLs) and flood resilience measures to be applied across the entirety of the ELPM site and also applicable to the 'Island Site' element to be as follows:

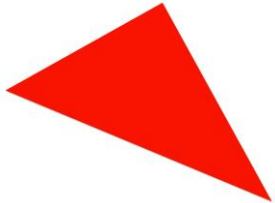
- (i) FFLs are to be set 600mm above the 1 in 100 year return period plus 35% climate change allowance event (in respect of the River Irwell, Hutchinson's Goit and Crow Trees Farm Brook);
- (ii) Where existing levels and infrastructure mean compliance with (i) above is not achievable a clear rationale for such departure should be provided;
- (iii) It is recommended that consideration of risks and the provision of flood resilience measures be included up to the 1 in 100 year level plus 70% climate change (in respect of the River Irwell, Hutchinson's Goit and Crow Trees Farm Brook).

It would be reasonable to use the modelling commissioned by Homes England as evidence of compliance with the above EA requirements.

- This report is included in full within Appendix L.

## 2.3 WYG HYDRAULIC TECHNICAL NOTE DATED NOVEMBER 2020

- This is a summary of further modelling focussed on flooding resulting from CTFB.
- Several flood scenarios are modelled, specifically the 5%, 1% and 0.1% AEP events. In addition, climate change modelling is applied to the 1% AEP with 35% & 70% uplifts. A final scenario is modelled, the 1% AEP + 35% cc allowance but with 100% blockage of CTFB culvert.

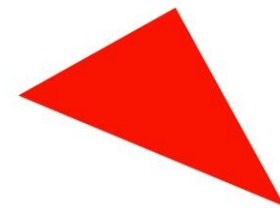
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- Of the 6 modelled scenarios, the 1% AEP + 35% cc with full culvert blockage produces the highest flood levels at all positions throughout the site.
  - The site has a significant fall from north to south with existing site levels over the developable area ranging from 66.14m AOD (highest) to 64.01m AOD (lowest).
  - As a result, flood levels for all scenarios vary with the hydraulic gradient generally following the site levels. Maximum flood levels for the critical 1% AEP + 35% (culvert blocked) event range from 66.11m AOD at the north to 64.17m AOD at the south.
  - As a consequence, a single site wide finished floor level (FFL) is not appropriate throughout the site & new housing units should be considered on a block-by-block basis.
  - This report is included in full in Appendix M.

## **2.4 WYG FLOOD RISK AND DRAINAGE ASSESSMENT PROPOSED DEVELOPMENT OF FORMER EAST LANCASHIE PAPER MILLS, RADCLIFFE DATED JUNE 2018**

- This report refers to the full ELPM site, an overall area of 23ha on the north bank of the River Irwell. The site has the capacity to be developed by up to 400 dwellings, with sports facilities and open public space.
- Most of this report does not directly refer to nor is relevant to the small Island Site under consideration.
- The flood modelling contained within the report indicates that the 1% AEP + 35% cc uplift level for the River Irwell is 64.6m AOD at its closest position to the Island Site.

## **3.0 EXISTING SITE DETAILS**

- 3.1 The site is irregular in shape, with a fall of approximately 2m from north to south. The site is bounded by Spring Lane to the north, Cock Clod Street to the east, Pollitt Street & Howard Street to the west and Rectory Lane to the south.
- 3.2 The site has an area of 0.57ha but of this only 0.44ha is developable as there is a “no build” area to the south containing UU plant and apparatus.
- 3.3 The centre of the site comprises grassed open land with a few small mature and semi-mature trees and bushes. The site is traversed by a concrete path.
- 3.4 The north of the site is demarked by an area of hardstanding with concrete bollards forming the boundary to Howard Street.
- 3.5 There is 19<sup>th</sup> century terraced housing to the surrounding streets.



- 3.6 CTFB flows in a southerly direction across the site crossing beneath Spring Lane immediately to the north. It is understood that CTFB was culverted around 1930. The culvert headwall to the north of Spring Lane and outfall on the north bank of the River Irwell are visible and accessible. The culvert has several directional changes and is 1.55m deep by 2.4m wide at a depth varying between 2.5m and 3.0m below existing site levels. Access manholes are present along the culvert.
- 3.7 The site has had an industrial past and is associated with ELPM. It is understood that a brewery was present on site. The site was cleared of buildings in or around 2001.
- 3.8 The Lead Local Flood Authority (LLFA) is Bury Council.
- 3.9 There has been no site-specific intrusive ground investigation to date, though a Phase 1 Preliminary Risk Assessment is under preparation. It is believed that natural deposits are likely to be Devensian Till (glacial clay) overlying rocks of the Pennine Middle Coal Measures.
- 3.10 The site is in a known coal mining area with, it is understood, the potential to be affected by shallow workings.

#### **4.0 PROPOSED DEVELOPMENT**

- 4.1 Development plans have been made available prepared by AEW Architects of Manchester. The proposed development consists of 7 new houses in a single terrance and 20 apartments with drainage and parking infrastructure. Vehicle access to the new development will be from Pollitt Street, Howard Street and Baybutt Street.
- 4.2 Any residential development of this type is classified in Table 2 of the NPPG below, as within the "More Vulnerable" category in consideration of flood risk.
- 4.3 Since part of the development is in FZ's 2 and 3, then in accordance with Table 3 of the NPPG below, any of the "More Vulnerable" components of the site located in FZ 2 should pass the Sequential Test and any units located in FZ 3 would be required to pass the Exception Test.
- 4.4 However, the site (and the much larger full ELPM site) has been allocated within the local plan, and hence it has been sequentially allocated based on an SFRA and therefore further Sequential Tests and Exception Tests are not required. This is reinforced by the fact that the site has been granted Outline Planning Permission.

**Table 2: Flood Risk Vulnerability Classification**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Essential Infrastructure</b> <ul style="list-style-type: none"><li>• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk.</li><li>• Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood.</li><li>• Wind turbines</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Highly Vulnerable</b> <ul style="list-style-type: none"><li>• Police stations, ambulance stations and fire stations and command centres and telecommunications installations required to be operational during flooding.</li><li>• Emergency dispersal points.</li><li>• Basement dwellings.</li><li>• Caravans, mobile homes and park homes intended for permanent residential use<sup>3</sup>.</li><li>• Installations requiring hazardous substances consent<sup>4</sup>. Where there is a demonstratable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as "essential infrastructure"<sup>5</sup>.</li></ul> |
| <b>More Vulnerable</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |



- Hospitals
- Residential institutions such as residential care homes, children's homes, social services homes, prison 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<sup>6</sup>.
- Sites used for holiday or short-let caravans and camping, *subject to a specific warning and evacuation plan*.

#### Less Vulnerable

- Police, ambulance and fire stations which are *not* required to be operational during flooding.
- Buildings used for shops, financial, professional and other services, restaurants and cafes, hot food takeaways, offices, general industry, storage and distribution, non-residential institutions not included in "more vulnerable" and assembly and leisure.
- Land and buildings used for agriculture and forestry.
- Waste treatment (except landfill and hazardous waste facilities).
- Minerals working and processing (except for sand and gravel working).
- Water treatment works which do *not* need to remain operational during times of flood.
- Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place.)

<sup>3</sup> For any proposal involving a change of use of land to a caravan, camping or chalet site, or to a mobile home site or park home site, the Sequential and Exception Tests should be applied.

<sup>4</sup> See Circular 04/00: *Planning controls for hazardous substances* (paragraph 18) at: [www.communities.gov.uk/publications/planningandbuilding/circular/planningcontrols](http://www.communities.gov.uk/publications/planningandbuilding/circular/planningcontrols)

<sup>5</sup> In considering any development proposal for such an installation, local planning authorities should have regard to planning policy on pollution in the National Planning Policy Framework.

<sup>6</sup> For definition, see *Planning for Sustainable Waste Management: Companion Guide to Planning Policy Statement 10* at [www.communities.gov.uk/publications/planningandbuilding/planningsustainable](http://www.communities.gov.uk/publications/planningandbuilding/planningsustainable)  
See footnote 3.

#### Water-compatible development

- Flood control infrastructure.
- Water transmission infrastructure and pumping stations.
- Sand and gravel working.
- Docks, marinas and wharves.
- Navigation facilities.
- Ministry of Defence installations.
- Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location.
- Water-based recreation (excluding sleeping accommodation).
- Lifeguard and coastguard stations.
- Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms.

Essential ancillary sleeping or residential accommodation for staff required by uses in this category *subject to a specific warning and evacuation plan*.

#### Notes to Table 2:

- This classification is based partly on Department for Environment, Food and Rural Affairs and Environment Agency research on *Flood Risks to People (FD2321/TR2)* and also on the need of some uses to keep functioning during flooding.
- Buildings that combine a mixture of uses should be placed in to the higher of the relevant classes of flood risk sensitivity. Developments that allow uses to be distributed over the site may fall within several classes of flood risk sensitivity.
- The impact of a flood on the particularly uses identified within this flood risk vulnerability classification will vary within each vulnerability class. Therefore, the flood risk management infrastructure and other risk mitigation measures needed to ensure the development is safe may differ between uses within a particular vulnerability classification.

**Table 3: Flood Risk Vulnerability and Flood Zone "Compatibility"**

|                    |                               | Essential Infrastructure | Water Compatible | Highly Vulnerable       | More Vulnerable         | Less Vulnerable |
|--------------------|-------------------------------|--------------------------|------------------|-------------------------|-------------------------|-----------------|
| Zone (see table 1) | Zone 1                        | ✓                        | ✓                | ✓                       | ✓                       | ✓               |
|                    | Zone 2                        | ✓                        | ✓                | Exception Test required | ✓                       | ✓               |
|                    | Zone 3a                       | Exception Test required  | ✓                | ✗                       | Exception Test required | ✓               |
|                    | Zone 3b functional floodplain | Exception Test required  | ✓                | ✗                       | ✗                       | ✗               |

**Key:**            ✓ Development is appropriate  
                      ✗ Development should not be permitted.

**Notes to Table 3:**

This table does not show:

- The application of the Sequential Test which guides development to Flood Zone 1 first, then Zone 2, and then Zone 3;
- Flood risk assessment requirements; or
- the policy aims for each flood zone.

## 5.0 EFFECTS OF CLIMATE CHANGE

- 5.1 Reference is made to the Environment Agency document: Flood Risk Assessments: Climate Change Allowances dated February 2016 & updated in March 2020.

**Table 2: Peak rainfall intensity allowance in small and urban catchments (use 1961 to 1990 baseline)**

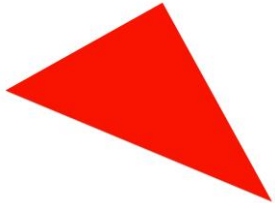
| Applies across all England | Total potential change anticipated for 2015 - 2039 | Total potential change anticipated for 2040 - 2069 | Total potential change anticipated for 2070 - 2115 |
|----------------------------|----------------------------------------------------|----------------------------------------------------|----------------------------------------------------|
| Upper end                  | 10%                                                | 20%                                                | 40%                                                |
| Central                    | 5%                                                 | 10%                                                | 20%                                                |

The site is unaffected by changes in sea levels.

## 6.0 PROBABILITY OF FLOODING

- 6.1 It is a requirement of the NPPG that flooding from all possible sources should be assessed. Accordingly, consideration must be given to the possibility of flooding from the following sources:

- rivers and watercourses
- sewers
- sea
- overland flows
- ground water
- reservoirs, canals and artificial sources



Consideration must also be given to the possibility of transferring flooding to other locations off site.

In respect of the above possible flood sources, the assessed risks are as follows:

## **6.2 Flooding from Rivers/Watercourses**

The site is at risk from flooding from CTFB, hence the placing of areas of the site in FZ 2 and FZ 3. Flooding can occur as a result of 3 scenarios as follows:

- Due to overtopping of CTFB channel to the north of Spring Lane in extreme rainfall causing flood water to pass over the site.
- Due to the trash screen at the upstream entrance to CTFB culvert becoming blocked.
- Due to a combination of these two events occurring simultaneously.

It is understood that the upstream entrance to CTFB culvert is protected by telemetry warning of rising water levels.

It is also understood that the site and immediate area was not subject to flooding in the Boxing Day Storm of 2015. The storm is believed to have been between a 1% AEP and 0.5% AEP severity (ie 1:100yrs to 1:200yrs).

Flood risk is assessed as MODERATE TO HIGH.

## **6.3 Flooding from the Sea**

The site is at an elevation of 65m AOD & at least 50km from the nearest coastline.

The risk of flooding from the sea is therefore assessed as ZERO.

## **6.4 Flooding from Land**

This is discussed above under risks from Rivers and Watercourses and there is an obvious overland flood route as a result of CTFB overtopping just north of the site and flowing across Spring Lane.

Flood risk is again assessed as MODERATE TO HIGH.

## **6.5 Flooding from Ground Water**

The possibility of flooding from groundwater has been considered. However, the proposed development is to be constructed fully above ground level without basements.

This risk is assessed as VERY LOW.

## **6.6 Flooding from Sewers**

Flooding from sewers can occur when a sewer is overwhelmed by heavy rainfall, becomes blocked, is damaged or of inadequate capacity. Flooding is most likely to occur to combined sewers. The UU sewer map shows sewers in the area to be of substantial size and it is understood that there is no record of sewer flooding in the area, confirmed in the UU Consultation Response in Appendix H.

It is therefore be concluded that this risk is VERY LOW.

## 6.7 Flooding from Reservoirs, Canals and Artificial Sources

There is a reservoir 350m east of the site but at a level below the lowest site level. The Manchester Bolton and Bury Canal also exists approximately 500m to the north.

Flood risk from these bodies is considered NEGLIGIBLE.

## 7.0 MITIGATION MEASURES

7.1 In view of the site's partial location in FZ's 2 and 3, mitigation measures are required to provide protection against future flood risk. These are discussed below under the headings of future site levels and also flood water storage.

### 7.2 Site Levels

Detailed consideration has been given to the CTFB flood modelling in the WYG Report of November 2020. This models six flood scenarios as follows:

- 5% AEP
- 1% AEP
- 1% AEP + 35% cc uplift
- 1% AEP + 70% cc uplift
- 0.1% AEP
- 1% AEP + 35% cc uplift with culvert blocked

Of these, the last scenario produces the highest anticipated flood levels across the site and these levels are therefore adopted for design purposes in respect of the development floor levels. However, the hydraulic flood gradient follows the existing fall from north to south and therefore a single site-wide floor level is not appropriate or practical and each separate block floor level is considered individually in the table below.

| Block | 1% AEP + 35% | 1% AEP + 70% | 0.1% AEP | 1% AEP + 35% Culvert blocked | FFL   | Freeboard above max flood level (mm) |
|-------|--------------|--------------|----------|------------------------------|-------|--------------------------------------|
| 1     | 65.96        | 65.98        | 66.00    | 66.11                        | 66.41 | 300                                  |
| 2     | n/a          | n/a          | n/a      | n/a                          | 67.10 | n/a                                  |
| 3     | n/a          | 65.94        | 65.95    | 66.04                        | 66.40 | 360                                  |
| 4     | 65.89        | 65.90        | 65.90    | 65.92                        | 66.40 | 480                                  |
| 5     | 65.60        | 65.71        | 65.72    | 65.77                        | 66.07 | 300                                  |
| 6     | 64.42        | 64.51        | 64.52    | 64.59                        | 64.90 | 310                                  |

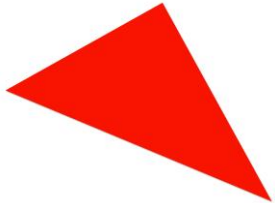
The modelled 1% + 35% cc flood level for the River Irwell at its closest point to the site is 64.60m and therefore all proposed blocks have a minimum freeboard of 300mm above main river flooding.

It is understood that normal EA advice for floor levels is to set them at 600mm above critical flood level. However, this is not practical as floor levels must tie into existing street levels (there are no proposed new streets) and other requirements in respect disability access must be considered. Therefore, a minimum freeboard level of 300mm is considered acceptable in view of the obvious "worst case" flood scenario having been adopted.

### 7.3 On Site Flood Storage

A guiding principle of development within a flood zone is that water should not be displaced off site, worsening flood conditions elsewhere.

Reference should be made to the Flood Map and Mitigation Measures included in Appendix J.



There is no intention to significantly alter site levels in a manner that would create an adverse effect off site. Nevertheless, the construction of the terraced housing block would cause a reduction in on-site volume. Based on critical flood levels there is a calculated volume loss of 142m<sup>3</sup>. This takes into consideration the proposed building areas plus surrounding paths and drives multiplied by the mean depth.

Mitigation is possible and proposed by constructing a shallow swale, 16m wide by 200mm deep directly centred on the existing culvert. This provides compensatory volume of 224m<sup>3</sup>, a gain of 82m<sup>3</sup> (58%) over the existing. This can readily be incorporated into the scheme, involves minimum landscaping and there is ample cover above the culvert to accommodate this small reduction in surface levels. In addition, the location of the swale is of benefit to the existing terraced housing on Pollitt Street and Howard Street, diverting and channelling water away from these properties.

The purpose of this swale would be to accommodate any flood flows during the worst case storm events, in areas where would have no affects on the proposed plots. The proposal would include a perforated land drain below the lowest point to ensure that once the storm passes, the water can soak away into the drainage system to be discharged at the controlled rate.

## 8.0 SURFACE WATER DRAINAGE STRATEGY

8.1 It is the Environment Agency, United Utilities, Building Regulations and the Lead Local Flood Authority policy for all surface water systems for development sites to be designed using Sustainable Drainage Systems (SuDs) wherever possible.

8.2 Rainfall intensities, see profiles in Appendix E, are as indicated in the table below.

|                             | YR 2 | YR 30 | YR 100 | YR 100 + 40% |
|-----------------------------|------|-------|--------|--------------|
| Rainfall Intensity<br>mm/hr | 82.6 | 157.4 | 205.3  | 287.4        |

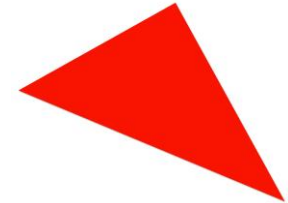
The existing greenfield run-off rates are as follows:

|                            | YR 1 | Q <sub>BAR</sub> | YR 30 | YR 100 |
|----------------------------|------|------------------|-------|--------|
| Peak Run-Off<br>Litres/sec | 2.9  | 3.3              | 5.7   | 6.9    |

Post-development, with an increased impermeable area on site of 1,220m<sup>2</sup>, peak run-off rates are predicted to be as follows:

|                            | YR 1 | YR 30 | YR 100 | YR 100 + 40% CC |
|----------------------------|------|-------|--------|-----------------|
| Peak Run-Off<br>Litres/sec | 28.0 | 53.3  | 69.6   | 97.4            |

NPPG requires that surface water discharge should be restricted as close as possible to equivalent greenfield run-off rates.



### 8.3 Discharge Rates

Greenfield run-off rates are included in Appendix F. These have been calculated using the H R Wallingford greenfield run-off rates calculator, based on the IH124 Approach. The greenfield rate for the 1 in 1yr return is calculated as 2.9 l/s, the 1 in 30yr return as 5.7 l/s & the 1 in 100yr as 6.9 l/s.  $Q_{BAR}$  is calculated as 3.3 l/s. However, as  $Q_{BAR}$  falls below the default minimum of 5 l/s this higher figure is adopted as the maximum permissible site discharge.

### 8.4 Discharge Method

Paragraph 080 of the NPPG: Flood Risk & Coastal Change sets out the following hierarchy of drainage options:

- Into the ground (infiltration)
- To a surface water body
- To a surface water sewer, highway drain or other drainage system
- To a combined sewer

### 8.5 Soakaways

The first consideration for the disposal of surface water is infiltration via soakaways. However, drift geology is believed to be to be Glacial Till (clay), overlying rocks of the Pennine Middle Coal Measures. Further ground intrusive investigations have proved that infiltration will not be possible, therefore contingencies for other methods of surface water disposal should be considered.

### 8.6 Watercourse

There is a suitable watercourse (CTFB) crossing the site. A connection to this watercourse could be explored for the discharge of surface water from this site at a controlled rate to be agreed by the LLFA.

### 8.7 Surface Water Sewer & Combined Sewer

In view of the proximity of the watercourse, discharge to sewers need not be considered further.

### 8.8 Attenuation Storage

As soakaways are unlikely to be feasible, attenuation storage will be required. Attenuation storage estimates are included in Appendix G. In line with current best practice, storage volumes have been assessed for the 1:30yr return (the design criteria as per Sewers for Adoption) and for the exceedance event of 1:100yr + 40% cc allowance. The respective volumes are a maximum of 27m<sup>3</sup> and 63m<sup>3</sup>. These volumes are based on a discharge rate of 5.0 l/s (ie  $Q_{BAR}$ ). The 1:30yr volume would be in underground pipes / tanks & the exceedance (the difference between the two volumes) could also be underground, most likely in a cellular structure. This would be considered at detailed design stage. Furthermore, the attenuation volumes are indicative only and should also be verified at detailed design stage.

A preliminary drainage layout is included in Appendix K.

### 8.9 Sustainable Drainage Systems

Other options considered are as follows:

Detention basins and ponds

These are not considered to be suitable as this is a small dense site with no significant area of available public open space.

## Rainwater Harvesting

The attenuation benefits of rainwater harvesting have been shown to be minimal and can only be realised when the tanks are not full. Similarly, rainwater butts would only provide minor benefits.

## Green Roofs

Green roofs are not identified on preliminary plans. Given the nature of budgeted cost social housing, the significant additional costs involved in installing and maintaining green roofing, plus the additional dead load are not considered to be a practical option. Any benefits would be disproportionate to the likely significant construction and ongoing maintenance costs involved.

## Porous / Permeable Paving

The site includes drives and parking areas that may be suitable for permeable paving. Surface water storage could be provided within sub-base material and this could be considered at detailed design stage, though impermeable underlying ground may be unsuitable to receive infiltration.

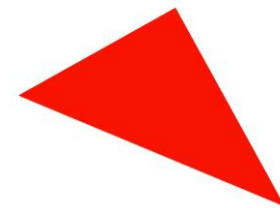
## 9.0 FOUL WATER DRAINAGE STRATEGY

- 9.1 There are existing public sewers in the area owned and maintained by United Utilities. Guidance contained within Sewers for Adoption Edition 7 states that design foul flows should be 4,000 litres per dwelling per 24-hour period. With 27 units on the site, the design foul flow will be  $4,000 \times 27 \div 24 = 3,600$  l/s.
- 9.2 There is a 300mm diameter combined sewer adjacent to the site in Howard Street and this is UU's preferred connection point. However, due to site levels, pumping may be required to achieve connection and therefore other existing sewers may prove more favourable for gravity connection. United Utilities will allow a foul connection to the sewer system at an unrestricted rate. Reference should be made to the UU Consultation Response in Section 12.

## 10.0 FLOOD RISK MANAGEMENT MEASURES

- 10.1 In the event of extreme emergency, the local authority and other emergency services have contingency plans for dealing with consequences of flooding.
- 10.2 Setting finished floor levels of the buildings at the levels indicated and at least 150mm above surrounding external ground, and shedding surface water away from the buildings, will avoid the risk of damage to buildings and contents from overland flood flows around the site.
- 10.3 The design of surface water drainage should ensure that there are no uncontrolled off-site overland flood flows created by the proposed development. Where possible, site surfaces should be modelled so that flood flows generated on site from events beyond the stipulated drainage design criteria will flow to and be contained on site within landscaped or paved areas such that there is no increased risk of flooding to buildings and other vulnerable areas. Such flood flows should not be allowed to flow from the site onto adjoining / adjacent property or highways.
- 10.4 Home owners and landlords will be responsible for the maintenance of private drainage systems on site to ensure satisfactory performance. United Utilities will be responsible for the maintenance of any public sewers on the site.





## **11.0 OFF-SITE IMPACTS**

- 11.1 Proposed on-site drainage will be designed and constructed in accordance with Part H of The Building Regulations, Sewers for Adoption, and any additional requirements of United Utilities, the LLFA and the Environment Agency, as appropriate.
- 11.2 All on-site roofs and pavings are to drain into the design surface water drainage system, thereby ensuring there will be no off-site flood flows generated by the development.
- 11.3 The risk of flood flows entering and leaving the site will remain after development though are considered minimal. Any risk will be further reduced because the drainage designs will be such that there will be no flooding during all rainfall events up to and including the critical 30 year storm, and no overland flows from the critical 100 year storm.
- 11.4 By implementation of the flood procedures and by careful design of the flood protection measures as described above, all residual flood-related risks will be minimised as far as possible after the development has been completed.
- 11.5 Clearly, the existing extreme flood risks to the nearby terraced housing remain, and there is nothing significant that can be done to reduce risk, due to the property levels. However, the measures and recommendations contained in this report do not in any way adversely affect these properties.

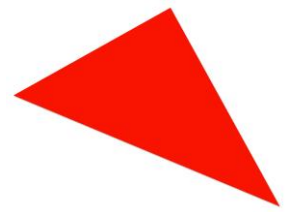
## **12.0 UNITED UTILITIES CONSULTATION RESPONSE**

- 12.1 United Utilities response dated 6<sup>th</sup> April 2021 is attached in Appendix H. In summary it states the following:-
  - 1) Foul water will be allowed to drain into the 300mm public combined sewer network within Howard Street or at any other convenient position.
  - 2) In order to comply with the drainage hierarchy outlined in Building Regulations H3 and National Planning Practice Guidance surface water should be drained via infiltration systems wherever possible. Failing this drainage design should follow the SuDS hierarchy.
- 12.3 United Utilities do not record any instances of flooding in the immediate area.

## **13.0 RESIDUAL RISKS**

- 13.1 This Flood Risk Assessment, prepared in accordance with NPPG and EA Guidelines, demonstrates that the risk of on-site flooding from all sources resulting from the proposed development can be minimised despite the positioning in FZ's 2 and 3.
- 13.2 Nevertheless, risks from further extreme flooding do remain particularly from flood events beyond the level of those that have been modelled. Also, nearby terraced housing remains at risk due to lower levels though flood risk will not be made worse by these proposals.
- 13.3 Furthermore, it is believed that the risk of transferring flooding elsewhere is negligible and site re-profiling and on-site attenuation will reduce this to a level below that which currently exists.
- 13.4 Adoption of the new surface water system by UU should ensure satisfactory functioning and maintenance.
- 13.5 Accordingly, and notwithstanding any other planning issues, it is not considered that the proposed

development has any adverse effects on the current site, or the surrounding area in respect of flooding. Providing the advice contained within the Flood Risk Assessment is implemented, there are no adverse residual risks to either the development or the surrounding area.



#### **14.0 SUMMARY AND CONCLUSIONS**

- 14.1 The proposed re-development of the site involves the construction of 27 new dwellings with parking and drainage infrastructure.
- 14.2 The site has been acquired by Homes England and is designated for affordable housing. Outline Planning Permission has already been granted by Bury Council.
- 14.3 The site sits within FZ's 1, 2 and 3, with the primary risk of flooding coming from overtopping of the existing culvert running beneath the site.
- 14.4 The site has been subject to significant recent flood modelling of a variety of flood scenarios, enabling the critical flood levels to be identified. These vary throughout the site due to a topographical fall from north to south.
- 14.5 This report demonstrates that the site can be safely developed and in such a way as to minimise risk to future property and residents whilst also creating no greater risk to property immediately off site.
- 14.6 Specifically, property levels will be set above critical flood levels and additional flood storage will be provided in excess of any loss.
- 14.7 New surface water drainage will be designed to discharge at the current greenfield run-off rate.

#### **15.0 RECOMMENDATIONS**

- 15.1 Submit this Flood Risk Assessment and Drainage Strategy to the Planning Authority in support of the Planning Application.
- 15.2 In due course, as infiltration is now proved not possible due to poor ground conditions, consult the LLFA to request a discharge point and rate to the existing culverted watercourse on site.
- 15.3 If attenuation is to be provided, check the attenuation volumes included in this report when undertaking the detailed drainage design.
- 15.4 Offer the new drainage systems to UU for adoption under a Section 104 Agreement.

**SIGNED (electronically)**

*A Mulligan*

**A Mulligan BEng**

**CARLEY DAINES AND PARTNERS LTD**

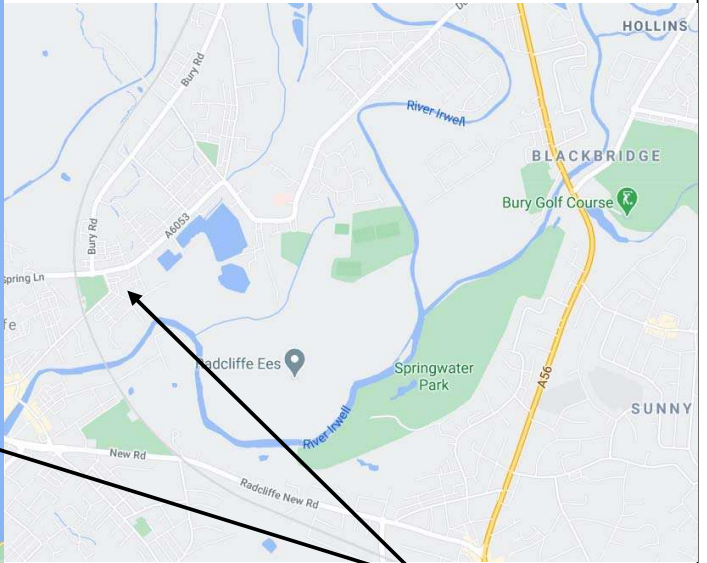
**AUTHORISED (electronically)**

*C R Carley*

**C R Carley JP MSc CEng MICE (Consultant)**

**CARLEY DAINES AND PARTNERS LTD**

## **APPENDIX A – LOCATION AND SITE PLAN**



**SITE  
LOCATION**



Site Centre:  
 OS X (Easting) 379021  
 OS Y (Northings) 407407

|                                                                                                                                                                                                                                                                                                                                                            |                            |                                                                                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|--------------------------------------------------------------------------------------|
|  <p>Next Generation Engineering Consultancy Services</p> <p>Tel: 0161 904 0187<br/>         E-mail: <a href="mailto:admin@nxconsulting.org.uk">admin@nxconsulting.org.uk</a><br/>         Web: <a href="http://www.nxconsulting.org.uk">www.nxconsulting.org.uk</a></p> | <p>Ref: NX418 Figure 1</p> | <p>Project:</p> <p>East Lancs Paper Mill</p> <p>Title:</p> <p>Site Location Plan</p> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|--------------------------------------------------------------------------------------|

## **APPENDIX B – UNITED UTILITIES SEWER RECORDS**

**White Young Green**

**Arndale Court  
Headingley  
Leeds  
LS6 2UJ**

**FAO: Tom Beavis**

Dear Sirs

**Location: THE E LANCS PAPER MILL CO CHURCH ST. EAST RADCLIFFE MANCHESTER M26  
2PG**

I acknowledge with thanks your request dated 02/12/16 for information on the location of our services.

Please find enclosed plans showing the approximate position of our apparatus known to be in the vicinity of this site.

The enclosed plans are being provided to you subject to the United Utilities terms and conditions for both the wastewater and water distribution plans which are shown attached.

If you are planning works anywhere in the North West, please read our access statement before you start work to check how it will affect our network.

<http://www.unitedutilities.com/work-near-asset.aspx>.

I trust the above meets with your requirements and look forward to hearing from you should you need anything further.

If you have any queries regarding this matter please telephone us on 0370 7510101.

Yours Faithfully,



Amanda Simmonds  
Property Searches Manager

**United Utilities Water Limited**  
Property Searches  
Ground Floor Grasmere House  
Lingley Mere Business Park  
Great Sankey  
Warrington  
WA5 3LP  
DX 715568 Warrington  
Telephone 0370 751 0101

[Property.searches@uuplc.co.uk](mailto:Property.searches@uuplc.co.uk)

Your Ref: A090070-193  
Our Ref: 16/ 1254069  
Date: 5/12/2016



### **TERMS AND CONDITIONS - WASTERWATER & WATER DISTRIBUTION PLANS**

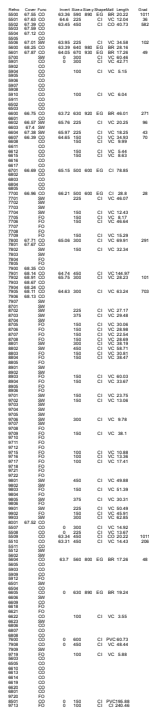
These provisions apply to the public sewerage, water distribution and telemetry systems (including sewers which are the subject of an agreement under Section 104 of the Water Industry Act 1991 and mains installed in accordance with the agreement for the self-construction of water mains) (UUWL apparatus) of United Utilities Water Limited "(UUWL)".

#### **TERMS AND CONDITIONS:**

1. This Map and any information supplied with it is issued subject to the provisions contained below, to the exclusion of all others and no party relies upon any representation, warranty, collateral contract or other assurance of any person (whether party to this agreement or not) that is not set out in this agreement or the documents referred to in it.
2. This Map and any information supplied with it is provided for general guidance only and no representation, undertaking or warranty as to its accuracy, completeness or being up to date is given or implied.
3. In particular, the position and depth of any UUWL apparatus shown on the Map are approximate only and given in accordance with the best information available. The nature of the relevant system and/or its actual position may be different from that shown on the plan and UUWL is not liable for any damage caused by incorrect information provided save as stated in section 199 of the Water Industry Act 1991. UUWL strongly recommends that a comprehensive survey is undertaken in addition to reviewing this Map to determine and ensure the precise location of any UUWL apparatus. The exact location, positions and depths should be obtained by excavation trial holes.
4. The location and position of private drains, private sewers and service pipes to properties are not normally shown on this Map but their presence must be anticipated and accounted for and you are strongly advised to carry out your own further enquiries and investigations in order to locate the same.
5. The position and depth of UUWL apparatus is subject to change and therefore this Map is issued subject to any removal or change in location of the same. The onus is entirely upon you to confirm whether any changes to the Map have been made subsequent to issue and prior to any works being carried out.
6. This Map and any information shown on it or provided with it must not be relied upon in the event of any development, construction or other works (including but not limited to any excavations) in the vicinity of UUWL apparatus or for the purpose of determining the suitability of a point of connection to the sewerage or other distribution systems.
7. No person or legal entity, including any company shall be relieved from any liability howsoever and whensoever arising for any damage caused to UUWL apparatus by reason of the actual position and/or depths of UUWL apparatus being different from those shown on the Map and any information supplied with it.
8. If any provision contained herein is or becomes legally invalid or unenforceable, it will be taken to be severed from the remaining provisions which shall be unaffected and continue in full force and affect.
9. This agreement shall be governed by English law and all parties submit to the exclusive jurisdiction of the English courts, save that nothing will prevent UUWL from bringing proceedings in any other competent jurisdiction, whether concurrently or otherwise.







Scale: 1:1250      Date: 05/12/2016

Printed By: Property Searches

|                         |                             |               |                  |
|-------------------------|-----------------------------|---------------|------------------|
| <b>MANHOLE FUNCTION</b> |                             | <b>LEGEND</b> |                  |
| PS                      | Pipe                        |               |                  |
| SW                      | Surface Water               |               |                  |
| CO                      | Concrete                    |               |                  |
| OW                      | Overflow                    |               |                  |
| <b>SEWER SHAPE</b>      |                             |               |                  |
| CO                      | Circular                    | TR            | Triangular       |
| EG                      | egg                         | AR            | Arch             |
| OV                      | Oval                        | BA            | Barrel           |
| FT                      | Flat Top                    | HO            | Horseshoe        |
| RE                      | Rectangle                   |               |                  |
| UN                      | Unknow                      | UN            | Unspecified      |
| <b>SEWER MATERIAL</b>   |                             |               |                  |
| AC                      | Asphalt Cement              | DS            | Ductile Iron     |
| BR                      | Brick                       | PG            | Precast Concrete |
| PE                      | Polyethylene                | CS            | Cast Iron        |
| RP                      | Reinforced Plastic Material | CC            | Concrete         |
| CO                      | Concrete                    | ST            | Steel            |
| CSB                     | Concrete Segment Block      | VC            | Vertical Clay    |
| CO                      | Concrete Segment Unobscured | PP            | Polypropylene    |
| CO                      | Concrete Segment Unobscured | PF            | Polypropylene    |
| PC                      | Plastic/Steel Composite     | MC            | Masonry Concrete |
| PSC                     | Plastic/Steel Composite     | MR            | Masonry Curbed   |
| GC                      | Glass Reinforced Concrete   |               |                  |



**United Utilities**  
helping life flow smoothly

**SEWER RECORDS**

## SEWER RECORDS

[illegible][illegible]

[illegible]



OS Sheet No: SD7907SE  
Scale: 1:1250 Date: 05/12/2016  
7 Nodes  
Sheet 1 of 1

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 **United Utilities**  
helping life flow smoothly

**SEWER RECORDS**



WASTE WATER SYMBOLOGY

| Combined | Foul | Surface | Overflow |                        |
|----------|------|---------|----------|------------------------|
|          |      |         |          | Manhole                |
|          |      |         |          | Manhole, side entry    |
|          |      |         |          | Public sewer           |
|          |      |         |          | Private sewer          |
|          |      |         |          | S104 sewer             |
|          |      |         |          | Rising Main, public    |
|          |      |         |          | Rising Main, private   |
|          |      |         |          | Rising main, S104      |
|          |      |         |          | Highway Drain, private |
|          |      |         |          | WW Pumping Station     |
|          |      |         |          | Inspection Chamber     |
|          |      |         |          | Extent of Survey       |
|          |      |         |          | Head of System         |
|          |      |         |          | Soakaway               |
|          |      |         |          | Rodding Eye            |
|          |      |         |          | Lamp Hole              |
|          |      |         |          | T Junction/Saddle      |
|          |      |         |          | Gully                  |
|          |      |         |          | Air Valve              |
|          |      |         |          | Non Return Valve       |
|          |      |         |          | Sewer Overflow         |
|          |      |         |          | Cascade                |
|          |      |         |          | Flow Meter             |
|          |      |         |          | Hatch Box              |
|          |      |         |          | Hydrobrake             |
|          |      |         |          | Inlet                  |
|          |      |         |          | Bifurcation            |
|          |      |         |          | Catchpit               |
|          |      |         |          | Oil Interceptor        |
|          |      |         |          | Penstock               |
|          |      |         |          | Summit                 |
|          |      |         |          | Valve                  |
|          |      |         |          | Valve chamber          |
|          |      |         |          | Washout Chamber        |
|          |      |         |          | Drop Shaft             |
|          |      |         |          | WW Treatment Works     |
|          |      |         |          | Septic Tank            |
|          |      |         |          | Vent Column            |
|          |      |         |          | Network Storage Tank   |
|          |      |         |          | Orifice Plate          |
|          |      |         |          | Vortex Chamber         |
|          |      |         |          | Penstock Chamber       |
|          |      |         |          | Screen Chamber         |
|          |      |         |          | Discharge Point        |
|          |      |         |          | Outfall                |

MANHOLE FUNCTION

|    |               |
|----|---------------|
| FO | Foul          |
| SW | Surface Water |
| CO | Combined      |
| OV | Overflow      |

SEWER SHAPE

|    |             |    |             |
|----|-------------|----|-------------|
| CI | Circular    | SQ | Square      |
| EG | Egg         | TR | Trapezoidal |
| OV | Oval        | AR | Arch        |
| FT | Flat Top    | BA | Barrel      |
| RE | Rectangular | HO | Horse Shoe  |
|    |             | U  | Unspecified |

SEWER MATERIAL

|     |                        |    |                    |
|-----|------------------------|----|--------------------|
| AC  | Asbestos Cement        | DI | Ductile Iron       |
| BR  | Brick                  | VC | Vitrified Clay     |
| CO  | Concrete               | PP | Polypropylene      |
| CSB | Concrete Segment       | PF | Pitched Fibre      |
| CSU | Concrete Segment       | MA | Masonary, Coursed  |
| CC  | Concrete Box Culverted | MA | Masonary, Random   |
| PSC | Plastic                | RP | Reinforced Plastic |
| GR  | Glass Reinforced       | CI | Cast Iron          |
| GRP | Glass Reinforced       | SI | Spun Iron          |
| PVC | Polyvinyl Chloride     | ST | Steel              |
| PE  | Polyethylene           | U  | Unspecified        |



Control Kiosk



Sludge Main

ABANDONED PIPE

|  |               |
|--|---------------|
|  | Public Sewer  |
|  | Rising Main   |
|  | Private Sewer |
|  | Sludge Main   |

Cleanwater Symbology

Pipework

| Live | Proposed |                                                    |
|------|----------|----------------------------------------------------|
|      |          | Distribution Main - Pressurised Main               |
|      |          | LDTM Treated Water Distribution - Pressurised main |
|      |          | LDTM Treated Water Distribution - Gravity main     |
|      |          | Trunk Main - Pressurised main                      |
|      |          | Raw Water Aqueduct - Pressurised Main              |
|      |          | Raw Water Aqueduct - Gravity Main                  |
|      |          | LDTM Raw Water Distribution - Pressurised main     |
|      |          | LDTM Raw Water Distribution - Gravity main         |
|      |          | Private Pipe                                       |
|      |          | Comms Pipe                                         |
|      |          | Concessionary Service                              |

Abandoned

|  |                                 |
|--|---------------------------------|
|  | LDTM Treated Water Distribution |
|  | Trunk Main                      |
|  | Raw Water Aqueduct              |
|  | LDTM Raw Water Distribution     |
|  | Distribution main               |
|  | Private Pipe                    |
|  | Comms Pipe                      |
|  | Concessionary Service           |

Property Types

| Live | Proposed |                       |
|------|----------|-----------------------|
|      |          | Condition Report      |
|      |          | Pumping Station       |
|      |          | Water Treatment Works |
|      |          | Valve House           |
|      |          | Water Tower           |
|      |          | Service Reservoir     |
|      |          | Supply Reservoir      |
|      |          | Pipe Bridges          |

Nodes

| Live | Proposed |                           |
|------|----------|---------------------------|
|      |          | End Cap                   |
|      |          | CC Valve open             |
|      |          | CC Valve closed           |
|      |          | AC Valve open             |
|      |          | AC Valve closed           |
|      |          | Air Valve                 |
|      |          | Sluice Valve              |
|      |          | Non Return Valve          |
|      |          | Pressure Management Valve |
|      |          | Change of Characteristics |
|      |          | Anode                     |
|      |          | Chlorination Point        |
|      |          | De Chlorination Point     |
|      |          | Bore Hole                 |
|      |          | Inlet Point               |
|      |          | Bulk Supply Point         |
|      |          | Fire Hydrant              |
|      |          | Hydrant                   |
|      |          | Pump                      |
|      |          | Site Termination          |
|      |          | Service Start             |
|      |          | Service End               |
|      |          | Commercial Meter          |
|      |          | Domestic Meter            |
|      |          | Strainer Point            |
|      |          | Access Point              |
|      |          | Hatch Box                 |
|      |          | IP Point                  |
|      |          | Sampling Station          |
|      |          | Logger Box                |
|      |          | Stop Tap                  |

| Matertial Types |                 | Lining Types |                |
|-----------------|-----------------|--------------|----------------|
| AC              | Asbestos Cement | CL           | Cement Lining  |
| CI              | Cast Iron       | TB           | Tar or Bitumen |
| CU              | Copper          | ERL          | Epoxy Resin    |
| CO              | Concrete        |              |                |
| DI              | Ductile Iron    |              |                |
| GI              | Galvanised Iron |              |                |
| GR              | Grey Iron       |              |                |
| OT              | Others          |              |                |
| PB              | Lead            |              |                |
| PV              | uPVC            |              |                |
| SI              | Spun Iron       |              |                |
| ST              | Steel           |              |                |
| UN              | Unknown         |              |                |
| PE              | Ployethelene    |              |                |

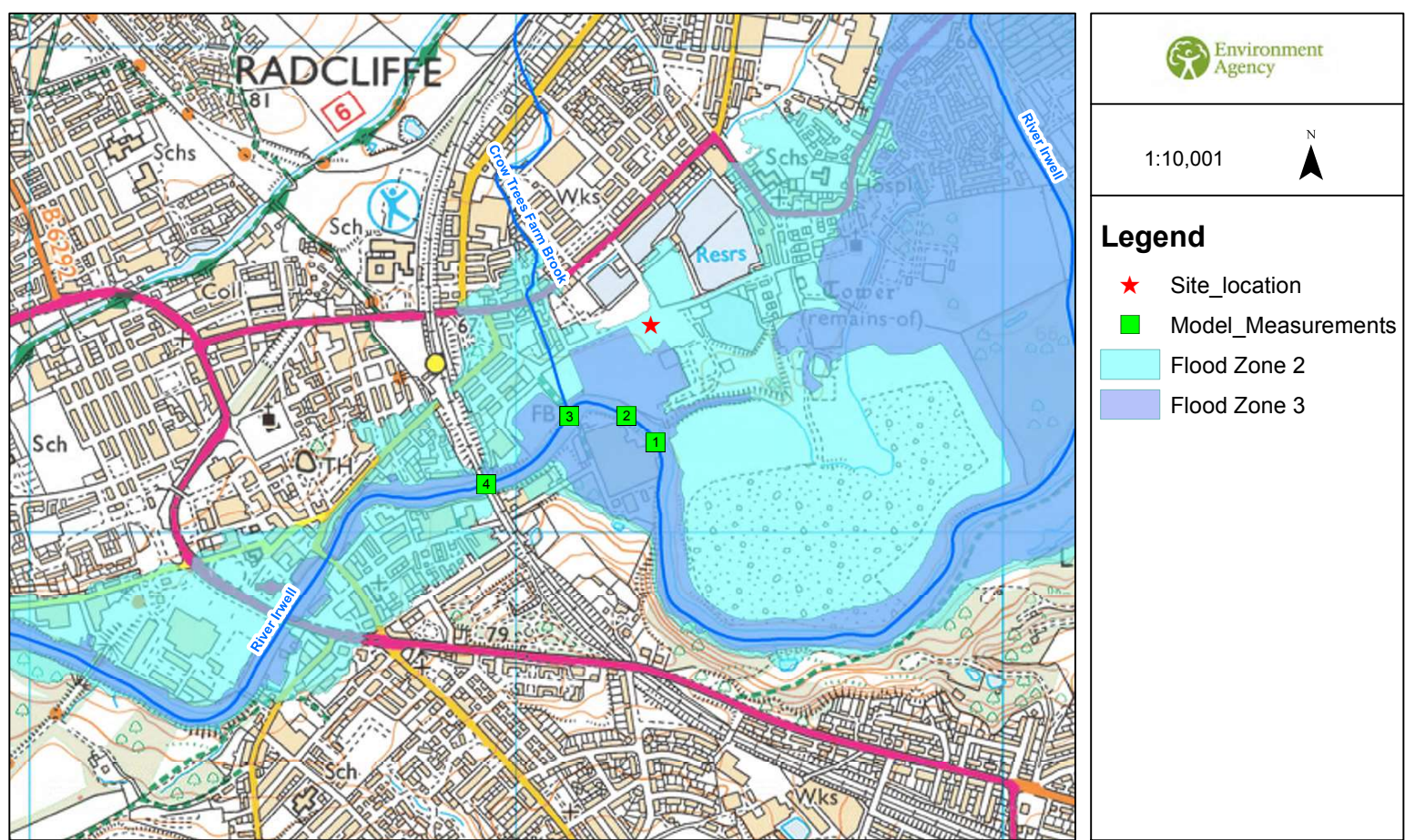
| Insertion Types |                      |
|-----------------|----------------------|
| DD              | Die Drawn            |
| DR              | Directional Drilling |
| MO              | Moling               |
| PI              | Pipeline             |
| SL              | Slip Lined           |





## **Appendix D - EA Product 4**

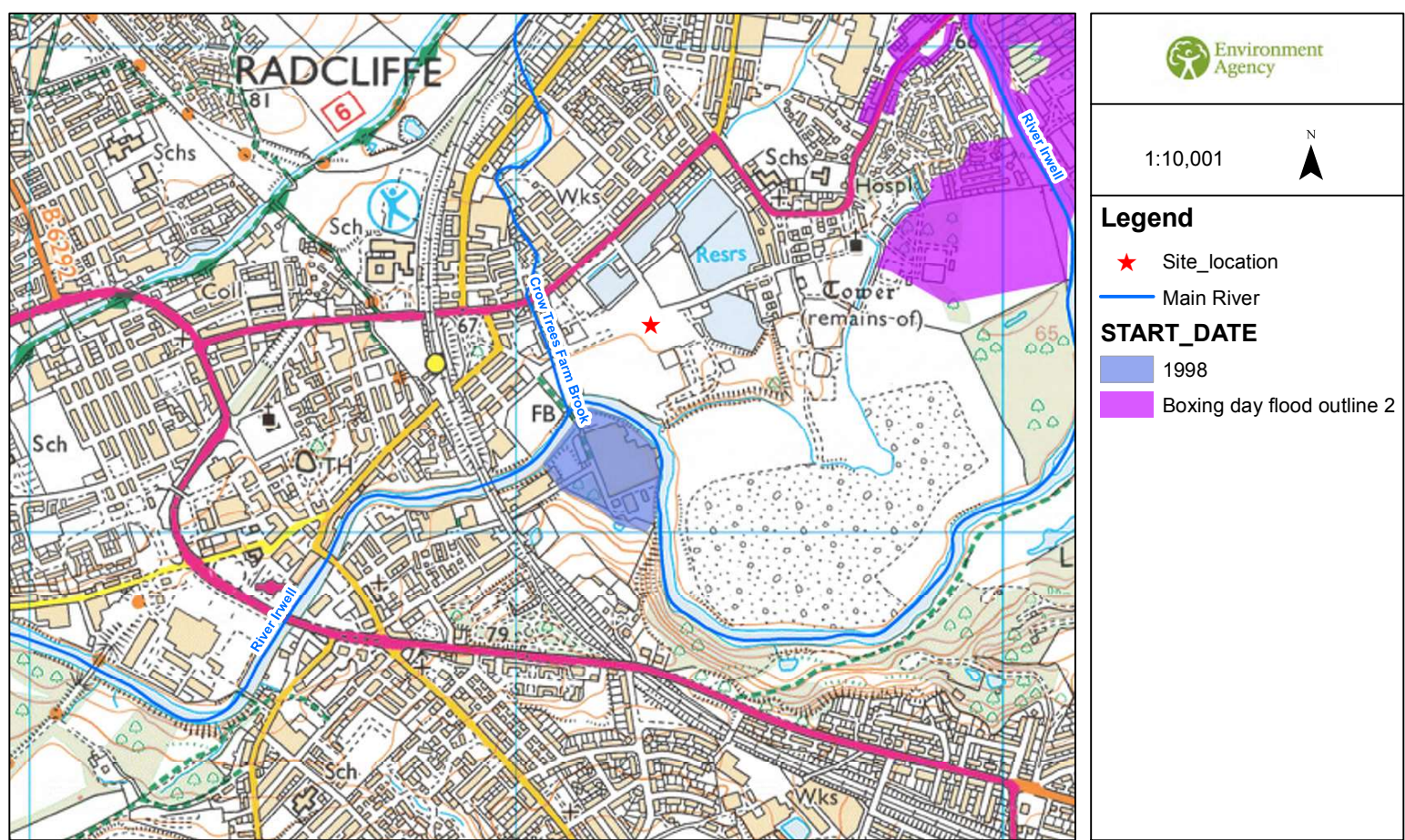
Detailed Flood Map centred on East Lancs Paper Mill, Bury M26 2PS. Created 19/10/2016 [GMMC26337AB]



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**Contact Us:** National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 08708 506 506 (Mon-Fri 8-6). Email: [enquiries@environment-agency.gov.uk](mailto:enquiries@environment-agency.gov.uk)



Historic Flood Map centred on East Lancs Paper Mill, Bury M26 2PS. Created 19/10/2016 [GMMC26337AB]



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| Map Reference | Model Node Reference     | Easting | Northing | Data                          | Undefended              |                            | Defended                |                            |
|---------------|--------------------------|---------|----------|-------------------------------|-------------------------|----------------------------|-------------------------|----------------------------|
|               |                          |         |          |                               | 1 % AEP (1 in 100 year) | 0.1 % AEP (1 in 1000 year) | 1 % AEP (1 in 100 year) | 0.1 % AEP (1 in 1000 year) |
| 1             | ea013_Model_IRWE04_0232  | 379288  | 407186   | Modelled Water Level (m aodN) | 63.56                   | 65.16                      | 63.59                   | 65.04                      |
|               |                          |         |          | Modelled Flow (cumecs)        | 419.17                  | 561.68                     | 421.62                  | 566.26                     |
| 2             | ea013_Model_IRWE04_0146  | 379228  | 407240   | Modelled Water Level (m aodN) | 63.39                   | 65.11                      | 63.42                   | 64.97                      |
|               |                          |         |          | Modelled Flow (cumecs)        | 421.43                  | 545.57                     | 424.36                  | 552.31                     |
| 3             | ea013_Model_IRWE04_0000u | 379111  | 407239   | Modelled Water Level (m aodN) | 63.36                   | 65.16                      | 63.41                   | 65.04                      |
|               |                          |         |          | Modelled Flow (cumecs)        | 406.04                  | 449.25                     | 405.93                  | 435.98                     |
| 4             | ea013_Model_IRWE03_5797  | 378940  | 407099   | Modelled Water Level (m aodN) | 62.96                   | 64.52                      | 63.00                   | 64.41                      |
|               |                          |         |          | Modelled Flow (cumecs)        | 444.06                  | 623.15                     | 448.29                  | 615.32                     |

Model data taken from Radcliffe and Redvales 2016 Study (Draft Levels)

Notes:  
AEP - Annual Exceedence Probability  
m aodN - metres above ordnance datum Newlyn  
cumecs - cubic metres per second

| Historc Flooding    |            |            |                    |                                                |
|---------------------|------------|------------|--------------------|------------------------------------------------|
| Flood Event Code    | Start Date | End Date   | Source of Flooding | Cause of Flooding                              |
| FEB01173            | 23/10/1998 | 24/10/1998 | main river         | obstruction/blockage - channel                 |
| Boxing Day Flooding | 26/12/2015 | 26/12/2015 | main river         | channel capacity exceeded (no raised defences) |

## **APPENDIX C – PROPOSED SITE PLAN**



NOTES

- All dimensions and levels are to be checked on site.
  - Any discrepancies are to be reported to the architect before any work commences
  - This drawing shall not be scaled to ascertain any dimensions. Work to figured dimensions only.
  - This drawing shall not be reproduced without express written permission from AEW.
  - Title overlay drawings and ownership boundaries are produced using all reasonable endeavors. AEW cannot be responsible for the accuracy or scale discrepancy of base plans supplied to them.
  - All works are to be undertaken in accordance with Building Regulations and the latest British Standards.
  - All proprietary materials and products are to be used strictly in accordance with the manufacturers recommendations.
- This drawing contains the following model files: -  
12216-AEW-XX-XX-M3-A-0001

CDM 2015

Client notified of duties: Jan 2021  
Principal Designer: CPC  
Unless noted below, all known hazards have been highlighted on the drawing:

Accommodation Schedule

- 17 1 Bed Apartments (45.0-46.0m²)  
3 2 Bed Apartments (57.15m²)

20 Apartments

House Schedule

- 5 3 Bed House (91.1m²) Plots 2 - 6  
2 4 Bed House (101.0m²) Plots 1 & 7

7 Houses

27 Total Units

Key

- Site Boundary  
Culvert  
Culvert Easement Zone  
Water Main  
Public Sewer  
Substation

Dotted, future Third Party  
realligned road

CUNLIFFE STREET & BAYBUTT  
STREET TO BE OFFERED FOR  
ADOPTION

| P01 | Date 22 | Issued for SE co-ordination | DS       | CS         |
|-----|---------|-----------------------------|----------|------------|
| Rev | Date    | Description                 | Drawn By | Checked By |

|        |                  |
|--------|------------------|
| Status | Purpose of Issue |
| S2     | Co-ordination    |

drawing stage Stage 2

client Great Places Housing Group

project Radcliffe, ELPm Island Site

drawing title Proposed Site Plan - Co-ordination

date 11/02/21 drawn DS  
scale@ A1 As indicated checked BR

Rev P01

12216-AEW-A-0007

aew architects  
0161 214 4370  
www.aewarchitects.com

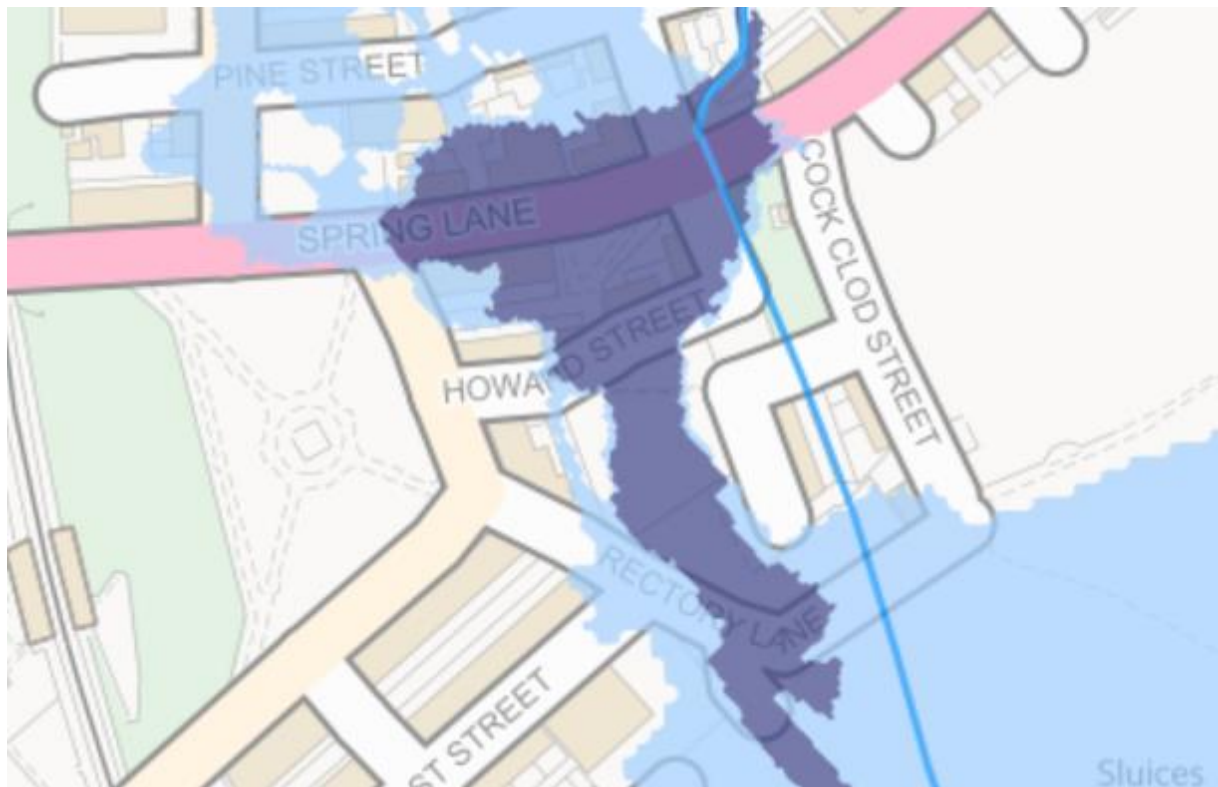


## **APPENDIX D – ENVIRONMENT AGENCY FLOOD MAP**



## EAST LANCS PAPER MILL

### ENVIRONMENT AGENCY FLOOD MAP



## **APPENDIX E – RAINFALL INTENSITIES**

|                                                       |                                    |                                                                                     |
|-------------------------------------------------------|------------------------------------|-------------------------------------------------------------------------------------|
| Carley Daines and Partners Limited                    |                                    | Page 1                                                                              |
| 11 Bridgewater Road<br>Worsley<br>Manchester, M28 3JE | East Lancs Paper Mill<br>Radcliffe |  |
| Date 08/04/2021                                       | Designed by CRC                    |                                                                                     |
| File                                                  | Checked by AM                      |                                                                                     |
| Innovyze                                              | Network 2020.1                     |                                                                                     |

### Rainfall profile

Storm duration (mins) 30

FSR Data

Region England and Wales

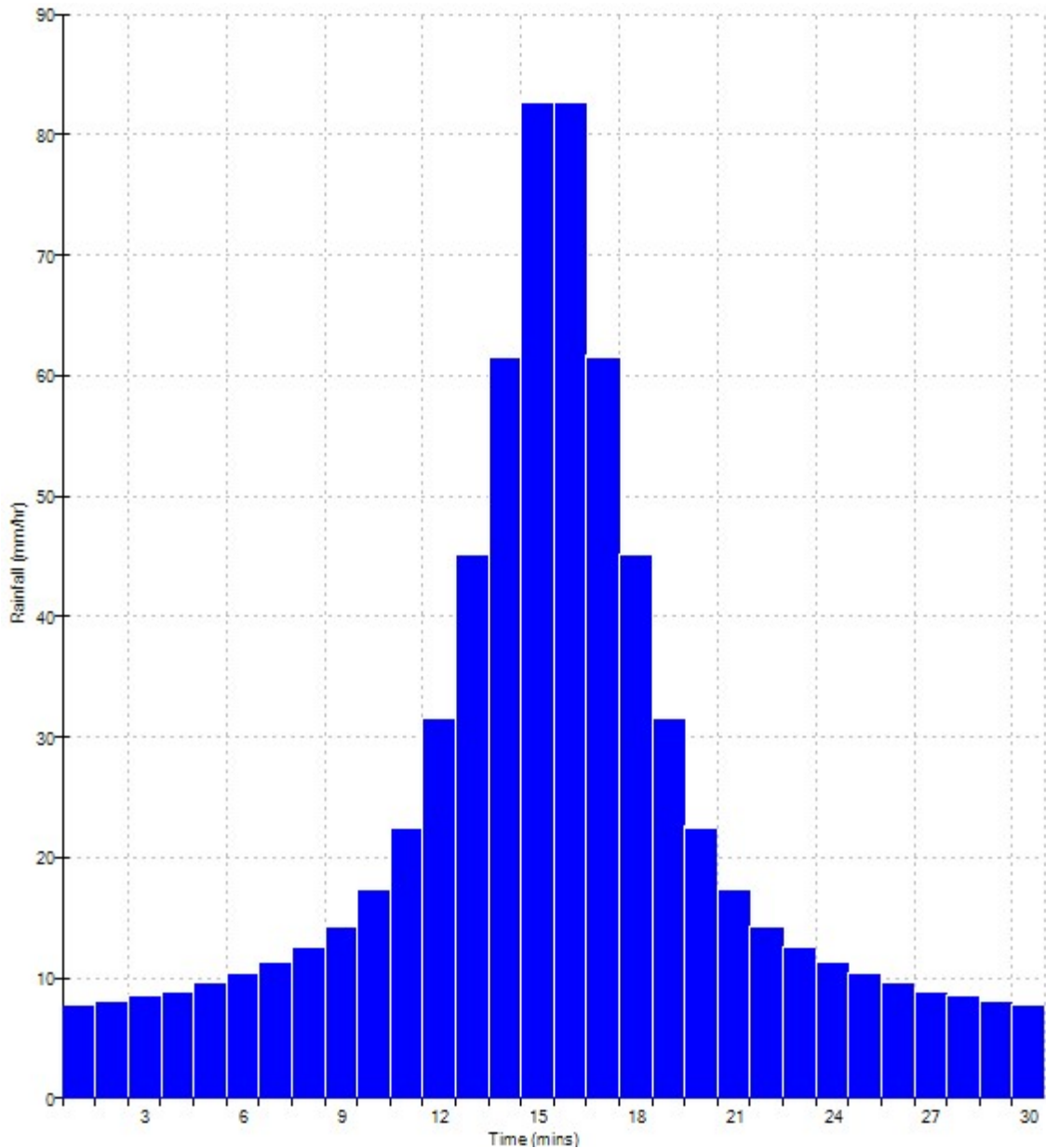
M5-60 (mm) 19.000

Ratio R 0.297

Peak Intensity (mm/hr) 82.639

Ave. Intensity (mm/hr) 23.384

Return Period (years) 2.0

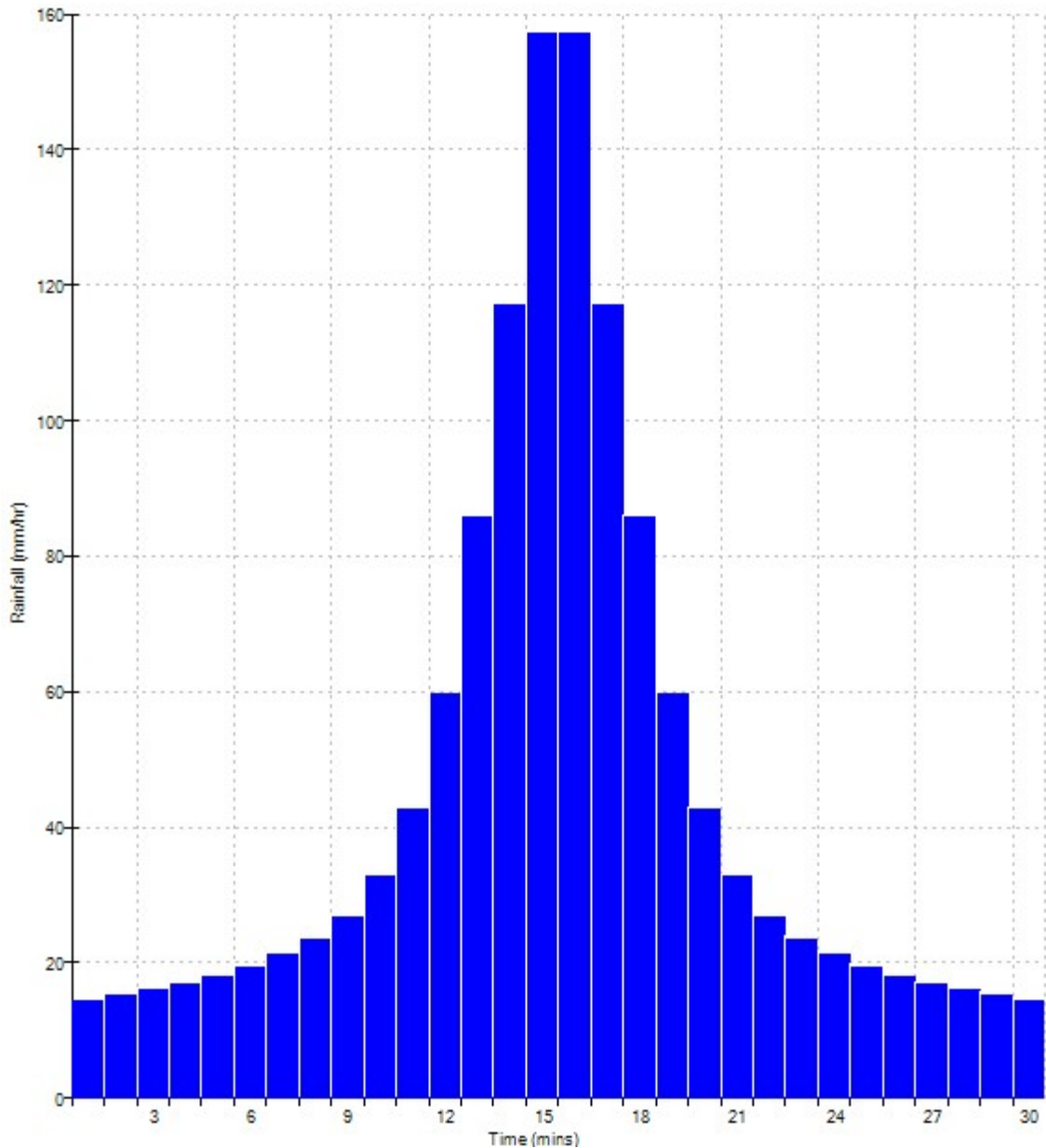


|                                                       |                                    |                                                                                     |
|-------------------------------------------------------|------------------------------------|-------------------------------------------------------------------------------------|
| Carley Daines and Partners Limited                    |                                    | Page 1                                                                              |
| 11 Bridgewater Road<br>Worsley<br>Manchester, M28 3JE | East Lancs Paper Mill<br>Radcliffe |  |
| Date 08/04/2021                                       | Designed by CRC                    |                                                                                     |
| File                                                  | Checked by AM                      |                                                                                     |
| Innovyze                                              | Network 2020.1                     |                                                                                     |

### Rainfall profile

Storm duration (mins) 30

FSR Data  
Region England and Wales  
M5-60 (mm) 19.000  
Ratio R 0.297  
Peak Intensity (mm/hr) 157.376  
Ave. Intensity (mm/hr) 44.532  
Return Period (years) 30.0

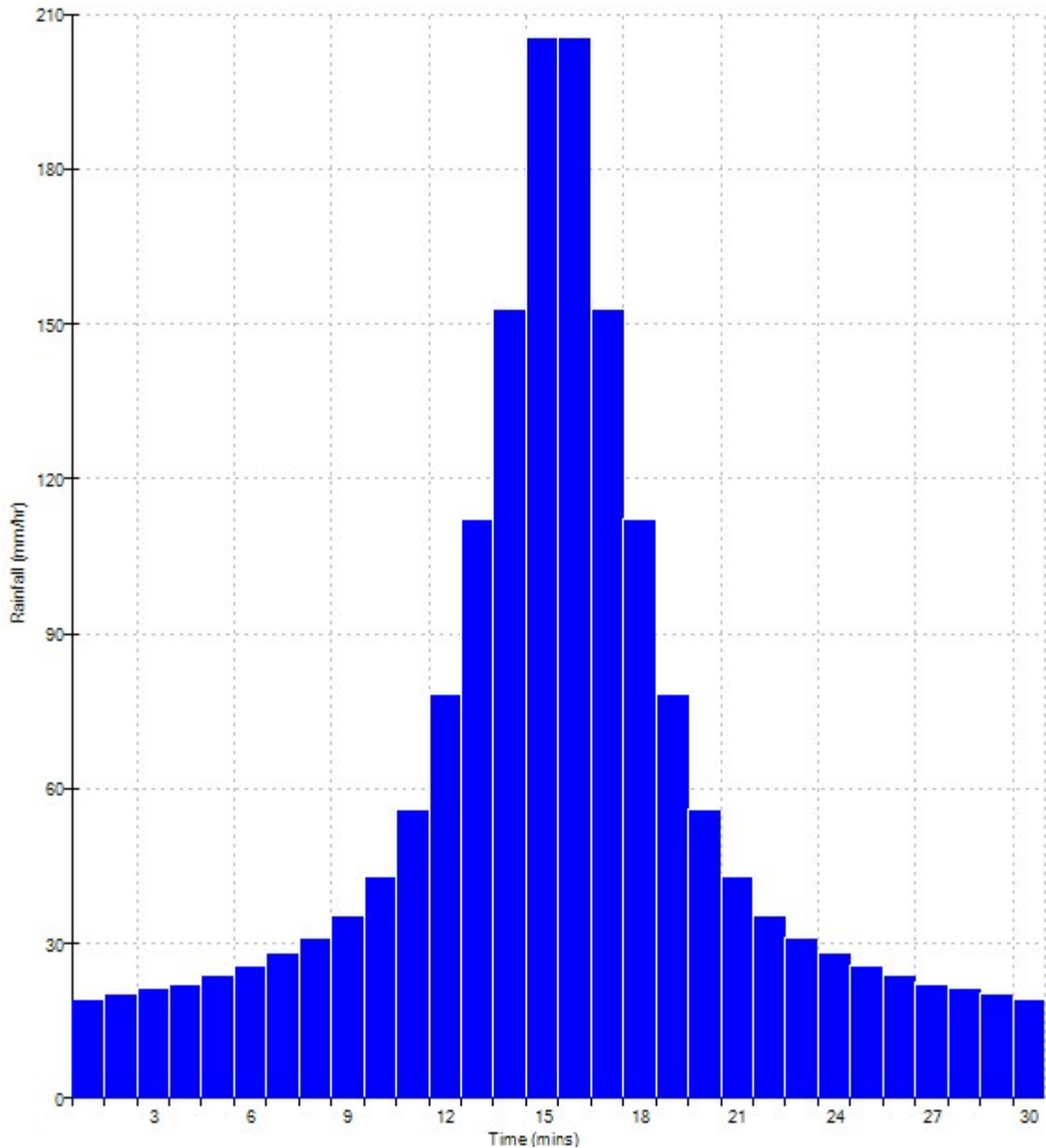


|                                                       |                                    |                                                                                     |
|-------------------------------------------------------|------------------------------------|-------------------------------------------------------------------------------------|
| Carley Daines and Partners Limited                    |                                    | Page 1                                                                              |
| 11 Bridgewater Road<br>Worsley<br>Manchester, M28 3JE | East Lancs Paper Mill<br>Radcliffe |  |
| Date 08/04/2021                                       | Designed by CRC                    |                                                                                     |
| File                                                  | Checked by AM                      |                                                                                     |
| Innovyze                                              | Network 2020.1                     |                                                                                     |

### Rainfall profile

Storm duration (mins) 30

FSR Data  
Region England and Wales  
M5-60 (mm) 19.000  
Ratio R 0.297  
Peak Intensity (mm/hr) 205.340  
Ave. Intensity (mm/hr) 58.104  
Return Period (years) 100.0





## **APPENDIX F – GREENFIELD RUN -OFF ESTIMATION**

|                |                       |
|----------------|-----------------------|
| Calculated by: | Chris Carley          |
| Site name:     | East Lancs Paper Mill |
| Site location: | Radcliffe             |

This is an estimation of the greenfield runoff rates that are used 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). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

## Site Details

|            |                   |
|------------|-------------------|
| Latitude:  | 53.56332° N       |
| Longitude: | 2.31792° W        |
| Reference: | 1392427352        |
| Date:      | Apr 08 2021 09:15 |

## Runoff estimation approach

IH124

## Site characteristics

|                       |      |
|-----------------------|------|
| Total site area (ha): | 0.44 |
|-----------------------|------|

## Methodology

|                                     |                             |
|-------------------------------------|-----------------------------|
| Q <sub>BAR</sub> estimation method: | Calculate from SPR and SAAR |
| SPR estimation method:              | Calculate from SOIL type    |

## Soil characteristics

|              | Default | Edited |
|--------------|---------|--------|
| SOIL type:   | 4       | 4      |
| HOST class:  | N/A     | N/A    |
| SPR/SPRHOST: | 0.47    | 0.47   |

## Hydrological characteristics

|                                | Default | Edited |
|--------------------------------|---------|--------|
| SAAR (mm):                     | 1028    | 1028   |
| Hydrological region:           | 10      | 10     |
| Growth curve factor 1 year:    | 0.87    | 0.87   |
| Growth curve factor 30 years:  | 1.7     | 1.7    |
| Growth curve factor 100 years: | 2.08    | 2.08   |
| Growth curve factor 200 years: | 2.37    | 2.37   |

## Notes

### (1) Is Q<sub>BAR</sub> < 2.0 l/s/ha?

When Q<sub>BAR</sub> is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

### (2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

### (3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

## Greenfield runoff rates

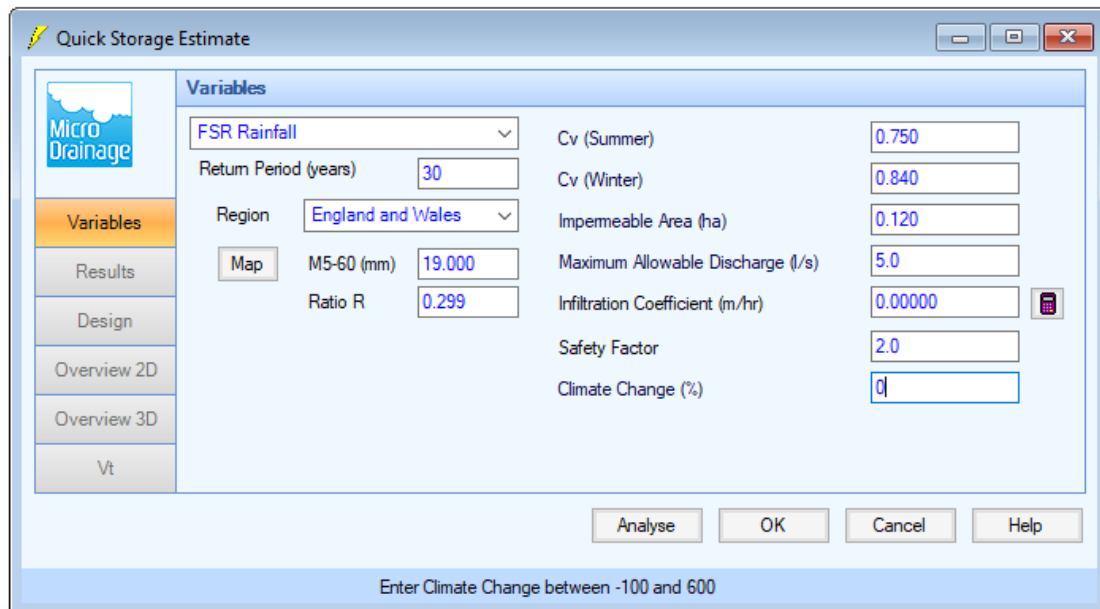
|                         | Default | Edited |
|-------------------------|---------|--------|
| Q <sub>BAR</sub> (l/s): | 3.33    | 3.33   |
| 1 in 1 year (l/s):      | 2.9     | 2.9    |
| 1 in 30 years (l/s):    | 5.66    | 5.66   |
| 1 in 100 years (l/s):   | 6.93    | 6.93   |
| 1 in 200 years (l/s):   | 7.89    | 7.89   |

This report was produced using the greenfield runoff tool developed by HR Wallingford and available at [www.uksuds.com](http://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 [www.uksuds.com/terms-and-conditions.htm](http://www.uksuds.com/terms-and-conditions.htm). The outputs from this tool are estimates of greenfield runoff rates. 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 this data in the design or operational characteristics of any drainage scheme.

## **APPENDIX G – PRELIMINARY STORAGE VOLUME ESTIMATE**

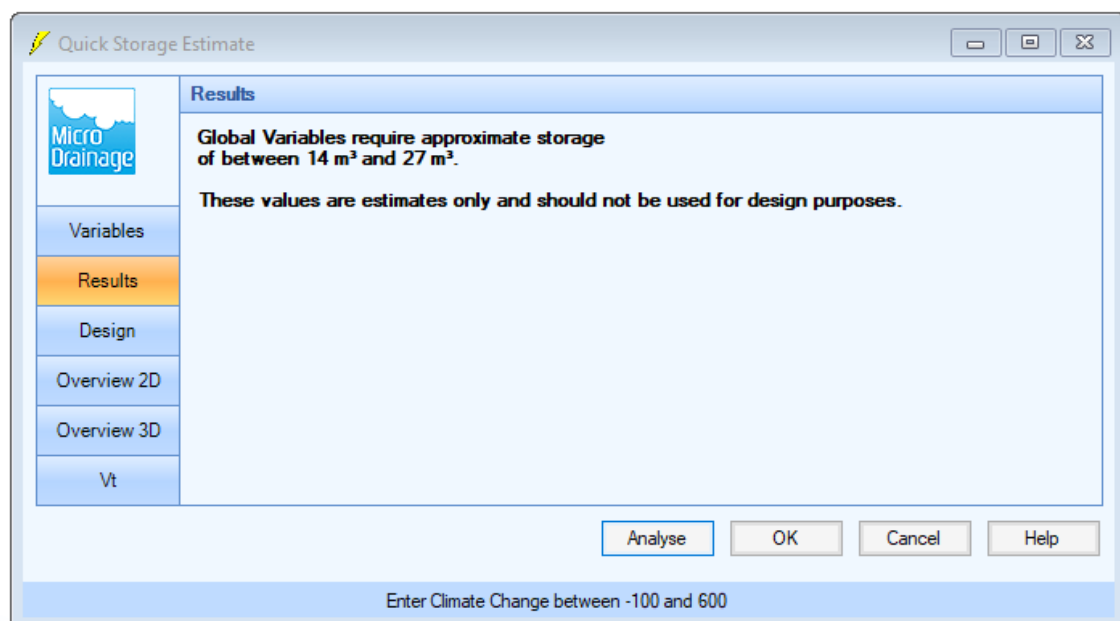
## EAST LANCS PAPER MILL – PRELIMINARY STORAGE ESTIMATE.

1 IN 30 YEAR STORM – UP TO 27M<sup>3</sup> REQUIRED.



The screenshot shows the 'Quick Storage Estimate' window with the 'Variables' tab selected. The left sidebar contains buttons for 'Variables', 'Results', 'Design', 'Overview 2D', 'Overview 3D', and 'Vt'. The main area is divided into two columns of input fields. The left column includes 'FSR Rainfall' (dropdown), 'Return Period (years)' (30), 'Region' (England and Wales), a 'Map' button, 'M5-60 (mm)' (19.000), and 'Ratio R' (0.299). The right column includes 'Cv (Summer)' (0.750), 'Cv (Winter)' (0.840), 'Impermeable Area (ha)' (0.120), 'Maximum Allowable Discharge (l/s)' (5.0), 'Infiltration Coefficient (m/hr)' (0.00000), 'Safety Factor' (2.0), and 'Climate Change (%)' (0). At the bottom are 'Analyse', 'OK', 'Cancel', and 'Help' buttons. A status bar at the very bottom reads 'Enter Climate Change between -100 and 600'.

| Variable                          | Value             |
|-----------------------------------|-------------------|
| FSR Rainfall                      | [Dropdown]        |
| Return Period (years)             | 30                |
| Region                            | England and Wales |
| M5-60 (mm)                        | 19.000            |
| Ratio R                           | 0.299             |
| Cv (Summer)                       | 0.750             |
| Cv (Winter)                       | 0.840             |
| Impermeable Area (ha)             | 0.120             |
| Maximum Allowable Discharge (l/s) | 5.0               |
| Infiltration Coefficient (m/hr)   | 0.00000           |
| Safety Factor                     | 2.0               |
| Climate Change (%)                | 0                 |



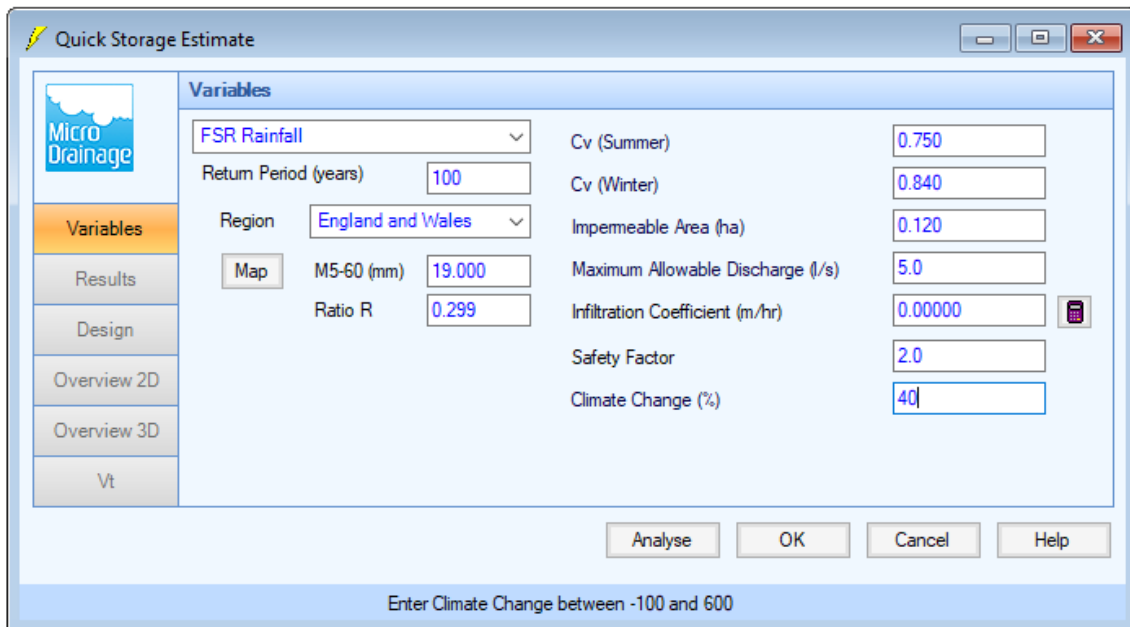
The screenshot shows the 'Quick Storage Estimate' window with the 'Results' tab selected. The left sidebar is the same as the previous window, but the 'Results' button is highlighted. The main area displays the following text: 'Global Variables require approximate storage of between 14 m<sup>3</sup> and 27 m<sup>3</sup>. These values are estimates only and should not be used for design purposes.' At the bottom are 'Analyse', 'OK', 'Cancel', and 'Help' buttons. The status bar at the very bottom reads 'Enter Climate Change between -100 and 600'.

**Global Variables require approximate storage of between 14 m<sup>3</sup> and 27 m<sup>3</sup>.**

**These values are estimates only and should not be used for design purposes.**

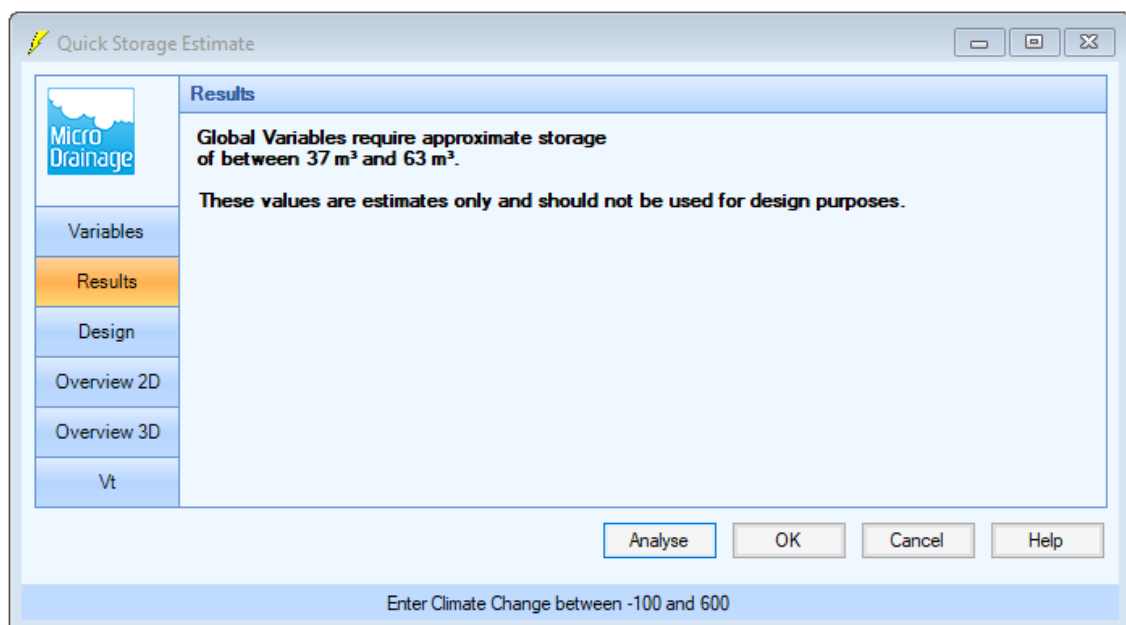
## EAST LANCS PAPER MILL – PRELIMINARY STORAGE ESTIMATE.

1 IN 100 YEAR STORM (+40% CLIMATE CHANGE) – UP TO 63M<sup>3</sup> REQUIRED.



The screenshot shows the 'Variables' tab of the 'Quick Storage Estimate' window. The left sidebar contains buttons for 'Variables', 'Results', 'Design', 'Overview 2D', 'Overview 3D', and 'Vt'. The main area is divided into two columns of input fields. The first column includes 'FSR Rainfall' (dropdown), 'Return Period (years)' (100), 'Region' (England and Wales), a 'Map' button, 'M5-60 (mm)' (19.000), and 'Ratio R' (0.299). The second column includes 'Cv (Summer)' (0.750), 'Cv (Winter)' (0.840), 'Impervious Area (ha)' (0.120), 'Maximum Allowable Discharge (l/s)' (5.0), 'Infiltration Coefficient (m/hr)' (0.00000), 'Safety Factor' (2.0), and 'Climate Change (%)' (40). At the bottom are 'Analyse', 'OK', 'Cancel', and 'Help' buttons. A footer note states: 'Enter Climate Change between -100 and 600'.

| Variable                          | Value             |
|-----------------------------------|-------------------|
| FSR Rainfall                      | [Dropdown]        |
| Return Period (years)             | 100               |
| Region                            | England and Wales |
| M5-60 (mm)                        | 19.000            |
| Ratio R                           | 0.299             |
| Cv (Summer)                       | 0.750             |
| Cv (Winter)                       | 0.840             |
| Impervious Area (ha)              | 0.120             |
| Maximum Allowable Discharge (l/s) | 5.0               |
| Infiltration Coefficient (m/hr)   | 0.00000           |
| Safety Factor                     | 2.0               |
| Climate Change (%)                | 40                |



The screenshot shows the 'Results' tab of the 'Quick Storage Estimate' window. The left sidebar is the same as the previous screen, but 'Results' is now selected. The main area displays the following text: 'Global Variables require approximate storage of between 37 m<sup>3</sup> and 63 m<sup>3</sup>. These values are estimates only and should not be used for design purposes.' At the bottom are 'Analyse', 'OK', 'Cancel', and 'Help' buttons. A footer note states: 'Enter Climate Change between -100 and 600'.

**Global Variables require approximate storage of between 37 m<sup>3</sup> and 63 m<sup>3</sup>.**

**These values are estimates only and should not be used for design purposes.**



## **APPENDIX H – UNITED UTILITIES CONSULTATION RESPONSE**

## Chris Carley

---

**From:** Andrew Mulligan  
**Sent:** 07 April 2021 12:43  
**To:** David Middleton  
**Cc:** Chris Carley  
**Subject:** FW: Pre Development Enquiry - East Lancs Paper Mill, Spring Lane, Radcliffe, Bury M26 2PS - UU ref 4200038451  
**Attachments:** FW: Request for a Pre Development Enquiry - 12866 - East Lancs Paper Mill - Bury.

Hi David, Chris,

Please find attached the PDE response form UU for 1286 -East Lancs Paper Mill.

Thanks,

Andrew.

**Regards**

**Andrew Mulligan**  
Civil Engineer BEng (Hons)



Carley  
Daines and  
Partners Limited  
Consulting Civil and Structural Engineers



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**From:** Wastewater Developer Services <WastewaterDeveloperServices@uuplc.co.uk>  
**Sent:** 06 April 2021 12:06  
**To:** Andrew Mulligan <Andrew.Mulligan@carleydaines.co.uk>  
**Cc:** Wastewater Developer Services <WastewaterDeveloperServices@uuplc.co.uk>  
**Subject:** Pre Development Enquiry - East Lancs Paper Mill, Spring Lane, Radcliffe, Bury M26 2PS - UU ref 4200038451

Good Morning Andrew,

## **Pre Development Enquiry - East Lancs Paper Mill, Spring Lane, Radcliffe, Bury M26 2PS - UU ref 4200038451**

For future reference we now have a new wastewater pre-development enquiry form designed to be easier and more user friendly which is available on our website via the following link:

<https://www.unitedutilities.com/builders-developers/larger-developments/pre-development/wastewater-pre-dev/>

We have carried out an assessment of your application which is based on the information provided. This pre-development advice on your drainage strategy will be valid for 12 months. Your drainage strategy will need to be reviewed by other competent authorities as part of the planning process, and we advise that you carry out the necessary site investigations to confirm the viability of your proposals.

If your investigations require access to our public sewer network, we ask that you contact our network engineers with a request for an access certificate via our main contact telephone number 0345 3723223 or refer to the link below:

<https://www.unitedutilities.com/builders-developers/working-near-our-assets/>

### **Historic Flooding Incidents**

I can confirm that we have no current record of sewer flooding on our DG5 register within the vicinity of the proposed development. The DG5 register is a register of properties that have flooded as a result of hydraulic inadequacy of the public sewer network.

Please note that United Utilities Water Limited (UW) can only record and check flooding events which are reported to us and we have to comply with our Regulators instructions on the qualification of flooding events to place on the register.

Our response does not include:

- any sewer flooding events caused by blockages or collapses which are the result of third party actions, natural events or other actions over which UW has no control and not a facet of sewer capacity; or
- any historical sewer flooding events that have been removed from the register as a result of investment in our infrastructure.

### **Foul Water**

Foul flow from this site will be allowed to drain into the public foul water/combined sewer system at an unrestricted rate and at any convenient point.

Our preferred point of discharge would be to the 300mm diameter public combined sewer within Howard Street (draining westwards) located to the West of your proposed development.

If you are able to identify an alternative, more suitable point of discharge, we request that you contact us at your earliest convenience so that we can assess suitability.

### **Surface Water**

All surface water flow from the proposed development should drain in-line with the drainage hierarchy, as outlined in Paragraph 80, (Reference ID: 7-080-20150323), of the National Planning Practice Guidance. We also recommend you prioritise the use of multi-functional sustainable drainage systems for the management of surface water in accordance with national planning policy.

*Generally, the aim should be to discharge surface run off as high up the following hierarchy of drainage options as reasonably practicable.*

This is outlined as follows, in order of priority:

- 1. into the ground (infiltration);**
- 2. to a surface waterbody;**
- 3. to a surface water sewer or highway drain;**
- 4. to a combined sewer.**

For guidance, The North West SuDS Pro-Forma provides information on the appropriate evidence required at each stage of the hierarchy, to demonstrate how each level has been discounted.

The Lead Local Flood Authority has responsibility for all surface water drainage concerns and their input to your proposal is critical. You should also consider whether it is necessary to discuss your proposal with the Environment Agency, or Internal Drainage Board (if operating in your area).

The Local Planning Authority are the determining authority for any application for planning permission and the appropriate authority for determining cost viability of a proposed drainage scheme, such assessments are outside of the jurisdiction of United Utilities.

### **Infiltration**

As noted in your email, surface water runoff generated from this development should discharge to the ground via infiltration system where feasible.

A detailed evidence based feasibility assessment must be carried out in line with Chapter 25 of the CIRIA SuDS Manual 2015 to determine whether infiltration is a suitable method of surface water disposal.

Particular attention must be paid to Ground Water Source Protection Zones to ensure that the risk of pollution to these valuable resources is not compromised. Details can be obtained from the government website:

<https://www.gov.uk/guidance/groundwater-source-protection-zones-spzs#find-groundwater-spzs>

If your site is in a Groundwater Source Protection Zone, you should have regard to the Environment Agency's approach to Groundwater Protection. Information on this is available via the link below:

<https://www.gov.uk/government/publications/groundwater-protection-position-statements>

Please note that such a location could have implications for the principle of your development and the need for additional mitigating measures to protect the groundwater environment and public water supply in the detailed design of your site.

### **Waterbody**

If an evidence based assessment has been carried out and confirms that infiltration is not feasible, we recommend that you contact the Lead Local Flood Authority (LLFA) and/or Environment Agency to discuss a point of discharge to the culverted watercourse located within the site boundary, shown on the site plan provided. Discharge rates and consents must be discussed with the LLFA.

### **Public Sewer**

In accordance with the hierarchy of drainage options within the National Planning Practice Guidance, both discharge to ground via infiltration and discharge to a waterbody should be discounted prior to consideration of discharging surface water to the public sewer system. Evidence should be provided to demonstrate how these have been discounted, as outlined in the North West SuDS pro-forma.

Once evidence is provided as outlined above, United Utilities will consider a connection to the 300 mm diameter public combined sewer within Howard Street, as with foul, but at a pass forward flow to be agreed by the Lead Local Flood Authority. United Utilities request that any agreed rate does not exceed 5 l/s.

As a Water Company, we have no obligation to accept highway drainage into our public sewer network. However, should your proposals include runoff from highways, we would request that consideration is given to SuDS components that deliver source control are incorporated within the design of the scheme to reduce the volume and frequency of discharges of these flows to the public sewer.

### **Levels**

For low-lying sites, (where the ground level of the site or the level of a basement is below the ground level at the point where the drainage connects to the public sewer), care should be taken to ensure that the property is not at increased risk of flooding. If these circumstances exist, we recommend that you contact us to discuss further. It could affect the detailed design of your site and result in the need to incorporate appropriate mitigating measures in your drainage scheme.

### **Land drainage / Overland flows / track drainage**

United Utilities have no obligation, and furthermore we do not accept land drainage, overland flows or track drainage into the public sewerage network under any circumstances

### **Sewer Adoptions**

If you intend to put the sewers forward for adoption (including any SuDS components that can come within the meaning of a sewer), please note United Utilities assess adoption applications based on the current Design & Construction Guidance and local practices which have now replaced 'Sewers For Adoption 6<sup>th</sup> Edition'.

We recommend that you submit a pre design assessment to the sewer adoption mailbox ([SewerAdoptions@uuplc.co.uk](mailto:SewerAdoptions@uuplc.co.uk)) stating pre design assessment in the title

Please refer to links below to obtain further guidance:

<https://www.unitedutilities.com/builders-developers/larger-developments/wastewater/sewer-adoptions/>

Site drainage must be designed in accordance with Building Regulations, National Planning Policy, and local flood authority guidelines, we would recommend that you speak and make suitable agreements with the relevant statutory bodies.

If you intend to put forward your wastewater assets for adoption by United Utilities, the proposed detail design will be subject to a technical appraisal by an Adoption Engineer as we need to be sure that the proposals meets the requirements set out in the Design & Construction Guidance. The proposed design should give consideration to long term operability and give United Utilities a safe and cost effective proposal for the lifetime of the assets. In these cases, we strongly recommend that no construction commences until the detailed drainage design, submitted as part of the Section 104 application, has been assessed and accepted in writing by United Utilities. Any work carried out prior to the technical assessment being approved is done entirely at the developer's own risk and could be subject to change.

### **Codes For Adoption**

The new Codes for Adoption are outlined on the Water UK Website. The link below takes you to their webpage:

<https://www.water.org.uk/technical-guidance/developers-services/codes-for-adoption/>

A free copy of the new Design & Construction Guidance can be downloaded via the link below:

<https://www.water.org.uk/wp-content/uploads/2020/03/SSG-App-C-Des-Con-Guide-v-2-100320-C.pdf>



### Existing Wastewater Assets Crossing the Site

We have significant assets within the site boundary that cannot realistically be diverted. We would ask that you obtain a copy of our asset data records from your provider and plan your development around them ensuring that all legal easements are observed. If any work is required that may impart vibration into the ground we would ask that you contact us for further advice. **Whilst these assets are shown on our records to only be within the area of the site marked as 'non-developable area', please note United Utilities will require unrestricted vehicular access to these assets.**

### Existing Water Assets Crossing the Site

It is the developer responsibility to identify utilities on-site. Where clean water assets are shown on our records, we recommend that you contact our Water Pre-Development Team, via the following email address:

[DeveloperServicesWater@uuplc.co.uk](mailto:DeveloperServicesWater@uuplc.co.uk). Further information for this service can be found on our website via the link below:

<https://www.unitedutilities.com/builders-developers/larger-developments/pre-development/water-pre-dev/>

### Connection Application

Although we may discuss and agree discharge points and rates in principle, please be aware that you will have to apply for a formal sewer connection. This is so that we can assess the method of construction, Health & Safety requirements and to ultimately inspect the connection when it is made. Details of the application process and the form itself can be obtained from our website by following the link below:

<https://www.unitedutilities.com/builders-developers/larger-developments/wastewater/sewer-connections/>

We recommend that the detailed design should confirm the locations of all utilities in the area and ensure that any proposed drainage solution considers routing and clash checks where required.

If we can be of any further assistance please don't hesitate to contact us further.

Many thanks and kind regards,

Tom



**Thomas Bethell**  
Assistant Engineer  
Developer Services & Metering  
Customer Services  
**M:** 07880 339 195  
[unitedutilities.com](http://unitedutilities.com)

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United Utilities Group PLC, Haweswater House, Lingley Mere  
Business Park, Lingley Green Avenue, Great Sankey,  
Warrington, WA5 3LP  
Registered in England and Wales. Registered No 6559020

[www.unitedutilities.com](http://www.unitedutilities.com)

[www.unitedutilities.com/subsidiaries](http://www.unitedutilities.com/subsidiaries)

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## **APPENDIX J – FLOOD MAP AND MITIGATION MEASURES**



FLOOD LEVELS SHOWN ARE BASED ON WATERCO MODELLING DATED NOVEMBER 2020 FOR 1% AEP + 35 % CC ALLOWANCE ASSUMING FULL CULVERT BLOCKAGE

FFL's SHOWN ARE TO GIVE MINIMUM + 300mm ABOVE MAXIMUM FLOOD LEVEL

REV. DATE DESCRIPTION

CLIENT

GREAT PLACES HOUSING GROUP

Carley  
Daines and  
Partners Limited  
Consulting Civil and Structural Engineers

11 Bridgewater Road Walkden  
Worsley Manchester M28 3JE  
Tel 0161 799 2720 Fax 0161 790 3474

TITLE

NEW DEVELOPMENT  
ELPM ISLAND SITE  
RADCLIFFE

FLOOD MAP  
FLOOD MITIGATION MEASURES

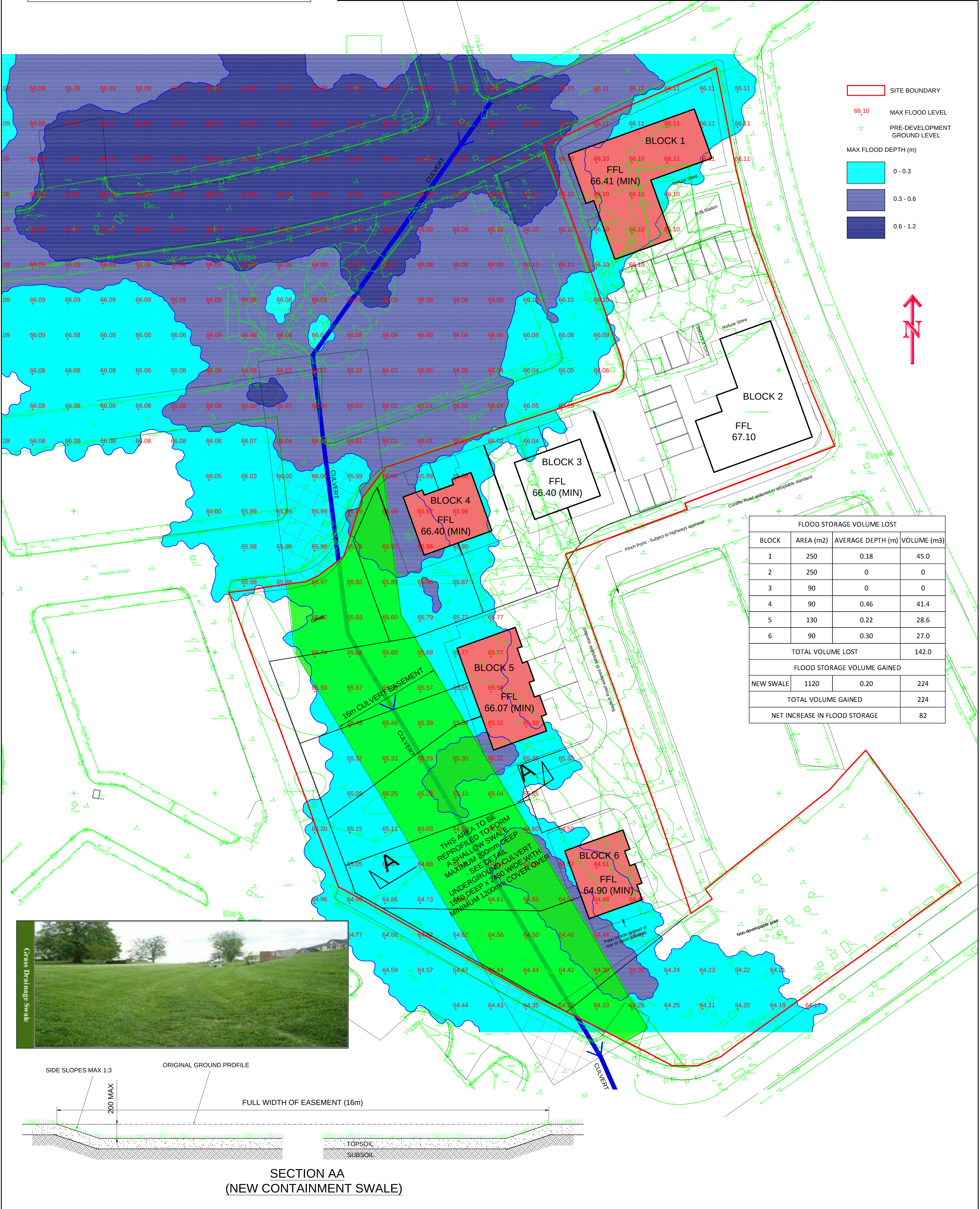
Drawn M-HOLE Checked DM

Date MARCH 2021 Date MARCH 2021

Scale 1:250 @ A1 1:500 @ A3

Drawing No.

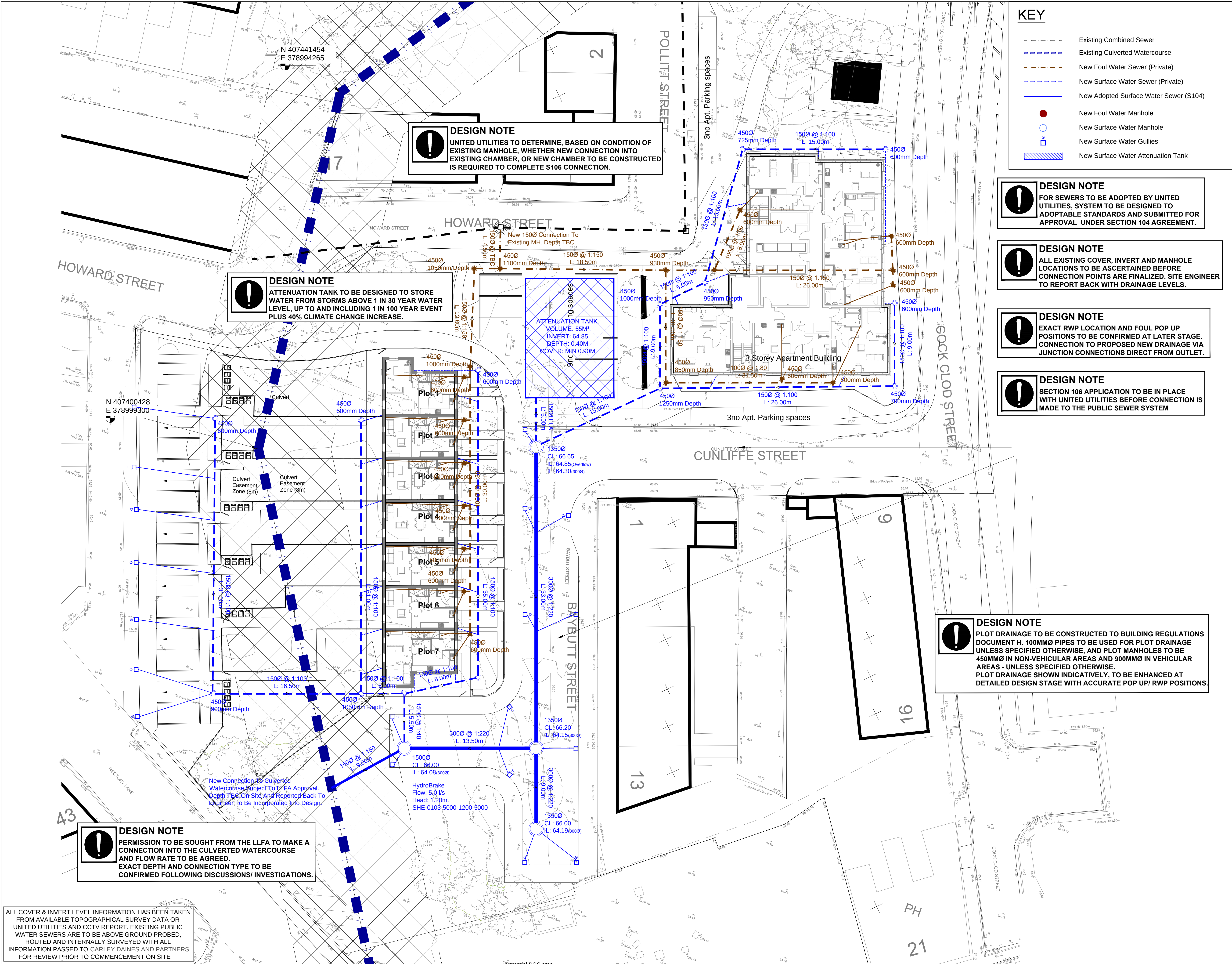
21-B-12866/50





## **APPENDIX K – PROPOSED DRAINAGE PLAN**





| NOTES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                |                                                                        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|------------------------------------------------------------------------|
| <p>0m 10m 20m</p> <p>1:200 scale bar</p> <p><b>SITE LOCATION</b><br/>FORMER EAST LANCS PAPER MILL, RADCLIFFE, BURY, GREATER MANCHESTER.<br/>M26 2GU.<br/>EASTINGS: 379000;<br/>NORTHINGS: 407400.</p> <p><b>NOTES</b></p> <p>1. ALL DRAINAGE WORKS HAVE BEEN DESIGNED AND ARE TO BE CONSTRUCTED IN ACCORDANCE WITH BUILDING REGULATIONS DOCUMENT H &amp; "SEWERS FOR ADOPTION 6TH EDITION" SUPPLEMENT GUIDELINES AND STANDARD DETAILS</p> <p>2. ALL CLAY PIPE WORK SHALL BE EXTRA STRENGTH CLAYWARE TO BS EN 295:1991 PART 1</p> <p>3. ALL PRECAST CONCRETE PIPEWORK SHALL BE TO THE CLASS STATED ON THE DRAWINGS IN ACCORDANCE WITH BS EN 1315:2002. ALL MANHOLES AND CHAMBERS SHALL BE TO BS EN 1817:2002</p> <p>4. THE CONTRACTOR MAY EJECT TO USE REINFORCED PVC PIPES AS COVERED BY BS 4668:2000 &amp; BS EN 1401:1. STRUCTURED WALL U/PVC PIPES TO COMPLY WITH WIS 4-35-01. (BY PRIOR AGREEMENT WITH ADOPTING AUTHORITY) MAX. PIPE LENGTH TO BE 3.0M</p> <p>5. ALL LEVELS RELATE TO TOPOGRAPHICAL SURVEY DATUM</p> <p>6. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS</p> <p>7. PLOT DRAINAGE CONNECTIONS TO SEWERS MUST BE 150MM DIAMETER AND UNLESS OTHERWISE STATED LAD TO THE INVERT SHOWN</p> <p>8. ALL INSPECTION CHAMBERS TO BE 600MM DIAMETER POLYPROPYLENE WITH A MAXIMUM DEPTH OF 1200mm FOR THE STANDARD UNIT &amp; A MAXIMUM DEPTH OF 3000mm WHEN A 350mm REDUCING RING IS USED</p> <p>9. ALL PLOT DRAINAGE RUNS TO BE 100mm DIAMETER AT A NOMINAL FALL OF 1:80 UNLESS NOTED OTHERWISE</p> <p>10. FLOODING EYES AT START OF EACH DRAINAGE RUN</p> <p>11. ALLOW FOR 5.0M OF ADOPTED DRAINAGE CHANNEL PER PROPERTY AT HIGHWAY BOUNDARY</p> <p>12. SURFACE WATER FROM PLOT PARKING AREAS MUST NOT DISCHARGE ONTO THE HIGHWAY</p> <p>13. PLOT DRAINAGE RUNS TO BE KEPT WITHIN THE CURTILAGE OF THE PLOT THEY SERVE WHEREVER POSSIBLE</p> <p>14. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ENSURING THAT ANY EXISTING INVERT LEVELS INDICATED ON DRAWINGS ARE CORRECT BEFORE THE WORKS ARE COMPLETED</p> <p>15. ALL CONNECTIONS TO ADOPTABLE SEWERS SHALL BE MADE BY MANUFACTURED JUNCTION PIPES. SADDLE CONNECTIONS WILL NOT BE PERMITTED, UNLESS SPECIFIED</p> <p>16. ALL SEWERS FOR ADOPTION WITH GREATER THAN 1.20M COVER IN ROADS OR 0.9M COVER IN FIELDS SHALL HAVE CLASS S GRANULAR BED AND SURROUND</p> <p>17. ANY SEWER WITH LESS THAN 1.2M COVER IN ROADS OR 0.9M COVER IN FIELDS SHALL HAVE A MINIMUM OF 150MM ST4 CONCRETE SURROUND. FLEXIBILITY SHALL BE MAINTAINED BY THE PROVISION OF FLEXCELL OR SIMILAR APPROVED JOINT FILLER BREAKS IN THE CONCRETE SURROUND AT EACH PIPE JOINT</p> <p>18. IT IS THE RESPONSIBILITY FOR THE CONTRACTOR TO CHECK ALL ONSITE EXISTING GROUND LEVELS PRIOR TO COMMENCING AND IF THERE ARE ANY DISCREPANCIES THE CONTRACTOR MUST REPORT TO THE ENGINEER IMMEDIATELY</p> <p>19. CONTRACTOR TO CONFIRM THE COVER LEVEL, INVERT LEVEL &amp; MANHOLE SIZE FOR THE EXISTING MANHOLE PRIOR TO CONTRACT START DATE</p> <p>20. ALL DRAINAGE SHOWN IN THIS DRAWING IS BASED ON ESTIMATES AND IS ALL SUBJECT TO A FURTHER DETAILED DESIGN STAGE AND IS SUBJECT TO CHANGE</p> <p>21. A NUMBER OF ASSUMPTIONS HAVE BEEN MADE IN REGARDS TO THE DISCHARGE METHOD OF SURFACE WATER</p> <p>WML GROUND REPORT SUGGESTS INFILTRATION MAY BE POSSIBLE DUE TO LOW GROUND CONTAMINATION</p> <p>UNITED UTILITIES AND LOCAL AUTHORITY SUGGEST INFILTRATION SHOULD BE THE FIRST METHOD OF DISCHARGE CONSIDERED, AND THIS STANCE WILL ONLY CHANGE SUBJECT TO PERCOLATION AND CONTAMINATION RESULTS SUGGESTING OTHERWISE</p> <p>THE SIZE OF SOAKAWAY PIT HAS BEEN SIZED VIA SOFTWARE USING ESTIMATED AND STANDARD FIGURES. A FURTHER DESIGN WILL BE CARRIED OUT FOLLOWING TESTING WITH SITE SPECIFIC VALUES ALONG WITH THE DETAILED DESIGN</p> |                |                                                                        |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 10/11/21       | REVISED TO INCLUDE ADDITIONAL PRIVATE ROAD AREAS, ATTENUATION REDUCED. |
| -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 08/11/21       | INITIAL ISSUE FOR COMMENT AND DISCUSSION PURPOSES.                     |
| REV.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | DATE           | DESCRIPTION                                                            |
| CLIENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                |                                                                        |
| GREAT PLACES HOUSING GROUP<br>AEW ARCHITECTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                |                                                                        |
| <p><b>Carley Daines and Partners Limited</b><br/>Consulting Civil and Structural Engineers</p> <p>11 Bridgewater Road Walkden<br/>Worsley Manchester M28 3JE<br/>Tel 0161 799 2720 Fax 0161 790 3474<br/>E-mail mail@carleydaines.co.uk</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                |                                                                        |
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| EAST LANCS PAPER MILL<br>RADCLIFFE, MANCHESTER                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                |                                                                        |
| PRELIMINARY DRAINAGE<br>STRATEGY DRAWING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                |                                                                        |
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| Date                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 05/11/2021     | Date 05/11/2021                                                        |
| Scale                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 1:200          | @ A1                                                                   |
| Drawing No.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 21-B-12866-200 | A                                                                      |



## **APPENDIX L – WYG FLOOD RISK AND DRAINAGE BRIEFING REPORT**

# East Lancs Paper Mill

## Island Site

### Flood Risk and Drainage Briefing Note

November 2<sup>nd</sup> 2020

#### **Introduction**

The 'Island Site' is bounded by Cock Clod Street in the east, Rectory Lane on the south and west and Howard St, Pollit St and Cross Lane on the north. The site is part of the wider East Lancs Paper Mill (ELPM) site which benefits from an outline planning approval (Bury Council Ref 62969 dated 19<sup>th</sup> December 2018). This briefing note considers issues of flood risk and drainage in respect of the Island Site alone. The note firstly considers the opportunities and constraints arising from the topography, flood risks, culverts and public sewer locations and then considers the implications for re-development.

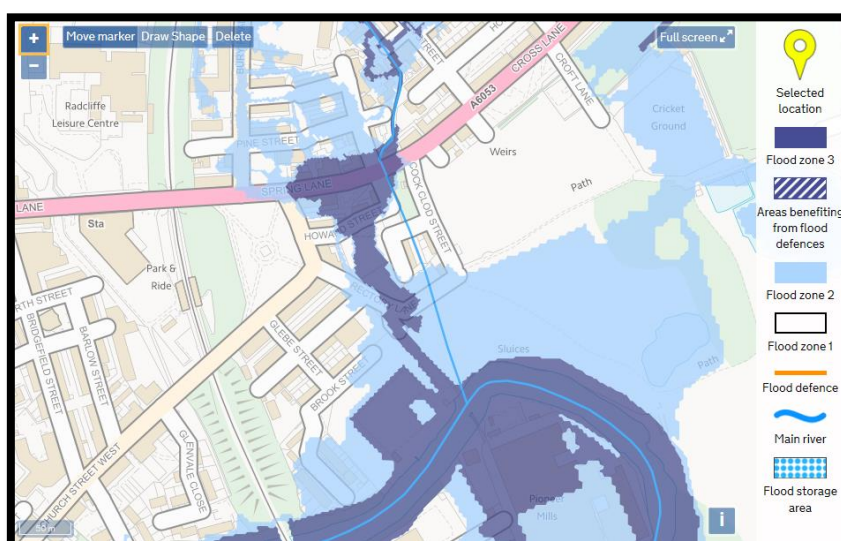
#### **Topography**

The site levels vary from the lowest point at the point where Rectory Lane divides into two arms, one running down to the River Irwell and one continuing to the point where its name changes to Church St East. At this location the topographical survey indicates a level of 63.70m Above Ordnance Datum (AOD). Proceeding around the site clockwise from this point along the roads the levels are as follows:

- Junction of Rectory Lane and Church St West: 66.48m AOD
- Junction of Rectory Lane and Howard St: 66.30m AOD
- Junction of Howard St and Pollit St: 66.04m AOD
- Junction of Pollit St and Cross Lane: 65.13m AOD
- Junction of Cross Lane and Cock Clod St: 66.17m AOD
- Junction of Cock Clod St and Rectory Lane: 64.72m AOD

#### **Flood Risk**

The 'Island Site' is in Flood Zones (FZ) 1, 2 and 3. The FZ 2 and 3 areas are on account of the flood risk from Crow Trees Farm Brook which passes through the site in culverts, the culvert system entry being located to the north of Spring Lane (A6053). The Crow Tree Farm Brook culvert outfalls into the River Irwell at the end of the extension of Rectory Road that leads to the site of a former bridge across the river. An excerpt of the Environment Agency Flood Map for planning is provided below.



**Extract of the EA Flood Map for Planning**

Product 4 data (freely available data held by the EA) for Crow Trees Farm Brook and the levels relevant to the Island Site requested in 2018 are as set out in Table 1 below.

As part of the outline planning application for the ELPM site (which included the Island Site), bespoke modelling of the River Irwell was undertaken to allow proposed topographical level changes within the wider ELPM Site to be considered. The level changes concerned are all outside of the boundaries of the 'Island Site' and therefore the modelling did not include Crow Trees Farm Brook. The ELPM bespoke modelling identified that flood levels at the Island Site due to the River Irwell are as set out in Table 1 below.

A summary of flood levels based on the final modelled development scenario with the relevant EA Crow Trees Farm Brook data is provided in Table 1 below.

**Table 1 – Modelled Flood Levels in the Watercourses (m AOD)**

| Flood Event       | Crow Trees Farm Brook | River Irwell |
|-------------------|-----------------------|--------------|
| 1 % AEP (FZ3)     | 66.19                 | 63.46        |
| 1 % AEP + 35%% CC | 66.24                 | 64.66        |
| 1 % AEP + 70%% CC | 66.27                 | 65.86        |
| 0.1 % (FZ2)       | 66.33                 | 65.68        |

The flood level due to Crow Trees Farm Brook provided in the above table relate to a model node located at the culvert entry at Cross Lane. As the land falls from a level of 66.1m AOD at Cross Street to a level of 63.70m AOD at the point where Rectory Lane splits into two, there will be a significant hydraulic gradient for flows in Crow Trees Brook across the site. If this hydraulic gradient is taken into account it will be possible to significantly reduce the required Finished Floor Levels in the lower southern part of the site. Modelling to demonstrate this has been commissioned by Homes England and will be made available to bidders as soon as it is available. However, levels in the lower southern part of the site will also need to consider flood levels due to the River Irwell.

The flood levels in relation to the River Irwell in Table 1 above are based on bespoke modelling undertaken for the ELPM site that supported the approved outline application. Product 4 levels for the River Irwell obtained in 2016 give the following levels: Q100 (1%): 63.36 (undefended); 63.41m (defended); Q1000 (0.1%): 65.16m (undefended); 65.04m (defended). EA did not hold data including climate change allowances in 2016. In submitting a new planning application for the Island site it is advised that bidders obtain the latest EA Product 4 data for the River Irwell at this location. The data has been provided to WYG and is included in Appendix A.

There is a residual flood risk to the site in the event of a blockage of the upstream entry to the Crow Trees Farm Brook culvert. In the event of a blockage water would build up behind the culvert entry and flow across Cross Street and into and through the site overland to the River Irwell. The EA have installed telemetry to give notification of high levels at the culvert entry. The modelling of Crow Trees Brook commissioned by Homes England will examine the blockage scenarios. It is anticipated that the blockage flow path can be largely contained within the maintenance strip associated with the Crow Trees Nest culvert (see below).

National surface water flood maps (see below) indicate overland flow routes through the site that are similar to the flows paths that would occur in the event of a culvert blockage.

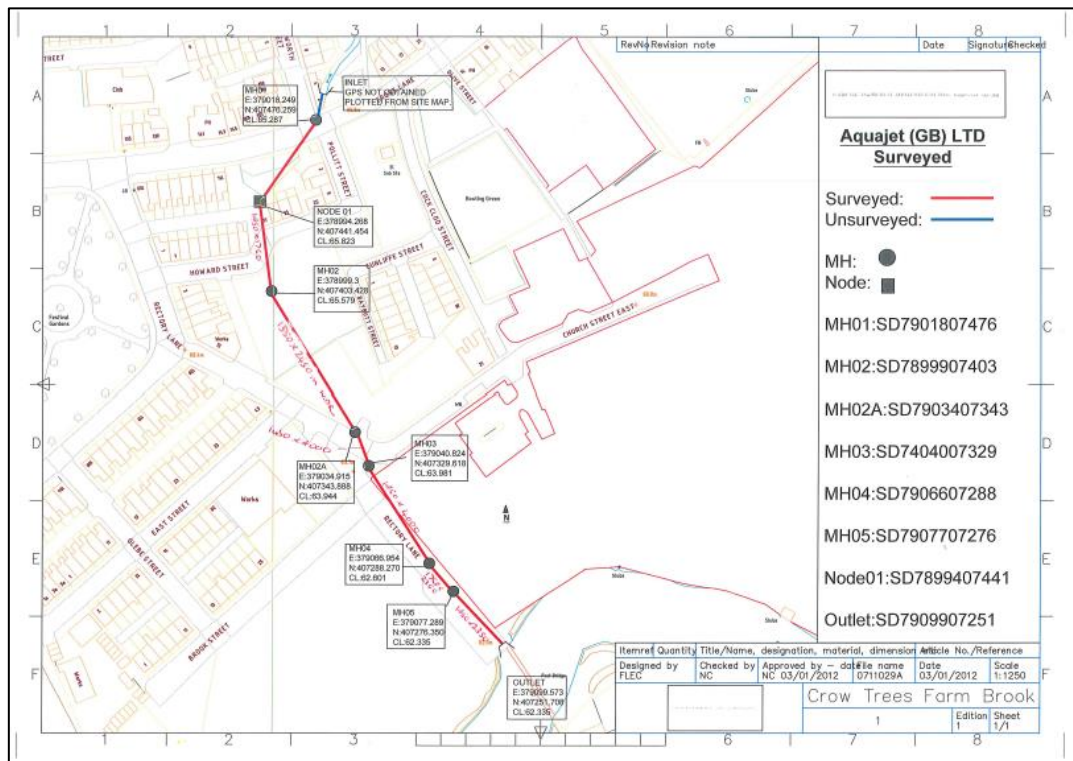




**Extent of Flooding from Surface Water**

## Watercourse Infrastructure

As 'Crow Trees Farm Brook' is a 'main river' it is under the administrative control of the Environment Agency. In conjunction with modelling of Crow Trees Brook extensive surveys of the culverts through the entirety of the catchment have been undertaken. A copy of an annotated plan taken from the culvert report supplied to WYG is provided below. A copy of the full report is available from the EA.



**Route of Crow Trees Farm Brook Culvert**

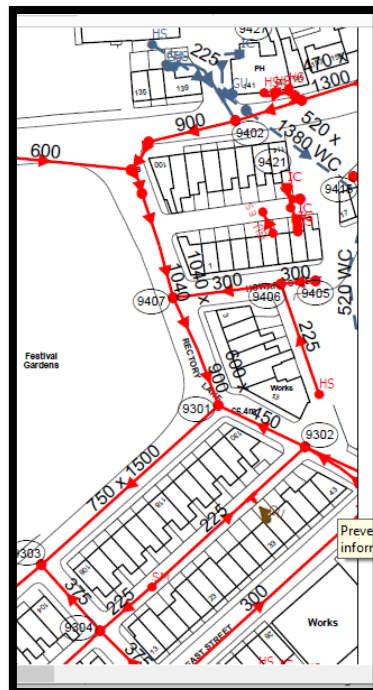
## Sewerage Infrastructure

There are public sewers in most of the roads around the site. Extracts of the United Utilities public sewer maps are provided below (obtained from UU in 2016). UU public sewer records indicate watercourse culverts with a dashed blue line. The line of the Crow Trees Farm Brook culvert on the UU sewer appears incorrect when compared with the surveyed EA record.

It should be noted that in addition to a network of combined public sewers in most of the streets around the development, UU have two large storage tanks adjacent to Rectory Road. It is understood that these are used to store surface water runoff that is mixed with an element of foul in order to limit former discharges of polluted stormwater into the local watercourses.



**Eastern Section of Island Site**



**Western Section of Island Site**

## Flood Risk Development Issues

### The Sequential Test

The 'high level' policy in flood risk management planning policy is the sequential test which seeks to direct new development to areas of lower flood risk.

Although the site benefits from an outline approval secured as part of the wider ELPM site approval, it is likely to be necessary in any new 'stand-alone' application to demonstrate that the Sequential Test can be passed.

The modelling of Crow Trees Farm Brook commissioned by Homes England is expected to reduce the footprint of FZs 2 and 3 and therefore if all new proposed residential buildings are located on land within FZ 1 the Sequential Test will be satisfactorily addressed.

As part of the ELPM application there were extensive discussions with the EA. In the submitted FRA Addendum (November 2018) Section 2.2 states:

*'Cost recoverable' advice was sought from the EA in order to obtain further clarification on the risk of flooding from the (Crow Trees Farm) Brook and any detailed modelling requirements. It was indicated in the meeting that although the EA Product 4 data imply that a considerable number of existing properties may be subject to flooding on a 1 in 20 year event, since telemetry and screening at the upstream culvert entry were introduced, there have not been reports of flooding (due to Crow Trees Farm Brook).*

*It was agreed with the EA that further detailed modelling of the culvert is not required if no modifications to the existing culvert are proposed and finished floor levels (and resilience measures if appropriate) are provided for any properties within the zone of influence of flooding from Crow Trees Farm Brook based on the relevant EA model data'.*

If it is proposed to significantly amend levels in the site to alter the shape of the Flood Zone 2 and 3 areas, it will be necessary to demonstrate that this does not have an adverse impact on other adjacent areas by either further river modelling or a methodology to be agreed with the EA.

**Demonstrating that the proposals are acceptably protected from flooding and safe for the users.**



Following a 'cost recoverable' meeting with the EA and the associated discussions the confirmed position in terms of future finished floor levels (FFLs) and flood resilience measures to be applied across the entirety of the ELPM site and also applicable to the 'Island Site' element to be as follows:

- (i) FFLs are to be set 600mm above the 1 in 100 year return period plus 35% climate change allowance event (in respect of the River Irwell, Hutchinson's Goit and Crow Trees Farm Brook);
- (ii) Where existing levels and infrastructure mean compliance with (i) above is not achievable a clear rationale for such departure should be provided;
- (iii) It is recommended that consideration of risks and the provision of flood resilience measures be included up to the 1 in 100 year level plus 70% climate change (in respect of the River Irwell, Hutchinson's Goit and Crow Trees Farm Brook).

It would be reasonable to use the modelling commissioned by Homes England as evidence of compliance with the above EA requirements.

### **Flood resilience measures.**

The Planning Practice Guidance 'Flood Risk and Coastal Change' includes a section on Flood Resilience and Flood Resistance: See PPG Para 059 Ref ID: 7-059-20140306 and para 060 Ref ID: 7-060-20150415 (see gov.uk website). These sections of the PPG 'Flood Risk and Coastal Change' provide links to relevant documents on flood resistant and flood resilient design that should inform the design in order to comply with item (iii) above.

### **Working in Proximity to a Main River**

Master-planning of the site will need to take account of the presence of the culverted Crow Trees Farm Brook which runs through the middle of the site. Generally, the EA prefer to see an 8m set off on either side of the watercourse to allow for maintenance access. However, although Crow Trees Farm Brook is a 'main river', riparian responsibilities in relation to the watercourse remain with the landowner. The purpose of the maintenance strip is therefore to ensure that if the EA were to use their statutory powers to take action in the event of riparian owner failure, they would not be hindered in the exercise of these powers by obstacles arising from inappropriate development.

Accordingly, any works proposed within 8m of a watercourse edge require the consent of the EA that is controlled by means of flood defence consents. Details of the permit requirements can be found on the UK.gov website via a Search for Environment Agency Flood Risk Permits. Incursion of development

into the 8m set off strip, as shown in the current masterplan, is permissible if agreed with the EA and formalised via the appropriate Flood Risk Permit. The EA prefer to see culverts 'opened up' as part of new development. However, the depth of the culvert may make this impractical. Diversion of the culvert is permissible, again subject to agreement with the EA and subject to the appropriate flood risk permits being in place.

It is likely to be possible to contain the overland and blockage flood routes through the site within the required Crow Trees Brook maintenance strip.

### **Surface Water Drainage**

It is now an expectation and requirement of the NPPF and PPG that surface water drainage to serve new development include Sustainable Drainage Systems (SuDS). Surface water disposal should follow the established hierarchy for the disposal of surface water. At this site, infiltration is unlikely to be viable, so surface water disposal should be to Crow Trees Farm Brook at greenfield rates or at any less onerous rate agreed with Bury Council in their role as Lead Local Flood Authority.

### **Public Sewerage Infrastructure**

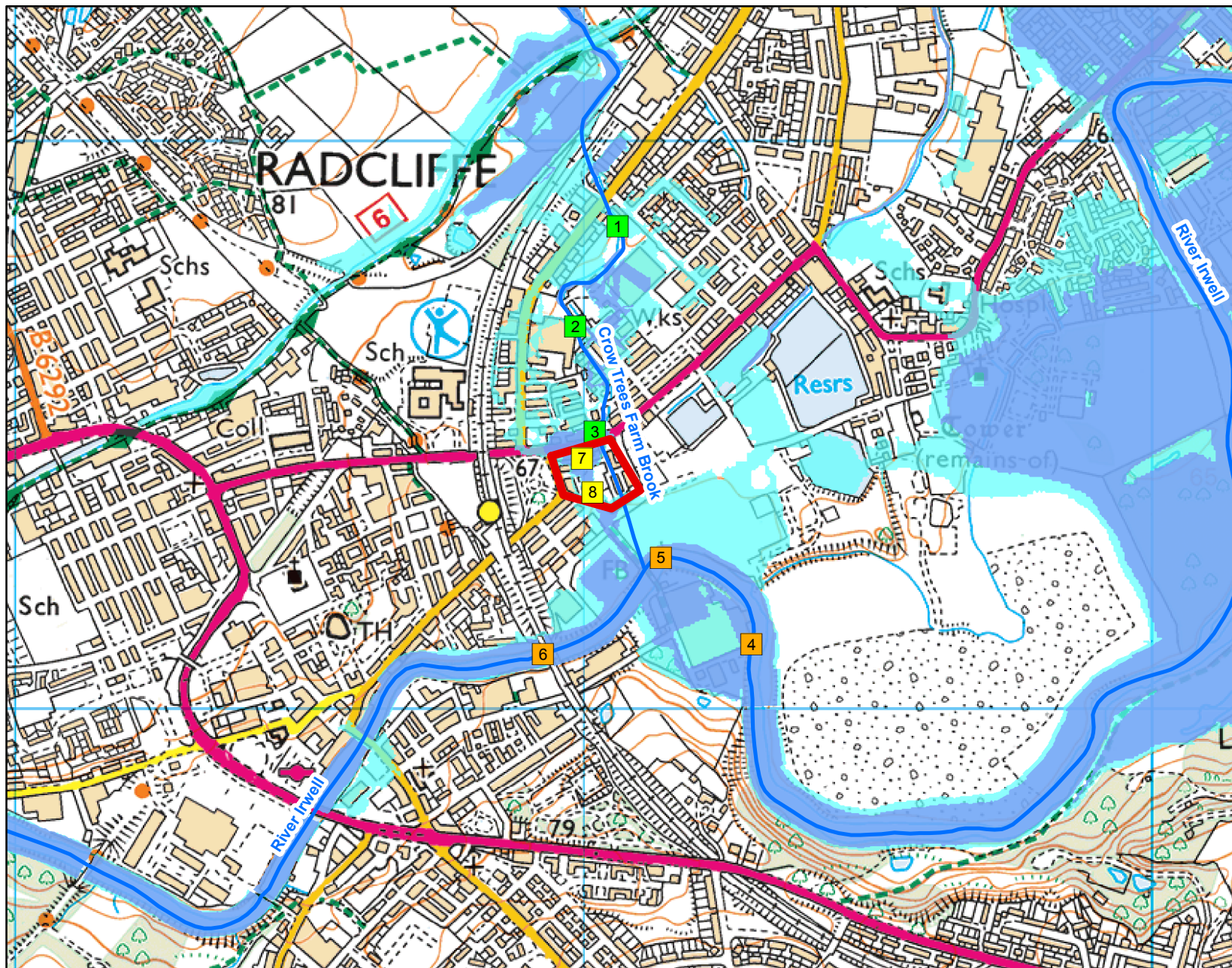
As identified above in this briefing note, there are public sewers in most of the highways within the Island Site. Provided the existing highway layout is retained it will not be necessary to undertake diversions. In addition, UU have stormwater holding tanks on land within the site adjacent to Rectory Lane. The appearance of this area requires improvement in conjunction with re-development of the site; however, the presence of the tanks will mean that UU will continue to require vehicular access to this area and any scheme of improvement will need to be agreed with UU.

### **Foul Drainage**

Following changes introduced by Ofwat there is a right of connection for foul drainage from consented development to public sewers. The site is well served by the existing public sewerage system. It is recommended that UU are consulted during the master-planning process.

## Appendix A – EA Flood Product 4 Data

Detailed Flood Map centred on Cock Clod Street, Radcliffe, Bury, M26 2PS. Created on 15/10/2020 [GMMC188712AB]



1:10,001

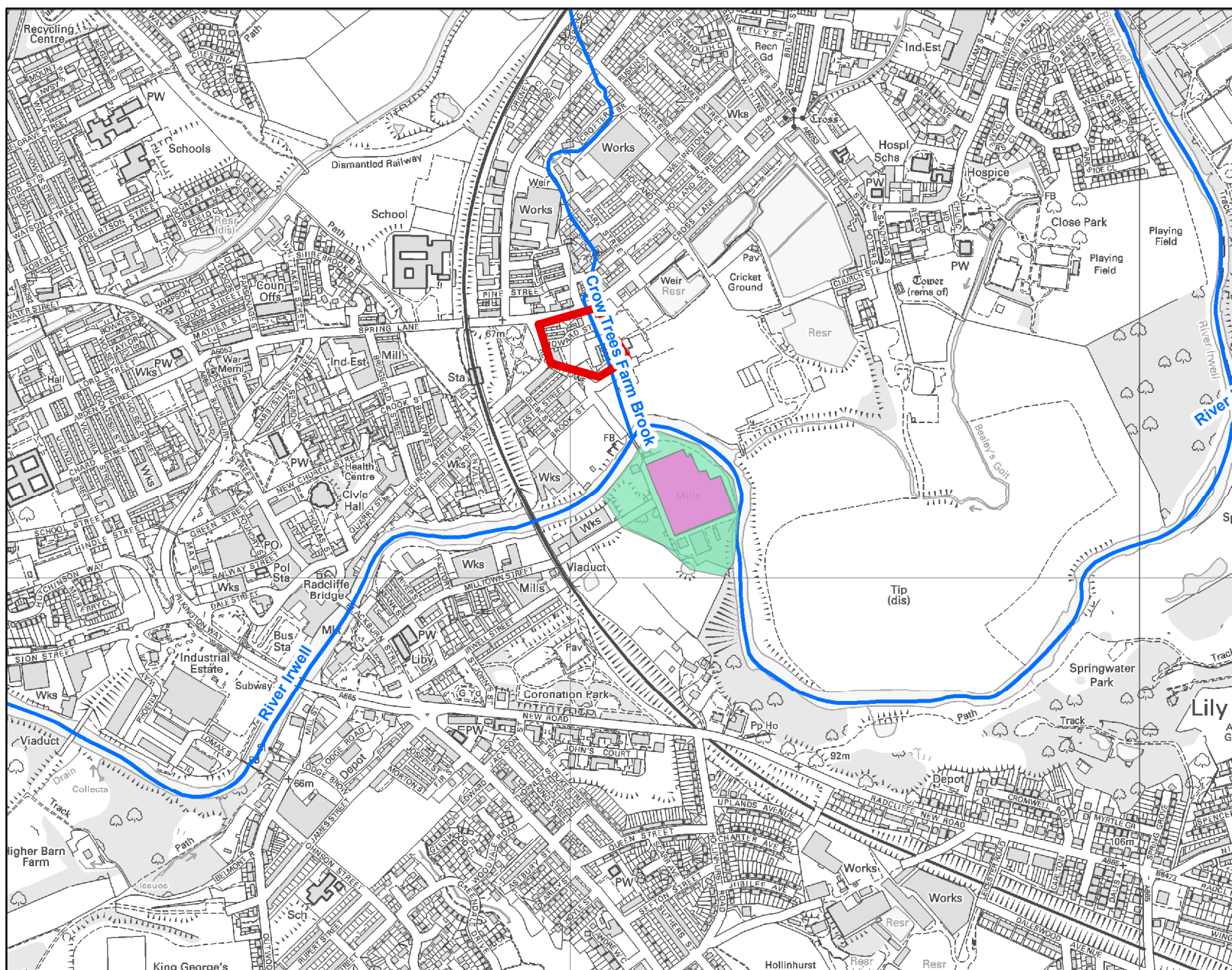


### Legend

- Site Location
- Crow Tree Brook
- Radcliffe & Redvales
- 2D Level
- Main River
- Flood Zone 3
- Flood Zone 2



# Recorded Flood Outline Map centred on Cock Clod Street, Radcliffe, Bury, M26 2PS. Created on 15/10/2020 [GMMC188712AB]



1:10,001



## Legend



Site Location



Main River

## Recorded Flood Outline

### Start Date



23/10/1998



26/12/2015

| Map Reference | Model Study Reference               | Existing | Forthcoming | Data                            | Unclassified           |                        |                         |                        |                        |                        |                          |                          |                                                |                                                |                           |                            |
|---------------|-------------------------------------|----------|-------------|---------------------------------|------------------------|------------------------|-------------------------|------------------------|------------------------|------------------------|--------------------------|--------------------------|------------------------------------------------|------------------------------------------------|---------------------------|----------------------------|
|               |                                     |          |             |                                 | 50 % AEP (1 in 2 year) | 20 % AEP (1 in 5 year) | 10 % AEP (1 in 10 year) | 5 % AEP (1 in 20 year) | 4 % AEP (1 in 25 year) | 2 % AEP (1 in 50 year) | 1.00 AEP (1 in 100 year) | 1.00 AEP (1 in 100 year) | 1 % AEP (1 in 100 year) + 30% increase in flow | 1 % AEP (1 in 100 year) + 50% increase in flow | 0.5 % AEP (1 in 200 year) | 0.1 % AEP (1 in 1000 year) |
| 1             | DSE, D412, D424, D425, D427A, D427B | 375662   | 407568      | Modelled Water Level (in seaft) | 48.75                  | 48.67                  | 48.58                   | 48.48                  | 48.38                  | 48.28                  | 48.18                    | 48.08                    | 47.98                                          | 47.88                                          | 47.78                     | 47.68                      |
|               |                                     |          |             | Modelled Flow (cumecs)          | 2.18                   | 2.17                   | 2.16                    | 2.15                   | 2.14                   | 2.13                   | 2.12                     | 2.11                     | 2.10                                           | 2.09                                           | 2.08                      | 2.07                       |
| 2             | DSE, D412, D424, D425, D427A, D427B | 378885   | 407673      | Modelled Water Level (in seaft) | 47.50                  | 46.55                  | 46.05                   | 45.55                  | 45.05                  | 44.55                  | 44.05                    | 43.55                    | 43.05                                          | 42.55                                          | 42.05                     | 41.55                      |
|               |                                     |          |             | Modelled Flow (cumecs)          | 2.06                   | 2.07                   | 2.08                    | 2.09                   | 2.10                   | 2.11                   | 2.12                     | 2.13                     | 2.14                                           | 2.15                                           | 2.16                      | 2.17                       |
| 3             | DSE, D412, D424, D425, D427A, D427B | 378621   | 407666      | Modelled Water Level (in seaft) | 46.75                  | 46.06                  | 45.35                   | 44.64                  | 43.93                  | 43.22                  | 42.51                    | 41.80                    | 41.09                                          | 40.38                                          | 39.67                     | 38.96                      |
|               |                                     |          |             | Modelled Flow (cumecs)          | 2.08                   | 2.03                   | 1.93                    | 1.83                   | 1.73                   | 1.63                   | 1.53                     | 1.43                     | 1.33                                           | 1.23                                           | 1.13                      | 1.03                       |

Model data taken from Cross River Break 2018 Study  
AEP - Annual Exceedance Probability  
in seaft - metres above ordnance datum Newlyn  
cumecs - cubic metres per second

Notes:  
\*Climate Change Scenario - 30%, 50% and 70% increase in flow calculated for the 2080's (2070 - 2150). Please see [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/566666/Climate-change-scenarios-for-the-2080s.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/566666/Climate-change-scenarios-for-the-2080s.pdf) for more information regarding the new climate change guidance. The location of the site and the type (vulnerability) of development determine the climate change allowances to consider in any flood risk assessment.

| Map Reference | Model Study Reference   | Existing | Forthcoming | Data                            | Unclassified           |                        |                         |                        |                        |                            |                         |                           |                            |                          | Classified             |                         |                        |                        |                           |                         |                           |                            |  |  |
|---------------|-------------------------|----------|-------------|---------------------------------|------------------------|------------------------|-------------------------|------------------------|------------------------|----------------------------|-------------------------|---------------------------|----------------------------|--------------------------|------------------------|-------------------------|------------------------|------------------------|---------------------------|-------------------------|---------------------------|----------------------------|--|--|
|               |                         |          |             |                                 | 50 % AEP (1 in 2 year) | 20 % AEP (1 in 5 year) | 10 % AEP (1 in 10 year) | 5 % AEP (1 in 20 year) | 2 % AEP (1 in 50 year) | 1.00 % AEP (1 in 100 year) | 1 % AEP (1 in 100 year) | 0.5 % AEP (1 in 200 year) | 0.1 % AEP (1 in 1000 year) | 1.00 % AEP (1 in 2 year) | 50 % AEP (1 in 5 year) | 10 % AEP (1 in 10 year) | 5 % AEP (1 in 20 year) | 2 % AEP (1 in 50 year) | 1.00 % AEP (1 in 75 year) | 1 % AEP (1 in 100 year) | 0.5 % AEP (1 in 200 year) | 0.1 % AEP (1 in 1000 year) |  |  |
| 4             | W011, D101, W012A, D102 | 379207   | 407114      | Modelled Water Level (in seaft) | 45.75                  | 45.49                  | 45.23                   | 44.96                  | 44.70                  | 44.43                      | 44.16                   | 43.89                     | 43.62                      | 43.35                    | 43.08                  | 42.81                   | 42.54                  | 42.27                  | 42.00                     | 41.73                   |                           |                            |  |  |
|               |                         |          |             | Modelled Flow (cumecs)          | 201.42                 | 200.12                 | 198.82                  | 197.52                 | 196.22                 | 194.92                     | 193.62                  | 192.32                    | 191.02                     | 189.72                   | 188.42                 | 187.12                  | 185.82                 | 184.52                 | 183.22                    | 181.92                  | 180.62                    |                            |  |  |
| 5             | W011, D101, W012A, D102 | 379445   | 407267      | Modelled Water Level (in seaft) | 45.75                  | 45.48                  | 45.21                   | 44.94                  | 44.67                  | 44.40                      | 44.13                   | 43.86                     | 43.59                      | 43.32                    | 43.05                  | 42.78                   | 42.51                  | 42.24                  | 41.97                     | 41.70                   |                           |                            |  |  |
|               |                         |          |             | Modelled Flow (cumecs)          | 201.42                 | 200.34                 | 199.26                  | 198.17                 | 197.09                 | 196.01                     | 194.93                  | 193.85                    | 192.77                     | 191.69                   | 190.61                 | 189.53                  | 188.45                 | 187.37                 | 186.29                    | 185.21                  | 184.13                    |                            |  |  |
| 6             | W011, D101, W012A, D102 | 379683   | 407397      | Modelled Water Level (in seaft) | 45.77                  | 45.49                  | 45.20                   | 44.92                  | 44.63                  | 44.34                      | 44.05                   | 43.76                     | 43.47                      | 43.18                    | 42.89                  | 42.60                   | 42.31                  | 42.02                  | 41.73                     | 41.44                   |                           |                            |  |  |
|               |                         |          |             | Modelled Flow (cumecs)          | 201.70                 | 200.33                 | 199.33                  | 198.32                 | 197.31                 | 196.30                     | 195.29                  | 194.28                    | 193.27                     | 192.26                   | 191.25                 | 190.24                  | 189.23                 | 188.22                 | 187.21                    | 186.20                  | 185.19                    |                            |  |  |

Model data taken from River 879 & Redcliffe 2018 Study  
AEP - Annual Exceedance Probability  
in seaft - metres above ordnance datum Newlyn  
cumecs - cubic metres per second

Notes:  
Climate Change Scenario - We do not hold climate change measurements at this location. For further guidance on climate change within the GMAC area please see the attachment 'Flood risk assessments: Climate change allowance'. Particularly section 3, table B which shows the Local precautionary allowances for potential climate change impacts.

| Map Reference | Model Study Reference | Existing | Forthcoming | Data                            | Unclassified                                   |                                                |                                                |
|---------------|-----------------------|----------|-------------|---------------------------------|------------------------------------------------|------------------------------------------------|------------------------------------------------|
|               |                       |          |             |                                 | 1 % AEP (1 in 100 year) + 30% increase in flow | 1 % AEP (1 in 100 year) + 50% increase in flow | 1 % AEP (1 in 100 year) + 70% increase in flow |
| 7             | 20 Land               | 378889   | 407445      | Modelled Water Level (in seaft) | 45.53                                          | 45.54                                          | 45.55                                          |
| 8             |                       |          |             | Modelled Water Level (in seaft) | 44.75                                          | 44.69                                          | 44.63                                          |

Model data taken from Cross River Break 2018 Study  
AEP - Annual Exceedance Probability  
in seaft - metres above ordnance datum Newlyn  
cumecs - cubic metres per second

Notes:  
\*Climate Change Scenario - 30%, 50% and 70% increase in flow calculated for the 2080's (2070 - 2150). Please see [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/566666/Climate-change-scenarios-for-the-2080s.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/566666/Climate-change-scenarios-for-the-2080s.pdf) for more information regarding the new climate change guidance. The location of the site and the type (vulnerability) of development determine the climate change allowances to consider in any flood risk assessment.

| Flood Event Code | Name        | Start Date | End Date | Source of Flooding | Cause of Flooding                              |
|------------------|-------------|------------|----------|--------------------|------------------------------------------------|
| 48875            | Ice         | 20101008   | 20101008 | Main River         | Over-saturation of ground                      |
| 487887           | Phoenix 166 | 20101015   | 20101015 |                    | Channel capacity exceeded (in raised defences) |

# Flood risk assessments: Climate change allowances

## Application of the allowances and local considerations

### Greater Manchester, Merseyside & Cheshire

#### 1) The climate change allowances

The [National Planning Practice Guidance](#) refers planners, developers and advisors to the Environment Agency guidance on considering climate change in Flood Risk Assessments (FRAs). This guidance was updated in February 2016 and is available on [Gov.uk](#) and should be read in conjunction with this document. The guidance can be used for planning applications, local plans, neighbourhood plans and other projects. It provides climate change allowances for peak river flow, peak rainfall, sea level rise, wind speed and wave height. The guidance provides a range of allowances to assess fluvial flooding, rather than a single national allowance. It advises on what allowances to use for assessment based on vulnerability classification, flood zone and development lifetime.

#### 2) Assessment of climate change impacts on fluvial flooding

**Table A** below indicates the level of technical assessment of climate change impacts on fluvial flooding appropriate for new developments depending on their scale and location. This should be used as **a guide only**. Ultimately, the agreed approach should be based on expert local knowledge of flood risk conditions, local sensitivities and other influences. **For these reasons we recommend that applicants and / or their consultants should contact the Environment Agency at the pre-planning application stage to confirm the assessment approach, on a case by case basis.** **Table A** defines three possible approaches to account for flood risk impacts due to climate change, in new development proposals:

- **Basic:** Developer can add an allowance to the 'design flood' (i.e. 1% annual probability) peak levels to account for potential climate change impacts. The allowance should be derived and agreed locally by Environment Agency teams.
- **Intermediate:** Developer can use existing modelled flood and flow data to construct a stage-discharge rating curve, which can be used to interpolate a flood level based on the required peak flow allowance to apply to the 'design flood' flow.
- **Detailed:** Perform detailed hydraulic modelling, through either re-running Environment Agency hydraulic models (if available) or construction of a new model by the developer.

**Table A – Indicative guide to assessment approach**

| <u>VULNERABILITY CLASSIFICATION</u> | <u>FLOOD ZONE</u> | <u>DEVELOPMENT TYPE</u>     |                     |                     |
|-------------------------------------|-------------------|-----------------------------|---------------------|---------------------|
|                                     |                   | <u>MINOR</u>                | <u>SMALL-MAJOR</u>  | <u>LARGE-MAJOR</u>  |
| <b>ESSENTIAL INFRASTRUCTURE</b>     | Zone 2            | Detailed                    |                     |                     |
|                                     | Zone 3a           | Detailed                    |                     |                     |
|                                     | Zone 3b           | Detailed                    |                     |                     |
| <b>HIGHLY VULNERABLE</b>            | Zone 2            | Intermediate/ Basic         | Intermediate/ Basic | Detailed            |
|                                     | Zone 3a           | Not appropriate development |                     |                     |
|                                     | Zone 3b           | Not appropriate development |                     |                     |
| <b>MORE VULNERABLE</b>              | Zone 2            | Basic                       | Basic               | Intermediate/ Basic |
|                                     | Zone 3a           | Basic                       | Detailed            | Detailed            |
|                                     | Zone 3b           | Not appropriate development |                     |                     |
| <b>LESS VULNERABLE</b>              | Zone 2            | Basic                       | Basic               | Intermediate/ Basic |
|                                     | Zone 3a           | Basic                       | Basic               | Detailed            |
|                                     | Zone 3b           | Not appropriate development |                     |                     |
| <b>WATER COMPATIBLE</b>             | Zone 2            | None                        |                     |                     |
|                                     | Zone 3a           | Intermediate/ Basic         |                     |                     |
|                                     | Zone 3b           | Detailed                    |                     |                     |

**NOTES:**

- Minor: 1-9 dwellings/ less than 0.5 ha | Office / light industrial under 1ha | General industrial under 1 ha | Retail under 1 ha | Gypsy/traveller site between 0 and 9 pitches
- Small-Major: 10 to 30 dwellings | Office / light industrial 1ha to 5ha | General industrial 1ha to 5ha | Retail over 1ha to 5ha | Gypsy/traveller site over 10 to 30 pitches
- Large-Major: 30+ dwellings | Office / light industrial 5ha+ | General industrial 5ha+ | Retail 5ha+ | Gypsy/traveller site over 30+ pitches | any other development that creates a non residential building or development over 1000 sq m.

**The assessment approach should be agreed with the Environment Agency as part of pre-planning application discussions to avoid abortive work.**

### 3) Specific local considerations

Where the Environment Agency and the applicant and / or their consultant has agreed that a 'basic' level of assessment is appropriate the figures in Table B below can be used as a precautionary allowance for potential climate change impacts on peak 'design' (i.e. 1% annual probability) fluvial flood level rather than undertaking detailed modelling.

**Table B – Local precautionary allowances for potential climate change impacts**

| Watercourse | Central | Higher Central | Upper |
|-------------|---------|----------------|-------|
| All         | 0.15m   | 0.24m          | 0.48m |

Use of these allowances will only be accepted after discussion with the Environment Agency.

### 4) Fluvial food risk mitigation

Read the guidance on [Gov.uk](https://www.gov.uk) to find out which allowances to use to **assess** the impact of climate change on flood risk.

For planning consultations where we are a statutory consultee and our [Flood risk standing advice](#) **does not** apply we use the following benchmarks to inform flood risk **mitigation** for different vulnerability classifications. **These are a guide only. We strongly recommend you contact us at the pre-planning application stage to confirm this on a case by case basis. Please note you may be charged for this advice.** For planning consultations where we are not a statutory consultee or our [Flood risk Standing advice](#) applies we recommend local planning authorities and developers use these benchmarks but we do not expect to be consulted.

- For development classed as '[Essential Infrastructure](#)' our benchmark for flood risk mitigation is for it to be designed to the '**upper end**' climate change allowance for the epoch that most closely represents the lifetime of the development, including decommissioning.
- For [highly vulnerable](#) in flood zone 2, the '**higher central**' climate change allowance is our minimum benchmark for flood risk mitigation. In sensitive locations it may be necessary to use the **upper end** allowance.
- For [more vulnerable developments](#) in flood zone 2, the '**central**' climate change allowance is our minimum benchmark for flood risk mitigation, and in flood zone 3 the '**higher central**' climate change allowance is our minimum benchmark for flood risk



mitigation. In sensitive locations it may be necessary to use the **higher central** (in flood zone 2) and the **upper end** allowance (in flood zone 3).

- For [water compatible](#) or [less vulnerable](#) development (e.g. commercial), the 'central' climate change allowance for the epoch that most closely represents the lifetime of the development is our minimum benchmark for flood risk mitigation. In sensitive locations it may be necessary to use the **higher central** (particularly in flood zone 3) to inform built in resilience.

There may be circumstances where local evidence supports the use of other data or allowances. Where you think this is the case we may want to check this data and how you propose to use it.

END.

## **APPENDIX M – WYG HYDRAULIC TECHNICAL REPORT**



## Island Site, Radcliffe

# Hydraulic Modelling Technical Note

November 2020



| Project Information |                                                                                                     |
|---------------------|-----------------------------------------------------------------------------------------------------|
| Project:            | Island Site, Radcliffe                                                                              |
| Report Title:       | Hydraulic Modelling Technical Note                                                                  |
| Client:             | WYG                                                                                                 |
| Instruction:        | The instruction to undertake this report was received from Matthew Elliott on behalf of the Client. |
| File Ref:           | 13478-201106-TN_01.docx                                                                             |

| Approval Record |                                                           |
|-----------------|-----------------------------------------------------------|
| Author:         | Alekh Thykannidyl                                         |
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| Document History |          |             |
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## Glossary

Principal technical terms and abbreviations are included in the Glossary Table below, please note that this list is not exhaustive.

| Term          | Definition                                                                                                                                                                                                                          |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1D (Model)    | 1-Dimensional model typically built using watercourse cross-section survey data to represent the watercourse and adjacent floodplain                                                                                                |
| 2D (Model)    | 2-Dimensional model typically built using LiDAR and site specific topographic data to represent the wider floodplain                                                                                                                |
| 1D-2D (Model) | Combination of 1D and 2D model (i.e. typically a representation of the watercourse and floodplain)                                                                                                                                  |
| AEP           | Annual Exceedance Probability (i.e. The probability that a storm event will occur in any given year, e.g. a 100 year return period refers to there being a probability of 1 in 100 that a storm event will occur in any given year) |
| BL            | Blockage Scenario Model Simulation                                                                                                                                                                                                  |
| DEV           | Proposed Site Layout Model                                                                                                                                                                                                          |
| EA            | Environment Agency (England)                                                                                                                                                                                                        |
| EXG           | Existing Site Layout Model                                                                                                                                                                                                          |
| FFL           | Finished Floor Level                                                                                                                                                                                                                |
| HMR or TN     | Hydraulic Modelling Report <u>or</u> Technical Note                                                                                                                                                                                 |
| LiDAR         | Light Detection and Ranging (i.e. Ground elevation data)                                                                                                                                                                            |
| MIT or OPT    | Flood Mitigation Option Modelling                                                                                                                                                                                                   |
| Model Inflow  | This is the volume of water that is input into the model to generate the flood extents                                                                                                                                              |
| NFC           | Normal Flow Conditions (i.e. as surveyed conditions, typically with no structure blockage or breach of any defences)                                                                                                                |
| NRW           | Natural Resources Wales                                                                                                                                                                                                             |
| SEPA          | Scottish Environment Protection Agency                                                                                                                                                                                              |
| ST            | Sensitivity Test                                                                                                                                                                                                                    |

## Introduction

Waterco has been commissioned to undertake a hydraulic modelling study of Crow Trees Farm Brook (CTFB), a tributary of the River Irwell culverted under a proposed development site (referred to hereon as 'Island Site') at Radcliffe, M26 2PR. The site is part of the adjacent East Lancashire Paper Mill (ELPM) Site which benefits from an outline planning approval. The purpose of this study is to provide indicative flood levels and outlines at the Island Site due to flood risk from CTFB.

It should be noted that the River Irwell (and potentially Bealey's Goit watercourse) pose a further source of fluvial flood risk to the site which is currently not simulated within in the CTFB model. The output from the 2018 ELPM site modelling (scheme 12168) of the River Irwell is briefly discussed in relation to this site.

A location plan and an aerial photograph of the site are included in Appendix A. The National Grid Reference (NGR) of the site is 379040 407390.

The site is brownfield, covering an area of 1.02ha. The site comprises hardstanding, derelict buildings, and is overgrown. The site is bordered by Howard Street and the A6053 to the north, Cock Clod Street to the east and Rectory Lane to the south and south-west.

A topographical survey of the wider ELPM site was undertaken in November 2016 and provided by the Client. The survey data is included in Appendix B for information. The survey shows existing site levels fall from north-east to south-west, from a level of approximately 67.17m AOD near the eastern site boundary to 63.97m AOD near the south-western site boundary.

The current EA Flood Maps for Planning (November 2020) for the site show food risk from both the CTFB and River Irwell watercourses. The flood maps show about one-half of the site area to be located within Flood Zone 3 – an area considered to be at relatively high risk of fluvial flooding with an annual probability of the flooding greater than 1% (1 in 100) AEP (annual exceedance probability). Approximately 16% of the site area is located within Flood Zone 2 – an area considered to be at medium risk of fluvial flooding with an annual probability of the flooding between 1% and 0.1% (1 in 1000) AEP. The remaining site area is located within Flood Zone 1 – an area considered to be at low risk of fluvial flooding with an annual probability of the flooding lower than 0.1% (1 in 1000) AEP. An extract of the current EA Flood Zones is included in Appendix C for reference. The EA Historical Flood Map included in Appendix C shows no records of past flooding at the site.

It is understood that the current CTFB flood zones are based on the outputs of a detailed EA 1D/2D<sup>1</sup> ISIS-TUFLOW model built in 2016. To provide an improved site-specific assessment of fluvial flood risk from CTFB the existing 1D/2D hydraulic model has been updated to include topographical survey of site. Additional model updates such as inclusion of the direct flood risk from the River Irwell have not been completed as part of this study. It is likely that a more detailed site-specific assessment of flood risk at the site, which is outside the current scope of this study, will be required in the future if Planning approval is sought for the

---

<sup>1</sup> A 1D/2D hydrodynamic model is comprised of a 1-Dimensional (1D) river network model (based on surveyed river cross-sections) coupled with a 2-Dimensional (2D) Digital Terrain Model (DTM) of the potential floodplain (created from LiDAR).

development.

This brief Technical Note summarises the updates made to the current EA CTFB model and provides hydraulic model outputs which will inform Master Planning of the Island Site. This document does not constitute a detailed Hydraulic Modelling Report, rather it provides an outline of the works completed along with a brief review of project outputs.

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## Modelling Assessment

A copy of the current EA CTFB model has been sourced and used as the base for this study.

The latest version(s) of hydraulic modelling software Flood Modeller Pro (FMP – previously ISIS) and TUFLOW available at the start of the project have been used for all simulations; 4.6 and 2020-01-AB respectively.

To investigate the fluvial flood risk from CTFB at the site during the existing (EXG) scenario, a range of fluvial events have been simulated; namely the 5% (1 in 20), 1% (1 in 100) and 0.1% (1 in 1000) AEP events. The impact of future climate change (CC) has also been investigated during the 1% AEP event by increasing flows by 35% (CC1) and 70% (CC2). The flow data within the current EA model was calculated by Capita AECOM in 2016. The inflow data and storm duration used have been briefly reviewed and are considered suitable for use for the purposes of this study. Therefore, no change has been made to the current EA model hydrology.

A review of the 1D network reach and the 2D TUFLOW domain was carried out to confirm the extent adequately covers the proposed development site.

The existing 1D FMP model network of CTFB starts 140m south of Withins Reservoir (NGR 378700 408680, Node ref: CROT01\_01777) and ends at the watercourse's confluence with the River Irwell (NGR 379065 407230, Node ref: CROT01\_DS). Approximately 1.75km of the watercourse has been modelled.

The EA 1D model cross-sections have been reviewed and updated where required to include panel markers to improve conveyance curves.

A Head-Time (HT) boundary condition has been applied as the 1D model downstream boundary condition. In the current EA Model, a constant stage value of 58m AOD has been applied as the downstream boundary level. In this study a constant stage value of 61.2m AOD corresponding to 50% AEP event maximum water level in the River Irwell has been applied. The River Irwell water levels have been extracted from the EA Bury South model (2017) at the River Irwell 1D model node IRWE4\_0000u.

During model testing, sensitivity of the downstream boundary stage value on flood risk at the site has been completed through additional simulations. The River Irwell maximum water levels of 61.96m AOD, 62.36m AOD, 62.49m AOD and 63.13m AOD corresponding to the 10% AEP, 5% AEP, 4% AEP and 1% AEP events respectively have been tested as the downstream boundary stage values. Model outputs from these simulations are discussed further below.

No other changes have been made to the 1D model data, including boundary locations, lateral inflow locations and hydrographs, structure representation, Manning's n roughness etc.

The 2D TUFLOW domain has been constructed from 1m LiDAR data (flown in 2016 and downloaded in 2020) and site-specific topographical survey data. The extent of the linked 1D/2D model domain is presented in Appendix D.

The 2D model cell size has been unchanged from the EA model and set as 2m. Existing TUFLOW z-shape features used to represent the bank elevations, parapet levels, canal levels and to correct minor LiDAR

filtering errors were kept unchanged from the EA model and utilised.

OS MasterMap data (provided with the current EA model) has been used to classify land use and assign Manning's n roughness coefficients throughout the floodplain. The coefficient values have been unchanged from the EA model.

Head-Discharge (HQ) downstream boundary condition applied in the existing EA 2D model has been replaced by a 2D HT boundary condition. A constant stage value of 61.2m AOD corresponding to 50% AEP event water level in the River Irwell has been applied similar to the 1D model.

No further changes have been made to the 2D domain or boundaries.

The A6053 Cross Lane Culvert (Model Ref: CROT01\_00270; NGR 379020 407490) is considered potentially critical to flooding at the site given its proximity to the site and potential to block. To investigate flood risk at the site in the event of a blockage of this structure, blockage scenario simulation has been performed and detailed in Table 3. Due to the small size of the culvert structure opening, a 100% blockage has been investigated. FMP does not allow representation of 100% blockage, hence a 99.9% blockage has been specified using an IED file.

**Table 1 - Blockage Scenario Simulation**

| Scenario Ref | Structure                | Fluvial Event   | % Blockage | Model Ref |
|--------------|--------------------------|-----------------|------------|-----------|
| BL1          | A6053 Cross Lane Culvert | 1% AEP + 35% CC | 100%       | BL1-99.9  |

During model testing an additional blockage scenario investigating a lower percentage culvert blockage of 80% has been completed as a sensitivity test to understand the impact of the culvert on flood risk at the site. The results of this test have not been mapped but discussed briefly in the Results section further below.

No other sensitivity tests have been carried out as part of this study. We recommend that further sensitivity testing is carried out, should the scheme progress beyond feasibility.

## Summary of Results

This section of the report documents the results obtained from the primary simulations and blockage scenarios for the EXG site.

Maximum flood depth, velocity and hazard mapping has been provided for each primary simulation in Appendix E. Flood hazard ratings have been calculated in accordance with DEFRA document 'FD2320: Flood Risks to People' and EA guidance document 'Supplementary Note on Flood Hazard Ratings and Thresholds'.

In addition to the mapping, calculated maximum water levels were extracted at each node along the 1D network model and compared for each simulation. A table of this data has been provided in Appendix F. Maximum water level data has also been extracted across the site in the 2D domain for the all the AEP events, and represented in Appendix G.

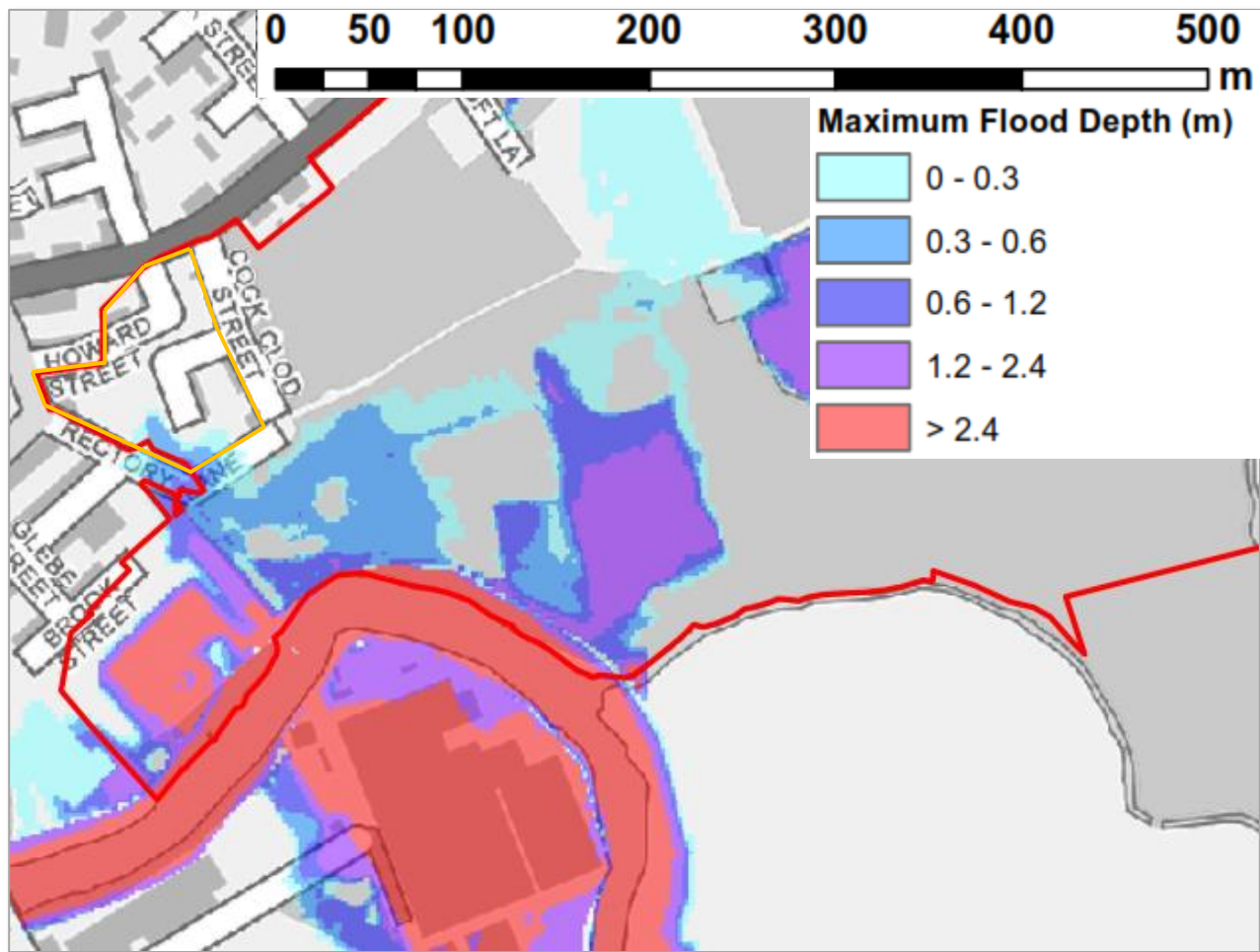
Detailed below is a summary of the flood mechanisms for the simulated events, which is to be read in conjunction with the above detailed information.

### EXG Simulations

The results of the hydraulic modelling show the development site to experience flooding during all the simulated flood events. The extent of flooding on the site increases from the lower to the higher AEP events. Some portions of the site near the eastern and western site boundaries, which are at a higher ground elevation, remains flood free during all the simulated events.

During all the simulated events, floodwater is shown to exceed Crow Trees Farm Brook channel capacity upstream of the A6053 Cross Lane Culvert and overtop the road. From here floodwater flows south and enters the site via the northern site boundary causing low-lying areas of the site to experience flooding. Floodwater continues to flow south and exits the site via the southern site boundary to discharge into the River Irwell.

The 2018 ELPM site modelling results show the Island Site experiences flooding in the southwest of the site during the 1% AEP + 35%CC event as a result of the River Irwell and / or Bealey's Goit overtopping their banks. Figure 1 shows an extract of the results.



**Figure 1 Extract from ELPM scheme. 1% AEP event plus 35% climate change allowance, existing site scenario. The orange line shows the approximate site boundary of the Island Site, and the red line the ELPM site boundary.**

### Blockage Scenario Simulation

Model outputs from the 1%AEP + 35%CC event, BL1 blockage scenario (100% blockage of A6053 Cross Lane Culvert) show the flood extents on the site are similar but slightly larger than the unblocked scenario extents. The flood depths on the site are also shown to increase by up to 150mm relative to the unblocked scenario. The flood risk associated with the blockage can be attributed to the significantly reduced flow capacity of the culvert, leading to additional water levels and spilling upstream of the structure.

A sensitivity test investigating a lower percentage (80%) blockage of culvert showed that the flood depths on the site increase by up to 120mm relative to the unblocked scenario.

The downstream boundary sensitivity tests simulated had mixed results, the simulation corresponding to the 10% AEP event water level in the River Irwell showed negligible impact on flood risk at the site relative to the current EA model results. However, the other simulations corresponding to 5% AEP, 4% AEP and 1% AEP event water levels in the River Irwell were found to be unstable with the simulations crashing or results having major instabilities. We recommend further investigation into the model stability is carried and that agreement with the EA is sorted regarding the model set-up at downstream boundary or whether the CTFB

model be combined with the River Irwell model.

### **Model Flood Extents versus EA Flood Zones**

A comparison of modelled flood extents versus current EA Flood Zones on the site show that the flood extents are similar. The modelled 1% AEP event flood extents almost match with the EA FZ3 outline, whereas the modelled 0.1% AEP event flood extents are slightly smaller compared to the EA FZ2 outline on the site. The minor differences can be attributed to the site-specific model updates carried out as part of this study.



## Recommendations

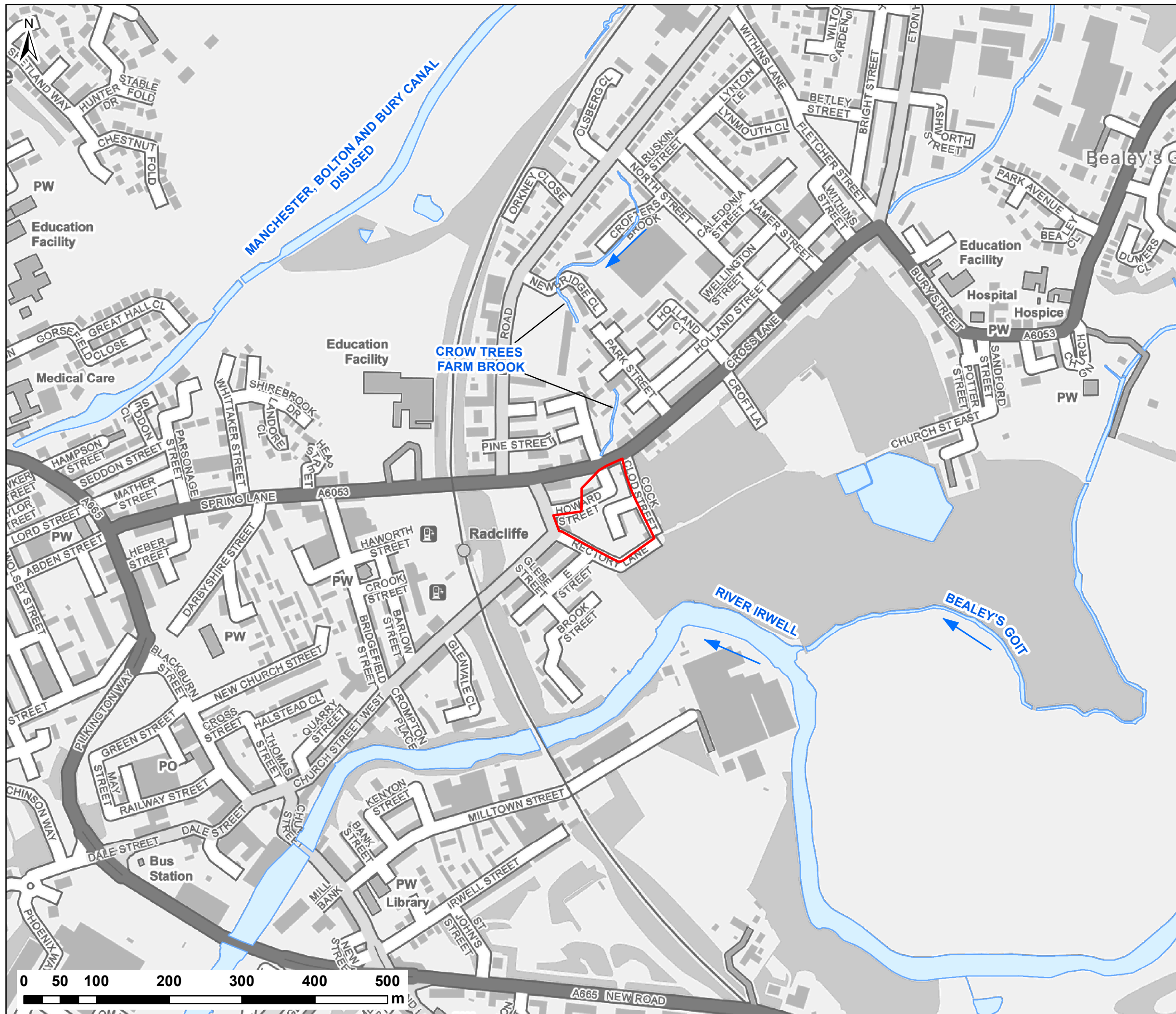
The outputs from the updated EA Crow Trees Farm Brook hydraulic model and associated technical note should be used to inform the Master Planning of the site. If Planning approval is sought for the development in the future, it is recommended that additional works are carried out for a detailed site-specific assessment of flood risk. We highly recommend liaison with the EA to confirm all modelling requirements for Planning Approval. A detailed modelling methodology should be submitted to the EA to confirm (but not limited to):

- The model extents and boundary conditions. The CTFB model includes the River Irwell water levels as downstream boundary condition. The model could be updated to include representation of the River Irwell and Bealey's Goit to assess the direct flood risk from the River Irwell at the site.
- Watercourse inflows and required AEP events. If the CTFB and the River Irwell model are to be combined, or the CTFB model is extended to include a truncated section of the Irwell, it is likely that variable storm durations for the two river catchments will have to be simulated for different AEP events.
- Blockage locations. There are several culverts along the CTFB watercourse and Bealey's Goit which could impact flooding at the site if blocked and so may be a requirement of the EA to investigate such blockages.

Further recommendations for additional modelling include:

- Sensitivity testing of key model parameters such as roughness coefficients, inflows and downstream boundary conditions.
- Investigation into the model stability to understand why some of the downstream sensitivity runs crashed, as this could be a sign of poor overall model performance.

## **Appendix A    Location Plan & Aerial Image**



NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

**LEGEND**

Site Boundary

Watercourses / Water Bodies

CLIENT:

**Waterco**

[www.waterco.co.uk](http://www.waterco.co.uk)

SCHEME:

**ISLAND SITE,  
RADCLIFFE**

PLOT TITLE:

**LOCATION PLAN**

|                     |          |            |                                      |
|---------------------|----------|------------|--------------------------------------|
| PLOT STATUS:        |          | DATE:      |                                      |
| <b>FINAL</b>        |          | 04/11/2020 |                                      |
| DRAWN:              | CHECKED: | APPROVED:  | PLOT SCALE @ A3:                     |
| VJ                  | SB       | DH         | 1:5,000<br>(UNLESS STATED OTHERWISE) |
| PLOT NAME:          |          |            | REV:                                 |
| 13478-Location_Plan |          |            | -                                    |





NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

LEGEND

Site Boundary



CLIENT:



[www.waterco.co.uk](http://www.waterco.co.uk)

SCHEME:

ISLAND SITE,  
RADCLIFFE

PLOT TITLE:

AERIAL PLAN

PLOT STATUS:

FINAL

DATE:

03/11/2020

DRAWN:

VJ

CHECKED:

SB

APPROVED:

DH

PLOT SCALE @ A3:

1:5,000

(UNLESS STATED OTHERWISE)

PLOT NAME:

13478-Aerial\_Plan

REV:

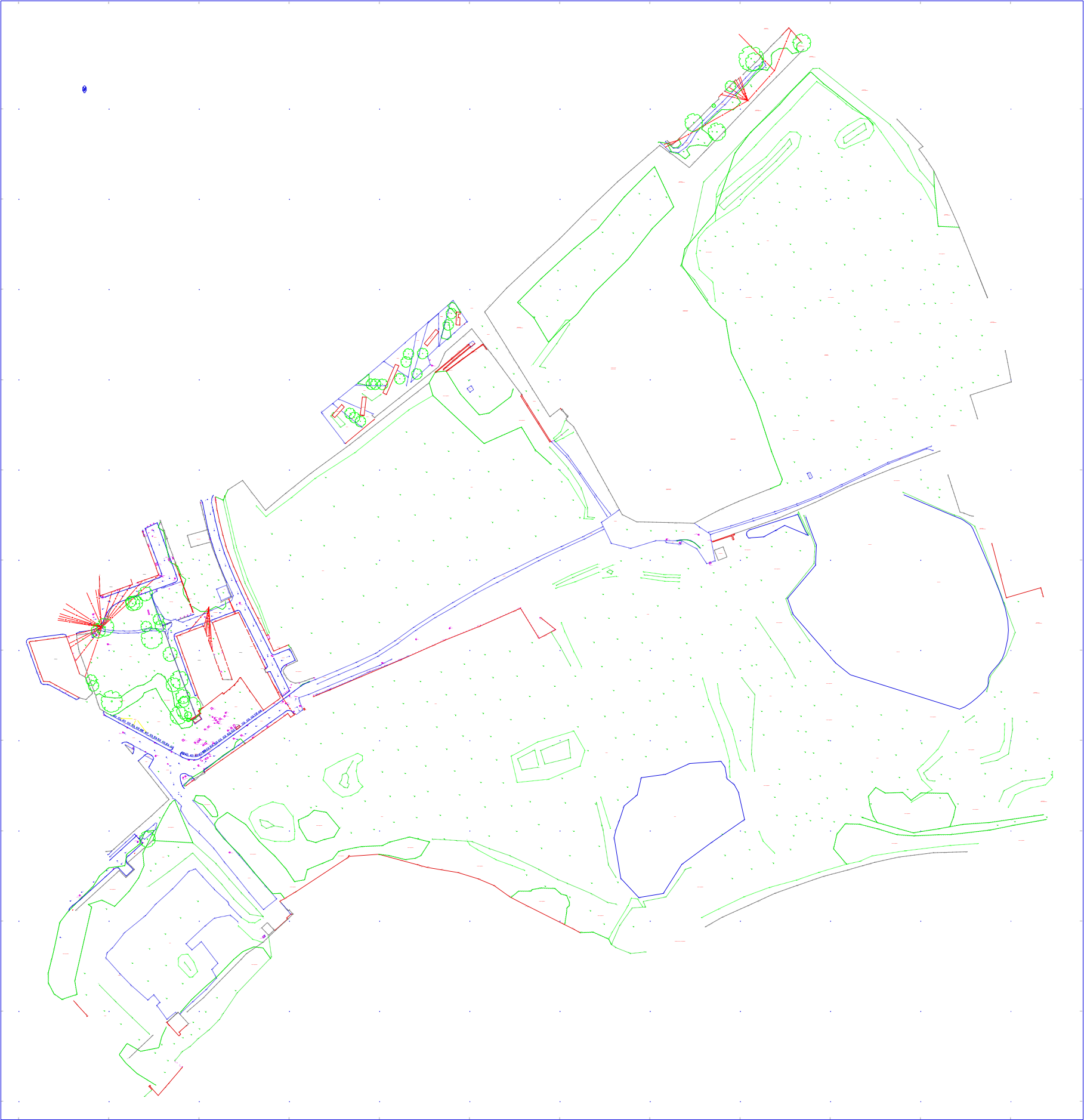
-

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

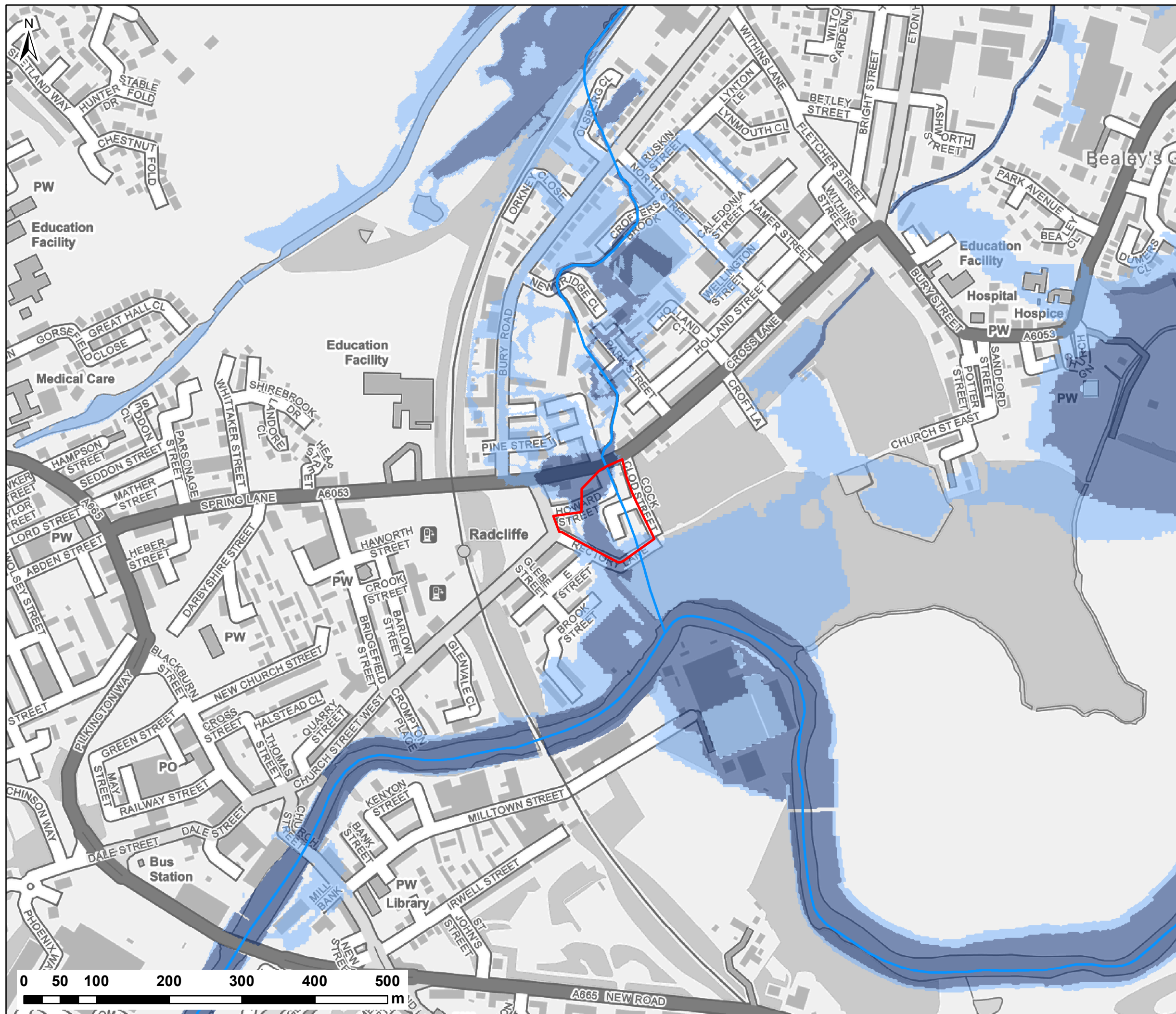


## **Appendix B    Survey Data**





## Appendix C    EA Flood Maps



NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

**LEGEND**

- Site Boundary
- EA Main Rivers
- EA Flood Zone 3
- EA Flood Zone 2

CLIENT:

[www.waterco.co.uk](http://www.waterco.co.uk)

SCHEME:

**ISLAND SITE,  
RADCLIFFE**

PLOT TITLE:

**EA FLOOD MAP FOR PLANNING**  
DATA ACCESSED OCTOBER 2020

|                |          |           |                                      |
|----------------|----------|-----------|--------------------------------------|
| PLOT STATUS:   |          |           | DATE:                                |
| FINAL          |          |           | 03/11/2020                           |
| DRAWN:         | CHECKED: | APPROVED: | PLOT SCALE @ A3:                     |
| VJ             | SB       | DH        | 1:5,000<br>(UNLESS STATED OTHERWISE) |
| PLOT NAME:     |          |           | REV:                                 |
| 13478-EA_FZ_FM |          |           | -                                    |





NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

#### LEGEND

-  Site Boundary
-  Historical Flood Map



CLIENT:



A TETRA TECH COMPANY

  
[www.waterco.co.uk](http://www.waterco.co.uk)

SCHEME:

**ISLAND SITE,  
RADCLIFFE**

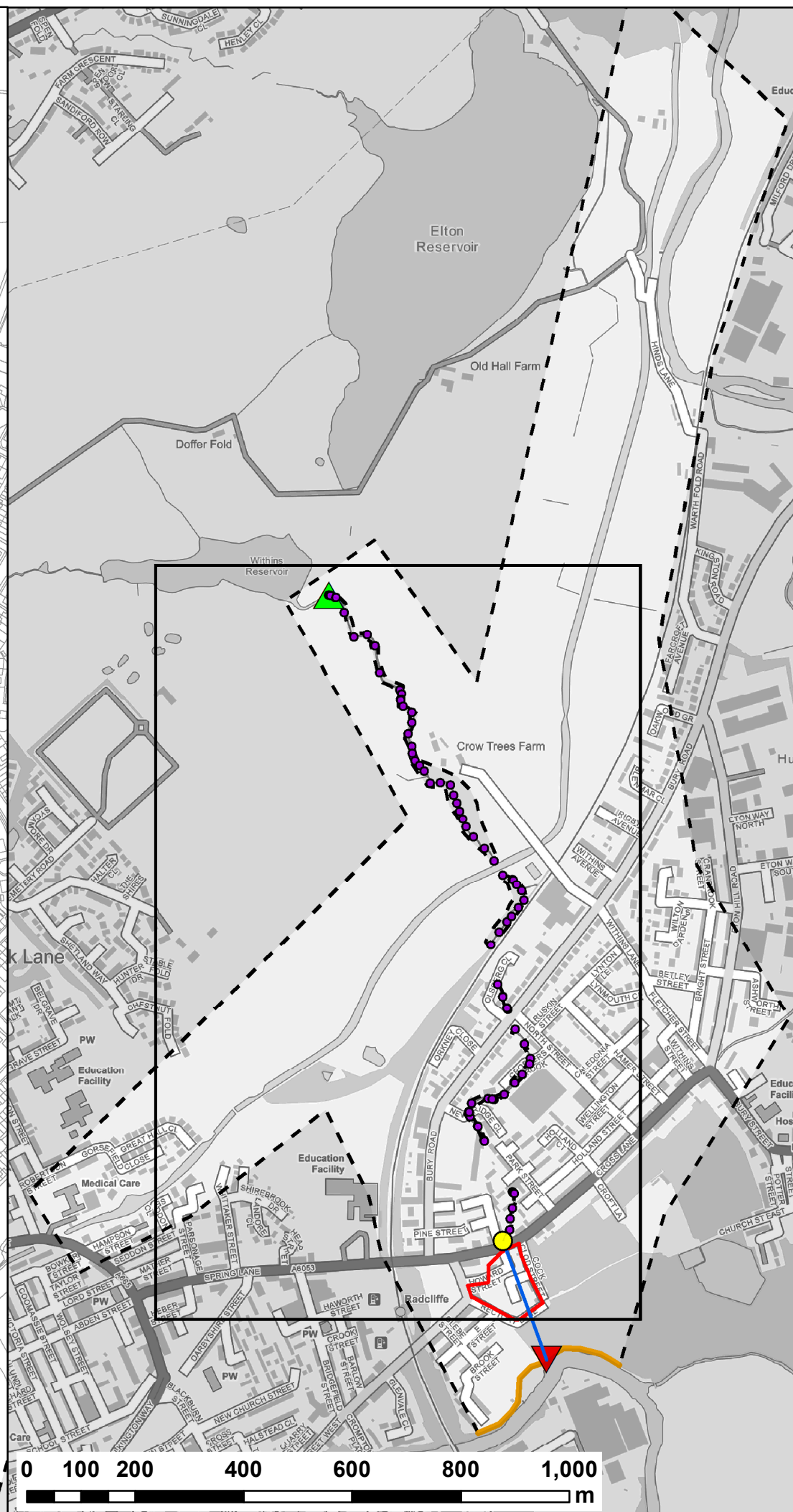
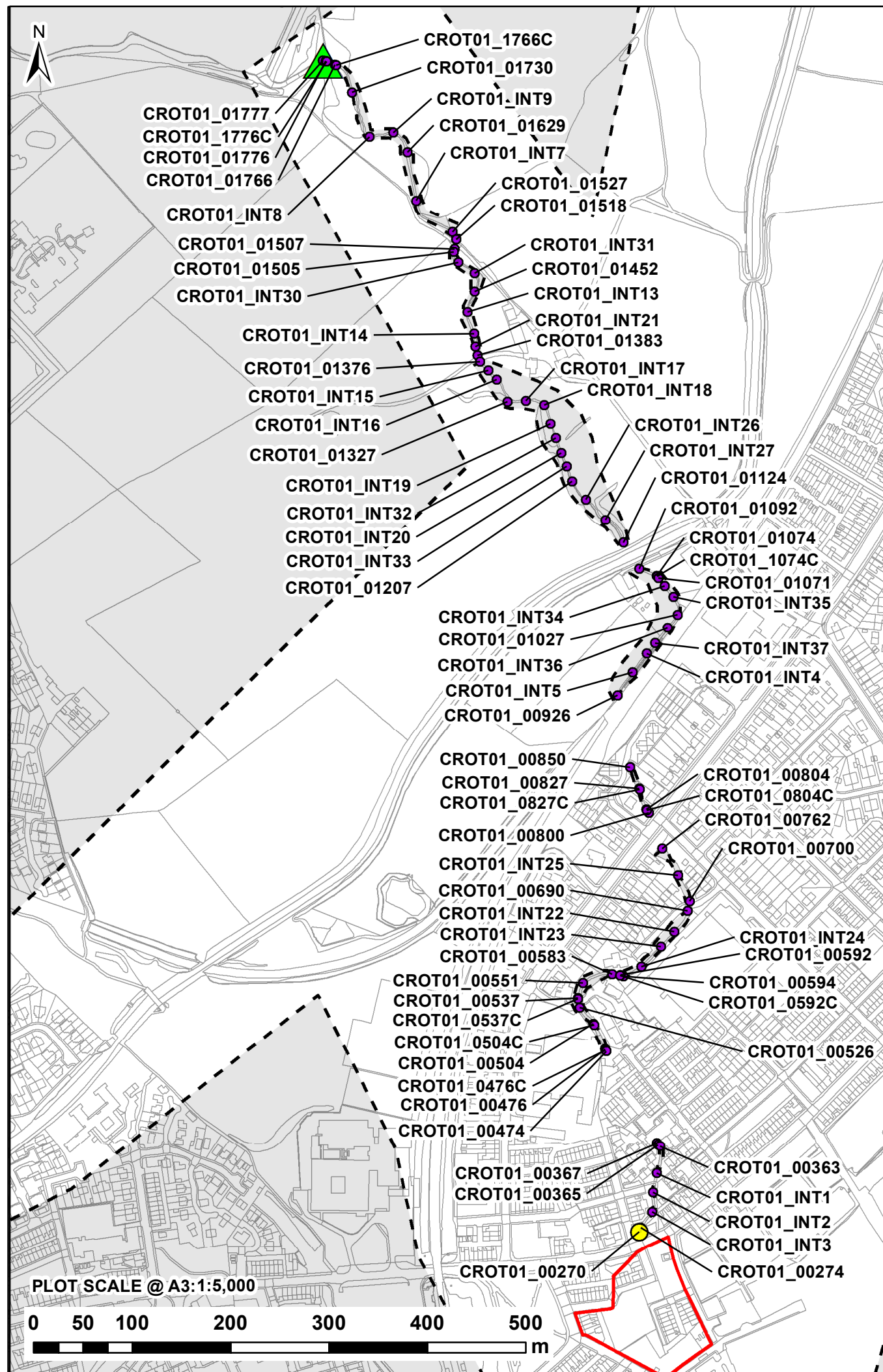
PLOT TITLE:

**EA HISTORICAL FLOOD MAP**  
DATA ACCESSED OCTOBER 2020

|               |          |            |                                      |
|---------------|----------|------------|--------------------------------------|
| PLOT STATUS:  |          | DATE:      |                                      |
| FINAL         |          | 03/11/2020 |                                      |
| DRAWN:        | CHECKED: | APPROVED:  | PLOT SCALE @ A3:                     |
| VJ            | SB       | DH         | 1:5,000<br>(UNLESS STATED OTHERWISE) |
| PLOT NAME:    |          |            | REV:                                 |
| 13478-EA_Hist |          |            | -                                    |



## **Appendix D    1D/2D Model Extents**



NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

**LEGEND**

- Site Boundary
- Model Extent
- A6053 Culvert Blockage Location
- 1D Nodes
- 1D Model Inflow Location
- 1D Model Outflow Location
- Culvert Section
- 2D Downstream Boundary

CLIENT: **Wygg**  
A TETRA TECH COMPANY

**waterco**  
www.waterco.co.uk

SCHEME: **ISLAND SITE, RADCLIFFE**

PLOT TITLE: **MODEL EXTENT**

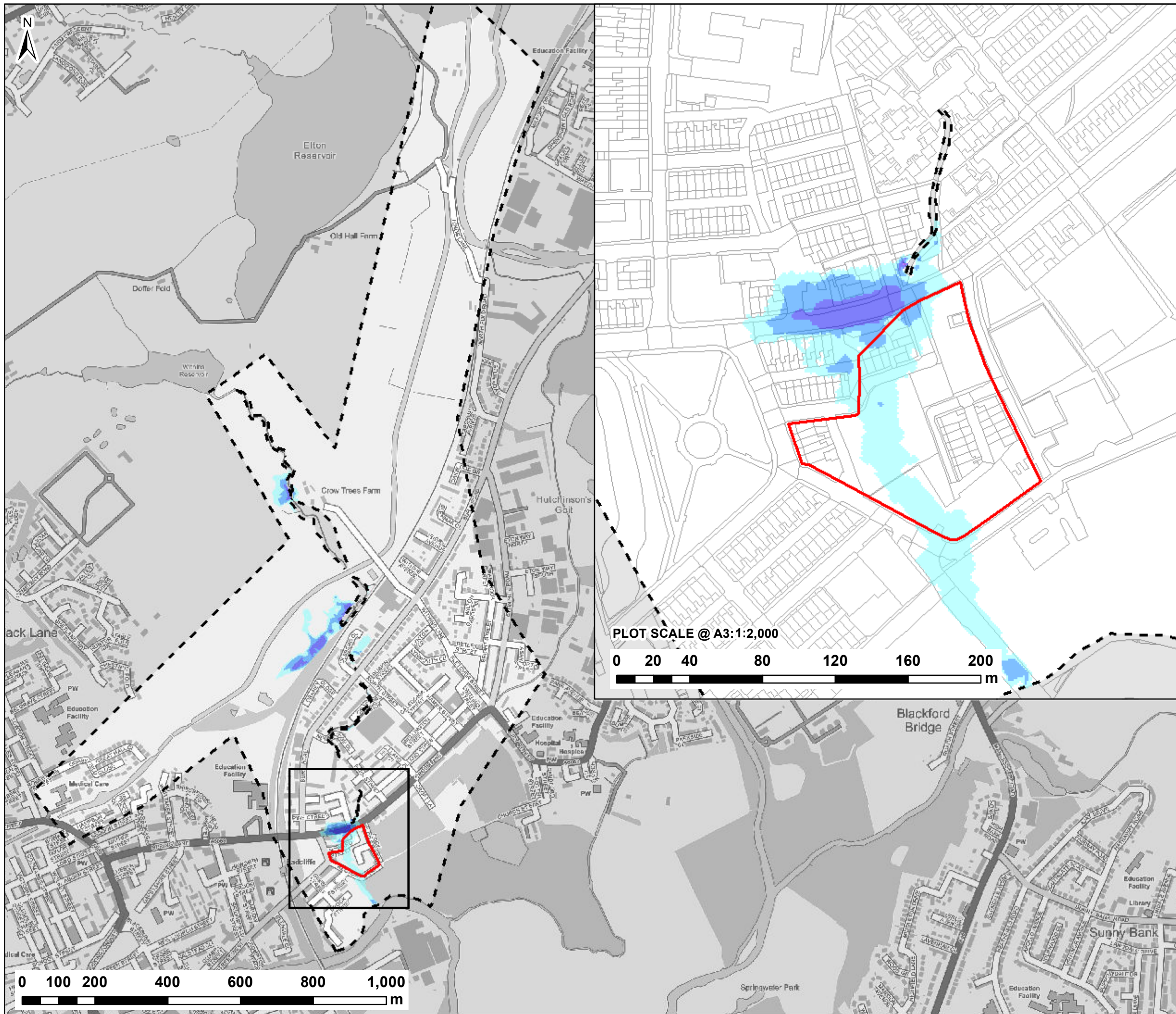
PLOT STATUS: **FINAL** DATE: 03/11/2020

DRAWN: VJ CHECKED: SB APPROVED: DH PLOT SCALE @ A3: 1:10,000 (UNLESS STATED OTHERWISE)

PLOT NAME: 13478-1D\_2D\_Model\_Extent REV: -

## **Appendix E    Flood Mapping**





NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

**LEGEND**

Site Boundary  
Model Extent

**Maximum Flood Depth (m)**

- 0 - 0.3
- 0.3 - 0.6
- 0.6 - 1.2
- 1.2 - 2.4
- > 2.4

CLIENT: **Wygg**  
A TETRA TECH COMPANY

**Waterco**  
www.waterco.co.uk

SCHEME: **ISLAND SITE, RADCLIFFE**

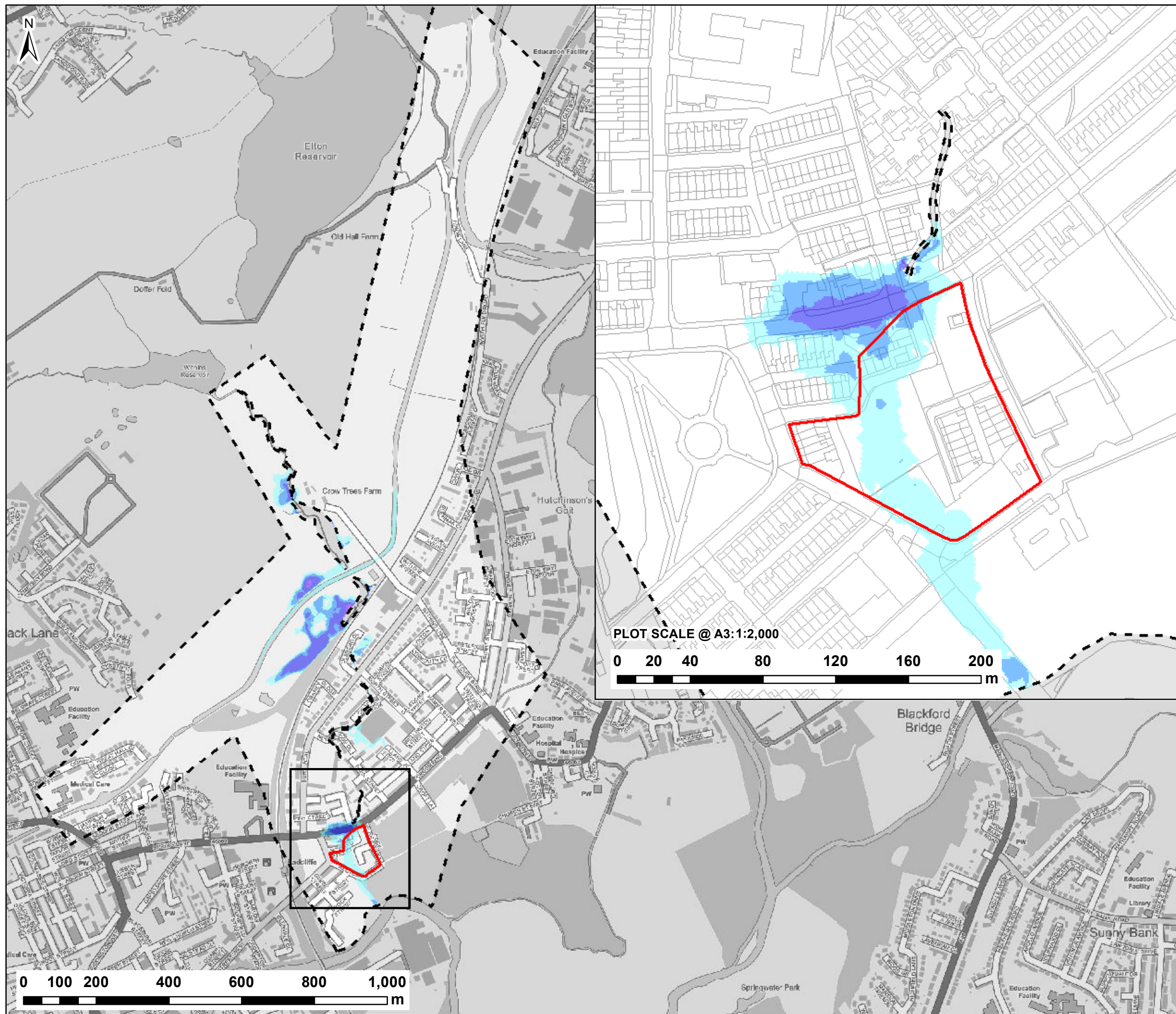
PLOT TITLE: **MAXIMUM FLOOD DEPTH  
5% AEP FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
NORMAL FLOW CONDITIONS**

PLOT STATUS: **FINAL** DATE: 03/11/2020

DRAWN: VJ CHECKED: SB APPROVED: DH PLOT SCALE @ A3: 1:10,000 (UNLESS STATED OTHERWISE)

PLOT NAME: 13478-CRT\_Q20\_EXG\_NFC\_D REV: -





**NOTES:**  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

**LEGEND**

Site Boundary  
Model Extent

**Maximum Flood Depth (m)**

- 0 - 0.3
- 0.3 - 0.6
- 0.6 - 1.2
- 1.2 - 2.4
- > 2.4

**CLIENT:**  
  
A TETRA TECH COMPANY

**waterco**  
www.waterco.co.uk

**SCHEME:**  
**ISLAND SITE, RADCLIFFE**

**PLOT TITLE:**  
**MAXIMUM FLOOD DEPTH**  
1% AEP FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
NORMAL FLOW CONDITIONS

**PLOT STATUS:**  
**FINAL**

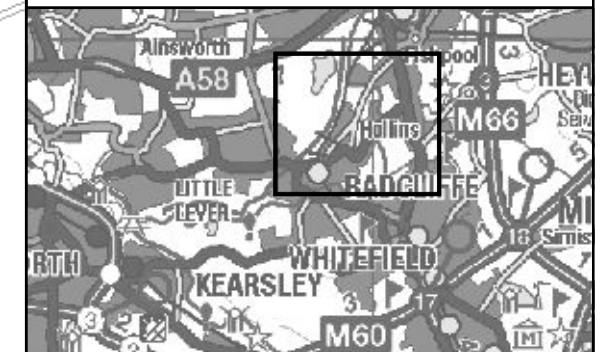
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03/11/2020

**DRAWN:** VJ  
**CHECKED:** SB  
**APPROVED:** DH

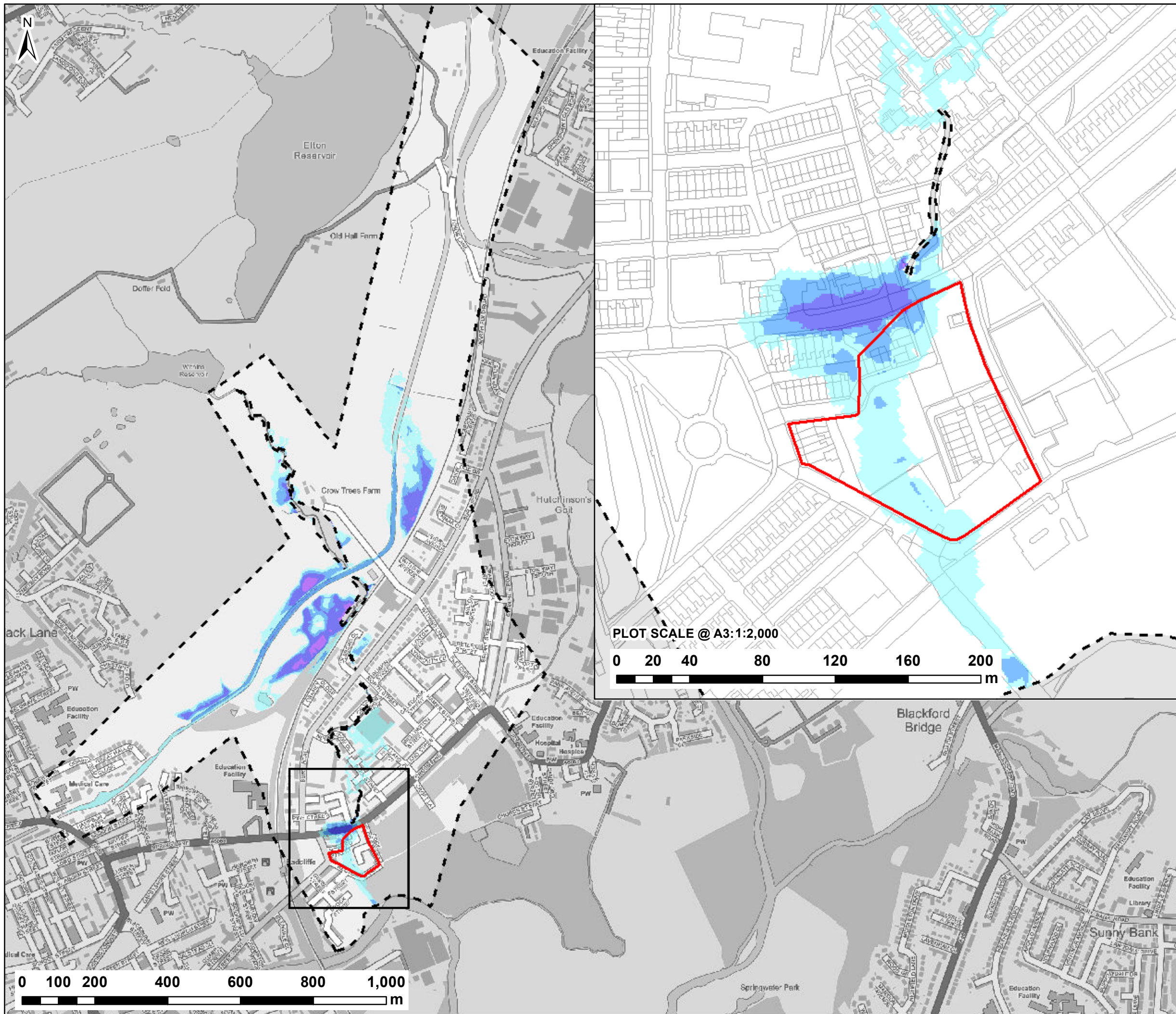
**PLOT SCALE @ A3:**  
1:10,000  
(UNLESS STATED OTHERWISE)

**PLOT NAME:**  
13478-CRT\_Q100\_EXG\_NFC\_D

**REV:**  
-







**NOTES:**  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

**LEGEND**

Site Boundary  
Model Extent

**Maximum Flood Depth (m)**

- 0 - 0.3
- 0.3 - 0.6
- 0.6 - 1.2
- 1.2 - 2.4
- > 2.4

**CLIENT:**  
  
A TETRA TECH COMPANY

**waterco**  
www.waterco.co.uk

**SCHEME:**  
**ISLAND SITE, RADCLIFFE**

**PLOT TITLE:**  
**MAXIMUM FLOOD DEPTH**  
1% AEP + 35% CC FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
NORMAL FLOW CONDITIONS

**PLOT STATUS:**  
**FINAL**

**DATE:**  
03/11/2020

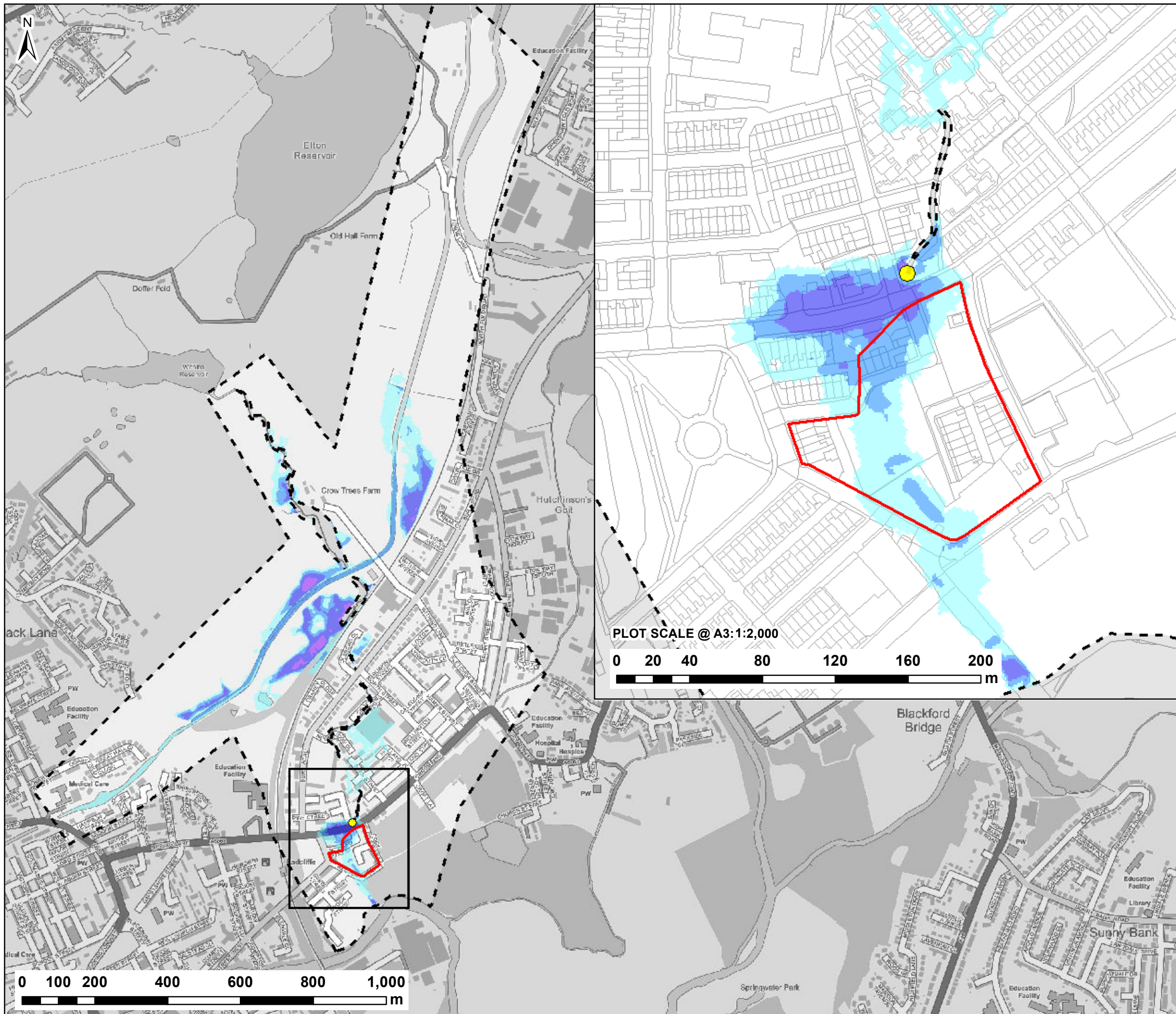
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**CHECKED:** SB  
**APPROVED:** DH

**PLOT SCALE @ A3:**  
1:10,000  
(UNLESS STATED OTHERWISE)

**PLOT NAME:**  
13478-CRT\_Q100CC1\_EXG\_NFC\_D

**REV:**  
-





NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

**LEGEND**

- Site Boundary
- Model Extent
- A6053 Culvert Blockage Location

**Maximum Flood Depth (m)**

- 0 - 0.3
- 0.3 - 0.6
- 0.6 - 1.2
- 1.2 - 2.4
- > 2.4

CLIENT:   
A TETRA TECH COMPANY

  
www.waterco.co.uk

SCHEME: **ISLAND SITE, RADCLIFFE**

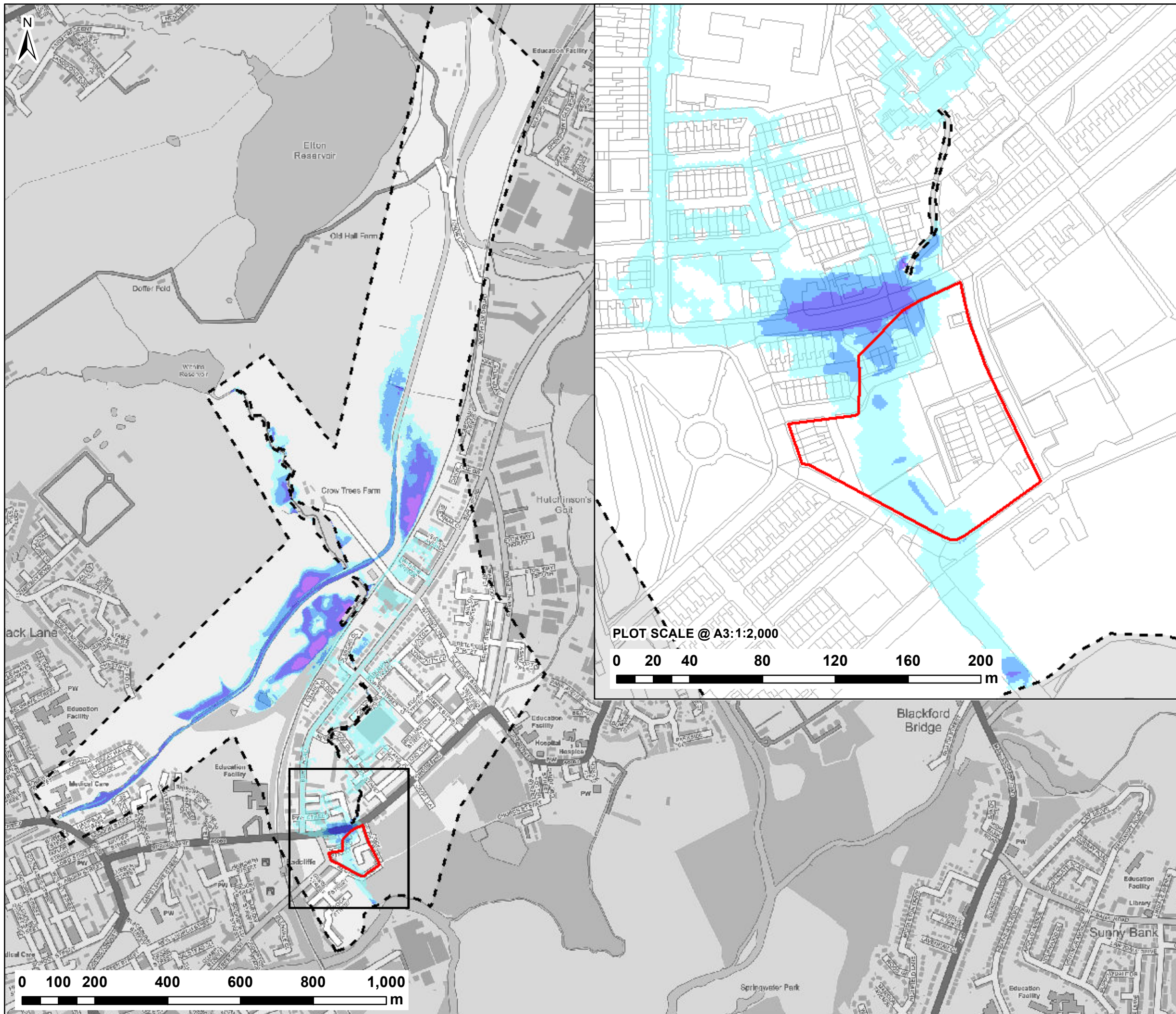
PLOT TITLE: **MAXIMUM FLOOD DEPTH  
1% AEP + 35% CC FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
100% BLOCKAGE A6053 CULVERT**

PLOT STATUS: **FINAL** DATE: 03/11/2020

DRAWN: VJ CHECKED: SB APPROVED: DH PLOT SCALE @ A3: 1:10,000 (UNLESS STATED OTHERWISE)

PLOT NAME: 13478-CRT\_Q100CC1\_EXG\_BL1-99.9\_D REV: -





NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

**LEGEND**

Site Boundary  
Model Extent

**Maximum Flood Depth (m)**

- 0 - 0.3
- 0.3 - 0.6
- 0.6 - 1.2
- 1.2 - 2.4
- > 2.4

CLIENT:   
A TETRA TECH COMPANY

  
www.waterco.co.uk

SCHEME: **ISLAND SITE, RADCLIFFE**

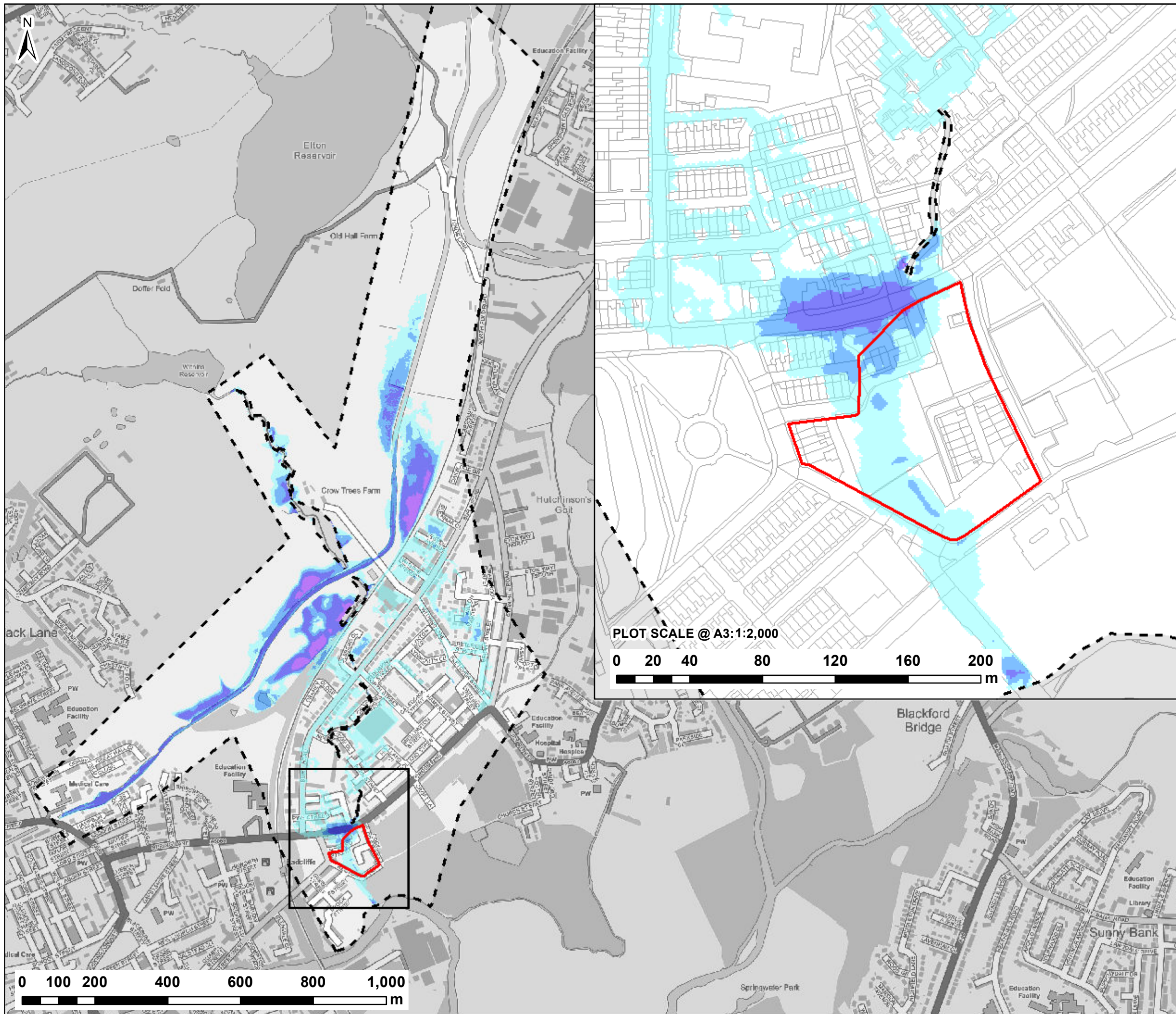
PLOT TITLE: **MAXIMUM FLOOD DEPTH  
1% AEP + 70% CC FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
NORMAL FLOW CONDITIONS**

PLOT STATUS: **FINAL** DATE: 03/11/2020

DRAWN: VJ CHECKED: SB APPROVED: DH PLOT SCALE @ A3: 1:10,000 (UNLESS STATED OTHERWISE)

PLOT NAME: 13478-CRT\_Q100CC2\_EXG\_NFC\_D REV: -





**NOTES:**  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

**LEGEND**

Site Boundary  
Model Extent

**Maximum Flood Depth (m)**

- 0 - 0.3
- 0.3 - 0.6
- 0.6 - 1.2
- 1.2 - 2.4
- > 2.4

**CLIENT:**  
  
A TETRA TECH COMPANY

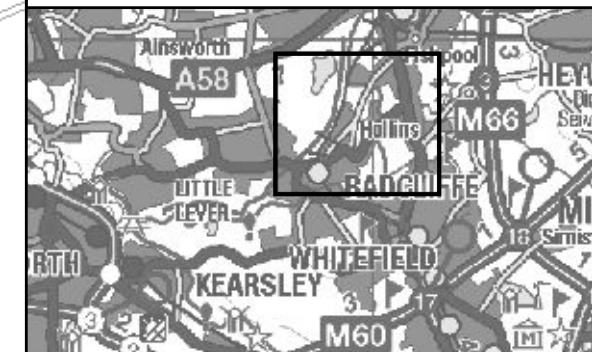
**SCHEME:**  
**ISLAND SITE, RADCLIFFE**

**PLOT TITLE:**  
**MAXIMUM FLOOD DEPTH**  
0.1% AEP FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
NORMAL FLOW CONDITIONS

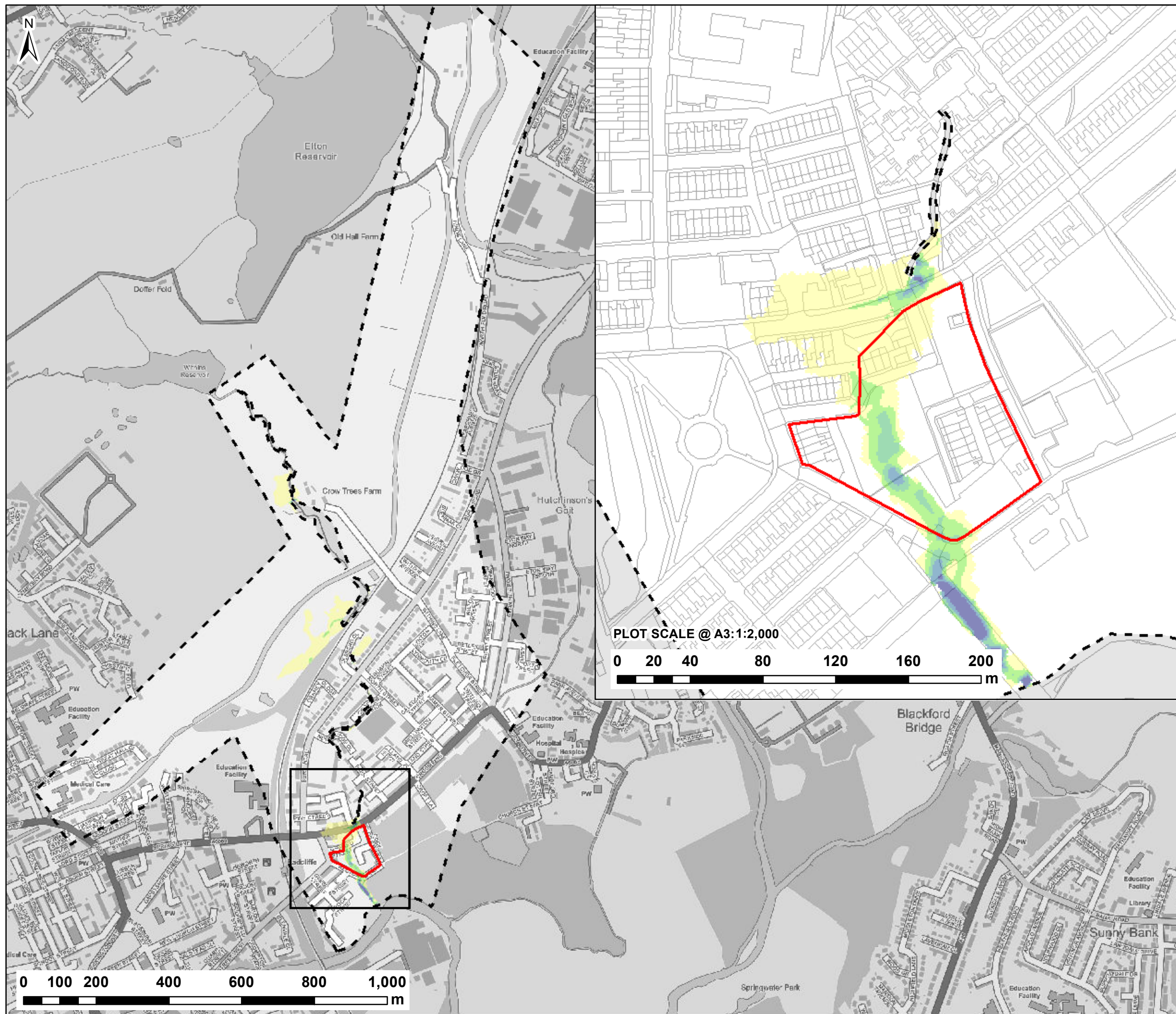
**PLOT STATUS:** **FINAL** **DATE:** 03/11/2020

**DRAWN:** VJ **CHECKED:** SB **APPROVED:** DH **PLOT SCALE @ A3:** 1:10,000 (UNLESS STATED OTHERWISE)

**PLOT NAME:** 13478-CRT\_Q1000\_EXG\_NFC\_D **REV:** -







NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

**LEGEND**

Site Boundary

Model Extent

**Maximum Velocity (m/s)**

- < 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

CLIENT:   
A TETRA TECH COMPANY

  
www.waterco.co.uk

SCHEME: **ISLAND SITE, RADCLIFFE**

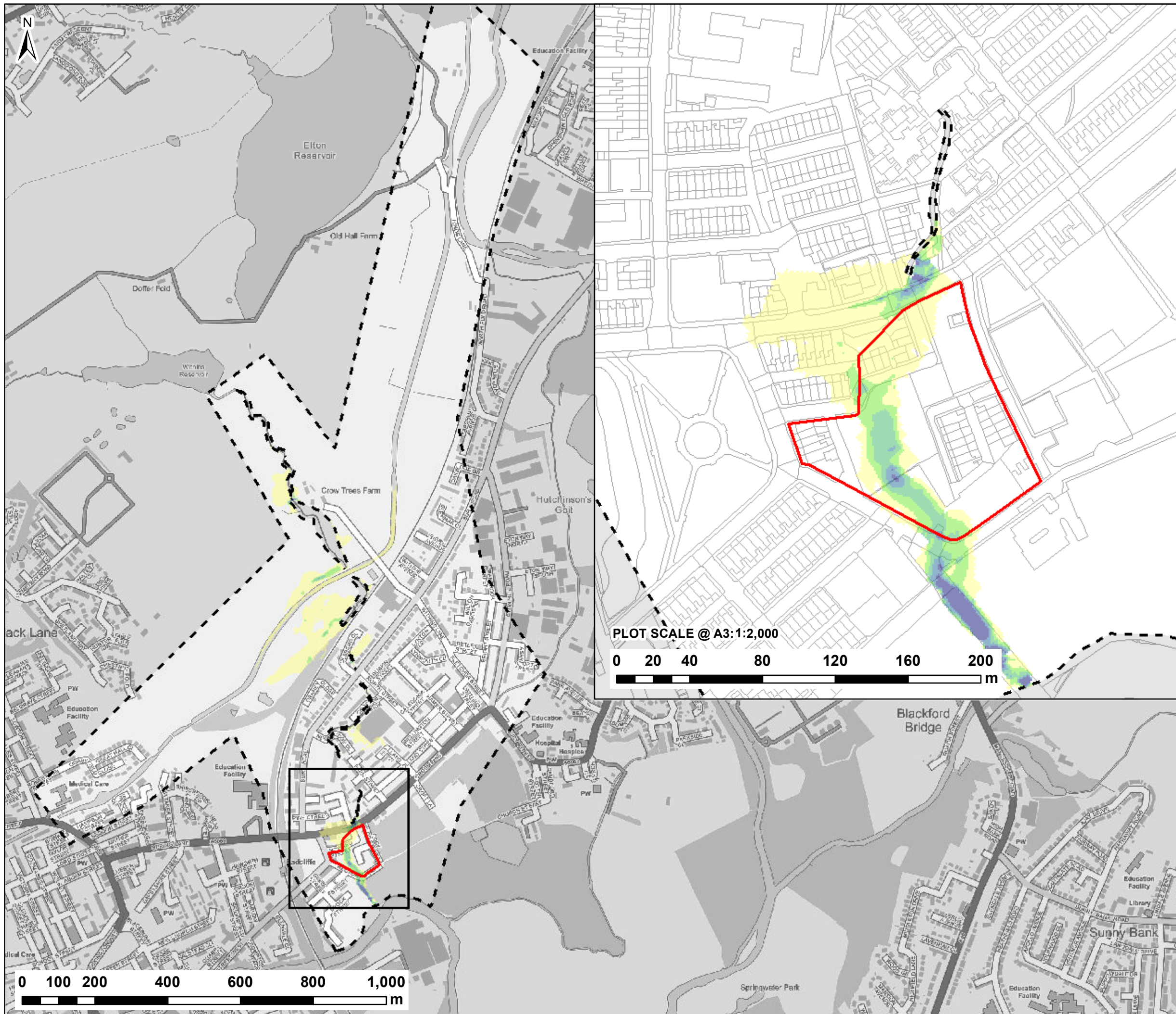
PLOT TITLE: **MAXIMUM VELOCITY  
5% AEP FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
NORMAL FLOW CONDITIONS**

PLOT STATUS: **FINAL** DATE: 03/11/2020

DRAWN: VJ CHECKED: SB APPROVED: DH PLOT SCALE @ A3: 1:10,000 (UNLESS STATED OTHERWISE)

PLOT NAME: 13478-CRT\_Q20\_EXG\_NFC\_V REV: -





NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

**LEGEND**

Site Boundary

Model Extent

**Maximum Velocity (m/s)**

- < 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

CLIENT:   
A TETRA TECH COMPANY

  
www.waterco.co.uk

SCHEME: **ISLAND SITE, RADCLIFFE**

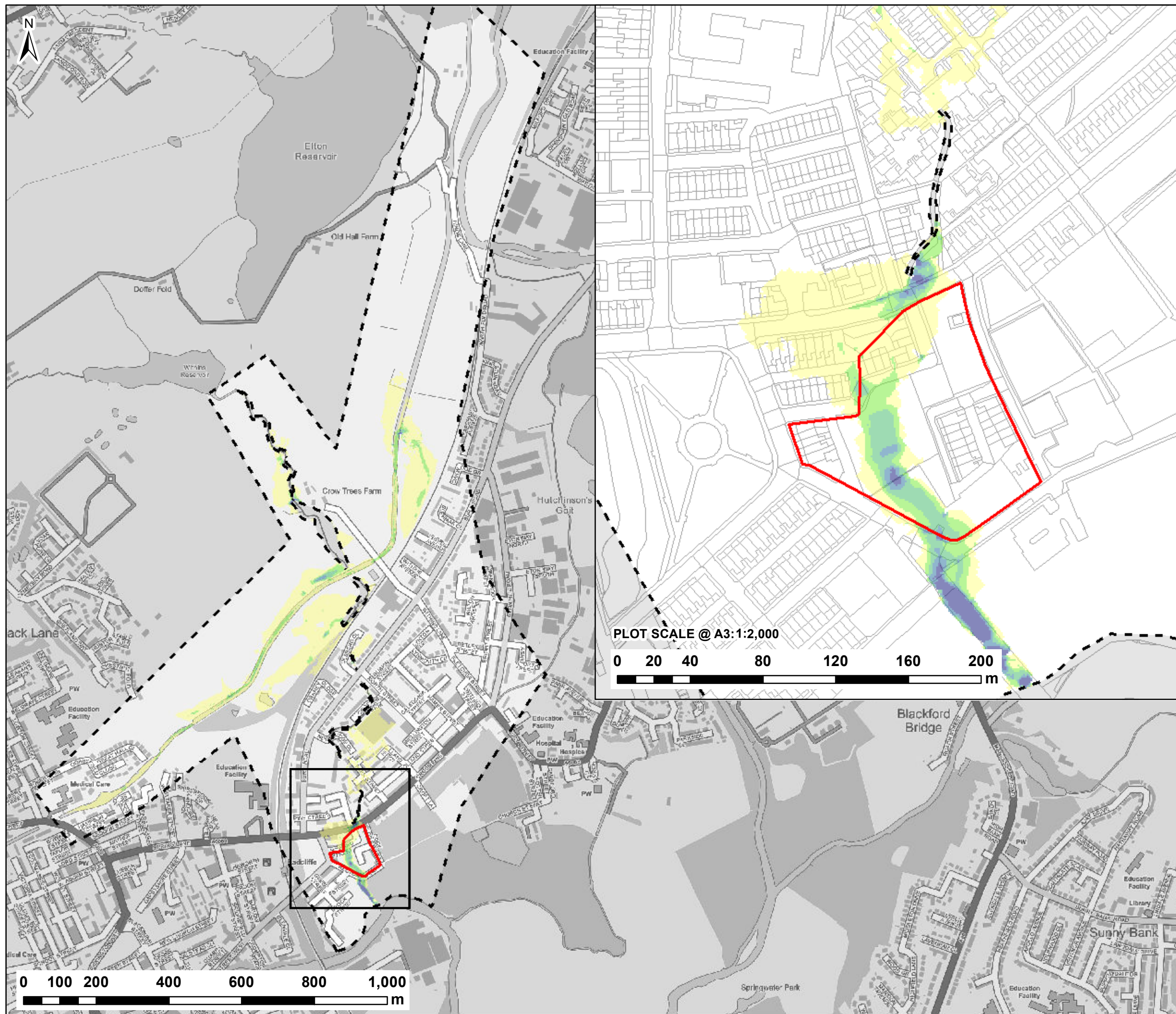
PLOT TITLE: **MAXIMUM VELOCITY  
1% AEP FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
NORMAL FLOW CONDITIONS**

PLOT STATUS: **FINAL** DATE: 03/11/2020

DRAWN: VJ CHECKED: SB APPROVED: DH PLOT SCALE @ A3: 1:10,000 (UNLESS STATED OTHERWISE)

PLOT NAME: 13478-CRT\_Q100\_EXG\_NFC\_V REV: -





NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

**LEGEND**

Site Boundary

Model Extent

**Maximum Velocity (m/s)**

- < 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

CLIENT: **Wyg**  
A TETRA TECH COMPANY

**Waterco**  
www.waterco.co.uk

SCHEME: **ISLAND SITE, RADCLIFFE**

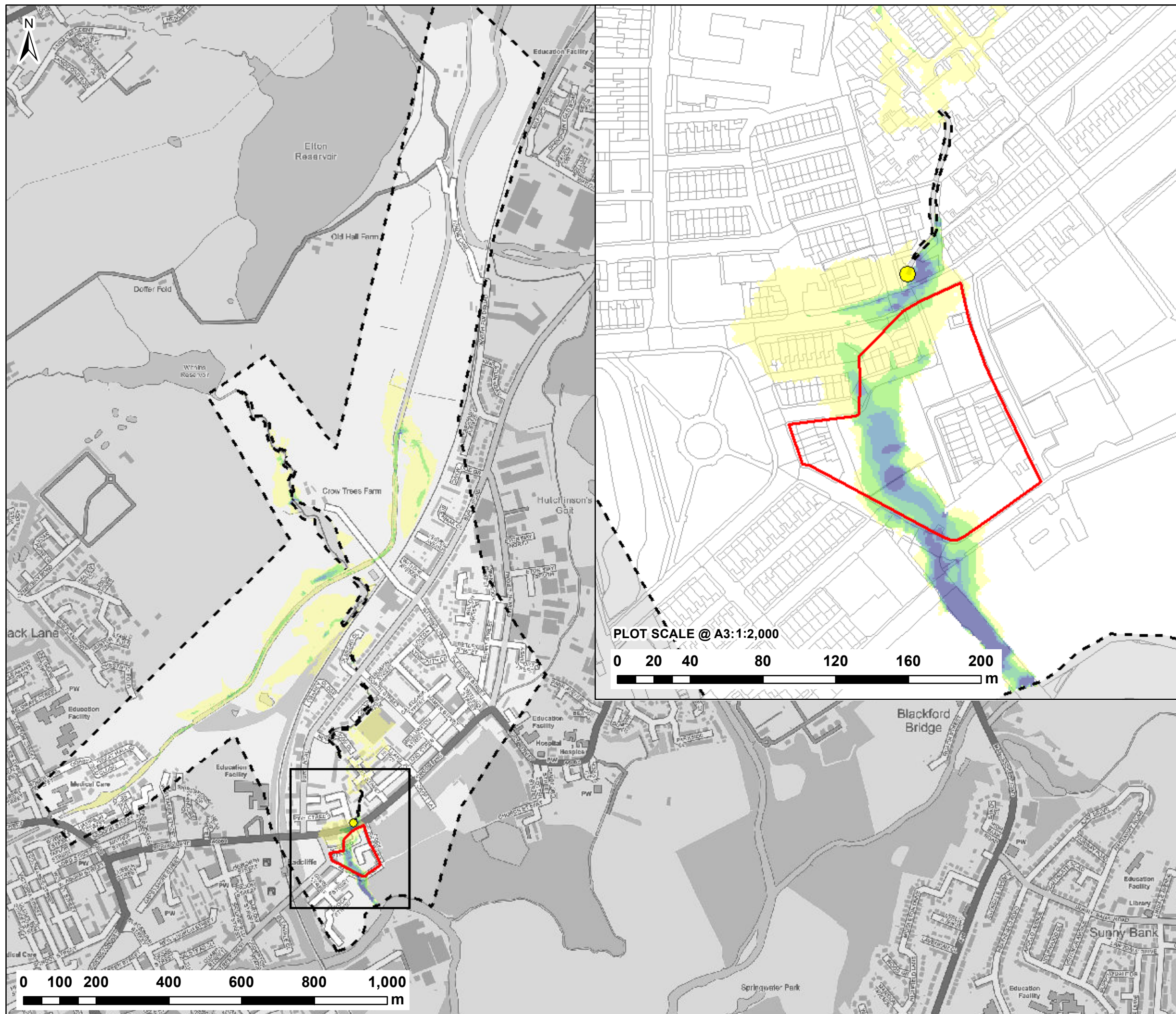
PLOT TITLE: **MAXIMUM VELOCITY  
1% AEP + 35% CC FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
NORMAL FLOW CONDITIONS**

PLOT STATUS: **FINAL** DATE: 03/11/2020

DRAWN: VJ CHECKED: SB APPROVED: DH PLOT SCALE @ A3: 1:10,000 (UNLESS STATED OTHERWISE)

PLOT NAME: 13478-CRT\_Q100CC1\_EXG\_NFC\_V REV: -





NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

**LEGEND**

- Site Boundary
- Model Extent
- A6053 Culvert Blockage Location

**Maximum Velocity (m/s)**

- < 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

CLIENT:   
A TETRA TECH COMPANY

  
www.waterco.co.uk

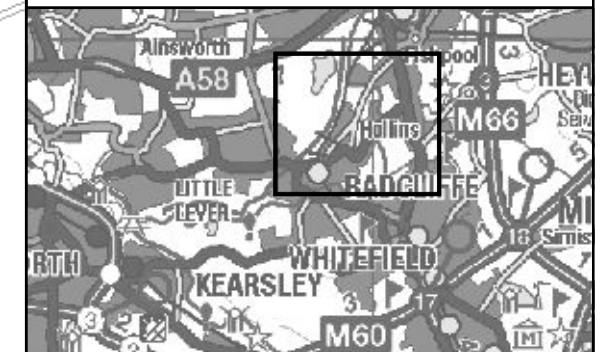
SCHEME: **ISLAND SITE, RADCLIFFE**

PLOT TITLE: **MAXIMUM VELOCITY  
1% AEP + 35% CC FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
100% BLOCKAGE A6053 CULVERT**

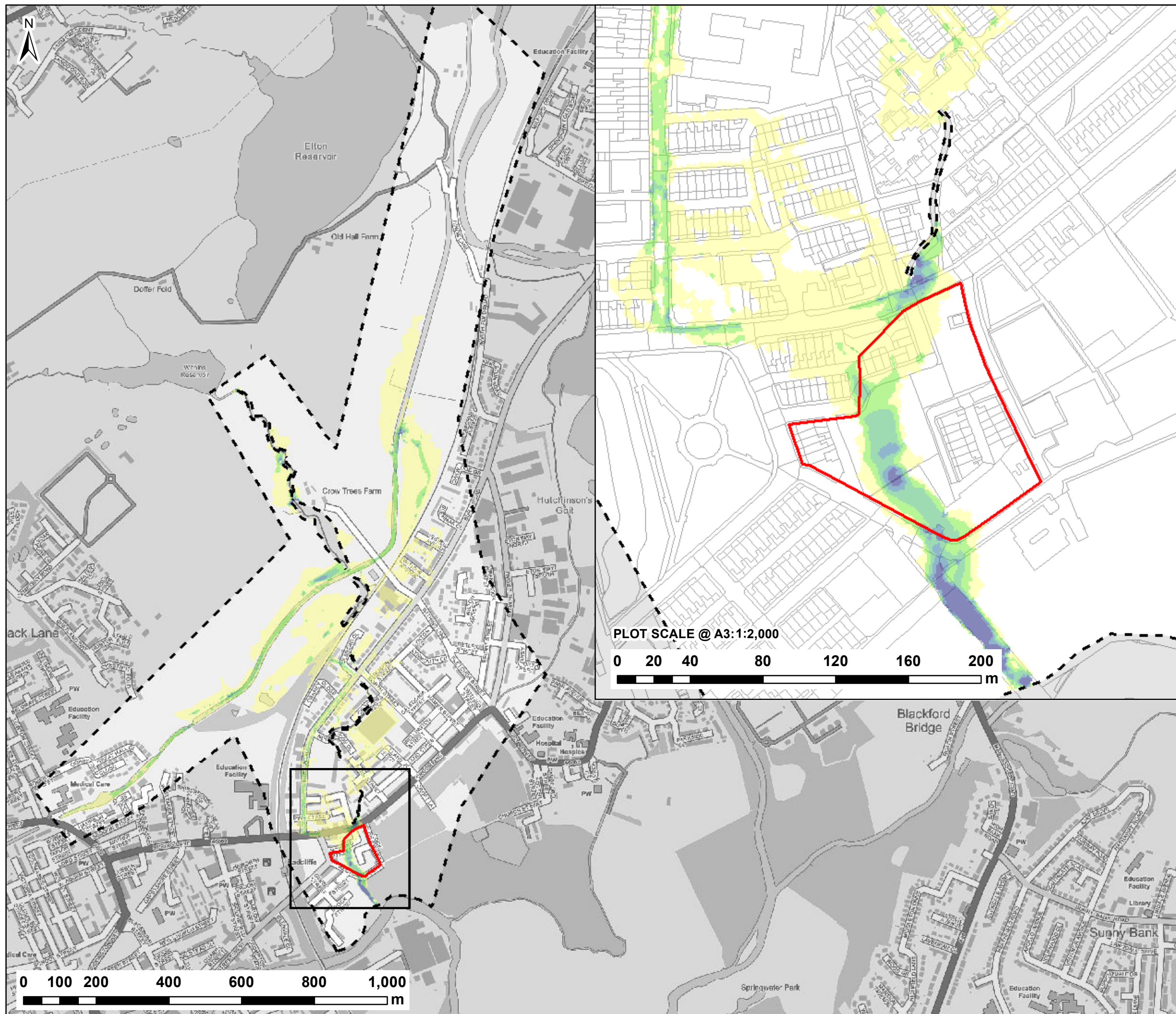
PLOT STATUS: **FINAL** DATE: 03/11/2020

DRAWN: VJ CHECKED: SB APPROVED: DH PLOT SCALE @ A3: 1:10,000 (UNLESS STATED OTHERWISE)

PLOT NAME: 13478-CRT\_Q100CC1\_EXG\_BL1-99.9\_V REV: -







**NOTES:**  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

**LEGEND**

Site Boundary

Model Extent

**Maximum Velocity (m/s)**

- < 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

**CLIENT:**

**waterco**  
www.waterco.co.uk

**SCHEME:**

**ISLAND SITE, RADCLIFFE**

**PLOT TITLE:**

**MAXIMUM VELOCITY**  
1% AEP + 70% CC FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
NORMAL FLOW CONDITIONS

**PLOT STATUS:** FINAL

**DATE:** 03/11/2020

**DRAWN:** VJ

**CHECKED:** SB

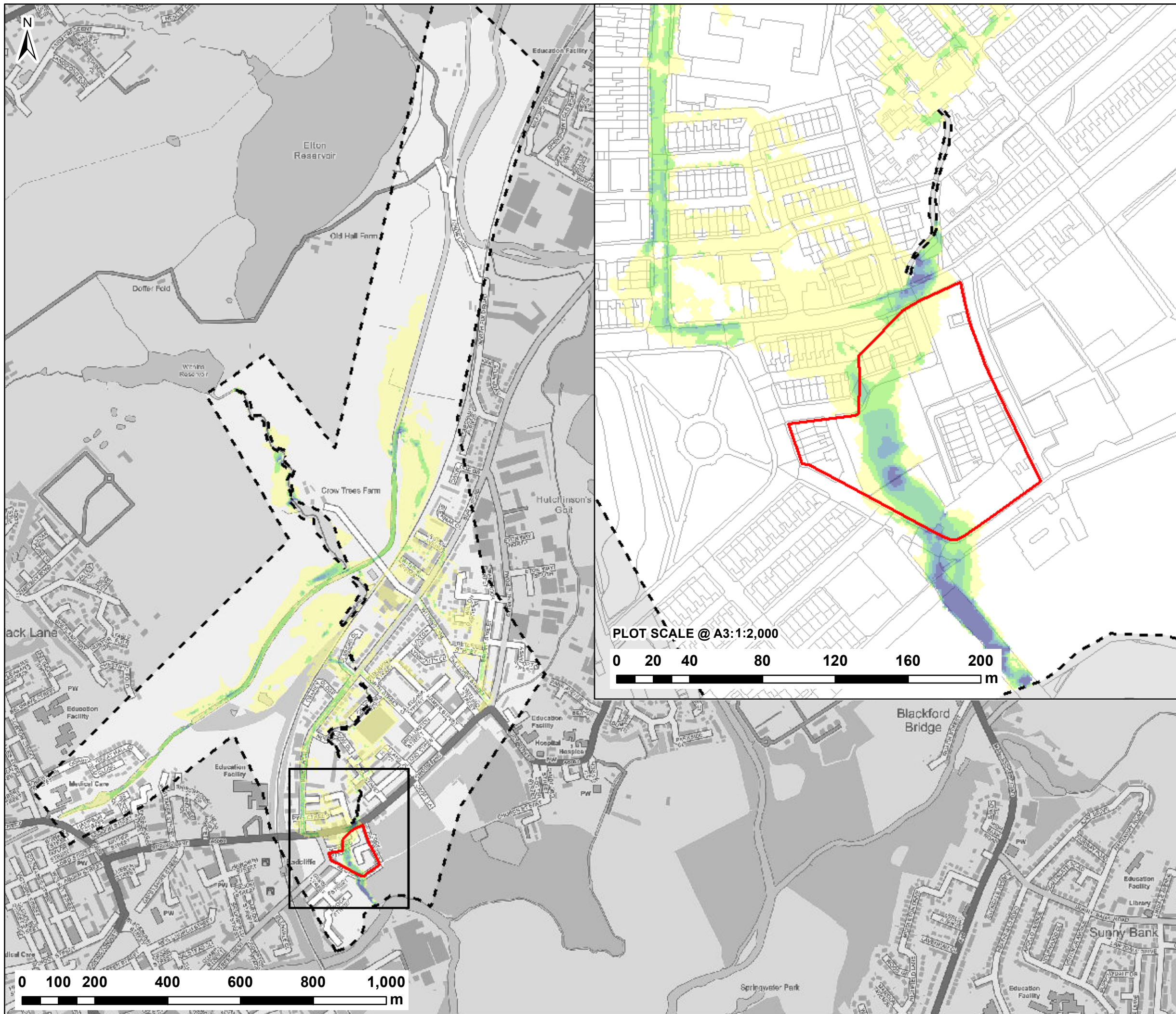
**APPROVED:** DH

**PLOT SCALE @ A3:** 1:10,000  
(UNLESS STATED OTHERWISE)

**PLOT NAME:** 13478-CRT\_Q100CC2\_EXG\_NFC\_V

**REV:** -





NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

**LEGEND**

Site Boundary

Model Extent

**Maximum Velocity (m/s)**

- < 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

CLIENT:

**Waterco**  
www.waterco.co.uk

SCHEME:

**ISLAND SITE,  
RADCLIFFE**

PLOT TITLE:

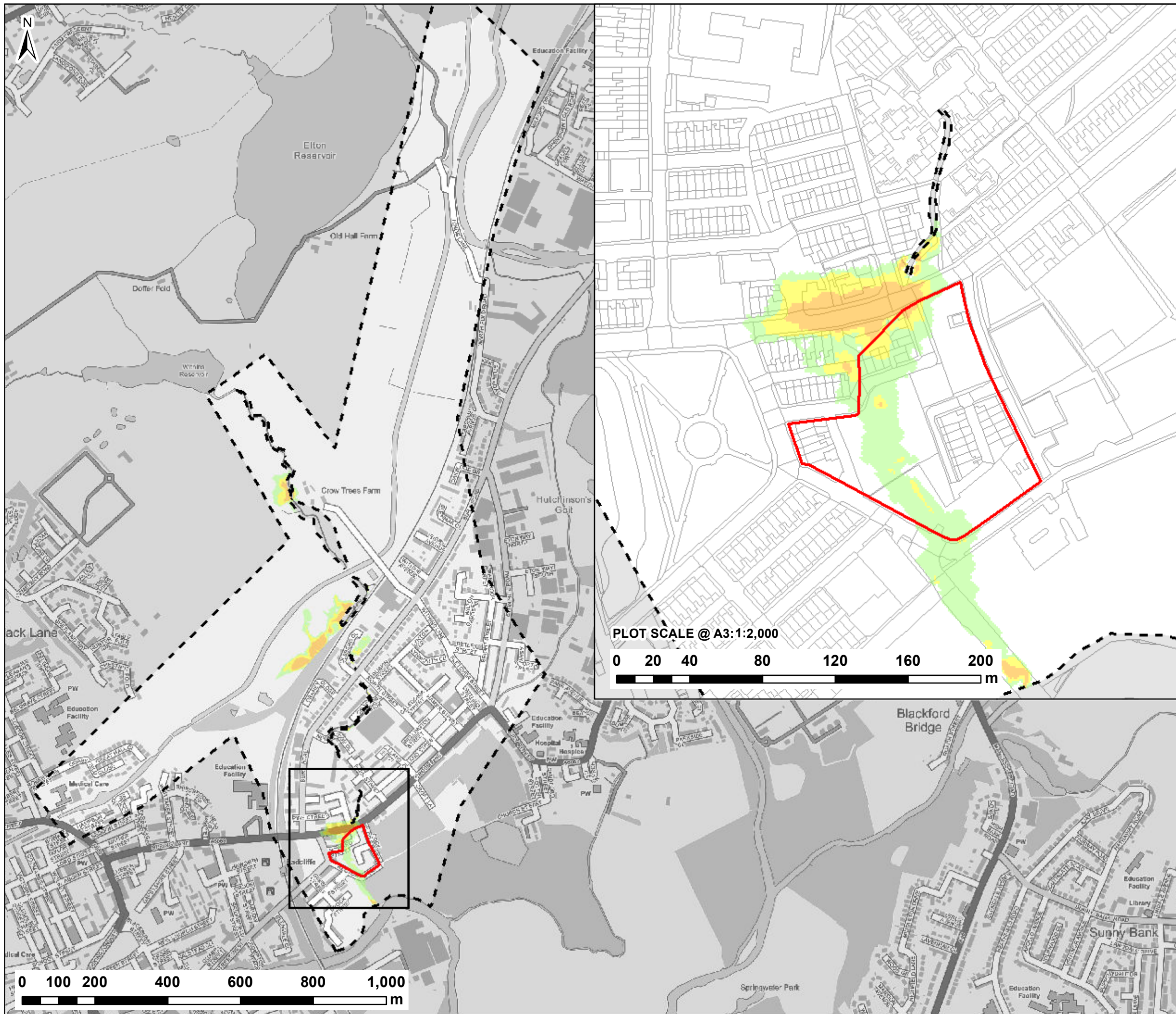
**MAXIMUM VELOCITY  
0.1% AEP FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
NORMAL FLOW CONDITIONS**

PLOT STATUS: **FINAL** DATE: 03/11/2020

DRAWN: VJ CHECKED: SB APPROVED: DH PLOT SCALE @ A3: 1:10,000 (UNLESS STATED OTHERWISE)

PLOT NAME: 13478-CRT\_Q1000\_EXG\_NFC\_V REV: -





NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

**LEGEND**

Site Boundary  
Model Extent

**Maximum Flood Hazard Rating (FD2320)**

< 0.75 (Caution)  
0.75 - 1.25 (Danger for Some)  
1.25 - 2 (Danger for Most)  
> 2.0 (Danger for All)

CLIENT:   
A TETRA TECH COMPANY

  
www.waterco.co.uk

SCHEME: **ISLAND SITE, RADCLIFFE**

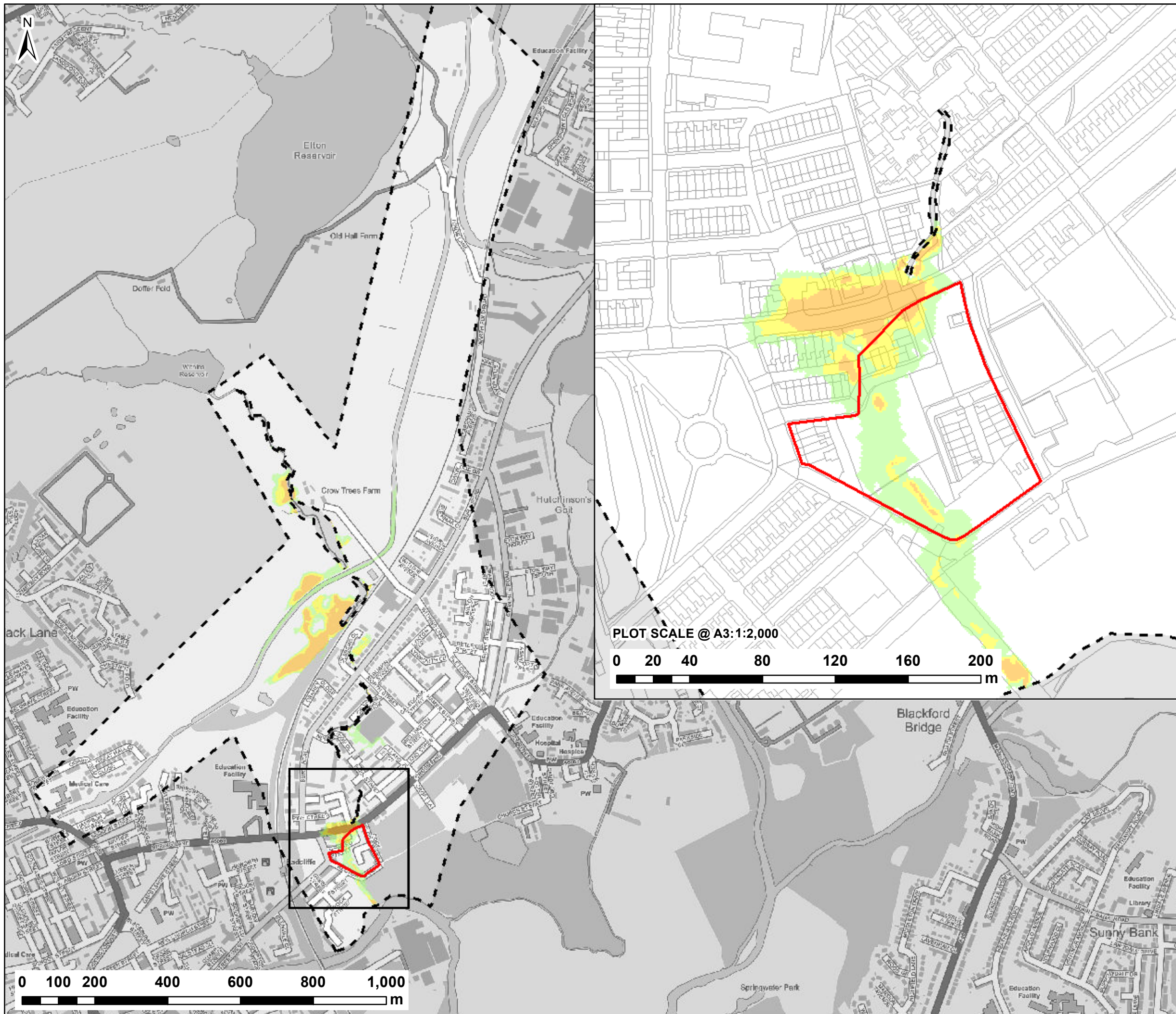
PLOT TITLE: **FLOOD HAZARD RATING  
5% AEP FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
NORMAL FLOW CONDITIONS**

PLOT STATUS: **FINAL** DATE: 03/11/2020

DRAWN: VJ CHECKED: SB APPROVED: DH PLOT SCALE @ A3: 1:10,000 (UNLESS STATED OTHERWISE)

PLOT NAME: 13478-CRT\_Q20\_EXG\_NFC\_HZ REV: -





NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

**LEGEND**

Site Boundary  
Model Extent

**Maximum Flood Hazard Rating (FD2320)**

< 0.75 (Caution)  
0.75 - 1.25 (Danger for Some)  
1.25 - 2 (Danger for Most)  
> 2.0 (Danger for All)

CLIENT:   
A TETRA TECH COMPANY

  
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SCHEME: **ISLAND SITE, RADCLIFFE**

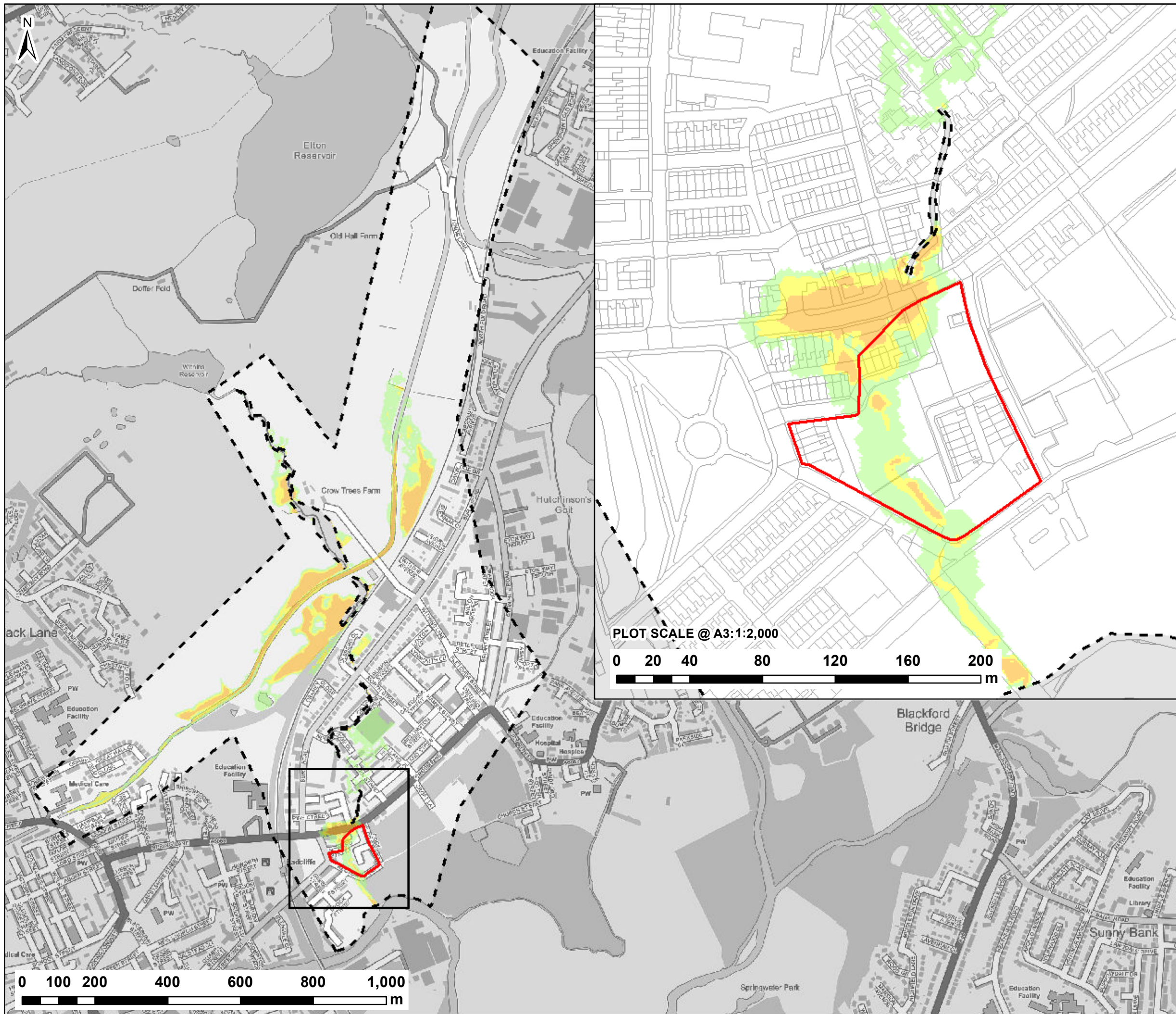
PLOT TITLE: **FLOOD HAZARD RATING  
1% AEP FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
NORMAL FLOW CONDITIONS**

PLOT STATUS: **FINAL** DATE: 03/11/2020

DRAWN: VJ CHECKED: SB APPROVED: DH PLOT SCALE @ A3: 1:10,000 (UNLESS STATED OTHERWISE)

PLOT NAME: 13478-CRT\_Q100\_EXG\_NFC\_HZ REV: -





NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

**LEGEND**

Site Boundary  
Model Extent

**Maximum Flood Hazard Rating (FD2320)**

< 0.75 (Caution)  
0.75 - 1.25 (Danger for Some)  
1.25 - 2 (Danger for Most)  
> 2.0 (Danger for All)

CLIENT: **Wyg**  
A TETRA TECH COMPANY

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SCHEME: **ISLAND SITE, RADCLIFFE**

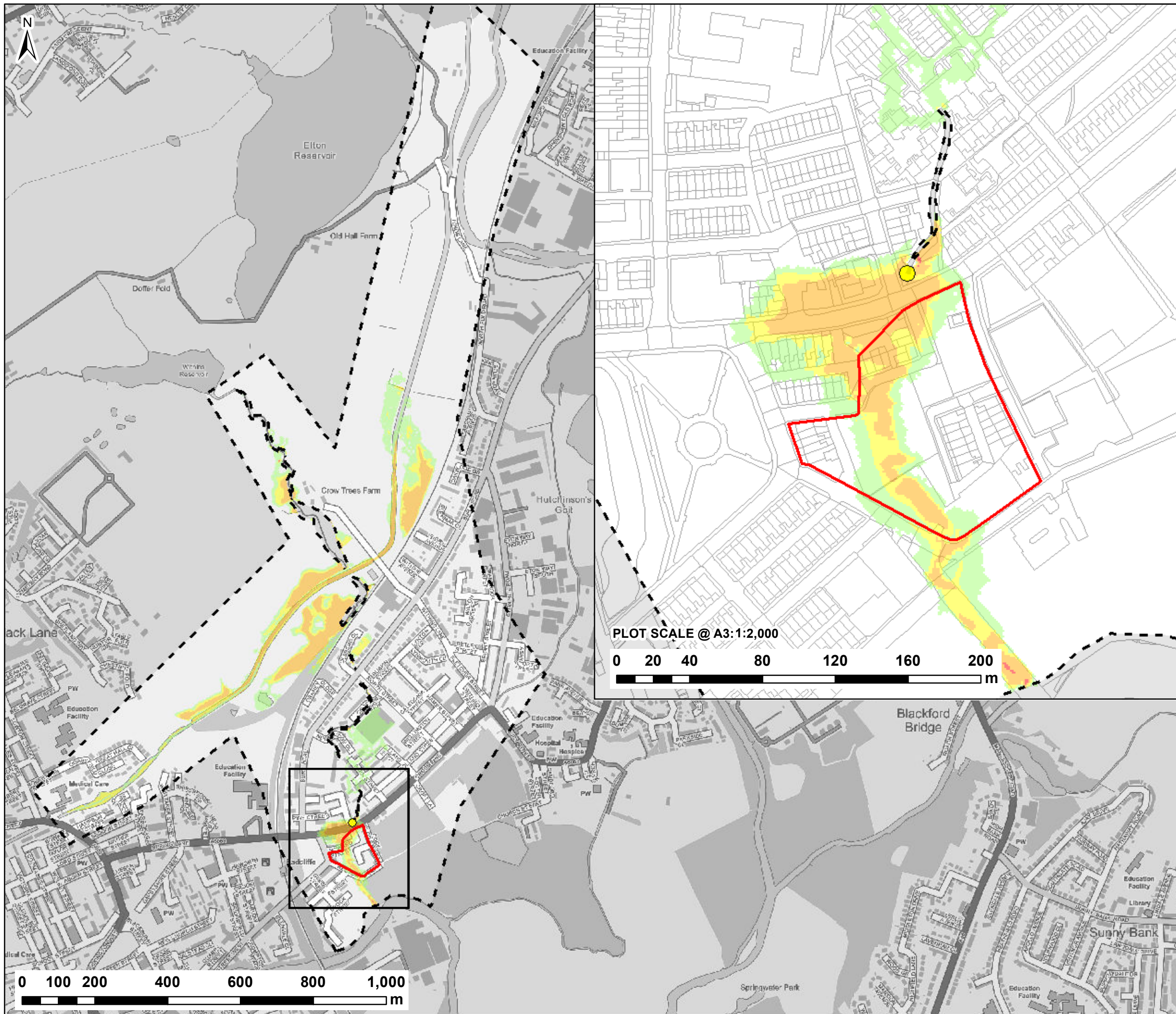
PLOT TITLE: **FLOOD HAZARD RATING**  
1% AEP + 35% CC FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
NORMAL FLOW CONDITIONS

PLOT STATUS: **FINAL** DATE: 03/11/2020

DRAWN: VJ CHECKED: SB APPROVED: DH PLOT SCALE @ A3: 1:10,000 (UNLESS STATED OTHERWISE)

PLOT NAME: 13478-CRT\_Q100CC1\_EXG\_NFC\_HZ REV: -





NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

**LEGEND**

- Site Boundary
- Model Extent
- A6053 Culvert Blockage Location

**Maximum Flood Hazard Rating (FD2320)**

- < 0.75 (Caution)
- 0.75 - 1.25 (Danger for Some)
- 1.25 - 2 (Danger for Most)
- > 2.0 (Danger for All)

CLIENT:   
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SCHEME: **ISLAND SITE, RADCLIFFE**

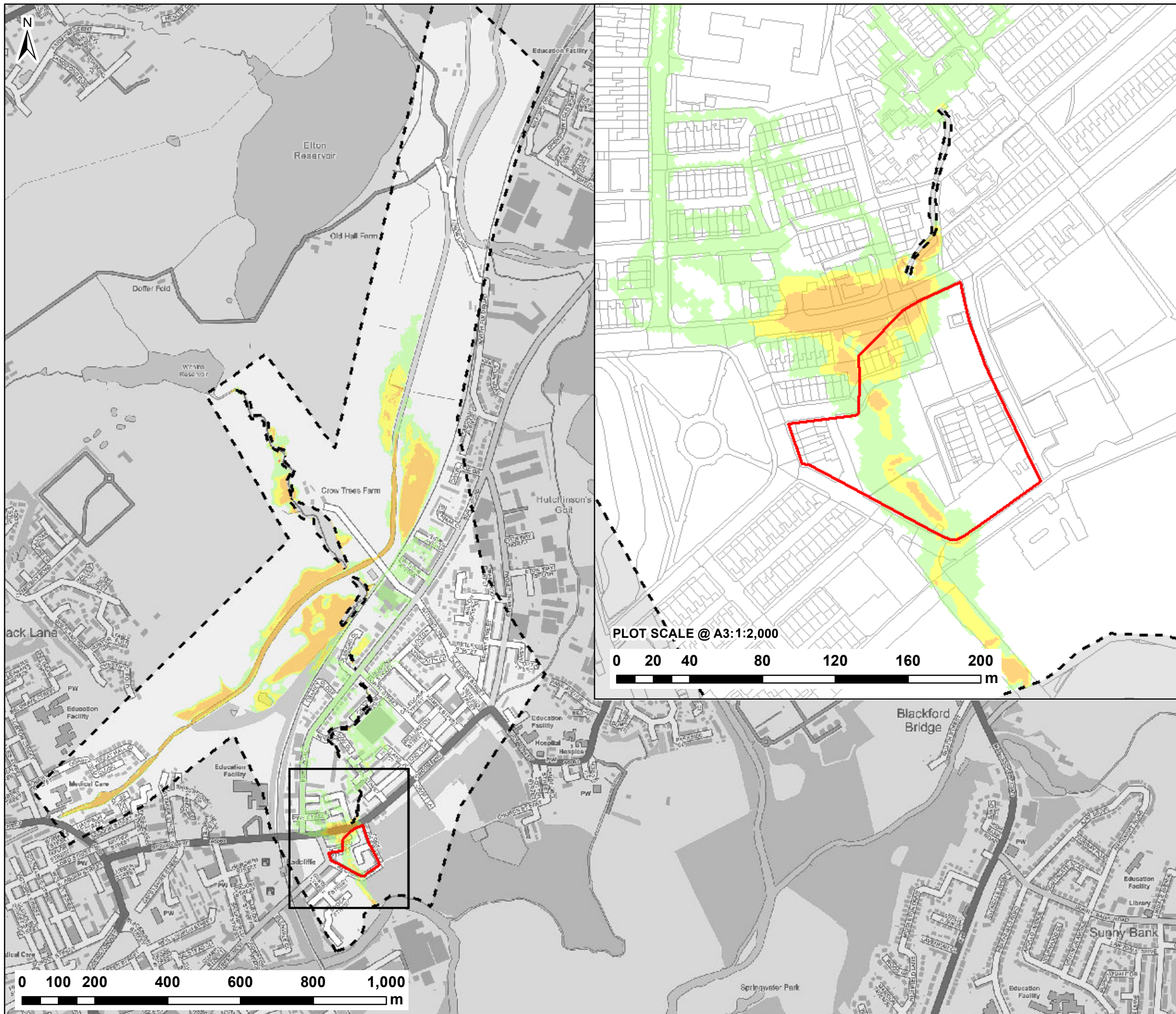
PLOT TITLE: **FLOOD HAZARD RATING**  
1% AEP + 35% CC FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
100% BLOCKAGE A6053 CULVERT

PLOT STATUS: **FINAL** DATE: 03/11/2020

DRAWN: VJ CHECKED: SB APPROVED: DH PLOT SCALE @ A3: 1:10,000 (UNLESS STATED OTHERWISE)

PLOT NAME: 13478-CRT\_Q100CC1\_EXG\_BL1-99.9\_HZ REV: -





NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

**LEGEND**

Site Boundary  
Model Extent

**Maximum Flood Hazard Rating (FD2320)**

< 0.75 (Caution)  
0.75 - 1.25 (Danger for Some)  
1.25 - 2 (Danger for Most)  
> 2.0 (Danger for All)

CLIENT:   
A TETRA TECH COMPANY

  
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SCHEME: **ISLAND SITE, RADCLIFFE**

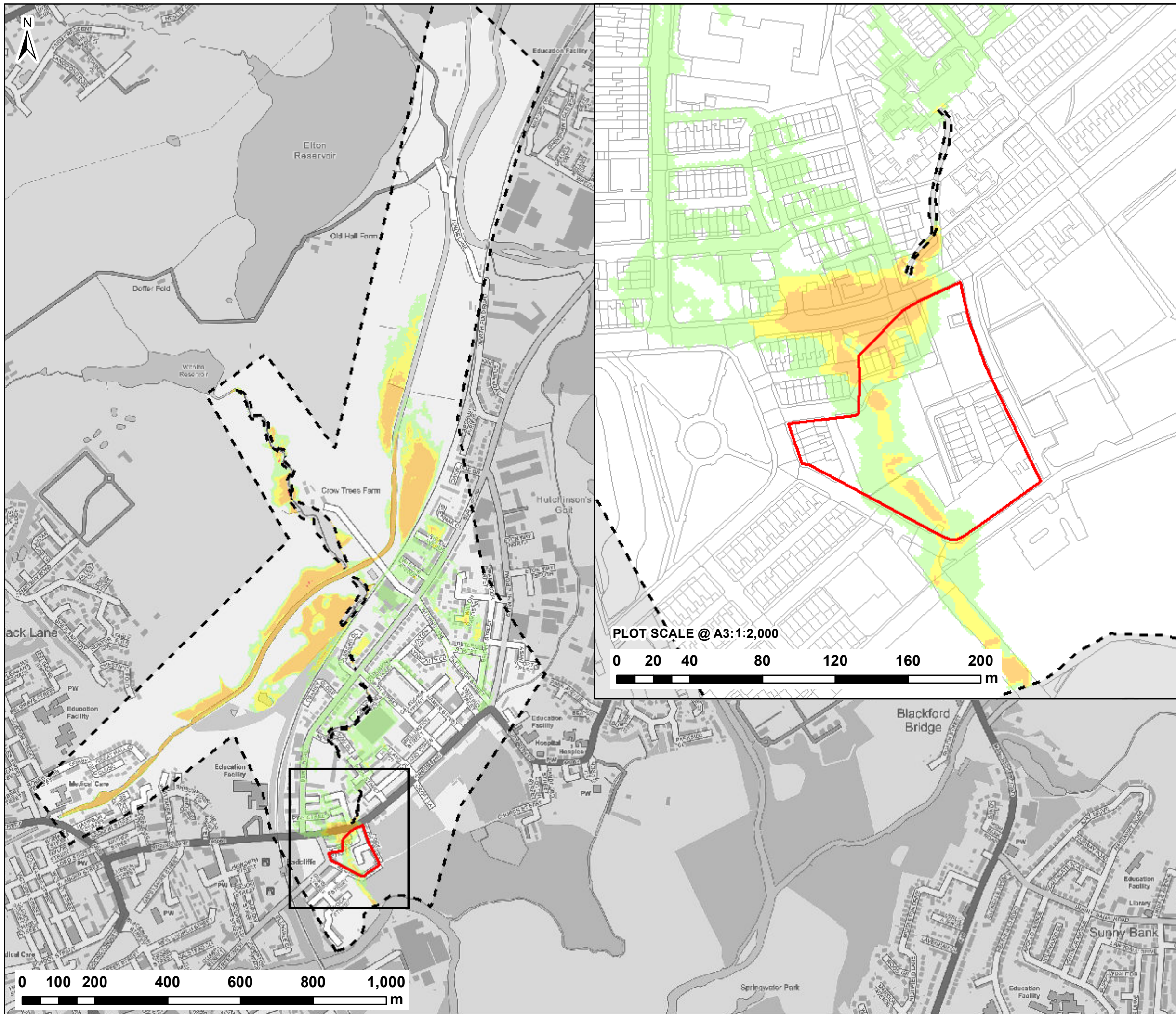
PLOT TITLE: **FLOOD HAZARD RATING**  
1% AEP + 70% CC FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
NORMAL FLOW CONDITIONS

PLOT STATUS: **FINAL** DATE: 03/11/2020

DRAWN: VJ CHECKED: SB APPROVED: DH PLOT SCALE @ A3: 1:10,000 (UNLESS STATED OTHERWISE)

PLOT NAME: 13478-CRT\_Q100CC2\_EXG\_NFC\_HZ REV: -





NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE

**LEGEND**

Site Boundary  
Model Extent

**Maximum Flood Hazard Rating (FD2320)**

< 0.75 (Caution)  
0.75 - 1.25 (Danger for Some)  
1.25 - 2 (Danger for Most)  
> 2.0 (Danger for All)

CLIENT:   
A TETRA TECH COMPANY

  
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SCHEME: **ISLAND SITE, RADCLIFFE**

PLOT TITLE: **FLOOD HAZARD RATING  
0.1% AEP FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
NORMAL FLOW CONDITIONS**

PLOT STATUS: **FINAL** DATE: 03/11/2020

DRAWN: VJ CHECKED: SB APPROVED: DH PLOT SCALE @ A3: 1:10,000 (UNLESS STATED OTHERWISE)

PLOT NAME: 13478-CRT\_Q1000\_EXG\_NFC\_HZ REV: -

**Appendix F    Tabulated 1D Model Results**



Hydraulic Model Results - Island Site, Radcliffe



1D FMP Model Results - Maximum Water Levels (mAOD)

Normal Flow Condition Simulations

Date: 29-10-2020  
Model Type: FMP-TUFLOW  
FMP Build: 4.6  
TUFLOW Build: 2020-01-AB

Normal Flow Condition Simulations - NFC

| Model Ref   | Event                             | DTM                        |
|-------------|-----------------------------------|----------------------------|
| Q20 EXG     | 5% AEP (1 in 20)                  | Existing Site Layout (EXG) |
| Q100 EXG    | 1% AEP (1 in 100)                 |                            |
| Q100CC1 EXG | 1% AEP + 35% Climate Change (CC1) |                            |
| Q100CC2 EXG | 1% AEP + 70% Climate Change (CC2) |                            |
| Q1000 EXG   | 0.1% AEP (1 in 1000)              |                            |

Notes:

ID/2D model build 005  
EXG = Existing site layout  
Nodes adjacent to site are highlighted in yellow

| Node Label            | Notable Features | NORMAL FLOW CONDITIONS (NFC) - EXG SCENARIO |                                    |                                                |                                                |                                       |
|-----------------------|------------------|---------------------------------------------|------------------------------------|------------------------------------------------|------------------------------------------------|---------------------------------------|
|                       |                  | Q20                                         | Q100                               | Q100CC1                                        | Q100CC2                                        | Q1000                                 |
|                       |                  | Q20-EXG-NFC<br>(5% AEP)<br>(mAOD)           | Q100-EXG-NFC<br>(1% AEP)<br>(mAOD) | Q100CC1-EXG-NFC<br>(1% AEP + 35% CC)<br>(mAOD) | Q100CC2-EXG-NFC<br>(1% AEP + 70% CC)<br>(mAOD) | Q1000-EXG-NFC<br>(0.1% AEP)<br>(mAOD) |
| Crow Trees Farm Brook | CROT01_01777     | 79.61                                       | 79.98                              | 80.24                                          | 80.83                                          | 80.87                                 |
|                       | CROT01_01776     | 79.58                                       | 79.95                              | 80.21                                          | 80.91                                          | 81.01                                 |
|                       | 01776BU          | 79.58                                       | 79.95                              | 80.21                                          | 80.91                                          | 81.01                                 |
|                       | 01776BD          | 79.58                                       | 79.95                              | 80.21                                          | 80.37                                          | 80.45                                 |
|                       | 01776SU          | 79.58                                       | 79.95                              | 80.21                                          | 80.91                                          | 81.01                                 |
|                       | 01776SD          | 79.58                                       | 79.95                              | 80.21                                          | 80.37                                          | 80.45                                 |
|                       | CROT01_1776C     | 79.58                                       | 79.95                              | 80.21                                          | 80.37                                          | 80.45                                 |
|                       | CROT01_01766     | 79.54                                       | 79.90                              | 80.22                                          | 80.42                                          | 80.49                                 |
|                       | CROT01_1766C     | 78.87                                       | 79.08                              | 79.25                                          | 79.41                                          | 79.48                                 |
|                       | CROT01_01730     | 78.45                                       | 78.61                              | 78.74                                          | 78.85                                          | 78.90                                 |
|                       | CROT01_INT8      | 78.09                                       | 78.28                              | 78.41                                          | 78.52                                          | 78.57                                 |
|                       | CROT01_INT9      | 77.93                                       | 78.13                              | 78.26                                          | 78.37                                          | 78.42                                 |
|                       | CROT01_INT10     | 77.79                                       | 78.00                              | 78.16                                          | 78.27                                          | 78.31                                 |
|                       | CROT01_01629     | 77.70                                       | 77.91                              | 78.07                                          | 78.17                                          | 78.22                                 |
|                       | CROT01_INT7      | 77.31                                       | 77.63                              | 77.88                                          | 78.00                                          | 78.04                                 |
|                       | CROT01_01527     | 77.25                                       | 77.59                              | 77.86                                          | 77.99                                          | 78.04                                 |
|                       | CROT01_INT11     | 77.24                                       | 77.58                              | 77.85                                          | 77.98                                          | 78.04                                 |
|                       | CROT01_INT12     | 77.22                                       | 77.57                              | 77.84                                          | 77.97                                          | 78.02                                 |
|                       | CROT01_01518     | 77.19                                       | 77.54                              | 77.82                                          | 77.95                                          | 78.01                                 |
|                       | 01518_IN         | 77.19                                       | 77.54                              | 77.82                                          | 77.95                                          | 78.01                                 |
|                       | 01518CU          | 77.09                                       | 77.33                              | 77.52                                          | 77.64                                          | 77.69                                 |
|                       | 01507CD          | 77.07                                       | 77.31                              | 77.50                                          | 77.62                                          | 77.67                                 |
|                       | 01507_OUT        | 76.84                                       | 76.93                              | 77.03                                          | 77.17                                          | 77.24                                 |
|                       | CROT01_01507     | 76.84                                       | 76.93                              | 77.03                                          | 77.17                                          | 77.24                                 |
|                       | CROT01_01505     | 76.82                                       | 76.91                              | 77.00                                          | 77.15                                          | 77.22                                 |
|                       | CROT01_INT30     | 76.82                                       | 76.90                              | 76.96                                          | 77.01                                          | 77.03                                 |
|                       | CROT01_INT31     | 76.82                                       | 76.89                              | 76.94                                          | 76.99                                          | 77.01                                 |
|                       | CROT01_01452     | 76.81                                       | 76.88                              | 76.93                                          | 76.97                                          | 76.99                                 |
|                       | CROT01_INT13     | 76.81                                       | 76.87                              | 76.91                                          | 76.94                                          | 76.96                                 |
|                       | CROT01_INT14     | 76.81                                       | 76.87                              | 76.92                                          | 76.96                                          | 76.98                                 |
|                       | CROT01_INT21     | 76.80                                       | 76.84                              | 76.85                                          | 76.85                                          | 76.85                                 |
|                       | CROT01_01383     | 76.81                                       | 76.88                              | 76.94                                          | 76.98                                          | 77.01                                 |
|                       | 01383IN          | 76.81                                       | 76.88                              | 76.94                                          | 76.98                                          | 77.01                                 |
|                       | 01383CU          | 75.13                                       | 76.08                              | 76.25                                          | 76.36                                          | 76.42                                 |
|                       | 01376CD          | 75.14                                       | 76.05                              | 76.21                                          | 76.32                                          | 76.38                                 |
|                       | 01376OUT         | 75.14                                       | 76.05                              | 76.21                                          | 76.32                                          | 76.38                                 |
|                       | CROT01_01376     | 75.14                                       | 76.05                              | 76.21                                          | 76.32                                          | 76.38                                 |
|                       | CROT01_INT15     | 75.08                                       | 76.03                              | 76.18                                          | 76.29                                          | 76.35                                 |
|                       | CROT01_INT16     | 75.07                                       | 76.03                              | 76.18                                          | 76.29                                          | 76.35                                 |
|                       | CROT01_01327     | 75.07                                       | 76.04                              | 76.18                                          | 76.29                                          | 76.35                                 |
|                       | CROT01_INT17     | 75.07                                       | 76.04                              | 76.18                                          | 76.29                                          | 76.35                                 |
|                       | CROT01_INT18     | 75.07                                       | 76.03                              | 76.18                                          | 76.29                                          | 76.35                                 |
|                       | CROT01_INT19     | 75.07                                       | 76.03                              | 76.18                                          | 76.29                                          | 76.35                                 |
|                       | CROT01_INT32     | 75.07                                       | 76.03                              | 76.18                                          | 76.29                                          | 76.35                                 |
|                       | CROT01_INT20     | 75.07                                       | 76.03                              | 76.18                                          | 76.29                                          | 76.35                                 |
|                       | CROT01_INT33     | 75.07                                       | 76.03                              | 76.18                                          | 76.29                                          | 76.35                                 |
|                       | CROT01_01207     | 75.07                                       | 76.03                              | 76.18                                          | 76.29                                          | 76.35                                 |
|                       | CROT01_INT26     | 75.07                                       | 76.03                              | 76.18                                          | 76.29                                          | 76.35                                 |
|                       | CROT01_INT27     | 75.07                                       | 76.03                              | 76.18                                          | 76.29                                          | 76.35                                 |
|                       | CROT01_01124     | 75.06                                       | 76.03                              | 76.18                                          | 76.29                                          | 76.35                                 |
|                       | 01124IN          | 75.06                                       | 76.03                              | 76.18                                          | 76.29                                          | 76.35                                 |
|                       | 01124CU          | 74.25                                       | 74.83                              | 74.93                                          | 75.02                                          | 75.08                                 |
|                       | 01092CD          | 73.21                                       | 73.35                              | 73.49                                          | 73.55                                          | 73.58                                 |
|                       | 01092OUT         | 73.21                                       | 73.35                              | 73.49                                          | 73.55                                          | 73.58                                 |
|                       | CROT01_01092     | 73.21                                       | 73.35                              | 73.49                                          | 73.55                                          | 73.58                                 |
|                       | CROT01_01074     | 73.17                                       | 73.36                              | 73.51                                          | 73.58                                          | 73.60                                 |
|                       | 01074BU          | 73.17                                       | 73.36                              | 73.51                                          | 73.58                                          | 73.60                                 |
|                       | 01074BD          | 72.89                                       | 73.34                              | 73.50                                          | 73.57                                          | 73.59                                 |
|                       | 01074SU          | 73.17                                       | 73.36                              | 73.51                                          | 73.58                                          | 73.60                                 |
|                       | 01074SD          | 72.89                                       | 73.34                              | 73.50                                          | 73.57                                          | 73.59                                 |
|                       | CROT01_1074C     | 72.89                                       | 73.34                              | 73.50                                          | 73.57                                          | 73.59                                 |
|                       | CROT01_01071     | 72.86                                       | 73.33                              | 73.49                                          | 73.57                                          | 73.59                                 |
|                       | CROT01_INT34     | 72.88                                       | 73.33                              | 73.49                                          | 73.56                                          | 73.59                                 |
|                       | CROT01_INT35     | 72.89                                       | 73.33                              | 73.49                                          | 73.56                                          | 73.59                                 |
|                       | CROT01_01027     | 72.90                                       | 73.33                              | 73.49                                          | 73.56                                          | 73.59                                 |
|                       | CROT01_INT36     | 72.89                                       | 73.33                              | 73.49                                          | 73.56                                          | 73.59                                 |
|                       | CROT01_INT37     | 72.89                                       | 73.33                              | 73.49                                          | 73.56                                          | 73.59                                 |
|                       | CROT01_INT4      | 72.89                                       | 73.33                              | 73.49                                          | 73.56                                          | 73.59                                 |
|                       | CROT01_INT5      | 72.89                                       | 73.33                              | 73.49                                          | 73.56                                          | 73.59                                 |
|                       | CROT01_INT6      | 72.89                                       | 73.33                              | 73.49                                          | 73.56                                          | 73.59                                 |
|                       | CROT01_00926     | 72.89                                       | 73.33                              | 73.49                                          | 73.56                                          | 73.59                                 |
|                       | 00926IN          | 72.89                                       | 73.33                              | 73.49                                          | 73.56                                          | 73.59                                 |
|                       | 00926CU          | 72.49                                       | 72.83                              | 72.95                                          | 73.01                                          | 73.02                                 |
|                       | 00926CUin1       | 72.33                                       | 72.63                              | 72.73                                          | 72.79                                          | 72.80                                 |
|                       | 00926CUin2       | 72.15                                       | 72.41                              | 72.50                                          | 72.54                                          | 72.55                                 |
|                       | 00926CUin3       | 71.96                                       | 72.16                              | 72.23                                          | 72.27                                          | 72.28                                 |
|                       | 00926CUin4       | 71.73                                       | 71.88                              | 71.93                                          | 71.96                                          | 71.97                                 |
|                       | 00850CD          | 71.48                                       | 71.55                              | 71.58                                          | 71.59                                          | 71.60                                 |
|                       | 00850OUT         | 71.48                                       | 71.55                              | 71.58                                          | 71.59                                          | 71.60                                 |
|                       | CROT01_00850     | 71.48                                       | 71.55                              | 71.58                                          | 71.59                                          | 71.60                                 |
|                       | CROT01_00827     | 71.45                                       | 71.54                              | 71.57                                          | 71.59                                          | 71.60                                 |
|                       | 00827BU          | 71.45                                       | 71.54                              | 71.57                                          | 71.59                                          | 71.60                                 |
|                       | 00827BD          | 71.16                                       | 71.29                              | 71.35                                          | 71.38                                          | 71.40                                 |
|                       | 00827SU          | 71.45                                       | 71.54                              | 71.57                                          | 71.59                                          | 71.60                                 |
|                       | 00827SD          | 71.16                                       | 71.29                              | 71.35                                          | 71.38                                          | 71.40                                 |
|                       | CROT01_0827C     | 71.16                                       | 71.29                              | 71.35                                          | 71.38                                          | 71.40                                 |
|                       | CROT01_00804     | 71.05                                       | 71.20                              | 71.27                                          | 71.31                                          | 71.33                                 |
|                       | CROT01_0804C     | 70.92                                       | 71.14                              | 71.21                                          | 71.26                                          | 71.28                                 |
|                       | CROT01_00800     | 70.86                                       | 71.08                              | 71.16                                          | 71.21                                          | 71.23                                 |



Hydraulic Model Results - Island Site, Radcliffe



1D FMP Model Results - Maximum Water Levels (mAOD)

Normal Flow Condition Simulations

Date: 29-10-2020  
Model Type: FMP-TUFLOW  
FMP Build: 4.6  
TUFLOW Build: 2020-01-AB

Normal Flow Condition Simulations - NFC

| Model Ref   | Event                             | DTM                        |
|-------------|-----------------------------------|----------------------------|
| Q20 EXG     | 5% AEP (1 in 20)                  | Existing Site Layout (EXG) |
| Q100 EXG    | 1% AEP (1 in 100)                 |                            |
| Q100CC1 EXG | 1% AEP + 35% Climate Change (CC1) |                            |
| Q100CC2 EXG | 1% AEP + 70% Climate Change (CC2) |                            |
| Q1000 EXG   | 0.1% AEP (1 in 1000)              |                            |

Notes:

1D/2D model build 005  
EXG = Existing site layout  
Nodes adjacent to site are highlighted in yellow

| Node Label   | Notable Features                           | NORMAL FLOW CONDITIONS (NFC) - EXG SCENARIO |                                    |                                                |                                                |                                       |
|--------------|--------------------------------------------|---------------------------------------------|------------------------------------|------------------------------------------------|------------------------------------------------|---------------------------------------|
|              |                                            | Q20                                         | Q100                               | Q100CC1                                        | Q100CC2                                        | Q1000                                 |
|              |                                            | Q20-EXG-NFC<br>(5% AEP)<br>(mAOD)           | Q100-EXG-NFC<br>(1% AEP)<br>(mAOD) | Q100CC1-EXG-NFC<br>(1% AEP + 35% CC)<br>(mAOD) | Q100CC2-EXG-NFC<br>(1% AEP + 70% CC)<br>(mAOD) | Q1000-EXG-NFC<br>(0.1% AEP)<br>(mAOD) |
| 00800IN      | Culvert under Bury Road                    | 70.86                                       | 71.08                              | 71.16                                          | 71.21                                          | 71.23                                 |
| 00800CU      |                                            | 70.50                                       | 70.59                              | 70.62                                          | 70.64                                          | 70.66                                 |
| 00800CUin1   |                                            | 70.39                                       | 70.46                              | 70.48                                          | 70.49                                          | 70.52                                 |
| 00800CUin2   |                                            | 70.25                                       | 70.31                              | 70.34                                          | 70.36                                          | 70.39                                 |
| 00800CUin3   |                                            | 70.17                                       | 70.23                              | 70.24                                          | 70.25                                          | 70.26                                 |
| 00762CD      |                                            | 70.09                                       | 70.14                              | 70.15                                          | 70.16                                          | 70.17                                 |
| 00762OUT     | Culvert under Crofters Brook               | 70.09                                       | 70.14                              | 70.15                                          | 70.16                                          | 70.17                                 |
| CROT01_00762 |                                            | 70.09                                       | 70.14                              | 70.15                                          | 70.16                                          | 70.17                                 |
| CROT01_INT25 |                                            | 69.93                                       | 69.99                              | 70.02                                          | 70.06                                          | 70.08                                 |
| CROT01_00700 |                                            | 69.86                                       | 69.92                              | 69.95                                          | 69.99                                          | 70.00                                 |
| 00700IN      |                                            | 69.86                                       | 69.92                              | 69.95                                          | 69.99                                          | 70.00                                 |
| 00700CU      |                                            | 69.82                                       | 69.87                              | 69.90                                          | 69.93                                          | 69.95                                 |
| 00690CD      | Culvert under Crofters Brook               | 69.79                                       | 69.84                              | 69.88                                          | 69.91                                          | 69.93                                 |
| 00690OUT     |                                            | 69.72                                       | 69.76                              | 69.80                                          | 69.83                                          | 69.84                                 |
| CROT01_00690 |                                            | 69.72                                       | 69.76                              | 69.80                                          | 69.83                                          | 69.84                                 |
| CROT01_INT22 |                                            | 69.60                                       | 69.64                              | 69.67                                          | 69.70                                          | 69.71                                 |
| CROT01_INT23 |                                            | 69.52                                       | 69.57                              | 69.59                                          | 69.61                                          | 69.62                                 |
| CROT01_INT24 |                                            | 69.43                                       | 69.48                              | 69.51                                          | 69.53                                          | 69.54                                 |
| CROT01_00594 | Small bridge at Windsor Court              | 69.40                                       | 69.46                              | 69.48                                          | 69.51                                          | 69.52                                 |
| CROT01_00592 |                                            | 69.43                                       | 69.48                              | 69.51                                          | 69.53                                          | 69.54                                 |
| 00592BU      |                                            | 69.43                                       | 69.48                              | 69.51                                          | 69.53                                          | 69.54                                 |
| 00592BD      |                                            | 69.37                                       | 69.43                              | 69.45                                          | 69.48                                          | 69.49                                 |
| 00592SU      |                                            | 69.43                                       | 69.48                              | 69.51                                          | 69.53                                          | 69.54                                 |
| 00592SD      |                                            | 69.37                                       | 69.43                              | 69.45                                          | 69.48                                          | 69.49                                 |
| CROT01_0592C | Bridge at Newbridge Close                  | 69.37                                       | 69.43                              | 69.45                                          | 69.48                                          | 69.49                                 |
| CROT01_00583 |                                            | 69.20                                       | 69.25                              | 69.29                                          | 69.33                                          | 69.34                                 |
| CROT01_00551 |                                            | 69.11                                       | 69.18                              | 69.23                                          | 69.27                                          | 69.29                                 |
| CROT01_00537 |                                            | 69.03                                       | 69.10                              | 69.16                                          | 69.20                                          | 69.22                                 |
| 00537BU      |                                            | 69.03                                       | 69.10                              | 69.16                                          | 69.20                                          | 69.22                                 |
| 00537BD      |                                            | 69.03                                       | 69.10                              | 69.16                                          | 69.20                                          | 69.22                                 |
| 00537SU      | Metal access bridge                        | 69.03                                       | 69.10                              | 69.16                                          | 69.20                                          | 69.22                                 |
| 00537SD      |                                            | 69.03                                       | 69.10                              | 69.16                                          | 69.20                                          | 69.22                                 |
| CROT01_0537C |                                            | 69.03                                       | 69.10                              | 69.16                                          | 69.20                                          | 69.22                                 |
| CROT01_00526 |                                            | 68.95                                       | 69.03                              | 69.09                                          | 69.14                                          | 69.16                                 |
| CROT01_00504 |                                            | 68.79                                       | 68.85                              | 68.90                                          | 68.94                                          | 68.96                                 |
| 00504BLU     |                                            | 68.79                                       | 68.85                              | 68.90                                          | 68.94                                          | 68.96                                 |
| 00504BLD     | Culvert from Station Works to Hoyles Court | 68.75                                       | 68.81                              | 68.86                                          | 68.89                                          | 68.91                                 |
| CROT01_0504C |                                            | 68.75                                       | 68.81                              | 68.86                                          | 68.89                                          | 68.91                                 |
| CROT01_00476 |                                            | 68.70                                       | 68.76                              | 68.81                                          | 68.84                                          | 68.86                                 |
| CROT01_0476C |                                            | 68.03                                       | 68.09                              | 68.13                                          | 68.16                                          | 68.18                                 |
| CROT01_00474 |                                            | 68.08                                       | 68.15                              | 68.20                                          | 68.24                                          | 68.26                                 |
| 00474IN      |                                            | 68.08                                       | 68.15                              | 68.20                                          | 68.24                                          | 68.26                                 |
| 00474CU      | Bridge near Hoyles Court and Gingham Court | 67.86                                       | 67.89                              | 67.91                                          | 67.93                                          | 67.94                                 |
| 00474CUin1   |                                            | 67.20                                       | 67.24                              | 67.26                                          | 67.28                                          | 67.30                                 |
| 00474CUin2   |                                            | 66.59                                       | 66.64                              | 66.68                                          | 66.71                                          | 66.73                                 |
| 00367CD      |                                            | 66.22                                       | 66.29                              | 66.35                                          | 66.38                                          | 66.40                                 |
| 00367OUT     |                                            | 66.22                                       | 66.29                              | 66.35                                          | 66.38                                          | 66.40                                 |
| CROT01_00367 |                                            | 66.22                                       | 66.29                              | 66.35                                          | 66.38                                          | 66.40                                 |
| CROT01_00365 | A6053 Cross Lane Culvert                   | 66.22                                       | 66.29                              | 66.35                                          | 66.38                                          | 66.40                                 |
| 00365BU      |                                            | 66.22                                       | 66.29                              | 66.35                                          | 66.38                                          | 66.40                                 |
| 00365BD      |                                            | 66.22                                       | 66.29                              | 66.35                                          | 66.38                                          | 66.40                                 |
| 00365SU      |                                            | 66.22                                       | 66.29                              | 66.35                                          | 66.38                                          | 66.40                                 |
| 00365SD      |                                            | 66.22                                       | 66.29                              | 66.35                                          | 66.38                                          | 66.40                                 |
| CROT01_00363 |                                            | 66.22                                       | 66.29                              | 66.35                                          | 66.38                                          | 66.40                                 |
| CROT01_INT1  | Crow Trees Farm Brook Outflow Location     | 66.18                                       | 66.24                              | 66.29                                          | 66.32                                          | 66.33                                 |
| CROT01_INT2  |                                            | 66.17                                       | 66.23                              | 66.28                                          | 66.30                                          | 66.32                                 |
| CROT01_INT3  |                                            | 66.15                                       | 66.19                              | 66.21                                          | 66.21                                          | 66.21                                 |
| CROT01_00274 |                                            | 66.18                                       | 66.25                              | 66.30                                          | 66.33                                          | 66.34                                 |
| CROT01_00270 |                                            | 66.18                                       | 66.25                              | 66.30                                          | 66.33                                          | 66.34                                 |
| 00270BL      |                                            | 66.18                                       | 66.25                              | 66.30                                          | 66.33                                          | 66.34                                 |
| 00270IN      | A6053 Cross Lane Culvert                   | 66.18                                       | 66.25                              | 66.30                                          | 66.33                                          | 66.34                                 |
| 00270CU      |                                            | 64.41                                       | 64.41                              | 64.41                                          | 64.41                                          | 64.41                                 |
| 00270CUin1   |                                            | 63.69                                       | 63.69                              | 63.69                                          | 63.69                                          | 63.69                                 |
| 00270CUin2   |                                            | 62.98                                       | 62.98                              | 62.98                                          | 62.98                                          | 62.98                                 |
| 00270CUin3   |                                            | 62.25                                       | 62.25                              | 62.25                                          | 62.25                                          | 62.25                                 |
| 00270CUin4   |                                            | 61.58                                       | 61.58                              | 61.58                                          | 61.58                                          | 61.58                                 |
| 00270CUin5   | A6053 Cross Lane Culvert                   | 61.21                                       | 61.21                              | 61.21                                          | 61.21                                          | 61.21                                 |
| 00270CUin6   |                                            | 61.22                                       | 61.22                              | 61.22                                          | 61.22                                          | 61.22                                 |
| 00020CD      |                                            | 61.22                                       | 61.23                              | 61.23                                          | 61.23                                          | 61.23                                 |
| 00020OR      |                                            | 61.20                                       | 61.20                              | 61.20                                          | 61.20                                          | 61.20                                 |
| CROT01_DS    |                                            | 61.20                                       | 61.20                              | 61.20                                          | 61.20                                          | 61.20                                 |

# Hydraulic Model Results - Island Site, Radcliffe



## 1D FMP Model Results - Maximum Water Levels (mAOD)

### Blockage Scenarios

Date: 29-10-2020

Model Type: FMP-TUFLOW

FMP Build: 4.6

TUFLOW Build: 2020-01-AB

### Blockage Scenarios

| Model Ref        | Details                                   | Event   | DTM                        |
|------------------|-------------------------------------------|---------|----------------------------|
| Q100CC1 BL1-99.9 | 100% Blockage of A6053 Cross Lane Culvert | Q100CC1 | Existing Site Layout (EXG) |

### Notes:

1D/2D model build 005  
BL = Blockage Scenarios  
Nodes adjacent to site are highlighted in yellow

| Node Label   | Notable Features                                                               | NFC                                          | BLOCKAGE SCENARIOS-EXG                                          |
|--------------|--------------------------------------------------------------------------------|----------------------------------------------|-----------------------------------------------------------------|
|              |                                                                                | Q100CC1-EXG-NFC<br>(1% AEP+ 35%CC)<br>(mAOD) | BL1-99.9<br>Q100CC1-EXG-BL1-99.9<br>(1% AEP + 35% CC)<br>(mAOD) |
| CROT01_01777 | Crow Trees Farm Brook Inflow Location                                          | 80.24                                        | 80.24                                                           |
| CROT01_01776 |                                                                                | 80.21                                        | 80.21                                                           |
| 01776BU      | Bridge downstream of the Withins Reservoir spillway                            | 80.21                                        | 80.21                                                           |
| 01776BD      |                                                                                | 80.21                                        | 80.21                                                           |
| 01776SU      |                                                                                | 80.21                                        | 80.21                                                           |
| 01776SD      |                                                                                | 80.21                                        | 80.21                                                           |
| CROT01_1776C |                                                                                | 80.21                                        | 80.21                                                           |
| CROT01_01766 |                                                                                | 80.22                                        | 80.22                                                           |
| CROT01_1766C |                                                                                | 79.25                                        | 79.25                                                           |
| CROT01_01730 |                                                                                | 78.74                                        | 78.74                                                           |
| CROT01_INT8  |                                                                                | 78.41                                        | 78.41                                                           |
| CROT01_INT9  |                                                                                | 78.26                                        | 78.26                                                           |
| CROT01_INT10 |                                                                                | 78.16                                        | 78.16                                                           |
| CROT01_01629 |                                                                                | 78.07                                        | 78.07                                                           |
| CROT01_INT7  |                                                                                | 77.88                                        | 77.88                                                           |
| CROT01_01527 |                                                                                | 77.86                                        | 77.86                                                           |
| CROT01_INT11 |                                                                                | 77.85                                        | 77.85                                                           |
| CROT01_INT12 |                                                                                | 77.84                                        | 77.84                                                           |
| CROT01_01518 |                                                                                | 77.82                                        | 77.82                                                           |
| 01518_IN     | Culvert under a path upstream Crow Trees Farm                                  | 77.82                                        | 77.82                                                           |
| 01518CU      |                                                                                | 77.52                                        | 77.52                                                           |
| 01507CD      |                                                                                | 77.50                                        | 77.50                                                           |
| 01507_OUT    |                                                                                | 77.03                                        | 77.03                                                           |
| CROT01_01507 |                                                                                | 77.03                                        | 77.03                                                           |
| CROT01_01505 |                                                                                | 77.00                                        | 77.00                                                           |
| CROT01_INT30 |                                                                                | 76.96                                        | 76.96                                                           |
| CROT01_INT31 |                                                                                | 76.94                                        | 76.94                                                           |
| CROT01_01452 |                                                                                | 76.93                                        | 76.93                                                           |
| CROT01_INT13 |                                                                                | 76.91                                        | 76.91                                                           |
| CROT01_INT14 |                                                                                | 76.92                                        | 76.92                                                           |
| CROT01_INT21 |                                                                                | 76.85                                        | 76.85                                                           |
| CROT01_01383 |                                                                                | 76.94                                        | 76.94                                                           |
| 01383IN      | Culvert under a path near Crow Trees Farm                                      | 76.94                                        | 76.94                                                           |
| 01383CU      |                                                                                | 76.25                                        | 76.25                                                           |
| 01376CD      |                                                                                | 76.21                                        | 76.21                                                           |
| 01376OUT     |                                                                                | 76.21                                        | 76.21                                                           |
| CROT01_01376 |                                                                                | 76.21                                        | 76.21                                                           |
| CROT01_INT15 |                                                                                | 76.18                                        | 76.18                                                           |
| CROT01_INT16 |                                                                                | 76.18                                        | 76.18                                                           |
| CROT01_01327 |                                                                                | 76.18                                        | 76.18                                                           |
| CROT01_INT17 |                                                                                | 76.18                                        | 76.18                                                           |
| CROT01_INT18 |                                                                                | 76.18                                        | 76.18                                                           |
| CROT01_INT19 |                                                                                | 76.18                                        | 76.18                                                           |
| CROT01_INT32 |                                                                                | 76.18                                        | 76.18                                                           |
| CROT01_INT20 |                                                                                | 76.18                                        | 76.18                                                           |
| CROT01_INT33 |                                                                                | 76.18                                        | 76.18                                                           |
| CROT01_01207 |                                                                                | 76.18                                        | 76.18                                                           |
| CROT01_INT26 |                                                                                | 76.18                                        | 76.18                                                           |
| CROT01_INT27 |                                                                                | 76.18                                        | 76.18                                                           |
| CROT01_01124 |                                                                                | 76.18                                        | 76.18                                                           |
| 01124IN      | Culvert under the Manchester Bury and Bolton Canal                             | 76.18                                        | 76.18                                                           |
| 01124CU      |                                                                                | 74.93                                        | 74.93                                                           |
| 01092CD      |                                                                                | 73.49                                        | 73.48                                                           |
| 01092OUT     |                                                                                | 73.49                                        | 73.48                                                           |
| CROT01_01092 |                                                                                | 73.49                                        | 73.48                                                           |
| CROT01_01074 |                                                                                | 73.51                                        | 73.51                                                           |
| 01074BU      | Bridge located between Manchester Bury and Bolton Canal and the Metrolink Line | 73.51                                        | 73.51                                                           |
| 01074BD      |                                                                                | 73.50                                        | 73.49                                                           |
| 01074SU      |                                                                                | 73.51                                        | 73.51                                                           |
| 01074SD      |                                                                                | 73.50                                        | 73.49                                                           |
| CROT01_1074C |                                                                                | 73.50                                        | 73.49                                                           |

# Hydraulic Model Results - Island Site, Radcliffe



## 1D FMP Model Results - Maximum Water Levels (mAOD)

### Blockage Scenarios

Date: 29-10-2020

Model Type: FMP-TUFLOW

FMP Build: 4.6

TUFLOW Build: 2020-01-AB

### Blockage Scenarios

| Model Ref        | Details                                   | Event   | DTM                        |
|------------------|-------------------------------------------|---------|----------------------------|
| Q100CC1 BL1-99.9 | 100% Blockage of A6053 Cross Lane Culvert | Q100CC1 | Existing Site Layout (EXG) |

### Notes:

1D/2D model build 005  
BL = Blockage Scenarios  
Nodes adjacent to site are highlighted in yellow

| Node Label   | Notable Features | NFC                                          | BLOCKAGE SCENARIOS-EXG                              |
|--------------|------------------|----------------------------------------------|-----------------------------------------------------|
|              |                  | Q100CC1-EXG-NFC<br>(1% AEP+ 35%CC)<br>(mAOD) | BL1-99.9                                            |
|              |                  |                                              | Q100CC1-EXG-BL1-99.9<br>(1% AEP + 35% CC)<br>(mAOD) |
| CROT01_01071 |                  | 73.49                                        | 73.49                                               |
| CROT01_INT34 |                  | 73.49                                        | 73.49                                               |
| CROT01_INT35 |                  | 73.49                                        | 73.49                                               |
| CROT01_01027 |                  | 73.49                                        | 73.49                                               |
| CROT01_INT36 |                  | 73.49                                        | 73.49                                               |
| CROT01_INT37 |                  | 73.49                                        | 73.49                                               |
| CROT01_INT4  |                  | 73.49                                        | 73.49                                               |
| CROT01_INT5  |                  | 73.49                                        | 73.49                                               |
| CROT01_INT6  |                  | 73.49                                        | 73.49                                               |
| CROT01_00926 |                  | 73.49                                        | 73.49                                               |
| 00926IN      |                  | 73.49                                        | 73.49                                               |
| 00926CU      |                  | 72.95                                        | 72.95                                               |
| 00926CUIn1   |                  | 72.73                                        | 72.74                                               |
| 00926CUIn2   |                  | 72.50                                        | 72.50                                               |
| 00926CUIn3   |                  | 72.23                                        | 72.23                                               |
| 00926CUIn4   |                  | 71.93                                        | 71.93                                               |
| 00850CD      |                  | 71.58                                        | 71.58                                               |
| 00850OUT     |                  | 71.58                                        | 71.58                                               |
| CROT01_00850 |                  | 71.58                                        | 71.58                                               |
| CROT01_00827 |                  | 71.57                                        | 71.57                                               |
| 00827BU      |                  | 71.57                                        | 71.57                                               |
| 00827BD      |                  | 71.35                                        | 71.35                                               |
| 00827SU      |                  | 71.57                                        | 71.57                                               |
| 00827SD      |                  | 71.35                                        | 71.35                                               |
| CROT01_0827C |                  | 71.35                                        | 71.35                                               |
| CROT01_00804 |                  | 71.27                                        | 71.27                                               |
| CROT01_0804C |                  | 71.21                                        | 71.21                                               |
| CROT01_00800 |                  | 71.16                                        | 71.16                                               |
| 00800IN      |                  | 71.16                                        | 71.16                                               |
| 00800CU      |                  | 70.62                                        | 70.62                                               |
| 00800CUIn1   |                  | 70.48                                        | 70.48                                               |
| 00800CUIn2   |                  | 70.34                                        | 70.34                                               |
| 00800CUIn3   |                  | 70.24                                        | 70.24                                               |
| 00762CD      |                  | 70.15                                        | 70.15                                               |
| 00762OUT     |                  | 70.15                                        | 70.15                                               |
| CROT01_00762 |                  | 70.15                                        | 70.15                                               |
| CROT01_INT25 |                  | 70.02                                        | 70.02                                               |
| CROT01_00700 |                  | 69.95                                        | 69.95                                               |
| 00700IN      |                  | 69.95                                        | 69.95                                               |
| 00700CU      |                  | 69.90                                        | 69.90                                               |
| 00690CD      |                  | 69.88                                        | 69.88                                               |
| 00690OUT     |                  | 69.80                                        | 69.80                                               |
| CROT01_00690 |                  | 69.80                                        | 69.80                                               |
| CROT01_INT22 |                  | 69.67                                        | 69.67                                               |
| CROT01_INT23 |                  | 69.59                                        | 69.59                                               |
| CROT01_INT24 |                  | 69.51                                        | 69.51                                               |
| CROT01_00594 |                  | 69.48                                        | 69.48                                               |
| CROT01_00592 |                  | 69.51                                        | 69.51                                               |
| 00592BU      |                  | 69.51                                        | 69.51                                               |
| 00592BD      |                  | 69.45                                        | 69.45                                               |
| 00592SU      |                  | 69.51                                        | 69.51                                               |
| 00592SD      |                  | 69.45                                        | 69.45                                               |
| CROT01_0592C |                  | 69.45                                        | 69.45                                               |
| CROT01_00583 |                  | 69.29                                        | 69.29                                               |
| CROT01_00551 |                  | 69.23                                        | 69.23                                               |
| CROT01_00537 |                  | 69.16                                        | 69.16                                               |
| 00537BU      |                  | 69.16                                        | 69.16                                               |
| 00537BD      |                  | 69.16                                        | 69.16                                               |
| 00537SU      |                  | 69.16                                        | 69.16                                               |
| 00537SD      |                  | 69.16                                        | 69.16                                               |
| CROT01_0537C |                  | 69.16                                        | 69.16                                               |



# Hydraulic Model Results - Island Site, Radcliffe



## 1D FMP Model Results - Maximum Water Levels (mAOD)

### Blockage Scenarios

Date: 29-10-2020

Model Type: FMP-TUFLOW

FMP Build: 4.6

TUFLOW Build: 2020-01-AB

### Blockage Scenarios

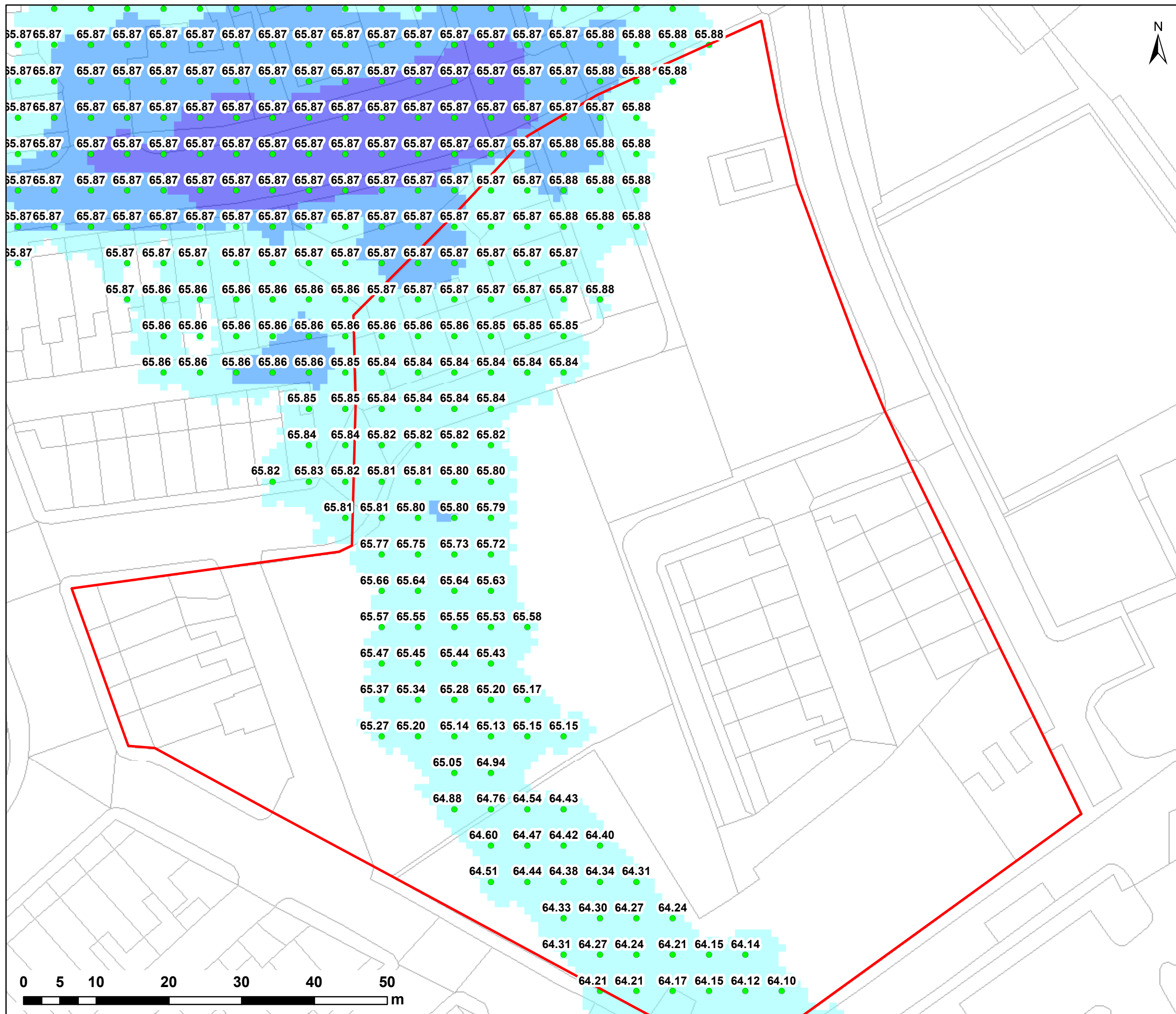
| Model Ref        | Details                                   | Event   | DTM                        |
|------------------|-------------------------------------------|---------|----------------------------|
| Q100CC1 BL1-99.9 | 100% Blockage of A6053 Cross Lane Culvert | Q100CC1 | Existing Site Layout (EXG) |

### Notes:

1D/2D model build 005  
BL = Blockage Scenarios  
Nodes adjacent to site are highlighted in yellow

| Node Label   | Notable Features                           | NFC                                          | BLOCKAGE SCENARIOS-EXG                              |
|--------------|--------------------------------------------|----------------------------------------------|-----------------------------------------------------|
|              |                                            |                                              | BL1-99.9                                            |
|              |                                            | Q100CC1-EXG-NFC<br>(1% AEP+ 35%CC)<br>(mAOD) | Q100CC1-EXG-BL1-99.9<br>(1% AEP + 35% CC)<br>(mAOD) |
| CROT01_00526 |                                            | 69.09                                        | 69.09                                               |
| CROT01_00504 |                                            | 68.90                                        | 68.90                                               |
| 00504BLU     | Metal access bridge                        | 68.90                                        | 68.90                                               |
| 00504BLD     |                                            | 68.86                                        | 68.86                                               |
| CROT01_0504C |                                            | 68.86                                        | 68.86                                               |
| CROT01_00476 |                                            | 68.81                                        | 68.81                                               |
| CROT01_0476C |                                            | 68.13                                        | 68.13                                               |
| CROT01_00474 |                                            | 68.20                                        | 68.20                                               |
| 00474IN      | Culvert from Station Works to Hoyles Court | 68.20                                        | 68.20                                               |
| 00474CU      |                                            | 67.91                                        | 67.91                                               |
| 00474CUIn1   |                                            | 67.26                                        | 67.26                                               |
| 00474CUIn2   |                                            | 66.68                                        | 66.72                                               |
| 00367CD      |                                            | 66.35                                        | 66.47                                               |
| 00367OUT     |                                            | 66.35                                        | 66.47                                               |
| CROT01_00367 |                                            | 66.35                                        | 66.47                                               |
| CROT01_00365 |                                            | 66.35                                        | 66.48                                               |
| 00365BU      | Bridge near Hoyles Court and Gingham Court | 66.35                                        | 66.48                                               |
| 00363BD      |                                            | 66.35                                        | 66.48                                               |
| 00365SU      |                                            | 66.35                                        | 66.48                                               |
| 00363SD      |                                            | 66.35                                        | 66.48                                               |
| CROT01_00363 |                                            | 66.35                                        | 66.48                                               |
| CROT01_INT1  |                                            | 66.29                                        | 66.44                                               |
| CROT01_INT2  |                                            | 66.28                                        | 66.43                                               |
| CROT01_INT3  |                                            | 66.21                                        | 66.32                                               |
| CROT01_00274 |                                            | 66.30                                        | 66.45                                               |
| CROT01_00270 |                                            | 66.30                                        | 66.45                                               |
| 00270BL      | A6053 Cross Lane Culvert (BL1)             | 66.30                                        | 66.45                                               |
| 00270IN      |                                            | 66.30                                        | 64.72                                               |
| 00270CU      |                                            | 64.41                                        | 64.18                                               |
| 00270CUIn1   |                                            | 63.69                                        | 63.47                                               |
| 00270CUIn2   |                                            | 62.98                                        | 62.77                                               |
| 00270CUIn3   |                                            | 62.25                                        | 62.04                                               |
| 00270CUIn4   |                                            | 61.58                                        | 61.38                                               |
| 00270CUIn5   |                                            | 61.21                                        | 61.21                                               |
| 00270CUIn6   |                                            | 61.22                                        | 61.20                                               |
| 00020CD      |                                            | 61.23                                        | 61.20                                               |
| 00020OR      |                                            | 61.20                                        | 61.20                                               |
| CROT01_DS    | Crow Trees Farm Brook Outflow Location     | 61.20                                        | 61.20                                               |

## **Appendix G    Maximum Water Level Mapping**



NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE  
2) MAXIMUM WATER LEVELS HAVE BEEN RESAMPLED AT A 5m HORIZONTAL RESOLUTION

**LEGEND**

Site Boundary

Water Level Points (m AOD)

**Maximum Flood Depth (m)**

0 - 0.3

0.3 - 0.6

0.6 - 1.2

1.2 - 2.4

> 2.4

CLIENT:

[www.waterco.co.uk](http://www.waterco.co.uk)

SCHEME:

**ISLAND SITE,  
RADCLIFFE**

PLOT TITLE:

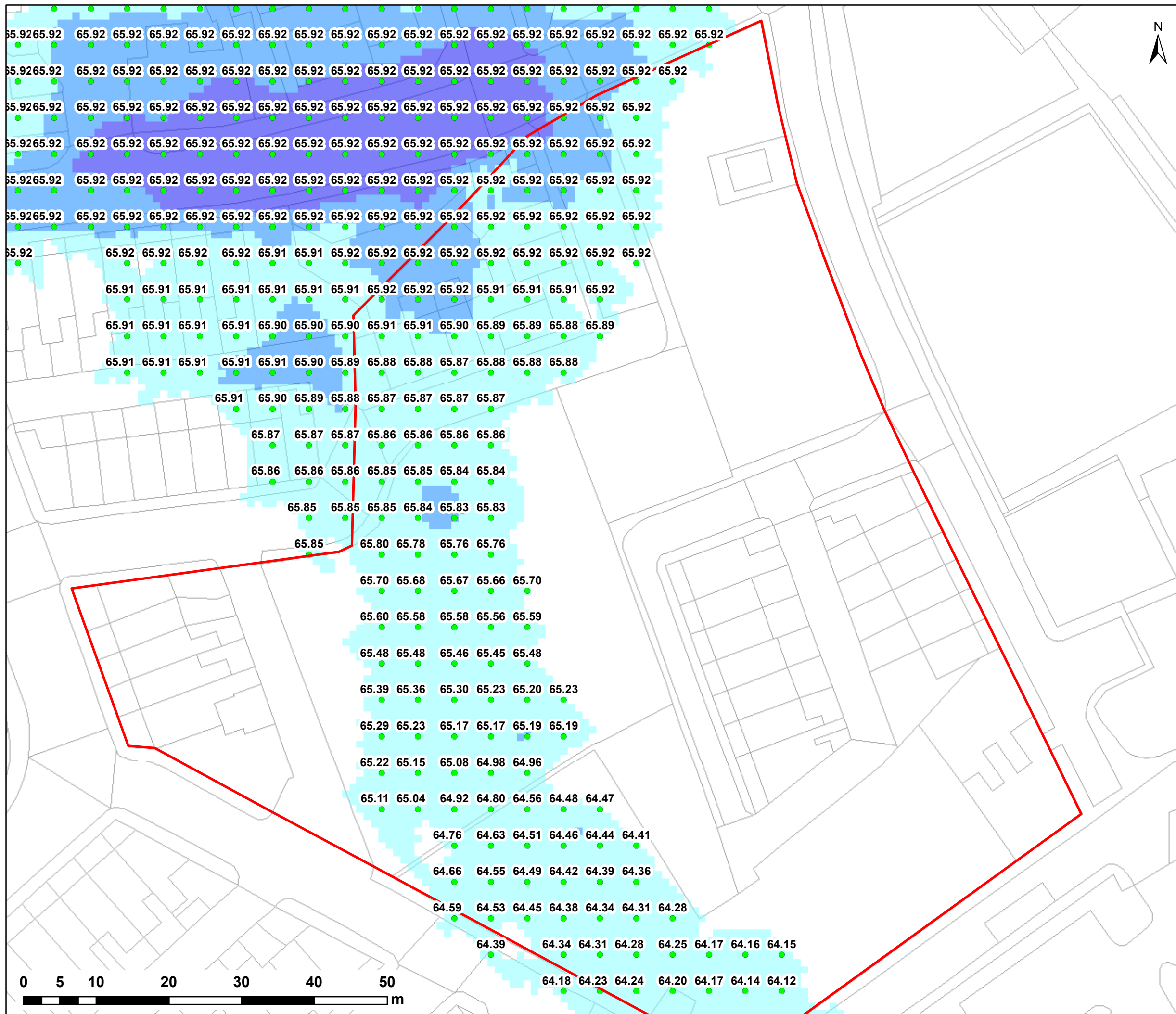
**MAXIMUM WATER LEVELS**  
5% AEP FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
NORMAL FLOW CONDITIONS

|              |  |  |            |
|--------------|--|--|------------|
| PLOT STATUS: |  |  | DATE:      |
| FINAL        |  |  | 03/11/2020 |

|        |          |           |                           |
|--------|----------|-----------|---------------------------|
| DRAWN: | CHECKED: | APPROVED: | PLOT SCALE @ A3:          |
| VJ     | SB       | DH        | 1:500                     |
|        |          |           | (UNLESS STATED OTHERWISE) |

|                          |      |
|--------------------------|------|
| PLOT NAME:               | REV: |
| 13478-CRT_Q20_EXG_NFC_WL | -    |





NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE  
2) MAXIMUM WATER LEVELS HAVE BEEN RESAMPLED AT A 5m HORIZONTAL RESOLUTION

### LEGEND

- Site Boundary
  - Water Level Points (m AOD)
- Maximum Flood Depth (m)**
- 0 - 0.3
  - 0.3 - 0.6
  - 0.6 - 1.2
  - 1.2 - 2.4
  - > 2.4



CLIENT:



A TETRA TECH COMPANY

  
[www.waterco.co.uk](http://www.waterco.co.uk)

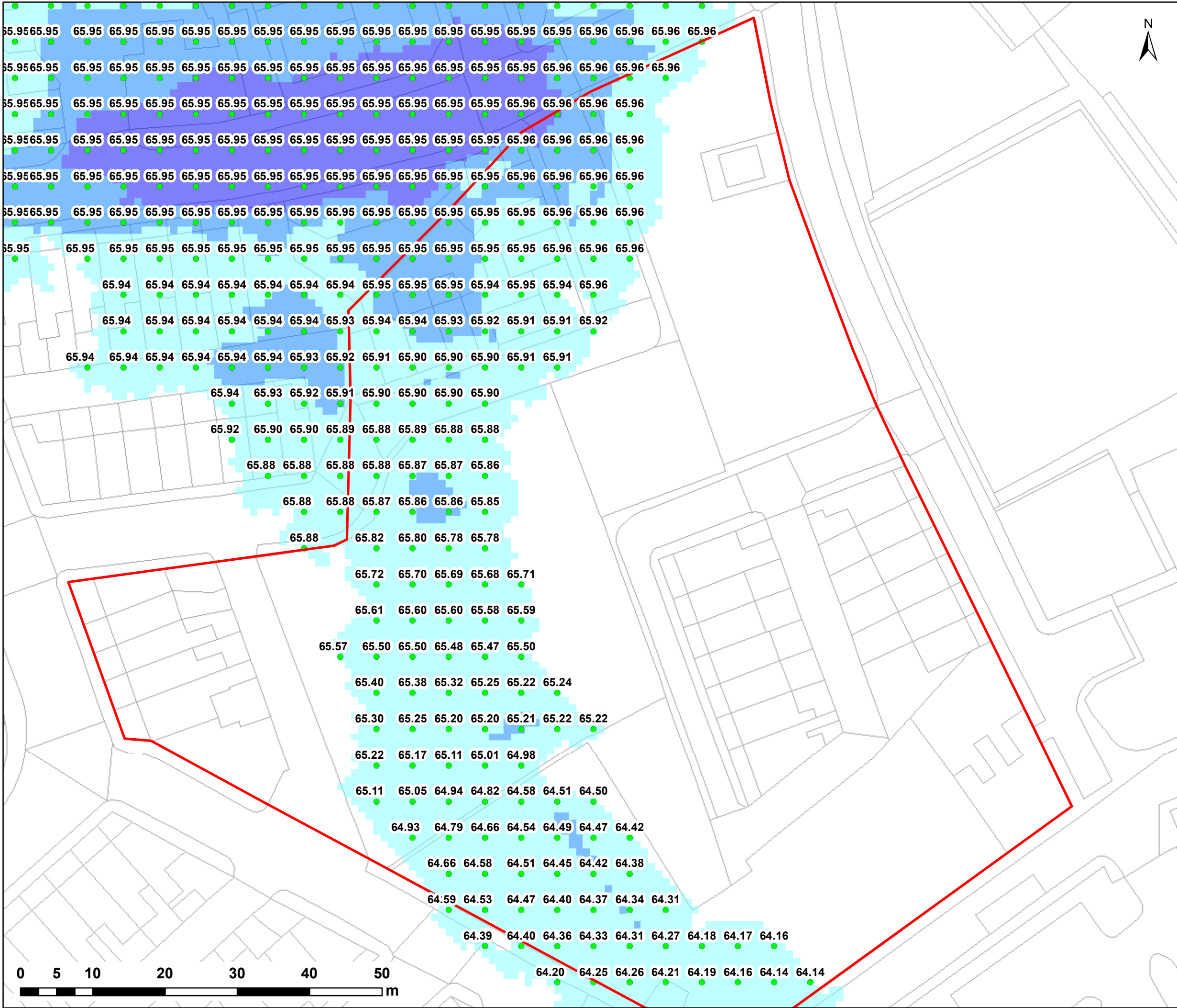
SCHEME:

**ISLAND SITE,  
RADCLIFFE**

PLOT TITLE:

**MAXIMUM WATER LEVELS**  
1% AEP FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
NORMAL FLOW CONDITIONS

|                           |          |           |                           |
|---------------------------|----------|-----------|---------------------------|
| PLOT STATUS:              |          |           | DATE:                     |
| FINAL                     |          |           | 03/11/2020                |
| DRAWN:                    | CHECKED: | APPROVED: | PLOT SCALE @ A3:          |
| VJ                        | SB       | DH        | 1:500                     |
|                           |          |           | (UNLESS STATED OTHERWISE) |
| PLOT NAME:                |          |           | REV:                      |
| 13478-CRT_Q100_EXG_NFC_WL |          |           | -                         |



NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE  
2) MAXIMUM WATER LEVELS HAVE BEEN RESAMPLED AT A 5m HORIZONTAL RESOLUTION

LEGEND

- Site Boundary
- Water Level Points (m AOD)

Maximum Flood Depth (m)

- 0 - 0.3
- 0.3 - 0.6
- 0.6 - 1.2
- 1.2 - 2.4
- > 2.4



CLIENT:   
A TETRA TECH COMPANY

  
www.waterco.co.uk

SCHEME: **ISLAND SITE, RADCLIFFE**

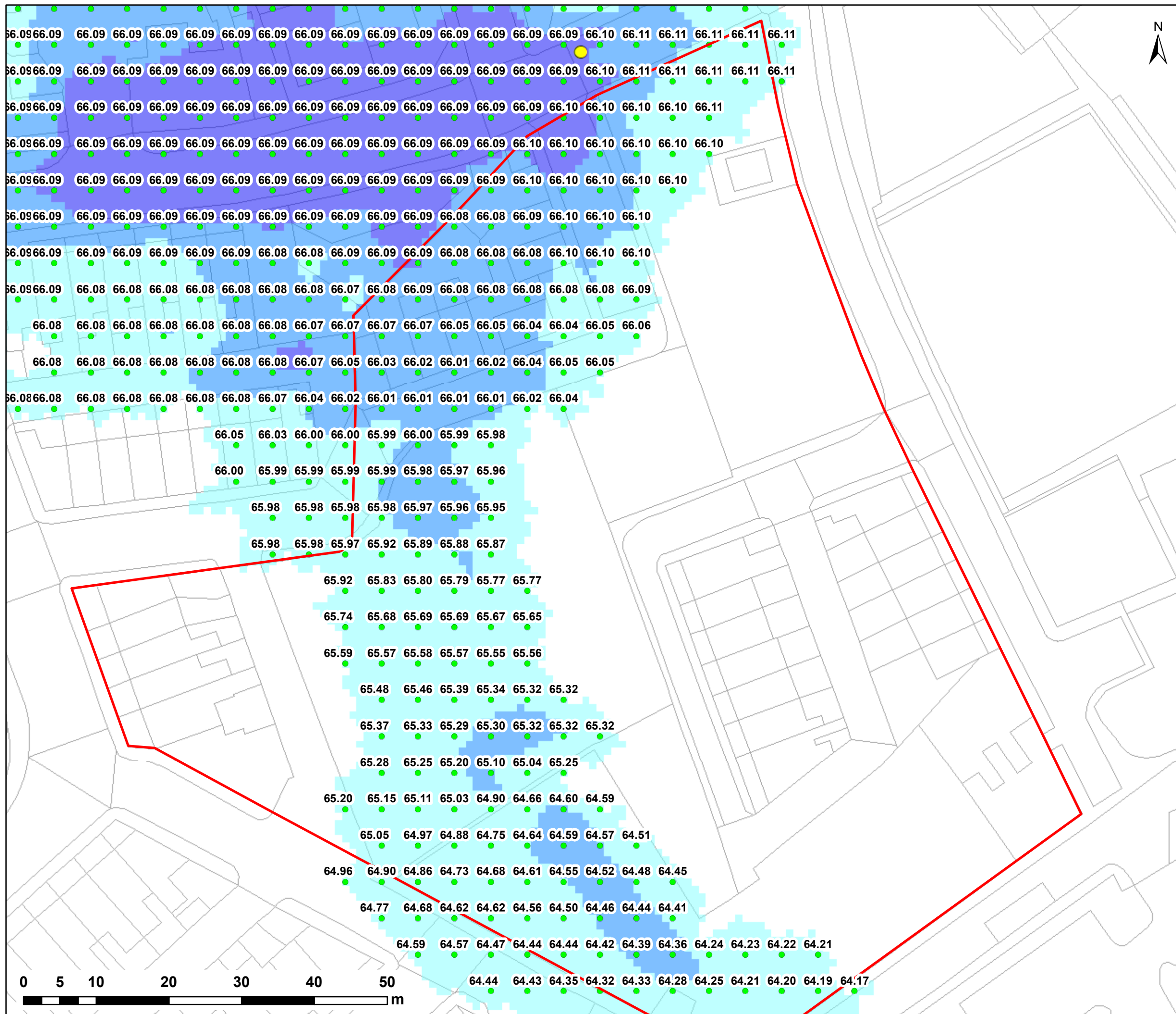
PLOT TITLE: **MAXIMUM WATER LEVELS**  
1% AEP + 35% CC FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
NORMAL FLOW CONDITIONS

PLOT STATUS: **FINAL** DATE: 03/11/2020

|           |             |              |                                                  |
|-----------|-------------|--------------|--------------------------------------------------|
| DRAWN: VJ | CHECKED: SB | APPROVED: DH | PLOT SCALE @ A3: 1:500 (UNLESS STATED OTHERWISE) |
|-----------|-------------|--------------|--------------------------------------------------|

|                                         |        |
|-----------------------------------------|--------|
| PLOT NAME: 13478-CRT_Q100CC1_EXG_NFC_WL | REV: - |
|-----------------------------------------|--------|





NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE  
2) MAXIMUM WATER LEVELS HAVE BEEN RESAMPLED AT A 5m HORIZONTAL RESOLUTION

**LEGEND**

Site Boundary

Water Level Points (m AOD)

A6053 Culvert Blockage Location

**Maximum Flood Depth (m)**

0 - 0.3

0.3 - 0.6

0.6 - 1.2

1.2 - 2.4

> 2.4

CLIENT:

[www.waterco.co.uk](http://www.waterco.co.uk)

SCHEME:

**ISLAND SITE,  
RADCLIFFE**

PLOT TITLE:

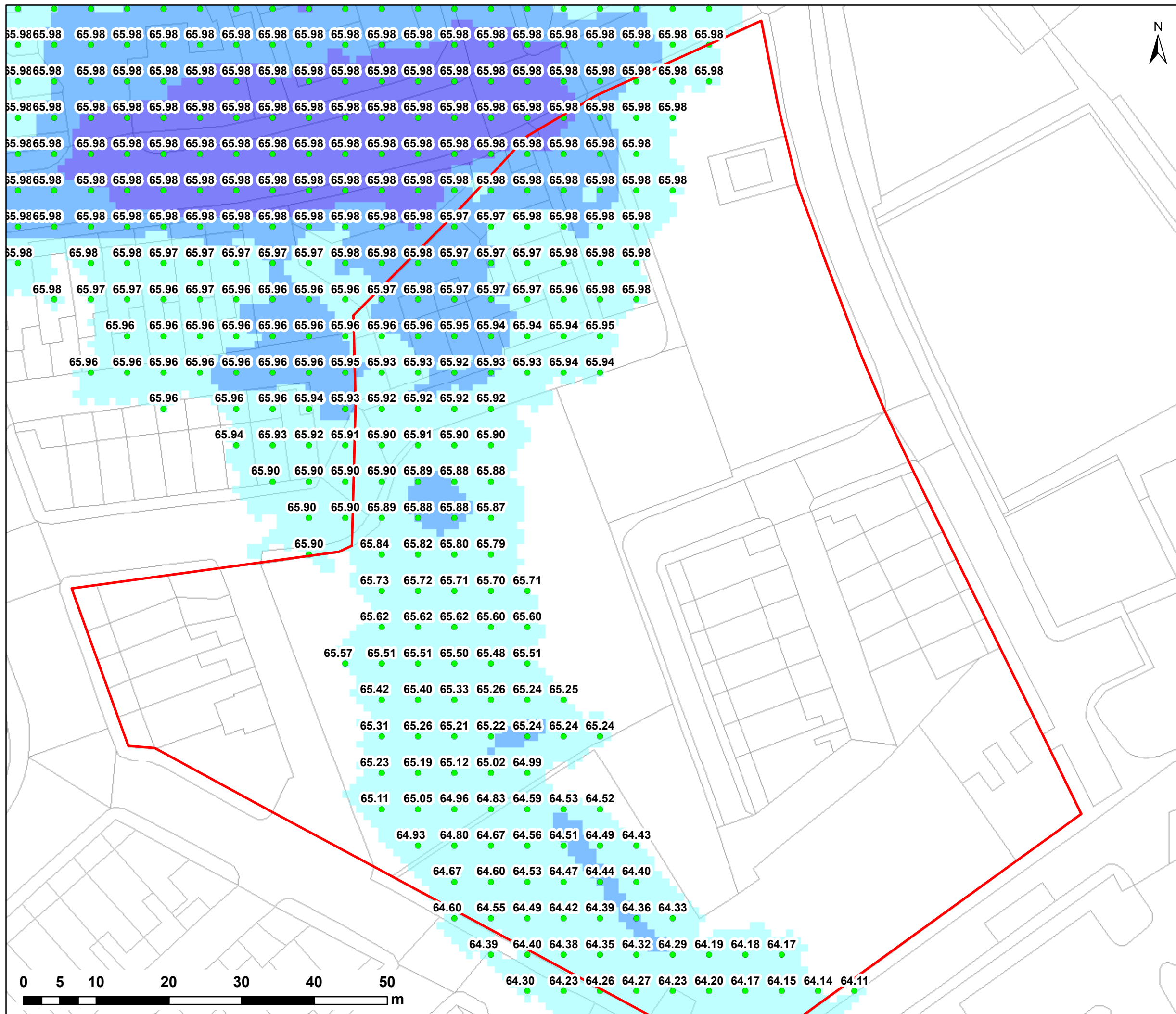
**MAXIMUM WATER LEVELS**  
1% AEP + 35% CC FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
100% BLOCKAGE A6053 CULVERT

|              |  |  |            |
|--------------|--|--|------------|
| PLOT STATUS: |  |  | DATE:      |
| FINAL        |  |  | 03/11/2020 |

|        |          |           |                           |
|--------|----------|-----------|---------------------------|
| DRAWN: | CHECKED: | APPROVED: | PLOT SCALE @ A3:          |
| VJ     | SB       | DH        | 1:500                     |
|        |          |           | (UNLESS STATED OTHERWISE) |

|                                   |      |
|-----------------------------------|------|
| PLOT NAME:                        | REV: |
| 13478-CRT_Q100CC1_EXG_BL1-99.9_WL | -    |





NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE  
2) MAXIMUM WATER LEVELS HAVE BEEN RESAMPLED AT A 5m HORIZONTAL RESOLUTION

**LEGEND**

Site Boundary

Water Level Points (m AOD)

**Maximum Flood Depth (m)**

0 - 0.3

0.3 - 0.6

0.6 - 1.2

1.2 - 2.4

> 2.4

CLIENT:

[www.waterco.co.uk](http://www.waterco.co.uk)

SCHEME:

**ISLAND SITE,  
RADCLIFFE**

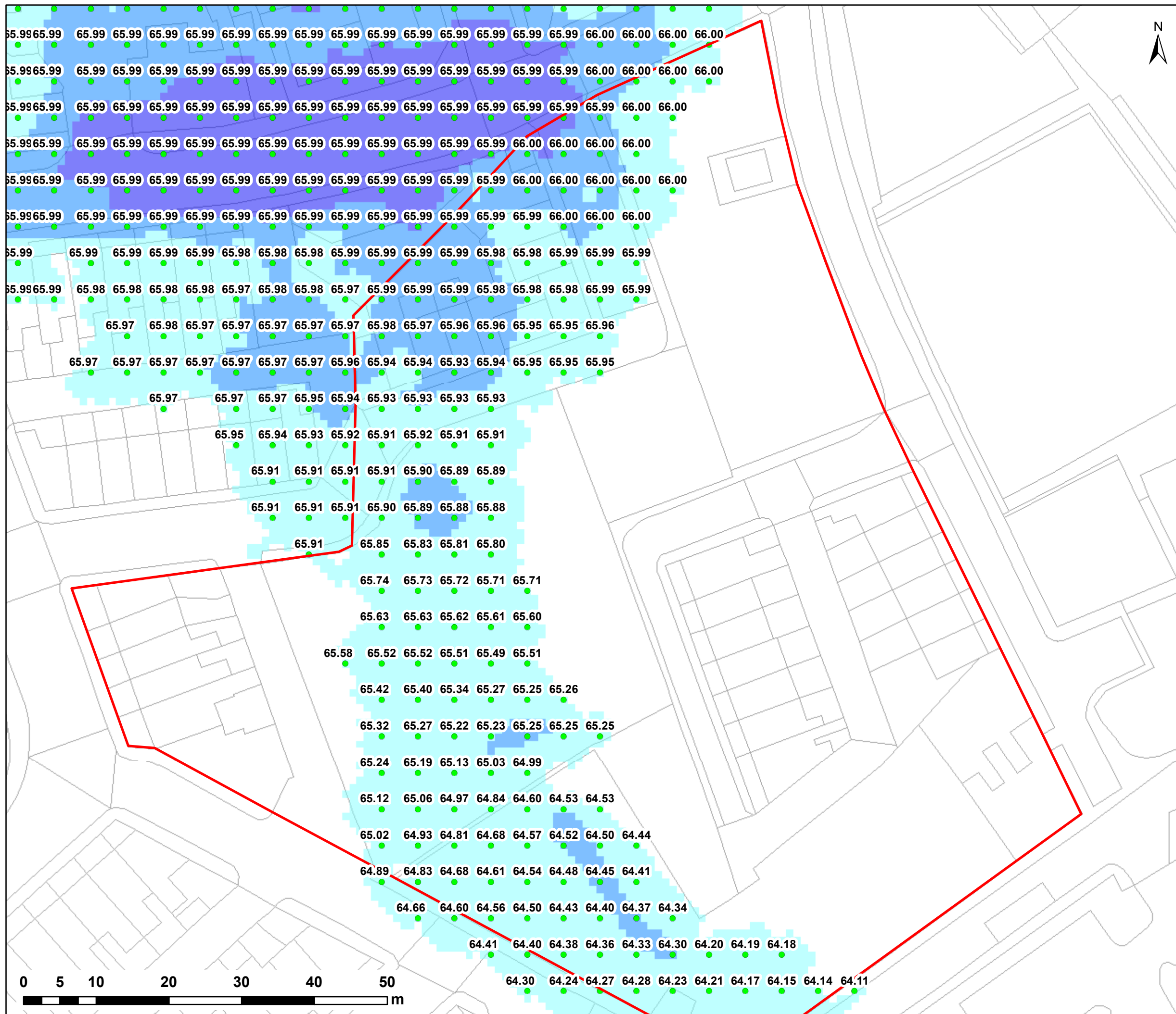
PLOT TITLE:

**MAXIMUM WATER LEVELS**  
1% AEP + 70% CC FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
NORMAL FLOW CONDITIONS

|              |  |  |            |
|--------------|--|--|------------|
| PLOT STATUS: |  |  | DATE:      |
| FINAL        |  |  | 03/11/2020 |

|        |          |           |                           |
|--------|----------|-----------|---------------------------|
| DRAWN: | CHECKED: | APPROVED: | PLOT SCALE @ A3:          |
| VJ     | SB       | DH        | 1:500                     |
|        |          |           | (UNLESS STATED OTHERWISE) |

|                              |      |
|------------------------------|------|
| PLOT NAME:                   | REV: |
| 13478-CRT_Q100CC2_EXG_NFC_WL | -    |



NOTES:  
1) ALL DIMENSIONS ARE IN METRES AND ALL LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS STATED OTHERWISE  
2) MAXIMUM WATER LEVELS HAVE BEEN RESAMPLED AT A 5m HORIZONTAL RESOLUTION

**LEGEND**

Site Boundary

Water Level Points (m AOD)

**Maximum Flood Depth (m)**

0 - 0.3

0.3 - 0.6

0.6 - 1.2

1.2 - 2.4

> 2.4

CLIENT:

[www.waterco.co.uk](http://www.waterco.co.uk)

SCHEME:

**ISLAND SITE,  
RADCLIFFE**

PLOT TITLE:

**MAXIMUM WATER LEVELS**  
0.1% AEP FLUVIAL EVENT  
EXISTING SITE LAYOUT (EXG)  
NORMAL FLOW CONDITIONS

|              |  |  |            |
|--------------|--|--|------------|
| PLOT STATUS: |  |  | DATE:      |
| <b>FINAL</b> |  |  | 03/11/2020 |

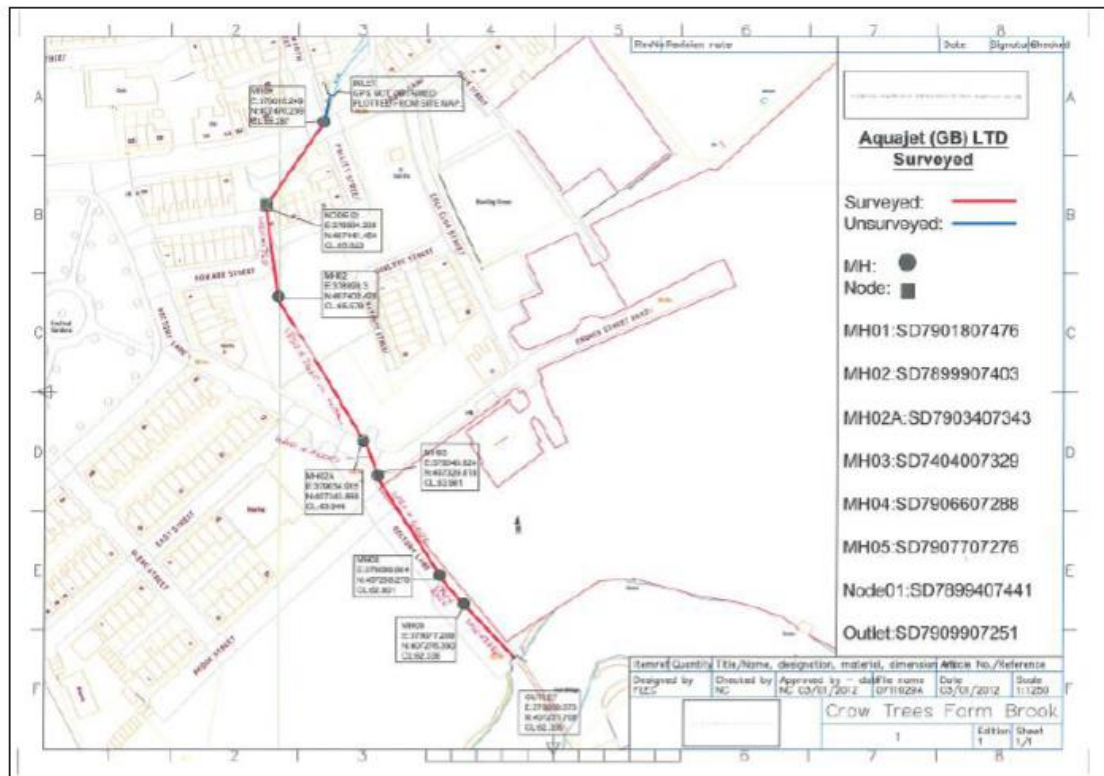
|        |          |           |                           |
|--------|----------|-----------|---------------------------|
| DRAWN: | CHECKED: | APPROVED: | PLOT SCALE @ A3:          |
| VJ     | SB       | DH        | 1:500                     |
|        |          |           | (UNLESS STATED OTHERWISE) |

|                            |      |
|----------------------------|------|
| PLOT NAME:                 | REV: |
| 13478-CRT_Q1000_EXG_NFC_WL | -    |

## **APPENDIX N – CULVERT SURVEY**



# CROW TREES FARM CULVERT SURVEY



Route of Crow Trees Farm Brook Culvert