

Antrim Hollywell Burn Feasibility Report

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1 EXECUTIVE SUMMARY

1.1 INTRODUCTION

AECOM was commissioned by the Department of Agriculture and Rural Development (DARD) Rivers Agency to appraise flood risk to the Tesco Distribution Centre and Kilbegs Industrial Estate in Antrim Town, from the Hollywell Burn/Plaskets Burn watercourses and other contributing sources, and to investigate options (including economic viability) to alleviate any potential flooding from a 1 in 100 year event.

In addition, the causes and mechanisms of the flood event at the Tesco Distribution Centre on the 17th October 2011 along the Hollywell Burn/ Plaskets Burn in Kilbegs Industrial Estate were investigated.

1.2 HISTORY OF FLOODING

On the 17th October 2011 flooding from the Hollywell Burn affected the Tesco Distribution Centre on the Kilbegs Road, Antrim with floodwaters close to entering the warehouse and electrical switch room. The storm drainage arrangement for the site is a pumped system from the site into the Hollywell Burn which in this flood event helped to prevent further flooding. However if the floodwaters had entered the electrical switch room causing power loss to the pumping station there was the potential for higher flood levels and the likelihood of further damage.

1.3 RIVER MODELLING

A hydrodynamic one-dimensional hydraulic model of the watercourse integrated with a two-dimensional model of the surrounding topography was provided by Rivers Agency to AECOM in InfoWorks ICM format. The model was updated with topographical survey data supplied by Trueline Surveys.

The model was then run using the flows generated from hydrological assessment methods which was included within the model provided. The results of the model show that flooding commences in the 1 in 5 year event and is generally limited to an area in the north-west of Antrim (Hollywell Burn and Plaskets Burn). The 1 in 100 year event shows an increased flood extent in this area and in fields to the west of Antrim. The flooding from Hollywell Burn/Plaskets Burn shown by the model matches the flooding previously experienced at the Tesco Distribution Centre in this area on the 17th October 2011.

1.4 FLOOD PROTECTION OPTIONS

The Hollywell Burn/Plaskets Burn was assessed for suitable flood protection options as identified below.

- Option 1 – Do Nothing
- Option 2 – Do Minimum Measures – Decrease channel vegetation.
- Option 3 – Raise the existing embankment level and channel maintenance.
- Option 4 – Construction of floodwalls and channel maintenance.
- Option 5 – Flood storage upstream

Option Assessment

Following an assessment of the various merits and drawbacks of each of the potential flood alleviation options, it was decided that only one of the options was suitable for providing flood protection. This option was:

Option 4 - Construction of floodwalls and channel maintenance works.

The other options were ruled out for a variety of reasons;

- Options 1 and 2 do not provide the required flood protection up to a 1 in 100 year flood event.

- Option 3 was not achievable due to the amount of land take required to raise and widen the bank to the required levels.
- Option 5 was not feasible due to the limited amount of suitable land available to provide the necessary storage.

1.5 BENEFIT COST ANALYSIS

The cost of damages for the Q5, Q10, Q25, Q50 and Q100 flood events were calculated based upon the Multi-Coloured Manual and discounted over a period of 100 years in order to determine the present value of benefits for each option.

The benefit cost analysis shows that option 4 (Construction of floodwalls and channel maintenance) is economically viable as it has a benefit/cost ratio of approximately 36.

2 TERMS OF REFERENCE

AECOM was commissioned by the Department of Agriculture and Rural Development (DARD) Rivers Agency to appraise flood risk to the Tesco Distribution Centre and Kilbegs Industrial Estate in Antrim Town, from the Hollywell Burn/Plaskets Burn and other contributing sources, and to investigate options (including economic viability) to alleviate any potential flooding from a 1 in 100 year return period event.

2.1 SCOPE OF THE BRIEF

The main requirements of the brief were to:

- Advise the Employer on the need for arrangements to be made for, and define the extent of any necessary surveys (including but not limited to topographical, geophysical or CCTV surveys).
- Assess flood risk and analyse the flooding mechanism within the Kilbegs Industrial Estate using the existing Hollywell Burn and Plaskets Burn Infoworks ICM models provided.
- Determine the hydraulic capacity of the existing channel, culvert network and pertinent structures and comment on their ability to contain the estimated flood flows.
- Consider the effects of development, as proposed in the latest Area Plan, on flows in the watercourses
- Investigate the performance of any back drainage systems and how they may contribute to the overall flooding mechanism.
- Utilise the existing model to evaluate the impact of any proposed flood defence / alleviation options (including upstream and downstream of the works location); and to run a model simulation for the recommended solution as appropriate.
- Consider a range of options that would remove the threat of flooding up to and including the Q100 scenario. In developing options consideration should be given to the technical (buildability and construction issues), economic and environmental aspects of proposals.
- Identify and consider any interim measures that could readily be undertaken in order to alleviate flooding within the study area; make recommendations on the viability, effectiveness and appropriateness of such measures.
- Identify and quantify the flood damage to properties presently at risk of flooding in flood events up to the predicted Q100 event in accordance with the procedures outlined in the Flood Hazard Research Centre (FHRC) Multi-Coloured Manual.
- Consider the flood damage avoidance benefit for each of the options considered as part of the economic assessment, highlighting any residual flood risk.
- Recommend the most cost effective solution for providing flood protection to the 1 in 100 year standard.
- Review potential visual and environmental impacts of proposed works and allow for consultation with Rivers Agency Environmental Advisors.
- Consult any local or other authorities including Utility Providers; Antrim and Newtownabbey Borough Council; NI Water, NIEA; Transport NI, about matters of principle in connection with the outline / recommended proposals for the Project.
- Undertake technical liaison with Rivers Agency staff as appropriate (including but not limited to Local Area, Asset Management, Hydrometric Section etc), and other organisations such as DRD Transport NI, District Councils, NI Water, NIEA.
- Undertake liaison with residents, landowners and developers as required to gain an understanding of the flooding history within the area and to assist the Consultant in producing a map illustrating all landowners potentially affected by the recommended solution and their known contact details.

3 SITE DESCRIPTION

3.1 HOLLYWELL BURN

The Hollywell Burn which was designated in October 1980 is a man-made channel on a diversionary route to facilitate the development of Kilbegs Industrial Estate. The watercourse is heavily tree-lined which may have been planted as part of the designated diversion.

The Hollywell Burn catchment area upstream of the discharge point into the Plaskets Burn is 8.49km² and the length of the watercourse itself is 6.61km. An assessment of the catchment area upstream of Kilbegs Industrial Estate was carried out by looking at mapping and contours and it appears to be mostly low to medium sloped and predominantly rural with scattered residential developments, and the M2 motorway passing through it. See drawing ANTR-ACM-XX-XX-DR-CE-01001 in Appendix A.

It is noted from the Prefeasibility Report completed by DARD Rivers Agency that the sizes of the existing infrastructure, within the watercourses in the vicinity of the site, appear to have significant capacity to exceed the estimated flows from the catchment calculations.

3.2 PLASKETS BURN

The Plaskets Burn upstream of the confluence with the Hollywell Burn is also called the Ferguson River. The catchment area is approximately 5.67 km², the watercourse length is estimated at 6.12km and it discharges into the Six Mile Water. The catchment appears to be low to medium sloped, predominantly rural with scattered residential developments and the M2 Motorway passing through it.

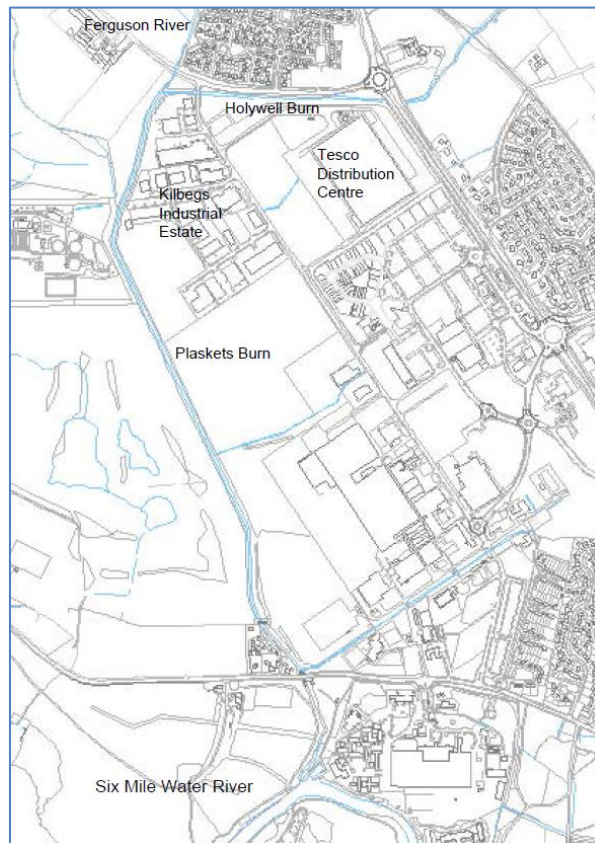


Fig 3.0 Site Location Map

4 SITE SURVEY

4.1 PRELIMINARY SURVEY

A preliminary survey of Kilbegs Industrial Estate and associated watercourses within the extents of this study of work was undertaken by AECOM and Rivers Agency on 22nd June 2015. The purpose of this survey was to identify the scope for further survey works and assess levels and dimensions of any key features including inlet and outlet screens, weirs and any outfalls or mill races that may contribute to flood risk.

4.2 LOCAL HYDRAULIC FEATURES

The study reach is made up of open channels and two hydraulic structures which take the form of two road bridges.

The structures on the Hollywell Burn adjacent to Kilbegs Industrial Estate are shown in Drawing ANTR-ACM-XX-XX-DR-CE-01002, Appendix A. Further information of the hydraulic structures is detailed in Table 4.0 below.

<i>Bridge No;</i>	<i>Size of Culverts</i>	<i>Description</i>
1	Upstream: 1.95m x 2.0m 2.10m x 1.8m Downstream: 1.8 Diameter (x2)	Twin Arch A26 Road Bridge
2	5.3m. x 2.0m (x2)	Twin box culverts – Access road to industrial Estate

Table 4.0: Description of structures in Study Reach

4.3 EXISTING SERVICES INFRASTRUCTURE

AECOM undertook a service investigation for the site using existing service information which includes the existing foul and storm drainage which may have an impact upon the flood risk associated with the site (See Drawing ANTR-URS-XX-XX-DR-CE-01004, Appendix A).

A network of existing water mains and trunk sewers was identified within the nearby housing development and roads network in the direct vicinity of the Hollywell Burn. These services are all under the ownership of NI Water. Due to the Tesco Distribution Centre site being at a lower level to the banks of the Hollywell Burn, Tesco has a pumping station within their site pumping the storm drainage out into the Hollywell Burn. After reviewing the existing services information and completing a site walk, it has been confirmed that there are two outfall points into the Hollywell Burn on the left hand bank.

NIE provided a network map of their services in the vicinity of the Tesco Distribution Centre and Hollywell Burn. The location of the underground and overhead cables have been identified. Cables cross the Hollywell Burn into the Tesco Distribution Centre and Kilbegs Industrial Estate at two separate points as shown on drawing ANTR-ACM-XX-XX-DR-CE-01003, Appendix A. There is no hydraulic impact of the NIE services in the direct vicinity of the Hollywell Burn. However there is a possibility that some NIE cables may need to be diverted to allow the construction of any proposed flood alleviation works.

4.4 TOPOGRAPHICAL SURVEY

AECOM was provided with an existing hydraulic model representative of the current conditions. A topographical survey of finished floor levels within Kilbegs Industrial Estate was required in order to assess the damages from a range of flood event. The extent of the survey area is shown in drawing ANTR-ACM-XX-XX-DR-CE-01005, Appendix A.

5 CONSULTATIONS

AECOM consulted with a number of parties in relation to the flood risk investigation for Kilbegs Industrial Estate.

5.1 RIVERS AGENCY

AECOM consulted with DARD Rivers Agency Area Staff regarding the history of the flooding in Kilbegs Industrial Estate. DARD Rivers Agency Area Staff were able to provide details of the extent of the flooding on 17th October 2011 in the flood report included within the DARD Rivers Agency Prefeasibility Report dated September 2012.

5.2 ECOLOGY AND AMENITY

AECOM consulted with DARD Rivers Agency Environment Section in order to identify any ecological issues which may have to be considered during the flood risk investigation in line with the Water Framework Directive (WFD) and Floods Directive.

<i>Environmental Impact</i>	<i>Characteristics of Impact</i>	<i>Mitigation Measures</i>
Human Beings	Accessibility requirement for houses and commercial buildings during proposed works	Traffic Control Measures required.
Flora	Loss of mature tree and shrub cover.	Significant tree removal should be minimised where possible. Shrub removal may be required. Removal should be carried outside nesting season (1st March to 31st August). Care should be taken to minimise root disturbance during removal.
Fauna	Potential impact on nesting birds and fisheries.	Timing of works as above to ensure no disturbance of nesting birds. Channel works should aim to maximise the potential for local and migratory fish.
Water	Potential Water Quality Issue.	Sediment trapping mechanisms should be considered if any work is carried out.

5.3 LOCAL RESIDENTS

AECOM sent out letters to current occupiers/landowners of properties within Kilbegs Industrial Estate requesting any anecdotal information on previous flood events. No information was received.

6 DESK STUDY INVESTIGATION

6.1 PLANNING ISSUES

The Antrim, Ballymena and Larne Local Area Plan 2016 stated that the Regional Development Strategy (RDS) has designated Antrim Town as one of the main towns of the Belfast Metropolitan Area (BMA) hinterland, to be developed as a countermagnet to the BMA.

Antrim was identified by the RDS as a major industrial centre with spare capacity in terms of infrastructure and services and also for being particularly well placed within the ring of main towns around Belfast to accommodate the growing proportion of the housing market.

Any new development should not increase flood risk elsewhere in line with “Planning Policy Statement 15 – Planning and Flood Risk.” In principle this means the storm water runoff rates and volumes of storm water discharged from urban developments should be approximate to the existing greenfield run off over a range of storm events. Therefore any future industrial and residential development in the vicinity of the study area should not have any adverse effects on the predicted flooding events.

6.2 HISTORY OF FLOODING

Kilbegs Industrial Estate has been subject to flooding from the Hollywell Burn watercourse. There has only been one reported flood event from the Hollywell Burn in this area (17th October 2011).

AECOM, as discussed in Section 5.3 of this report, has sent out letters to current occupiers/landowners of properties within Kilbegs Industrial Estate requesting any anecdotal information on previous flood events. No information was received.

6.2.1 FLOOD EVENT ON 17TH OCTOBER 2011

According to the Prefeasibility Report produced for the flood event on 17th October 2011 by DARD Rivers Agency, one commercial property was affected by localised out of bank flooding from the Hollywell Burn watercourse, see Fig 5.0.

The out of bank flooding occurred at a low point on the left hand bank of the Hollywell Burn causing flooding within the site around the Tesco Distribution Centre. The Prefeasibility Report stated that no buildings were inundated during this flood event. However it should be noted that the level of the floodwaters was close to entering the main building and electrical switch room which provides power to a pumping station.

Due to the topography of the site storm drainage is pumped from the site into the Hollywell Burn. Therefore if the floodwaters had reached the electrical switch room causing the complex and the pumping station to lose power there was potential for greater flooding and damage.



Fig 5.0 Flooding on 17th October 2011 in the Tesco Distribution Centre site (sourced from the Prefeasibility Report by DARD Rivers Agency)

7 RIVER FLOW ASSESSMENT

AECOM reviewed the river flood flow assessment undertaken by JBA Consulting for both the Hollywell Burn and Plaskets Burn watercourses.

7.1 FLOW ESTIMATION

AECOM was provided with an existing hydraulic model representative of the current conditions which included the inflow data and downstream boundary conditions. These were reviewed prior to undertaking modelling and found to be accurate.

7.2 FUTURE DEVELOPMENT

As discussed above in section 6.1 the impact of future development on the storm water run-off within the catchment area for the Hollywell Burn and Plaskets Burn watercourses was considered. The current Antrim proposals shows that Antrim Town is within the areas zoned for development as discussed in Section 6.1.1 of this report.

8 HYDRAULIC MODELLING OF THE EXISTING SYSTEM

A base hydraulic model was provided with a range of flood events including the 1 in 100 year flood event. Additional models were then constructed to assess the effectiveness of any proposed flood alleviation options.

8.1 INFOWORKS ICM MODELLING

The primary objectives of the hydraulic modelling were:

- To assess the existing hydraulic capacities and out of bank flow paths of both the Hollywell Burn and Plaskets Burn watercourses.
- To use the hydraulic model to estimate water levels, out of bank flow paths and flood extents, for a range of return periods for different scenarios, including “Do Nothing” and with “Do Something” flood alleviation measures.

The hydraulic model is a hydrodynamic one-dimensional hydraulic model of the watercourse integrated with a two-dimensional model of the surrounding terrain.

The model can be modified to assess possible scenarios and run using the flows generated from a hydrological assessment method described previously, to monitor the impact on the hydrologic regime of the watercourses.

8.2 MODEL CALIBRATION AND VERIFICATION

The availability of hydrometric data determines the modelling approach in terms of detailed calibration and validation. Gauged information was not available for this area; therefore the model was calibrated using best estimates of values for hydraulic variables using best practice and experience. Model results were examined and a “reality check” was made to determine if the results were realistic. This involved carrying out a site visit to review the flood levels and comparing these with anecdotal evidence collected from the 17th October 2011 flood event. The return period of the 17th October 2011 flood event is estimated to be 1 in 100 years.

8.2.1 SENSITIVITY ANALYSIS AND UNCERTAINTY

A sensitivity analysis was undertaken using the 1 in 100 year return period design flows to ascertain the impact from variations in critical parameters on peak water levels. These analyses are detailed within the separate Model Report.

These parameters included:

- Flow events;
- Culvert, channel and structural roughness coefficients;
- Downstream boundary conditions;
- Inlet/Outlet head losses and degree of blockage.

8.2.2 ROUGHNESS COEFFICIENT

The Manning value ‘n’ is a measure of the roughness of the bed and side slopes of the watercourse. Evidence from the site visit and the examination of photographs was used to provide a best estimate of the Manning values for the terrain for use in the hydraulic model.

The Manning values for the terrain were varied in order to produce good correlation with the flood levels that correspond to the 17th October 2011 flood event.

Table 8.0 summarises the value of Manning ‘n’ used within the InfoWorks ICM analysis.

<i>Location</i>	<i>Manning ‘n’</i>
Open Channel - Bed	0.07
Open Channel - Banks	0.07
Bridge – Bridge Openings	0.025
Terrain – Grass areas	0.03
Terrain – Hardstanding Areas	0.01

Table 8.0: Manning ‘n’ used within analysis

8.2.3 DOWNSTREAM WATER LEVELS

The downstream water level of 13.00mOD obtained from the JBA Consulting Report for Lough Neagh was varied to assess the impact on the existing 1 in 100 year levels used in the InfoWorks ICM model.

8.3 HYDRAULIC ASSESSMENT OF EXISTING SYSTEM

Table 8.1 shows the flood levels relative to the ordnance datum from each cross section for a range of flood events, and it is based on the following assumptions;

- All bridge openings are free from debris.
- Roughness values listed in Table 8.0 are representative of the condition of the existing bridge openings, channel and terrain.
- Downstream level remains constant.

<i>Cross Section No:</i>	<i>Q2 Max Flood Level (m.AOD)</i>	<i>Q5 Max Flood Level (m.AOD)</i>	<i>Q10 Max Flood Level (m.AOD)</i>	<i>Q25 Max Flood Level (m.AOD)</i>	<i>Q50 Max Flood Level (m.AOD)</i>	<i>Q100 Max Flood Level (m.AOD)</i>	<i>Q100cc Max Flood Level (m.AOD)</i>	<i>Q1000 Max Flood Level (m.AOD)</i>
CS001	19.72	19.81	19.88	19.98	20.07	20.16	20.25	20.48
CS002	19.27	19.44	19.56	19.71	19.82	19.93	20.04	20.30
CS003	18.99	19.19	19.31	19.44	19.54	19.64	19.73	19.95
CS004	18.83	19.03	19.14	19.24	19.31	19.37	19.42	19.55
CS005	18.66	18.85	18.95	19.03	19.08	19.13	19.17	19.26
CS006	18.45	18.61	18.69	18.76	18.81	18.85	18.89	18.98
CS007	18.26	18.40	18.47	18.53	18.57	18.61	18.65	18.75
CS008	17.98	18.08	18.13	18.18	18.22	18.26	18.31	18.46

Table 8.1: Maximum flood levels for each cross section

Section locations are shown on drawing ANTR-ACM-XX-XX-DR-CE-01018.

9 ASSESSMENT OF FLOOD RISK

Modelling based on the assumptions outlined in the hydraulic assessment has shown that out of bank flooding will occur along sections of the Hollywell Burn for flows equal to and in excess of Q5. The extent of the flooding in these areas is shown on the flood maps ANTR-ACM-XX-XX-DR-CE-01006 to ANTR-ACM-XX-XX-DR-CE-01014 for Q5 to Q1000 flood events.

9.1 AREAS AT RISK

Flooding occurs along the Hollywell Burn equal to and in excess of 1 in 5 year event. The extent of this flooding poses a high risk to commercial properties. The properties at risk during a 1 in 100 year event are:

- Tesco Distribution Centre,
- 17 Commercial units within Kilbegs Industrial Estate

In total, 18 commercial properties have the potential to flood during a 1 in 100 year event however flood damages are only realised for commercial properties without a basement with flood depths greater than 250mm. When this is factored in, damages are only calculable for the Tesco Distribution Centre and 4 units within the Kilbegs Industrial Estate. Details of the depth of floods of each property are shown in the estimated damages tables included within Appendix C of the Economic Appraisal.

The Infoworks ICM model showed that out of bank flooding from the Hollywell Burn occurred at one location during a Q100 flow event. (See Figure 9.0). Other units within Kilbegs industrial Estate will be affected by flooding within the surrounding grounds and car parking areas. It is noted that the finished floor levels for buildings were not taken into account in the InfoWorks ICM model.

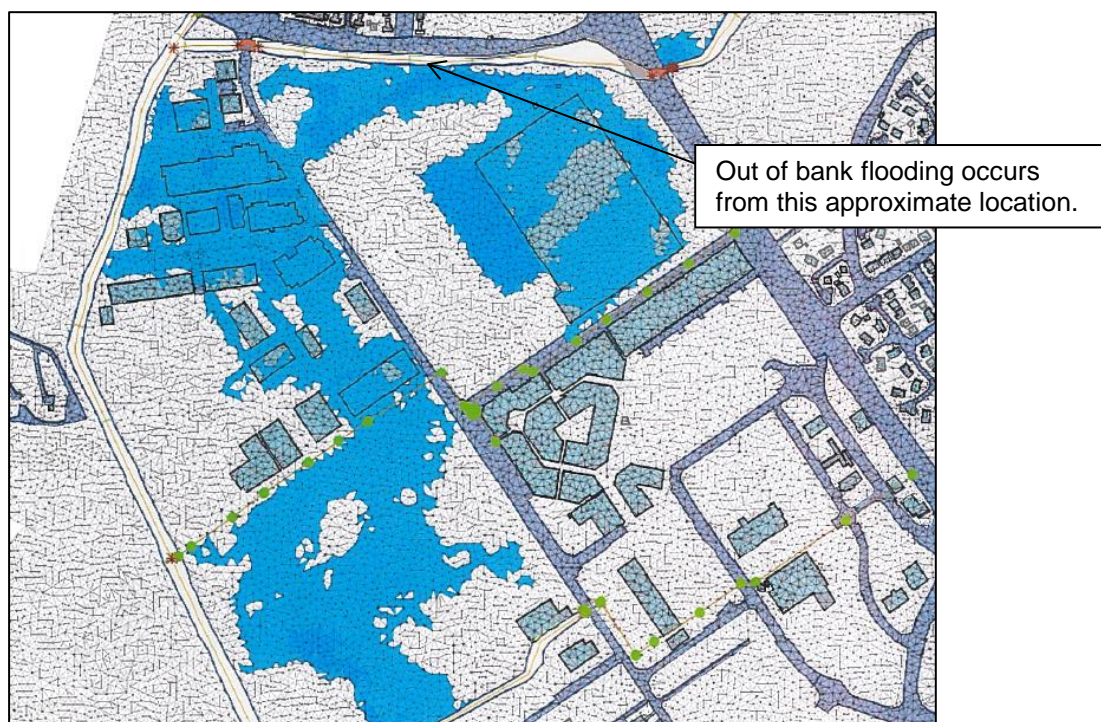


Figure 9.0: Infoworks ICM Model showing extent of out of bank flooding in a Q100 flow event.

9.2 FLOOD RISK IDENTIFICATION

The flood model was assessed to identify the consequences and risks of flooding on the following receptor groups taking account of a 1 in 100 year flood event.

9.2.1 HUMAN HEALTH

Consideration was given to any significant impact of flooding on human health including the risk of loss of life. This relates to the speed of flooding, the depth of flooding and local

demographics. This is quantified within the Economical Appraisal. It is also possible to assess the economic effects of loss of life, stress etc. caused by flooding.

9.2.2 ENVIRONMENT

The environmental impacts of flooding include effects on the natural environment from floodwater intrusion and the impacts of associated pollution on important habitats and biodiversity. This includes any landscape, recreation or conservation areas within Kilbegs Industrial Estate.

9.2.3 ECONOMY

Economic impacts comprise all impacts which have an economic element, including environmental impacts and indirect effects such as stress if the impacts can be quantified in financial terms.

9.2.4 CRITICAL INFRASTRUCTURE

The study identified of any vulnerable buildings which may be at risk from flooding, e.g. Schools, Police stations, government offices, NI Water Pumping Stations, NIE Sub Stations, BT telephone exchange etc. Consideration was given to the road and transport network in the area.

9.3 RISK TO RECEPTOR GROUPS

The impacts of a 1 in 100 year flood event upon the receptor groups were considered for both the Hollywell Burn and Plaskets Burn watercourses.

9.3.1 HUMAN HEALTH

There is a low risk to human life given the depth of water associated with the flood event and the number of properties affected during the 1 in 100 year flood event.

9.3.2 ENVIRONMENT

As detailed in Section 3 of this report the Hollywell Burn and Plaskets Burn catchment areas are predominantly rural and hence during extreme flooding events the amounts of pollutants (eg. oils) entering the Hollywell Burn and Plaskets Burn from increased run-off from hard standing areas are unlikely to have a significant impact.

9.3.3 ECONOMY

Out of bank flooding would potentially result in 18 commercial properties in the vicinity of the Hollywell Burn and Plaskets Burn being inundated during a 1 in 100 year flood event, resulting in a significant economic impact from flood damages.

9.3.4 CRITICAL INFRASTRUCTURE

The infrastructure affected by flooding along the Hollywell Burn was the Tesco Distribution Centre on the Kilbegs Road. The floodwaters overtopped the left hand bank of the Hollywell Burn inundating the site and came close to entering the warehouse and electrical switch room which powers the complex and the pumping station. Due to the topography of the site the storm drainage is pumped from the site to the Hollywell Burn. Consequently had the electrical switch room been flooded and the pumping station lost power; there was the potential for greater flooding and subsequent damage.

10 SUMMARY OF CAUSES OF FLOODING

The flooding of the Hollywell Burn and Plaskets Burn can be attributed to a combination of factors including:

- Under-sized open channel system,
- The channel and embankments are overgrown with vegetation causing a high Manning's value.

These factors are expanded on below.

10.1 CAPACITY OF SYSTEM

The InfoWorks Model identified a number of bridge openings which have significant capacities exceeding the estimated flows from the catchment calculations. Open channel sections were identified to not have the capacity to convey a Q100 flow as discussed in a previous section of this report.

10.2 HYDRAULIC INEFFICIENCIES

The growth of Antrim Town over a period of time and the development of the Kilbegs Industrial Estate and the Tesco Distribution Centre resulted in the diversion of the Hollywell Burn using a man-made open channel which has the potential to surcharge during a 1 in a 100 year flood event.

10.3 BLOCKED OPENINGS

The InfoWorks ICM model was constructed on the assumption that all bridge openings would be free from debris.

10.4 OVERLAND FLOW

It is considered that overland flow as a result of an extreme rainfall event was a contributing factor to the flooding of the Tesco Distribution Centre.

11 FLOOD PROTECTION OPTIONS

To determine suitable flood protection options the Hollywell Burn and Plaskets Burn were examined. Flood protection options for the Hollywell Burn and Plaskets Burn are identified below.

The Tesco Distribution Centre and Kilbegs Industrial Estate are affected during a 1 in 100 year flood event as a result of the factors outlined previously.

Various flood protection options were considered for the Hollywell Burn:

- **Option 1** – Do nothing
- **Option 2** – Do minimum measures – Decrease channel vegetation.
- **Option 3** – Raise the existing embankment level and channel maintenance.
- **Option 4** – Construction of floodwalls and channel maintenance.
- **Option 5** – Flood storage upstream

The factors influencing the choice of options include:

- Ability to provide flood protection against a 1 in 100 year flood event
- Impact on any proposed developments
- Environmental Impact
- Ground Conditions
- Aesthetics
- Cost

The proposals and viability of each option are considered in the following sections.

11.1 CONSIDERATION OF FLOOD ALLEVIATION OPTIONS

Each of the options identified for the Hollywell Burn was individually considered and assessed in relation to their impact upon the surrounding area.

Option 1 - Do Nothing

The 'Do Nothing' scenario assumes that there will be no change to the existing flood protection during a 100 year project life. This is not an option due to the Hollywell Burn being a designated watercourse meaning Rivers Agency have a continued obligation for the maintenance of it. From the results of the hydraulic analysis it can be seen that the Tesco Distribution Centre and 17 commercial properties within the Kilbegs Industrial Estate are within the flood extent areas for Hollywell Burn and will be affected during a 1 in 100 year flood event.

The threat therefore remains of recurrent flooding and during a period between 2016 – 2116 flood damage costs are likely to be incurred. In addition the accumulation of deposits on river beds and bridge openings contributes to reduced hydraulic capacities, and if not dealt with, is likely to pose an increased flood risk.

Option 2 - Do Minimum

The "Do Minimum" scenario includes reducing the Manning's coefficient by decreasing the vegetation within the channel along Hollywell Burn and Plaskets Burn. This would provide an increase in channel capacity. To ensure the bridge openings and channel remain free from debris regular inspections and maintenance would also be required. This option would not give adequate flood protection for a 1 in 100 flood event however will be used as a baseline scenario for this report to assess all other options. Drawing ANTR-ACM-XX-XX-DR-CE-01015 shows the work requirements for option 2.

Option 3 - Raise the existing Embankment level and Channel Maintenance.

Option 3 considers raising the existing left hand side embankment of the Hollywell Burn, along with reduction to the Manning's coefficient of the channel by removal of some vegetation from the channel of the Hollywell Burn and Plaskets Burn. The Embankment would be raised along the river bank to approximately 20.70m AOD in order to provide the Q100 protection level and 0.6m freeboard, as shown in drawing ANTR-ACM-XX-XX-DR-CE-01016.

Advantages:

- The proposed measures provide adequate flood protection for up to a 100 year return period.
- The aesthetics of the river will remain largely unchanged.

Disadvantages:

- The risk of flooding occurring as result of blocked openings is not eliminated
- The stability of the existing embankment is unknown.
- The large amount of land take required.

Option 4 - Construction of Floodwalls and Channel Maintenance.

Option 4 considers constructing a floodwall along the left hand side of the Hollywell Burn along with reduction to the Manning's coefficient of the channel by removal of some vegetation from the channel of the Hollywell Burn and Plaskets Burn. The floodwall would be constructed along the river bank to provide the Q100 protection level and 0.6m freeboard. It would be designed as a reinforced concrete wall approximately 0.4m wide with the depth and width of foundation dependent on the existing ground conditions. To minimise any detrimental aesthetic impact, it is proposed to build the bank up around the wall. This option would have a life expectancy of 100 years. See Figure 11.0 below.

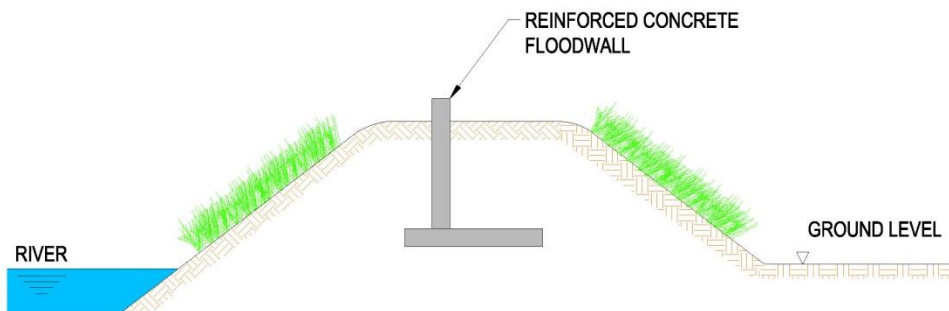


Figure 11.0 – Reinforced Concrete Floodwall

The required levels and locations for the proposed flood walls are listed in Table 11.0 below. The average height above the existing crest level for the flood walls would be in the range of 1.0 to 1.6 meters.

<i>Location</i>	<i>Proposed top of Flood Wall Level (m.AOD)</i>
Left hand bank of Hollywell Burn for approximately 182m.	20.70
Left hand bank of Hollywell Burn for approximately 200 m.	20.20

Table 11.0: Proposed Flood Wall

Drawing ANTR-ACM--XX-XX-DR-CE-01017 highlights the works required for option 4; The advantages and disadvantages of this option are listed below:

Advantages:

- The proposed measures provide adequate flood protection for up to a 100 year return period.
- The aesthetics of the river will still remain
- A reinforced concrete floodwall requires a minimal amount of maintenance and can be inspected easily

Disadvantages:

- The risk of flooding occurring as result of blocked openings is not eliminated
- Foundations would be subject to suitable site investigation of ground stability and service locations.

Option 5 – Flood Storage

Option 5 considers the provision of flood storage upstream of the Hollywell Burn by formation of a wetland area.

During periods of high flow a proportion of the flood water would be diverted into the flood storage area. This would reduce the peak flow in the Hollywell Burn and Plaskets Burn and the extent of flooding.

A suitable flood storage scheme would incorporate a wetland area upstream of Hollywell Burn and Plaskets Burn by lowering the river banks and regrading farmland. Preliminary estimations would suggest a flood storage volume of approximately 134,000m³ would be required, equating to approximately 13.4 hectares with an average depth of 1m.

The advantages and disadvantages of creating a flood storage area are listed below:

Advantages:

- Improved ecological value in the long term by the creation of a wetland.
- Most sustainable option.
- Would require a minimum amount of maintenance.

Disadvantages:

- Substantial land agreements required including compensation measures to land owners and possible vesting orders.
- Limited number of sites available due to residential housing and the local road network.
- Further works would still be required along the Hollywell Burn and Plaskets Burn, i.e. dredging and desilting etc.
- An ecological study would be required. Additional modelling would be required further upstream of the study area to determine the extent of flood storage provision.
- The large amount of suitable land required.

The InfoWorks ICM model was modified to show the impact of the proposed measures on the existing flood levels.

Option Assessment

Following an assessment of the various merits and drawbacks of each of the potential flood alleviation options, it was decided that only one of the options was suitable for providing flood protection with minimal maintenance being required. The option was:

- Option 4 - Construction of floodwalls and channel maintenance.

Options 1 and 2 were ruled out as they do not provide the required flood protection up to a 1 in 100 year flood event. Option 3 was also ruled out due to amount of land take required to raise and widen the bank to the required levels to achieve protection levels. Option 5 was discounted as the large amount of suitable land required to provide the flood storage may be unattainable.

12 ECONOMIC ANALYSIS

12.1 FLOOD ALLEVIATION OPTIONS AND COST ESTIMATES HOLLYWELL BURN AND PLASKETS BURNS.

The flood risk investigation identified that out of channel flooding will occur along the Hollywell Burn and Plaskets Burn.

This section outlines the cost estimates for each of the options considered for the Hollywell Burn and Plaskets Burn.

Table 12.0 shows a summary of the costs for the options considered for the Hollywell Burn and Plaskets Burn. Option 2 was included in this assessment for the benefit of comparison. For a detailed breakdown of the costs for each option refer to Appendix C.

The costs have been estimated using tendered rates for similar schemes within Northern Ireland (costs in brackets include for optimism bias – refer to Economic Appraisal).

<i>Item</i>	<i>Period Required</i>	<i>Option 2 (£)</i>	<i>Option 4 (£)</i>
Capital Cost	One off Cost	17,185.50 (23,681.62)	282,391.98 (389,136.15)
Regular inspections, cleaning and decreasing the vegetation in the channel by Rivers Agency	Annual Cost	3,640.00	3,640.00

Table 12.0 – Hollywell Burn and Plaskets Burn Option Cost Summary.

12.2 HOLLYWELL BURN AND PLASKETS BURN BENEFIT ANALYSIS

The benefits were calculated in accordance with the method described in 'Flood Coastal Erosion Risk Management Appraisal Guidance' (FCERM-AG). The 2011 revision of 'The Green Book – Appraisal and Evaluation in Central Government' recommends the discount rate of 3.5% for years 0 – 30, 3% for years 31 – 75, and 2.5% for years 76 – 100.

The assessment indicates that the annual benefit for providing flood protection against a 1 in 100 year return period amounts to:

Total Annual Benefit = £605,498.57

The net present value of annual benefits has been calculated using test discount rates and amounts to:

Present Value of Annual Benefits = £18,082,223.74

These figures indicate that Option 4 would therefore provide benefits of flood damage avoidance of approximately £18,082,224.

12.2.1 BENEFIT COST COMPARISON

The Net Present Value (NPV) has been derived and discounted to the same base date, using guidance from FCERM-AG. NPVs and benefit/cost ratios for the different options are shown on the Project Summary Sheet spreadsheet in Appendix D of the Antrim Hollywell Burn Economic Appraisal and in Table 12.2.

	<i>Total Discounted Cost (£)</i>	<i>Discounted Flood Damage Avoidance Benefit (£) (inc intangibles)</i>	<i>Net Present Value (NPV) (£)</i>	<i>Benefit / Cost Ratio</i>
Option 2 – Do Minimum	132,384.26	0.00	-132,384.26	0.00
Option 4 – Construction of a floodwall and maintenance to the channel	497,838.79	18,082,223.74	17,584,384.95	36.32

Table 12.2 – Summary of Benefits and Costs

12.2.2 SUMMARY

The benefit cost analysis shows that Option 4 is economically viable as it has a benefit/cost ratio greater than 1. Option 2, as indicated in Table 12.2 above, does not have any economic benefits. Hence Option 4 represents the best value for money.

A hydraulic analysis of the Hollywell Burn and Plaskets Burn identified that 18 commercial properties could potentially be affected during a 1 in 100 year flood event.

The areas identified as being at risk from flooding are listed below:

- Tesco Distribution Centre,
- 17 Commercial units within Kilbegs Industrial Estate.

A range of flood alleviation options was considered in detail for the Hollywell Burn and Plaskets Burn in order to provide protection against a 1 in 100 year flood event.

The cost of damages for the Q5, Q10, Q25, Q50 and Q100 flood events were calculated based upon the Multi-Coloured Manual and discounted over a period of 100 years in order to determine the present value of benefits for each option.

The benefit cost analysis found that option 4 for the Hollywell Burn is economically viable with a benefit cost ratio greater than 1 (approximately 36).

APPENDIX A – Drawings

APPENDIX B - Options Cost

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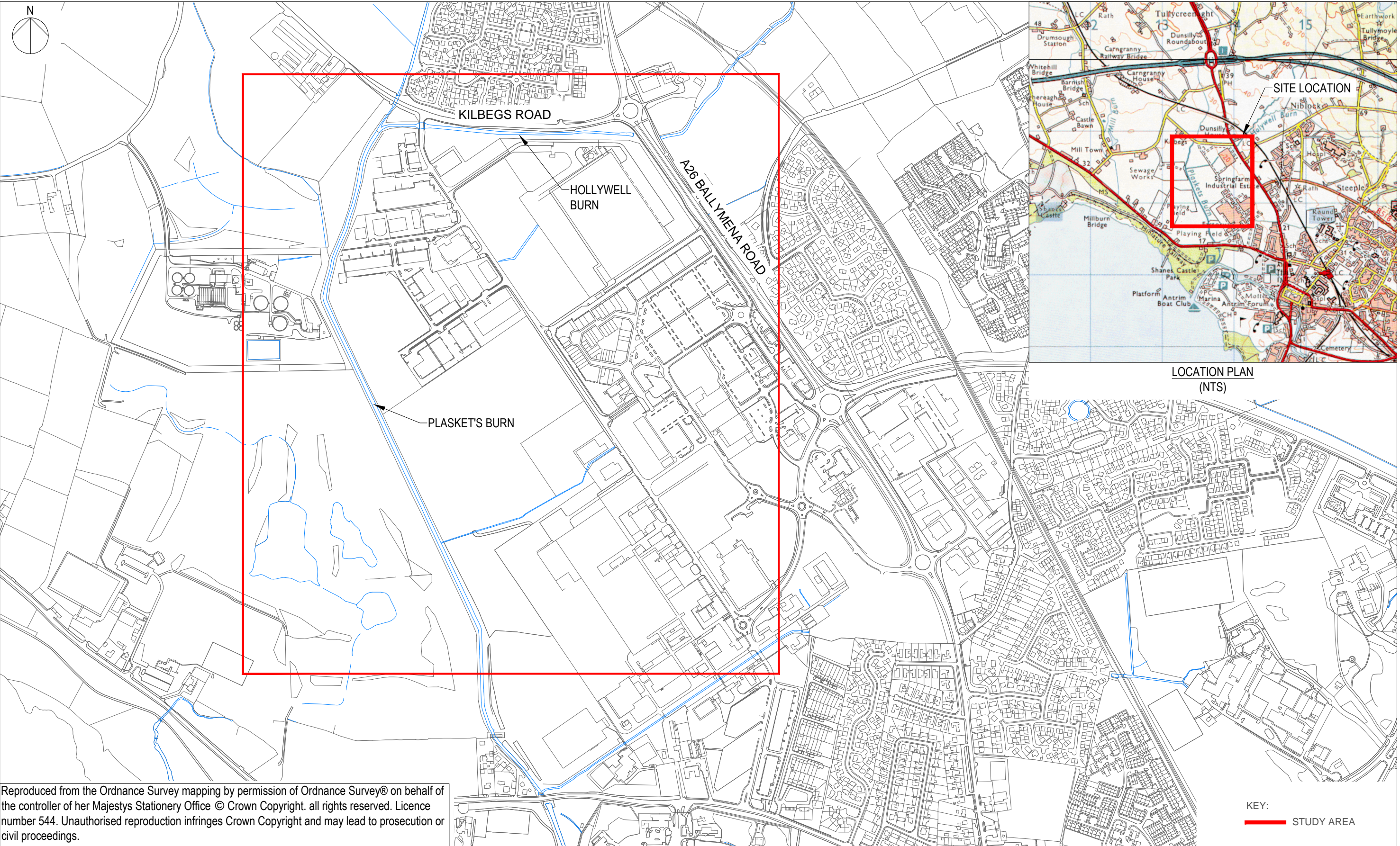
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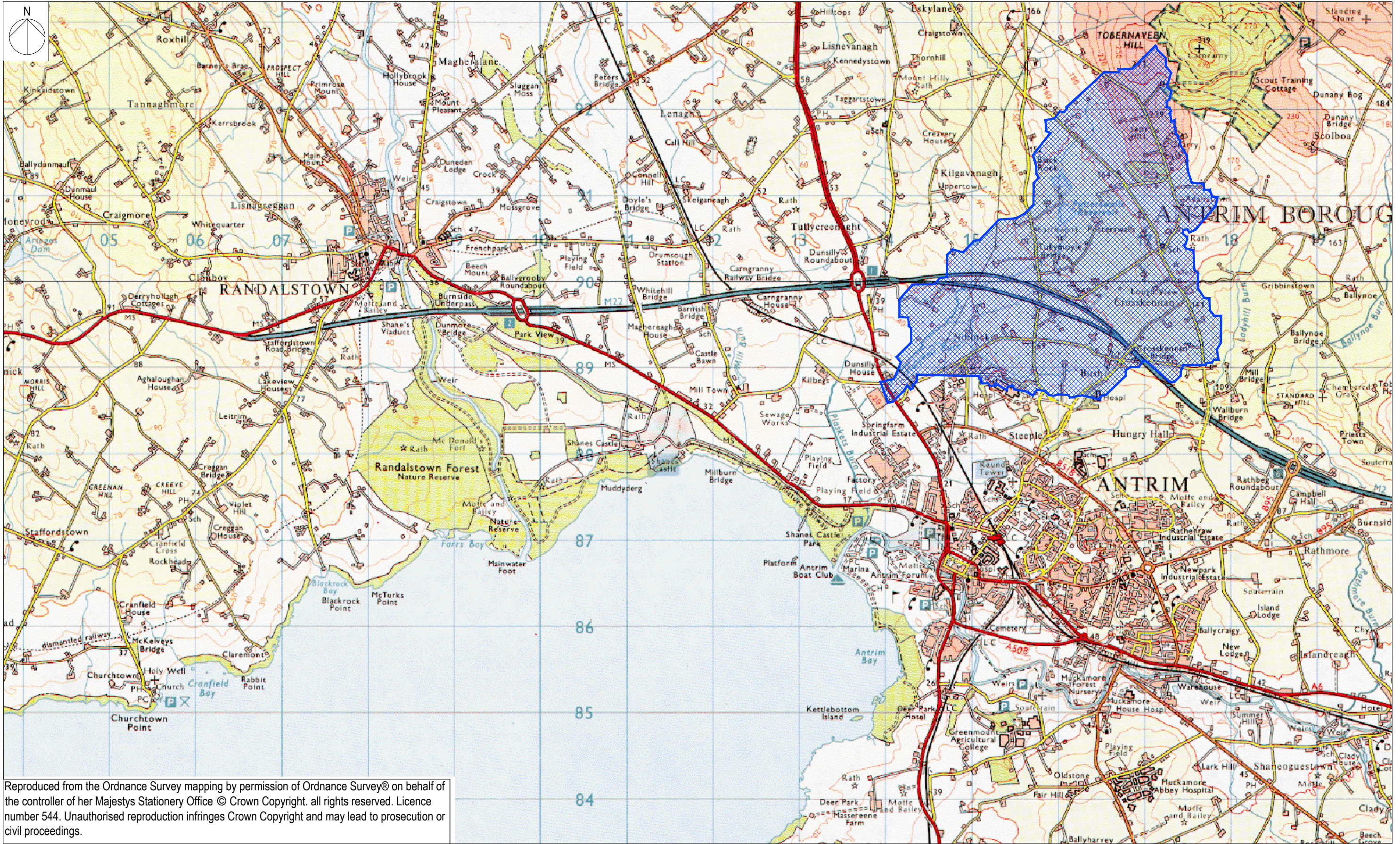
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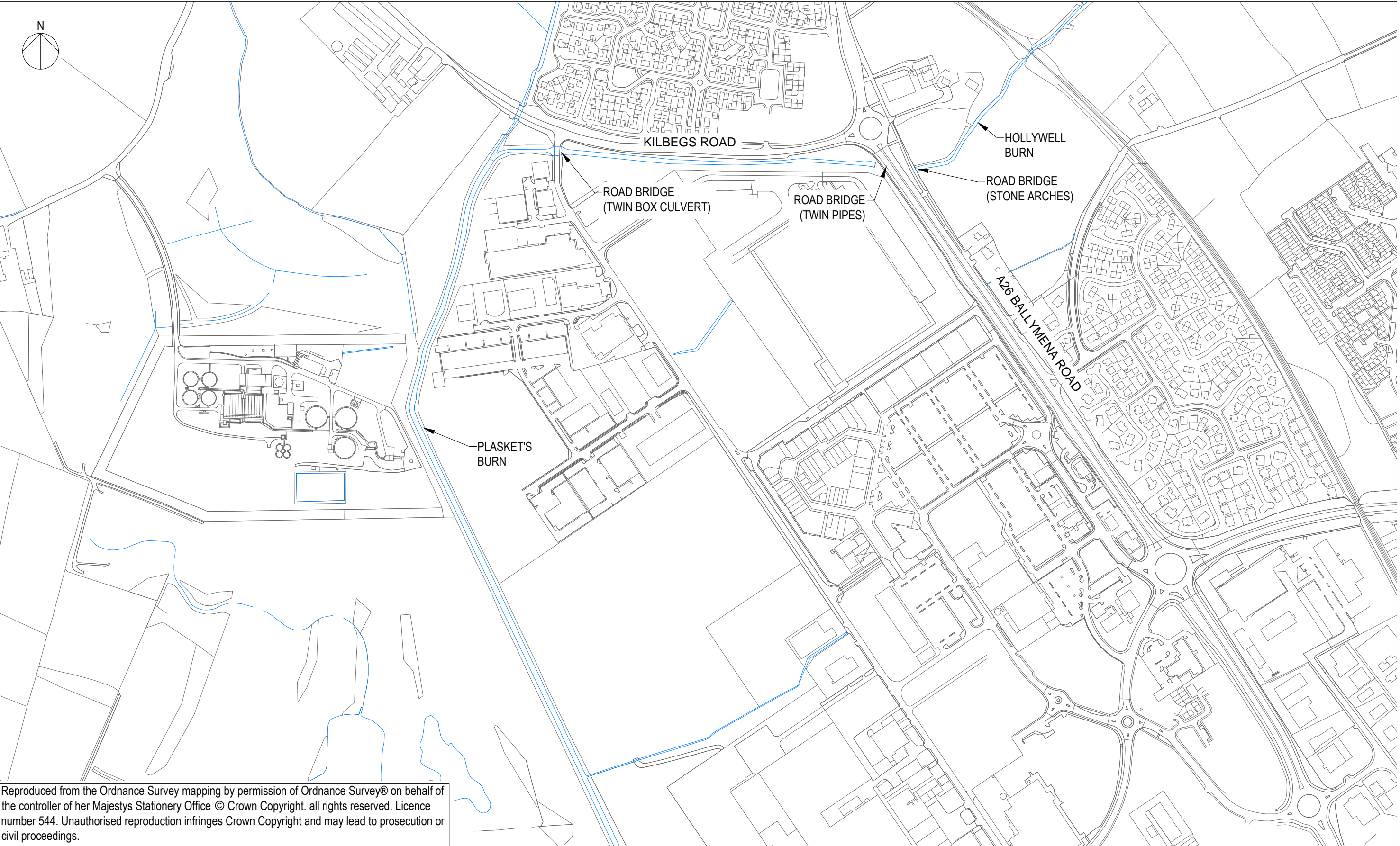
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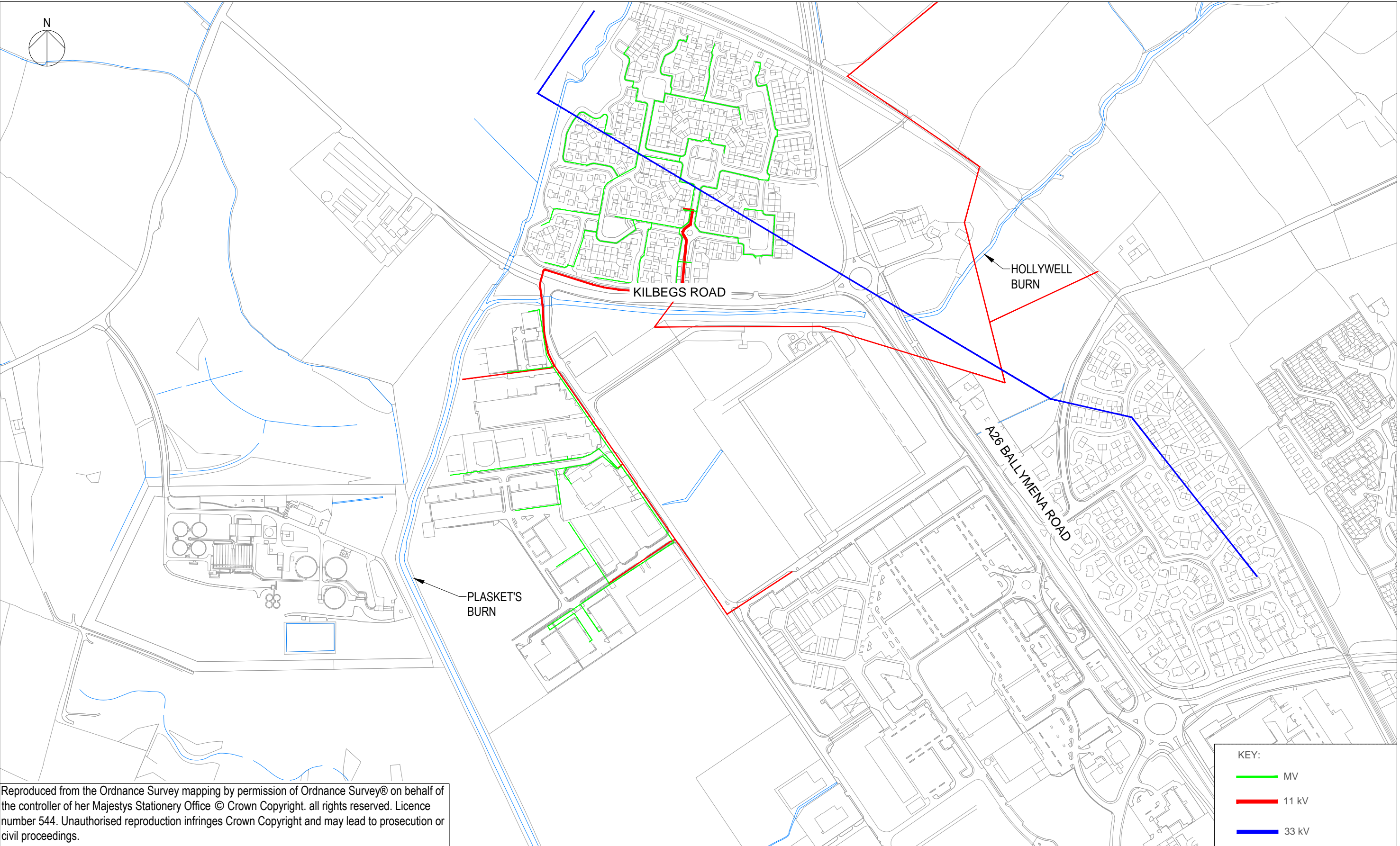
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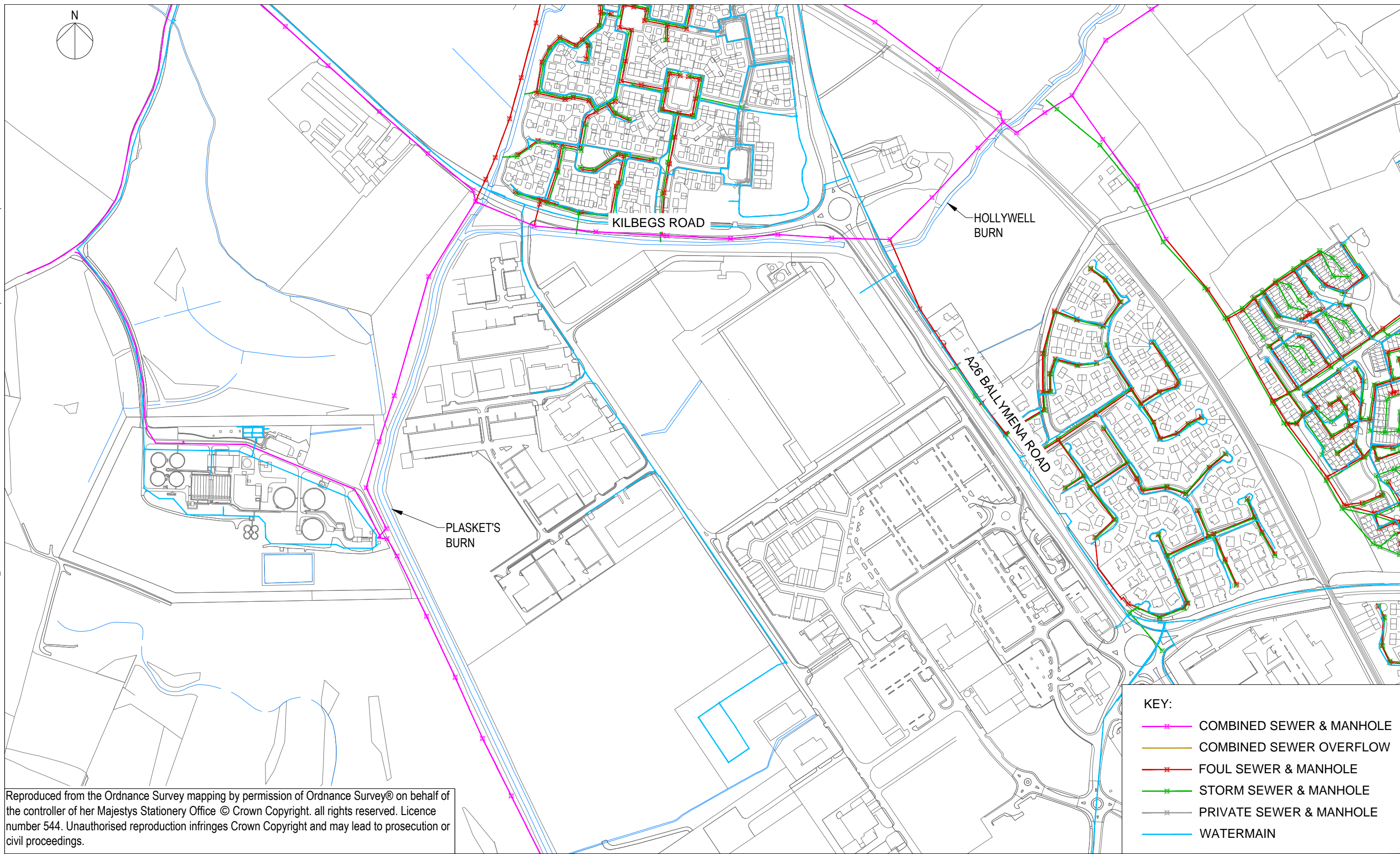
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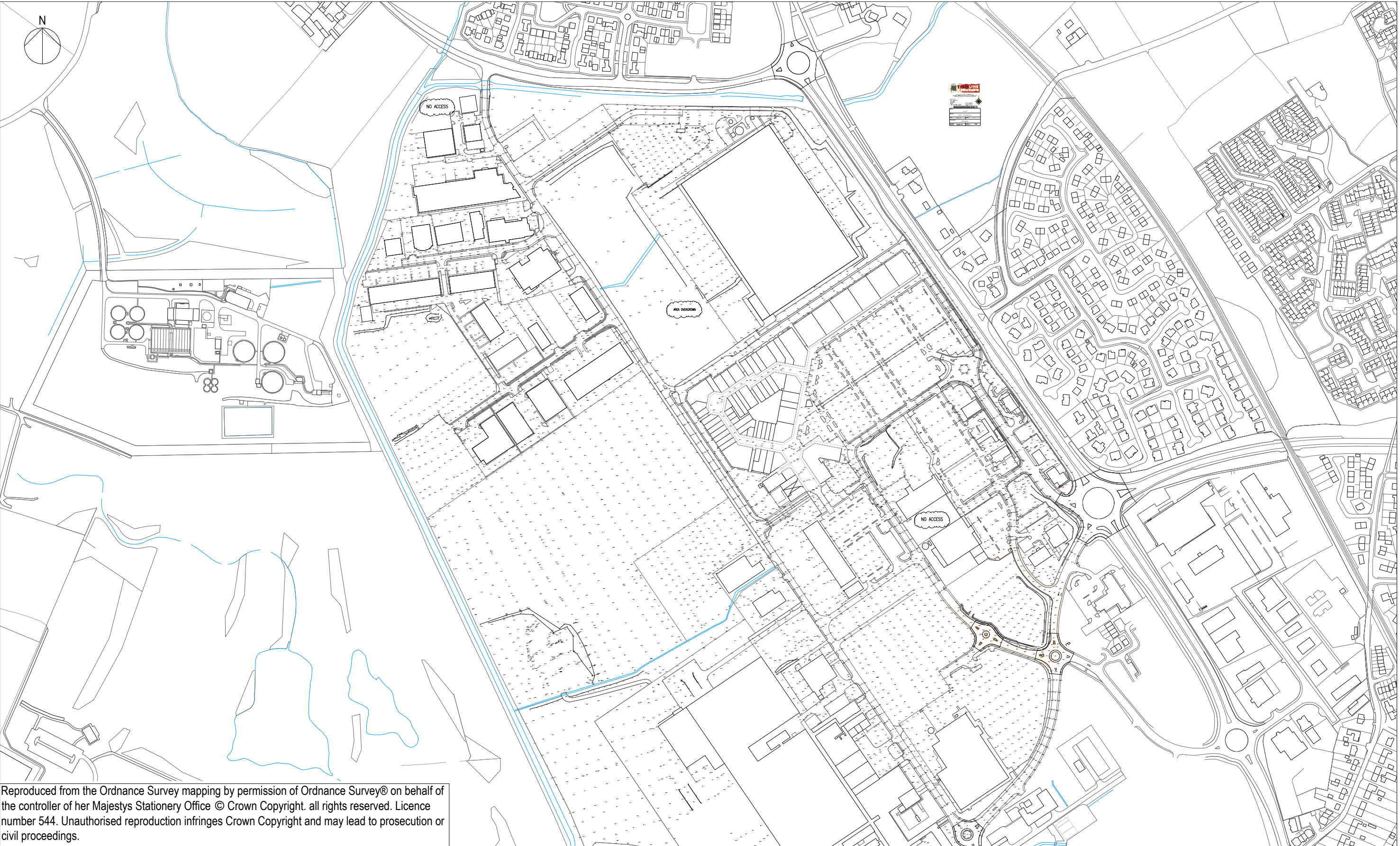
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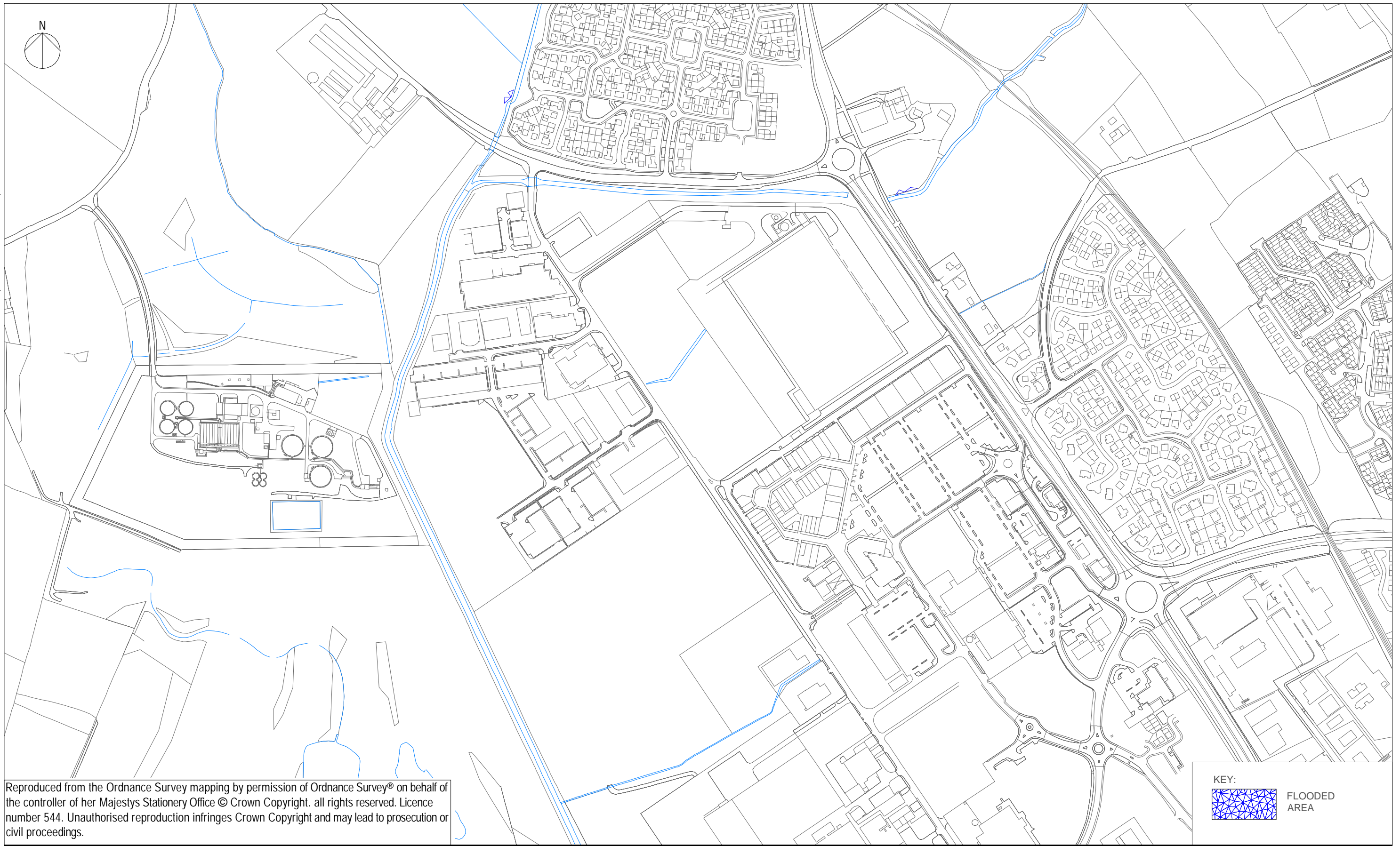


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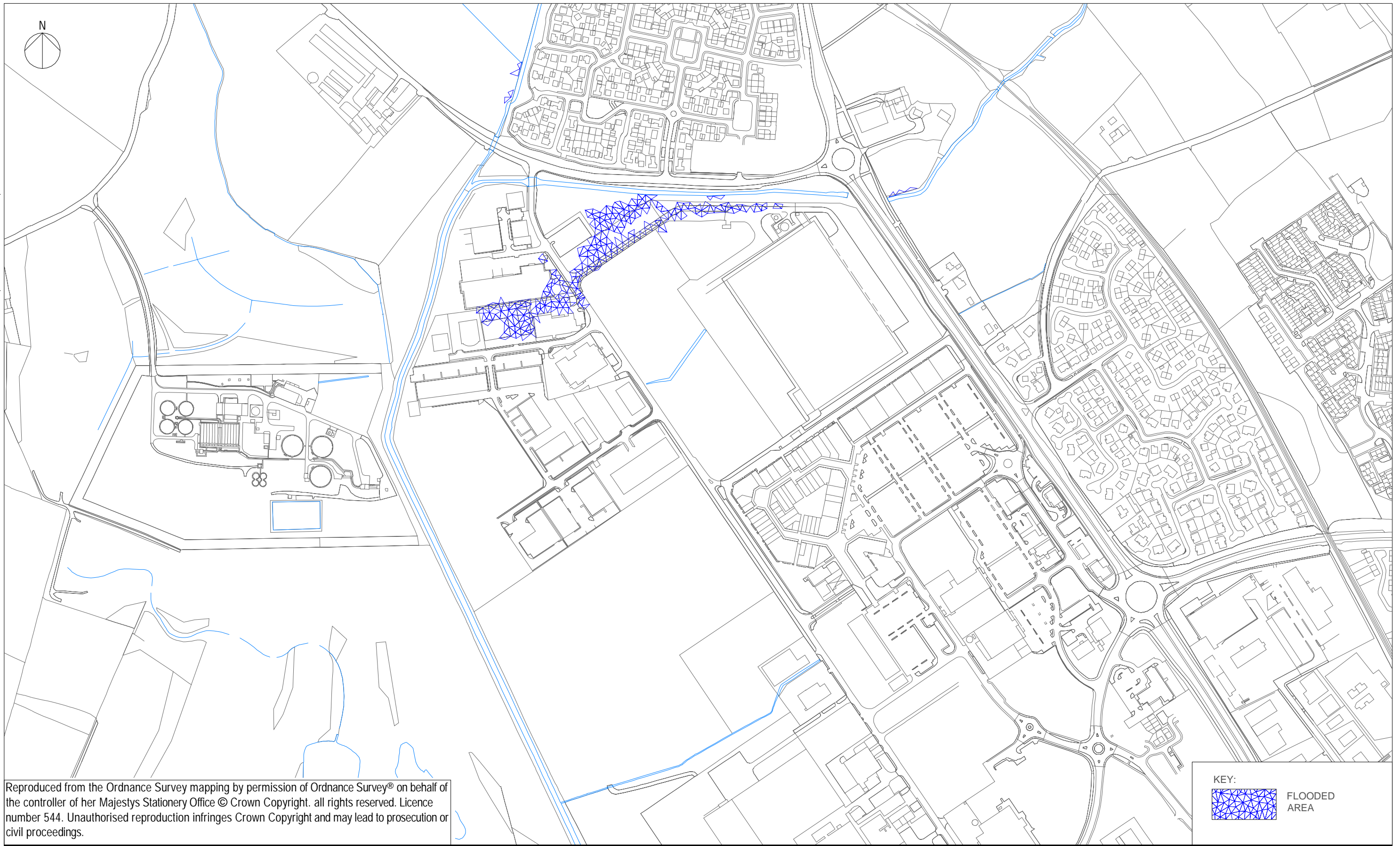
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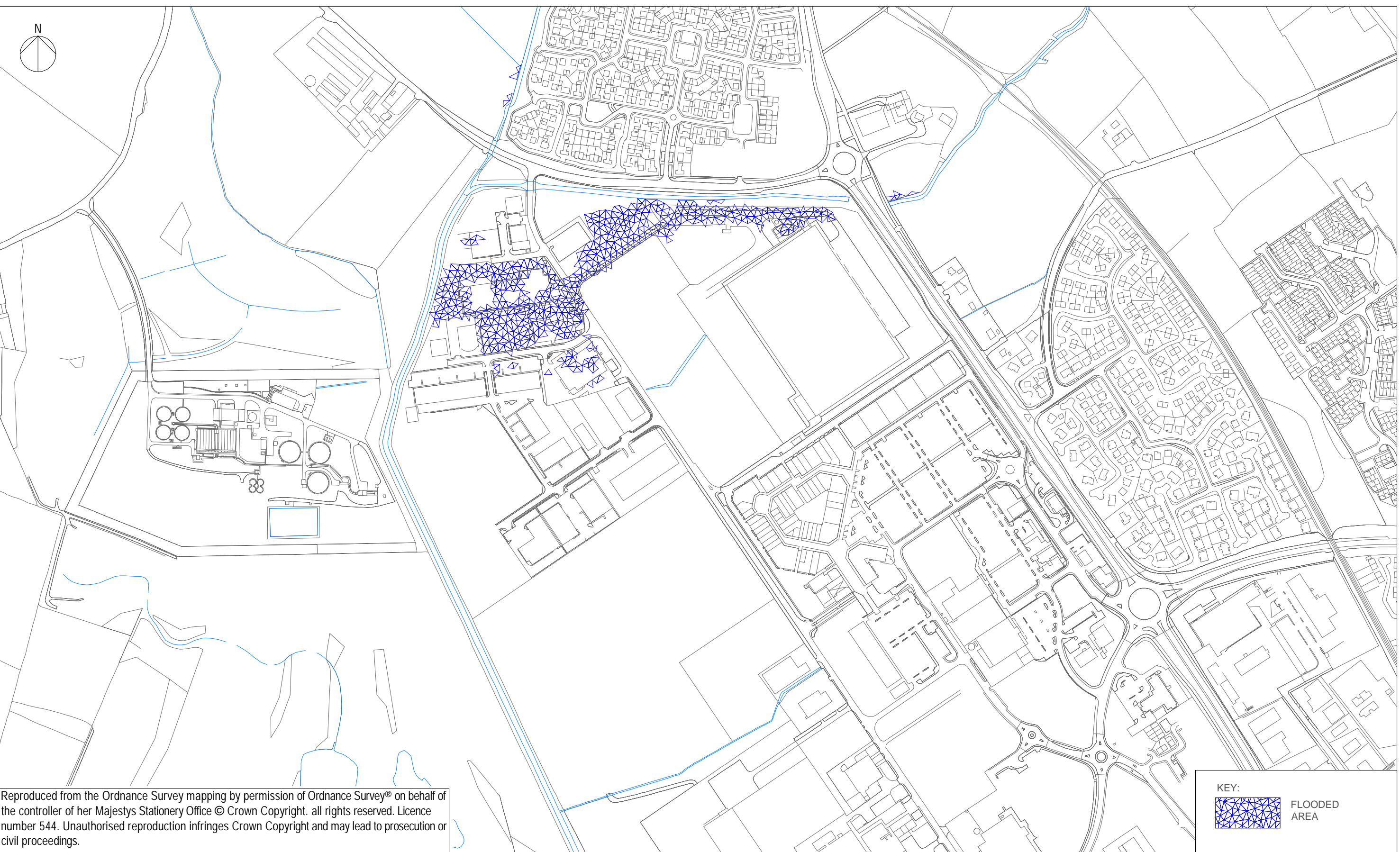
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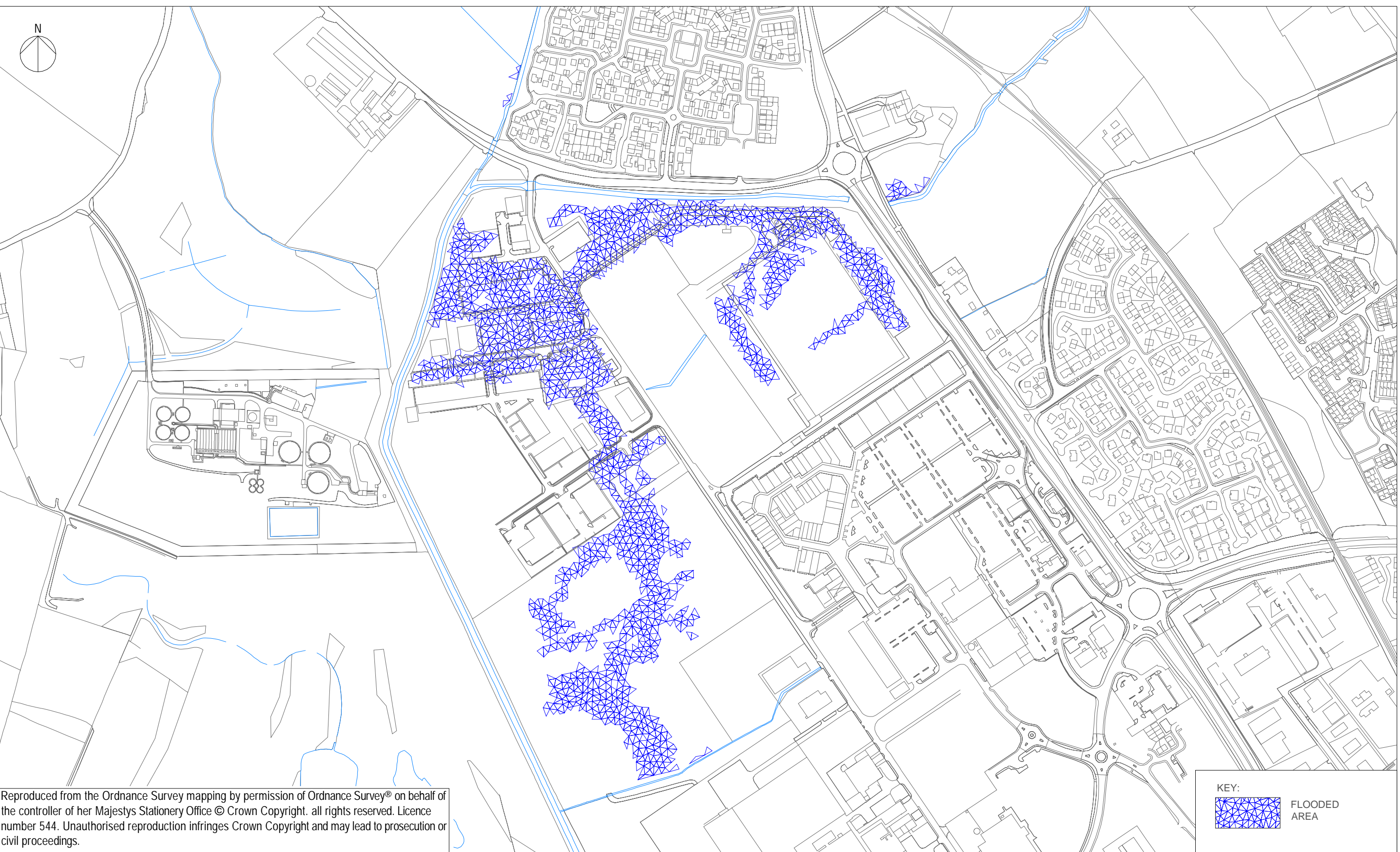
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 Name : G:\DOCUMENTS\47074278 - MISCELLANEOUS PROJECT07 - CIVIL ENGINEERING\CE01-WIP01_01-DRAWINGS\ANTRIM - HOLYWELL BURNT\ANTR-ACM-XX-XX-DR-CE-01009 (1 IN 25 YEAR FLOOD EXTENT)



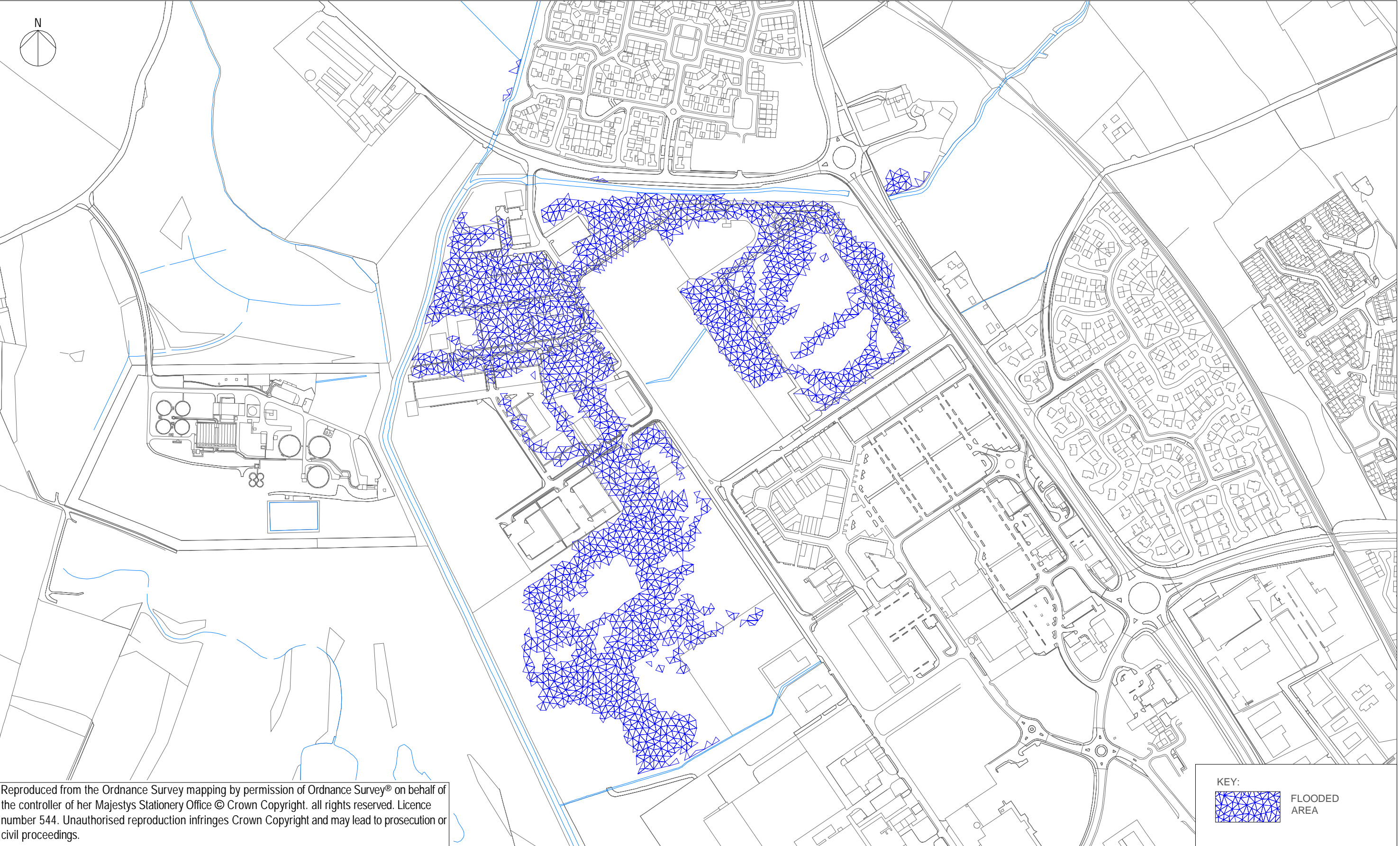
KEY:
 FLOODED AREA

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Project Title ANTRIM - HOLYWELL BURN		Drawing Title 1 IN 25 YEAR FLOOD EXTENT ANTRIM		Purpose of issue PRELIMINARY		THIS DOCUMENT HAS BEEN PREPARED PURSUANT TO AND SUBJECT TO THE TERMS OF AECOM'S APPOINTMENT BY ITS CLIENT. AECOM ACCEPTS NO LIABILITY FOR ANY USE OF THIS DOCUMENT OTHER THAN BY ITS ORIGINAL CLIENT OR FOLLOWING AECOM'S EXPRESS AGREEMENT TO SUCH USE, AND ONLY FOR THE PURPOSES FOR WHICH IT WAS PREPARED AND PROVIDED.		Beechill House Beechill Road, Belfast BT8 7RP Tel:T: +44 (0)28 9070 5111 Fax:F: +44 (0)28 9079 5651 www.aecom.com	
Client 		AECOM Internal Project No. 47074278		Suitability Suitability		Drawing Number ANTR-ACM-XX-XX-DR-CE-01009		Rev P2	
		Designed - Drawn MM Checked JA Approved KMcC Date JUN 2016		Scale @ A3 -					




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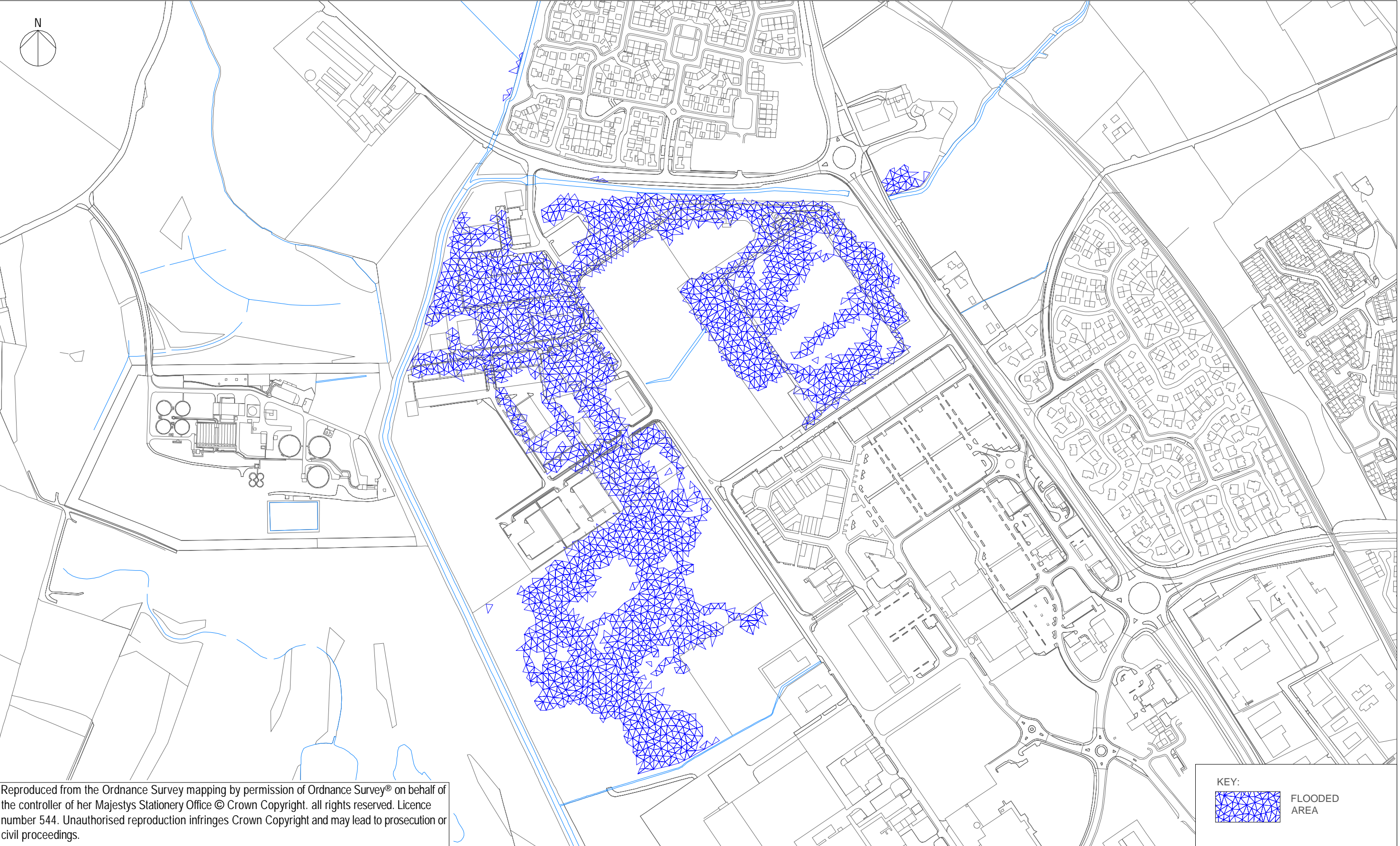
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Project Title ANTRIM - HOLYWELL BURN		Drawing Title 1 IN 50 YEAR FLOOD EXTENT ANTRIM		Purpose of issue PRELIMINARY		THIS DOCUMENT HAS BEEN PREPARED PURSUANT TO AND SUBJECT TO THE TERMS OF AECOM'S APPOINTMENT BY ITS CLIENT. AECOM ACCEPTS NO LIABILITY FOR ANY USE OF THIS DOCUMENT OTHER THAN BY ITS ORIGINAL CLIENT OR FOLLOWING AECOM'S EXPRESS AGREEMENT TO SUCH USE, AND ONLY FOR THE PURPOSES FOR WHICH IT WAS PREPARED AND PROVIDED.		Beechill House Beechill Road, Belfast BT8 7RP Tel:T: +44 (0)28 9070 5111 Fax:F: +44 (0)28 9079 5651 www.aecom.com	
Client 		AECOM Internal Project No. 47074278		Suitability Suitability		Drawing Number ANTR-ACM-XX-XX-DR-CE-01010		Rev P2	
		Designed - Drawn MM Checked JA Approved KMcC Date JUN 2016		Scale @ A3 -					




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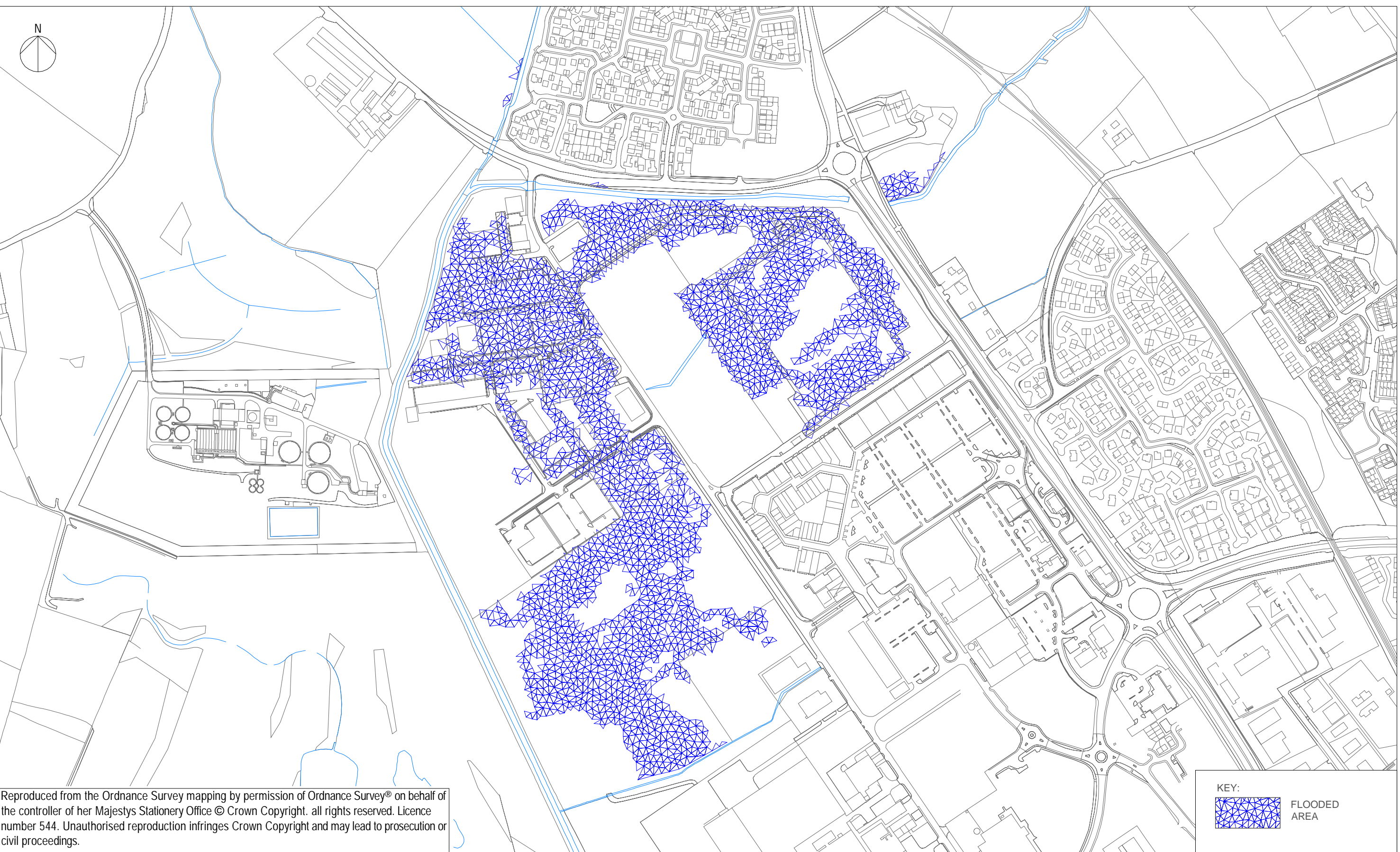
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KEY:
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Project Title ANTRIM - HOLYWELL BURN		Drawing Title 1 IN 75 YEAR FLOOD EXTENT ANTRIM		Purpose of issue PRELIMINARY		THIS DOCUMENT HAS BEEN PREPARED PURSUANT TO AND SUBJECT TO THE TERMS OF AECOM'S APPOINTMENT BY ITS CLIENT. AECOM ACCEPTS NO LIABILITY FOR ANY USE OF THIS DOCUMENT OTHER THAN BY ITS ORIGINAL CLIENT OR FOLLOWING AECOM'S EXPRESS AGREEMENT TO SUCH USE, AND ONLY FOR THE PURPOSES FOR WHICH IT WAS PREPARED AND PROVIDED.		Beechill House Beechill Road, Belfast BT8 7RP Tel:T: +44 (0)28 9070 5111 Fax:F: +44 (0)28 9079 5651 www.aecom.com	
Client 		AECOM Internal Project No. 47074278		Suitability Suitability Zone / Mileage ...		Drawing Number ANTR-ACM-XX-XX-DR-CE-01011		Rev P2	
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		Date JUN 2016							




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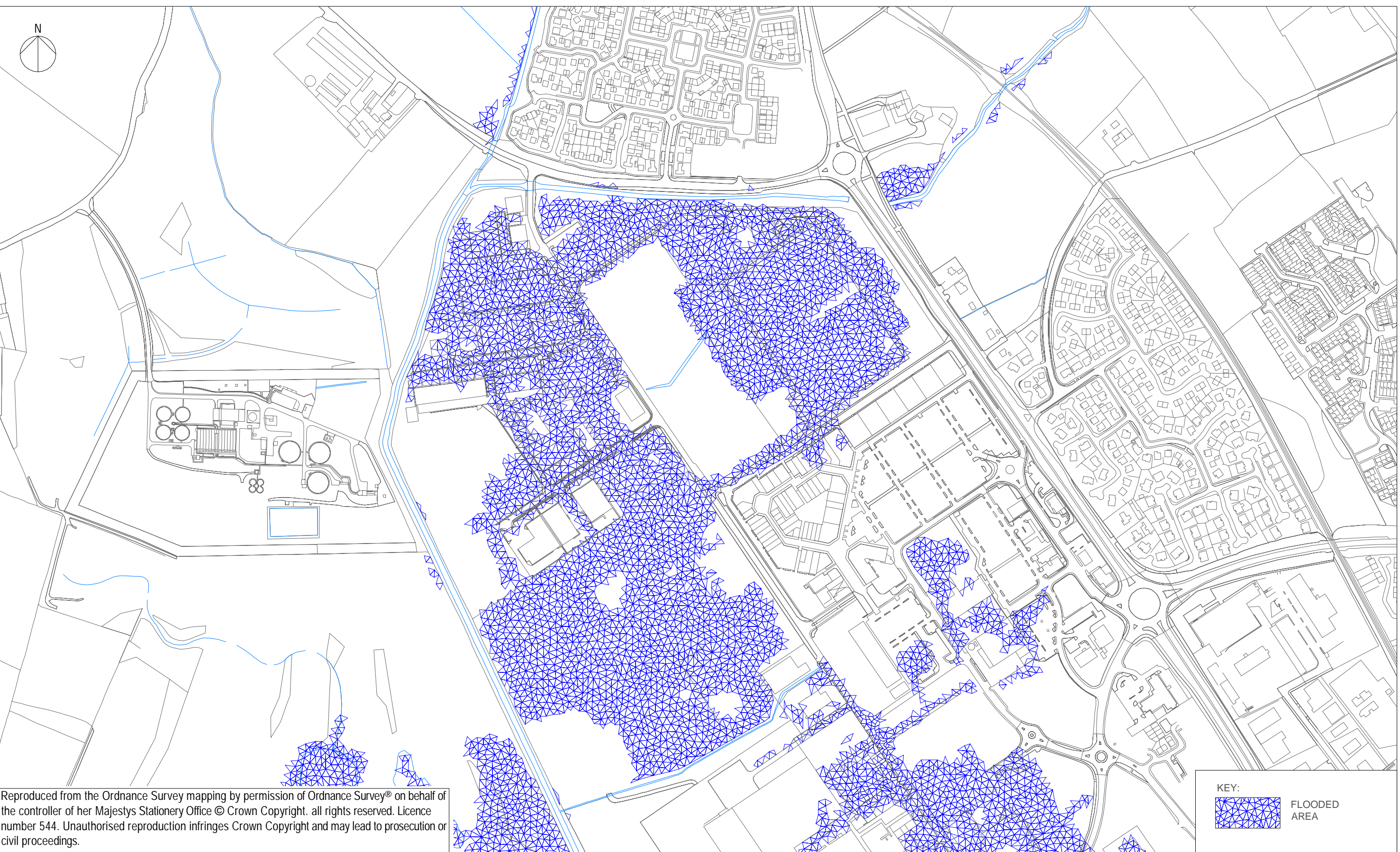
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KEY:
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Project Title ANTRIM - HOLYWELL BURN		Drawing Title 1 IN 100 YEAR FLOOD EXTENT ANTRIM		Purpose of issue PRELIMINARY		THIS DOCUMENT HAS BEEN PREPARED PURSUANT TO AND SUBJECT TO THE TERMS OF AECOM'S APPOINTMENT BY ITS CLIENT. AECOM ACCEPTS NO LIABILITY FOR ANY USE OF THIS DOCUMENT OTHER THAN BY ITS ORIGINAL CLIENT OR FOLLOWING AECOM'S EXPRESS AGREEMENT TO SUCH USE, AND ONLY FOR THE PURPOSES FOR WHICH IT WAS PREPARED AND PROVIDED.		Beechill House Beechill Road, Belfast BT8 7RP Tel:T: +44 (0)28 9070 5111 Fax:F: +44 (0)28 9079 5651 www.aecom.com	
Client 		AECOM Internal Project No. 47074278		Suitability Suitability		Drawing Number ANTR-ACM-XX-XX-DR-CE-01012		Rev P2	
		Designed - Drawn MM Checked JA Approved KMcC Date JUN 2016							
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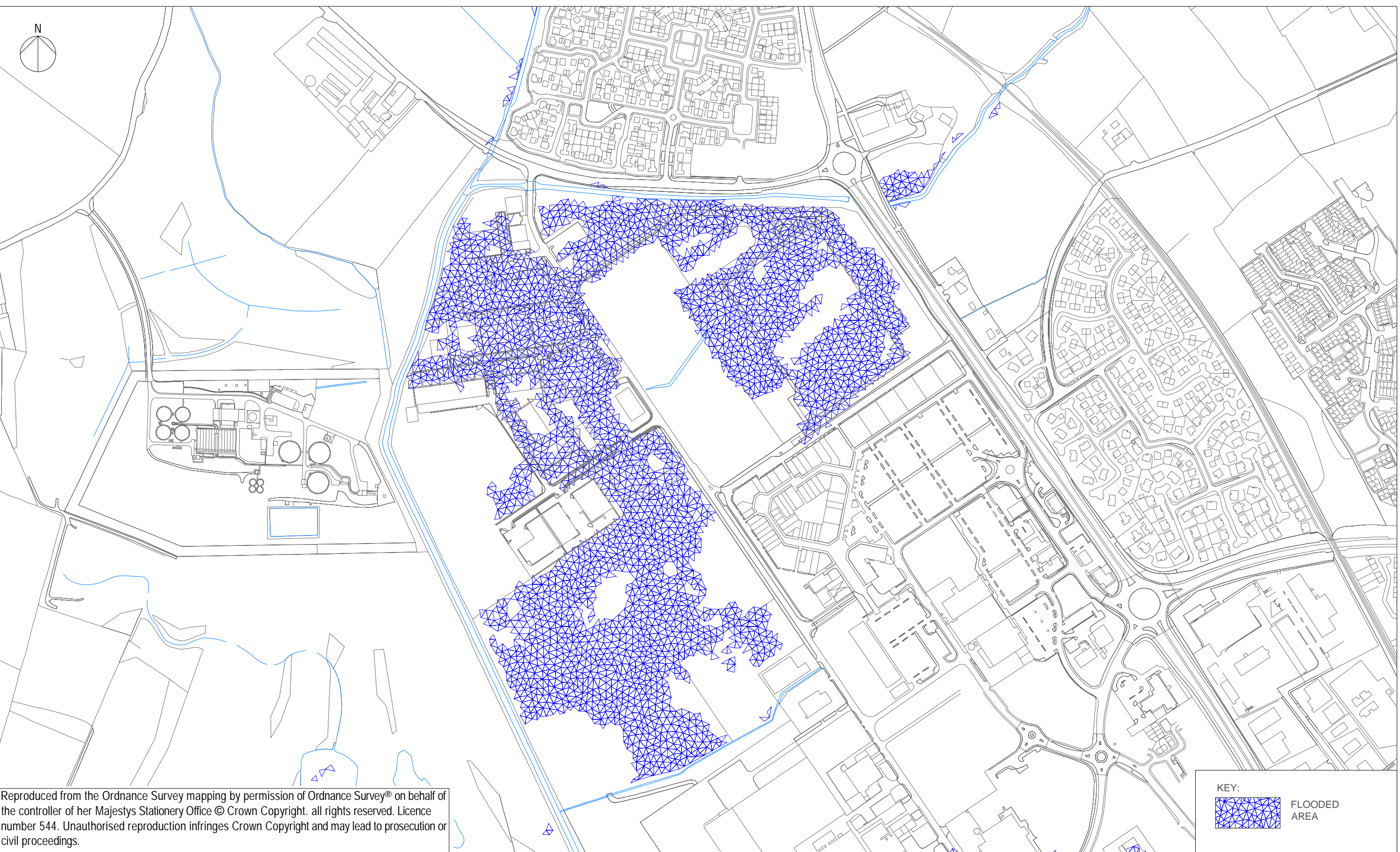


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Project Title ANTRIM - HOLYWELL BURN		Drawing Title 1 IN 1000 YEAR FLOOD EXTENT ANTRIM		Purpose of Issue PRELIMINARY		THIS DOCUMENT HAS BEEN PREPARED PURSUANT TO AND SUBJECT TO THE TERMS OF AECOM'S APPOINTMENT BY ITS CLIENT. AECOM ACCEPTS NO LIABILITY FOR ANY USE OF THIS DOCUMENT OTHER THAN BY ITS ORIGINAL CLIENT OR FOLLOWING AECOM'S EXPRESS AGREEMENT TO SUCH USE, AND ONLY FOR THE PURPOSES FOR WHICH IT WAS PREPARED AND PROVIDED.		Beechill House Beechill Road, Belfast BT8 7RP Tel:T: +44 (0)28 9070 5111 Fax:F: +44 (0)28 9079 5651 www.aecom.com			
Client 		Designed - Drawn MM Checked JA Approved KMcC Date JUN 2016		AECOM Internal Project No. 47074278 Scale @ A3 -							

X Date : 30 January 2017 14:42:47
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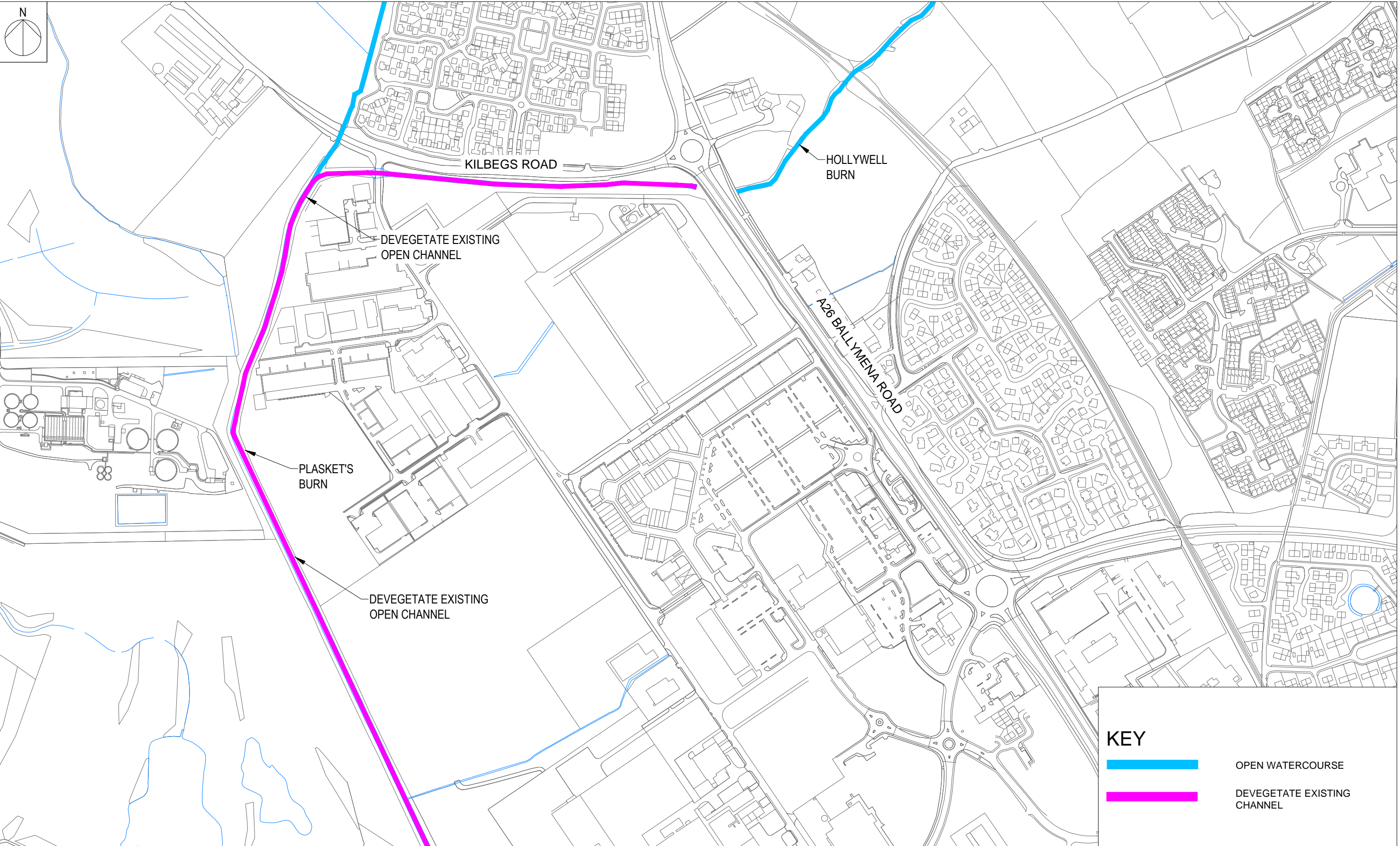
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KEY:
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Project Title ANTRIM - HOLYWELL BURN		Drawing Title 1 IN 100 YEAR + CLIMATE CHANGE FLOOD EXTENT; ANTRIM		Purpose of Issue PRELIMINARY		THIS DOCUMENT HAS BEEN PREPARED PURSUANT TO AND SUBJECT TO THE TERMS OF AECOM'S APPOINTMENT BY ITS CLIENT. AECOM ACCEPTS NO LIABILITY FOR ANY USE OF THIS DOCUMENT OTHER THAN BY ITS ORIGINAL CLIENT OR FOLLOWING AECOM'S EXPRESS AGREEMENT TO SUCH USE, AND ONLY FOR THE PURPOSES FOR WHICH IT WAS PREPARED AND PROVIDED.		Beechill House Beechill Road, Belfast BT8 7RP Tel:T: +44 (0)28 9070 5111 Fax:F: +44 (0)28 9079 5651 www.aecom.com	
Client 		AECOM Internal Project No. 47074278		Suitability Suitability Zone / Mileage ...		Drawing Number ANTR-ACM-XX-XX-DR-CE-01014		Rev P2	
		Designed - Drawn MM Checked JA Approved KMcC Date JUN 2016							



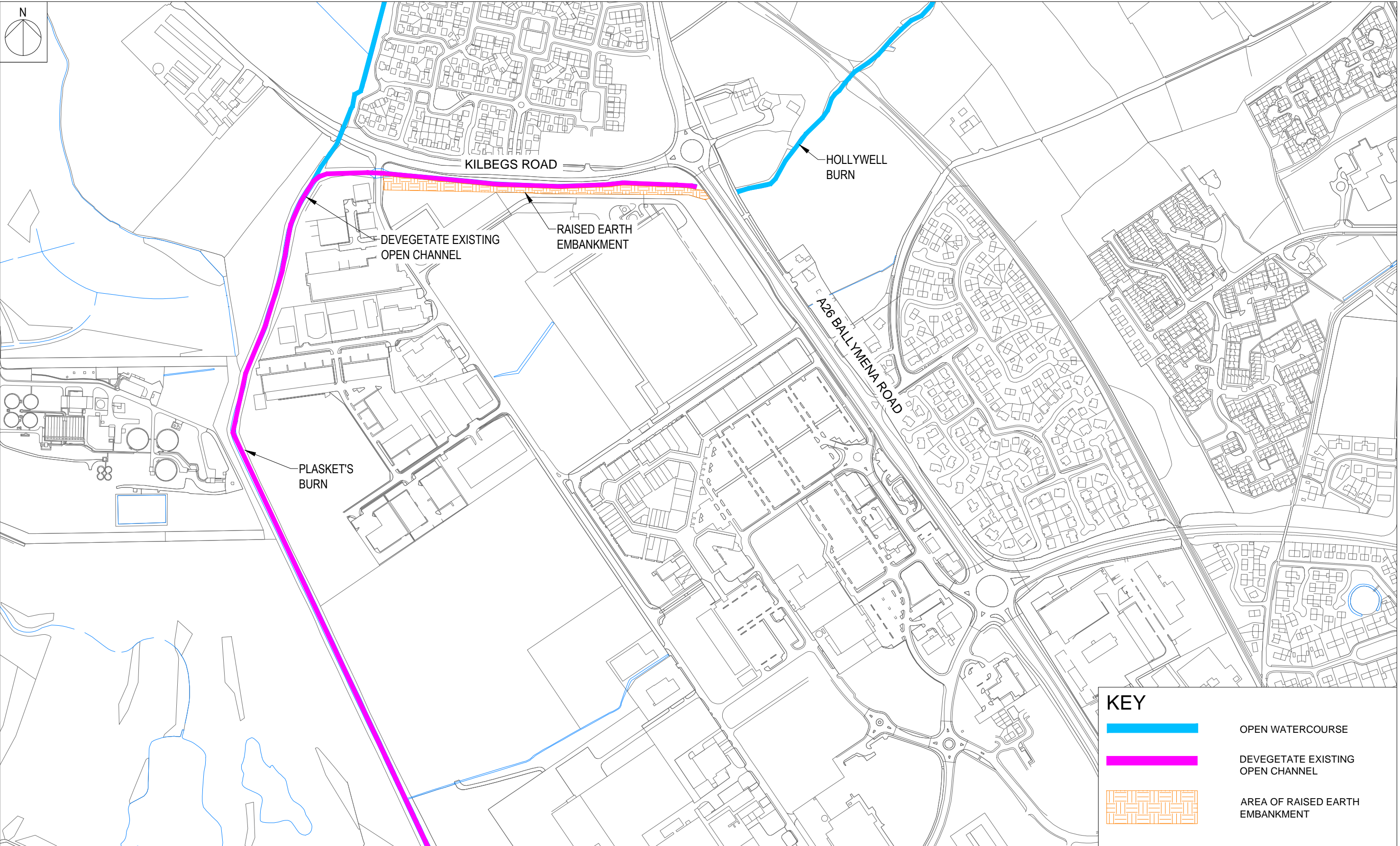
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 File Name : G:\DOCUMENTS\47074278 - MISCELLANEOUS PROJECT07 - CIVIL ENGINEERING\DRAWINGS\CE01-WP01_01-DRAWINGS\ANTRIM - HOLLYWELL BURN\ANTR-ACM-XX-XX-DR-CE-01015 (OPTION 2 MINIMAL MEASURES)








Project Title ANTRIM - HOLLYWELL BURN		Drawing Title OPTION 2 MINIMAL MEASURES ANTRIM		Purpose of issue PRELIMINARY		THIS DOCUMENT HAS BEEN PREPARED PURSUANT TO AND SUBJECT TO THE TERMS OF AECOM'S APPOINTMENT BY ITS CLIENT. AECOM ACCEPTS NO LIABILITY FOR ANY USE OF THIS DOCUMENT OTHER THAN BY ITS ORIGINAL CLIENT OR FOLLOWING AECOM'S EXPRESS AGREEMENT TO SUCH USE, AND ONLY FOR THE PURPOSES FOR WHICH IT WAS PREPARED AND PROVIDED.		Beechill House Beechill Road, Belfast BT8 7RP Tel:T: +44 (0)28 9070 5111 Fax:F: +44 (0)28 9079 5651 www.aecom.com	
Client 		AECOM Internal Project No. 47074278		Designed - Drawn MM Checked KMcC Approved - Date -					
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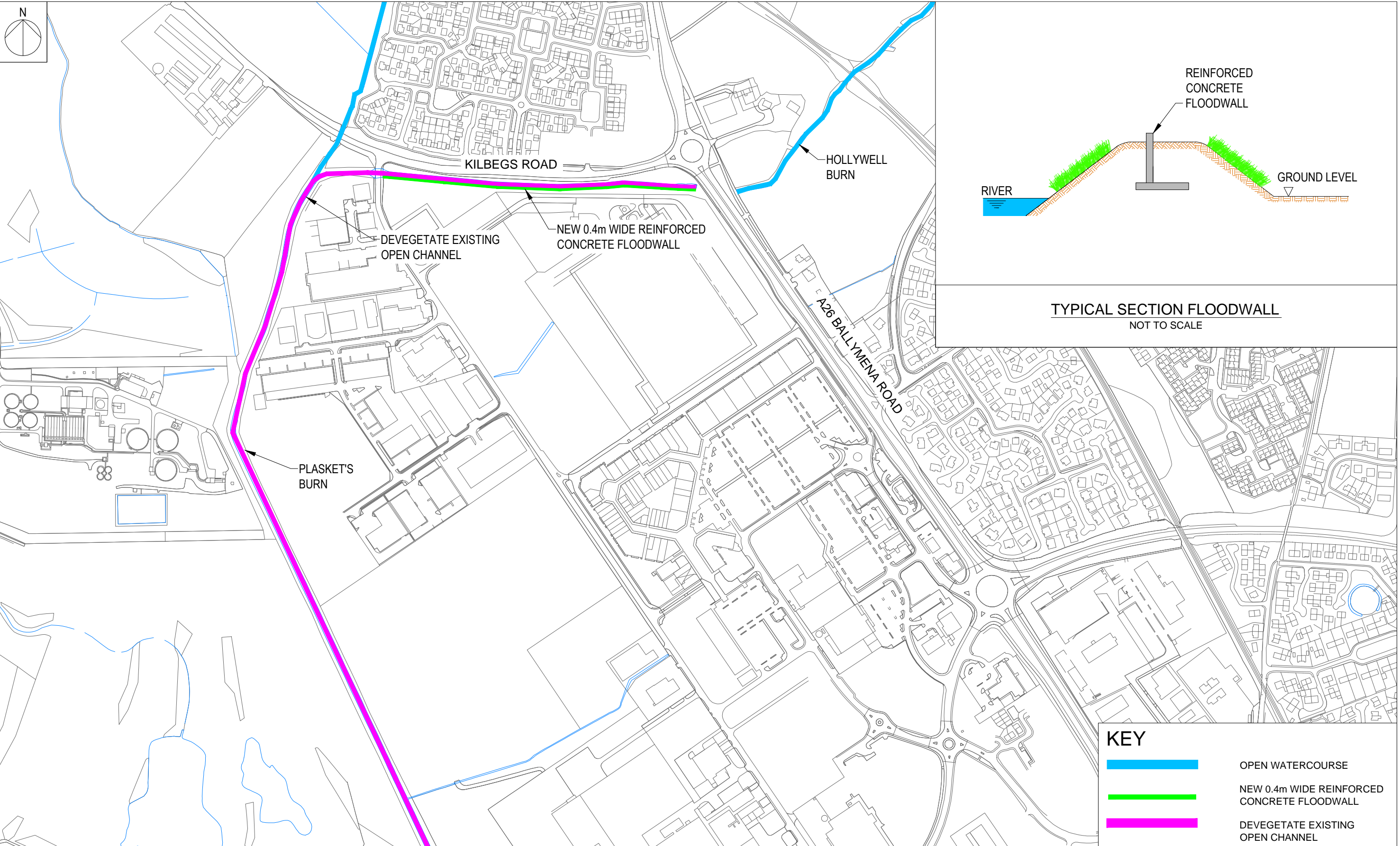
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KEY	
	OPEN WATERCOURSE
	DEVEGETATE EXISTING OPEN CHANNEL
	AREA OF RAISED EARTH EMBANKMENT



Project Title ANTRIM - HOLLYWELL BURN		Drawing Title OPTION 3 ANTRIM DE-VEGETATION AND RAISE EMBANKMENT		Purpose of issue PRELIMINARY			THIS DOCUMENT HAS BEEN PREPARED PURSUANT TO AND SUBJECT TO THE TERMS OF AECOM'S APPOINTMENT BY ITS CLIENT. AECOM ACCEPTS NO LIABILITY FOR ANY USE OF THIS DOCUMENT OTHER THAN BY ITS ORIGINAL CLIENT OR FOLLOWING AECOM'S EXPRESS AGREEMENT TO SUCH USE, AND ONLY FOR THE PURPOSES FOR WHICH IT WAS PREPARED AND PROVIDED.		Beechill House Beechill Road, Belfast BT8 7RP Tel:T: +44 (0)28 9070 5111 Fax:F: +44 (0)28 9079 5651 www.aecom.com			
Client 		AECOM Internal Project No. 47074278		Designed - Drawn MM Checked KMcC Approved - Date -								
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Plot Date : 09 November 2016 10:22:48
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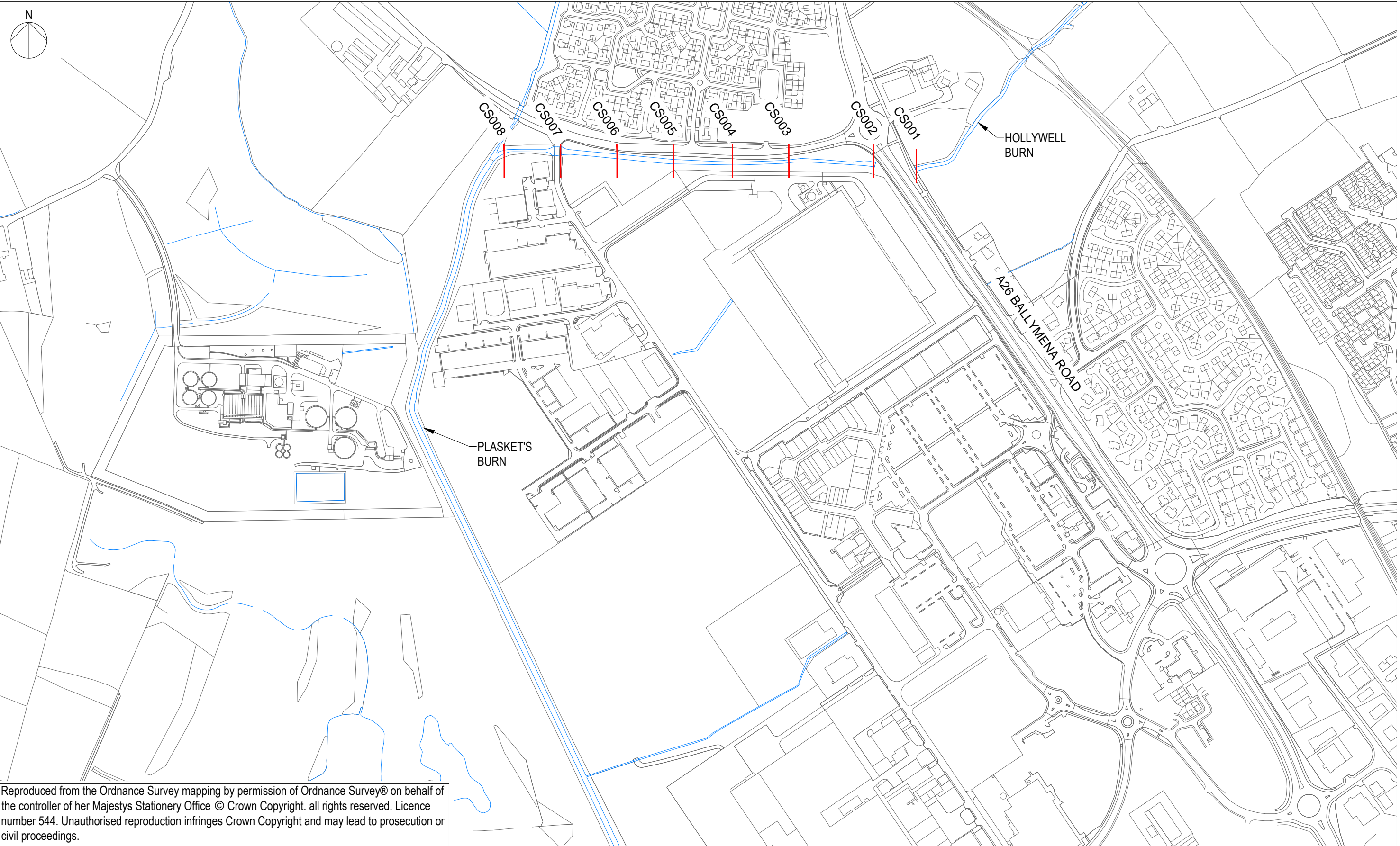


TYPICAL SECTION FLOODWALL
NOT TO SCALE



KEY	
	OPEN WATERCOURSE
	NEW 0.4m WIDE REINFORCED CONCRETE FLOODWALL
	DEVEGETATE EXISTING OPEN CHANNEL

Project Title ANTRIM - HOLLYWELL BURN		Drawing Title OPTION 4 ANTRIM DE-VEGETATION AND FLOOD WALL		Purpose of issue PRELIMINARY		THIS DOCUMENT HAS BEEN PREPARED PURSUANT TO AND SUBJECT TO THE TERMS OF AECOM'S APPOINTMENT BY ITS CLIENT. AECOM ACCEPTS NO LIABILITY FOR ANY USE OF THIS DOCUMENT OTHER THAN BY ITS ORIGINAL CLIENT OR FOLLOWING AECOM'S EXPRESS AGREEMENT TO SUCH USE, AND ONLY FOR THE PURPOSES FOR WHICH IT WAS PREPARED AND PROVIDED.		Beechill House Beechill Road, Belfast BT8 7RP Tel:T: +44 (0)28 9070 5111 Fax:F: +44 (0)28 9079 5651 www.aecom.com			
Client 		AECOM Internal Project No. 47074278		Designed - Drawn MM Checked KMcC Approved - Date -				Suitability Suitability			Drawing Number ANTR-ACM-XX-XX-DR-CE-01017
Scale @ A3 1:5000		Zone / Mileage MA									

Plot Date : 09 November 2016 10:50:41
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Project Title ANTRIM - HOLLYWELL BURN	Drawing Title MODEL SECTION LINE LOCATION PLAN ANTRIM	Purpose of issue PRELIMINARY					THIS DOCUMENT HAS BEEN PREPARED PURSUANT TO AND SUBJECT TO THE TERMS OF AECOM'S APPOINTMENT BY ITS CLIENT. AECOM ACCEPTS NO LIABILITY FOR ANY USE OF THIS DOCUMENT OTHER THAN BY ITS ORIGINAL CLIENT OR FOLLOWING AECOM'S EXPRESS AGREEMENT TO SUCH USE, AND ONLY FOR THE PURPOSES FOR WHICH IT WAS PREPARED AND PROVIDED.	Beechill House Beechill Road, Belfast BT8 7RP Tel:T: +44 (0)28 9070 5111 Fax:F: +44 (0)28 9079 5651 www.aecom.com	
		Designed -	Drawn SES	Checked KMcC	Approved -	Date -			
Client 		AECOM Internal Project No. 47074278		Suitability Suitability					
		Scale @ A3 1:5000		Zone / Mileage MA					