Project Details

Environment Agency

NEC4 Professional Service Contract (PSC)

Modelling Technical Scope

Project / contract Information

Project name	Ashford FRM model
Expected completion date	31/03/2022
Version number	6
Environment Agency Area	Kent and South London
Area lead	Joseph Williamson
Modelling technical	Craig Jefferies
Contact for additional information	Joseph Williamson, David Rich

This Scope should be read in conjunction with Operational Instruction 379_05 "Computational modelling to assess flood and coastal risk" current at the Contract Date. In the event of conflict, this Scope shall prevail. The *service is* compliant with the version of the Minimum Technical Requirements set out in OI_379_05.

Project Overview

a) This project is to build a new hydraulic model from new survey data and revised hydrology.
The focus of the study is Ashford urban area and town centre (including the surrounding Borough – approx. TR0085242860) from the upstream extents of its five main rivers: the Great Stour, East Stour, Whitewater Dyke, Ruckinge Dyke, and Aylesford Stream; in addition to two tributaries of the Great Stour - the Kennington and Brook Streams. Ashford has been identified as an area of future growth and has seen major floodplain development in the last 6 years. An up-to-date understanding of flood risk is required to allow continued growth in a safe and sustainable way. This includes updated mapping, scenario testing and flood warning considerations. The study will model two major Flood Storage Areas for the first time, informing future capital works to maintain the standard of service they provide. The study will also inform a subsequent options appraisal and economic update for Ashford FRM Options including potential South Ashford FAS.

b) Ashford is primarily located within the River Stour catchment in Kent. Confluences for five main rivers are located within Ashford: the Great Stour, the East Stour, the Ruckinge Dyke, the Whitewater Dyke and the Aylesford Stream. In addition, the Kennington Stream joins the Great Stour on the northeast edge of Ashford. The total length of the watercourses to be modelled will be aprox 45km.
The Stour catchment encompasses a land area of just over 1000 km2 and has two main tributaries: the Great Stour, which has its source at Lenham (near Maidstone), and the East Stour, which has its source at Postling (near Folkestone); their confluence is at Ashford.
Downstream of the town, the river winds through the countryside past Wye and onto Canterbury to its tidal limit at Fordwich. The tidal reaches flow through low lying marshland until it reaches Sandwich before entering the sea at Pegwell Bay. This study is focussed on the part of the Stour catchment upstream of the Wye gauging station. The Wye gauging station is approximately 5.5 km downstream of Ashford, and its catchment encompasses a land area of approximately 230 km2.
Farming is the main land use outside the urban areas. Land use quality in the catchment is generally grade 2 (very good) or grade 3 (good). Until the 1950s the main farming activity was grazing, but the introduction of spray irrigation led to the increased cultivation of vegetables and salad crops.
Both the Great Stour and East Stour originate on the Weald Clay and Lower Greensand. The Whitewater Dyke and the Ruckinge Dyke are mainly on the Weald Clay, which means they are flashy with rapid surface run-off and high peak flows, with a typical percentage rainfall runoff of around 46%. The top of the Great Stour and the East Stour catchments are mainly in the Lower Greensand, which means that these tributaries have a slower response to rainfall, with a typical percentage of rainfall runoff of around 28%.
The other part of the catchment that differs significantly is the urban area of Ashford which is underlain by Weald Clay, Lower Greensand and Gault Clay. The urbanised areas on the Lower Greensand have had their natural response modified to give a more rapid and higher runoff.
The Great Stour to Wye gauging station is moderately urban (the FEH parameter URBEXT2000 is 0.045).
The hydrology of the Great Stour and East Stour has been artificially influenced by the introduction of two flood storage reservoirs: Hothfield on the Great Stour (completed in 1991) and Aldington on the East Stour (completed in 1989). The impact of these reservoirs is to attenuate flood flows upstream of Ashford, thereby reducing flooding in the town.
The hydrological characteristic of much of the Stour catchment is composed of two types of responses, flashy in the upper reaches and in the urban areas, and a much slower response to rainfall downstream of the confluence with the East Stour. The rainfall distribution is fairly uniform.

3: Local Flood History

The *Consultant* shall produce a written commentary in the Interim Hydrology Report to document local flood history analysis. The commentary shall consider the following events:

February 2014, February 2009, January 2008, February 2007, December 2002, November 2000

5: Hydrological Assessment & Hydrometric Review

The *Consultant* shall undertake the following activities to provide a hydrological assessment and / or hydrometric review in accordance with the Environment Agency's Flood Estimation Guidelines.

Reporting

5.1.1 Submit a Hydrology Method statement for acceptance by the *Client* before commencing the hydrological assessment and/or hydrometric review. This shall set out the proposed approach, review of hydrometric data, catchment schematisation, and set out the methods and outputs.

5.1.2 Submit a Draft Hydrology Report to the *Client* for acceptance prior to the commencement of design simulations.

5.1.4 Submit a Final Hydrology Report to the *Client* for acceptance prior to commencement of hydraulic modelling.

Review data availability

5.2.1 Undertake a review of the hydrometric data (rainfall, levels, flow, flood extent) that are available for use for in the study (including donor catchments, model calibration and verification of models). Assess data availability, and the uncertainties in the accuracy of the data and what effect this could have on the reliability and accuracy of model outputs.

5.2.2 Review the performance of all rating relationships that will be used in this study during high flow conditions. The rating throughout the full range of flows shall also be assessed, albeit in a less rigorous manner. The review shall include commentary on the extrapolation above validated range, modular limits, likely hydraulic control in drowned mode and inter-site comparison. Clear conclusions on the suitability of ratings for rainfall-runoff model development and calibration of hydraulic models must be provided. Conclusions must include an estimate of likely gauge accuracy (% error in flow) for flows up to and including AMAX1. An indication of gauge accuracy at high and extreme flows (0.1% AEP or similar) shall be provided where possible.

5.2.3 Review the available survey data and any existing hydraulic models to determine whether a detailed model can be updated / constructed to improve the rating relationship at required gauging stations. State the extent of model required, any new survey requirements, and the most appropriate modelling approach. Consider whether simpler methods (e.g. velocity/area) can produce the required results.

5.2.4 Recommend any improvements to hydrometric networks and data collection in floods

Catchment understanding

5.4.1 Schematise the catchment. Subcatchment schematisation shall represent key hydrological features (e.g. changes in catchment response, key tributaries/confluences, flood storage reservoirs). Catchment delineation must be verified including use of surface water sewer data in urbanised catchments. A GIS shape file of subcatchment boundaries must be provided for acceptance by the *Client* as part of the Draft Hydrology Report. Boundary unit type (ReFH, FEH, pumped catchment, etc) and inflow locations (point, distributed lateral) shall be described and justified.

5.4.2 Agree representation of reservoirs within the catchment with the *Client*.

Design flow estimation - general

5.5 Tabulate the hydraulic model node labels corresponding to the locations of all level and flow recorders and other points of interest within the modelled area

Design flow estimation - statistical method

5.6.1 Agree peak flow data to be used for the analyses with the *Client.* The data will be based on available data as modified during the study (e.g. by the modelled rating curves).

5.6.2 Undertake flood frequency analysis at all gauging stations using the agreed peak flow data. By default, FEH statistical methods (using the latest updates) will be applied - changes to these methods shall be agreed with the *Client* . Compare with any relevant previous estimates. The degree of uncertainty in the estimates shall be assessed. The effect of these uncertainties on the modelled levels and flood extents shall be assessed and documented.

5.6.3 Where available use historical information to inform flood frequency analyses and choice of design values

Design flow estimation - rainfall-runoff methods

5.7.1 Assess the applicability of rainfall-runoff methods such as ReFH1 and ReFH2.

5.7.2 Determine the critical design storm(s), including storm duration, DDF and ARF parameters. If the modelled area has a large variation in catchment size and response at different points of interest, the selection of design storms shall take this into account.

5.7.3 Derive design flood hydrographs (e.g. ReFH, factor ReFH to fit statistical \ accepted design peaks, Archer method)

5.7.4 Improve estimated rainfall-runoff parameters in accordance with the FEH Guidelines.

Reconcile results and produce final design values

5.9.1 Reconcile the results from different approaches (e.g. rainfall-runoff and statistical). If peak flows are significantly changed, the effect on runoff volumes shall be investigated and hydrograph shapes amended if necessary.

5.9.2 Compare flood estimates with previous studies at all gauging stations and other points of interest. Justify the final selection of methodology to be taken forward to design runs.

7: Fluvial - New Hydraulic Model Build

The *Consultant* shall construct and deliver a new hydrodynamic hydraulic model extending over all Main River using updated LiDAr and channel surveys, as provided by the *Client*. For fluvial models a single model is required and the *Consultant* must advise and obtain the *Client's* acceptance should multiple models be needed to achieve acceptable simulation times. Acceptable run-times are considered 72 hours for 7-day 0.1% AEP simulation on the *Client's* CMP computer. The model must be able to simulate flood events for:

- Produce fluvial flood zone extents (undefended) for return periods (AEP); 5%, 1%, 0.1% & 1% + climate change allowances (35%, 45%, 105%)
- Produce an areas benefitting from defences (ABD) for the Flood Map. Historic embankments to be removed from the undefended and represented in the defended, and not considered a formal flood defence for the ABD.
- Produce fluvial defended extents for return periods; 50%, 20%, 10%, 5%, 3.3%, 2%, 1.33%, 1%, 0.5%, 0.1% AEPs & 1% + climate change allowances (35%, 45%, 105%)
- Produce fluvial undefended extents for return periods; 50%, 20%, 10%, 5%, 3.3%, 2%, 1.33%, 1%, 0.5%, 0.1% AEPs & 1% + climate change allowances (35%, 45%, 105%)
- Quantify, map and visualise uncertainty for all the above. Every modelled scenario has uncertainty (which should be quantified with an upper and lower water level), these should be mapped along with the central estimate. The method to do this will be discussed and agreed with the *Client* to ensure a pragmatic approach.
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9: Model Proving, Calibration and Verification & Sensitivity

The *Consultant* shall provide written interpretation of results, including impact on model calibration / proving, design configuration, onset of flooding, standard of protection and recommendations for prioritisation of maintenance.

9.1 Calibrate the New Model through simulation of up to 3 events and verify performance through simulation of up to a further 2 events. Suggested events include: February 2014, February 2009, January 2008, February 2007, December 2002, November 2000. Inflows shall be generated using observed rainfall and flow data and the *Consultant* is expected to select events to maximise available information. Variation in antecedent conditions between events must be explicitly computed.

Where appropriate flow data can be derived for historic events, and at gauged sites agreed as suitable for use for calibration/verification purposes (to be agreed via the Hydrology Method Statement), the *Consultant* shall achieve peak level fit at all gauged locations of ± 150 mm, with replication of overall hydrograph shape. Variance between the observed and modelled hydrographs shall be presented to the *Client* at a face to face calibration review meeting along with draft flood outlines for any out of bank calibration events. The *Client's* acceptance of the calibration is required before progression to design event simulation.

Fluvial Models:

As a minimum the *Consultant* shall undertake sensitivity analysis on all fluvial models to flows, roughness and downstream boundary condition. Sensitivity analysis to be undertaken for the 1% AEP or AEP closest to bank top level (where the 1% AEP event is in bank), will be submitted to the *Client* for acceptance and comprise:

9.11 Simulations to determine sensitivity to operation of structures.

9.12 Simulations to determine sensitivity to initial conditions/storage availability.

10: Design Simulations & Results

All scenarios listed below must be delivered for defended scenarios:

Fluvial hazard scenarios are modelled with the flood defence system scenario of defended, no failure by breaching.

Scenarios:

- Produce fluvial defended extents for return periods; 50%, 20%, 10%, 5%, 3.3%, 2%, 1.33%, 1%, 0.5%, 0.1% AEPs & 1% + climate change allowances (35%, 45%, 105%)
- Produce fluvial undefended extents for return periods; 50%, 20%, 10%, 5%, 3.3%, 2%, 1.33%, 1%, 0.5%, 0.1% AEPs & 1% + climate change allowances (35%, 45%, 105%)

Climate change scenarios are required as part of this project. Please refer to Minimum Technical Requirements for Modelling for details of climate change requirements.

Include model runs for all defended AEPs to compare the existing scenario with the do nothing (i.e. no maintenance) - assumptions to be agreed

The *Consultant* shall provide written commentary on the %AEP of onset of flooding, standard of protection (including freeboard, in accordance with the *Client's* Fluvial Freeboard Guidance Note 2000 - W187) and suitability of fit with the anecdotal historic evidence of flooding. Limitations with historical evidence results shall be clearly identified in the conclusions and further recommendations shall be given if appropriate (e.g. state where new telemetry gauges shall be installed, where new survey / LiDAR would improve model accuracy etc). This commentary is to be included within the draft and final Model Report.

In addition the *Client* requires:

10.1 Identify the design event probabilities for which the defence provides benefit – this shall include all events where retained water level is above local ground levels. The assessment shall include identification of receptors protected. The analysis must be sufficiently detailed to distinguish between individual communities and include strategic infrastructure (trunk road, railways, power sub-stations). Provide this commentary as part of the Model Report.

10.3 Animations of flow and velocity vectors for the 2D model domain for 5 locations x 5 animations x 5 %AEPs.

10.4 Simulate structure blockage scenarios for 5 locations x 5 scenarios x 5 %AEPs, including:

- Pledges Mill fish pass and sluices

Return Periods: 5yr, 20yr, 100yr defended for the following scenario:

100% blockage of fish/eel pass inlet and spillway up to the top of the structure dividers at grid reference: TR0152542798, at the same time as a 50% blockage of the upstream/adjacent sluice gates at grid reference: TR0152342793.

- Trash screen on Kennington Stream

Return Periods: 5yr, 20yr, 100yr defended for the following scenario:

75% blockage of trash screen at grid reference: TR0190044195.

- Culvert on Brook Stream

Return Periods: 5yr, 20yr, 100yr defended for the following scenarios:

50% blockage of culvert under road at grid reference: TR0636544129.

75% blockage of culvert under road at grid reference: TR0636544129.

- Allow for additional 2 locations x 2 scenarios x 3 %AEPs.

Additionally:

- SoP Analysis of Aldington and Hothfield Flood Storage Areas

Supplier to determine the current Standard of Protection (SoP) provided by the Aldington and Hothfield Flood Storage Areas. At what return period flood event do the spillways overtop? What flow do the hydrobrake structures restrict flow to? What SoP is provided to Ashford? How does this vary downstream? What areas are afforded a 1 in 100 year SoP?

- East Stour between Norman Road and Torrington Road

Return Periods: 5yr, 20yr, 100yr defended for the following scenario:

An increase in channel roughness and reduction in channel capacity to simulate a large amount of in-channel debris e.g. shopping trolleys, bikes etc. between grid references TR0111741308 and TR0126441679. Method to be advised by supplier.

11: Flood Warning Improvements

The *Consultant* shall deliver the following services in accordance with Operational Instruction 137_05 Flood Warning Levels of Services and OI 55_07 Threshold Setting in Flood Incident Management. The following services are anticipated following receipt of the improved flood outlines but allowance shall be made by the *Consultant* for liaising with the Flood Resilience team for specific guidance on the process and at key points:

11.1 Review the existing Flood Alert Areas and / or Flood Warning Areas extents in comparison with the updated modelled outputs and advise whether modifications are required to the extents. Review the first impacts (out of bank), first property to flood and trigger thresholds using the updated and accepted flood maps / levels. There are 6 existing Flood Alert Areas and 6 existing Flood Warning Areas.

11.1.1 Update the existing Flood Alert Areas and / or Flood Warning Areas extents based on the updated modelled outputs (without defences 0.1% AEP plus historic flood extents, where appropriate) following the *Client's* acceptance of recommended modifications from 11.1 and provide revised extents.

11.4 Deliver an Excel spreadsheet which includes %AEP, land use type, risk category assigned and number of commercial / residential properties for each FWFRA. Information on suggested FWAs shall include names of FWFRAs aggregated to make the FWA, highest AEP, total number of properties, breakdown of commercial and residential properties, vulnerable receptors (utilities, hospitals, care homes etc) and overall assigned risk category.

11.5 Produce flood extent shapefiles with associated level at Flood Warning gauge for each of 6 existing Flood Warning Areas. Outlines are required for each simulated (with defences) %AEP between onset of flooding and the Extreme Flood Outline. Submit the proposal for the *Client's* acceptance whether onset of flooding is first property to flood, first impacts or overtopping of defences.

11.6 Produce flood hazard shapefiles with associated level at the Flood Warning gauge for each of 6 existing Flood Warning Areas. Outlines are required for each simulated (with defences) %AEP between onset of flooding and the Extreme Flood Outline. Submit the proposal for the *Client's* acceptance whether onset of flooding is first property to flood, first impacts or overtopping of defences.

11.7 Review the data quality of the gauge sites in the study area and provide a detailed recommendation for the gauges to be used in level-level correlation for each FWA.

11.8 Produce level-level correlation between the onset of flooding location and Flood Warning Gauge Site for each Flood Warning Area. Determine the frequency the trigger level will be exceeded. Make recommendations for improvements, explaining the benefits.

11.9 Produce travel time between the onset of flooding location and Flood Warning Gauge Site based on model results and verify these results through comparison with the available hydrometric data.

Available Data - Treat as Site Information

All datasets supplied for the project must be returned to the *Client* upon project completion. Datasets returned should adopt the appropriate security marking, be password protected/encrypted in accordance with the latest government guidelines. Data that will be made available to the *Consultant* include:

Hydrometric data:

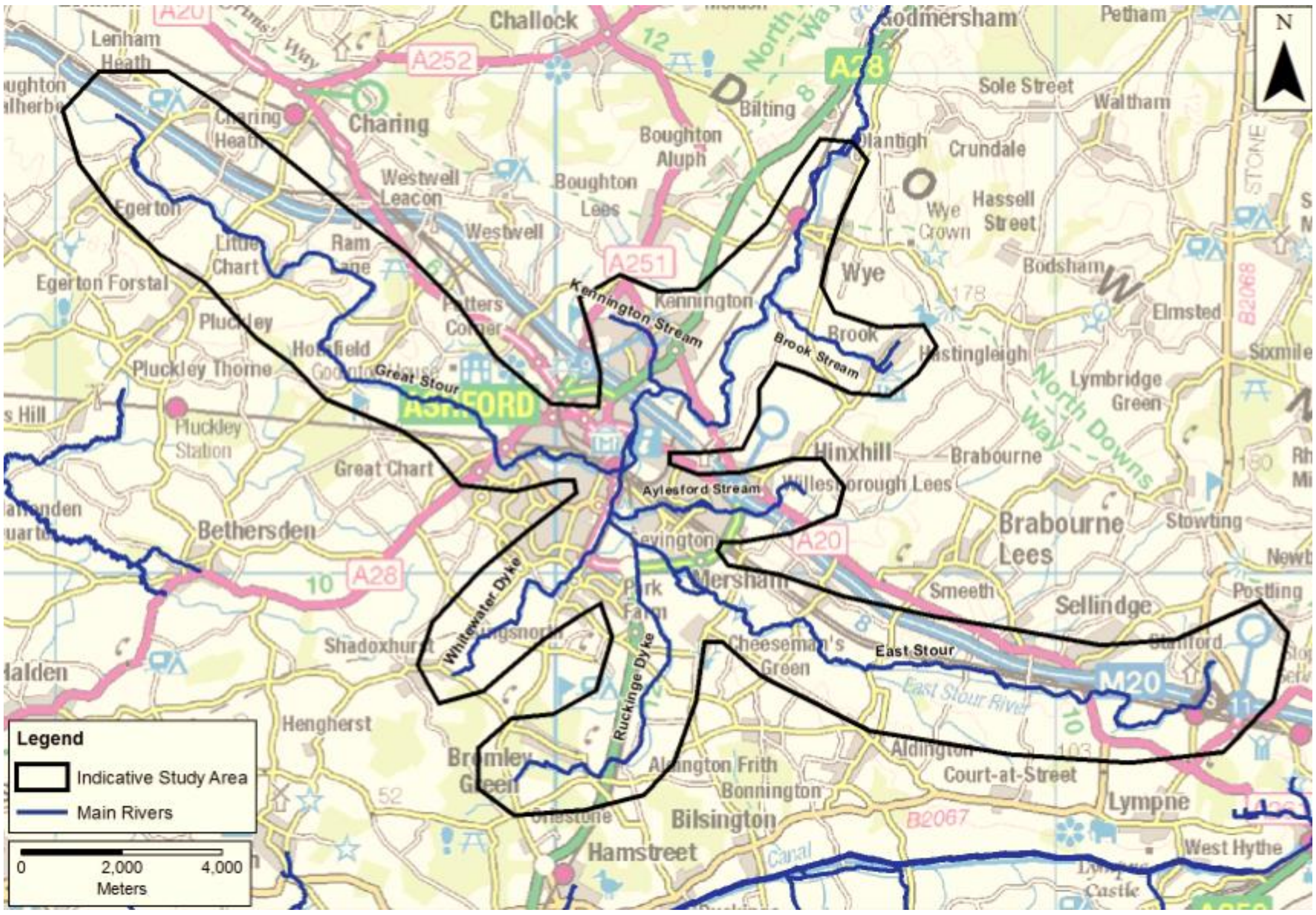
Station	Location	Type (Flow / Level / Rainfall, Wind, Wave Height / Direction)	Period of record	Time interval (15 min/daily)	Fluvial/Coastal	Known data quality issues
654306001 WYE GS	TR0488047000	Flow/Level	10/101962 to present	15 min	Fluvial	N/A
654220001 AYLESFORD STREAM GS	TR0235441272	Flow/Level	15/12/2003 to present	15 min	Fluvial	N/A
654210001 SOUTH WILLESBOROUGH GS	TR0151340704	Flow/Level	31/12/1975 to present	15 min	Fluvial	N/A
654200001 ASHFORD CROSSING GS	TR0129641975	Flow/Level	01/12/1964 to present	15 min	Fluvial	N/A
654110001 CHART LEACON GS	TQ9922942280	Flow/Level	31/12/1979 to present	15 min	Fluvial	N/A
654110002 BROWN MILL GS	TQ9585645200	Flow/Level	01/06/2001 to present	15 min	Fluvial	N/A

geometry	Site number	Site name	Site sub-type
X: 608600, Y: 138200, Z: NaN	EFSO020263	SELLINDGE S.T.W.	Effluent site
X: 601951, Y: 143307, Z: NaN	EFSO020004	ASHFORD W W T W	Effluent site
X: 604850, Y: 146600, Z: NaN	EFSO020235	WYE S.T.W.	Effluent site
X: 606050, Y: 144350, Z: NaN	EFSO020140	NATS LANE. BROOK SEWAGE DISPOSAL WORKS	Effluent site
X: 609287, Y: 138428, Z: NaN	644213002	COURT LODGE FM	Groundwater level (observation boreholes) manually read
X: 595230, Y: 145772, Z: NaN	644110002	COLDHAM	Groundwater level (observation boreholes) manually read
X: 605910, Y: 148350, Z: NaN	644401007	OLANTIGHE TOWERS WYE	Groundwater level (observation boreholes) manually read
X: 608630, Y: 138196, Z: NaN	664213501	SELLINDGE STW TBR	Precipitation - recording
X: 602048, Y: 143327, Z: NaN	301845	BYBROOK STW RG	Precipitation - recording
X: 595856, Y: 145200, Z: NaN	654110002	BROWN MILL GS	River flow - continuous
X: 599229, Y: 142280, Z: NaN	654110001	CHART LEACON GS	River flow - continuous
X: 601296, Y: 141975, Z: NaN	654200001	ASHFORD CROSSING GS	River flow - continuous
X: 601513, Y: 140704, Z: NaN	654210001	SOUTH WILLESBOROUGH GS	River flow - continuous
X: 602354, Y: 141272, Z: NaN	654220001	AYLESFORD STREAM GS	River flow - continuous
X: 604880, Y: 147000, Z: NaN	654306001	WYE GS	River flow - continuous
X: 610728, Y: 137649, Z: NaN	654211002	SELLINDGE RL	Surface water level (including tide and lake level) - continuous
X: 606662, Y: 138142, Z: NaN	654211001	ALDINGTON TELEMETRY	Surface water level (including tide and lake level) - continuous
X: 596891, Y: 143657, Z: NaN	654110004	HOTHFIELD US RL	Surface water level (including tide and lake level) - continuous
X: 597191, Y: 143509, Z: NaN	654110005	HOTHFIELD DS RL	Surface water level (including tide and lake level) - continuous
X: 599924, Y: 139569, Z: NaN	654234001	WHITE WATER DYKE	Surface water level (including tide and lake level) - continuous
X: 601378, Y: 136239, Z: NaN	654232001	RUCKINGE DYKE	Surface water level (including tide and lake level) - continuous

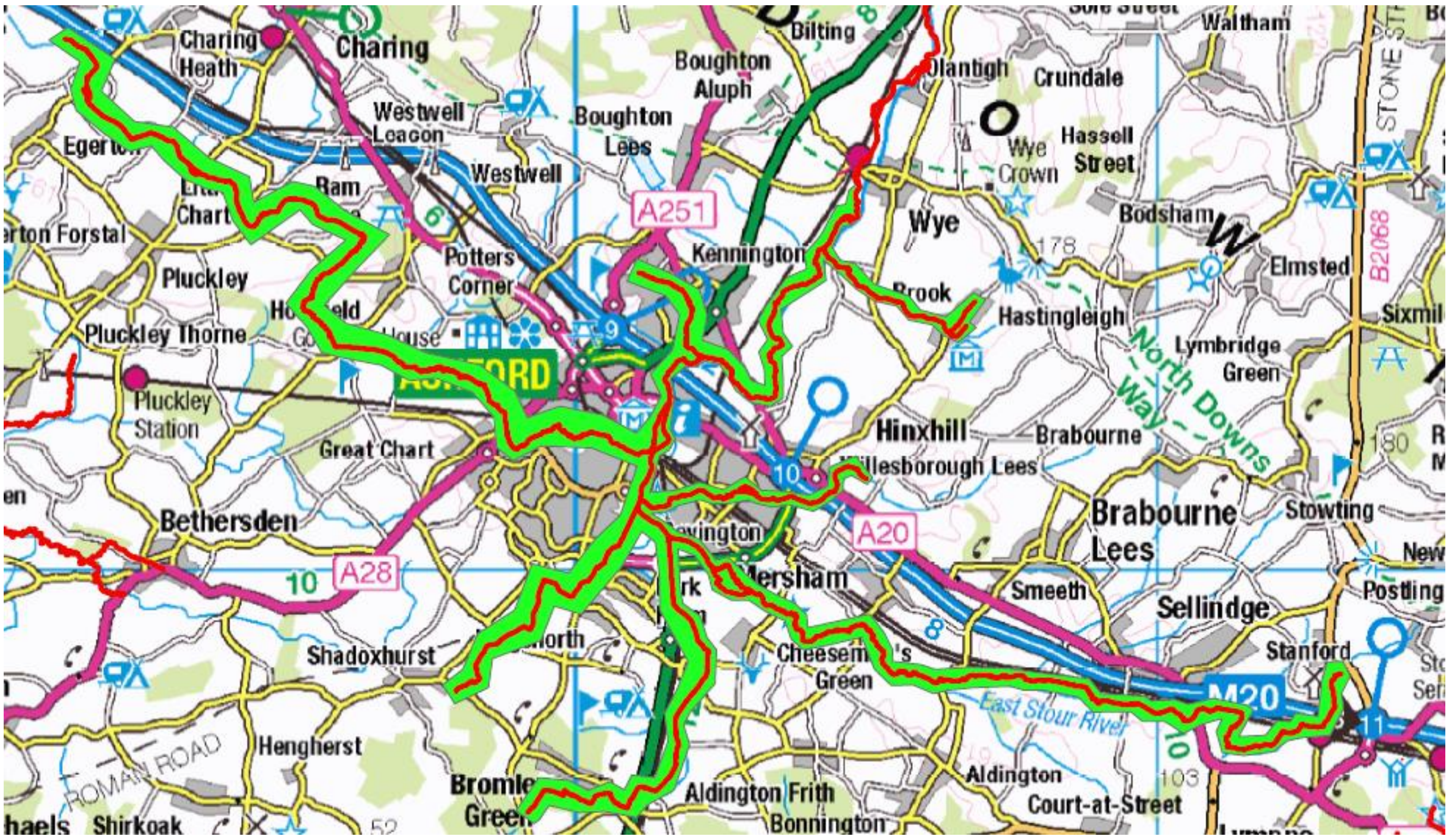
Other Data

- Kent Area Autumn 2000 Floods Review Area Report
- 2000 photos incl aerial
- 2013-2014 Post Flood Analysis: KSL Area
- Autumn 2000 Great Stour flood rarity (July 2014)
- Previous Modelling reports

Remote Sensing Coverage Map



New Survey Coverage Map



Asset data types:

The *Client* will provide an AIMS Database containing all asset details at the beginning of the project. Assets to be included are:

Types	Other details
Raised Defences - Walls/Embankments	

Flood history information:

Event Date	Location	Data Type	Other Details	Known data quality issues
2000	Great Stour	Flood Report	Great Stour Flood rarity report	
2014	KSL Area	Flood Report, Photographs/Aerial Photography		
2000	Stour	Flood Report, Photographs/Aerial Photography		

Existing Model Summary - Fluvial Hydraulic

Model name	Date	Length of modelled watercourse (km)	Hydraulic model type	Other Type	Description	Information only or to be updated
South Ashford 2D Modelling Study	Oct 2010		Flood Modeller Pro - Tuflow			Info only