Project Details

Environment Agency

NEC4 Professional Service Contract (PSC)

Modelling Technical Scope

Project / contract Information

Project name	Ravensbourne Modelling
Expected completion date	31/03/2023
Version number	9
Environment Agency Area	Kent, South London and East Sussex
Area Lead	[redacted]
Modelling technical	[redacted]
Contact for additional information	Asset Performance Team, Fisheries, Biodiversity and Geomorphology & Flood Resilience Team

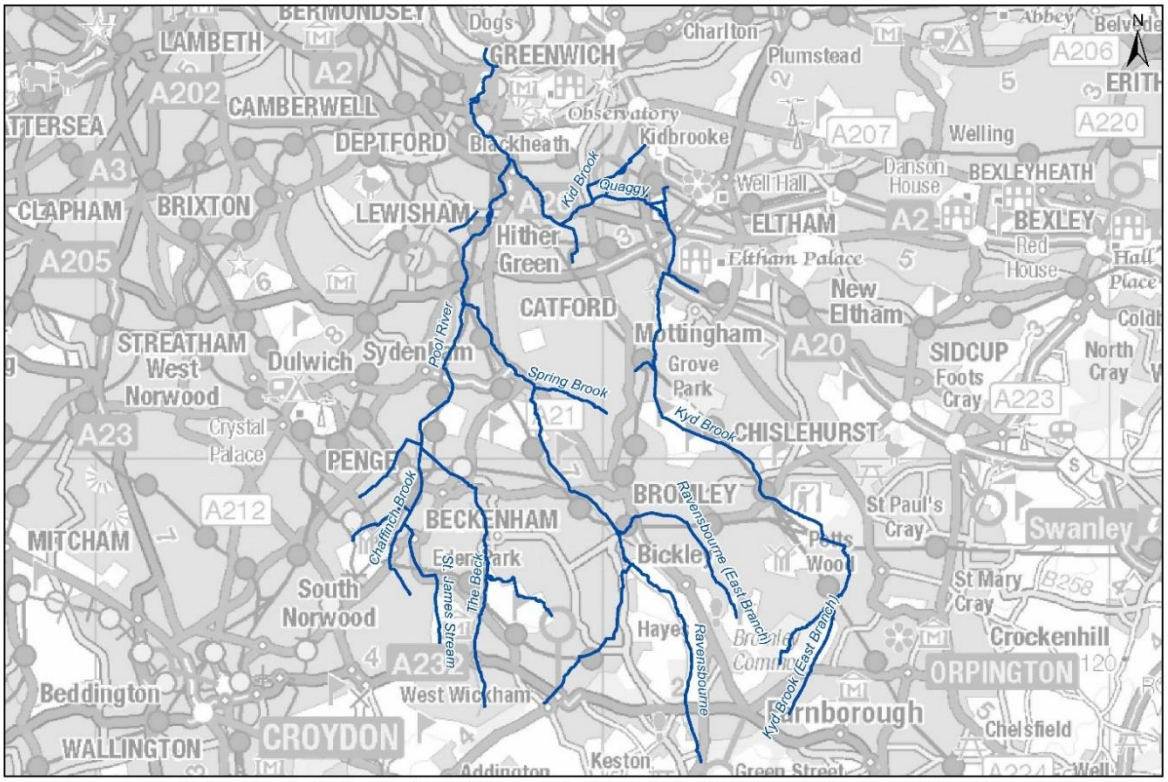
This Scope should be read in conjunction with Operational Instruction 379_05 “Computational modelling to assess flood and coastal risk” current at the Contract Date. In the event of conflict, this Scope shall prevail. The service is compliant with the Minimum Technical Requirements set out in the Operational Instruction 379_05 and NEC4 Minimum Technical Requirements for Modelling_v2.2.

Project Overview

a) The focus of this project is to update the existing fluvial Ravensbourne model undertaken in 2015 (CH2M Hill) to provide updated flood risk mapping and provide a baseline model for subsequent scheme models, including Petts Wood and Chinbrook Meadows. The updated model will therefore be fit for future use over the next 10 years. There are several known changes throughout the catchment to channels, culverts and land use. An extensive series of channel surveys was undertaken in 2018 (see list in available data section) and new LiDAR has been produced. [redacted] The Ravensbourne catchment also experienced flooding in 2013/14 at Eltham, and since there has been an increased focus on non-compliant trash screens and their operation. This resulted in the replacement of the Eltham Palace trash screen and a wider, national project looking at high risk trash screens. An inception study was commissioned by the Environment Agency and undertaken by JBA in April 2021. The inception study reviewed the existing survey data, hydrology methods and hydraulic model build and provided recommendations to inform the main stage model update, and these have been included within this scope. The intent is to update the hydrology and the Quaggy domain of the model first, before carrying out the modelling work at Chinbrook Meadows and Petts Wood, both of which will be scoped separately and under separate contracts, before subsequently moving onto updating the remaining part of the catchment model and hydrology of the Ravensbourne branch.

b) The Ravensbourne catchment includes the following main rivers: Ravensbourne, Quaggy and Pool, plus all tributaries. The source of the Ravensbourne is at Caeasar's Well in Keston, and joins the River Thames at Deptford. The Pool River joins the Ravensbourne at Catford and the Quaggy River converges at Lewisham. The Quaggy branch is known as the Kyd Brook upstream of Sundridge Park. The study covers approximately 75km of main river, and is heavily culverted and significantly influenced by surface water, sewer flow and groundwater. The lower reach at Deptford Creek is tidally influenced by the River Thames.

Map of Study Area



1: Hydraulic Model Review

This section is not relevant to this study.

2: Hydrological Model & Tidal / Coastal Boundary Review

This section is not relevant to this study

3: Local Flood History

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

3.1 Ranking and severity / probability of events.

3.2 Likely causal mechanism of flooding (including combined sources).

3.3 The *Consultant* shall collect and evaluate data from the *Client*, London Borough of Bromley, Royal Borough of Greenwich, London Borough of Lewisham, and Thames Water.

3.4 The *Consultant* shall collect and evaluate data from social media / other potential sources of information.

Project Specific Requirements

3.5 The *Consultant* shall consider extending the systematic gauge record where appropriate.

4: Site Visit and Topographic Survey

This *Consultant* shall:

4.1 Visit the site to understand the local flood flow pathways and flood history. The *Client* will facilitate this visit and arrange for appropriate staff to accompany the *Consultant* to provide local knowledge. The *Consultant* shall give the *Client* 7 working days' notice prior to any required visits.

5:Hydrological Assessment & Hydrometric Review

The *Consultant* shall undertake the following activities to provide a hydrological assessment and 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 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. If it is not possible, then to give reasons.

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 Update subcatchment schematisation to improve delineation of urbanised areas, improve resolution of inflows, changes on the ground.

5.4.3 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 (previous studies listed in the available data section of the scope). 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 Estimates of peak flows of different annual exceedance probabilities shall be made at locations determined by the *Consultant*.

5.6.4 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).

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 (contained within the Project Specific Data section) at all gauging stations and other points of interest. Justify the final selection of methodology to be taken forward to design runs.

Other considerations

5.10.1 Assess the joint probability of fluvial and/or tidal response from the following watercourses, and recommend design approach for acceptance by the *Client*.
-Deptford Creek

Project Specific Requirements

5.11 The *Consultant* shall make recommendations supported by evidence for the number of critical storm durations (as required under section 5.7.2) for acceptance by the *Client* before the commencement of the design runs.

5.12 The *Consultant* shall undertake an additional data review (to that listed in Section 5.2.1) as set out in the recommendations from the inception phase. This data review shall include a 'data rescue' or retrieval of 'lost' earlier period of record data for gauges. This data shall be investigated and analysis updated if appropriate.

6: Tidal / Coastal Boundary Analysis

This section is not relevant to this study

7: Fluvial – New Hydraulic Model Build

This section is not relevant to this study

8: Fluvial – Update Existing Hydraulic Model(s)

The *Consultant* shall update the with-defences and without defences Ravensbourne model (2015) hydraulic model(s). The scope for updating will be confirmed following acceptance by the *Client* of the Model Review Report. The following activities are required:

The model must be able to simulate flood events for:
Fluvial undefended: 20%, 5%, 2%, 1%, 0.5%, 0.1%; Fluvial defended: 50%, 20%, 10%, 5%, 3.3%,2%, 1.33%, 1%, 0.5%, 0.1%; Tidal defended: 20%, 5%, 2%, 1%, 0.5%, 0.1% AEPs. Climate change scenarios are required as part of this project. Please refer to Minimum Technical Requirements for Modelling for details of climate change requirements.

8.1 Extension of the model downstream by 2 km to include Deptford Creek.

8.2 This section is not relevant to this study.

8.3 Update of asset crest levels. Allow for 80 % of data to be modified.

8.4 Updating of the floodplain representation using latest LiDAR. The area requiring update is shown on the study area plan in Project Overview, and contained within the data download package.

8.5 Updating of:
Trash screen representing Beckenham Hill representing TQ3846271584
Trash screen representing Mottingham Lane representing TQ4115873492
Culverts representing Bromley South development representing TQ4029068570
Channel representing Lewisham Gateway (Confluence Park) representing TQ3821075810
Trash screen representing Sutcliffe Park representing TQ4128774631
Plus additional structures listed in Appendix A.

8.6 This section is not relevant to this study.

8.7 This section is not relevant to this study.

8.8 This section is not relevant to this study.

8.9 This section is not relevant to this study.

8.10 The model will be updated with the most up to date topographic survey and remote sensing data available at the time of baseline model development.

Project Specific Requirements

8.11 The model will be updated with new channel and culvert surveys (as detailed in the available data section) . Allow for 80% of data to be modified. The area requiring an update is shown on the Survey Coverage Map.

8.12 Assess the joint probability of fluvial and/or tidal response from the Ravensbourne, Deptford Creek and River Thames. Downstream boundary should use the Thames in-channel water levels obtained from the 'Thames Estuary 2100 Estuary Water Levels project, by Jacobs and TE2100'. The in-channel water level should be combined with the design events listed above.

8.13 The *Consultant* shall review and update the spills that exist in the model, and include additional spills where required. Where a spill is determined to be required, the *Consultant* shall asses the adequacy of the survey that exists to represent the flow behaviour and make recommendations to the *Client* for additional surveying which would better represent a flood flow route.

8.14 Prior to the completion of the hydraulic model build, the *Consultant* shall confirm with the *Client* the extent of the areas where local detailed asset/combined surface water modelling is

proposed. The *Consultant* will then incorporate reasonable features into the model to facilitate it being merged with more detailed modelling at those locations in the future.

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 model through simulation of up to 3 events and verify performance through simulation of up to a further 2 events. Inflows shall be generated using observed rainfall and flow data and the *Consultant* is expected to select events to make best use of available information. Variation in antecedent conditions between events must be explicitly computed.

The *Consultant* shall achieve peak level fit at all gauged locations of ± 150 mm, with replication of overall hydrograph shape. Coastal models must be calibrated using available tide gauges and wave buoys. 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:

9.4.1 ±20% flows

9.4.2 ±20% roughness

9.4.3 ±500mm change in tidal downstream boundary

Project Specific Requirements

9.18 Simulations to determine sensitivity to various catchment opportunities, listed in the attached document titled Appendix B.

10: Design Simulations & Results

All scenarios listed below must be delivered for defended scenarios:

Fluvial, tidal, coastal and surface water hazard scenarios are modelled with the flood defence system scenario of defended, no failure by breaching.

Scenarios:
Fluvial undefended: 20%, 5%, 2%, 1%, 0.5%, 0.1%; Fluvial defended: 50%, 20%, 10%, 5%, 3.3%,2%, 1.33%, 1%, 0.5%, 0.1%; Tidal defended: 20%, 5%, 2%, 1%, 0.5%, 0.1% AEPs. Climate change scenarios are required as part of this project. Please refer to Minimum Technical Requirements for Modelling for details of climate change requirements.

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 Note2000 - 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 *Consultant* shall:

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 Produce animations of flow and velocity vectors for the 2D model domain for 5 locations x 1 animations x 2%AEPs.

10.4 Simulate structure blockage scenarios for 30 locations x 2 scenarios x 3 %AEPs.

10.5 Simulate removal/addition of sediment for 8 locations x 1 scenarios x 3 %AEPs.

10.7 Produce a table of the number of residential, critical infrastructure and other non-residential properties within all defended, undefended and blockage %AEP outlines referring to the flood level at the nearest relevant river gauge(s) - if applicable).

Project Specific Requirements

10.9 The *Consultant* shall assess the degree of confidence that can be attributed to the flood modelling along the different river reaches within the catchment.

10.10 The *Consultant* shall submit a technical note for acceptance by the *Client*. This shall set out recommendations for freeboard to be applied to new building floor levels, the soffits of culverts and bridges, and new fluvial flood defences, considering the guidance for freeboard and residual uncertainty allowances.

10.11 The *Consultant* shall produce a GIS shapefile containing polygons to identify the spatial extent within which each different freeboard value should be applied.

10.12 The *Consultant* shall confirm with the *Client* on the completion of the draft baseline model build, whether additional input data has become available that should be incorporated into the flood model, including for the culverts.

10.13 The *Consultant* shall undertake logical overlay post-processing of the outputs, using national surface water data and previous flood events, to provide outputs to demonstrate the likely coverage proportions of fluvial, surface water and combined sources of flood risk.

11: Flood Warning Improvements

The *Consultant* shall deliver the following services in accordance with Operational Instruction 381_03 Defining Flood Alert and Flood Warning Areas and OI 55_07 Threshold Setting in Flood Incident Management. The following services are required following receipt of the improved flood outlines. Prior to commencing these activities the *Consultant* is to engage with the Flood Resilience Team for specific guidance.

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 is 1 existing Flood Alert Area and 12 existing Flood Warning Areas – these are listed in the available data section.

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 (the *Client* will provide an example/ template) 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 12 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 12 existing Flood Warning Areas (detailed within the available data section). 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 at which 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.

13: Flood Forecasting – Inception Stage

This section is not relevant to this study

14: Flood Forecasting – Model Development and Calibration

This section is not relevant to this study

15: Costal – New Hydraulic Model

This section is not relevant to this study

16: Coastal – Hydraulic Model Review

This section is not relevant to this study

17: Costal – Update Existing Hydraulic Model(s)

This section is not relevant to this study

18:Broadscale Modelling

This section is not relevant to this study

19:Options Appraisal

This section is not relevant to this study

20:Surface Water – Hydraulic Model Review

This section is not relevant to this study

21: Surface Water – Update Existing Hydraulic Model(s)

This section is not relevant to this study

22:Surface Water – New Hydraulic Model Build

This section is not relevant to this study

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
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
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[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	

Flood Alert Areas and Flood Warning Areas:

Target Area	Target Area Name	Target Area Description	Floodline Quick Dial Number	Target Area Code	Target Area Name	Target Area Description	Floodline Quick Dial Number
[redacted]	[redacted]	[redacted]	217025	[redacted]	[redacted]	[redacted]	[redacted]
				[redacted]	[redacted]	[redacted]	[redacted]
				[redacted]	[redacted]	[redacted]	[redacted]
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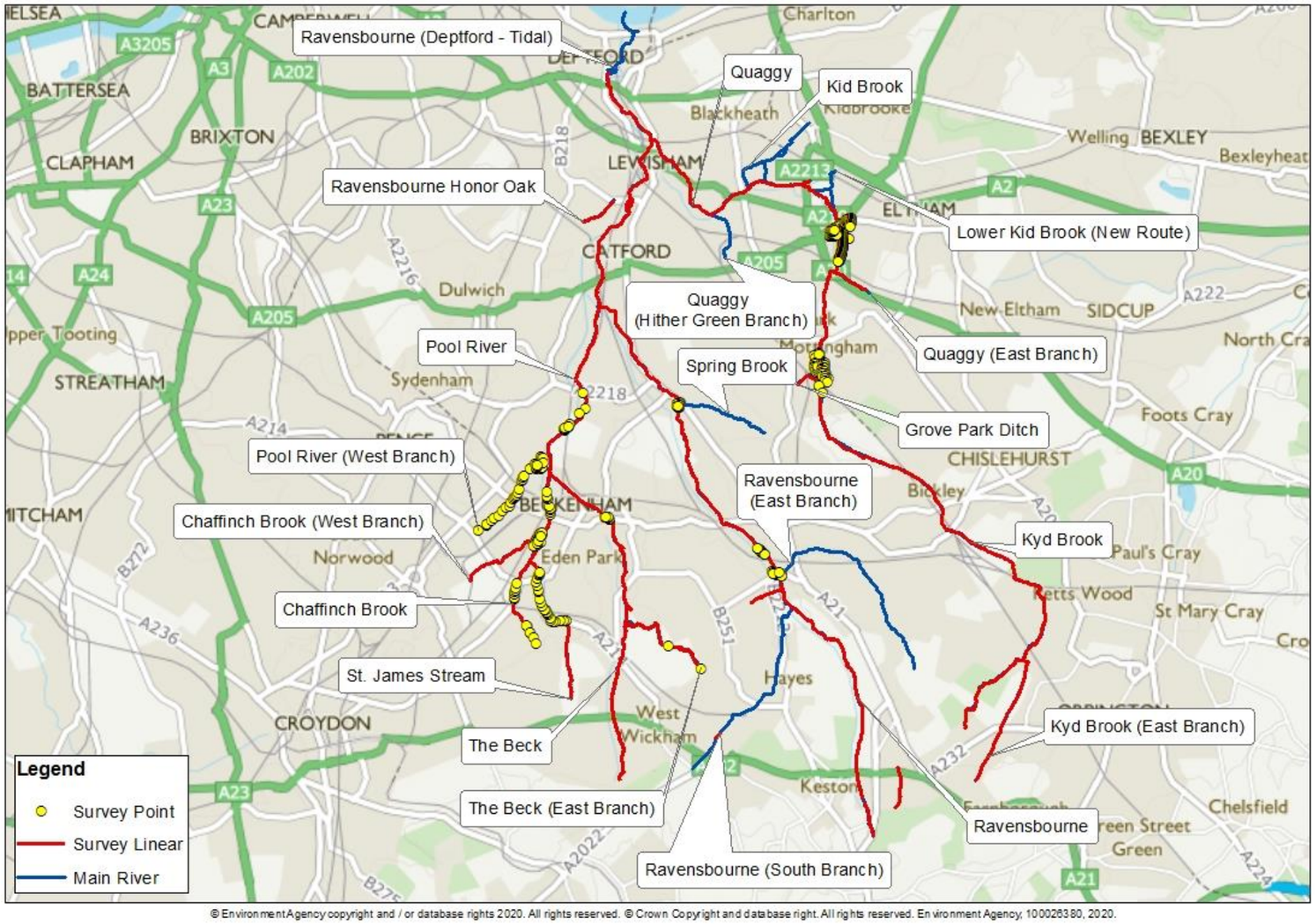
Survey Coverage Map



Survey Coverage Shapefile

Survey.zip

[redacted]

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	Culvert surveys, channel survey, topographic survey, bathymetric survey.

Flood history information:

Event Date	Loc	Data Type	Other Details	Known data quality issues
[redacted]		[redacted]		
[redacted]		[redacted]		
[redacted]		[redacted]	[redacted]	
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Project Specific Data:

Please list any relevant existing model reports / technical notes etc.
[redacted]
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[redacted]
[redacted]
[redacted]

Existing Model Summary – Fluvial Hydraulic

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

Model name	Date	Length of watercourse (km)	Hydraulic Model Type	Other Type	Description	Information only or to be updated
[redacted]	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]