ANNEX B2

Hydrological & Hydraulic Modelling: Tame and Trent

Minworth SRO

Severn Trent Water & Affinity Water

AECOM

Hydrological and Hydraulic Modelling for the Tame and Trent Strategic Resource Options (SRO)

Minworth SRO and South Lincolnshire Reservoir (SLR) SRO Hydrological and Hydraulic Modelling Report

Affinity Water, Anglian Water Services Ltd and Severn Trent Water Ltd

Project number: 60671264

October 2022

Affinity Water
Taking care of your water

SEVERN TRENT

Delivering a better world

Author names redacted

Quality information

Prepared by	Checked by	Verified by	Approved by
[redacted] Engineer - Water, AECOM	[redacted] Senior Engineer - Water, AECOM	[redacted] Technical Director, AECOM	[redacted] Technical Director, AECOM
[redacted] Graduate Consultant - Water, AECOM	[redacted] Rachel Evans Ltd		
[redacted] Graduate Engineer - Water, AECOM			

Revision History

Revision	Revision date	Details	Authorized	Name	Position
D0	May 2022	Draft of Sections 1-4 describing Phases 1-3	27/05/2022	[redacted]	Technical Director
D1	July 2022	Draft Report for first-line assurance	12/07/2022	[redacted]	Technical Director
D2	July 2022	First-line assurance comments addressed	21/07/2022	[redacted]	Technical Director
D3	Sept 2022	EA assurance comments addressed	02/09/2022	[redacted]	Technical Director
D4	Oct 2022	Final	11/10/2022	[redacted]	Technical Director

Prepared for:

Affinity Water, Anglian Water Services Ltd and Severn Trent Water Ltd
Project: C-03844

Prepared by:

AECOM Limited
Midpoint, Alencon Link
Basingstoke
Hampshire RG21 7PP
United Kingdom

T: +44(0)1256 310200
aecom.com

Table of Contents

1. Introduction 1
1.1 Background 1
1.2 Aim and approach 1
1.3 Study phases 2
2. Phase 1 3
2.1 SRO operation summary 3
2.2 Study area and river reach sensitivity 3
2.3 Data review 5
2.4 Aquator model review 6
2.5 Hydraulic model review 15
2.6 Gauged flow analysis 16
3. Phase 2 18
3.1 Overview 18
3.2 Surveys 18
3.3 Modelling scenarios 21
4. Phase 3 25
4.1 Overview 25
4.2 Aquator disaggregation 25
4.4 1D Hydraulic modelling 28
5. Phase 4 34
5.1 Overview 34
5.2 Aquator modelling 34
5.3 HOF Analysis for Drought Year 1976 45
5.4 1D Hydraulic modelling 46
5.5 2D modelling 54
6. Summary and Next Steps 55
6.1 Summary 55
6.2 Next Steps 56
Appendix A Figures 57
Appendix B 1D model results 91
Appendix C Inflows for initial 1D model runs 110
Appendix D 2D Modelling Report 114

Figures

Figure 2-1 Location of SROs within the study river system, and maximum ‘water take’ volumes 4
Figure 2-2 Trent at North Muskham – Gauged and Simulated Flows....................10
Figure 2-3 Trent at Shardlow – Gauged and Simulated Flows....................10
Figure 2-4 River reach schematic - Tame / Upper Trent (note, figure not to scale) 12
Figure 2-5 River reach schematic – Mid / Lower Trent (note, figure not to scale) 13
Figure 2-6 Gauged FDCs....................17
Figure 3-1 AECOM’s ARCboat 18
Figure 3-2 Survey extent for River Tame at Lea Marston Lakes 19
Figure 3-3 Survey extent for River Tame at Tamworth 20
Figure 3-4 Survey extent for River Trent at Winshill....................20
Figure 3-5 Percentage of time in a month where Minworth SRO is used to support STT....................23
Figure 4-1 Disaggregation process at Hopwas Bridge, Tame and Trent confluence and Drakelow 26
Figure 4-2 Disaggregation process at Drakelow, Dove and Shardlow....................27
Figure 5-1 North Muskham FDCs....................36
Figure 5-2 Drakelow FDCs....................36
Figure 5-3 North Muskham Seasonal Duration Analysis 38
Figure 5-4 Drakelow Seasonal Duration Analysis....................38
Figure 5-5 Colwick FDCs 40
Figure 5-6 Shardlow FDCs....................40
Figure 5-7 Tame Downstream of Anker FDCs 41
Figure 5-8 Trent downstream of Soar FDCs....................41
Figure 5-9 Trent Downstream of Mease FDCs 42
Figure 5-10 Trent Downstream of Dove FDCs....................42
Figure 5-11 North Muskham Hydrograph for Dry Year 1976....................43
Figure 5-12 Drakelow Hydrograph for Dry Year 1976 43
Figure 5-13 Colwick Hydrograph for Dry Year 1976....................44
Figure 5-14 Shardlow Hydrograph for Dry Year 1976 44
Figure 5-15: North Muskham Seasonal Duration Analysis for Drought Year 1976....................45
Figure 5-16: Drakelow Seasonal Duration Analysis for Drought Year 1976....................46

Tables

Table 2-1 Summary of Tame and Trent locations represented in the Aquator model....................7
Table 2-2 Comparison of gauged and modelled flow statistics, 1999 – 2018 (Ml/d)....................9
Table 2-3 Summary of Tame and Trent locations which could be calculated from Aquator model output 14
Table 2-4 Gauged Flow Statistics at Key Gauging Stations....................17
Table 3-1 GUC SRO operation profiles to be modelled in Aquator....................22
Table 3-2 Hydraulic modelling scenarios to be simulated....................24
Table 4-1 Comparison of Gate 1 and Gate 2 Hydraulic Model Convergence for the Q95 Event....................29
Table 4-2 1D Hydraulic model updates undertaken at Gate 2....................31
Table 5-1 North Muskham and Drakelow – percentage Exceedance flow at which the HOF would be triggered for different SRO scenarios 37
Table 5-2 North Muskham and Drakelow – Number of Days Flow is Equal to or Less than HOF 37
Table 5-3 North Muskham Seasonal Duration Analysis....................39
Table 5-4 Drakelow Seasonal Duration Analysis....................39
Table 5-5: North Muskham and Drakelow – Number of Days Flow is Equal to or Less than HOF in drought year 1976....................45
Table 5-6 Calculated Discharge Volume for Minworth WwTW (values all in Ml/d)....................47
Table 5-7 Tame - hydrological inflows in baseline hydraulic model (m^3/s) 47
Table 5-8 Trent 2 - hydrological inflows in baseline hydraulic model (m^3/s) 48
Table 5-9 Trent 3 - hydrological inflows in baseline hydraulic model (m^3/s) 49
Table 5-10 Trent 4 - hydrological inflows in baseline hydraulic model (m^3/s) 51
Table 5-11 QMed Analysis: SROs impact on stage for QMed flow at Drakelow and Lea Marston Lakes 54

1. Introduction

1.1 Background

1.1.1 Affinity Water, along with Severn Trent Water (STW) and Anglian Water (jointly referred to as the Project Management Board (PMB)) are developing Strategic Resource Options (SRO) through the Regulators Alliance for Progressing Infrastructure development (RAPID) Gate 2 process. Operation of the SROs has the potential to impact on flows in the River Tame and River Trent and therefore hydrological and hydraulic modelling services are required to support assessment of the feasibility of the SROs.

1.1.2 The SROs of relevance are Minworth, Grand Union Canal (GUC), Severn to Thames Transfer (STT) and South Lincolnshire Reservoir (SLR). Operation of these SROs could result in a flow reduction in the Rivers Tame and Trent (hereafter referred to as the “study river system”), either as a result of:

- direct abstraction from the River Trent – as is the case for the SLR SRO, or,
- a reduction of treated discharge flow to the River Tame from Minworth Wastewater Treatment Works (WwTW) – as is the case for the Minworth SRO which supports the STT and GUC SROs.

1.2 Aim and approach

1.2.1 The aim of the Tame and Trent Modelling Study (hereafter referred to as the “modelling study”), is to quantify the potential hydrological and hydraulic changes to the River Tame and River Trent arising from the operation of the SROs, including ‘in combination’ changes when all the relevant SROs are considered together. In order to achieve this aim, both hydrological and hydraulic modelling has been undertaken.

1.2.2 The hydrological and water resources systems modelling has been used to identify how the flow regime of the study river system might change as a result of operating the SROs. This has been undertaken using the Aquator Water Resource System model provided by STW covering the study river system. The use of Aquator allows an assessment of how:

- the daily flow values across the study river system might change at any key locations in the system; and
- operation of the SROs may affect availability of water for other abstractors from the system, particularly linked to flow related licence conditions such as ‘Hands off Flow’(HoF) and identifying suitable thresholds where flow reductions could be limited to prevent impact on other abstractors.

1.2.3 Aquator simulations are useful to define assessments linked to water availability. However, they do not identify how such flow changes would manifest in changes to hydraulic parameters such as water level change, velocity, or wetted area of a river channel, all of which are important factors in assessing potential ecology or habitat linked responses to changes in flow regimes. Hydraulic models are required to achieve this outcome, and hence flow changes predicted by Aquator have then been simulated in hydraulic models to provide estimates of hydraulic parameter changes at key locations. For 1D simulations, the hydraulic models have been adapted from existing models constructed for the Environment Agency in Flood Modeller software.

1.2.4 To support ongoing SRO scheme design and statutory environmental assessment reporting at RAPID[1] Gate 2 for each of the SROs, the modelling study includes an assessment of:

- hydraulic and hydrological change within the study river system to support parallel environmental and eco-hydrological assessment studies for connected habitats, and,
- the potential effects of operating the SROs on existing abstraction licences (with respect to hydrologically linked licence conditions).

1.3 Study phases

1.3.1 Prior to using the Aquator model and the Flood Modeller hydraulic models, a review of their adequacy for the study purpose was required (Phase 1). Where additional data or model improvements were required, this has been identified (Phase 2) and subsequently undertaken (Phase 3 and 4), to develop models that are suitable to simulate the required outputs (Phase 4).

1.3.2 This Project Report records the outcomes of the four phases of the modelling study:

- Phase 1 – review of data and models (November 2021 to January 2022)
- Phase 2 – collation of additional survey data for model improvements, and identification of model scenarios to run. (February 2022 to May 2022)
- Phase 3 – model updates and improvements, initial simulations to support wider Gate 2 assessments, and recommendations for further model improvements to be undertaken during Phase 4. (January 2022 to April 2022)
- Phase 4 – implementation of further model improvements, simulation of the SRO operation scenarios using the updated models, output interpretation, abstraction impact assessment and final reporting. (April 2022 to July 2022)

[1] RAPID – Regulators' Alliance for Progressing Infrastructure Development

2. Phase 1

2.1 SRO operation summary

2.1.1 At the start of the modelling study, a simplified representation of the SRO operation and usage was agreed with the PMB to support a review of model adequacy in simulating the SRO operation. This consisted of a maximum daily 'water take' value for each of the relevant SROs, initially discounting any seasonal or wider supply/demand balance driven variability.

2.1.2 The maximum daily 'water take' volumes associated with each SRO and the approximate locations are shown in Figure 2-1.

2.1.3 During Phase 2, the operation assumptions of the SROs were reviewed and refined based on reasonable estimates of scheme utilisation to support model scenario development. This is described in Section 3.3.

2.2 Study area and river reach sensitivity

2.2.1 The modelling study area reflects the extent and coverage of available hydraulic and Aquator models. The upstream boundary for hydraulic modelling uses the nearest flow gauge upstream of Minworth WwTW discharge on the River Tame (Water Orton). This gauge was selected as it was important to represent modelled flows for a section upstream before the river becomes influence by Minworth discharges. The tidal limit on the River Trent at Cromwell Weir was selected as the downstream extent. Whilst a hydraulic model could be used for the tidal sections of river downstream of Cromwell Weir, the focus of the Gate 2 study was on the fluvial extent of the river system, as any hydraulic impact of the SROs operation in the tidal reaches would be minimal compared to the daily tidal level influence downstream of Cromwell Weir. This is demonstrated through observation of the diurnal change in water level recorded a Torksey level gauge due to tidal influences which typically gives a range of 1 m. This would be significantly in excess of a level change induced by changes in flow as a result of operating SROs.

2.2.2 Sensitivity of the modelled reaches was then defined. Sensitive locations within the study river system were identified using baseline environmental information collated as part of RAPID Gate 1 and through liaison with technical leads undertaking the parallel Gate 2 Tame, Trent and Humber environmental assessment study[2]. The purpose was to ensure that data collection and model refinement was focused on the locations where it is most critical to have modelled outputs.

2.2.3 The locations within the modelled extent were identified through development of a GIS which included the following information:

- Statutory and non-statutory designated sites with direct or indirect hydrological connectivity to the study river systems.
- Weir systems, including weir pools.
- Areas of high sedimentation risk identified at Gate 1.
- Areas of key habitat sensitivity including the connecting River Mease Special Area of Conservation (SAC) and River Blythe Site of Special Scientific Interest (SSSI).
- Key tributary inputs.
- Abstractions and discharges greater than 10Ml/d.

[2] Environmental Assessment for the Trent Strategic Resource Options (SRO): Minworth SRO and South Lincolnshire Reservoir (SLR) SRO: Results and Recommendations. Report to Affinity Water, Anglian Water Services Ltd and Severn Trent Water Ltd. REP-003_Summary Report. AECOM, July 2022

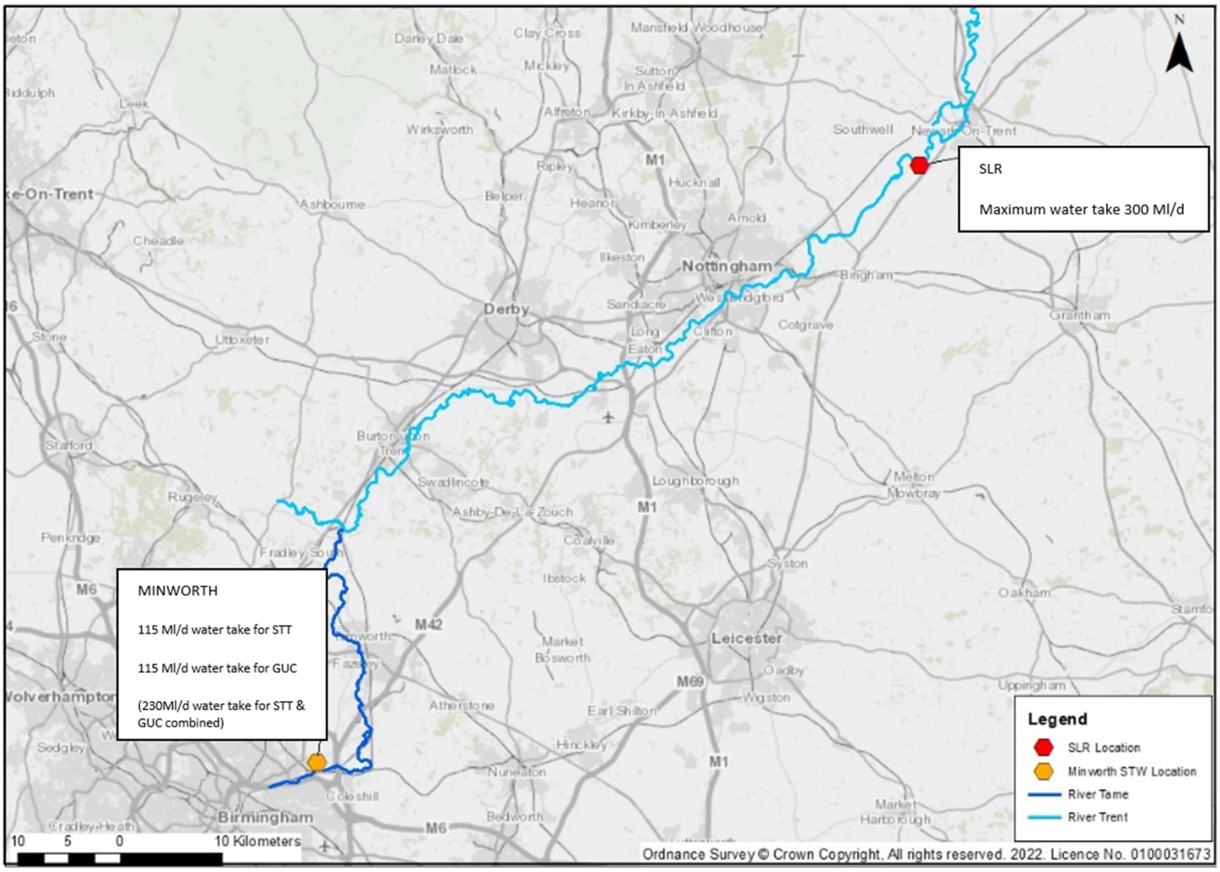


Figure 2-1 Location of SROs within the study river system, and maximum 'water take' volumes

2.3 Data review

Data and model availability

2.3.1 The following existing data sources and models were collated for the modelling study. All data was reviewed for adequacy and usage specific to the requirements of the Gate 2 modelling study.

- Gauged flow and water level data at key gauging stations located on the study river systems received from the Environment Agency.
- Stage-discharge relationship review reports for key gauging stations on the study river systems.
- Spot flow gauging at locations on the study river systems (including for the River Mease SAC) received from the Environment Agency.
- Lower Trent and Erewash, and the Tame, Anker and Mease Abstraction Licence Strategies (ALS).
- Abstraction licences relevant to the study river systems, including licenced quantities.
- Discharge permit information, including permitted discharge volumes.
- Details of abstraction licences within the study river system with a Hands off Flow (HoF) condition.
- Hydraulic Models of the River Tame and River Trent downstream of the River Tame confluence provided in Flood Modeller software.
- STW's Aquator model covering the study river systems, including historical and stochastic data sets used for the draft Water Resources Management Plan 2024 (WRMP24)[3].
- Report on the details of GR6J rainfall-runoff modelling undertaken to produce catchment inflow series for the Severn, Trent, and Wye basins[4] and a further report for extended stochastic inflow sequences and climate change perturbed sequences of flows[5].
- Technical note (Effluent discharge calculation methods) providing a brief outline of how profiles of effluent discharge flows were produced for the Aquator Model.
- Report on the details of Aquator water resources modelling undertaken for STW's WRMP24 deployable output and climate change impact assessment.
- Flow Naturalisation workbook for the study river systems containing data series and calculations used to create naturalised flows at key locations on the rivers Tame and Trent.
- Aquator modelling technical note for Minworth produced by Mott MacDonald.

Data adequacy

2.3.2 The available gauging flow data was reviewed and used to generate flow duration curves (FDC) at key gauging stations as a means to support review of hydraulic and hydrological modelling accuracy.

2.3.3 Discussion with the Environment Agency identified that the accuracy and reliability of the gauges at Hopwas Bridge on the River Tame, and Drakelow on the River Trent for low flows meant that they were not suitable for model comparison purposes; this was largely due to weed growth issues affecting the rating at low flows. These gauges have therefore not been used in the analysis, with information on flows at these locations provided by simulations of the Aquator model.

2.3.4 Abstraction licence data was limited to aggregation of actual licenced volumes as provided in the naturalisation workbook (and represented in the Aquator model), maximum licenced abstraction

[3] Database: dWRMP24 STW v1.1.43 (reduced).axvdbs
[4] Mott MacDonald (2021) Rainfall-runoff modelling main stage, Mott MacDonald.
[5] Mott MacDonald (2021) Rainfall-runoff modelling - Stochastics and climate change simulations.

volumes (daily and annual), and additional information on which licences had HoF conditions imposed. Actual recent abstraction data for each and every abstraction licence was not available.

2.3.5 The ALS, and information provided by the Environment Agency licence conditions were used to identify the assessment points used to set HoF conditions for linked abstraction licences in the study river systems as follows:

- Where conditioned, licenced abstractions from the Tame (downstream of the Blythe confluence) mostly refer to a HoF condition measured at Drakelow gauging station on the River Trent, using 1,380 Ml/d as the HoF value.
- Where conditioned, licenced abstractions from the Trent mostly refer to a HoF condition of 2,650 Ml/d as measured at the North Muskham gauging station on the River Trent.

2.3.6 These key locations are listed in Table 2-2 below and are the key sub-catchments within Aquator for which the catchment inflows have been calibrated and entered into the model.

2.3.7 These values have been used to inform the abstraction impact assessment as part of Phase 4 of the modelling study (see Section 5).

2.4 Aquator model review

2.4.1 A copy of STW's latest Aquator model database, which simulates the company's Strategic Grid Water Resource Zone (WRZ), was provided for review. The review focussed on two key aspects of the model relevant to the aim of the study:

- **Model Structure**: how is the Tame and Trent River system represented in Aquator, which locations are currently simulated, and what degree of aggregation is adopted relating to tributary inflows and artificial influence components relevant to the Tame and Trent study area?
- **Model Validation**: how well do simulated flow statistics match those from observed flow records, at key gauging station locations currently simulated in the Aquator model?

2.4.2 These key aspects are considered separately in the following two sections.

Model structure

2.4.3 A review of the Aquator schematic and component details, with reference to known information about the geographical and hydrological structure of the study river systems, has indicated the following:

- STW's Aquator model covers the Tame and Trent River from Minworth WwTW to North Muskham Gauging Station (eight reaches).
- Some gauging stations are well represented – e.g., Yoxall, Drakelow, Shardlow, Colwick and North Muskham (as well as Marston, Church Wilne and Kegworth on the key modelled tributaries of Dove, Derwent, and Soar respectively).
- Other gauging stations (and ungauged locations) are not modelled – e.g. Water Orton, Lea Marston Lakes.
- There are several locations downstream of confluences which are ostensibly represented by Aquator components, but due to the aggregation of catchment inflows and artificial influences, flows are likely to be underestimated (e.g., it is not clear whether simulated flow of the Trent downstream of the Tame confluence includes discharges from Tamworth WwTW and Alrewas and Barton quarries in the vicinity of the confluence).
- Catchment inflows are modelled as naturalised inflow data series (daily historic or stochastic flow values) amalgamated by key reaches, i.e. these data series exclude artificial influences.

- Abstractions and discharges are separate components but are amalgamated by reach/sub-catchment, based on a subdivision of the Tame and Trent into just eight reaches (only one of which is on the Tame).
- The exception is Minworth WwTW which is modelled as a separate discharge component in Aquator.
- Discharges are modelled in Aquator as fixed monthly profiles; non-public water supply abstractions are modelled as either daily or monthly profiles.
- Many tributary inflows are amalgamated in downstream catchments e.g. the rivers Anker, Mease, Erewash, Leen and Fairham Brook are not represented separately.
- Interactions with canals are not explicitly represented (e.g. Trent and Mersey canal at Alrewas).

2.4.4 Table 2-1 provides a list of locations on the rivers Tame and Trent, and corresponding Aquator component references, which are currently represented in the Severn Trent Aquator model. However, it should be noted that some locations at confluences may not include all relevant artificial influences, as mentioned in the bullet points above and in the 'Notes' column of the table. Also the catchment inflows have been amalgamated at a limited number of locations and would need factoring by relative catchment area to allocate adjustments to the confluence locations shown.

Table 2-1 Summary of Tame and Trent locations represented in the Aquator model

Location	National Grid Reference	Aquator component variable output	Aquator component name	Notes
Tame at Hopwas GS	[redacted]	RR219.Outflow.Net	Tame d/s Bourne	
Trent d/s of Tame confluence		RR164.Outflow.Net	Trent d/s Tame	*Likely to be an under-estimate as discharges between the Yoxall and Hopwas gauges, and the confluence, do not appear to be included (e.g. Tamworth WWTW).* *Adjust catchment inflows to improve flow estimates.*
Trent at Drakelow GS		RR208.Outflow.Net	Trent d/s Drakelow	
Trent d/s of Dove confluence		RR157.Outflow.Net	Trent d/s Dove	*Likely to be an under-estimate as discharges between Drakelow GS and the Dove confluence are excluded (e.g. Stanton and Claymills WWTW).* *Adjust catchment inflows to improve flow estimates.*
Trent at Shardlow GS		GS23.Outflow.Net	Shardlow	
Trent d/s of Derwent confluence		RR148.Outflow.Net	Trent d/s Derwent	*No significant abstractions/discharges identified between Shardlow GS and Derwent confluence.* *Adjust catchment inflows to improve flow estimates.*
Trent d/s of Soar confluence		RR160.Outflow.Net	Trent d/s Soar	*No significant abstractions/discharges identified between*

Grid references for continued monitoring locations redacted

Location	National Grid Reference	Aquator component variable output	Aquator component name	Notes
				Derwent confluence and Soar confluence. *Adjust catchment inflows to improve flow estimates.*
Trent at Colwick GS	[redacted]	GS26.Outflow.Net	Colwick	
Trent at North Muskham GS	[redacted]	GS30.Outflow.Net	N. Muskham	

2.4.5 Where individual abstractions and discharges are amalgamated in specific components within Aquator, it has not been possible within the scope and timeframe of the study to separate each and every influence. There does not appear to be a one-to-one relationship between the artificial influence profiles in Aquator, and those in the flow naturalisation spreadsheet, indicating that the flows have been grouped differently in each case. It may be possible to relate grid references of artificial influence locations to the locations of gauging stations and confluences, to identify the groupings and hence to disaggregate the artificial influence profiles to an increased number of reaches.

Model validation

2.4.6 A preliminary model validation exercise has been undertaken, based on simulated/gauged data at nine key locations which from comparison to the model set up, are well represented in the Aquator model structure. Gauged data was taken from the flow naturalisation spreadsheet, whilst simulated data was taken from an Aquator model run at fixed demand (believed to be 2016/17 dry year annual average demands) using the historic inflow sequences held within the model database.

2.4.7 The validation exercise covered the period 1999-2018 as this is the period of data used for the flow naturalisation and rainfall-runoff model calibration (with some exceptions: see notes on Yoxall and Hopwas Bridge below).

2.4.8 Comparison of the gauged and simulated daily flows indicated the following:

- Most locations show good/fair agreement in key mid-range and low flow statistics (generally <10% difference, with some exceptions).
- At the key downstream gauging station (North Muskham), the simulated Q_{95} flow statistic is within 4% of the gauged data Q_{95}, whilst the Hands off Flow (HoF) value of 2650 Ml/d is approximately equivalent to the Q_{96} flow statistic of the simulated dataset.
- The difference in the Q_{99} flow statistic is a little higher, at around 10%, at North Muskham; this may be partly because the upstream discharges, which contribute a relatively higher proportion of the extreme low flows, are only represented as monthly profiles so any daily variation which may be significant to daily low flow values is not reflected in the data.
- Additionally, the HoF value at North Muskham may be limiting upstream abstractions in practice at extreme low flows, but the HoF licence conditions on non-PWS abstractions are not explicitly modelled in Aquator and therefore these abstractions could be over-estimated at these low flows (with the Q_{99} being below the HoF).
- There are some anomalies, with differences of more than 10% in some key flow statistics at Hopwas Bridge, Yoxall and Drakelow, however these are likely to be related to issues with the gauged data as follows:
  - **Yoxall** – the rainfall-runoff report notes that 2018 was excluded from the calibration period due to erroneous data, however 2018 includes a notable low flow period and hence the 20% difference in the Q99 flow statistic.
  - **Hopwas Bridge** – the rainfall-runoff report notes that this catchment was combined with Drakelow for calibration due to issues with the gauged record.

– **Drakelow** – the rainfall-runoff report notes that some reprocessing of gauged flows has been necessary due to weed growth issues.

2.4.9 Summary results of the preliminary Aquator model validation are presented in Table 2-2.

Table 2-2 Comparison of gauged and modelled flow statistics, 1999 – 2018 (Ml/d)

	Q_{50}			Q_{95}			Q_{99}		
Location	Gauged	Modelled	Difference	Gauged	Modelled	Difference	Gauged	Modelled	Difference
Tame at Hopwas Bridge	1677.9	1287.7	-23%	1008.2	817.8	-19%	833.0	779.6	-6%
Trent at Yoxall	831.8	816.9	-2%	377.8	401.6	6%	302.9	364.4	20%
Trent at Drakelow	2398.0	2406.1	0%	1166.3	1338.6	15%	939.0	1255.8	34%
Dove at Marston	886.9	884.7	0%	333.1	321.8	-3%	290.1	278.1	-4%
Trent at Shardlow	3364.5	3429.7	2%	1597.1	1595.8	0%	1397.5	1452.5	4%
Derwent at Church Wilne	1126.6	1128.4	0%	416.2	423.9	2%	340.1	358.2	5%
Soar at Kegworth	605.9	597.4	-1%	292.4	298.2	2%	257.1	268.1	4%
Trent at Colwick	5230.3	5497.2	5%	2523.6	2470.0	-2%	2293.6	2220.6	-3%
Trent at North Muskham	5555.1	5811.1	5%	2570.1	2675.5	4%	2194.3	2411.2	10%

2.4.10 Some example hydrographs to illustrate the comparison of gauged and simulated flows over a recent period of low flows (2018) are shown in Figure 2-2 and Figure 2-3. It is observed that there is an apparent time lag of approximately 1 week, between daily simulated and gauged flows; this reflects that the Tame and Trent river system is a long river with significant time of travel between upstream and downstream locations, which is not reflected in the Aquator model.

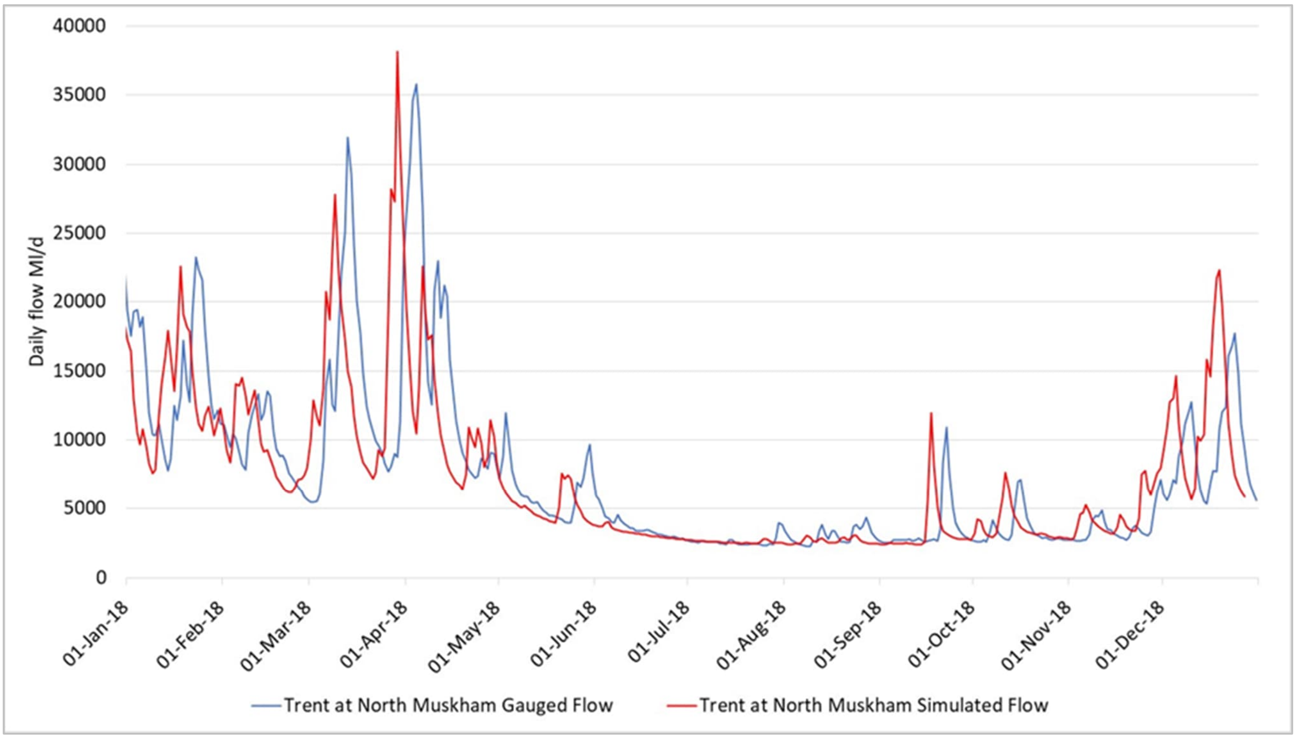


Figure 2-2 Trent at North Muskham – Gauged and Simulated Flows

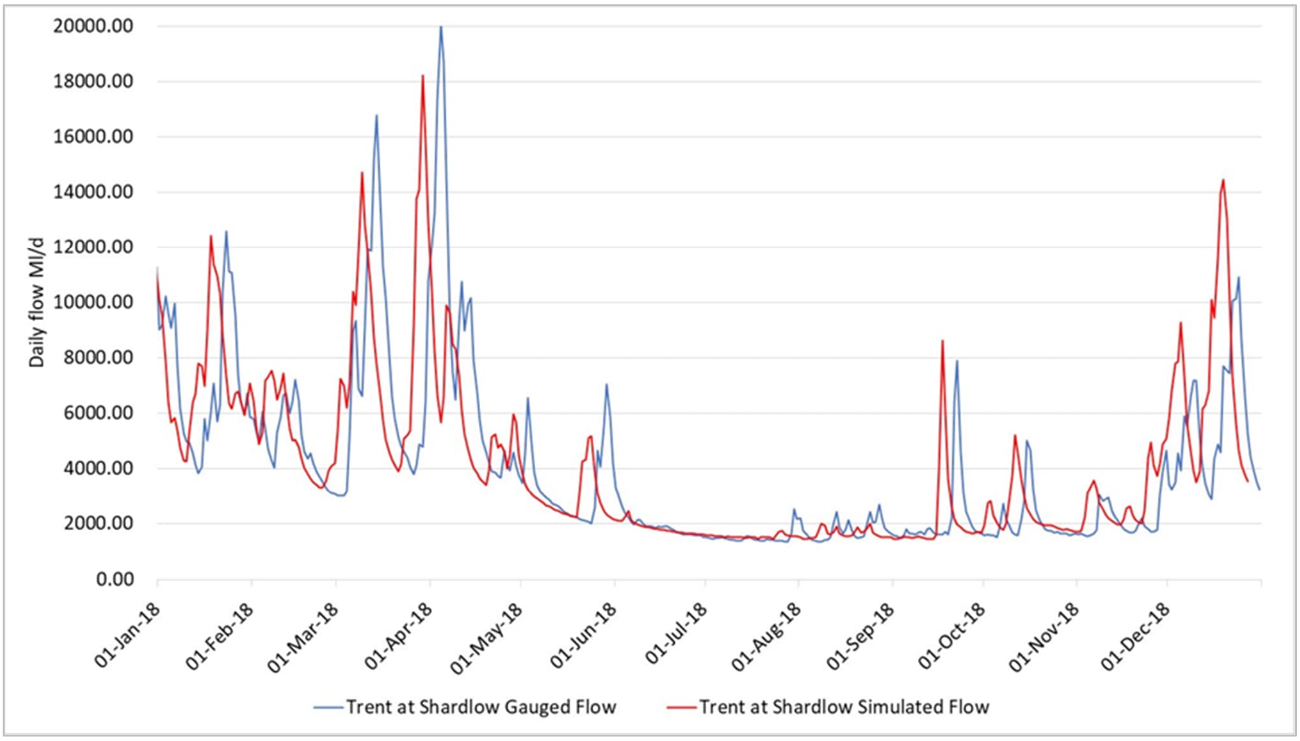


Figure 2-3 Trent at Shardlow – Gauged and Simulated Flows

2.4.11 A review of the model structure and a preliminary model validation exercise has indicated that the Severn Trent Aquator model can produce reasonable daily flow estimates (subject to a small flow lag) for several key gauging station locations without modification to the model. These are key sub-catchment locations where the catchment inflows have been calibrated and entered into the Aquator model (see Table 2-2 for locations).

2.4.12 Modifications and/or significant post-processing of model output would be required to extend this to additional locations which are required for flow impact assessment and hydraulic model input. This is explained in the subsequent sections of this report.

River reaches

2.4.13 There are multiple locations along the study river system at which flows are required for input to detailed hydraulic models, and which are of key ecological importance and therefore required for assessment of flow impacts. However, some of these may be located close together and/or may experience similar flow conditions, if there are no significant abstractions, discharges, or tributary inflows between them. Hence it is not necessary or feasible within the Gate 2 study timeframe to produce flow series for each individual location. The review of key locations enabled the river basins to be sub-divided into a set of distinct reaches for which sufficient data is available to disaggregate the existing Aquator components to a more detailed level than currently but is proportionate to the availability and granularity of existing data to carry out these calculations.

2.4.14 The key locations for which flow data series are required have been identified as follows, with the reach number (upstream location) as shown on the annotated schematics (Figure 2-4 and Figure 2-5):

- Tame at Water Orton gauging station (reach 2),
- Tame at Lea Marston Lakes gauging station (reach 4),
- Tame downstream of the Anker confluence (reach 6),
- Tame at Hopwas Bridge (reach 7),
- Trent downstream of the Mease confluence (reach 9),
- Trent at Drakelow gauging station (reach 10),
- Trent downstream of the Dove confluence (reach 11),
- Trent at Shardlow gauging station (reach 12),
- Trent downstream of the Soar confluence (reach 14),
- Trent at Colwick gauging station (reach 17), and
- Trent at North Muskham gauging station (reach 18).

2.4.15 Figure 2-4 and Figure 2-5 present annotated schematics of the Tame and Upper Trent, and Mid/Lower Trent, respectively. These schematics are not to scale but indicate the relative positions of gauging stations, abstractions and discharges and key confluences relative to proposed reach boundaries. The schematics are not directly from the Aquator model, and therefore do not indicate which components have or have not been modelled separately within Aquator, they are intended as a high-level schematic to assist in the understanding of the river system and to assist in the disaggregation calculations. The schematics show a total of 18 reaches which were initially identified as part of the supporting assessment work for the SROs at Gate 1, however the above 11 locations provide good coverage of the required locations for flow assessment and hydraulic modelling. For schematics extracted directly from the Aquator model, please refer to Figure 5 of Appendix A.

2.4.16 Gauged flow data is available for the gauging station locations listed above, as an alternative to utilising Aquator modelled output and carrying out additional flow calculations where necessary. However, as described previously, for the Hopwas Bridge and Drakelow gauges it is proposed to use the Aquator modelled output in preference at these gauged locations due to low flow gauging issues.

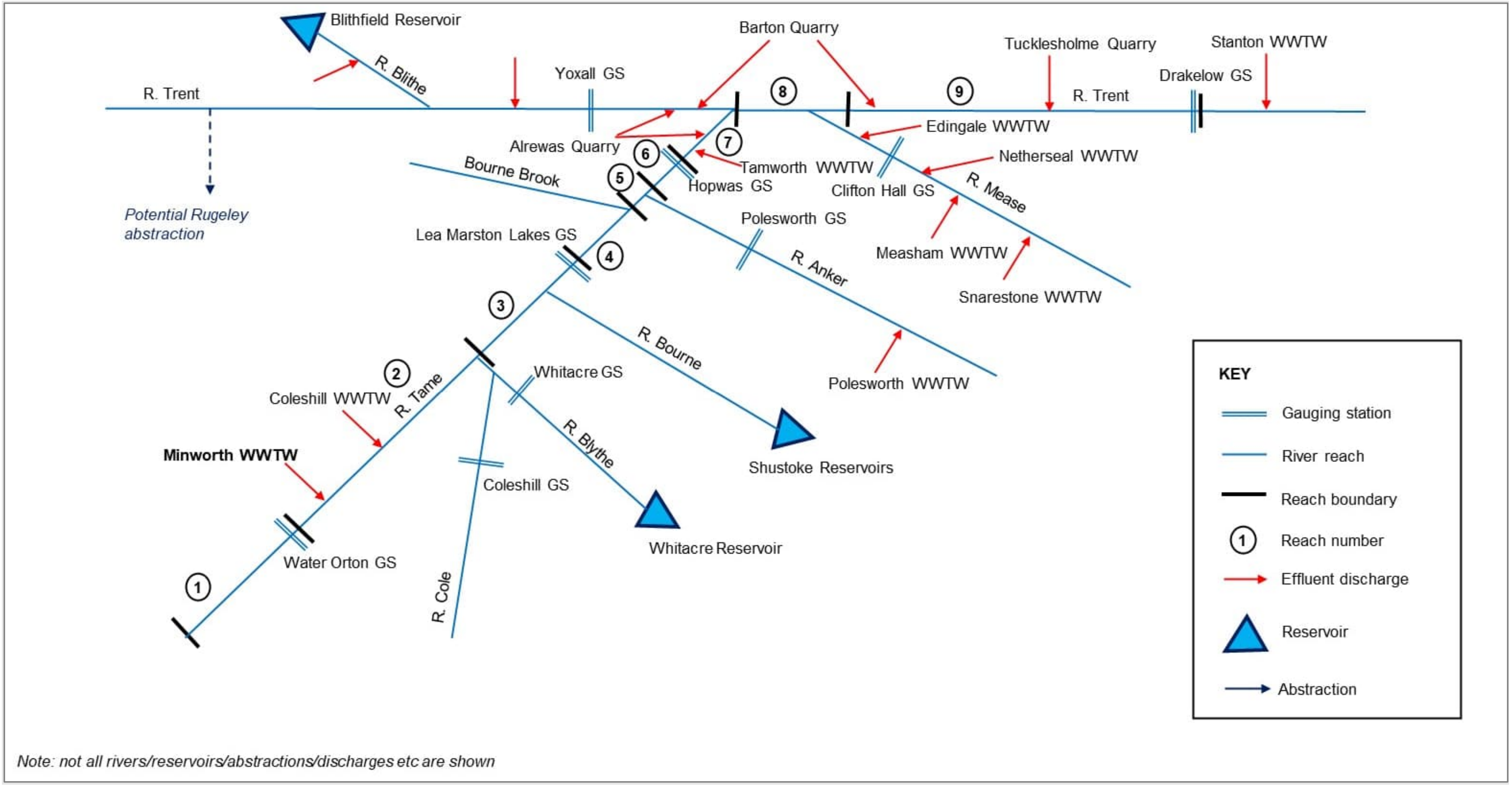


Figure 2-4 River reach schematic - Tame / Upper Trent (note, figure not to scale)

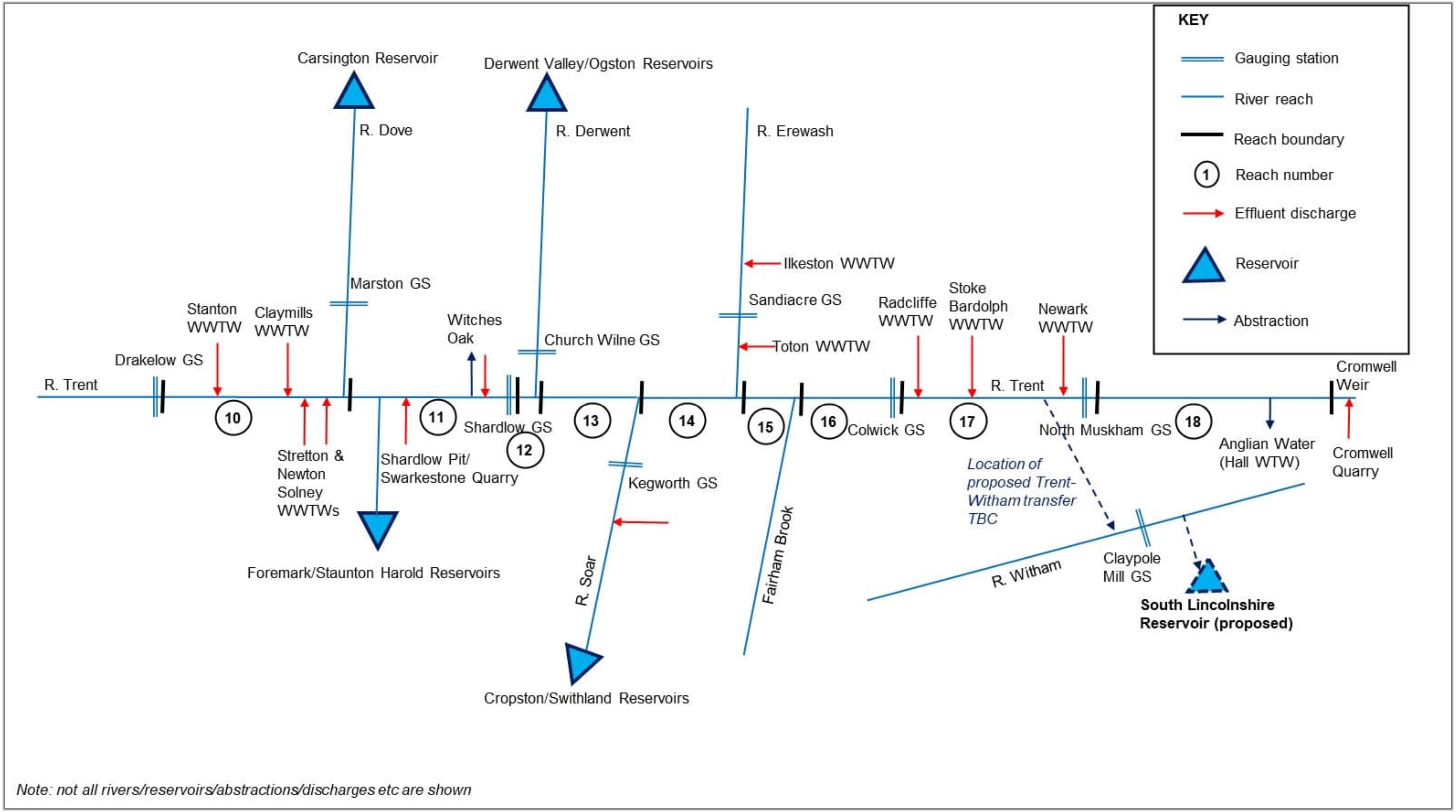


Figure 2-5 River reach schematic – Mid / Lower Trent (note, figure not to scale)

2.4.17 Locations which are currently represented in Aquator are listed in Table 2-1 (with some caveats relating to the accuracy of discharge aggregation at some confluence locations).

2.4.18 Table 2-3 lists additional locations for which flow data could be calculated from existing Aquator simulated locations. This would use individual sub-catchment output data from the rainfall-runoff modelling[6] which provides the hydrological inflows into the Aquator model, alongside and discharge and abstraction profiles from the flow naturalisation spreadsheet. For the purposes of Gate 2, and to allow for inclusion within the timeframe of the study, it was agreed to provide this output by applying post-processing calculations to output from the existing model, rather than attempting to modify for the model for these locations.

2.4.19 Disaggregated time series of catchment inflows and disaggregated daily or monthly profiles for abstractions and discharges, for the relevant tributaries/sub-catchment reaches is required as set out in Table 2-3.

Table 2-3 Summary of Tame and Trent locations which could be calculated from Aquator model output

Location	Overview of model calculation
Tame at Water Orton GS	Separate out the inflows from CM38 (using TA-WAO rainfall-runoff output) and separate out all upstream abstractions/discharges from DG18 using columns from flow naturalisation spreadsheet. These components would be located upstream of the Minworth discharge (DG17).
Tame d/s of Blythe confluence	Separate out the Cole inflows from CM38 (using CO-COL rainfall-runoff output) and separate out any downstream abstractions/discharges from DG18 using columns from flow naturalisation spreadsheet to locate further downstream. These would include any for the Anker at Polesworth, and any for Tame at Lea Marston Lakes excluding Minworth and Coleshill (discharges remining in DG18 will mainly represent Coleshill WWTW).
Tame at Lea Marston Lakes GS (d/s of Bourne confluence)	Separate out the inflows from CM38 (using TA-LEA rainfall-runoff output) and add these in downstream of the Tame/Bourne confluence. Abstractions/discharges for the Tame at Lea Marston Lakes are available from the flow naturalisation spreadsheet (but ensure Minworth & Coleshill excluded as these should remain upstream of the Blythe confluence).
Tame d/s of Anker confluence	Subtract a proportion of the catchment inflows *(by catchment area ratio)* from CM38 to represent the additional inflow between the Anker confluence and the Hopwas Bridge gauge; this inflow could be separated out into an additional inflow component upstream of the existing Hopwas Bridge component.
Trent d/s of Mease confluence	Separate out Mease inflows from CM55 *(not separately modelled in GR6J so would need to apportion using naturalised flows and/or catchment area)* and abstractions/discharges from DG42 using columns from flow naturalisation spreadsheet to create separate components for Mease tributary downstream of Tame/Trent confluence).
Trent d/s of Erewash confluence	Separate out Erewash inflows from CM34 (using ER-SAN rainfall-runoff output) and separate out any abstractions/discharges from DG34 using columns from flow naturalisation spreadsheet to create separate components for Erewash tributary downstream of Soar/Trent confluence). *(Need to check locations of abstractions/discharges on Trent between Soar/Trent confluence and Colwick GS).*
Trent d/s of Leen confluence	Separate out Leen inflows from CM34 (using LE-TRI rainfall-runoff output) and separate out any abstractions/discharges from DG34 using columns from flow naturalisation spreadsheet (in fact both appear to be zero for the Leen) to create separate components for the Leen tributary downstream of Erewash/Trent confluence). *(Need to check locations of abstractions/discharges on Trent between Soar/Trent confluence and Colwick GS).*

2.4.20 The process for disaggregation is described in Section 4.2.

[6] GR6J (Genie Rural, a 6-parameter Journalier) rainfall runoff models were used for the water resources modelling

2.5 Hydraulic model review

1D modelling

2.5.1 The following Flood Modeller hydraulic models were obtained from the Environment Agency:

- River Tame (Water Orton to Tame/Trent confluence),
- River Trent 2 (Meaford to Tame/Trent confluence and Tame/Trent confluence to Drakelow),
- River Trent 3 (Branston to the River Derwent), and
- River Trent 4 (River Derwent to Cromwell).

2.5.2 A review of the hydraulic models was carried out at Phase 1 which identified several limitations and uncertainties in the models for modelling low flow conditions, as the models were originally built for the purpose of strategic flood risk mapping. The outcomes of this review are as follows:

- There is uncertainty related to the use of the hydraulic models developed and calibrated for extreme high flows to model low flows and limitations associated with the accuracy of the results obtained from using these models in low flow conditions.
- Due to the strategic nature of the existing hydraulic models for use in flood estimation, surveyed cross-sections are spaced relatively far apart, particularly along the River Trent (> 200m). This spacing is appropriate for the intended use of the models and is generally in line with the specification set out in the Fluvial Design Guide.
- There are existing “sweetening” flows within the original high-flow hydraulic models to allow additional flow into the modelled reaches in order to prevent model instabilities. Whilst the sweetening flows contained within the hydraulic models were reduced as much as possible as part of initial assessment work completed at Gate 1, these flows are in addition to the catchment flows calculated from linear regression and are likely to have a significant influence on overall modelled flows, particularly for the Q95 and Q99 conditions.
- There are limitations with the consistency of wetted perimeter extent in all hydraulic models as the surveyed cross-section data is represented as 1D only with some cross-sections extending far into the floodplain and others more limited in extent. This channel representation is appropriate for the original intended use of the models. However, in low flow events, there is a potential for the results to be skewed where flow enters secondary side channels before it would spill over banks due to the way modelling software delays with more than one ‘channel’ in a cross section.
- The 4 No. hydraulic models are poorly geo-referenced, particularly along the River Trent, which may impact the potential to present the outputs of the wetted perimeter assessment spatially.

2.5.3 Following the review of the River Tame and 3 No. River Trent hydraulic models at Phase 1, the following recommendations were proposed to be undertaken at Phase 3 to improve confidence in modelled results for low-flow conditions:

- In order to assess the potential impacts of flow changes on wetted perimeter, refinements to the 1D cross-sections of all four hydraulic models should be carried out by trimming the 1D cross-sections appropriately.
- An exercise should be undertaken to improve model stability by trimming hydraulic model extents not within the Area of Interest (AOI) for this Study and removing any reservoir / floodplain / spill units which are dry in low flow conditions.
- As additional surveyed data was not available in the timescale of the project, interpolate units should be added to the hydraulic models between river sections to help overcome stability issues.
- On improving model stability, further iterations of the hydraulic models should be simulated to reduce the existing sweetening flows as much as possible.
- The hydraulic models should be calibrated to reliable gauge data and flows generated from the Aquator modelling to improve confidence in the modelled flows in low flow conditions.

- The hydraulic models should be geo-referenced, particularly along the River Trent, to improve the outputs from the wetted perimeter assessment.
- Sensitivity testing should be carried out following completion of model calibration in order to understand how sensitive the model results are to change and to determine the residual uncertainty of the model results.

2.5.4 These recommendations are further discussed in Section 4.3 which outlines the subsequent model updates undertaken during Phase 3.

2D modelling

2.5.5 The 1D model approach is considered appropriate for the purposes of environmental assessment at Gate 2 for the majority of locations, as it provides reasonable estimates of relative wetted perimeter and water level change as a result of operating the SROs. However, it was identified with the environmental assessment team that fish passage assessment at some weir locations within the study river systems would benefit from understanding how velocities would vary across channel cross-sections as a result of flow changes. Therefore, 2D in-stream modelling would be helpful in these locations.

2.5.6 Given the need to collate bathymetric survey to support 2D model build, it was not possible within the Gate 2 timeframes to undertake survey at all weir locations within the study river system. Initial model effort was focused on the weirs nearest the source of change at Minworth. It was therefore agreed with the Environment Agency and the PMB that a 2D model build at three identified locations of Lea Marston Lakes (River Tame), Tamworth (River Tame) and Winshill (River Trent) would be undertaken with Phase 2 data collection of bathymetric survey required to enable the structures to be modelled in detail. The three identified locations requiring survey are described in Section 3.2. Details of the 2D modelling approach and results are documented in a separate 2D Modelling Report (Appendix D).

2.6 Gauged flow analysis

2.6.1 Prior to the wider use of the Aquator model, an initial analysis was undertaken using the gauged flow record for gauging stations with a reliable rating at low flows. The aim of this analysis was to:

- provide context to the parallel environmental assessment studies on the maximum potential impact in flow availability within the river system, and,
- support initial calibration of the hydraulic models.

2.6.2 A gauged flow analysis was performed for the following gauging stations:

- Tame at Water Orton,
- Tame at Lea Marston Lake,
- Trent at Colwick,
- Trent at North Muskham, and,
- Trent at Shardlow.

2.6.3 Using gauged flow records from a range of time periods dating as far back as 1955, FDCs have been produced for each station. The FDC for each station is presented in Figure 2-6. The key flow statistics for each location are presented in Table 2-4.

2.6.4 Prior to the completion of scenario runs with Aquator, the gauged FDCs were used to support hydraulic model calibration. They were also used to consider the impact of the initial maximum flow reductions for each SRO applied to provide early indication to the environmental assessment project of the scale of potential flow impacts.

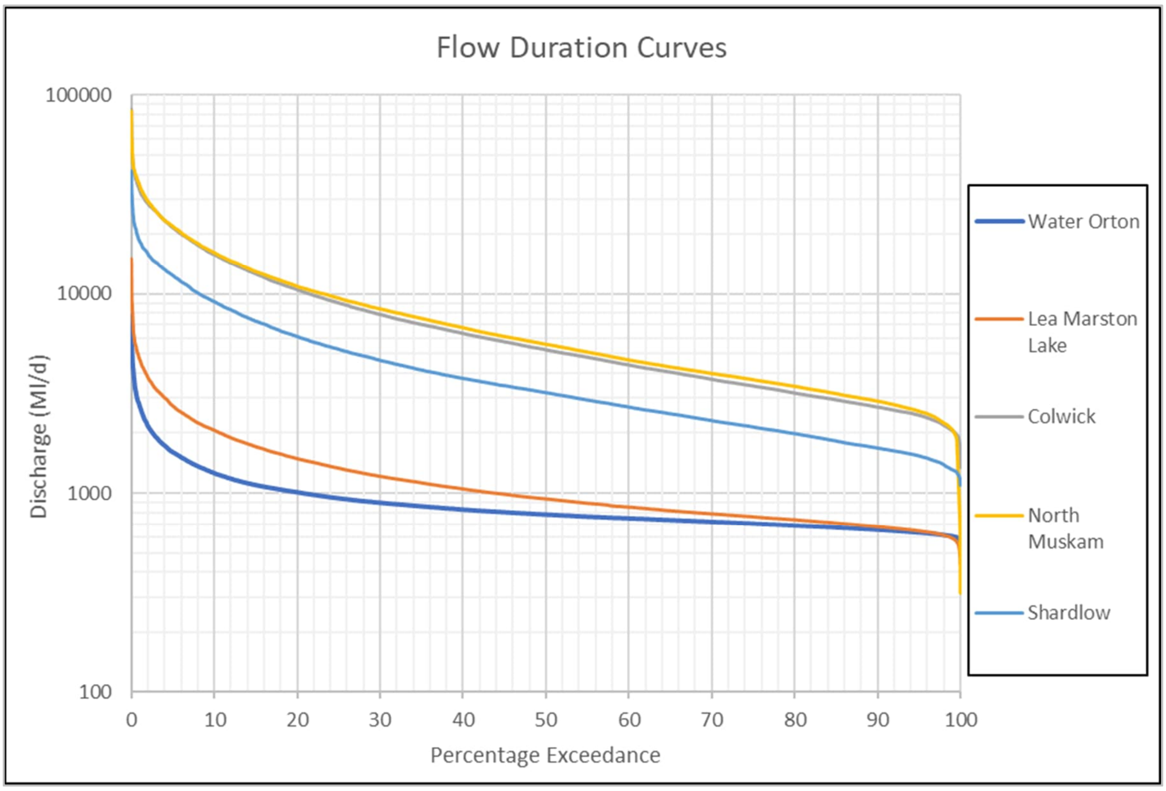


Figure 2-6 Gauged FDCs

Table 2-4 Gauged Flow Statistics at Key Gauging Stations

Location	Tame at Water Orton		Tame at Lea Marston Lake		Trent at Colwick		Trent at North Muskham		Trent at Shardlow	
Period of Record	*01/10/1955 to 31/08/1982 & 02/02/1993 to 08/02/2022*		*01/11/1981 to 08/02/2022*		*01/10/1958 to 05/01/1971 & 01/09/1976 to 24/01/2022*		*01/10/1968 to 07/12/2021*		*01/08/1991 to 16/12/2021*	
Flow	m^3/s	Ml/d	m^3/s	Ml/d	m^3/s	Ml/d	m^3/s	Ml/d	m^3/s	Ml/d
Q10	9.37	809.7	23.9	2065	182.83	15724.8	187.05	16161.2	105	9072
Q50	3.82	330	10.8	933.1	60.62	5235.8	64.66	5586.8	36.9	3188.2
Q75	2.92	252.3	8.79	759.5	39.94	3447.4	42.94	3710.1	24.8	2142.7
Q95	2.11	182.3	7.46	645	28.5	2462.4	29.86	2579.7	17.8	1537.9
Q99	1.8	155.5	6.85	592	23.94	2065	24.22	2092.3	15.1	1304.6

3. Phase 2

3.1 Overview

3.1.1 Phase 2 delivered additional survey data and defined the scenarios required to adequately represent the range of operating scenarios for the SROs. Additional survey data was collected for the additional 2D modelling exercise which is documented in the 2D Modelling Report (Appendix D).

3.2 Surveys

3.2.1 The focus for collection of additional survey data for the study was to support targeted 2D hydraulic modelling for the three weir locations (as described in section 2.5.6). To construct 2D hydraulic models, detailed bathymetric survey of the sections to be modelled is required.

3.2.2 The bathymetric data collection was undertaken using a Cadden BALI Single Beam Echo Sounder (SBES) or equivalent. Positioning is achieved using the BALI's internal Trimble DGNSS receiver using corrections from the Trimble VRS NOW RTK Service.

3.2.3 The GNSS receiver with the associated antenna is mounted on the ARCboat above the echo sounder transducer. Data from the vessel is telemetered to the shore-based operator using the vehicle's data telemetry system which employs a conventional wireless networking architecture (WLAN).

3.2.4 The depth and position data from the echo sounder and GNSS receiver is output in real-time to a laptop PC. This provides real-time navigational information to the operator on the shoreline to enable the vehicle to be navigated along the pre-determined survey lines and will also provide a display of the bathymetric data being collected. During acquisition of the data, the vehicle's track is monitored and displayed to help ensure that a full and even coverage of the area is achieved.

3.2.5 The survey was carried out using AECOM's ARCboat (Figure 3-1). The boat is powered by twin DC electric motors driving shrouded propellers with twin rudders to provide very high manoeuvrability.

Figure 3-1 AECOM's ARCboat

3.2.7 The three locations are summarised below and shown in Figure 3-2 to Figure 3-4

- River Tame at Lea Marston Lakes – Upstream Grid Reference: [redacted] Downstream Grid Reference: [redacted]Including five weir structures:
  a. Lea Marston Weir,
  b. Coton Weir W,
  c. Coton Weir E,
  d. A4097 Weir, and
  e. Nether Whitacre Weir.
- River Tame at Tamworth Upstream Grid Reference: [redacted] Downstream Grid Reference: [redacted] / [redacted]. Including two weir structures:
  a. Broad Meadow LNR Upstream; and
  b. Broad Meadow LNR Downstream.
- River Trent at Winshill – Upstream Grid Reference:[redacted] Downstream Grid Reference: [redacted]. Including two weir structures:
  a. Meadow Weir, and
  b. Newton Weir.

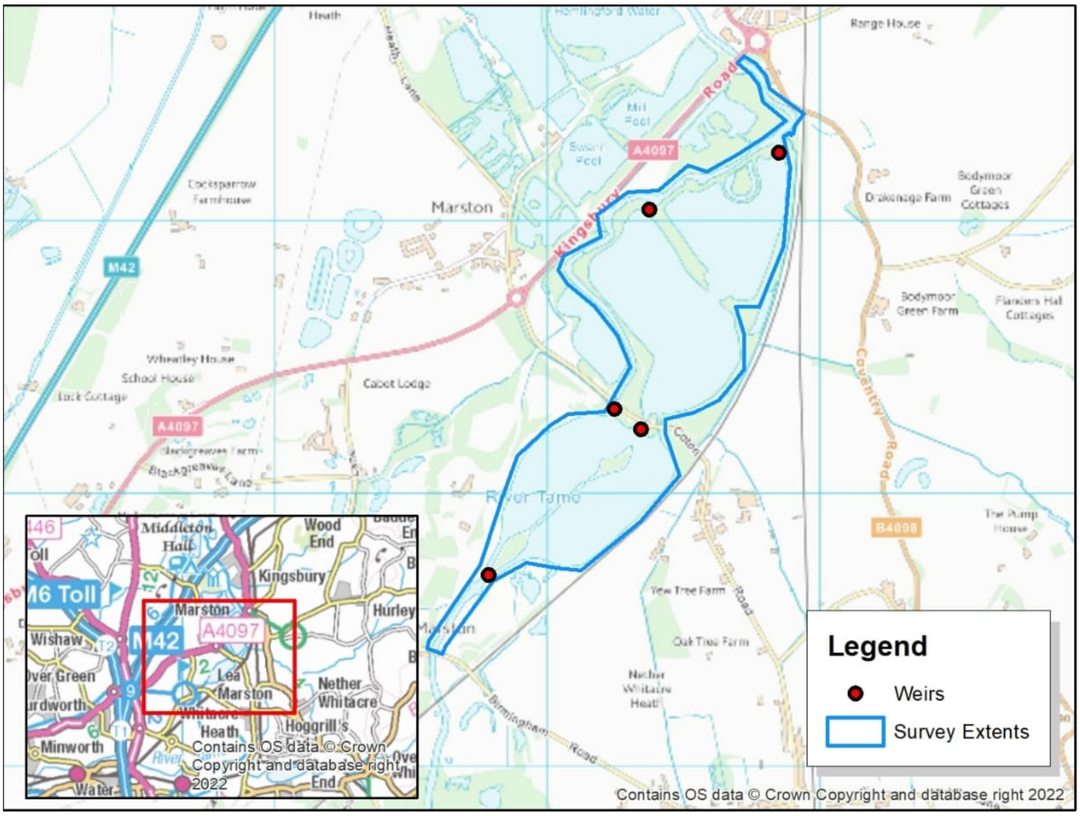


Figure 3-2 Survey extent for River Tame at Lea Marston Lakes

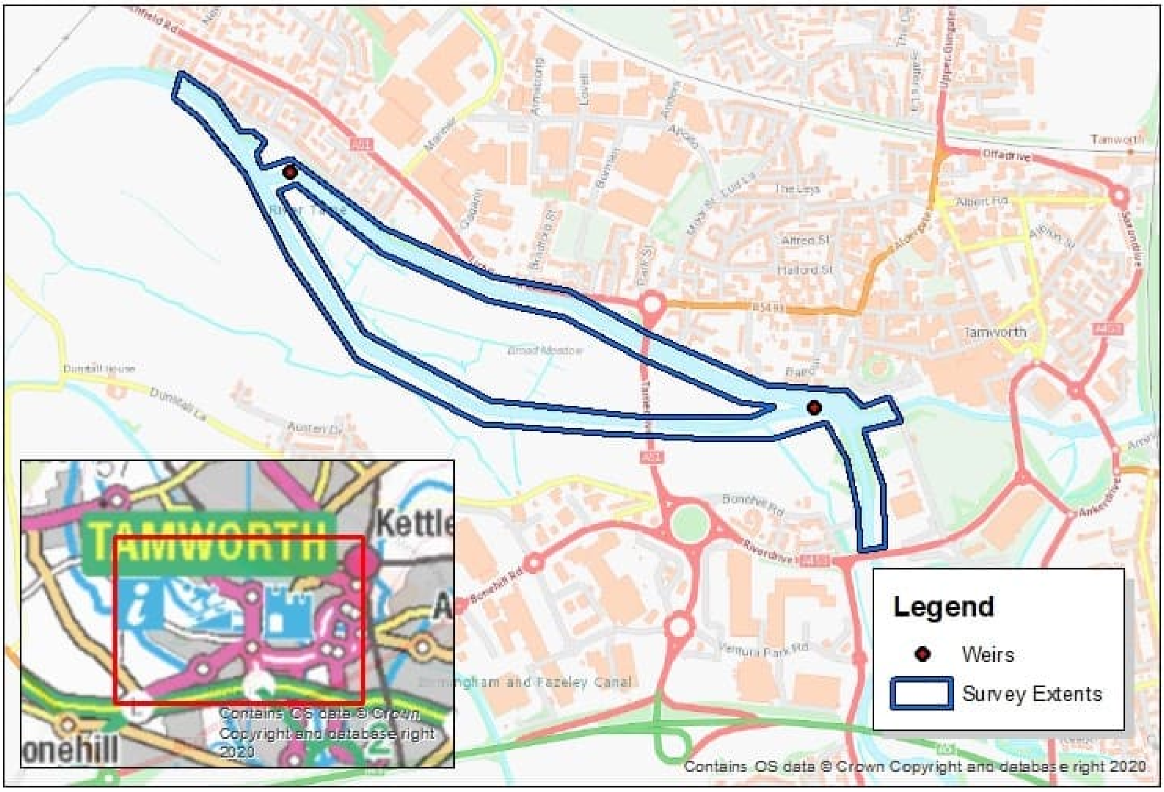


Figure 3-3 Survey extent for River Tame at Tamworth

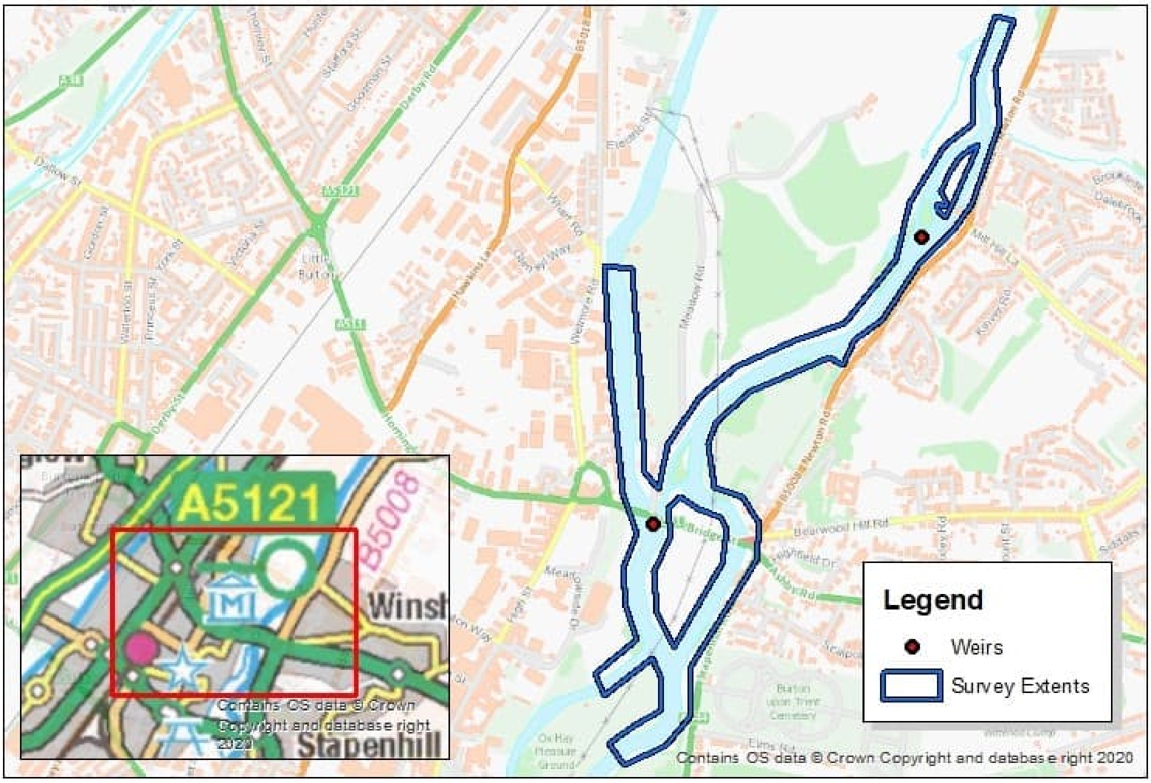


Figure 3-4 Survey extent for River Trent at Winshill

3.3 Modelling scenarios

SRO operation refinement

3.3.1 Prior to confirming modelling scenarios, it was important to define how the various SROs would operate in relation to available flow in the study river system. In particular, this was required to simulate how (using the Aquator model) operating the scenarios could influence the frequency with which the HoF values in the river study system could be triggered and hence affect existing abstractors. It was therefore important to have a representation of how frequently each SRO could be operated as accurately as possible so as not to misrepresent the impact the SROs could have.

3.3.2 Operation of the schemes will be refined iteratively during the RAPID gated process; however, to establish a reasonable representation at a point in time, consultation was undertaken with Affinity Water, STW, Anglian Water, and their consultants undertaking Gate 2 feasibility work for each SRO. The outcomes are summarised in the subsequent sections of this report for each SRO. These scenarios have been modelled in Aquator (using historical data series) in combination to assess the impact of operating all of the SROs on the HoFs and conditioned abstraction licences within the study river system. It is important to reiterate that the profiles described and simulated in the Aquator model, are subject to change and refinement as regional water resource plans are further developed. What has been modelled for the Gate 2 modelling study represents a point in time only.

Grand Union Canal (GUC)

3.3.3 Minworth SRO would be the source of water to feed the GUC SRO to support Affinity Water's supply area. The main factors influencing when (and how much) water would be required from the GUC scheme include:

- availability of water within Affinity Water's groundwater sources in relation to drought conditions,
- the severity of peak summer demands,
- the implementation of sustainability reductions on existing abstraction licences from Affinity Water sources, and
- if Affinity Water experience severe operational issues e.g. pollution events or large-scale outage owing to pollution.

3.3.4 Therefore, the need for water from the GUC SRO is not directly related to flow conditions in the study river system. A simplified representation of when (and how much) water would be transferred was agreed based on MISER modelling undertaken for Affinity Water. The MISER output generated agreement on two profiles: a normal dry year and drought profile, both giving a percentage of scheme utilisation for each month of the year. Drought in this context refers to a 1 in 50-year return period drought event. The water take for each month has been calculated based on a maximum utilisation of 115 Ml/d as set out in Table 3-1. A key assumption is that the GUC SRO would operate with a low baseflow at all times.

3.3.5 It should be noted that the percentage utilisation shown in Table 3-1 for a 'normal dry year' would not be this high every summer but has been selected to provide a reasonable precautionary assessment value for simulation in the model.

Table 3-1 GUC SRO operation profiles to be modelled in Aquator

Month	Normal-dry year profile		Drought profile	
	% utilisation	Water take (Ml/d)	% utilisation	Water take (Ml/d)
Jan	25.00%	28.75	25.00%	28.75
Feb	25.00%	28.75	25.00%	28.75
Mar	25.00%	28.75	25.00%	28.75
Apr	25.00%	28.75	25.00%	28.75
May	55.00%	63.25	65.00%	74.75
Jun	80.00%	92.00	100.00%	115.00
Jul	80.00%	92.00	100.00%	115.00
Aug	80.00%	92.00	100.00%	115.00
Sep	55.00%	63.25	65.00%	74.75
Oct	25.00%	28.75	25.00%	28.75
Nov	25.00%	28.75	25.00%	28.75
Dec	25.00%	28.75	25.00%	28.75

3.3.6 Simulating these profiles means that redirection of flow from Minworth can occur at any flow condition in the River Tame.

3.3.7 The profiles have been used in the study, with the normal dry year operating as the base case as part of a precautionary assessment approach, and the drought profile assumed to operate with a 1 in 50 year frequency; thus the drought profile has been included in simulations for four different events over the 200 year historical record.

Severn to Thames Transfer (STT)

3.3.8 Minworth SRO would be one of several support sources for the STT SRO. Minworth would supply water for the scheme (via the River Avon and on to the River Severn) as third in line source option after input from Netheridge and Vyrnwy reservoir have been used to their maximum. In addition, support from any source for STT is only required when flow in the River Severn is insufficient to supply the volumes required for the STT scheme. Therefore, the frequency of use (and volume) of the transfer from Minworth is not directly related to flow in the study river system.

3.3.9 Because operation of STT is dependent on flows in the River Severn as well as availability of flow from other support SROs, water resource modelling outputs (based on historical data series) were provided by Jacobs as part of the STT SRO Gate studies to determine when flow diversions from Minworth to support the STT would be triggered; outputs were supplied for the same historical data record as used for the STW Aquator model set up. These are to be used directly in the Aquator model covering the study river systems.

3.3.10 The water resource modelling outputs provided from the STT SRO Gate 2 studies demonstrate a lower frequency of operation of Minworth transfer for STT compared to the SLR scheme from the Trent and the GUC SRO. Figure 3-5 below shows graphically how frequently the Minworth SRO would be operated to support the STT SRO with a peak in August and September, operating just over a quarter of the time in these months based on the historical data period. Minworth SRO would be utilised infrequently between November and May (less than 5% of the month).

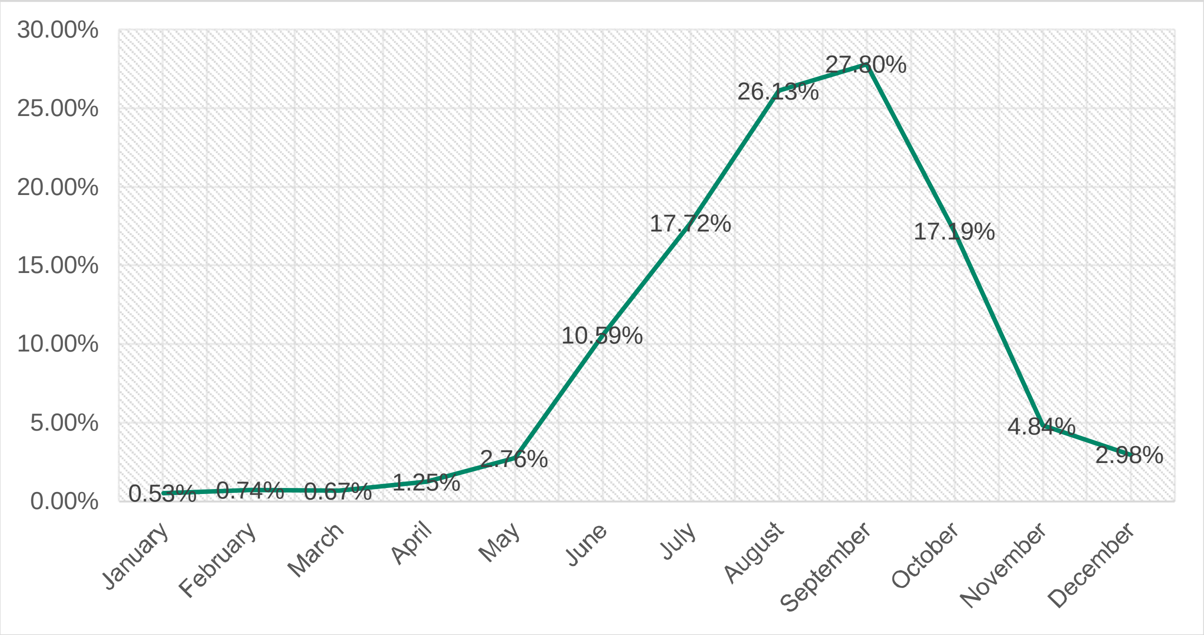


Figure 3-5 Percentage of time in a month where Minworth SRO is used to support STT

3.3.11 The modelling data from the STT SRO Gate 2 study shows, when the Minworth SRO is used to support the STT SRO, it is most frequently used (95% of the time) to its maximum of 115 Ml/d.

3.3.12 Simulating these outputs in the study river system Aquator model means that redirection of flow from Minworth can occur at any flow condition in the River Tame for the STT SRO.

South Lincolnshire Reservoir (SLR)

3.3.13 The SLR SRO would be principally supported by flows from the River Witham, with flows transferred from the River Trent when flow in the Witham is unavailable to fill the reservoir. The frequency of use (and volume of transfer) from the River Trent is therefore not directly related to flow in the study river system.

3.3.14 The abstraction from the Trent would be subject to HoF conditions measured at North Muskham restricting when (and how much) water can be abstracted as follows:

- Up to 300 Ml/d if flow at North Muskham is above 3,555 Ml/d.
- Up to 223.2 Ml/d if flow at North Muskham is above 2,875 Ml/d but lower than 3,555 Ml/d.
- Up to 123.9 Ml/d if flow above 2,650 Ml/d at North Muskham but lower than 2,875 Ml/d.
- Cease abstraction if flow at North Muskham is lower than 2,650 Ml/d.

3.3.15 Because of the relationship with flows in the River Witham (which are not within the spatial scope of this study), water resource modelling outputs based on historical data series needed to be provided by Mott Macdonald to determine when abstractions from the Trent to support the SLR would be triggered.

3.3.16 Prior to SLR run inputs being simulated and used in the study, it was necessary for the SLR modelling to take account of the influence of operating both GUC and STT. This is because the operation of both of these SROs has initially been considered outside of HoF conditions applied to abstraction licences. Therefore, operation of GUC and STT SROs would influence the timing and frequency of the HoF conditions which the SLR SRO operation would observe. A simulated Aquator time-series of North Muskham flow values including for the combined effect of GUC and STT (using the historical data set) were therefore provided to Mott Macdonald to use in simulations to determine when flow would be available in the River Trent to support the SLR. The subsequent simulations of SLR operation were provide to AECOM and these final outputs from the SLR resource modelling were then used as an abstraction component in the final Aquator model runs used in the HoF analysis reporting in Section 5 of this report.

Hydraulic modelling scenarios

3.3.17 The 1D and 2D hydraulic modelling has been undertaken using steady state flows. Whilst frequency of scheme operation is required for the hydrological (Aquator) modelling, the hydraulic models have been simulated for the worst-case water take volumes. These volumes have been simulated in isolation for each SRO, as well as in combination for each SRO affecting the river system and will also be simulated across a range of ambient flow conditions. This provides a sufficient range of simulated river hydraulic parameter change conditions to support the environmental assessment.

3.3.18 The scenarios modelled are set out in Table 3-2.

Table 3-2 Hydraulic modelling scenarios to be simulated

Scenario name	Flow condition	STT take (Ml/d)	GUC take (Ml/d)	SLR take (Ml/d)
High flow - STT or GUC only	Q10	115	-	-
High flow - STT & GUC only		115	115	-
High flow - all SROs		115	115	300
High flow - SLR only		-	-	300
Median flow - STT or GUC only	Q50	115	-	-
Median flow - STT & GUC only		115	115	-
Median flow - all SROs		115	115	300
Median flow - SLR only		-	-	300
Low flow - STT or GUC only	Q95	115	-	-
Low flow - STT & GUC only		115	115	-
Low flow - all SROs		115	115	0*
Low flow - SLR only		-	-	0*
Low flow - STT or GUC only	Q99	115	-	-
Low flow - STT & GUC only		115	115	-
Low flow - all SROs		115	115	0*
Low flow - SLR only		-	-	0*

**The HoF at North Muskham would apply to the SLR – the HoF is above the Q95 and hence SLR would not operate in this low flow condition. Note that the 1D model simulations completed as part of this study do include the SLR take of 300 Ml/d for the Q95 and Q99, to provide a comprehensive set of results.*

4. Phase 3

4.1 Overview

4.1.1 Phase 3 delivered the model improvements and refinements required to undertake simulation of the impact of the SROs on the study river system.

4.2 Aquator disaggregation

4.2.1 Simulated flows from the Aquator model at some locations needed to be adjusted, as catchment inflows, non-public water supply abstractions and discharges have been amalgamated and applied at the downstream end of key reaches within the model structure. Results from this model at any other locations therefore do not correctly reflect the effects of natural flow accretion or artificial influences on flows. Adjustments based on scaling catchment inflows and disaggregating artificial influence data, were therefore applied at the following locations:

- Trent downstream of the Mease confluence,
- Trent downstream of the Dove confluence,
- Tame downstream of the Anker confluence, and
- Trent downstream of the Soar confluence.

4.2.2 This will improve the accuracy of simulated flow values for input to the hydraulic model and allow for further calibration.

4.2.3 In order to carry out the disaggregation process the following data was required:

- Catchment areas obtained from the Flood Estimation Handbook (FEH) webservice,
- Aquator inflow series and baseline flow data, and
- maximum licence values and locations of abstractions and discharges. All abstraction and discharge values provided by the EA were accounted for in the disaggregation process.

Catchment inflow scaling

4.2.4 Catchment inflow series applied to each Aquator river reach were apportioned based on catchment area so that only the relevant catchment area for the Aquator model was utilised. The incremental catchment area, between Aquator locations at which inflows have been applied, was calculated by subtracting the relevant areas, taken from FEH for each location. The equivalent calculation was carried out for the intermediate location for which estimated flows are required, and the resulting value divided by the catchment area of the reach to determine the proportions of the incremental catchment area which are upstream/downstream of the intermediate location. For example, the calculations indicated that approximately 20% of the catchment between Drakelow and Shardlow is upstream of the Dove confluence.

4.2.5 Note that the calculations of incremental catchment area considered any tributaries which are modelled separately in Aquator and therefore have their own separate inflow series applied (for example, the catchment areas of the Dove, Derwent and Soar were subtracted as appropriate). This ensures that the catchment area ratio calculations were correctly applied to the portion of the Trent catchment (including unmodelled tributaries) represented by the inflow series to be scaled.

4.2.6 This catchment area apportioning was then applied as a ratio to the inflows from Aquator and then the adjusted inflow was added to, or removed from, the modelled flows abstracted from baseline Aquator run outputs (depending on which Aquator component is used as the basis for the calculation, and whether the intermediate location is upstream or downstream of this point).

4.2.7 Note that the apportioning of the catchment inflows based on relative catchment areas alone was felt to be a reasonable approach as the inflow time series input to Aquator are understood to exclude the artificial influences (which are applied separately) and therefore represent only the natural inflows to each river reach.

Disaggregating artificial influences

4.2.8 On each of the relevant reaches, the maximum abstractions and discharges (values associated with licences/permits) were collated, and a total value was calculated for the abstractions and discharges along the reach. These abstractions and discharges were split by location, with a representative proportion applied upstream and downstream of the relevant point. A visual representation of this process is seen in Figure 4-1 and Figure 4-2. For example, as shown in Figure 4-1, 39.9% of the discharges for Hopwas Bridge are located upstream of the Tame and Trent confluence, and the remaining 60.1% are downstream. Each calculated ratio was then applied to the relevant abstraction and discharge profile from Aquator to provide an estimate of the proportion of these artificial influences upstream and downstream of each required intermediate location of flow, in order to calculate flow profiles for each section of the river reach which are consistent with the combined existing Aquator data.

4.2.9 Note that apportioning the combined artificial influence flow datasets based on the maximum licence or permit flow values in each section of the reach was selected as the best available approach.

4.2.10 Depending on whether the required location of flow is upstream or downstream of the modelled outputs being adjusted, the abstractions were either then removed from the simulated flow and the discharges added or vice versa. A monthly profile of modelled abstractions and discharges was selected to reflect the seasonal variations, a monthly profile was a more manageable dataset than a daily profile. This produced a final disaggregated flow profile which will be used in the hydraulic modelling.

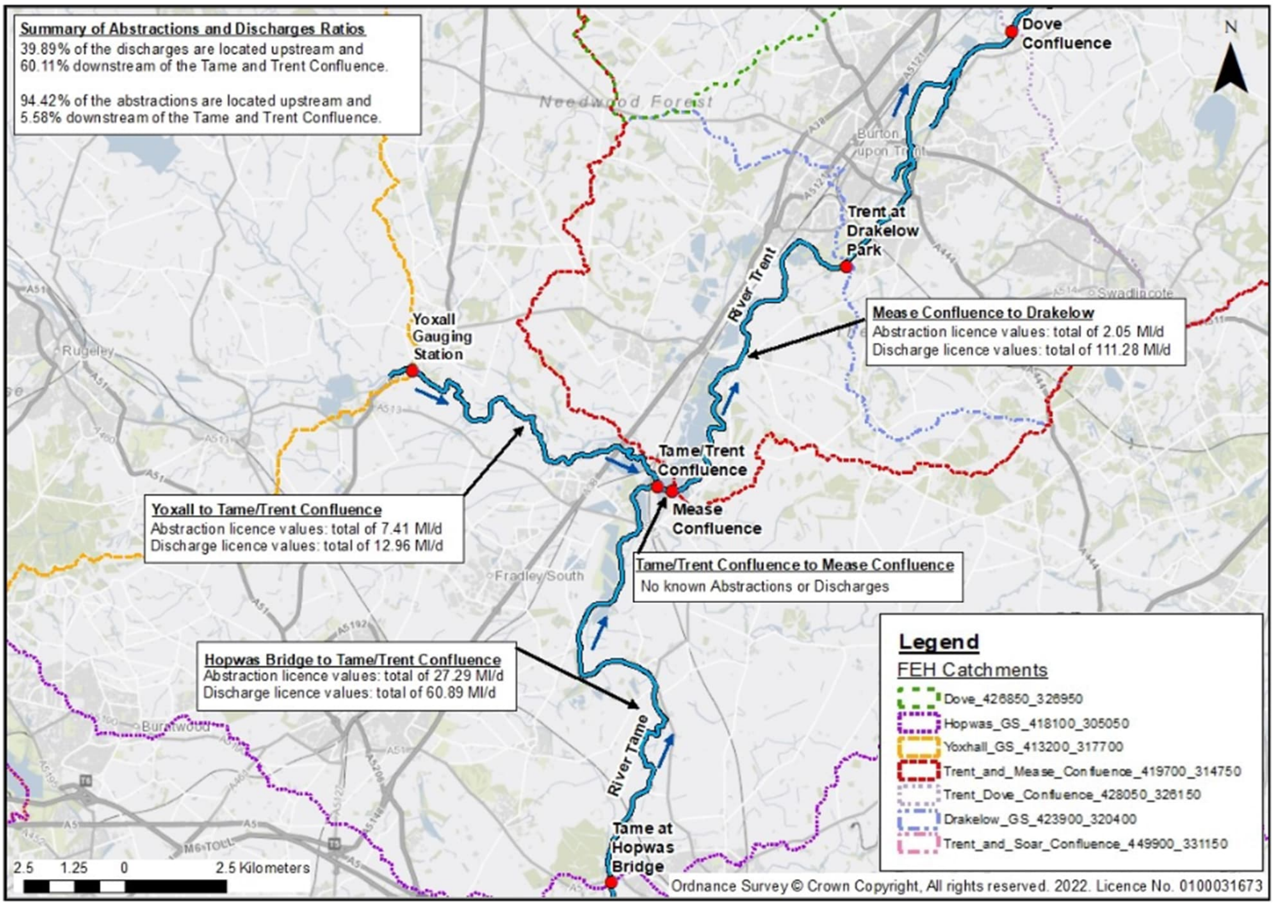


Figure 4-1 Disaggregation process at Hopwas Bridge, Tame and Trent confluence and Drakelow

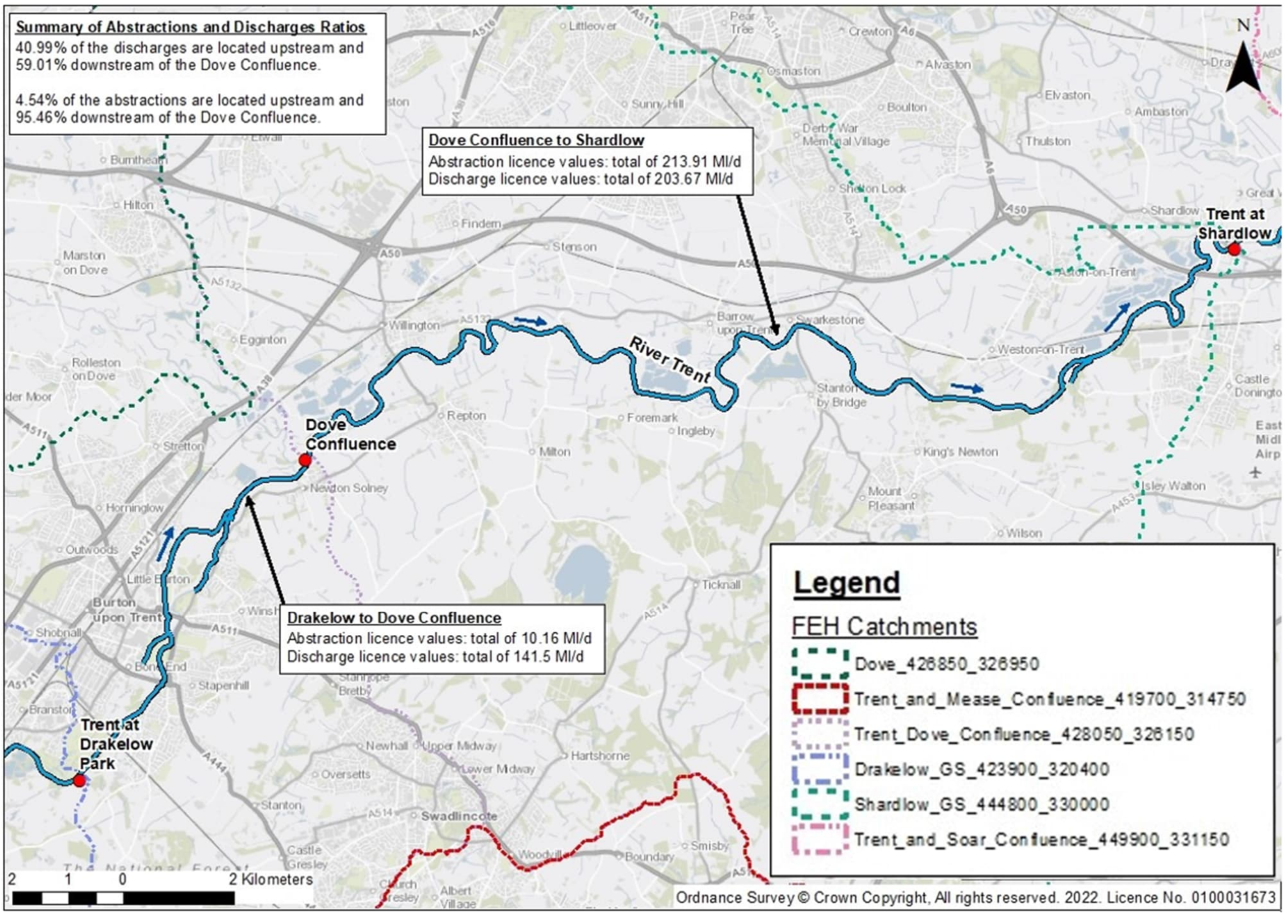


Figure 4-2 Disaggregation process at Drakelow, Dove and Shardlow

4.4 1D Hydraulic modelling

Model updates

4.4.1 The following updates and improvements have been made to the four 1D hydraulic models for the River Tame (Water Orton to Drakelow), River Trent 2 (Drakelow to Branston & Meaford to Tame/Trent confluence), River Trent 3 (Branston to the River Derwent), and River Trent 4 (River Derwent to Cromwell).

4.4.2 In order to assess the potential impacts of flow changes on wetted perimeter, refinements to the 1D cross-sections of all four hydraulic models were carried out to trim cross-sections to the main channel geometry only. This was undertaken as the extended cross-sections within the original flood models include a 1D representation of floodplain storage and conveyance which may distort wetted perimeter calculations.

4.4.3 There are several tributaries of the River Tame and River Trent within the hydraulic models that are poorly geo-referenced, are represented hydrologically by existing "sweetening" flows only upstream of their confluence with the Tame/Trent main rivers, and do not fall within the area of interest (AOI) for this study. As these reaches were causing model instabilities and the sweetening flows may be overestimating flows further downstream, certain areas of the models not of interest to this study were removed. This is further detailed in Table 4-2.

4.4.4 A significant number of floodplain units, reservoir units, and spill units within the hydraulic models, which are operational in the original high-flow flood models, are dry within low-flow conditions. Therefore, wherever possible, such units within the hydraulic models have been removed in order to improve model stability when reducing sweetening flows and calibrating the models.

4.4.5 Some of the surveyed cross sections used within the existing hydraulic models are spaced at a considerable distance (> 200m) in certain areas of the River Tame and River Trent. As additional surveyed data is not available, interpolate units have been added to the models between river sections to help overcome stability issues.

4.4.6 An exercise to geo-reference the 4 No. hydraulic models was undertaken at Phase 4 of the study so that results of the modelling can be presented spatially. The River Trent 2 hydraulic model has been fully georeferenced and the three other models have been georeferenced to sensitive reaches only. Geo-referencing was undertaken by manually measuring the distance between surveyed sections within Flood Modeller software to compare with the survey spacing.

4.4.7 The updates undertaken for each of the hydraulic models is tabulated in Table 4-2.

Hydraulic model stability

4.4.8 On completion of updating the River Tame and 3 No. River Trent hydraulic models with the recommendations outlined in Phase 1, convergence improved through all model runs, with no noticeable spikes or oscillations in hydrographs or long section animations.

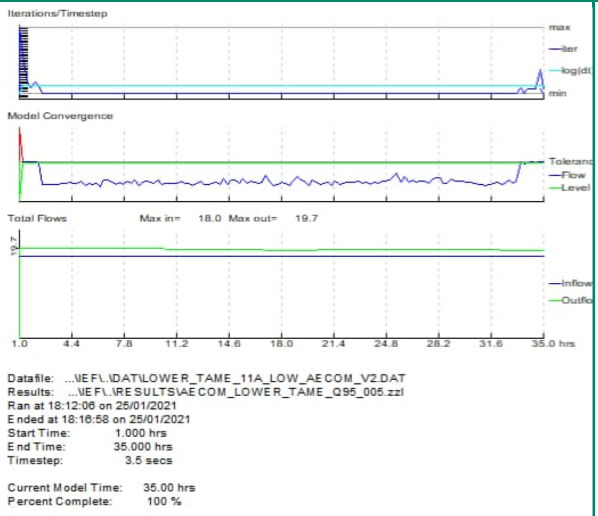
4.4.9 An analysis of the Q95 event simulations, the most extreme low flow event modelled at Phase 3, show mass balance remains within tolerance through the model simulations. A comparison between the Gate 1 and Gate 2 hydraulic models is shown in Table 4-1.

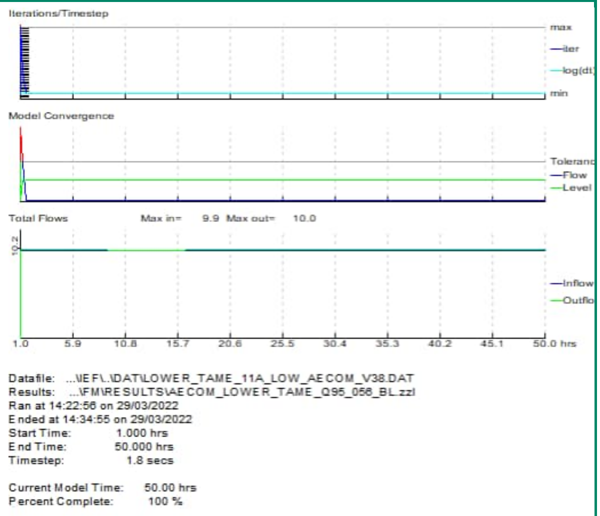
4.4.10 An analysis of the more extreme Q99 low flow event simulations was undertaken at Phase 4 which shows model convergence to be similar to the Q95 event, with mass balance within the tolerance limit for each hydraulic model.

Table 4-1 Comparison of Gate 1 and Gate 2 Hydraulic Model Convergence for the Q95 Event

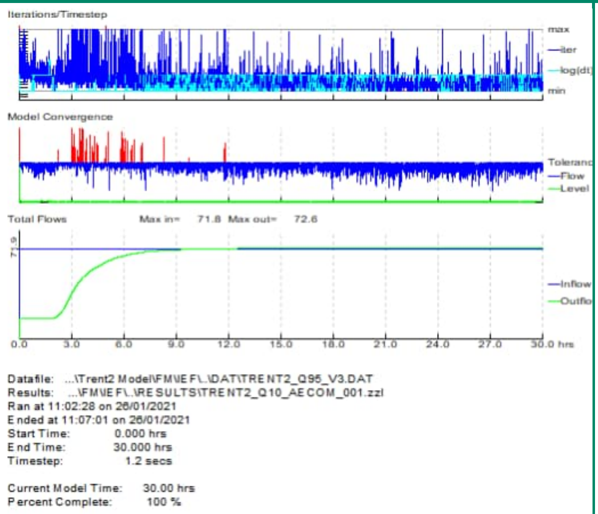
Gate 1 Hydraulic Models	Improved Gate 2 Hydraulic Models

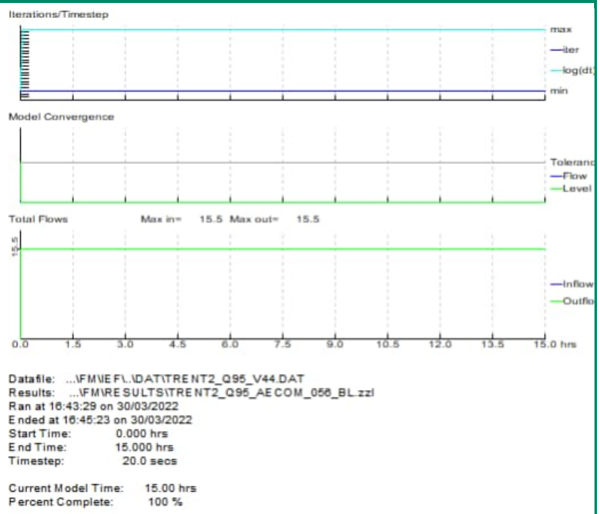
River Tame Hydraulic Model



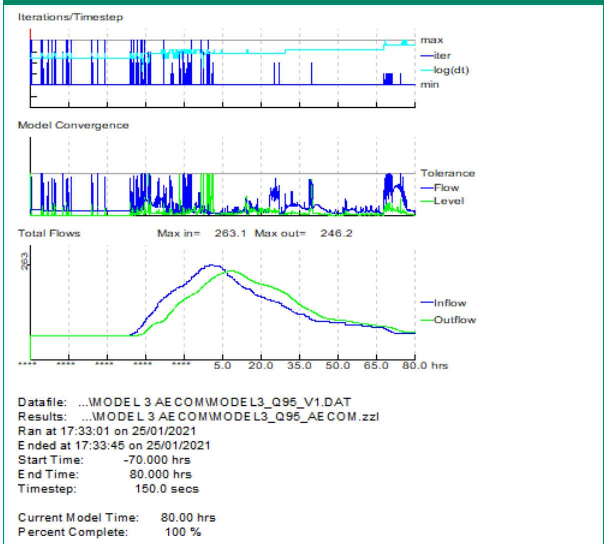


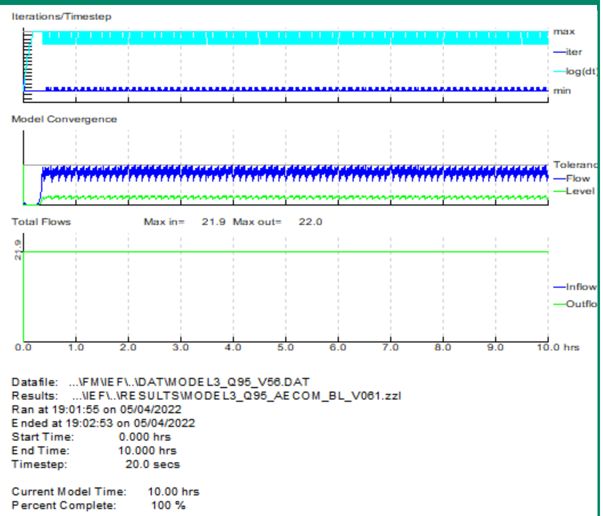
River Trent 2 Hydraulic Model



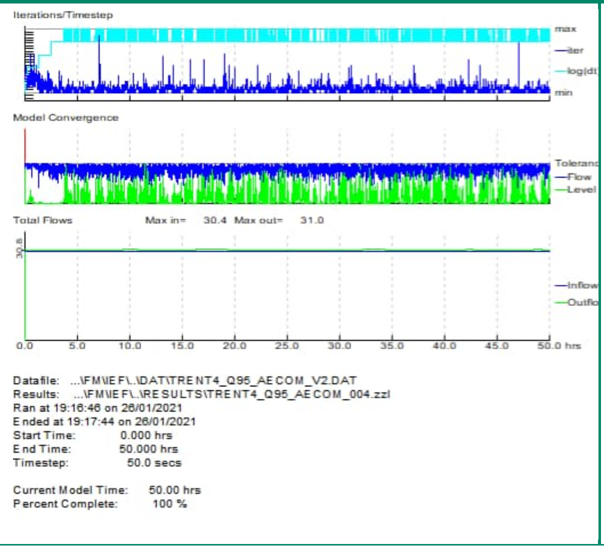


River Trent 3 Hydraulic Model





River Trent 4 Hydraulic Model



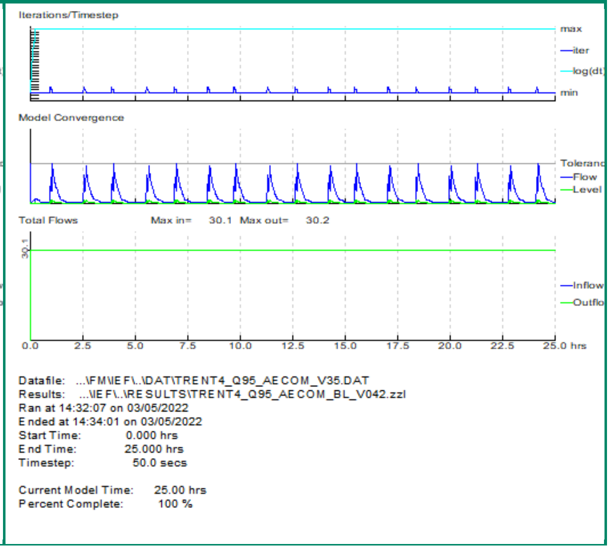


Table 4-2 1D Hydraulic model updates undertaken at Gate 2

	River Tame *(Water Orton to Tame/Trent Conf.)*		**River Trent 2** *(Meaford to Tame/Trent conf. and Tame/Trent conf. to Drakelow)*		**River Trent 3** *(Branston to River Derwent)*		**River Trent 4** *(River Derwent to Cromwell)*	
Model Size (nodes):	*Gate 1:* ***2502***	*Gate 2:* ***2712 / 2470 (Q99)***	*Gate 1:* ***836***	*Gate 2:* ***296***	*Gate 1:* ***631***	*Gate 2:* ***555***	*Gate 1:* ***1074***	*Gate 2:* ***950***
Updated Model Extent:	• No updates have been carried out to the River Tame hydraulic model extent as this model is of the lower River Tame only and in the Area of Interest (AOI) for this Study.		• The River Trent upstream of the Trent/Tame confluence has been removed from the River Trent 2 hydraulic model at the Gate 2 stage. The modelled inflow along this reach is sweetening flow only which was affecting model stability and is not within the AOI for this Study. This extent of the model also included sections of the River Blithe, River Swarbourn and River Sow which were also represented hydrologically with sweetening flows only. • The 150 m reach of the River Mease downstream of the Trent/Tame confluence has also been removed due to model instabilities and the representation of sweetening flows.		• The River Dove and River Derwent reaches have been removed from the Trent 3 model. Both rivers are poorly geo-refenced and the only hydrological inflows on either river are sweetening flows which are causing model instabilities and not within the AOI. • Within the Q95 event, a 2.65km reach of the River Trent is dry downstream of the A511 road bridge where the River Trent bifurcates as water level is below the crest of the Washlands Weir. This modelled reach has been removed from the Q95 model only, due to model instabilities when the channel is dry.		• The River Derwent and the 1.65 km reach of the River Trent upstream of the Trent/Derwent confluence have been removed from the Gate 2 hydraulic model as they are poorly geo-refenced and represented hydrologically with sweetening flows only. The inflow of the Trent 4 model at Point 12 already accounts for the River Derwent and upstream Trent flow from the Trent 3 hydraulic model. • Similarly, the River Soar and River Erewash reaches have been removed from the hydraulic model.	
Updated Model Units:	• Due to the significant size of the River Tame model and as the model already runs in stable condition, it was not thought to be necessary at Phase 3 of the project to remove any reservoir or spill units which are dry in low flow conditions. However, for the extreme low flow Q99 event simulated at Phase 4, an exercise to remove a considerable number of dry units and associated sweeting flows was undertaken for this event only to stabilise the model along the Tame.		• The reservoir and spill units on the River Tame upstream of the Derby to Birmingham railway line in proximity to the National Memorial Arboretum have been removed from the Gate 2 model as there are dry and unstable in low flow conditions.		• Floodplain, spill and reservoir units along the River Trent, in particular the area upstream of River Derwent confluence between Aston-on-Trent and Great Wilne have been removed which were causing model instabilities in low flow conditions. The spills in The Washlands in Burton-on-Trent (upstream of the model) and the reservoir and spill units associated with the River Dove and River Derwent have also been removed.		• Floodplain, spill and reservoir units associated with the River Derwent, River Soar and River Erewash have been removed from the Gate 2 hydraulic model as these units were dry, poorly geo-referenced and causing model instabilities in low flow conditions. To improve model stability, a considerable number of these units have also been removed from the hydraulic model along the extent of the River Trent.	
Trimmed Model Cross-sections:	✓		✓		✓		✓	
Interpolates Added:	✓		✓		✓		✓	
Model Fully Georeferenced:	✗		✓		✗		✗	
Other updates:	• Remote nodes added to crump weir units as the weirs directly control water levels and wetted perimeter values. • Model simulated in double precision to improve Mass Balance.		• Model simulated in double precision to improve Mass Balance.		• Model simulated in double precision to improve Mass Balance.		• Model simulated in double precision to improve Mass Balance.	

Hydraulic model inflows

4.4.11 At Phase 3, initial model runs to allow calibration of the River Tame hydraulic model included 450 Ml/day (5.208m^3/s) added to the upstream inflow at Water Orton within the Baseline Scenario to account for the maximum Dry Weather Flow (DWF) discharged from the Minworth WwTW. This is because the Water Orton gauge is upstream of the first outfall from Minworth WwTW.

4.4.12 To improve confidence in the use of the hydraulic models for low-flow conditions, the four hydraulic models were calibrated to either reliable spot flow data at flow gauges along the River Tame and River Trent or from updated hydrology outputted from the Aquator modelling. The calibrated modelled inflows and reduction of existing sweetening flows for the updated Baseline scenario for the Q95 and Q50 events only are discussed further for each hydraulic model below.

4.4.13 A revised representation of Minworth WwTW discharge has been included in the final model runs at Phase 4 (see Section 5.4), where the hydraulic models have been further calibrated. This is because discharge from Minworth WwTW for any given river flow condition will vary (i.e. it will not always be a dry weather flow) and so a single discharge value for Minworth WwTW is not a realistic assumption. The method described in Section 5.4 gives a simulated discharge range of 461 Ml/d to 420 Ml/d depending on the river flow value being simulated. To put these values into context, the calculated Minworth WwTW DWF using measured Total Daily Volume (TDV) between January 2019 and Dec 2021 was 434 Ml/d using the Q80 method.

River Tame

4.4.14 Following updates to the River Tame hydraulic model in Phase 3, existing sweetening flows were reduced by between 83% and 86% for the Q95 and Q50 Baseline scenarios. On updating the upstream model inflow to represent the maximum permitted Minworth DWF, the hydraulic model was calibrated to the Lea Marston flow gauge at Point 3 (flows calibrated within <0.1%) and modelled Aquator flows generated at Hopwas Bridge, Point 6 (<0.1%); this was achieved by reducing the tributaries inflows to a minimum. A summary of the hydraulic model inflows for the River Tame used for the initial model runs at Phase 3 are detailed in Appendix C.

4.4.15 The requirement to reduce tributary inflows to a minimum between Minworth WwTW and Lea Marston demonstrated that the maximum permitted DWF assumption for Minworth WwTW used at Phase 3 was too high and needed to be adjusted based on variable Minworth discharge values. This has been considered and addressed as part of Phase 4 of the project.

River Trent 2

4.4.16 The downstream flows from the River Tame hydraulic model at Phase 3 were added to the upstream extent of the River Trent 2 model, plus the additional River Trent inflow, to calibrate to the Drakelow Aquator flows downstream of the model. The existing sweetening flows were reduced by between 88% and 98% for the Q95 and Q50 events, respectively, and the downstream of the Trent 2 hydraulic model was calibrated to within <0.1% of the outputted Aquator flows. A summary of the calibrated inflows and reduced sweetening flows at Phase 3 are appended with this report.

River Trent 3

4.4.17 The downstream Trent 2 hydraulic model flows which were calibrated to the Drakelow Aquator flows at Phase 3 were used as the upstream inflow (Point 9) to the Trent 3 hydraulic model. The Trent 3 hydraulic model was further calibrated (flows within <0.1%) to the Shardlow Aquator flows downstream of the model at Point 11. All existing sweetening flows were removed from the model and a summary of modelled inflows are detailed in Appendix C.

River Trent 4

4.4.18 The downstream flows of the Trent 3 hydraulic model at Phase 3 were included upstream of the Trent 4 hydraulic model which consider the River Trent and River Derwent flows for the Q95 and Q50 scenarios.

4.4.19 In order to calibrate the Trent 4 hydraulic model to the Colwick Aquator flows at Point 16 (flows calibrated to within <0.5%), a reduction in flows was necessary from the previous Gate 1 hydraulic model flows. As such, a linear regression between catchment area and flow rate was used to reduce the inflows for Points 13 (River Soar), 14 (River Erewash) and 15 (Fairham Brook).

4.4.20 Similarly, to calibrate the modelled flows (<0.1%) at Point 17 (North Muskham), inflows were added to the model between Point 16 and Point 17 to represent the additional flow via a linear regression where the River Devon and River Greet enter the River Trent.

4.4.21 All sweetening flows were removed from the model. A summary of modelled inflows within the Trent 4 hydraulic model at Phase 3 are detailed in Appendix C.

5. Phase 4

5.1 Overview

5.1.1 Phase 4 of the modelling study summarises the results of the hydrological and hydraulic modelling simulations, including analysis of the impact of operating the SROs on abstractors.

5.2 Aquator modelling

5.2.1 The updated STW Aquator model was used to simulate the potential impact of the various SROs on low flow conditions at key locations.

5.2.2 A comparison has been made of the FDCs for a combination of SROs at eight locations. A seasonal duration analysis has been performed at North Muskham and Drakelow. These two locations have HOF conditions which apply to abstractions in the relevant reaches of the River Trent and River Tame, and this analysis assesses how the various SROs could change the frequency that HOF conditions (specified river flow) are crossed. In addition, Aquator outputs during four simulated drought years has been assessed to demonstrate the potential impact of the SROs.

List of SROs and simulated combinations

5.2.3 As discussed in Section 3.3, the following three SROs were modelled: GUC, STT and the SLR. The GUC and STT SROs were modelled by reducing the profile of daily discharges from the baseline time series used in the Aquator Minworth wastewater discharge component, to simulate the effect of utilising part of the baseline discharge for transfer via the GUC and/or to support the STT, thus reducing the discharge to the River Tame.

5.2.4 The SLR was modelled by adding a new Aquator abstraction component upstream of North Muskham gauge, to simulate a profile of abstractions (provided as output from a separate model) from the River Trent at this location, to support refill requirements for the potential South Lincolnshire Reservoir.

5.2.5 To make a comparison of the impact of SROs the following combination of simulations were run[7]:

- **Baseline:** no SRO applied to the model. The baseline model used was the model developed for the Environment Agency's Water Resource Management Plan, 2019.
- **Minworth GUC:** GUC utilisation profile subtracted from discharge time series at the Minworth component.
- **Minworth STT:** STT utilisation profile subtracted from discharge time series at the Minworth component.
- **Minworth GUC + STT:** GUC and STT combined utilisation profile subtracted from discharge time series at the Minworth component.
- **Minworth GUC + SLR:** GUC profile subtracted from discharge time series at the Minworth component and SLR utilisation profile abstracted from River Trent via new abstraction component upstream of North Muskham.
- **Minworth STT + SLR:** STT profile subtracted from discharge time series at the Minworth component and SLR utilisation profile abstracted via abstraction component upstream of North Muskham.
- **Minworth GUC+STT+SLR:** GUC and STT combined utilisation profile subtracted from discharge time series at the Minworth component and SLR utilisation profile abstracted from abstraction component upstream of North Muskham.

5.2.6 For each of the seven simulations, results in the form of daily simulated flow data were extracted from the Aquator model at the following locations:

- Trent at Colwick gauging station (Aquator component name – Colwick).

[7] SLR only runs have been completed separately as part of the SLR SRO assessment and feasibility studies

- Trent at North Muskham gauging station (Aquator component name – N Muskham).
- Trent at Shardlow gauging station (Aquator component name – Shardlow).
- Trent at Drakelow gauging station (Aquator component name – Trent d/s Drakelow).
- Tame downstream of Anker confluence (Disaggregated).
- Trent downstream of Soar confluence (Disaggregated).
- Trent downstream of Mease confluence (Disaggregated).
- Trent downstream of Dove confluence (Disaggregated).

5.2.7 Flows at the 'disaggregated' locations were estimated by adjusting daily flows at existing simulated locations to separate out aggregated catchment inflows and abstractions and discharges from reaches which had been combined within the Aquator model.

Modelling uncertainties

5.2.8 Like any model, Aquator modelling used for this analysis involves uncertainties. Below is a list of the uncertainties that need to be considered when analysing the results presented in this section.

- The Aquator model was not developed for detailed flow modelling and is therefore only calibrated against key gauged locations/catchments most relevant to STW's current abstraction regime.
- Abstraction and discharge data used for model calibration is based on historic data and may not be representative of future flows with respect to climate change or changes in abstraction licencing in the study river systems.
- The time-series inputs in Aquator of discharges and some non-public water supply abstractions, are at a monthly rather than daily resolution and therefore do not reflect daily variations which may be significant in low flow periods
- The SLR abstraction time series and the utilisation profile for STT were generated from separate simulation models; full details of these model and assumptions relating to the operation of both SROs have not been reviewed within the scope of this analysis.
- The accuracy of the flows at the disaggregated locations cannot be verified by reference to gauged data and is limited by the lack of daily observed data for the abstractions and discharges which needed to be disaggregated from Aquator combined components (the split was based on maximum licensed values).

Aquator Outputs: FDC and HOF Analysis

5.2.9 FDCs indicate the percentage of time that a given flow is equalled or exceeded in a given time series. The impact of operating the SROs is to alter the FDC when the SROs are simulated over the historical period of data. Therefore, a series of alternate FDCs have been produced from the modelling for the six SRO scenarios described above and compared to the baseline FDC.

5.2.10 Figure 5-1 and Figure 5-2 show the baseline and scenario FDCs for North Muskham and Drakelow which both have HOF conditions applied to abstractions in the relevant river reaches. The HOF is also represented in the figures for each location. The principal HOF for analysis is set at North Muskham, with the majority of abstraction licences having conditions set related to the North Muskham HOF. A small number of conditioned licences with a low total daily abstraction volume refer to the HOF at Drakelow, which has been set to protect the principal HOF at North Muskham.

5.2.11 It should be noted that the modelling has initially assumed that the HOF condition will not apply to the reduction in flow from Minworth SRO used to support GUC and STT, therefore these two SROs continue to operate when the HOF values are reached. This approach has been taken as a precautionary assessment to understand the impacts and implications of operating the SROs in this way; however it is acknowledged that this scenario is unlikely. The SLR profile used in the simulations observes the HOF condition at North Muskham, reducing maximum daily abstraction volumes permitted prior to the HOF value being reached, and ceasing abstraction altogether when the HOF value is triggered (for further details refer to section 3.3).

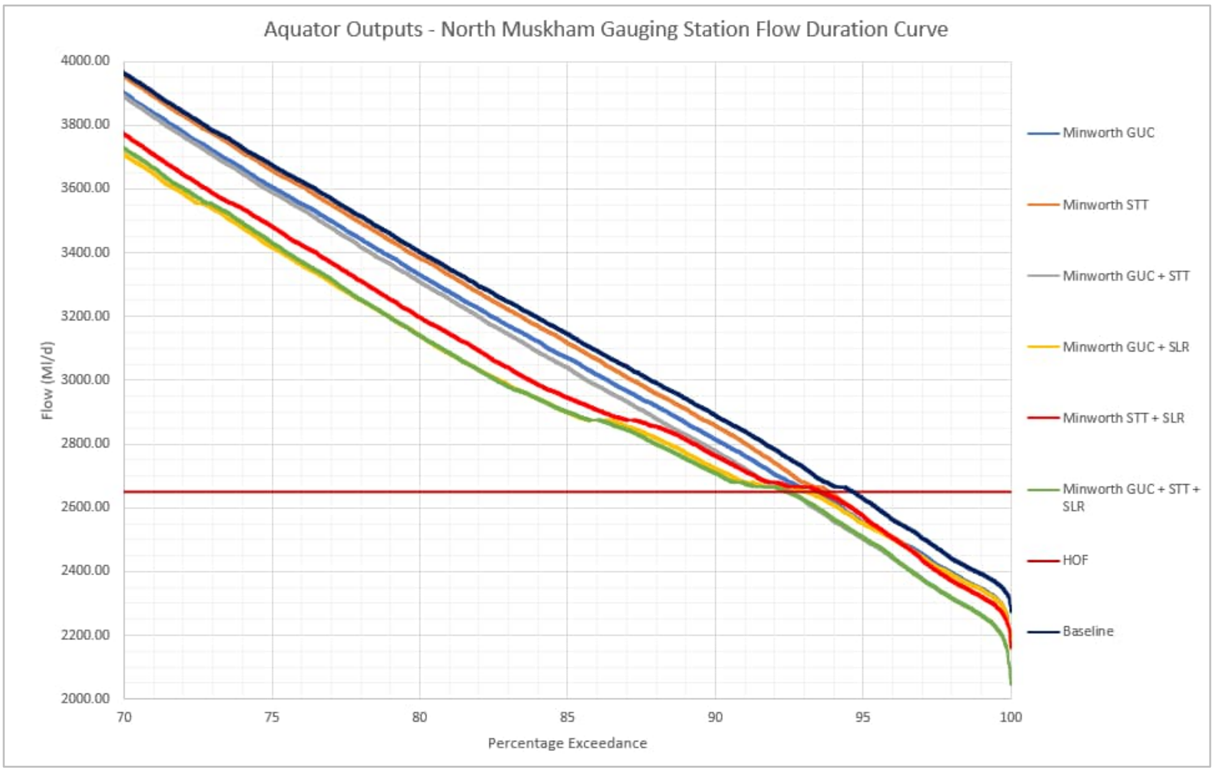


Figure 5-1 North Muskham FDCs

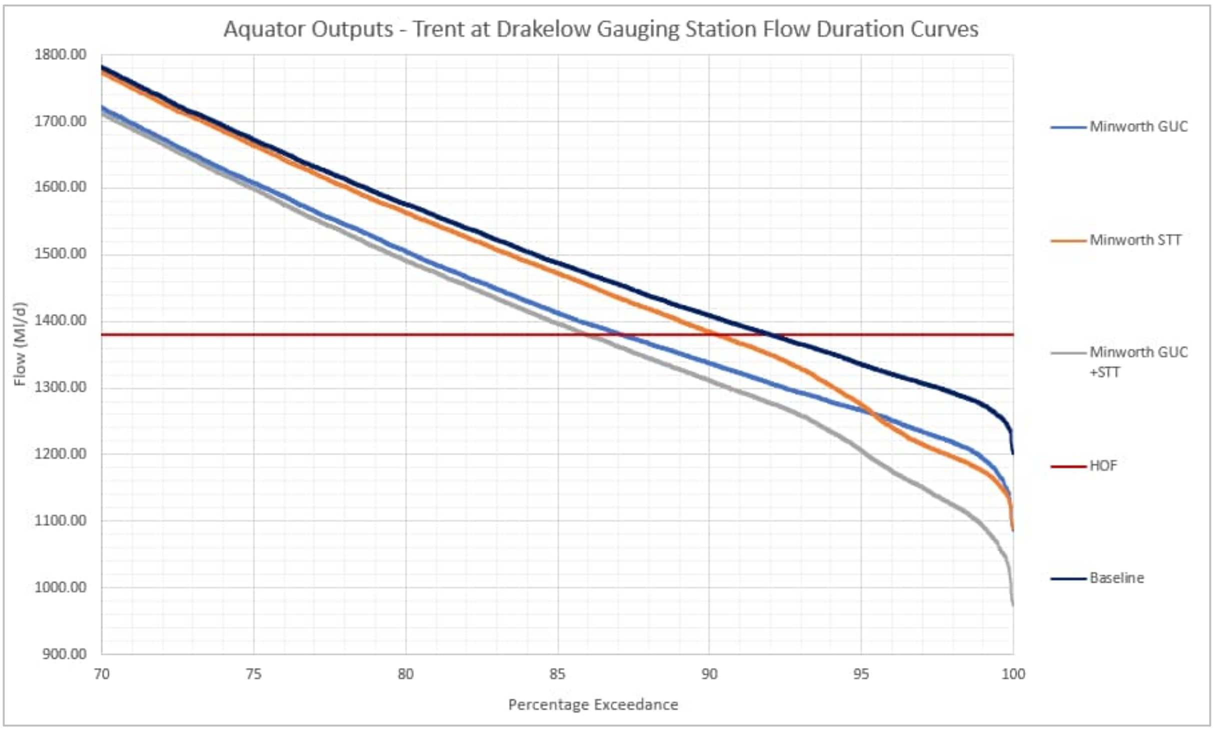


Figure 5-2 Drakelow FDCs

5.2.12 In Figure 5-2 only four FDCs are visible. This is because the abstraction of the SLR SRO has no impact on the simulated flow at Drakelow as it is located upstream of the proposed SLR location. Therefore, the FDCs for Minworth GUC, Minworth STT and Minworth GUC + STT are the same as Minworth GUC+SLR, Minworth STT+SLR and Minworth GUC+STT+SLR respectively.

5.2.13 The impact of each SRO at North Muskham and Drakelow is shown by the change in percentage exceedance flow at which the HOF would be triggered as presented in Table 5-1.

Table 5-1 North Muskham and Drakelow – percentage Exceedance flow at which the HOF would be triggered for different SRO scenarios

Location	HOF (Ml/d)	% Exceedance at HOF						
		Baseline	Minworth GUC	Minworth STT	Minworth GUC + STT	Minworth GUC + SLR	Minworth STT + SLR	Minworth GUC+STT+SLR
North Muskham	2650	94.7	93.4	93.8	92.6	93.1	93.6	92.4
Drakelow	1380	92	87.1	90.2	85.9	87.1	90.2	85.9

5.2.14 Alternatively, these results can be presented as the total number of days that flow is equal to or less than HOF out of the total simulated time series spanning 01/01/1920 – 31/12/2010. This is shown in Table 5-2.

Table 5-2 North Muskham and Drakelow – Number of Days Flow is Equal to or Less than HOF

Location	HOF	Total number of days	Number of days flow is equal to or less than HOF (As a % of total days)						
			Baseline	Minworth GUC	Minworth STT	Minworth GUC+STT	Minworth GUC+SLR	Minworth STT+SLR	Minworth GUC+STT+SLR
North Muskham	2650	33238	1774 (5.3%)	2193 (6.6 %)	2060 (6.2%)	2460 (7.4%)	2293 (6.9%)	2127 (6.4%)	2526 (7.6%)
Drakelow	1380	33238	2661 (8%)	4289 (12.9%)	3244 (9.8%)	4671 (14.1%)	4288 (12.9%)	3244 (9.8%)	4670 (14.1%)

5.2.15 The Aquator outputs at North Muskham show that the likelihood of flow dropping below the HOF condition is increased the most by the Minworth GUC+STT+SLR scenario. As North Muskham is downstream of the proposed SLR abstraction this result is expected. Despite having the same maximum water take value, the likelihood of flow crossing the HOF is increased slightly more by the Minworth GUC than the Minworth STT scenario; this is because of the difference in assumed/modelled utilisation profiles between the two scenarios with GUC assumed to operate more frequently than STT.

5.2.16 Results at Drakelow show that the likelihood of flow crossing the HOF condition is increased the most by the Minworth GUC+STT scenario. As Drakelow is upstream of the proposed South Lincolnshire Reservoir abstraction the addition of the SLR abstraction scenario has no impact on the flow in this location[8]. The likelihood of flow crossing the HOF is increased more by the Minworth GUC scenario than the Minworth STT scenario.

5.2.17 A seasonal duration analysis was performed to show the variation in the percentage of days the HOF is crossed throughout a yearly profile. Figure 5-3 and Figure 5-4 present this analysis. Note in the graphs, the months are numbered on the x axis starting with one for January and twelve for December.

[8] It is noted however that if SLR SRO were to impact on frequency of HOF trigger at North Muskham a change may be required in the HOF trigger at Drakelow.

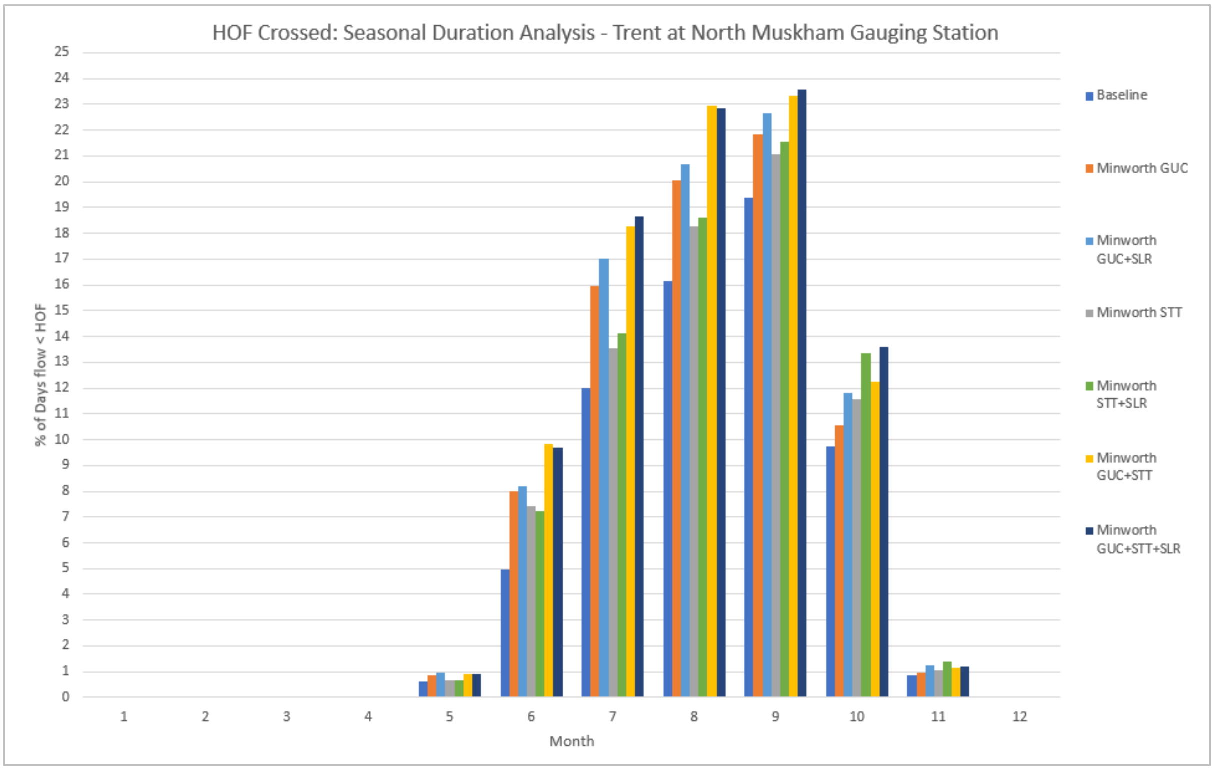


Figure 5-3 North Muskham Seasonal Duration Analysis

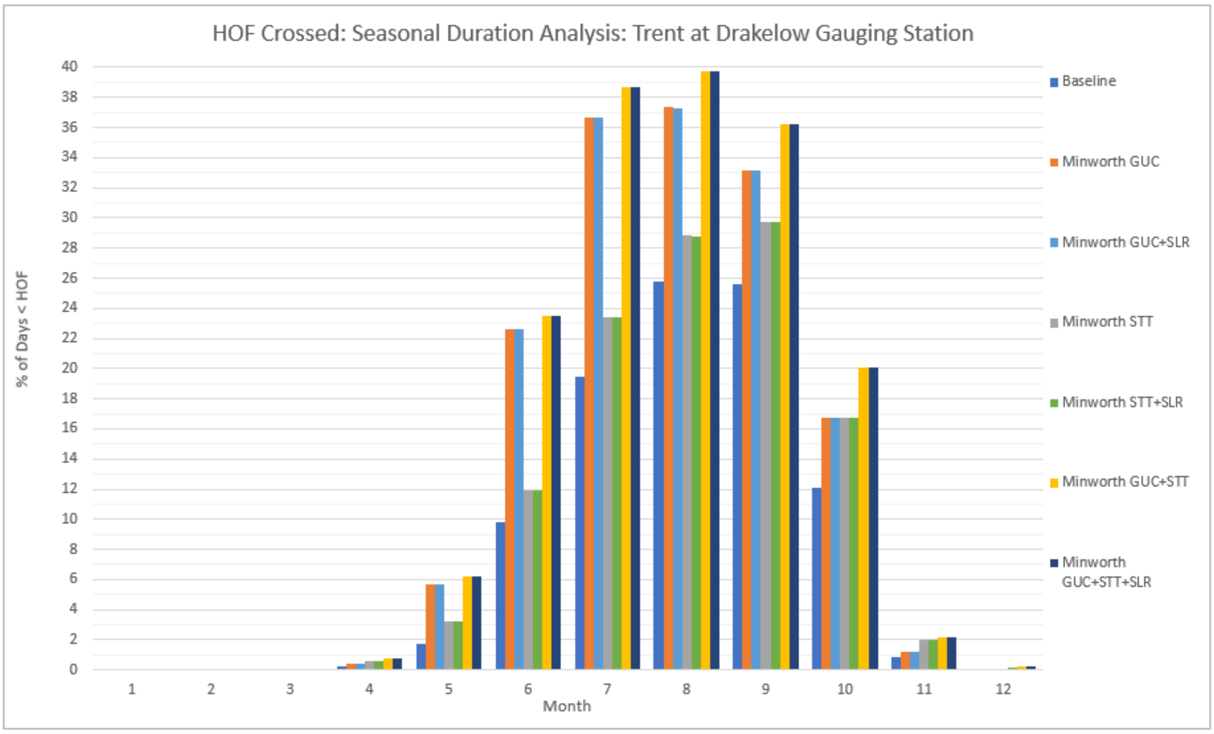


Figure 5-4 Drakelow Seasonal Duration Analysis

5.2.18 The results show that for North Muskham September is the month with the greatest percentage of days that the HOF condition is crossed. For Drakelow, August is the month with the greatest percentage of days that the HOF condition is crossed.

5.2.19 The SROs have a greater impact on the percentage of days the HOF is crossed at Drakelow than at North Muskham. The greatest difference in percentage between Baseline and Minworth GUC+STT+SLR is around 20% for Drakelow compared to 7% for North Muskham.

5.2.20 Table 5-3 and Table 5-4 below present the tabulated data from Figure 5-3 and Figure 5-4. A heat effect colouration has been provided in this tables, with blue showing low frequency of HOF trigger and brighter red showing higher frequency of trigger.

Table 5-3 North Muskham Seasonal Duration Analysis

Location:		North Muskham						
Crossing of:		HOF						
Scenario:		Baseline	Minworth GUC	Minworth STT	Minworth GUC+STT	Minworth GUC + SLR	Minworth STT + SLR	Minworth GUC +STT+SLR
% of time daily flow is below the HOF each month	Jan	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mar	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	May	0.6	0.9	0.7	0.9	1.0	0.7	0.9
	Jun	4.9	8.0	7.4	9.8	8.2	7.3	9.7
	Jul	12.0	16.0	13.5	18.3	17.0	14.1	18.6
	Aug	16.1	20.1	18.3	22.9	20.7	18.6	22.9
	Sep	19.4	21.8	21.1	23.3	22.6	21.5	23.6
	Oct	9.7	10.6	11.6	12.2	11.8	13.3	13.6
	Nov	0.9	1.0	1.1	1.2	1.2	1.4	1.2
	Dec	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 5-4 Drakelow Seasonal Duration Analysis

Location:		Drakelow						
Crossing of:		HOF						
Scenario:		Baseline	Minworth GUC	Minworth STT	Minworth GUC+STT	Minworth GUC + SLR	Minworth STT + SLR	Minworth GUC +STT+SLR
% of time daily flow is below the HOF each month	Jan	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Feb	0.0	0.0	0.1	0.2	0.0	0.1	0.2
	Mar	0.0	0.0	0.2	0.3	0.0	0.2	0.3
	Apr	2.6	3.5	3.0	3.8	3.5	3.0	3.8
	May	10.8	17.3	11.0	17.4	17.3	11.0	17.4
	Jun	29.0	40.1	29.7	40.3	40.1	29.7	40.3
	Jul	45.2	56.7	46.6	57.4	56.7	46.6	57.4
	Aug	42.6	50.8	44.7	52.7	50.9	44.7	52.6
	Sep	41.0	46.7	42.3	47.8	46.7	42.3	47.7
	Oct	26.7	28.3	28.1	29.5	28.3	28.1	29.5
	Nov	3.1	3.5	3.6	4.1	3.5	3.6	4.1
	Dec	0.4	0.6	1.5	1.9	0.6	1.5	1.9

5.2.21 The FDCs for the remaining six locations (including disaggregated locations) are shown in Figure 5-5 to Figure 5-10.

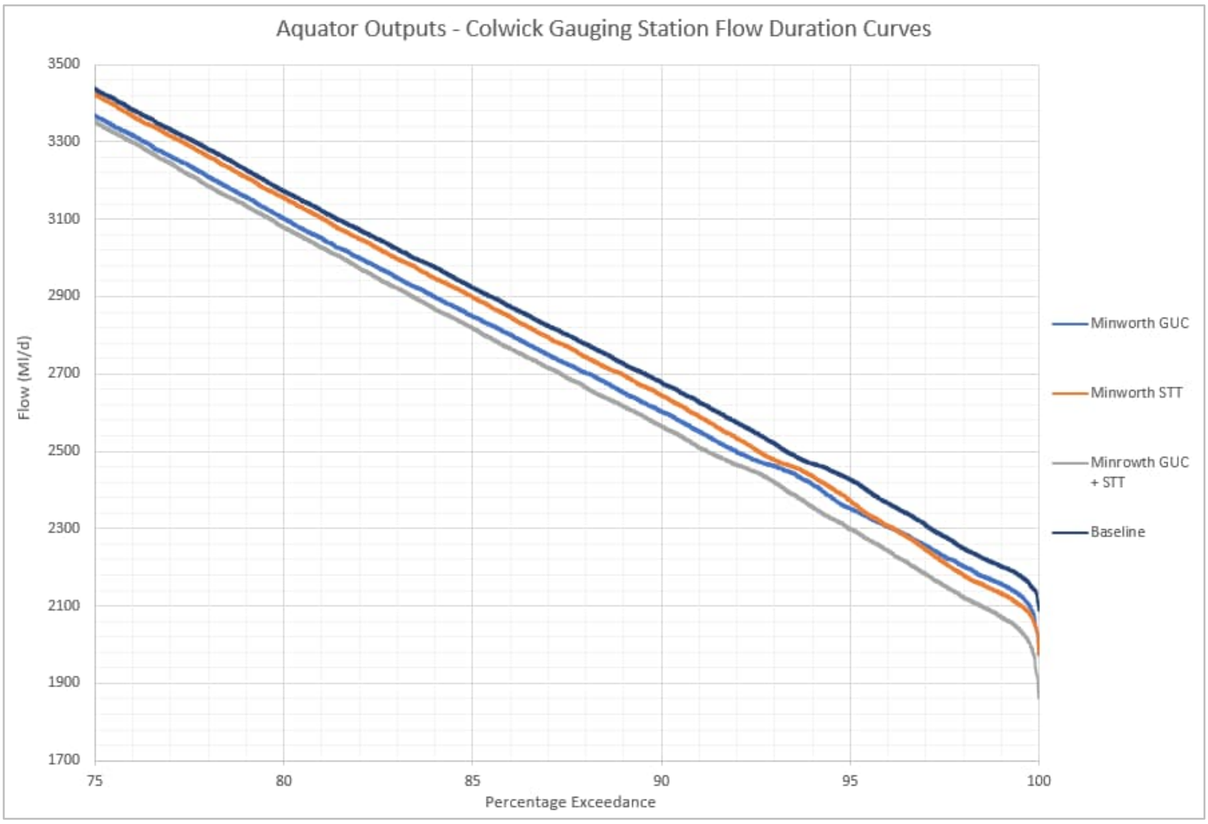


Figure 5-5 Colwick FDCs

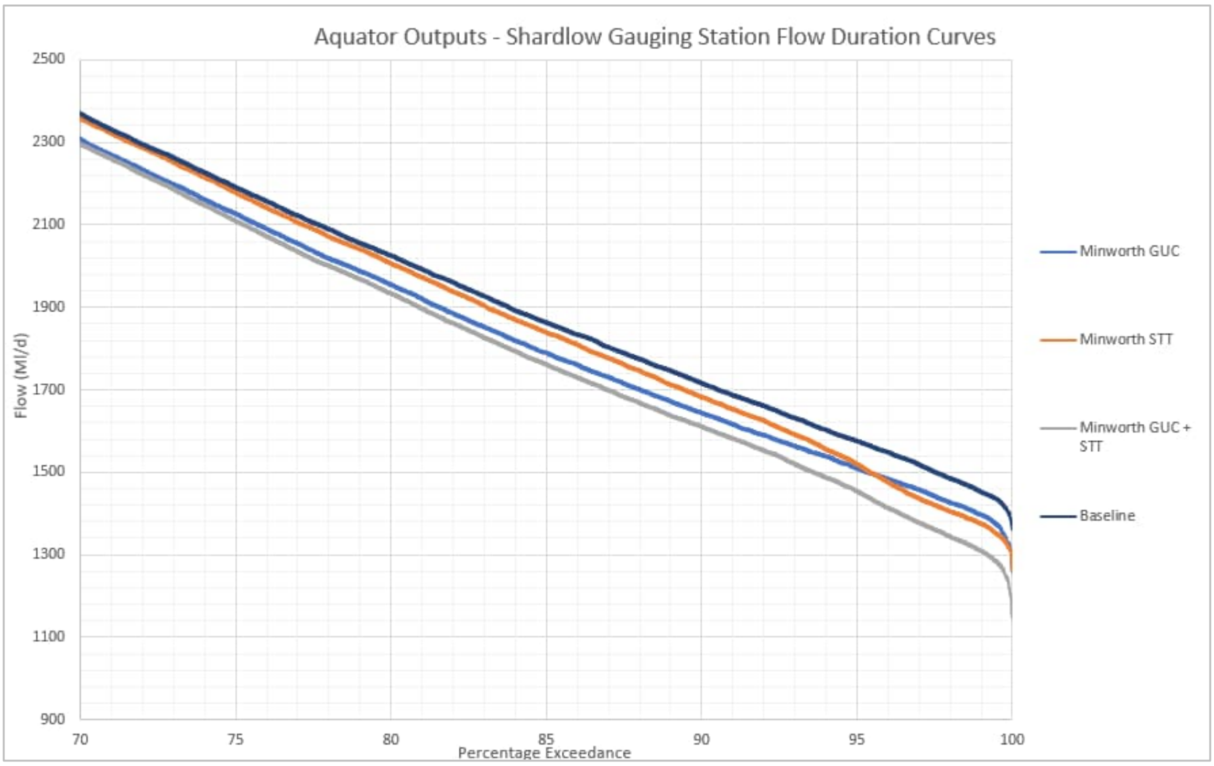


Figure 5-6 Shardlow FDCs

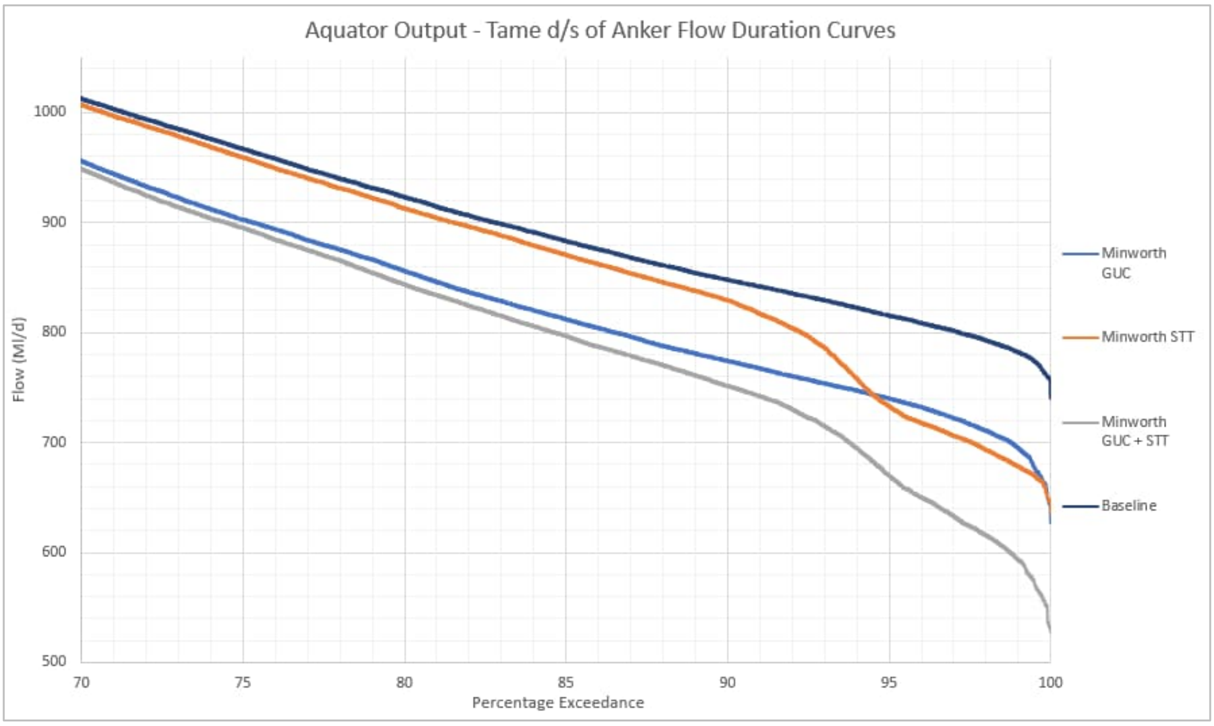


Figure 5-7 Tame Downstream of Anker FDCs

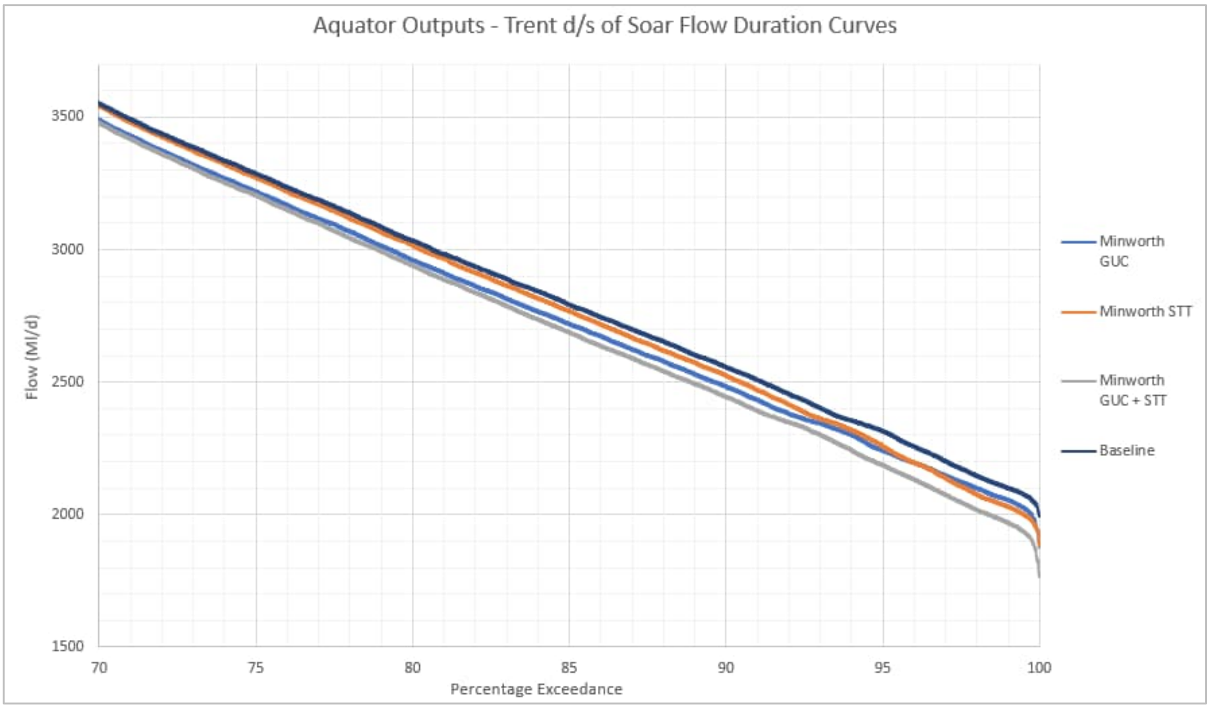


Figure 5-8 Trent downstream of Soar FDCs

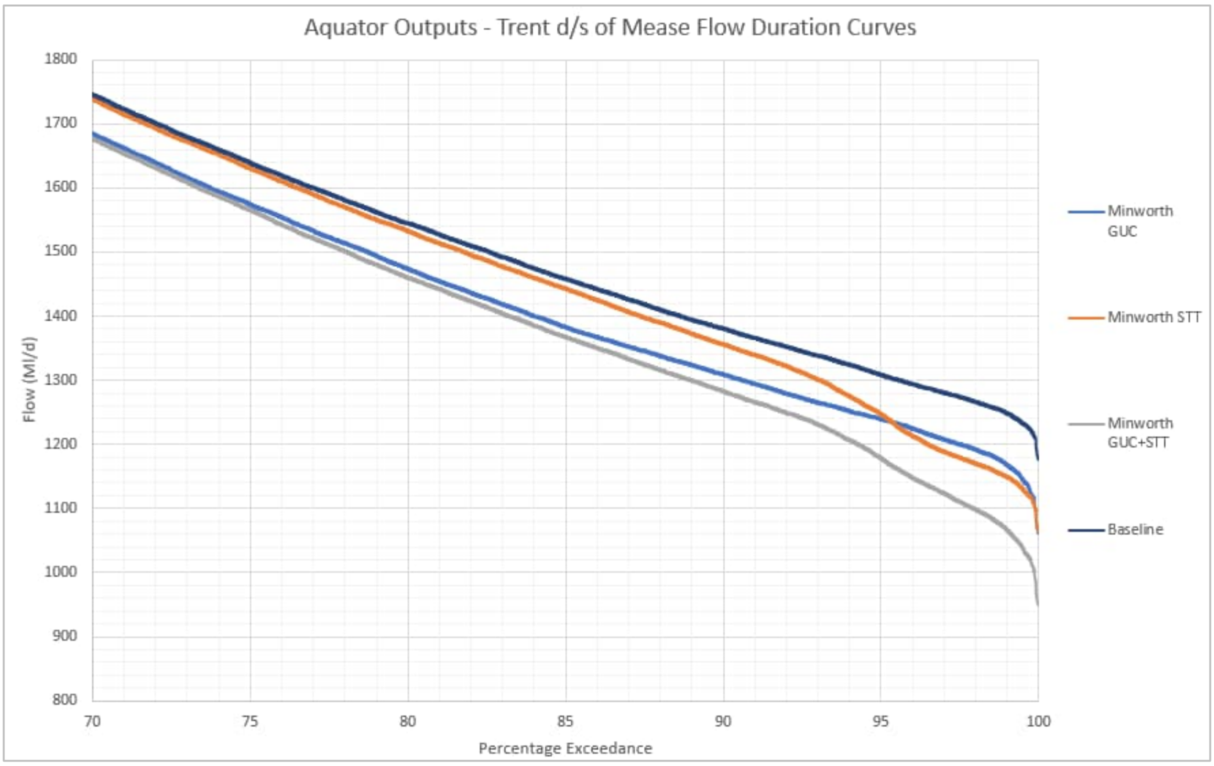


Figure 5-9 Trent Downstream of Mease FDCs

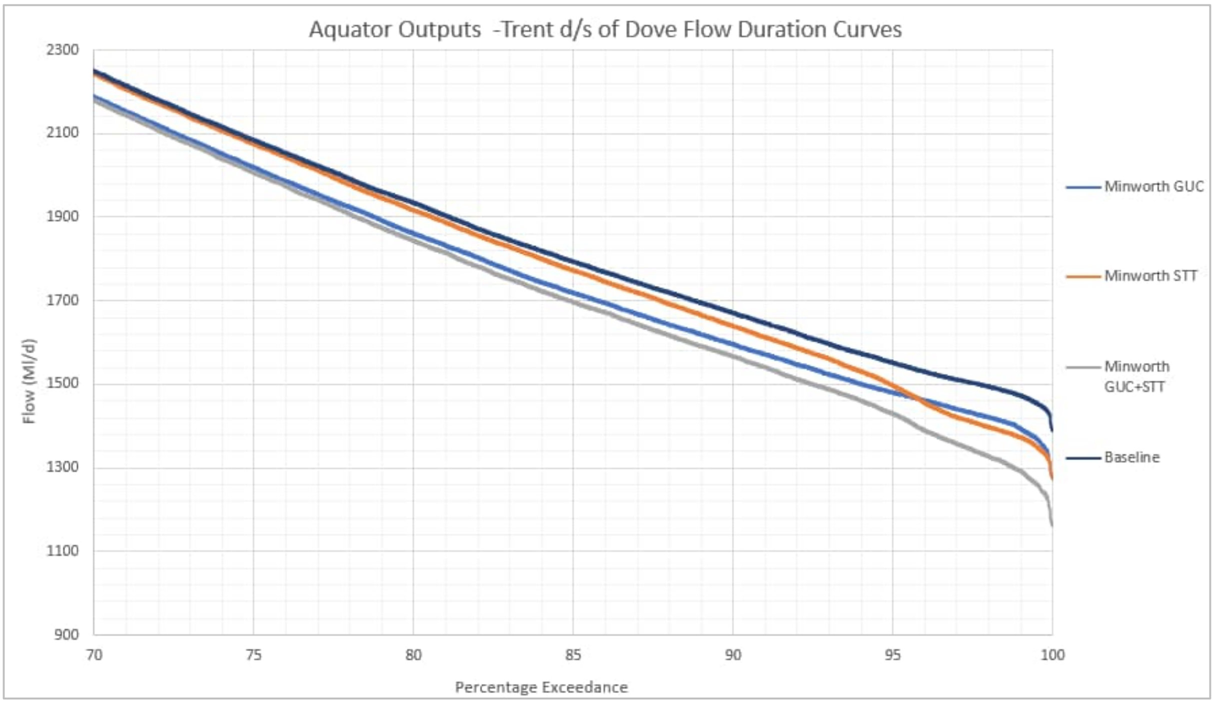


Figure 5-10 Trent Downstream of Dove FDCs

Dry Year Hydrographs

5.2.22 From the Aquator outputs, simulated hydrographs for the drought year 1976 have been produced for North Muskham, Drakelow, Colwick and Shardlow. 1976 has been chosen as flow values are lowest when compared to the three other drought years considered (1921, 1934 and 1944).

5.2.23 For clarity only the Baseline results and Minworth GUC+STT+SLR have been plotted on the hydrograph. This shows the largest difference of flow values at each location and increases the legibility of the hydrograph.

5.2.24 The HOF condition is shown on the North Muskham and Drakelow hydrographs alongside the Q95 for the Baseline simulation on all hydrographs.

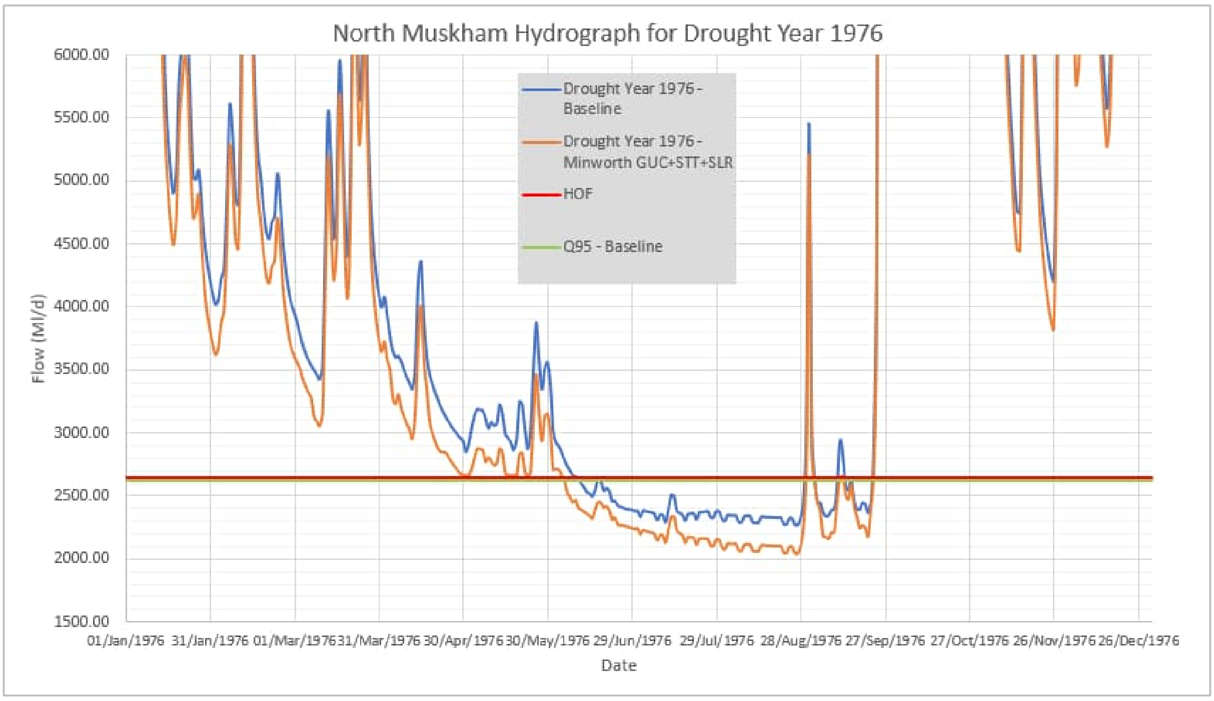


Figure 5-11 North Muskham Hydrograph for Dry Year 1976

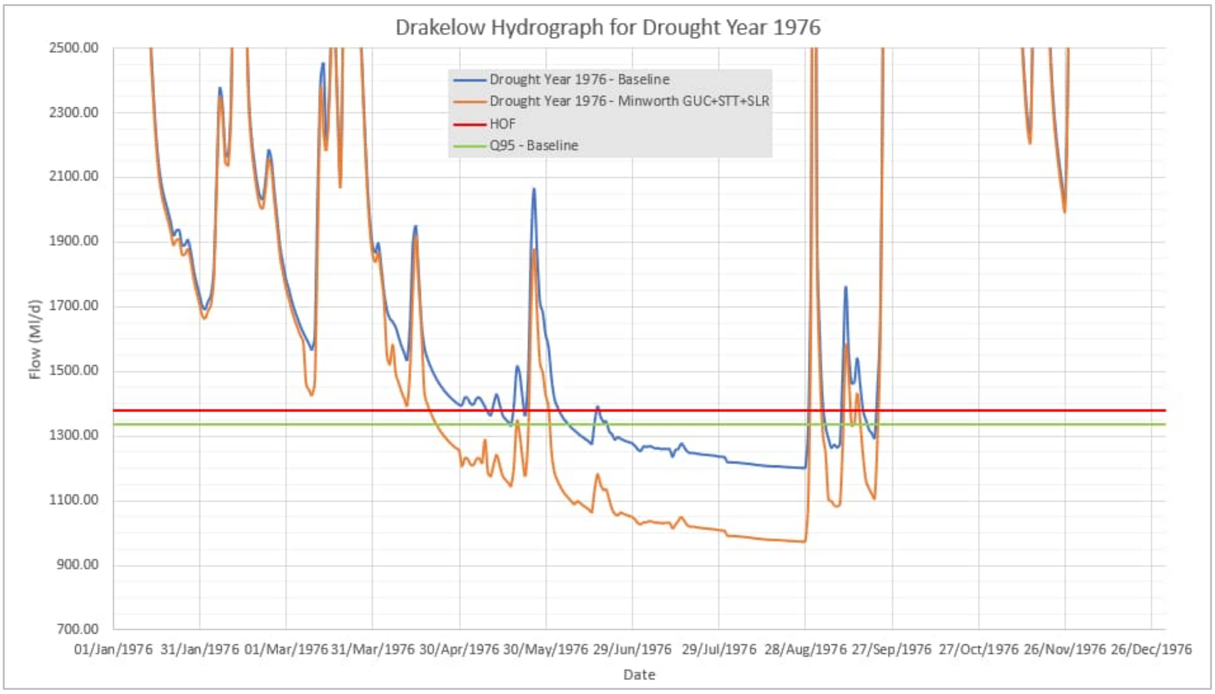


Figure 5-12 Drakelow Hydrograph for Dry Year 1976

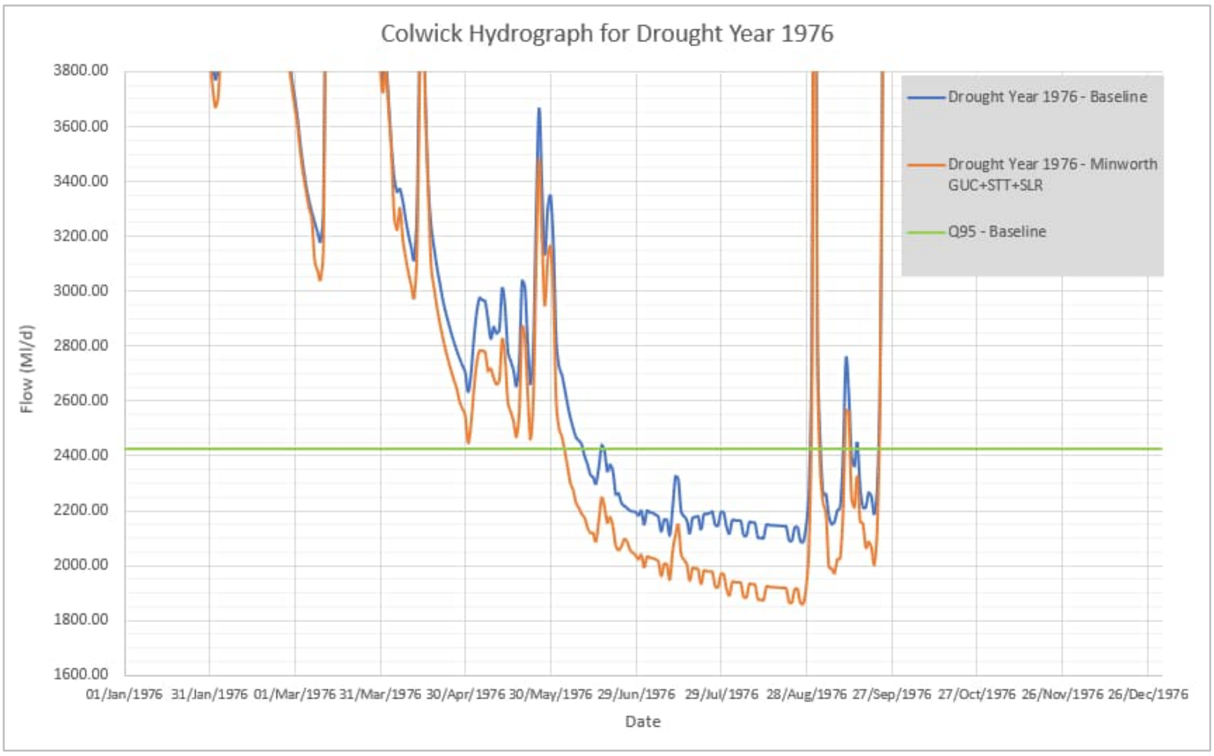


Figure 5-13 Colwick Hydrograph for Dry Year 1976

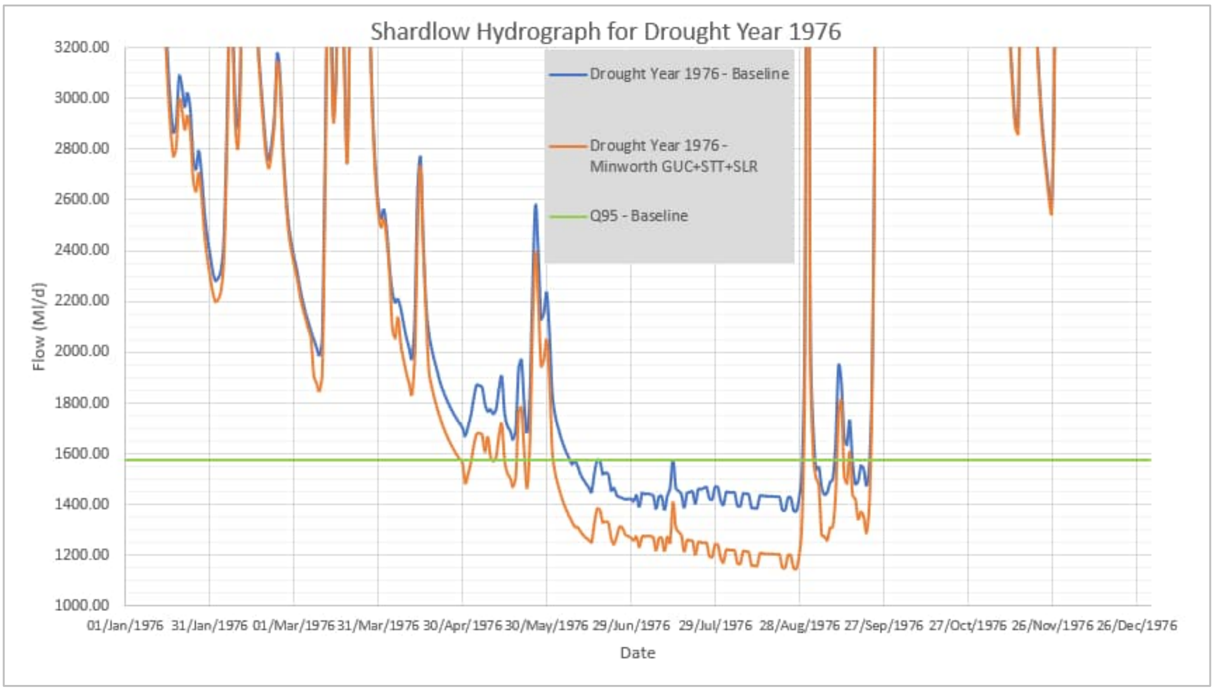


Figure 5-14 Shardlow Hydrograph for Dry Year 1976

5.2.25 These hydrographs show the impact that the Minworth GUC+STT+SLR scenario has on flow at the four locations compared to Baseline results.

5.3 HOF Analysis for Drought Year 1976

5.3.1 Table 5-5 below shows the number of days flow at North Muskham and Drakelow is equal to or less than HOF in the drought year 1976.

Table 5-5: North Muskham and Drakelow – Number of Days Flow is Equal to or Less than HOF in drought year 1976

Location	HOF	Total number of days	Number of days flow is equal to or less than HOF in drought year 1976 (As a % of total days)						
			Baseline	Minworth GUC	Minworth STT	Minworth GUC+STT	Minworth GUC+SLR	Minworth STT+SLR	Minworth GUC+STT+SLR
North Muskham	2650	366	100 (27.3%)	103 (28.1%)	104 (28.4%)	106 (28.9%)	102 (27.9%)	104 (28.4%)	105 (28.7%)
Drakelow	1380	366	104 (28.4%)	126 (34.4%)	132 (36.1%)	139 (38%)	126 (34.4%)	132 (36.1%)	139 (38%)

5.3.2 A seasonal duration analysis was performed to show the variation in the percentage of days the HOF is crossed throughout the year 1976. Figure 5-15 and Figure 5-16 presents this analysis. To note, in the graphs, the months are numbered on the x axis starting with one for January and twelve for December.

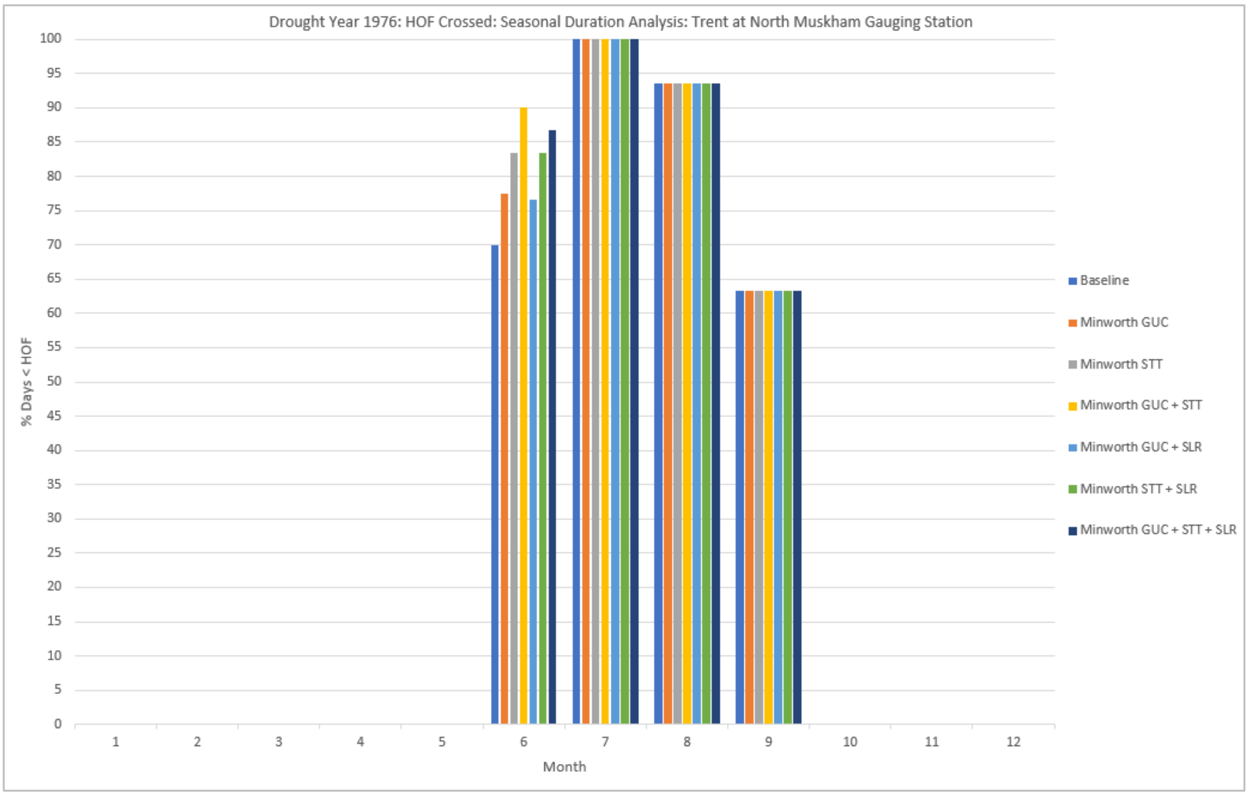


Figure 5-15: North Muskham Seasonal Duration Analysis for Drought Year 1976

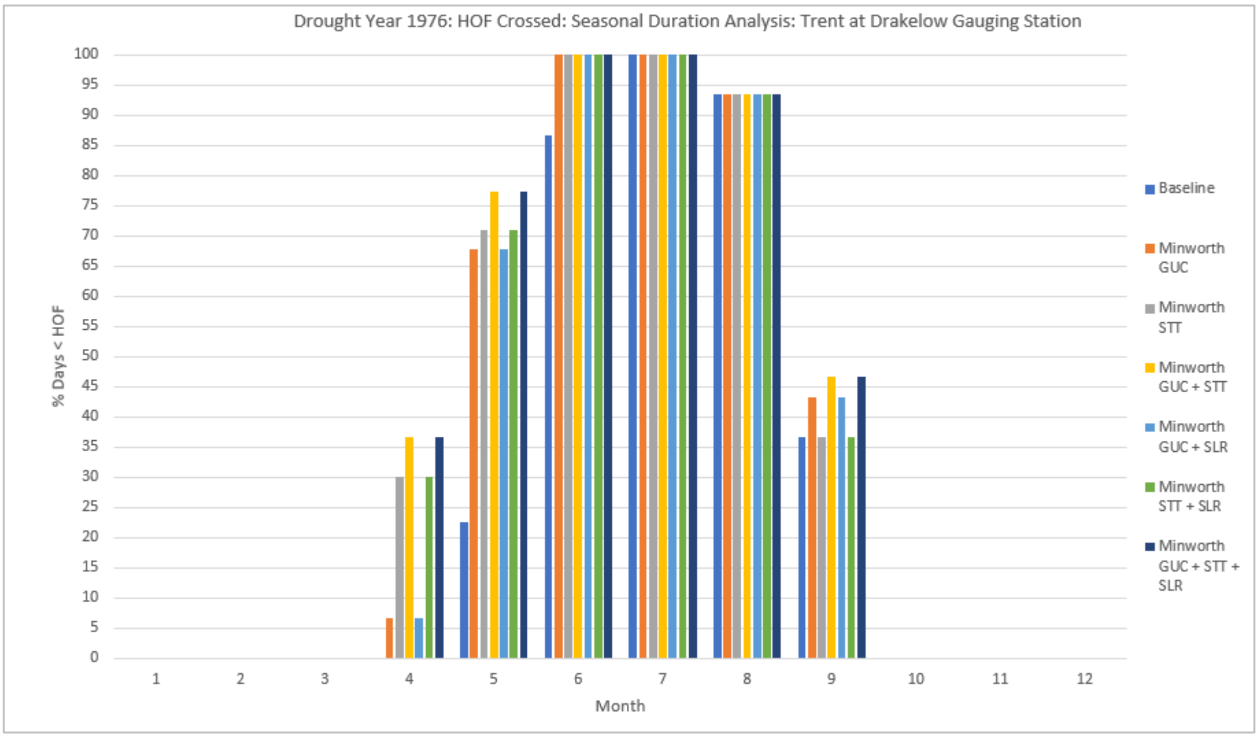


Figure 5-16: Drakelow Seasonal Duration Analysis for Drought Year 1976

5.3.3 The results show that in a drought year, the effect of operation of the SROs is relatively limited, particularly for North Muskham as the HOF is exceeded for significant periods in the baseline. However, the SROs would trigger earlier and later HOF exceedance in spring and autumn respectively at Drakelow and earlier spring exceedance for North Muskham.

5.4 1D Hydraulic modelling

Hydraulic model inflows

Minworth WwTW Discharge Representation

5.4.1 The initial simulations undertaken at Phase 3 identified that the assumption of a single discharge value from Minworth WwTW based on maximum permitted DWF was an oversimplification. It was overestimating the WwTW input for lower river flow statistics and underestimating input for higher flows resulting in the need for unrealistic tributary adjustments (reduced flow) into the model between Minworth and the Lea Marston gauge in order for the flow calibration to match.

5.4.2 A review of the input value for Minworth WwTW was therefore undertaken for different flow scenarios at Phase 4 to further improve the representation of tributary into the River Tame between Water Orton and Lea Marston (inflows from the River Blythe, River Cole and River Bourne).

5.4.3 For Phase 4, STW provided daily measured discharge volumes from Minworth between 2018 and 2021 and a review of this data showed the measured Minworth WwTW discharge to have a high variance (324 Ml/d to 1085 Ml/d), which is to be expected for a large, combined sewer catchment. As a result, there is no direct correlation between a given river flow statistic and a discharge value from Minworth WwTW. Therefore, in order to best estimate a reasonable discharge volume for Minworth WwTW for any given river flow, it was necessary to back-calculate it by comparing the nearest gauged Q flow upstream (Water Orton) and downstream of the Minworth discharge (Lea Marston) and considering all of the tributary inflows between the two gauges; tributary inflows were determined based on a mixture of gauges and Aquator outputs for ungauged tributaries.

5.4.4 The following equation has been used for any given river flow statistic:

Minworth WwTW discharge volume assumption = Lea Marston (gauge Q_x) – Water Orton (gauge Q_x) – River Bourne (Aquator Q_x) – River Blythe (Aquator Q_x) – Cole (gauge Q_x)

5.4.5 This approach is considered to the most appropriate way of reasonably varying the assumption on Minworth WwTW discharge. The following flows for Minworth WwTW have been estimated using this approach, as set out in Table 5-6; this gives a simulated discharge range of 461 Ml/d to 420 Ml/d.

Table 5-6 Calculated Discharge Volume for Minworth WwTW (values all in Ml/d)

Event	River Blythe (Aquator)	River Bourne (Aquator)	Cole (gauge)	Water Orton (gauge)	Lea Marston (gauge)	Minworth WwTW
Q10	458	106	177	812	2013	461
Q50	50	15	47	332	924	481
Q95	0	3	18	184	627	422
Q99	0	2	15	156	592	420

5.4.6 As well as varying the Minworth discharge for different river flow conditions, the representation of the Minworth WwTW discharge has been further refined within the River Tame hydraulic model in Phase 4 to split the discharge volume 50:50 via the Water Orton Lane Outfall and the Edison Road Outfall.

River Tame

5.4.7 The hydraulic model for the River Tame, which was updated during Phase 3 of the project, was re-simulated with the updated Minworth WwTW discharge representation detailed above.

5.4.8 As part of the Phase 4 works, an analysis of the impact on HOF conditions was undertaken within Aquator software, where data was available, to disaggregate the existing Aquator components to a more detailed level than previously undertaken at Phase 3.

5.4.9 Flows from the River Tame downstream of the River Anker taken from Aquator have been used to further calibrate the hydraulic model for the Q99, Q95, Q50 and Q10 events in Phase 4.

5.4.10 The final modelled flows in the River Tame hydraulic model have been calibrated to the Lea Marston flow gauge at Point 3 (within 1%) in addition to the modelled Aquator flows downstream of the River Anker at Point 5 (within 1%) and Hopwas Bridge at Point 6 (within 2%) for all events. A summary of the hydraulic model inflows for the River Tame at Phase 4 is provided in Table 5-7.

Table 5-7 Tame - hydrological inflows in baseline hydraulic model (m^3/s)

River Tame Baseline Hydrological Inflows (m^3/s)						
Model Inflow	**Type of Flow**	**Q99**	**Q95**	**Q50**	**Q10**	**Comment**
TM067777	Flow Estimate	4.231	4.576	6.625	12.064	Includes estimated Minworth WwTW discharge split 50:50 between the Water Orton Lane Outfall and the Edison Road Outfall
Minor3	Flow Estimate	2.431	2.446	2.785	2.664	
Blythe1	Sweetening Flow	0.01	0.01	0.01	0.01	
ColeTot	Sweetening Flow	0.01	0.01	0.01	0.01	
Shustoke	Sweetening Flow	0.01	0.01	0.01	0.01	
Minor4	Sweetening Flow	0.01	0.01	0.01	0.01	
Minor5	Sweetening Flow	0.01	0.01	0.01	0.01	
Minor6	Sweetening Flow	0	0.01	0.01	0.01	
Minor7	Sweetening Flow	0	0.01	0.01	0.01	
Minor8	Sweetening Flow	0	0.01	0.01	0.01	
Minor9	Sweetening Flow	0.01	0.01	0.01	0.01	
Minor10	Sweetening Flow	0.01	0.01	0.01	0.01	
NetherWhit	Sweetening Flow	0.01	0.01	0.01	0.01	
Gallows	Sweetening Flow	0.01	0.01	0.01	0.01	
ANKR0602	Sweetening Flow	0.025	0.025	0.025	0.025	
Point_2	Flow Estimate	0.074	0.118	1.171	8.428	

River Tame Baseline Hydrological Inflows (m³/s)						
Point_3 (Lea Marston)	Flow Estimate	0	0	0	0	Modelled flow has been calibrated to the Lea Marston flow gauge
Point_4	Flow Estimate	0.213	0.196	0.340	1.067	
Point_5	Flow Estimate	1.909	1.759	3.048	9.579	Modelled flow has been calibrated to the River Anker disaggregated Aquator model flow
Point_6 (Hopwas Bridge)	Flow Estimate	0.0163	0.02	0.04	0.155	Modelled flow has been calibrated to the Hopwas Bridge Aquator model flow
TM046249RB	Sweetening Flow	0.015	0.015	0.015	0.015	
TM035439LB	Sweetening Flow	0	0.055	0.05	0.05	
T1_125	Sweetening Flow	0	0.05	0.05	0.05	
TM031111RB	Sweetening Flow	0	0.05	0.05	0.05	
SWEET11	Sweetening Flow	0	0.05	0.05	0.05	
SWEET6	Sweetening Flow	0.05	0.05	0.05	0.05	
TFRC1196LB	Sweetening Flow	0	0.05	0.05	0.05	
TM024752LB	Sweetening Flow	0	0.05	0.05	0.05	
TM021944LB	Sweetening Flow	0	0.05	0.05	0.05	
SWEET15	Sweetening Flow	0	0.05	0.05	0.05	
TM022539RB	Sweetening Flow	0	0.05	0.05	0.05	
TM053703in	Sweetening Flow	0.01	0.01	0.01	0.01	
TM063876RB	Sweetening Flow	0.1	0.1	0.1	0.1	
Bourne	Sweetening Flow	0	0	0	0	
Total Flow:		9.163	9.890	14.785	34.726	
Sweetening Flow:		0.29	0.77	0.77	0.77	
Sweetening Flow Reduced:		94%	83%	83%	83%	
% Sweetening Flow in Model:		3%	8%	5%	2%	

River Trent 2

5.4.11 The flows at the River Tame / River Trent confluence in the River Trent 2 hydraulic model have been estimated using the Aquator flows at Hopwas Bridge (Point 6) and flows generated from Aquator software downstream of the River Trent (upstream of the River Tame confluence) at Yoxall.

5.4.12 At Phase 3 of the project, the River Trent downstream the River Mease confluence (Point 8) was calibrated to the Drakelow (Point 9) Aquator flows. However, the River Mease has now been calibrated to the disaggregated Aquator flows downstream of the River Mease at Phase 4 (calibrated to <0.1%). Additional inflows have been added to represent the minor tributaries of Walton and Branston within the Phase 4 hydraulic model downstream of the River Mease to account for the additional flow between the Mease and Drakelow Aquator outputs. A catchment linear regression has been used to split the additional flow. All sweetening flows have been removed from the hydraulic model. A summary of the calibrated inflows is shown in Table 5-8.

Table 5-8 Trent 2 - hydrological inflows in baseline hydraulic model (m³/s)

River Trent 2 Baseline Hydrological Inflows (m³/s)						
Model Inflow	**Type of Flow**	**Q99**	**Q95**	**Q50**	**Q10**	**Comment**
Yoxall_2	Sweetening Flow	0	0	0	0	Upstream of Tame / Trent confluence along the River Trent so inflows have been removed from model.
3161405565	Sweetening Flow	0	0	0	0	
3161411373	Sweetening Flow	0	0	0	0	
3161416632	Sweetening Flow	0	0	0	0	
M_1	Sweetening Flow	0	0	0	0	
Point_7 (Tame / Trent confluence)	Flow Estimate	12.92	13.75	22.51	54.30	The Tame / Trent confluence. Downstream flows of the Tame model plus additional Trent

River Trent 2 Baseline Hydrological Inflows (m^3/s)						
						inflow to calibrate to Drakelow Aquator flows.
BLYTHE	Sweetening Flow	0	0	0	0	
312311660	Sweetening Flow	0	0	0	0	
SOW	Sweetening Flow	0	0	0	0	
316512616	Sweetening Flow	0	0	0	0	
3161424005	Sweetening Flow	0	0	0	0	
Point_8 (Mease)	Flow Estimate	1.35	1.23	3.25	11.13	Modelled flow has been calibrated to the River Mease disaggregated Aquator model flow
Walton	Flow Estimate	0.09	0.1	0.17	0.47	Inflows added at Phase 4 using catchment linear regression to represent additional flow between River Mease and Drakelow
Branston	Flow Estimate	0.21	0.21	0.37	1.02	
Point_9 (Drakelow)	Flow Estimate	N/A	N/A	N/A	N/A	Not represented as an inflow but downstream of the Trent 2. Represented upstream of Trent 3 model as 316127740. Modelled flow calibrated to Drakelow Aquator flows.
Total Flow:		14.27	14.98	25.76	65.43	
Sweetening Flow:		0	0	0	0	
Sweetening Flow Reduced:		100%	100%	100%	100%	
% Sweetening Flow in Model:		0%	0%	0%	0%	

River Trent 3

5.4.13 The upstream Trent 3 model inflow has been calibrated to the Drakelow Aquator flows at Point 9. The Phase 4 hydraulic model has also been calibrated at the River Dove (Point 10) to the disaggregated Aquator flows (within 0.1%) as well as the Aquator flows generated downstream of Shardlow at Point 11 (<0.1%). The River Derwent at Point 12 (Trent 2) and the River Soar at Point 13 (Trent 3) inflows have been calibrated using a linear catchment regression of the flows between the Aquator flows at Shardlow and the disaggregated Aquator flows downstream of the River Soar. All sweetening flows have been removed from the hydraulic model. A summary of the Trent 3 model inflows is provided in Table 5-9.

Table 5-9 Trent 3 - hydrological inflows in baseline hydraulic model (m^3/s)

River Trent 3 Baseline Hydrological Inflows (m^3/s)						
Model Inflow	**Type of Flow**	**Q99**	**Q95**	**Q50**	**Q10**	**Comment**
316127740 (point 9 Drakelow)	Flow Estimate	14.57	15.29	26.3	66.92	Flows taken the Drakelow Aquator flows.
Point 10 (Dove)	Flow Estimate	2.28	2.45	8.72	27.33	Modelled flow has been calibrated to the River Dove disaggregated Aquator model flow
310316950	Sweetening Flow	0	0	0	0	
316122960	Sweetening Flow	0	0	0	0	
RiverDerwent	Sweetening Flow	0	0	0	0	
Point_11 (Trent @ Shardlow)	Flow Estimate	-0.17	0.23	1.88	4.34	Modelled flow has been calibrated to the Shardlow Aquator flows.
Point_12 (Derwent)	Flow Estimate	3.53	3.95	8.96	27.79	Linear regression of catchment area and flow rate used to estimate flows

River Trent 3 Baseline Hydrological Inflows (m^3/s)						
						of River Derwent and River Soar between Point 11 and Point 13 Aquator flows
Total Flow:		20.21	21.92	45.86	126.38	
Sweetening Flow:		0	0	0	0	
Sweetening Flow Reduced:		100%	100%	100%	100%	
% Sweetening Flow in Model:		0%	0%	0%	0%	

River Trent 4

5.4.14 As detailed above, the River Derwent at Point 12 (Trent 2) and the River Soar at Point 13 (Trent 3) inflows have been calibrated using a linear catchment regression of the flows between the Aquator flows at Shardlow and the disaggregated Aquator flows downstream of the River Soar. The Phase 4 Trent 4 hydraulic model has also been calibrated to the Aquator flows at Colwick (Point 16) and North Muskham (Point 17) with all modelled flows calibrated to within 0.1%. All sweetening flows have been removed from the hydraulic model. A summary of the Trent 4 model inflows is shown in Table 5-10.

Table 5-10 Trent 4 - hydrological inflows in baseline hydraulic model (m^3/s)

River Trent 4 Baseline Hydrological Inflows (m^3/s)						
Model Inflow	**Type of Flow**	**Q99**	**Q95**	**Q50**	**Q10**	**Comment**
Point_12 (Trent + Derwent)	Flow Estimate	20.21	21.92	45.86	126.38	Flows taken from downstream of the Trent 3 hydraulic model.
Trent	Sweetening Flow	0.00		0.00	0.00	
Point_13 (River Soar)	Flow Estimate	4.08	4.57	10.36	32.12	Linear regression of catchment area and flow rate used to estimate flows of River Derwent and River Soar between Point 11 and Point 13 Aquator flows. Modelled flow has been calibrated at Point 13 to disaggregated River Soar Aquator flows
Point_14 (River Erewash)	Flow Estimate	0.85	0.93	1.82	5.44	
Point_15 (Fairham Brook)	Flow Estimate	0.34	0.37	0.72	2.13	
RiverSoar	Sweetening Flow	0.00	0.00	0.00	0.00	
RiverDerwent	Sweetening Flow	0.00	0.00	0.00	0.00	
RiverLeen	Sweetening Flow	0.00	0.00	0.00	0.00	
RiverErewash	Sweetening Flow	0.00	0.00	0.00	0.00	
Point_16 (Trent @ Colwick)	Flow Estimate	0.00	0.00	0.00	0.00	Modelled flow has been calibrated to the Colwick Aquator flows.
River Devon	Flow Estimate	1.81	1.93	2.85	5.34	Inflows added to Gate 2 model to calibrate to Point 17. A linear regression has been used between catchment area and flow rate.
River Greet	Flow Estimate	0.38	0.40	0.59	1.10	
Point_17 (Trent @ N Muskham)	Flow Estimate	0.00	0.00	0.00	0.00	Modelled flow has been calibrated to the North Muskham Aquator flows.
RiverDevon	Sweetening Flow	0.00	0.00	0.00	0.00	
LatInf1	Sweetening Flow	0.00	0.00	0.00	0.00	
LatInf2	Sweetening Flow	0.00	0.00	0.00	0.00	
Total Flow:		27.67	30.12	62.20	172.51	
Sweetening Flow:		0	0	0	0	
Sweetening Flow Reduced:		100%	100%	100%	100%	
% Sweetening Flow in Model:		0%	0%	0%	0%	

Sensitivity Testing

5.4.15 Sensitivity testing of Manning's 'n' (+/- 10%) and weir coefficients (+/- 20%) for the Q95 event has been carried out following completion of model calibration in order to understand how sensitive the model results are to change and to determine the residual uncertainty of the model results. The sensitivity testing results for each model are tabulated in Appendix B.

5.4.16 The testing shows the Tame, Trent 2 and Trent 4 hydraulic models to be the least sensitive to changes in Manning's roughness or weir coefficients with percentage change of water depth, wetted perimeter, flow and velocity compared with the Baseline scenario, predominantly between 0% and 2% for each sensitivity test.

5.4.17 The Trent 3 model is the most sensitive model to change on the River Trent with percentage change typically between 1% and 5% for water depth and wetted perimeter and between 5% and 10% for velocity. However, it is worth noting that there is minimal change in flows at the sensitive reaches within the Trent 3 model for each sensitivity test.

5.4.18 Based on this analysis, the hydraulic models can be considered slightly sensitive to these parameters. The sensitivity is minor and the roughness values and weir coefficients used are deemed to be appropriate.

Scenarios

5.4.19 The 1D hydraulic models have been run for the Q10, Q50, Q95, Q99 events, for the following scenarios:

- STT or GUC max value on its own (115Ml/d loss at Minworth split 50:50 between Water Orton Lane Outfall and the Edison Road).
- STT & GUC combined max value (230 Ml/d loss at Minworth split 50:50 between Water Orton Lane Outfall and the Edison Road).
- STT & GUC & SLR (230 Ml/d loss at Minworth split 50:50 between Water Orton Lane Outfall and the Edison Road and 300 Ml/d on Lower Trent).
- SLR on its own (300 Ml/d only on Lower Trent).

Uncertainty and limitations

5.4.20 Limitations and uncertainties are outlined below which impact results and objectives of the hydraulic model.

- Daily measured discharge volumes from Minworth WwTW between 2018 and 2021 were reviewed, however, the measured discharge is observed to have a high variance (3.75 m^3/s to 12.56 m^3/s). As a result, there is no direct correlation between a given river flow statistic and a discharge value from Minworth WwTW. Therefore, it was necessary to back-calculate it by comparing the nearest gauged Q flow upstream (Water Orton) and downstream of the Minworth discharge (Lea Marston) and considering all of the tributary inflows between the two gauges. This approach is considered to the most appropriate way of reasonably varying the assumption on Minworth WwTW discharge.
- A significant number of floodplain units, reservoir units, and spill units within the hydraulic models, which are operational in the original high-flow flood models, are dry within low-flow conditions. Therefore, wherever possible, such units within the hydraulic models have been removed in order to improve model stability when reducing sweetening flows and calibrating the models. However, some of these units and associated sweetening flows still exist in the River Tame hydraulic model. It is possible that the sweetening flows on the River Tame may be slightly overestimating flow within the model.
- Due to the strategic nature of the existing hydraulic models for use in flood estimation, surveyed cross-sections are spaced relatively far apart, particularly along the River Trent (> 200m). This spacing is appropriate for the intended use of the models and is generally in line with the specification set out in the Fluvial Design Guide, however, large spacing between cross-sections can impact model stability in low flow conditions. As no survey has been

provided with the models, it is assumed that the survey used to inform the legacy models is old and therefore may not be the best representation of geometry of the river network.

- Linear regression between catchment area and flow rate was used to best estimate tributary flows where reliable gauge data or Aquator flows were not available for calibration. It is possible that this method may overestimate or underestimate tributary flows in the hydraulic models between calibrated points.
- There is uncertainty related to the use of the hydraulic models developed and calibrated for extreme high flows in Flood Modeller software to model low flows and may be limitations associated with the accuracy of the results obtained from using these models in low flow conditions.

Results

5.4.21 Appendix A Figures 1 -4 display the changes in water level, depth, velocity, wetted perimeter and flow for the four different scenarios.

- **Figure 1**: Changes in **Water Level, Depth** and **Velocity** for the following scenarios:
  - GUC or STT (115Ml/day loss at Minworth WwTW)
  - GUC & STT in combination (300Ml/day loss at Minworth WwTW).
- **Figure 2:** Changes in **Wetted Perimeter** and **Flow** for the following scenarios:
  - GUC or STT (115Ml/day loss at Minworth WwTW)
  - GUC & STT in combination (300Ml/day loss at Minworth WwTW).
- **Figure 3:** Changes in **Water Level**, **Depth** and **Velocity** along the Lower Trent for the following scenarios:
  - SLR, GUC & STT in combination
  - SLR
- **Figure 4:** Changes in **Wetted Perimeter** and **Flow** along the Lower Trent for the following scenarios:
  - SLR, GUC & STT in combination
  - SLR

5.4.22 MS Excel workbooks of the Phase 4 hydraulic model results are included in Appendix B.

Flood Flow Assessment

5.4.23 In addition to the low flow scenarios, the parallel environmental assessment project had identified the need to consider whether the operation of the SROs could impact on the frequency of out of bank flows, given the importance of inundation to some of the water dependent habitat located in the floodplain of the study river systems.

5.4.24 The mean annual maxima flood (QMED) flow was used as an indicator of the flow at which the study river systems would be at, or slightly above bank full, to determine whether operation of the SROs would then be likely to significantly reduce water level to prevent (or reduce the timing of the onset of) flooding.

5.4.25 An analysis was undertaken for the gauging stations at Lea Marston (Tame) and Drakelow (Trent) using the rating curves reported within the stage-discharge rating review reports for both gauging stations. The aim of this analysis is to calculate a reasonable estimate for the difference in river stage when the SROs are abstracted from QMED flows.

5.4.26 Rating curves for both gauging stations were used to confirm the relationship between flow and stage for high flows. These rating curves were taken from Flow Derivation Method Review reports produced by the Environment Agency. For Drakelow, Rating number 10.v1 (Section 2) was used and for Lea Marston Lakes Rating number 3.v1 (Section 2) was used. The rating curve equations were rearranged to calculate stage from a given flow. QMED flows values were taken from the NRFA website and the corresponding stage was calculated.

5.4.27 To represent the maximum possible abstraction for the Minworth GUC + STT SRO, 230 Ml/d was subtracted from QMED at both gauging stations and the new stages were calculated from the reduced flow values. To represent either the Minworth GUC or the Minworth STT SRO being abstracted, 115 Ml/d was subtracted from QMED and again the stages were calculated for the reduced flow values. These results are summarised in Table 5-11.

Table 5-11 QMed Analysis: SROs impact on stage for QMed flow at Drakelow and Lea Marston Lakes

Gauging Station	Flow – QMed (m^3/s)	Stage for QMed (m)	Flow - Minworth GUC or STT (m^3/s)	Stage for GUC or STT (m)	Flow – Minworth GUC + STT (m^3/s)	Stage for GUC + STT (m)
Drakelow	177	2.88	175.67	2.87	174.34	2.87
Lea Marston Lakes	118	1.63	116.67	1.63	115.34	1.63

5.4.28 The results show that the SROs will have a minimal impact on river stage when applied to QMED flows. The maximum difference at Drakelow is estimated to be 10mm for the Minworth GUC+STT SRO. Therefore, it can be concluded that the SRO abstractions are too small to influence river level at high flows and hence will not significantly alter the frequency with which the rivers overtop onto the floodplain.

5.5 2D modelling

5.5.1 2D models have been developed for three locations: Lea Marston Lakes (River Tame), Tamworth (River Tame) and Winshill (River Trent). Details of the 2D modelling approach and results are documented in a separate 2D Modelling Report (Appendix D).

6. Summary and Next Steps

6.1 Summary

6.1.1 A hydrological and hydraulic modelling exercise has been undertaken to identify the impact of operating the GUC, STT and SLR SROs on flow and hydraulic conditions within the Rivers Tame and Trent. The modelling has considered each SRO in isolation and in combination and has been used to identify the impact on abstraction licence operation with respect to HOFs (included in this report) and to support environmental assessment in a parallel exercise[9] completed and reported for the RAPID Gate 2 process.

6.1.2 The process has involved updating and/or adapting existing models. An existing Aquator model of the Tame and Trent system has been used to simulate changes in flow using historical data sets, with an exercise undertaken to increase the number of localities at which flow changes can be extracted from the model. Additionally, operation of the SROs has been represented in the Aquator modelling through the use of estimates of SRO utilisation seasonally and in response to river flow conditions, derived from a combination of demand assumptions and simulations of water resource models.

6.1.3 Existing 1D hydraulic models of the Tame and Trent, originally built for flood modelling, have been adapted to improve spatial representation of the channel geometry, improve model stability at low flows and focus on in-bank flows. A low flow calibration exercise has been undertaken using a combination of gauged data and Aquator simulations. The 1D model has been used to simulate changes in water level/depth, wetted perimeter and width averaged velocity as a result of SRO operation throughout the study river system.

6.1.4 Additionally, discrete 2D in-stream models have been constructed for three locations where fish passage over structures has the potential to be impacted by SRO operation; these models have been constructed using bathymetric survey collated for this modelling study and have produced simulations of potential width variable velocity changes over the structures as a result of operating the SROs. Details of the 2D modelling approach and results are documented in a separate 2D Modelling Report (Appendix D).

6.1.5 The hydrological analysis completed using Aquator has demonstrated that the frequency with which HOF conditions would be triggered as a result of SRO operation would increase, with a greater change shown at the Drakelow assessment point compared to North Muskham. The greatest difference in percentage of days when the HOF would be triggered between Baseline and SRO operation is around 20% for Drakelow compared to 7% for North Muskham for the worst case month (July). The change in flow percentile at which the HOF would be triggered as a result of the SRO operation also varies between the two assessment points, with a small change for North Muskham (Q94.7 to Q92.4), but a larger change for Drakelow (Q92 to Q85.9).

6.1.6 Hydraulic modelling has demonstrated the impact of the different SROs on flow conditions. Along the Tame, modelling of either the STT or GUC SRO results in change in water level of -2 to -8cm across the range of flow events modelled, with the larger changes occurring during the lower flow events (Q99 and Q95). Once joining the River Trent, the magnitude of impact consistently reduces. Reductions in water levels of circa. -5.5cm are shown to occur on the River Trent at Cherry Holme during the Q99. These reduce to circa. -4.2cm at Willington Wetlands (Q99), and downstream of Shardlow the reductions are typically less than 1cm during the Q99 event.

6.1.7 As anticipated, modelling of the STT and GUC SROs in combination displays a greater impact on water level reduction. Change in water level of -7.7cm are modelled to occur at Lea Marston Lake LWS, -15.5cm at Whitacre Heath SSSI and -17cm at Ladywalk LWS (Q99).

6.1.8 Variation in the magnitude of change between cross section locations is evident, which arises due to local variation in channel characteristics (for example geometry, gradient) and proximity to structures within the channel.

[9] Environmental Assessment for the Trent Strategic Resource Options (SRO): Minworth SRO and South Lincolnshire Reservoir (SLR) SRO: Results and Recommendations. Report to Affinity Water, Anglian Water Services Ltd and Severn Trent Water Ltd. REP-003_Summary Report. AECOM, July 2022

6.1.9 Implementation of the SLR SRO has a relatively minor effect on river hydraulic conditions in the lower part of the River Trent. Water levels are shown to reduce by up to 2cm when considering the SLR on its own, and up to 4cm when considering the SLR in combination with the STT and GUC.

6.1.10 The outputs from this hydraulic modelling exercise have been used to assess the impact on riparian priority habitats and designated sites as part of the environmental assessment for Gate 2[10].

6.2 Next Steps

6.2.1 As part of further modelling assessment into Gate 3, the following additional tasks should be considered:

- The need for further 2D modelling of weir systems within the River Trent should be considered where the environmental assessment requires additional information to effectively assess fish passage at key structures. Additional bathymetric and topographic survey would be required to support this process.
- Further adaptation of the Aquator model to represent the spatial location of abstractions, discharges and tributary inflows more accurately would be useful, subject to the availability of observed data for abstractions and discharges (and additional rainfall-runoff modelling may be required). This will allow direct simulation of expected future flows at additional locations in the river system, as opposed to relying on disaggregation calculations.
- Development of the Severn Trent Aquator model to include a more detailed representation of the South Lincolnshire Reservoir component would be a valuable enhancement. This would require data on reservoir capacity, demand profiles, abstraction licence scenarios, River Witham flows and potential operating rules for reservoir refill. This model enhancement would enable different scenarios relating to the operation of the South Lincolnshire Reservoir abstraction to be tested directly within the Severn Trent model, without the need to pass simulated outputs between two separate models. It would allow for more efficient assessment of different SRO assumptions/combinations.
- Low flow spot gauging would be useful in verifying or further calibrating the 1D and 2D model outputs.
- The use of actual observed data for individual abstractions/discharges would potentially improve the accuracy of the HOF analysis.
- Simulation of varying abstraction futures for existing licences would add additional detail to the HOF analysis, particularly in relation to the energy sector and future energy strategies.
- Further analysis on the impact of HOF abstraction cessation being implemented could be considered linked to a more detailed representation of when HOF alerts are triggered.
- Use of Stochastic hydrological datasets and application of climate change factors to determine whether operation of the SROs could have a different effect on other abstractors and/or hydraulic river conditions in a future climate scenario.
- Hydraulic modelling of flows lower than Q99 could be considered for key river reaches considered most sensitive to ecological impact. Further 2D modelling of weirs would facilitate modelling of lower flows in these specific weir locations, and for other locations, truncation of sections of the 1D model could be considered to attempt to remove stability issues likely to be encountered at flows lower than Q99.

[10] Environmental Assessment for the Trent Strategic Resource Options (SRO): Minworth SRO and South Lincolnshire Reservoir (SLR) SRO: Results and Recommendations. Report to Affinity Water, Anglian Water Services Ltd and Severn Trent Water Ltd. REP-003_Summary Report. AECOM, July 2022

Appendix A Figures

Figure 1: Changes in **Water Level, Depth** and **Velocity** for the following scenarios:

- GUC or STT (115Ml/day loss at Minworth WwTW)
- GUC & STT in combination (300Ml/day loss at Minworth WwTW).

Figure 2: Changes in **Wetted Perimeter** and **Flow** for the following scenarios:

- GUC or STT (115Ml/day loss at Minworth WwTW)
- GUC & STT in combination (300Ml/day loss at Minworth WwTW).

Figure 3: Changes in **Water Level, Depth** and **Velocity** along the Lower Trent for the following scenarios:

- SLR, GUC & STT in combination
- SLR

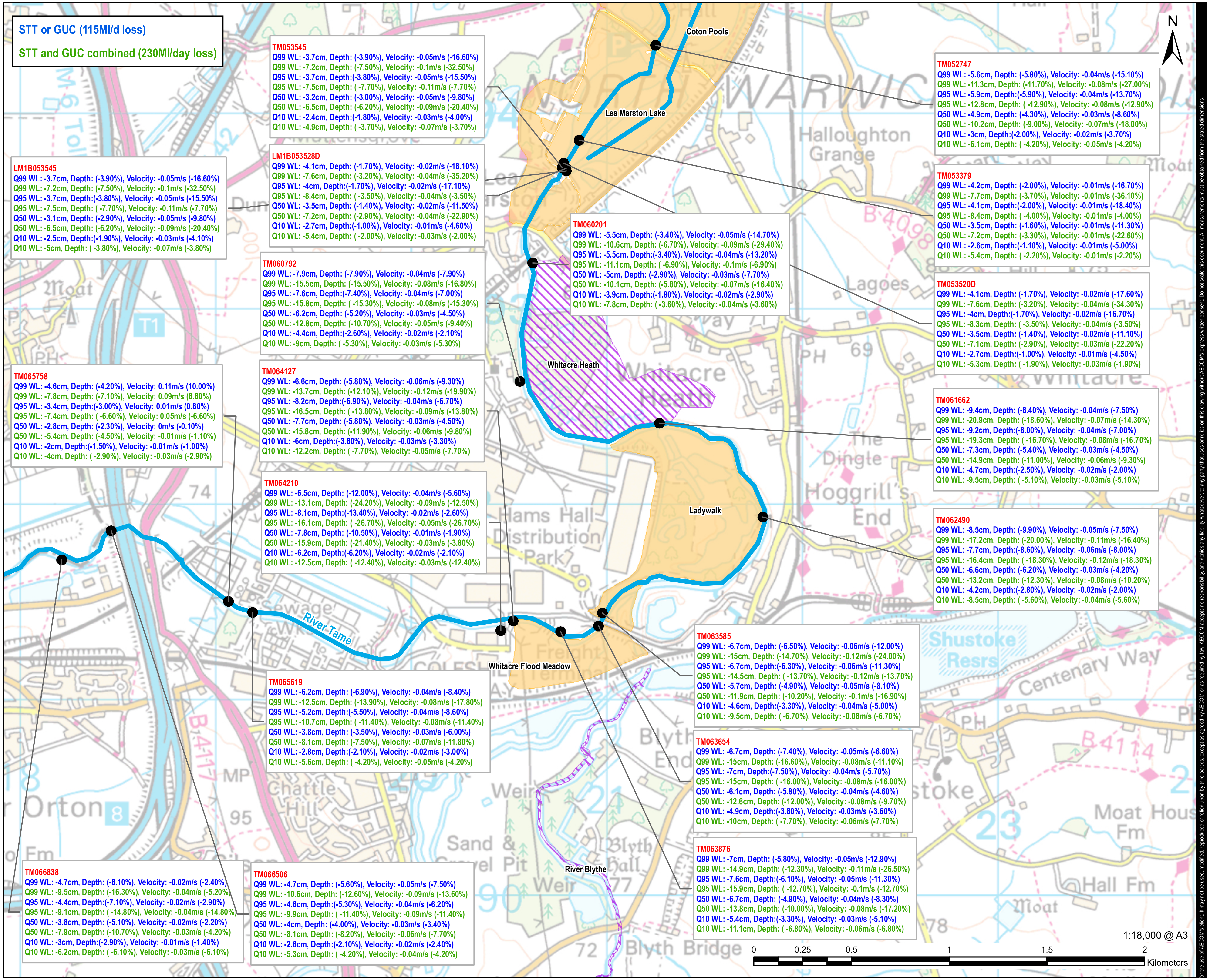
Figure 4: Changes in **Wetted Perimeter** and **Flow** along the Lower Trent for the following scenarios:

- SLR, GUC & STT in combination
- SLR

Figure 5: Schematic Outputs directly from the Aquator Model

Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON06PFPSW001\UKLON06PFPSW001-V1DPE\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure1_Q99_Q95_Q50_Q10_WaterLevel_Velocity.mxd



AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

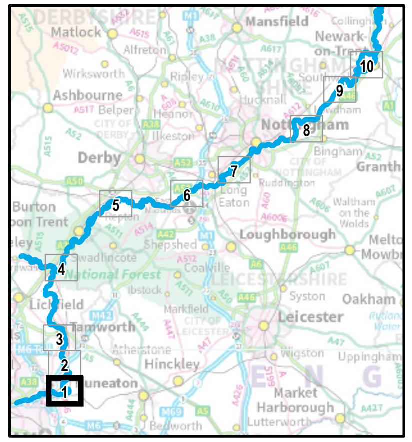
Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Tame Node
- Rivers
- Water Dependent LWS
- Water Dependent SSSI



NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Rivers Tame and Trent.
The following scenarios have been modelled: 115Ml/day loss at Minworth, corresponding to either the Severn Trent Transfer (STT) SRO, or the Grand Union Canal (GUC) SRO. 230Ml/day loss at Minworth, corresponding to STT and GUC in combination.
This figure shows the change in water level (cm), % change in depth, and change in velocity (m/s) from the baseline conditions. Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 1 of 10

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

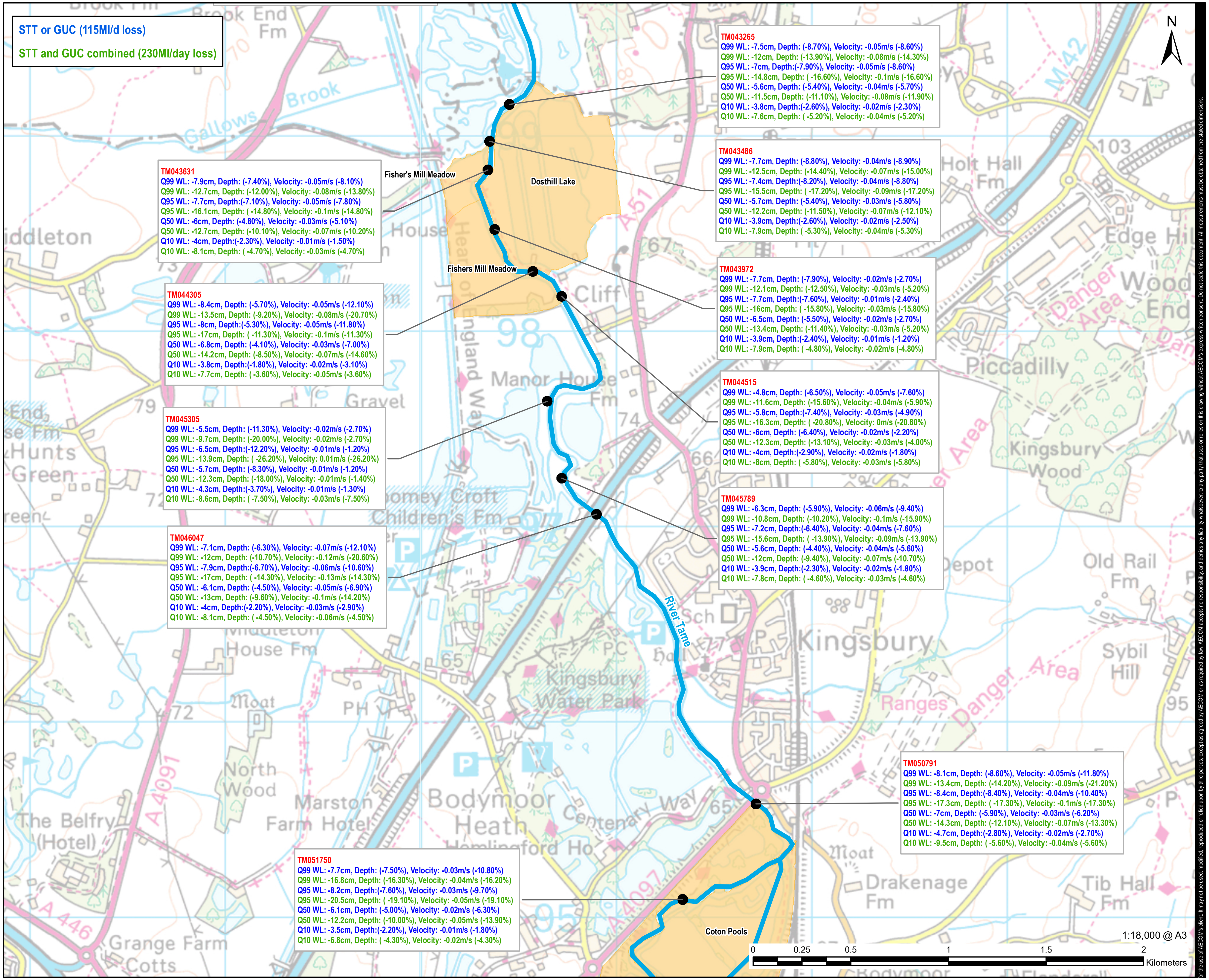
60671264

FIGURE TITLE

Changes in Water Level, Depth and Velocity (Q99, Q95, Q50, Q10) for STT and GUC

FIGURE NUMBER

Figure 1



Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON06PFPSW001\UKLON06PFPSW001-V1\DP\Projects\Tame_And_Trent\Layout\220630_Figure1_Q99_Q95_Q50_Q10_WaterLevel_Velocity.mxd

AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

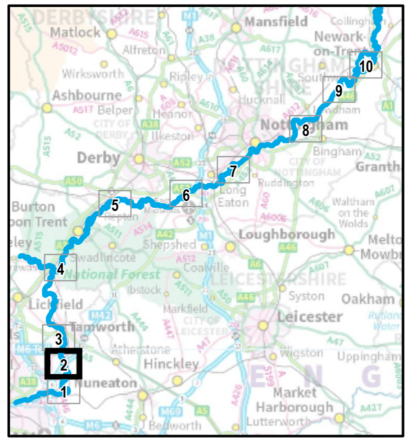
Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Tame Node
- Rivers
- Water Dependent LWS



NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Rivers Tame and Trent.
The following scenarios have been modelled: 115Ml/day loss at Minworth, corresponding to either the Severn Trent Transfer (STT) SRO, or the Grand Union Canal (GUC) SRO.
230Ml/day loss at Minworth, corresponding to STT and GUC in combination.
This figure shows the change in water level (cm), % change in depth, and change in velocity (m/s) from the baseline conditions. Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 2 of 10

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

60671264

FIGURE TITLE

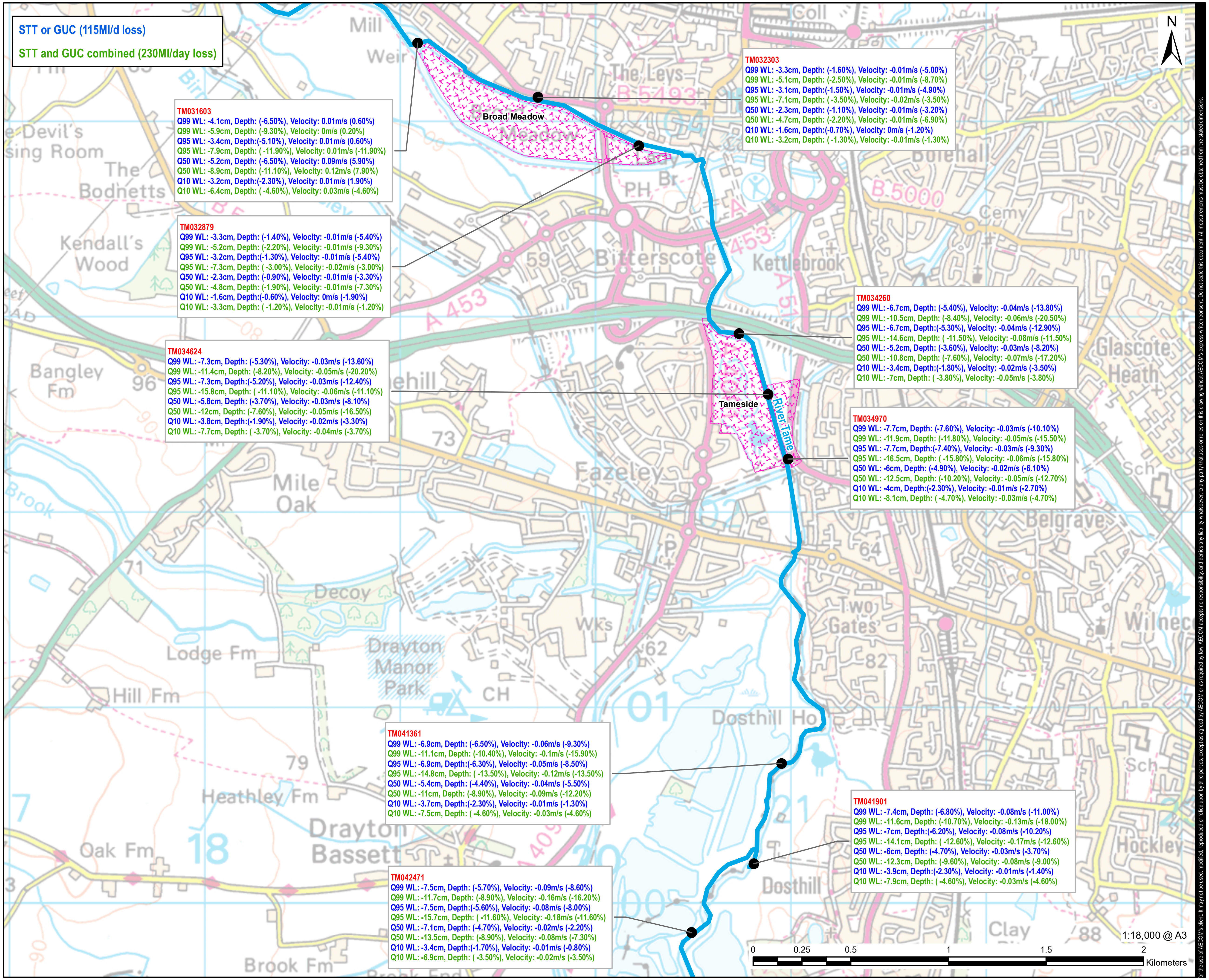
Changes in Water Level, Depth and Velocity (Q99, Q95, Q50, Q10) for STT and GUC

FIGURE NUMBER

Figure 1

Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON06PFPSW001\V1DPE\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure1_Q99_Q95_Q50_Q10_WaterLevel_Velocity.mxd



AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

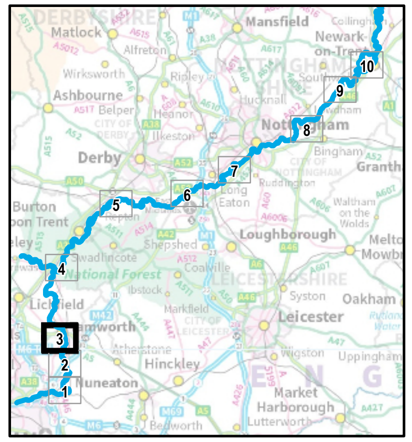
Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Tame Node
- Rivers
- Water Dependent LNR



NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Rivers Tame and Trent.
The following scenarios have been modelled: 115Ml/day loss at Minworth, corresponding to either the Severn Trent Transfer (STT) SRO, or the Grand Union Canal (GUC) SRO. 230Ml/day loss at Minworth, corresponding to STT and GUC in combination.
This figure shows the change in water level (cm), % change in depth, and change in velocity (m/s) from the baseline conditions. Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 3 of 10

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

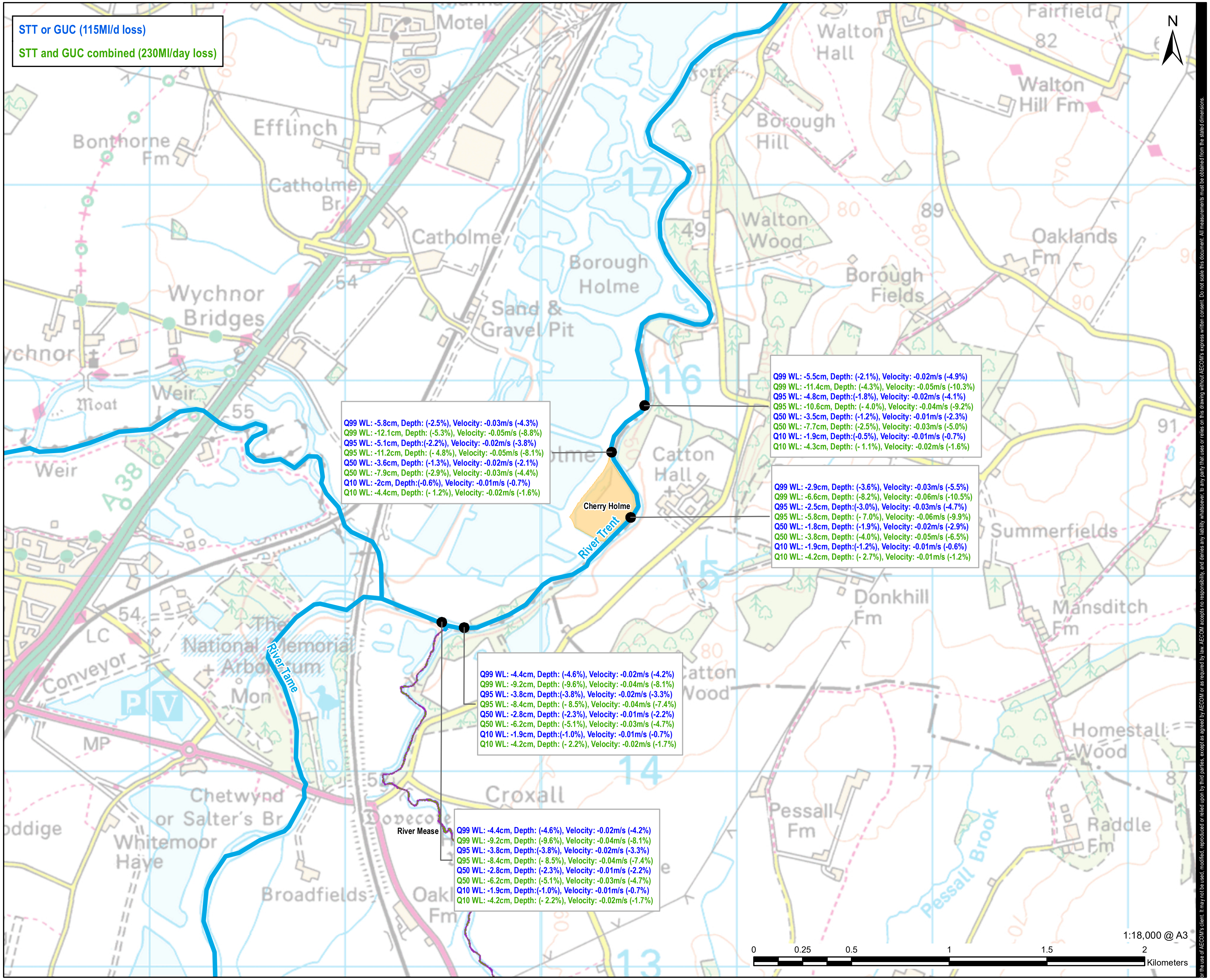
60671264

FIGURE TITLE

Changes in Water Level, Depth and Velocity (Q99, Q95, Q50, Q10) for STT and GUC

FIGURE NUMBER

Figure 1



AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

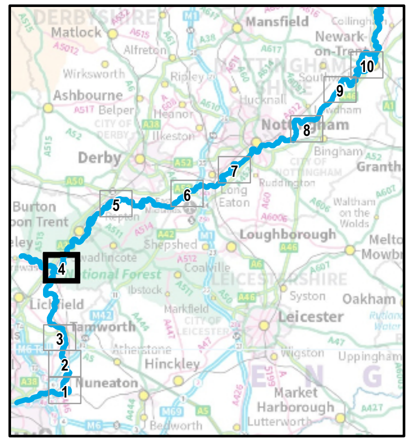
Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Trent 2 Node
- Rivers
- Water Dependent LWS
- Water Dependent SAC
- Water Dependent SSSI



NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Rivers Tame and Trent.
The following scenarios have been modelled: 115Ml/day loss at Minworth, corresponding to either the Severn Trent Transfer (STT) SRO, or the Grand Union Canal (GUC) SRO. 230Ml/day loss at Minworth, corresponding to STT and GUC in combination.
This figure shows the change in water level (cm), % change in depth, and change in velocity (m/s) from the baseline conditions. Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 4 of 10

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

60671264

FIGURE TITLE

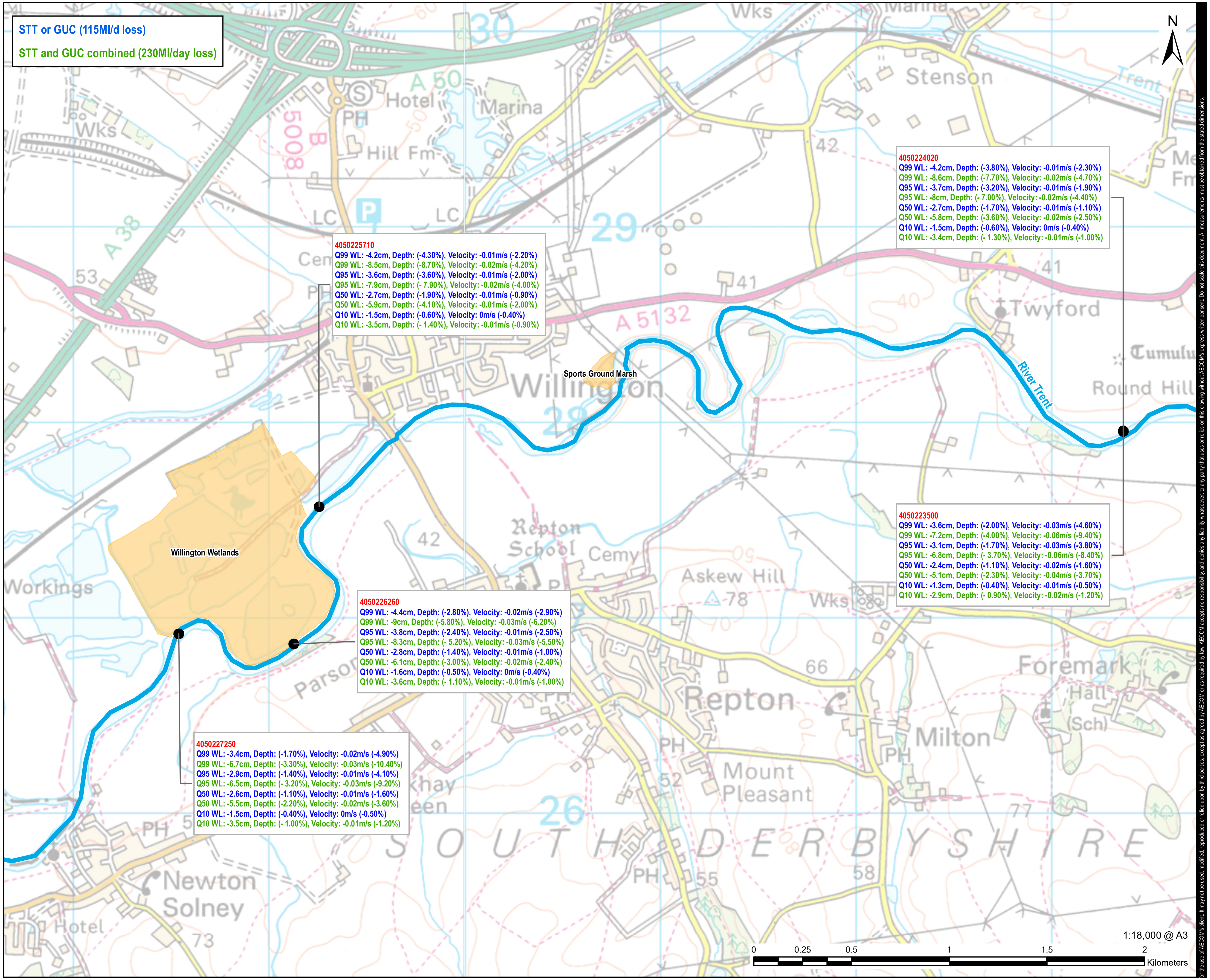
Changes in Water Level, Depth and Velocity (Q99, Q95, Q50, Q10) for STT and GUC

FIGURE NUMBER

Figure 1

Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON06PFPSW001\V1DPE\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure1_Q99_Q95_Q50_Q10_WaterLevel_Velocity.mxd



AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

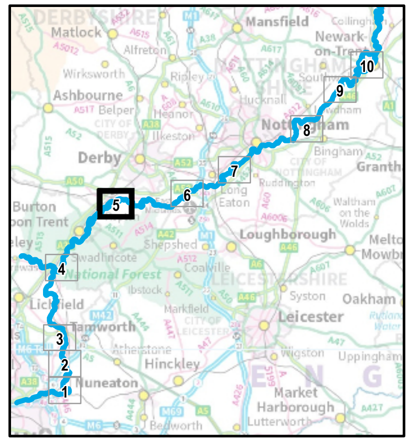
Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Trent 3 Node
- Rivers
- Water Dependent LWS



NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Rivers Tame and Trent.
The following scenarios have been modelled: 115Ml/day loss at Minworth, corresponding to either the Severn Trent Transfer (STT) SRO, or the Grand Union Canal (GUC) SRO. 230Ml/day loss at Minworth, corresponding to STT and GUC in combination.
This figure shows the change in water level (cm), % change in depth, and change in velocity (m/s) from the baseline conditions. Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 5 of 10

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

60671264

FIGURE TITLE

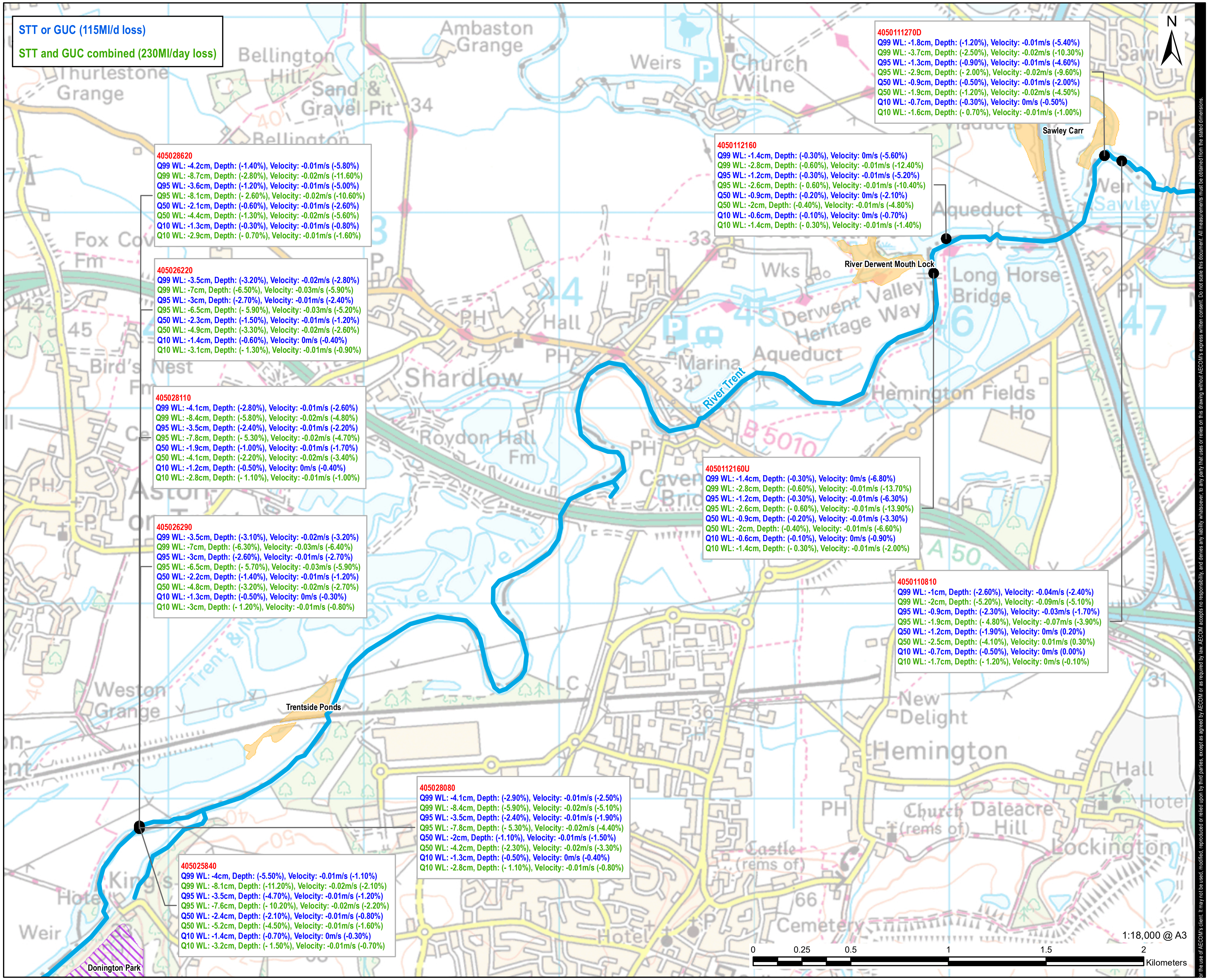
Changes in Water Level, Depth and Velocity (Q99, Q95, Q50, Q10) for STT and GUC

FIGURE NUMBER

Figure 1

Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON06PFPSW001\UKLON06PFPSW001-V1\DP\EL\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure1_Q99_Q95_Q50_Q10_WaterLevel_Velocity.mxd



AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Trent 3 Node
- Rivers
- Water Dependent LWS
- Water Dependent SSSI

NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Rivers Tame and Trent.
The following scenarios have been modelled: 115Ml/day loss at Minworth, corresponding to either the Severn Trent Transfer (STT) SRO, or the Grand Union Canal (GUC) SRO. 230Ml/day loss at Minworth, corresponding to STT and GUC in combination.
This figure shows the change in water level (cm), % change in depth, and change in velocity (m/s) from the baseline conditions. Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 6 of 10

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

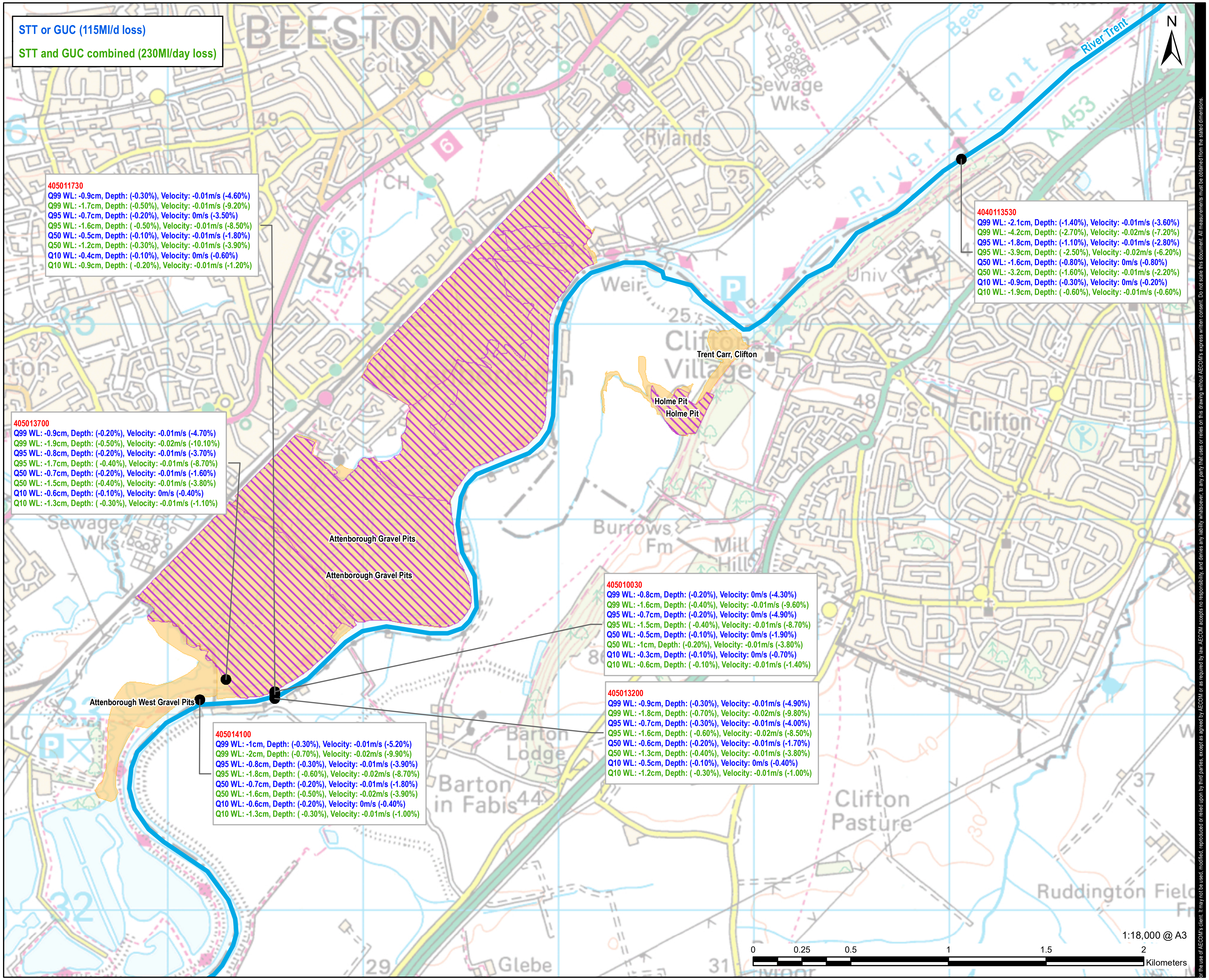
60671264

FIGURE TITLE

Changes in Water Level, Depth and Velocity (Q99, Q95, Q50, Q10) for STT and GUC

FIGURE NUMBER

Figure 1



AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

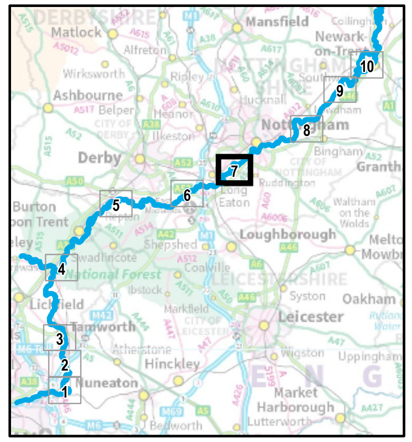
Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Trent 4 Node
- Rivers
- Water Dependent LWS
- Water Dependent SSSI



NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Rivers Tame and Trent.
The following scenarios have been modelled: 115Ml/day loss at Minworth, corresponding to either the Severn Trent Transfer (STT) SRO, or the Grand Union Canal (GUC) SRO.
230Ml/day loss at Minworth, corresponding to STT and GUC in combination.
This figure shows the change in water level (cm), % change in depth, and change in velocity (m/s) from the baseline conditions.
Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 7 of 10

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

60671264

FIGURE TITLE

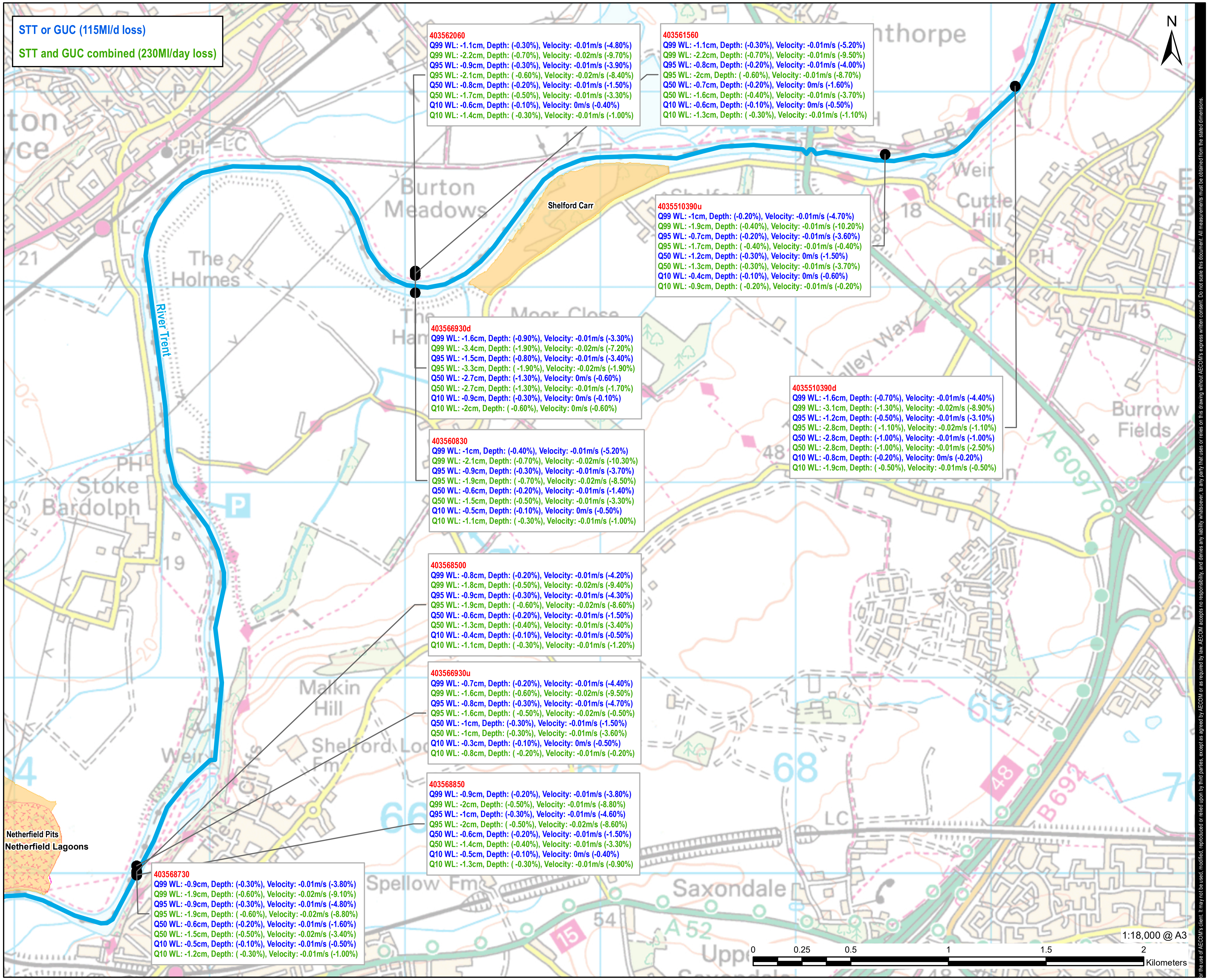
Changes in Water Level, Depth and Velocity (Q99, Q95, Q50, Q10) for STT and GUC

FIGURE NUMBER

Figure 1

Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON06PFPSW001\UKLON06PFPSW001-V1\DPEL\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure1_Q99_Q95_Q50_Q10_WaterLevel_Velocity.mxd



AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

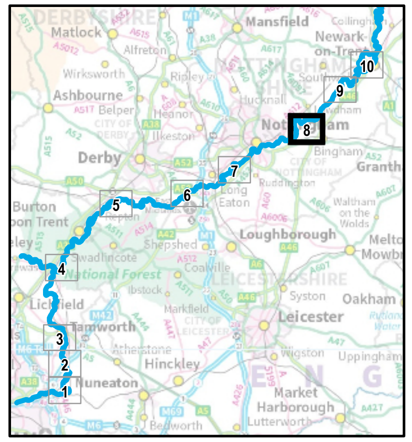
Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Trent 4 Node
- Rivers
- Water Dependent LWS
- Water Dependent LNR



NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Rivers Tame and Trent.
The following scenarios have been modelled:
115Ml/day loss at Minworth, corresponding to either the Severn Trent Transfer (STT) SRO, or the Grand Union Canal (GUC) SRO.
230Ml/day loss at Minworth, corresponding to STT and GUC in combination.
This figure shows the change in water level (cm), % change in depth, and change in velocity (m/s) from the baseline conditions.
Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 8 of 10

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

60671264

FIGURE TITLE

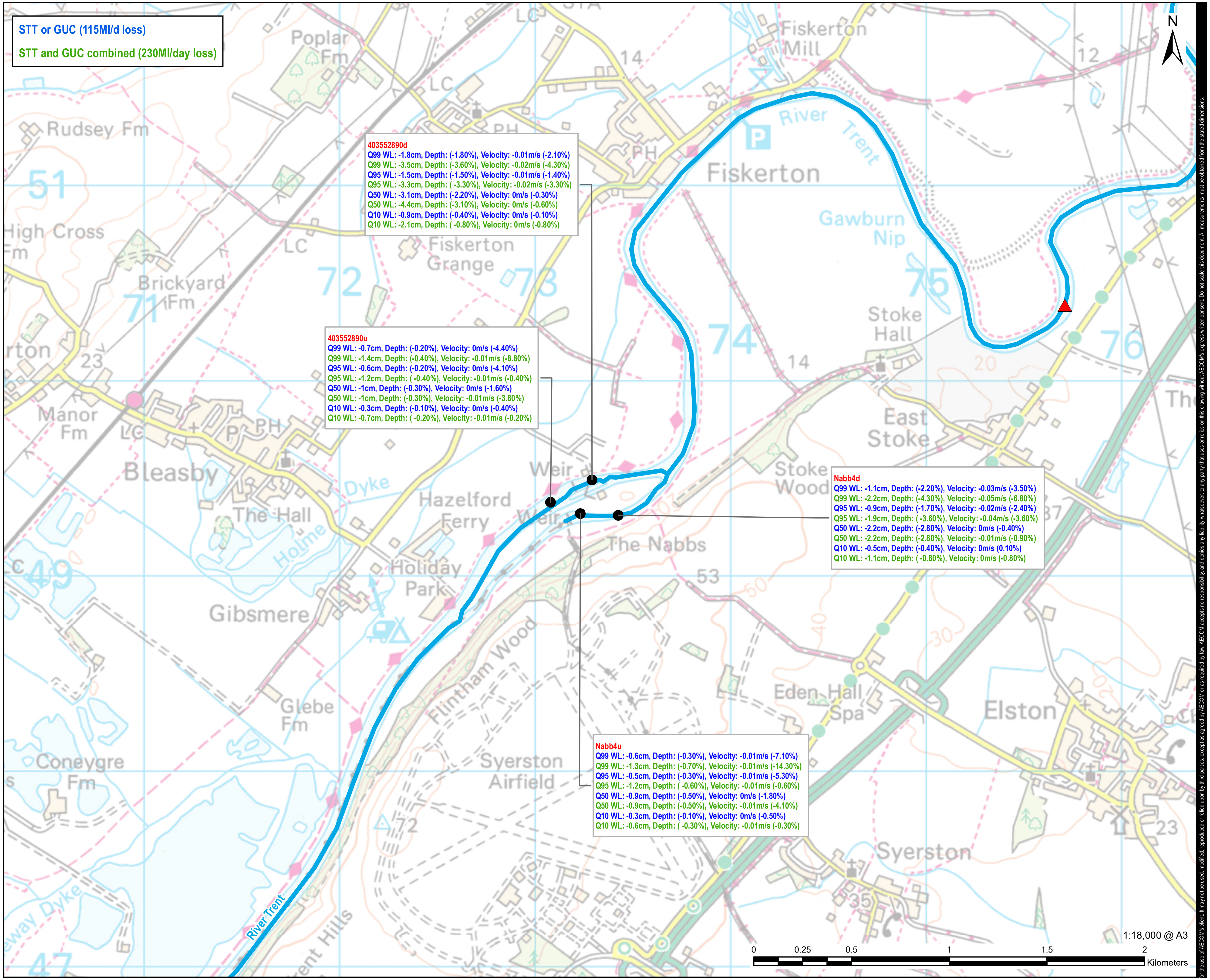
Changes in Water Level, Depth and Velocity (Q99, Q95, Q50, Q10) for STT and GUC

FIGURE NUMBER

Figure 1

Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13
Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON06PFPSW001\V1DPE\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure1_Q99_Q95_Q50_Q10_WaterLevel_Velocity.mxd

Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13



AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

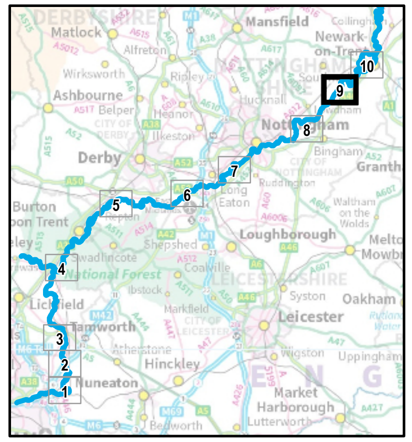
Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Trent 4 Node
- SLR
- Rivers



NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Rivers Tame and Trent.
The following scenarios have been modelled: 115Ml/day loss at Minworth, corresponding to either the Severn Trent Transfer (STT) SRO, or the Grand Union Canal (GUC) SRO. 230Ml/day loss at Minworth, corresponding to STT and GUC in combination.
This figure shows the change in water level (cm), % change in depth, and change in velocity (m/s) from the baseline conditions. Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 9 of 10

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

60671264

FIGURE TITLE

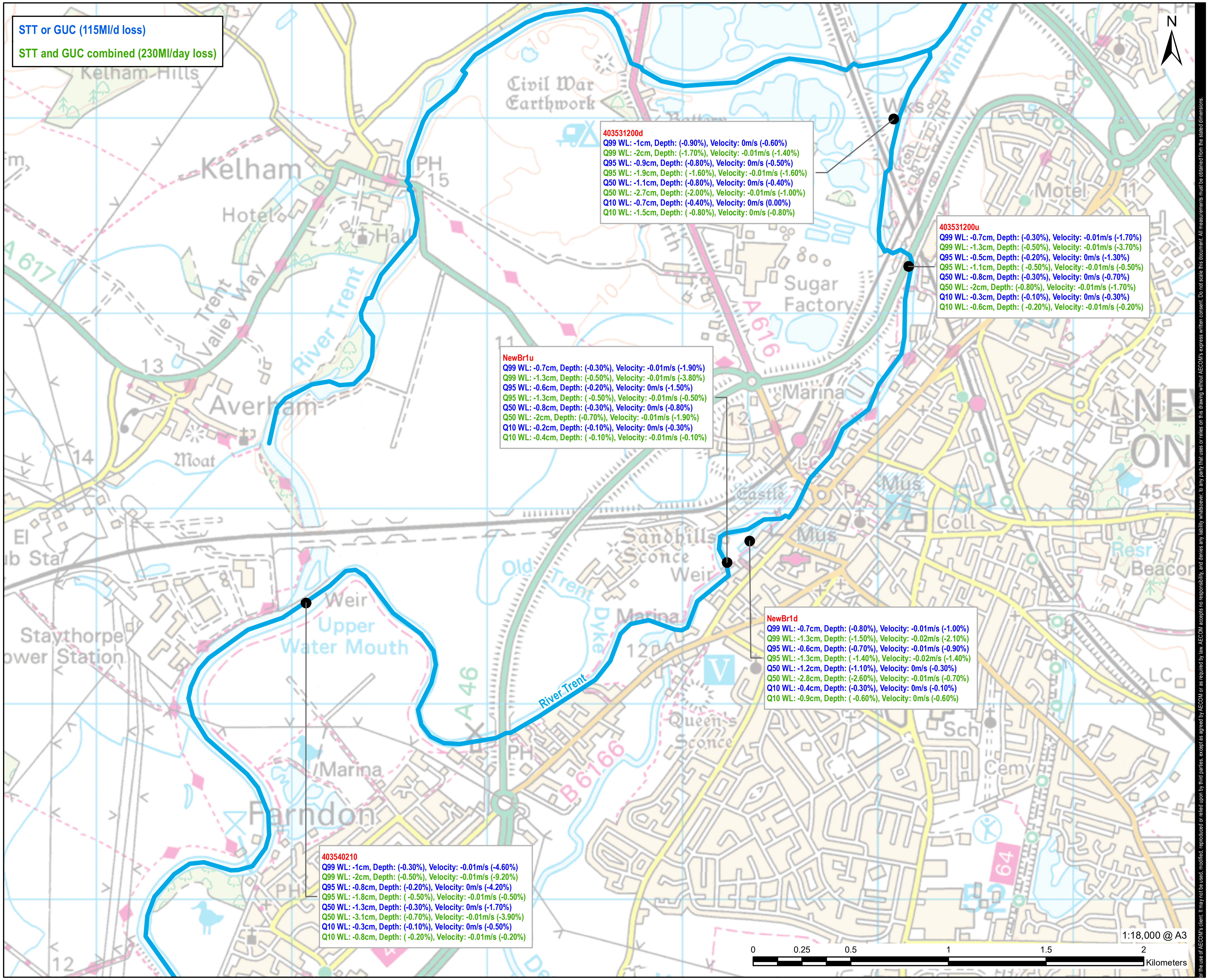
Changes in Water Level, Depth and Velocity (Q99, Q95, Q50, Q10) for STT and GUC

FIGURE NUMBER

Figure 1

Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON6PFPSW001\V1DPE\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure1_Q99_Q95_Q50_Q10_WaterLevel_Velocity.mxd



PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

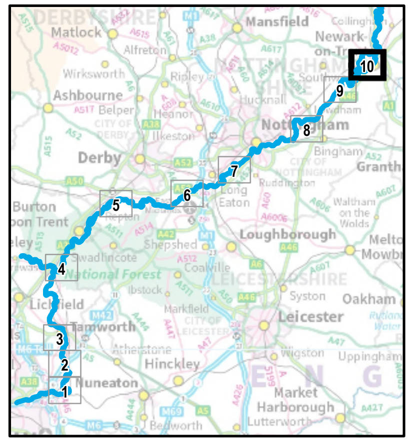
Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Trent 4 Node
- Rivers



NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Rivers Tame and Trent.
The following scenarios have been modelled:
115Ml/day loss at Minworth, corresponding to either the Severn Trent Transfer (STT) SRO, or the Grand Union Canal (GUC) SRO.
230Ml/day loss at Minworth, corresponding to STT and GUC in combination.
This figure shows the change in water level (cm), % change in depth, and change in velocity (m/s) from the baseline conditions.
Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 10 of 10

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

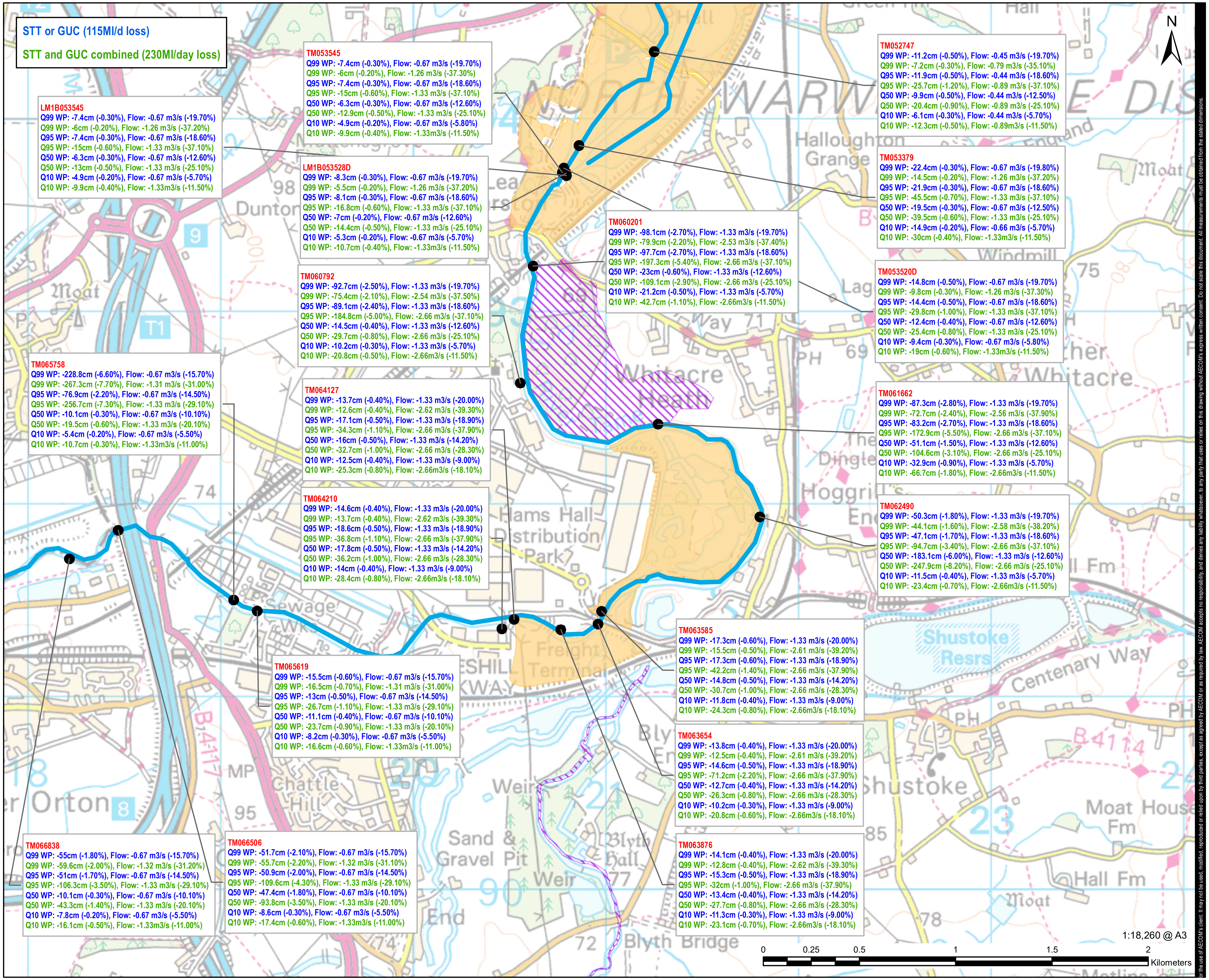
60671264

FIGURE TITLE

Changes in Water Level, Depth and Velocity (Q99, Q95, Q50, Q10) for STT and GUC

FIGURE NUMBER

Figure 1



Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON6PFPSW001\V1DPE\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure2_Q99_Q95_Q50_Q10_Wetted_Perimeter.mxd

Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13

AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Tame Node
- Rivers
- Water Dependent LWS
- Water Dependent SSSI

NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Rivers Tame and Trent.
The following scenarios have been modelled: 115Ml/day loss at Minworth, corresponding to either the Severn Trent Transfer (STT) SRO, or the Grand Union Canal (GUC) SRO.
230Ml/day loss at Minworth, corresponding to STT and GUC in combination.
This figure shows the change in wetted perimeter (m), and change in flow (m3/s) from the baseline conditions.
Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 1 of 10

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

60671264

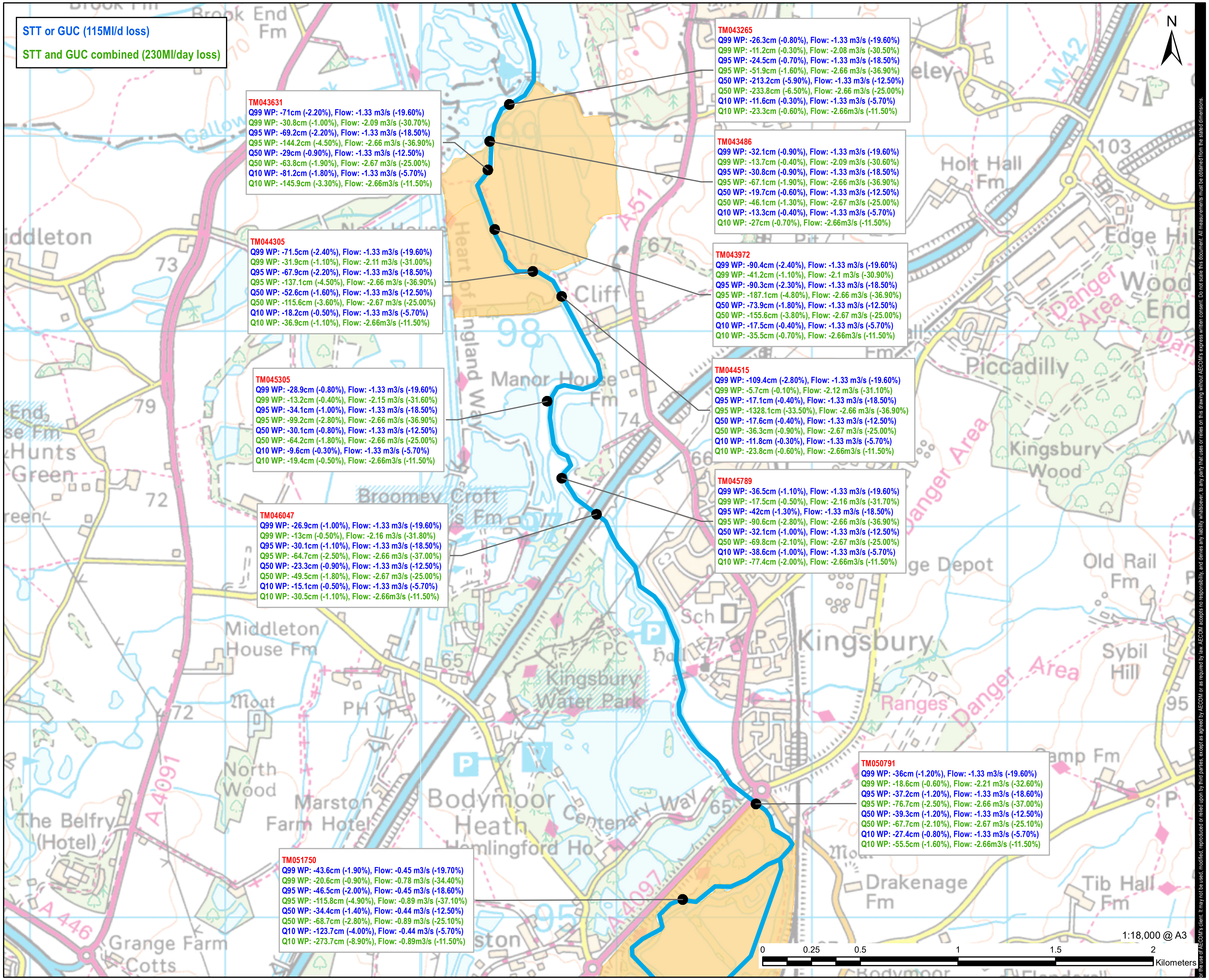
FIGURE TITLE

Changes in Wetted Perimeter and Flow (Q99, Q95, Q50, Q10) for STT and GUC

FIGURE NUMBER

Figure 2

Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13



AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Tame Node
- Rivers
- Water Dependent LWS

NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Rivers Tame and Trent.
The following scenarios have been modelled: 115Ml/day loss at Minworth, corresponding to either the Severn Trent Transfer (STT) SRO, or the Grand Union Canal (GUC) SRO. 230Ml/day loss at Minworth, corresponding to STT and GUC in combination.
This figure shows the change in wetted perimeter (m), and change in flow (m3/s) from the baseline conditions.
Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 2 of 10

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

60671264

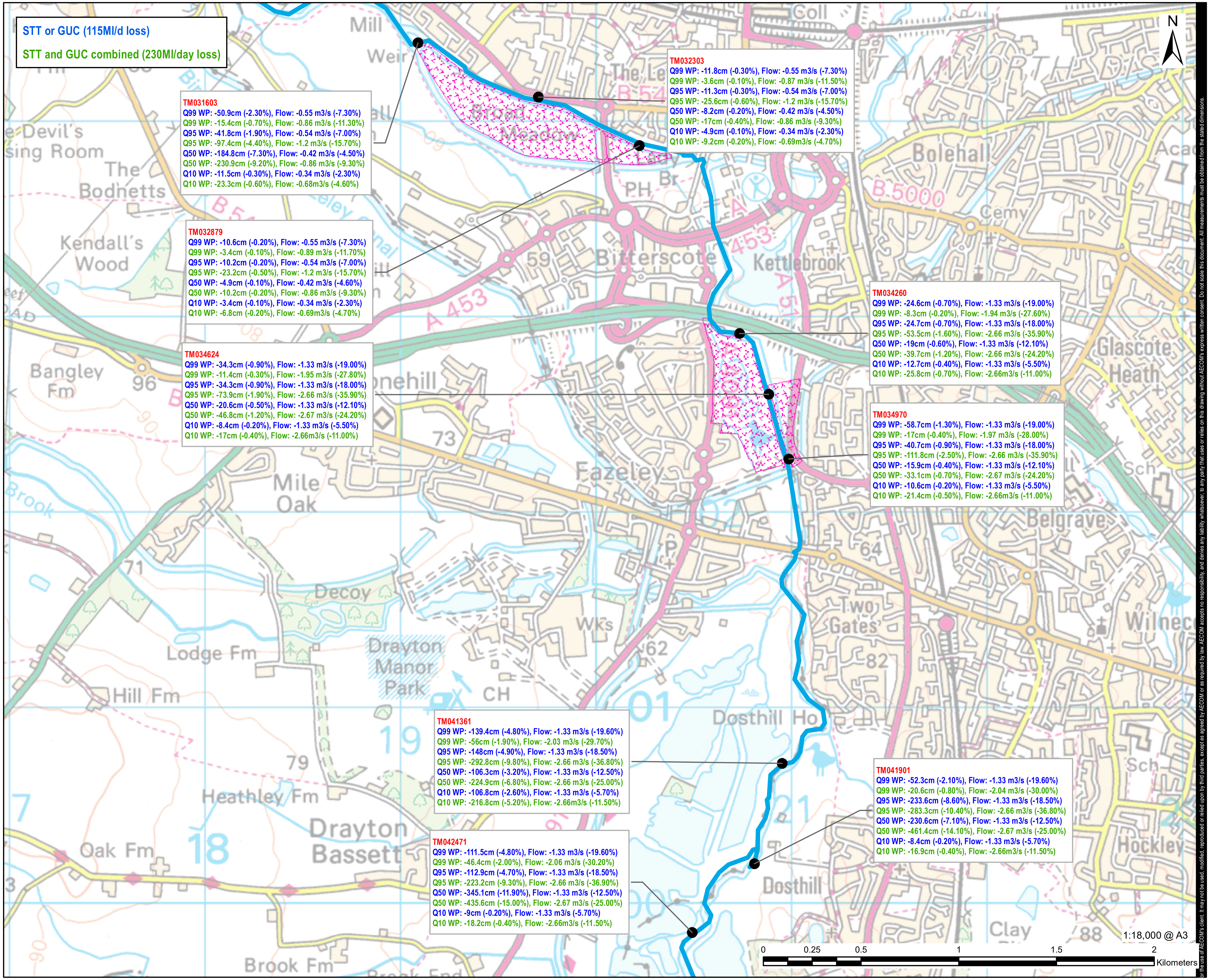
FIGURE TITLE

Changes in Wetted Perimeter and Flow (Q99, Q95, Q50, Q10) for STT and GUC

FIGURE NUMBER

Figure 2

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON6\Legacy\UKLON6PFPSW001\UKLON6PFPSW001-V1\DPE\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure2_Q99_Q95_Q50_Q10_Wetted_Perimeter.mxd



Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON06PFPSW001\UKLON06PFPSW001-V1\DPE\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure2_Q99_Q95_Q50_Q10_Wetted_Perimeter.mxd

AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

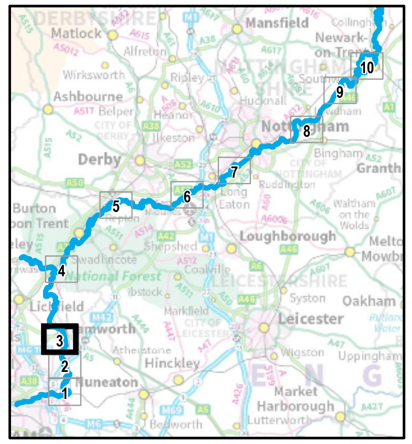
Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Tame Node
- Rivers
- Water Dependent LNR



NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Rivers Tame and Trent.
The following scenarios have been modelled: 115Ml/day loss at Minworth, corresponding to either the Severn Trent Transfer (STT) SRO, or the Grand Union Canal (GUC) SRO. 230Ml/day loss at Minworth, corresponding to STT and GUC in combination.
This figure shows the change in wetted perimeter (m), and change in flow (m3/s) from the baseline conditions.
Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 3 of 10

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

60671264

FIGURE TITLE

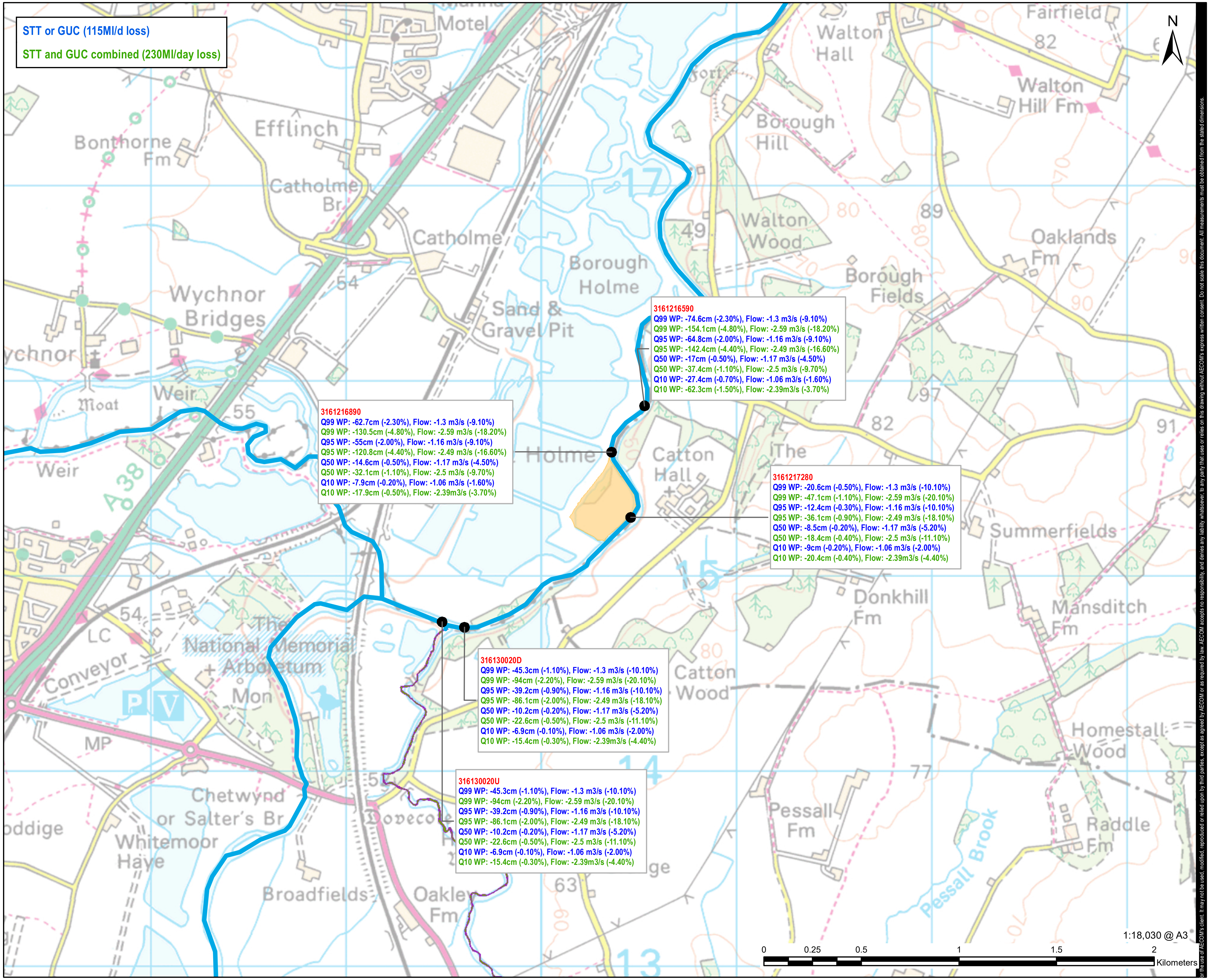
Changes in Wetted Perimeter and Flow (Q99, Q95, Q50, Q10) for STT and GUC

FIGURE NUMBER

Figure 2

Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON06PFPSW001\UKLON6PFPSW001-V1\DFE\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure2_Q99_Q95_Q50_Q10_Wetted_Perimeter.mxd



AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

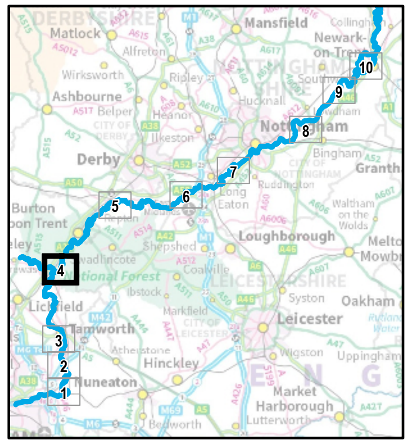
Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Trent 2 Node
- Rivers
- Water Dependent LWS
- Water Dependent SAC
- Water Dependent SSSI



NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Rivers Tame and Trent.
The following scenarios have been modelled:
115Ml/day loss at Minworth, corresponding to either the Severn Trent Transfer (STT) SRO, or the Grand Union Canal (GUC) SRO.
230Ml/day loss at Minworth, corresponding to STT and GUC in combination.
This figure shows the change in wetted perimeter (m), and change in flow (m3/s) from the baseline conditions.
Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 4 of 10

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

60671264

FIGURE TITLE

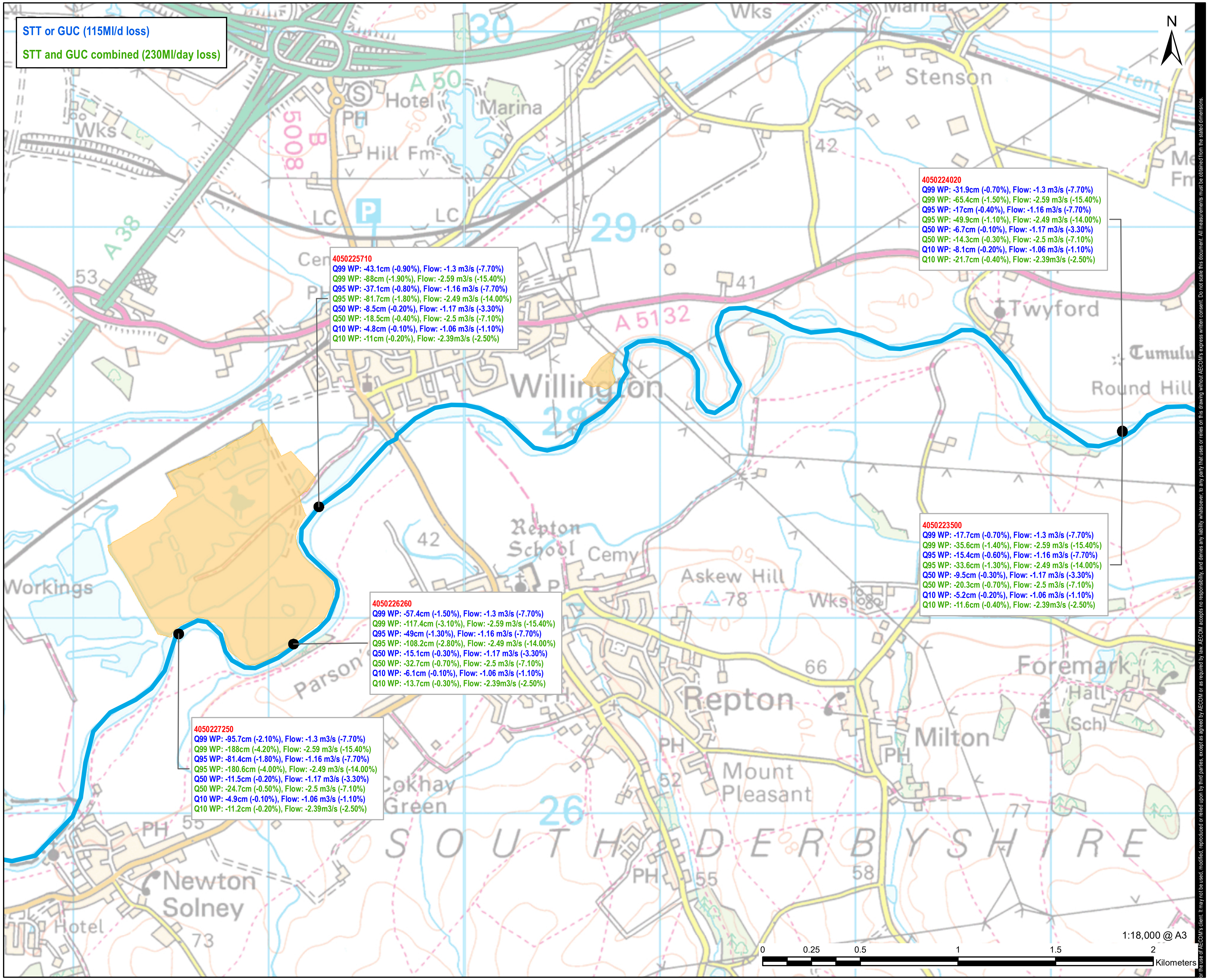
Changes in Wetted Perimeter and Flow (Q99, Q95, Q50, Q10) for STT and GUC

FIGURE NUMBER

Figure 2

Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON06FPSW001\V1DPE\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure2_Q99_Q95_Q50_Q10_Wetted_Perimeter.mxd



AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Trent 3 Node
- Rivers
- Water Dependent LWS

NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Rivers Tame and Trent.
The following scenarios have been modelled: 115Ml/day loss at Minworth, corresponding to either the Severn Trent Transfer (STT) SRO, or the Grand Union Canal (GUC) SRO. 230Ml/day loss at Minworth, corresponding to STT and GUC in combination.
This figure shows the change in wetted perimeter (m), and change in flow (m3/s) from the baseline conditions.
Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 5 of 10

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

60671264

FIGURE TITLE

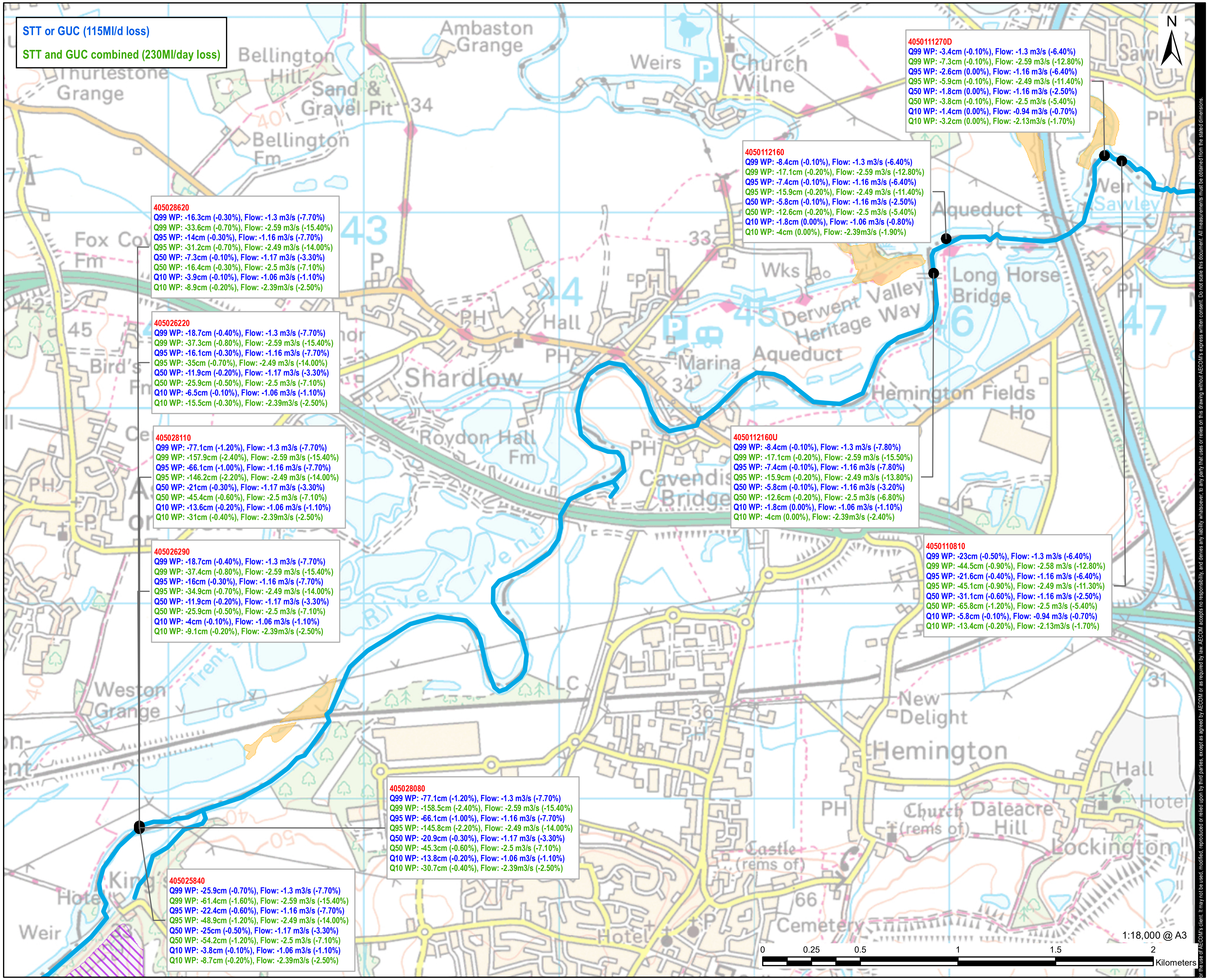
Changes in Wetted Perimeter and Flow (Q99, Q95, Q50, Q10) for STT and GUC

FIGURE NUMBER

Figure 2

Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON6FPFSW001\UKLON06FPFSW001-V1\DPE\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure2_Q99_Q95_Q50_Q10_Wetted_Perimeter.mxd



AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Trent 3 Node
- Rivers
- Water Dependent LWS
- Water Dependent SSSI

NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Rivers Tame and Trent.
The following scenarios have been modelled: 115Ml/day loss at Minworth, corresponding to either the Severn Trent Transfer (STT) SRO, or the Grand Union Canal (GUC) SRO. 230Ml/day loss at Minworth, corresponding to STT and GUC in combination.
This figure shows the change in wetted perimeter (m), and change in flow (m3/s) from the baseline conditions.
Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 6 of 10

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

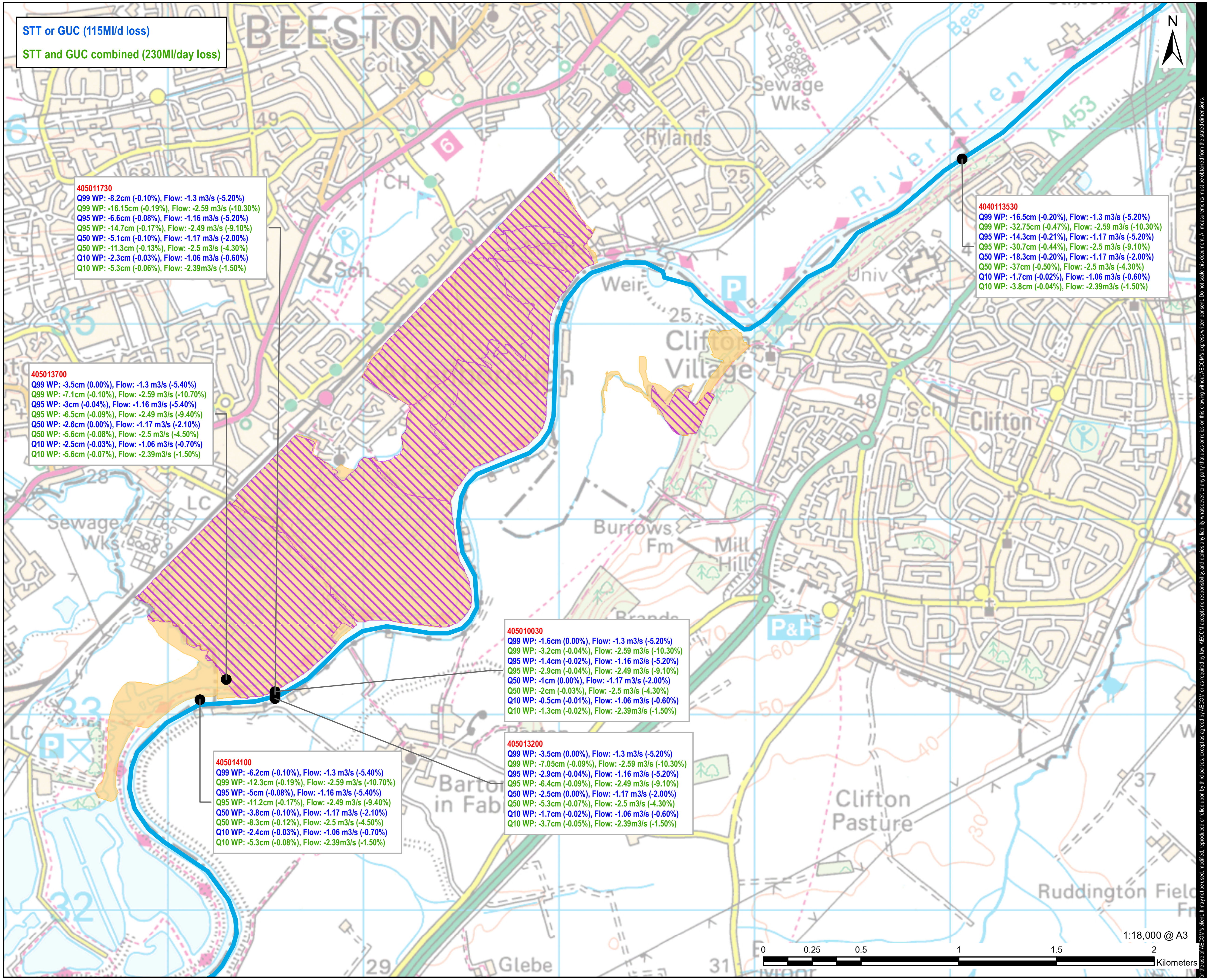
60671264

FIGURE TITLE

Changes in Wetted Perimeter and Flow (Q99, Q95, Q50, Q10) for STT and GUC

FIGURE NUMBER

Figure 2



Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON06FPSW001\UKLON06FPSW001-V1\DPE\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure2_Q99_Q95_Q50_Q10_Wetted_Perimeter.mxd

AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

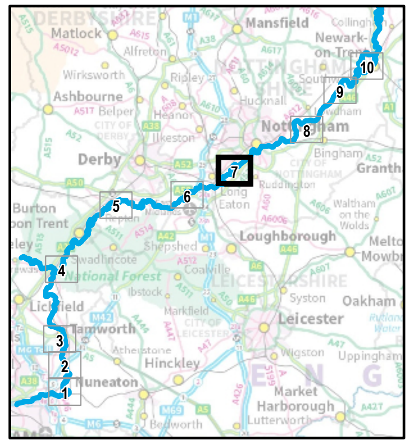
Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Trent 4 Node
- Rivers
- Water Dependent LWS
- Water Dependent SSSI



NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Rivers Tame and Trent.
The following scenarios have been modelled: 115Ml/day loss at Minworth, corresponding to either the Severn Trent Transfer (STT) SRO, or the Grand Union Canal (GUC) SRO. 230Ml/day loss at Minworth, corresponding to STT and GUC in combination.
This figure shows the change in wetted perimeter (m), and change in flow (m3/s) from the baseline conditions.
Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 7 of 10

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

60671264

FIGURE TITLE

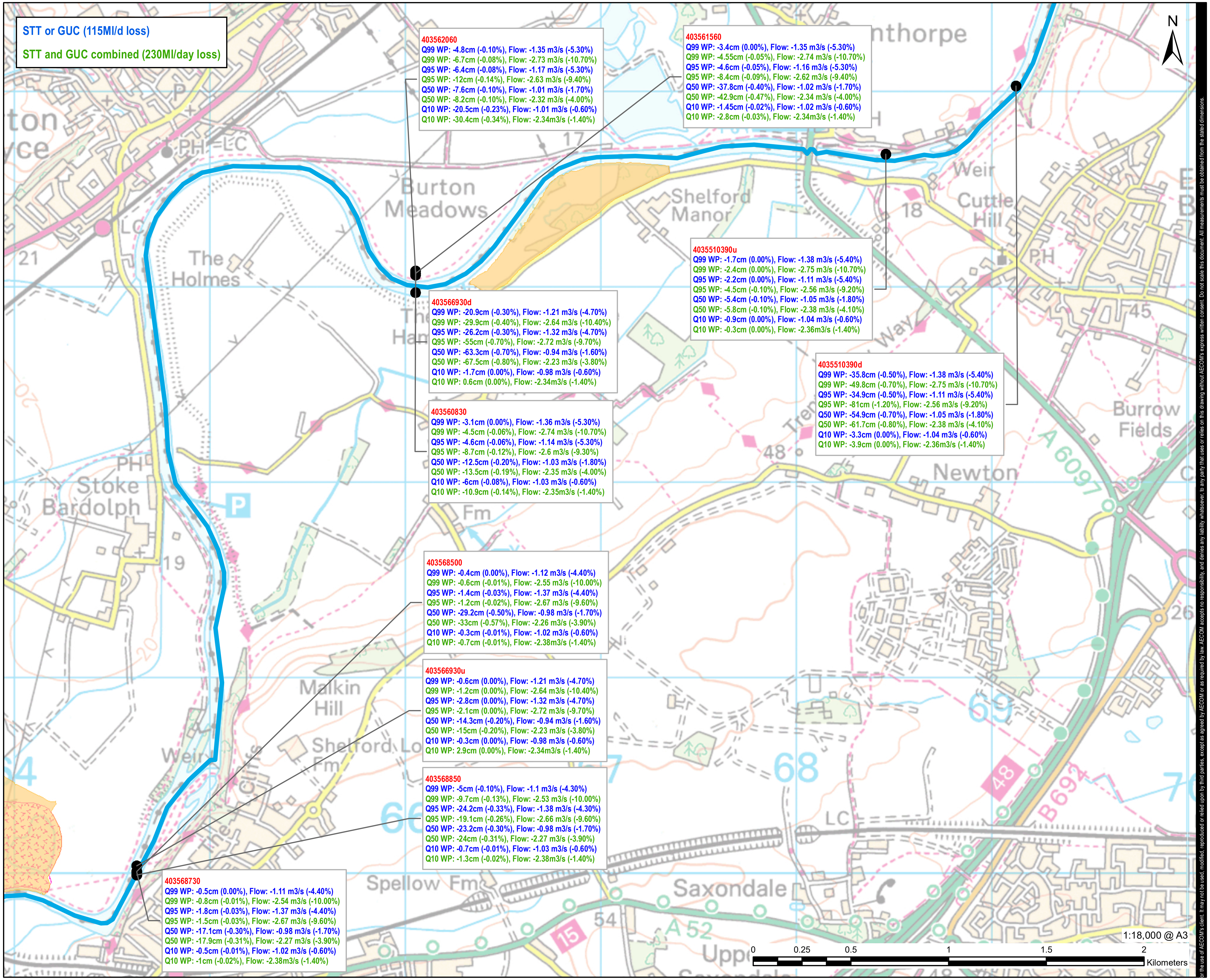
Changes in Wetted Perimeter and Flow (Q99, Q95, Q50, Q10) for STT and GUC

FIGURE NUMBER

Figure 2

Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON06PFPSW001\UKLON06PFPSW001-V1\DPE\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure2_Q99_Q95_Q50_Q10_Wetted_Perimeter.mxd



AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

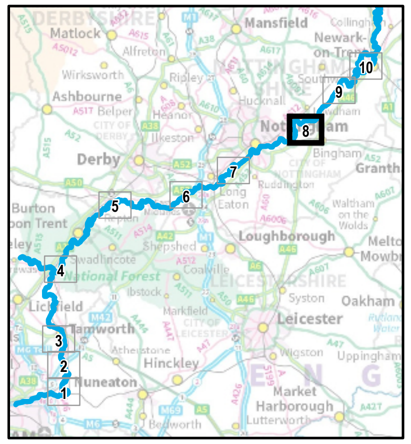
Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Trent 4 Node
- Rivers
- Water Dependent LWS
- Water Dependent LNR



NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Rivers Tame and Trent.
The following scenarios have been modelled:
115Ml/day loss at Minworth, corresponding to either the Severn Trent Transfer (STT) SRO, or the Grand Union Canal (GUC) SRO.
230Ml/day loss at Minworth, corresponding to STT and GUC in combination.
This figure shows the change in wetted perimeter (m), and change in flow (m3/s) from the baseline conditions.
Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

60671264

FIGURE TITLE

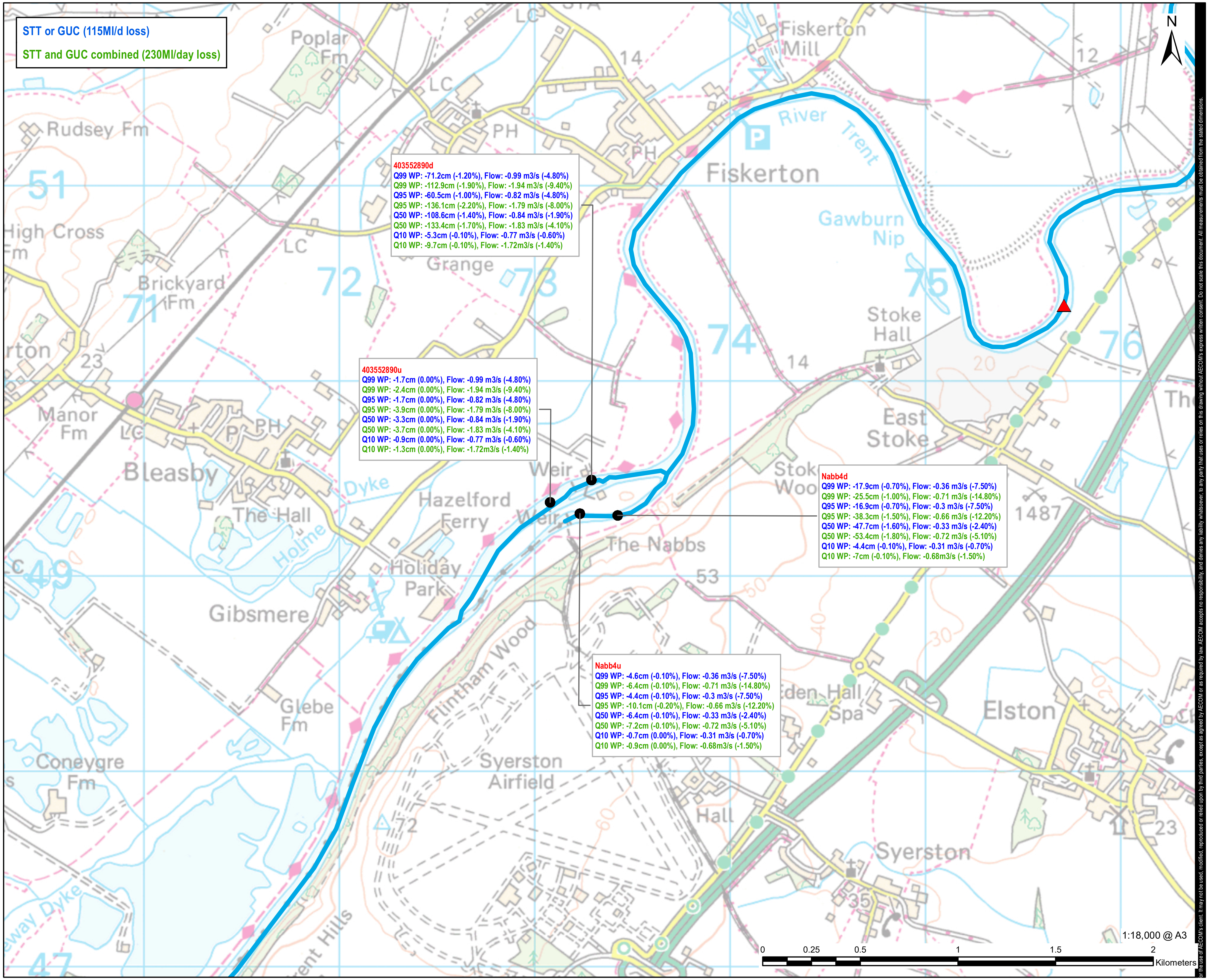
Changes in Wetted Perimeter and Flow (Q99, Q95, Q50, Q10) for STT and GUC

FIGURE NUMBER

Figure 2

Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON06PFPSW001\UKLON06PFPSW001-V1\DFE\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure2_Q99_Q95_Q50_Q10_Wetted_Perimeter.mxd



AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

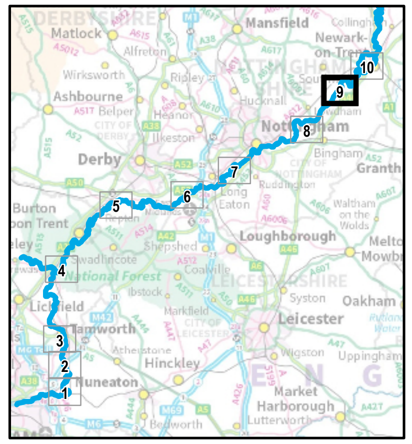
Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Trent 4 Node
- SLR
- Rivers



NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Rivers Tame and Trent.
The following scenarios have been modelled: 115Ml/day loss at Minworth, corresponding to either the Severn Trent Transfer (STT) SRO, or the Grand Union Canal (GUC) SRO. 230Ml/day loss at Minworth, corresponding to STT and GUC in combination.
This figure shows the change in wetted perimeter (m), and change in flow (m3/s) from the baseline conditions.
Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 9 of 10

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

60671264

FIGURE TITLE

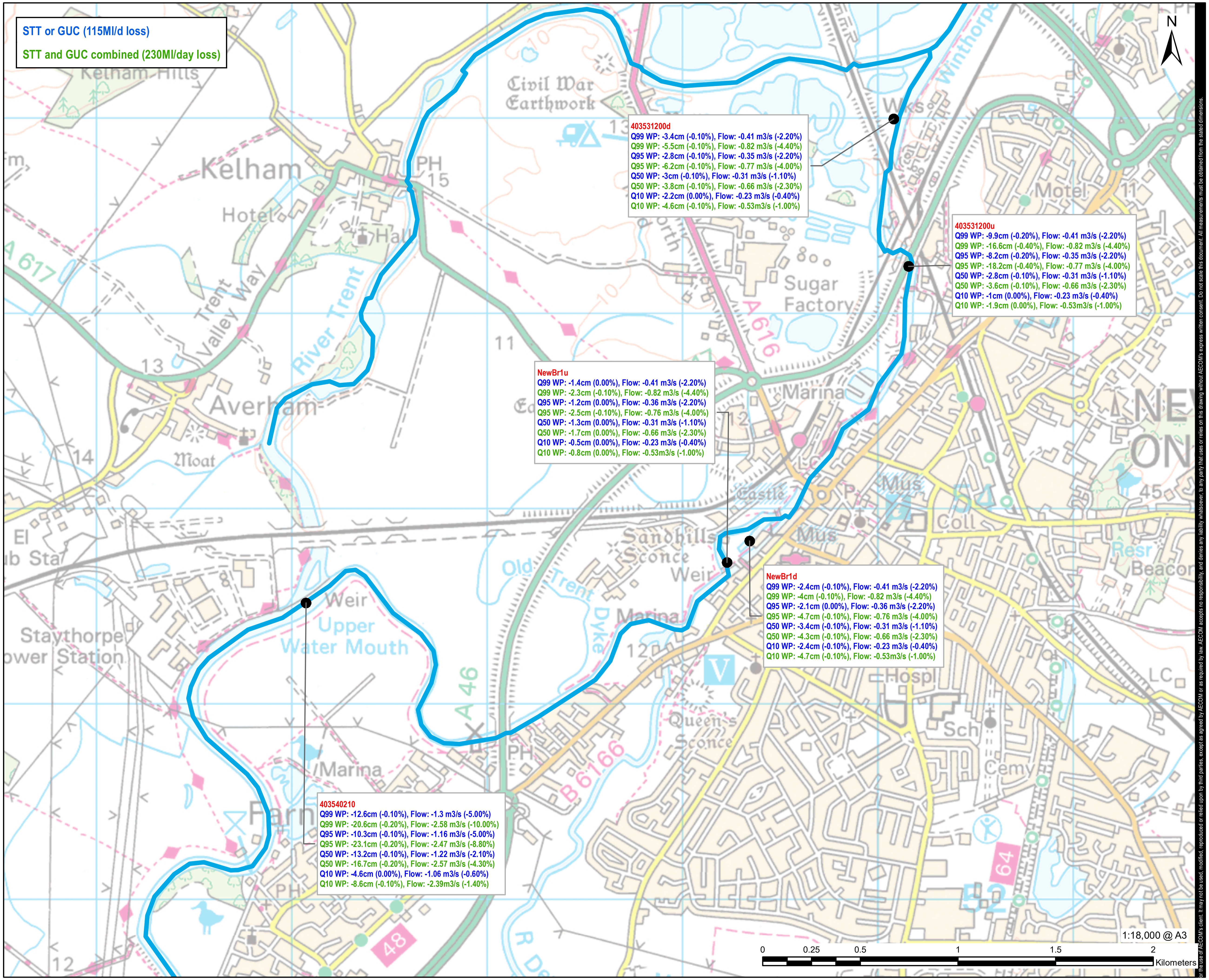
Changes in Wetted Perimeter and Flow (Q99, Q95, Q50, Q10) for STT and GUC

FIGURE NUMBER

Figure 2

Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON06PFPSW001\UKLON06PFPSW001-V1\DP\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure2_Q99_Q95_Q50_Q10_Wetted_Perimeter.mxd



...or the use of AECOM's client. It may not be used, modified, reproduced or relied upon by third parties, except as agreed by AECOM or as required by law. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that uses or relies on this drawing without AECOM's express written consent. Do not scale this document. All measurements must be obtained from the stated dimensions.

AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

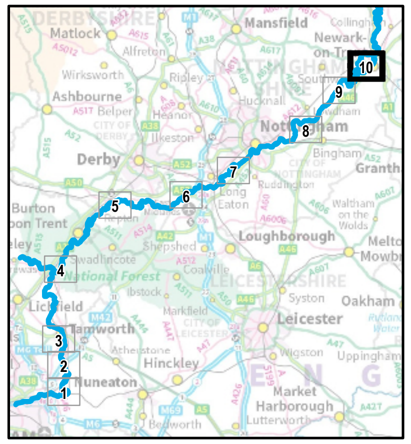
Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Trent 4 Node
- Rivers



NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Rivers Tame and Trent.
The following scenarios have been modelled: 115Ml/day loss at Minworth, corresponding to either the Severn Trent Transfer (STT) SRO, or the Grand Union Canal (GUC) SRO. 230Ml/day loss at Minworth, corresponding to STT and GUC in combination.
This figure shows the change in wetted perimeter (m), and change in flow (m3/s) from the baseline conditions.
Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 10 of 10

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

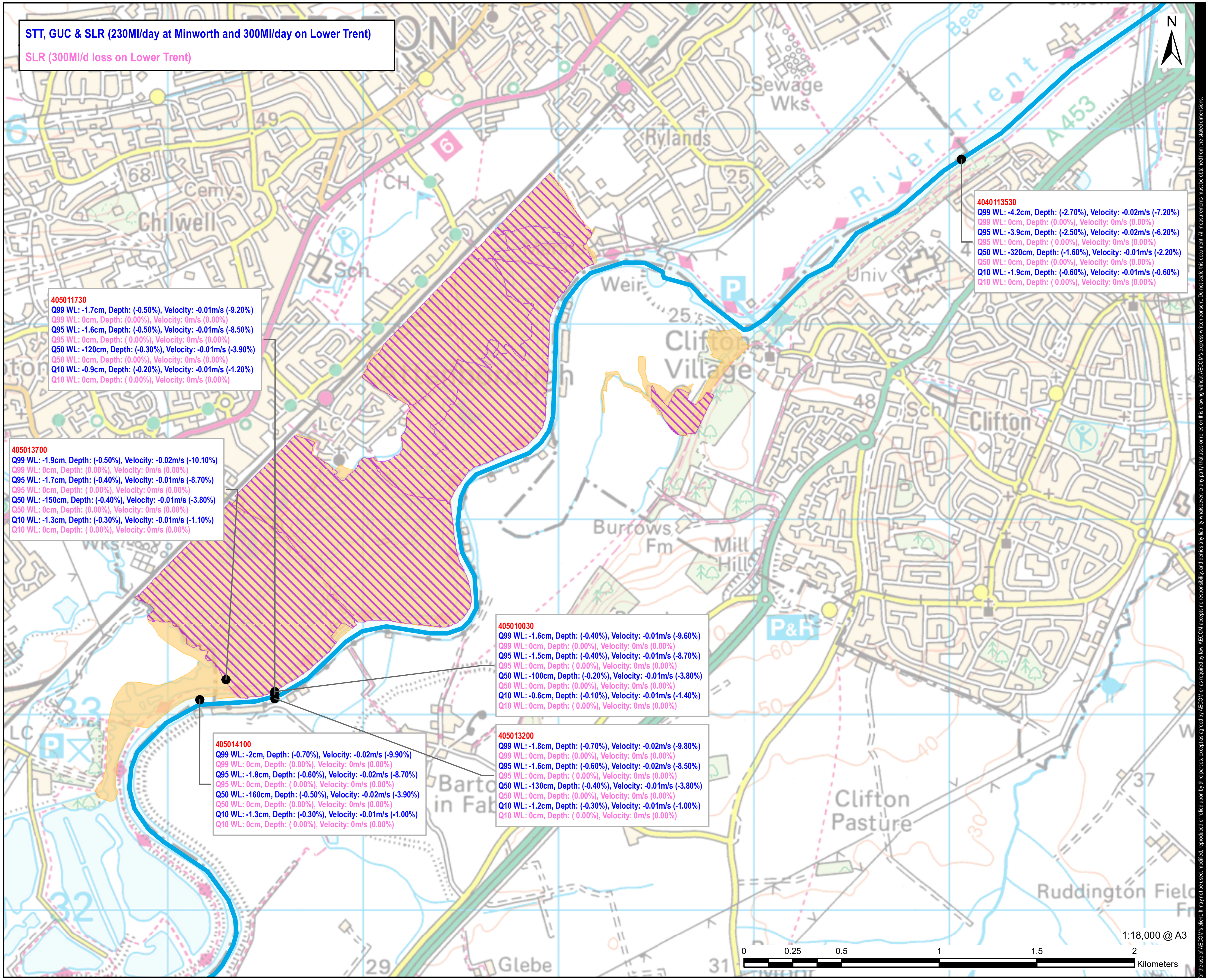
60671264

FIGURE TITLE

Changes in Wetted Perimeter and Flow (Q99, Q95, Q50, Q10) for STT and GUC

FIGURE NUMBER

Figure 2



Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON06PFPSW001\UKLON06PFPSW001-V1\DPE\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure3_Q99_Q95_Q50_Q10_WaterLevel_Velocity_TRENT4_CandD.mxd

AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Trent 4 Node
- Rivers
- Water Dependent LWS
- Water Dependent SSSI

NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Lower Trent.
The following scenarios have been modelled: 230Ml/day loss at Minworth and 300Ml/day loss on the Lower Trent for the South Lincolnshire Reservoir (SLR).
300Ml/day loss on the Lower Trent, corresponding to the SLR.
This figure shows the change in water level (cm), % change in depth, and change in velocity (m/s) from the baseline conditions. Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 1 of 4

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

60671264

FIGURE TITLE

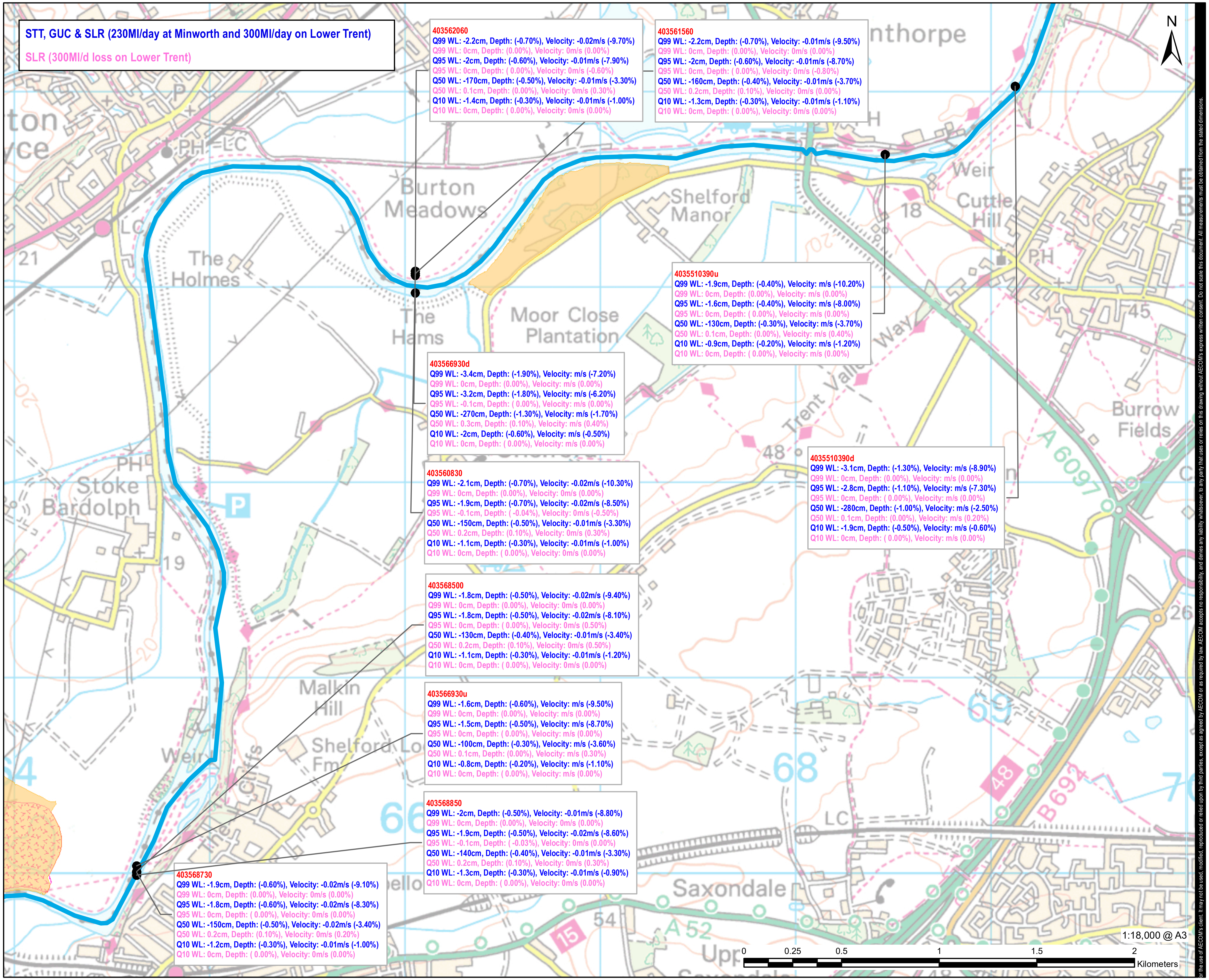
Changes in Water Level, Depth and Velocity on Lower Trent (Q99, Q95, Q50, Q10) for SLR, STT and GUC

FIGURE NUMBER

Figure 3

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON06PFPSW001-V1\DPE\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure3_Q99_Q95_Q50_Q10_WaterLevel_Velocity_TRENT4_CandD.mxd

Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13



AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Trent 4 Node
- Rivers
- Water Dependent LWS
- Water Dependent LNR

NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Lower Trent.
The following scenarios have been modelled: 230Ml/day loss at Minworth and 300Ml/day loss on the Lower Trent for the South Lincolnshire Reservoir (SLR).
300Ml/day loss on the Lower Trent, corresponding to the SLR.
This figure shows the change in water level (cm), % change in depth, and change in velocity (m/s) from the baseline conditions. Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 2 of 4

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

60671264

FIGURE TITLE

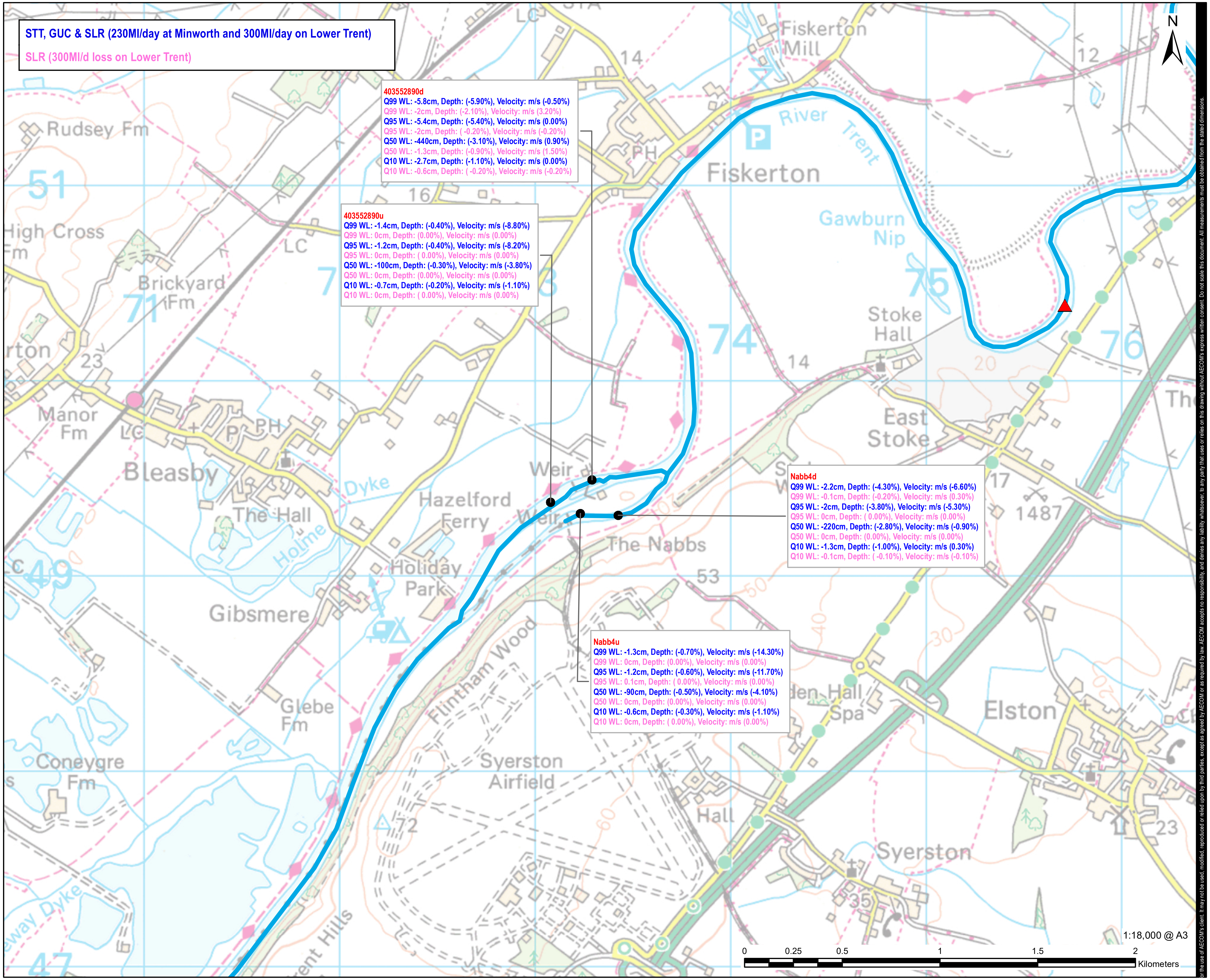
Changes in Water Level, Depth and Velocity on Lower Trent (Q99, Q95, Q50, Q10) for SLR, STT and GUC

FIGURE NUMBER

Figure 3

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON06PFPSW001-V1\DPE\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure3_Q99_Q95_Q50_Q10_WaterLevel_Velocity_TRENT4_CandD.mxd

Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13



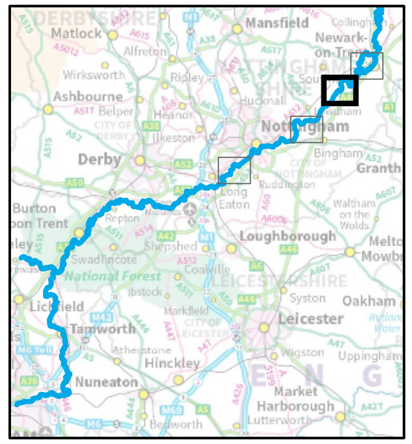
AECOM

PROJECT
Strategic Resource Options: Tame and Trent Modelling

CLIENT
Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT
Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND
- Trent 4 Node
- SLR
- Rivers



NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Lower Trent.
The following scenarios have been modelled: 230Ml/day loss at Minworth and 300Ml/day loss on the Lower Trent for the South Lincolnshire Reservoir (SLR).
300Ml/day loss on the Lower Trent, corresponding to the SLR.
This figure shows the change in water level (cm), % change in depth, and change in velocity (m/s) from the baseline conditions.
Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 3 of 4

ISSUE PURPOSE
Modelling Report

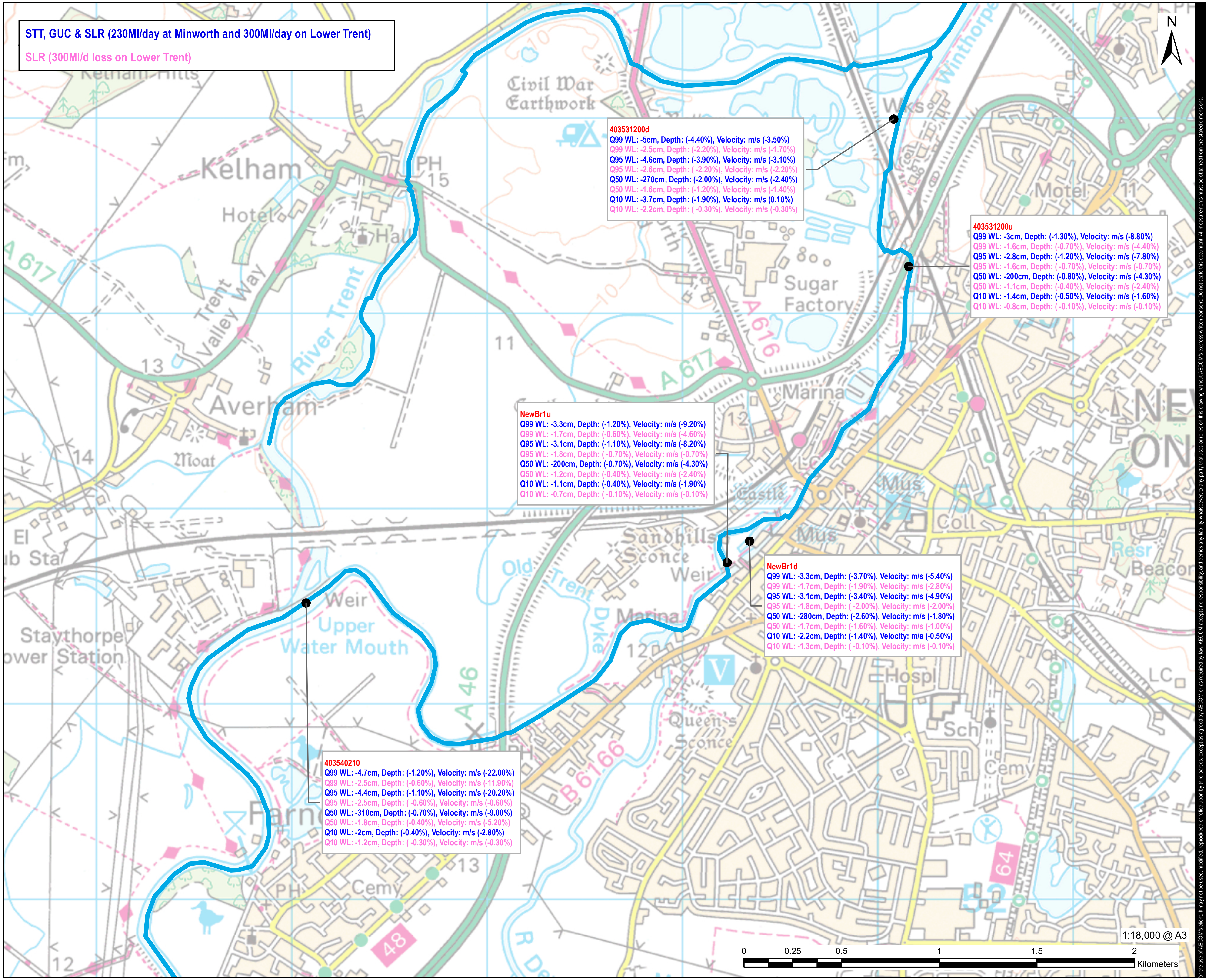
PROJECT NUMBER
60671264

FIGURE TITLE
Changes in Water Level, Depth and Velocity on Lower Trent (Q99, Q95, Q50, Q10) for SLR, STT and GUC

FIGURE NUMBER
Figure 3

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON06PFPSW001\UKLON06PFPSW001-V1DPE\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure3_Q99_Q95_Q50_Q10_WaterLevel_Velocity_TRENT4_CandD.mxd

Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13



AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- ● Trent 4 Node
- Rivers

NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Lower Trent.
The following scenarios have been modelled: 230Ml/day loss at Minworth and 300Ml/day loss on the Lower Trent for the South Lincolnshire Reservoir (SLR).
300Ml/day loss on the Lower Trent, corresponding to the SLR.
This figure shows the change in water level (cm), % change in depth, and change in velocity (m/s) from the baseline conditions.
Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 4 of 4

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

60671264

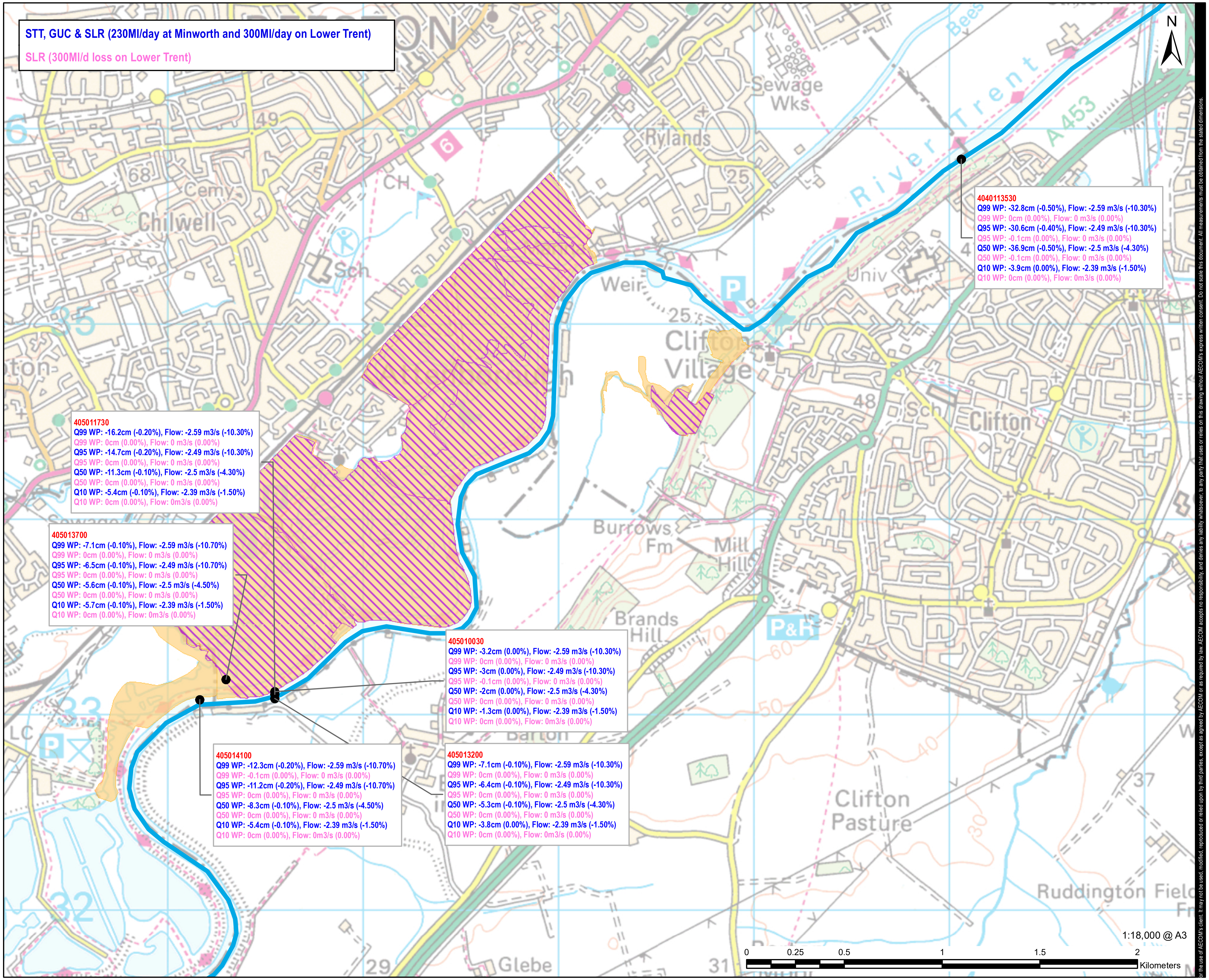
FIGURE TITLE

Changes in Water Level, Depth and Velocity on Lower Trent (Q99, Q95, Q50, Q10) for SLR, STT and GUC

FIGURE NUMBER

Figure 3

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON06PFPSW001\UKLON06PFPSW001\V1DPE\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure4_Q99_Q95_Q50_Q10_Wetted_Perimeter_TRENT4_CandD Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13



AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Trent 4 Node
- Rivers
- Water Dependent LWS
- Water Dependent SSSI

NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Lower Trent.
The following scenarios have been modelled:
230Ml/day loss at Minworth and 300Ml/day loss on the Lower Trent for the South Lincolnshire Reservoir (SLR).
300Ml/day loss on the Lower Trent, corresponding to the SLR.
This figure shows the change in wetted perimeter (m), and change in flow (m3/s) from the baseline conditions.
Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 1 of 4

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

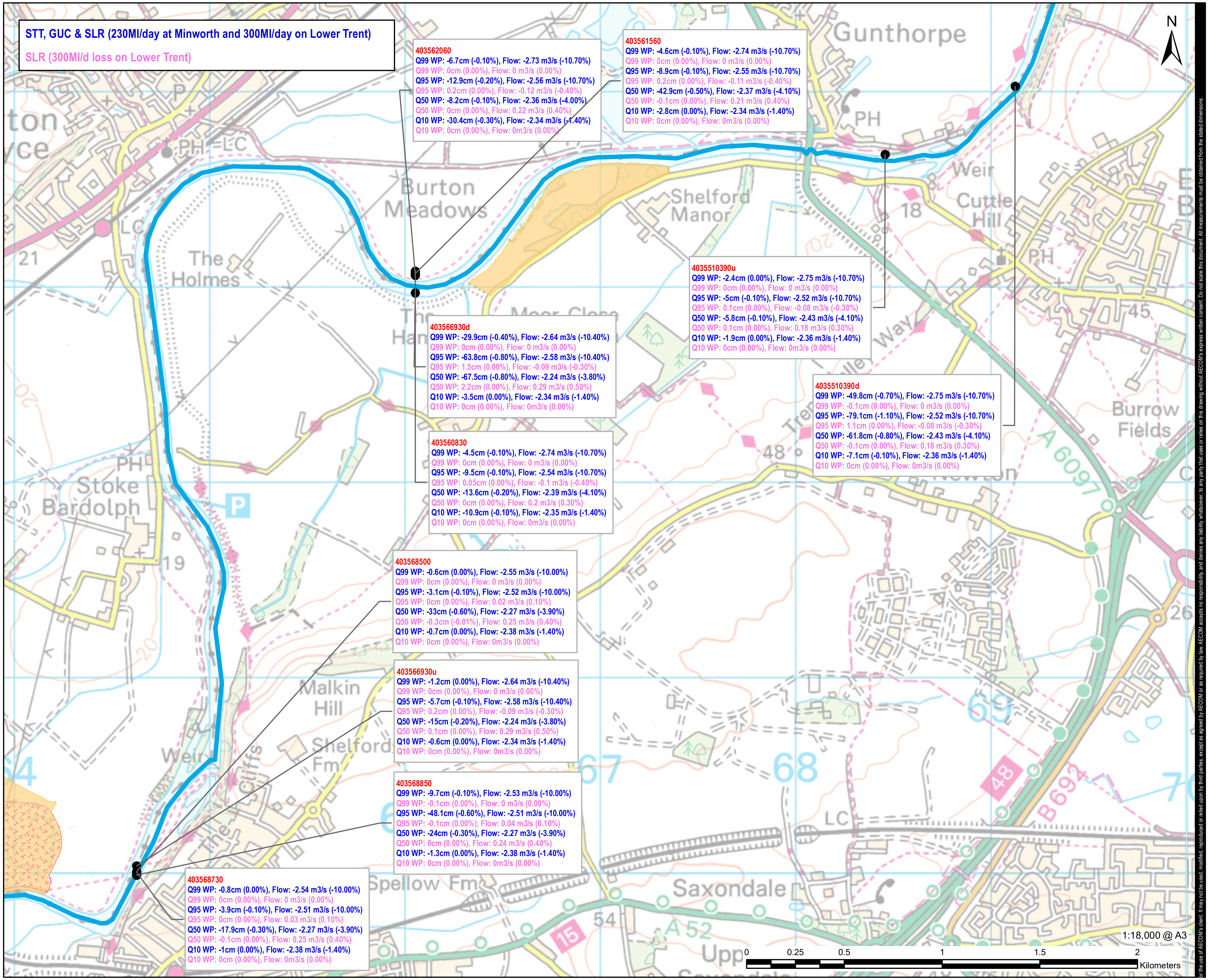
60671264

FIGURE TITLE

Changes in Wetted Perimeter and Flow on Lower Trent (Q99, Q95, Q50, Q10) for SLR, STT and GUC

FIGURE NUMBER

Figure 4



Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13

AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

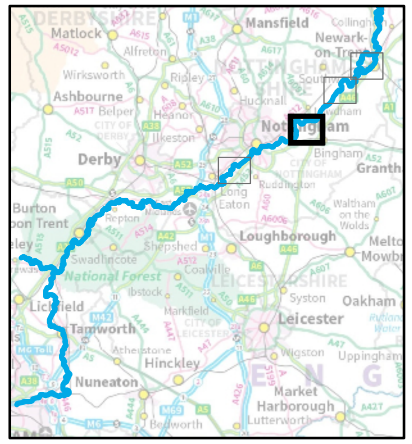
Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Trent 4 Node
- Rivers
- Water Dependent LWS
- Water Dependent LNR



NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Lower Trent.
The following scenarios have been modelled: 230Ml/day loss at Minworth and 300Ml/day loss on the Lower Trent for the South Lincolnshire Reservoir (SLR).
300Ml/day loss on the Lower Trent, corresponding to the SLR.
This figure shows the change in wetted perimeter (m), and change in flow (m3/s) from the baseline conditions.
Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 2 of 4

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

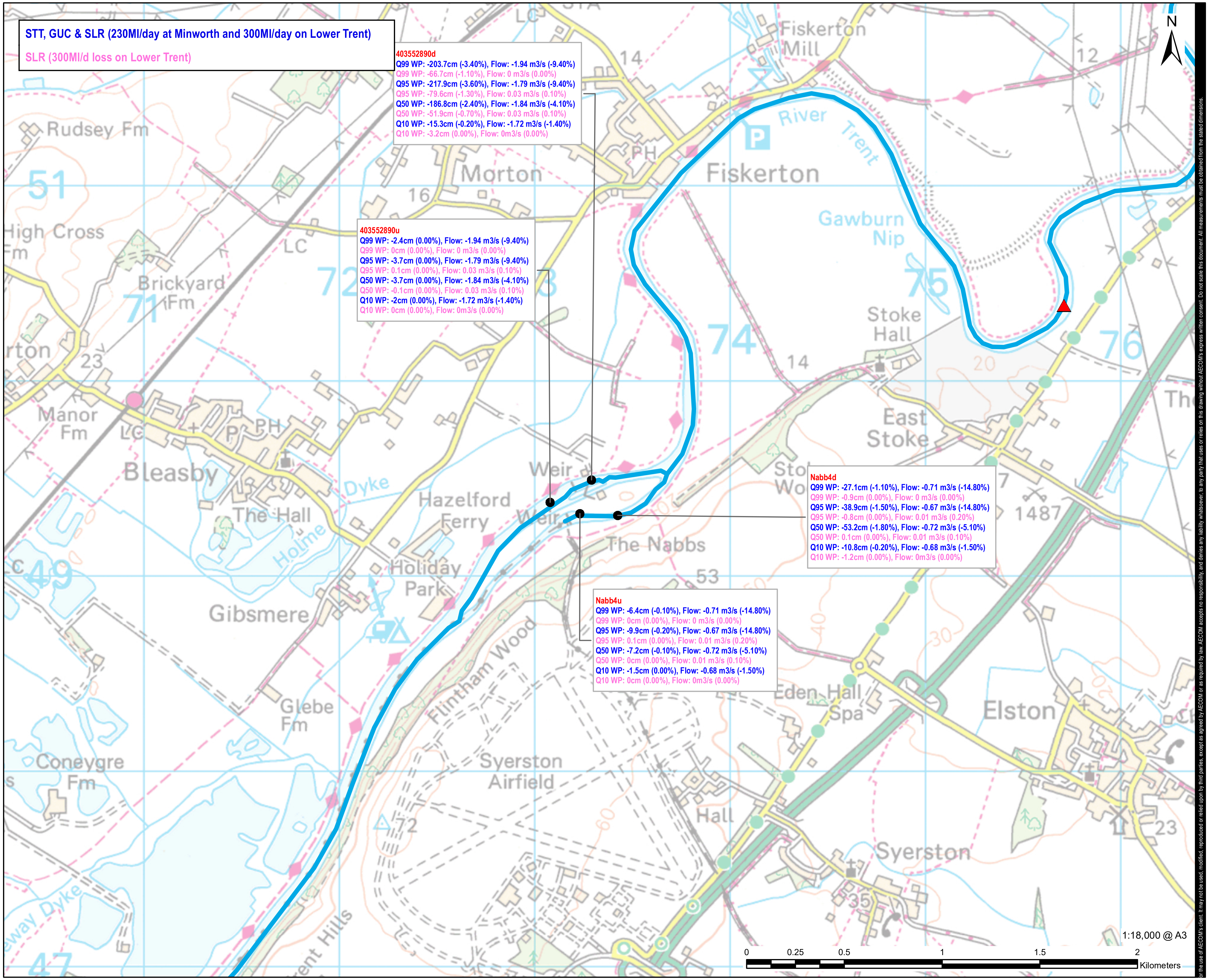
60671264

FIGURE TITLE

Changes in Wetted Perimeter and Flow on Lower Trent (Q99, Q95, Q50, Q10) for SLR, STT and GUC

FIGURE NUMBER

Figure 4



AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

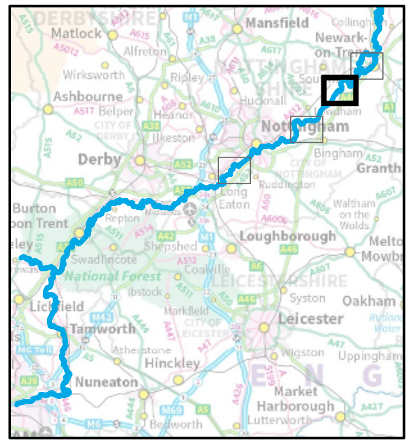
Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- ● Trent 4 Node
- ▲ SLR
- Rivers



NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Lower Trent.
The following scenarios have been modelled: 230Ml/day loss at Minworth and 300Ml/day loss on the Lower Trent for the South Lincolnshire Reservoir (SLR).
300Ml/day loss on the Lower Trent, corresponding to the SLR.
This figure shows the change in wetted perimeter (m), and change in flow (m3/s) from the baseline conditions.
Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 3 of 4

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

60671264

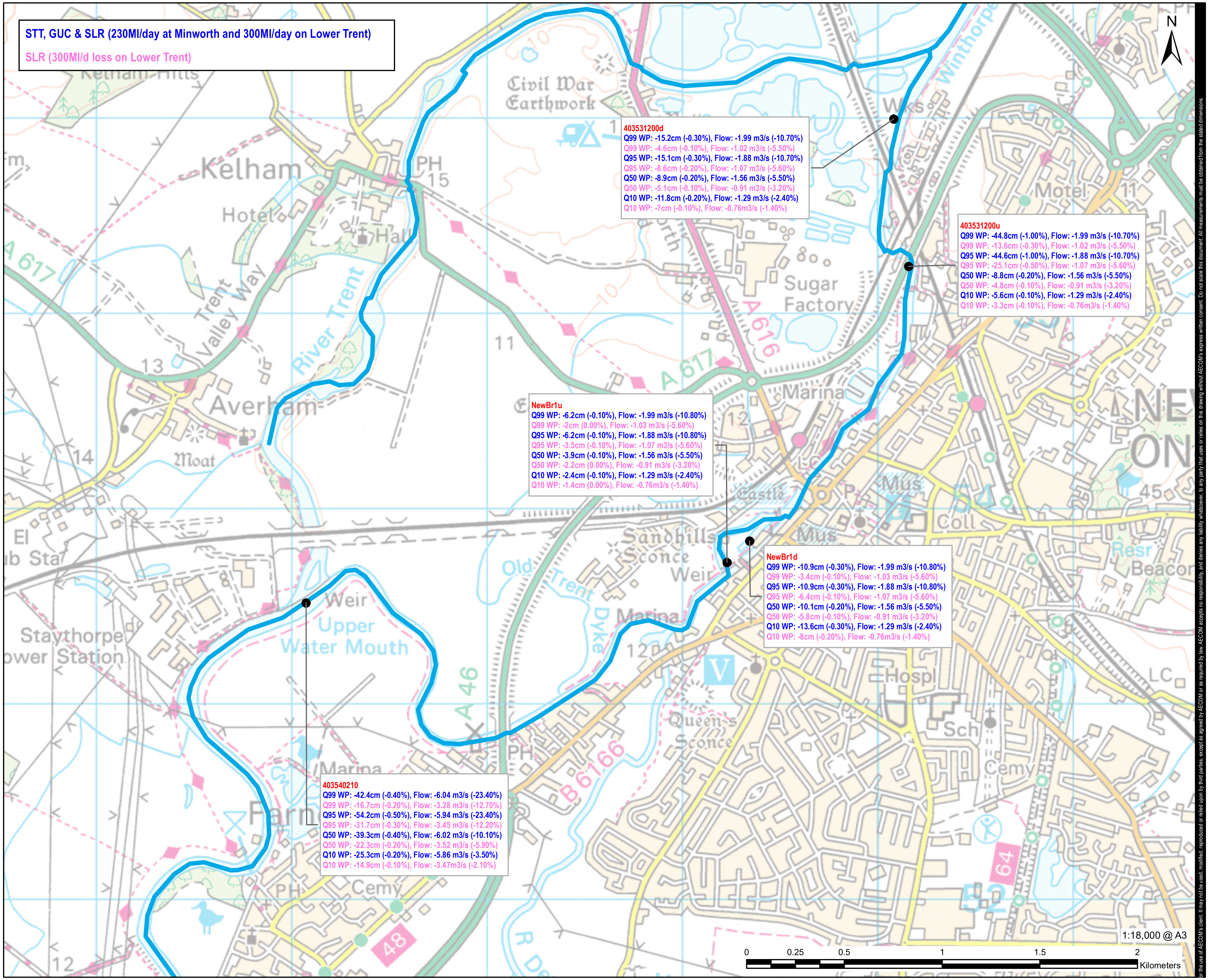
FIGURE TITLE

Changes in Wetted Perimeter and Flow on Lower Trent (Q99, Q95, Q50, Q10) for SLR, STT and GUC

FIGURE NUMBER

Figure 4

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON06PFPSW001\V1\DPE\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure4_Q99_Q95_Q50_Q10_Wetted_Perimeter_TRENT4_CandD Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13



AECOM

PROJECT

Strategic Resource Options: Tame and Trent Modelling

CLIENT

Affinity Water, Severn Trent Water and Anglian Water

CONSULTANT

Aldgate Tower
2, Leman Street
London, E1 8FA
United Kingdom
T +44-0207-645-2000

LEGEND

- Trent 4 Node
- Rivers

NOTES

Hydraulic models have been simulated to assess the impact of several Strategic Resource Options (SROs) on the Lower Trent.
The following scenarios have been modelled: 230Ml/day loss at Minworth and 300Ml/day loss on the Lower Trent for the South Lincolnshire Reservoir (SLR).
300Ml/day loss on the Lower Trent, corresponding to the SLR.
This figure shows the change in wetted perimeter (m), and change in flow (m3/s) from the baseline conditions.
Results are presented for four flow conditions (Q99, Q95, Q50 and Q10).

Sheet 4 of 4

ISSUE PURPOSE

Modelling Report

PROJECT NUMBER

60671264

FIGURE TITLE

Changes in Wetted Perimeter and Flow on Lower Trent (Q99, Q95, Q50, Q10) for SLR, STT and GUC

FIGURE NUMBER

Figure 4

Filename: \\na.aecomnet.com\lfs\EMEA\London-UKLON06\Legacy\UKLON06PFPSW001\UKLON06PFPSW001-V1\DPE\Library\GIS_DATA\Projects\Tame_And_Trent\Layout\220630_Figure4_Q99_Q95_Q50_Q10_Wetted_Perimeter_TRENT4_CandD.mxd Revision: 0 Drawn: NK Checked: SL Approved: DH Date: 2022-07-13

Figure 5a -Aquator schematic – Tame and Upper Trent

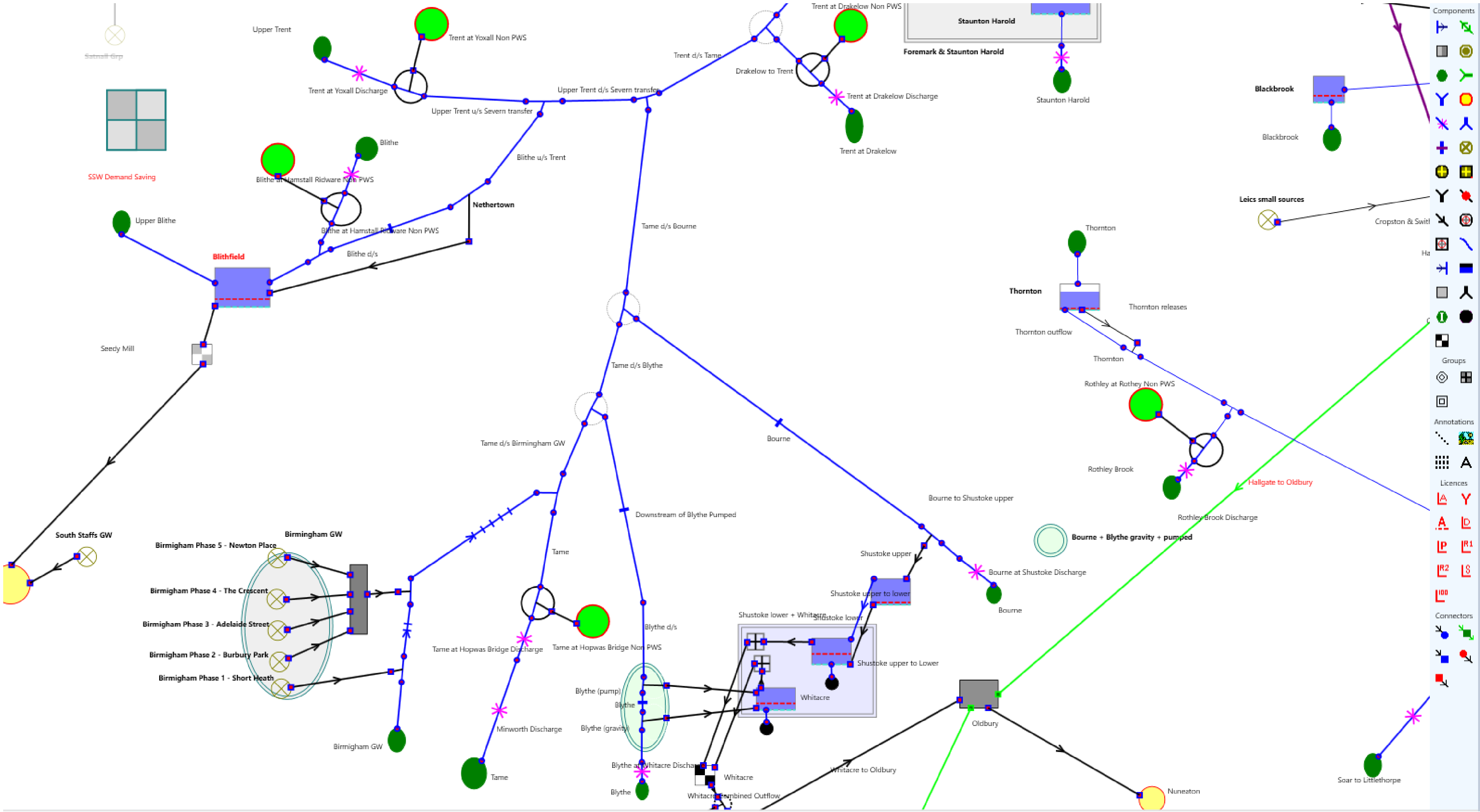


Figure 5b - Aquator schematic – Tame and Upper Trent – with component identifiers

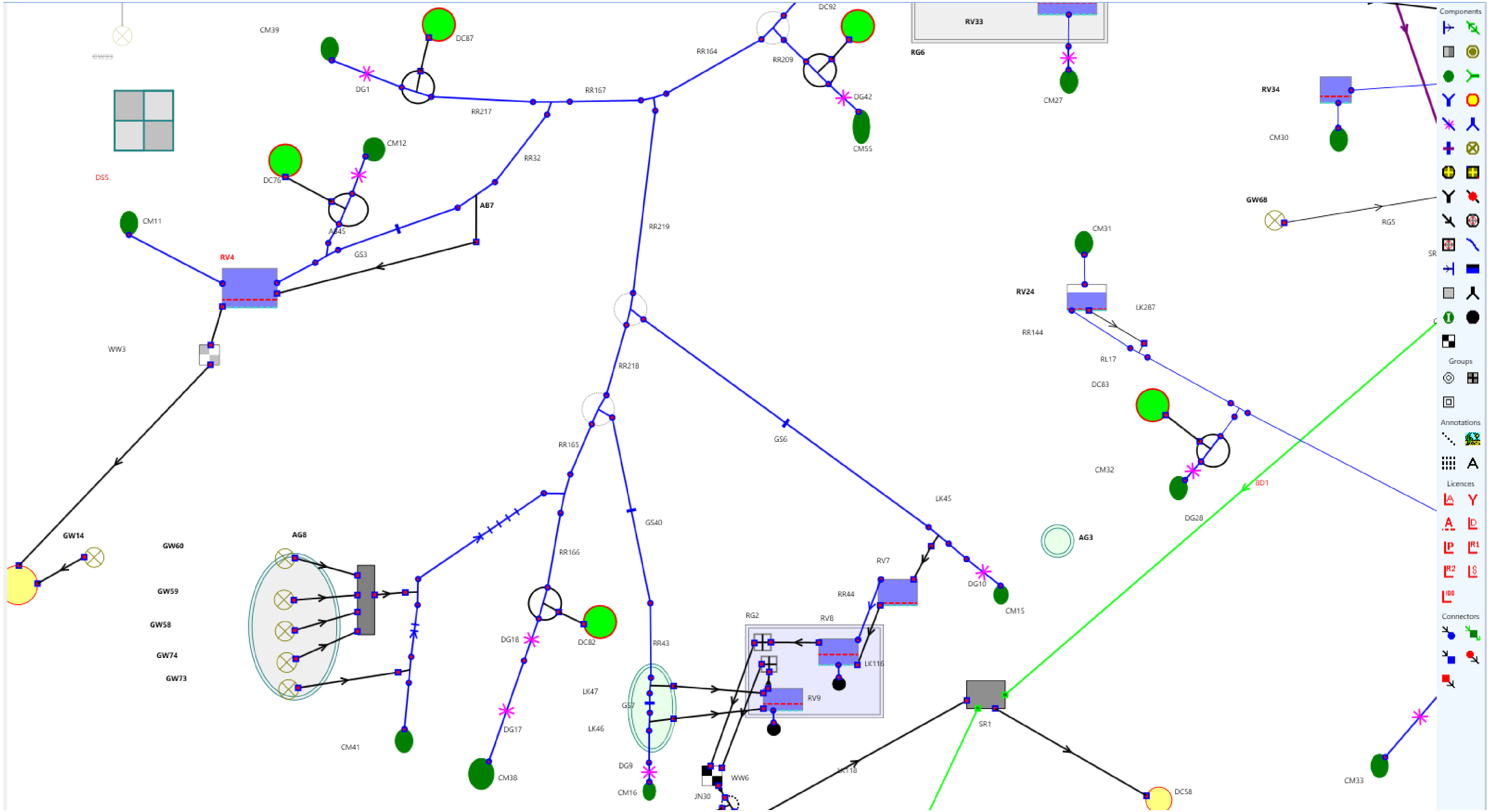


Figure 5c - Aquator schematic – Mid Trent

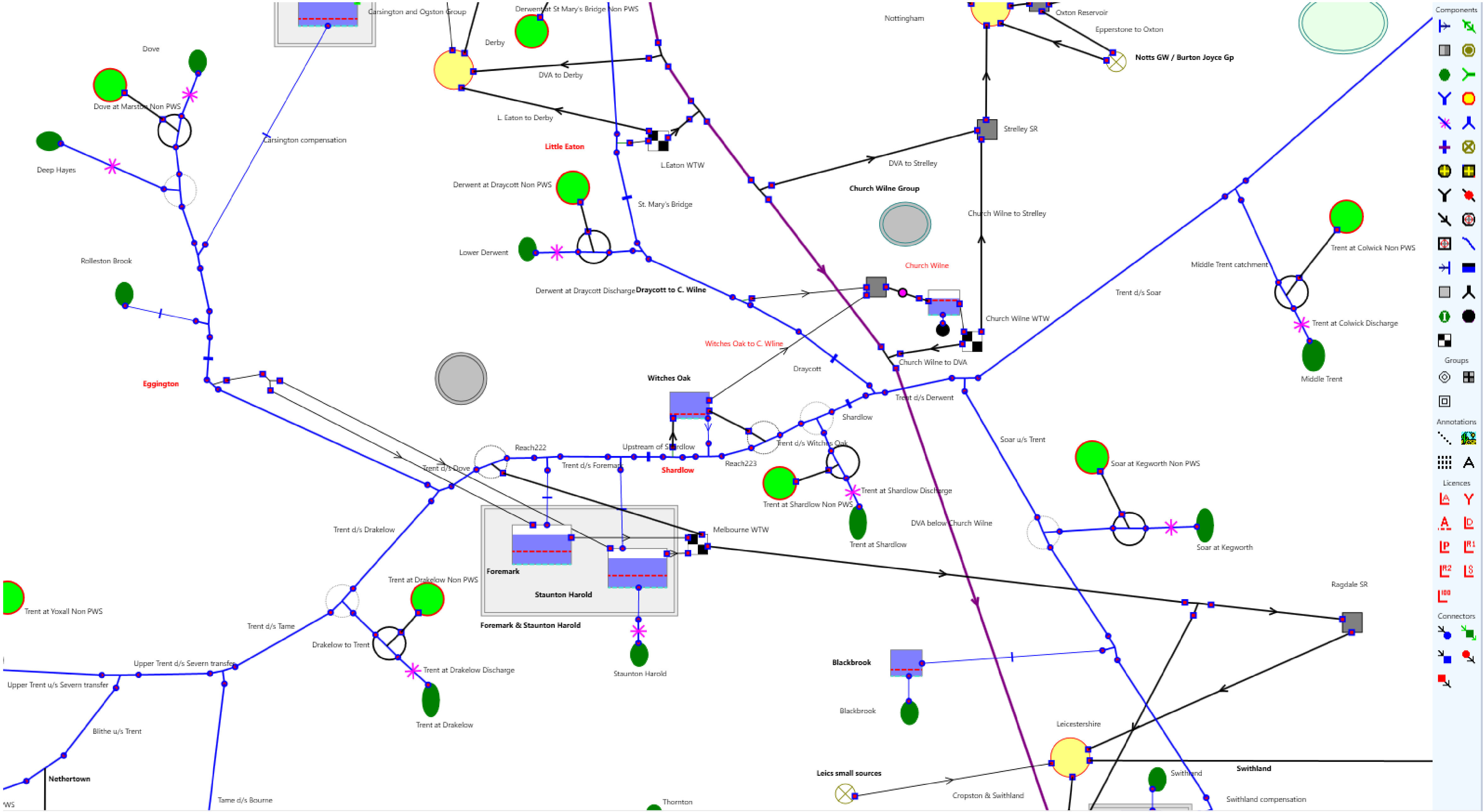


Figure 5d - Aquator schematic – Mid Trent – with component identifiers

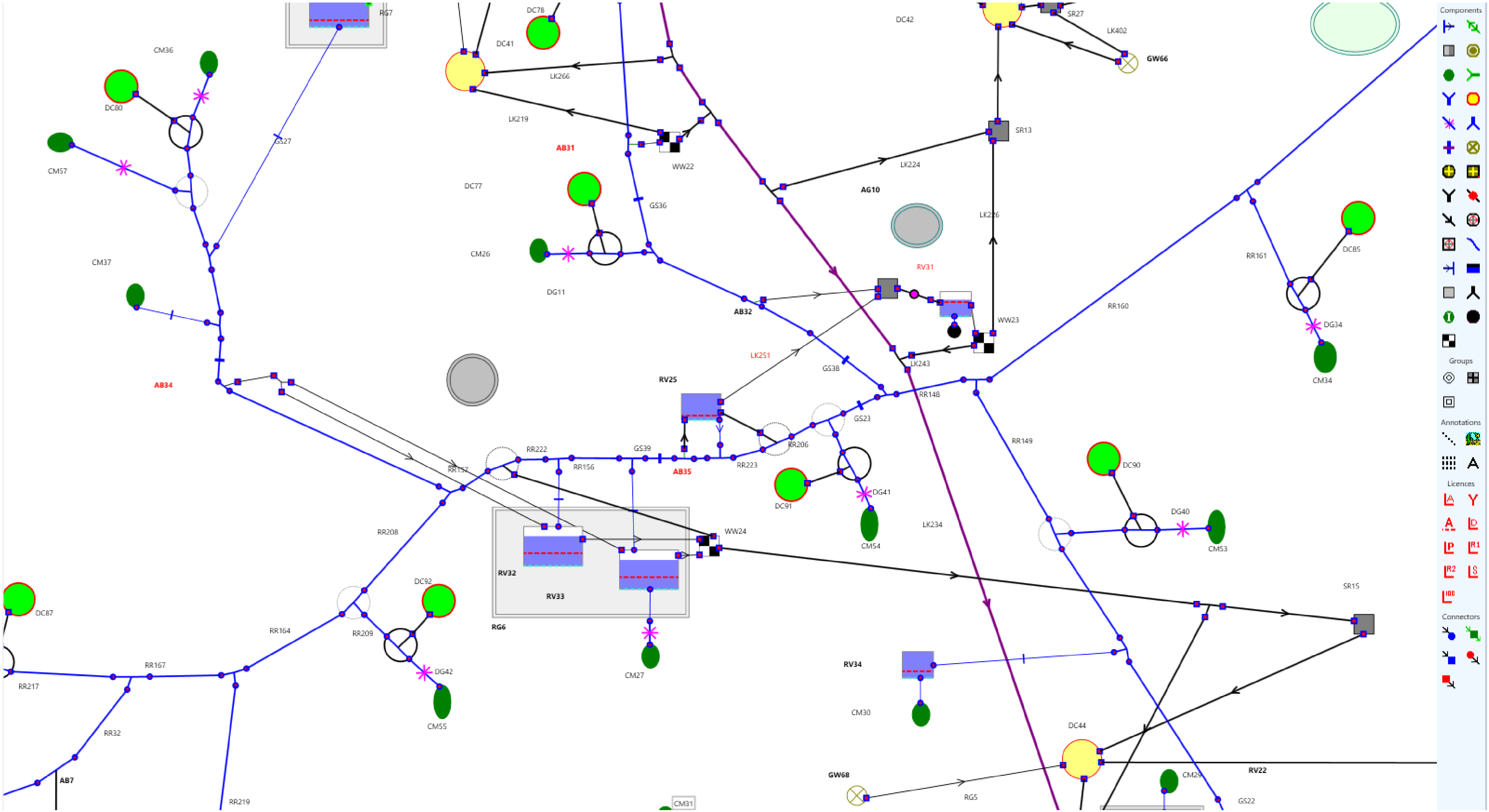


Figure 5e - Aquator schematic – Lower Trent

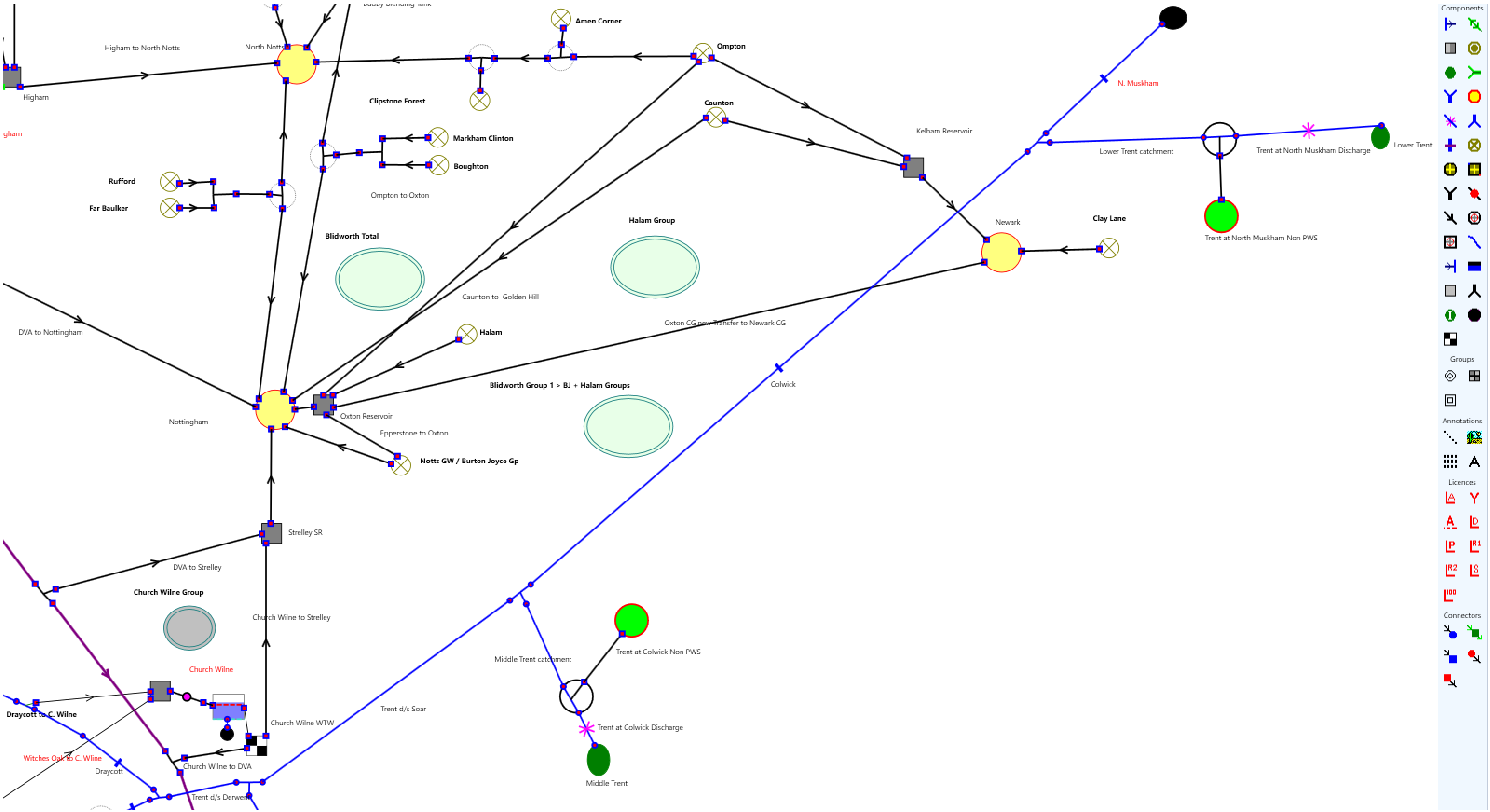
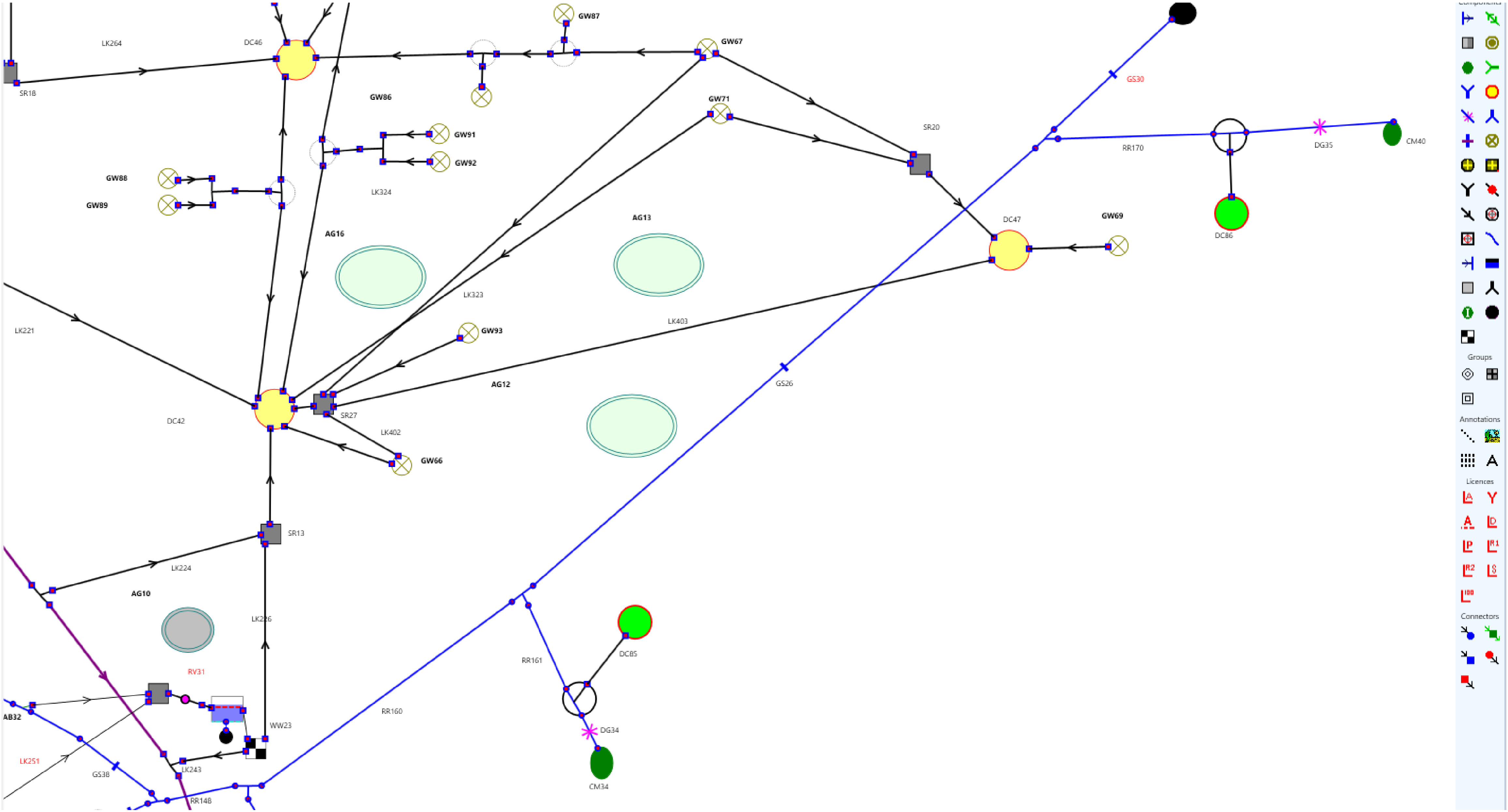


Figure 5f - Aquator schematic – Lower Trent – with component identifiers



Appendix B 1D model results

MS Excel workbooks have been prepared summarising the results for each model: River Tame, Trent 2, Trent 3 and Trent 4. The workbooks record the water level, depth, velocity, wetted perimeter and flow for each of the modelled scenarios.

Author names redacted

Project: Strategic Resource Options: Tame and Trent Modelling Study
Deliverable: Project Report Appendix B: 'Tame' 1D Hydraulic Modelling Results
Revision Date: 12th July 2022

Quality Information

Originator: [redacted] Graduate Water Consultant
Checker: [redacted], Engineer; Sarah Littlewood, Principal Consultant
Verifier: [redacted] Technical Director

Notes and Key Assumptions

1. The results in this MS Workbook should be reviewed with reference to the Project Report.
2. The outputs in this MS Workbook are based on a calibrated model. The final modelled flows in the River Tame hydraulic model have been calibrated to the Lea Marston flow gauge at Point 3 (within 1%) in addition to the modelled Aquator flows downstream of the River Anker at Point 5 (within 1%) and Hopwas Bridge at Point 6 (within 2%) for all events.
3. Q10, Q50, Q95 and Q99 flow conditions have been simulated for these calibrated runs.
4. All runs are steady state flow - but this summary uses the mean outputs across the simulation timesteps for water level and max wetted perimeter values.
5. All baseline runs included a DWF at Minworth WwTW.
6. Scenario A = 115 Ml/d flow reduction at Minworth WwTW (equivalent to either GUC or STT operated at their maximum).
7. Scenario B = 230 Ml/d flow reduction at Minworth WwTW (equivalent to both GUC and STT operating at their maximum).

Grid references for continued monitoring locations redacted

Figure 1A: Tame Node Locations

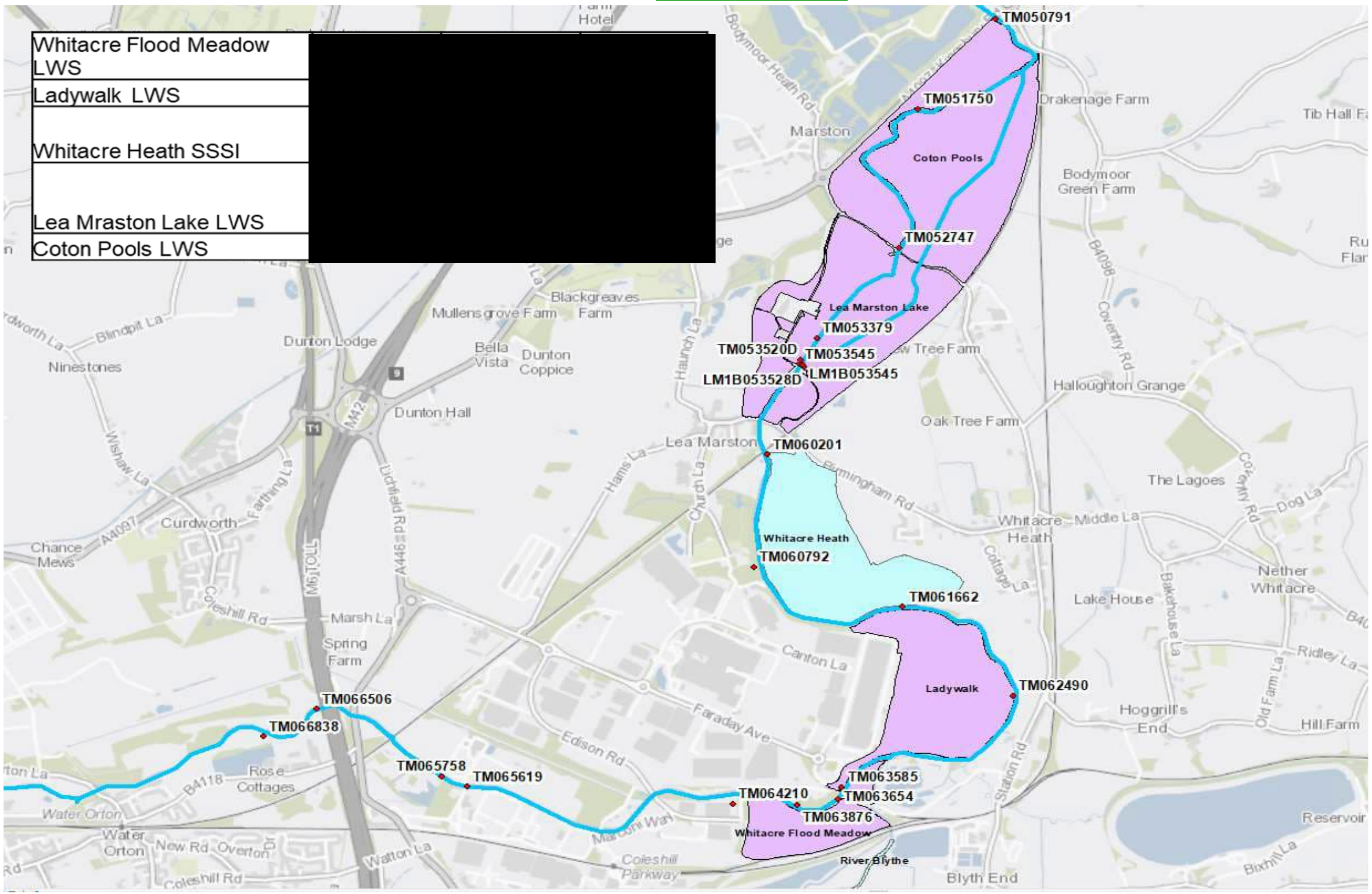


Figure 1B: Tame Node Locations

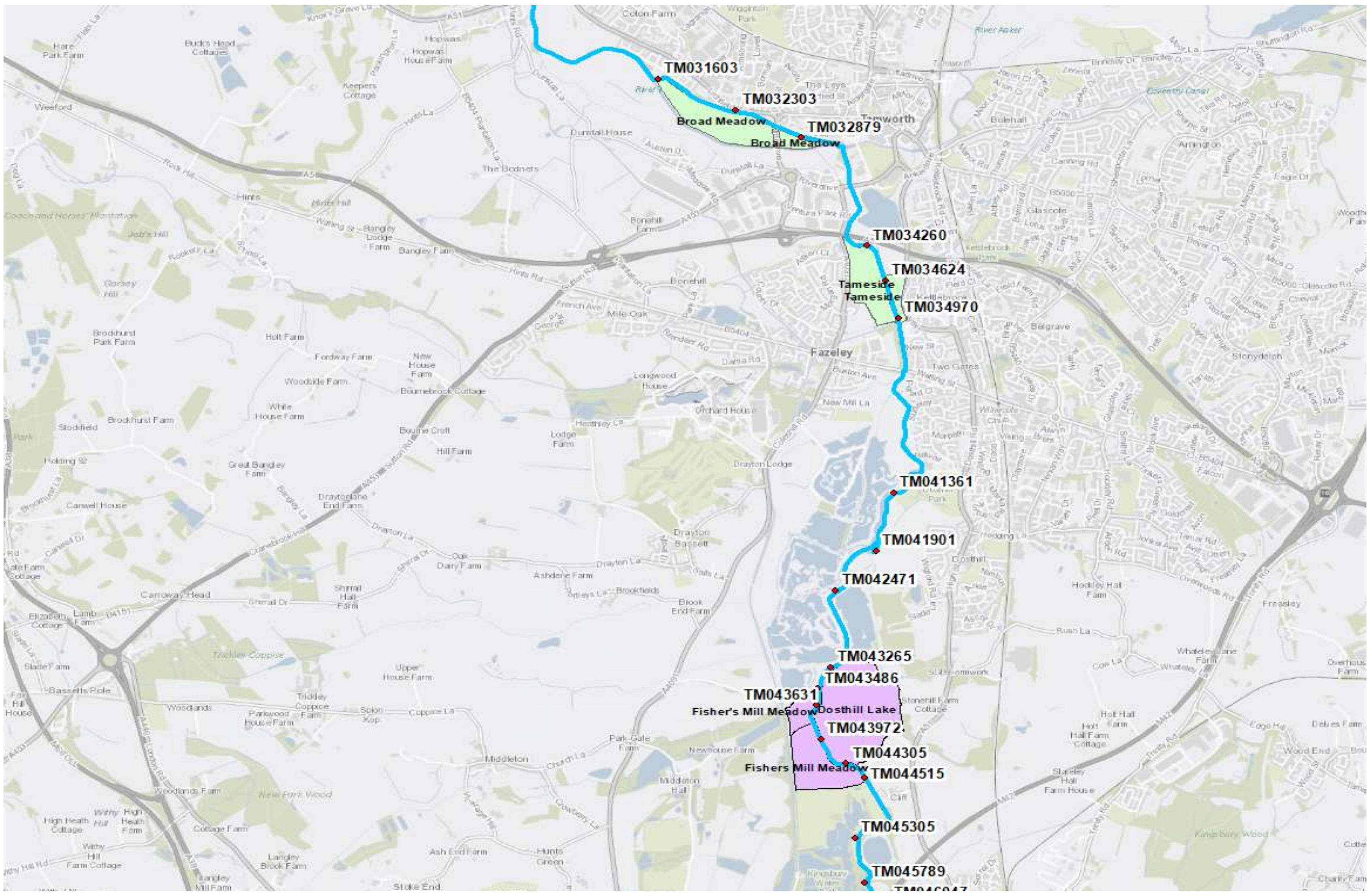


Table 1: Stage and Water Depth

Cross Section	Bed Elevation (mAOD)	Q99 Baseline Mean Stage (mAOD)	Q99 Simulated Baseline Water max depth (m)	Q99 Scenario A Stage (mAOD)	Q99 Scenario A water level change from baseline (m)	Q99 Scenario A maximum water depth change (%)	Q99 Scenario B Stage (mAOD)	Q99 Scenario B water level change from baseline (m)	Q99 Scenario B maximum water depth change (%)
TM066838	72.027	72.61	0.583	72.563	-0.047	-8.06%	72.515	-0.095	-16.30%
TM066506	71.500	72.342	0.842	72.295	-0.047	-5.58%	72.236	-0.106	-12.59%
TM065758	70.350	71.446	1.096	71.4	-0.046	-4.20%	71.368	-0.078	-7.12%
TM065619	70.140	71.037	0.897	70.975	-0.062	-6.91%	70.912	-0.125	-13.94%
TM064210	69.13	69.671	0.541	69.606	-0.065	-12.01%	69.54	-0.131	-24.21%
TM064127	68.486	69.616	1.13	69.55	-0.066	-5.84%	69.479	-0.137	-12.12%
TM063654	68.267	69.169	0.902	69.102	-0.067	-7.43%	69.019	-0.15	-16.63%
TM063585	68.109	69.132	1.023	69.065	-0.067	-6.55%	68.982	-0.15	-14.66%
TM063876	68.108	69.322	1.214	69.252	-0.07	-5.77%	69.173	-0.149	-12.27%
TM062490	67.000	67.862	0.862	67.777	-0.085	-9.86%	67.69	-0.172	-19.95%
TM061662	66.033	67.156	1.123	67.062	-0.094	-8.37%	66.947	-0.209	-18.61%
TM060792	65.727	66.726	0.999	66.647	-0.079	-7.91%	66.571	-0.155	-15.52%
TM053545	65.540	66.501	0.961	66.464	-0.037	-3.85%	66.429	-0.072	-7.49%
LM1B053545	65.540	66.501	0.961	66.464	-0.037	-3.85%	66.429	-0.072	-7.49%
TM060201	64.974	66.569	1.595	66.514	-0.055	-3.45%	66.463	-0.106	-6.65%
TM053379	64.353	66.425	2.072	66.383	-0.042	-2.03%	66.348	-0.077	-3.72%
TM053520D	64.060	66.424	2.364	66.383	-0.041	-1.73%	66.348	-0.076	-3.21%
LM1B053528D	64.060	66.424	2.364	66.383	-0.041	-1.73%	66.348	-0.076	-3.21%
TM052747	63.900	64.867	0.967	64.811	-0.056	-5.79%	64.754	-0.113	-11.69%
TM051750	63.190	64.222	1.032	64.145	-0.077	-7.46%	64.054	-0.168	-16.28%
TM050791	62.500	63.444	0.944	63.363	-0.081	-8.58%	63.31	-0.134	-14.19%
TM045305	61.595	62.08	0.485	62.025	-0.055	-11.34%	61.983	-0.097	-20.00%
TM046047	61.52	62.646	1.126	62.575	-0.071	-6.31%	62.526	-0.12	-10.66%
TM045789	61.496	62.558	1.062	62.495	-0.063	-5.93%	62.45	-0.108	-10.17%
TM044515	60.871	61.613	0.742	61.565	-0.048	-6.47%	61.497	-0.116	-15.63%
TM043972	60.255	61.227	0.972	61.15	-0.077	-7.92%	61.106	-0.121	-12.45%
TM043486	60.116	60.987	0.871	60.91	-0.077	-8.84%	60.862	-0.125	-14.35%
TM043265	60.032	60.894	0.862	60.819	-0.075	-8.70%	60.774	-0.12	-13.92%
TM043631	59.991	61.052	1.061	60.973	-0.079	-7.45%	60.925	-0.127	-11.97%
TM044305	59.940	61.406	1.466	61.322	-0.084	-5.73%	61.271	-0.135	-9.21%
TM042471	58.846	60.157	1.311	60.082	-0.075	-5.72%	60.04	-0.117	-8.92%
TM041901	58.662	59.75	1.088	59.676	-0.074	-6.80%	59.634	-0.116	-10.66%
TM041361	58.352	59.416	1.064	59.347	-0.069	-6.48%	59.305	-0.111	-10.43%
TM034970	57.073	58.084	1.011	58.007	-0.077	-7.62%	57.965	-0.119	-11.77%
TM034260	56.770	58.018	1.248	57.951	-0.067	-5.37%	57.913	-0.105	-8.41%
TM034624	56.676	58.062	1.386	57.989	-0.073	-5.27%	57.948	-0.114	-8.23%
TM032303	55.694	57.743	2.049	57.71	-0.033	-1.61%	57.692	-0.051	-2.49%
TM032879	55.337	57.757	2.42	57.724	-0.033	-1.36%	57.705	-0.052	-2.15%
TM031603	54.884	55.519	0.635	55.478	-0.041	-6.46%	55.46	-0.059	-9.29%

Cross Section	Q95 Baseline Mean Stage (mAOD)	Q95 Simulated Baseline Water max depth (m)	Q95 Scenario A Stage (mAOD)	Q95 Scenario A water level change from baseline (m)	Q95 Scenario A maximum water depth change (%)	Q95 Scenario B Stage (mAOD)	Q95 Scenario B water level change from baseline (m)	Q95 Scenario B maximum water depth change (%)
TM066838	72.644	0.617	72.6	-0.044	-7.13%	72.553	-0.091	-14.75%
TM066506	72.372	0.872	72.326	-0.046	-5.28%	72.273	-0.099	-11.35%
TM065758	71.476	1.126	71.442	-0.034	-3.02%	71.402	-0.074	-6.57%
TM065619	71.083	0.943	71.031	-0.052	-5.51%	70.976	-0.107	-11.35%
TM064210	69.733	0.603	69.652	-0.081	-13.43%	69.572	-0.161	-26.70%
TM064127	69.679	1.193	69.597	-0.082	-6.87%	69.514	-0.165	-13.83%
TM063654	69.206	0.939	69.136	-0.07	-7.45%	69.056	-0.15	-15.97%
TM063585	69.167	1.058	69.1	-0.067	-6.33%	69.022	-0.145	-13.71%
TM063876	69.365	1.257	69.289	-0.076	-6.05%	69.206	-0.159	-12.65%
TM062490	67.896	0.896	67.819	-0.077	-8.59%	67.732	-0.164	-18.30%
TM061662	67.188	1.155	67.096	-0.092	-7.97%	66.995	-0.193	-16.71%
TM060792	66.76	1.033	66.684	-0.076	-7.36%	66.602	-0.158	-15.30%
TM053545	66.512	0.972	66.475	-0.037	-3.81%	66.437	-0.075	-7.72%
LM1B053545	66.512	0.972	66.475	-0.037	-3.81%	66.437	-0.075	-7.72%
TM060201	66.587	1.613	66.532	-0.055	-3.41%	66.476	-0.111	-6.88%
TM053379	66.437	2.084	66.396	-0.041	-1.97%	66.353	-0.084	-4.03%
TM053520D	66.436	2.376	66.396	-0.04	-1.68%	66.353	-0.083	-3.49%
LM1B053528D	66.436	2.376	66.396	-0.04	-1.68%	66.352	-0.084	-3.54%
TM052747	64.896	0.996	64.837	-0.059	-5.92%	64.768	-0.128	-12.85%
TM051750	64.264	1.074	64.182	-0.082	-7.64%	64.059	-0.205	-19.09%
TM050791	63.502	1.002	63.418	-0.084	-8.38%	63.329	-0.173	-17.27%
TM045305	62.126	0.531	62.061	-0.065	-12.24%	61.987	-0.139	-26.18%
TM046047	62.708	1.188	62.629	-0.079	-6.65%	62.538	-0.17	-14.31%
TM045789	62.617	1.121	62.545	-0.072	-6.42%	62.461	-0.156	-13.92%
TM044515	61.653	0.782	61.595	-0.058	-7.42%	61.49	-0.163	-20.84%
TM043972	61.265	1.010	61.188	-0.077	-7.62%	61.105	-0.16	-15.84%
TM043486	61.016	0.900	60.942	-0.074	-8.22%	60.861	-0.155	-17.22%
TM043265	60.923	0.891	60.853	-0.07	-7.86%	60.775	-0.148	-16.61%
TM043631	61.082	1.091	61.005	-0.077	-7.06%	60.921	-0.161	-14.76%
TM044305	61.445	1.505	61.365	-0.08	-5.32%	61.275	-0.17	-11.30%
TM042471	60.195	1.349	60.12	-0.075	-5.56%	60.038	-0.157	-11.64%
TM041901	59.783	1.121	59.713	-0.07	-6.24%	59.642	-0.141	-12.58%
TM041361	59.45	1.098	59.381	-0.069	-6.28%	59.302	-0.148	-13.48%
TM034970	58.117	1.044	58.04	-0.077	-7.38%	57.952	-0.165	-15.80%
TM034260	58.044	1.274	57.977	-0.067	-5.26%	57.898	-0.146	-11.46%
TM034624	58.094	1.418	58.021	-0.073	-5.15%	57.936	-0.158	-11.14%
TM032303	57.748	2.054	57.717	-0.031	-1.51%	57.677	-0.071	-3.46%
TM032879	57.763	2.426	57.731	-0.032	-1.32%	57.69	-0.073	-3.01%
TM031603	55.548	0.664	55.514	-0.034	-5.12%	55.469	-0.079	-11.90%

Cross Section	Sens. A - Q95, Plus 20% Weir Coefficient: Mean Stage (mAOD)	Simulated Water max depth (m)	Water Depth change from Baseline (m)	Water Depth change from Baseline (%)	Sens. B - Q95, Minus 20% Weir Coefficient: Mean Stage (mAOD)	Simulated Water max depth (m)	Water Depth change from Baseline (m)	Water Depth change from Baseline (%)
TM066838	72.644	0.617	0.000	0.00%	72.644	0.617	0.000	0.00%
TM066506	72.372	0.872	0.000	0.00%	72.372	0.872	0.000	0.00%
TM065758	71.476	1.126	0.000	0.00%	71.476	1.126	0.000	0.00%
TM065619	71.083	0.943	0.000	0.00%	71.083	0.943	0.000	0.00%
TM064210	69.733	0.603	0.000	0.00%	69.733	0.603	0.000	0.00%
TM064127	69.679	1.193	0.000	0.00%	69.679	1.193	0.000	0.00%
TM063654	69.206	0.939	0.000	0.00%	69.206	0.939	0.000	0.00%
TM063585	69.167	1.058	0.000	0.00%	69.167	1.058	0.000	0.00%
TM063876	69.365	1.257	0.000	0.00%	69.365	1.257	0.000	0.00%
TM062490	67.896	0.896	0.000	0.00%	67.896	0.896	0.000	0.00%
TM061662	67.188	1.155	0.000	0.00%	67.188	1.155	0.000	0.00%
TM060792	66.76	1.033	0.000	0.00%	66.763	1.036	0.003	0.29%
TM053545	66.51	0.970	-0.002	-0.21%	66.52	0.980	0.008	0.82%
LM1B053545	66.51	0.970	-0.002	-0.21%	66.52	0.980	0.008	0.82%
TM060201	66.585	1.611	-0.002	-0.12%	66.593	1.619	0.006	0.37%
TM053379	66.368	2.015	-0.069	-3.31%	66.488	2.135	0.051	2.45%
TM053520D	66.368	2.308	-0.068	-2.86%	66.487	2.427	0.051	2.15%
LM1B053528D	66.368	2.308	-0.068	-2.86%	66.487	2.427	0.051	2.15%
TM052747	64.896	0.996	0.000	0.00%	64.897	0.997	0.001	0.10%
TM051750	64.229	1.039	-0.035	-3.26%	64.28	1.090	0.016	1.49%
TM050791	63.501	1.001	-0.001	-0.10%	63.502	1.002	0.000	0.00%
TM045305	62.126	0.531	0.000	0.00%	62.126	0.531	0.000	0.00%
TM046047	62.708	1.188	0.000	0.00%	62.708	1.188	0.000	0.00%
TM045789	62.617	1.121	0.000	0.00%	62.617	1.121	0.000	0.00%
TM044515	61.653	0.782	0.000	0.00%	61.653	0.782	0.000	0.00%
TM043972	61.265	1.010	0.000	0.00%	61.265	1.010	0.000	0.00%
TM043486	61.016	0.900	0.000	0.00%	61.016	0.900	0.000	0.00%
TM043265	60.923	0.891	0.000	0.00%	60.923	0.891	0.000	0.00%
TM043631	61.081	1.090	-0.001	-0.09%	61.082	1.091	0.000	0.00%
TM044305	61.445	1.505	0.000	0.00%	61.445	1.505	0.000	0.00%
TM042471	60.195	1.349	0.000	0.00%	60.195	1.349	0.000	0.00%
TM041901	59.783	1.121	0.000	0.00%	59.784	1.122	0.001	0.09%
TM041361	59.45	1.098	0.000	0.00%	59.45	1.098	0.000	0.00%
TM034970	58.107	1.034	-0.010	-0.96%	58.126	1.053	0.009	0.86%
TM034260	58.032	1.262	-0.012	-0.94%	58.056	1.286	0.012	0.94%
TM034624	58.084	1.408	-0.010	-0.71%	58.104	1.428	0.010	0.71%
TM032303	57.669	1.975	-0.079	-3.85%	57.798	2.104	0.050	2.43%
TM032879	57.693	2.356	-0.070	-2.89%	57.808	2.471	0.045	1.85%
TM031603	55.587	0.703	0.039	5.87%	55.525	0.641	-0.023	-3.46%

Cross Section	Sens. C - Q95, Plus 10% Manning's: Mean Stage (mAOD)	Simulated Water max depth (m)	Water Depth change from Baseline (m)	Water Depth change from Baseline (%)	Sens. D - Q95, Minus 10% Manning's: Mean Stage (mAOD)	Simulated Water max depth (m)	Water Depth change from Baseline (m)	Water Depth change from Baseline (%)
TM066838	72.679	0.652	0.035	5.67%	72.618	0.591	-0.026	-4.21%
TM066506	72.4	0.900	0.028	3.21%	72.351	0.851	-0.021	-2.41%
TM065758	71.493	1.143	0.017	1.51%	71.451	1.101	-0.025	-2.22%
TM065619	71.121	0.981	0.038	4.03%	71.054	0.914	-0.029	-3.08%
TM064210	69.777	0.647	0.044	7.30%	69.693	0.563	-0.040	-6.63%
TM064127	69.723	1.237	0.044	3.69%	69.637	1.151	-0.042	-3.52%
TM063654	69.246	0.979	0.040	4.26%	69.175	0.908	-0.031	-3.30%
TM063585	69.203	1.094	0.036	3.40%	69.139	1.030	-0.028	-2.65%
TM063876	69.405	1.297	0.040	3.18%	69.334	1.226	-0.031	-2.47%
TM062490	67.942	0.942	0.046	5.13%	67.86	0.860	-0.036	-4.02%
TM061662	67.238	1.205	0.050	4.33%	67.147	1.114	-0.041	-3.55%
TM060792	66.795	1.068	0.035	3.39%	66.733	1.006	-0.027	-2.61%
TM053545	66.512	0.972	0.000	0.00%	66.512	0.972	0.000	0.00%
LM1B053545	66.512	0.972	0.000	0.00%	66.512	0.972	0.000	0.00%
TM060201	66.601	1.627	0.014	0.87%	66.577	1.603	-0.010	-0.62%
TM053379	66.437	2.084	0.000	0.00%	66.437	2.084	0.000	0.00%
TM053520D	66.436	2.376	0.000	0.00%	66.436	2.376	0.000	0.00%
LM1B053528D	66.436	2.376	0.000	0.00%	66.436	2.376	0.000	0.00%
TM052747	64.925	1.025	0.029	2.91%	64.868	0.968	-0.028	-2.81%
TM051750	64.289	1.099	0.025	2.33%	64.234	1.044	-0.030	-2.79%
TM050791	63.543	1.043	0.041	4.09%	63.461	0.961	-0.041	-4.09%
TM045305	62.162	0.567	0.036	6.78%	62.087	0.492	-0.039	-7.34%
TM046047	62.747	1.227	0.039	3.28%	62.667	1.147	-0.041	-3.45%
TM045789	62.652	1.156	0.035	3.12%	62.58	1.084	-0.037	-3.30%
TM044515	61.686	0.815	0.033	4.22%	61.62	0.749	-0.033	-4.22%
TM043972	61.304	1.049	0.039	3.86%	61.225	0.970	-0.040	-3.96%
TM043486	61.052	0.936	0.036	4.00%	60.978	0.862	-0.038	-4.22%
TM043265	60.956	0.924	0.033	3.70%	60.888	0.856	-0.035	-3.93%
TM043631	61.122	1.131	0.040	3.67%	61.042	1.051	-0.040	-3.67%
TM044305	61.483	1.543	0.038	2.52%	61.405	1.465	-0.040	-2.66%
TM042471	60.237	1.391	0.042	3.11%	60.15	1.304	-0.045	-3.34%
TM041901	59.821	1.159	0.038	3.39%	59.744	1.082	-0.039	-3.48%
TM041361	59.481	1.129	0.031	2.82%	59.416	1.064	-0.034	-3.10%
TM034970	58.153	1.080	0.036	3.45%	58.08	1.007	-0.037	-3.54%
TM034260	58.074	1.304	0.030	2.35%	58.013	1.243	-0.031	-2.43%
TM034624	58.128	1.452	0.034	2.40%	58.059	1.383	-0.035	-2.47%
TM032303	57.746	2.052	-0.002	-0.10%	57.75	2.056	0.002	0.10%
TM032879	57.763	2.426	0.000	0.00%	57.762	2.425	-0.001	-0.04%
TM031603	55.566	0.682	0.018	2.71%	55.531	0.647	-0.017	-2.56%

Cross Section	Bed Elevation (mAOD)	Q50 Baseline Mean Stage (mAOD)	Q50 Simulated Baseline Water max depth (m)	Q50 Scenario A Stage (mAOD)	Q50 Scenario A water level change from baseline (m)	Q50 Scenario A maximum water depth change (%)	Q50 Scenario B Stage (mAOD)	Q50 Scenario B water level change from baseline (m)	Q50 Scenario B maximum water depth change (%)
TM066838	72.027	72.768	0.741	72.73	-0.038	-5.13%	72.689	-0.079	-10.66%
TM066506	71.500	72.492	0.992	72.452	-0.04	-4.03%	72.411	-0.081	-8.17%
TM065758	70.350	71.55	1.200	71.522	-0.028	-2.33%	71.496	-0.054	-4.50%
TM065619	70.140	71.218	1.078	71.18	-0.038	-3.53%	71.137	-0.081	-7.51%
TM064210	69.13	69.874	0.744	69.796	-0.078	-10.48%	69.715	-0.159	-21.37%
TM064127	68.486	69.819	1.333	69.742	-0.077	-5.78%	69.661	-0.158	-11.85%
TM063654	68.267	69.318	1.051	69.257	-0.061	-5.80%	69.192	-0.126	-11.99%
TM063585	68.109	69.274	1.165	69.217	-0.057	-4.89%	69.155	-0.119	-10.21%
TM063876	68.108	69.484	1.376	69.417	-0.067	-4.87%	69.346	-0.138	-10.03%
TM062490	67.000	68.07	1.070	68.004	-0.066	-6.17%	67.938	-0.132	-12.34%
TM061662	66.033	67.384	1.351	67.311	-0.073	-5.40%	67.235	-0.149	-11.03%
TM060792	65.727	66.927	1.200	66.865	-0.062	-5.17%	66.799	-0.128	-10.67%
TM053545	65.540	66.597	1.057	66.565	-0.032	-3.03%	66.532	-0.065	-6.15%
LM1B053545	65.540	66.597	1.057	66.566	-0.031	-2.93%	66.532	-0.065	-6.15%
TM060201	64.974	66.719	1.745	66.669	-0.05	-2.87%	66.618	-0.101	-5.79%
TM053379	64.353	66.531	2.178	66.496	-0.035	-1.61%	66.459	-0.072	-3.31%
TM053520D	64.060	66.53	2.470	66.495	-0.035	-1.42%	66.459	-0.071	-2.87%
LM1B053528D	64.060	66.531	2.471	66.496	-0.035	-1.42%	66.459	-0.072	-2.91%
TM052747	63.900	65.028	1.128	64.979	-0.049	-4.34%	64.926	-0.102	-9.04%
TM051750	63.190	64.416	1.226	64.355	-0.061	-4.98%	64.294	-0.122	-9.95%
TM050791	62.500	63.685	1.185	63.615	-0.07	-5.91%	63.542	-0.143	-12.07%
TM045305	61.595	62.28	0.685	62.223	-0.057	-8.32%	62.157	-0.123	-17.96%
TM046047	61.52	62.876	1.356	62.815	-0.061	-4.50%	62.746	-0.13	-9.59%
TM045789	61.496	62.769	1.273	62.713	-0.056	-4.40%	62.649	-0.12	-9.43%
TM044515	60.871	61.808	0.937	61.748	-0.06	-6.40%	61.685	-0.123	-13.13%
TM043972	60.255	61.431	1.176	61.366	-0.065	-5.53%	61.297	-0.134	-11.39%
TM043486	60.116	61.177	1.061	61.12	-0.057	-5.37%	61.055	-0.122	-11.50%
TM043265	60.032	61.073	1.041	61.017	-0.056	-5.38%	60.958	-0.115	-11.05%
TM043631	59.991	61.25	1.259	61.19	-0.06	-4.77%	61.123	-0.127	-10.09%
TM044305	59.940	61.621	1.681	61.553	-0.068	-4.05%	61.479	-0.142	-8.45%
TM042471	58.846	60.37	1.524	60.299	-0.071	-4.66%	60.235	-0.135	-8.86%
TM041901	58.662	59.944	1.282	59.884	-0.06	-4.68%	59.821	-0.123	-9.59%
TM041361	58.352	59.594	1.242	59.54	-0.054	-4.35%	59.484	-0.11	-8.86%
TM034970	57.073	58.294	1.221	58.234	-0.06	-4.91%	58.169	-0.125	-10.24%
TM034260	56.770	58.2	1.430	58.148	-0.052	-3.64%	58.092	-0.108	-7.55%
TM034624	56.676	58.265	1.589	58.207	-0.058	-3.65%	58.145	-0.12	-7.55%
TM032303	55.694	57.839	2.145	57.816	-0.023	-1.07%	57.792	-0.047	-2.19%
TM032879	55.337	57.856	2.519	57.833	-0.023	-0.91%	57.808	-0.048	-1.91%
TM031603	54.884	55.688	0.804	55.636	-0.052	-6.47%	55.599	-0.089	-11.07%

Cross Section	Q10 Baseline Mean Stage (mAOD)	Q10 Simulated Baseline Water max depth (m)	Q10 Scenario A Stage (mAOD)	Q10 Scenario A water level change from baseline (m)	Q10 Scenario A maximum water depth change (%)	Q10 Scenario B Stage (mAOD)	Q10 Scenario B water level change from baseline (m)	Q10 Scenario B maximum water depth change (%)
TM066838	73.05	1.023	73.02	-0.03	-2.93%	72.988	-0.062	-6.06%
TM066506	72.764	1.264	72.738	-0.026	-2.06%	72.711	-0.053	-4.19%
TM065758	71.717	1.367	71.697	-0.02	-1.46%	71.677	-0.04	-2.93%
TM065619	71.476	1.336	71.448	-0.028	-2.10%	71.42	-0.056	-4.19%
TM064210	70.136	1.006	70.074	-0.062	-6.16%	70.011	-0.125	-12.43%
TM064127	70.076	1.590	70.016	-0.06	-3.77%	69.954	-0.122	-7.67%
TM063654	69.572	1.305	69.523	-0.049	-3.75%	69.472	-0.1	-7.66%
TM063585	69.523	1.414	69.477	-0.046	-3.25%	69.428	-0.095	-6.72%
TM063876	69.74	1.632	69.686	-0.054	-3.31%	69.629	-0.111	-6.80%
TM062490	68.528	1.528	68.486	-0.042	-2.75%	68.443	-0.085	-5.56%
TM061662	67.903	1.870	67.856	-0.047	-2.51%	67.808	-0.095	-5.08%
TM060792	67.411	1.684	67.367	-0.044	-2.61%	67.321	-0.09	-5.34%
TM053545	66.851	1.311	66.827	-0.024	-1.83%	66.802	-0.049	-3.74%
LM1B053545	66.852	1.312	66.827	-0.025	-1.91%	66.802	-0.05	-3.81%
TM060201	67.127	2.153	67.088	-0.039	-1.81%	67.049	-0.078	-3.62%
TM053379	66.812	2.459	66.786	-0.026	-1.06%	66.758	-0.054	-2.20%
TM053520D	66.809	2.749	66.782	-0.027	-0.98%	66.756	-0.053	-1.93%
LM1B053528D	66.81	2.750	66.783	-0.027	-0.98%	66.756	-0.054	-1.96%
TM052747	65.367	1.467	65.337	-0.03	-2.04%	65.306	-0.061	-4.16%
TM051750	64.758	1.568	64.723	-0.035	-2.23%	64.69	-0.068	-4.34%
TM050791	64.204	1.704	64.157	-0.047	-2.76%	64.109	-0.095	-5.58%
TM045305	62.747	1.152	62.704	-0.043	-3.73%	62.661	-0.086	-7.47%
TM046047	63.318	1.798	63.278	-0.04	-2.22%	63.237	-0.081	-4.51%
TM045789	63.183	1.687	63.144	-0.039	-2.31%	63.105	-0.078	-4.62%
TM044515	62.258	1.387	62.218	-0.04	-2.88%	62.178	-0.08	-5.77%
TM043972	61.892	1.637	61.853	-0.039	-2.38%	61.813	-0.079	-4.83%
TM043486	61.614	1.498	61.575	-0.039	-2.60%	61.535	-0.079	-5.27%
TM043265	61.494	1.462	61.456	-0.038	-2.60%	61.418	-0.076	-5.20%
TM043631	61.705	1.714	61.665	-0.04	-2.33%	61.624	-0.081	-4.73%
TM044305	62.077	2.137	62.039	-0.038	-1.78%	62	-0.077	-3.60%
TM042471	60.798	1.952	60.764	-0.034	-1.74%	60.729	-0.069	-3.53%
TM041901	60.39	1.728	60.351	-0.039	-2.26%	60.311	-0.079	-4.57%
TM041361	60	1.648	59.963	-0.037	-2.25%	59.925	-0.075	-4.55%
TM034970	58.782	1.709	58.742	-0.04	-2.34%	58.701	-0.081	-4.74%
TM034260	58.631	1.861	58.597	-0.034	-1.83%	58.561	-0.07	-3.76%
TM034624	58.733	2.057	58.695	-0.038	-1.85%	58.656	-0.077	-3.74%
TM032303	58.108	2.414	58.092	-0.016	-0.66%	58.076	-0.032	-1.33%
TM032879	58.132	2.795	58.116	-0.016	-0.57%	58.099	-0.033	-1.18%
TM031603	56.284	1.400	56.252	-0.032	-2.29%	56.22	-0.064	-4.57%

Table 2: Wetted Perimeter (WP)

		Q99						
Cross Section	Bed Elevation (mAOD)	Baseline WP (m)	Scenario A WP (m)	Scenario A WP change from baseline (m)	Scenario A WP change from baseline (%)	Scenario B WP(m)	Scenario B WP change from baseline (m)	Scenario B WP change from baseline (%)
TM066838	72.027	29.892	29.342	-0.550	-1.84%	29.296	-0.596	-1.99%
TM066506	71.500	25.169	24.652	-0.517	-2.05%	24.612	-0.557	-2.21%
TM065758	70.350	34.539	32.251	-2.288	-6.62%	31.866	-2.673	-7.74%
TM065619	70.140	25.15	24.995	-0.155	-0.62%	24.985	-0.165	-0.66%
TM064210	69.13	34.332	34.186	-0.146	-0.43%	34.195	-0.137	-0.40%
TM064127	68.486	31.504	31.367	-0.137	-0.43%	31.378	-0.126	-0.40%
TM063654	68.267	32.253	32.115	-0.138	-0.43%	32.128	-0.125	-0.39%
TM063585	68.109	29.906	29.733	-0.173	-0.58%	29.751	-0.155	-0.52%
TM063876	68.108	32.749	32.608	-0.141	-0.43%	32.621	-0.128	-0.39%
TM062490	67.000	27.392	26.889	-0.503	-1.84%	26.951	-0.441	-1.61%
TM061662	66.033	30.908	30.035	-0.873	-2.82%	30.181	-0.727	-2.35%
TM060792	65.727	36.607	35.68	-0.927	-2.53%	35.853	-0.754	-2.06%
TM053545	65.540	24.623	24.549	-0.074	-0.30%	24.563	-0.060	-0.24%
LM1B053545	65.540	24.622	24.548	-0.074	-0.30%	24.562	-0.060	-0.24%
TM060201	64.974	36.356	35.375	-0.981	-2.70%	35.557	-0.799	-2.20%
TM053379	64.353	66.403	66.179	-0.224	-0.34%	66.258	-0.145	-0.22%
TM053520D	64.060	30.723	30.575	-0.148	-0.48%	30.625	-0.098	-0.32%
LM1B053528D	64.060	29.699	29.616	-0.083	-0.28%	29.644	-0.055	-0.19%
TM052747	63.900	21.835	21.723	-0.112	-0.51%	21.763	-0.072	-0.33%
TM051750	63.190	23.259	22.823	-0.436	-1.87%	23.053	-0.206	-0.89%
TM050791	62.500	31.023	30.663	-0.360	-1.16%	30.837	-0.186	-0.60%
TM045305	61.595	35.524	35.235	-0.289	-0.81%	35.392	-0.132	-0.37%
TM046047	61.52	26.206	25.937	-0.269	-1.03%	26.076	-0.130	-0.50%
TM045789	61.496	32.276	31.911	-0.365	-1.13%	32.101	-0.175	-0.54%
TM044515	60.871	39.508	38.414	-1.094	-2.77%	39.451	-0.057	-0.14%
TM043972	60.255	38.222	37.318	-0.904	-2.37%	37.81	-0.412	-1.08%
TM043486	60.116	34.749	34.428	-0.321	-0.92%	34.612	-0.137	-0.39%
TM043265	60.032	33.332	33.069	-0.263	-0.79%	33.22	-0.112	-0.34%
TM043631	59.991	31.949	31.239	-0.710	-2.22%	31.641	-0.308	-0.96%
TM044305	59.940	30.49	29.775	-0.715	-2.35%	30.171	-0.319	-1.05%
TM042471	58.846	23.463	22.348	-1.115	-4.75%	22.999	-0.464	-1.98%
TM041901	58.662	25.1	24.577	-0.523	-2.08%	24.894	-0.206	-0.82%
TM041361	58.352	29.294	27.9	-1.394	-4.76%	28.734	-0.560	-1.91%
TM034970	57.073	44.566	43.979	-0.587	-1.32%	44.396	-0.170	-0.38%
TM034260	56.770	33.959	33.713	-0.246	-0.72%	33.876	-0.083	-0.24%
TM034624	56.676	38.344	38.001	-0.343	-0.89%	38.23	-0.114	-0.30%
TM032303	55.694	42.773	42.655	-0.118	-0.28%	42.737	-0.036	-0.08%
TM032879	55.337	46.06	45.954	-0.106	-0.23%	46.026	-0.034	-0.07%
TM031603	54.884	21.936	21.427	-0.509	-2.32%	21.782	-0.154	-0.70%

	Q95						
Cross Section	Baseline WP (m)	Scenario A WP (m)	Scenario A WP change from baseline (m)	Scenario A WP change from baseline (%)	Scenario B WP(m)	Scenario B WP change from baseline (m)	Scenario B WP change from baseline (%)
TM066838	30.289	29.779	-0.51	-1.68%	29.226	-1.063	-3.51%
TM066506	25.503	24.994	-0.509	-2.00%	24.407	-1.096	-4.30%
TM065758	35.219	34.45	-0.769	-2.18%	32.652	-2.567	-7.29%
TM065619	25.266	25.136	-0.13	-0.51%	24.999	-0.267	-1.06%
TM064210	34.475	34.289	-0.186	-0.54%	34.107	-0.368	-1.07%
TM064127	31.636	31.465	-0.171	-0.54%	31.293	-0.343	-1.08%
TM063654	32.331	32.185	-0.146	-0.45%	31.619	-0.712	-2.20%
TM063585	29.997	29.824	-0.173	-0.58%	29.575	-0.422	-1.41%
TM063876	32.835	32.682	-0.153	-0.47%	32.515	-0.32	-0.97%
TM062490	27.601	27.13	-0.471	-1.71%	26.654	-0.947	-3.43%
TM061662	31.183	30.351	-0.832	-2.67%	29.454	-1.729	-5.54%
TM060792	37.003	36.112	-0.891	-2.41%	35.155	-1.848	-4.99%
TM053545	24.645	24.571	-0.074	-0.30%	24.495	-0.15	-0.61%
LM1B053545	24.644	24.57	-0.074	-0.30%	24.494	-0.15	-0.61%
TM060201	36.676	35.699	-0.977	-2.66%	34.703	-1.973	-5.38%
TM053379	66.468	66.249	-0.219	-0.33%	66.013	-0.455	-0.68%
TM053520D	30.765	30.621	-0.144	-0.47%	30.467	-0.298	-0.97%
LM1B053528D	29.723	29.642	-0.081	-0.27%	29.555	-0.168	-0.57%
TM052747	21.894	21.775	-0.119	-0.54%	21.637	-0.257	-1.17%
TM051750	23.498	23.033	-0.465	-1.98%	22.34	-1.158	-4.93%
TM050791	31.281	30.909	-0.372	-1.19%	30.514	-0.767	-2.45%
TM045305	35.767	35.426	-0.341	-0.95%	34.775	-0.992	-2.77%
TM046047	26.443	26.142	-0.301	-1.14%	25.796	-0.647	-2.45%
TM045789	32.621	32.201	-0.42	-1.29%	31.715	-0.906	-2.78%
TM044515	39.625	39.454	-0.171	-0.43%	26.344	-13.281	-33.52%
TM043972	38.668	37.765	-0.903	-2.34%	36.797	-1.871	-4.84%
TM043486	34.87	34.562	-0.308	-0.88%	34.199	-0.671	-1.92%
TM043265	33.433	33.188	-0.245	-0.73%	32.914	-0.519	-1.55%
TM043631	32.216	31.524	-0.692	-2.15%	30.774	-1.442	-4.48%
TM044305	30.82	30.141	-0.679	-2.20%	29.449	-1.371	-4.45%
TM042471	24.038	22.909	-1.129	-4.70%	21.806	-2.232	-9.29%
TM041901	27.175	24.839	-2.336	-8.60%	24.342	-2.833	-10.43%
TM041361	30.025	28.545	-1.48	-4.93%	27.097	-2.928	-9.75%
TM034970	44.653	44.246	-0.407	-0.91%	43.535	-1.118	-2.50%
TM034260	34.054	33.807	-0.247	-0.73%	33.519	-0.535	-1.57%
TM034624	38.493	38.15	-0.343	-0.89%	37.754	-0.739	-1.92%
TM032303	42.792	42.679	-0.113	-0.26%	42.536	-0.256	-0.60%
TM032879	46.079	45.977	-0.102	-0.22%	45.847	-0.232	-0.50%
TM031603	22.282	21.864	-0.418	-1.88%	21.308	-0.974	-4.37%

	Sens. A - Q95, Plus 20% Weir			Sens. B - Q95, Minus 20% Weir			Sens. C - Q95, Plus 10% Manning's			Sens. D - Q95, Minus 10% Manning's		
Cross Section	WP (m)	change from Baseline (m)	Change from Baseline (%)	WP (m)	change from Baseline (m)	Change from Baseline (%)	WP (m)	change from Baseline (m)	Change from Baseline (%)	WP (m)	change from Baseline (m)	Change from Baseline (%)
TM066838	30.289	0	0.00%	30.289	0	0.00%	30.698	0.409	1.35%	29.987	-0.302	-1.00%
TM066506	25.503	0	0.00%	25.503	0	0.00%	25.818	0.315	1.24%	25.272	-0.231	-0.91%
TM065758	35.219	0	0.00%	35.219	0	0.00%	35.282	0.063	0.18%	34.653	-0.566	-1.61%
TM065619	25.266	0	0.00%	25.266	0	0.00%	25.435	0.169	0.67%	25.194	-0.072	-0.28%
TM064210	34.475	0	0.00%	34.475	0	0.00%	34.575	0.1	0.29%	34.383	-0.092	-0.27%
TM064127	31.636	0	0.00%	31.636	0	0.00%	31.726	0.09	0.28%	31.549	-0.087	-0.28%
TM063654	32.331	0	0.00%	32.331	0	0.00%	32.413	0.082	0.25%	32.266	-0.065	-0.20%
TM063585	29.997	0	0.00%	29.997	0	0.00%	30.089	0.092	0.31%	29.924	-0.073	-0.24%
TM063876	32.835	0	0.00%	32.835	0	0.00%	32.915	0.08	0.24%	32.772	-0.063	-0.19%
TM062490	27.601	0	0.00%	27.601	0	0.00%	27.886	0.285	1.03%	27.381	-0.22	-0.80%
TM061662	31.182	-0.001	0.00%	31.185	0.002	0.01%	32.262	1.079	3.46%	30.821	-0.362	-1.16%
TM060792	36.999	-0.004	-0.01%	37.04	0.037	0.10%	37.156	0.153	0.41%	36.683	-0.32	-0.86%
TM053545	24.641	-0.004	-0.02%	24.661	0.016	0.06%	24.645	0	0.00%	24.645	0	0.00%
LM1B053545	24.64	-0.004	-0.02%	24.66	0.016	0.06%	24.644	0	0.00%	24.644	0	0.00%
TM060201	36.651	-0.025	-0.07%	36.794	0.118	0.32%	36.927	0.251	0.68%	36.505	-0.171	-0.47%
TM053379	66.099	-0.369	-0.56%	66.742	0.274	0.41%	66.468	0	0.00%	66.468	0	0.00%
TM053520D	30.521	-0.244	-0.79%	30.947	0.182	0.59%	30.765	0	0.00%	30.765	0	0.00%
LM1B053528D	29.585	-0.138	-0.46%	29.825	0.102	0.34%	29.723	0	0.00%	29.723	0	0.00%
TM052747	21.892	-0.002	-0.01%	21.894	0	0.00%	21.95	0.056	0.26%	21.836	-0.058	-0.26%
TM051750	23.296	-0.202	-0.86%	23.588	0.09	0.38%	23.641	0.143	0.61%	23.328	-0.17	-0.72%
TM050791	31.279	-0.002	-0.01%	31.282	0.001	0.00%	31.452	0.171	0.55%	31.102	-0.179	-0.57%
TM045305	35.765	-0.002	-0.01%	35.768	0.001	0.00%	35.956	0.189	0.53%	35.561	-0.206	-0.58%
TM046047	26.442	-0.001	0.00%	26.444	0.001	0.00%	26.59	0.147	0.56%	26.288	-0.155	-0.59%
TM045789	32.619	-0.002	-0.01%	32.623	0.002	0.01%	32.824	0.203	0.62%	32.407	-0.214	-0.66%
TM044515	39.625	0	0.00%	39.625	0	0.00%	39.724	0.099	0.25%	39.529	-0.096	-0.24%
TM043972	38.665	-0.003	-0.01%	38.671	0.003	0.01%	39.125	0.457	1.18%	38.198	-0.47	-1.22%
TM043486	34.87	0	0.00%	34.871	0.001	0.00%	35.02	0.15	0.43%	34.714	-0.156	-0.45%
TM043265	33.434	0.001	0.00%	33.434	0.001	0.00%	33.55	0.117	0.35%	33.31	-0.123	-0.37%
TM043631	32.213	-0.003	-0.01%	32.218	0.002	0.01%	32.578	0.362	1.12%	31.857	-0.359	-1.11%
TM044305	30.818	-0.002	-0.01%	30.821	0.001	0.00%	31.147	0.327	1.06%	30.483	-0.337	-1.09%
TM042471	24.033	-0.005	-0.02%	24.04	0.002	0.01%	24.666	0.628	2.61%	23.358	-0.68	-2.83%
TM041901	27.168	-0.007	-0.03%	27.179	0.004	0.01%	28.061	0.886	3.26%	25.06	-2.115	-7.78%
TM041361	30.026	0.001	0.00%	30.029	0.004	0.01%	30.69	0.665	2.21%	29.31	-0.715	-2.38%
TM034970	44.627	-0.026	-0.06%	44.678	0.025	0.06%	44.749	0.096	0.21%	44.555	-0.098	-0.22%
TM034260	34.009	-0.045	-0.13%	34.097	0.043	0.13%	34.164	0.11	0.32%	33.94	-0.114	-0.33%
TM034624	38.445	-0.048	-0.12%	38.54	0.047	0.12%	38.652	0.159	0.41%	38.331	-0.162	-0.42%
TM032303	42.504	-0.288	-0.67%	42.972	0.18	0.42%	42.785	-0.007	-0.02%	42.797	0.005	0.01%
TM032879	45.857	-0.222	-0.48%	46.175	0.096	0.21%	46.08	0.001	0.00%	46.077	-0.002	0.00%
TM031603	22.762	0.48	2.15%	21.998	-0.284	-1.27%	22.509	0.227	1.02%	22.078	-0.204	-0.92%

		Q50						
Cross Section	Bed Elevation (mAOD)	Baseline WP (m)	Scenario A WP (m)	Scenario A WP change from baseline (m)	Scenario A WP change from baseline (%)	Scenario B WP(m)	Scenario B WP change from baseline (m)	Scenario B WP change from baseline (%)
TM066838	72.027	31.249	31.148	-0.101	-0.32%	30.816	-0.433	-1.39%
TM066506	71.500	26.877	26.403	-0.474	-1.76%	25.939	-0.938	-3.49%
TM065758	70.350	35.484	35.383	-0.101	-0.28%	35.289	-0.195	-0.55%
TM065619	70.140	26.57	26.459	-0.111	-0.42%	26.333	-0.237	-0.89%
TM064210	69.13	34.795	34.617	-0.178	-0.51%	34.433	-0.362	-1.04%
TM064127	68.486	31.926	31.766	-0.16	-0.50%	31.599	-0.327	-1.02%
TM063654	68.267	32.563	32.436	-0.127	-0.39%	32.3	-0.263	-0.81%
TM063585	68.109	30.272	30.124	-0.148	-0.49%	29.965	-0.307	-1.01%
TM063876	68.108	33.073	32.939	-0.134	-0.41%	32.796	-0.277	-0.84%
TM062490	67.000	30.338	28.507	-1.831	-6.04%	27.859	-2.479	-8.17%
TM061662	66.033	33.286	32.775	-0.511	-1.54%	32.24	-1.046	-3.14%
TM060792	65.727	37.464	37.319	-0.145	-0.39%	37.167	-0.297	-0.79%
TM053545	65.540	24.814	24.751	-0.063	-0.25%	24.685	-0.129	-0.52%
LM1B053545	65.540	24.814	24.751	-0.063	-0.25%	24.684	-0.13	-0.52%
TM060201	64.974	38.325	38.095	-0.23	-0.60%	37.234	-1.091	-2.85%
TM053379	64.353	66.982	66.787	-0.195	-0.29%	66.587	-0.395	-0.59%
TM053520D	64.060	31.099	30.975	-0.124	-0.40%	30.845	-0.254	-0.82%
LM1B053528D	64.060	29.911	29.841	-0.07	-0.23%	29.767	-0.144	-0.48%
TM052747	63.900	22.157	22.058	-0.099	-0.45%	21.953	-0.204	-0.92%
TM051750	63.190	24.354	24.01	-0.344	-1.41%	23.667	-0.687	-2.82%
TM050791	62.500	32.126	31.733	-0.393	-1.22%	31.449	-0.677	-2.11%
TM045305	61.595	36.574	36.273	-0.301	-0.82%	35.932	-0.642	-1.76%
TM046047	61.52	27.078	26.845	-0.233	-0.86%	26.583	-0.495	-1.83%
TM045789	61.496	33.502	33.181	-0.321	-0.96%	32.804	-0.698	-2.08%
TM044515	60.871	40.083	39.907	-0.176	-0.44%	39.72	-0.363	-0.91%
TM043972	60.255	40.597	39.858	-0.739	-1.82%	39.041	-1.556	-3.83%
TM043486	60.116	35.494	35.297	-0.197	-0.56%	35.033	-0.461	-1.30%
TM043265	60.032	35.898	33.766	-2.132	-5.94%	33.56	-2.338	-6.51%
TM043631	59.991	33.227	32.937	-0.29	-0.87%	32.589	-0.638	-1.92%
TM044305	59.940	32.266	31.74	-0.526	-1.63%	31.11	-1.156	-3.58%
TM042471	58.846	28.986	25.535	-3.451	-11.91%	24.63	-4.356	-15.03%
TM041901	58.662	32.672	30.366	-2.306	-7.06%	28.058	-4.614	-14.12%
TM041361	58.352	33.012	31.949	-1.063	-3.22%	30.763	-2.249	-6.81%
TM034970	57.073	45.122	44.963	-0.159	-0.35%	44.791	-0.331	-0.73%
TM034260	56.770	34.626	34.436	-0.19	-0.55%	34.229	-0.397	-1.15%
TM034624	56.676	39.198	38.992	-0.206	-0.53%	38.73	-0.468	-1.19%
TM032303	55.694	43.122	43.04	-0.082	-0.19%	42.952	-0.17	-0.39%
TM032879	55.337	46.276	46.227	-0.049	-0.11%	46.174	-0.102	-0.22%
TM031603	54.884	25.227	23.379	-1.848	-7.33%	22.918	-2.309	-9.15%

	Q10						
Cross Section	Baseline WP (m)	Scenario A WP (m)	Scenario A WP change from baseline (m)	Scenario A WP change from baseline (%)	Scenario B WP(m)	Scenario B WP change from baseline (m)	Scenario B WP change from baseline (%)
TM066838	31.996	31.918	-0.078	-0.24%	31.835	-0.161	-0.50%
TM066506	28.562	28.476	-0.086	-0.30%	28.388	-0.174	-0.61%
TM065758	35.996	35.942	-0.054	-0.15%	35.889	-0.107	-0.30%
TM065619	27.327	27.245	-0.082	-0.30%	27.161	-0.166	-0.61%
TM064210	35.39	35.25	-0.14	-0.40%	35.106	-0.284	-0.80%
TM064127	32.459	32.334	-0.125	-0.39%	32.206	-0.253	-0.78%
TM063654	33.09	32.988	-0.102	-0.31%	32.882	-0.208	-0.63%
TM063585	30.911	30.793	-0.118	-0.38%	30.668	-0.243	-0.79%
TM063876	33.602	33.489	-0.113	-0.34%	33.371	-0.231	-0.69%
TM062490	32.581	32.466	-0.115	-0.35%	32.347	-0.234	-0.72%
TM061662	36.925	36.596	-0.329	-0.89%	36.258	-0.667	-1.81%
TM060792	38.587	38.485	-0.102	-0.26%	38.379	-0.208	-0.54%
TM053545	25.324	25.275	-0.049	-0.19%	25.225	-0.099	-0.39%
LM1B053545	25.323	25.274	-0.049	-0.19%	25.224	-0.099	-0.39%
TM060201	40.302	40.09	-0.212	-0.53%	39.875	-0.427	-1.06%
TM053379	68.544	68.395	-0.149	-0.22%	68.244	-0.3	-0.44%
TM053520D	32.092	31.998	-0.094	-0.29%	31.902	-0.19	-0.59%
LM1B053528D	30.469	30.416	-0.053	-0.17%	30.362	-0.107	-0.35%
TM052747	22.835	22.774	-0.061	-0.27%	22.712	-0.123	-0.54%
TM051750	30.938	29.701	-1.237	-4.00%	28.201	-2.737	-8.85%
TM050791	35.158	34.884	-0.274	-0.78%	34.603	-0.555	-1.58%
TM045305	38.195	38.099	-0.096	-0.25%	38.001	-0.194	-0.51%
TM046047	28.75	28.599	-0.151	-0.53%	28.445	-0.305	-1.06%
TM045789	39.142	38.756	-0.386	-0.99%	38.368	-0.774	-1.98%
TM044515	41.413	41.295	-0.118	-0.28%	41.175	-0.238	-0.57%
TM043972	49.606	49.431	-0.175	-0.35%	49.251	-0.355	-0.72%
TM043486	36.992	36.859	-0.133	-0.36%	36.722	-0.27	-0.73%
TM043265	39.39	39.274	-0.116	-0.29%	39.157	-0.233	-0.59%
TM043631	44.111	43.299	-0.812	-1.84%	42.652	-1.459	-3.31%
TM044305	34.453	34.271	-0.182	-0.53%	34.084	-0.369	-1.07%
TM042471	44.883	44.793	-0.09	-0.20%	44.701	-0.182	-0.41%
TM041901	39.359	39.275	-0.084	-0.21%	39.19	-0.169	-0.43%
TM041361	41.556	40.488	-1.068	-2.57%	39.388	-2.168	-5.22%
TM034970	46.415	46.309	-0.106	-0.23%	46.201	-0.214	-0.46%
TM034260	36.218	36.091	-0.127	-0.35%	35.96	-0.258	-0.71%
TM034624	40.333	40.249	-0.084	-0.21%	40.163	-0.17	-0.42%
TM032303	43.989	43.94	-0.049	-0.11%	43.897	-0.092	-0.21%
TM032879	46.855	46.821	-0.034	-0.07%	46.787	-0.068	-0.15%
TM031603	39.879	39.764	-0.115	-0.29%	39.646	-0.233	-0.58%

Table 3: Velocity

Cross Section	Bed Elevation (mAOD)	Q99 Baseline Velocity (m/s)	Q99 Scenario A Velocity (m/s)	Q99 Scenario A Velocity change from baseline (m/s)	Q99 Scenario A Velocity change from baseline (%)	Q99 Scenario B Velocity (m/s)	Q99 Scenario B Velocity change from baseline (m/s)	Q99 Scenario B Velocity change from baseline (%)
TM066838	72.027	0.698	0.681	-0.017	-2.44%	0.662	-0.036	-5.16%
TM066506	71.500	0.641	0.593	-0.048	-7.49%	0.554	-0.087	-13.57%
TM065758	70.350	1.064	1.17	0.106	9.96%	1.158	0.094	8.83%
TM065619	70.140	0.455	0.417	-0.038	-8.35%	0.374	-0.081	-17.80%
TM064210	69.13	0.713	0.673	-0.04	-5.61%	0.624	-0.089	-12.48%
TM064127	68.486	0.623	0.565	-0.058	-9.31%	0.499	-0.124	-19.90%
TM063654	68.267	0.731	0.683	-0.048	-6.57%	0.65	-0.081	-11.08%
TM063585	68.109	0.508	0.447	-0.061	-12.01%	0.386	-0.122	-24.02%
TM063876	68.108	0.396	0.345	-0.051	-12.88%	0.291	-0.105	-26.52%
TM062490	67.000	0.697	0.645	-0.052	-7.46%	0.583	-0.114	-16.36%
TM061662	66.033	0.517	0.478	-0.039	-7.54%	0.443	-0.074	-14.31%
TM060792	65.727	0.495	0.456	-0.039	-7.88%	0.412	-0.083	-16.77%
TM053545	65.540	0.32	0.267	-0.053	-16.56%	0.216	-0.104	-32.50%
LM1B053545	65.540	0.32	0.267	-0.053	-16.56%	0.216	-0.104	-32.50%
TM060201	64.974	0.32	0.273	-0.047	-14.69%	0.226	-0.094	-29.38%
TM053379	64.353	0.036	0.03	-0.006	-16.67%	0.023	-0.013	-36.11%
TM053520D	64.060	0.102	0.084	-0.018	-17.65%	0.067	-0.035	-34.31%
LM1B053528D	64.060	0.105	0.086	-0.019	-18.10%	0.068	-0.037	-35.24%
TM052747	63.900	0.285	0.242	-0.043	-15.09%	0.208	-0.077	-27.02%
TM051750	63.190	0.259	0.231	-0.028	-10.81%	0.217	-0.042	-16.22%
TM050791	62.500	0.425	0.375	-0.05	-11.76%	0.335	-0.09	-21.18%
TM045305	61.595	0.892	0.868	-0.024	-2.69%	0.868	-0.024	-2.69%
TM046047	61.52	0.577	0.507	-0.07	-12.13%	0.458	-0.119	-20.62%
TM045789	61.496	0.598	0.542	-0.056	-9.36%	0.503	-0.095	-15.89%
TM044515	60.871	0.675	0.624	-0.051	-7.56%	0.635	-0.04	-5.93%
TM043972	60.255	0.592	0.576	-0.016	-2.70%	0.561	-0.031	-5.24%
TM043486	60.116	0.459	0.418	-0.041	-8.93%	0.39	-0.069	-15.03%
TM043265	60.032	0.526	0.481	-0.045	-8.56%	0.451	-0.075	-14.26%
TM043631	59.991	0.567	0.521	-0.046	-8.11%	0.489	-0.078	-13.76%
TM044305	59.940	0.381	0.335	-0.046	-12.07%	0.302	-0.079	-20.73%
TM042471	58.846	0.987	0.902	-0.085	-8.61%	0.827	-0.16	-16.21%
TM041901	58.662	0.727	0.647	-0.08	-11.00%	0.596	-0.131	-18.02%
TM041361	58.352	0.634	0.575	-0.059	-9.31%	0.533	-0.101	-15.93%
TM034970	57.073	0.297	0.267	-0.03	-10.10%	0.251	-0.046	-15.49%
TM034260	56.770	0.298	0.257	-0.041	-13.76%	0.237	-0.061	-20.47%
TM034624	56.676	0.243	0.21	-0.033	-13.58%	0.194	-0.049	-20.16%
TM032303	55.694	0.161	0.153	-0.008	-4.97%	0.147	-0.014	-8.70%
TM032879	55.337	0.129	0.122	-0.007	-5.43%	0.117	-0.012	-9.30%
TM031603	54.884	1.69	1.7	0.01	0.59%	1.694	0.004	0.24%

Cross Section	Q95 Baseline Velocity (m/s)	Q95 Scenario A Velocity (m/s)	Q95 Scenario A Velocity change from baseline (m/s)	Q95 Scenario A Velocity change from baseline (%)	Q95 Scenario B Velocity (m/s)	Q95 Scenario B Velocity change from baseline (m/s)	Q95 Scenario B Velocity change from baseline (%)
TM066838	0.692	0.672	-0.02	-2.89%	0.649	-0.043	-6.21%
TM066506	0.658	0.617	-0.041	-6.23%	0.571	-0.087	-13.22%
TM065758	0.997	1.005	0.008	0.80%	1.051	0.054	5.42%
TM065619	0.465	0.425	-0.04	-8.60%	0.381	-0.084	-18.06%
TM064210	0.657	0.64	-0.017	-2.59%	0.61	-0.047	-7.15%
TM064127	0.593	0.553	-0.04	-6.75%	0.499	-0.094	-15.85%
TM063654	0.714	0.673	-0.041	-5.74%	0.63	-0.084	-11.76%
TM063585	0.512	0.454	-0.058	-11.33%	0.391	-0.121	-23.63%
TM063876	0.397	0.352	-0.045	-11.34%	0.3	-0.097	-24.43%
TM062490	0.701	0.645	-0.056	-7.99%	0.58	-0.121	-17.26%
TM061662	0.525	0.488	-0.037	-7.05%	0.443	-0.082	-15.62%
TM060792	0.498	0.463	-0.035	-7.03%	0.421	-0.077	-15.46%
TM053545	0.335	0.283	-0.052	-15.52%	0.228	-0.107	-31.94%
LM1B053545	0.335	0.283	-0.052	-15.52%	0.228	-0.107	-31.94%
TM060201	0.334	0.29	-0.044	-13.17%	0.239	-0.095	-28.44%
TM053379	0.038	0.031	-0.007	-18.42%	0.025	-0.013	-34.21%
TM053520D	0.108	0.09	-0.018	-16.67%	0.071	-0.037	-34.26%
LM1B053528D	0.111	0.092	-0.019	-17.12%	0.072	-0.039	-35.14%
TM052747	0.293	0.253	-0.04	-13.65%	0.211	-0.082	-27.99%
TM051750	0.268	0.242	-0.026	-9.70%	0.222	-0.046	-17.16%
TM050791	0.424	0.38	-0.044	-10.38%	0.329	-0.095	-22.41%
TM045305	0.835	0.825	-0.01	-1.20%	0.844	0.009	1.08%
TM046047	0.574	0.513	-0.061	-10.63%	0.445	-0.129	-22.47%
TM045789	0.579	0.535	-0.044	-7.60%	0.487	-0.092	-15.89%
TM044515	0.647	0.615	-0.032	-4.95%	0.647	0	0.00%
TM043972	0.587	0.573	-0.014	-2.39%	0.553	-0.034	-5.79%
TM043486	0.466	0.425	-0.041	-8.80%	0.379	-0.087	-18.67%
TM043265	0.535	0.489	-0.046	-8.60%	0.437	-0.098	-18.32%
TM043631	0.575	0.53	-0.045	-7.83%	0.478	-0.097	-16.87%
TM044305	0.39	0.344	-0.046	-11.79%	0.294	-0.096	-24.62%
TM042471	0.987	0.908	-0.079	-8.00%	0.807	-0.18	-18.24%
TM041901	0.735	0.66	-0.075	-10.20%	0.565	-0.17	-23.13%
TM041361	0.636	0.582	-0.054	-8.49%	0.514	-0.122	-19.18%
TM034970	0.301	0.273	-0.028	-9.30%	0.242	-0.059	-19.60%
TM034260	0.31	0.27	-0.04	-12.90%	0.228	-0.082	-26.45%
TM034624	0.25	0.219	-0.031	-12.40%	0.186	-0.064	-25.60%
TM032303	0.163	0.155	-0.008	-4.91%	0.144	-0.019	-11.66%
TM032879	0.13	0.123	-0.007	-5.38%	0.114	-0.016	-12.31%
TM031603	1.677	1.687	0.01	0.60%	1.687	0.01	0.60%

Cross Section	Sens. A - Q95, +20% Weir Coefficient Velocity (m/s)	Sens. A change from Baseline (m/s)	Sens. A % change from Baseline (%)	Sens. B - Q95, -20% Weir Coefficient Velocity (m/s)	Sens. B change from Baseline (m/s)	Sens. B % change from Baseline (%)	Sens. C - Q95, +10% Manning's Velocity (m/s)	Sens. C change from Baseline (m/s)	Sens. C % change from Baseline (%)	Sens. D - Q95, -10% Manning's Velocity (m/s)	Sens. D change from Baseline (m/s)	Sens. D % change from Baseline (%)
TM066838	0.692	0	0.00%	0.692	0	0.00%	0.631	-0.061	-8.82%	0.745	0.053	7.66%
TM066506	0.658	0	0.00%	0.658	0	0.00%	0.624	-0.034	-5.17%	0.686	0.028	4.26%
TM065758	0.997	0	0.00%	0.997	0	0.00%	0.919	-0.078	-7.82%	1.123	0.126	12.64%
TM065619	0.465	0	0.00%	0.465	0	0.00%	0.444	-0.021	-4.52%	0.482	0.017	3.66%
TM064210	0.657	0	0.00%	0.657	0	0.00%	0.602	-0.055	-8.37%	0.717	0.06	9.13%
TM064127	0.593	0	0.00%	0.593	0	0.00%	0.555	-0.038	-6.41%	0.635	0.042	7.08%
TM063654	0.714	0	0.00%	0.714	0	0.00%	0.663	-0.051	-7.14%	0.762	0.048	6.72%
TM063585	0.512	0	0.00%	0.512	0	0.00%	0.489	-0.023	-4.49%	0.531	0.019	3.71%
TM063876	0.397	0	0.00%	0.397	0	0.00%	0.381	-0.016	-4.03%	0.412	0.015	3.78%
TM062490	0.701	0	0.00%	0.701	0	0.00%	0.655	-0.046	-6.56%	0.741	0.04	5.71%
TM061662	0.525	0	0.00%	0.525	0	0.00%	0.489	-0.036	-6.86%	0.555	0.03	5.71%
TM060792	0.499	0.001	0.20%	0.496	-0.002	-0.40%	0.471	-0.027	-5.42%	0.521	0.023	4.62%
TM053545	0.336	0.001	0.30%	0.332	-0.003	-0.90%	0.335	0	0.00%	0.335	0	0.00%
LM1B053545	0.336	0.001	0.30%	0.332	-0.003	-0.90%	0.335	0	0.00%	0.335	0	0.00%
TM060201	0.335	0.001	0.30%	0.332	-0.002	-0.60%	0.329	-0.005	-1.50%	0.338	0.004	1.20%
TM053379	0.039	0.001	2.63%	0.037	-0.001	-2.63%	0.038	0	0.00%	0.038	0	0.00%
TM053520D	0.112	0.004	3.70%	0.105	-0.003	-2.78%	0.108	0	0.00%	0.108	0	0.00%
LM1B053528D	0.114	0.003	2.70%	0.108	-0.003	-2.70%	0.111	0	0.00%	0.111	0	0.00%
TM052747	0.293	0	0.00%	0.293	0	0.00%	0.285	-0.008	-2.73%	0.301	0.008	2.73%
TM051750	0.28	0.012	4.48%	0.262	-0.006	-2.24%	0.26	-0.008	-2.99%	0.278	0.01	3.73%
TM050791	0.424	0	0.00%	0.424	0	0.00%	0.406	-0.018	-4.25%	0.444	0.02	4.72%
TM045305	0.835	0	0.00%	0.835	0	0.00%	0.76	-0.075	-8.98%	0.934	0.099	11.86%
TM046047	0.574	0	0.00%	0.574	0	0.00%	0.55	-0.024	-4.18%	0.602	0.028	4.88%
TM045789	0.579	0	0.00%	0.579	0	0.00%	0.548	-0.031	-5.35%	0.616	0.037	6.39%
TM044515	0.647	0	0.00%	0.647	0	0.00%	0.598	-0.049	-7.57%	0.703	0.056	8.66%
TM043972	0.587	0	0.00%	0.587	0	0.00%	0.541	-0.046	-7.84%	0.644	0.057	9.71%
TM043486	0.466	0	0.00%	0.466	0	0.00%	0.443	-0.023	-4.94%	0.493	0.027	5.79%
TM043265	0.535	0	0.00%	0.535	0	0.00%	0.508	-0.027	-5.05%	0.566	0.031	5.79%
TM043631	0.575	0	0.00%	0.575	0	0.00%	0.542	-0.033	-5.74%	0.612	0.037	6.43%
TM044305	0.39	0	0.00%	0.39	0	0.00%	0.376	-0.014	-3.59%	0.406	0.016	4.10%
TM042471	0.986	-0.001	-0.10%	0.987	0	0.00%	0.928	-0.059	-5.98%	1.059	0.072	7.29%
TM041901	0.735	0	0.00%	0.735	0	0.00%	0.693	-0.042	-5.71%	0.777	0.042	5.71%
TM041361	0.636	0	0.00%	0.636	0	0.00%	0.606	-0.03	-4.72%	0.671	0.035	5.50%
TM034970	0.304	0.003	1.00%	0.297	-0.004	-1.33%	0.287	-0.014	-4.65%	0.316	0.015	4.98%
TM034260	0.313	0.003	0.97%	0.306	-0.004	-1.29%	0.301	-0.009	-2.90%	0.318	0.008	2.58%
TM034624	0.252	0.002	0.80%	0.248	-0.002	-0.80%	0.243	-0.007	-2.80%	0.258	0.008	3.20%
TM032303	0.2	0.037	22.70%	0.143	-0.02	-12.27%	0.162	-0.001	-0.61%	0.165	0.002	1.23%
TM032879	0.158	0.028	21.54%	0.114	-0.016	-12.31%	0.129	-0.001	-0.77%	0.131	0.001	0.77%
TM031603	1.797	0.12	7.16%	1.592	-0.085	-5.07%	1.597	-0.08	-4.77%	1.754	0.077	4.59%

Cross Section	Bed Elevation (mAOD)	Q50 Baseline Velocity (m/s)	Q50 Scenario A Velocity (m/s)	Q50 Scenario A Velocity change from baseline (m/s)	Q50 Scenario A Velocity change from baseline (%)	Q50 Scenario B Velocity (m/s)	Q50 Scenario B Velocity change from baseline (m/s)	Q50 Scenario B Velocity change from baseline (%)
TM066838	72.027	0.742	0.726	-0.016	-2.16%	0.711	-0.031	-4.18%
TM066506	71.500	0.766	0.74	-0.026	-3.39%	0.707	-0.059	-7.70%
TM065758	70.350	1.065	1.064	-0.001	-0.09%	1.053	-0.012	-1.13%
TM065619	70.140	0.57	0.536	-0.034	-5.96%	0.503	-0.067	-11.75%
TM064210	69.13	0.682	0.669	-0.013	-1.91%	0.656	-0.026	-3.81%
TM064127	68.486	0.65	0.621	-0.029	-4.46%	0.586	-0.064	-9.85%
TM063654	68.267	0.783	0.747	-0.036	-4.60%	0.707	-0.076	-9.71%
TM063585	68.109	0.602	0.553	-0.049	-8.14%	0.5	-0.102	-16.94%
TM063876	68.108	0.471	0.432	-0.039	-8.28%	0.39	-0.081	-17.20%
TM062490	67.000	0.814	0.78	-0.034	-4.18%	0.731	-0.083	-10.20%
TM061662	66.033	0.601	0.574	-0.027	-4.49%	0.545	-0.056	-9.32%
TM060792	65.727	0.572	0.546	-0.026	-4.55%	0.518	-0.054	-9.44%
TM053545	65.540	0.457	0.412	-0.045	-9.85%	0.364	-0.093	-20.35%
LM1B053545	65.540	0.457	0.412	-0.045	-9.85%	0.364	-0.093	-20.35%
TM060201	64.974	0.428	0.395	-0.033	-7.71%	0.358	-0.07	-16.36%
TM053379	64.353	0.053	0.047	-0.006	-11.32%	0.041	-0.012	-22.64%
TM053520D	64.060	0.153	0.136	-0.017	-11.11%	0.119	-0.034	-22.22%
LM1B053528D	64.060	0.157	0.139	-0.018	-11.46%	0.121	-0.036	-22.93%
TM052747	63.900	0.384	0.351	-0.033	-8.59%	0.315	-0.069	-17.97%
TM051750	63.190	0.331	0.31	-0.021	-6.34%	0.285	-0.046	-13.90%
TM050791	62.500	0.519	0.487	-0.032	-6.17%	0.45	-0.069	-13.29%
TM045305	61.595	0.862	0.852	-0.01	-1.16%	0.85	-0.012	-1.39%
TM046047	61.52	0.711	0.662	-0.049	-6.89%	0.61	-0.101	-14.21%
TM045789	61.496	0.683	0.645	-0.038	-5.56%	0.61	-0.073	-10.69%
TM044515	60.871	0.692	0.677	-0.015	-2.17%	0.664	-0.028	-4.05%
TM043972	60.255	0.634	0.617	-0.017	-2.68%	0.601	-0.033	-5.21%
TM043486	60.116	0.555	0.523	-0.032	-5.77%	0.488	-0.067	-12.07%
TM043265	60.032	0.637	0.601	-0.036	-5.65%	0.561	-0.076	-11.93%
TM043631	59.991	0.667	0.633	-0.034	-5.10%	0.599	-0.068	-10.19%
TM044305	59.940	0.487	0.453	-0.034	-6.98%	0.416	-0.071	-14.58%
TM042471	58.846	1.112	1.088	-0.024	-2.16%	1.031	-0.081	-7.28%
TM041901	58.662	0.844	0.813	-0.031	-3.67%	0.768	-0.076	-9.00%
TM041361	58.352	0.761	0.719	-0.042	-5.52%	0.668	-0.093	-12.22%
TM034970	57.073	0.362	0.34	-0.022	-6.08%	0.316	-0.046	-12.71%
TM034260	56.770	0.402	0.369	-0.033	-8.21%	0.333	-0.069	-17.16%
TM034624	56.676	0.322	0.296	-0.026	-8.07%	0.269	-0.053	-16.46%
TM032303	55.694	0.188	0.182	-0.006	-3.19%	0.175	-0.013	-6.91%
TM032879	55.337	0.151	0.146	-0.005	-3.31%	0.14	-0.011	-7.28%
TM031603	54.884	1.531	1.622	0.091	5.94%	1.652	0.121	7.90%

Cross Section	Q10 Baseline Velocity (m/s)	Q10 Scenario A Velocity (m/s)	Q10 Scenario A Velocity change from baseline (m/s)	Q10 Scenario A Velocity change from baseline (%)	Q10 Scenario B Velocity (m/s)	Q10 Scenario B Velocity change from baseline (m/s)	Q10 Scenario B Velocity change from baseline (%)
TM066838	0.839	0.827	-0.012	-1.43%	0.814	-0.025	-2.98%
TM066506	0.935	0.913	-0.022	-2.35%	0.891	-0.044	-4.71%
TM065758	1.22	1.208	-0.012	-0.98%	1.194	-0.026	-2.13%
TM065619	0.793	0.769	-0.024	-3.03%	0.745	-0.048	-6.05%
TM064210	0.75	0.734	-0.016	-2.13%	0.717	-0.033	-4.40%
TM064127	0.762	0.737	-0.025	-3.28%	0.709	-0.053	-6.96%
TM063654	0.866	0.835	-0.031	-3.58%	0.803	-0.063	-7.27%
TM063585	0.733	0.696	-0.037	-5.05%	0.656	-0.077	-10.50%
TM063876	0.589	0.559	-0.03	-5.09%	0.528	-0.061	-10.36%
TM062490	1.058	1.037	-0.021	-1.98%	1.014	-0.044	-4.16%
TM061662	0.788	0.772	-0.016	-2.03%	0.756	-0.032	-4.06%
TM060792	0.755	0.739	-0.016	-2.12%	0.722	-0.033	-4.37%
TM053545	0.809	0.777	-0.032	-3.96%	0.743	-0.066	-8.16%
LM1B053545	0.809	0.776	-0.033	-4.08%	0.743	-0.066	-8.16%
TM060201	0.65	0.631	-0.019	-2.92%	0.612	-0.038	-5.85%
TM053379	0.1	0.095	-0.005	-5.00%	0.091	-0.009	-9.00%
TM053520D	0.291	0.278	-0.013	-4.47%	0.264	-0.027	-9.28%
LM1B053528D	0.304	0.29	-0.014	-4.61%	0.275	-0.029	-9.54%
TM052747	0.65	0.626	-0.024	-3.69%	0.6	-0.05	-7.69%
TM051750	0.502	0.493	-0.009	-1.79%	0.481	-0.021	-4.18%
TM050791	0.742	0.722	-0.02	-2.70%	0.702	-0.04	-5.39%
TM045305	0.965	0.952	-0.013	-1.35%	0.94	-0.025	-2.59%
TM046047	1.07	1.039	-0.031	-2.90%	1.006	-0.064	-5.98%
TM045789	0.913	0.897	-0.016	-1.75%	0.879	-0.034	-3.72%
TM044515	0.829	0.814	-0.015	-1.81%	0.799	-0.03	-3.62%
TM043972	0.727	0.718	-0.009	-1.24%	0.709	-0.018	-2.48%
TM043486	0.786	0.766	-0.02	-2.54%	0.744	-0.042	-5.34%
TM043265	0.84	0.821	-0.019	-2.26%	0.802	-0.038	-4.52%
TM043631	0.799	0.787	-0.012	-1.50%	0.774	-0.025	-3.13%
TM044305	0.742	0.719	-0.023	-3.10%	0.694	-0.048	-6.47%
TM042471	1.061	1.052	-0.009	-0.85%	1.044	-0.017	-1.60%
TM041901	0.973	0.959	-0.014	-1.44%	0.944	-0.029	-2.98%
TM041361	0.965	0.952	-0.013	-1.35%	0.939	-0.026	-2.69%
TM034970	0.526	0.512	-0.014	-2.66%	0.497	-0.029	-5.51%
TM034260	0.656	0.633	-0.023	-3.51%	0.61	-0.046	-7.01%
TM034624	0.519	0.502	-0.017	-3.28%	0.484	-0.035	-6.74%
TM032303	0.255	0.252	-0.003	-1.18%	0.248	-0.007	-2.75%
TM032879	0.209	0.205	-0.004	-1.91%	0.202	-0.007	-3.35%
TM031603	0.723	0.737	0.014	1.94%	0.753	0.03	4.15%

Table 4: Flow

		Q99						
Cross section	Bed Elevation (mAOD)	Baseline Flow (m3)	Scenario A Flow (m3)	Scenario A Flow change from baseline (m3)	Scenario A Flow change from baseline (%)	Scenario B Flow (m3)	Scenario B Flow change from baseline (m3)	Scenario B Flow change from baseline (%)
TM066838	72.027	4.231	3.565	-0.666	-15.74%	2.91	-1.321	-31.22%
TM066506	71.500	4.231	3.565	-0.666	-15.74%	2.914	-1.317	-31.13%
TM065758	70.350	4.231	3.565	-0.666	-15.74%	2.919	-1.312	-31.01%
TM065619	70.140	4.231	3.565	-0.666	-15.74%	2.92	-1.311	-30.99%
TM064210	69.13	6.662	5.33	-1.332	-19.99%	4.041	-2.621	-39.34%
TM064127	68.486	6.662	5.33	-1.332	-19.99%	4.042	-2.62	-39.33%
TM063654	68.267	6.662	5.33	-1.332	-19.99%	4.05	-2.612	-39.21%
TM063585	68.109	6.662	5.33	-1.332	-19.99%	4.051	-2.611	-39.19%
TM063876	68.108	6.662	5.33	-1.332	-19.99%	4.046	-2.616	-39.27%
TM062490	67.000	6.766	5.434	-1.332	-19.69%	4.184	-2.582	-38.16%
TM061662	66.033	6.766	5.434	-1.332	-19.69%	4.203	-2.563	-37.88%
TM060792	65.727	6.766	5.434	-1.332	-19.69%	4.227	-2.539	-37.53%
TM053545	65.540	3.383	2.717	-0.666	-19.69%	2.123	-1.26	-37.25%
LM1B053545	65.540	3.384	2.717	-0.667	-19.71%	2.124	-1.26	-37.23%
TM060201	64.974	6.766	5.434	-1.332	-19.69%	4.239	-2.527	-37.35%
TM053379	64.353	3.383	2.712	-0.671	-19.83%	2.126	-1.257	-37.16%
TM053520D	64.060	3.383	2.717	-0.666	-19.69%	2.123	-1.26	-37.25%
LM1B053528D	64.060	3.384	2.717	-0.667	-19.71%	2.124	-1.26	-37.23%
TM052747	63.900	2.259	1.814	-0.445	-19.70%	1.467	-0.792	-35.06%
TM051750	63.190	2.259	1.814	-0.445	-19.70%	1.482	-0.777	-34.40%
TM050791	62.500	6.786	5.453	-1.333	-19.64%	4.576	-2.21	-32.57%
TM045305	61.595	6.807	5.474	-1.333	-19.58%	4.658	-2.149	-31.57%
TM046047	61.52	6.796	5.463	-1.333	-19.61%	4.632	-2.164	-31.84%
TM045789	61.496	6.806	5.473	-1.333	-19.59%	4.647	-2.159	-31.72%
TM044515	60.871	6.807	5.474	-1.333	-19.58%	4.69	-2.117	-31.10%
TM043972	60.255	6.807	5.474	-1.333	-19.58%	4.707	-2.1	-30.85%
TM043486	60.116	6.807	5.474	-1.333	-19.58%	4.722	-2.085	-30.63%
TM043265	60.032	6.807	5.474	-1.333	-19.58%	4.73	-2.077	-30.51%
TM043631	59.991	6.807	5.474	-1.333	-19.58%	4.718	-2.089	-30.69%
TM044305	59.940	6.807	5.474	-1.333	-19.58%	4.698	-2.109	-30.98%
TM042471	58.846	6.807	5.474	-1.333	-19.58%	4.75	-2.057	-30.22%
TM041901	58.662	6.817	5.484	-1.333	-19.55%	4.775	-2.042	-29.95%
TM041361	58.352	6.817	5.484	-1.333	-19.55%	4.79	-2.027	-29.73%
TM034970	57.073	7.03	5.697	-1.333	-18.96%	5.061	-1.969	-28.01%
TM034260	56.770	7.03	5.697	-1.333	-18.96%	5.089	-1.941	-27.61%
TM034624	56.676	7.03	5.697	-1.333	-18.96%	5.076	-1.954	-27.80%
TM032303	55.694	7.575	7.022	-0.553	-7.30%	6.704	-0.871	-11.50%
TM032879	55.337	7.576	7.022	-0.554	-7.31%	6.691	-0.885	-11.68%
TM031603	54.884	7.57	7.017	-0.553	-7.31%	6.714	-0.856	-11.31%

	Q95						
Cross section	Baseline Flow (m3)	Scenario A Flow (m3)	Scenario A Flow change from baseline (m3)	Scenario A Flow change from baseline (%)	Scenario B Flow (m3)	Scenario B Flow change from baseline (m3)	Scenario B Flow change from baseline (m3)
TM066838	4.576	3.911	-0.665	-14.53%	3.245	-1.331	-29.09%
TM066506	4.576	3.911	-0.665	-14.53%	3.245	-1.331	-29.09%
TM065758	4.576	3.911	-0.665	-14.53%	3.245	-1.331	-29.09%
TM065619	4.576	3.911	-0.665	-14.53%	3.245	-1.331	-29.09%
TM064210	7.022	5.692	-1.33	-18.94%	4.36	-2.662	-37.91%
TM064127	7.022	5.692	-1.33	-18.94%	4.36	-2.662	-37.91%
TM063654	7.022	5.692	-1.33	-18.94%	4.36	-2.662	-37.91%
TM063585	7.022	5.692	-1.33	-18.94%	4.36	-2.662	-37.91%
TM063876	7.022	5.692	-1.33	-18.94%	4.36	-2.662	-37.91%
TM062490	7.17	5.84	-1.33	-18.55%	4.508	-2.662	-37.13%
TM061662	7.17	5.84	-1.33	-18.55%	4.508	-2.662	-37.13%
TM060792	7.17	5.84	-1.33	-18.55%	4.508	-2.662	-37.13%
TM053545	3.585	2.92	-0.665	-18.55%	2.254	-1.331	-37.13%
LM1B053545	3.586	2.92	-0.666	-18.57%	2.254	-1.332	-37.14%
TM060201	7.17	5.84	-1.33	-18.55%	4.508	-2.662	-37.13%
TM053379	3.584	2.919	-0.665	-18.55%	2.254	-1.33	-37.11%
TM053520D	3.585	2.92	-0.665	-18.55%	2.254	-1.331	-37.13%
LM1B053528D	3.586	2.92	-0.666	-18.57%	2.254	-1.332	-37.14%
TM052747	2.394	1.95	-0.444	-18.55%	1.507	-0.887	-37.05%
TM051750	2.394	1.949	-0.445	-18.59%	1.507	-0.887	-37.05%
TM050791	7.192	5.858	-1.334	-18.55%	4.53	-2.662	-37.01%
TM045305	7.218	5.885	-1.333	-18.47%	4.556	-2.662	-36.88%
TM046047	7.202	5.868	-1.334	-18.52%	4.54	-2.662	-36.96%
TM045789	7.217	5.883	-1.334	-18.48%	4.555	-2.662	-36.89%
TM044515	7.219	5.885	-1.334	-18.48%	4.556	-2.663	-36.89%
TM043972	7.218	5.885	-1.333	-18.47%	4.556	-2.662	-36.88%
TM043486	7.219	5.885	-1.334	-18.48%	4.556	-2.663	-36.89%
TM043265	7.218	5.885	-1.333	-18.47%	4.556	-2.662	-36.88%
TM043631	7.218	5.885	-1.333	-18.47%	4.556	-2.662	-36.88%
TM044305	7.218	5.885	-1.333	-18.47%	4.556	-2.662	-36.88%
TM042471	7.219	5.885	-1.334	-18.48%	4.556	-2.663	-36.89%
TM041901	7.229	5.895	-1.334	-18.45%	4.566	-2.663	-36.84%
TM041361	7.229	5.895	-1.334	-18.45%	4.566	-2.663	-36.84%
TM034970	7.425	6.091	-1.334	-17.97%	4.762	-2.663	-35.87%
TM034260	7.425	6.091	-1.334	-17.97%	4.762	-2.663	-35.87%
TM034624	7.425	6.091	-1.334	-17.97%	4.762	-2.663	-35.87%
TM032303	7.663	7.125	-0.538	-7.02%	6.461	-1.202	-15.69%
TM032879	7.663	7.125	-0.538	-7.02%	6.462	-1.201	-15.67%
TM031603	7.657	7.119	-0.538	-7.03%	6.456	-1.201	-15.68%

	Sens. A - Q95, +20% Weir Coefficient			Sens. B - Q95, -20% Weir Coefficient		
Cross section	Flow (m3)	change from Baseline (m3)	% change from Baseline (%)	Flow (m3)	change from Baseline (m3)	% change from Baseline (%)
TM066838	4.576	0	0.00%	4.576	0	0.00%
TM066506	4.576	0	0.00%	4.576	0	0.00%
TM065758	4.576	0	0.00%	4.576	0	0.00%
TM065619	4.576	0	0.00%	4.576	0	0.00%
TM064210	7.022	0	0.00%	7.022	0	0.00%
TM064127	7.022	0	0.00%	7.022	0	0.00%
TM063654	7.022	0	0.00%	7.022	0	0.00%
TM063585	7.022	0	0.00%	7.022	0	0.00%
TM063876	7.022	0	0.00%	7.022	0	0.00%
TM062490	7.17	0	0.00%	7.17	0	0.00%
TM061662	7.17	0	0.00%	7.17	0	0.00%
TM060792	7.17	0	0.00%	7.17	0	0.00%
TM053545	3.584	-0.001	-0.03%	3.585	0	0.00%
LM1B053545	3.586	0	0.00%	3.585	-0.001	-0.03%
TM060201	7.17	0	0.00%	7.17	0	0.00%
TM053379	3.587	0.003	0.08%	3.584	0	0.00%
TM053520D	3.584	-0.001	-0.03%	3.585	0	0.00%
LM1B053528D	3.586	0	0.00%	3.585	-0.001	-0.03%
TM052747	2.393	-0.001	-0.04%	2.394	0	0.00%
TM051750	2.393	-0.001	-0.04%	2.394	0	0.00%
TM050791	7.189	-0.003	-0.04%	7.194	0.002	0.03%
TM045305	7.216	-0.002	-0.03%	7.22	0.002	0.03%
TM046047	7.199	-0.003	-0.04%	7.204	0.002	0.03%
TM045789	7.214	-0.003	-0.04%	7.219	0.002	0.03%
TM044515	7.216	-0.003	-0.04%	7.22	0.001	0.01%
TM043972	7.216	-0.002	-0.03%	7.22	0.002	0.03%
TM043486	7.216	-0.003	-0.04%	7.22	0.001	0.01%
TM043265	7.216	-0.002	-0.03%	7.22	0.002	0.03%
TM043631	7.216	-0.002	-0.03%	7.22	0.002	0.03%
TM044305	7.216	-0.002	-0.03%	7.22	0.002	0.03%
TM042471	7.216	-0.003	-0.04%	7.22	0.001	0.01%
TM041901	7.226	-0.003	-0.04%	7.23	0.001	0.01%
TM041361	7.226	-0.003	-0.04%	7.23	0.001	0.01%
TM034970	7.422	-0.003	-0.04%	7.426	0.001	0.01%
TM034260	7.422	-0.003	-0.04%	7.426	0.001	0.01%
TM034624	7.422	-0.003	-0.04%	7.426	0.001	0.01%
TM032303	8.924	1.261	16.46%	6.898	-0.765	-9.98%
TM032879	8.924	1.261	16.46%	6.898	-0.765	-9.98%
TM031603	8.92	1.263	16.49%	6.891	-0.766	-10.00%

	Sens. C - Q95, +10% Manning's			Sens. D - Q95, -10% Manning's		
Cross section	Flow (m3)	change from Baseline (m3)	% change from Baseline (%)	Flow (m3)	change from Baseline (m3)	% change from Baseline (%)
TM066838	4.576	0	0.00%	4.576	0	0.00%
TM066506	4.576	0	0.00%	4.576	0	0.00%
TM065758	4.576	0	0.00%	4.576	0	0.00%
TM065619	4.576	0	0.00%	4.576	0	0.00%
TM064210	7.022	0	0.00%	7.022	0	0.00%
TM064127	7.022	0	0.00%	7.022	0	0.00%
TM063654	7.022	0	0.00%	7.022	0	0.00%
TM063585	7.022	0	0.00%	7.022	0	0.00%
TM063876	7.022	0	0.00%	7.022	0	0.00%
TM062490	7.17	0	0.00%	7.17	0	0.00%
TM061662	7.17	0	0.00%	7.17	0	0.00%
TM060792	7.17	0	0.00%	7.17	0	0.00%
TM053545	3.584	-0.001	-0.03%	3.585	0	0.00%
LM1B053545	3.586	0	0.00%	3.585	-0.001	-0.03%
TM060201	7.17	0	0.00%	7.17	0	0.00%
TM053379	3.584	0	0.00%	3.584	0	0.00%
TM053520D	3.584	-0.001	-0.03%	3.585	0	0.00%
LM1B053528D	3.586	0	0.00%	3.585	-0.001	-0.03%
TM052747	2.394	0	0.00%	2.394	0	0.00%
TM051750	2.394	0	0.00%	2.394	0	0.00%
TM050791	7.192	0	0.00%	7.192	0	0.00%
TM045305	7.218	0	0.00%	7.218	0	0.00%
TM046047	7.202	0	0.00%	7.202	0	0.00%
TM045789	7.217	0	0.00%	7.217	0	0.00%
TM044515	7.218	-0.001	-0.01%	7.218	-0.001	-0.01%
TM043972	7.218	0	0.00%	7.218	0	0.00%
TM043486	7.218	-0.001	-0.01%	7.218	-0.001	-0.01%
TM043265	7.218	0	0.00%	7.218	0	0.00%
TM043631	7.218	0	0.00%	7.219	0.001	0.01%
TM044305	7.219	0.001	0.01%	7.219	0.001	0.01%
TM042471	7.218	-0.001	-0.01%	7.219	0	0.00%
TM041901	7.228	-0.001	-0.01%	7.229	0	0.00%
TM041361	7.228	-0.001	-0.01%	7.228	-0.001	-0.01%
TM034970	7.425	0	0.00%	7.425	0	0.00%
TM034260	7.424	-0.001	-0.01%	7.424	-0.001	-0.01%
TM034624	7.425	0	0.00%	7.425	0	0.00%
TM032303	7.596	-0.067	-0.87%	7.726	0.063	0.82%
TM032879	7.596	-0.067	-0.87%	7.726	0.063	0.82%
TM031603	7.596	-0.061	-0.80%	7.715	0.058	0.76%

		Q50						
Cross section	Bed Elevation (mAOD)	Baseline Flow (m3)	Scenario A Flow (m3)	Scenario A Flow change from baseline (m3)	Scenario A Flow change from baseline (%)	Scenario B Flow (m3)	Scenario B Flow change from baseline (m3)	Scenario B Flow change from baseline (m3)
TM066838	72.027	6.625	5.959	-0.666	-10.05%	5.294	-1.331	-20.09%
TM066506	71.500	6.625	5.959	-0.666	-10.05%	5.294	-1.331	-20.09%
TM065758	70.350	6.625	5.959	-0.666	-10.05%	5.294	-1.331	-20.09%
TM065619	70.140	6.625	5.959	-0.666	-10.05%	5.294	-1.331	-20.09%
TM064210	69.13	9.41	8.078	-1.332	-14.16%	6.748	-2.662	-28.29%
TM064127	68.486	9.41	8.078	-1.332	-14.16%	6.748	-2.662	-28.29%
TM063654	68.267	9.41	8.078	-1.332	-14.16%	6.748	-2.662	-28.29%
TM063585	68.109	9.41	8.078	-1.332	-14.16%	6.748	-2.662	-28.29%
TM063876	68.108	9.41	8.078	-1.332	-14.16%	6.748	-2.662	-28.29%
TM062490	67.000	10.611	9.279	-1.332	-12.55%	7.949	-2.662	-25.09%
TM061662	66.033	10.611	9.279	-1.332	-12.55%	7.949	-2.662	-25.09%
TM060792	65.727	10.611	9.279	-1.332	-12.55%	7.949	-2.662	-25.09%
TM053545	65.540	5.305	4.639	-0.666	-12.55%	3.974	-1.331	-25.09%
LM1B053545	65.540	5.306	4.64	-0.666	-12.55%	3.975	-1.331	-25.08%
TM060201	64.974	10.611	9.279	-1.332	-12.55%	7.949	-2.662	-25.09%
TM053379	64.353	5.303	4.638	-0.665	-12.54%	3.974	-1.329	-25.06%
TM053520D	64.060	5.305	4.639	-0.666	-12.55%	3.974	-1.331	-25.09%
LM1B053528D	64.060	5.306	4.64	-0.666	-12.55%	3.975	-1.331	-25.08%
TM052747	63.900	3.54	3.096	-0.444	-12.54%	2.653	-0.887	-25.06%
TM051750	63.190	3.54	3.096	-0.444	-12.54%	2.653	-0.887	-25.06%
TM050791	62.500	10.631	9.298	-1.333	-12.54%	7.966	-2.665	-25.07%
TM045305	61.595	10.657	9.325	-1.332	-12.50%	7.993	-2.664	-25.00%
TM046047	61.52	10.641	9.308	-1.333	-12.53%	7.976	-2.665	-25.04%
TM045789	61.496	10.656	9.323	-1.333	-12.51%	7.991	-2.665	-25.01%
TM044515	60.871	10.658	9.325	-1.333	-12.51%	7.992	-2.666	-25.01%
TM043972	60.255	10.658	9.325	-1.333	-12.51%	7.993	-2.665	-25.00%
TM043486	60.116	10.658	9.325	-1.333	-12.51%	7.993	-2.665	-25.00%
TM043265	60.032	10.657	9.325	-1.332	-12.50%	7.993	-2.664	-25.00%
TM043631	59.991	10.657	9.325	-1.332	-12.50%	7.992	-2.665	-25.01%
TM044305	59.940	10.658	9.325	-1.333	-12.51%	7.992	-2.666	-25.01%
TM042471	58.846	10.657	9.325	-1.332	-12.50%	7.992	-2.665	-25.01%
TM041901	58.662	10.667	9.335	-1.332	-12.49%	8.002	-2.665	-24.98%
TM041361	58.352	10.667	9.334	-1.333	-12.50%	8.003	-2.664	-24.97%
TM034970	57.073	11.008	9.675	-1.333	-12.11%	8.343	-2.665	-24.21%
TM034260	56.770	11.007	9.675	-1.332	-12.10%	8.343	-2.664	-24.20%
TM034624	56.676	11.008	9.675	-1.333	-12.11%	8.343	-2.665	-24.21%
TM032303	55.694	9.318	8.895	-0.423	-4.54%	8.455	-0.863	-9.26%
TM032879	55.337	9.319	8.895	-0.424	-4.55%	8.455	-0.864	-9.27%
TM031603	54.884	9.313	8.89	-0.423	-4.54%	8.449	-0.864	-9.28%

	Q10						
Cross section	Baseline Flow (m3)	Scenario A Flow (m3)	Scenario A Flow change from baseline (m3)	Scenario A Flow change from baseline (%)	Scenario B Flow (m3)	Scenario B Flow change from baseline (m3)	Scenario B Flow change from baseline (m3)
TM066838	12.064	11.398	-0.666	-5.52%	10.733	-1.331	-11.03%
TM066506	12.064	11.398	-0.666	-5.52%	10.733	-1.331	-11.03%
TM065758	12.064	11.398	-0.666	-5.52%	10.733	-1.331	-11.03%
TM065619	12.064	11.398	-0.666	-5.52%	10.733	-1.331	-11.03%
TM064210	14.728	13.396	-1.332	-9.04%	12.066	-2.662	-18.07%
TM064127	14.728	13.396	-1.332	-9.04%	12.066	-2.662	-18.07%
TM063654	14.728	13.396	-1.332	-9.04%	12.066	-2.662	-18.07%
TM063585	14.728	13.396	-1.332	-9.04%	12.066	-2.662	-18.07%
TM063876	14.728	13.396	-1.332	-9.04%	12.066	-2.662	-18.07%
TM062490	23.186	21.854	-1.332	-5.74%	20.524	-2.662	-11.48%
TM061662	23.186	21.854	-1.332	-5.74%	20.524	-2.662	-11.48%
TM060792	23.186	21.854	-1.332	-5.74%	20.524	-2.662	-11.48%
TM053545	11.596	10.929	-0.667	-5.75%	10.264	-1.332	-11.49%
LM1B053545	11.59	10.925	-0.665	-5.74%	10.26	-1.33	-11.48%
TM060201	23.186	21.854	-1.332	-5.74%	20.524	-2.662	-11.48%
TM053379	11.595	10.931	-0.664	-5.73%	10.263	-1.332	-11.49%
TM053520D	11.596	10.929	-0.667	-5.75%	10.264	-1.332	-11.49%
LM1B053528D	11.59	10.925	-0.665	-5.74%	10.26	-1.33	-11.48%
TM052747	7.732	7.288	-0.444	-5.74%	6.845	-0.887	-11.47%
TM051750	7.732	7.288	-0.444	-5.74%	6.845	-0.887	-11.47%
TM050791	23.205	21.872	-1.333	-5.74%	20.543	-2.662	-11.47%
TM045305	23.23	21.897	-1.333	-5.74%	20.567	-2.663	-11.46%
TM046047	23.215	21.882	-1.333	-5.74%	20.553	-2.662	-11.47%
TM045789	23.23	21.897	-1.333	-5.74%	20.568	-2.662	-11.46%
TM044515	23.23	21.897	-1.333	-5.74%	20.567	-2.663	-11.46%
TM043972	23.23	21.897	-1.333	-5.74%	20.566	-2.664	-11.47%
TM043486	23.23	21.897	-1.333	-5.74%	20.566	-2.664	-11.47%
TM043265	23.23	21.897	-1.333	-5.74%	20.567	-2.663	-11.46%
TM043631	23.23	21.897	-1.333	-5.74%	20.567	-2.663	-11.46%
TM044305	23.23	21.897	-1.333	-5.74%	20.566	-2.664	-11.47%
TM042471	23.23	21.897	-1.333	-5.74%	20.566	-2.664	-11.47%
TM041901	23.24	21.907	-1.333	-5.74%	20.576	-2.664	-11.46%
TM041361	23.24	21.907	-1.333	-5.74%	21.576	-1.664	-7.16%
TM034970	24.307	22.974	-1.333	-5.48%	21.644	-2.663	-10.96%
TM034260	24.307	22.974	-1.333	-5.48%	21.643	-2.664	-10.96%
TM034624	24.307	22.974	-1.333	-5.48%	21.643	-2.664	-10.96%
TM032303	14.778	14.436	-0.342	-2.31%	14.085	-0.693	-4.69%
TM032879	14.778	14.435	-0.343	-2.32%	14.085	-0.693	-4.69%
TM031603	14.754	14.413	-0.341	-2.31%	14.073	-0.681	-4.62%

Author names redacted

Project: Strategic Resource Options: Tame and Trent Modelling Study
Deliverable: Project Report Appendix B: 'Trent 2' 1D Hydraulic Modelling Results
Revision Date: 12th July 2022

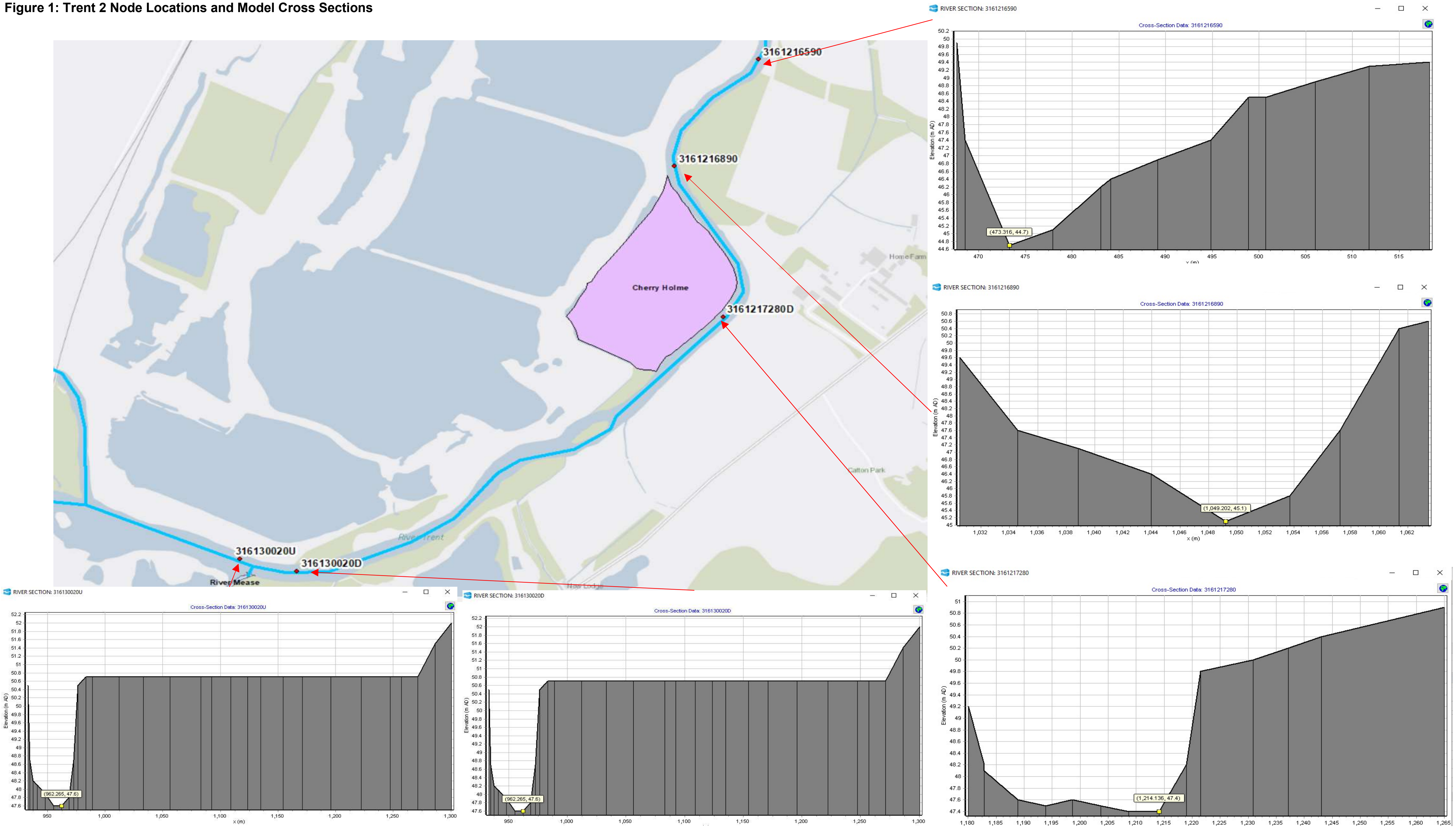
Quality Information

Originator: [redacted] Graduate Water Consultant
Checker: [redacted] Engineer; Sarah Littlewood, Principal Consultant
Verifier: [redacted] Technical Director

Notes and Key Assumptions

1. The results in this MS Workbook should be reviewed with reference to the Project Report.
2. The outputs in this MS Workbook are based on a calibrated model. The model has been calibrated to the disaggregated flow at the River Mease and downstream at Drakelow.
3. Q10, Q50, Q95 and Q99 flow conditions have been simulated for these calibrated runs.
4. All runs are steady state flow - but this summary uses the mean outputs across the simulation timesteps for water level and max wetted perimeter values.
5. All baseline runs included a DWF at Minworth WwTW.
6. Scenario A = 115 Ml/d flow reduction at Minworth WwTW (equivalent to either GUC or STT operated at their maximum).
7. Scenario B = 230 Ml/d flow reduction at Minworth WwTW (equivalent to both GUC and STT operating at their maximum).

Figure 1: Trent 2 Node Locations and Model Cross Sections



		Q99							
Cross section	Bed elevation (mAOD)	Baseline Mean Stage (mAOD)	Simulated Baseline Water max depth (m)	Scenario A Stage (mAOD)	Scenario A water level change from baseline (m)	Scenario A maximum water depth change (%)	Scenario B Stage (mAOD)	Scenario B water level change from baseline (m)	Scenario B maximum water depth change (%)
316130020U	47.6	48.561	0.961	48.517	-0.044	-4.58%	48.469	-0.092	-9.57%
316130020D	47.6	48.561	0.961	48.517	-0.044	-4.58%	48.469	-0.092	-9.57%
3161217280	47.4	48.203	0.803	48.174	-0.029	-3.61%	48.137	-0.066	-8.22%
3161216890	45.1	47.382	2.282	47.324	-0.058	-2.54%	47.261	-0.121	-5.30%
3161216590	44.7	47.328	2.628	47.273	-0.055	-2.09%	47.214	-0.114	-4.34%

		Q95															
Cross section	Bed elevation (mAOD)	Baseline Mean Stage (mAOD)	Simulated Baseline Water max depth (m)	Scenario A Stage (mOAD)	Scenario A water level change from baseline (m)	Scenario A maximum water depth change (%)	Scenario B Stage (mAOD)	Scenario B water level change from baseline (m)	Scenario B maximum water depth change (%)	***Mannings +10%***	***% Change***	***Mannings - 10%***	***% Change***	***Weir Coefficient (+20%)***	***% Change***	***Weir Coefficient (-20%)***	***% Change***
316130020U	47.6	48.589	0.989	48.551	-0.038	-3.84%	48.505	-0.084	-8.49%	48.629	4.04%	48.548	-4.15%	48.589	0.00%	48.589	0.00%
316130020D	47.6	48.589	0.989	48.551	-0.038	-3.84%	48.505	-0.084	-8.49%	48.629	4.04%	48.548	-4.15%	48.589	0.00%	48.589	0.00%
3161217280	47.4	48.224	0.824	48.199	-0.025	-3.03%	48.166	-0.058	-7.04%	48.239	1.82%	48.211	-1.58%	48.224	0.00%	48.224	0.00%
3161216890	45.1	47.413	2.313	47.362	-0.051	-2.20%	47.301	-0.112	-4.84%	47.476	2.72%	47.352	-2.64%	47.413	0.00%	47.413	0.00%
3161216590	44.7	47.357	2.657	47.309	-0.048	-1.81%	47.251	-0.106	-3.99%	47.415	2.18%	47.302	-2.07%	47.357	0.00%	47.357	0.00%

		Q50							
Cross section	Bed elevation (mAOD)	Baseline Mean Stage (mAOD)	Simulated Baseline Water max depth (m)	Scenario A Stage (mOAD)	Scenario A water level reduction from baseline (m)	Scenario A maximum water depth change (%)	Scenario B Stage (mAOD)	Scenario B water level reduction from baseline (m)	Scenario B maximum water depth change (%)
316130020U	47.6	48.825	1.225	48.797	0.028	2.29%	48.763	0.062	5.06%
316130020D	47.6	48.825	1.225	48.797	0.028	2.29%	48.763	0.062	5.06%
3161217280	47.4	48.346	0.946	48.328	0.018	1.90%	48.308	0.038	4.02%
3161216890	45.1	47.799	2.699	47.763	0.036	1.33%	47.72	0.079	2.93%
3161216590	44.7	47.727	3.027	47.692	0.035	1.16%	47.65	0.077	2.54%

		Q10							
Cross section	Bed elevation (mAOD)	Baseline Mean Stage (mAOD)	Simulated Baseline Water max depth (m)	Scenario A Stage (mOAD)	Scenario A water level change from baseline (m)	Scenario A maximum water depth change (%)	Scenario B Stage (mAOD)	Scenario B water level change from baseline (m)	Scenario B maximum water depth change (%)
316130020U	47.600	49.472	1.872	49.453	0.019	1.01%	49.430	0.042	2.24%
316130020D	47.600	49.472	1.872	49.453	0.019	1.01%	49.430	0.042	2.24%
3161217280	47.400	48.944	1.544	48.925	0.019	1.23%	48.902	0.042	2.72%
3161216890	45.100	48.701	3.601	48.681	0.02	0.56%	48.657	0.044	1.22%
3161216590	44.700	48.602	3.902	48.583	0.019	0.49%	48.559	0.043	1.10%

	Q99						
Cross section	Baseline WP (m)	Scenario A WP (m)	Scenario A WP change from baseline (m)	Scenario A WP change from baseline (%)	Scenario B WP(m)	Scenario B WP change from baseline (m)	Scenario B WP change from baseline (%)
316130020U	42.813	42.36	-0.453	-1.06%	41.873	-0.940	-2.20%
316130020D	42.813	42.36	-0.453	-1.06%	41.873	-0.940	-2.20%
3161217280	42.266	42.06	-0.206	-0.49%	41.795	-0.471	-1.11%
3161216890	27.028	26.401	-0.627	-2.32%	25.723	-1.305	-4.83%
3161216590	32.252	31.506	-0.746	-2.31%	30.711	-1.541	-4.78%

	Q95														
Cross section	Baseline WP (m)	Scenario A WP (m)	Scenario A WP change from baseline (m)	Scenario A WP change from baseline (%)	Scenario B WP(m)	Scenario B WP change from baseline (m)	Scenario B WP change from baseline (%)	***Manning's +10%***	***% Change***	***Manning's - 10%***	***% Change***	***Weir Coefficient +20%***	***% Change***	***Weir Coefficient - 20%***	***% Change***
316130020U	43.098	42.706	-0.392	-0.91%	42.237	-0.861	-2.00%	*43.5055*	*0.95%*	*42.883*	*-0.50%*	*43.0965*	*0.00%*	*43.0965*	*0.00%*
316130020D	43.098	42.706	-0.392	-0.91%	42.237	-0.861	-2.00%	*43.5055*	*0.95%*	*42.883*	*-0.50%*	*43.0965*	*0.00%*	*43.0965*	*0.00%*
3161217280	42.367	42.243	-0.124	-0.29%	42.006	-0.361	-0.85%	*42.439*	*0.17%*	*42.3535*	*-0.03%*	*42.3665*	*0.00%*	*42.3665*	*0.00%*
3161216890	27.362	26.812	-0.550	-2.01%	26.154	-1.208	-4.41%	*28.038*	*2.47%*	*27.0105*	*-1.28%*	*27.3605*	*-0.01%*	*27.3605*	*-0.01%*
3161216590	32.641	31.993	-0.648	-1.99%	31.217	-1.424	-4.36%	*33.294*	*2.00%*	*32.242*	*-1.22%*	*32.6395*	*0.00%*	*32.6395*	*0.00%*

	Q50						
Cross section	Baseline WP (m)	Scenario A WP (m)	Scenario A WP change from baseline (m)	Scenario A WP change from baseline (%)	Scenario B WP(m)	Scenario B WP change from baseline (m)	Scenario B WP change from baseline (%)
316130020U	44.688	44.586	-0.102	-0.23%	44.462	-0.226	-0.51%
316130020D	44.688	44.586	-0.102	-0.23%	44.462	-0.226	-0.51%
3161217280	42.957	42.872	-0.085	-0.20%	42.773	-0.184	-0.43%
3161216890	30.178	30.032	-0.146	-0.48%	29.857	-0.321	-1.06%
3161216590	34.806	34.636	-0.170	-0.49%	34.432	-0.374	-1.07%

	Q10						
Cross section	Baseline WP (m)	Scenario A WP (m)	Scenario A WP change from baseline (m)	Scenario A WP change from baseline (%)	Scenario B WP(m)	Scenario B WP change from baseline (m)	Scenario B WP change from baseline (%)
316130020U	47.059	46.99	-0.069	-0.15%	46.905	-0.154	-0.33%
316130020D	47.059	46.99	-0.069	-0.15%	46.905	-0.154	-0.33%
3161217280	45.859	45.769	-0.090	-0.20%	45.655	-0.204	-0.44%
3161216890	33.837	33.758	-0.079	-0.23%	33.658	-0.179	-0.53%
3161216590	41.876	41.602	-0.274	-0.65%	41.253	-0.623	-1.49%

	Q99						
Cross section	Baseline Flow (m3/s)	Scenario A Flow (m3/s)	Scenario A Flow change from baseline (m3/s)	Scenario A Flow change from baseline (%)	Scenario B WP(m3/s)	Scenario B Flow change from baseline (m3/s)	Scenario B Flow change from baseline (%)
316130020U	12.92	11.618	1.302	10.08%	10.328	2.592	20.06%
316130020D	12.92	11.618	1.302	10.08%	10.328	2.592	20.06%
3161217280	12.92	11.618	1.302	10.08%	10.328	2.592	20.06%
3161216890	14.27	12.968	1.302	9.12%	11.678	2.592	18.16%
3161216590	14.27	12.968	1.302	9.12%	11.678	2.592	18.16%

	Q95															
Cross section	Baseline Flow (m3/s)	Scenario A Flow (m3/s)	Scenario A Flow change from baseline (m3/s)	Scenario A Flow change from baseline (%)	Scenario B Flow (m3/s)	Scenario B Flow change from baseline (m3/s)	Scenario B Flow change from baseline (m3/s)	***Manning's +10%***	***% Change***	***Manning's - 10%***	***% Change***	***Weir Coefficient +20%***	***% Change***	***Weir Coefficient - 20%***	***% Change***
316130020U	13.75	12.586	-1.164	-8.47%	11.261	-2.489	-18.10%	13.75	0.00%	13.765	0.11%	13.75	0.00%	13.75	0.00%
316130020D	13.75	12.586	-1.164	-8.47%	11.261	-2.489	-18.10%	13.75	0.00%	13.765	0.11%	13.75	0.00%	13.75	0.00%
3161217280	13.75	12.586	-1.164	-8.47%	11.261	-2.489	-18.10%	13.75	0.00%	13.794	0.32%	13.75	0.00%	13.75	0.00%
3161216890	14.98	13.816	-1.164	-7.77%	12.491	-2.489	-16.62%	14.98	0.00%	15.039	0.39%	14.98	0.00%	14.98	0.00%
3161216590	14.98	13.816	-1.164	-7.77%	12.491	-2.489	-16.62%	14.98	0.00%	15.05	0.47%	14.98	0.00%	14.98	0.00%

	Q50						
Cross section	Baseline Flow (m3/s)	Scenario A Flow (m3/s)	Scenario A Flow change from baseline (m3/s)	Scenario A Flow change from baseline (%)	Scenario B WP(m3/s)	Scenario B Flow change from baseline (m3/s)	Scenario B Flow change from baseline (%)
316130020U	22.51	21.344	-1.166	-5.18%	20.01	-2.500	-11.11%
316130020D	22.51	21.344	-1.166	-5.18%	20.01	-2.500	-11.11%
3161217280	22.51	21.344	-1.166	-5.18%	20.01	-2.500	-11.11%
3161216890	25.76	24.594	-1.166	-4.53%	23.26	-2.500	-9.70%
3161216590	25.76	24.594	-1.166	-4.53%	23.26	-2.500	-9.70%

	Q10						
Cross section	Baseline Flow (m3/s)	Scenario A Flow (m3/s)	Scenario A Flow change from baseline (m3/s)	Scenario A Flow change from baseline (%)	Scenario B Flow (m3/s)	Scenario B Flow change from baseline (m3/s)	Scenario B Flow change from baseline (m3/s)
316130020U	54.3	53.24	-1.060	-1.95%	51.91	-2.390	-4.40%
316130020D	54.3	53.24	-1.060	-1.95%	51.91	-2.390	-4.40%
3161217280	54.3	53.24	-1.060	-1.95%	51.91	-2.390	-4.40%
3161216890	65.43	64.37	-1.060	-1.62%	63.04	-2.390	-3.65%
3161216590	65.43	64.37	-1.060	-1.62%	63.04	-2.390	-3.65%

	Q99						
Cross section	Baseline Velocity (m/s)	Scenario A Velocity (m/s)	Scenario A Velocity change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Velocity (m/s)	Scenario B Velocity change from baseline (m/s)	Scenario B Velocity change from baseline (%)
316130020U	0.505	0.484	-0.021	-4.16%	0.464	-0.041	-8.12%
316130020D	0.505	0.484	-0.021	-4.16%	0.464	-0.041	-8.12%
3161217280	0.579	0.547	-0.032	-5.53%	0.518	-0.061	-10.54%
3161216890	0.6	0.574	-0.026	-4.33%	0.547	-0.053	-8.83%
3161216590	0.447	0.425	-0.022	-4.92%	0.401	-0.046	-10.29%

	Q95															
Cross section	Baseline Velocity (m/s)	Scenario A Velocity (m/s)	Scenario A Velocity change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Velocity (m/s)	Scenario B Velocity change from baseline (m/s)	Scenario B Velocity change from baseline (m/s)	***Manning's +10%***	***% Change***	***Manning's - 10%***	***% Change***	***Weir Coefficient +20%***	***% Change***	***Weir Coefficient - 20%***	***% Change***
316130020U	0.516	0.499	-0.017	-3.29%	0.478	-0.038	-7.36%	0.489	-5.23%	0.548	6.20%	0.516	0.00%	0.516	0.00%
316130020D	0.516	0.499	-0.017	-3.29%	0.478	-0.038	-7.36%	0.489	-5.23%	0.548	6.20%	0.516	0.00%	0.516	0.00%
3161217280	0.596	0.568	-0.028	-4.70%	0.537	-0.059	-9.90%	0.582	-2.35%	0.611	2.52%	0.596	0.00%	0.596	0.00%
3161216890	0.614	0.591	-0.023	-3.75%	0.564	-0.050	-8.14%	0.582	-5.21%	0.649	5.70%	0.614	0.00%	0.614	0.00%
3161216590	0.459	0.44	-0.019	-4.14%	0.417	-0.042	-9.15%	0.439	-4.36%	0.482	5.01%	0.459	0.00%	0.459	0.00%

	Q50						
Cross section	Baseline Velocity (m/s)	Scenario A Velocity (m/s)	Scenario A Velocity change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Velocity (m/s)	Scenario B Velocity change from baseline (m/s)	Scenario B Velocity change from baseline (%)
316130020U	0.633	0.619	-0.014	-2.21%	0.603	-0.030	-4.74%
316130020D	0.633	0.619	-0.014	-2.21%	0.603	-0.030	-4.74%
3161217280	0.819	0.795	-0.024	-2.93%	0.766	-0.053	-6.47%
3161216890	0.78	0.764	-0.016	-2.05%	0.746	-0.034	-4.36%
3161216590	0.605	0.591	-0.014	-2.31%	0.575	-0.030	-4.96%

	Q10						
Cross section	Baseline Velocity (m/s)	Scenario A Velocity (m/s)	Scenario A Velocity change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Velocity (m/s)	Scenario B Velocity change from baseline (m/s)	Scenario B Velocity change from baseline (m/s)
316130020U	0.889	0.883	-0.006	-0.67%	0.874	-0.015	-1.69%
316130020D	0.889	0.883	-0.006	-0.67%	0.874	-0.015	-1.69%
3161217280	1.081	1.075	-0.006	-0.56%	1.068	-0.013	-1.20%
3161216890	1.179	1.171	-0.008	-0.68%	1.16	-0.019	-1.61%
3161216590	0.955	0.948	-0.007	-0.73%	0.94	-0.015	-1.57%

Author names redacted

Project: Strategic Resource Options: Tame and Trent Modelling Study
Deliverable: Project Report Appendix B: 'Trent 3' 1D Hydraulic Modelling Results
Revision Date: 12th July 2022

Quality Information
Originator: [redacted], Graduate Water Consultant
Checker: [redacted], Engineer; Sarah Littlewood, Principal Consultant
Verifier: [redacted] Technical Director

Notes and Key Assumptions

1. The results in this MS Workbook should be reviewed with reference to the Project Report.
2. The outputs in this MS Workbook are based on a calibrated model. The model has been calibrated to the disaggregated flow at the River Mease and downstream at Drakelow.
3. Q10, Q50, Q95 and Q99 flow conditions have been simulated for these calibrated runs.
4. All runs are steady state flow - but this summary uses the mean outputs across the simulation timesteps for water level and max wetted perimeter values.
5. All baseline runs included a DWF at Minworth WwTW.
6. Scenario A = 115 Ml/d flow reduction at Minworth WwTW (equivalent to either GUC or STT operated at their maximum).
7. Scenario B = 230 Ml/d flow reduction at Minworth WwTW (equivalent to both GUC and STT operating at their maximum).

Figure 1A: Trent 3 Node Locations and Cross Sections

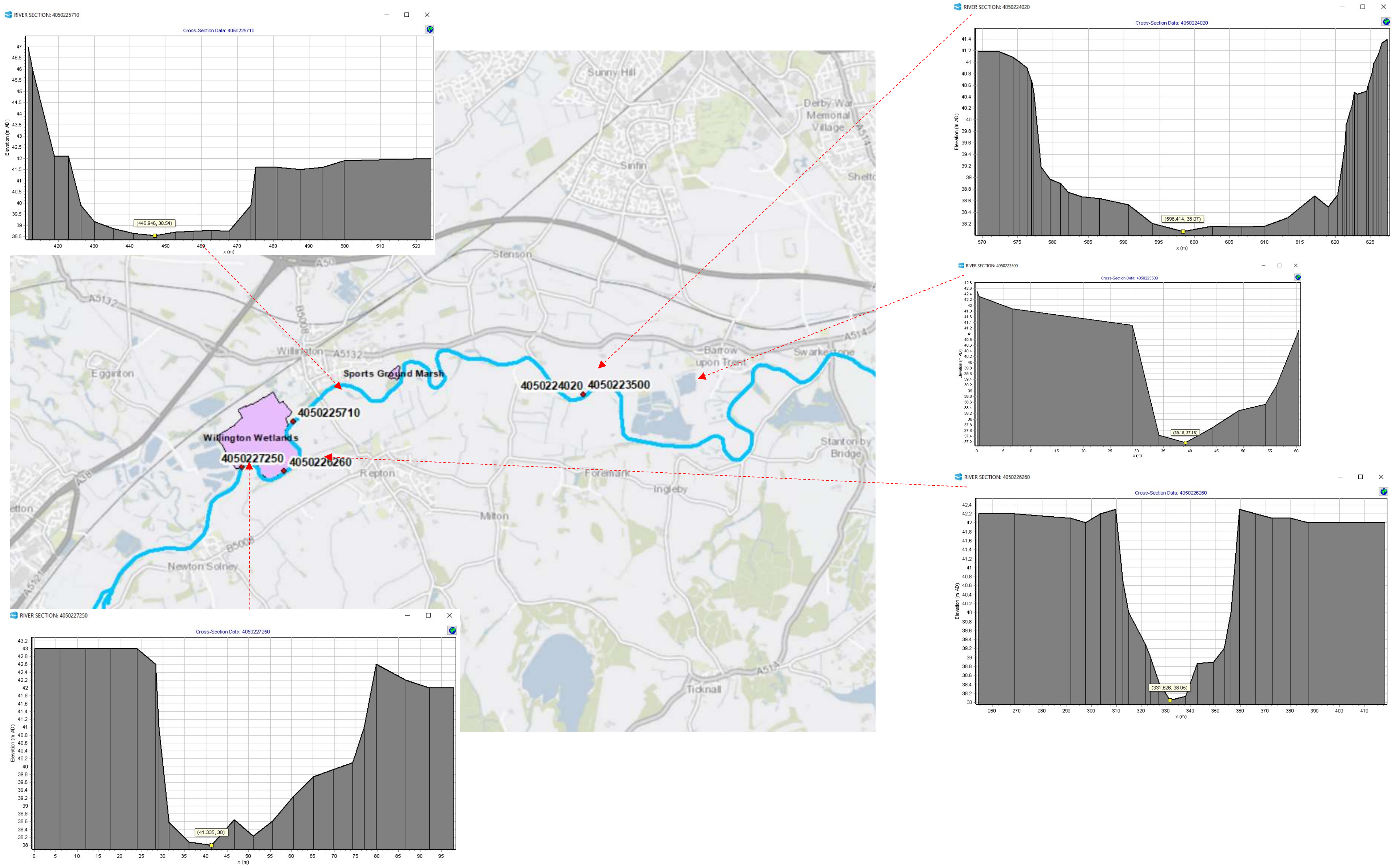
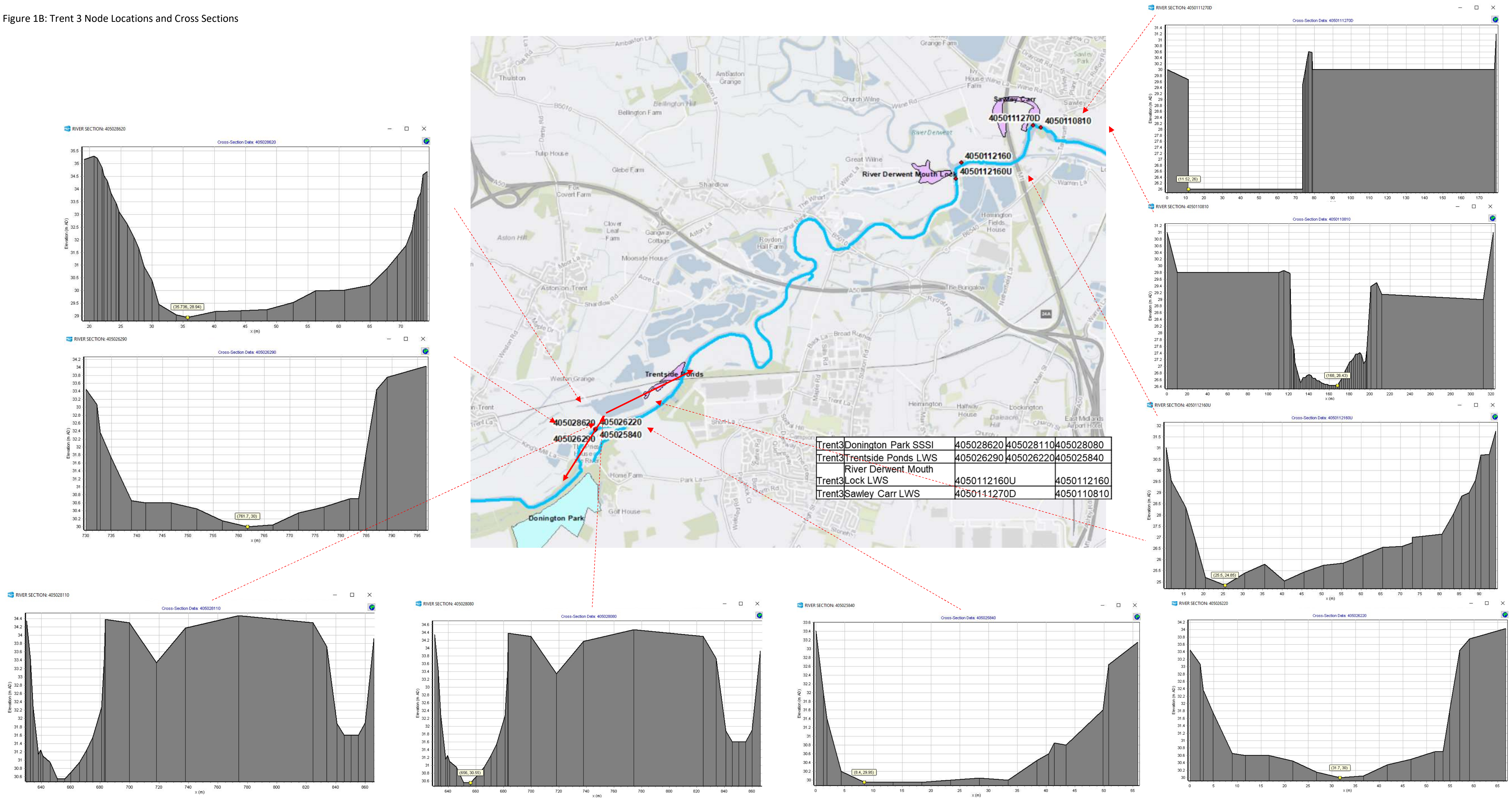


Figure 1B: Trent 3 Node Locations and Cross Sections



		Q99							
Cross Section	Bed Elevation (mAOD)	Baseline Mean Stage (mAOD)	Simulated Baseline Water max depth (m)	Scenario A Stage (mAOD)	Scenario A water level change from baseline (m)	Scenario A maximum water depth change (%)	Scenario B Stage (mAOD)	Scenario B water level change from baseline (m)	Scenario B maxiumum water depth change (%)
405028080	30.55	31.983	1.433	31.942	-0.041	-2.86%	31.899	-0.084	-5.86%
405028110	30.55	31.989	1.439	31.948	-0.041	-2.85%	31.905	-0.084	-5.84%
405026290	30	31.12	1.12	31.085	-0.035	-3.13%	31.05	-0.07	-6.25%
405025840	29.95	30.671	0.721	30.631	-0.04	-5.55%	30.59	-0.081	-11.23%
4050224020	38.07	39.185	1.115	39.143	-0.042	-3.77%	39.099	-0.086	-7.71%
4050227250	38	40.023	2.023	39.989	-0.034	-1.68%	39.956	-0.067	-3.31%
4050226260	38.05	39.605	1.555	39.561	-0.044	-2.83%	39.515	-0.09	-5.79%
4050225710	38.54	39.512	0.972	39.47	-0.042	-4.32%	39.427	-0.085	-8.74%
405028620	28.94	32.02	3.08	31.978	-0.042	-1.36%	31.933	-0.087	-2.82%
4050111270D	26	27.451	1.451	27.433	-0.018	-1.24%	27.414	-0.037	-2.55%
4050110810	26.43	26.813	0.383	26.803	-0.01	-2.61%	26.793	-0.02	-5.22%
405026220	30	31.082	1.082	31.047	-0.035	-3.23%	31.012	-0.07	-6.47%
4050112160	24.85	29.314	4.464	29.3	-0.014	-0.31%	29.286	-0.028	-0.63%
4050112160U	24.85	29.314	4.464	29.3	-0.014	-0.31%	29.286	-0.028	-0.63%
4050223500	37.18	38.976	1.796	38.94	-0.036	-2.00%	38.904	-0.072	-4.01%

		Q95							
Cross Section	Bed Elevation (mAOD)	Baseline Mean Stage (mAOD)	Simulated Baseline Water max depth (m)	Scenario A Stage (mAOD)	Scenario A water level change from baseline (m)	Scenario A maximum water depth change (%)	Scenario B Stage (mAOD)	Scenario B water level change from baseline (m)	Scenario B maxiumum water depth change (%)
405028080	30.55	32.01	1.460	31.975	-0.035	-2.40%	31.932	-0.078	-5.34%
405028110	30.55	32.016	1.466	31.981	-0.035	-2.39%	31.938	-0.078	-5.32%
405026290	30	31.142	1.142	31.112	-0.03	-2.63%	31.077	-0.065	-5.69%
405025840	29.95	30.698	0.748	30.663	-0.035	-4.68%	30.622	-0.076	-10.16%
4050224020	38.07	39.213	1.143	39.176	-0.037	-3.24%	39.133	-0.08	-7.00%
4050227250	38	40.046	2.046	40.017	-0.029	-1.42%	39.981	-0.065	-3.18%
4050226260	38.05	39.634	1.584	39.596	-0.038	-2.40%	39.551	-0.083	-5.24%
4050225710	38.54	39.539	0.999	39.503	-0.036	-3.60%	39.46	-0.079	-7.91%
405028620	28.94	32.048	3.108	32.012	-0.036	-1.16%	31.967	-0.081	-2.61%
4050111270D	26	27.47	1.470	27.457	-0.013	-0.88%	27.441	-0.029	-1.97%
4050110810	26.43	26.826	0.396	26.817	-0.009	-2.27%	26.807	-0.019	-4.80%
405026220	30	31.104	1.104	31.074	-0.03	-2.72%	31.039	-0.065	-5.89%
4050112160	24.85	29.332	4.482	29.32	-0.012	-0.27%	29.306	-0.026	-0.58%
4050112160U	24.85	29.332	4.482	29.32	-0.012	-0.27%	29.306	-0.026	-0.58%
4050223500	37.18	39	1.820	38.969	-0.031	-1.70%	38.932	-0.068	-3.74%

	Sens. A - Q95, Plus 20% Weir Coefficient				Sens. B - Q95, Minus 20% Weir Coefficient			
Cross Section	Mean Stage (mAOD)	Simulated Water max depth (m)	Water Depth change from Baseline (m)	Water Depth change from Baseline (%)	Mean Stage (mAOD)	Simulated Water max depth (m)	Water Depth change from Baseline (m)	Water Depth change from Baseline (%)
405028080	32.01	1.460	0.000	0.00%	31.966	1.416	-0.044	-3.01%
405028110	32.016	1.466	0.000	0.00%	31.972	1.422	-0.044	-3.00%
405026290	31.142	1.142	0.000	0.00%	31.104	1.104	-0.038	-3.33%
405025840	30.698	0.748	0.000	0.00%	30.652	0.702	-0.046	-6.15%
4050224020	39.213	1.143	0.000	0.00%	39.165	1.095	-0.048	-4.20%
4050227250	40.046	2.046	0.000	0.00%	40.01	2.010	-0.036	-1.76%
4050226260	39.634	1.584	0.000	0.00%	39.584	1.534	-0.050	-3.16%
4050225710	39.539	0.999	0.000	0.00%	39.492	0.952	-0.047	-4.70%
405028620	32.048	3.108	0.000	0.00%	32.003	3.063	-0.045	-1.45%
4050111270D	27.47	1.470	0.000	0.00%	27.456	1.456	-0.014	-0.95%
4050110810	26.826	0.396	0.000	0.00%	26.81	0.380	-0.016	-4.04%
405026220	31.104	1.104	0.000	0.00%	31.066	1.066	-0.038	-3.44%
4050112160	29.332	4.482	0.000	0.00%	29.331	4.481	-0.001	-0.02%
4050112160U	29.332	4.482	0.000	0.00%	29.331	4.481	-0.001	-0.02%
4050223500	39	1.820	0.000	0.00%	38.958	1.778	-0.042	-2.31%

	Sens. C - Q95, Plus 10% Mannings				Sens. D - Q95, Minus 10% Mannings			
Cross Section	Mean Stage (mAOD)	Simulated Water max depth (m)	Water Depth Change from Baseline (m)	Water Depth change from Baseline (%)	Mean Stage (mAOD)	Simulated Water max depth (m)	Water Depth change from Baseline (m)	Water Depth change from Baseline (%)
405028080	32.067	1.517	0.057	3.90%	31.966	1.416	-0.044	-3.01%
405028110	32.073	1.523	0.057	3.89%	31.972	1.422	-0.044	-3.00%
405026290	31.192	1.192	0.050	4.38%	31.104	1.104	-0.038	-3.33%
405025840	30.757	0.807	0.059	7.89%	30.652	0.702	-0.046	-6.15%
4050224020	39.274	1.204	0.061	5.34%	39.165	1.095	-0.048	-4.20%
4050227250	40.096	2.096	0.050	2.44%	40.01	2.010	-0.036	-1.76%
4050226260	39.698	1.648	0.064	4.04%	39.584	1.534	-0.050	-3.16%
4050225710	39.599	1.059	0.060	6.01%	39.492	0.952	-0.047	-4.70%
405028620	32.106	3.166	0.058	1.87%	32.003	3.063	-0.045	-1.45%
4050111270D	27.496	1.496	0.026	1.77%	27.456	1.456	-0.014	-0.95%
4050110810	26.847	0.417	0.021	5.30%	26.81	0.380	-0.016	-4.04%
405026220	31.154	1.154	0.050	4.53%	31.066	1.066	-0.038	-3.44%
4050112160	29.333	4.483	0.001	0.02%	29.331	4.481	-0.001	-0.02%
4050112160U	29.333	4.483	0.001	0.02%	29.331	4.481	-0.001	-0.02%
4050223500	39.054	1.874	0.054	2.97%	38.958	1.778	-0.042	-2.31%

		Q50							
Cross Section	Bed Elevation (mAOD)	Baseline Mean Stage (mAOD)	Simulated Baseline Water max depth (m)	Scenario A Stage (mAOD)	Scenario A water level change from baseline (m)	Scenario A maximum water depth change (%)	Scenario B Stage (mAOD)	Scenario B water level change from baseline (m)	Scenario B maxiumum water depth change (%)
405028080	30.55	32.372	1.822	32.352	-0.02	-1.10%	32.33	-0.042	-2.31%
405028110	30.55	32.379	1.829	32.36	-0.019	-1.04%	32.338	-0.041	-2.24%
405026290	30	31.521	1.521	31.499	-0.022	-1.45%	31.473	-0.048	-3.16%
405025840	29.95	31.118	1.168	31.094	-0.024	-2.05%	31.066	-0.052	-4.45%
4050224020	38.07	39.673	1.603	39.646	-0.027	-1.68%	39.615	-0.058	-3.62%
4050227250	38	40.458	2.458	40.432	-0.026	-1.06%	40.403	-0.055	-2.24%
4050226260	38.05	40.107	2.057	40.079	-0.028	-1.36%	40.046	-0.061	-2.97%
4050225710	38.54	39.988	1.448	39.961	-0.027	-1.86%	39.929	-0.059	-4.07%
405028620	28.94	32.431	3.491	32.41	-0.021	-0.60%	32.387	-0.044	-1.26%
4050111270D	26	27.644	1.644	27.635	-0.009	-0.55%	27.625	-0.019	-1.16%
4050110810	26.43	27.046	0.616	27.034	-0.012	-1.95%	27.021	-0.025	-4.06%
405026220	30	31.484	1.484	31.461	-0.023	-1.55%	31.435	-0.049	-3.30%
4050112160	24.85	29.549	4.699	29.54	-0.009	-0.19%	29.529	-0.02	-0.43%
4050112160U	24.85	29.549	4.699	29.54	-0.009	-0.19%	29.529	-0.02	-0.43%
4050223500	37.18	39.396	2.216	39.372	-0.024	-1.08%	39.345	-0.051	-2.30%

		Q10							
Cross Section	Bed Elevation (mAOD)	Baseline Mean Stage (mAOD)	Simulated Baseline Water max depth (m)	Scenario A Stage (mAOD)	Scenario A water level change from baseline (m)	Scenario A maximum water depth change (%)	Scenario B Stage (mAOD)	Scenario B water level change from baseline (m)	Scenario B maxiumum water depth change (%)
405028080	30.55	33.172	2.622	33.159	-0.013	-0.50%	33.144	-0.028	-1.07%
405028110	30.55	33.182	2.632	33.17	-0.012	-0.46%	33.154	-0.028	-1.06%
405026290	30	32.411	2.411	32.398	-0.013	-0.54%	32.381	-0.03	-1.24%
405025840	29.95	32.048	2.098	32.034	-0.014	-0.67%	32.016	-0.032	-1.53%
4050224020	38.07	40.708	2.638	40.693	-0.015	-0.57%	40.674	-0.034	-1.29%
4050227250	38	41.509	3.509	41.494	-0.015	-0.43%	41.474	-0.035	-1.00%
4050226260	38.05	41.2	3.150	41.184	-0.016	-0.51%	41.164	-0.036	-1.14%
4050225710	38.54	41.052	2.512	41.037	-0.015	-0.60%	41.017	-0.035	-1.39%
405028620	28.94	33.274	4.334	33.261	-0.013	-0.30%	33.245	-0.029	-0.67%
4050111270D	26	28.345	2.345	28.338	-0.007	-0.30%	28.329	-0.016	-0.68%
4050110810	26.43	27.853	1.423	27.846	-0.007	-0.49%	27.836	-0.017	-1.19%
405026220	30	32.373	2.373	32.359	-0.014	-0.59%	32.342	-0.031	-1.31%
4050112160	24.85	30.107	5.257	30.101	-0.006	-0.11%	30.093	-0.014	-0.27%
4050112160U	24.85	30.107	5.257	30.101	-0.006	-0.11%	30.093	-0.014	-0.27%
4050223500	37.18	40.286	3.106	40.273	-0.013	-0.42%	40.257	-0.029	-0.93%

Q99

Cross Section	Baseline WP (m)	Scenario A WP (m)	Scenario A WP change from baseline (m)	Scenario A WP change from baseline (%)	Scenario B WP(m)	Scenario B WP change from baseline (m)	Scenario B WP change from baseline (%)
405028080	65.098	64.327	0.771	1.18%	63.513	1.585	2.43%
405028110	65.208	64.437	0.771	1.18%	63.629	1.579	2.42%
405026290	49.062	48.875	0.187	0.38%	48.688	0.374	0.76%
405025840	39.421	39.162	0.259	0.66%	38.807	0.614	1.56%
4050224020	44.843	44.524	0.319	0.71%	44.189	0.654	1.46%
4050227250	45.042	44.085	0.957	2.12%	43.162	1.880	4.17%
4050226260	38.305	37.731	0.574	1.50%	37.131	1.174	3.06%
4050225710	45.58	45.149	0.431	0.95%	44.7	0.880	1.93%
405028620	47.078	46.915	0.163	0.35%	46.742	0.336	0.71%
4050111270D	66.984	66.95	0.034	0.05%	66.911	0.073	0.11%
4050110810	48.132	47.902	0.230	0.48%	47.687	0.445	0.92%
405026220	48.859	48.672	0.187	0.38%	48.486	0.373	0.76%
4050112160	79.652	79.568	0.084	0.11%	79.481	0.171	0.21%
4050112160U	79.652	79.568	0.084	0.11%	79.481	0.171	0.21%
4050223500	26.097	25.92	0.177	0.68%	25.741	0.356	1.36%

Q95

Cross Section	Baseline WP (m)	Scenario A WP (m)	Scenario A WP change from baseline (m)	Scenario A WP change from baseline (%)	Scenario B WP(m)	Scenario B WP change from baseline (m)	Scenario B WP change from baseline (%)
405028080	65.603	64.942	-0.661	-1.01%	64.145	-1.458	-2.22%
405028110	65.715	65.054	-0.661	-1.01%	64.253	-1.462	-2.22%
405026290	49.181	49.021	-0.16	-0.33%	48.832	-0.349	-0.71%
405025840	39.592	39.368	-0.224	-0.57%	39.103	-0.489	-1.24%
4050224020	44.947	44.777	-0.17	-0.38%	44.448	-0.499	-1.11%
4050227250	45.671	44.857	-0.814	-1.78%	43.865	-1.806	-3.95%
4050226260	38.679	38.189	-0.49	-1.27%	37.597	-1.082	-2.80%
4050225710	45.862	45.491	-0.371	-0.81%	45.045	-0.817	-1.78%
405028620	47.187	47.047	-0.14	-0.30%	46.875	-0.312	-0.66%
4050111270D	67.023	66.997	-0.026	-0.04%	66.964	-0.059	-0.09%
4050110810	48.444	48.228	-0.216	-0.45%	47.993	-0.451	-0.93%
405026220	48.979	48.818	-0.161	-0.33%	48.629	-0.35	-0.71%
4050112160	79.762	79.688	-0.074	-0.09%	79.603	-0.159	-0.20%
4050112160U	79.762	79.688	-0.074	-0.09%	79.603	-0.159	-0.20%
4050223500	26.215	26.061	-0.154	-0.59%	25.879	-0.336	-1.28%

Sens. A - Q95, Plus 20% Weir Coefficient			Sens. B - Q95, Minus 20% Weir Coefficient			Sens. C - Q95, Plus 10% Mannings			Sens. D - Q95, Minus 10% Mannings		
WP (m)	Change from Baseline (m)	Change from Baseline (%)	WP (m)	Change from Baseline (m)	Change from Baseline (%)	WP (m)	Change from Baseline (m)	Change from Baseline (%)	WP (m)	Change from Baseline (m)	Change from Baseline (%)
65.603	0	0.00%	64.772	-0.831	-1.27%	66.667	1.064	1.62%	64.772	-0.831	-1.27%
65.715	0	0.00%	64.885	-0.83	-1.26%	66.781	1.066	1.62%	64.885	-0.83	-1.26%
49.182	0.001	0.00%	48.977	-0.204	-0.41%	49.446	0.265	0.54%	48.977	-0.204	-0.41%
39.591	-0.001	0.00%	39.297	-0.295	-0.75%	39.974	0.382	0.96%	39.297	-0.295	-0.75%
44.947	0	0.00%	44.693	-0.254	-0.57%	45.123	0.176	0.39%	44.693	-0.254	-0.57%
45.671	0	0.00%	44.664	-1.007	-2.20%	47.076	1.405	3.08%	44.664	-1.007	-2.20%
38.679	0	0.00%	38.029	-0.65	-1.68%	39.511	0.832	2.15%	38.029	-0.65	-1.68%
45.862	0	0.00%	45.373	-0.489	-1.07%	46.485	0.623	1.36%	45.373	-0.489	-1.07%
47.187	0	0.00%	47.012	-0.175	-0.37%	47.411	0.224	0.47%	47.012	-0.175	-0.37%
67.023	0	0.00%	66.995	-0.028	-0.04%	67.075	0.052	0.08%	66.995	-0.028	-0.04%
48.449	0.005	0.01%	48.071	-0.373	-0.77%	48.903	0.459	0.95%	48.071	-0.373	-0.77%
48.979	0	0.00%	48.773	-0.206	-0.42%	49.244	0.265	0.54%	48.773	-0.206	-0.42%
79.762	0	0.00%	79.759	-0.003	0.00%	79.768	0.006	0.01%	79.759	-0.003	0.00%
79.762	0	0.00%	79.759	-0.003	0.00%	79.768	0.006	0.01%	79.759	-0.003	0.00%
26.215	0	0.00%	26.009	-0.206	-0.79%	26.482	0.267	1.02%	26.009	-0.206	-0.79%

Q50

Cross Section	Baseline WP (m)	Scenario A WP (m)	Scenario A WP change from baseline (m)	Scenario A WP change from baseline (%)	Scenario B WP(m)	Scenario B WP change from baseline (m)	Scenario B WP change from baseline (%)
405028080	71.598	71.389	-0.209	-0.29%	71.145	-0.453	-0.63%
405028110	71.684	71.474	-0.21	-0.29%	71.23	-0.454	-0.63%
405026290	51.205	51.086	-0.119	-0.23%	50.946	-0.259	-0.51%
405025840	45.782	45.532	-0.25	-0.55%	45.24	-0.542	-1.18%
4050224020	46.171	46.104	-0.067	-0.15%	46.028	-0.143	-0.31%
4050227250	48.8	48.685	-0.115	-0.24%	48.553	-0.247	-0.51%
4050226260	44.013	43.862	-0.151	-0.34%	43.686	-0.327	-0.74%
4050225710	49.886	49.801	-0.085	-0.17%	49.701	-0.185	-0.37%
405028620	48.739	48.666	-0.073	-0.15%	48.575	-0.164	-0.34%
4050111270D	67.371	67.353	-0.018	-0.03%	67.333	-0.038	-0.06%
4050110810	54.131	53.82	-0.311	-0.57%	53.473	-0.658	-1.22%
405026220	51.004	50.885	-0.119	-0.23%	50.745	-0.259	-0.51%
4050112160	81.099	81.041	-0.058	-0.07%	80.973	-0.126	-0.16%
4050112160U	81.099	81.041	-0.058	-0.07%	80.973	-0.126	-0.16%
4050223500	27.984	27.889	-0.095	-0.34%	27.781	-0.203	-0.73%

Q10

Cross Section	Baseline WP (m)	Scenario A WP (m)	Scenario A WP change from baseline (m)	Scenario A WP change from baseline (%)	Scenario B WP(m)	Scenario B WP change from baseline (m)	Scenario B WP change from baseline (%)
405028080	80.356	80.218	-0.138	-0.17%	80.049	-0.307	-0.38%
405028110	80.469	80.333	-0.136	-0.17%	80.159	-0.31	-0.39%
405026290	55.8	55.76	-0.04	-0.07%	55.709	-0.091	-0.16%
405025840	51.891	51.853	-0.038	-0.07%	51.804	-0.087	-0.17%
4050224020	51.554	51.473	-0.081	-0.16%	51.337	-0.217	-0.42%
4050227250	52.863	52.814	-0.049	-0.09%	52.751	-0.112	-0.21%
4050226260	49.115	49.054	-0.061	-0.12%	48.978	-0.137	-0.28%
4050225710	53.231	53.183	-0.048	-0.09%	53.121	-0.11	-0.21%
405028620	51.963	51.924	-0.039	-0.08%	51.874	-0.089	-0.17%
4050111270D	68.772	68.758	-0.014	-0.02%	68.74	-0.032	-0.05%
4050110810	77.115	77.057	-0.058	-0.08%	76.981	-0.134	-0.17%
405026220	55.685	55.62	-0.065	-0.12%	55.53	-0.155	-0.28%
4050112160	82.726	82.708	-0.018	-0.02%	82.686	-0.04	-0.05%
4050112160U	82.726	82.708	-0.018	-0.02%	82.686	-0.04	-0.05%
4050223500	31.535	31.483	-0.052	-0.16%	31.419	-0.116	-0.37%

	Q99						
Cross section	Baseline Flow (m3)	Scenario A Flow (m3)	Scenario A Flow change from baseline (m3)	Scenario A Flow change from baseline (%)	Scenario B Flow (m3)	Scenario B Flow change from baseline (m3)	Scenario B Flow change from baseline (%)
405028080	16.85	15.55	-1.3	-7.72%	14.259	-2.591	-15.38%
405028110	16.85	15.55	-1.3	-7.72%	14.259	-2.591	-15.38%
405026290	16.85	15.55	-1.3	-7.72%	14.259	-2.591	-15.38%
405025840	16.85	15.55	-1.3	-7.72%	14.259	-2.591	-15.38%
4050224020	16.85	15.55	-1.3	-7.72%	14.259	-2.591	-15.38%
4050227250	16.85	15.55	-1.3	-7.72%	14.259	-2.591	-15.38%
4050226260	16.85	15.55	-1.3	-7.72%	14.259	-2.591	-15.38%
4050225710	16.85	15.55	-1.3	-7.72%	14.259	-2.591	-15.38%
405028620	16.85	15.55	-1.3	-7.72%	14.259	-2.591	-15.38%
4050111270D	20.211	18.911	-1.3	-6.43%	17.62	-2.591	-12.82%
4050110810	20.211	18.911	-1.3	-6.43%	17.629	-2.582	-12.78%
405026220	16.85	15.55	-1.3	-7.72%	14.259	-2.591	-15.38%
4050112160	20.211	18.911	-1.3	-6.43%	17.62	-2.591	-12.82%
4050112160U	16.68	15.38	-1.3	-7.79%	14.089	-2.591	-15.53%
4050223500	16.85	15.55	-1.3	-7.72%	14.259	-2.591	-15.38%

	Q95						
Cross section	Baseline Flow (m3)	Scenario A Flow (m3)	Scenario A Flowchange from baseline (m3)	Scenario A Flowchange from baseline (%)	Scenario B Flow (m3)	Scenario B Flowchange from baseline (m3)	Scenario B Flowchange from baseline (m3)
405028080	17.74	16.58	-1.16	-6.54%	15.251	-2.489	-14.03%
405028110	17.74	16.58	-1.16	-6.54%	15.251	-2.489	-14.03%
405026290	17.74	16.58	-1.16	-6.54%	15.251	-2.489	-14.03%
405025840	17.74	16.579	-1.161	-6.54%	15.251	-2.489	-14.03%
4050224020	17.74	16.58	-1.16	-6.54%	15.25	-2.49	-14.04%
4050227250	17.74	16.58	-1.16	-6.54%	15.25	-2.49	-14.04%
4050226260	17.74	16.58	-1.16	-6.54%	15.25	-2.49	-14.04%
4050225710	17.74	16.58	-1.16	-6.54%	15.25	-2.49	-14.04%
405028620	17.74	16.58	-1.16	-6.54%	15.251	-2.489	-14.03%
4050111270D	21.92	20.76	-1.16	-5.29%	19.431	-2.489	-11.35%
4050110810	21.918	20.759	-1.159	-5.29%	19.431	-2.487	-11.35%
405026220	17.74	16.58	-1.16	-6.54%	15.251	-2.489	-14.03%
4050112160	21.919	20.76	-1.159	-5.29%	19.431	-2.488	-11.35%
4050112160U	17.969	16.81	-1.159	-6.45%	15.481	-2.488	-13.85%
4050223500	17.74	16.58	-1.16	-6.54%	15.25	-2.49	-14.04%

Cross section	Sens. A - Q95, +20% Weir Coefficient			Sens. B - Q95, -20% Weir Coefficient			Sens. C - Q95, +10% Mannings			Sens. D - Q95, -10% Mannings		
	Flow (m3)	Change from Baseline (m3)	% Change from Baseline (%)	Flow (m3)	Change from Baseline (m3)	% Change from Baseline (%)	Flow (m3)	Change from Baseline (m3)	% Change from Baseline (%)	Flow (m3)	Change from Baseline (m3)	% Change from Baseline (%)
405028080	17.74	0	0.00%	17.74	0	0.00%	17.739	-0.001	-0.01%	17.74	0	0.00%
405028110	17.74	0	0.00%	17.74	0	0.00%	17.739	-0.001	-0.01%	17.74	0	0.00%
405026290	17.74	0	0.00%	17.74	0	0.00%	17.739	-0.001	-0.01%	17.74	0	0.00%
405025840	17.74	0	0.00%	17.74	0	0.00%	17.739	-0.001	-0.01%	17.74	0	0.00%
4050224020	17.74	0	0.00%	17.74	0	0.00%	17.74	0	0.00%	17.74	0	0.00%
4050227250	17.74	0	0.00%	17.74	0	0.00%	17.74	0	0.00%	17.74	0	0.00%
4050226260	17.74	0	0.00%	17.74	0	0.00%	17.74	0	0.00%	17.74	0	0.00%
4050225710	17.74	0	0.00%	17.74	0	0.00%	17.74	0	0.00%	17.74	0	0.00%
405028620	17.74	0	0.00%	17.74	0	0.00%	17.739	-0.001	-0.01%	17.74	0	0.00%
4050111270D	21.92	0	0.00%	21.92	0	0.00%	21.919	-0.001	0.00%	21.92	0	0.00%
4050110810	21.918	0	0.00%	21.92	0.002	0.01%	21.919	0.001	0.00%	21.92	0.002	0.01%
405026220	17.74	0	0.00%	17.74	0	0.00%	17.739	-0.001	-0.01%	17.74	0	0.00%
4050112160	21.92	0.001	0.00%	21.92	0.001	0.00%	21.919	0	0.00%	21.92	0.001	0.00%
4050112160U	17.97	0.001	0.01%	17.97	0.001	0.01%	17.969	0	0.00%	17.97	0.001	0.01%
4050223500	17.74	0	0.00%	17.74	0	0.00%	17.74	0	0.00%	17.74	0	0.00%

	Q50						
Cross section	Baseline Flow (m3)	Scenario A Flow (m3)	Scenario A Flow Change from baseline (m3)	Scenario A Flow Change from baseline (%)	Scenario B Flow (m3)	Scenario B Flow Change from baseline (m3)	Scenario B Flow Change from baseline (m3)
405028080	35.019	33.854	-1.165	-3.33%	32.519	-2.5	-7.14%
405028110	35.019	33.854	-1.165	-3.33%	32.519	-2.5	-7.14%
405026290	35.019	33.854	-1.165	-3.33%	32.519	-2.5	-7.14%
405025840	35.019	33.854	-1.165	-3.33%	32.519	-2.5	-7.14%
4050224020	35.02	33.854	-1.166	-3.33%	32.52	-2.5	-7.14%
4050227250	35.02	33.854	-1.166	-3.33%	32.52	-2.5	-7.14%
4050226260	35.02	33.854	-1.166	-3.33%	32.52	-2.5	-7.14%
4050225710	35.02	33.854	-1.166	-3.33%	32.52	-2.5	-7.14%
405028620	35.019	33.854	-1.165	-3.33%	32.519	-2.5	-7.14%
4050111270D	45.858	44.695	-1.163	-2.54%	43.359	-2.499	-5.45%
4050110810	45.858	44.695	-1.163	-2.54%	43.359	-2.499	-5.45%
405026220	35.019	33.854	-1.165	-3.33%	32.519	-2.5	-7.14%
4050112160	45.858	44.695	-1.163	-2.54%	43.359	-2.499	-5.45%
4050112160U	36.898	35.735	-1.163	-3.15%	34.399	-2.499	-6.77%
4050223500	35.02	33.854	-1.166	-3.33%	32.52	-2.5	-7.14%

	Q10						
Cross section	Baseline Flow (m3)	Scenario A Flow (m3)	Scenario A Flow Change from baseline (m3)	Scenario A Flow change from baseline (%)	Scenario B Flow (m3)	Scenario B Flow Change from baseline (m3)	Scenario B Flow change from baseline (m3)
405028080	94.249	93.19	-1.059	-1.12%	91.859	-2.39	-2.54%
405028110	94.249	93.19	-1.059	-1.12%	91.859	-2.39	-2.54%
405026290	94.249	93.19	-1.059	-1.12%	91.859	-2.39	-2.54%
405025840	94.249	93.19	-1.059	-1.12%	91.859	-2.39	-2.54%
4050224020	94.25	93.19	-1.06	-1.12%	91.86	-2.39	-2.54%
4050227250	94.25	93.19	-1.06	-1.12%	91.86	-2.39	-2.54%
4050226260	94.25	93.19	-1.06	-1.12%	91.86	-2.39	-2.54%
4050225710	94.25	93.19	-1.06	-1.12%	91.86	-2.39	-2.54%
405028620	94.249	93.19	-1.059	-1.12%	91.859	-2.39	-2.54%
4050111270D	125.515	124.576	-0.939	-0.75%	123.388	-2.127	-1.69%
4050110810	125.515	124.576	-0.939	-0.75%	123.388	-2.127	-1.69%
405026220	94.249	93.19	-1.059	-1.12%	91.859	-2.39	-2.54%
4050112160	126.378	125.32	-1.058	-0.84%	123.989	-2.389	-1.89%
4050112160U	98.588	97.53	-1.058	-1.07%	96.199	-2.389	-2.42%
4050223500	94.25	93.19	-1.06	-1.12%	91.86	-2.39	-2.54%

Q99

Cross Section	Baseline Velocity (m/s)	Scenario A Velocity (m/s)	Scenario A Velocity Change from baseline (m/s)	Scenario A Velocity Change from baseline (%)	Scenario B Velocity (m/s)	Scenario B Velocity Change from baseline (m/s)	Scenario B Velocity Change from baseline (%)
405028080	0.355	0.346	-0.009	-2.54%	0.337	-0.018	-5.07%
405028110	0.352	0.343	-0.009	-2.56%	0.335	-0.017	-4.83%
405026290	0.5	0.484	-0.016	-3.20%	0.468	-0.032	-6.40%
405025840	0.753	0.745	-0.008	-1.06%	0.737	-0.016	-2.12%
4050224020	0.513	0.501	-0.012	-2.34%	0.489	-0.024	-4.68%
4050227250	0.327	0.311	-0.016	-4.89%	0.293	-0.034	-10.40%
4050226260	0.517	0.502	-0.015	-2.90%	0.485	-0.032	-6.19%
4050225710	0.543	0.531	-0.012	-2.21%	0.52	-0.023	-4.24%
405028620	0.173	0.163	-0.01	-5.78%	0.153	-0.02	-11.56%
4050111270D	0.224	0.212	-0.012	-5.36%	0.201	-0.023	-10.27%
4050110810	1.819	1.776	-0.043	-2.36%	1.726	-0.093	-5.11%
405026220	0.527	0.512	-0.015	-2.85%	0.496	-0.031	-5.88%
4050112160	0.089	0.084	-0.005	-5.62%	0.078	-0.011	-12.36%
4050112160U	0.073	0.068	-0.005	-6.85%	0.063	-0.01	-13.70%
4050223500	0.657	0.627	-0.03	-4.57%	0.595	-0.062	-9.44%

Q95

Cross Section	Baseline Velocity (m/s)	Scenario A Velocity (m/s)	Scenario A Velocity Change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Velocity (m/s)	Scenario B Velocity Change from baseline (m/s)	Scenario B Velocity change from baseline (%)
405028080	0.36	0.353	-0.007	-1.94%	0.344	-0.016	-4.44%
405028110	0.358	0.35	-0.008	-2.23%	0.341	-0.017	-4.75%
405026290	0.51	0.496	-0.014	-2.75%	0.48	-0.03	-5.88%
405025840	0.76	0.751	-0.009	-1.18%	0.743	-0.017	-2.24%
4050224020	0.521	0.511	-0.01	-1.92%	0.498	-0.023	-4.41%
4050227250	0.338	0.324	-0.014	-4.14%	0.307	-0.031	-9.17%
4050226260	0.527	0.514	-0.013	-2.47%	0.498	-0.029	-5.50%
4050225710	0.551	0.54	-0.011	-2.00%	0.529	-0.022	-3.99%
405028620	0.18	0.171	-0.009	-5.00%	0.161	-0.019	-10.56%
4050111270D	0.24	0.229	-0.011	-4.58%	0.217	-0.023	-9.58%
4050110810	1.867	1.835	-0.032	-1.71%	1.794	-0.073	-3.91%
405026220	0.537	0.524	-0.013	-2.42%	0.509	-0.028	-5.21%
4050112160	0.096	0.091	-0.005	-5.21%	0.086	-0.01	-10.42%
4050112160U	0.079	0.074	-0.005	-6.33%	0.068	-0.011	-13.92%
4050223500	0.677	0.651	-0.026	-3.84%	0.62	-0.057	-8.42%

Cross Section	Sens. A - Q95, +20% Weir Coefficient			Sens. B - Q95, -20% Weir Coefficient			Sens. C - Q95, +10% Mannings			Sens. D - Q95, -10% Mannings		
	Velocity (m/s)	Change from Baseline (m/s)	% Change from Baseline (%)	Velocity (m/s)	Change from Baseline (m/s)	% Change from Baseline (%)	Velocity (m/s)	Change from Baseline (m/s)	% Change from Baseline (%)	Velocity (m/s)	Change from Baseline (m/s)	% Change from Baseline (%)
405028080	0.36	0	0.00%	0.382	0.022	6.11%	0.336	-0.024	-6.67%	0.382	0.022	6.11%
405028110	0.358	0	0.00%	0.379	0.021	5.87%	0.333	-0.025	-6.98%	0.379	0.021	5.87%
405026290	0.51	0	0.00%	0.537	0.027	5.29%	0.478	-0.032	-6.27%	0.537	0.027	5.29%
405025840	0.76	0	0.00%	0.819	0.059	7.76%	0.693	-0.067	-8.82%	0.819	0.059	7.76%
4050224020	0.521	0	0.00%	0.555	0.034	6.53%	0.484	-0.037	-7.10%	0.555	0.034	6.53%
4050227250	0.338	0	0.00%	0.349	0.011	3.25%	0.325	-0.013	-3.85%	0.349	0.011	3.25%
4050226260	0.527	0	0.00%	0.558	0.031	5.88%	0.493	-0.034	-6.45%	0.558	0.031	5.88%
4050225710	0.551	0	0.00%	0.588	0.037	6.72%	0.509	-0.042	-7.62%	0.588	0.037	6.72%
405028620	0.18	0	0.00%	0.184	0.004	2.22%	0.176	-0.004	-2.22%	0.184	0.004	2.22%
4050111270D	0.24	0	0.00%	0.242	0.002	0.83%	0.236	-0.004	-1.67%	0.242	0.002	0.83%
4050110810	1.867	0	0.00%	1.995	0.128	6.86%	1.726	-0.141	-7.55%	1.995	0.128	6.86%
405026220	0.537	0	0.00%	0.568	0.031	5.77%	0.502	-0.035	-6.52%	0.568	0.031	5.77%
4050112160	0.096	0	0.00%	0.096	0	0.00%	0.096	0	0.00%	0.096	0	0.00%
4050112160U	0.079	0	0.00%	0.079	0	0.00%	0.079	0	0.00%	0.079	0	0.00%
4050223500	0.677	0	0.00%	0.703	0.026	3.84%	0.646	-0.031	-4.58%	0.703	0.026	3.84%

Q50

Cross Section	Baseline Velocity (m/s)	Scenario A Velocity (m/s)	Scenario A Velocity Change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Velocity (m/s)	Scenario B Velocity Change from baseline (m/s)	Scenario B Velocity change from baseline (%)
405028080	0.478	0.471	-0.007	-1.46%	0.462	-0.016	-3.35%
405028110	0.475	0.467	-0.008	-1.68%	0.459	-0.016	-3.37%
405026290	0.661	0.653	-0.008	-1.21%	0.643	-0.018	-2.72%
405025840	0.865	0.858	-0.007	-0.81%	0.851	-0.014	-1.62%
4050224020	0.65	0.643	-0.007	-1.08%	0.634	-0.016	-2.46%
4050227250	0.494	0.486	-0.008	-1.62%	0.476	-0.018	-3.64%
4050226260	0.67	0.663	-0.007	-1.04%	0.654	-0.016	-2.39%
4050225710	0.663	0.657	-0.006	-0.90%	0.65	-0.013	-1.96%
405028620	0.303	0.295	-0.008	-2.64%	0.286	-0.017	-5.61%
4050111270D	0.449	0.44	-0.009	-2.00%	0.429	-0.02	-4.45%
4050110810	2.035	2.04	0.005	0.25%	2.042	0.007	0.34%
405026220	0.685	0.677	-0.008	-1.17%	0.667	-0.018	-2.63%
4050112160	0.187	0.183	-0.004	-2.14%	0.178	-0.009	-4.81%
4050112160U	0.151	0.146	-0.005	-3.31%	0.141	-0.01	-6.62%
4050223500	0.977	0.961	-0.016	-1.64%	0.941	-0.036	-3.68%

Q10

Cross Section	Baseline Velocity (m/s)	Scenario A Velocity (m/s)	Scenario A Velocity Change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Velocity (m/s)	Scenario B Velocity Change from baseline (m/s)	Scenario B Velocity change from baseline (%)
405028080	0.715	0.712	-0.003	-0.42%	0.709	-0.006	-0.84%
405028110	0.711	0.708	-0.003	-0.42%	0.704	-0.007	-0.98%
405026290	0.959	0.956	-0.003	-0.31%	0.951	-0.008	-0.83%
405025840	1.117	1.114	-0.003	-0.27%	1.109	-0.008	-0.72%
4050224020	0.938	0.934	-0.004	-0.43%	0.929	-0.009	-0.96%
4050227250	0.779	0.775	-0.004	-0.51%	0.77	-0.009	-1.16%
4050226260	0.938	0.934	-0.004	-0.43%	0.929	-0.009	-0.96%
4050225710	0.899	0.895	-0.004	-0.44%	0.891	-0.008	-0.89%
405028620	0.609	0.604	-0.005	-0.82%	0.599	-0.01	-1.64%
4050111270D	0.862	0.858	-0.004	-0.46%	0.853	-0.009	-1.04%
4050110810	1.63	1.63	0	0.00%	1.629	-0.001	-0.06%
405026220	0.98	0.976	-0.004	-0.41%	0.971	-0.009	-0.92%
4050112160	0.438	0.435	-0.003	-0.68%	0.432	-0.006	-1.37%
4050112160U	0.342	0.339	-0.003	-0.88%	0.335	-0.007	-2.05%
4050223500	1.583	1.575	-0.008	-0.51%	1.564	-0.019	-1.20%

Author names redacted

Project: Strategic Resource Options: Tame and Trent Modelling Study
Deliverable: Project Report Appendix B: 'Trent 4' 1D Hydraulic Modelling Results
Revision Date: 12th July 2022

Quality Information
Originator: [redacted], Graduate Water Consultant
Checker: [redacted], Engineer; Sarah Littlewood, Principal Consultant
Verifier: [redacted] Technical Director

Notes and Key Assumptions

1. The results in this MS Workbook should be reviewed with reference to the Project Report.
2. The outputs in this MS Workbook are based on a calibrated model. The model has been calibrated to the disaggregated flow at the River Soar and Aquator flows at Colwick and North Muskham.
3. Q10, Q50, Q95 and Q99 flow conditions have been simulated for these calibrated runs.
4. All runs are steady state flow - but this summary uses the mean outputs across the simulation timesteps for water level and max wetted perimeter values.
5. All baseline runs included a DWF at Minworth WwTW.
6. Scenario A = 115 Ml/d flow reduction at Minworth WwTW (equivalent to either GUC or STT operated at their maximum).
7. Scenario B = 230 Ml/d flow reduction at Minworth WwTW (equivalent to both GUC and STT operating at their maximum).
8. Scenario C = 230 Ml/d flow reduction at Minworth WwTW (equivalent to both GUC and STT operating at their maximum) and 300 Ml/d loss for SLR on the Lower Trent.
9. Scenario D = 300 Ml/day loss for SLR on the Lower Trent only. (No losses at Minworth WwTW).

Figure 1A: Trent 4 Node Locations and Cross Sections

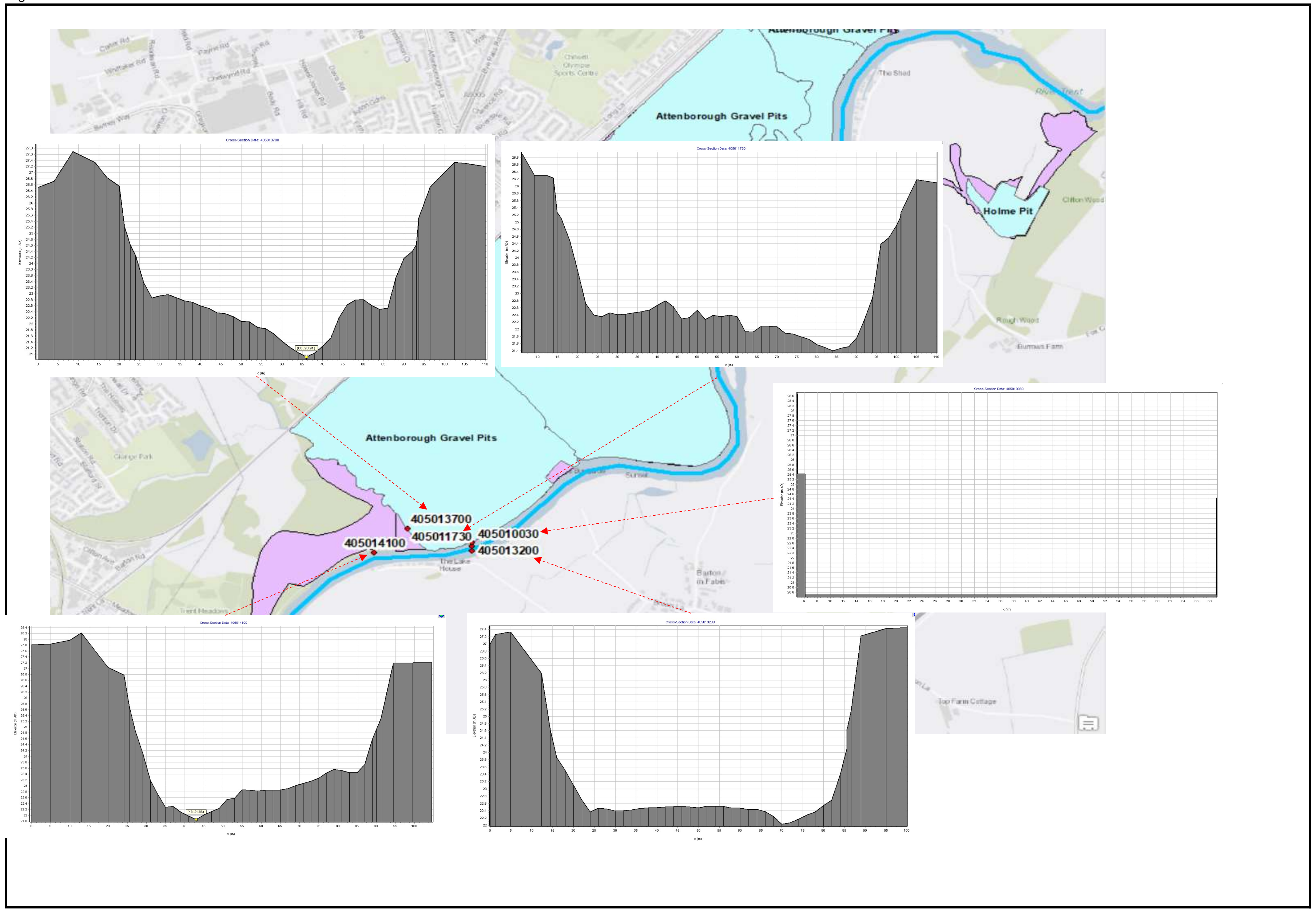
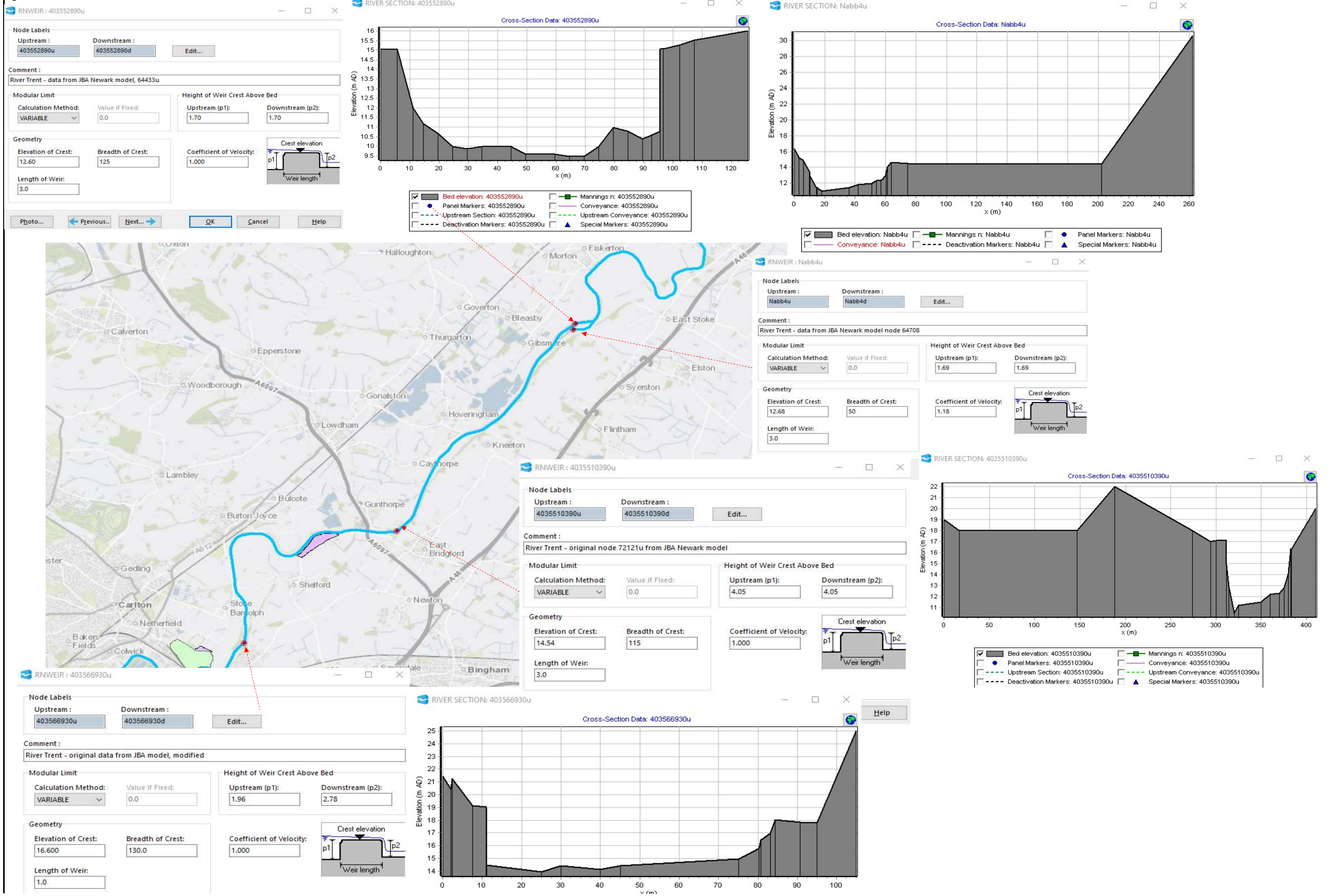


Figure 1B: Trent 4 Node Locations and Cross Sections

Figure 1C: Trent 4 Node Locations and Cross Sections



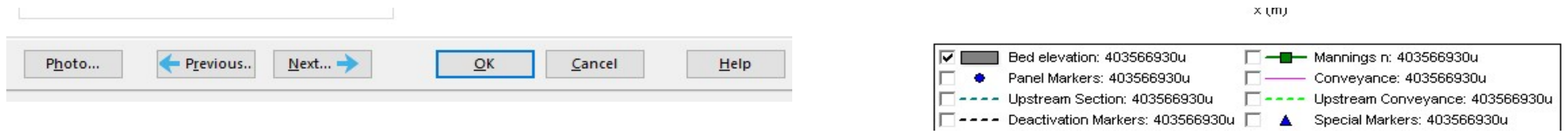


Figure 1D: Trent 4 Node Locations and Cross Sections

Cross Section 403531200U is the cross section upstream of the weir looking downstream to the weir. No cross sectional plot for the weir at this location.

Weir has been represented by a Spill unit, shown on the left of the two cross sections. The right cross section is upstream of the Averham Weir

Sensitive R – Q99

Cross section	Bed elevation (mAOD)	Baseline Mean Stage (mAOD)	Simulated Baseline Water Mean depth (m)	Scenario A Mean Stage (mOAD)	Scenario A water level Change from baseline (m)	Scenario A Mean water depth change (%)	Scenario B Mean Stage (mAOD)	Scenario B water level Change from baseline (m)	Scenario B mean water depth change (%)	Scenario C Mean Stage (mOAD)	Scenario C water level Change from baseline (m)	Scenario C Mean water depth change (%)	Scenario D Mean Stage (mAOD)	Scenario D water level Change from baseline (m)	Scenario D mean water depth change (%)
405014100	21.86	24.761	2.901	24.751	-0.010	-0.34%	24.741	-0.020	-0.69%	24.741	-0.020	-0.69%	24.761	0.000	0.00%
405013700	20.91	24.757	3.847	24.748	-0.009	-0.23%	24.738	-0.019	-0.49%	24.738	-0.019	-0.49%	24.757	0.000	0.00%
405013200	22.03	24.753	2.723	24.744	-0.009	-0.33%	24.735	-0.018	-0.66%	24.735	-0.018	-0.66%	24.753	0.000	0.00%
405011730	21.4	24.747	3.347	24.738	-0.009	-0.27%	24.73	-0.017	-0.51%	24.73	-0.017	-0.51%	24.747	0.000	0.00%
405010030	20.5	24.741	4.241	24.733	-0.008	-0.19%	24.725	-0.016	-0.38%	24.725	-0.016	-0.38%	24.741	0.000	0.00%
4040113530	19.69	21.232	1.542	21.211	-0.021	-1.36%	21.19	-0.042	-2.72%	21.19	-0.042	-2.72%	21.232	0.000	0.00%
403568850	13.17	16.858	3.688	16.849	-0.009	-0.24%	16.838	-0.020	-0.54%	16.838	-0.020	-0.54%	16.858	0.000	0.00%
403568730	13.87	16.856	2.986	16.847	-0.009	-0.30%	16.837	-0.019	-0.64%	16.837	-0.019	-0.64%	16.856	0.000	0.00%
403568500	13.57	16.853	3.283	16.845	-0.008	-0.24%	16.835	-0.018	-0.55%	16.835	-0.018	-0.55%	16.853	0.000	0.00%
403562060	11.6	14.833	3.233	14.822	-0.011	-0.34%	14.811	-0.022	-0.68%	14.811	-0.022	-0.68%	14.833	0.000	0.00%
403561560	11.5	14.831	3.331	14.82	-0.011	-0.33%	14.809	-0.022	-0.66%	14.809	-0.022	-0.66%	14.831	0.000	0.00%
403560830	12	14.824	2.824	14.814	-0.010	-0.35%	14.803	-0.021	-0.74%	14.803	-0.021	-0.74%	14.824	0.000	0.00%

Sensitive R – Q95

Cross section	Baseline Mean Stage (mAOD)	Simulated Baseline Water Mean depth (m)	Scenario A Mean Stage (mOAD)	Scenario A water level Change from baseline (m)	Scenario A mean water depth change (%)	Scenario B Mean Stage (mAOD)	Scenario B water level Change from baseline (m)	Scenario B mean water depth change (%)	Scenario C Mean Stage (mOAD)	Scenario C water level Change from baseline (m)	Scenario C mean water depth change (%)	Scenario D Mean Stage (mAOD)	Scenario D water level Change from baseline (m)	Scenario D mean water depth change (%)	Manning's (+10%)	% Change	Manning's (-10%)	% Change	Weir Coefficient (+20%)	% Change	Weir Coefficient (-20%)	% Change
405014100	24.777	2.917	24.769	-0.008	-0.27%	24.759	-0.018	-0.62%	24.759	-0.018	-0.62%	24.777	0.000	0.00%	24.78	0.17%	24.77	-0.17%	24.78	0.00%	24.772	-0.17%
405013700	24.773	3.863	24.765	-0.008	-0.21%	24.756	-0.017	-0.44%	24.756	-0.017	-0.44%	24.773	0.000	0.00%	24.78	0.10%	24.77	-0.10%	24.77	0.00%	24.77	-0.10%
405013200	24.768	2.738	24.761	-0.007	-0.26%	24.752	-0.016	-0.58%	24.752	-0.016	-0.58%	24.768	0.000	0.00%	24.77	0.15%	24.77	-0.11%	24.77	0.00%	24.77	-0.11%
405011730	24.761	3.361	24.754	-0.007	-0.21%	24.745	-0.016	-0.48%	24.745	-0.016	-0.48%	24.761	0.000	0.00%	24.76	0.03%	24.76	-0.06%	24.76	0.00%	24.76	-0.06%
405010030	24.754	4.254	24.747	-0.007	-0.16%	24.739	-0.015	-0.35%	24.739	-0.015	-0.35%	24.754	0.000	0.00%	24.75	0.00%	24.75	0.00%	24.75	0.00%	24.75	0.00%
4040113530	21.268	1.578	21.25	-0.018	-1.14%	21.229	-0.039	-2.47%	21.229	-0.039	-2.47%	21.268	0.000	0.00%	21.31	2.72%	21.23	-2.72%	21.27	-0.06%	21.23	-2.72%
403568850	16.876	3.706	16.866	-0.010	-0.27%	16.856	-0.020	-0.54%	16.857	-0.019	-0.51%	16.875	-0.001	-0.03%	16.88	0.11%	16.87	-0.13%	16.88	0.00%	16.87	-0.13%
403568730	16.873	3.003	16.864	-0.009	-0.30%	16.854	-0.019	-0.63%	16.855	-0.018	-0.60%	16.873	0.000	0.00%	16.88	0.13%	16.87	-0.13%	16.87	0.00%	16.87	-0.13%
403568500	16.87	3.300	16.861	-0.009	-0.27%	16.851	-0.019	-0.58%	16.852	-0.018	-0.55%	16.87	0.000	0.00%	16.87	0.09%	16.87	-0.12%	16.87	0.00%	16.87	-0.12%
403562060	14.851	3.251	14.842	-0.009	-0.28%	14.83	-0.021	-0.65%	14.831	-0.02	-0.62%	14.851	0.000	0.00%	14.86	0.15%	14.85	-0.15%	14.85	0.00%	14.85	-0.15%
403561560	14.848	3.348	14.84	-0.008	-0.24%	14.828	-0.020	-0.60%	14.828	-0.02	-0.60%	14.848	0.000	0.00%	14.85	0.12%	14.84	-0.12%	14.85	0.00%	14.84	-0.12%
403560830	14.841	2.841	14.832	-0.009	-0.32%	14.822	-0.019	-0.67%	14.822	-0.019	-0.67%	14.84	-0.001	-0.04%	14.84	0.07%	14.84	-0.11%	14.84	-0.04%	14.84	-0.11%

Sensitive R – Q50

Cross section	Bed elevation (mAOD)	Baseline Mean Stage (mAOD)	Simulated Baseline Water Mean depth (m)	Scenario A Mean Stage (mOAD)	Scenario A water level Change from baseline (m)	Scenario A Mean water depth change (%)	Scenario B Mean Stage (mAOD)	Scenario B water level Change from baseline (m)	Scenario B mean water depth change (%)	Scenario C Mean Stage (mOAD)	Scenario C water level Change from baseline (m)	Scenario C Mean water depth change (%)	Scenario D Mean Stage (mAOD)	Scenario D water level Change from baseline (m)	Scenario D mean water depth change (%)
405014100	21.86	24.977	3.117	24.97	-0.007	-0.22%	24.961	-0.016	-0.51%	24.961	-0.016	-0.51%	24.977	0.000	0.00%
405013700	20.91	24.964	4.054	24.957	-0.007	-0.17%	24.949	-0.015	-0.37%	24.949	-0.015	-0.37%	24.964	0.000	0.00%
405013200	22.03	24.947	2.917	24.941	-0.006	-0.21%	24.934	-0.013	-0.45%	24.934	-0.013	-0.45%	24.947	0.000	0.00%
405011730	21.4	24.92	3.520	24.915	-0.005	-0.14%	24.908	-0.012	-0.34%	24.908	-0.012	-0.34%	24.92	0.000	0.00%
405010030	20.5	24.893	4.393	24.888	-0.005	-0.11%	24.883	-0.010	-0.23%	24.883	-0.010	-0.23%	24.893	0.000	0.00%
4040113530	19.69	21.691	2.001	21.675	-0.016	-0.80%	21.659	-0.032	-1.60%	21.659	-0.032	-1.60%	21.691	0.000	0.00%
403568850	13.17	17.087	3.917	17.081	-0.006	-0.15%	17.073	-0.014	-0.36%	17.073	-0.014	-0.36%	17.089	0.002	0.05%
403568730	13.87	17.079	3.209	17.073	-0.006	-0.19%	17.064	-0.015	-0.47%	17.064	-0.015	-0.47%	17.081	0.002	0.06%
403568500	13.57	17.068	3.498	17.062	-0.006	-0.17%	17.055	-0.013	-0.37%	17.055	-0.013	-0.37%	17.07	0.002	0.06%
403562060	11.6	15.084	3.484	15.076	-0.008	-0.23%	15.067	-0.017	-0.49%	15.067	-0.017	-0.49%	15.085	0.001	0.03%
403561560	11.5	15.074	3.574	15.067	-0.007	-0.20%	15.058	-0.016	-0.45%	15.058	-0.016	-0.45%	15.076	0.002	0.06%
403560830	12	15.048	3.048	15.042	-0.006	-0.20%	15.033	-0.015	-0.49%	15.033	-0.015	-0.49%	15.05	0.002	0.07%

Sensitive R – Q10

Cross section	Baseline Mean Stage (mAOD)	Simulated Baseline Water Mean depth (m)	Scenario A Mean Stage (mOAD)	Scenario A water level Change from baseline (m)	Scenario A mean water depth change (%)	Scenario B Mean Stage (mAOD)	Scenario B water level Change from baseline (m)	Scenario B mean water depth change (%)	Scenario C Mean Stage (mOAD)	Scenario C water level Change from baseline (m)	Scenario C mean water depth change (%)	Scenario D Mean Stage (mAOD)	Scenario D water level change from baseline (cm)	Scenario D mean water depth change (%)
405014100	25.611	3.751	25.605	-0.006	-0.16%	25.598	-0.013	-0.35%	25.598	-0.013	-0.35%	25.611	0.000	0.00%
405013700	25.565	4.655	25.559	-0.006	-0.13%	25.552	-0.013	-0.28%	25.552	-0.013	-0.28%	25.565	0.000	0.00%
405013200	25.497	3.467	25.492	-0.005	-0.14%	25.485	-0.012	-0.35%	25.485	-0.012	-0.35%	25.497	0.000	0.00%
405011730	25.369	3.969	25.365	-0.004	-0.10%	25.36	-0.009	-0.23%	25.36	-0.009	-0.23%	25.369	0.000	0.00%
405010030	25.227	4.727	25.224	-0.003	-0.06%	25.221	-0.006	-0.13%	25.221	-0.006	-0.13%	25.227	0.000	0.00%
4040113530	22.719	3.029	22.71	-0.009	-0.30%	22.7	-0.019	-0.63%	22.7	-0.019	-0.63%	22.719	0.000	0.00%
403568850	17.731	4.561	17.726	-0.005	-0.11%	17.718	-0.013	-0.29%	17.718	-0.013	-0.29%	17.731	0.000	0.00%
403568730	17.692	3.822	17.687	-0.005	-0.13%	17.68	-0.012	-0.31%	17.68	-0.012	-0.31%	17.692	0.000	0.00%
403568500	17.646	4.076	17.642	-0.004	-0.10%	17.635	-0.011	-0.27%	17.635	-0.011	-0.27%	17.646	0.000	0.00%
403562060	15.785	4.185	15.779	-0.006	-0.14%	15.771	-0.014	-0.33%	15.771	-0.014	-0.33%	15.785	0.000	0.00%
403561560	15.751	4.251	15.745	-0.006	-0.14%	15.738	-0.013	-0.31%	15.738	-0.013	-0.31%	15.751	0.000	0.00%
403560830	15.644	3.644	15.639	-0.005	-0.14%	15.633	-0.011	-0.30%	15.633	-0.011	-0.30%	15.644	0.000	0.00%

Weir CS – Q99

Cross section	Bed elevation (mAOD)	Baseline Mean Stage (mAOD)	Simulated Baseline Water Mean depth (m)	Scenario A Mean Stage (mOAD)	Scenario A water level Change from baseline (m)	Scenario A Mean water depth change (%)	Scenario B Mean Stage (mAOD)	Scenario B water level Change from baseline (m)	Scenario B mean water depth change (%)	Scenario C Mean Stage (mOAD)	Scenario C water level Change from baseline (m)	Scenario C Mean water depth change (%)	Scenario D Mean Stage (mAOD)	Scenario D water level Change from baseline (m)	Scenario D mean water depth change (%)
403566930u	13.940	16.84	2.900	16.833	-0.007	-0.24%	16.824	-0.016	-0.55%	16.824	-0.016	-0.55%	16.84	0.000	0.00%
403566930d	13.160	14.909	1.749	14.893	-0.016	-0.91%	14.875	-0.034	-1.94%	14.875	-0.034	-1.94%	14.909	0.000	0.00%
4035510390u	10.490	14.812	4.322	14.802	-0.010	-0.23%	14.793	-0.019	-0.44%	14.793	-0.019	-0.44%	14.812	0.000	0.00%
4035510390d	10.490	12.927	2.437	12.911	-0.016	-0.66%	12.896	-0.031	-1.27%	12.896	-0.031	-1.27%	12.927	0.000	0.00%
Nabb4u	10.990	12.826	1.836	12.82	-0.006	-0.33%	12.813	-0.013	-0.71%	12.813	-0.013	-0.71%	12.826	0.000	0.00%
Nabb4d	10.990	11.497	0.507	11.486	-0.011	-2.17%	11.475	-0.022	-4.34%	11.475	-0.022	-4.34%	11.496	-0.001	-0.20%
403552890u	9.470	12.826	3.356	12.819	-0.007	-0.21%	12.812	-0.014	-0.42%	12.812	-0.014	-0.42%	12.826	0.000	0.00%
403552890d	9.470	10.445	0.975	10.427	-0.018	-1.85%	10.41	-0.035	-3.59%	10.387	-0.058	-5.95%	10.425	-0.020	-2.05%
403540210	6.370	10.325	3.955	10.315	-0.010	-0.25%	10.305	-0.020	-0.51%	10.278	-0.047	-1.19%	10.3	-0.025	-0.63%
NewBr1u	7.540	10.243	2.703	10.236	-0.007	-0.26%	10.23	-0.013	-0.48%	10.21	-0.033	-1.22%	10.226	-0.017	-0.63%
NewBr1d	7.670	8.562	0.892	8.555	-0.007	-0.78%	8.549	-0.013	-1.46%	8.529	-0.033	-3.70%	8.545	-0.017	-1.91%
403531200u	5.840	8.225	2.385	8.218	-0.007	-0.29%	8.212	-0.013	-0.55%	8.195	-0.030	-1.26%	8.209	-0.016	-0.67%
403531200d	5.210	6.358	1.148	6.348	-0.010	-0.87%	6.338	-0.020	-1.74%	6.308	-0.050	-4.36%	6.333	-0.025	-2.18%

Weir CS – Q95

Cross section	Baseline Mean Stage (mAOD)	Simulated Baseline Water Mean depth (m)	Scenario A Mean Stage (mOAD)	Scenario A water level Change from baseline (m)	Scenario A mean water depth change (%)	Scenario B Mean Stage (mAOD)	Scenario B water level Change from baseline (m)	Scenario B mean water depth change (%)	Scenario C Mean Stage (mOAD)	Scenario C water level Change from baseline (m)	Scenario C mean water depth change (%)	Scenario D Mean Stage (mAOD)	Scenario D water level Change from baseline (m)	Scenario D mean water depth change (%)	Manning's (+10%)	% Change	Manning's (-10%)	% Change	Weir Coefficient (+20%)	% Change	Weir Coefficient (-20%)	% Change
403566930u	16.855	2.915	16.847	-0.008	-0.27%	16.839	-0.016	-0.55%	16.84	-0.015	-0.51%	16.855	0.000	0.00%	16.86	0.00%	16.85	-0.03%	16.86	0.00%	16.85	-0.03%
403566930d	14.939	1.779	14.924	-0.015	-0.84%	14.906	-0.033	-1.85%	14.907	-0.032	-1.80%	14.938	-0.001	-0.01%	14.96	1.12%	14.92	-1.18%	14.94	-0.06%	14.92	-1.18%
4035510390u	14.826	4.336	14.819	-0.007	-0.16%	14.809	-0.017	-0.39%	14.81	-0.016	-0.37%	14.826	0.000	0.00%	14.83	0.00%	14.83	0.00%	14.83	0.00%	14.83	0.00%
4035510390d	12.952	2.462	12.940	-0.012	-0.49%	12.924	-0.028	-1.14%	12.924	-0.028	-1.14%	12.952	0.000	0.00%	12.98	0.93%	12.93	-0.85%	12.95	0.00%	12.93	-0.85%
Nabb4u	12.837	1.847	12.832	-0.005	-0.27%	12.825	-0.012	-0.65%	12.825	-0.012	-0.65%	12.838	0.001	0.01%	12.84	0.05%	12.84	0.00%	12.84	0.05%	12.84	0.00%
Nabb4d	11.514	0.524	11.505	-0.009	-1.72%	11.495	-0.019	-3.63%	11.494	-0.020	-3.82%	11.514	0.000	0.00%	11.53	3.05%	11.50	-2.86%	11.51	0.00%	11.50	-2.86%
403552890u	12.837	3.367	12.831	-0.006	-0.18%	12.825	-0.012	-0.36%	12.825	-0.012	-0.36%	12.837	0.000	0.00%	12.84	0.00%	12.84	0.00%	12.84	0.00%	12.84	0.00%
403552890d	10.476	1.006	10.461	-0.015	-1.49%	10.443	-0.033	-3.28%	10.422	-0.054	-5.37%	10.456	-0.020	-0.19%	10.51	3.08%	10.45	-2.88%	10.46	-1.89%	10.45	-2.88%
SLR Abstraction																						
403540210	10.342	3.972	10.334	-0.008	-0.20%	10.324	-0.018	-0.45%	10.298	-0.044	-1.11%	10.317	-0.025	-0.63%	10.35	0.10%	10.34	-0.13%	10.32	-0.68%	10.34	-0.13%
NewBr1u	10.256	2.716	10.250	-0.006	-0.22%	10.243	-0.013	-0.48%	10.225	-0.031	-1.14%	10.238	-0.018	-0.66%	10.25	-0.29%	10.26	0.26%	10.22	-1.51%	10.26	0.26%
NewBr1d	8.575	0.905	8.569	-0.006	-0.66%	8.562	-0.013	-1.44%	8.544	-0.031	-3.43%	8.557	-0.018	-1.99%	8.60	2.21%	8.56	-2.21%	8.59	1.77%	8.56	-2.21%
403531200u	8.236	2.396	8.231	-0.005	-0.21%	8.225	-0.011	-0.46%	8.208	-0.028	-1.17%	8.22	-0.016	-0.67%	8.23	-0.29%	8.24	0.29%	8.25	0.54%	8.24	0.29%
403531200d	6.377	1.167	6.368	-0.009	-0.77%	6.358	-0.019	-1.63%	6.331	-0.046	-3.94%	6.351	-0.026	-2.23%	6.40	1.80%	6.36	-1.71%	6.40	1.89%	6.36	-1.71%

Weir CS – Q50

Cross section	Bed elevation (mAOD)	Baseline Mean Stage (mAOD)	Simulated Baseline Water Mean depth (m)	Scenario A Mean Stage (mOAD)	Scenario A water level Change from baseline (m)	Scenario A Mean water depth change (%)	Scenario B Mean Stage (mAOD)	Scenario B water level Change from baseline (m)	Scenario B mean water depth change (%)	Scenario C Mean Stage (mOAD)	Scenario C water level Change from baseline (m)	Scenario C Mean water depth change (%)	Scenario D Mean Stage (mAOD)	Scenario D water level Change from baseline (m)	Scenario D mean water depth change (%)
403566930u	13.940	17.016	3.076	17.012	-0.004	-0.13%	17.006	-0.010	-0.33%	17.006	-0.010	-0.33%	17.017	0.001	0.03%
403566930d	13.160	15.315	2.155	15.304	-0.011	-0.51%	15.288	-0.027	-1.25%	15.288	-0.027	-1.25%	15.318	0.003	0.14%
4035510390u	10.490	15.002	4.512	14.996	-0.006	-0.13%	14.99	-0.012	-0.27%	14.989	-0.013	-0.29%	15.003	0.001	0.02%
4035510390d	10.490	13.313	2.823	13.3	-0.013	-0.46%	13.285	-0.028	-0.99%	13.285	-0.028	-0.99%	13.314	0.001	0.04%
Nabb4u	10.990	12.964	1.974	12.96	-0.004	-0.20%	12.955	-0.009	-0.46%	12.955	-0.009	-0.46%	12.964	0.000	0.00%
Nabb4d	10.990	11.772	0.782	11.762	-0.010	-1.28%	11.75	-0.022	-2.81%	11.75	-0.022	-2.81%	11.772	0.000	0.00%
403552890u	9.470	12.968	3.498	12.963	-0.005	-0.14%	12.958	-0.010	-0.29%	12.958	-0.010	-0.29%	12.968	0.000	0.00%
403552890d	9.470	10.873	1.403	10.858	-0.015	-1.07%	10.842	-0.031	-2.21%	10.829	-0.044	-3.14%	10.86	-0.013	-0.93%
SLR Abstraction															
403540210	6.370	10.524	4.154	10.518	-0.006	-0.14%	10.511	-0.013	-0.31%	10.493	-0.031	-0.75%	10.506	-0.018	-0.43%
NewBr1u	7.540	10.381	2.841	10.377	-0.004	-0.14%	10.373	-0.008	-0.28%	10.361	-0.020	-0.70%	10.369	-0.012	-0.42%
NewBr1d	7.670	8.735	1.065	8.729	-0.006	-0.56%	8.723	-0.012	-1.13%	8.707	-0.028	-2.63%	8.718	-0.017	-1.60%
403531200u	5.840	8.359	2.519	8.355	-0.004	-0.16%	8.351	-0.008	-0.32%	8.339	-0.020	-0.79%	8.348	-0.011	-0.44%
403531200d	5.210	6.563	1.353	6.558	-0.005	-0.37%	6.552	-0.011	-0.81%	6.536	-0.027	-2.00%	6.547	-0.016	-1.18%

Weir CS – Q10

Cross section	Baseline Mean Stage (mAOD)	Simulated Baseline Water Mean depth (m)	Scenario A Mean Stage (mOAD)	Scenario A water level Change from baseline (m)	Scenario A mean water depth change (%)	Scenario B Mean Stage (mAOD)	Scenario B water level Change from baseline (m)	Scenario B mean water depth change (%)	Scenario C Mean Stage (mOAD)	Scenario C water level Change from baseline (m)	Scenario C mean water depth change (%)	Scenario D Mean Stage (mAOD)	Scenario D water level change from baseline (cm)	Scenario D mean water depth change (%)
403566930u	17.429	3.489	17.426	-0.003	-0.09%	17.421	-0.008	-0.23%	17.421	-0.008	-0.23%	17.429	0.000	0.00%
403566930d	16.386	3.226	16.377	-0.009	-0.28%	16.366	-0.020	-0.62%	16.366	-0.020	-0.62%	16.386	0.000	0.00%
4035510390u	15.450	4.960	15.446	-0.004	-0.08%	15.441	-0.009	-0.18%	15.441	-0.009	-0.18%	15.45	0.000	0.00%
4035510390d	14.353	3.863	14.345	-0.008	-0.21%	14.334	-0.019	-0.49%	14.334	-0.019	-0.49%	14.353	0.000	0.00%
Nabb4u	13.275	2.285	13.272	-0.003	-0.13%	13.269	-0.006	-0.26%	13.269	-0.006	-0.26%	13.275	0.000	0.00%
Nabb4d	12.319	1.329	12.314	-0.005	-0.38%	12.308	-0.011	-0.83%	12.306	-0.013	-0.98%	12.318	-0.001	-0.08%
403552890u	13.303	3.833	13.300	-0.003	-0.08%	13.296	-0.007	-0.18%	13.296	-0.007	-0.18%	13.303	0.000	0.00%
403552890d	12.000	2.530	11.991	-0.009	-0.36%	11.979	-0.021	-0.83%	11.973	-0.027	-1.07%	11.994	-0.006	-0.24%
SLR Abstraction														
403540210	10.958	4.588	10.955	-0.003	-0.07%	10.950	-0.008	-0.17%	10.938	-0.020	-0.44%	10.946	-0.012	-0.26%
NewBr1u	10.653	3.113	10.651	-0.002	-0.06%	10.649	-0.004	-0.13%	10.642	-0.011	-0.35%	10.646	-0.007	-0.07%
NewBr1d	9.194	1.524	9.190	-0.004	-0.26%	9.185	-0.009	-0.59%	9.172	-0.022	-1.44%	9.181	-0.013	-0.14%
403531200u	8.660	2.820	8.657	-0.003	-0.11%	8.654	-0.006	-0.21%	8.646	-0.014	-0.50%	8.652	-0.008	-0.09%
403531200d	7.174	1.964	7.167	-0.007	-0.36%	7.159	-0.015	-0.76%	7.137	-0.037	-1.88%	7.152	-0.022	-0.31%

Sensitive R — Q99

Cross section	Baseline Mean WP (m)	Scenario A Mean WP (m)	Scenario A WP Change from baseline (m)	Scenario A WP change from baseline (%)	Scenario B Mean WP (m)	Scenario B Mean WP change from baseline (m)	Scenario B Mean WP change from baseline (%)	Scenario C Mean WP (m)	Scenario C WP Change from baseline (m)	Scenario C WP change from baseline (%)	Scenario D Mean WP (m)	Scenario D Mean WP Change from baseline (m)	Scenario D Mean WP change from baseline (%)
405014100	64.9655	64.9035	-0.062	-0.10%	64.8425	-0.123	-0.19%	64.8425	-0.123	-0.19%	64.965	-0.001	0.00%
405013700	73.7865	73.7515	-0.035	-0.05%	73.7155	-0.071	-0.10%	73.7155	-0.071	-0.10%	73.7865	0.000	0.00%
405013200	74.797	74.7625	-0.034	-0.05%	74.7265	-0.070	-0.09%	74.7265	-0.070	-0.09%	74.797	0.000	0.00%
405011730	85.2265	85.145	-0.082	-0.10%	85.065	-0.162	-0.19%	85.065	-0.162	-0.19%	85.2265	0.000	0.00%
405010030	73.257	73.2415	-0.016	-0.02%	73.225	-0.032	-0.04%	73.225	-0.032	-0.04%	73.257	0.000	0.00%
4040113530	69.0915	68.927	-0.164	-0.24%	68.764	-0.328	-0.47%	68.764	-0.328	-0.47%	69.0915	0.000	0.00%
403568850	73.842	73.7925	-0.049	-0.07%	73.745	-0.097	-0.13%	73.7455	-0.096	-0.13%	73.8415	-0.001	0.00%
403568730	57.6445	57.64	-0.005	-0.01%	57.6365	-0.008	-0.01%	57.6365	-0.008	-0.01%	57.6445	0.000	0.00%
403568500	55.9265	55.923	-0.003	-0.01%	55.9205	-0.006	-0.01%	55.9205	-0.006	-0.01%	55.9265	0.000	0.00%
403562060	83.9835	83.9355	-0.048	-0.06%	83.9165	-0.067	-0.08%	83.9165	-0.067	-0.08%	83.9835	0.000	0.00%
403561560	89.8495	89.816	-0.034	-0.04%	89.804	-0.046	-0.05%	89.804	-0.046	-0.05%	89.8495	0.000	0.00%
403560830	71.714	71.683	-0.031	-0.04%	71.669	-0.045	-0.06%	71.669	-0.045	-0.06%	71.714	0.000	0.00%

Sensitive R — Q95

Cross section	Baseline Mean WP (m)	Scenario A mean WP (m)	Scenario A WP change from baseline (m)	Scenario A WP change from baseline (%)	Scenario B Mean WP(m)	Scenario B WP Change from baseline (m)	Scenario B WP change from baseline (%)	Scenario C mean WP (m)	Scenario C WP Change from baseline (m)	Scenario C WP change from baseline (%)	Scenario D Mean WP(m)	Scenario D WP Change from baseline (m)	Scenario D WP change from baseline (%)	Manning's (+10%)	% Change	Manning's (-10%)	% Change	Weir Coefficient (+20%)	% Change	Weir Coefficient (-20%)	% Change
405014100	65.0655	65.015	-0.050	-0.08%	64.954	-0.112	-0.17%	64.954	-0.1115	-0.17%	65.0655	0.000	#NAME?	65.0975	0.05%	65.0355	-0.05%	65.0655	0.00%	65.0355	-0.05%
405013700	73.846	73.816	-0.030	-0.04%	73.7815	-0.065	-0.09%	73.7815	-0.0645	-0.09%	73.846	0.000	0.00%	73.8615	0.02%	73.8315	-0.02%	73.846	0.00%	73.8315	-0.02%
405013200	74.8565	74.8275	-0.029	-0.04%	74.7925	-0.064	-0.09%	74.7925	-0.064	-0.09%	74.8565	0.000	0.00%	74.87	0.02%	74.8445	-0.02%	74.8565	0.00%	74.8445	-0.02%
405011730	85.3585	85.2925	-0.066	-0.08%	85.212	-0.147	-0.17%	85.212	-0.1465	-0.17%	85.3585	0.000	0.00%	85.373	0.02%	85.3435	-0.02%	85.3585	0.00%	85.3435	-0.02%
405010030	73.2835	73.27	-0.014	-0.02%	73.254	-0.029	-0.04%	73.254	-0.0295	-0.04%	73.283	-0.001	0.00%	73.2835	0.00%	73.2835	0.00%	73.2835	0.00%	73.2835	0.00%
4040113530	69.37	69.227	-0.143	-0.21%	69.0635	-0.307	-0.44%	69.0645	-0.3055	-0.44%	69.3695	-0.001	0.00%	69.698	0.47%	69.0345	-0.48%	69.3655	-0.01%	69.0345	-0.48%
403568850	74.028	73.7865	-0.242	-0.33%	73.8375	-0.191	-0.26%	73.547	-0.481	-0.65%	74.0275	-0.001	0.00%	74.1215	0.13%	73.6815	-0.47%	74.0335	0.01%	73.6815	-0.47%
403568730	57.659	57.6405	-0.018	-0.03%	57.644	-0.015	-0.03%	57.6205	-0.0385	-0.07%	57.659	0.000	0.00%	57.6655	0.01%	57.631	-0.05%	57.658	0.00%	57.631	-0.05%
403568500	55.9385	55.924	-0.014	-0.03%	55.9265	-0.012	-0.02%	55.908	-0.0305	-0.05%	55.9385	0.000	0.00%	55.9415	0.01%	55.918	-0.04%	55.936	0.00%	55.918	-0.04%
403562060	84.0945	84.0305	-0.064	-0.08%	83.974	-0.120	-0.14%	83.966	-0.1285	-0.15%	84.097	0.002	0.00%	84.129	0.04%	84.0655	-0.03%	84.0615	-0.04%	84.0655	-0.03%
403561560	89.926	89.8805	-0.046	-0.05%	89.842	-0.084	-0.09%	89.837	-0.089	-0.10%	89.928	0.002	0.00%	89.948	0.02%	89.9085	-0.02%	89.9005	-0.03%	89.9085	-0.02%
403560830	71.7965	71.75	-0.046	-0.06%	71.709	-0.087	-0.12%	71.7015	-0.095	-0.13%	71.797	0.001	0.00%	71.8065	0.01%	71.78	-0.02%	71.7715	-0.03%	71.78	-0.02%

Sensitive R — Q50

Cross section	Baseline Mean WP (m)	Scenario A Mean WP (m)	Scenario A WP Change from baseline (m)	Scenario A WP change from baseline (%)	Scenario B Mean WP (m)	Scenario B Mean WP change from baseline (m)	Scenario B Mean WP change from baseline (%)	Scenario C Mean WP (m)	Scenario C WP Change from baseline (m)	Scenario C WP change from baseline (%)	Scenario D Mean WP (m)	Scenario D Mean WP change from baseline (m)	Scenario D Mean WP change from baseline (%)
405014100	66.2365	66.1985	-0.038	-0.06%	66.154	-0.083	-0.12%	66.154	-0.083	-0.12%	66.2365	0.000	0.00%
405013700	74.5615	74.5355	-0.026	-0.03%	74.5055	-0.056	-0.08%	74.5055	-0.056	-0.08%	74.5615	0.000	0.00%
405013200	75.554	75.5295	-0.025	-0.03%	75.5015	-0.053	-0.07%	75.5015	-0.053	-0.07%	75.554	0.000	0.00%
405011730	86.862	86.8115	-0.050	-0.06%	86.749	-0.113	-0.13%	86.749	-0.113	-0.13%	86.862	0.000	0.00%
405010030	73.562	73.5525	-0.010	-0.01%	73.542	-0.020	-0.03%	73.542	-0.020	-0.03%	73.562	0.000	0.00%
4040113530	74.509	74.3265	-0.183	-0.24%	74.1395	-0.370	-0.50%	74.14	-0.369	-0.50%	74.5085	-0.001	0.00%
403568850	78.1905	77.959	-0.231	-0.30%	77.951	-0.240	-0.31%	77.951	-0.240	-0.31%	78.1905	0.000	0.00%
403568730	58.331	58.16	-0.171	-0.29%	58.1525	-0.179	-0.31%	58.1525	-0.179	-0.31%	58.3305	-0.001	0.00%
403568500	57.813	57.521	-0.292	-0.51%	57.4835	-0.330	-0.57%	57.4835	-0.330	-0.57%	57.81	-0.003	-0.01%
403562060	85.3475	85.272	-0.075	-0.09%	85.2655	-0.082	-0.10%	85.2655	-0.082	-0.10%	85.3475	0.000	0.00%
403561560	92.1695	91.7915	-0.378	-0.41%	91.7405	-0.429	-0.47%	91.7405	-0.429	-0.47%	92.1685	-0.001	0.00%
403560830	72.639	72.514	-0.125	-0.17%	72.5035	-0.135	-0.19%	72.5035	-0.135	-0.19%	72.639	0.000	0.00%

Sensitive R — Q10

Cross section	Baseline Mean WP (m)	Scenario A mean WP (m)	Scenario A WP Change from baseline (m)	Scenario A WP change from baseline (%)	Scenario B Mean WP(m)	Scenario B WP Change from baseline (m)	Scenario B WP change from baseline (%)	Scenario C mean WP (m)	Scenario C WP Change from baseline (m)	Scenario C WP change from baseline (%)	Scenario D Mean WP(m)	Scenario D WP Change from baseline (m)	Scenario D WP change from baseline (%)
405014100	69.1675	69.1435	-0.024	-0.03%	69.114	-0.053	-0.08%	69.114	-0.0535	-0.08%	69.1675	0.000	0.00%
405013700	76.514	76.489	-0.025	-0.03%	76.4575	-0.056	-0.07%	76.4575	-0.0565	-0.07%	76.514	0.000	0.00%
405013200	77.4645	77.448	-0.017	-0.02%	77.427	-0.037	-0.05%	77.427	-0.0375	-0.05%	77.4645	0.000	0.00%
405011730	90.2685	90.2455	-0.023	-0.03%	90.215	-0.053	-0.06%	90.215	-0.0535	-0.06%	90.2685	0.000	0.00%
405010030	74.2295	74.224	-0.005	-0.01%	74.217	-0.013	-0.02%	74.217	-0.0125	-0.02%	74.2295	0.000	0.00%
4040113530	95.346	95.329	-0.017	-0.02%	95.3075	-0.038	-0.04%	95.3075	-0.0385	-0.04%	95.346	0.000	0.00%
403568850	80.572	80.5655	-0.007	-0.01%	80.559	-0.013	-0.02%	80.559	-0.013	-0.02%	80.572	0.000	0.00%
403568730	61.424	61.419	-0.005	-0.01%	61.4145	-0.010	-0.02%	61.4145	-0.0095	-0.02%	61.424	0.000	0.00%
403568500	59.6145	59.6115	-0.003	-0.01%	59.6075	-0.007	-0.01%	59.6075	-0.007	-0.01%	59.6145	0.000	0.00%
403562060	88.58	88.375	-0.205	-0.23%	88.276	-0.304	-0.34%	88.276	-0.304	-0.34%	88.58	0.000	0.00%
403561560	93.6885	93.674	-0.014	-0.02%	93.6605	-0.028	-0.03%	93.6605	-0.028	-0.03%	93.6885	0.000	0.00%
403560830	76.41	76.35	-0.060	-0.08%	76.301	-0.109	-0.14%	76.301	-0.109	-0.14%	76.41	0.000	0.00%

Weir CS — Q99

Weir CS													
403566930u	76.193	76.1875	-0.005	-0.01%	76.182	-0.011	-0.02%	76.1815	-0.0115	-0.02%	76.193	0	0.00%
403566930d	81.198	80.9895	-0.209	-0.26%	80.899	-0.299	-0.37%	80.899	-0.299	-0.37%	81.198	0	0.00%
4035510390u	72.662	72.6455	-0.017	-0.02%	72.639	-0.024	-0.03%	72.6385	-0.0235	-0.03%	72.662	0	0.00%
4035510390d	68.2265	67.869	-0.358	-0.52%	67.729	-0.498	-0.73%	67.729	-0.4975	-0.73%	68.226	-0.0005	0.00%
Nabb4u	51.316	51.2705	-0.046	-0.09%	51.252	-0.064	-0.12%	51.252	-0.064	-0.12%	51.316	0	0.00%
Nabb4d	24.7285	24.5495	-0.179	-0.72%	24.474	-0.255	-1.03%	24.458	-0.2705	-1.09%	24.7195	-0.009	-0.04%
403552890u	90.6985	90.6815	-0.017	-0.02%	90.675	-0.023	-0.03%	90.675	-0.0235	-0.03%	90.6985	0	0.00%
403552890d	59.9225	59.2105	-0.712	-1.19%	58.794	-1.129	-1.88%	57.8855	-2.037	-3.40%	59.2555	-0.667	-1.11%
SLR Abstraction													
403540210	98.9525	98.827	-0.126	-0.13%	98.747	-0.206	-0.21%	98.529	-0.4235	-0.43%	98.786	-0.1665	-0.17%
NewBr1u	45.537	45.523	-0.014	-0.03%	45.514	-0.023	-0.05%	45.475	-0.062	-0.14%	45.517	-0.02	-0.04%
NewBr1d	42.3045	42.2805	-0.024	-0.06%	42.265	-0.040	-0.09%	42.1955	-0.109	-0.26%	42.271	-0.0335	-0.08%
403531200u	45.5375	45.4385	-0.099	-0.22%	45.372	-0.166	-0.36%	45.0895	-0.448	-0.98%	45.402	-0.1355	-0.30%
403531200d	46.6895	46.6555	-0.034	-0.07%	46.635	-0.055	-0.12%	46.538	-0.1515	-0.32%	46.6435	-0.046	-0.10%

Weir CS — Q95

Weir CS														Manning's (+10%)	% Change	Manning's (-10%)	% Change	Weir Coefficient (+20%)	% Change	Weir Coefficient (-20%)	% Change
403566930u	76.214	76.186	-0.028	-0.04%	76.193	-0.021	-0.03%	76.1565	-0.057	-0.07%	76.215	0.001	0.00%	76.21	-0.01%	76.185	-0.04%	76.1985	-0.02%	76.185	-0.04%
403566930d	81.715	81.453	-0.262	-0.32%	81.166	-0.550	-0.67%	81.077	-0.638	-0.78%	81.73	0.015	0.02%	82.21	0.61%	81.24	-0.58%	81.527	-0.23%	81.24	-0.58%
4035510390u	72.705	72.683	-0.022	-0.03%	72.660	-0.045	-0.06%	72.655	-0.049	-0.07%	72.7055	0.001	0.00%	72.70	0.00%	72.7035	0.00%	72.6905	-0.02%	72.7035	0.00%
4035510390d	68.976	68.627	-0.349	-0.51%	68.166	-0.810	-1.17%	68.1855	-0.790	-1.15%	68.9865	0.011	0.02%	69.63	0.95%	68.4295	-0.79%	68.855	-0.18%	68.4295	-0.79%
Nabb4u	51.409	51.366	-0.044	-0.08%	51.308	-0.101	-0.20%	51.3105	-0.099	-0.19%	51.41	0.001	0.00%	51.41	0.01%	51.4105	0.00%	51.3955	-0.03%	51.4105	0.00%
Nabb4d	25.083	24.914	-0.169	-0.67%	24.700	-0.383	-1.52%	24.694	-0.389	-1.55%	25.0745	-0.008	-0.03%	25.41	1.30%	24.7985	-1.13%	25.024	-0.23%	24.7985	-1.13%
403552890u	90.734	90.718	-0.017	-0.02%	90.696	-0.039	-0.04%	90.697	-0.037	-0.04%	90.7345	0.000	0.00%	90.74	0.00%	90.7355	0.00%	90.729	-0.01%	90.7355	0.00%
403552890d	61.203	60.598	-0.605	-0.99%	59.842	-1.361	-2.22%	59.0235	-2.179	-3.56%	60.407	-0.796	-1.30%	62.43	2.01%	60.0235	-1.93%	60.4025	-1.31%	60.0235	-1.93%
SLR Abstraction																					
403540210	99.174	99.072	-0.103	-0.10%	98.944	-0.231	-0.23%	98.632	-0.542	-0.55%	98.8575	-0.317	-0.32%	99.235	0.06%	99.115	-0.06%	98.839	-0.34%	99.115	-0.06%
NewBr1u	45.563	45.551	-0.011	-0.03%	45.538	-0.025	-0.05%	45.501	-0.061	-0.13%	45.5275	-0.035	-0.08%	45.5475	-0.03%	45.577	0.03%	45.4815	-0.18%	45.577	0.03%
NewBr1d	42.352	42.331	-0.021	-0.05%	42.305	-0.047	-0.11%	42.2425	-0.109	-0.26%	42.288	-0.064	-0.15%	42.4225	0.17%	42.2795	-0.17%	42.4065	0.13%	42.2795	-0.17%
403531200u	45.722	45.640	-0.082	-0.18%	45.540	-0.182	-0.40%	45.276	-0.446	-0.97%	45.4705	-0.251	-0.55%	45.6145	-0.23%	45.8285	0.23%	45.932	0.46%	45.8285	0.23%
403531200d	46.753	46.725	-0.027	-0.06%	46.691	-0.062	-0.13%	46.6015	-0.151	-0.32%	46.667	-0.085	-0.18%	46.822	0.15%	46.689	-0.14%	46.826	0.16%	46.689	-0.14%

Weir CS — Q50

Weir CS													
403566930u	77.032	76.889	-0.143	-0.19%	76.883	-0.150	-0.19%	76.8825	-0.1495	-0.19%	77.0325	0.0005	0.00%
403566930d	88.304	87.671	-0.633	-0.72%	87.630	-0.674	-0.76%	87.6295	-0.6745	-0.76%	88.3255	0.0215	0.02%
4035510390u	73.1865	73.133	-0.053	-0.07%	73.129	-0.058	-0.08%	73.1285	-0.058	-0.08%	73.187	0.0005	0.00%
4035510390d	75.023	74.4745	-0.548	-0.73%	74.406	-0.617	-0.82%	74.4055	-0.6175	-0.82%	75.0225	-0.0005	0.00%
Nabb4u	52.38	52.3165	-0.063	-0.12%	52.309	-0.072	-0.14%	52.3085	-0.0715	-0.14%	52.38	0	0.00%
Nabb4d	30.2095	29.733	-0.476	-1.58%	29.676	-0.533	-1.77%	29.6775	-0.532	-1.76%	30.2105	0.001	0.00%
403552890u	91.134	91.1015	-0.033	-0.04%	91.097	-0.037	-0.04%	91.097	-0.037	-0.04%	91.1335	-0.0005	0.00%
403552890d	77.5015	76.4155	-1.086	-1.40%	76.168	-1.334	-1.72%	75.6335	-1.868	-2.41%	76.983	-0.5185	-0.67%
SLR Abstraction													
403540210	101.798	101.666	-0.132	-0.13%	101.632	-0.167	-0.16%	101.4055	-0.3925	-0.39%	101.575	-0.223	-0.22%
NewBr1u	45.813	45.8	-0.013	-0.03%	45.797	-0.017	-0.04%	45.774	-0.039	-0.09%	45.791	-0.022	-0.05%
NewBr1d	42.9135	42.8795	-0.034	-0.08%	42.871	-0.043	-0.10%	42.813	-0.1005	-0.23%	42.856	-0.0575	-0.13%
403531200u	46.686	46.658	-0.028	-0.06%	46.651	-0.035	-0.08%	46.598	-0.088	-0.19%	46.6385	-0.0475	-0.10%
403531200d	47.36	47.3305	-0.029	-0.06%	47.323	-0.037	-0.08%	47.2715	-0.0885	-0.19%	47.309	-0.051	-0.11%

Weir CS — Q10

Weir CS													
403566930u	78.044	78.042	-0.002	0.00%	78.073	0.029	0.04%	78.0385	-0.005	-0.01%	78.044	0.000	0.00%
403566930d	96.359	96.342	-0.017	-0.02%	96.365	0.006	0.01%	96.324	-0.035	-0.04%	96.359	0.000	0.00%
4035510390u	74.296	74.287	-0.009	-0.01%	74.293	-0.003	0.00%	74.2775	-0.019	-0.02%	74.296	0.000	0.00%
4035510390d	81.249	81.217	-0.032	-0.04%	81.210	-0.039	-0.05%	81.1785	-0.070	-0.09%	81.249	0.000	0.00%
Nabb4u	53.152	53.145	-0.007	-0.01%	53.143	-0.009	-0.02%	53.137	-0.015	-0.03%	53.152	0.000	0.00%
Nabb4d	47.241	47.197	-0.044	-0.09%	47.171	-0.070	-0.15%	47.133	-0.108	-0.23%	47.229	-0.012	-0.03%
403552890u	92.137	92.128	-0.009	-0.01%	92.124	-0.013	-0.01%	92.1165	-0.020	-0.02%	92.1365	0.000	0.00%
403552890d	88.193	88.140	-0.053	-0.06%	88.096	-0.096	-0.11%	88.04	-0.153	-0.17%	88.1605	-0.032	-0.04%
SLR Abstraction													
403540210	107.334	107.289	-0.046	-0.04%	107.248	-0.086	-0.08%	107.081	-0.253	-0.24%	107.185	-0.149	-0.14%
NewBr1u	46.358	46.354	-0.005	-0.01%	46.350	-0.008	-0.02%	46.3345	-0.024	-0.05%	46.344	-0.014	-0.03%
NewBr1d	44.946	44.922	-0.024	-0.05%	44.899	-0.047	-0.10%	44.8105	-0.135	-0.30%	44.8665	-0.079	-0.18%
403531200u	47.932	47.922	-0.010	-0.02%	47.913	-0.019	-0.04%	47.8765	-0.056	-0.12%	47.899	-0.033	-0.07%
403531200d	49.346	49.324	-0.022	-0.04%	49.300	-0.046	-0.09%	49.228	-0.118	-0.24%	49.2755	-0.070	-0.14%

Sensitive R — Q99

Cross section	Baseline Mean Flow (m3)	Scenario A Mean Flow (m3)	Scenario A Flow Change from baseline (m3)	Scenario A Flow change from baseline (%)	Scenario B Mean Flow(m3)	Scenario B Flow Change from baseline (m3)	Scenario B Flow change from baseline (%)	Scenario C Mean Flow (m3)	Scenario C Flow Change from baseline (m3)	Scenario C Flow change from baseline (%)	Scenario D Mean Flow(m3)	Scenario D Flow Change from baseline (m3)	Scenario D Flow change from baseline (%)
405014100	24.291	22.99	-1.301	-5.36%	21.7	-2.591	-10.67%	21.7	-2.591	-10.67%	24.29	-0.001	0.00%
405013700	24.291	22.99	-1.301	-5.36%	21.7	-2.591	-10.67%	21.7	-2.591	-10.67%	24.29	-0.001	0.00%
405013200	25.141	23.84	-1.301	-5.17%	22.55	-2.591	-10.31%	22.55	-2.591	-10.31%	25.14	-0.001	0.00%
405011730	25.141	23.84	-1.301	-5.17%	22.55	-2.591	-10.31%	22.55	-2.591	-10.31%	25.14	-0.001	0.00%
405010030	25.141	23.84	-1.301	-5.17%	22.55	-2.591	-10.31%	22.55	-2.591	-10.31%	25.14	-0.001	0.00%
4040113530	25.141	23.841	-1.300	-5.17%	22.549	-2.592	-10.31%	22.549	-2.592	-10.31%	25.14	-0.001	0.00%
403568850	25.356	24.256	-1.100	-4.34%	22.823	-2.533	-9.99%	22.823	-2.533	-9.99%	25.355	-0.001	0.00%
403568730	25.362	24.256	-1.106	-4.36%	22.823	-2.539	-10.01%	22.823	-2.539	-10.01%	25.361	-0.001	0.00%
403568500	25.372	24.255	-1.117	-4.40%	22.823	-2.549	-10.05%	22.823	-2.549	-10.05%	25.371	-0.001	0.00%
403562060	25.559	24.214	-1.345	-5.26%	22.826	-2.733	-10.69%	22.826	-2.733	-10.69%	25.558	-0.001	0.00%
403561560	25.563	24.21	-1.353	-5.29%	22.827	-2.736	-10.70%	22.827	-2.736	-10.70%	25.563	0.000	0.00%
403560830	25.568	24.205	-1.363	-5.33%	22.827	-2.741	-10.72%	22.827	-2.741	-10.72%	25.567	-0.001	0.00%

Sensitive R — Q95

Cross section	Baseline Mean Flow (m)	Scenario A Flow (m)	Scenario A Flow Change from baseline (m)	Scenario A Flow change from baseline (%)	Scenario B Flow (m3)	Scenario B Flow Change from baseline (m3)	Scenario B Flow change from baseline (m3)	Scenario C Mean Flow (m)	Scenario C Flow Change from baseline (m)	Scenario C Flow change from baseline (%)	Scenario D Mean Flow (m3)	Scenario D Flow Change from baseline (m3)	Scenario D Flow change from baseline (m3)	Manning's (+10%)	% Change	Manning's (-10%)	% Change	Weir Coefficient (+20%)	% Change	Weir Coefficient (-20%)	% Change
405014100	26.49	25.331	-1.159	-4.38%	24	-2.490	-9.40%	24	-2.490	-9.40%	26.49	0.000	0.00%	26.49	0.00%	26.49	0.00%	26.49	0.00%	26.49	0.00%
405013700	26.49	25.331	-1.159	-4.38%	24	-2.490	-9.40%	24	-2.490	-9.40%	26.49	0.000	0.00%	26.49	0.00%	26.49	0.00%	26.49	0.00%	26.49	0.00%
405013200	27.423	26.261	-1.162	-4.24%	24.93	-2.493	-9.09%	24.93	-2.493	-9.09%	27.42	-0.003	-0.01%	27.423	0.00%	27.423	0.00%	27.423	0.00%	27.423	0.00%
405011730	27.423	26.261	-1.162	-4.24%	24.93	-2.493	-9.09%	24.93	-2.493	-9.09%	27.42	-0.003	-0.01%	27.423	0.00%	27.423	0.00%	27.423	0.00%	27.423	0.00%
405010030	27.423	26.26	-1.163	-4.24%	24.93	-2.493	-9.09%	24.93	-2.493	-9.09%	27.42	-0.003	-0.01%	27.423	0.00%	27.422	0.00%	27.423	0.00%	27.422	0.00%
4040113530	27.425	26.26	-1.165	-4.25%	24.929	-2.496	-9.10%	24.931	-2.494	-9.09%	27.42	-0.005	-0.02%	27.424	0.00%	27.421	-0.01%	27.424	0.00%	27.421	-0.01%
403568850	27.859	26.484	-1.375	-4.94%	25.197	-2.662	-9.56%	25.353	-2.506	-9.00%	27.897	0.038	0.14%	27.826	-0.12%	27.797	-0.22%	27.978	0.43%	27.797	-0.22%
403568730	27.863	26.491	-1.372	-4.92%	25.198	-2.665	-9.56%	25.352	-2.511	-9.01%	27.894	0.031	0.11%	27.828	-0.13%	27.796	-0.24%	27.973	0.39%	27.796	-0.24%
403568500	27.869	26.502	-1.367	-4.91%	25.198	-2.671	-9.58%	25.351	-2.518	-9.04%	27.888	0.019	0.07%	27.831	-0.14%	27.793	-0.27%	27.964	0.34%	27.793	-0.27%
403562060	27.868	26.694	-1.174	-4.21%	25.235	-2.633	-9.45%	25.311	-2.557	-9.18%	27.747	-0.121	-0.43%	27.816	-0.19%	27.732	-0.49%	27.771	-0.35%	27.732	-0.49%
403561560	27.858	26.698	-1.160	-4.16%	25.239	-2.619	-9.40%	25.307	-2.551	-9.16%	27.744	-0.114	-0.41%	27.813	-0.16%	27.733	-0.45%	27.765	-0.33%	27.733	-0.45%
403560830	27.845	26.702	-1.143	-4.10%	25.244	-2.601	-9.34%	25.303	-2.542	-9.13%	27.741	-0.104	-0.37%	27.808	-0.13%	27.733	-0.40%	27.758	-0.31%	27.733	-0.40%

Sensitive R — Q50

Cross section	Baseline Mean Flow (m3)	Scenario A Mean Flow (m3)	Scenario A Flow Change from baseline (m3)	Scenario A Flow change from baseline (%)	Scenario B Mean Flow(m3)	Scenario B Flow Change from baseline (m3)	Scenario B Flow change from baseline (%)	Scenario C Mean Flow (m3)	Scenario C Flow Change from baseline (m3)	Scenario C Flow change from baseline (%)	Scenario D Mean Flow(m3)	Scenario D Flow Change from baseline (m3)	Scenario D Flow change from baseline (%)
405014100	56.223	55.05	-1.173	-2.09%	53.72	-2.503	-4.45%	53.72	-2.503	-4.45%	56.22	-0.003	-0.01%
405013700	56.223	55.05	-1.173	-2.09%	53.72	-2.503	-4.45%	53.72	-2.503	-4.45%	56.22	-0.003	-0.01%
405013200	58.043	56.87	-1.173	-2.02%	55.54	-2.503	-4.31%	55.54	-2.503	-4.31%	58.04	-0.003	-0.01%
405011730	58.042	56.87	-1.172	-2.02%	55.54	-2.502	-4.31%	55.54	-2.502	-4.31%	58.039	-0.003	-0.01%
405010030	58.042	56.87	-1.172	-2.02%	55.54	-2.502	-4.31%	55.54	-2.502	-4.31%	58.039	-0.003	-0.01%
4040113530	58.04	56.87	-1.170	-2.02%	55.54	-2.500	-4.31%	55.54	-2.500	-4.31%	58.04	0.000	0.00%
403568850	58.579	57.594	-0.985	-1.68%	56.311	-2.268	-3.87%	56.306	-2.273	-3.88%	58.823	0.244	0.42%
403568730	58.576	57.594	-0.982	-1.68%	56.311	-2.265	-3.87%	56.306	-2.270	-3.88%	58.823	0.247	0.42%
403568500	58.572	57.594	-0.978	-1.67%	56.311	-2.261	-3.86%	56.305	-2.267	-3.87%	58.823	0.251	0.43%
403562060	58.604	57.594	-1.010	-1.72%	56.28	-2.324	-3.97%	56.244	-2.360	-4.03%	58.822	0.218	0.37%
403561560	58.613	57.594	-1.019	-1.74%	56.276	-2.337	-3.99%	56.239	-2.374	-4.05%	58.822	0.209	0.36%
403560830	58.624	57.594	-1.030	-1.76%	56.273	-2.351	-4.01%	56.233	-2.391	-4.08%	58.822	0.198	0.34%

Sensitive R — Q10

Cross section	Baseline Mean Flow (m)	Scenario A Flow (m)	Scenario A Flow Change from baseline (m)	Scenario A Flow change from baseline (%)	Scenario B Flow (m3)	Scenario B Flow Change from baseline (m3)	Scenario B Flow change from baseline (m3)	Scenario C Mean Flow (m)	Scenario C Flow Change from baseline (m)	Scenario C Flow change from baseline (%)	Scenario D Mean Flow (m3)	Scenario D Flow Change from baseline (m3)	Scenario D Flow change from baseline (m3)
405014100	158.5	157.44	-1.060	-0.67%	156.11	-2.390	-1.51%	156.11	-2.390	-1.51%	158.5	0.000	0.00%
405013700	158.5	157.44	-1.060	-0.67%	156.11	-2.390	-1.51%	156.11	-2.390	-1.51%	158.5	0.000	0.00%
405013200	163.94	162.88	-1.060	-0.65%	161.55	-2.390	-1.46%	161.55	-2.390	-1.46%	163.94	0.000	0.00%
405011730	163.94	162.88	-1.060	-0.65%	161.55	-2.390	-1.46%	161.55	-2.390	-1.46%	163.94	0.000	0.00%
405010030	163.94	162.88	-1.060	-0.65%	161.55	-2.390	-1.46%	161.55	-2.390	-1.46%	163.94	0.000	0.00%
4040113530	163.939	162.88	-1.059	-0.65%	161.55	-2.389	-1.46%	161.55	-2.389	-1.46%	163.939	0.000	0.00%
403568850	166.04	165.012	-1.028	-0.62%	163.657	-2.383	-1.44%	163.657	-2.383	-1.44%	166.04	0.000	0.00%
403568730	166.036	165.012	-1.024	-0.62%	163.657	-2.379	-1.43%	163.657	-2.379	-1.43%	166.036	0.000	0.00%
403568500	166.032	165.012	-1.020	-0.61%	163.657	-2.375	-1.43%	163.657	-2.375	-1.43%	166.032	0.000	0.00%
403562060	166.02	165.01	-1.010	-0.61%	163.684	-2.336	-1.41%	163.684	-2.336	-1.41%	166.02	0.000	0.00%
403561560	166.027	165.01	-1.017	-0.61%	163.686	-2.341	-1.41%	163.686	-2.341	-1.41%	166.027	0.000	0.00%
403560830	166.036	165.01	-1.026	-0.62%	163.689	-2.347	-1.41%	163.689	-2.347	-1.41%	166.036	0.000	0.00%

Weir CS — Q99

Weir CS													
403566930u	25.461	24.253	-1.208	-4.74%	22.823	-2.638	-10.36%	22.823	-2.638	-10.36%	25.461	0.000	0.00%
403566930d	25.461	24.253	-1.208	-4.74%	22.823	-2.638	-10.36%	22.823	-2.638	-10.36%	25.461	0.000	0.00%
4035510390u	25.575	24.193	-1.382	-5.40%	22.828	-2.747	-10.74%	22.828	-2.747	-10.74%	25.575	0.000	0.00%
4035510390d	25.575	24.193	-1.382	-5.40%	22.828	-2.747	-10.74%	22.828	-2.747	-10.74%	25.575	0.000	0.00%
Nabb4u	4.818	4.455	-0.363	-7.53%	4.106	-0.712	-14.78%	4.106	-0.712	-14.78%	4.818	0.000	0.00%
Nabb4d	4.818	4.455	-0.363	-7.53%	4.106	-0.712	-14.78%	4.106	-0.712	-14.78%	4.818	0.000	0.00%
403552890u	20.679	19.692	-0.987	-4.77%	18.735	-1.944	-9.40%	18.735	-1.944	-9.40%	20.679	0.000	0.00%
403552890d	20.679	19.692	-0.987	-4.77%	18.735	-1.944	-9.40%	18.735	-1.944	-9.40%	20.679	0.000	0.00%
SLR Abstraction													
403540210	25.841	24.539	-1.302	-5.04%	23.264	-2.577	-9.97%	19.797	-6.044	-23.39%	22.562	-3.279	-12.69%
NewBr1u	18.471	18.063	-0.408	-2.21%	17.653	-0.818	-4.43%	16.484	-1.987	-10.76%	17.438	-1.033	-5.59%
NewBr1d	18.471	18.063	-0.408	-2.21%	17.653	-0.818	-4.43%	16.484	-1.987	-10.76%	17.438	-1.033	-5.59%
403531200u	18.473	18.066	-0.407	-2.20%	17.656	-0.817	-4.42%	16.488	-1.985	-10.75%	17.456	-1.017	-5.51%
403531200d	18.473	18.066	-0.407	-2.20%	17.656	-0.817	-4.42%	16.488	-1.985	-10.75%	17.456	-1.017	-5.51%

Weir CS — Q95

Weir CS														Manning's (+10%)	% Change	Manning's (-10%)	% Change	Weir Coefficient (+20%)	% Change	Weir Coefficient (-20%)	% Change
403566930u	27.918	26.599	-1.319	-4.72%	25.2	-2.718	-9.74%	25.343	-2.575	-9.22%	27.831	-0.087	-0.31%	27.85	-0.24%	27.777	-0.51%	27.882	-0.13%	27.777	-0.51%
403566930d	27.918	26.599	-1.319	-4.72%	25.2	-2.718	-9.74%	25.343	-2.575	-9.22%	27.831	-0.087	-0.31%	27.85	-0.24%	27.777	-0.51%	27.882	-0.13%	27.777	-0.51%
4035510390u	27.817	26.706	-1.111	-3.99%	25.254	-2.563	-9.21%	25.295	-2.522	-9.07%	27.736	-0.081	-0.29%	27.799	-0.06%	27.742	-0.27%	27.746	-0.26%	27.742	-0.27%
4035510390d	27.817	26.706	-1.111	-3.99%	25.254	-2.563	-9.21%	25.295	-2.522	-9.07%	27.736	-0.081	-0.29%	27.799	-0.06%	27.742	-0.27%	27.746	-0.26%	27.742	-0.27%
Nabb4u	5.429	5.125	-0.304	-5.60%	4.765	-0.664	-12.23%	4.764	-0.665	-12.25%	5.441	0.012	0.22%	5.445	0.29%	5.429	0.00%	5.442	0.24%	5.429	0.00%
Nabb4d	5.429	5.125	-0.304	-5.60%	4.765	-0.664	-12.23%	4.764	-0.665	-12.25%	5.441	0.012	0.22%	5.445	0.29%	5.429	0.00%	5.442	0.24%	5.429	0.00%
403552890u	22.327	21.509	-0.818	-3.66%	20.537	-1.790	-8.02%	20.534	-1.793	-8.03%	22.359	0.032	0.14%	22.334	0.03%	22.359	0.14%	22.36	0.15%	22.359	0.14%
403552890d	22.327	21.509	-0.818	-3.66%	20.537	-1.790	-8.02%	20.534	-1.793	-8.03%	22.359	0.032	0.14%	22.334	0.03%	22.359	0.14%	22.36	0.15%	22.359	0.14%
SLR Abstraction																					
403540210	28.183	27.022	-1.161	-4.12%	25.709	-2.474	-8.78%	22.239	-5.944	-21.09%	24.735	-3.448	-12.23%	28.188	0.02%	28.195	0.04%	28.227	0.16%	28.195	0.04%
NewBr1u	19.256	18.901	-0.355	-1.84%	18.493	-0.763	-3.96%	17.378	-1.878	-9.75%	18.185	-1.071	-5.56%	18.789	-2.43%	19.718	2.40%	20.158	4.68%	19.718	2.40%
NewBr1d	19.256	18.901	-0.355	-1.84%	18.493	-0.763	-3.96%	17.378	-1.878	-9.75%	18.185	-1.071	-5.56%	18.789	-2.43%	19.718	2.40%	20.158	4.68%	19.718	2.40%
403531200u	19.257	18.904	-0.353	-1.83%	18.491	-0.766	-3.98%	17.378	-1.879	-9.76%	18.183	-1.074	-5.58%	18.789	-2.43%	19.717	2.39%	20.155	4.66%	19.717	2.39%
403531200d	19.257	18.904	-0.353	-1.83%	18.491	-0.766	-3.98%	17.378	-1.879	-9.76%	18.183	-1.074	-5.58%	18.789	-2.43%	19.717	2.39%	20.155	4.66%	19.717	2.39%

Weir CS — Q50

Weir CS													
403566930u	58.536	57.594	-0.942	-1.61%	56.31	-2.226	-3.80%	56.299	-2.237	-3.82%	58.823	0.287	0.49%
403566930d	58.536	57.594	-0.942	-1.61%	56.31	-2.226	-3.80%	56.299	-2.237	-3.82%	58.823	0.287	0.49%
4035510390u	58.647	57.594	-1.053	-1.80%	56.265	-2.382	-4.06%	56.22	-2.427	-4.14%	58.822	0.175	0.30%
4035510390d	58.647	57.594	-1.053	-1.80%	56.265	-2.382	-4.06%	56.22	-2.427	-4.14%	58.822	0.175	0.30%
Nabb4u	14.06	13.729	-0.331	-2.35%	13.345	-0.715	-5.09%	13.341	-0.719	-5.11%	14.071	0.011	0.08%
Nabb4d	14.06	13.729	-0.331	-2.35%	13.345	-0.715	-5.09%	13.341	-0.719	-5.11%	14.071	0.011	0.08%
403552890u	44.71	43.865	-0.845	-1.89%	42.881	-1.829	-4.09%	42.871	-1.839	-4.11%	44.738	0.028	0.06%
403552890d	44.71	43.865	-0.845	-1.89%	42.881	-1.829	-4.09%	42.871	-1.839	-4.11%	44.738	0.028	0.06%
SLR Abstraction													
403540210	59.404	58.184	-1.220	-2.05%	56.832	-2.572	-4.33%	53.382	-6.022	-10.14%	55.885	-3.519	-5.92%
NewBr1u	28.293	27.979	-0.314	-1.11%	27.632	-0.661	-2.34%	26.735	-1.558	-5.51%	27.382	-0.911	-3.22%
NewBr1d	28.293	27.979	-0.314	-1.11%	27.632	-0.661	-2.34%	26.735	-1.558	-5.51%	27.382	-0.911	-3.22%
403531200u	28.292	27.979	-0.313	-1.11%	27.635	-0.657	-2.32%	26.736	-1.556	-5.50%	27.379	-0.913	-3.23%
403531200d	28.292	27.979	-0.313	-1.11%	27.635	-0.657	-2.32%	26.736	-1.556	-5.50%	27.379	-0.913	-3.23%

Weir CS — Q10

Weir CS													
403566930u	165.995	165.011	-0.984	-0.59%	163.66	-2.335	-1.41%	163.66	-2.335	-1.41%	165.995	0.000	0.00%
403566930d	165.995	165.011	-0.984	-0.59%	163.66	-2.335	-1.41%	163.66	-2.335	-1.41%	165.995	0.000	0.00%
4035510390u	166.054	165.01	-1.044	-0.63%	163.694	-2.360	-1.42%	163.694	-2.360	-1.42%	166.054	0.000	0.00%
4035510390d	166.054	165.01	-1.044	-0.63%	163.694	-2.360	-1.42%	163.694	-2.360	-1.42%	166.054	0.000	0.00%
Nabb4u	44.428	44.123	-0.305	-0.69%	43.747	-0.681	-1.53%	43.747	-0.681	-1.53%	44.428	0.000	0.00%
Nabb4d	44.428	44.123	-0.305	-0.69%	43.747	-0.681	-1.53%	43.747	-0.681	-1.53%	44.428	0.000	0.00%
403552890u	121.658	120.888	-0.770	-0.63%	119.941	-1.717	-1.41%	119.941	-1.717	-1.41%	121.658	0.000	0.00%
403552890d	121.658	120.888	-0.770	-0.63%	119.941	-1.717	-1.41%	119.941	-1.717	-1.41%	121.658	0.000	0.00%
SLR Abstraction													
403540210	167.169	166.11	-1.059	-0.63%	164.775	-2.394	-1.43%	161.305	-5.864	-3.51%	163.699	-3.470	-2.08%
NewBr1u	54.675	54.442	-0.233	-0.43%	54.149	-0.526	-0.96%	53.386	-1.289	-2.36%	53.912	-0.763	-1.40%
NewBr1d	54.675	54.442	-0.233	-0.43%	54.149	-0.526	-0.96%	53.386	-1.289	-2.36%	53.912	-0.763	-1.40%
403531200u	54.675	54.442	-0.233	-0.43%	54.149	-0.526	-0.96%	53.386	-1.289	-2.36%	53.912	-0.763	-1.40%
403531200d	54.675	54.442	-0.233	-0.43%	54.149	-0.526	-0.96%	53.386	-1.289	-2.36%	53.912	-0.763	-1.40%

Sensitive R — Q99

Cross section	Baseline Mean Velocity (m/s)	Scenario A Mean Velocity (m/s)	Scenario A Velocity Change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Mean Velocity (m/s)	Scenario B Velocity Change from baseline (m/s)	Scenario B Velocity change from baseline (%)	Scenario C Mean Velocity (m/s)	Scenario C Velocity Change from baseline (m/s)	Scenario C Velocity change from baseline (%)	Scenario D Mean Velocity (m/s)	Scenario D Velocity Change from baseline (m/s)	Scenario D Velocity change from baseline (%)
405014100	0.213	0.202	-0.011	-5.16%	0.192	-0.021	-9.86%	0.192	-0.021	-9.86%	0.213	0.000	0.00%
405013700	0.149	0.142	-0.007	-4.70%	0.134	-0.015	-10.07%	0.134	-0.015	-10.07%	0.149	0.000	0.00%
405013200	0.163	0.155	-0.008	-4.91%	0.147	-0.016	-9.82%	0.147	-0.016	-9.82%	0.163	0.000	0.00%
405011730	0.13	0.124	-0.006	-4.62%	0.118	-0.012	-9.23%	0.118	-0.012	-9.23%	0.13	0.000	0.00%
405010030	0.094	0.09	-0.004	-4.26%	0.085	-0.009	-9.57%	0.085	-0.009	-9.57%	0.094	0.000	0.00%
4040113530	0.307	0.296	-0.011	-3.58%	0.285	-0.022	-7.17%	0.285	-0.022	-7.17%	0.307	0.000	0.00%
403568850	0.16	0.154	-0.006	-3.75%	0.146	-0.014	-8.75%	0.146	-0.014	-8.75%	0.16	0.000	0.00%
403568730	0.209	0.201	-0.008	-3.83%	0.19	-0.019	-9.09%	0.19	-0.019	-9.09%	0.209	0.000	0.00%
403568500	0.192	0.184	-0.008	-4.17%	0.174	-0.018	-9.38%	0.174	-0.018	-9.38%	0.192	0.000	0.00%
403562060	0.165	0.157	-0.008	-4.85%	0.149	-0.016	-9.70%	0.149	-0.016	-9.70%	0.165	0.000	0.00%
403561560	0.116	0.11	-0.006	-5.17%	0.105	-0.011	-9.48%	0.105	-0.011	-9.48%	0.116	0.000	0.00%
403560830	0.174	0.165	-0.009	-5.17%	0.156	-0.018	-10.34%	0.156	-0.018	-10.34%	0.174	0.000	0.00%

Sensitive R — Q95

Cross section	Baseline Mean Velocity (m/s)	Scenario A Mean Velocity (m/s)	Scenario A Velocity Change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Mean Velocity (m/s)	Scenario B Velocity Change from baseline (m/s)	Scenario B Velocity change from baseline (m/s)	Scenario C Mean Velocity (m/s)	Scenario C Velocity Change from baseline (m/s)	Scenario C Velocity change from baseline (%)	Scenario D Mean Velocity (m/s)	Scenario D Velocity Change from baseline (m/s)	Scenario D Velocity change from baseline (m/s)	**Manning's (+10%)**	***% Change***	**Manning's (-10%)**	***% Change***	**Weir Coefficient (+20%)**	***% Change***	**Weir Coefficient (-20%)**	***% Change***
405014100	0.23	0.221	-0.009	-3.91%	0.21	-0.020	-8.70%	0.21	-0.020	-8.70%	0.23	0.000	0.00%	0.229	-0.43%	0.23	0.00%	0.23	0.00%	0.23	0.00%
405013700	0.161	0.155	-0.006	-3.73%	0.147	-0.014	-8.70%	0.147	-0.014	-8.70%	0.161	0.000	0.00%	0.161	0.00%	0.162	0.62%	0.161	0.00%	0.162	0.62%
405013200	0.176	0.169	-0.007	-3.98%	0.161	-0.015	-8.52%	0.161	-0.015	-8.52%	0.176	0.000	0.00%	0.176	0.00%	0.176	0.00%	0.176	0.00%	0.176	0.00%
405011730	0.141	0.136	-0.005	-3.55%	0.129	-0.012	-8.51%	0.129	-0.012	-8.51%	0.141	0.000	0.00%	0.141	0.00%	0.141	0.00%	0.141	0.00%	0.141	0.00%
405010030	0.103	0.098	-0.005	-4.85%	0.094	-0.009	-8.74%	0.094	-0.009	-8.74%	0.103	0.000	0.00%	0.103	0.00%	0.103	0.00%	0.103	0.00%	0.103	0.00%
4040113530	0.325	0.316	-0.009	-2.77%	0.305	-0.020	-6.15%	0.305	-0.020	-6.15%	0.325	0.000	0.00%	0.314	-3.38%	0.336	3.38%	0.325	0.00%	0.336	3.38%
403568850	0.175	0.167	-0.008	-4.57%	0.16	-0.015	-8.57%	0.16	-0.015	-8.57%	0.175	0.000	0.00%	0.174	-0.57%	0.175	0.00%	0.176	0.57%	0.175	0.00%
403568730	0.228	0.217	-0.011	-4.82%	0.208	-0.020	-8.77%	0.209	-0.019	-8.33%	0.228	0.000	0.00%	0.227	-0.44%	0.227	-0.44%	0.228	0.00%	0.227	-0.44%
403568500	0.209	0.2	-0.009	-4.31%	0.191	-0.018	-8.61%	0.192	-0.017	-8.13%	0.21	0.001	0.48%	0.209	0.00%	0.209	0.00%	0.21	0.48%	0.209	0.00%
403562060	0.178	0.171	-0.007	-3.93%	0.163	-0.015	-8.43%	0.164	-0.014	-7.87%	0.177	-0.001	-0.56%	0.177	-0.56%	0.178	0.00%	0.178	0.00%	0.178	0.00%
403561560	0.126	0.121	-0.005	-3.97%	0.115	-0.011	-8.73%	0.115	-0.011	-8.73%	0.125	-0.001	-0.79%	0.125	-0.79%	0.125	-0.79%	0.125	-0.79%	0.125	-0.79%
403560830	0.188	0.181	-0.007	-3.72%	0.172	-0.016	-8.51%	0.172	-0.016	-8.51%	0.187	-0.001	-0.53%	0.187	-0.53%	0.187	-0.53%	0.187	-0.53%	0.187	-0.53%

Sensitive R — Q50

Cross section	Baseline Mean Velocity (m/s)	Scenario A Mean Velocity (m/s)	Scenario A Velocity Change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Mean Velocity (m/s)	Scenario B Velocity Change from baseline (m/s)	Scenario B Velocity change from baseline (%)	Scenario C Mean Velocity (m/s)	Scenario C Velocity Change from baseline (m/s)	Scenario C Velocity Change from baseline (%)	Scenario D Mean Velocity (m/s)	Scenario D Velocity Change from baseline (m/s)	Scenario D Velocity Change from baseline (%)
405014100	0.44	0.432	-0.008	-1.82%	0.423	-0.017	-3.86%	0.423	-0.017	-3.86%	0.44	0.000	0.00%
405013700	0.316	0.311	-0.005	-1.58%	0.304	-0.012	-3.80%	0.304	-0.012	-3.80%	0.316	0.000	0.00%
405013200	0.344	0.338	-0.006	-1.74%	0.331	-0.013	-3.78%	0.331	-0.013	-3.78%	0.344	0.000	0.00%
405011730	0.28	0.275	-0.005	-1.79%	0.269	-0.011	-3.93%	0.269	-0.011	-3.93%	0.28	0.000	0.00%
405010030	0.21	0.206	-0.004	-1.90%	0.202	-0.008	-3.81%	0.202	-0.008	-3.81%	0.21	0.000	0.00%
4040113530	0.51	0.506	-0.004	-0.78%	0.499	-0.011	-2.16%	0.499	-0.011	-2.16%	0.51	0.000	0.00%
403568850	0.336	0.331	-0.005	-1.49%	0.325	-0.011	-3.27%	0.325	-0.011	-3.27%	0.337	0.001	0.30%
403568730	0.439	0.432	-0.007	-1.59%	0.424	-0.015	-3.42%	0.424	-0.015	-3.42%	0.44	0.001	0.23%
403568500	0.408	0.402	-0.006	-1.47%	0.394	-0.014	-3.43%	0.394	-0.014	-3.43%	0.41	0.002	0.49%
403562060	0.334	0.329	-0.005	-1.50%	0.323	-0.011	-3.29%	0.323	-0.011	-3.29%	0.335	0.001	0.30%
403561560	0.243	0.239	-0.004	-1.65%	0.234	-0.009	-3.70%	0.234	-0.009	-3.70%	0.243	0.000	0.00%
403560830	0.36	0.355	-0.005	-1.39%	0.348	-0.012	-3.33%	0.348	-0.012	-3.33%	0.361	0.001	0.28%

Sensitive R — Q10

Cross section	Baseline Mean Velocity (m/s)	Scenario A Mean Velocity (m/s)	Scenario A Velocity Change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Mean Velocity (m/s)	Scenario B Velocity Change from baseline (m/s)	Scenario B Velocity change from baseline (m/s)	Scenario C Mean Velocity (m/s)	Scenario C Velocity Change from baseline (m/s)	Scenario C Velocity change from baseline (%)	Scenario D Mean Velocity (m/s)	Scenario D Velocity Change from baseline (m/s)	Scenario D Velocity change from baseline (m/s)
405014100	0.938	0.934	-0.004	-0.43%	0.929	-0.009	-0.96%	0.929	-0.009	-0.96%	0.938	0.000	0.00%
405013700	0.717	0.714	-0.003	-0.42%	0.709	-0.008	-1.12%	0.709	-0.008	-1.12%	0.717	0.000	0.00%
405013200	0.785	0.782	-0.003	-0.38%	0.777	-0.008	-1.02%	0.777	-0.008	-1.02%	0.785	0.000	0.00%
405011730	0.668	0.664	-0.004	-0.60%	0.66	-0.008	-1.20%	0.66	-0.008	-1.20%	0.668	0.000	0.00%
405010030	0.552	0.548	-0.004	-0.72%	0.544	-0.008	-1.45%	0.544	-0.008	-1.45%	0.552	0.000	0.00%
4040113530	0.832	0.83	-0.002	-0.24%	0.827	-0.005	-0.60%	0.827	-0.005	-0.60%	0.832	0.000	0.00%
403568850	0.745	0.742	-0.003	-0.40%	0.738	-0.007	-0.94%	0.738	-0.007	-0.94%	0.745	0.000	0.00%
403568730	0.987	0.982	-0.005	-0.51%	0.977	-0.010	-1.01%	0.977	-0.010	-1.01%	0.987	0.000	0.00%
403568500	0.948	0.943	-0.005	-0.53%	0.937	-0.011	-1.16%	0.937	-0.011	-1.16%	0.948	0.000	0.00%
403562060	0.709	0.706	-0.003	-0.42%	0.702	-0.007	-0.99%	0.702	-0.007	-0.99%	0.709	0.000	0.00%
403561560	0.55	0.547	-0.003	-0.55%	0.544	-0.006	-1.09%	0.544	-0.006	-1.09%	0.55	0.000	0.00%
403560830	0.809	0.805	-0.004	-0.49%	0.801	-0.008	-0.99%	0.801	-0.008	-0.99%	0.809	0.000	0.00%

Weir CS — Q99

403566930u	0.158	0.151	-0.007	-4.43%	0.143	-0.015	-9.49%	0.143	-0.015	-9.49%	0.158	0.000	0.00%
403566930d	0.334	0.323	-0.011	-3.29%	0.31	-0.024	-7.19%	0.31	-0.024	-7.19%	0.334	0.000	0.00%
4035510390u	0.127	0.121	-0.006	-4.72%	0.114	-0.013	-10.24%	0.114	-0.013	-10.24%	0.127	0.000	0.00%
4035510390d	0.27	0.258	-0.012	-4.44%	0.246	-0.024	-8.89%	0.246	-0.024	-8.89%	0.27	0.000	0.00%
Nabb4u	0.084	0.078	-0.006	-7.14%	0.072	-0.012	-14.29%	0.072	-0.012	-14.29%	0.084	0.000	0.00%
Nabb4d	0.777	0.75	-0.027	-3.47%	0.724	-0.053	-6.82%	0.726	-0.051	-6.56%	0.779	0.002	0.26%
403552890u	0.091	0.087	-0.004	-4.40%	0.083	-0.008	-8.79%	0.083	-0.008	-8.79%	0.091	0.000	0.00%
403552890d	0.562	0.55	-0.012	-2.14%	0.538	-0.024	-4.27%	0.559	-0.003	-0.53%	0.58	0.018	3.20%
SLR Abstraction													
403540210	0.109	0.104	-0.005	-4.59%	0.099	-0.010	-9.17%	0.085	-0.024	-22.02%	0.096	-0.013	-11.93%
NewBr1u	0.26	0.255	-0.005	-1.92%	0.25	-0.010	-3.85%	0.236	-0.024	-9.23%	0.248	-0.012	-4.62%
NewBr1d	0.796	0.788	-0.008	-1.01%	0.779	-0.017	-2.14%	0.753	-0.043	-5.40%	0.774	-0.022	-2.76%
403531200u	0.296	0.291	-0.005	-1.69%	0.285	-0.011	-3.72%	0.27	-0.026	-8.78%	0.283	-0.013	-4.39%
403531200d	0.631	0.627	-0.004	-0.63%	0.622	-0.009	-1.43%	0.609	-0.022	-3.49%	0.62	-0.011	-1.74%

Weir CS — Q95

														Manning's (+10%)	***% Change***	**Manning's (-10%)**	***% Change***	**Weir Coefficient (+20%)**	***% Change***	**Weir Coefficient (-20%)**	***% Change***
403566930u	0.172	0.164	-0.008	-4.65%	0.156	-0.016	-9.30%	0.157	-0.015	-8.72%	0.171	-0.001	-0.58%	0.172	0.00%	0.171	-0.58%	0.172	0.00%	0.171	-0.58%
403566930d	0.355	0.343	-0.012	-3.38%	0.331	-0.024	-6.76%	0.333	-0.022	-6.20%	0.354	-0.001	-0.28%	0.347	-2.25%	0.361	1.69%	0.355	0.00%	0.361	1.69%
4035510390u	0.137	0.132	-0.005	-3.65%	0.125	-0.012	-8.76%	0.126	-0.011	-8.03%	0.137	0.000	0.00%	0.137	0.00%	0.137	0.00%	0.137	0.00%	0.137	0.00%
4035510390d	0.288	0.279	-0.009	-3.12%	0.267	-0.021	-7.29%	0.267	-0.021	-7.29%	0.287	-0.001	-0.35%	0.284	-1.39%	0.291	1.04%	0.287	-0.35%	0.291	1.04%
Nabb4u	0.094	0.089	-0.005	-5.32%	0.083	-0.011	-11.70%	0.083	-0.011	-11.70%	0.094	0.000	0.00%	0.094	0.00%	0.094	0.00%	0.094	0.00%	0.094	0.00%
Nabb4d	0.818	0.798	-0.020	-2.44%	0.773	-0.045	-5.50%	0.775	-0.043	-5.26%	0.821	0.003	0.37%	0.773	-5.50%	0.868	6.11%	0.821	0.37%	0.868	6.11%
403552890u	0.098	0.094	-0.004	-4.08%	0.09	-0.008	-8.16%	0.09	-0.008	-8.16%	0.098	0.000	0.00%	0.098	0.00%	0.098	0.00%	0.098	0.00%	0.098	0.00%
403552890d	0.579	0.571	-0.008	-1.38%	0.56	-0.019	-3.28%	0.579	0.000	0.00%	0.597	0.018	3.11%	0.552	-4.66%	0.606	4.66%	0.597	3.11%	0.606	4.66%
SLR Abstraction																					
403540210	0.119	0.114	-0.005	-4.20%	0.109	-0.010	-8.40%	0.095	-0.024	-20.17%	0.105	-0.014	-11.76%	0.118	-0.84%	0.119	0.00%	0.12	0.84%	0.119	0.00%
NewBr1u	0.269	0.265	-0.004	-1.49%	0.26	-0.009	-3.35%	0.247	-0.022	-8.18%	0.256	-0.013	-4.83%	0.264	-1.86%	0.274	1.86%	0.288	7.06%	0.274	1.86%
NewBr1d	0.812	0.805	-0.007	-0.86%	0.797	-0.015	-1.85%	0.772	-0.040	-4.93%	0.79	-0.022	-2.71%	0.766	-5.67%	0.861	6.03%	0.828	1.97%	0.861	6.03%
403531200u	0.306	0.302	-0.004	-1.31%	0.296	-0.010	-3.27%	0.282	-0.024	-7.84%	0.292	-0.014	-4.58%	0.3	-1.96%	0.312	1.96%	0.318	3.92%	0.312	1.96%
403531200d	0.639	0.636	-0.003	-0.47%	0.631	-0.008	-1.25%	0.619	-0.020	-3.13%	0.628	-0.011	-1.72%	0.605	-5.32%	0.674	5.48%	0.648	1.41%	0.674	5.48%

Weir CS — Q50

403566930u	0.337	0.332	-0.005	-1.48%	0.325	-0.012	-3.56%	0.325	-0.012	-3.56%	0.338	0.001	0.30%
403566930d	0.536	0.533	-0.003	-0.56%	0.527	-0.009	-1.68%	0.527	-0.009	-1.68%	0.538	0.002	0.37%
4035510390u	0.273	0.269	-0.004	-1.47%	0.263	-0.010	-3.66%	0.263	-0.010	-3.66%	0.274	0.001	0.37%
4035510390d	0.485	0.48	-0.005	-1.03%	0.473	-0.012	-2.47%	0.473	-0.012	-2.47%	0.486	0.001	0.21%
Nabb4u	0.219	0.215	-0.004	-1.83%	0.21	-0.009	-4.11%	0.21	-0.009	-4.11%	0.219	0.000	0.00%
Nabb4d	1.071	1.067	-0.004	-0.37%	1.061	-0.010	-0.93%	1.061	-0.010	-0.93%	1.071	0.000	0.00%
403552890u	0.186	0.183	-0.003	-1.61%	0.179	-0.007	-3.76%	0.179	-0.007	-3.76%	0.186	0.000	0.00%
403552890d	0.686	0.684	-0.002	-0.29%	0.682	-0.004	-0.58%	0.692	0.006	0.87%	0.696	0.010	1.46%
SLR Abstraction													
403540210	0.233	0.229	-0.004	-1.72%	0.224	-0.009	-3.86%	0.212	-0.021	-9.01%	0.221	-0.012	-5.15%
NewBr1u	0.369	0.366	-0.003	-0.81%	0.362	-0.007	-1.90%	0.353	-0.016	-4.34%	0.36	-0.009	-2.44%
NewBr1d	0.941	0.938	-0.003	-0.32%	0.934	-0.007	-0.74%	0.924	-0.017	-1.81%	0.932	-0.009	-0.96%
403531200u	0.415	0.412	-0.003	-0.72%	0.408	-0.007	-1.69%	0.397	-0.018	-4.34%	0.405	-0.010	-2.41%
403531200d	0.736	0.733	-0.003	-0.41%	0.729	-0.007	-0.95%	0.718	-0.018	-2.45%	0.726	-0.010	-1.36%

Weir CS — Q10

403566930u	0.815	0.811	-0.004	-0.49%	0.806	-0.009	-1.10%	0.806	-0.009	-1.10%	0.815	0.000	0.00%
403566930d	0.814	0.813	-0.001	-0.12%	0.81	-0.004	-0.49%	0.81	-0.004	-0.49%	0.814	0.000	0.00%
4035510390u	0.676	0.672	-0.004	-0.59%	0.668	-0.008	-1.18%	0.668	-0.008	-1.18%	0.676	0.000	0.00%
4035510390d	0.84	0.838	-0.002	-0.24%	0.835	-0.005	-0.60%	0.835	-0.005	-0.60%	0.84	0.000	0.00%
Nabb4u	0.557	0.554	-0.003	-0.54%	0.551	-0.006	-1.08%	0.551	-0.006	-1.08%	0.557	0.000	0.00%
Nabb4d	1.325	1.326	0.001	0.08%	1.326	0.001	0.08%	1.329	0.004	0.30%	1.328	0.003	0.23%
403552890u	0.452	0.45	-0.002	-0.44%	0.447	-0.005	-1.11%	0.447	-0.005	-1.11%	0.452	0.000	0.00%
403552890d	0.773	0.772	-0.001	-0.13%	0.771	-0.002	-0.26%	0.773	0.000	0.00%	0.775	0.002	0.26%
SLR Abstraction													
403540210	0.562	0.559	-0.003	-0.53%	0.555	-0.007	-1.25%	0.546	-0.016	-2.85%	0.552	-0.010	-1.78%
NewBr1u	0.625	0.623	-0.002	-0.32%	0.62	-0.005	-0.80%	0.613	-0.012	-1.92%	0.618	-0.007	-1.12%
NewBr1d	1.124	1.123	-0.001	-0.09%	1.122	-0.002	-0.18%	1.118	-0.006	-0.53%	1.121	-0.003	-0.27%
403531200u	0.673	0.671	-0.002	-0.30%	0.668	-0.005	-0.74%	0.662	-0.011	-1.63%	0.666	-0.007	-1.04%
403531200d	0.827	0.827	0.000	0.00%	0.828	0.001	0.12%	0.828	0.828	100.12%	0.828	0.001	0.12%

Appendix C Inflows for initial 1D model runs

Tables C-1, C-2, C-3 and C-4 present the hydrological inflows for the baseline hydraulic models that were applied for the *initial model runs* during Phase 3. The inflows used in the latest versions of the models are presented in Section 5 of this Report.

Table C-1 River Tame hydrological inflows in baseline hydraulic model for initial runs

River Tame Baseline Hydrological Inflows						
		Gate 1	Gate 2	Gate 1	Gate 2	
Model Inflow	**Type of Flow**	**Q95**	**Q95**	**Q50**	**Q50**	**Comment**
TM067777	Flow Estimate	2.13	7.338	3.84	9.02	Includes 450 Ml/day Minworth Wastewater Treatment Works discharge
Minor3	Sweetening Flow	0.2	0.01	0.2	0.01	
Blythe1	Sweetening Flow	0.2	0.01	0.2	0.01	
ColeTot	Sweetening Flow	0.2	0.01	0.2	0.01	
Shustoke	Sweetening Flow	0.2	0.01	0.2	0.01	
Minor4	Sweetening Flow	0.116	0.01	0.116	0.01	
Minor5	Sweetening Flow	0.2	0.01	0.2	0.01	
Minor6	Sweetening Flow	0.2	0.01	0.2	0.01	
Minor7	Sweetening Flow	0.164	0.01	0.164	0.01	
Minor8	Sweetening Flow	0.2	0.01	0.2	0.01	
Minor9	Sweetening Flow	0.131	0.01	0.131	0.01	
Minor10	Sweetening Flow	0.102	0.01	0.102	0.01	
NetherWhit	Sweetening Flow	0.2	0.01	0.2	0.01	
Gallows	Sweetening Flow	0.2	0.01	0.2	0.01	
ANKR0602	Sweetening Flow	0.56	0.025	0.2	0.025	
Point_2	Flow Estimate	4.39	-0.082	6.27	0.99	
Point_3 (Lea Marston)	Flow Estimate	0.74	0	0.62	0.62	Modelled flow has been calibrated to the Lea Marston flow gauge
Point_4	Flow Estimate	0.01	0.01	1.13	1.13	
Point_5	Flow Estimate	1.33	1.12	3.09	2.22	
Point_6 (Hopwas Bridge)	Flow Estimate	2.99	0	4.2	0	Modelled flow has been calibrated to the Hopwas Bridge Aquator model flow
TM046249RB	Sweetening Flow	0.015	0.015	0.015	0.015	
TM035439LB	Sweetening Flow	0.015	0.055	0.015	0.05	
T1_125	Sweetening Flow	0.1	0.05	0.1	0.05	
TM031111RB	Sweetening Flow	0.05	0.05	0.05	0.05	
SWEET11	Sweetening Flow	0.05	0.05	0.05	0.05	
SWEET6	Sweetening Flow	0.1	0.05	0.1	0.05	
TFRC1196LB	Sweetening Flow	0.1	0.05	0.1	0.05	
TM024752LB	Sweetening Flow	1	0.05	1	0.05	
TM021944LB	Sweetening Flow	0.1	0.05	0.1	0.05	
SWEET15	Sweetening Flow	0.1	0.05	0.1	0.05	
TM022539RB	Sweetening Flow	0.05	0.05	0.05	0.05	
TM053703in	Sweetening Flow	0.01	0.01	0.01	0.01	
TM063876RB	Sweetening Flow	0.1	0.1	0.1	0.1	
Bourne	Sweetening Flow	1.447	0.25	1.447	0.1	
Total Flow:		17.70	9.42	24.90	20.09	
Sweetening Flow:		6.11	1.04	5.75	0.88	
Sweetening Flow Reduced:		N/A	83%	N/A	86%	
% Sweetening Flow in Model:		35%	11%	23%	4%	

Table C-2 River Trent 2 hydrological inflows in baseline hydraulic model for initial runs

River Trent 2 Baseline Hydrological Inflows						
		Gate 1	Gate 2	Gate 1	Gate 2	
Model Inflow	**Type of Flow**	**Q95**	**Q95**	**Q50**	**Q50**	**Comment**
Yoxall_2	Sweetening Flow	0.2	N/A	0.2	N/A	Upstream of Tame / Trent confluence along the River Trent so inflows have been removed from model.
3161405565	Sweetening Flow	0.2	N/A	0.2	N/A	
3161411373	Sweetening Flow	0.2	N/A	0.2	N/A	
3161416632	Sweetening Flow	0.2	N/A	0.2	N/A	
M_1	Sweetening Flow	0.2	0.025	0.2	0.025	
Point_7 (Tame / Trent confluence)	Flow Estimate	13.01	14.92	25.19	25.05	The Tame / Trent confluence. Downstream flows of the Tame model plus additional Trent inflow to calibrate to Drakelow Aquator flows.
BLYTHE	Sweetening Flow	0.2	0	0.2	0	
312311660	Sweetening Flow	0.2	0.025	0.2	0.025	
SOW	Sweetening Flow	0.2	0	0.2	0	
316512616	Sweetening Flow	0.2	0	0.2	0	
3161424005	Sweetening Flow	0.2	0	0.2	0	
Point_8 (Mease)	Flow Estimate	0.52	0.52	1.2	1.2	
Point_9 (Drakelow)	Flow Estimate	N/A	N/A	N/A	N/A	Not represented as an inflow but downstream of the Trent 2. Represented upstream of Trent 3 model as 316127740. Modelled flow calibrated to Drakelow Aquator flows.
Total Flow:		15.53	15.49	28.39	26.30	
Sweetening Flow:		2	0.05	1	0.05	
Sweetening Flow Reduced:		N/A	88%	N/A	98%	
% Sweetening Flow in Model:		13%	2%	7%	0.3%	

Table C-3 River Trent 3 hydrological inflows in baseline hydraulic model for initial runs

River Trent 3 Baseline Hydrological Inflows						
		Gate 1	Gate 2	Gate 1	Gate 2	
Model Inflow	**Type of Flow**	**Q95**	**Q95**	**Q50**	**Q50**	**Comment**
316127740 (point 9 Drakelow)	Flow Estimate	14.17	15.493	27	26.3	Downstream flows taken from downstream of the Trent 2 hydraulic model which has been calibrated to the Drakelow Aquator flows.
Point 10 (Dove)	Flow Estimate	2.9	1.967	7.61	8.54	
310316950	Sweetening Flow	0.2	0	0.2	0	
316122960	Sweetening Flow	0.2	0	0.2	0	
RiverDerwent	Sweetening Flow	0.2	0	0.2	0	
Point_11 (Trent @ Shardlow)	Flow Estimate	0.51	0.51	2.06	2.06	Modelled flow has been calibrated to the Shardlow Aquator flows.
Point_12 (Derwent)	Flow Estimate	3.97	3.97	8.35	8.35	
Total Flow:		22.15	21.94	45.62	45.25	
Sweetening Flow:		0.6	0	0.6	0	
Sweetening Flow Reduced:		N/A	100%	N/A	100%	
% Sweetening Flow in Model:		3%	0%	1.3%	0%	

Table C-4 River Trent 4 hydrological inflows in baseline hydraulic model for initial runs

River Trent 4 Baseline Hydrological Inflows						
		Gate 1	Gate 2	Gate 1	Gate 2	
Model Inflow	**Type of Flow**	**Q95**	**Q95**	**Q50**	**Q50**	**Comment**
Point_12 (Trent + Derwent)	Flow Estimate	21.55	25.91	45.02	53.60	Downstream flows taken from downstream of the Trent 3 hydraulic model.
Trent	Sweetening Flow	0.2	0	0.2	0	
Point_13 (River Soar)	Flow Estimate	4.32	1.55	10.04	4.26	A linear regression between catchment area and flow rate has been used to estimate flows between Point 12 (d/s of River Trent 2 model) and Point 16 (calibrated Colwick Aquator flows.
Point_14 (River Erewash)	Flow Estimate	0.67	0.23	1.55	0.64	
Point_15 (Fairham Brook)	Flow Estimate	0.33	0.09	0.76	0.25	
RiverSoar	Sweetening Flow	0.2	0	0.2	0	
RiverDerwent	Sweetening Flow	0.2	0	0.2	0	
RiverLeen	Sweetening Flow	0.2	0	0.2	0	
RiverErewash	Sweetening Flow	0.2	0	0.2	0	
Point_16 (Trent @ Colwick)	Flow Estimate	1.13	0	1.83	0	Modelled flow has been calibrated to the Colwick Aquator flows.
River Devon	Flow Estimate	N/A	1.93	N/A	2.85	Inflows added to Gate 2 model to calibrate to Point 17. A linear regression has been used between catchment area and flow rate.
River Greet	Flow Estimate	N/A	0.4	N/A	0.59	
Point_17 (Trent @ N Muskham)	Flow Estimate	0.8	0	4.3	0	Modelled flow has been calibrated to the North Muskham Aquator flows.
RiverDevon	Sweetening Flow	0.2	0	0.2	0	
LatInf1	Sweetening Flow	0.2	0	0.2	0	
LatInf2	Sweetening Flow	0.2	0	0.2	0	
Total Flow:		30.4	30.11	65.10	62.20	
Sweetening Flow:		1.6	0	1.6	0	
Sweetening Flow Reduced:		N/A	100%	N/A	100%	
% Sweetening Flow in Model:		5%	0%	2%	0%	

Appendix D 2D Modelling Report

Appendix D: 2D Modelling Report

Minworth SRO and South Lincolnshire Reservoir (SLR) SRO Hydrological and Hydraulic Modelling Report

Affinity Water, Anglian Water Services Ltd and Severn Trent Water Ltd

Project number: 60671264

October 2022

Delivering a better world

Author names redacted

Quality information

Prepared by	Checked by	Verified by	Approved by
[redacted]	[redacted]	[redacted]	[redacted]
Graduate Water Consultant	Principal Engineer	Technical Director	Technical Director

Revision History

Revision	Revision date	Details	Authorized	Name	Position
01	Aug 2022	For first line assurance	CP	[redacted]	Technical Director
02	Aug 2022	For EA & second line assurance	CP	[redacted]	Technical Director
03	Oct 2022	Final	CP	[redacted]	Technical Director

Prepared for:

Affinity Water, Anglian Water Services Ltd and Severn Trent Water Ltd
Project: C-03844

Prepared by:

AECOM Limited
Midpoint, Alencon Link
Basingstoke
Hampshire RG21 7PP
United Kingdom

T: +44(0)1256 310200
aecom.com

Table of Contents

1. Introduction to 2D Modelling 6
1.1 Project Background 6
1.2 2D Modelling Rationale 7
2. Model Development 8
2.1 Data 8
2.2 River Tame at Lea Marston 8
2.3 River Tame at Tamworth 22
2.4 River Trent at Winshill 33
2.5 Simulations 44
3. Results 46
3.2 Lea Marston Results 46
3.3 Tamworth Results 63
3.4 Winshill Results 76
4. Summary of Results 91
4.1 Lea Marston 91
4.2 Tamworth 91
4.3 Winshill 91
4.4 Next Steps 92
Annex A: Bathymetric Survey TN 93

Figures

Figure 2-1: River Tame at Lea Marston – LiDAR Topographic Elevation ... 11
Figure 2-2: River Tame at Lea Marston – 2D Model Build ... 12
Figure 2-3: River Tame at Lea Marston – 2D Model Build & Topographic Adjustment around Crump Weirs ... 13
Figure 2-4: River Tame at Lea Marston – 2D Model Build & Topographic Adjustment around Coton Road Weirs. 14
Figure 2-5 : River Tame at Lea Marston – 2D Model Build & Topographic Adjustment around Weirs LM2A0000 & LM2B0000 ... 15
Figure 2-6: River Tame at Lea Marston – Topographic Elevation Post Model Build, Crump Weirs TM053538S1 & LM1B053538S1 ... 16
Figure 2-7: River Tame at Lea Marston – Satellite image of Crump Weirs: TM053538S1 & LM11B053538S1 ... 17
Figure 2-8: River Tame at Lea Marston – Topographic Elevation Post Model, Coton Road Weirs TM052794SU, LMCW093SU & LMEW094SU ... 18
Figure 2-9: River Tame at Lea Marston – Satellite Image of Coton Road Weirs: TM052794SU, LMCW093SU & LMEW094SU ... 19
Figure 2-10: River Tame at Lea Marston – Topographic Elevation Post Model Build, weirs LM2A0000 & LM2B0000 ... 20
Figure 2-11: River Tame at Lea Marston – Satellite Image of two weirs downstream of Lea Marston Lakes, LM2A0000 (left) & LM2B0000 (right) ... 21
Figure 2-12:River Tame at Tamworth – LIDAR Topographic Elevation ... 24
Figure 2-13: River Tame at Tamworth – 2D Model Build ... 25
Figure 2-14: River Tame at Tamworth – Adjusted LiDAR topography surrounding Tamworth Weir TM033154W .. 26
Figure 2-15: River Tame at Tamworth – Satellite Image of Weir No.1 at Tamworth: TM033154W ... 27
Figure 2-16: River Tame at Tamworth – Adjusted LiDAR topography surrounding Tamworth Weir TM031648 ... 28
Figure 2-17: River Tame at Tamworth – Satellite Image of Wier No.2 at Tamworth: TM031648 ... 29
Figure 2-18: River Tame at Tamworth – Model Topography following LiDAR adjustment, surrounding weir TM033154W ... 30
Figure 2-19: River Tame at Tamworth – Elevation post – LiDAR adjustment surrounding weir TM031648 ... 31
Figure 2-20: River Tame at Tamworth – Elevation post – LiDAR Adjustment & Cross Sections ... 32
Figure 2-21: River Trent at Winshill – LiDAR Topographic Elevation ... 35
Figure 2-22: River Trent at Winshill – 2D Model Build ... 36
Figure 2-23: River Trent at Winshill – Topographic Adjustment around Weir 1, 316124050x ... 37
Figure 2-24: River Trent at Winshill – Satellite Image of Weir No.1 at Winshill: 316124050x ... 38
Figure 2-25: River Trent at Winshill – Topographic Adjustment around Weir 2: 316123050 ... 39
Figure 2-26: River Trent at Winshill – Satellite Image of Weir No.2 at Winshill: 316123050 ... 40
Figure 2-27: River Trent at Winshill – Elevation Post Model Build, Weir 1: 316124050x ... 41
Figure 2-28: River Trent at Winshill – Elevation Post Model Build, Weir 2: 316123050 ... 42
Figure 2-29: River Trent at Winshill – Topographic Post-Model Build Comparison ... 43
Figure 3-1: River Tame at Lea Marston – PO Points & Lines at Crump Weir, TM053538S1 & LM1B05358S1 ... 47
Figure 3-2: River Tame at Lea Marston – PO Points & Lines at Coton Road Weirs ... 48
Figure 3-3: River Tame at Lea Marston – PO Points & Lines, Weir: LM2A000 & LM2B0000 ... 49
Table 3-1: River Tame at Lea Marston – Water Depth Difference, Q99 & Q95 Flow Condition – Results from PO Lines ... 50
Table 3-2: River Tame at Lea Marston – Water Depth Difference, Q50 & Q10 Flow Condition – Results from PO Lines ... 51
Table 3-3: River Tame at Lea Marston – Velocity Difference, Q99 & Q95 Flow Condition – Results from PO Points ... 52
Table 3-4: River Tame at Lea Marston – Velocity Difference, Q50 & Q10 Flow Condition – Results from PO Points ... 53
Figure 3-4: River Tame at Lea Marston – Q95 Baseline Water Depth ... 54
Figure 3-5: River Tame at Lea Marston – Q95 Baseline Velocities ... 55
Figure 3-6: River Tame at Lea Marston – Max. Water Level Difference between Q95 Baseline and Q95 Scenario A ... 56
Figure 3-7: River Tame at Lea Marston – Max. Velocity Difference between Q95 Baseline and Scenario A ... 57
Figure 3-8: River Tame at Lea Marston – Max. Water Level Difference between Q95 Baseline and Q95 Scenario B ... 58
Figure 3-9: River Tame at Lea Marston – Max Velocity Difference between Q95 Baseline & Q95 Scenario B ... 59
... 60
... 60

Figure 3-10: River Tame at Lea Marston – Q95 Baseline Modelled Velocity (top left) at crump weirs. Q95 Scenario (top right) A & Scenario B (bottom left) Velocities Changes from Q95 Baseline 60
Figure 3-11: River Tame at Lea Marston – Q95 Baseline Modelled Velocity (top left) at Weir LM2A000. Q95 Scenario A (top right) & Scenario B (bottom left) changes in Velocities from Q95 Baseline, at Weir LM2A0000 .. 61
Figure 3-12: River Tame at Lea Marston – Q95 Baseline Modelled Velocity (top left). Q95 Scenario A (top right) & Scenario B (bottom left) changes in Velocities from Q95 Baseline, at Weir LM2B0000 62
Figure 3-13: River Tame at Tamworth – PO Points & Lines, Weir TM033154W.. 64
Figure 3-14: River Tame at Tamworth – PO Points & Lines, Weir TM031648.. 65
Table 3-6: River Tame at Tamworth – Velocity Difference... 67
Figure 3-15: River Tame at Tamworth – Q95 Baseline Water Depth 68
Figure 3-16: River Tame at Tamworth – Q95 Baseline Velocities.. 69
Figure 3-17: River Tame at Tamworth – Max. Water Level Difference between Q95 Baseline and Q95 Scenario A 70
Figure 3-18: River Tame at Tamworth – Max. Velocity Difference between Q95 Baseline and Q95 Scenario A ... 71
Figure 3-19: River Tame at Tamworth – Max. Water Level Difference between Q95 Baseline and Q95 Scenario B 72
Figure 3-20: River Tame at Tamworth – Max. Velocity Difference between Q95 Baseline and Q95 Scenario B ... 73
Figure 3-21: River Tame at Tamworth – Q95 Baseline Modelled Velocity (top left). Q95 Scenario A (top right) & Scenario B (bottom left) change in Velocities from Q95 Baseline, at Weir No.1 TM033154W............................ 74
Figure 3-22: River Tame at Tamworth – Q95 Baseline Modelled Velocity (top left). Q95 Scenario A (top right) & Scenario B (bottom left) change in Velocity compared with Q95 Baseline, at Weir No.2 TM031648.................... 75
Figure 3-23: River Trent at Winshill – PO Points & Lines at Weir No.1, 316124050x... 77
Figure 3-24: River Trent at Winshill – PO Points & Lines at Weir No. 2, 316123050.. 78
Figure 3-25: River Trent at Winshill – Q95 Baseline Maximum Water Depth... 83
Figure 3-26: River Trent at Winshill – Q95 Baseline Maximum Velocities 84
Figure 3-27: River Trent at Winshill – Q95 Scenario A Water Level Difference from Q95 Baseline...................... 85
Figure 3-28: River Trent at Winshill – Q95 Scenario B Water Level Difference from Q95 Baseline 86
Figure 3-29: River Trent at Winshill – Q95 Scenario A Velocity Difference from Q95 Baseline 87
Figure 3-30: River Trent at Winshill – Q95 Scenario B Velocity Difference from Q95 Baseline............................ 88
Figure 3-31: River Trent at Winshill – Q95 Baseline Modelled Velocities (top left). Q95 Scenario A (top right) & Scenario B (bottom left) Velocity Difference from Q95 Baseline at Weir No.1, 316124050x................................ 89
Figure 3-32: River Trent at Winshill – Q95 Baseline Modelled Velocities (top left). Q95 Scenario A (top right) & Scenario B (bottom left) Velocity Difference from Q95 Baseline at Weir No.2, 316123050 90

Tables

Table 2-1 Datasets used in the 2D model development 8
Table 2-2: River Tame at Lea Marston model parameters 8
Table 2-3: Boundary Conditions for Lea Marston... 10
Table 2-4: River Tame at Tamworth model parameters 22
Table 2-5: Tamworth 2D Boundary Conditions.. 23
Table 2-6: Winshill 2D Model Build.. 33
Table 2-7: Winshill Boundary Conditions... 34
Table 3-1: River Tame at Lea Marston – Water Depth Difference, Q99 & Q95 Flow Condition........................... 50
Table 3-2: River Tame at Lea Marston – Water Depth Difference, Q50 & Q10 Flow Condition............................ 51
Table 3-3: River Tame at Lea Marston – Velocity Difference, Q99 & Q95 Flow Condition 52
Table 3-4: River Tame at Lea Marston – Velocity Difference, Q50 & Q10 Flow Condition 53
Table 3-5: River Tame at Tamworth – Water Depth Difference.. 66
Table 3-6: River Tame at Tamworth – Velocity Difference... 67
Table 3-7: River Trent at Winshill – Water Depth Difference, Q99 & Q95 Flow Conditions................................. 79
Table 3-8: River Trent at Winshill – Water Depth Difference, Q50 & Q10 Flow Conditions................................. 80
Table 3-9: River Trent at Winshill – Velocity Difference, Q99 & Q95 Flow Conditions 81
Table 3-10: River Trent at Winshill – Velocity Differences, Q50 & Q10 Flow Conditions 82

1. Introduction to 2D Modelling

1.1 Project Background

1.1.1 Affinity Water, along with Severn Trent Water (STW) and Anglian Water (jointly referred to as the Project Management Board (PMB)) are developing Strategic Resource Options (SRO) through the Regulators Alliance for Progressing Infrastructure development (RAPID) Gate 2 process. Operation of the SROs has the potential to impact on flows in the River Tame and River Trent and therefore hydrological and hydraulic modelling has been undertaken to support assessment of the feasibility of the SROs.

1.1.2 The SROs of relevance are Minworth, Grand Union Canal (GUC), Severn to Thames Transfer (STT) and South Lincolnshire Reservoir (SLR). Operation of these SROs could result in a flow reduction in the Rivers Tame and Trent (hereafter referred to as the “study river system”), either as a result of:

- direct abstraction from the River Trent – as is the case for the SLR SRO, or,
- a reduction of treated discharge flow to the River Tame from Minworth Wastewater Treatment Works (WwTW) – as is the case for the Minworth SRO which supports the STT and GUC SROs.

1.1.3 The following modelling has been undertaken:

- Hydrological and water resource systems modelling using Aquator Water Resource System model provided by STW to identify how the flow regime of the study river system might change as a result of operating the SROs.
- 1D Hydraulic modelling to identify changes in hydraulic parameters such as water level, depth, velocity, and wetted perimeter of a river channel, all of which are important factors in assessing potential ecology or habitat linked responses to changes in flow regimes.

1.1.4 The modelling methodology and findings from these two types of modelling are reported in the *Strategic Resource Options: Hydrological and Hydraulic Modelling for the Tame and Trent: Project Report,* to which this document forms Appendix D. The overall study and all modelling completed is referred to hereafter as the “modelling study”.

1.1.5 This document (Appendix D) reports on a third strand of modelling - 2D modelling, completed to support assessment of fish passage at three key locations (Figure 1-1) where weir structures are present and where fish passage has the potential to be impacted by changes in flow as a result of operating the SROs. These locations were agreed with the Environment Agency as priority for the Gate 2 work based on the sensitivity to change and their proximity to Minworth WwTW discharges.

1.1.6 As part of the 2D modelling, four flow conditions have been simulated within the models to represent a range of river flow conditions relevant to fish passage: Q10, Q50, Q95 and Q99. Three SRO operational scenarios have been simulated for each of the four river flow conditions, and are described below:

- Baseline (BL) – baseline boundary conditions as described in the 1D modelling, calibrated and validated to gauge data along the entire reach – there is no SRO operated in this scenario.
- Scenario A (SA) – one of either the STT or GUC SRO operating at its maximum value (115 Ml/d loss).
- Scenario B (SB) – Worst case of both STT and GUC SROs operating combined at their maximum value (230 Ml/d loss).

1.1.7 It should be noted that the SLR Abstraction is not relevant to the 2D modelling completed for this Gate 2 study as the three locations modelled in 2D are located upstream of the proposed SLR abstraction (Figure 1-1).

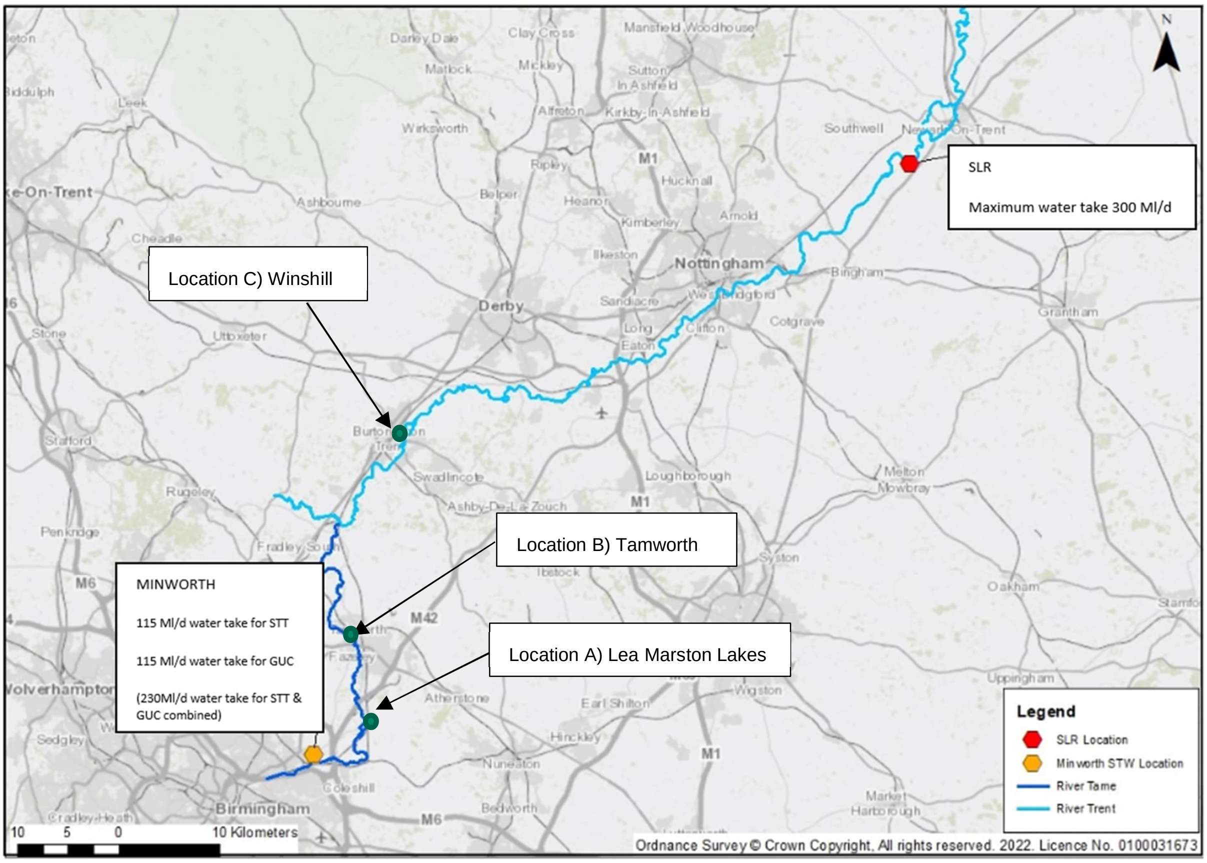


Figure 1-1: 2D modelling locations relative to the SRO locations

1.2 2D Modelling Rationale

1.2.1 The outputs from the 1D modelling completed are suitable to identify the impact on riparian priority habitats and designated sites, but further information is useful for the assessment of fish passage at structures.

1.2.2 In order to fully inform the assessment of fish migration at specific structures, it is necessary to understand the variability in velocity and water depth around the structures and the river sections upstream and downstream during a range of flow conditions, including low flows. A 2D modelling approach was therefore proposed in discussion with the Environment Agency.

1.2.3 From 2D model outputs, it is possible to review how depth and velocity vary across the channel under different flow conditions induced by operation of the SRO. There may be different options for fish passage across the channel and through 2D in-channel modelling it is possible to assess this. Passage routes and attractant flows may also be considered with different species of fish favouring different conditions.

1.2.4 This report summarises the 2D hydraulic modelling that has been undertaken as part of the modelling study at three locations:

1. River Tame at Lea Marston Lakes, including five weir structures.
2. River Tame at Tamworth, including two weir structures.
3. River Trent at Winshill, including two weir structures.

1.2.5 It should be noted that throughout this report, references to model file names and specific terminology related to the software package used (TUFLOW) have been highlighted in dark blue text.

2. Model Development

2.1 Data

2.1.1 Table 2-1 details the datasets which have been acquired and used as part of the 2D model development. Phase 1 of the modelling study has provided calibrated flows from both the Aquator and 1D model alongside flow data from gauging stations.

Table 2-1 Datasets used in the 2D model development

Flood Modeller 1D Model	The following Flood Modeller hydraulic models were obtained from the Environment Agency: • River Tame (Water Orton to Tame/Trent Confluence), • River Trent 2 (Meaford to Tame/Trent confluence & Tame/Trent confluence to Drakelow). • River Trent 3 (Barnston to the River Derwent), and • River Trent 4 (River Derwent to Cromwell). Lea Marston and Tamworth are located in the River Tame model, the 1D network consists of 2502 nodes. Winshill is located in the River Trent 3 model consisting of 631 nodes.
LiDAR Data	The LiDAR Composite 2020 1m DTM data for the three models has been acquired from the DEFRA Survey Data Download interface. 1 m resolution tiles have been merged to cover focus area. *Updated July 2021.*
Bathymetric Survey Data	Undertaken by AECOM, with the survey delivered on 01/06/2022 (see Annex A). A remote ARCboat fitted with a Cadden BALI Single Beam Echo Sounder (SBES) was used to undertake the survey, covering water depths greater than 30 cm.
Boundary Condition Data	As part of the 1D modelling, inflows have been defined, calibrated, and validated against gauge data along the River Tame, as part of the Phase 1 work. Flow and stage results have been extracted from the 1D model at steady state condition, for each flow condition and scenario. • The 2D QT (flow-time) and HT (head or stage time) boundaries have been set up in the 2D model to correspond with 1D flow and stage results from the 1D models, respectively. • The QT boundaries set the inflow, and the HT boundary sets the stage at the downstream boundary of the 2D model.

2.2 River Tame at Lea Marston

2.2.1 Table 2-2 outlines the key model build parameters for the reach of the River Tame at Lea Marston including two weir structures.

Table 2-2: River Tame at Lea Marston model parameters

Lea Marston	
Software	Tuflow Classic: 2020-01-AB-iDP-w64
Tuflow Control File (.tcf)	▪ Timestep = 1 second ▪ Run time = 12 hours ▪ PO points & Lines outputting Q, H, & V
	The run time allows the model to overcome the initial conditions and to reach steady state. **Simulation run time: 12 hours**
Boundary Condition File (.tbc)	Boundary conditions have been taken from the 1D model – calibrated & validated against gauge data – from cross sections that correspond with location of the 2D boundary conditions, refer to Table 2-1.

Lea Marston	
	▪ QT Boundary – **Tame_Inflow** – location is downstream of Birmingham Road, 1D FM node: *TM053877* ▪ HT Boundary – **Tame_DS –** location is upstream of Kingsbury Road, 1D FM node: *TM050791*
Bc_dbase (.csv)	The Boundary Condition database file reads in the assigned 'Flow Condition and Scenario' QT & HT .csv boundary files – steady state flow (m^3/s) & stage (m AOD) have been extracted from the 1D model. The River Tame and HT and QT boundary value has been taken from the 1D cross sections results for each flow condition & scenario, corresponding to their location represented in the 2D model.
Material File (.tmf)	The Mannings 'N' Roughness for the channel are **0.030 & 0.035**. The Lakes are also defined as **0.030**. These Manning's N values have been taken from the 1D Flood Model. A **0.050 default manning's roughness** value has been applied outside of the main channels.
Geometry Control File (.tgc)	▪ A **Cell size of 2 m** has been defined. ▪ A **domain area of 2800 m * 1000 m** has been defined in metres, X & Y respectively. The origin of the domain is defined by 2d_loc_LeaMarston_001.MIF. ▪ Code Area has been defined as the active area for Lea Marston – 2d_code_LeaMarston_001.MIF – this is for low flow modelling, the code area is extended marginally outside of channel bank. The topography is defined using a combination of: ▪ The base grid – LeaMarston_1m_DTM_merge.asc – is composed of Bathymetric survey data stamped onto LiDAR data. See Figure 2-1 for the original LiDAR survey data, and Figure 2-2 for the bathymetry survey extent. ▪ Interpolation of the channel shape using data from 1D cross sections from the original EA model (where bathymetric survey data was not available) – 2d_zsh_LeaMarstonChannel_009.MIF. The channel topography has been interpolated connecting point elevations extracted from the original EA 1D model and connected using the *TIN line shape_option* in Tuflow. A polygon encompassing the 1D point elevation and TIN lines, acts as a triangulation boundary, see Figure 2-2 through to Figure 2-5. Coton Road elevation has been raised – 2d_zsh_CotonRoad_001.mif – using the '*NO MERGE' shape_option* in Tuflow. ▪ Weirs have been defined as *2d Zsh lines*, with the crest level set to the defined 1D Flood Modeller Elevation. *Shape_option* has been set to *'MAX'*, and crest has been extended over bank – 2d_zsh_LeaMarstonWeirs_006.MIF. Refer to Figure 2-4 and Figure 2-5. ▪ Crump Weirs have been represented as *2d zshape polygons*, with the weir crest defined from the 1D model and set to '*MAX*' and extended into the channel banks – 2d_zsh_LeaMarston_CrumpWeirs_006.MIF. A polygon connecting known point elevations from the 1D model has been connected using TIN lines, see Figure 2-3. The encompassing polygon -- 2d_zsh_LeaMarstonWeirs_006.MIF – *shape_option* has been set to '**No Merge'**, preventing interpolation with surrounding Lidar. ▪ Upstream and downstream of Coton Road where there has been gaps in the bathymetry, interpolation between the bathymetry and Lidar point elevations has been undertaken to merge these data sets – 2d_zsh_LM_USWeir_Lowering_003.MIF – Figure 2-2 and Figure 2-4. ▪ Where there are culverts, these have been modelled as open channels with dimension from the 1D model: upstream inverts level, downstream invert level, & culvert width – zsh_LM_USWeir_Lowering_004.MIF, refer to Figure 2-4. ▪ Initial Water Levels for the lakes have been set to the elevation of the weir at the downstream extent of the lakes. For the channel, the initial water level has been set to the Head Boundary – stage taken from the Q50

Lea Marston	
	Baseline – 2d_IWL_LeaMarston_001.MIF. The duration of the simulation ensures steady state is achieved, therefore overcoming initial conditions. ▪ Manning's roughness has been defined for the channel upstream of the weirs, and downstream of the weirs – 2d_mat_Tamworth_001.MIF – values used are as described in the 1D Flood Modeller Model

2.2.2 The boundary condition HT and QT for each flow condition and scenario have been detailed in table below.

Table 2-3: Boundary Conditions for Lea Marston.

Lea Marston			Q10			Q50			Q95			Q99		
River Tame Network – 1D FM	2D BC	Node	BL	SA	SB	BL	SA	SB	BL	SA	SB	BL	SA	SB
	QT (m^3/s)	TM053877 (Tame Inflow)	23.19	21.85	20.52	10.61	9.28	7.95	7.17	5.84	4.51	6.77	5.43	4.10
	HT (m AOD)	TM050791 (Tame Stage)	64.20	64.16	64.11	63.69	63.62	63.54	63.50	63.42	63.33	63.44	63.36	63.28

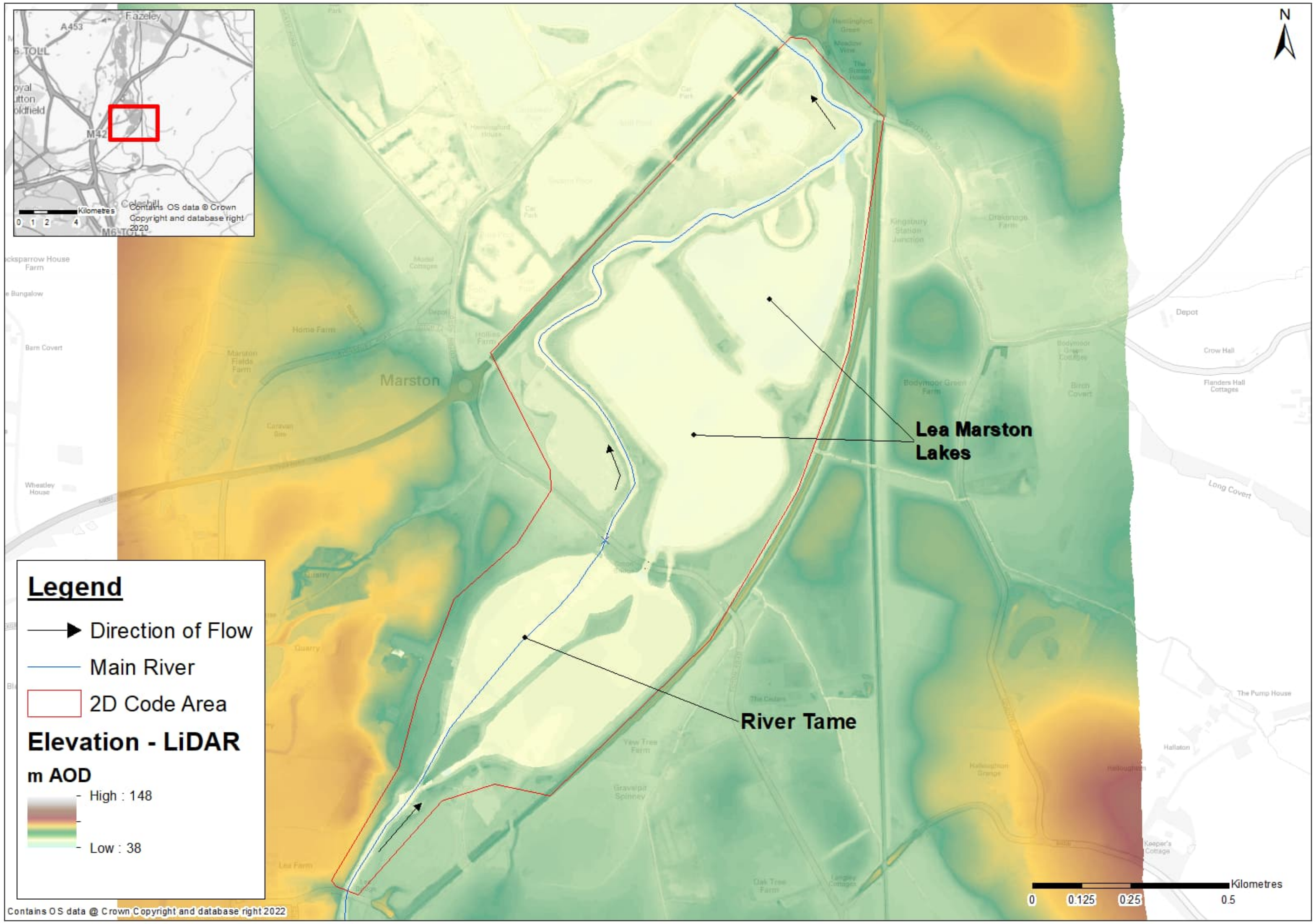


Figure 2-1: River Tame at Lea Marston – LiDAR Topographic Elevation

Figure 2-2: River Tame at Lea Marston – 2D Model Build

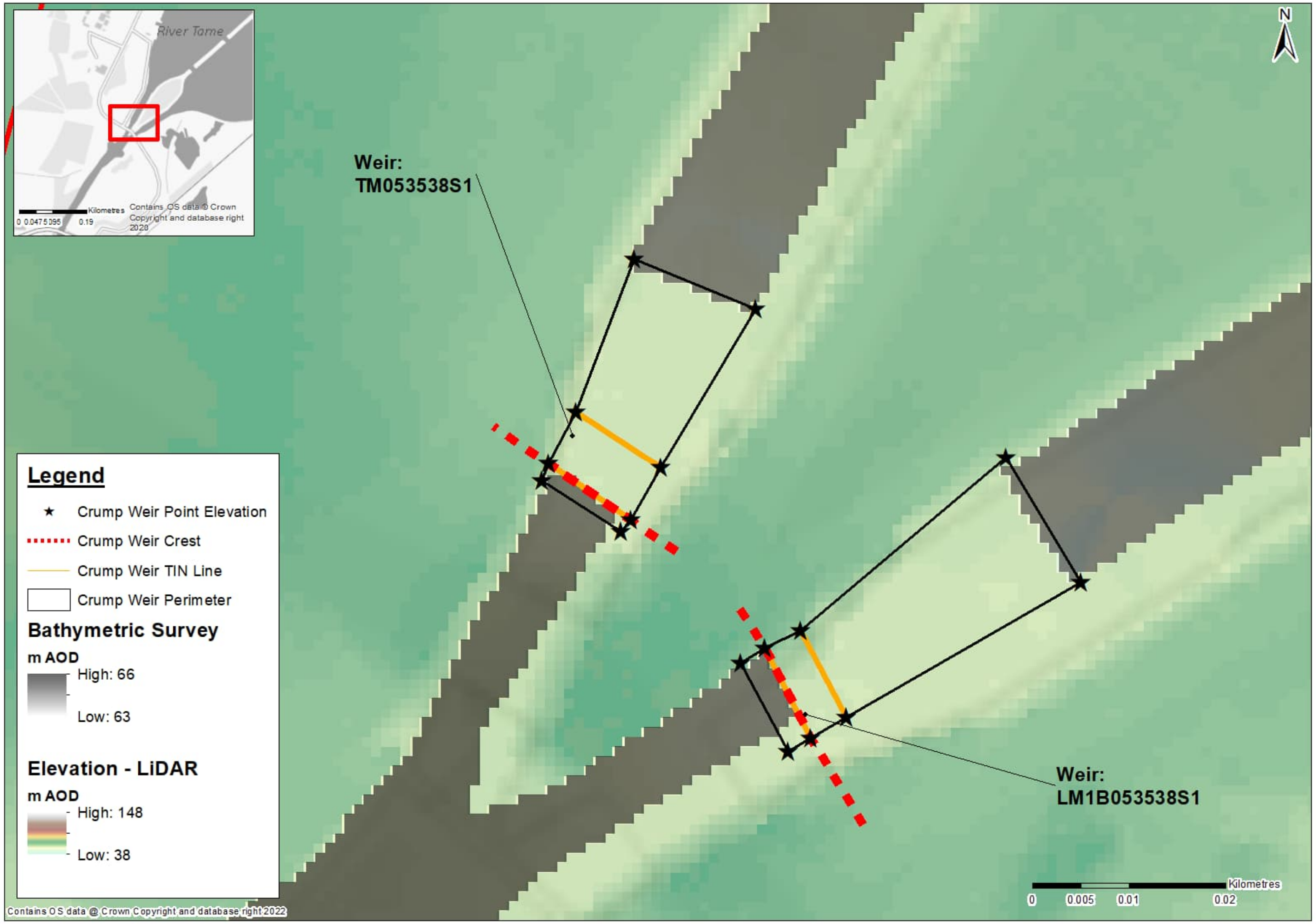


Figure 2-3: River Tame at Lea Marston – 2D Model Build & Topographic Adjustment around Crump Weirs

Figure 2-4: River Tame at Lea Marston – 2D Model Build & Topographic Adjustment around Coton Road Weirs.

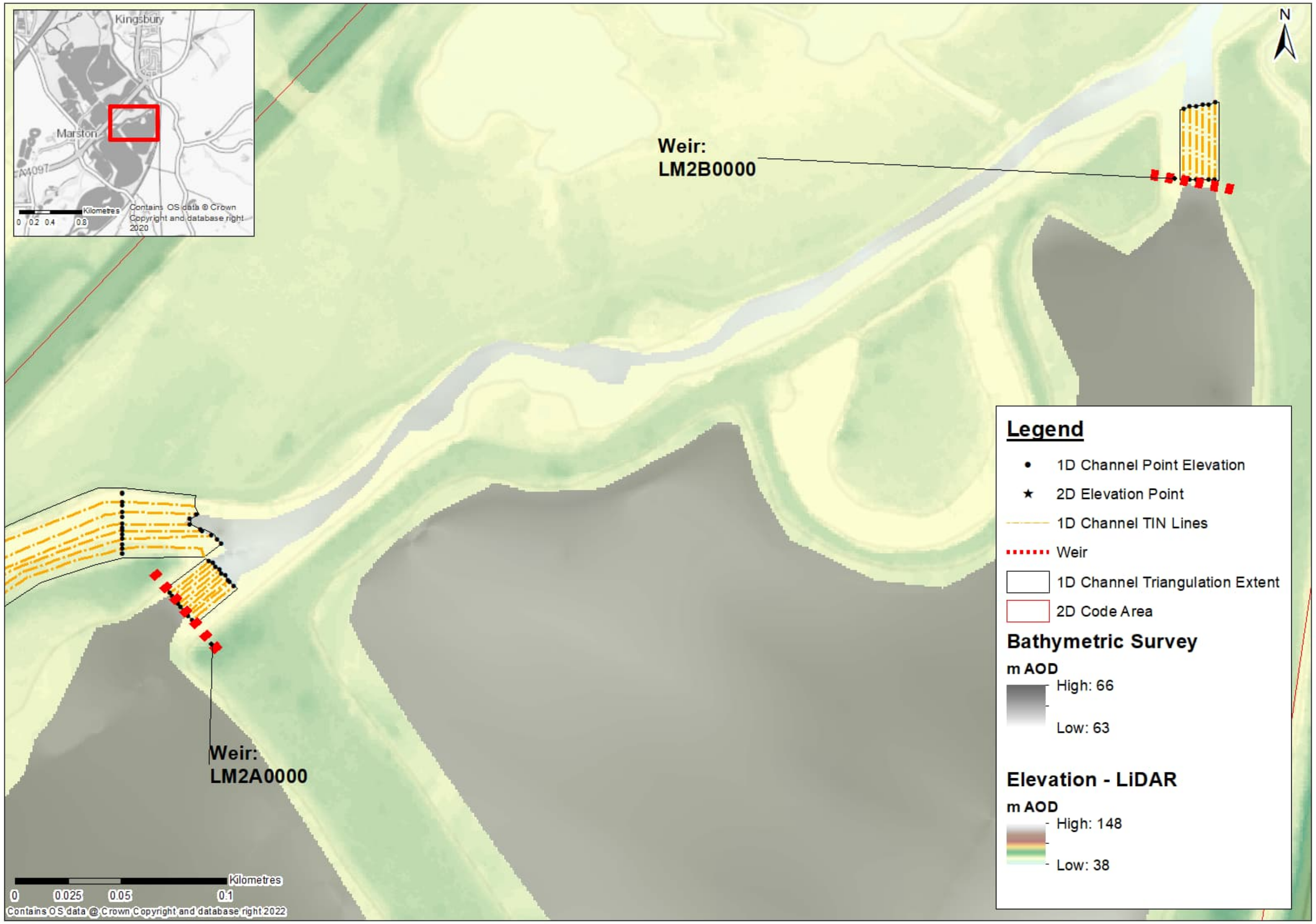


Figure 2-5 : River Tame at Lea Marston – 2D Model Build & Topographic Adjustment around Weirs LM2A0000 & LM2B0000

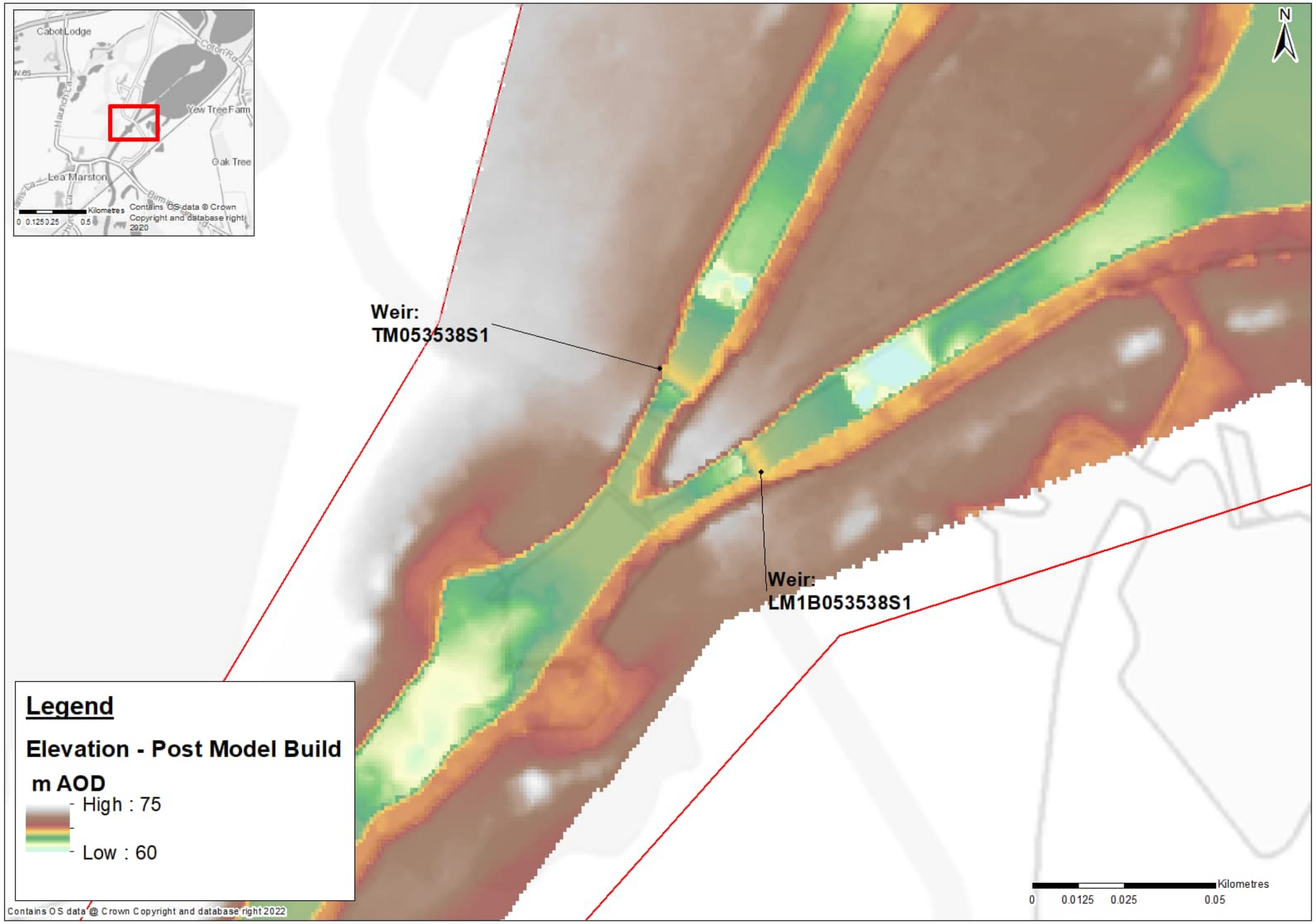


Figure 2-6: River Tame at Lea Marston – Topographic Elevation Post Model Build, Crump Weirs TM053538S1 & LM1B053538S1

Figure 2-7: River Tame at Lea Marston – Satellite image of Crump Weirs: TM053538S1 & LM11B053538S1

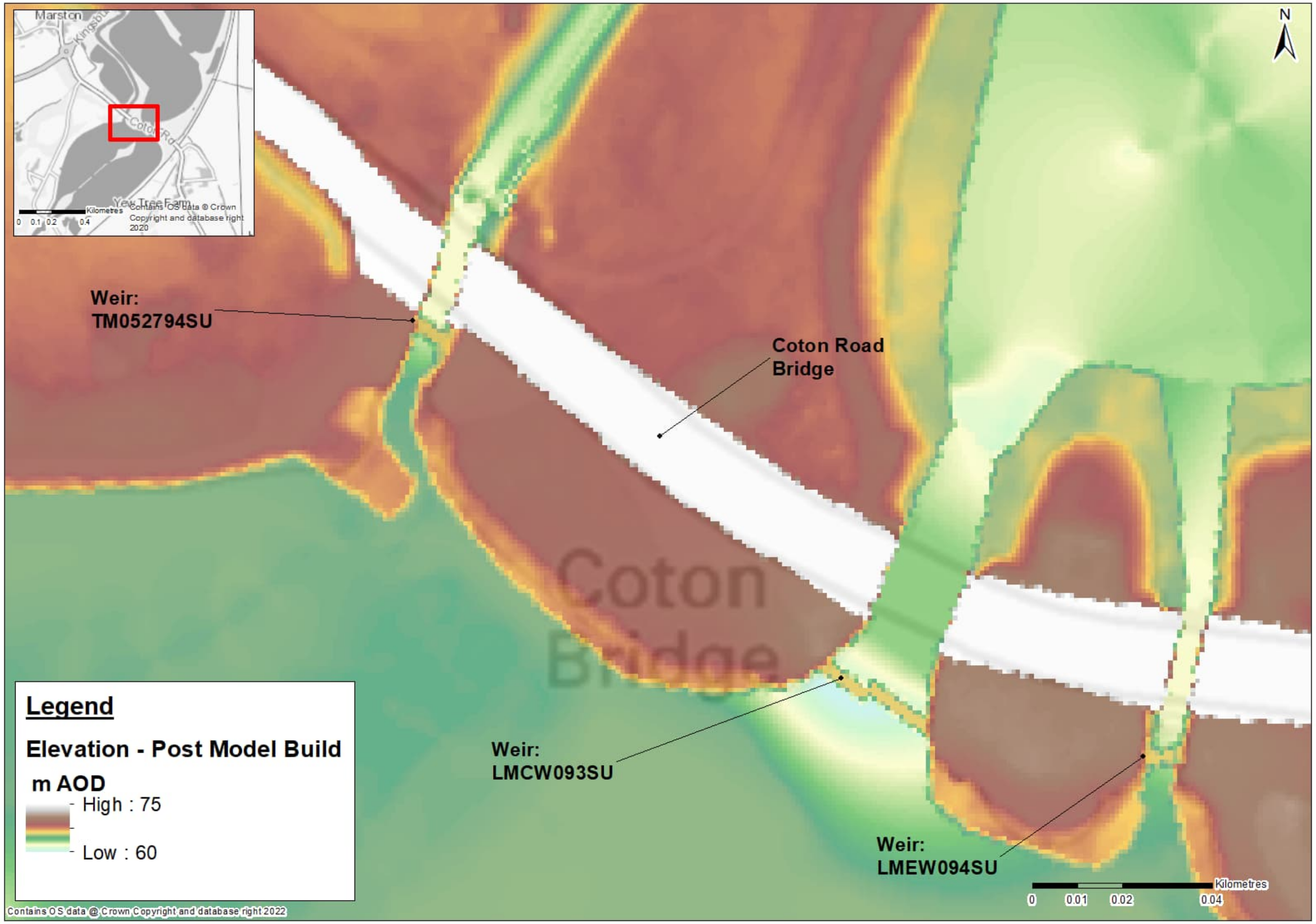


Figure 2-8: River Tame at Lea Marston – Topographic Elevation Post Model, Coton Road Weirs TM052794SU, LMCW093SU & LMEW094SU

Figure 2-9: River Tame at Lea Marston – Satellite Image of Coton Road Weirs: TM052794SU, LMCW093SU & LMEW094SU

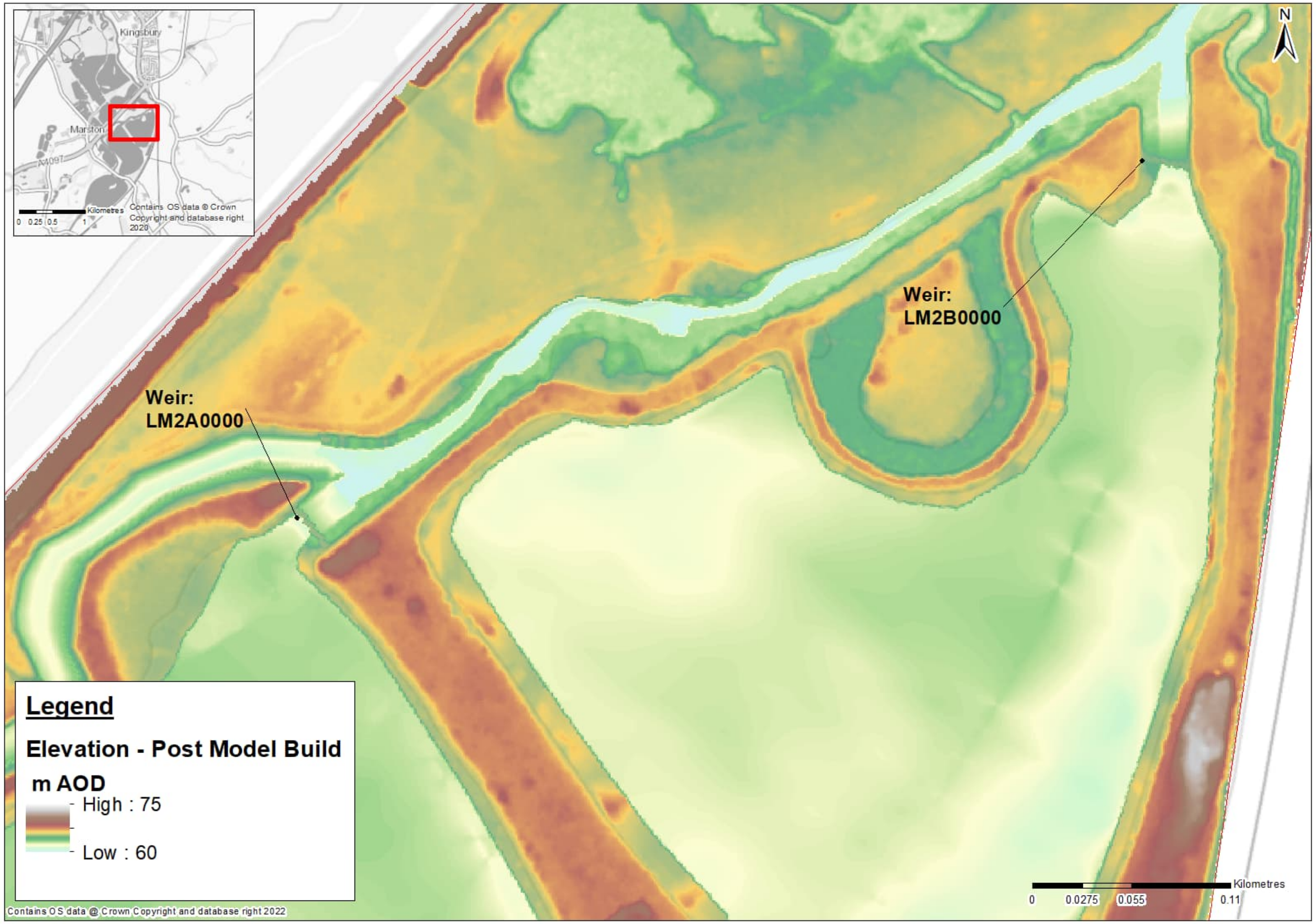


Figure 2-10: River Tame at Lea Marston – Topographic Elevation Post Model Build, weirs LM2A0000 & LM2B0000

Figure 2-11: River Tame at Lea Marston – Satellite Image of two weirs downstream of Lea Marston Lakes, LM2A0000 (left) & LM2B0000 (right)

2.3 River Tame at Tamworth

2.3.1 Table 2-4 outlines the key model build parameters for the reach of the River Tame at Tamworth including two weir structures.

2.3.2 Table 2-5: Tamworth 2D Boundary Conditions details the Boundary Conditions for Tamworth. The River Tame 2D QT & HT Boundaries have been defined from flow and stage results extracted at nodes within the 1D Flood Modeller network. The 1D nodes selected from the 1D model coincide with the location of the 2D boundary.

2.3.3 For the Anker inflow, an existing inflow boundary has been defined in the 1D model, see Table 5-6 Baseline Tame Hydrological Inflows, in the main report. 1D node Point_5 represents the Anker Inflows and has been calibrated to River Anker Aquator Disaggregation Model.

2.3.4 For Scenario A and B, flows were simulated in the 1D model with the associated water take per day, and outputs have been used within the 2D model.

2.3.5 The River Anker QT boundary remains consistent for each SRO operation scenario as the water take is upstream of the Tame / Anker confluence.

2.3.6 As discussed in the main report for the modelling study**,** inflows have been calibrated to gauged and Aquator Model flows to present the 2D modelling Inflow boundaries. The Boundary conditions used for the 2D modelling are described below:

Table 2-4: River Tame at Tamworth model parameters

Software	Tuflow Classic: 2020-01-AB-iDP-w64
Tuflow Control File (.tcf)	▪ Timestep = 1 second ▪ Run time = 4 hours ▪ PO points & Lines outputting Q, H, & V
	The run time allows the model to overcome the initial conditions and to reach steady state. **Simulation run time: 4 hours**
Boundary Condition File (.tbc)	Boundary condition have been taken from the 1D Flood Modeller Model, refer to Table 2-5. ▪ QT Boundary – **Tame_Inflow** – location is downstream of Riverdrive Road, 1D FM node: *TM0335542* ▪ QT Boundary – **Anker_Inflow** – location upstream of Anker & Tame Confluence, 1D FM node: *Point_5* ▪ HT Boundary – **Tame_DS –** location is downstream of Oxbridge Way Road, 1D FM node: *TM031285*
Bc_dbase (.csv)	The Boundary Condition database file reads in the assigned 'Flow Condition and Scenario' QT & HT .csv boundary files – steady state flow (m^3/s) & stage (m AOD) have been extracted from the 1D model. The River Tame and HT and QT boundary value has been taken from the 1D cross sections results for each flow condition and scenario, corresponding to their location represented in the 2D model. The Anker inflow is represented as an Inflow Boundary in the 1D Flood Model. Therefore, the flow defined as part of the initial conditions set up in 1D QT Boundary has been extracted for 2D Anker inflow.
Material File (.tmf)	The Manning's 'N' roughness coefficients for the channel are **0.030 & 0.035**, which have been defined in the 1D model. A **0.050 default manning's roughness** for the rest of the reach has been defined, categorizing the out of channel roughness.
Geometry Control File (.tgc)	▪ A **Cell size of 2 m** has been defined. ▪ A **domain area of 2500 m * 900 m** has been defined in metres, X & Y respectively. The origin of the domain is defined by 2d_loc_Tamworth_R_002.MIF. ▪ Code Area has been defined as the active area for Tamworth – 2d_code_Tamworth_R_002.MIF – this is for low flow modelling, the code area is extended marginally outside of channel bank.

The topography is defined using a combination of:

- The base grid – Tamworth_DTM_002.asc – is composed of Bathymetric survey data stamped onto LiDAR data. See Figure 2-12 for the original LiDAR survey data, and Figure 2-13 for the bathymetry survey extent.
- Interpolation of the channel shape using 1D cross sections data from the original EA model (where bathymetric survey data was not available) – 2d_zsh_Channel_009.MIF. The channel topography has been interpolated connecting point elevations extracted from the 1D model connected using the *TIN line shape_option* in Tuflow. A polygon encompassing the 1 d point elevation and *TIN lines*, acts as a triangulation boundary, see Figure 2-13 through to Figure 2-18.
- Weirs have been defined as *2d Zsh lines*, with the crest level set to the defined 1D Flood Modeller Elevation. *Shape_option* has been set to '*MAX*', and crest has been extended over bank. Refer to Figure 2-14 & Figure 2-16.
- Weir TM0330154W includes a fish pass. The weir crest has been lowered to 43.3 m AOD with a width of 5 m using points along the *zsh line*, to represent the fish pass in 2D.
- Along the edge of the bathymetric survey extents, polygons with defined elevations have been used to merge the LiDAR and Bathymetry together – 2d_zsh_LidarSoft_009.MIF, see Figure 2-13 & Figure 2-20.
- Across the two weirs, a similar method as above has been carried out, used to interpolate the bed level across the weir. Point elevations have been taken from the Bathymetry upstream of the weir and connected to downstream 1D cross sectional elevations – 2d_zsh_WeirAdj_008.MIF. See Figure 2-14 through to Figure 2-19.
- Bridge piers have been created as polygons with defined elevations set to 1D Flood Modeller springing levels, and *shape_option* set to '*NO MERGE'* – 2d_zsh_Tamworth_Bridge_TFRC1249B_R_003.MIF & 2d_zsh_Bridge_TM032670B.MIF & 2d_zsh_Bridge_TM033205B.MIF, see Figure 2-14 & Figure 2-18.
- Initial Water Levels for the channels have been defined. For the northern channel, the initial water level has been set to the elevation of the second (downstream) weir crest. For the southern channel, the initial water level has been set to the Head Boundary – stage taken from the Q50 Baseline – 2d_IWL_Tamworth_Channel_R_004.MIF.
- Manning's roughness has been defined for the channel upstream of the weirs, and downstream of the weirs – 2d_mat_Tamworth_001.MIF – values used are as described in the 1D Flood Modeller Model.

2.3.7 The boundary condition HT and QT for each flow condition and scenario have been detailed in table below.

Table 2-5: Tamworth 2D Boundary Conditions

Tamworth			Q10			Q50			Q95			Q99		
	2D BC	Node	BL	SA	SB	BL	SA	SB	BL	SA	SB	BL	SA	SB
River Tame Network – 1D FM	QT (m^3/s)	TM033542 (Tame Inflow)	24.31	22.98	21.65	11.01	9.68	8.34	7.42	6.09	4.77	7.03	5.70	4.40
	QT (m^3/s)	Point_5 (Anker Inflow)	9.58	9.58	9.58	3.05	3.05	3.05	1.76	1.76	1.76	1.91	1.91	1.91
	HT (m AOD)	TM031285 (Tame Stage)	56.25	56.21	56.18	55.70	55.66	55.61	55.21	55.46	55.39	55.50	55.43	55.48

Figure 2-12:River Tame at Tamworth – LIDAR Topographic Elevation

Figure 2-13: River Tame at Tamworth – 2D Model Build

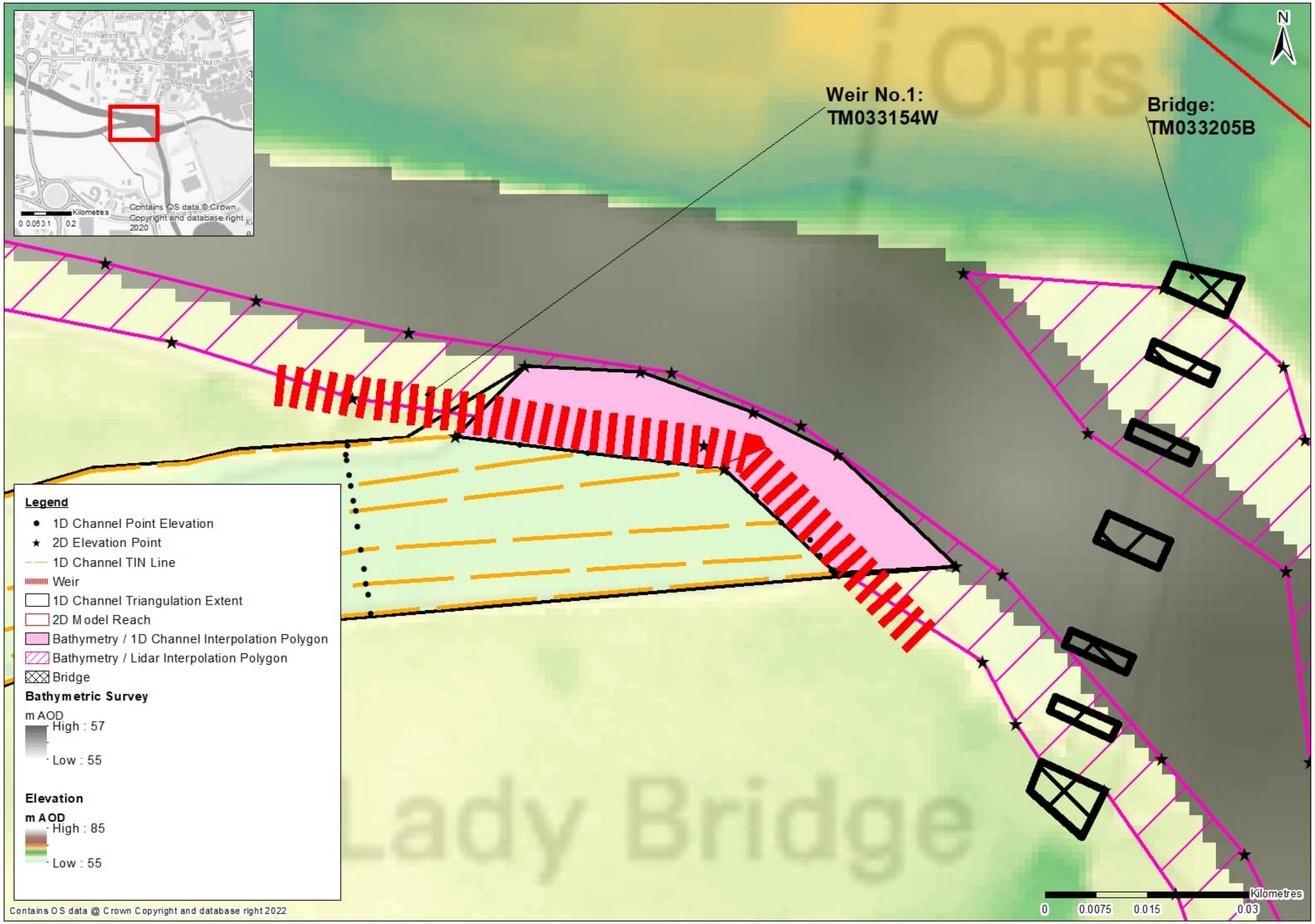


Figure 2-14: River Tame at Tamworth – Adjusted LiDAR topography surrounding Tamworth Weir TM033154W

Figure 2-15: River Tame at Tamworth – Satellite Image of Weir No.1 at Tamworth: TM033154W

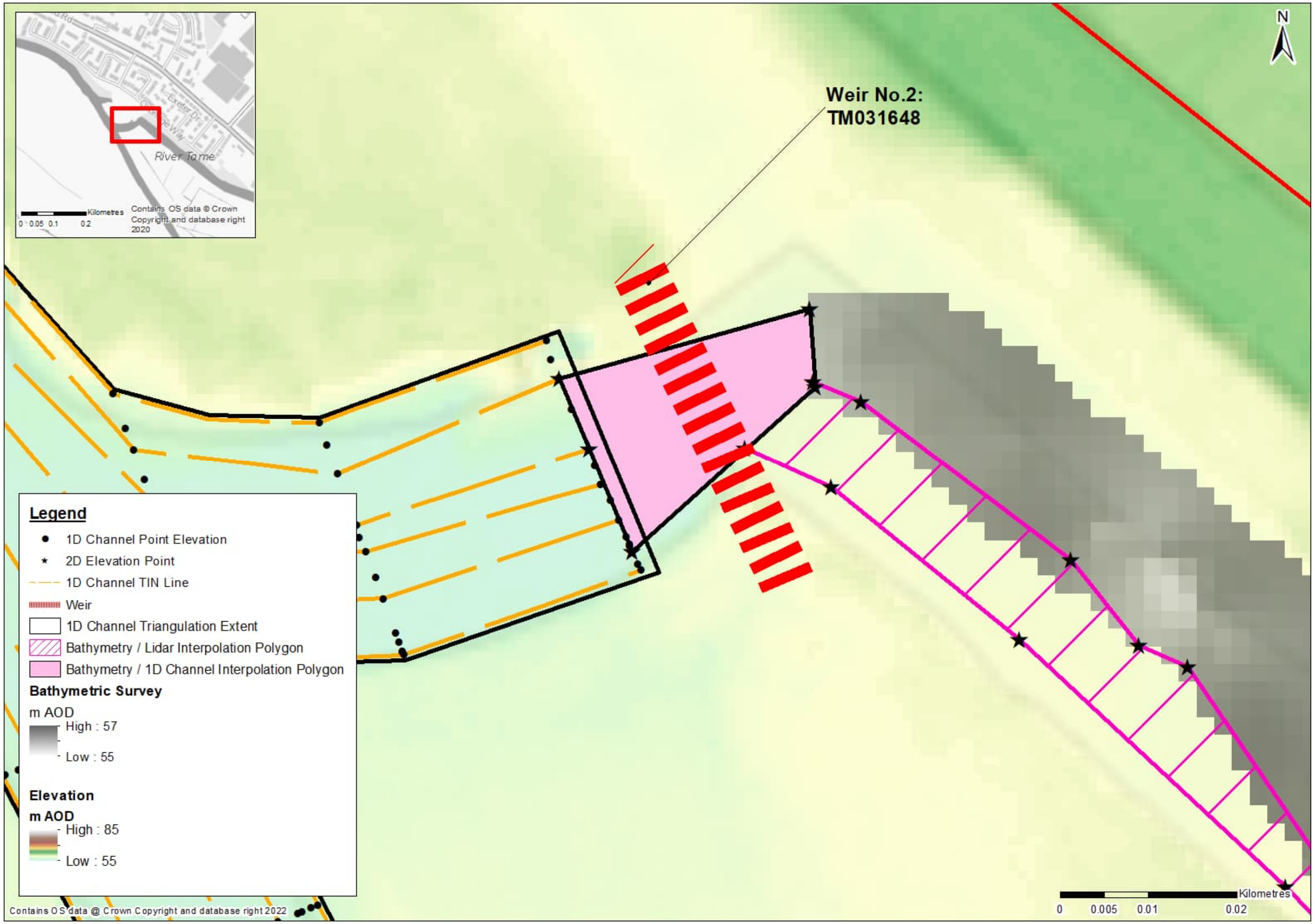


Figure 2-16: River Tame at Tamworth – Adjusted LiDAR topography surrounding Tamworth Weir TM031648

Figure 2-17: River Tame at Tamworth – Satellite Image of Wier No.2 at Tamworth: TM031648

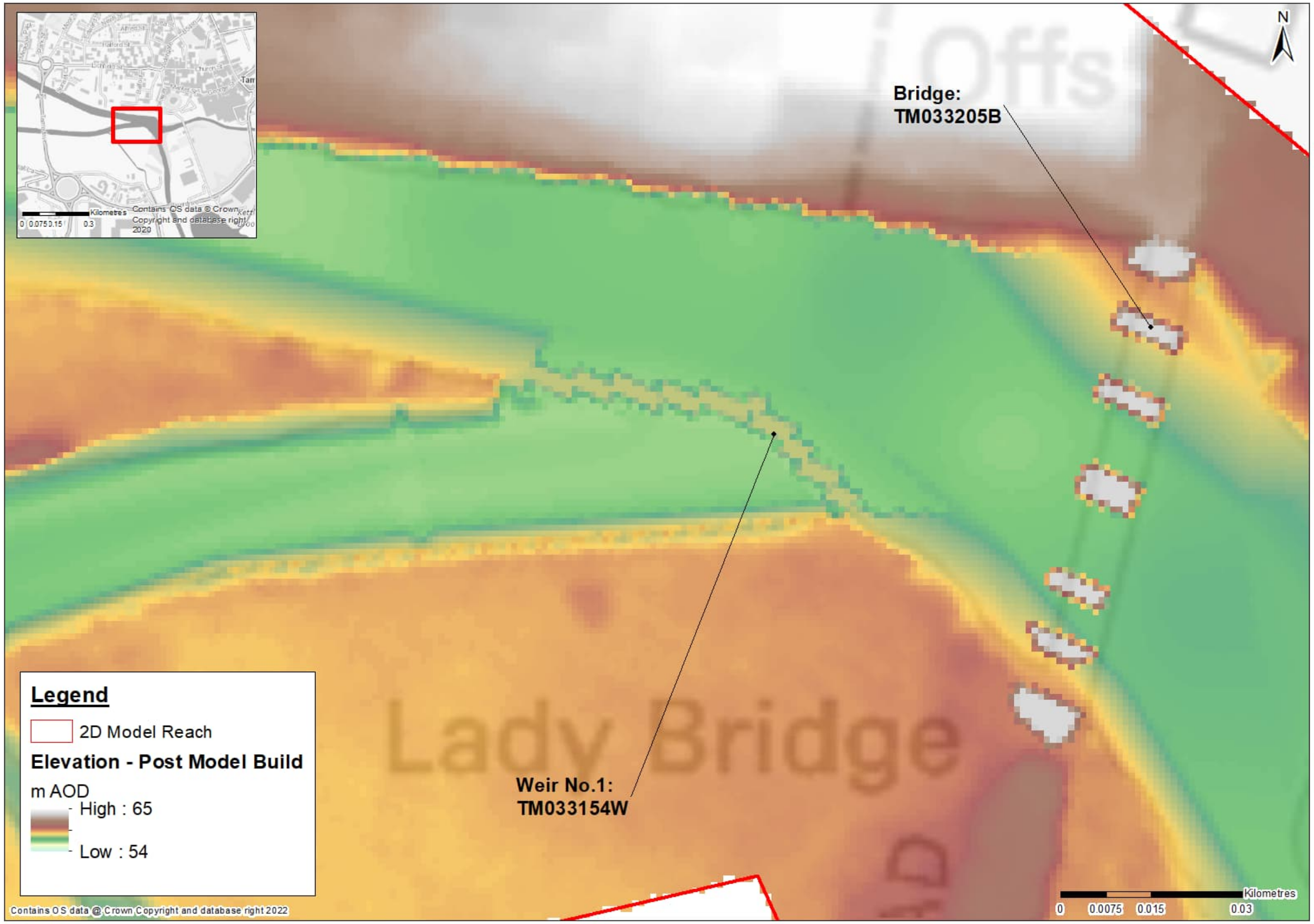


Figure 2-18: River Tame at Tamworth – Model Topography following LiDAR adjustment, surrounding weir TM033154W.

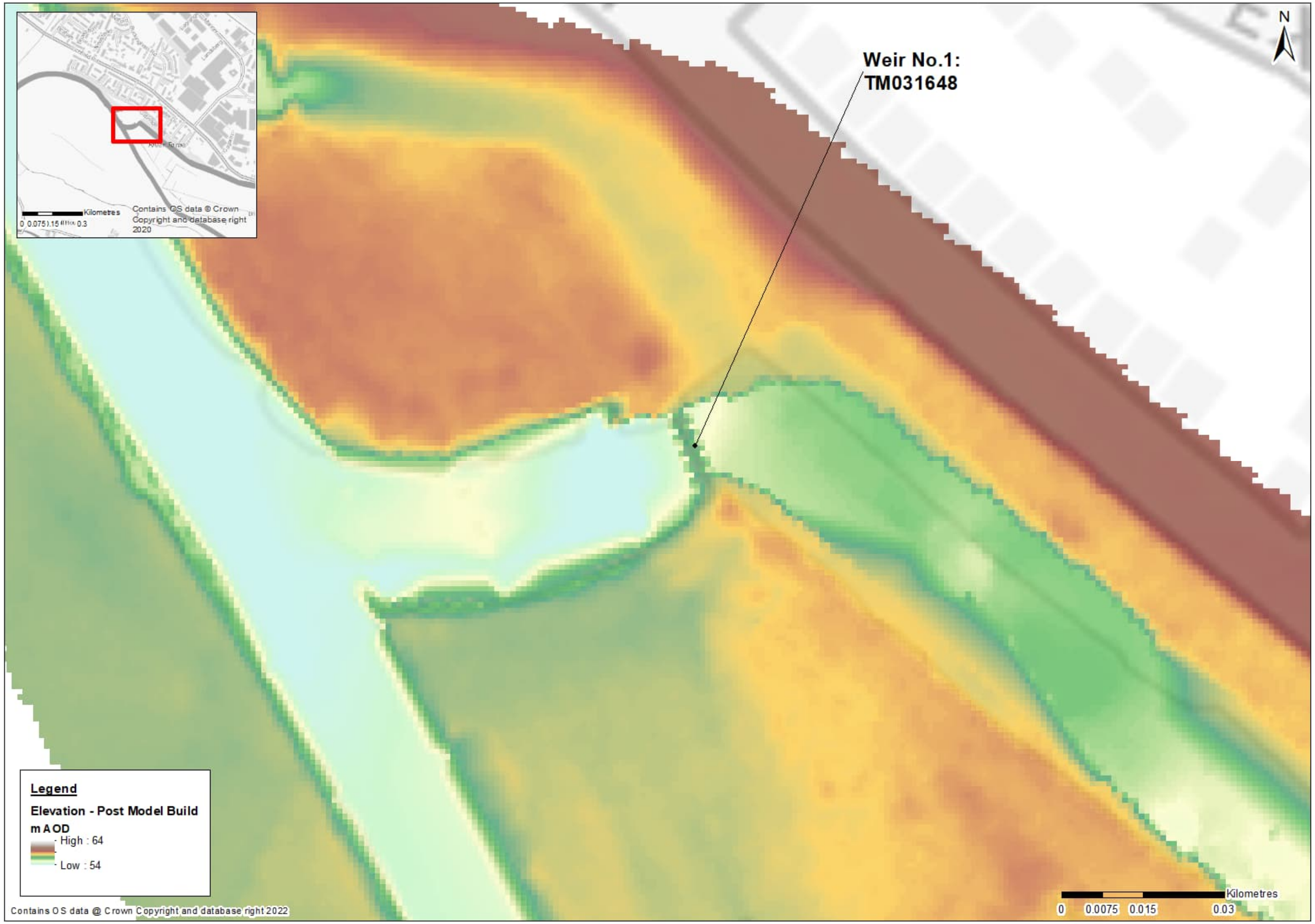


Figure 2-19: River Tame at Tamworth – Elevation post – LiDAR adjustment surrounding weir TM031648.

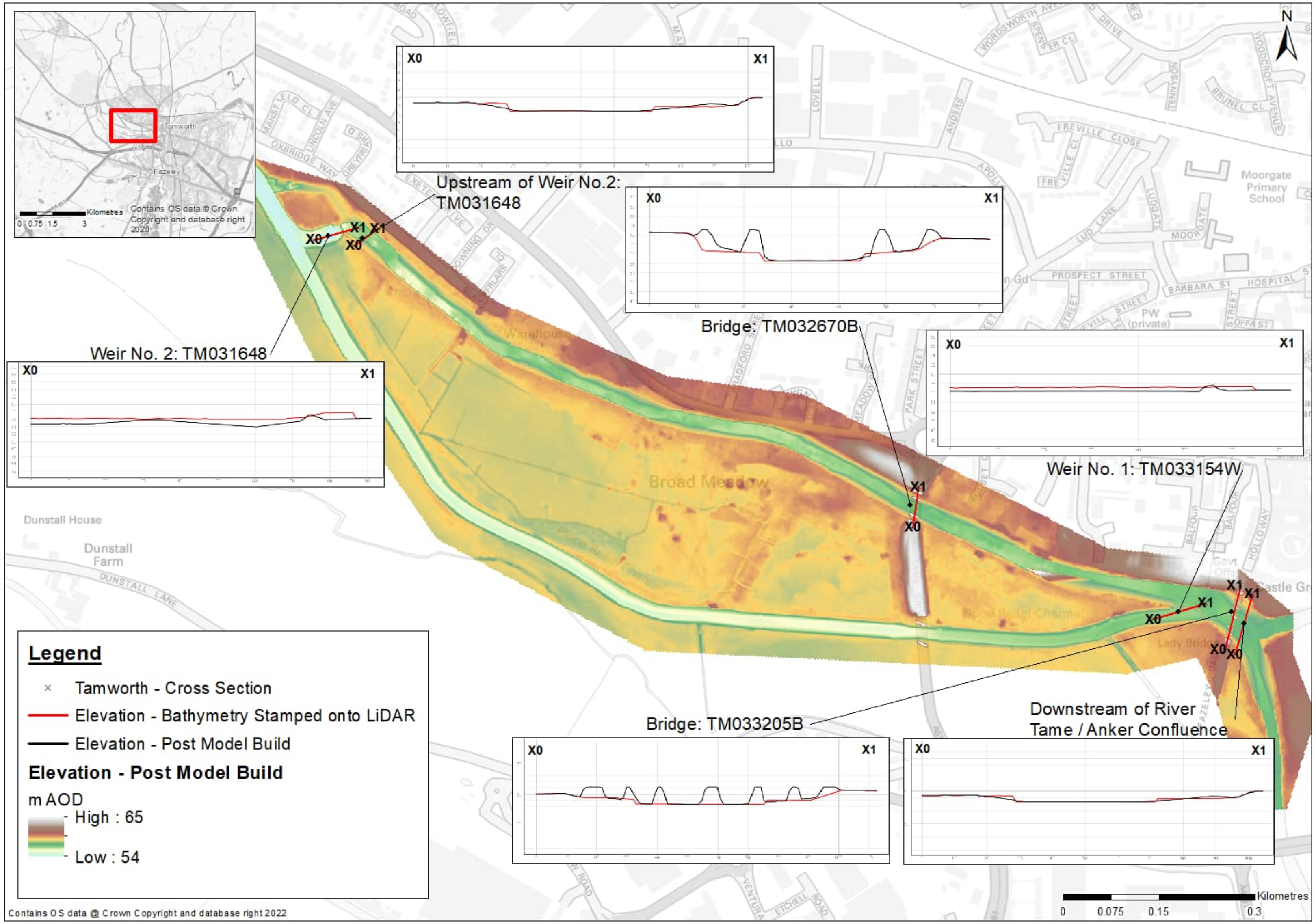


Figure 2-20: River Tame at Tamworth – Elevation post – LiDAR Adjustment & Cross Sections

2.4 River Trent at Winshill

2.4.1 Table 2-6: Winshill 2D Model Build outlines the model build strategy for Winshill.

Table 2-6: Winshill 2D Model Build

Software	Tuflow Classic: 2020-01-AB-iDP-w64
Tuflow Control File (.tcf)	▪ Timestep = 0.5 second ▪ Run time = 4 hours ▪ PO points & Lines outputting Q, H, & V
	The run time allows the model to overcome the initial conditions and to reach steady state. **Simulation run time: 4 hours**
Boundary Condition File (.tbc)	▪ QT Boundary – **Upper_Trent_Inflow** – location is downstream of Saint Peter's Bridge, 1D FM node: 316125330 ▪ QT Boundary – **Lower_Trent_Inflow** – location is downstream of Saint Peter's Bridge, 1D FM node: 316125000 ▪ HT Boundary – **Lower_Trent_DS –** location is upstream of the Trent channels confluence, 1D FM node: 316122430 ▪ HQ Boundary – a stretch of the Upper Trent Channel was not included in the 1D Model; therefore a gradient has been defined for the channel from LiDAR point inspection. Tuflow will use the gradient to calculate a stage-flow boundary to apply to the model.
Bc_dbase (.csv)	The Boundary Condition database file reads in the assigned 'Flow Condition and Scenario' QT & HT .csv boundary files – steady state flow (m^3/s) & stage (m AOD) have been extracted from the 1D model, see Table 2-7. The River Trent flows and stages have been extracted from the 1D model independently for each flow condition and scenario and the corresponding csv has been defined in the Winshill_bc_dbase.
Material File (.tmf)	The Manning's 'N' roughness coefficients for the channel are **0.030 & 0.035**, as defined in the 1D model. A **0.050 default manning's roughness** for the rest of the reach has been defined, categorizing the out of channel roughness.
Geometry Control File (.tgc)	▪ A **Cell size of 1 m** has been defined. ▪ A **domain area of 2500 m *91200 m** has been defined in metres, X & Y respectively. The origin of the domain is defined by 2d_loc_Winshill_R_002.MIF. ▪ Code Area has been defined as the active area – 2d_code_LeaMarston_R_003.MIF. The topography is defined using a combination of: ▪ The base grid – Winshill_DTM_MERGE.asc – is composed of Bathymetric survey data stamped onto LiDAR data. See Figure 2-21 for the original LiDAR survey data, and Figure 2-22 for the bathymetry survey extent. *Weirs have been defined as 2d zsh lines & points. Weir No.1: 316124050 crest has been defined using point elevations from the 1D model, with the crest being lowered where the fish pass is located. Weir No.2: 316123050 crest has been defined using a line with the elevation taken from FM. Shape_option has been set to 'MAX', and crest has been extended over bank. Refer to* ▪ Figure 2-23 and Figure 2-25. ▪ Along the edge of the bathymetric survey extents, polygons with defined elevations have been used to merge the LiDAR and Bathymetry together – 2d_zsh_Winshill_LidarSoft_003.MIF, see Figure 2-22 and Figure 2-29.

Across the two weirs, polygons with point elevations from the bathymetry data have been used interpolate the bed level across the weir – 2d_zsh_Winshill_WeirAdj_010.MIF, See

- Figure 2-23 and Figure 2-25.

Bridge piers have been created as polygons with defined elevations set to 1D Flood Modeller springing levels, and shape_option set to 'NO MERGE' – 2d_zsh_Winshill_Bridge_v3.MIF & 2d_zsh_Winshill_WeirBridge.MIF, see Figure 2-22,

- Figure 2-23 and Figure 2-29.

- Initial Water Levels for the channels have been defined. For the channel upstream of the two weirs, the initial water level has been set to the elevation of the second (downstream) weir crest height. The initial water level for the channels downstream of the weirs has been set to be below the weir crest.

- Manning's roughness has been defined from the 1D Flood Model.

Table 2-7: Winshill Boundary Conditions

Tamworth			**Q10**			**Q50**			**Q95**			**Q99**		
	2D BC	**Node**	**BL**	**SA**	**SB**	**BL**	**SA**	**SB**	**BL**	**SA**	**SB**	**BL**	**SA**	**SB**
River Tame Network – 1D FM	**QT (m^3/s)**	316125330 (Upper Trent Inflow)	9.44	9.17	8.84	0.98	0.79	0.58	0.00	0.00	0.00	0.00	0.00	0.00
	QT (m^3/s)	316125000 (Lower Trent Inflow)	57.48	56.69	55.69	25.320	24.35	23.22	15.29	14.13	12.80	14.57	13.27	11.98
	HT (m AOD)	316122430 (Lower Trent Stage)	43.31	43.29	43.26	42.41	42.38	42.34	42.07	42.03	41.99	42.05	42.00	41.95

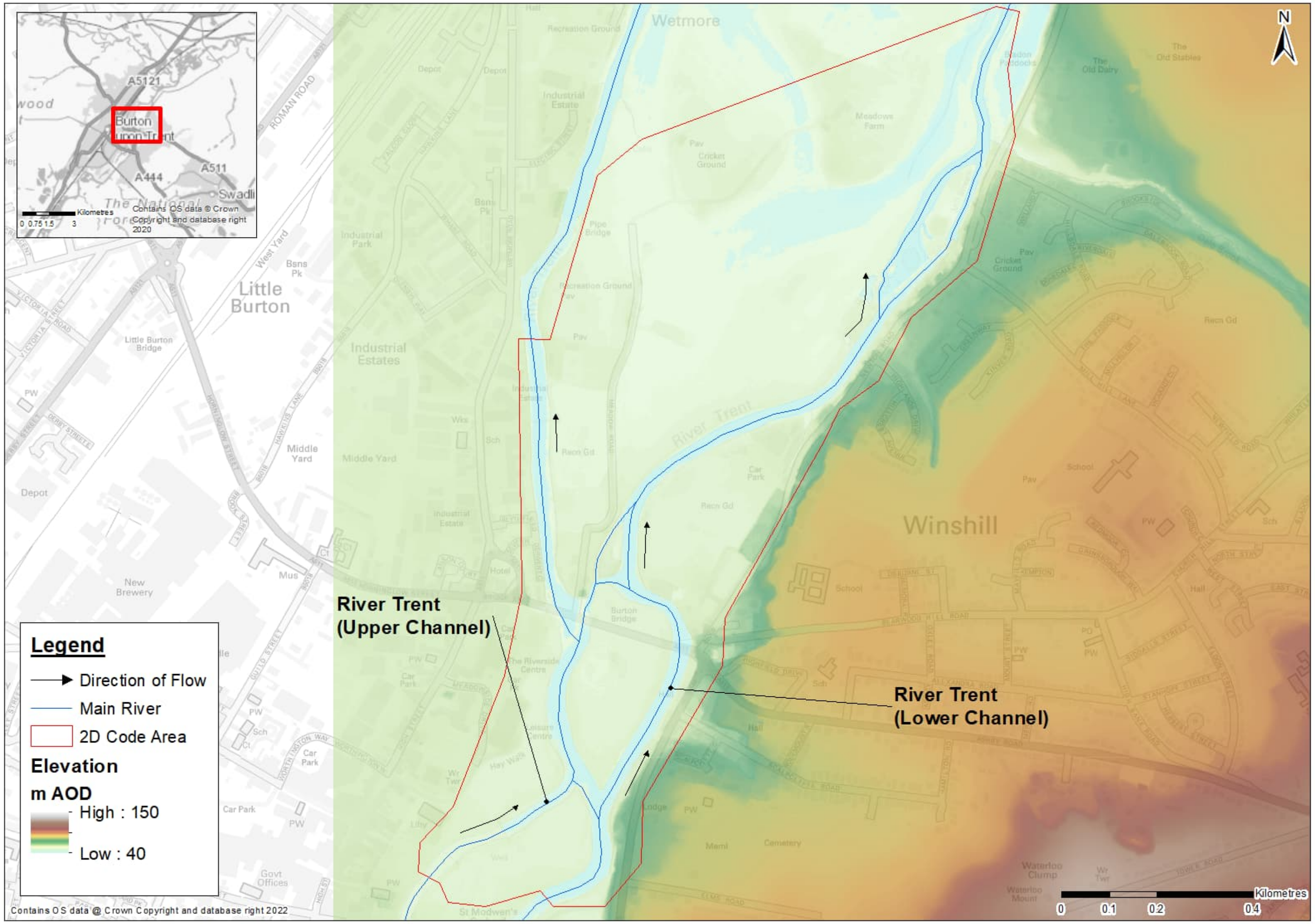


Figure 2-21: River Trent at Winshill – LiDAR Topographic Elevation

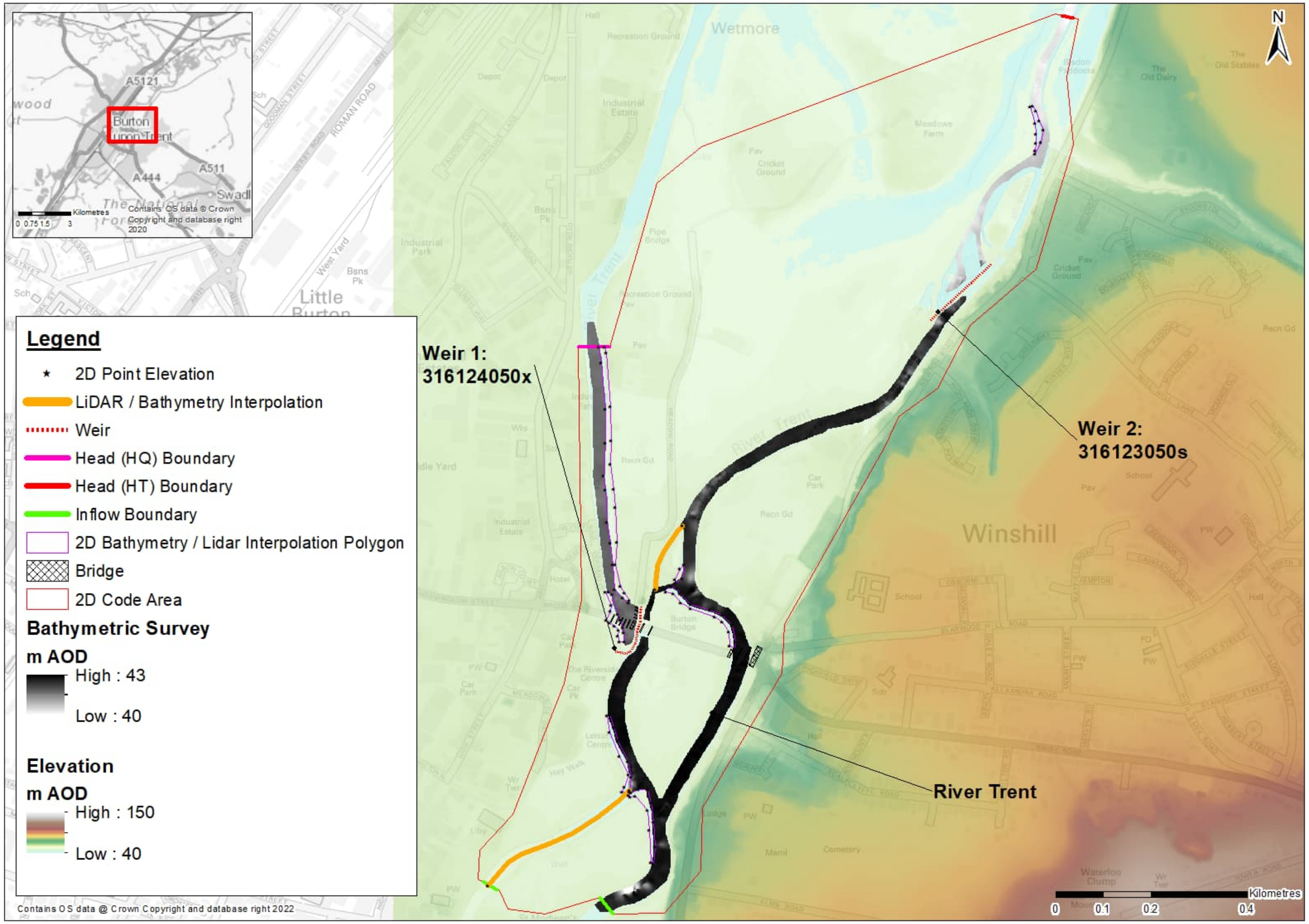


Figure 2-22: River Trent at Winshill – 2D Model Build

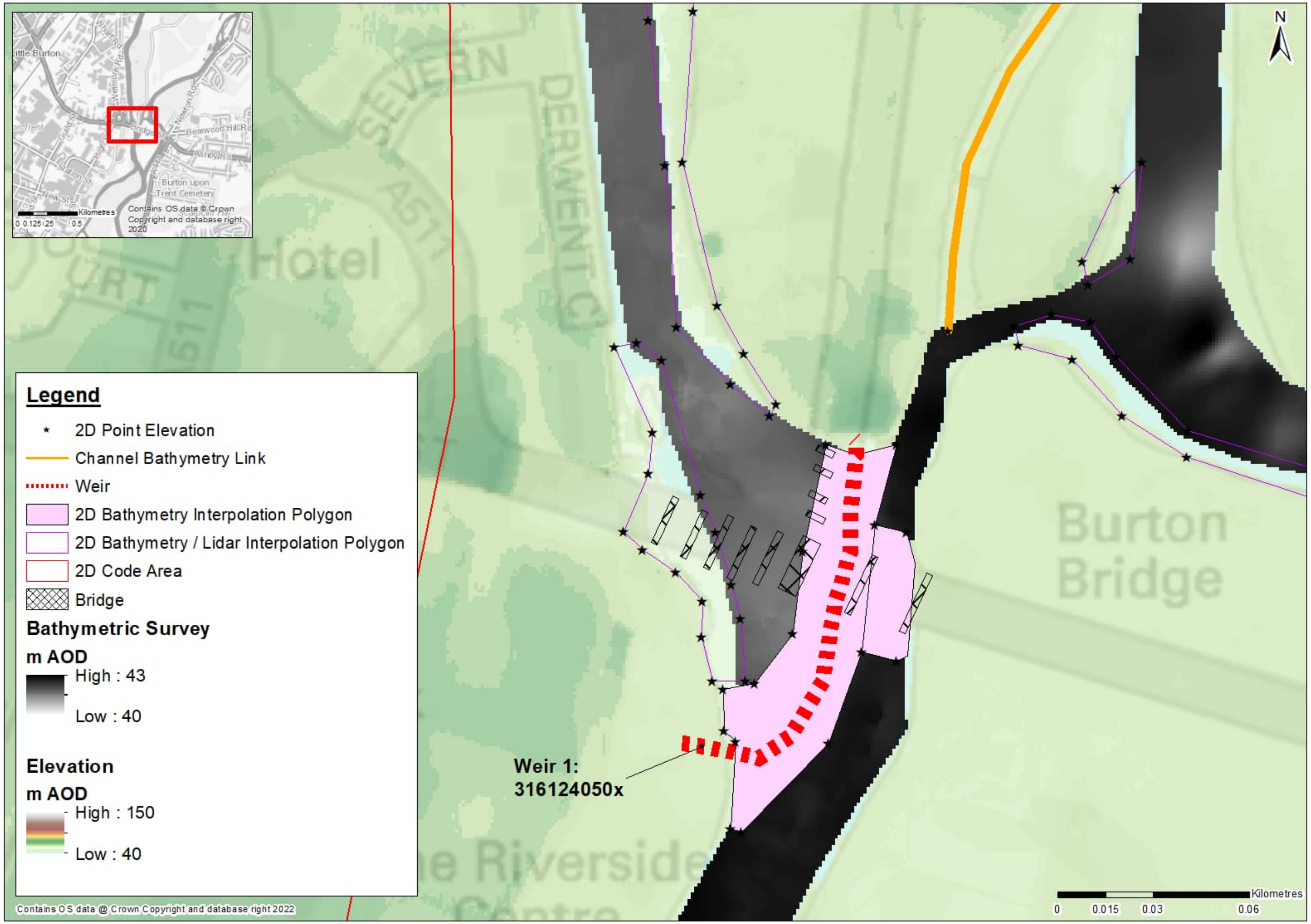


Figure 2-23: River Trent at Winshill – Topographic Adjustment around Weir 1, 316124050x

Figure 2-24: River Trent at Winshill – Satellite Image of Weir No.1 at Winshill: 316124050x

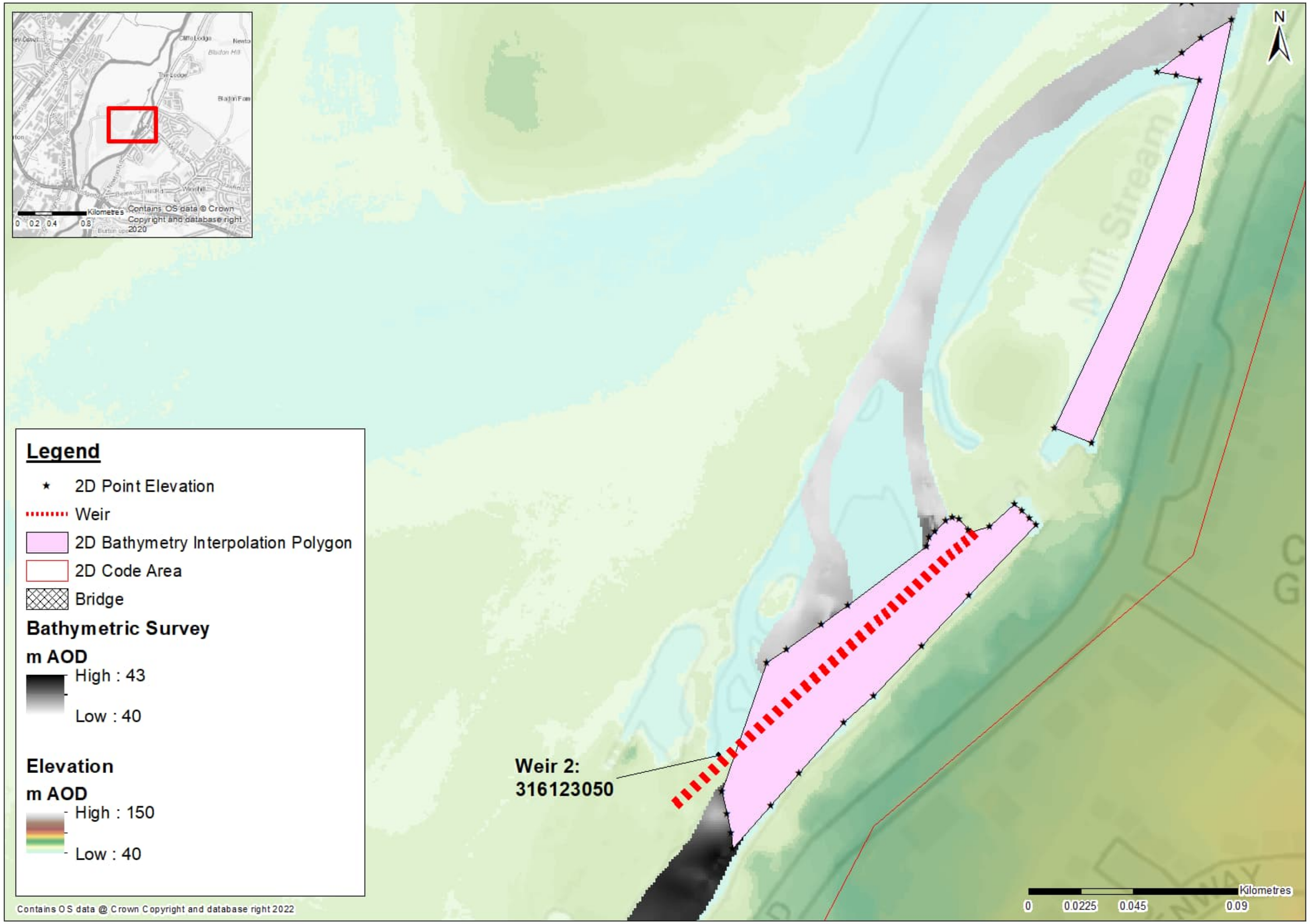


Figure 2-25: River Trent at Winshill – Topographic Adjustment around Weir 2: 316123050

Figure 2-26: River Trent at Winshill – Satellite Image of Weir No.2 at Winshill: 316123050

Figure 2-27: River Trent at Winshill – Elevation Post Model Build, Weir 1: 316124050x

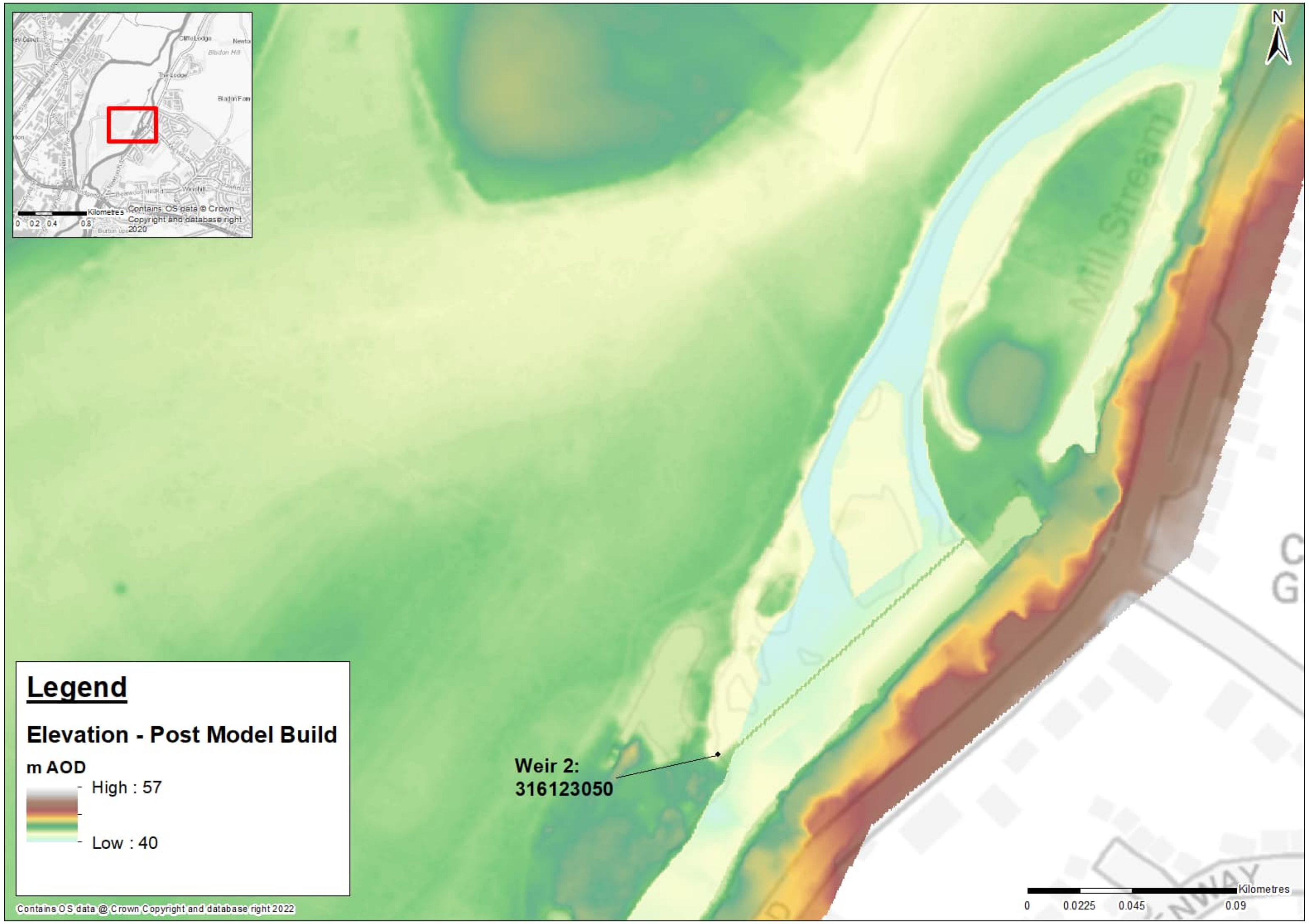


Figure 2-28: River Trent at Winshill – Elevation Post Model Build, Weir 2: 316123050

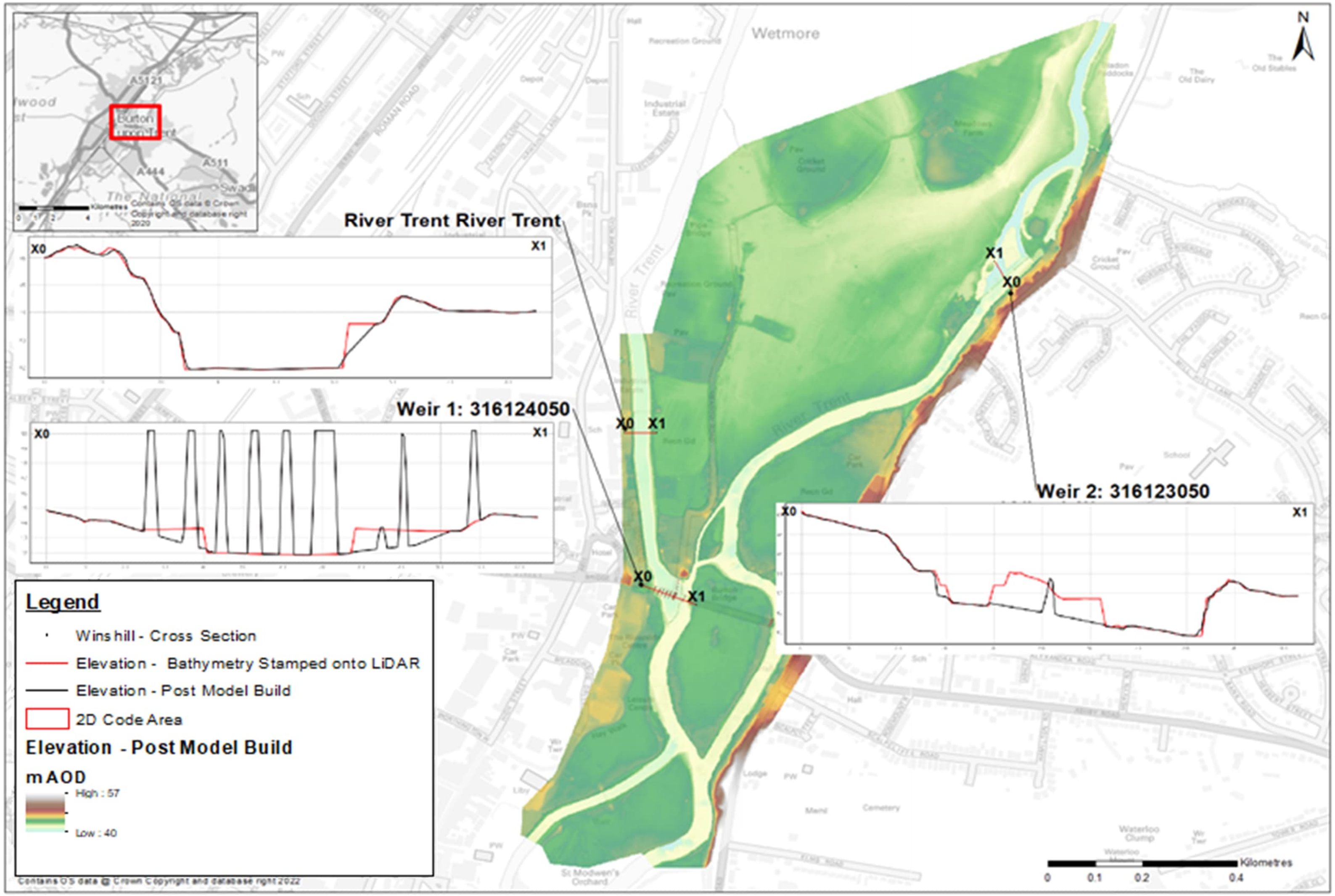


Figure 2-29: River Trent at Winshill – Topographic Post-Model Build Comparison

2.5 Simulations

Lea Marston

2.5.1 The 2D hydraulic models have been simulated for four different flow conditions, the Q10, Q50, Q95, and Q99. A baseline and two different SRO operational scenarios (see section 1.1) were simulated for each flow condition. Stage (H), Velocity (V) and Flow (Q) have been outputted at specific PO point and line locations.

2.5.2 The model found steady state in under 12 hours, after overcoming the initial conditions. The mass error and cumulative volume error for each flow condition and scenario remained under +/- 0.2% with the exception of the Q10 Scenario B which had a cumulative mass error -2.6%.

2.5.3 Each flow condition and scenario output the results from the PO Points and Lines which are shown in Figure 3-1 through to Figure 3-3 for the Lea Marston model.

Tamworth

2.5.4 The 2D hydraulic models have been simulated for four different flow conditions, the Q10, Q50, Q95, and Q99. A baseline and two different SRO operational scenarios were simulated for each flow condition. Stage (H), Velocity (V) and Flow (Q) have been outputted at specific PO point and line locations.

2.5.5 The model found steady state in under 4 hours, after overcoming the initial conditions. The mass error and cumulative volume error for each flow condition and scenario remained under +/- 1% with the exception of the Q10 Scenario A & B which had a cumulative mass error -1.16% & -1.24%, respectively.

2.5.6 Each flow condition and scenario output the results from the PO Points and Lines which are shown in Figure 3-13 and Figure 3-14 for the Tamworth model.

Winshill

2.5.7 The 2D hydraulic models have been simulated for four different flow conditions, the Q10, Q50, Q95, and Q99. A baseline and two different SRO operational scenarios were simulated for each flow condition. Stage (H), Velocity (V) and Flow (Q) have been outputted at specific PO point and line locations.

2.5.8 The model found steady state in under 4 hours, after overcoming the initial conditions. The mass error and cumulative volume error for each flow condition and scenario remained under +/- 1.91% for all of the flow condition scenarios.

2.5.9 Each flow condition and scenario output the results from the PO Points and Lines which are shown in Figure 3-23 and Figure 3-24 for the Tamworth model.

Limitations & Uncertainty

2.5.10 The following limitations and areas of uncertainty associated with the model build, simulations and results of the three models are detailed below:

- Due to the bathymetric survey data being collected via boat, shallow water depths of less than 0.3 m were inaccessible for the survey ARCboat. As such, data below 0.3 m is lacking from the survey. Therefore, interpolation has been required to smooth the model cell elevations between the LiDAR data and the bathymetry.
- The Arcboat was unable to collect data near the weirs, resulting in gaps in data across the structure. As described in the model development sections, interpolation has been used to smooth across these data gaps but there is less confidence in model results in these patches.
- ***Lea Marston & Tamworth –*** The Arcboat survey was unable to capture bathymetric survey data for the main River Tame channel at Lea Marston & Tamworth. Therefore, cross section point elevation data was taken from the 1D model in collaboration with a computational

interpolation method – Triangulated Irregular Network (TIN) Line—to determine the topography of the channel.

- ***Winshill*** – The 1D FM Network does not show flow connectivity through Flour Mill at Mill Hill, and as there is no available data, this section of the Trent Channel remains coherent to the 1D FM.
- ***Winshill*** – one of the bridges over the first weir has not been represented in 1D FM, therefore using the data available, a high-level interpretation of the bridge has been represented in the 2D model.
- ***Winshill –*** A small offshoot channel which reconnects with the Lower Trent Channel has not been represented in the 1D model, at Winshill. Satellite imagery has been used to determine the width of this channel and bathymetric points have been taken to determine the us and downstream bed elevation levels.
- Initial conditions – initial water level – has been pre-determined and is defined by the same value for each flow condition, either using the elevation taken from the 1D model at the most downstream weir, or the Q50 downstream stage. As such, the initial water level is not representative of each initial conditions. However, once the initial conditions are overcome the water level represents the initial flow conditions actual stage.
- ***Lea Marston*** – Representing the 1D culverts under Coton Road in the Lea Marston model caused instabilities in the 2D model. Therefore, the three culverts have been represented as open channels. This approach is justified as the culverts soffit level was not reached for the simulated flows.
- ***Tamworth & WInshill*** – The upstream weir at Tamworth and Winshill has been represented with a single crest level elevation in 1D model. A fish pass has been included based on information collected by AECOM.
- The model has been specifically set up for low flow modelling, and consequently, is unsuitable for high flow modelling.

3. Results

3.1.1 Results have been extracted for the four flow conditions and each of the SRO operational scenarios. These are as follows, and follow the run format of ***'River Reach***_RunID_***flow condition_Scenario***.ALL.sup:

- Q10 Baseline, Q10 Scenario A, & Q10 Scenario B
- Q50 Baseline, Q50 Scenario A, & Q50 Scenario B
- Q95 Baseline, Q95 Scenario A, & Q95 Scenario B
- Q99 Baseline, Q99 Scenario B, & Q99 Scenario B

3.2 Lea Marston Results

3.2.1 The 2D results for depth and velocity changes for all flow condition and scenarios have been included in Table 3-1 through to Table 3-4. The stage and velocity results have been extracted from PO point and line locations; these locations are shown in Figure 3-1, Figure 3-2 and Figure 3-3. Water depth has subsequently been calculated from the stage results using bed elevation inspection data.

3.2.2 For the purpose of this report, only the Q95 outputs have been schematised in figures (see Figure 3-4 through Figure 3-12) to represent a low flow condition. Model results have been made available for other flow conditions for ecological assessment. The baseline maximum water depths and velocities have been schematised for the Q95 flow condition, and depth and velocity differences are shown for the Q95 scenarios vs Q95 baseline.

3.2.3 A decrease in water depth has been displayed for each flow condition and scenario. Downstream of two weirs exiting Lea Marston Lakes – LM2A0000 & LM2B000 – is where the percentage change in water depth is greatest, especially for the lowest flow condition. The Q99 & Q95 Scenario B results show a decrease in water depth of approximately -20% & -25% see Table 3-1.

3.2.4 Velocities are shown to mainly decrease for each flow condition and scenario modelled, upstream and downstream of each weir. However, there are isolated areas where velocities are shown increase, see Table 3-3 and Table 3-4.

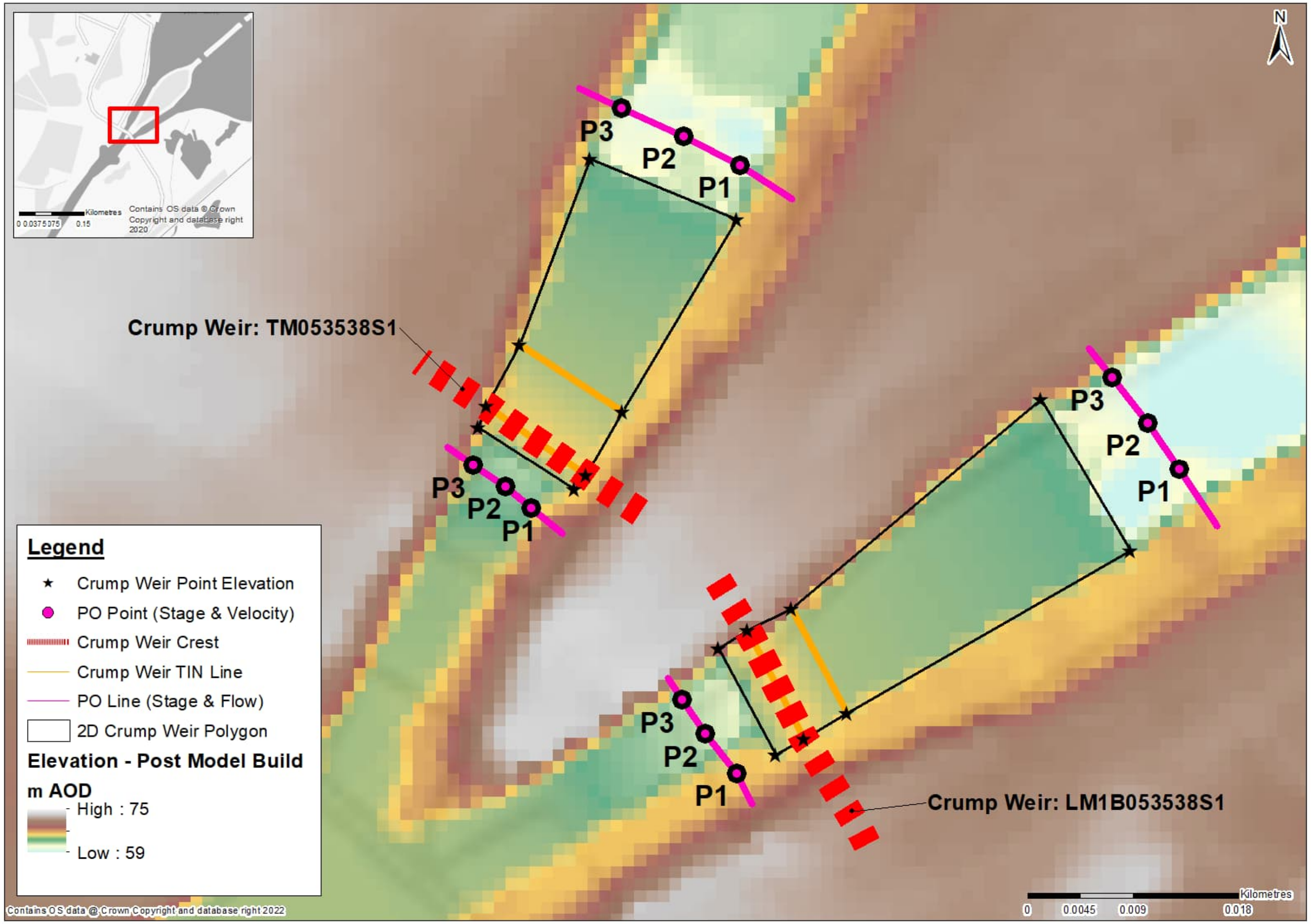


Figure 3-1: River Tame at Lea Marston – PO Points & Lines at Crump Weir, TM053538S1 & LM1B05358S1

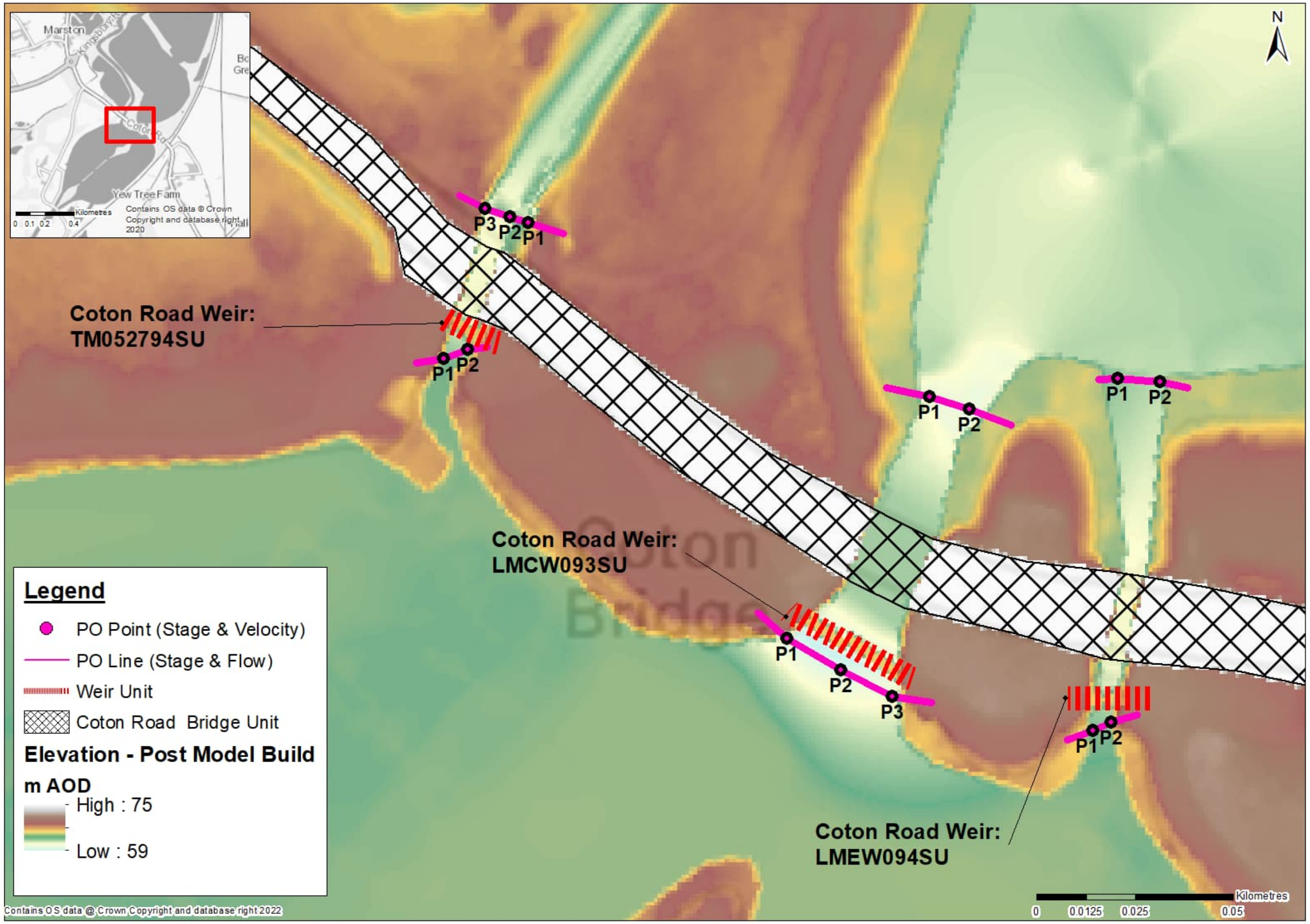


Figure 3-2: River Tame at Lea Marston – PO Points & Lines at Coton Road Weirs

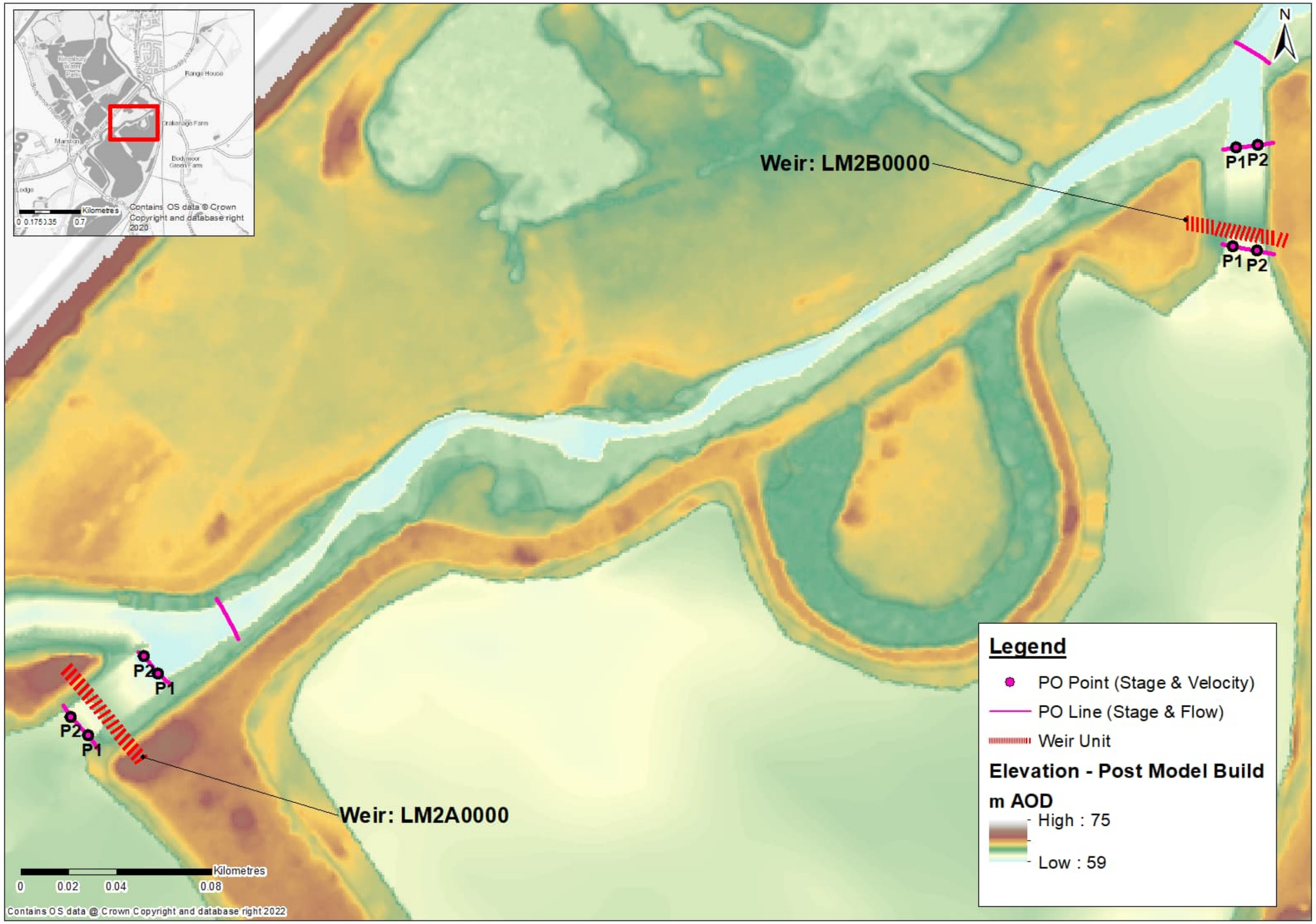


Figure 3-3: River Tame at Lea Marston – PO Points & Lines, Weir: LM2A000 & LM2B0000

		Q99								Q95							
Cross Section	Bed Elevation m AOD	Baseline Water Depth (m)	Simulated Baseline Stage (m AOD)	Scenario A Stage (mAOD)	Scenario A Water Depth change from Baseline (m)	Scenario A Maximum Water Depth change (%)	Scenario B Stage (mAOD)	Scenario B Water Depth change from Baseline (m)	Scenario B Maximum Water Depth Change (%)	Baseline Water Depth (m)	Simulated Baseline Stage (m AOD)	Scenario A Stage (mAOD)	Scenario A Water Depth change from Baseline (m)	Scenario A Maximum Water Depth change (%)	Scenario B Stage (mAOD)	Scenario B Water Depth change from Baseline (m)	Scenario B Maximum Water Depth Change (%)
Upstream Crump Weir (East)	64.36	2.14	**66.50**	**66.46**	-0.04	-1.8%	**66.41**	-0.09	-4.0%	2.15	**66.51**	**66.47**	-0.04	-1.7%	**66.43**	-0.08	-3.6%
Upstream Crump Weir (West)	64.70	1.76	**66.46**	**66.43**	-0.03	-1.8%	**66.40**	-0.06	-3.4%	1.77	**66.47**	**66.44**	-0.03	-1.8%	**66.40**	-0.07	-3.8%
Dowstream Crump Weir (East)	63.42	2.94	**66.36**	**66.32**	-0.04	-1.3%	**66.29**	-0.07	-2.3%	2.94	**66.36**	**66.33**	-0.03	-1.0%	**66.30**	-0.06	-2.0%
Upstream Crump Weir (West)	64.04	2.31	**66.35**	**66.32**	-0.03	-1.1%	**66.29**	-0.06	-2.5%	2.32	**66.36**	**66.33**	-0.03	-1.2%	**66.30**	-0.06	-2.5%
Upstream Coton Road Weir LMEW094SU (East)	64.80	1.54	**66.34**	**66.32**	-0.02	-1.4%	**66.29**	-0.05	-3.3%	1.55	**66.35**	**66.33**	-0.02	-1.5%	**66.30**	-0.05	-3.3%
Upstream Coton Road Weir LMCW093SU (Central)	63.24	3.11	**66.35**	**66.32**	-0.03	-1.0%	**66.29**	-0.06	-1.9%	3.12	**66.36**	**66.33**	-0.03	-1.0%	**66.30**	-0.06	-1.9%
Upstream of Coton Road Weir TM052794SU (West)	64.69	1.65	**66.34**	**66.32**	-0.02	-1.4%	**66.29**	-0.05	-3.1%	1.66	**66.35**	**66.32**	-0.03	-1.5%	**66.30**	-0.05	-3.2%
Dowstream of Coton Road Weir LMEW094SU (East)	64.55	0.99	**65.54**	**65.51**	-0.03	-3.2%	**65.48**	-0.06	-6.3%	0.99	**65.54**	**65.52**	-0.02	-2.3%	**65.49**	-0.05	-5.3%
Downstream of Coton Road Weir LMCW093SU (Central)	63.59	1.95	**65.54**	**65.51**	-0.03	-1.6%	**65.48**	-0.06	-3.2%	1.95	**65.54**	**65.52**	-0.02	-1.2%	**65.49**	-0.05	-2.7%
Downstream of Coton Road Weir TM052794SU (West)	64.16	0.74	**64.90**	**64.85**	-0.05	-6.3%	**64.80**	-0.10	-13.0%	0.75	**64.91**	**64.87**	-0.04	-5.2%	**64.82**	-0.09	-12.0%
Upstream of Weir LM2A000	64.209	1.33	**65.54**	**65.51**	-0.03	-2.4%	**65.48**	-0.06	-4.7%	1.33	**65.54**	**65.52**	-0.02	-1.7%	**65.49**	-0.05	-3.9%
Downstream of Weir LM2A0000	62.410	1.70	**64.11**	**63.93**	-0.18	-10.6%	**63.73**	-0.38	-22.3%	1.75	**64.16**	**63.98**	-0.18	-10.2%	**63.80**	-0.36	-20.5%
Upstream of Weir LM2B0000	63.788	1.74	**65.53**	**65.51**	-0.02	-1.3%	**65.48**	-0.05	-3.1%	1.75	**65.54**	**65.52**	-0.02	-1.4%	**65.49**	-0.05	-3.0%
Downstream of Weir LM2B0000	62.673	1.13	**63.80**	**63.69**	-0.11	-9.4%	**63.52**	-0.28	-24.6%	1.19	**63.86**	**63.73**	-0.13	-10.9%	**63.59**	-0.27	-22.4%
Downstream Boundary	61.65	1.87	**63.52**	**63.42**	-0.10	-5.3%	**63.32**	-0.20	-10.9%	1.94	**63.59**	**63.47**	-0.12	-6.2%	**63.37**	-0.22	-11.5%

Table 3-1: River Tame at Lea Marston – Water Depth Difference, Q99 & Q95 Flow Condition – Results from PO Lines

		Q50								Q10							
Cross Section	**Bed Elevation m AOD**	**Baseline Water Depth (m)**	**Simulated Baseline Stage (m AOD)**	**Scenario A Stage (mAOD)**	**Scenario A Water Depth change from Baseline (m)**	**Scenario A Maximum Water Depth change (%)**	**Scenario B Stage (mAOD)**	**Scenario B Water Depth change from Baseline (m)**	**Scenario B Maximum Water Depth Change (%)**	**Baseline Water Depth (m)**	**Simulated Baseline Stage (m AOD)**	**Scenario A Stage (mAOD)**	**Scenario A Water Depth change from Baseline (m)**	**Scenario A Maximum Water Depth change (%)**	**Scenario B Stage (mAOD)**	**Scenario B Water Depth change from Baseline (m)**	**Scenario B Maximum Water Depth Change (%)**
Upstream Crump Weir (East)	64.36	2.24	**66.60**	**66.57**	-0.03	-1.5%	**66.53**	-0.07	-3.0%	2.51	**66.87**	**66.85**	-0.02	-0.7%	**66.83**	-0.04	-1.6%
Upstream Crump Weir (West)	64.70	1.86	**66.56**	**66.53**	-0.03	-1.6%	**66.50**	-0.06	-3.0%	2.06	**66.76**	**66.74**	-0.02	-0.7%	**66.71**	-0.05	-2.2%
Dowstream Crump Weir (East)	63.42	3.00	**66.42**	**66.40**	-0.02	-0.7%	**66.37**	-0.05	-1.5%	3.21	**66.63**	**66.62**	-0.01	-0.2%	**66.60**	-0.03	-1.0%
Upstream Crump Weir (West)	64.04	2.39	**66.43**	**66.40**	-0.03	-1.2%	**66.38**	-0.05	-2.2%	2.60	**66.64**	**66.62**	-0.02	-0.8%	**66.60**	-0.04	-1.5%
Upstream Coton Road Weir LMEW094SU (East)	64.80	1.62	**66.42**	**66.39**	-0.03	-1.6%	**66.37**	-0.05	-3.1%	1.82	**66.62**	**66.60**	-0.02	-1.3%	**66.58**	-0.04	-2.3%
Upstream Coton Road Weir LMCW093SU (Central)	63.24	3.18	**66.42**	**66.40**	-0.02	-0.7%	**66.37**	-0.05	-1.5%	3.38	**66.62**	**66.60**	-0.02	-0.5%	**66.59**	-0.03	-1.0%
Upstream of Coton Road Weir TM052794SU (West)	64.69	1.72	**66.41**	**66.39**	-0.02	-1.2%	**66.36**	-0.05	-2.7%	1.88	**66.57**	**66.55**	-0.02	-1.0%	**66.53**	-0.04	-2.2%
Dowstream of Coton Road Weir LMEW094SU (East)	64.55	1.05	**65.60**	**65.58**	-0.02	-1.9%	**65.56**	-0.04	-4.1%	1.20	**65.75**	**65.74**	-0.01	-0.8%	**65.72**	-0.03	-2.3%
Downstream of Coton Road Weir LMCW093SU (Central)	63.59	2.01	**65.60**	**65.58**	-0.02	-1.0%	**65.56**	-0.04	-2.1%	2.16	**65.75**	**65.74**	-0.01	-0.5%	**65.72**	-0.03	-1.3%
Downstream of Coton Road Weir TM052794SU (West)	64.16	0.84	**65.00**	**64.97**	-0.03	-3.7%	**64.93**	-0.07	-8.2%	1.17	**65.33**	**65.29**	-0.04	-3.1%	**65.26**	-0.07	-5.9%
Upstream of Weir LM2A000	64.21	1.39	**65.60**	**65.58**	-0.02	-1.5%	**65.56**	-0.04	-3.1%	1.54	**65.75**	**65.73**	-0.02	-1.1%	**65.72**	-0.03	-2.0%
Downstream of Weir LM2A0000	62.41	2.11	**64.52**	**64.38**	-0.14	-6.7%	**64.24**	-0.28	-13.4%	2.71	**65.12**	**65.09**	-0.03	-1.3%	**65.05**	-0.07	-2.4%
Upstream of Weir LM2B0000	63.79	1.81	**65.60**	**65.58**	-0.02	-1.3%	**65.55**	-0.05	-2.5%	1.95	**65.74**	**65.73**	-0.01	-0.6%	**65.72**	-0.02	-1.2%
Downstream of Weir LM2B0000	62.67	1.51	**64.18**	**64.04**	-0.14	-9.3%	**63.94**	-0.24	-15.9%	2.16	**64.83**	**64.78**	-0.05	-2.4%	**64.73**	-0.10	-4.7%
Downstream Boundary	61.65	2.19	**63.84**	**63.74**	-0.10	-4.4%	**63.64**	-0.20	-8.9%	2.87	**64.52**	**64.46**	-0.06	-2.2%	**64.39**	-0.13	-4.4%

Table 3-2: River Tame at Lea Marston – Water Depth Difference, Q50 & Q10 Flow Condition – Results from PO Lines

		Q99							Q95						
PO Location	PO Point	Baseline Velocity (m/s)	Scenario A Velocity (m/s)	Scenario A Velocity change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Velocity (m/s)	Scenario B Velocity change from baseline (m/s)	Scenario B Velocity change from baseline (%)	Baseline Velocity (m/s)	Scenario A Velocity (m/s)	Scenario A Velocity change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Velocity (m/s)	Scenario B Velocity change from baseline (m/s)	Scenario B Velocity change from baseline (%)
	P1	**0.27**	**0.23**	-0.04	-15%	**0.09**	-0.18	-66%	**0.29**	**0.26**	-0.03	-10%	**0.16**	-0.14	-47%
	P2	**0.18**	**0.17**	0.00	0%	**0.10**	-0.08	-45%	**0.20**	**0.17**	-0.02	-10%	**0.12**	-0.07	-36%
US Crump Weir (East)	P3	**0.23**	**0.17**	-0.06	-26%	**0.15**	-0.08	-35%	**0.25**	**0.19**	-0.06	-24%	**0.17**	-0.08	-32%
	P1	**0.41**	**0.32**	-0.09	-22%	**0.27**	-0.13	-32%	**0.43**	**0.35**	-0.08	-19%	**0.26**	-0.17	-39%
	P2	**0.28**	**0.23**	-0.04	-15%	**0.19**	-0.09	-33%	**0.29**	**0.25**	-0.04	-14%	**0.20**	-0.09	-31%
US Crump Weir (West)	P3	**0.15**	**0.13**	-0.02	-14%	**0.10**	-0.04	-27%	**0.15**	**0.13**	-0.02	-13%	**0.11**	-0.04	-26%
	P1	**0.04**	**0.03**	-0.01	-24%	**0.03**	-0.01	-24%	**0.03**	**0.03**	0.00	0%	**0.03**	0.00	0%
	P2	**0.15**	**0.10**	-0.05	-34%	**0.06**	-0.08	-54%	**0.14**	**0.11**	-0.03	-21%	**0.08**	-0.06	-43%
DS Crump Weir (East)	P3	**0.14**	**0.08**	-0.06	-42%	**0.05**	-0.09	-63%	**0.15**	**0.11**	-0.04	-27%	**0.06**	-0.09	-61%
	P1	**0.06**	**0.04**	-0.01	-18%	**0.04**	-0.02	-36%	**0.04**	**0.04**	0.00	0%	**0.04**	0.00	0%
	P2	**0.17**	**0.13**	-0.04	-24%	**0.10**	-0.07	-42%	**0.17**	**0.14**	-0.04	-23%	**0.10**	-0.07	-41%
DS Crump Weir (West)	P3	**0.02**	**0.01**	-0.01	-47%	**0.01**	-0.01	-47%	**0.02**	**0.02**	0.00	0%	**0.01**	-0.01	-50%
	P1	**0.04**	**0.03**	-0.01	-26%	**0.03**	-0.01	-26%	**0.04**	**0.03**	-0.01	-23%	**0.03**	-0.01	-23%
	P2	**0.05**	**0.04**	-0.01	-21%	**0.03**	-0.01	-21%	**0.05**	**0.04**	-0.01	-19%	**0.04**	-0.02	-38%
US Coton Road Weir (Central)	P3	**0.02**	**0.02**	0.00	0%	**0.02**	0.00	0%	**0.02**	**0.02**	0.00	0%	**0.02**	0.00	0%
	P1	**0.11**	**0.10**	-0.01	-9%	**0.09**	-0.01	-9%	**0.11**	**0.10**	-0.01	-9%	**0.10**	-0.01	-9%
US Coton Road Weir (Central)	P2	**0.04**	**0.03**	-0.01	-23%	**0.01**	-0.04	-91%	**0.05**	**0.04**	-0.01	-21%	**0.01**	-0.04	-82%
	P1	**0.21**	**0.16**	-0.04	-20%	**0.11**	-0.09	-44%	**0.22**	**0.18**	-0.05	-22%	**0.13**	-0.10	-45%
US Coton Road Weir (West)	P2	**0.02**	**0.02**	0.00	0%	**0.07**	0.05	217%	**0.03**	**0.01**	-0.01	-36%	**0.05**	0.03	109%
	P1	**0.07**	**0.03**	-0.03	-46%	**0.02**	-0.04	-61%	**0.07**	**0.03**	-0.03	-45%	**0.03**	-0.04	-60%
DS Coton Road Weir (Central)	P2	**0.14**	**0.16**	0.02	14%	**0.13**	-0.01	-7%	**0.16**	**0.17**	0.01	6%	**0.14**	-0.02	-13%
	P1	**0.08**	**0.07**	-0.01	-12%	**0.06**	-0.02	-25%	**0.09**	**0.08**	-0.01	-12%	**0.07**	-0.02	-23%
DS Coton Road Weir (East)	P2	**0.09**	**0.07**	-0.02	-23%	**0.05**	-0.04	-45%	**0.09**	**0.07**	-0.02	-22%	**0.05**	-0.04	-44%
	P1	**0.00**	**0.00**	0.00	0%	**0.00**	0.00	0%	**0.01**	**0.00**	-0.01	-90%	**0.00**	-0.01	-90%
	P2	**0.20**	**0.15**	-0.05	-26%	**0.13**	-0.07	-36%	**0.18**	**0.18**	0.00	0%	**0.14**	-0.05	-28%
DS Coton Road Weir (West)	P3	**0.11**	**0.11**	0.00	0%	**0.09**	-0.03	-26%	**0.13**	**0.10**	-0.02	-16%	**0.09**	-0.03	-24%
	P1	**0.04**	**0.03**	-0.02	-46%	**0.01**	-0.03	-68%	**0.05**	**0.03**	-0.02	-40%	**0.01**	-0.04	-80%
US LM2A0000 Weir	P2	**0.04**	**0.03**	-0.02	-45%	**0.01**	-0.04	-91%	**0.05**	**0.03**	-0.02	-43%	**0.01**	-0.03	-64%
	P1	**0.09**	**0.06**	-0.03	-32%	**0.03**	-0.07	-74%	**0.09**	**0.07**	-0.02	-21%	**0.03**	-0.06	-64%
DS LM2A0000 Weir	P2	**0.01**	**0.00**	-0.01	-122%	**0.01**	0.00	0%	**0.00**	**0.00**	0.00	0%	**0.00**	0.00	0%
	P1	**0.13**	**0.12**	-0.02	-15%	**0.10**	-0.04	-30%	**0.14**	**0.12**	-0.02	-14%	**0.10**	-0.04	-28%
US LM2B0000 Weir	P2	**0.12**	**0.10**	-0.01	-9%	**0.08**	-0.03	-26%	**0.12**	**0.10**	-0.02	-16%	**0.09**	-0.03	-24%
	P1	**0.54**	**0.57**	0.04	7%	**0.60**	0.06	11%	**0.52**	**0.56**	0.04	8%	**0.61**	0.09	17%
DS LM2B0000 Weir	P2	**0.14**	**0.14**	0.01	7%	**0.16**	0.03	22%	**0.14**	**0.14**	0.00	0%	**0.14**	0.00	0%

Table 3-3: River Tame at Lea Marston – Velocity Difference, Q99 & Q95 Flow Condition – Results from PO Points

		Q50							Q10						
PO Location	PO Point	Baseline Velocity (m/s)	Scenario A Velocity (m/s)	Scenario A Velocity change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Velocity (m/s)	Scenario B Velocity change from baseline (m/s)	Scenario B Velocity change from baseline (%)	Baseline Velocity (m/s)	Scenario A Velocity (m/s)	Scenario A Velocity change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Velocity (m/s)	Scenario B Velocity change from baseline (m/s)	Scenario B Velocity change from baseline (%)
US Crump Weir (East)	P1	**0.38**	**0.37**	-0.02	-5%	**0.32**	-0.07	-18%	**0.54**	**0.41**	-0.12	-22%	**0.59**	0.06	11%
	P2	**0.28**	**0.25**	-0.03	-11%	**0.22**	-0.06	-21%	**0.63**	**0.58**	-0.05	-8%	**0.54**	-0.09	-14%
	P3	**0.39**	**0.34**	-0.04	-10%	**0.30**	-0.09	-23%	**0.79**	**0.75**	-0.05	-6%	**0.72**	-0.07	-9%
US Crump Weir (West)	P1	**0.56**	**0.50**	-0.06	-11%	**0.44**	-0.12	-21%	**0.80**	**0.74**	-0.05	-6%	**0.72**	-0.07	-9%
	P2	**0.38**	**0.34**	-0.04	-11%	**0.30**	-0.08	-21%	**0.73**	**0.70**	-0.02	-3%	**0.64**	-0.09	-12%
	P3	**0.21**	**0.19**	-0.02	-9%	**0.17**	-0.04	-19%	**0.39**	**0.38**	-0.01	-3%	**0.35**	-0.04	-10%
DS Crump Weir (East)	P1	**0.02**	**0.01**	0.00	0%	**0.02**	0.00	0%	**0.04**	**0.07**	0.02	45%	**0.04**	-0.01	-22%
	P2	**0.20**	**0.18**	-0.02	-10%	**0.16**	-0.04	-20%	**0.47**	**0.48**	0.01	2%	**0.43**	-0.03	-6%
	P3	**0.27**	**0.23**	-0.04	-15%	**0.18**	-0.09	-33%	**0.49**	**0.53**	0.04	8%	**0.52**	0.02	4%
DS Crump Weir (West)	P1	**0.04**	**0.04**	0.00	0%	**0.03**	0.00	0%	**0.05**	**0.06**	0.01	19%	**0.05**	0.00	0%
	P2	**0.24**	**0.21**	-0.03	-12%	**0.19**	-0.05	-20%	**0.44**	**0.41**	-0.03	-7%	**0.40**	-0.04	-9%
	P3	**0.06**	**0.05**	0.00	0%	**0.05**	-0.01	-17%	**0.11**	**0.10**	-0.01	-9%	**0.08**	-0.03	-28%
US Coton Road Weir (East)	P1	**0.06**	**0.06**	-0.01	-16%	**0.05**	-0.02	-32%	**0.13**	**0.12**	-0.01	-8%	**0.12**	-0.01	-8%
	P2	**0.07**	**0.06**	-0.01	-13%	**0.05**	-0.02	-27%	**0.15**	**0.14**	0.00	0%	**0.14**	-0.01	-7%
US Coton Road Weir (Central)	P1	**0.04**	**0.03**	-0.01	-22%	**0.03**	-0.02	-45%	**0.11**	**0.10**	-0.01	-9%	**0.09**	-0.01	-9%
	P2	**0.16**	**0.17**	0.01	6%	**0.13**	-0.03	-19%	**0.30**	**0.32**	0.02	7%	**0.31**	0.01	3%
	P3	**0.08**	**0.07**	-0.02	-24%	**0.06**	-0.02	-24%	**0.16**	**0.08**	-0.08	-49%	**0.06**	-0.10	-61%
US Coton Road Weir (West)	P1	**0.30**	**0.27**	-0.03	-10%	**0.24**	-0.06	-20%	**0.59**	**0.57**	-0.03	-5%	**0.54**	-0.06	-10%
	P2	**0.06**	**0.05**	-0.01	-18%	**0.03**	-0.02	-35%	**0.14**	**0.12**	-0.01	-7%	**0.11**	-0.02	-15%
DS Coton Road Weir (East)	P1	**0.11**	**0.07**	-0.04	-35%	**0.05**	-0.06	-53%	**0.26**	**0.24**	-0.02	-8%	**0.21**	-0.05	-19%
	P2	**0.23**	**0.22**	0.00	0%	**0.19**	-0.04	-18%	**0.42**	**0.40**	-0.02	-5%	**0.38**	-0.04	-10%
DS Coton Road Weir (Central)	P1	**0.08**	**0.08**	0.00	0%	**0.09**	0.01	12%	**0.20**	**0.22**	0.02	10%	**0.16**	-0.03	-15%
	P2	**0.17**	**0.14**	-0.03	-18%	**0.11**	-0.06	-36%	**0.15**	**0.11**	-0.04	-26%	**0.16**	0.01	6%
DS Coton Road Weir (West)	P1	**0.00**	**0.00**	0.00	0%	**0.01**	0.01	1%	**0.08**	**0.04**	-0.04	-49%	**0.03**	-0.06	-74%
	P2	**0.28**	**0.26**	-0.02	-7%	**0.22**	-0.06	-21%	**0.42**	**0.44**	0.01	2%	**0.42**	-0.01	-2%
	P3	**0.14**	**0.13**	-0.02	-14%	**0.13**	-0.02	-14%	**0.13**	**0.11**	-0.01	-8%	**0.11**	-0.01	-8%
US LM2A0000 Weir	P1	**0.10**	**0.08**	-0.02	-20%	**0.06**	-0.04	-39%	**0.32**	**0.30**	-0.02	-6%	**0.28**	-0.04	-12%
	P2	**0.09**	**0.07**	-0.02	-23%	**0.06**	-0.03	-34%	**0.27**	**0.26**	-0.01	-4%	**0.23**	-0.03	-11%
DS LM2A0000 Weir	P1	**0.14**	**0.14**	0.00	0%	**0.11**	-0.02	-15%	**0.12**	**0.15**	0.02	16%	**0.13**	0.01	8%
	P2	**0.00**	**0.02**	0.01	213%	**0.01**	0.00	0%	**0.15**	**0.08**	-0.07	-45%	**0.13**	-0.03	-19%
US LM2B0000 Weir	P1	**0.18**	**0.17**	-0.01	-5%	**0.15**	-0.03	-16%	**0.30**	**0.29**	-0.01	-3%	**0.28**	-0.02	-7%
	P2	**0.17**	**0.15**	-0.02	-12%	**0.13**	-0.04	-24%	**0.29**	**0.29**	0.00	0%	**0.28**	0.00	0%
DS LM2B0000 Weir	P1	**0.50**	**0.53**	0.03	6%	**0.52**	0.02	4%	**0.43**	**0.51**	0.08	19%	**0.55**	0.13	30%
	P2	**0.13**	**0.14**	0.01	8%	**0.14**	0.01	8%	**0.08**	**0.01**	-0.06	-79%	**0.05**	-0.03	-40%

Table 3-4: River Tame at Lea Marston – Velocity Difference, Q50 & Q10 Flow Condition – Results from PO Points

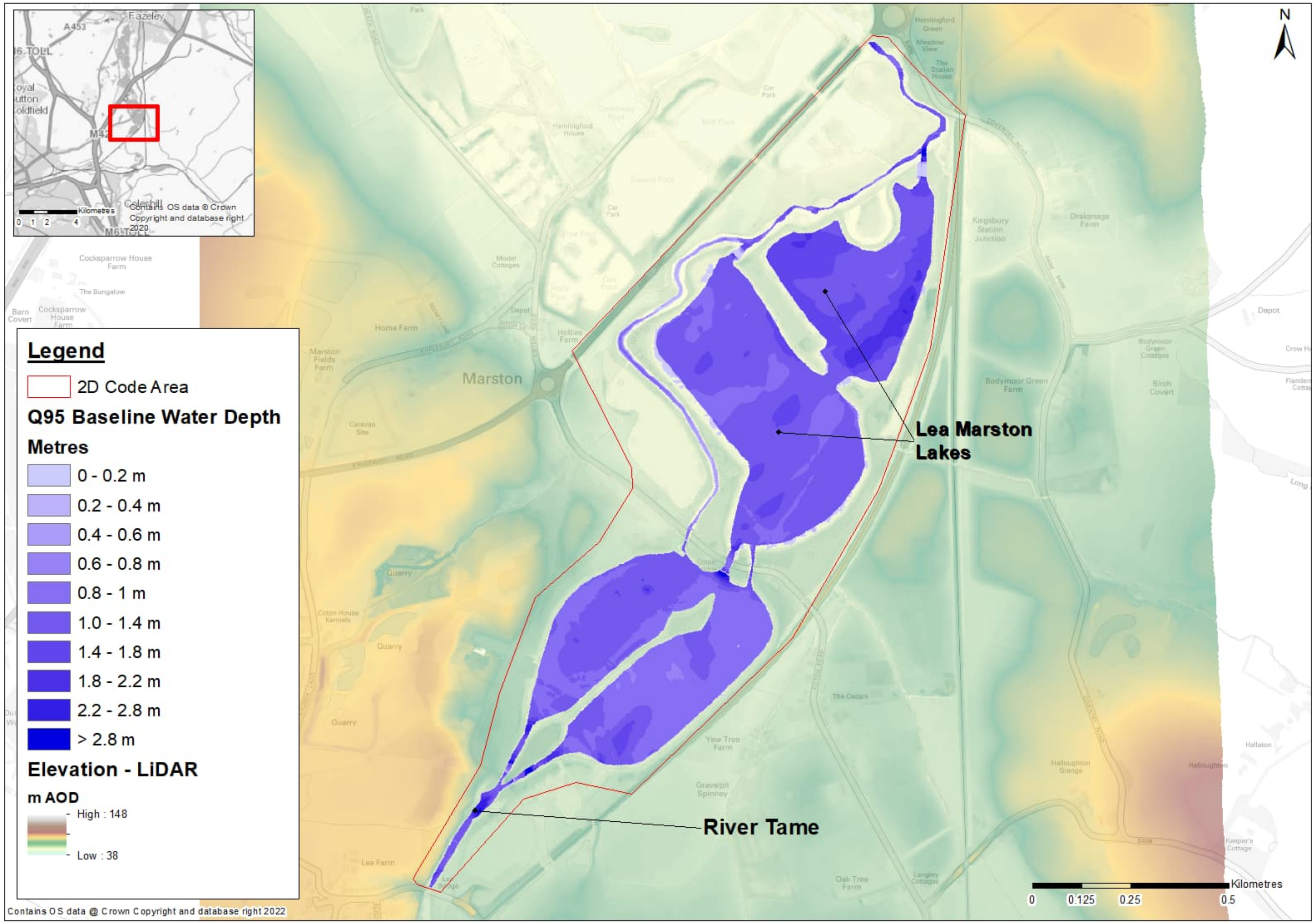


Figure 3-4: River Tame at Lea Marston – Q95 Baseline Water Depth

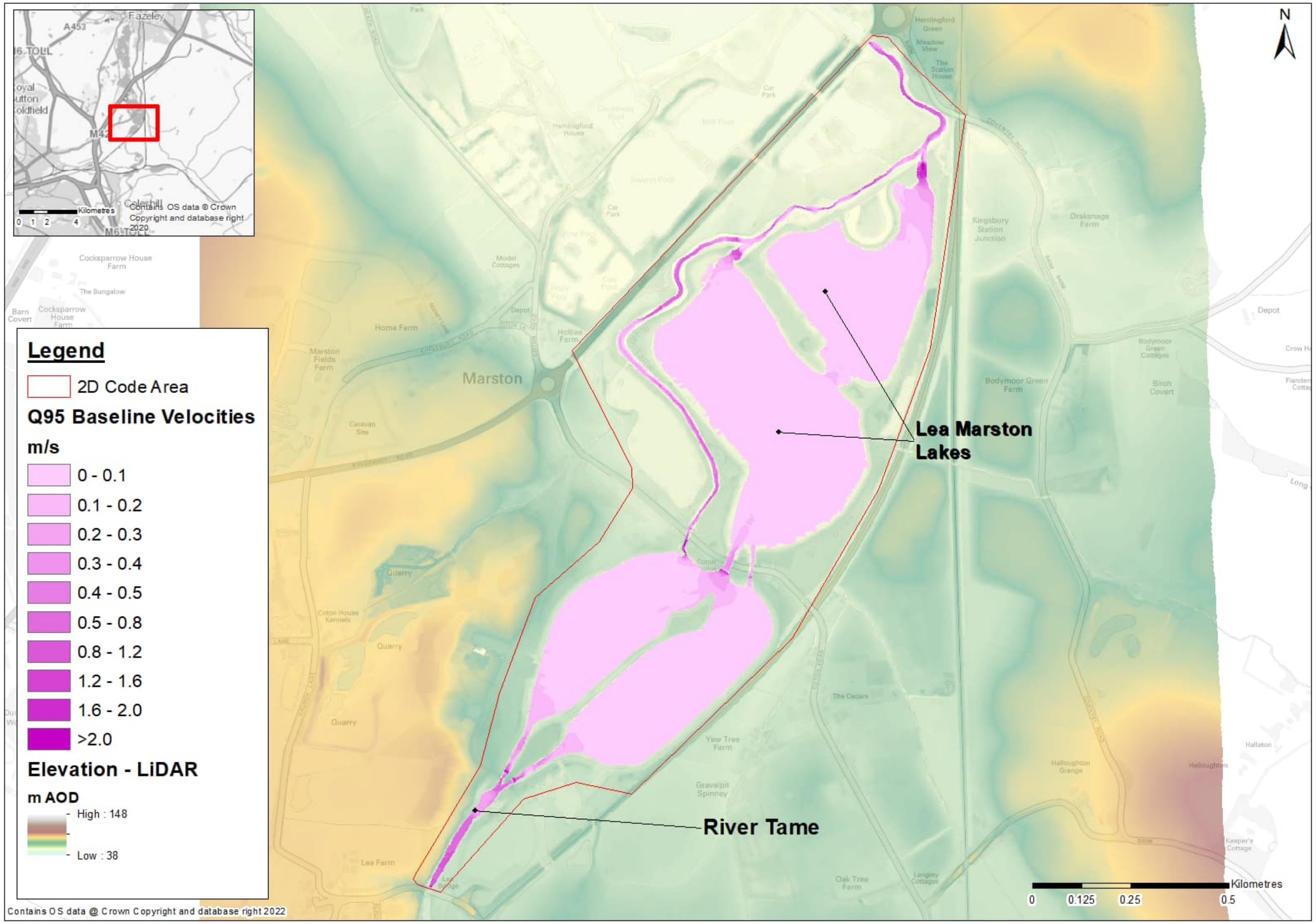
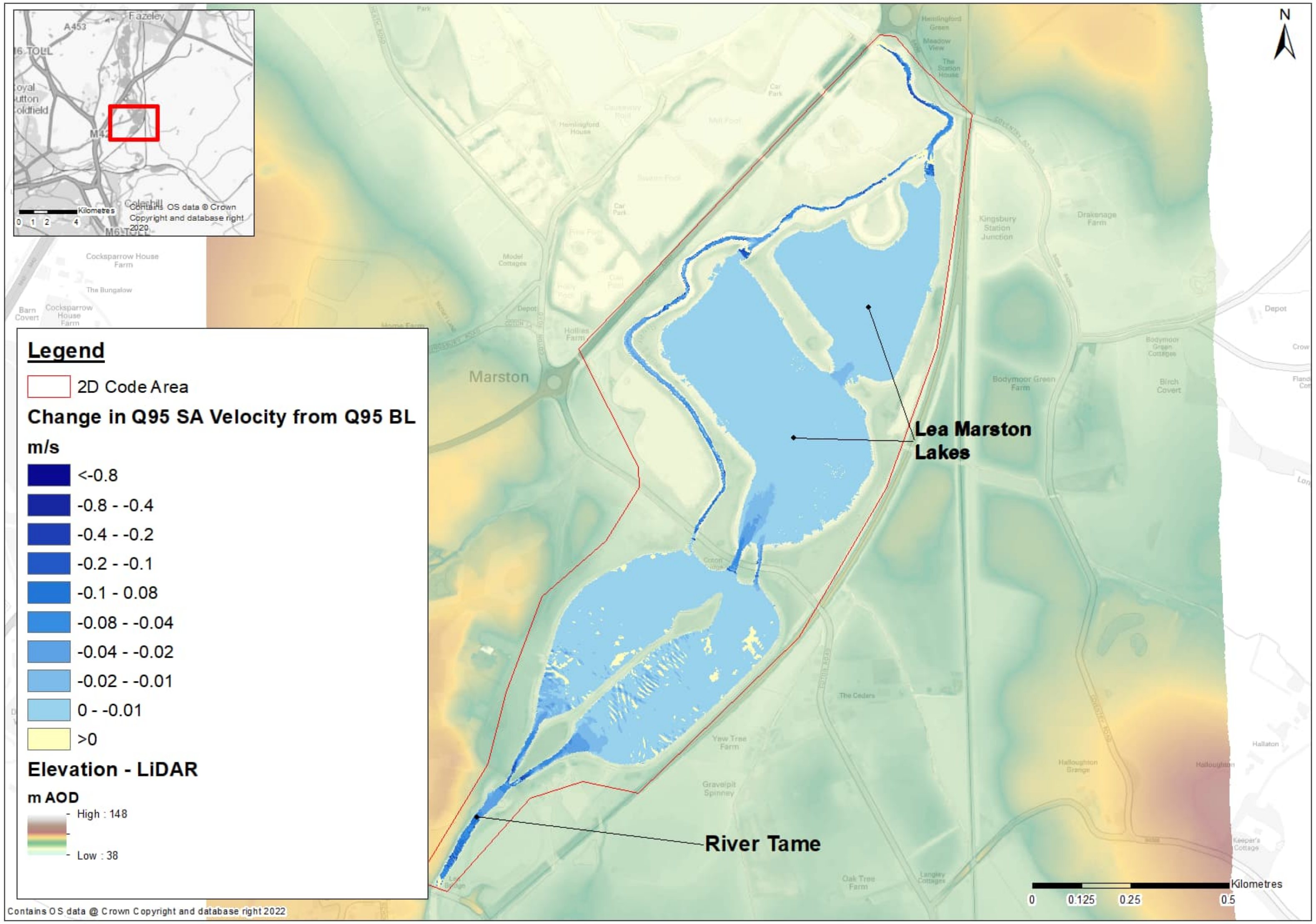


Figure 3-5: River Tame at Lea Marston – Q95 Baseline Velocities

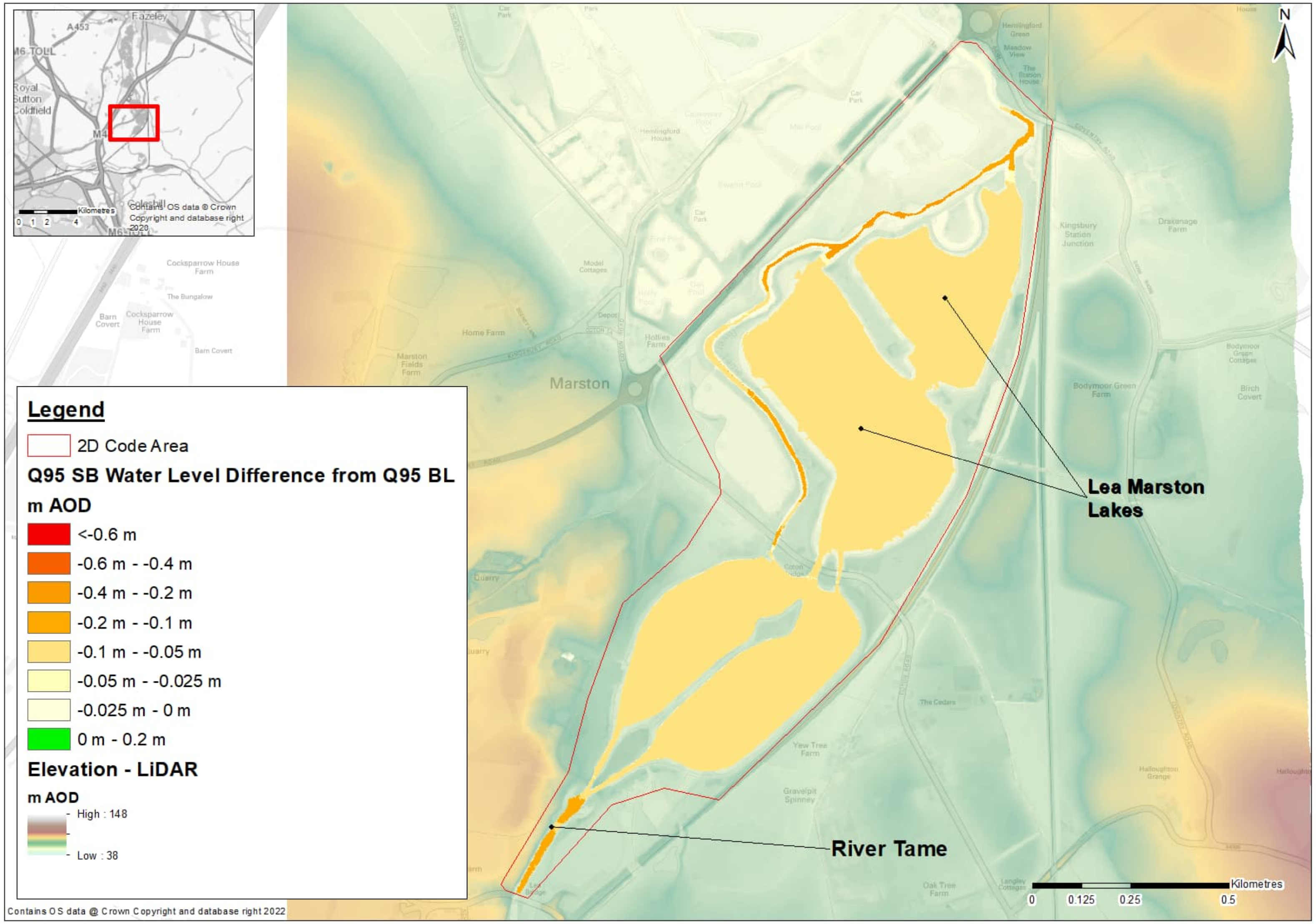
Note: negative numbers indicate a decrease in water depth when comparing the simulated scenario results with the simulated baseline model results.

Figure 3-6: River Tame at Lea Marston – Max. Water Level Difference between Q95 Baseline and Q95 Scenario A



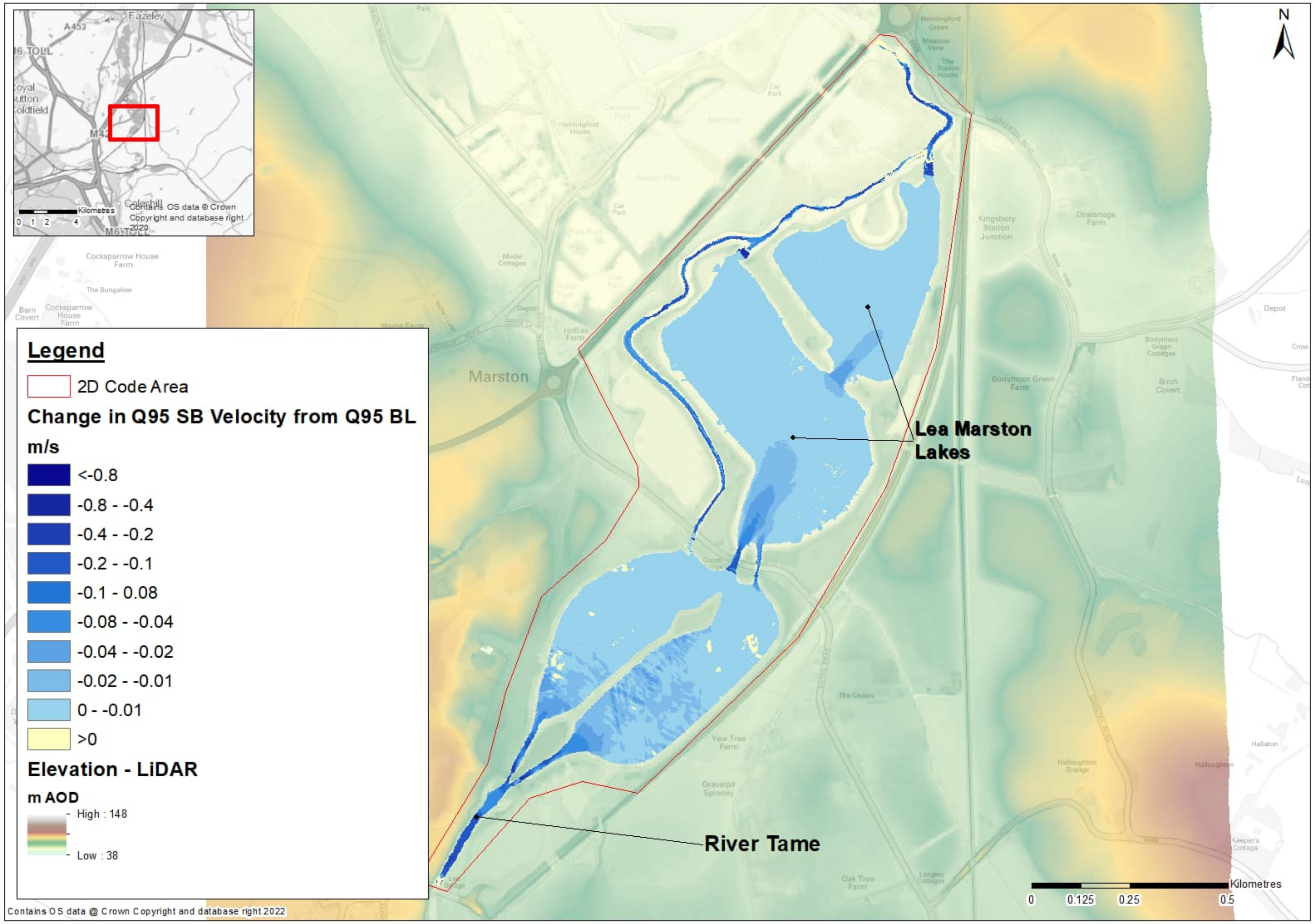
Note: negative numbers indicate a decrease in water velocity when comparing the simulated scenario results with the simulated baseline model results.

Figure 3-7: River Tame at Lea Marston – Max. Velocity Difference between Q95 Baseline and Scenario A



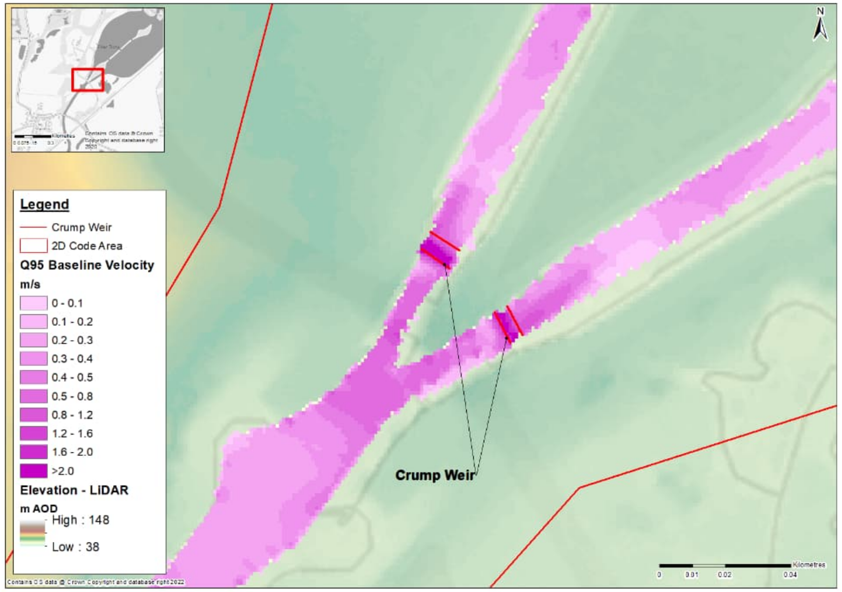
Note: negative numbers indicate a decrease in water depth when comparing the simulated scenario results with the simulated baseline model results.

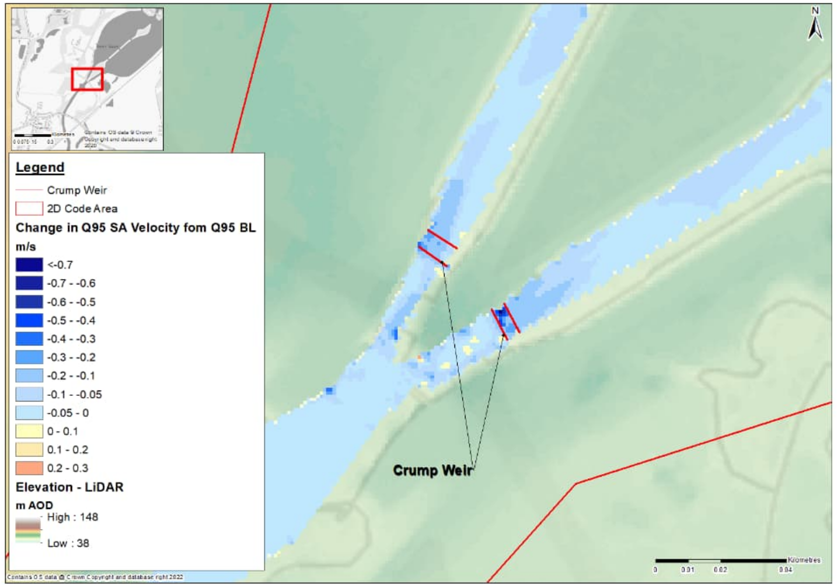
Figure 3-8: River Tame at Lea Marston – Max. Water Level Difference between Q95 Baseline and Q95 Scenario B

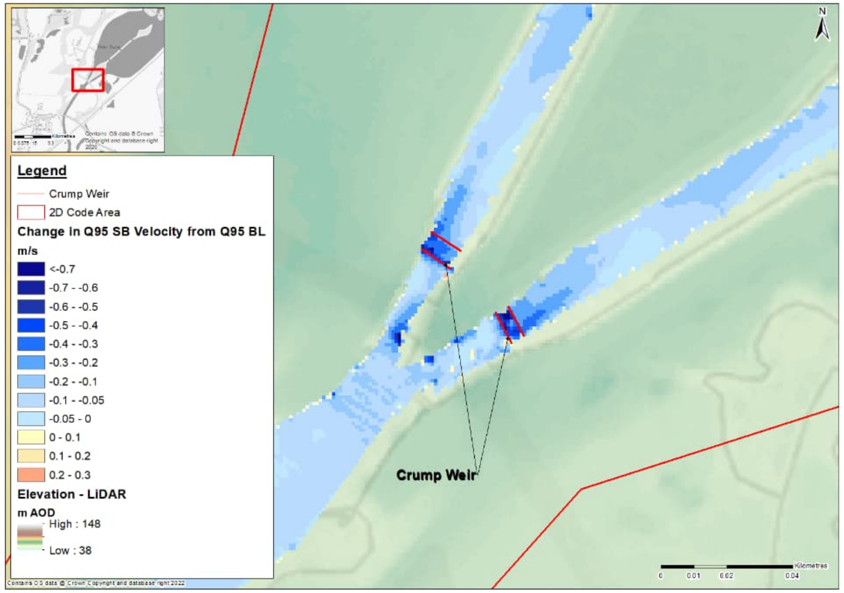


Note: negative numbers indicate a decrease in water velocity when comparing the simulated scenario results with the simulated baseline model results.

Figure 3-9: River Tame at Lea Marston – Max Velocity Difference between Q95 Baseline & Q95 Scenario B

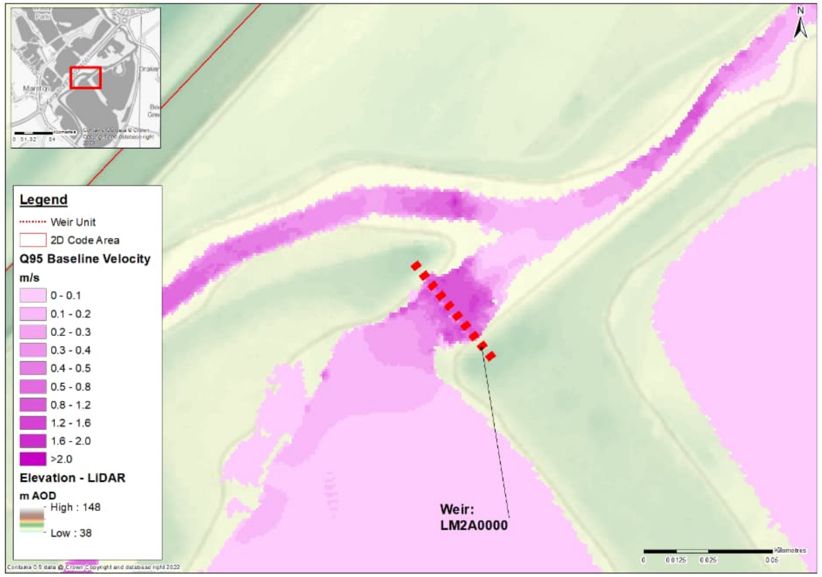


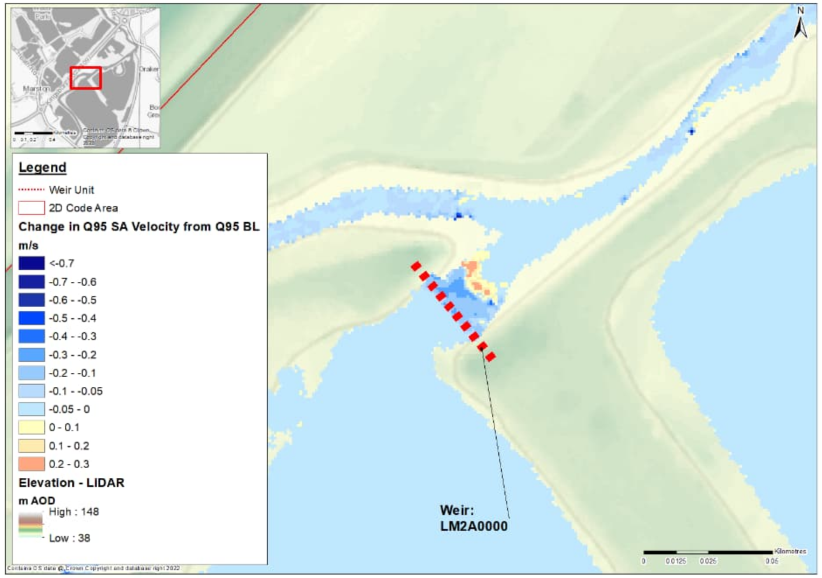


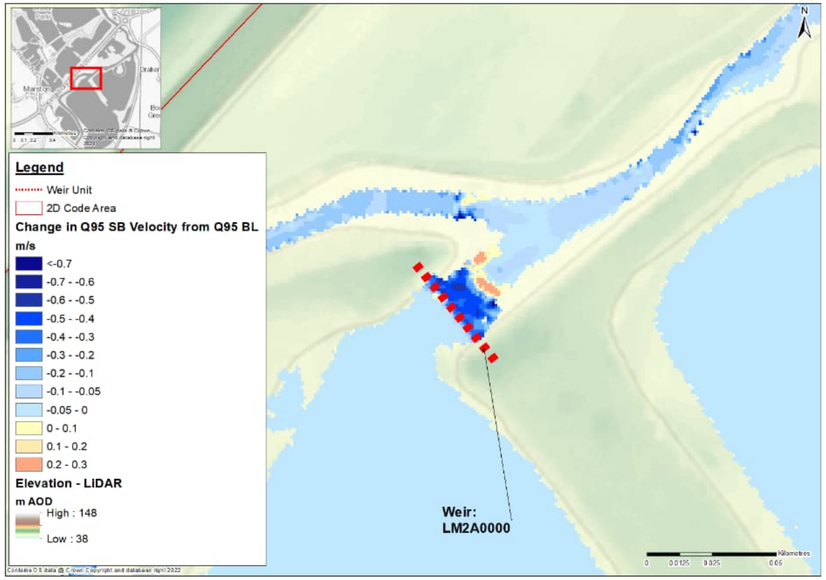


Note: negative numbers indicate a decrease in water velocity when comparing the simulated scenario results with the simulated baseline model results.

Figure 3-10: River Tame at Lea Marston – Q95 Baseline Modelled Velocity (top left) at crump weirs. Q95 Scenario (top right) A & Scenario B (bottom left) Velocities Changes from Q95 Baseline

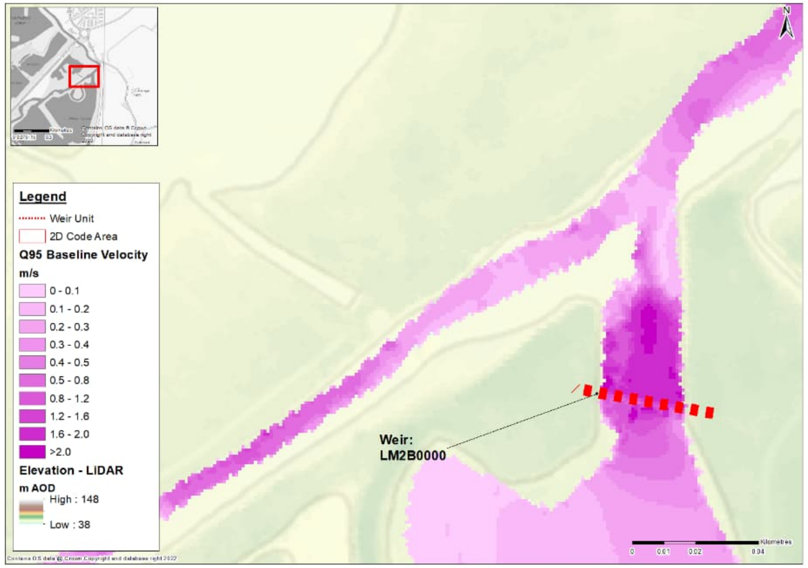


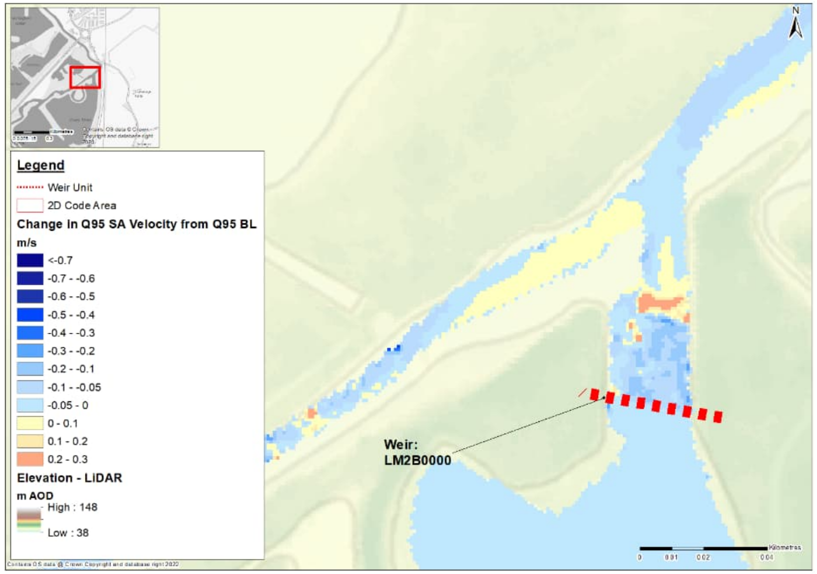


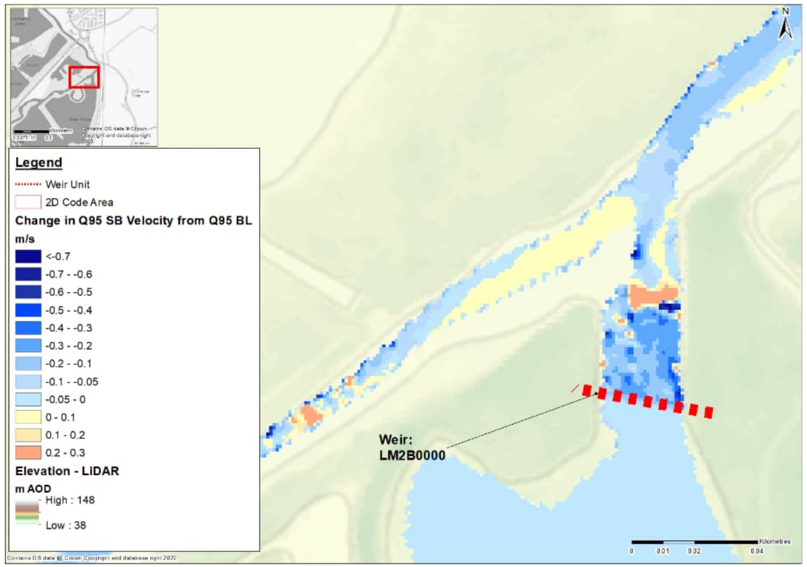


Note: negative numbers indicate a decrease in water velocity when comparing the simulated scenario results with the simulated baseline model results.

Figure 3-11: River Tame at Lea Marston – Q95 Baseline Modelled Velocity (top left) at Weir LM2A000. Q95 Scenario A (top right) & Scenario B (bottom left) changes in Velocities from Q95 Baseline, at Weir LM2A0000







Note: negative numbers indicate a decrease in water velocity when comparing the simulated scenario results with the simulated baseline model results.

Figure 3-12: River Tame at Lea Marston – Q95 Baseline Modelled Velocity (top left). Q95 Scenario A (top right) & Scenario B (bottom left) changes in Velocities from Q95 Baseline, at Weir LM2B0000

3.3 Tamworth Results

3.3.1 The 2D results for depth and velocity changes for each flow condition and scenarios are included in Table 3-5 and Table 3-6. The stage and velocity results have been extracted from PO point and line locations; these locations are shown in Figure 3-13 and Figure 3-14. Water depth has subsequently been calculated from the stage results in collaboration with bed elevation inspection data.

3.3.2 For the purpose of this report, only the Q95 outputs have been schematised in figures. The Q95 baseline maximum water depth and velocities have been schematised, as well as the changes in water depth and velocities when comparing the Q95 scenarios to the Q95 baseline.

3.3.3 A decrease in water depth has been displayed for each simulation. Downstream of the first weir is where the percentage change in water depth is greatest, especially for the lowest flow condition. The Q99 & Q95 Scenario B results show the greatest decrease in water depth of approximately -30%, see Table 3-5.

3.3.4 Points upstream and downstream of the weirs typically show decrease in velocity, for each flow condition and scenario. The greatest change in velocities is seen downstream of the first weir. For the Q95 & Q99 SB scenario, changes in velocities are as much as -60%, see Table 3-6 & Figure 3-21.

Figure 3-13: River Tame at Tamworth – PO Points & Lines, Weir TM033154W

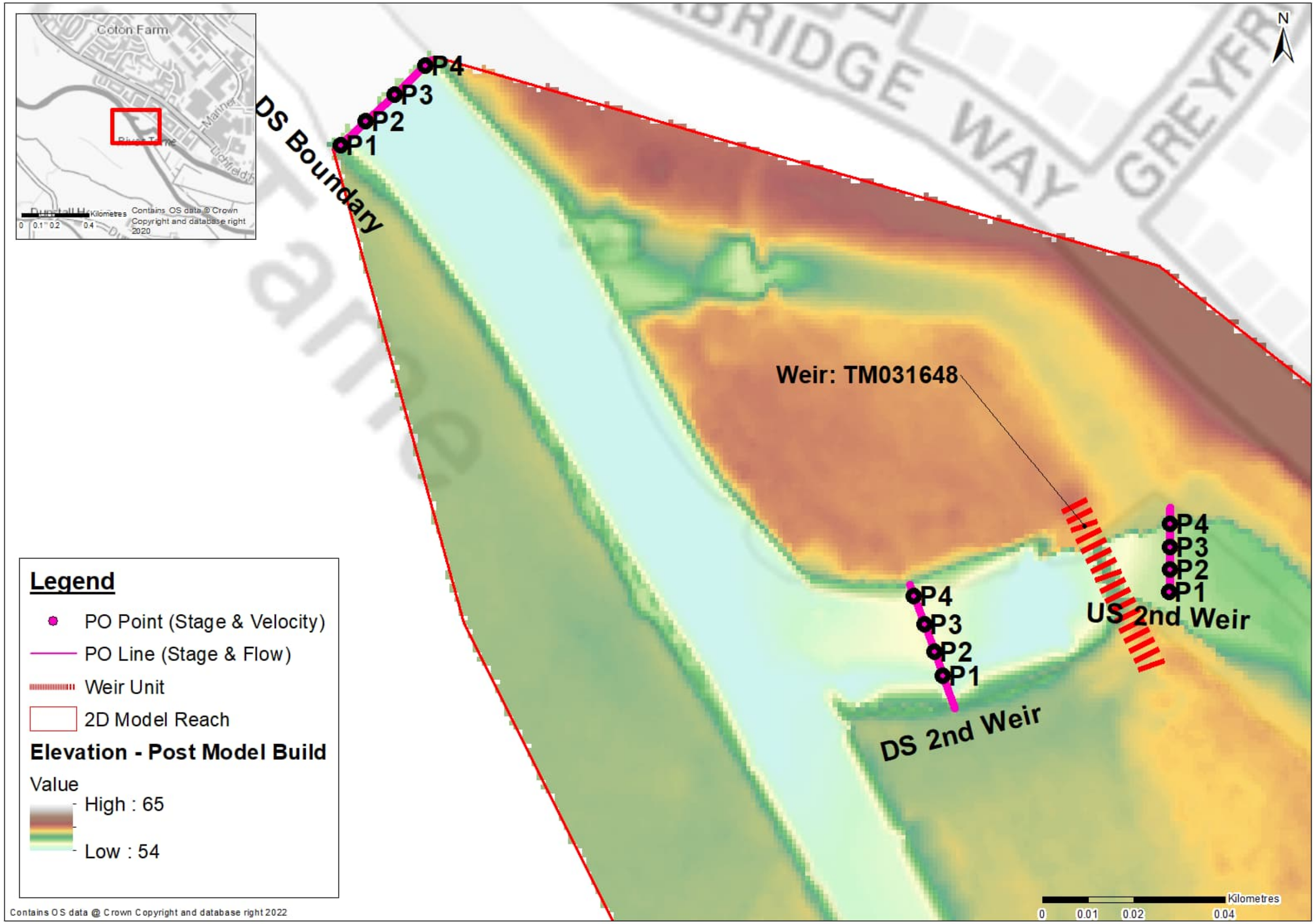


Figure 3-14: River Tame at Tamworth – PO Points & Lines, Weir TM031648

		Q99								Q95							
Cross Section	Bed Elevation m AOD	Baseline Water Depth (m)	Simulated Baseline Stage (m AOD)	Scenario A Stage (mAOD)	Scenario A Water Depth change from Baseline (m)	Scenario A Maximum Water Depth change (%)	Scenario B Stage (mAOD)	Scenario B Water Depth change from Baseline (m)	Scenario B Maximum Water Depth Change (%)	Baseline Water Depth (m)	Simulated Baseline Stage (m AOD)	Scenario A Stage (mAOD)	Scenario A Water Depth change from Baseline (m)	Scenario A Maximum Water Depth change (%)	Scenario B Stage (mAOD)	Scenario B Water Depth change from Baseline (m)	Scenario B Maximum Water Depth Change (%)
Downstream Boundary	54.356	1.16	**55.52**	**55.45**	-0.07	-6.1%	**55.37**	-0.15	-12.6%	1.18	**55.54**	**55.48**	-0.06	-5.2%	**55.41**	-0.13	-11.2%
Upstream Wier 1 (TM033154W)	56.43	1.29	**57.72**	**57.70**	-0.02	-1.8%	**57.62**	-0.10	-7.6%	1.29	**57.72**	**57.69**	-0.03	-2.5%	**57.63**	-0.09	-6.8%
Downstream of Weir 1 (TM033154W)	56.35	0.42	**56.77**	**56.69**	-0.08	-19.5%	**56.64**	-0.13	-31.0%	0.44	**56.79**	**56.70**	-0.09	-19.7%	**56.65**	-0.14	-32.6%
Upstream of Weir 2 (TM031648)	56.182	1.40	**57.58**	**57.55**	-0.03	-1.9%	**57.51**	-0.07	-4.8%	1.40	**57.58**	**57.56**	-0.02	-1.5%	**57.52**	-0.06	-4.3%
Downstream of Weir 2 (TM031648)	54.88	1.08	**55.96**	**55.94**	-0.02	-2.2%	**55.91**	-0.05	-4.8%	1.08	**55.96**	**55.94**	-0.02	-1.6%	**55.91**	-0.05	-4.3%

		Q50								Q10							
Cross Section	Bed Elevation m AOD	Baseline Water Depth (m)	Simulated Baseline Stage (m AOD)	Scenario A Stage (mAOD)	Scenario A Water Depth change from Baseline (m)	Scenario A Maximum Water Depth change (%)	Scenario B Stage (mAOD)	Scenario B Water Depth change from Baseline (m)	Scenario B Maximum Water Depth Change (%)	Baseline Water Depth (m)	Simulated Baseline Stage (m AOD)	Scenario A Stage (mAOD)	Scenario A Water Depth change from Baseline (m)	Scenario A Maximum Water Depth change (%)	Scenario B Stage (mAOD)	Scenario B Water Depth change from Baseline (m)	Scenario B Maximum Water Depth Change (%)
Downstream Boundary	54.356	1.37	**55.73**	**55.68**	-0.05	-3.8%	**55.63**	-0.10	-7.4%	1.92	**56.28**	**56.25**	-0.03	-1.7%	**56.22**	-0.06	-3.3%
Upstream Wier 1 (TM033154W)	56.43	1.37	**57.80**	**57.78**	-0.02	-1.5%	**57.77**	-0.03	-2.0%	1.56	**57.99**	**57.98**	-0.01	-0.9%	**57.97**	-0.02	-1.6%
Downstream of Weir 1 (TM033154W)	56.35	0.69	**57.04**	**56.98**	-0.06	-8.9%	**56.92**	-0.12	-17.8%	1.30	**57.65**	**57.62**	-0.03	-2.0%	**57.59**	-0.06	-4.9%
Upstream of Weir 2 (TM031648)	56.182	1.45	**57.63**	**57.62**	-0.01	-0.5%	**57.61**	-0.02	-1.5%	1.58	**57.76**	**57.76**	0.00	-0.2%	**57.75**	-0.01	-0.7%
Downstream of Weir 2 (TM031648)	54.88	1.14	**56.02**	**56.00**	-0.02	-1.8%	**55.98**	-0.04	-3.3%	1.53	**56.41**	**56.39**	-0.02	-1.0%	**56.36**	-0.05	-3.3%

Table 3-5: River Tame at Tamworth – Water Depth Difference

		Q99							Q95						
PO Location	PO Point	Baseline Velocity (m/s)	Scenario A Velocity (m/s)	Scenario A Velocity change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Velocity (m/s)	Scenario B Velocity change from baseline (m/s)	Scenario B Velocity change from baseline (%)	Baseline Velocity (m/s)	Scenario A Velocity (m/s)	Scenario A Velocity change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Velocity (m/s)	Scenario B Velocity change from baseline (m/s)	Velocity change from baseline (%)
US Weir No.1 TM033154W	P1	**0.22**	**0.19**	-0.03	-14%	**0.16**	-0.06	-27%	**0.22**	**0.20**	-0.02	-9%	**0.16**	-0.06	-27%
	P2	**0.25**	**0.22**	-0.03	-12%	**0.19**	-0.06	-24%	**0.25**	**0.22**	-0.03	-12%	**0.19**	-0.06	-24%
	P3	**0.21**	**0.19**	-0.02	-10%	**0.17**	-0.04	-19%	**0.21**	**0.19**	-0.02	-10%	**0.17**	-0.04	-19%
	P4	**0.23**	**0.22**	-0.01	-4%	**0.19**	-0.04	-17%	**0.23**	**0.22**	-0.01	-4%	**0.19**	-0.04	-17%
	P5	**0.27**	**0.26**	-0.01	-4%	**0.23**	-0.04	-15%	**0.27**	**0.26**	-0.01	-4%	**0.24**	-0.03	-11%
DS Weir No.1 TM033154W	P1	**0.00**	**0.00**	0.00	0%	**0.00**	0.00	0%	**0.02**	**0.00**	-0.02	-100%	**0.00**	-0.02	-100%
	P2	**0.22**	**0.13**	-0.09	-41%	**0.07**	-0.15	-68%	**0.24**	**0.14**	-0.10	-42%	**0.08**	-0.16	-67%
	P3	**0.20**	**0.11**	-0.09	-45%	**0.07**	-0.13	-65%	**0.21**	**0.12**	-0.09	-43%	**0.07**	-0.14	-67%
US Weir No.2 TM036148	P1	**0.34**	**0.33**	-0.01	-3%	**0.29**	-0.05	-15%	**0.35**	**0.33**	-0.02	-6%	**0.30**	-0.05	-14%
	P2	**0.34**	**0.31**	-0.03	-9%	**0.27**	-0.07	-21%	**0.34**	**0.32**	-0.02	-6%	**0.28**	-0.06	-18%
	P3	**0.25**	**0.23**	-0.02	-8%	**0.20**	-0.05	-20%	**0.25**	**0.23**	-0.02	-8%	**0.20**	-0.05	-20%
	P4	**0.15**	**0.14**	-0.01	-7%	**0.12**	-0.03	-20%	**0.15**	**0.14**	-0.01	-7%	**0.12**	-0.03	-20%
DS Weir No.2 TM031648	P1	**0.92**	**0.90**	-0.02	-2%	**0.87**	-0.05	-5%	**0.92**	**0.91**	-0.01	-1%	**0.88**	-0.04	-4%
	P2	**1.00**	**0.92**	-0.08	-8%	**0.81**	-0.19	-19%	**1.01**	**0.94**	-0.07	-7%	**0.82**	-0.19	-19%
	P3	**0.76**	**0.69**	-0.07	-9%	**0.59**	-0.17	-22%	**0.77**	**0.70**	-0.07	-9%	**0.61**	-0.16	-21%
	P4	**0.25**	**0.25**	0.00	0%	**0.22**	-0.03	-12%	**0.25**	**0.26**	0.01	4%	**0.22**	-0.03	-12%

		Q50							Q10						
PO Location	PO Point	Baseline Velocity (m/s)	Scenario A Velocity (m/s)	Scenario A Velocity change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Velocity (m/s)	Scenario B Velocity change from baseline (m/s)	Scenario B Velocity change from baseline (%)	Baseline Velocity (m/s)	Scenario A Velocity (m/s)	Scenario A Velocity change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Velocity (m/s)	Scenario B Velocity change from baseline (m/s)	Scenario B Velocity change from baseline
US Weir No.1 TM033154W	P1	**0.29**	**0.28**	-0.01	-3%	**0.27**	-0.02	-7%	**0.65**	**0.63**	-0.02	-3%	**0.62**	-0.03	-5%
	P2	**0.36**	**0.33**	-0.03	-8%	**0.30**	-0.06	-17%	**0.73**	**0.69**	-0.04	-5%	**0.67**	-0.06	-8%
	P3	**0.30**	**0.27**	-0.03	-10%	**0.25**	-0.05	-17%	**0.59**	**0.58**	-0.01	-2%	**0.56**	-0.03	-5%
	P4	**0.29**	**0.27**	-0.02	-7%	**0.26**	-0.03	-10%	**0.54**	**0.52**	-0.02	-4%	**0.51**	-0.03	-6%
DS Weir No.1 TM033154W	P1	**0.10**	**0.08**	-0.02	-20%	**0.07**	-0.03	-30%	**0.45**	**0.32**	-0.13	-29%	**0.39**	-0.06	-13%
	P2	**0.49**	**0.45**	-0.04	-8%	**0.36**	-0.13	-27%	**0.98**	**0.99**	0.01	1%	**0.94**	-0.04	-4%
	P3	**0.43**	**0.37**	-0.06	-14%	**0.34**	-0.09	-21%	**0.82**	**0.81**	-0.01	-1%	**0.79**	-0.03	-4%
US Weir No.2 TM036148	P1	**0.42**	**0.40**	-0.02	-5%	**0.38**	-0.04	-10%	**0.57**	**0.56**	-0.01	-2%	**0.54**	-0.03	-5%
	P2	**0.39**	**0.38**	-0.01	-3%	**0.36**	-0.03	-8%	**0.51**	**0.51**	0.00	0%	**0.50**	-0.01	-2%
	P3	**0.28**	**0.27**	-0.01	-4%	**0.26**	-0.02	-7%	**0.38**	**0.37**	-0.01	-3%	**0.37**	-0.01	-3%
	P4	**0.14**	**0.16**	0.02	14%	**0.16**	0.02	14%	**0.20**	**0.19**	-0.01	-5%	**0.18**	-0.02	-10%
DS Weir No.2 TM031648	P1	**0.88**	**0.93**	0.05	6%	**0.93**	0.05	6%	**0.63**	**0.63**	0.00	0%	**0.63**	0.00	0%
	P2	**1.13**	**1.11**	-0.02	-2%	**1.07**	-0.06	-5%	**0.81**	**0.81**	0.00	0%	**0.82**	0.01	1%
	P3	**0.91**	**0.86**	-0.05	-5%	**0.83**	-0.08	-9%	**0.74**	**0.74**	0.00	0%	**0.75**	0.01	1%
	P4	**0.29**	**0.30**	0.01	3%	**0.28**	-0.01	-3%	**0.32**	**0.30**	-0.02	-6%	**0.36**	0.04	13%

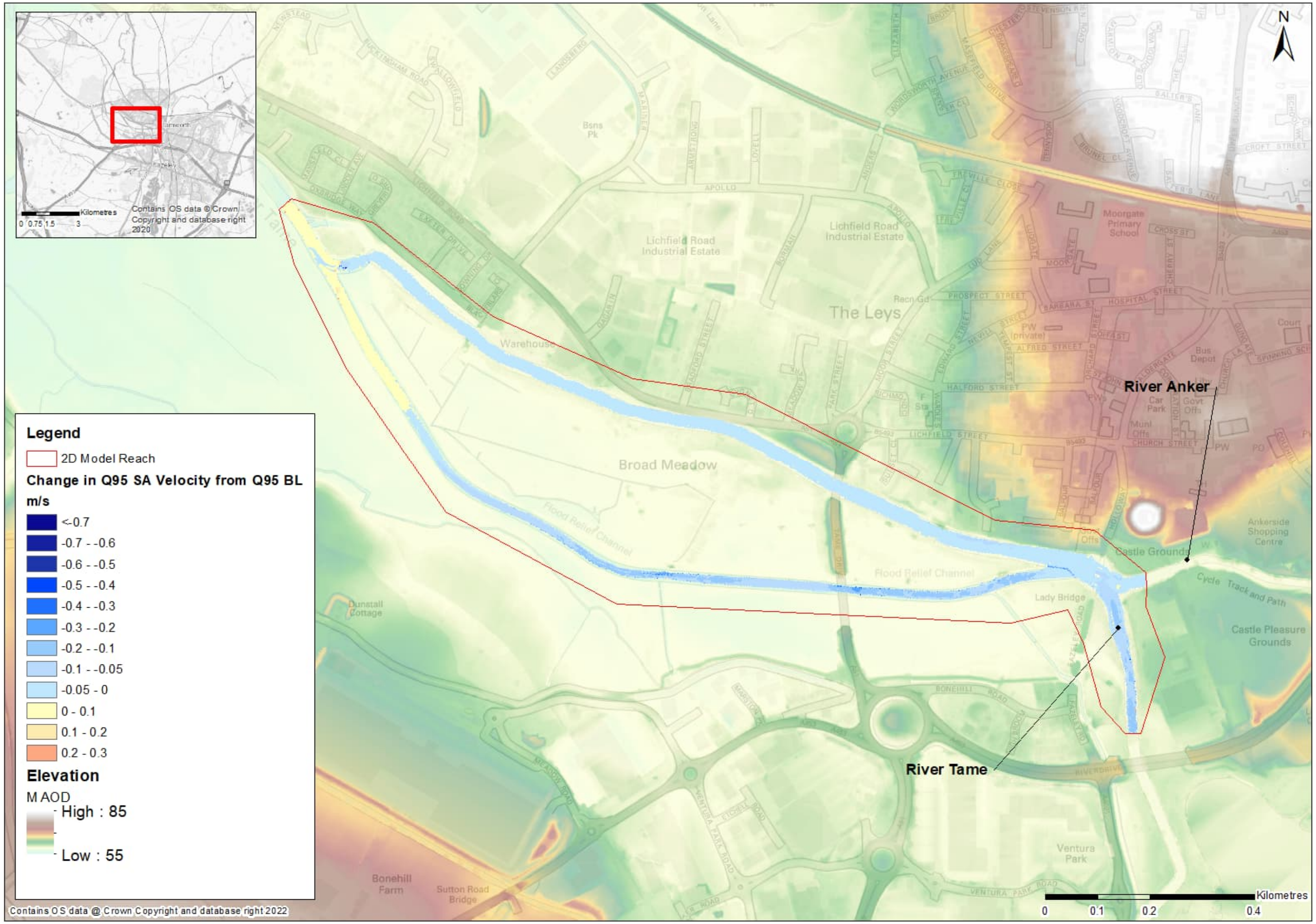
Table 3-6: River Tame at Tamworth – Velocity Difference

Figure 3-15: River Tame at Tamworth – Q95 Baseline Water Depth

Figure 3-16: River Tame at Tamworth – Q95 Baseline Velocities

Note: negative numbers indicate a decrease in water depth when comparing the simulated scenario results with the simulated baseline model results.

Figure 3-17: River Tame at Tamworth – Max. Water Level Difference between Q95 Baseline and Q95 Scenario A

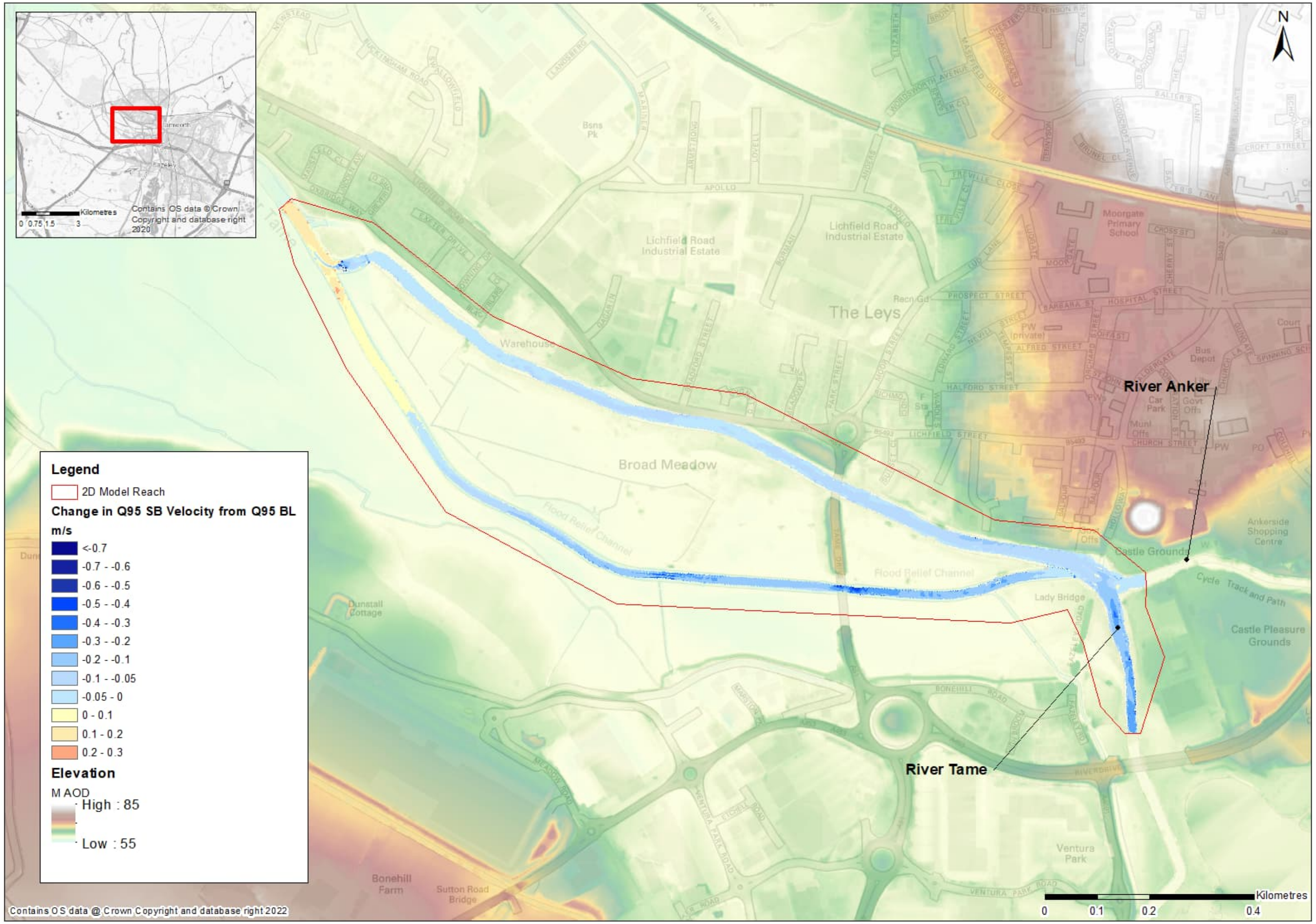


Note: negative numbers indicate a decrease in water velocity when comparing the simulated scenario results with the simulated baseline model results.

Figure 3-18: River Tame at Tamworth – Max. Velocity Difference between Q95 Baseline and Q95 Scenario A

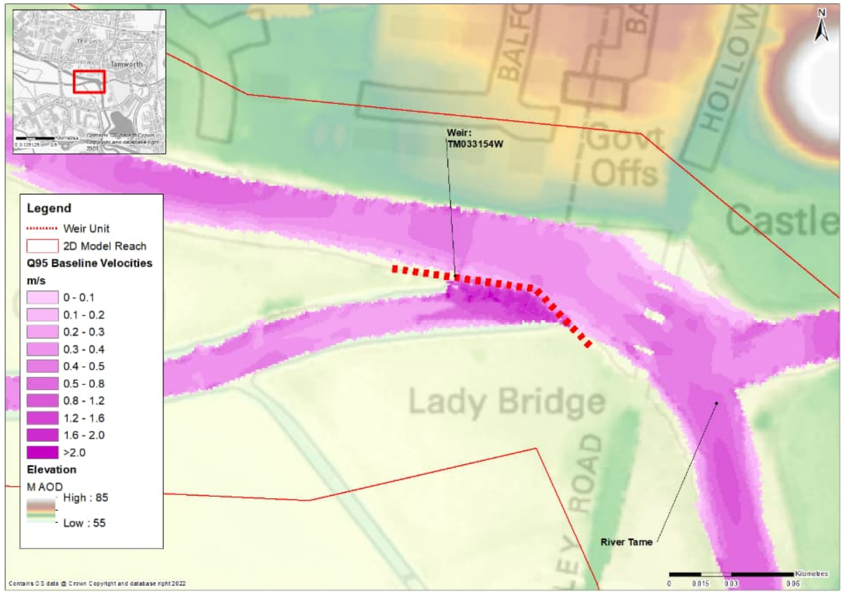
Note: negative numbers indicate a decrease in water depth when comparing the simulated scenario results with the simulated baseline model results.

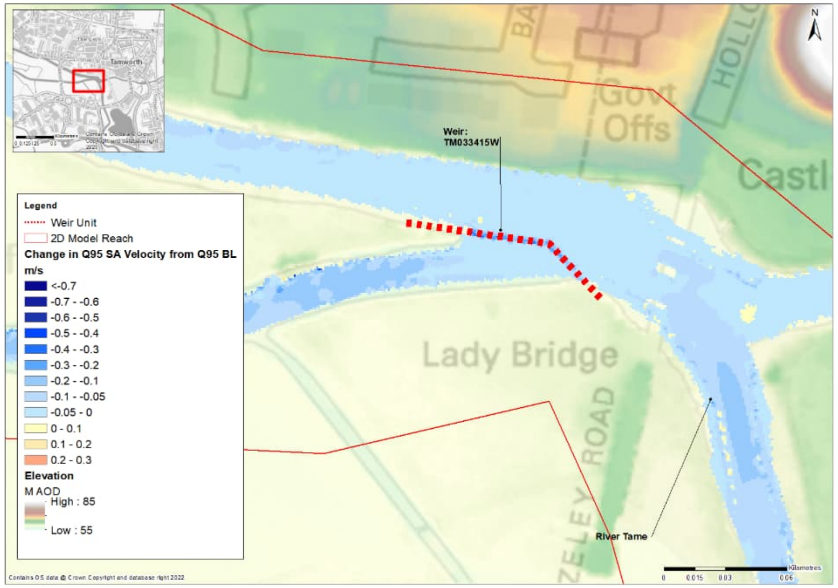
Figure 3-19: River Tame at Tamworth – Max. Water Level Difference between Q95 Baseline and Q95 Scenario B



Note: negative numbers indicate a decrease in water velocity when comparing the simulated scenario results with the simulated baseline model results.

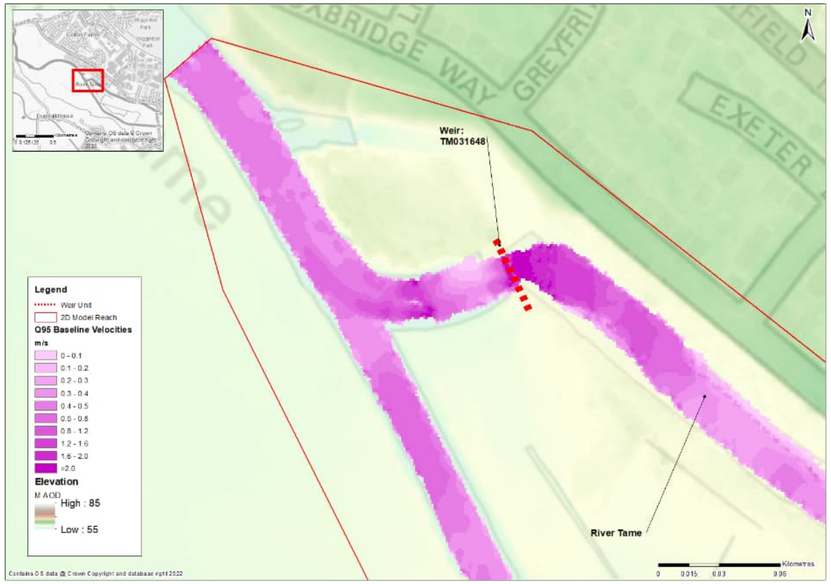
Figure 3-20: River Tame at Tamworth – Max. Velocity Difference between Q95 Baseline and Q95 Scenario B

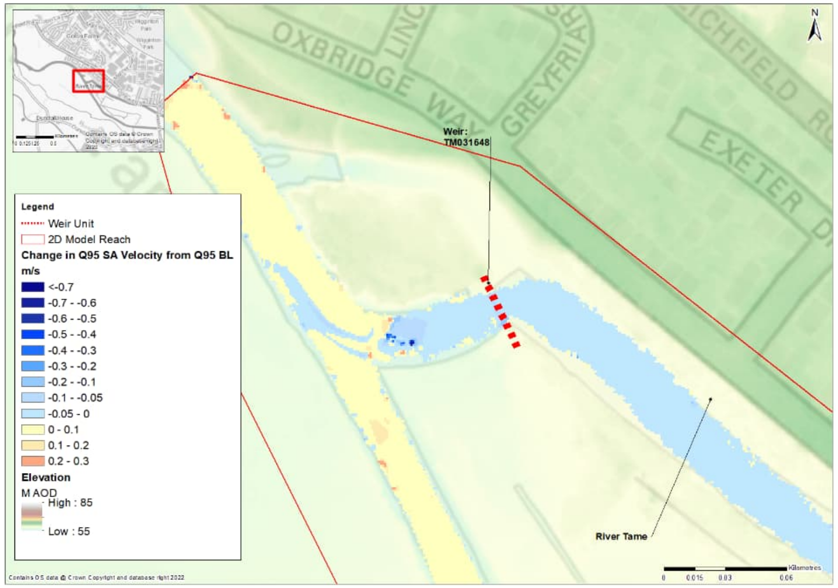


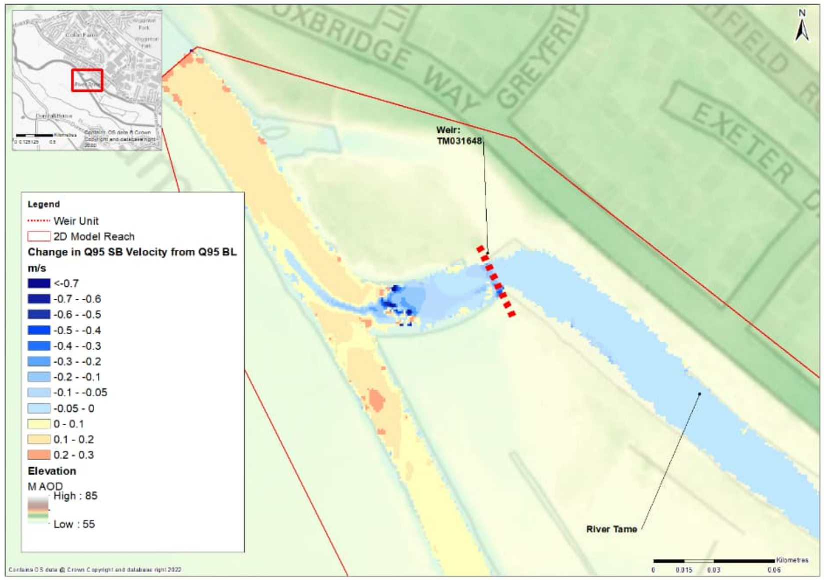


Note: negative numbers indicate a decrease in water velocity when comparing the simulated scenario results with the simulated baseline model results.

Figure 3-21: River Tame at Tamworth – Q95 Baseline Modelled Velocity (top left). Q95 Scenario A (top right) & Scenario B (bottom left) change in Velocities from Q95 Baseline, at Weir No.1 TM033154W







Note: negative numbers indicate a decrease in water velocity when comparing the simulated scenario results with the simulated baseline model results.

Figure 3-22: River Tame at Tamworth – Q95 Baseline Modelled Velocity (top left). Q95 Scenario A (top right) & Scenario B (bottom left) change in Velocity compared with Q95 Baseline, at Weir No.2 TM031648

3.4 Winshill Results

3.4.1 The 2D results for depth and velocity changes for each flow condition and scenarios are included in Table 3-7 through to Table 3-10. The stage and velocity results have been extracted from PO point and line locations; these locations are shown in Figure 3-23 and Figure 3-24. Water depths have subsequently been calculated using stage results and bed elevation inspection data.

3.4.2 For the purpose of this report, only the Q95 outputs have been schematised in figures (see Figure 3-25 through to Figure 3-32. The baseline maximum water depths and velocities have been schematised for the Q95 flow condition, and depth and velocity differences are shown for the Q95 scenarios vs Q95 baseline.

3.4.3 A decrease in water depth has been displayed for each simulation. Downstream of the first weir is where the percentage change in water depth is greatest, especially for the lowest flow condition. The Q99 Scenario B Results show the largest decrease in depth, of -8% when compared to the baseline, see Table 3-7 and Table 3-8.

3.4.4 Points upstream and downstream of the weirs typically show decrease in velocity for each flow condition and scenario. However, a couple of locations display an increase in velocity, refer to Table 3-9 & Table 3-10.

3.4.5 Point 1 & 7 downstream of the first weir are points along the channel banks and show the greatest variance in results for each flow condition and scenario.

Figure 3-23: River Trent at Winshill – PO Points & Lines at Weir No.1, 316124050x

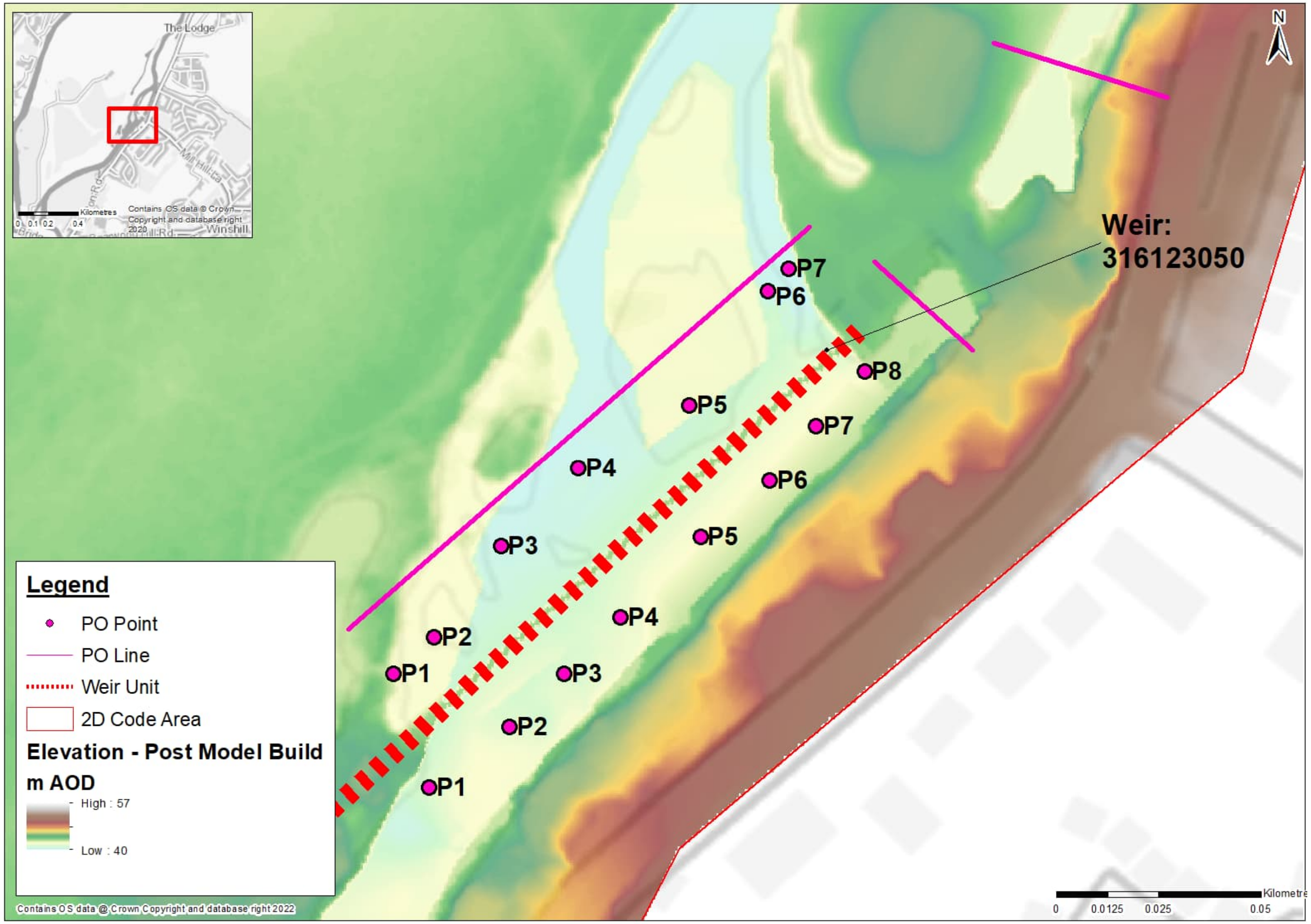


Figure 3-24: River Trent at Winshill – PO Points & Lines at Weir No. 2, 316123050

		Q99								Q95							
Cross Section	Bed Elevation m AOD	Baseline Water Depth (m)	Simulated Baseline Stage (m AOD)	Scenario A Stage (mAOD)	Scenario A Water Depth change from Baseline (m)	Scenario A Maximum Water Depth change (%)	Scenario B Stage (mAOD)	Scenario B Water Depth change from Baseline (m)	Scenario B Maximum Water Depth Change (%)	Baseline Water Depth (m)	Simulated Baseline Stage (m AOD)	Scenario A Stage (mAOD)	Scenario A Water Depth change from Baseline (m)	Scenario A Maximum Water Depth change (%)	Scenario B Stage (mAOD)	Scenario B Water Depth change from Baseline (m)	Scenario B Maximum Water Depth Change (%)
Downstream Boundary (west channel)	41.95	1.39	**43.34**	**43.33**	-0.01	-1%	**43.32**	-0.02	-2%	1.40	**43.35**	**43.34**	-0.01	-1%	**43.33**	-0.02	-2%
Downstream Boundary (east channel)	40.77	1.28	**42.05**	**42.00**	-0.05	-4%	**41.95**	-0.10	-8%	1.31	**42.08**	**42.04**	-0.04	-3%	**41.99**	-0.09	-7%
Upstream Wier 1 (316124050x)	42.44	1.42	**43.86**	**43.85**	-0.01	-1%	**43.84**	-0.02	-1%	1.42	**43.86**	**43.85**	-0.01	0%	**43.85**	-0.01	-1%
Downstream of Weir 1 (316124050x)	41.88	1.52	**43.40**	**43.38**	-0.02	-1%	**43.36**	-0.04	-2%	1.53	**43.41**	**43.39**	-0.02	-1%	**43.37**	-0.04	-2%
Upstream of Weir 2 (316123050)	42.74	1.12	**43.86**	**43.85**	-0.01	-1%	**43.84**	-0.02	-1%	1.12	**43.86**	**43.85**	-0.01	-1%	**43.85**	-0.01	-1%
Downstream of Weir 2 (316123050)	41.09	1.67	**42.76**	**42.75**	-0.01	0%	**42.75**	-0.01	-1%	1.67	**42.76**	**42.75**	-0.01	0%	**42.75**	-0.01	0%
Downstream Fish Passage (weir 1)	43.24	0.26	**43.50**	**43.49**	-0.01	-4%	**43.48**	-0.02	-8%	0.27	**43.51**	**43.50**	-0.01	-5%	**43.49**	-0.02	-9%

Table 3-7: River Trent at Winshill – Water Depth Difference, Q99 & Q95 Flow Conditions

Cross Section	Bed Elevation m AOD	Q50 Baseline Water Depth (m)	Q50 Simulated Baseline Stage (m AOD)	Q50 Scenario A Stage (mAOD)	Q50 Scenario A Water Depth change from Baseline (m)	Q50 Scenario A Maximum Water Depth change (%)	Q50 Scenario B Stage (mAOD)	Q50 Scenario B Water Depth change from Baseline (m)	Q50 Scenario B Maximum Water Depth Change (%)	Q10 Baseline Water Depth (m)	Q10 Simulated Baseline Stage (m AOD)	Q10 Scenario A Stage (mAOD)	Q10 Scenario A Water Depth change from Baseline (m)	Q10 Scenario A Maximum Water Depth change (%)	Q10 Scenario B Stage (mAOD)	Q10 Scenario B Water Depth change from Baseline (m)	Q10 Scenario B Maximum Water Depth Change (%)
Downstream Boundary (west channel)	41.95	1.54	**43.49**	**43.47**	-0.02	-1%	**43.46**	-0.03	-2%	2.24	**44.19**	**44.16**	-0.03	-1%	**44.16**	-0.03	-1%
Downstream Boundary (east channel)	40.77	1.65	**42.42**	**42.39**	-0.03	-2%	**42.35**	-0.07	-4%	2.58	**43.35**	**43.32**	-0.03	-1%	**43.29**	-0.06	-2%
Upstream Wier 1 (316124050x)	42.44	1.48	**43.92**	**43.91**	-0.01	0%	**43.91**	-0.01	-1%	1.86	**44.30**	**44.29**	-0.01	-1%	**44.27**	-0.03	-2%
Downstream of Weir 1 (316124050x)	41.88	1.71	**43.59**	**43.57**	-0.02	-1%	**43.55**	-0.04	-2%	2.42	**44.30**	**44.29**	-0.01	0%	**44.28**	-0.02	-1%
Upstream of Weir 2 (316123050)	42.74	1.16	**43.90**	**43.90**	0.00	0%	**43.89**	-0.01	-1%	1.30	**44.04**	**44.03**	-0.01	-1%	**44.03**	-0.01	-1%
Downstream of Weir 2 (316123050)	41.09	1.68	**42.77**	**42.77**	0.00	0%	**42.77**	0.00	0%	2.35	**43.44**	**43.41**	-0.03	-1%	**43.38**	-0.06	-3%
Downstream Fish Passage (weir 1)	43.24	0.35	**43.59**	**43.58**	-0.01	-2%	**43.58**	-0.01	-4%	1.04	**44.28**	**44.27**	-0.01	-1%	**44.25**	-0.03	-3%

Table 3-8: River Trent at Winshill – Water Depth Difference, Q50 & Q10 Flow Conditions

		Q99							Q95						
PO Location	PO Point	Baseline Velocity (m/s)	Scenario A Velocity (m/s)	Scenario A Velocity change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Velocity (m/s)	Scenario B Velocity change from baseline (m/s)	Scenario B Velocity change from baseline (%)	Baseline Velocity (m/s)	Scenario A Velocity (m/s)	Scenario A Velocity change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Velocity (m/s)	Scenario B Velocity change from baseline (m/s)	Scenario B Velocity change from baseline (%)
US Weir 1: 316124050x	P1	**0.28**	**0.26**	-0.02	-7%	**0.24**	-0.04	-14%	**0.29**	**0.27**	-0.02	-7%	**0.25**	-0.04	-14%
	P2	**0.26**	**0.24**	-0.02	-8%	**0.22**	-0.04	-15%	**0.27**	**0.25**	-0.02	-7%	**0.23**	-0.04	-15%
	P3	**0.19**	**0.17**	-0.02	-11%	**0.15**	-0.04	-21%	**0.20**	**0.18**	-0.02	-10%	**0.17**	-0.03	-15%
	P4	**0.12**	**0.10**	-0.02	-17%	**0.09**	-0.03	-25%	**0.12**	**0.11**	-0.01	-8%	**0.10**	-0.02	-17%
	P5	**0.08**	**0.08**	0.00	0%	**0.08**	0.00	0%	**0.08**	**0.08**	0.00	0%	**0.08**	0.00	0%
	P6	**0.08**	**0.08**	0.00	0%	**0.08**	0.00	0%	**0.08**	**0.08**	0.00	0%	**0.08**	0.00	0%
	P7	**0.16**	**0.15**	-0.01	-6%	**0.14**	-0.02	-13%	**0.16**	**0.15**	-0.01	-6%	**0.15**	-0.01	-6%
	P8	**0.21**	**0.20**	-0.01	-5%	**0.19**	-0.02	-10%	**0.21**	**0.20**	-0.01	-5%	**0.20**	-0.01	-5%
DS Weir 1: 316124050x	P1	**0.10**	**0.10**	0.00	0%	**0.07**	-0.03	-30%	**0.13**	**0.11**	-0.02	-15%	**0.09**	-0.04	-31%
	P2	**0.72**	**0.71**	-0.01	-1%	**0.70**	-0.02	-3%	**0.67**	**0.71**	0.04	6%	**0.72**	0.05	7%
	P3	**0.13**	**0.13**	0.00	0%	**0.12**	-0.01	-8%	**0.14**	**0.13**	-0.01	-7%	**0.13**	-0.01	-7%
	P4	**0.06**	**0.05**	-0.01	-17%	**0.05**	-0.01	-17%	**0.06**	**0.06**	0.00	0%	**0.05**	-0.01	-17%
	P5	**0.15**	**0.13**	-0.02	-13%	**0.12**	-0.03	-20%	**0.15**	**0.14**	-0.01	-7%	**0.13**	-0.02	-13%
	P6	**0.13**	**0.12**	-0.01	-8%	**0.11**	-0.02	-15%	**0.14**	**0.13**	-0.01	-7%	**0.12**	-0.02	-14%
US Weir 2: 316123050	P1	**0.11**	**0.09**	-0.02	-18%	**0.08**	-0.03	-27%	**0.12**	**0.10**	-0.02	-17%	**0.09**	-0.03	-25%
	P2	**0.09**	**0.08**	-0.01	-11%	**0.06**	-0.03	-33%	**0.10**	**0.08**	-0.02	-20%	**0.07**	-0.03	-30%
	P3	**0.08**	**0.07**	-0.01	-13%	**0.06**	-0.02	-25%	**0.08**	**0.07**	-0.01	-13%	**0.06**	-0.02	-25%
	P4	**0.07**	**0.06**	-0.01	-14%	**0.05**	-0.02	-29%	**0.07**	**0.06**	-0.01	-14%	**0.06**	-0.01	-14%
	P5	**0.07**	**0.06**	-0.01	-14%	**0.05**	-0.02	-29%	**0.07**	**0.06**	-0.01	-14%	**0.05**	-0.02	-29%
	P6	**0.04**	**0.03**	-0.01	-25%	**0.03**	-0.01	-25%	**0.04**	**0.04**	0.00	0%	**0.03**	-0.01	-25%
	P7	**0.03**	**0.02**	-0.01	-33%	**0.02**	-0.01	-33%	**0.03**	**0.02**	-0.01	-33%	**0.02**	-0.01	-33%
	P8	**0.01**	**0.00**	-0.01	-100%	**0.00**	-0.01	-100%	**0.01**	**0.00**	-0.01	-100%	**0.00**	-0.01	-100%
DS Weir 2: 316123050	P1	**0.06**	**0.06**	0.00	0%	**0.05**	-0.01	-17%	**0.07**	**0.06**	-0.01	-14%	**0.05**	-0.02	-29%
	P2	**0.04**	**0.04**	0.00	0%	**0.04**	0.00	0%	**0.05**	**0.04**	-0.01	-20%	**0.04**	-0.01	-20%
	P3	**0.08**	**0.07**	-0.01	-13%	**0.06**	-0.02	-25%	**0.08**	**0.07**	-0.01	-13%	**0.07**	-0.01	-13%
	P5	**0.01**	**0.01**	0.00	0%	**0.00**	-0.01	-100%	**0.01**	**0.01**	0.00	0%	**0.00**	-0.01	-100%
	P6	**0.06**	**0.05**	-0.01	-17%	**0.04**	-0.02	-33%	**0.06**	**0.06**	0.00	0%	**0.05**	-0.01	-17%
	P7	**0.12**	**0.11**	-0.01	-8%	**0.09**	-0.03	-25%	**0.13**	**0.12**	-0.01	-8%	**0.10**	-0.03	-23%
DS Fish Passage	P4	**1.90**	**1.85**	-0.05	-3%	**1.84**	-0.06	-3%	**1.89**	**1.89**	0.00	0%	**1.84**	-0.05	-3%

Table 3-9: River Trent at Winshill – Velocity Difference, Q99 & Q95 Flow Conditions

		Q50							Q10						
PO Location	PO Point	Baseline Velocity (m/s)	Scenario A Velocity (m/s)	Scenario A Velocity change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Velocity (m/s)	Scenario B Velocity change from baseline (m/s)	Scenario B Velocity change from baseline (%)	Baseline Velocity (m/s)	Scenario A Velocity (m/s)	Scenario A Velocity change from baseline (m/s)	Scenario A Velocity change from baseline (%)	Scenario B Velocity (m/s)	Scenario B Velocity change from baseline (m/s)	Scenario B Velocity change from baseline (%)
US Weir 1: 316124050x	P1	**0.47**	**0.45**	-0.02	-4%	**0.43**	-0.04	-9%	**0.88**	**0.88**	0.00	0%	**0.87**	-0.01	-1%
	P2	**0.42**	**0.41**	-0.01	-2%	**0.39**	-0.03	-7%	**0.84**	**0.83**	-0.01	-1%	**0.82**	-0.02	-2%
	P3	**0.34**	**0.32**	-0.02	-6%	**0.31**	-0.03	-9%	**0.68**	**0.67**	-0.01	-1%	**0.67**	-0.01	-1%
	P4	**0.23**	**0.22**	-0.01	-4%	**0.21**	-0.02	-9%	**0.45**	**0.44**	-0.01	-2%	**0.44**	-0.01	-2%
	P5	**0.09**	**0.09**	0.00	0%	**0.08**	-0.01	-11%	**0.16**	**0.15**	-0.01	-6%	**0.14**	-0.02	-13%
	P6	**0.08**	**0.08**	0.00	0%	**0.08**	0.00	0%	**0.27**	**0.28**	0.01	4%	**0.29**	0.02	7%
	P7	**0.20**	**0.19**	-0.01	-5%	**0.18**	-0.02	-10%	**0.14**	**0.13**	-0.01	-7%	**0.12**	-0.02	-14%
	P8	**0.26**	**0.25**	-0.01	-4%	**0.25**	-0.01	-4%	**0.09**	**0.07**	-0.02	-22%	**0.07**	-0.02	-22%
DS Weir 1: 316124050x	P1	**0.05**	**0.08**	0.03	60%	**0.14**	0.09	180%	**0.04**	**0.05**	0.01	25%	**0.05**	0.01	25%
	P2	**0.06**	**0.08**	0.02	33%	**0.11**	0.05	83%	**0.56**	**0.55**	-0.01	-2%	**0.53**	-0.03	-5%
	P3	**0.24**	**0.23**	-0.01	-4%	**0.21**	-0.03	-13%	**0.49**	**0.48**	-0.01	-2%	**0.47**	-0.02	-4%
	P4	**0.10**	**0.09**	-0.01	-10%	**0.09**	-0.01	-10%	**0.36**	**0.35**	-0.01	-3%	**0.34**	-0.02	-6%
	P5	**0.26**	**0.25**	-0.01	-4%	**0.24**	-0.02	-8%	**0.09**	**0.09**	0.00	0%	**0.09**	0.00	0%
	P6	**0.21**	**0.21**	0.00	0%	**0.20**	-0.01	-5%	**0.58**	**0.58**	0.00	0%	**0.57**	-0.01	-2%
US Weir 2: 316123050	P1	**0.25**	**0.23**	-0.02	-8%	**0.22**	-0.03	-12%	**0.82**	**0.80**	-0.02	-2%	**0.78**	-0.04	-5%
	P2	**0.19**	**0.18**	-0.01	-5%	**0.17**	-0.02	-11%	**0.60**	**0.59**	-0.01	-2%	**0.57**	-0.03	-5%
	P3	**0.16**	**0.15**	-0.01	-6%	**0.14**	-0.02	-13%	**0.51**	**0.50**	-0.01	-2%	**0.49**	-0.02	-4%
	P4	**0.13**	**0.13**	0.00	0%	**0.12**	-0.01	-8%	**0.42**	**0.41**	-0.01	-2%	**0.40**	-0.02	-5%
	P5	**0.14**	**0.13**	-0.01	-7%	**0.12**	-0.02	-14%	**0.40**	**0.39**	-0.01	-3%	**0.38**	-0.02	-5%
	P6	**0.08**	**0.08**	0.00	0%	**0.07**	-0.01	-13%	**0.23**	**0.23**	0.00	0%	**0.22**	-0.01	-4%
	P7	**0.05**	**0.05**	0.00	0%	**0.05**	0.00	0%	**0.15**	**0.15**	0.00	0%	**0.15**	0.00	0%
	P8	**0.01**	**0.01**	0.00	0%	**0.01**	0.00	0%	**0.01**	**0.02**	0.01	100%	**0.02**	0.01	100%
DS Weir 2: 316123050	P1	**0.12**	**0.11**	-0.01	-8%	**0.11**	-0.01	-8%	**0.06**	**0.07**	0.01	17%	**0.08**	0.02	33%
	P2	**0.05**	**0.05**	0.00	0%	**0.05**	0.00	0%	**0.03**	**0.03**	0.00	0%	**0.03**	0.00	0%
	P3	**0.11**	**0.11**	0.00	0%	**0.10**	-0.01	-9%	**0.19**	**0.18**	-0.01	-5%	**0.18**	-0.01	-5%
	P5	**0.05**	**0.06**	0.01	20%	**0.03**	-0.02	-40%	**0.34**	**0.33**	-0.01	-3%	**0.32**	-0.02	-6%
	P6	**0.14**	**0.12**	-0.02	-14%	**0.12**	-0.02	-14%	**0.30**	**0.34**	0.04	13%	**0.34**	0.04	13%
	P7	**0.21**	**0.20**	-0.01	-5%	**0.20**	-0.01	-5%	**0.51**	**0.50**	-0.01	-2%	**0.49**	-0.02	-4%
DS Fish Passage	P4	**2.04**	**2.00**	-0.04	-2%	**1.96**	-0.08	-4%	**0.60**	**0.60**	0.00	0%	**0.60**	0.00	0%

Table 3-10: River Trent at Winshill – Velocity Differences, Q50 & Q10 Flow Conditions

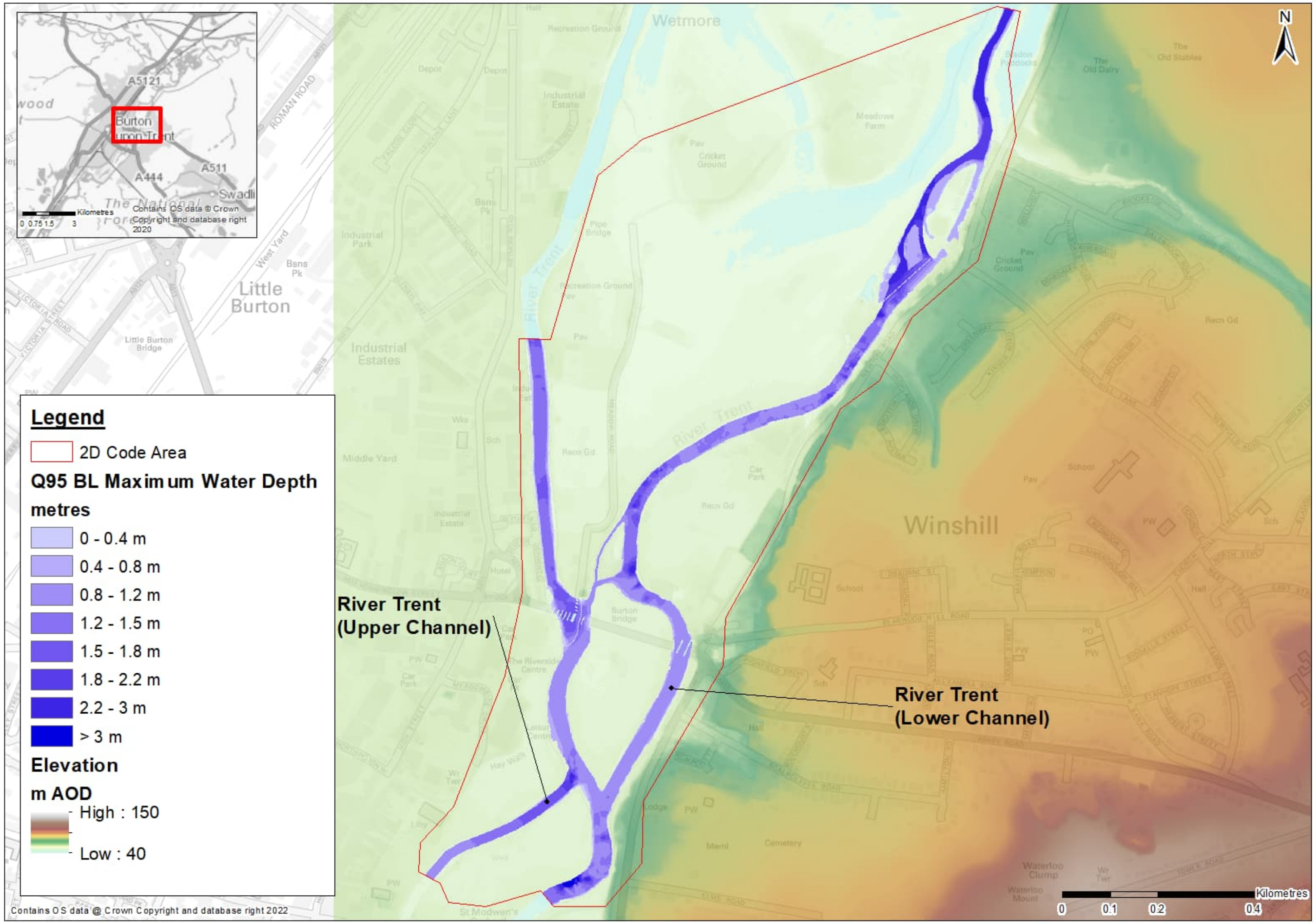


Figure 3-25: River Trent at Winshill – Q95 Baseline Maximum Water Depth

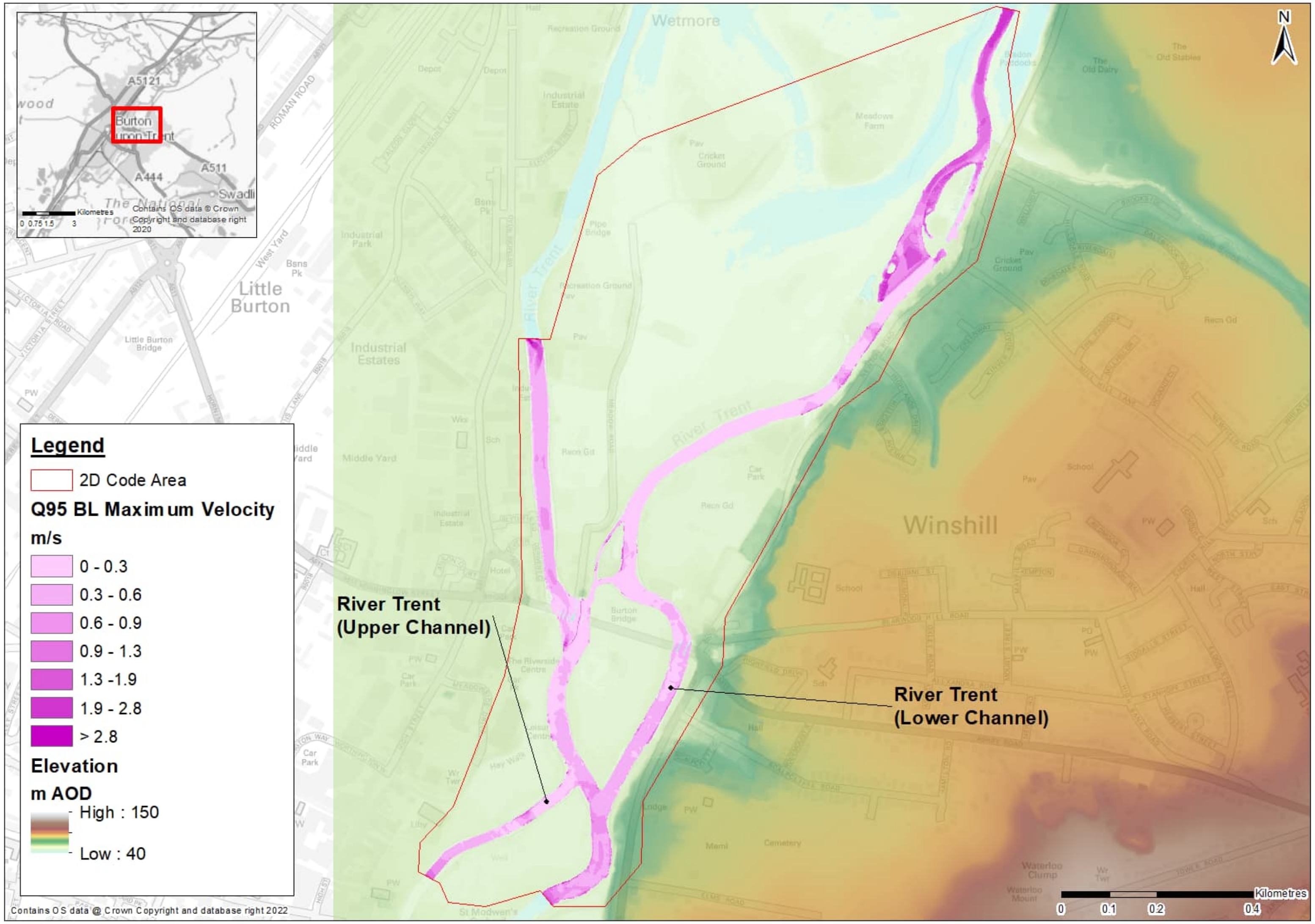
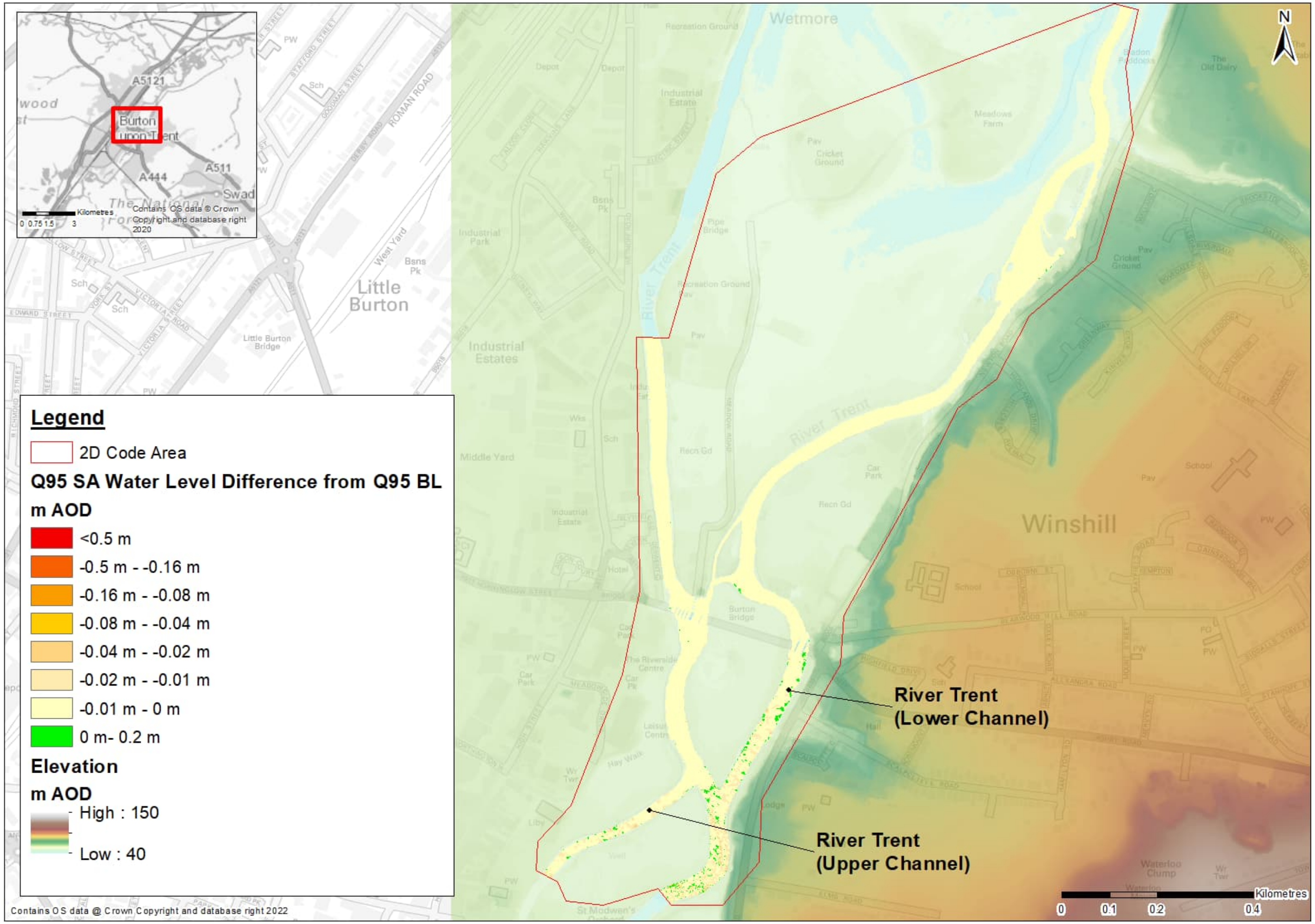
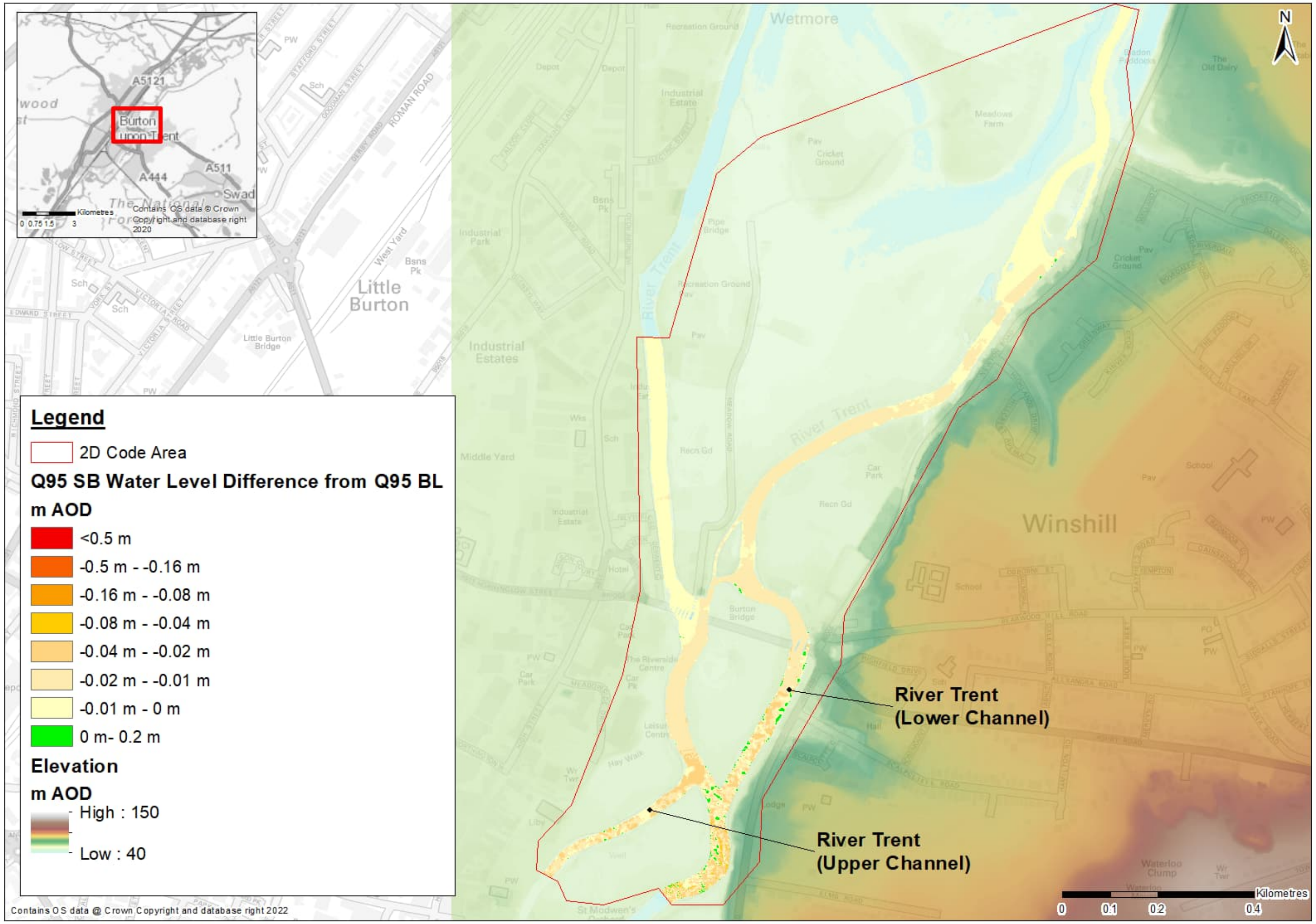


Figure 3-26: River Trent at Winshill – Q95 Baseline Maximum Velocities



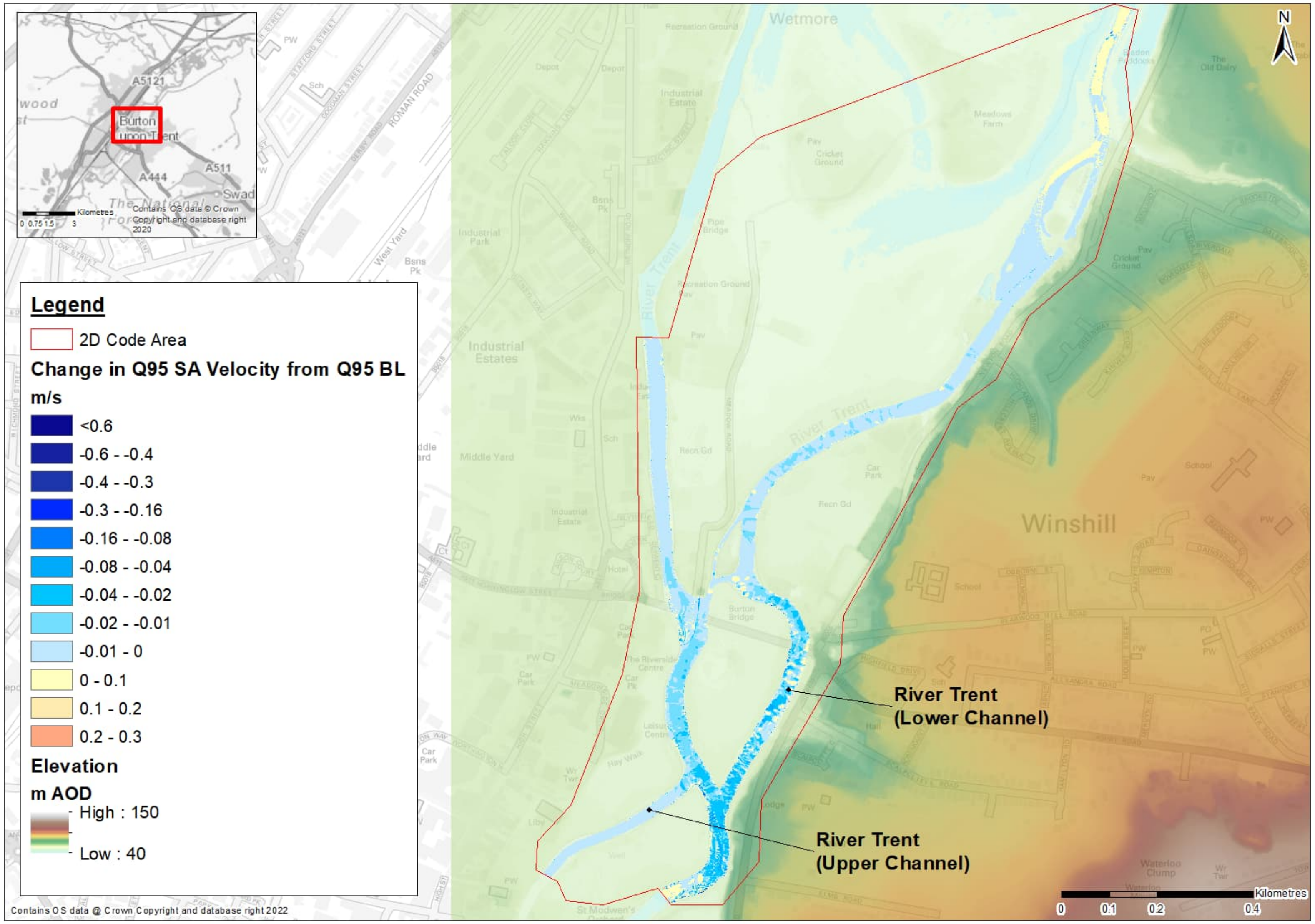
Note: negative numbers indicate a decrease in water depth when comparing the simulated scenario results with the simulated baseline model results.

Figure 3-27: River Trent at Winshill – Q95 Scenario A Water Level Difference from Q95 Baseline



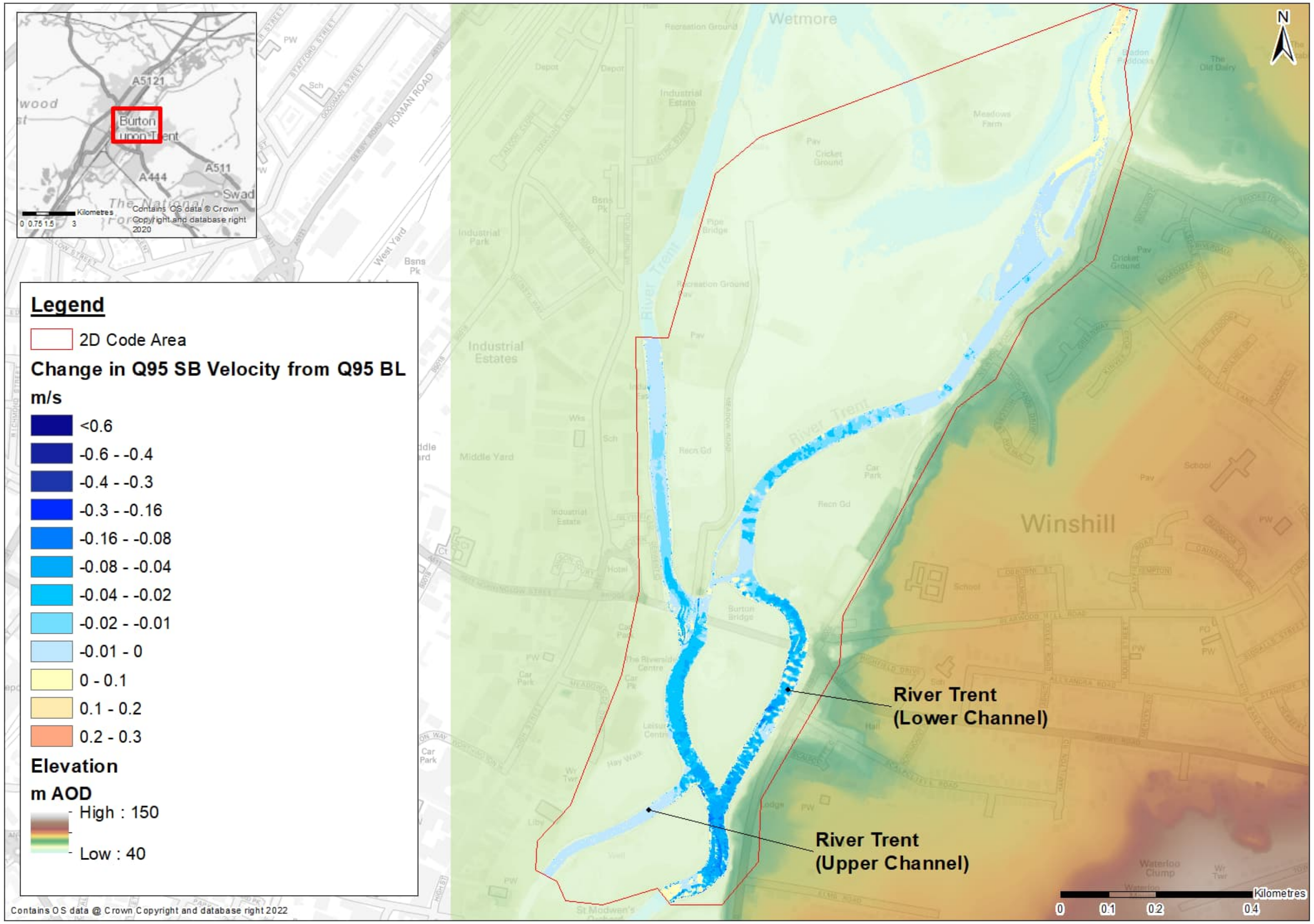
Note: negative numbers indicate a decrease in water depth when comparing the simulated scenario results with the simulated baseline model results.

Figure 3-28: River Trent at Winshill – Q95 Scenario B Water Level Difference from Q95 Baseline



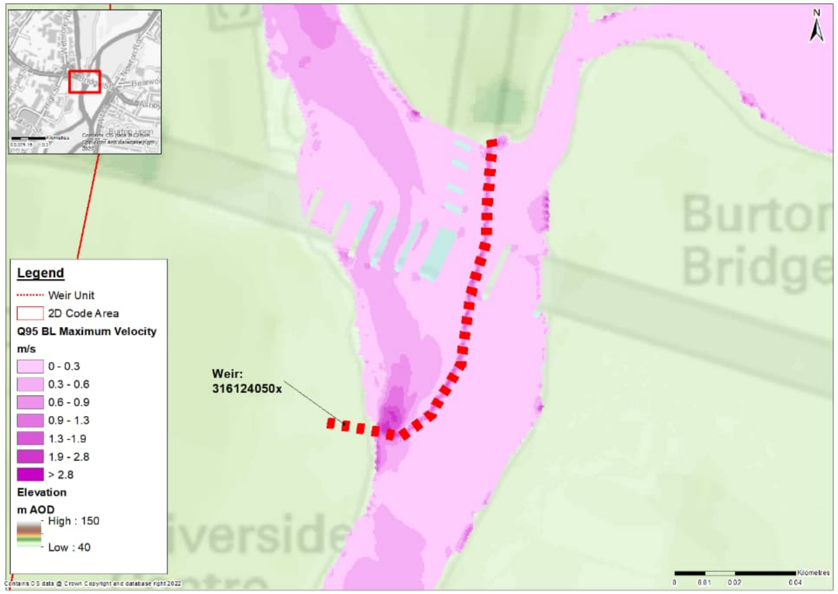
Note: negative numbers indicate a decrease in water velocity when comparing the simulated scenario results with the simulated baseline model results.

Figure 3-29: River Trent at Winshill – Q95 Scenario A Velocity Difference from Q95 Baseline



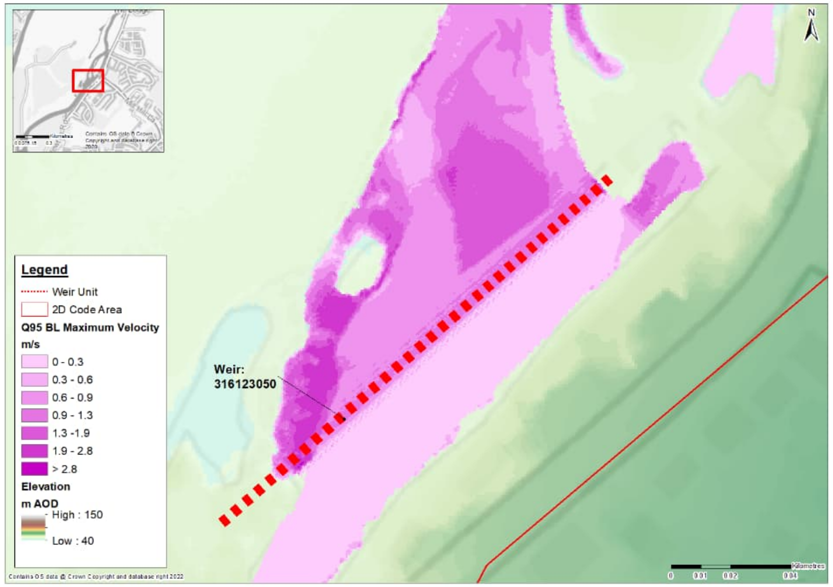
Note: negative numbers indicate a decrease in water velocity when comparing the simulated scenario results with the simulated baseline model results.

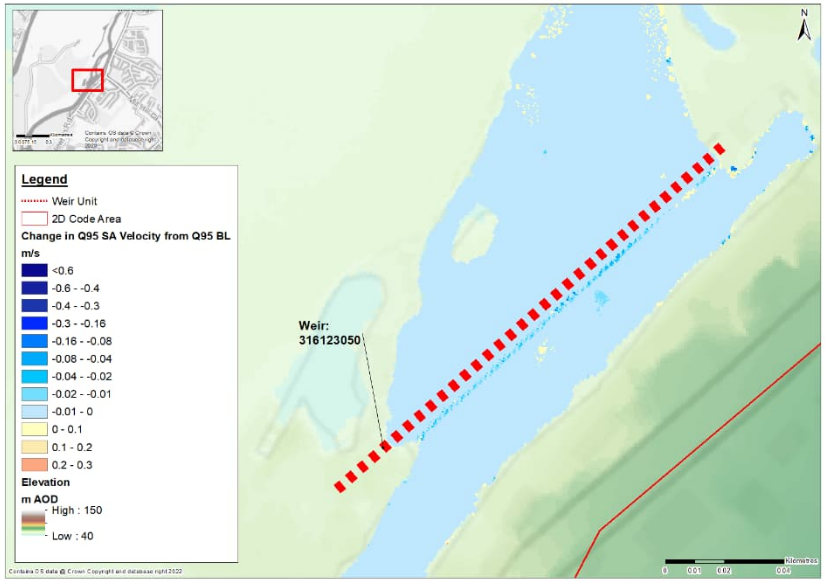
Figure 3-30: River Trent at Winshill – Q95 Scenario B Velocity Difference from Q95 Baseline

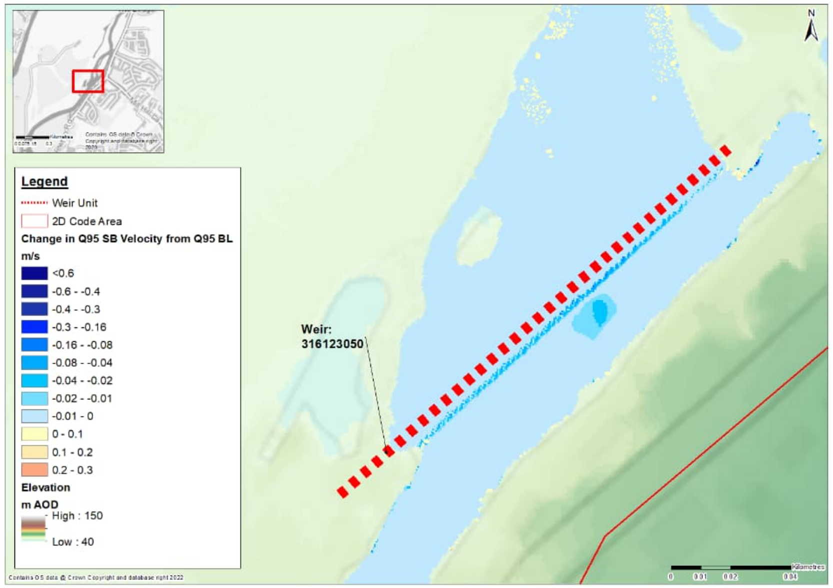


Note: negative numbers indicate a decrease in water velocity when comparing the simulated scenario results with the simulated baseline model results.

Figure 3-31: River Trent at Winshill – Q95 Baseline Modelled Velocities (top left). Q95 Scenario A (top right) & Scenario B (bottom left) Velocity Difference from Q95 Baseline at Weir No.1, 316124050x







Note: negative numbers indicate a decrease in water velocity when comparing the simulated scenario results with the simulated baseline model results.

Figure 3-32: River Trent at Winshill – Q95 Baseline Modelled Velocities (top left). Q95 Scenario A (top right) & Scenario B (bottom left) Velocity Difference from Q95 Baseline at Weir No.2, 316123050

4. Summary of Results

4.1 Lea Marston

4.1.1 The model results indicate that Scenarios A and B (SA and SB) would result in small reductions in depth, for both the channels and lakes at this site for all flow conditions. The most significant drop in water level, when comparing SA & SB with the baseline water level for all flow scenarios, is predicted downstream of weirs LM2A0000 and LM2B0000 (near the norther end of the site – see Figure 2-2). The maximum reduction at these locations is 0.18m for the Q99 flow condition (Table 3-1). Elsewhere, the reduction in water level is typically below 0.05m. Water levels reduce more in the main channel compared to the lakes as the water level in the lakes is controlled by the weir structure between the lake and the river.

4.1.2 The highest percentage depth reduction when comparing the baseline with SA occurs for the Q99 flow event and is observed downstream of weirs LM2A0000 and LM2B0000. The drop in depth is approximately 10% from the 1.7 m & 1.1 m baseline water depth, respectively for the two weirs.

4.1.3 For SB, the greatest reduction in depth also occurs downstream of weirs LM2A0000 & LM2B0000. In this case the drop in water depth is approximately -22% from the 1.7 m & 1.1 m baseline water depth, respectively.

4.1.4 For comparison, the percentage change in water depth for SB is typically around double that predicted for SA, based on the water levels taken upstream and downstream of the Lea Marston weirs (Table 3-1 and Table 3-2).

4.1.5 The highest baseline velocities are predicted in the vicinity of the crump weirs near the upstream end of the site, as well as the in the River Tame channel and downstream of all other weirs. Within the Lea Marston Lakes baseline velocities are shown to be very low (<0.1 m/s) and consequently changes in velocities for SA & SB are also low in this location.

4.1.6 The largest reductions in velocity are predicted in the vicinity of the weirs and in the Tame channel downstream of Coton Road (e.g. -0.28 m/s downstream of Weir LM2B0000, for Q99 SB - Table 3-3).

4.2 Tamworth

4.2.1 The largest reductions to water depth are predicted to occur downstream of the upstream weir at Tamworth (TM033154W - Figure 2-13). Reductions are 20% and 31% when comparing the Q99 SA and SB with the Q99 baseline water depth of 0.42 m, respectively.

4.2.2 Reductions in water depth predicted upstream and downstream of the second weir at Tamworth (TM031648) are approximately 2% for SA and 4% for SB, when comparing to the Q99 baseline water depth of approximately 1.1 m either side of the weir.

4.2.3 Reductions in velocity are predicted downstream of the upstream weir (TM033154W) particularly for the Q99 flow condition. Reductions of approximately 40% and 65% are predicted, when comparing the Q99 baseline when compared to SA and SB, respectively.

4.2.4 Reductions in water velocity predicted upstream and downstream of the second weir at Tamworth (TM031648) are approximately 8% for SA and 19% for SB, when comparing to the Q99 baseline velocity upstream of the weir of 0.3 m/s and a velocity of 0.9 m/s downstream.

4.3 Winshill

4.3.1 Only minor reductions in depths (<0.01m for Q95 - Figure 3-27) are predicted for SA at this site. For both the Q99 SA and SB the change in water depth upstream of both the Winshill weirs is minimal, with a greatest percentage decrease in water depth of 1%.

4.3.2 Water depths downstream of the fish passage at the first weir (316124050x - Figure 2-22) for the Q99 flow event show reductions in depths of 4% and 8% when for SA and SB respectively, when comparing with the Q99 baseline depth of 0.26 m.

4.3.3 Reductions in velocity upstream and downstream of the weirs at Winshill when comparing the Q99 SA with the Q99 baseline range typically between no change and 20%. The Q99 SB reductions in velocity are typically double those of the Q99 SA.

4.3.4 The velocity through the first weir passage shows a Q99 baseline velocity of 1.9 m/s. Reductions in velocity for Q99 are 3% for both scenarios.

4.4 Next Steps

4.4.1 As noted in the the *Strategic Resource Options: Hydrological and Hydraulic Modelling for the Tame and Trent: Project Report,* to which this document forms Appendix D, further 2D modelling of other weir structures in the River Trent between Winshill and the tidal limit at Cromwell is to be considered.

4.4.2 Prior to the commencement of Gate 3, a further round of bathymetric and structure survey work is ongoing to support further 2D modelling at key locations, including Sawley weir and Thrumpton Weir on the River Trent. Whilst this modelling work is not due to complete in time for reporting at Gate 2, it will be available to support further assessment at Gate 3.

Annex A: Bathymetric Survey TN

Author names redacted

Technical Note

Scheme Title:	River Tame & Trent	**Job No/Task No.:**	60671264
Subject:	River Tame & Trent Bathymetry Survey	**Client:**	Affinity Water
Prepared by:	[redacted]	**Date:**	23/08/2022
Checked by:	[redacted]	**Date:**	**28/09/2022**
Approved by:	[redacted]	**Date:**	**07/10/2022**

Revision History

Revision	Revision date	Details	Authorized	Name	Position
P01	23/08/2022	Draft	October 2022	[redacted]	Project Manager

1. Introduction

1.1 Project Description and Background

1.1.1 AECOM has completed 2D bathymetric surveys of two sections of the River Tame and one section of the River Trent where several weirs are present.

1.1.2 The purpose of the surveys was to define the elevation of the riverbed to support2D modelling of the waterbodies.

1.1.3 The three areas of the rivers that were surveyed are located at Lea Marston Lakes (Figure 1), the River Tame at Tamworth (Figure 2) and the River Trent at Winshill (Figure 3).

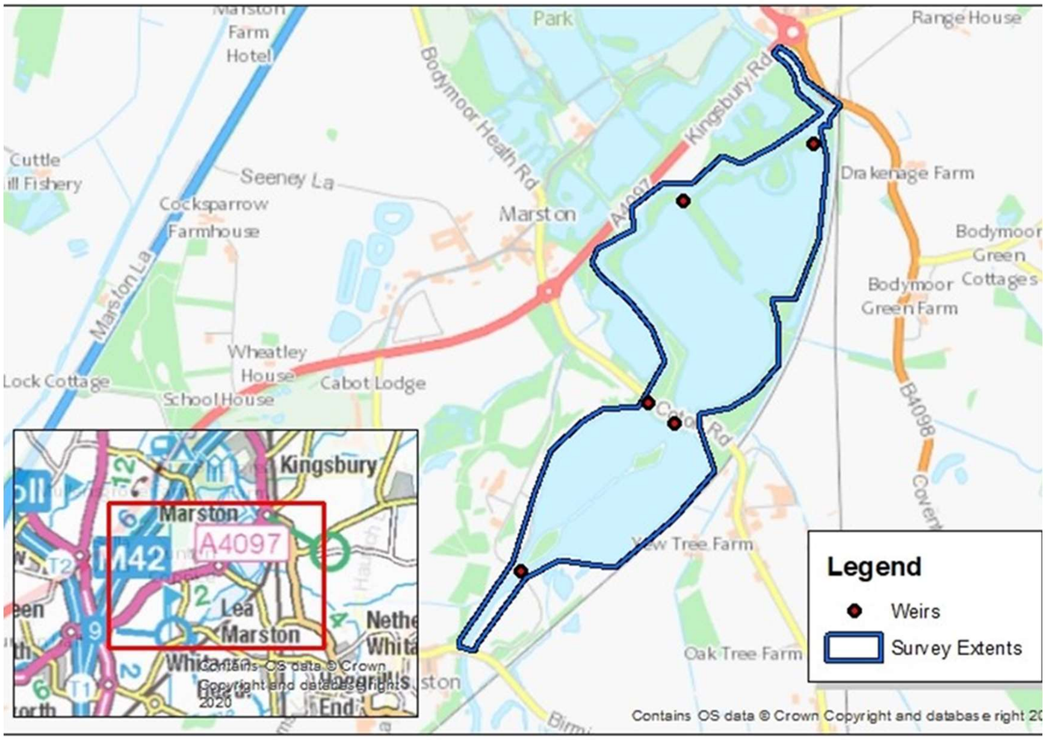


Figure 1: Lea Marston Lakes (areas within the blue polygon)

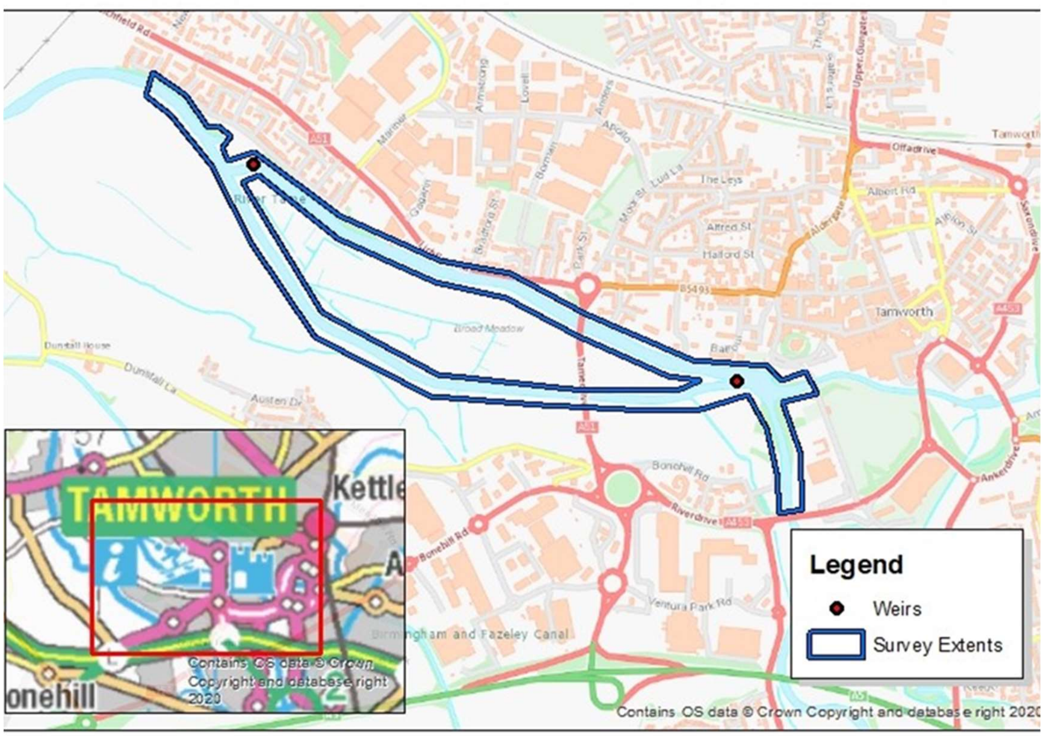


Figure 2: River Tame at Tamworth (area within the blue polygon)

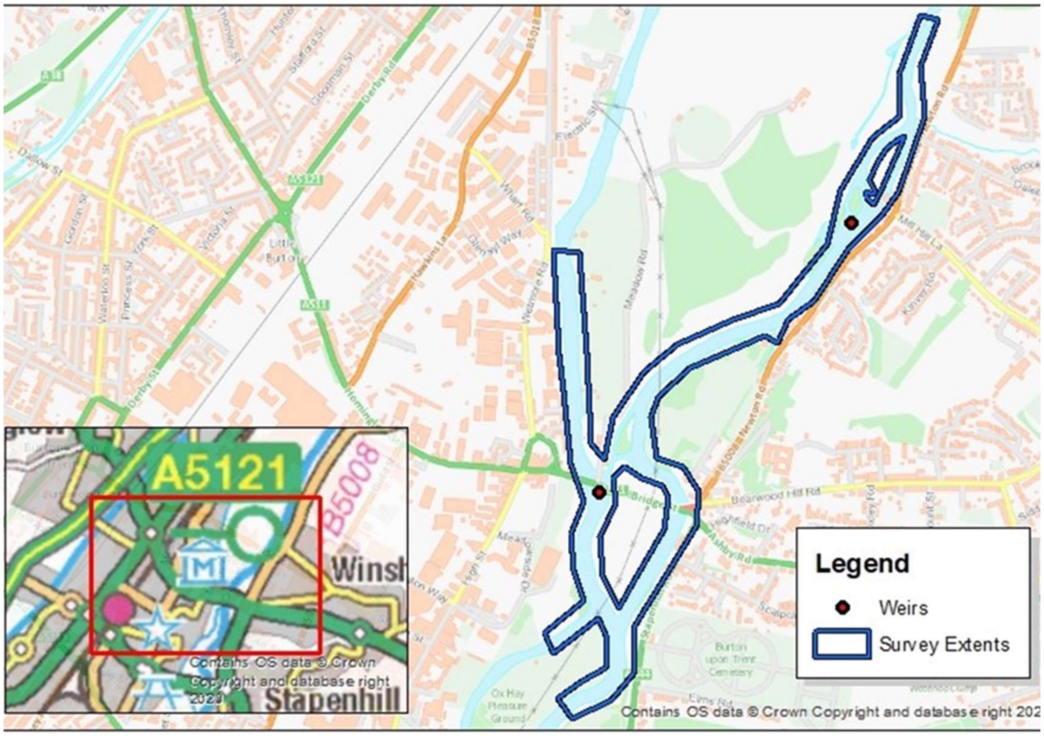


Figure 3: River Trent at Winshill (area within the blue polygon)

2. Methodology

2.1.1 The bathymetric surveys were conducted using the ARCboat, a remotely controlled survey boat. The boat is powered by twin DC electric motors driving shrouded propellers with twin rudders to provide very high manoeuvrability.

2.1.2 The boat has an overall length of 1.95 m, a beam of 0.72 m and a draft of 0.18 m. The total un-laden weight of the boat (including batteries) is 37.2 kg. The boat is operated by means of a standard 2.4 GHz remote controller.

2.1.3 The boat's moon-pool was designed to accept a variety of different sensors, including a single multi-beam echo-sounders, the data from which can be continuously monitored by the shore-based operator via the boat's inbuilt 5 GHz telemetry system.

2.1.4 The ARCboat provides a portable and stable survey platform for work in shallow water as well as in water bodies where access is limited. The ARCboat features a high accuracy DGNSS positioning system as well as the telemetry of both navigation and scientific data streams such that the boat can be piloted remotely.

2.1.5 The surveys, as far as reasonably possible, collected bathymetric water depth data to the riverbed.

2.2 Positioning

2.2.1 Positioning for the bathymetric survey was achieved using a "Powered by Trimble" L1/L2 RTK GNSS receiver built into the echosounder, operating in RTK mode using corrections from the Trimble RTK GNSS correction service. The manufacturers stated accuracy (RMS) for the receiver is 1 mm + 1 ppm in the horizontal and 15 mm + 1 ppm in the vertical.

2.2.2 The RTK GNSS receiver with the associated antenna was mounted above the echo sounder transducer.

2.3 Depth Measurement

2.3.1 Bathymetric data collection was undertaken using a Cadden Bali Dual frequency Echo Sounder This unit operates at frequencies of 200 kHz and 30KHz and the manufacturer's stated accuracy is +/- 0.2% of water depth. Please see data sheet on page 20 of this document.

2.3.2 The nominal minimum water depth that can be surveyed with the ARCboat is approximately 0.4 m to 0.5 m. In many places of these three sites water depths were less than this and this has caused problems with acquisitions and subsequent processing.

2.4 Navigation and data acquisition

2.4.1 The Bali v3 echosounder pings at a rate of five times per second along a survey transect. Data coverage on this entire survey averaged at approximately one data sample every 10cms along all of the transects.

2.4.2 Data from the ARCboat was telemetered to the operator using the boat's data telemetry system which employs a conventional wireless networking architecture (WLAN).

2.4.3 The depth and position data from the echo sounder unit and the GNSS receiver was outputted in real-time to a tablet PC running survey navigation and data acquisition software.

2.4.4 This provided the real-time navigational information to the operator and also provided a display of the recorded bathymetric data.

2.4.5 Following acquisition of all survey data the boat's track was examined to ensure that a full and even coverage of the survey area was achieved wherever possible.

2.5 Support boat

2.5.1 A small inflatable support boat with an outboard motor was available for launching should the range of the ARCboat' s remote-control system approach its limit of operation or should the nature and complexity of the waterbody to be surveyed warrant operation of a support boat to closely follow the ARCboat to aid its piloting (near shallow areas which are heavily vegetated for example).

2.6 Operation of the ARCboat

2.6.1 The banks of the waterbodies were generally subject to heavy vegetation or heavily wooded canopies. The banks were also, unstable under foot in places. Access to the full perimeter of each waterbody was not possible by foot, so the support boat was used extensively. Launch and recovery sites for the ARCboat and support boat were selected carefully to avoid areas where the bank was too unstable or too steep.

2.6.2 The ARCboat was transported in a van to a suitable location near the edge of the waterbodies from where it was launched from the bank by the two-man survey team. The van was parked as close as possible to the launch sites. Each of the launch locations are shown circled in pink in Figure 4, 5 and 6). Due to the heavily vegetated nature of some of the watercourses and the shallow depths, the support boat was used to closely follow the ARCboat to aid its piloting near shallow areas which were heavily vegetated. The support boat was also used where bank access was not possible due to land access and weir obstruction.

2.6.3 Areas that were not possible to survey are shown on the below figures and discussed further in section 2.7.

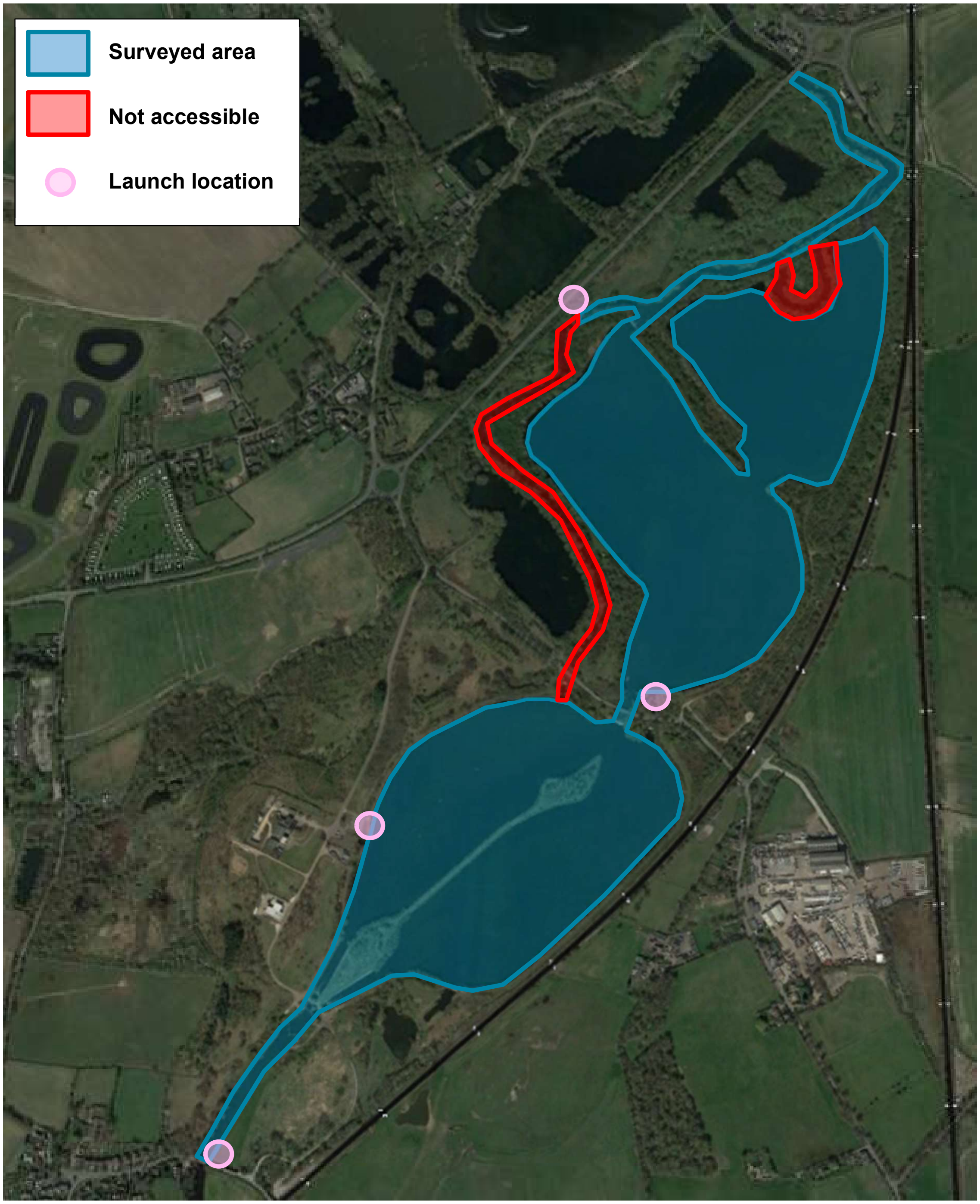


Figure 4: Lea Marston Lakes survey locations *Source: Google Earth (imagery date August 2022)*

Figure 5: River Tame at Tamworth survey locations ***Source: Google Earth (imagery date August 2022)***

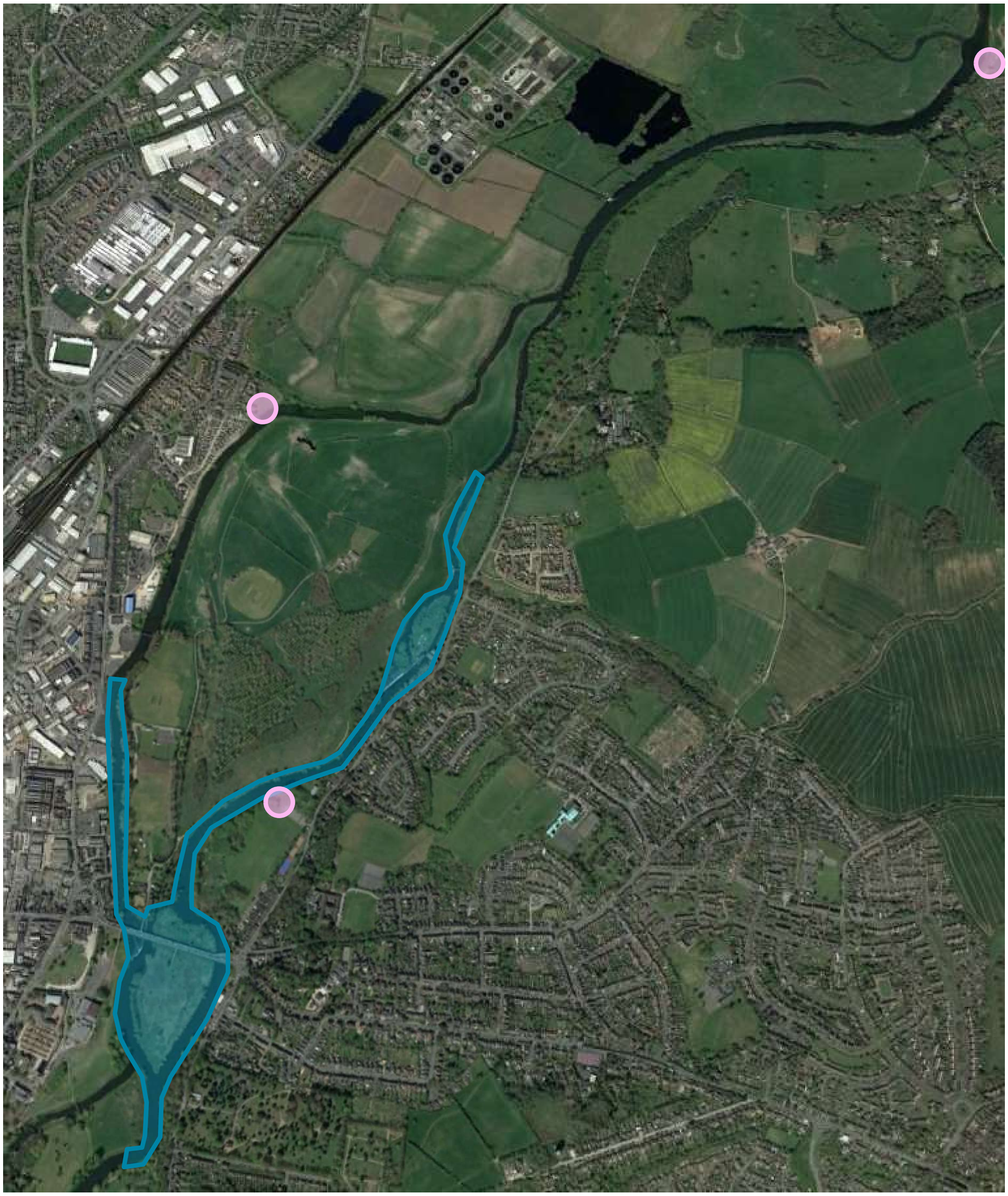


Figure 6: River Trent at Winshill survey locations *Source: Google Earth (imagery date August 2022)*

2.7 Limitations

2.7.1 As shown in the above figures there were inaccessible section of the rivers at Lea Marston and Tamworth. At Lea Marston these areas were inaccessible due to vegetation obstructions and shallow water levels. At Tamworth the river was not accessible in these locations due to the steep banks and shallow water levels preventing accurate readings. The weir on the western edge of the survey areas was also unsafe to launch close to it.

2.8 Bathymetric survey line plan

2.8.1 To allow the collection of bathymetric data the ARCboat, as far as possible, navigates a series of survey lines spanning the waterbody.

2.8.2 These track lines were positioned nominally at 10m intervals perpendicular to the direction of flow to allow an accurate contoured representation of bed levels to be derived. Transect lines were also followed up and downstream of the watercourse to help verify the depths recorded.

2.8.3 Due to the current of the river, additional soundings were also taken, where appropriate, to cover any gaps in the survey coverage or around particular features of interest identified during the survey. To avoid the risk of fouling the ARC boat's propellers and rudders, it was not possible to collect bathymetric data in areas of the river which were heavily vegetated, or where there are underwater obstructions such as submerged bushes, trees, boulders etc.

2.8.4 The ARCboat was also brought up to the weirs as close as safe to do so considering the current of the water over the weir and any obstruction present.

Vertical reference

The RTK GNSS elevations made whilst the RTK GNSS unit is mounted on the ARCboat was the primary method used to reduce the bathymetric data to Ordnance Datum Newlyn (ODN).

Depth measurement

2.8.5 The speed of sound in water was measured using a dedicated sound velocity profiling instrument, prior to commencement of each day's survey operations.

2.8.6 With the draught of the echo sounder transducer and speed of sound in water entered into the echo sounder unit, the echo sounder was then verified prior to running the survey against measurements of water depth made by hand using a survey staff. The instrument controls were then adjusted if the displayed depth was not in agreement with the known depth.

Positioning

2.8.7 System configuration, GNSS accuracy and communication checks was conducted on site and prior to deployment to ensure full system functionality.

2.9 Data processing

2.9.1 All survey work was delivered in British National Grid (OSGB36).

2.9.2 All survey data was reduced to elevations above Ordnance Datum Newlyn.

Elevation data

2.9.3 The raw depth and position data recorded during the bathymetric surveys was processed using the post-processing programmes. Post-processing included: removal of data spikes - resulting for example from fish or debris passing under the transducer; reduction of measured water depths to Ordnance Datum Newlyn.

2.9.4 The 200KHz signal gives returns mostly from the water/soft sediment interface and has been filtered to remove spikes and erroneous returns from deeper reflectors.

2.9.5 The 30KHz signal gives returns from the first significant reflector below the sediment surface. It has been filtered to remove spikes and erroneous returns from the shallower water/soft sediment interface. This is referred to in the results below as the "hard" sediment surface.

2.9.6 The resultant files were subjected to gridding and interpolation along irregular paths to produce a digital elevation model (DEM). The elevation models have been masked to the margins of the water courses as digitised from aerial imagery.

2.9.7 Water depths in many areas were close to, or less than, the effective limit of the equipment and depths contoured as less than 0.5m should be regarded as effectively showing that depths were in the range 0.5m to 0.3m (0.3m is the depth at which the ARCBoat grounds).

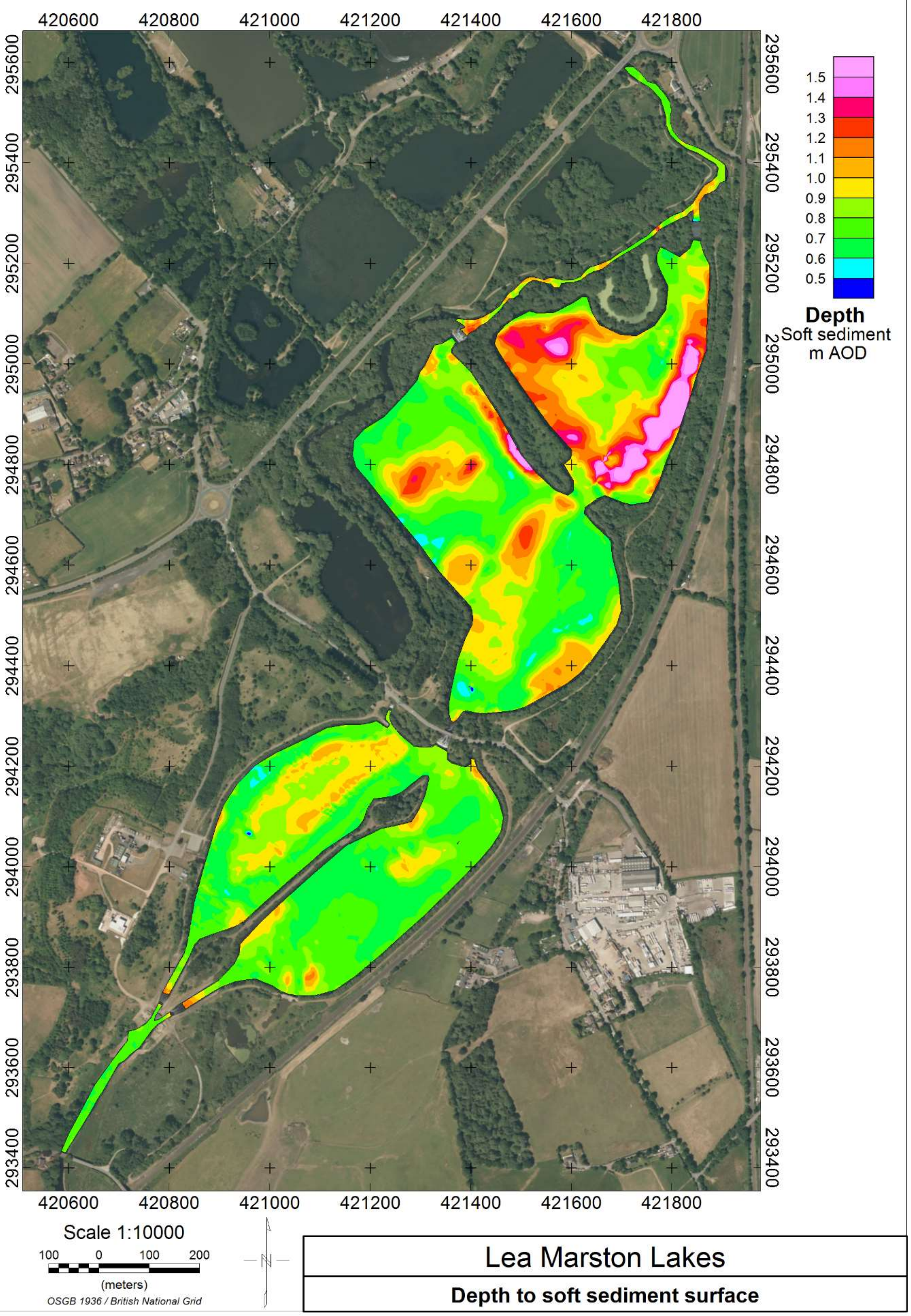
3. Results

3.1.1 Three contour charts of the riverbed in the three locations are further presented: The three versions presented are: -

- Depth below water level (at the date of the survey) of the “soft” sediment surface as calculated from the 200KHz signal.
- Elevation of the “soft” sediment surface reduced from the elevation of the sensor and the 200KHz signal.
- Elevation of the “hard” sediment surface reduced from the elevation of the sensor and the 30KHz signal.

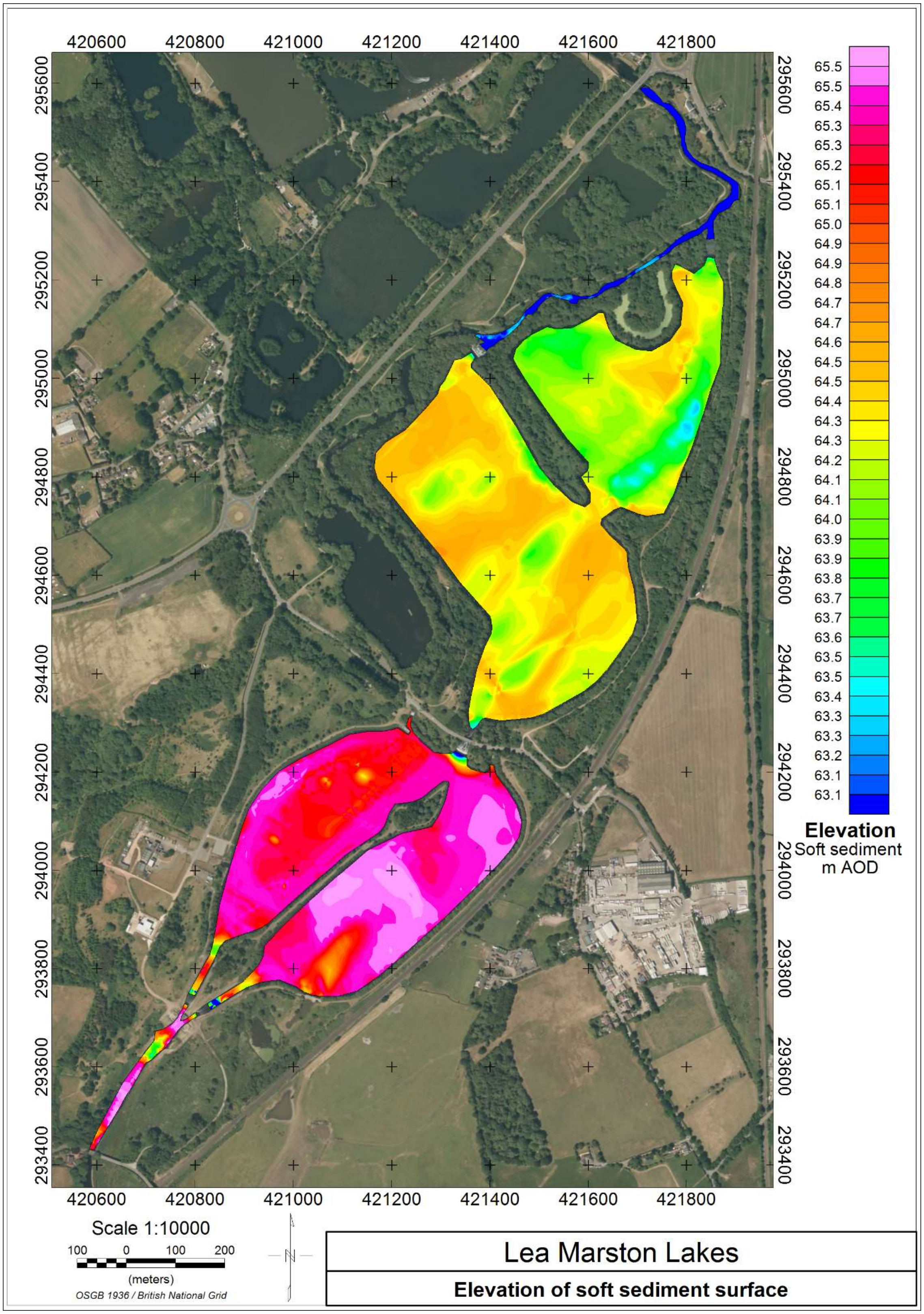
3.1.2 The data have also been delivered in xyz format electronically.

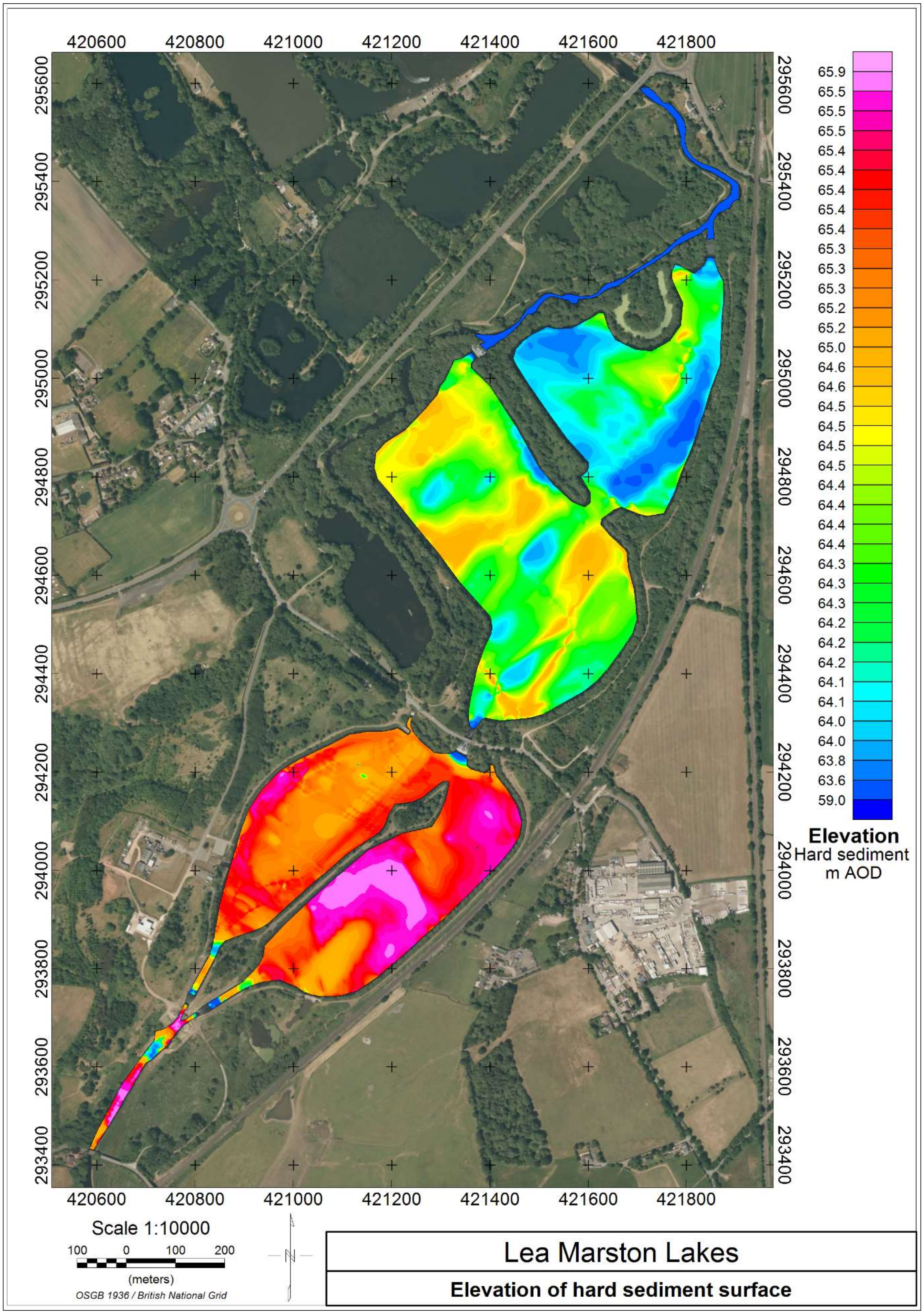
Lea Marston Lakes: Contour maps



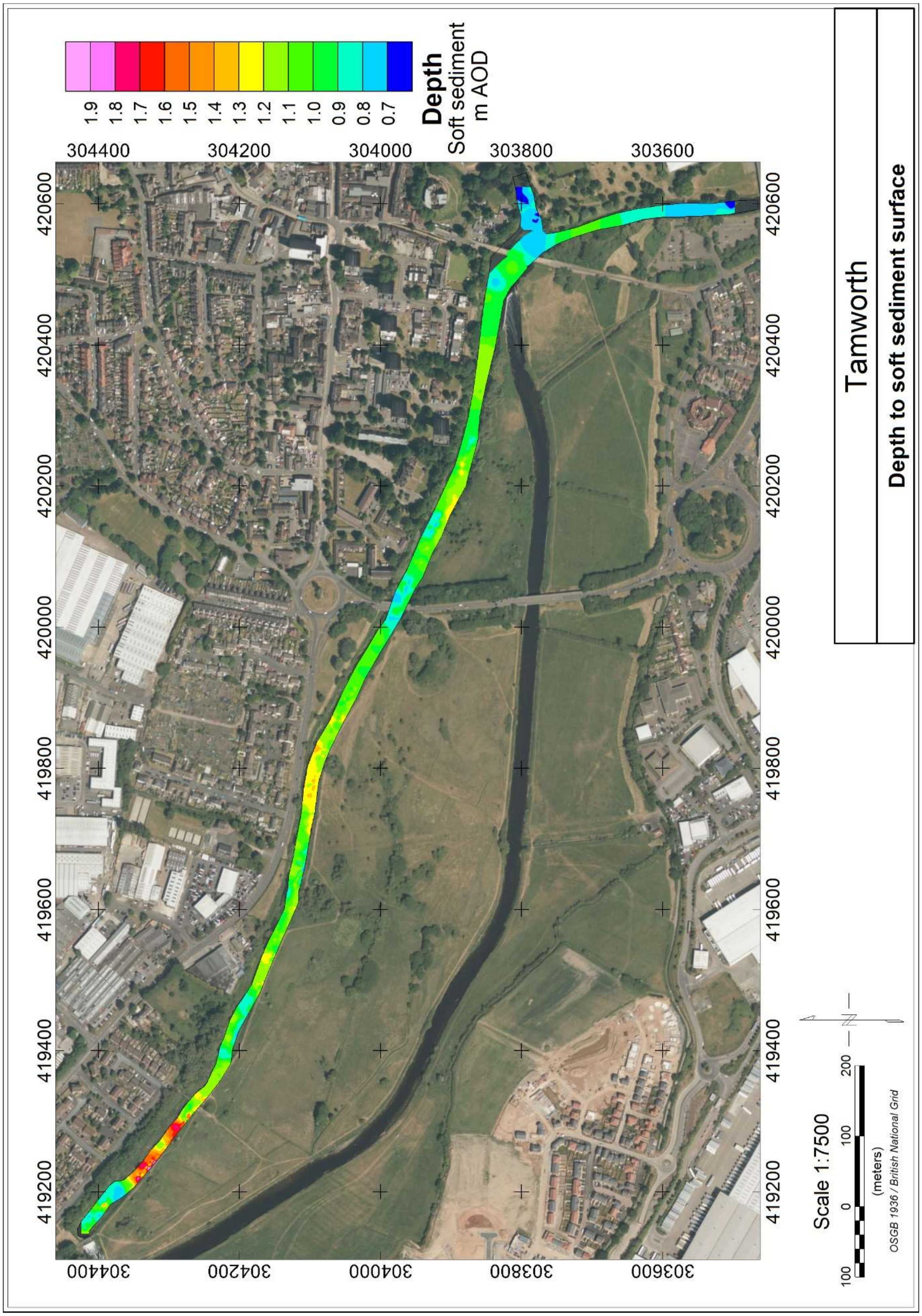
Lea Marston Lakes

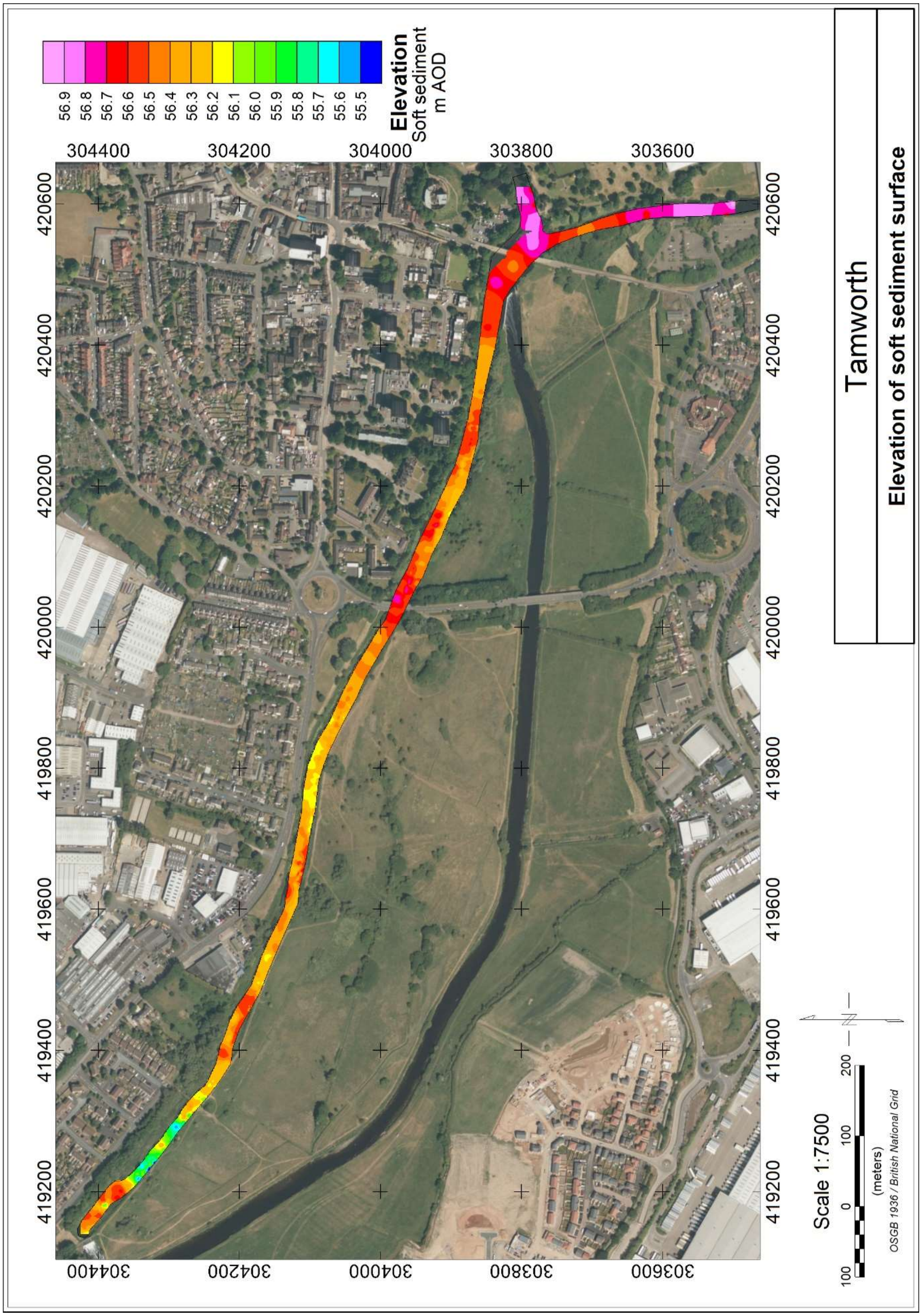
Depth to soft sediment surface

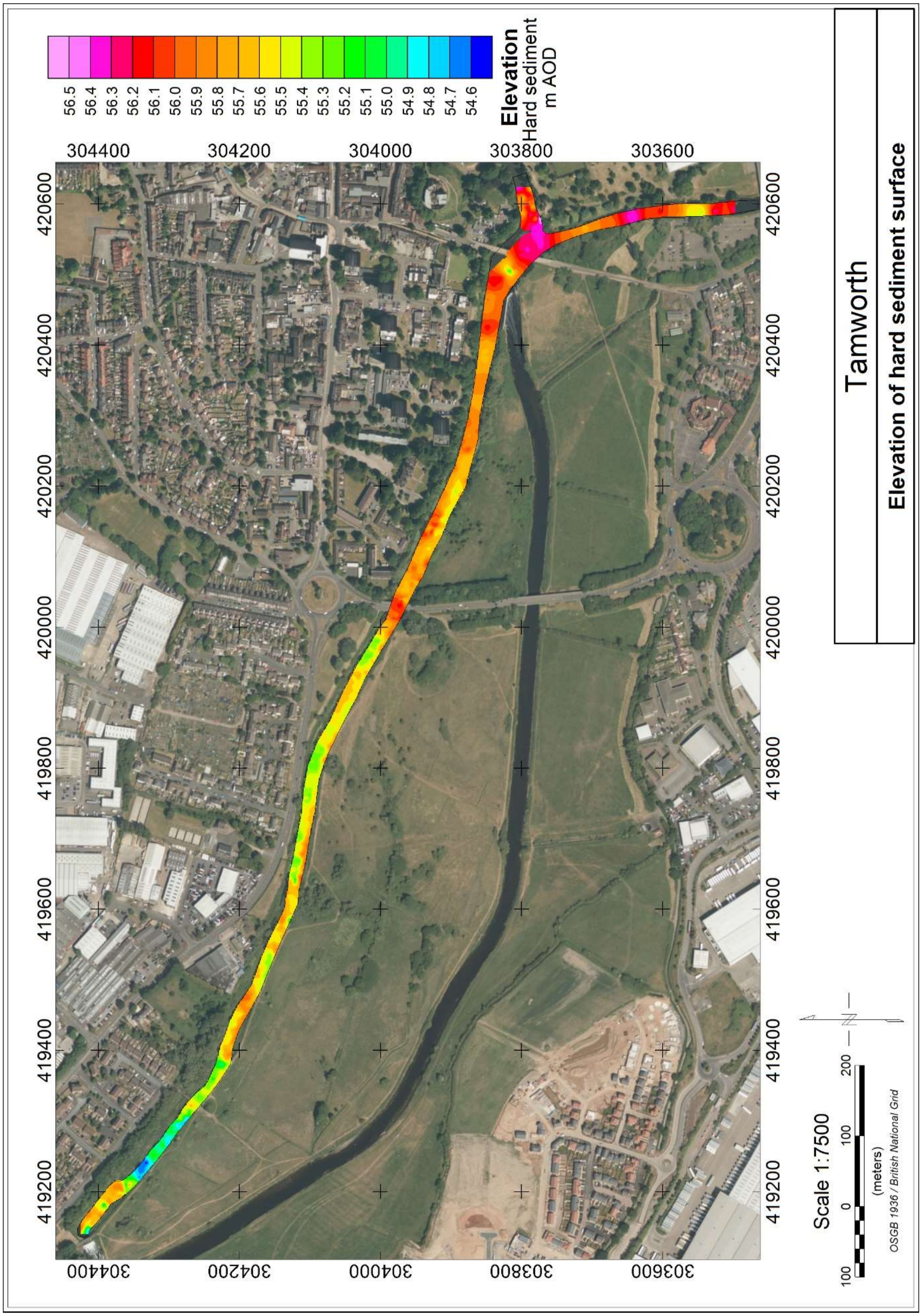

420600
420800
421000
421200
421400
421600
421800
295600
295400
295200
295000
294800
294600
294400
294200
294000
293800
293600
293400
65.5
65.5
65.4
65.3
65.3
65.2
65.1
65.1
65.0
64.9
64.9
64.8
64.7
64.7
64.6
64.5
64.5
64.4
64.3
64.3
64.2
64.1
64.1
64.0
63.9
63.9
63.8
63.7
63.7
63.6
63.5
63.5
63.4
63.3
63.3
63.2
63.1
63.1
Elevation
Soft sediment
m AOD
Scale 1:10000
100 0 100 200
(meters)
OSGB 1936 / British National Grid
N
Lea Marston Lakes
Elevation of soft sediment surface


420600
420800
421000
421200
421400
421600
421800
295600
295400
295200
295000
294800
294600
294400
294200
294000
293800
293600
293400
65.9
65.5
65.5
65.5
65.4
65.4
65.4
65.4
65.4
65.3
65.3
65.3
65.2
65.2
65.0
64.6
64.6
64.5
64.5
64.5
64.5
64.4
64.4
64.4
64.4
64.3
64.3
64.3
64.2
64.2
64.2
64.1
64.1
64.1
64.0
64.0
63.8
63.6
59.0
Elevation
Hard sediment
m AOD
Scale 1:10000
100 0 100 200
(meters)
OSGB 1936 / British National Grid
N
Lea Marston Lakes
Elevation of hard sediment surface

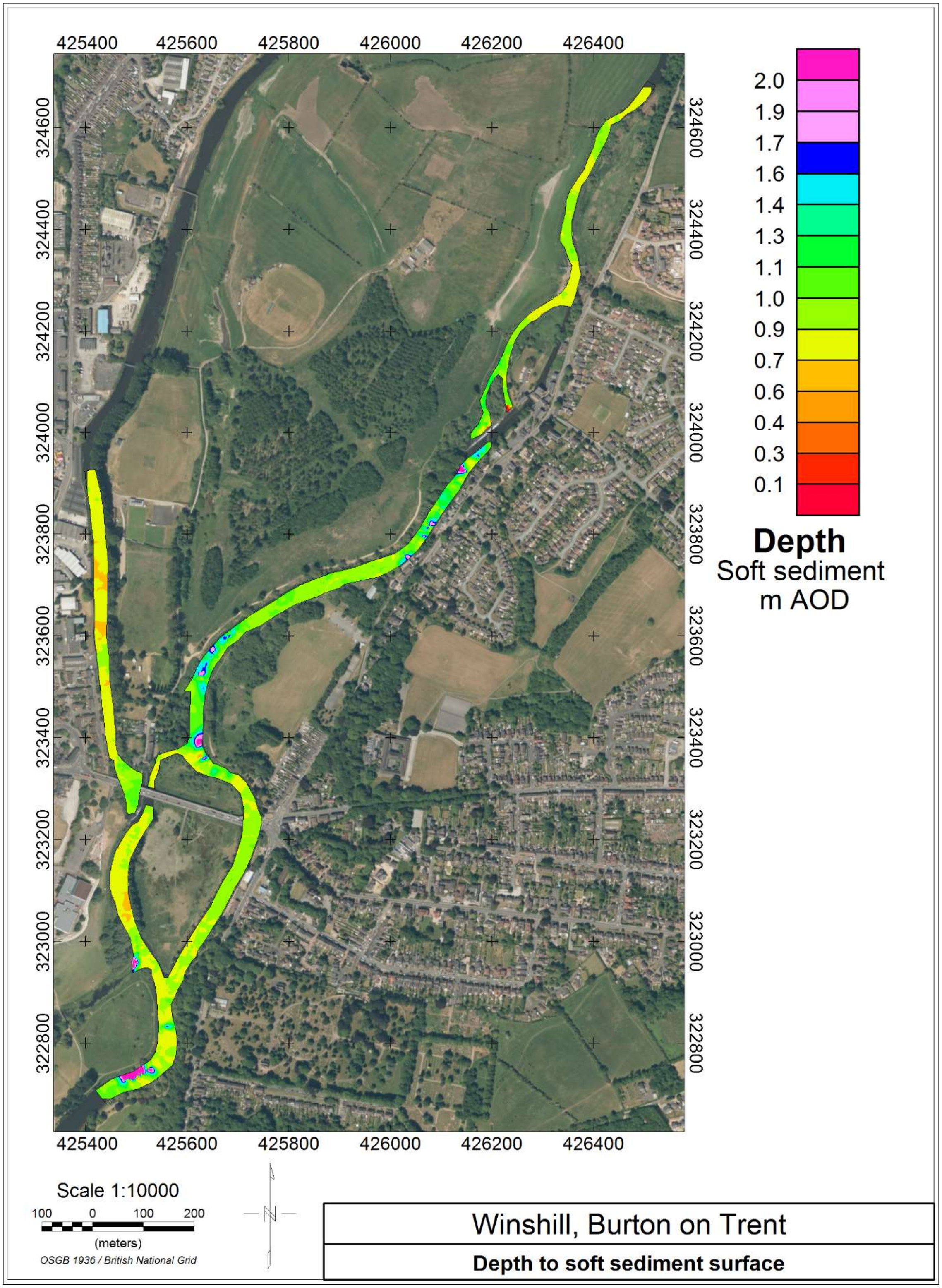
River Tame at Tamworth: Contour maps

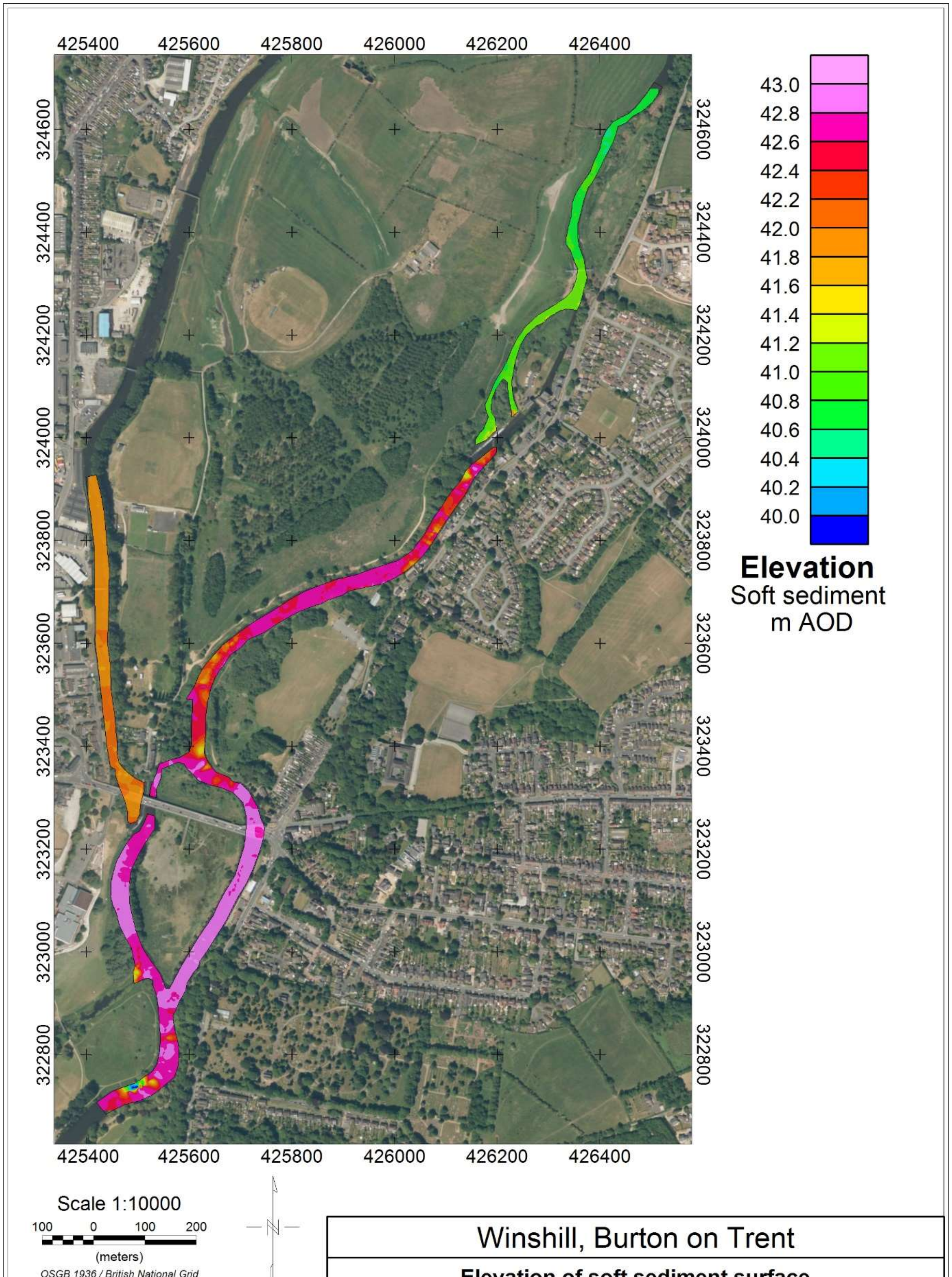



Elevation
Soft sediment
m AOD
56.9
56.8
56.7
56.6
56.5
56.4
56.3
56.2
56.1
56.0
55.9
55.8
55.7
55.6
55.5
304400
304200
304000
303800
303600
420600
420400
420200
420000
419800
419600
419400
419200
Tamworth
Elevation of soft sediment surface
Scale 1:7500
100
0
100
200
(meters)
OSGB 1936 / British National Grid


Elevation
Hard sediment
m AOD
56.5
56.4
56.3
56.2
56.1
56.0
55.9
55.8
55.7
55.6
55.5
55.4
55.3
55.2
55.1
55.0
54.9
54.8
54.7
54.6
304400
304200
304000
303800
303600
420600
420400
420200
420000
419800
419600
419400
419200
Tamworth
Elevation of hard sediment surface
Scale 1:7500
100
0
100
200
(meters)
OSGB 1936 / British National Grid

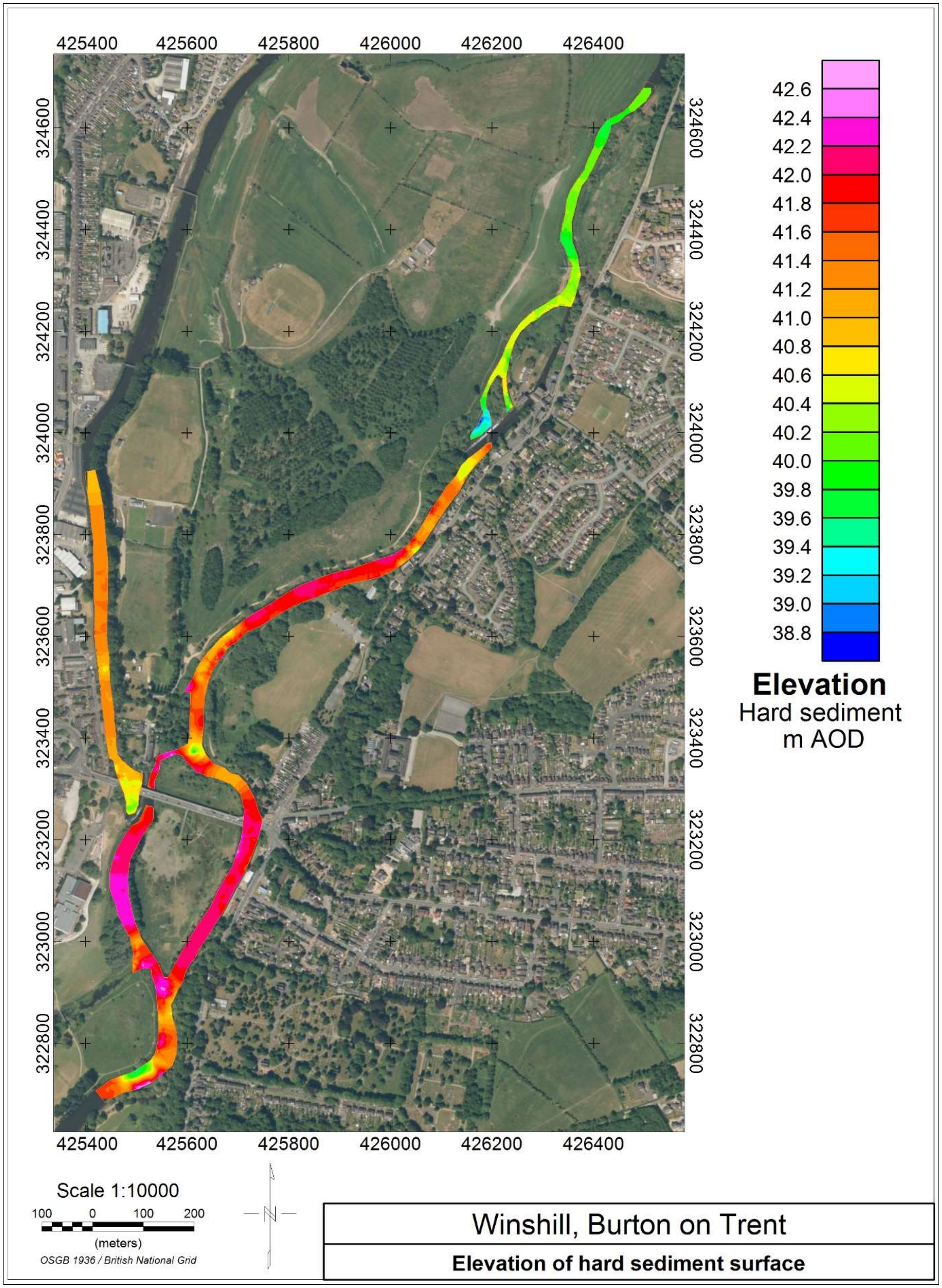
River Trent at Winshill: Contour maps





Winshill, Burton on Trent

Elevation of soft sediment surface



Data Sheets for the Cadden Bali Echosounder are provided below.

BALI V3

NEW VERSION

BAthymetry made LIght and simple

Portable and easy-to-use

- Quick to set up
- One surveyor can operate it

Professional Single and Dual Frequency Sounding

- Ideal for inland waters and coastal survey
- Can be upgraded from single to dual frequency

Affordable

- All-in-one cost effective GNSS RTK, SBES, modems & software system
- No training needed

WHAT'S NEW

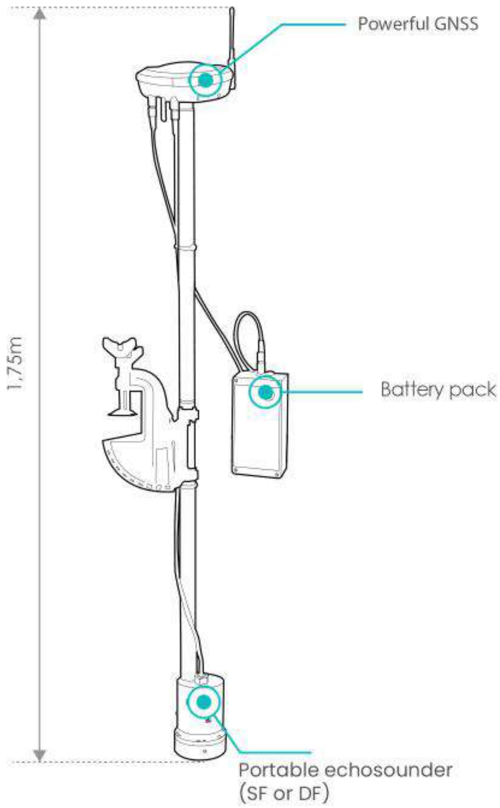
- ✓ New accessories & echosounders models
- ✓ Suitcase easy to transport & deploy
- ✓ Integrated & intuitive web server

BALI is an autonomous bathymetry survey solution, which is simple to operate, extremely accurate and affordable. It comes with either a single frequency (SF) or a dual frequency (DF) echosounder.

With BALI, hydro surveying is very intuitive. Professional tablets and software are not mandatory, as BALI can work completely stand alone or using any smartphone with its built-in software connected via Wi-Fi. The integrated smart antenna incorporates GNSS and radio modems to acquire RTK differential corrections in real time to deliver a precision of position of 1cm.

For demanding professionals, the NMEA output makes BALI compatible with any bathymetric software such as QINSy, HYPACK, etc.

GEOD® Parc du Petit Chatelier, 359 Route de Sainte Luce, 44300 Nantes | France | info@geodproducts.com | +33 (0)251 824 646 | cadden.fr



Scope of supply

GNSS antenna with POE cable

Echosounder

GSM/UHF antenna (if applicable)

Battery pack cable & charger

Rover rod (3 pieces)

Fixing bar

Transport case

Key features	
Portable echosounder	200 kHz (SF & DF) - 30 kHz (uniquement DF only)
Powerful GNSS	"Powered by Trimble" 240 channels L1/L2 RTK GNSS technology
Spécifications techniques	
Positioning	L1/L2 GPS, Glonass, BeiDou, Galileo enable (options available) RTK (1cm) – RTX (4cm) – SBAS (0,5m)
Echosounding	200 kHz echosounder (SF & DF)
	Range 200m– precision : 0,2% depth-9° beam width
	30 kHz echosounder (DF only)
	Range 200m – precision : 0,2% depth - 26° beam width
Radio communication	GSM cell (standard)
	Long range UHF (403-473 MHz)
I/O interfaces	Wi-Fi
	Ethernet
Data format	
◦ Position	Latitude, Longitude, Altitude (WGS84)
◦ Sounding	Water height (meter)
Data output	NMEA 0183
Software interface	Web browser
Physical characteristics	
Dimensions	SF et DF series – Height : 1,75 m
Weight	SF et DF series – 11kg (1 suitcase)
Environment	
◦ Temperature	Operating -10°C to +40°C Storage : -20°C to + 55°C
◦ Ingress protection	IP67
Monitoring (LEDs)	2 LEDs for GPS reception & UHF link
Power	Batterie type : rechargeable high capacity NiMH
	Autonomy : 5 to 10 hours (mode dependent)
	External DC : 12VDC (cable in option required)
Options and accessories	
◦ L-Band Trimble CenterPoint RTX corrections	
◦ GNSS BeiDou et Galileo	
◦ Internal UHF modem	
◦ Power cable for external input	

Specifications suject to change without notice

GEOD®

GEOD® is the brand of products invented by Cadden Supplier and designer of accurate positioning systems for maritime and industrial applications

Parc du Petit Chatelier,
359 Route de Sainte Luce
44300 Nantes | France
info@geodproducts.com
+33 (0)251 824 646

cadden.fr

aecom.com