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Review of Tarrant Abstraction Middle Stour Tributaries Investigation, Draft Final Report

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Dear Giles, Christopher and Helen

Thank you for sending the River Tarrant Preservation Society report on abstraction impacts and the final report for the Middle Stour Tributaries Investigation, Wessex Water reference number: BG201-3-127, on 27 February 2026. I have now completed my review and taken account of your comments.

Objective and scope of review

The objective of the review was to comment on the report and the validity of its findings on abstraction impacts, considering also:

- Wessex Water BG201C Middle Stour Final Report.
- My understanding of the hydrogeology of the area from work as external review to the Wessex Basin Model
- Knowledge of the Wessex Basin Model

The scope of my review therefore focusses on the general information, hydrogeology and groundwater modelling, but does not include assessment of the ecology surveys and results in Chapters 4 and 5.

I have now read:

- Low flows and drying of the River Tarrant – history, causes, impacts and potential solutions, September 2025, by John Lawson for the River Tarrant Preservation Society; and
- The Middle Stour tributaries investigation, Final Report, August 2019, by Wessex Water, ref BG201-3-127.

Both reports use the results of a previous version of the Wessex Basin model (accepted calibration run 427, run in 2018), rather than the current version, which was converted to use Modflow6 and calibrated in 2024, but is undergoing modifications to enhance its capability to simulate stream support.

I have focussed on the hydrogeological data and models, rather than the ecological evidence and interpretation which is not within my area of expertise.

Please note that I reviewed the draft version of the Middle Stour report in April 2018 for Wessex Water and the letter with my comments is included in the final version as Appendix G. I have also reviewed an earlier report by John Lawson in 2022, which used the same CSF model to simulate the impacts of groundwater

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abstraction on the River Ivel. This was for a meeting with Affinity Water, the Environment Agency and an expert group in 2022.

Comments on the Low flows and drying of the River Tarrant – history, causes, impacts and potential solutions report for the River Tarrant Preservation Society

The report is detailed and based on existing data, mostly collected by Wessex Water and the Environment Agency.

It includes historical information relating to conditions before the start of public water supply abstraction in the 1950s, implying that the Tarrant was perennial before the 1950s. However, this is mostly anecdotal, from long term residents, old press reports or inferred from the presence of mills, and more recently fish catch in the River Stour.

The report presents several plots of spot gauged flows in the Tarrant and Pimperne compared with groundwater levels in observations boreholes. Not surprisingly, there is a clear relationship, but this is non-linear and the equations fitted to the plots show a variety of parameters, with flow proportional to groundwater levels (minus a constant) multiplied by another constant and then raised to powers between 1.8 and 2.5. While these give a neat statistical fit, I do not consider that this analysis informs the hydrogeology.

Chapter 4 of the report describes the CSF lumped parameter model, which uses a spreadsheet to calculate the change in groundwater storage based on daily effective rainfall (from Wessex Basin groundwater model), abstraction and river flow. This is translated into a change in groundwater level at Four Acres OBH, which is in turn used to calculate river flows using the regression equations described in the previous paragraph. The stated principles of the model are that:

- Chalk stream baseflows are driven by the hydraulic head of the regional water table and the relationship between flows and heads as indicated by the regression equations
- Hydraulic head of the water table is determined by aquifer storage, which rises due to rainfall and falls due to stream flow and abstraction.

Beyond these statements and a diagram of a typical chalk valley (Figure 7), there appears to be no conceptual model which forms the basis of the numerical model.

The model is based on the assumptions that:

- The topographic catchments of the Tarrant (53.3 km^2 and Pimperne 11.5 km^2), which are assumed to coincident with the groundwater catchments and do not vary with time. (Note that the extent of groundwater catchments often varies with time due to fluctuations in groundwater levels).
- All aquifer parameters are uniform and constant within the modelled area.
- Subsurface flow out of the catchment is used as a calibration parameter to improve the model's fit to observations, but no details are given of how this is calculated and no values are quoted
- Specific yield is also used as a calibration parameter but no information is provided on the range of values used.

The calibrated model is fitted to the groundwater level hydrographs at Four Acres and two other observations boreholes. It has been adjusted to provide a close fit but no information is provided on the parameters used to generate the fit. The simulated stream flows are compared to the spot gauging data in several locations. The fit looks generally good but the modelled flows are peaky and may

overestimate high flows. It is also used to generate naturalised flows, presumably with no abstraction, although the assumptions are not stated.

Comparison of the modelled historical and naturalised flows is used to demonstrate the impacts of groundwater abstraction on flow and drying in the Tarrant and Pimperne, comparing the results with the Wessex Basin groundwater model (run 427). The predicted impacts are significantly different. The report concludes that 'although the CSF model does have some questionable underlying assumptions, it is a more reliable indicator of abstraction impacts in the lower Tarrant than the Wessex model.' The CSF model also appears to be thought to be more reliable than the hydrogeological analysis based on observations used by Wessex Water to assess the impacts on the Pimperne, where the Wessex Basin model calibration is poor.

Comments on the conclusions of the Tarrant report

I disagree with the conclusion that the CSF model provides a more reliable assessment of abstraction impacts than the Wessex model/hydrogeological analysis because:

- It is a highly simplified, lumped parameter model which is not based on a sound conceptual model
- The assumption of a groundwater catchment with uniform properties contradicts the evidence from the recent boreholes and the observed groundwater level distribution.
- Although the fit to the observations gives an apparently good model calibration, there is a lack of transparency in the way that this was achieved, with no details of assumed subsurface flow out of the catchment or range of specific yield values used.
- The assumptions used to generate naturalised flows are not stated, especially relating to groundwater throughflow out of the catchment. Any changes in groundwater throughflow could have a significant impact on the assigned impacts of abstraction on river flows.

In my opinion, simplified models of this type are appropriate for the initial stages of an impact assessment, following the principles of tiered risk assessment as used for example for land contamination (LCRM: Stage 1 risk assessment - GOV.UK). This approach allows the use of simplified models for the first two tiers of risk assessment, but as they tend to overestimate impacts/risks, more sophisticated models and data collection are required before any decisions are made.

However, it would be advisable to incorporate some of the observations on historical river flow and increased drying of the streams into the overall data set for this area if this has not already been done.

For completeness I am including my previous comments on the Middle Stour tributaries report here in italics, as they still apply to my view of this report. Note that the model runs referred to are from a previous version of the Wessex Basin model and not the current Environment Agency project, which was calibrated in 2024 and is nearing completion, although without any formal reporting.

Comments on the Middle Stour report (based on draft in April 2018, and also the final report)

From review of the information provided in the report and previous knowledge of the Wessex Basin groundwater model, I consider that:

- *The approach to the study is systematic and thorough, comprising a series of logical steps. The approach and data for the North Winterborne are, however, more limited.*

- *The report is thorough, detailed and presents a good mix of field observations, interpretation as conceptual understanding, numerical modelling and analysis of results.*
- *The field observations include detailed stream bed survey of the Tarrant and Pimperne, weekly observations of flowing reaches and spot flow gauging to give accretion profiles, spot flow measurements in the North Winterborne, new boreholes in the Tarrant and interfluve, pumping trials/signal tests at Black Lane and Shapwick, and additional groundwater monitoring at Stubhampton. This is considered to be a comprehensive investigation for the purposes of this study.*
- *The key features from the fieldwork were used to update the conceptual models of the Tarrant and Pimperne. The interpretation appears coherent and based on the data collected, although relies on 'unmapped faults' to explain some local features.*
- *The changes in the conceptual model have been applied one at a time to the numerical model, which now appears to adequately represent the conceptual model on a local basis. The revised transmissivity distribution looks much more like that of the Gussage/River Allen and remarkably similar to some of the early interpretations of the Chilterns Chalk. This is different to the remainder of the regional Wessex Basin model, as discussed below.*
- *The model calibration (Run 421 used in the draft version of the report, subsequently updated to run 427 for the final report but the differences in results are minor) looks better than Run 361 in the Tarrant catchment, especially for groundwater hydrographs and accretion profiles except July 2015. One of the features of the earlier versions of the Wessex Basin model was an ability to simulate flows well, especially in the lower reaches of the rivers with a surprisingly poor fit to groundwater levels in some areas. Beyond the area of refinement, the calibration remains the same as the accepted version of the model (e.g. Wimborne, but still too high at low flows; Gussage – different but not better) or better (R. Allen gauges). Unfortunately, the Pimperne calibration is not very good, with a very smooth modelled recession in contrast to the marked break in slope of the observations. Some of the gauges on the middle Tarrant (Rushton, Preston Farm) also show the same feature.*
- *The conclusions appear to be justified based on the evidence presented in the report (and assuming that the ecological data is adequate and has been correctly interpreted).*

Thus, the report and results presented fulfil the stated objectives, although there remain (inevitably) a few limitations and assumptions which could be viewed as the weaker points of the study:

- *The flow data are based on a limited period from 2015-2017, which does not represent the full range of climatic conditions, although the groundwater hydrographs cover a much longer time period, mostly more than 20 years.*
- *The local aquifer behaviour is frequently compared to the Environment Agency's Woodyates observations borehole. Although acknowledged that this location is unlikely to be affected by abstraction, it is some 12km northeast of the Tarrant valley and thus may not represent the same local aquifer response even though the shape of the hydrographs appears similar.*
- *Unmapped faults are postulated as a possible control on springs and represented in the model as horizontal flow barriers, based on accretion profiles and observed extent of influence from relatively short tests.*

- *The revised conceptual model and transmissivity distribution appear to fit the observations for the Middle Stour tributaries better than the previously accepted version used for Run 361. The considerable effort went into the original conceptual model and scenario runs derived from Run 361 formed the basis for decisions supported by model results. As the revised conceptual model and hydraulic properties are noticeably different, this now raises a significant issue for the remainder of the Wessex Basin model in how far they are applied beyond the Middle Stour tributaries, what justification there is for either the extension or explaining the contrasting behaviour, and what impact this may have on scenario results. The report comments that 'Initially, the changes were applied part of the North Winterborne catchment, but this was stopped as there were too few groundwater observation points to verify the calibration.' This illustrates the dilemma, even when considering the neighbouring catchment.*

- *The report gives time series of flow and groundwater levels for the calibration; I would also expect to see some groundwater level maps and flow balances for a wider area to support the comment that there are no detrimental impacts on the calibration of the rest of the modelled area.*

- *The calibration in the Pimperne is not considered adequate for use of the model for impact assessment. While the empirical approach based on monitoring is a reasonable choice and, in my opinion, better than applying a poorly calibrated model, it could appear that Wessex Water only uses the model selectively – and it certainly indicates some gaps in the conceptual understanding of the Pimperne.*

Now that I've reread the report, I have some additional comments:

- Wessex Water identify groundwater zones of influence for the PWS sources, which fit with the conceptual understanding. I would like to see a water balance (modelled or calculated) for these zones, as they appear relatively small for supply of the larger PWS abstractions (eg Black Lane). The water balances should consider recharge (from infiltration and stream leakage, subsurface inflows and outflows, contribution to streams (if any) and storage (to assess any longer term trends).

- Sensitivity analyses were run to assess the impact of the postulated unmapped faults, represented as Horizontal Flow Barriers (HFB). Comparison of the results of runs with and without HFBs concluded that 'The removal of the HFBs alters the accretion profile shape, particular around Ruston. However, when the extra days of drying are compared, with and without HFBs, they are practically the same. This indicates that the HFBs do not exert a dominant control on the PWS impact, although they improve the calibration.

- I now consider that the comparison with the hydrographs from the Woodyates observation borehole is valid, and that the hydrographs at Woodyates indicate that there is no long term trend in groundwater levels in the aquifer, based on records from 1942-2026 (West Woodyates Manor | British Geological Survey (BGS)).

- It would be prudent to rerun some of the abstraction impact scenarios using the latest version of the Wessex basin groundwater model, which is generally better calibrated than the previous version especially in areas of particular sensitivity, to ensure that the conclusions on impact of abstractions remain the same.

I hope this meets your requirements.

Yours sincerely



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