Appendix A

Summary of models/modelling relevant to Hampshire abstraction licensing Inquiry.

	Model	Governance	Basis	Use	Status	Core document reference
Water Resources Planning modelling (hydrological supply scenario modelling) included in this Statement of Common Ground.						
1	Stochastic weather generator model for rainfall data and associated Potential Evapotranspiration projections	Origin – SWS (Newcastle Uni. and Atkins)	Stochastic simulation of possible rainfall based on characteristics of historical rainfall. PE data from PENSE (MOSES projection being investigated)	Enables fuller risk assessment by simulation and system testing of a wider range of plausible hydrolgoical events, not just those of the historical record.		WRMP 14 scenario testing. Candover TWG scenarios (2015 & 16) dWRMP19, draft Drought Plan18, Hampshire Licence Inquiry
2	Test & Itchen groundwater and river flow model *NOTE: There are 2 versions of this model used for the purposes of the Inquiry. Refer to paragraphs 10 in the Statement of Common Ground - modelling for description and provenance in the context of Inquiry*	Origin – EA 2003. Owner – EA Distributor – 4R (Amec) & USGS (MODFLOW) Access – SWS Runner – EA, Amec, SWS (future)	Runoff, recharge, groundwater, winterbourne & river flow representation. 250 m grid square. Daily time step for rainfall, runoff & recharge simulation. ~Two-week time-step for GW simulation. Rainfall & Potential Evapotranspiration & abstraction (licence)	Simulates groundwater levels and, flows in Itchen, Test, Candover, Arle, Dever, Wey headwaters, etc. Provides naturalised river flows input to Aquator model. Used by EA and SWS to predict the impacts of abstraction, discharge and drought scheme operations, particularly relating to the Candover Scheme	4R & USGS MODFLOW are "industry standard" codes for distributed groundwater resource modelling. Models cover most of the UK major aquifers SWS, Portsmouth Water & EA T&I groundwater model accepted, subject to caveats, as best	14. EA Candover impact analysis record. 25. Amec FW 2015 GW model comments to TWG 28. Amec FW flood plain wetland risks 30. Soley at al. 2012 Lower Test RSA (2012). WRMP2014 scenarios. 2017 – SWS draft WRMP19 resource Assessments 2017 SWS – Model

	use.		& discharge inputs.		available tool for 'what if' predictive purposes for the Candover alongside field evidence. Better at assessing relative impacts, rather than absolute flows & levels.	update for drought forecasting 2017 SWS draft Drought Plan18 2017 - (Planned) Supporting SWS AMP6 NEP Investigations for Anton and Pilhill Brook
3	Aquator model	Origin (software developer) – Oxford Scientific Software Distributor – Hydro-Logic Services Support – Hydro-Logic Services Licences (runners) – SWS; Atkins.	Bespoke set up to system representation in terms of:- - supply sources; - abs. licences; - licence constraints (MRFs) - demand centres; - demand profiles; - network transfers; - network constraints - river flows Daily timestep Uses naturalised flows from Run 163 Test & Itchen groundwater model	Hydrological & water resource system simulation modelling. Aids deployable outputs assessment. Scenario simulation of operational choices and abstraction impacts on river flows. Provides demand profiles for input to T&I groundwater model scenario runs.	Software widely used in the UK. Has been used by SW to assess implications of sustainability reductions and drought interventions on supply deficits and river flows. Outputs shared with Testwood 2015 RSA project Augmentation Technical Working Group.	As above. New Aquator models of Hampshire and Isle of Wight set up by SWS for AMP6 use by SWS and Atkins for new draft Drought Plan and Hearing / Inquiry modelling. Includes updated demands and demand profiles. Four new water resources planning zone in place of previous Hants South WRZ, which better demonstrates network constraints (the model will continue to represent the whole of Hampshire).

List of ecological and environmental modelling and analysis NOT included in this Statement of Common Ground					
1	River Itchen, macro-invertebrate and flow relationships - Kevin Exley, EA.	Origin – K. Exley, EA (2006) – builds on concepts presented by Extence *et al.,* (1999) and macro-invertebrate community assessment by Exley 2003.	Linear regression analysis used to explore the links between the macro-invertebrate community of the River Itchen and antecedent flow statistics.	By EA in determining River Itchen Habs Regs Site Action abstraction licence conditions, 2007.	Southern Water did not contest in 2007 or since, although during AMP5 it has raised with EA the need for updating the 2006 .assessment with more recent observed data EA committed to do this work by 2021. Not seen by Fish Legal.	None
2	NEP "Pisces" Salmon migration model.	<u>Origin</u> – developed originally as part of the Lower Test NEP Investigation by the SWS team & EA Fisheries Specialist with PISCES conservation ltd. Further developments in 2015 under the direction of the Salmon Working Group ("SWG").	Technical inputs to model build from Dr .David Solomon, Dr Adrian Fewings (EA) and Atkins, Lower Test RSA team. Assumes timing of Salmon arrival at tidal limit in line with Mudeford fishery, Christchurch Harbour, Dorset.	Simulates the numbers and timing of salmon moving upstream past the Nursling Fish Counter. Several flow based functions can be explored with optional function of temperature, rainfall and 'willingness to move'. Model takes no account	Model "platform" very useful but validity regression models used were not agreed by all SWG members leading to disagreement amongst SWG members over the reliability outputs.	Recommendations were made by the SWG to try and improved the robustness of the statistical models and these have been taken forward by SWS in 2016-17 (see work by Fenn & Milner described below).

				of impacts of delayed migration on potential impacts on salmon downstream.	Fish Legal's consultant, John Lawson, was responsible for PISCES modelling undertaken for the SWG in 2015, but not subsequently.	
3	Colin Fenn & Antonio Scarbaci, 2017, (2016 for Draft) - Time Series Analysis of salmon count data from the Great Test, further analysis of environmental factors affecting fish migration in the Lower Great Test. further	Origin – Colin Fenn, Hydrologic, 20176	Univariate (ARIMA) and multivariate (ARIMA-X or Transfer Function Noise (TFN)) analysis analyses of salmon count data from Nursling Mill Great Test, 1996 – 2007.	Aimed to better identify, model and understand environmental controls on salmon migration in the Great Test.	The EA have only seen the draft report dated 2016. The EA may not agree with the conclusions of this report. Not seen by Fish Legal.	Further modelling of Little Test counter data ongoing as part of AMP6 Investigation. May be taken further forward in Lower Test Enabling project.
4	Nigel Milner et al / APEM Ltd , 2017 (2016 for Draft) – Advanced regression modelling of the response of salmon counts to flow and related variables in the lower Great Test Further analysis of environmental factors affecting fish migration in the	Origin – Nigel Milner / APEM Ltd. Previous versions of this work were issued to the AMP6 Testwood Investigations Steering Group (including the EA) in 2016 and 2017.	Linear regression, Generalised Linear Models, and Zero-Inflated Models.	To explore relationships between salmon counts, river flow and various related environmental variables (lagged flows, rainfall, and water temperature and tide cycle state).	The EA does not believe it has seen the 2017 report and therefore, may not agree with the conclusions of this report. Not seen by Fish Legal.	Further modelling of Little Test counter data ongoing as part of AMP6 Investigation. May be taken further forward in Lower Test Enabling project.

	Lower Great Test.					
5	Infoworks Hydraulic model. (Infoworks ICM RS v7.5.511.5.6) (Originally InfoWorks RS v11.5.6)	<u>Origin</u> – Software developer, supplier & support (Innovyze??) <u>Runner</u> - Atkins	Representation of Lower Great Test including the Great, Little and Middle Test upstream of Redbridge. 2D representation of floodplain storage. Tidal and flow boundaries river network between Testwood abstraction and Woodmill Pool.	Channel & flood plain water level, flow and velocity representation accounting for channel bathymetry, floodplain topography and structures (control structure / flow / level influencing structures).	Not seen by the EA. Not seen by Fish Legal.	Lower Test RSA NEP project (concluded 2012). Testwood 2015 RSA Model converted from InfoWorks RS to InfoWorks ICM as part of the further work intended in current for the ongoing AMP6 Lower Test Enabling project. Ongoing work for Hampshire Inquiry
6	Thermal model. (Atkins Aquatic Heat Modelling System)	<u>Origin (developer)</u> – Atkins & George Mitchell <u>Runner</u> – George Mitchell (now Technoeconomica) Atkins.	To simulate the Lower Test heat thermal balance in the Great Test between Testwood abstraction and Testwood Mill.,	Assess the impacts of abstraction on river temperatures downstream of the Testwood abstraction.	Conclusions indicate negligible impact of abstraction and are consistent with trends observed in EA's monitoring data from summer 2013. EA concerned re exaggerated cooling effect of R Blackwater. This matter outstanding and	Lower Test RSA NEP project (concluded 2012). Testwood 2015 RSA

					not agreed. Not seen by Fish Legal.	
7	Wetland model. Water table model. (After (Armstrong, 1993)(An adaptation of water table model (Swetnam et al 1998)	Origin – Atkins Runner - Atkins	Bespoke representation of clay stratigraphy underlying Lower Test Valley SSSI.	Accounts for influence of rainfall, evaporation, ditch water levels and surface water including tidal variations on hourly basis where relevant) and the influence of deeper aquifers (not relevant in Lower Test SSSI).	Work included in Lower Test RSA report. Not seen by the EA. Not seen by Fish Legal.	Lower Test RSA (concluded 2012).