Impact of groundwater abstraction on WFD status: regulation, methodology and uncertainties

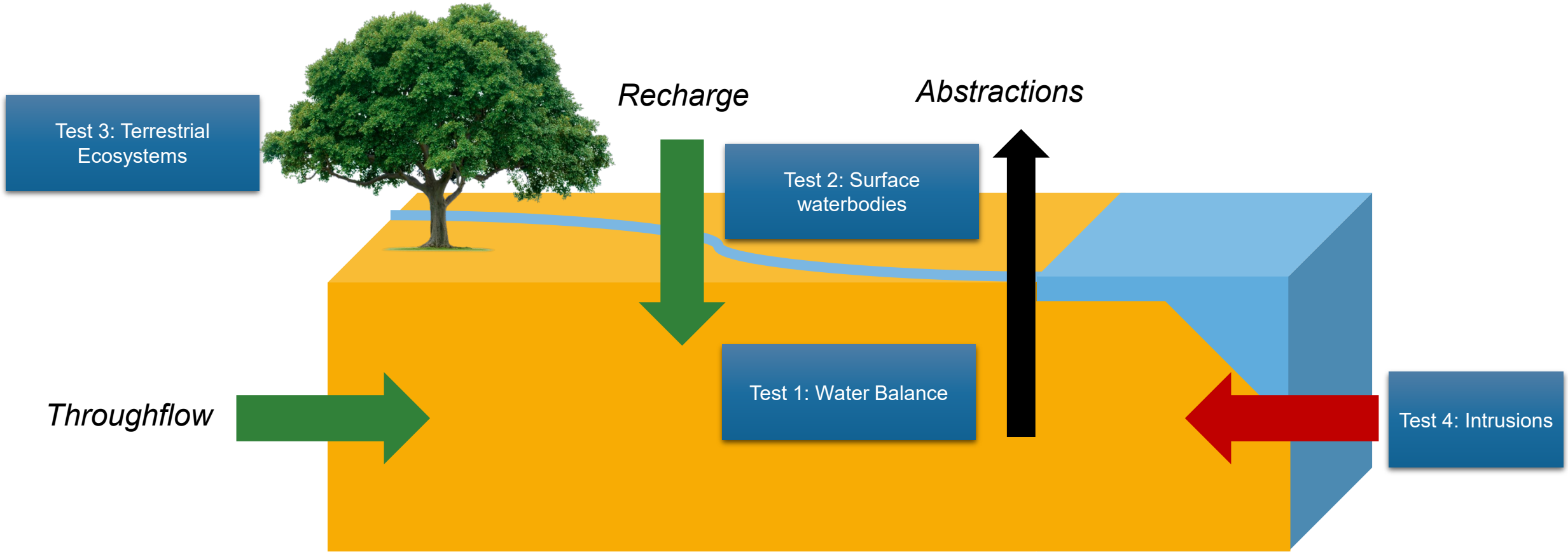
Alexander, S., Price, V., Dottridge, J., Rollins, B.
sarah.alexander@mottmac.com
victoria.m.price@mottmac.com
jane.dottridge@mottmac.com
b.rollins@gwscience.co.uk

Groundwater, Key to the Sustainable Development Goals

Contents

Introduction

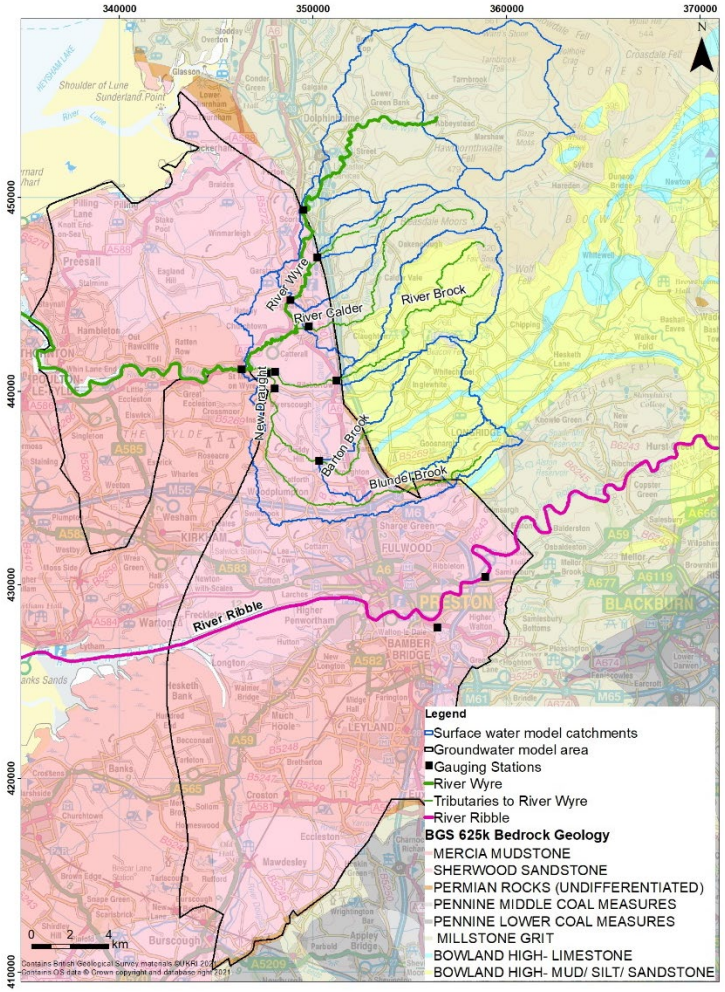
- **Groundwater Quantitative status** is an expression of the degree to which a groundwater body is affected by abstractions



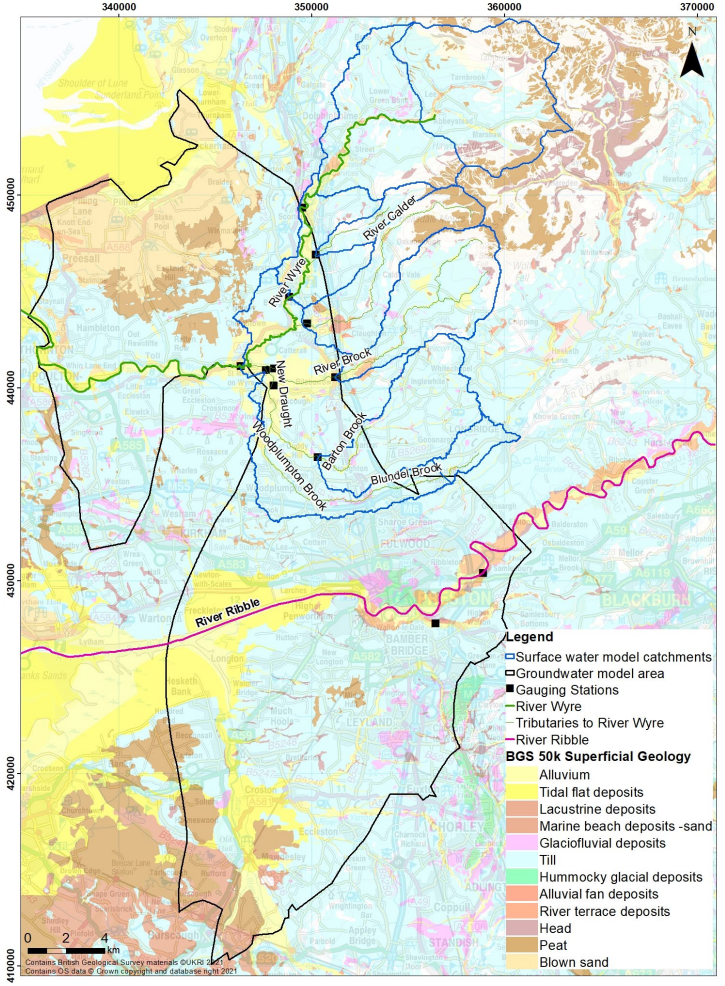
Case Study

Fylde Permo-Triassic Sandstone Aquifer

Study area



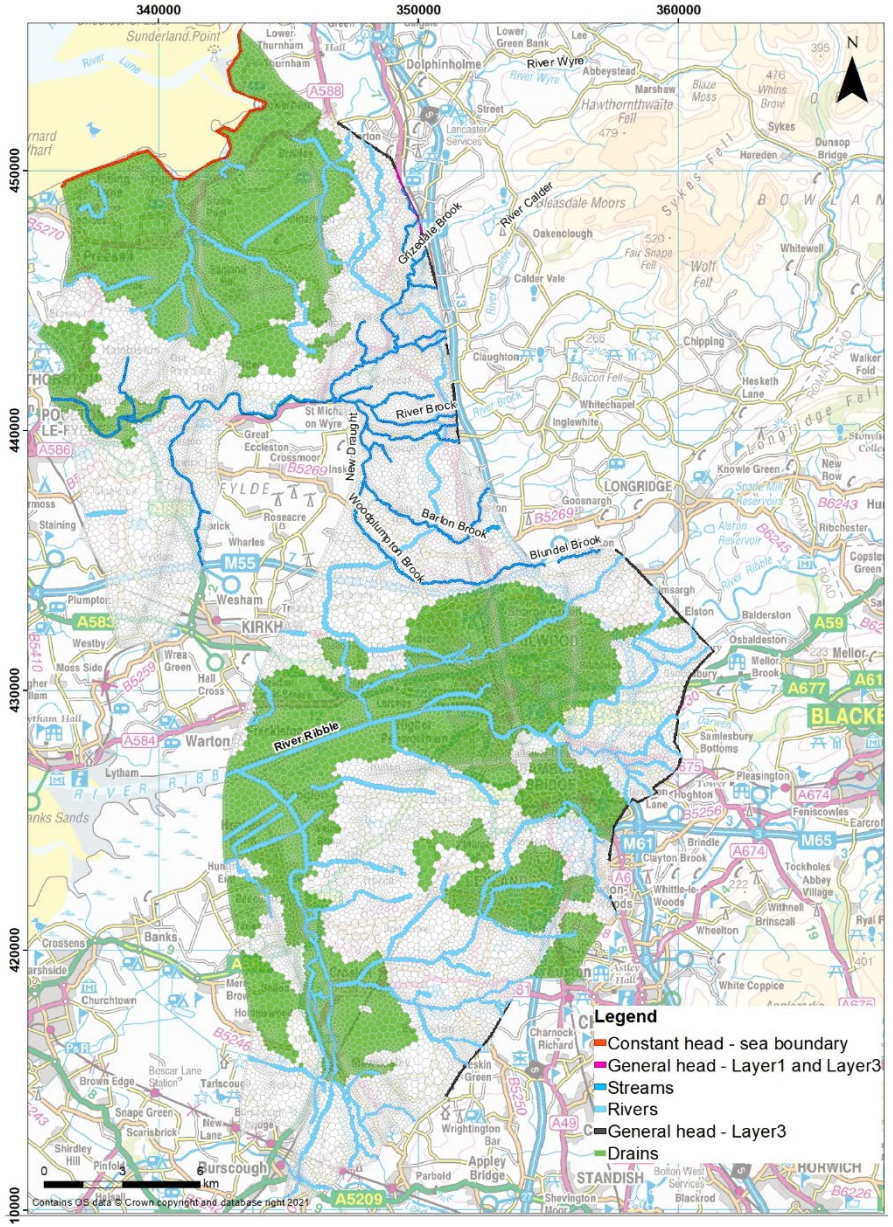
Bedrock geology



Superficial geology

Case Study: Model runs

- **Historical:** from 1969 to 2019
- **Naturalised:** All abstractions and discharges set to 0
- **Recent Actual (RA):** Abstractions set to average abstraction over the Recent Actual period (2015-2019)
- **Fully Licensed (FL):** Abstractions and discharges set to Fully Licensed rate
- **Future Predicted (FP):** Public Water Supply sources Recent Actual rates (2015-2019) multiplied by the growth factor
- **Switch off:** Public Water Supply sources set to 0. All other abstractions and discharges as in baseline



Boundary conditions (excluding abstractions)

WFD Tests – Groundwater Quantitative Status

Test 1: Water balance test

- Is the abstraction rate less than the available groundwater resource?

Test 2: Groundwater dependent surface water body test

- Is groundwater abstraction causing deterioration of ecological status in any of the surface water bodies supported by the groundwater body?

Test 4: Saline intrusion test

- Is saline intrusion occurring as a result of abstraction?

Test 3 (Groundwater dependent terrestrial ecosystems) - none identified for Fylde

Results

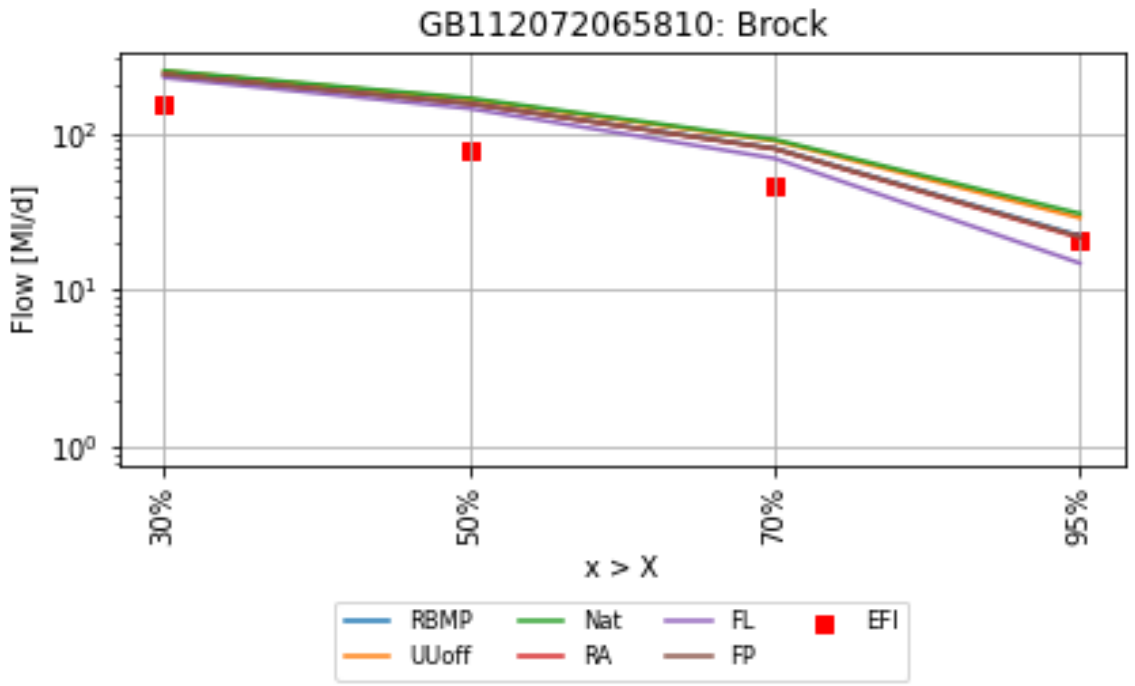
Test 1: Water balance

Scenario	Recent Actual	Fully Licensed	Future Predicted
Abstraction [Ml/d]	35.6	72.5	34.4
Recharge [Ml/d]	63.2	64.4	63.1
Groundwater flux [Ml/d]	5.1	10.1	5.0
Net environmental flow allocation [Ml/d]	34.1	34.1	34.1
Groundwater resource [Ml/d]	34.2	40.5	34.1
Groundwater balance [Ml/d]	-1.4	-32.0	-0.3
Abstraction as percentage of groundwater resource	**104%**	**179%**	**101%**
Result	Poor (low)	At risk	Probably at risk

Results

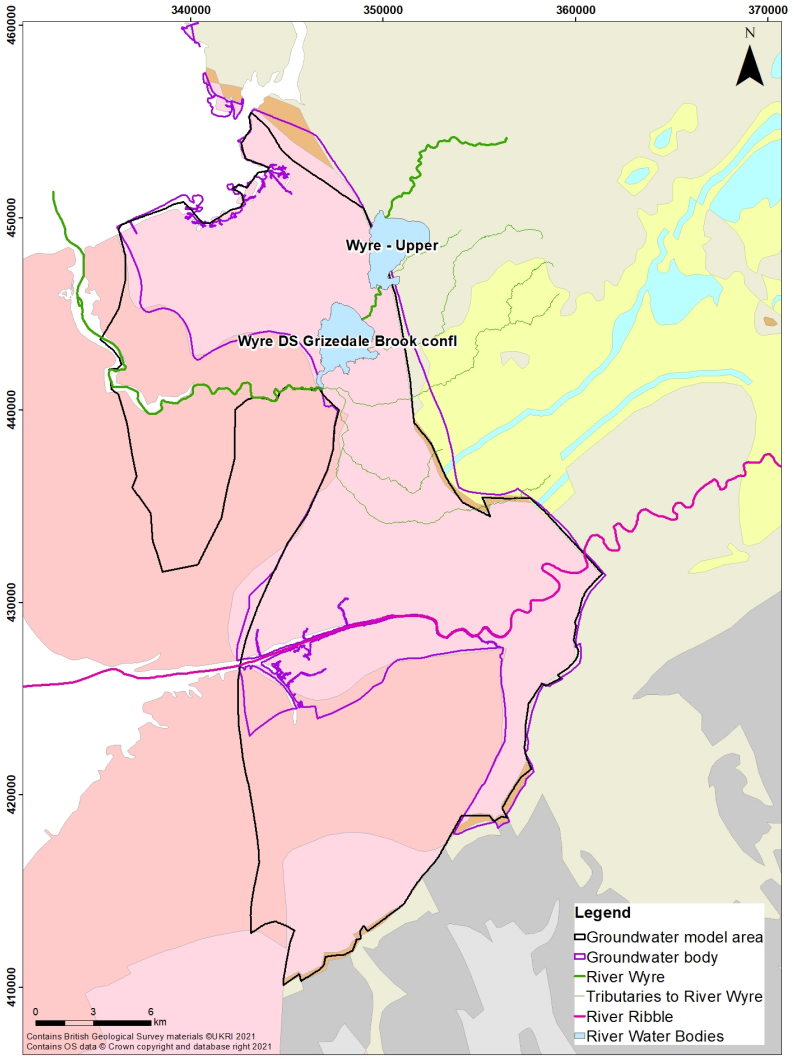
Test 2: Groundwater dependent surface waterbodies

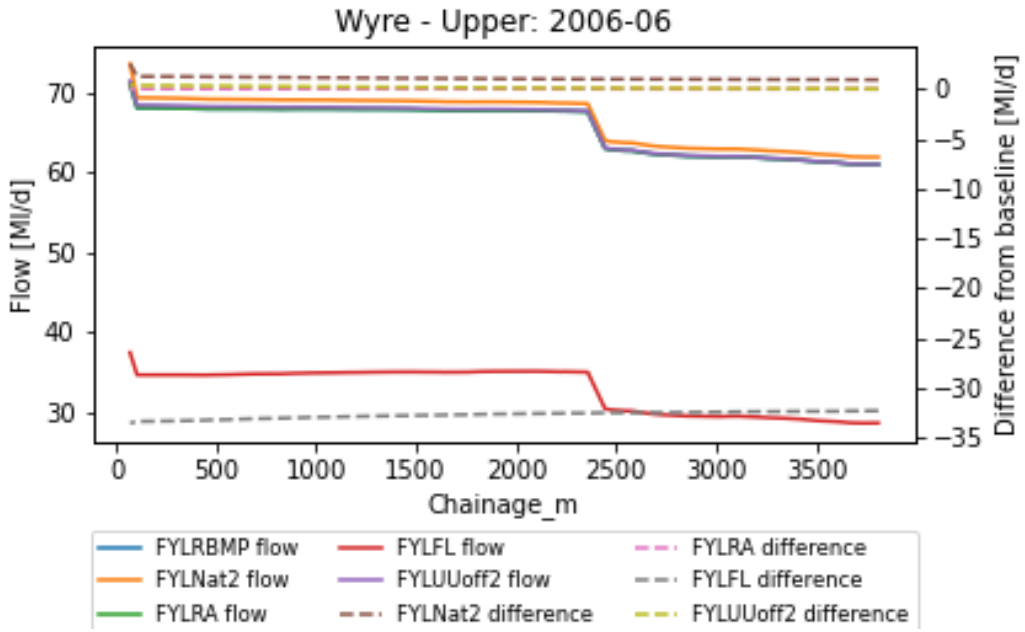
Surface waterbody	50% test	20% test	EFI test	Overall result
GB112071065500	Pass	Pass	Pass	Good (high)
AP1, Lower Ribble	Pass	Fail	Fail	Good (low)
GB112072065760	Pass	Fail	Fail	Good (low)
GB112072065800	Pass	Fail	Pass	Good (low)
AP7, River Brock	Pass	Fail	Fail	Good (low)
AP6, Woodplumpton Brook	Pass	Fail	Fail	Good (low)
AP8, River Calder	Pass	Fail	Pass	Good (low)
GB112072065810 (Brock)	Pass	Pass	Fail	Good (high)
GB112072065822 (Wyre ds Grizedale Brook confluence)	Pass	Fail	Fail	Good (low)
AP2, Wyre at Garstang	Pass	Fail	Fail	Good (low)
GB112072065790	Pass	Pass	Fail	Good (high)
AP1, Wyre at St Michaels	Pass	Pass	Fail	Good (high)
GB112072065860	Pass	Fail	Fail	Good (low)
GB112072065821 (Wyre – upper)	Pass	Fail	Fail	Good (low)
AP10, Grizedale Brook	Pass	Fail	Pass	Good (low)
AP9, River Cocker	Fail	Fail	Pass	Good (low)

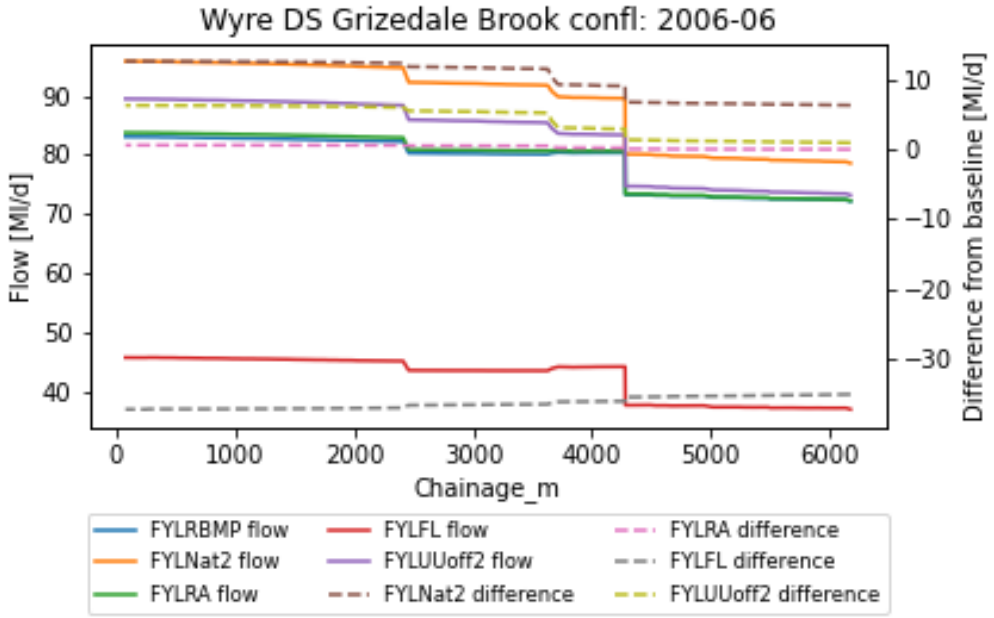


Results

Accretion profiles



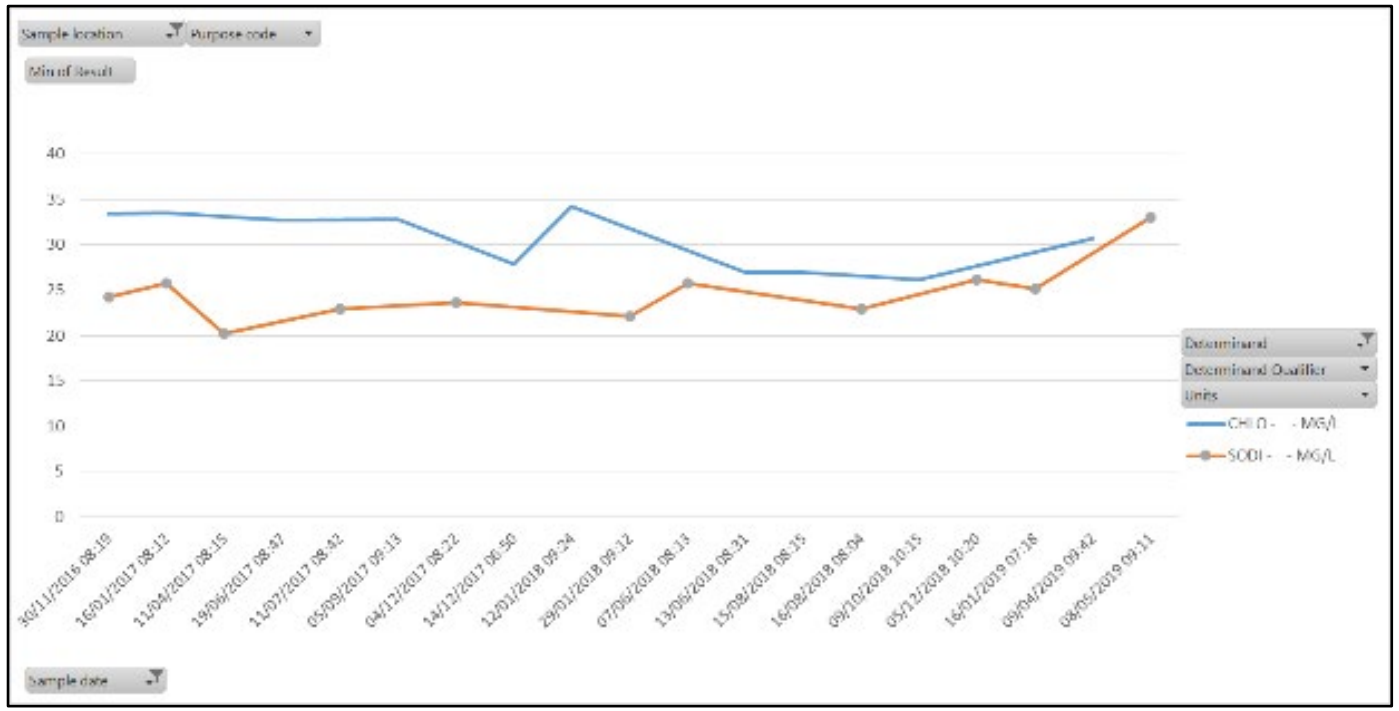




Results

Test 4: Saline intrusion

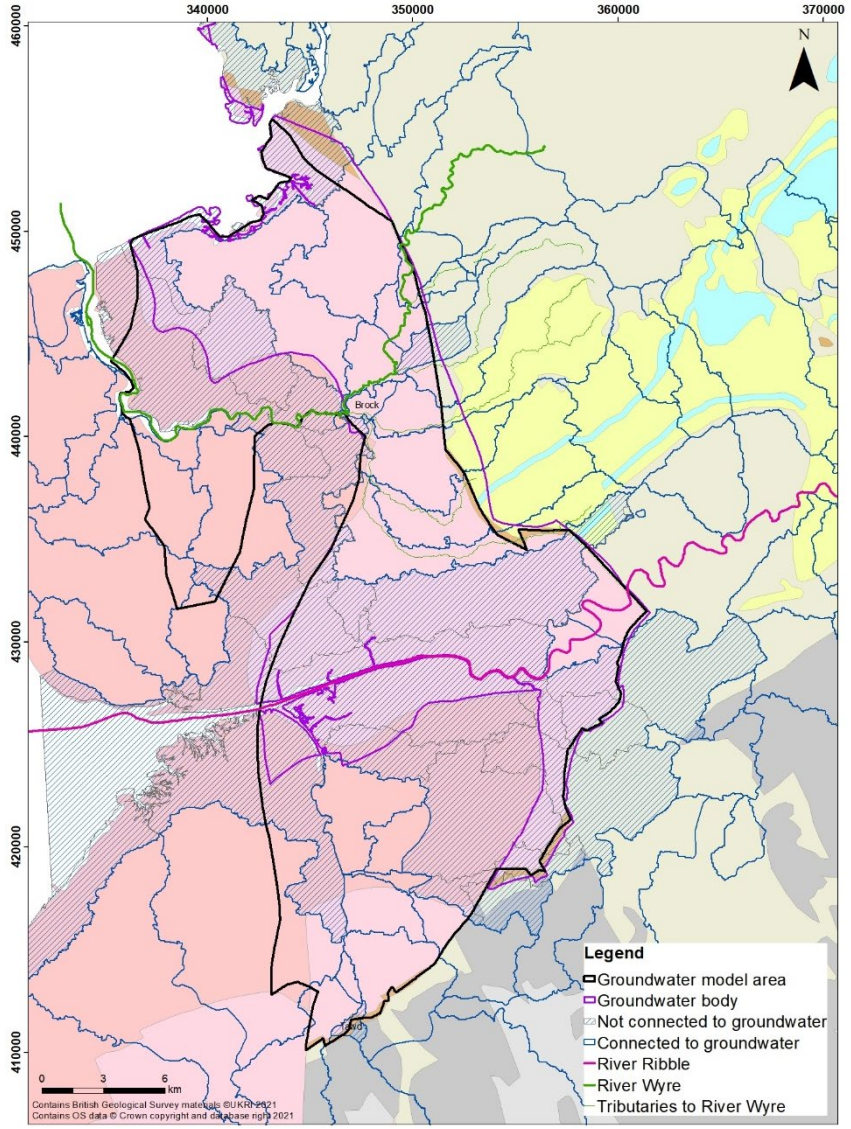
	Baseline [Ml/d]	Switch off run [Ml/d]	Difference [Ml/d]
Constant head boundary representing the sea	-4.31	-4.36	0.05



Uncertainties

Environmental Flow Allocation

- The baseflow from a groundwater body needed to support the environmental needs of the overlying water bodies
- Lack of ecological monitoring makes it difficult to define the EFI with confidence
- The EFI reflects flows across the whole surface water catchment. Where the surface water body intersected the groundwater model boundary, it was not appropriate to directly compare the EFI with the modelled flows
- The Environmental Flow Allocation is also dependent on the Base Flow Index



Conclusions

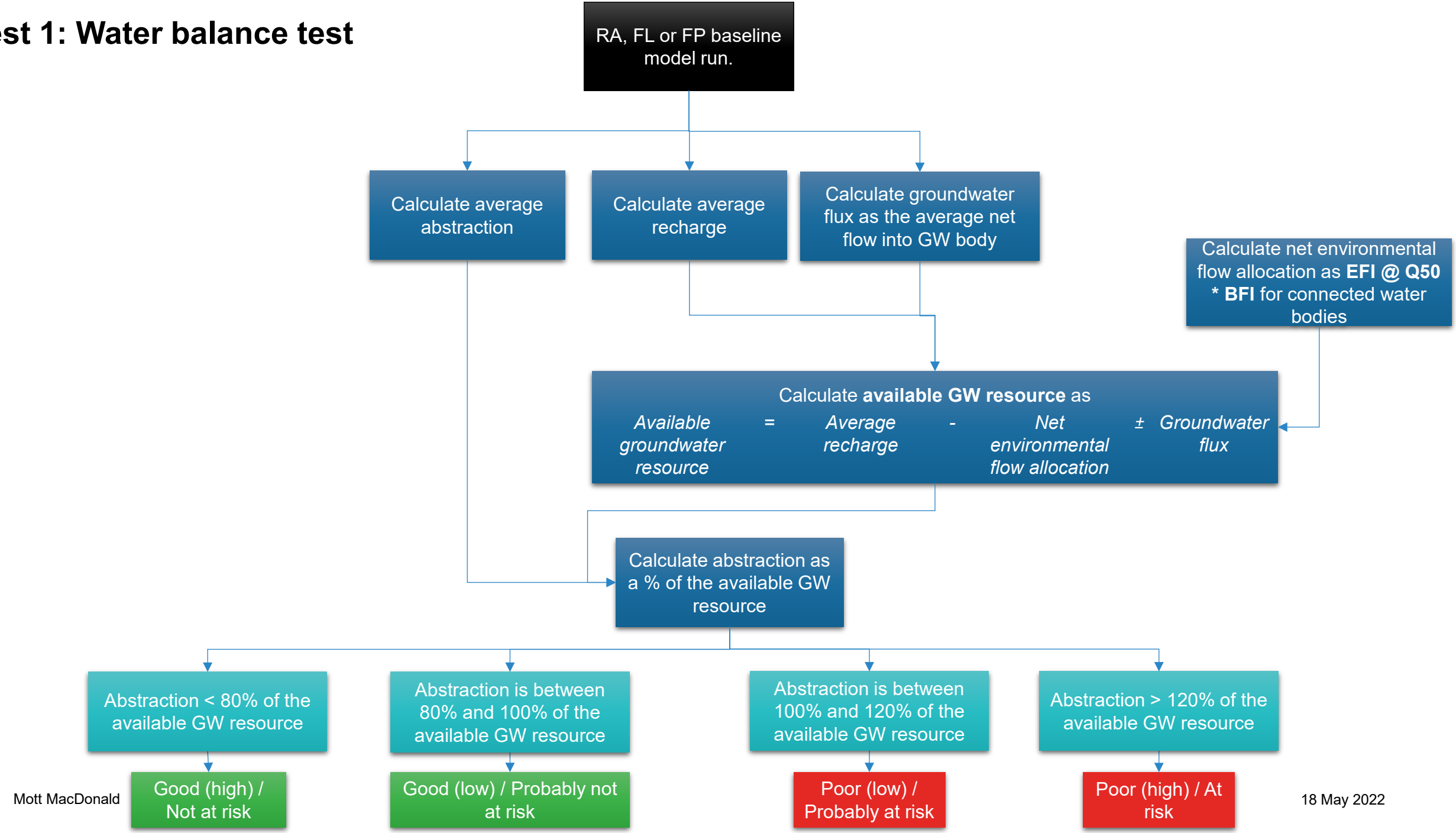
- The EA has provided guidance on assessing the Quantitative Status element of groundwater body WFD status
- Challenges in quantifying the links between groundwater, surface water and the health of ecosystems given the many uncertainties

River Wyre, St Michael's on Wyre

MOTT MACDONALD

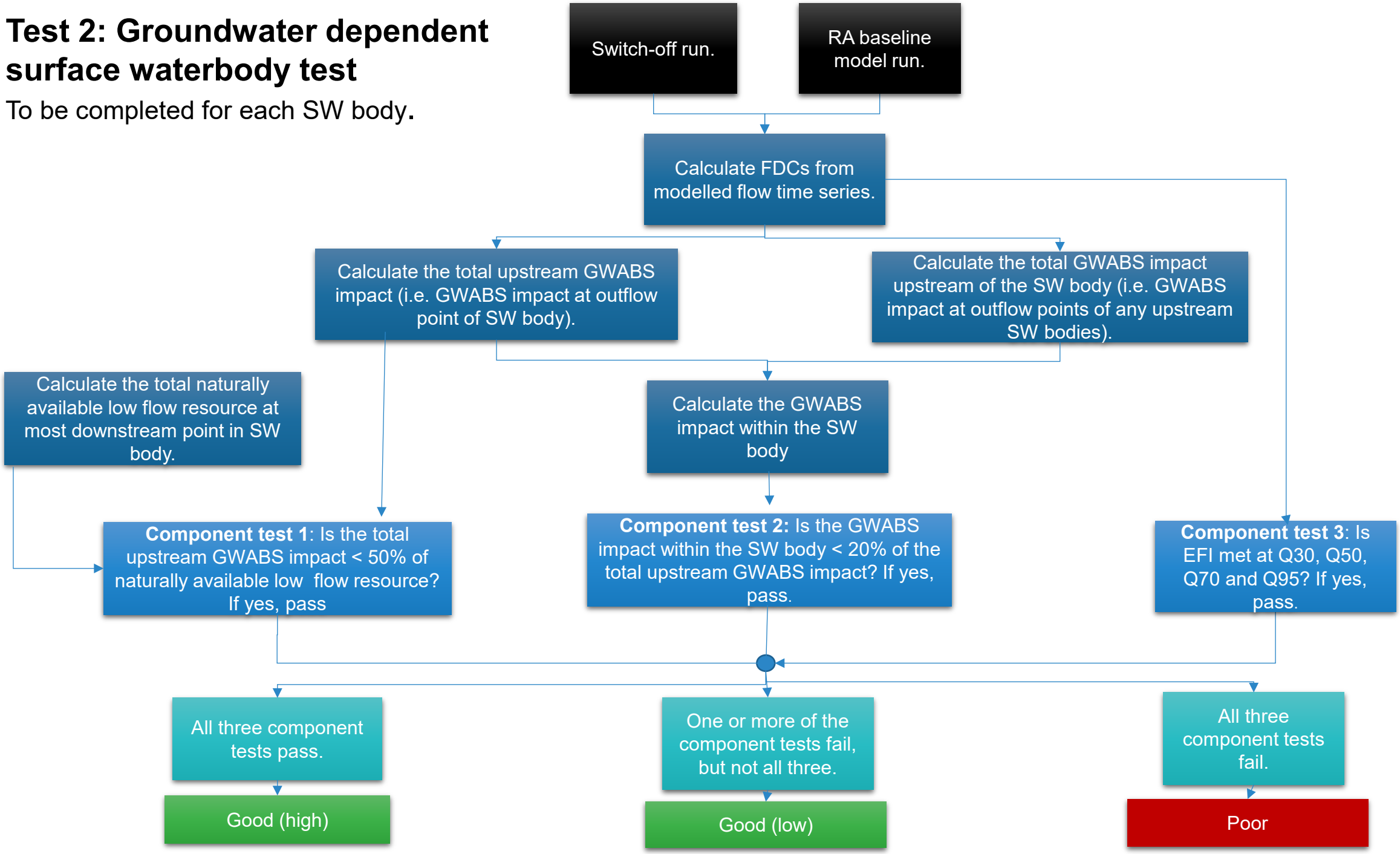
Thank you

Test 1: Water balance test

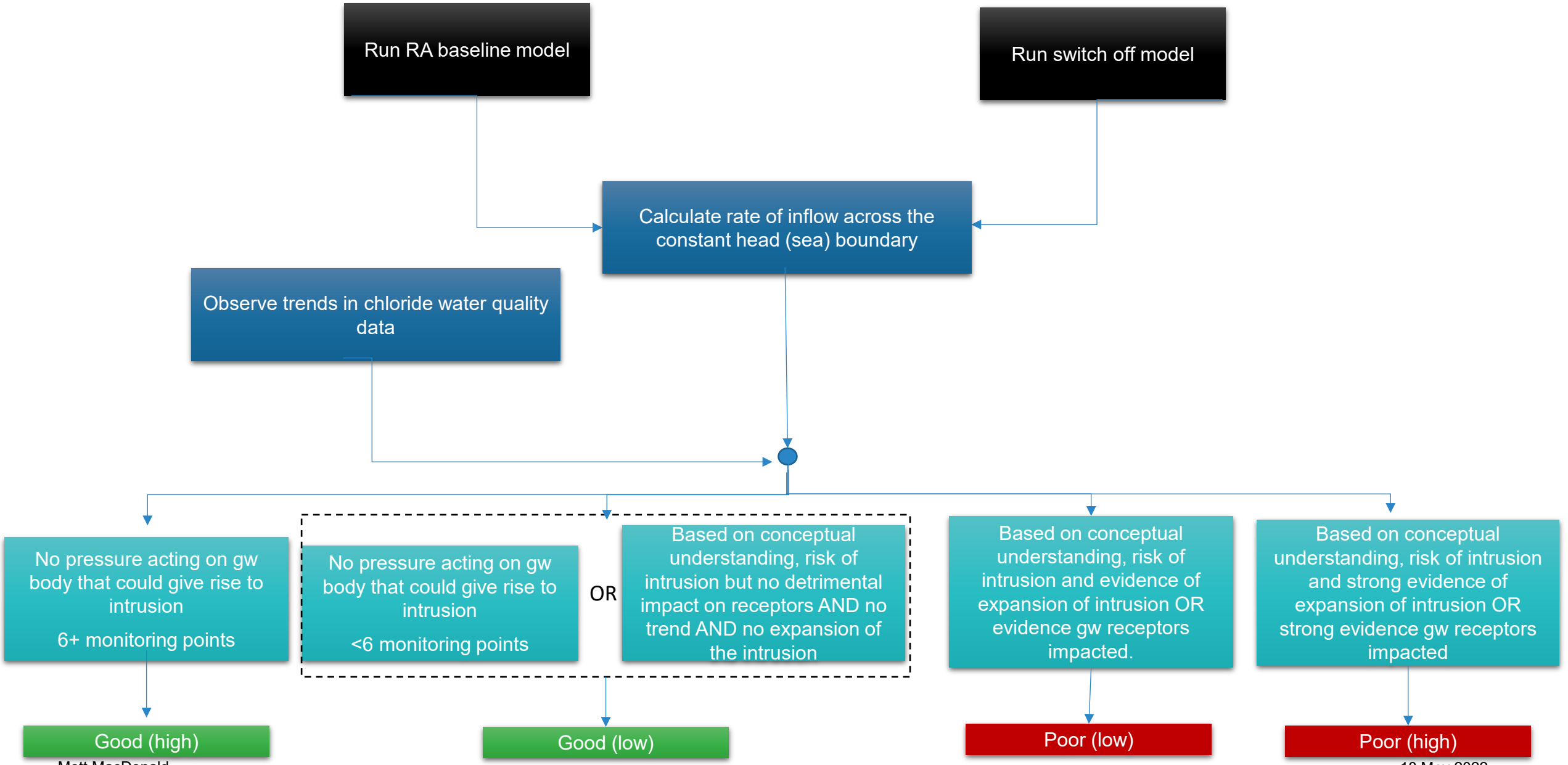


Test 2: Groundwater dependent surface waterbody test

To be completed for each SW body.

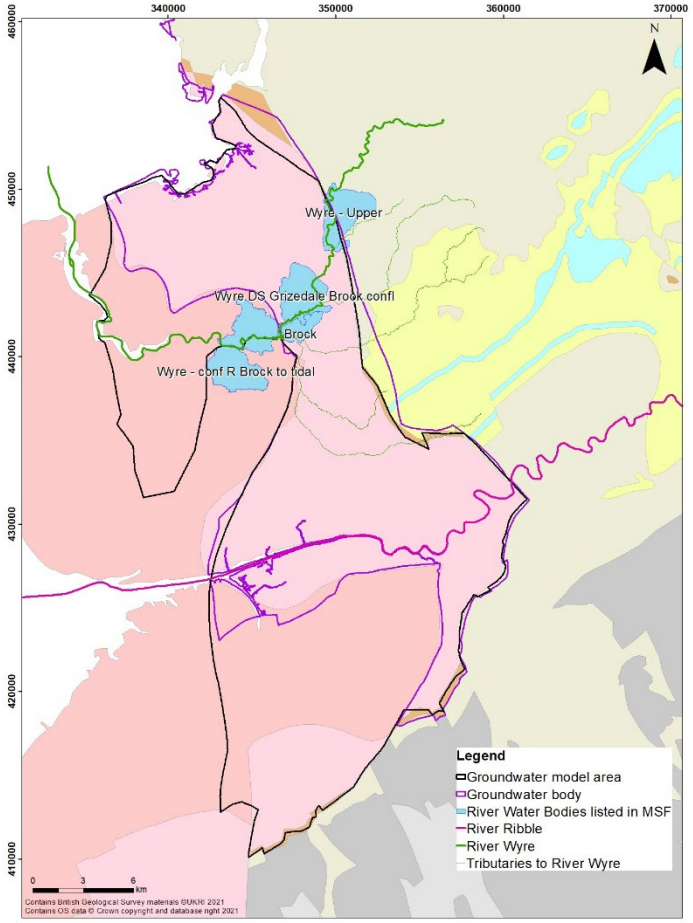


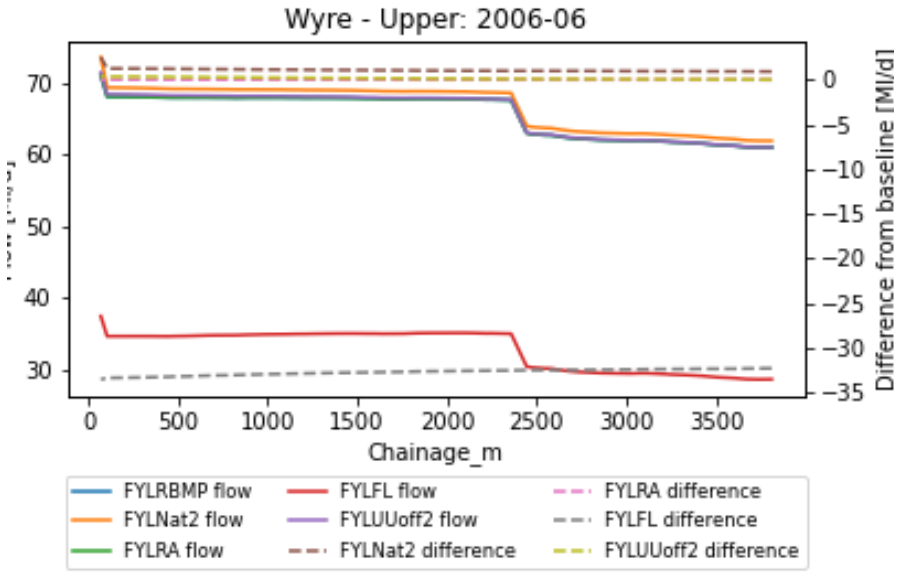
1.4: Saline or other intrusion test

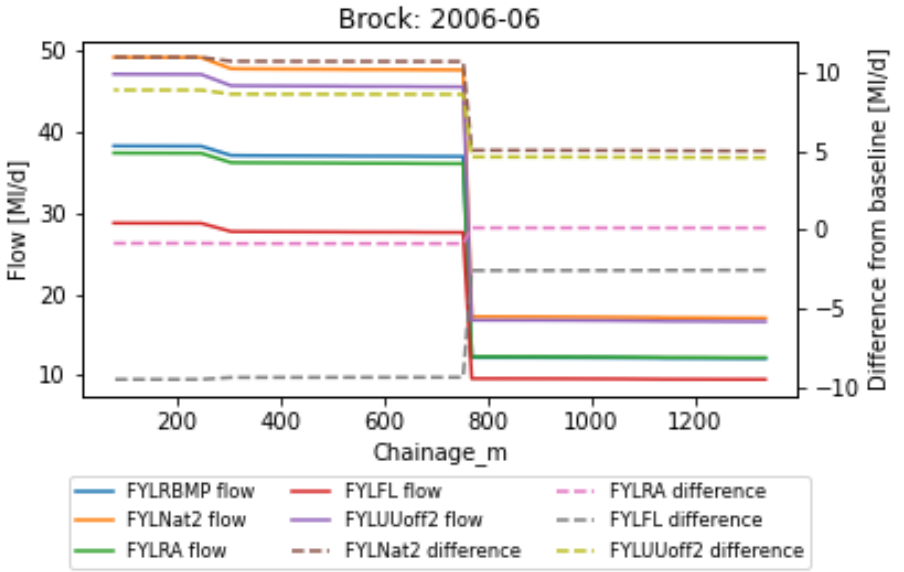


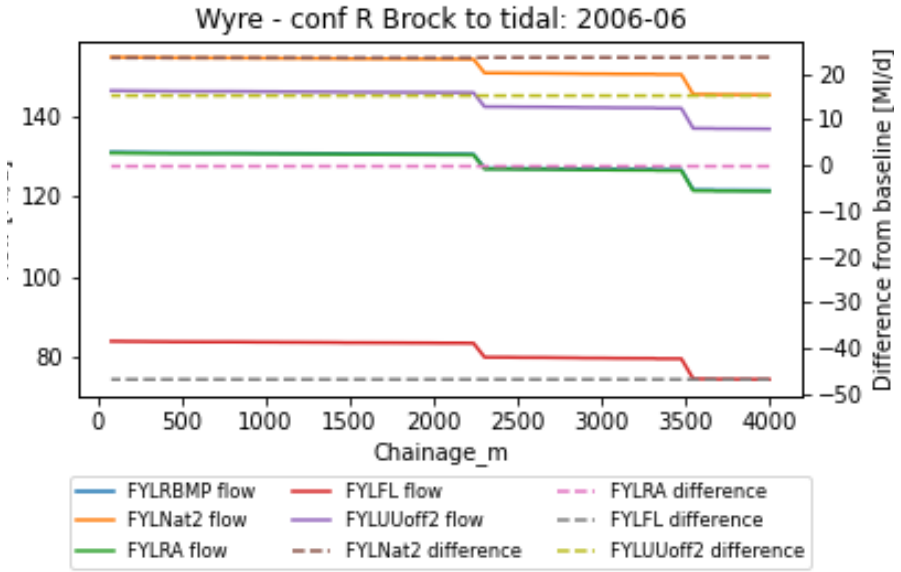
Accretion profiles

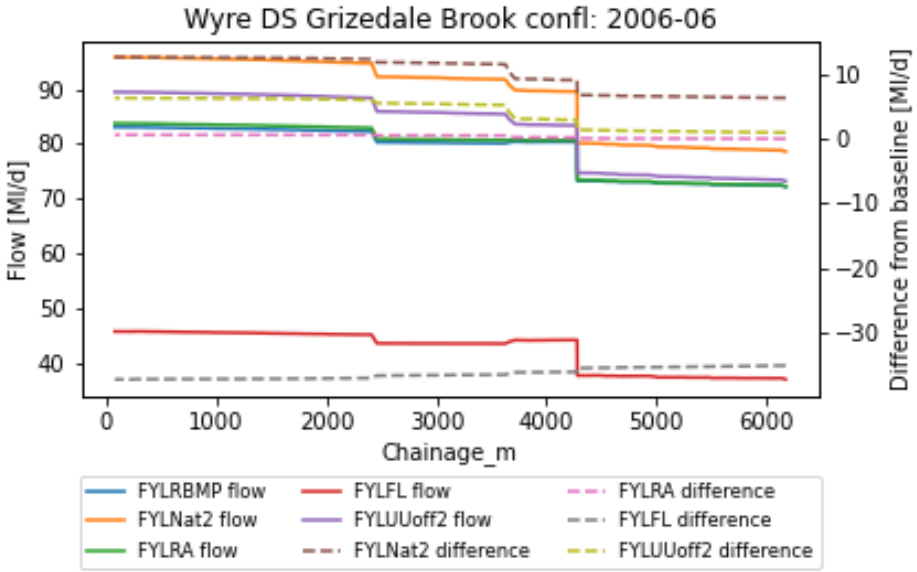
Dry: June 2006





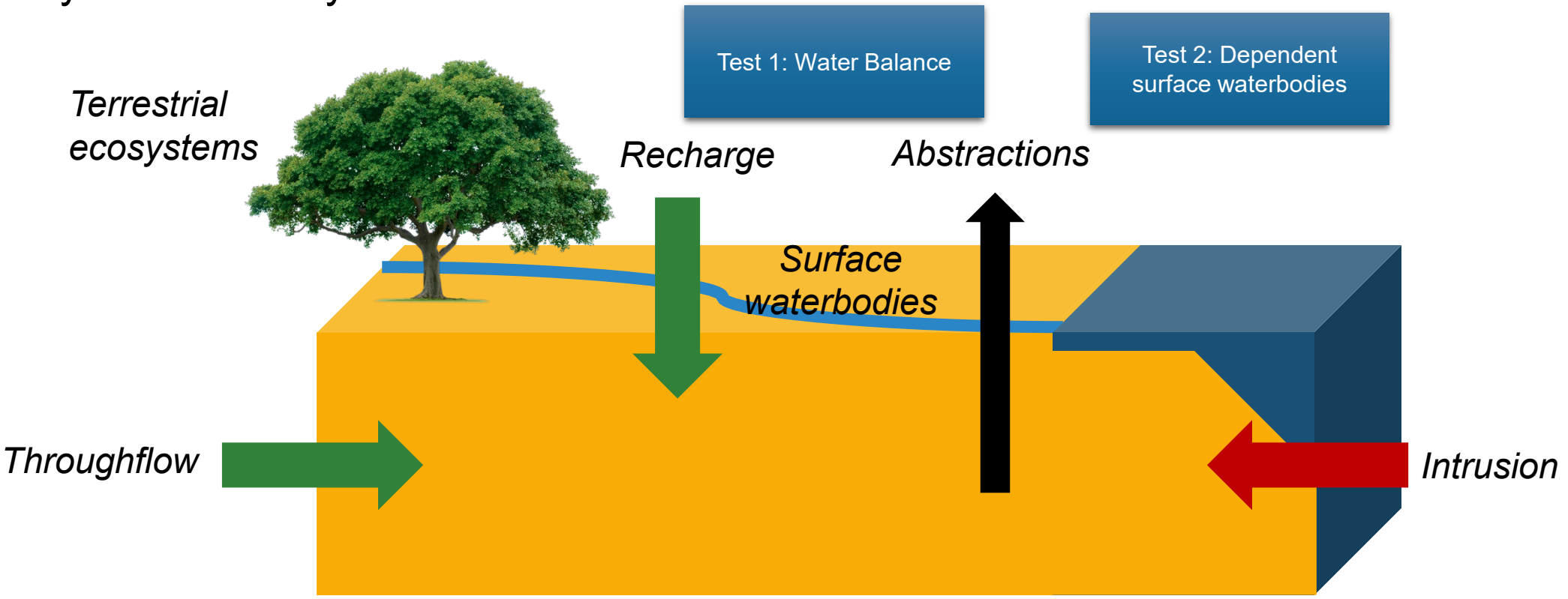






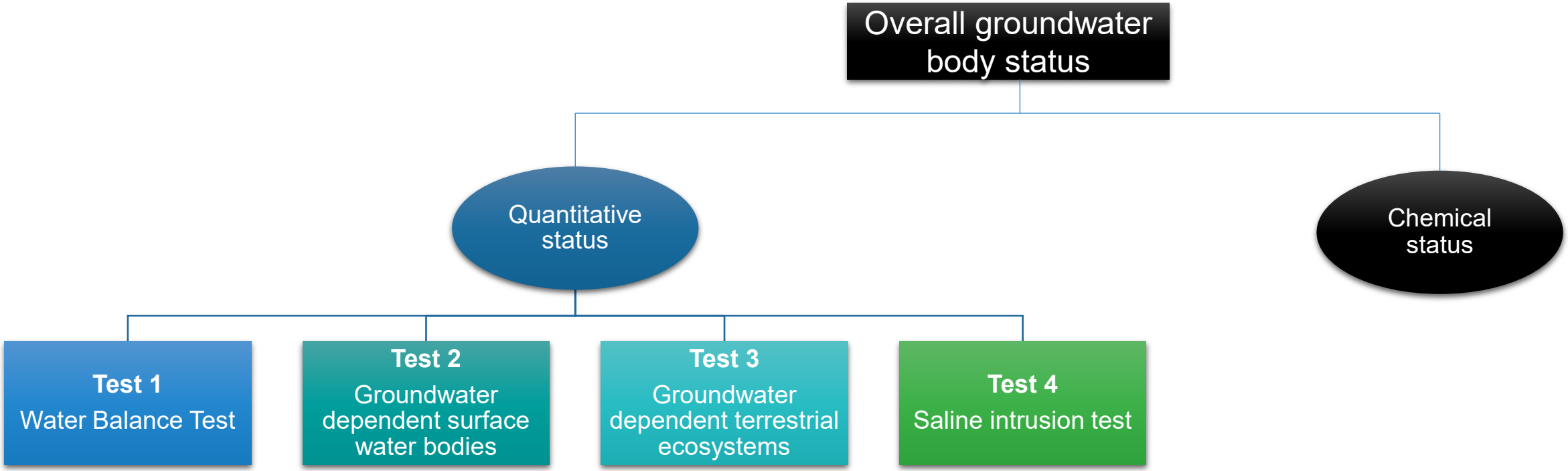
Introduction

- Under the Water Framework Directive, groundwater bodies are assessed based on their chemical and quantitative status
- **Groundwater Quantitative status** is an expression of the degree to which a groundwater body is affected by abstractions



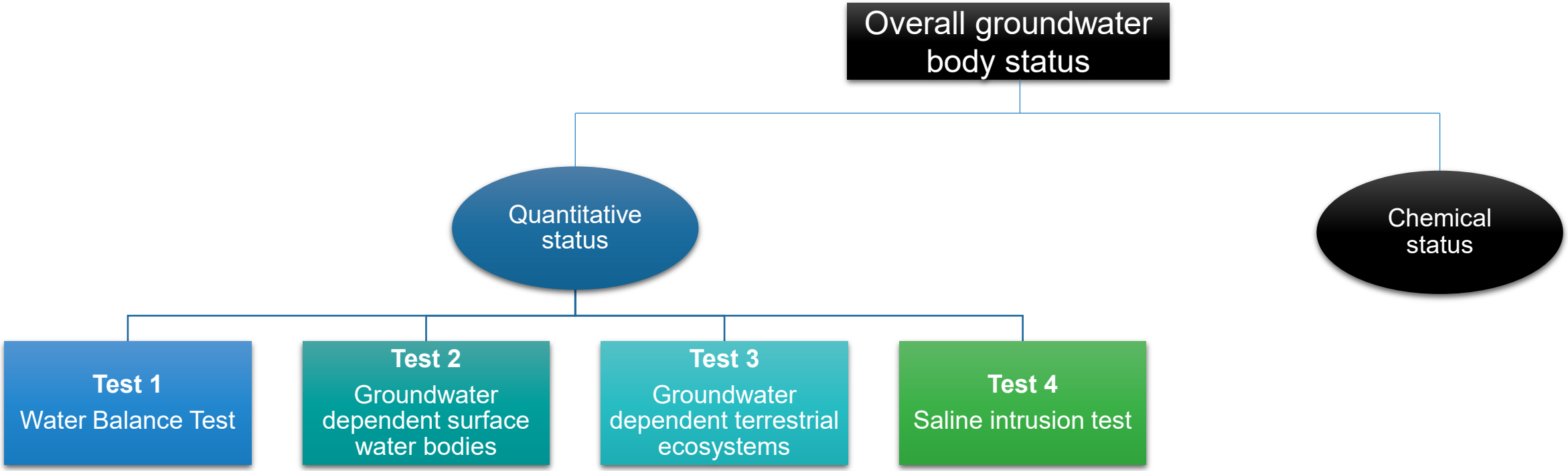
Introduction

- The Environment Agency has defined a test for each of the four components that affect the Quantitative Status element of the Overall Water Body classification
- Results can be good or poor for each test
- If any of the tests has poor status, then the overall Quantitative status is poor



Introduction

- Under the Water Framework Directive, groundwater bodies are assessed based on their chemical and quantitative status
- **Groundwater Quantitative status** is an expression of the degree to which a groundwater body is affected by abstractions



Results

Test 4: Saline intrusion

- Very small difference in flow across constant head boundary
- No trend in chloride concentration indicative of saline intrusion
- Test 4 status is good

	Constant Head
Baseline (Ml/d)	-4.31
Switch off	-4.36
Difference	0.05