Comparison of approaches for assessing WFD significant damage to groundwater dependent wetlands from water quality

Natalie Phillips (Environment Agency)
Mark Whiteman (Environment Agency)
Andrew Brooks (AMEC)

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- Gareth Farr (BGS)

Outline

- Comparison of approaches
- Adapting site investigation methods
- Local conceptual models - examples
- WFD timescales and conclusions

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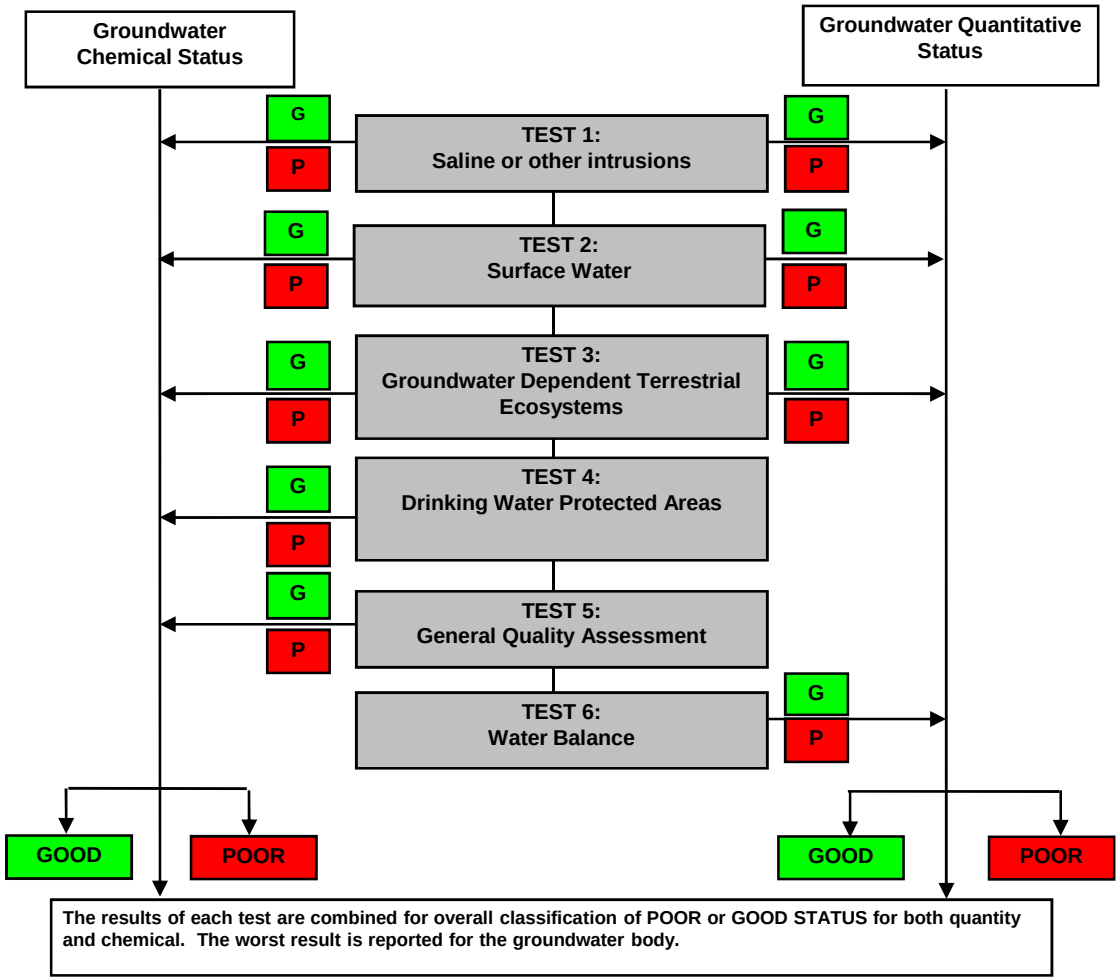
Classification tests – groundwater status



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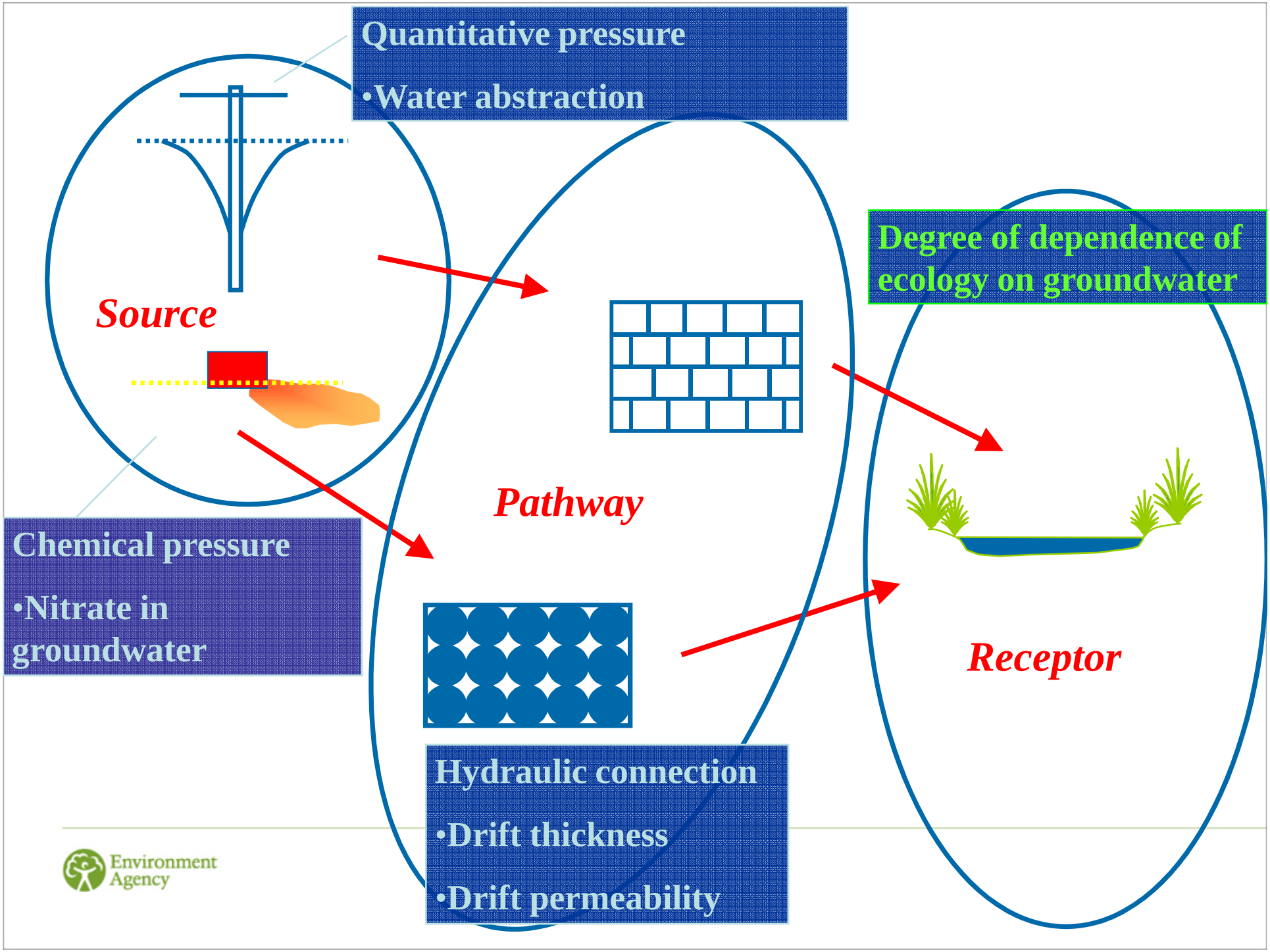
Quantitative pressure
•Water abstraction
Source
Degree of dependence of ecology on groundwater
Chemical pressure
•Nitrate in groundwater
Pathway
Receptor
Hydraulic connection
•Drift thickness
•Drift permeability
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Assessing Chemical risk

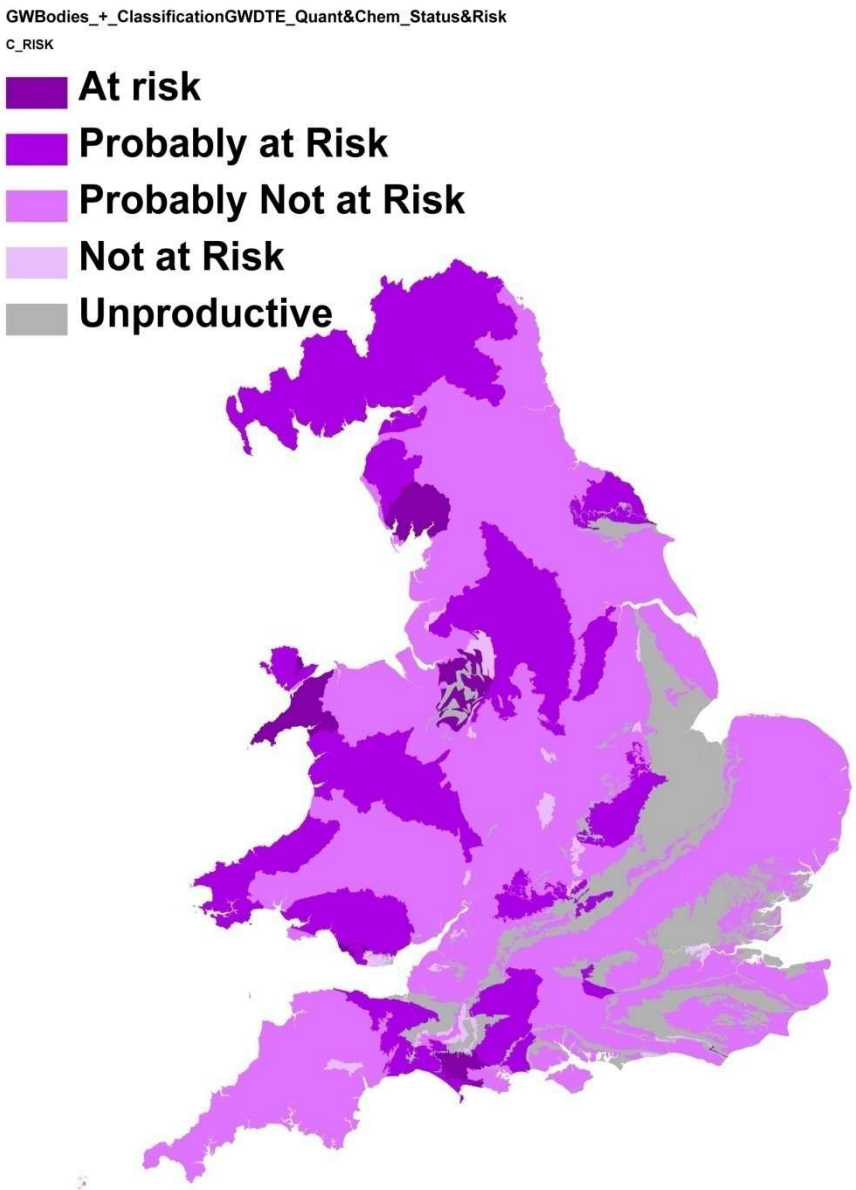
- RBC1 - phosphates
- RBC2 – nitrate thresholds
- High Risk = Local monitoring point with good connection to wetland + nitrate threshold exceeded
- Medium/low risk = threshold exceeded in groundwater body/more distant monitoring
- Nitrate loading (NEAP-N) used if insufficient data

Proposed nitrate trigger values (mg/l N)

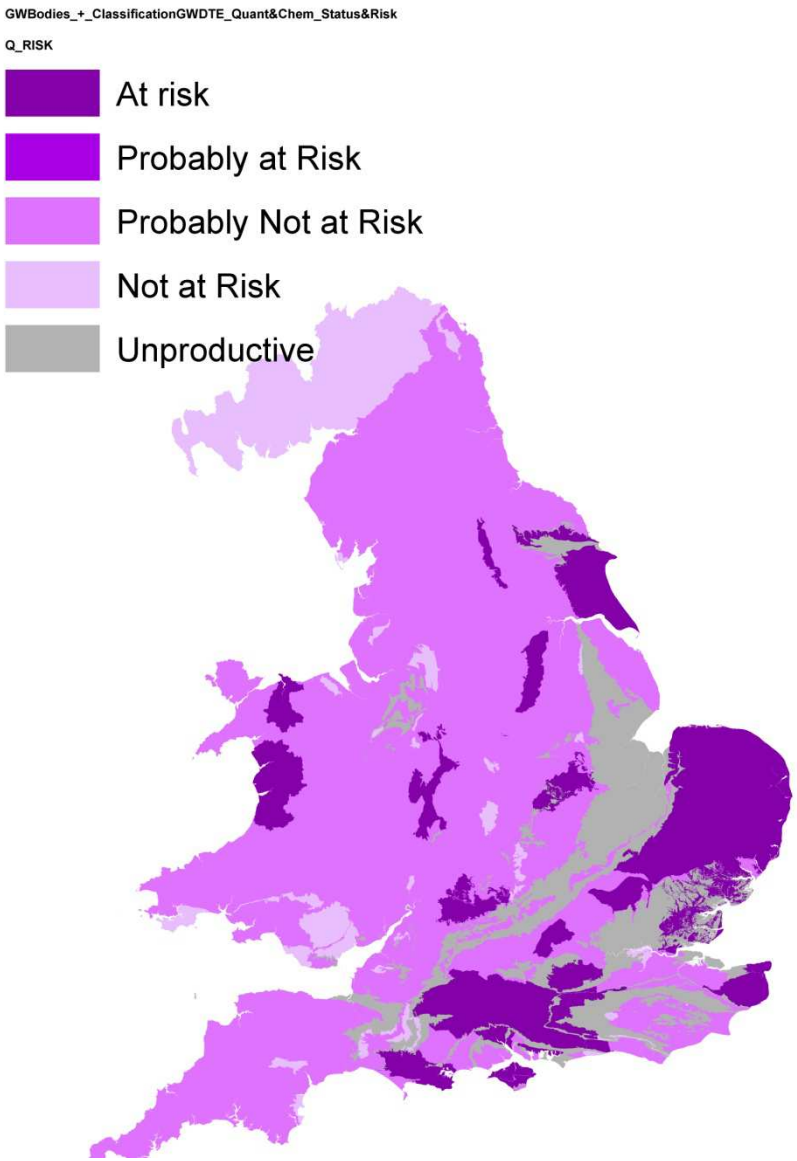
GWDTE category	Low altitude (<175mAOD)	Medium altitude (>175mAOD)	Any altitude
Quaking bog	4	1	
Wet Dune_			3
Fen (mesotrophic) and fen Meadow)	5	2	
Fen (oligotrophic and wetlands at Tufa forming springs)	4.5	1	
Wet Grassland	6	2	
Wet Heath	3	2	
Peatbog and woodland on peatbog			2
Wetlands directly irrigated by spring or seepage			2
Swamp (mesotrophic) and reedbed			5
Swamp (oligotrophic)			4
Wet Woodland	5	2	

First cycle (2007) risk screening results

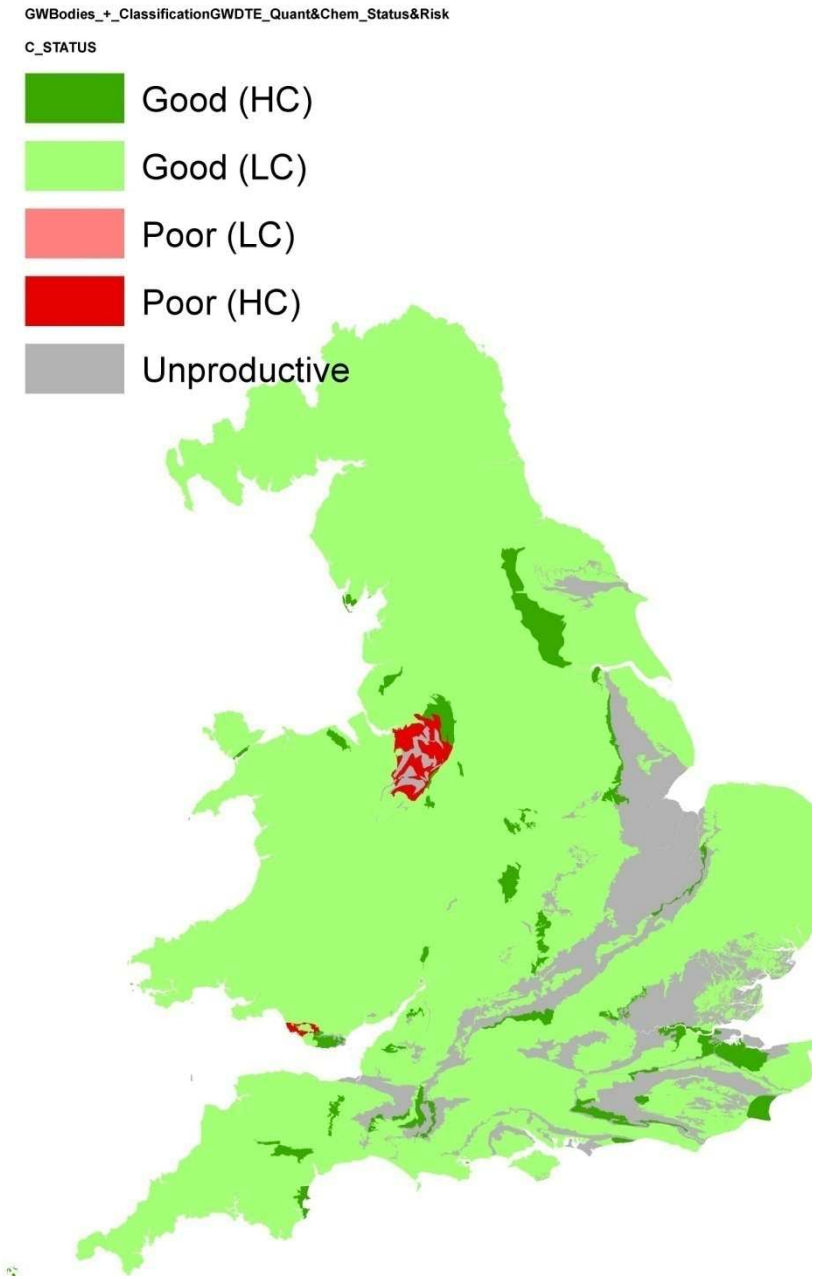
GWDTEs - Chemical Risk



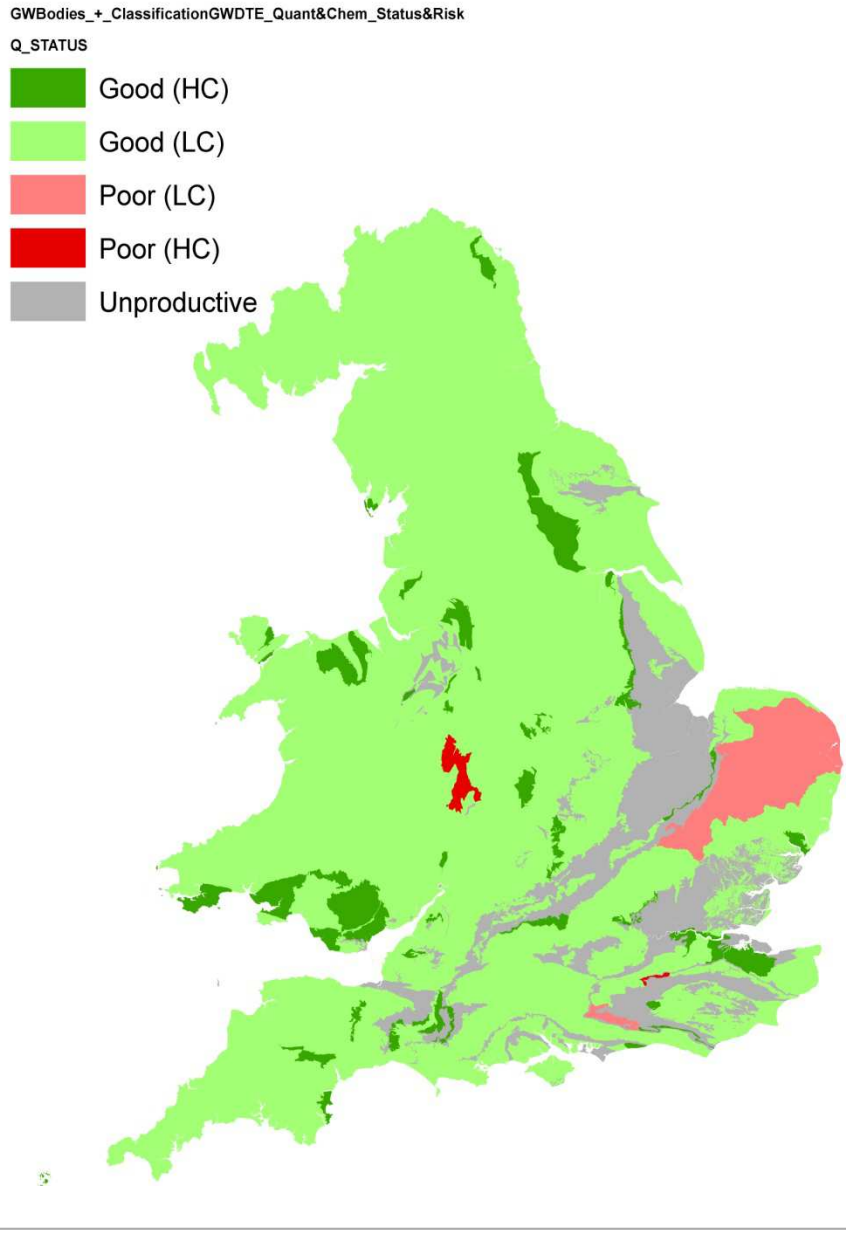
GWDTEs - Quantitative Risk



GWDTE test - Chemical Status

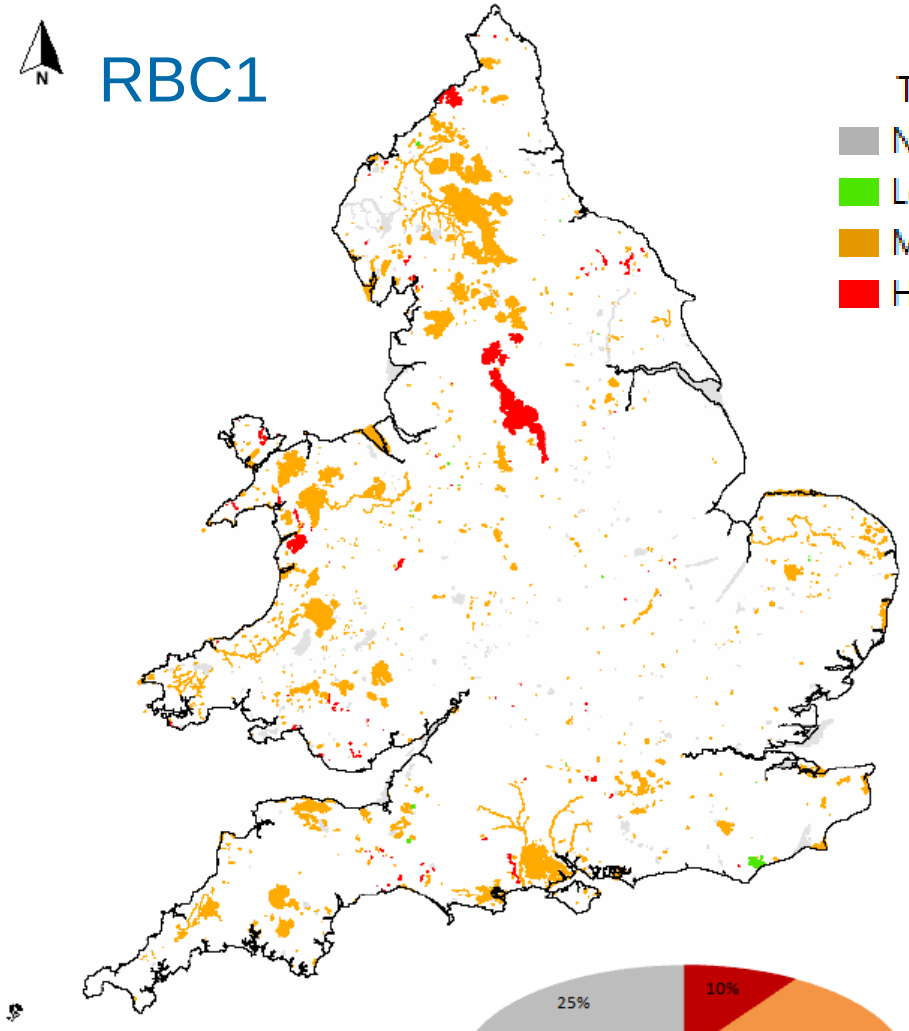


GWDTE Test Quantitative Status

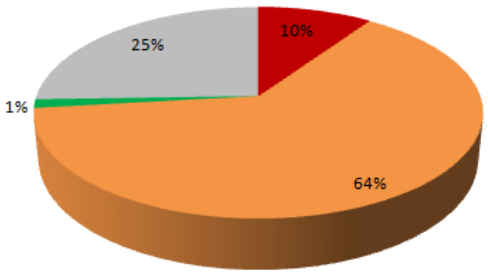


Chemical risk screening results

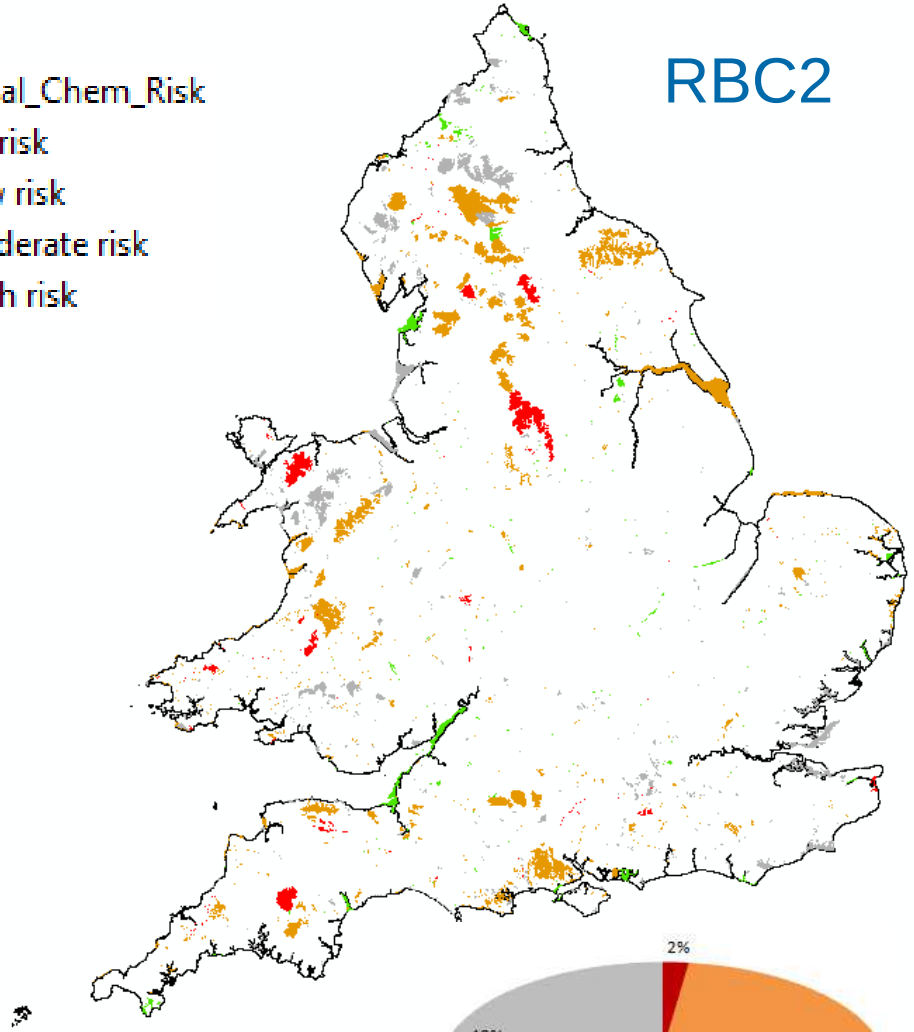
RBC1

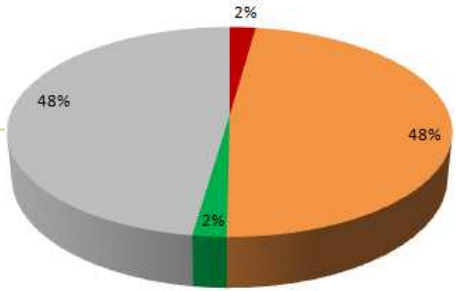


Total_Chem_Risk
- No risk
- Low risk
- Moderate risk
- High risk



RBC2





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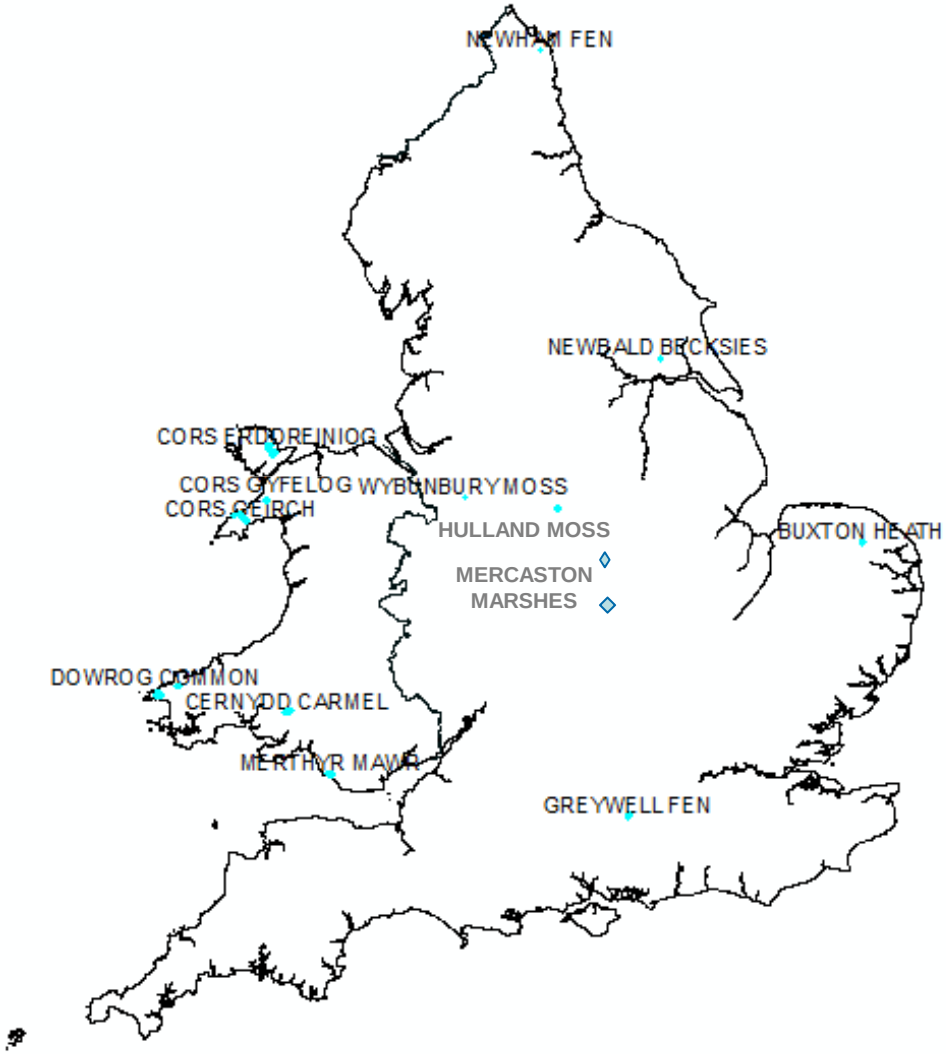
Investigations for RBC1 GWDTEs



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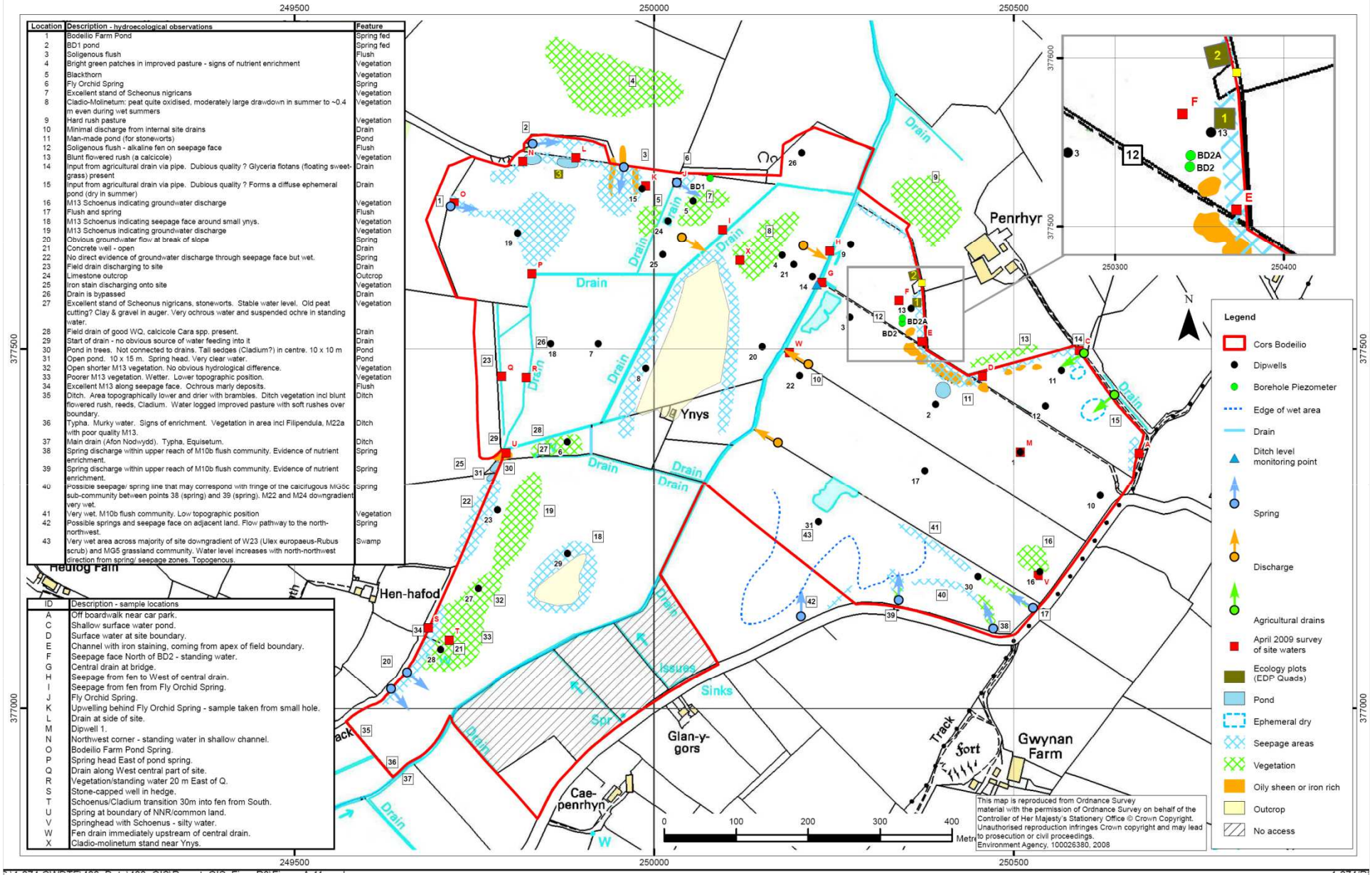
Site investigations – significant damage

- Many techniques assessed
- Local conceptual understanding is key
- Cost-effective methods e.g. GWDTE chemical sampling suite
- Assessed in terms of cost, time and contribution to understanding & decision-making



Location	Description - hydroecological observations	Feature
1	Bodeilio Farm Pond	Spring fed
2	BD1 pond	Spring fed
3	Soligenous flush	Flush
4	Bright green patches in improved pasture - signs of nutrient enrichment	Vegetation
5	Blackthorn	Vegetation
6	Fly Orchid Spring	Spring
7	Excellent stand of Scheonus nigricans	Vegetation
8	Cladio-Molinetum: peat quite oxidised, moderately large drawdown in summer to ~0.4 m even during wet summers	Vegetation
9	Hard rush pasture	Vegetation
10	Minimal discharge from internal site drains	Drain
11	Man-made pond (for stoneworts)	Pond
12	Soligenous flush - alkaline fen on seepage face	Flush
13	Blunt flowered rush (a calcicole)	Vegetation
14	Input from agricultural drain via pipe. Dubious quality ? Glyceria flotans (floating sweet-grass) present	Drain
15	Input from agricultural drain via pipe. Dubious quality ? Forms a diffuse ephemeral pond (dry in summer)	Drain
16	M13 Schoenus indicating groundwater discharge	Vegetation
17	Flush and spring	Flush
18	M13 Schoenus indicating seepage face around small ynys.	Vegetation
19	M13 Schoenus indicating groundwater discharge	Vegetation
20	Obvious groundwater flow at break of slope	Spring
21	Concrete well - open	Drain
22	No direct evidence of groundwater discharge through seepage face but wet.	Spring
23	Field drain discharging to site	Drain
24	Limestone outcrop	Outcrop
25	Iron stain discharging onto site	Vegetation
26	Drain is bypassed	Drain
27	Excellent stand of Scheonus nigricans, stoneworts. Stable water level. Old peat cutting? Clay & gravel in auger. Very ochrous water and suspended ochre in standing water.	Vegetation
28	Field drain of good WQ, calcicole Cara spp. present.	Drain
29	Start of drain - no obvious source of water feeding into it	Drain
30	Pond in trees. Not connected to drains. Tall sedges (Cladium?) in centre. 10 x 10 m	Pond
31	Open pond. 10 x 15 m. Spring head. Very clear water.	Pond
32	Open shorter M13 vegetation. No obvious hydrological difference.	Vegetation
33	Poorer M13 vegetation. Wetter. Lower topographic position.	Vegetation
34	Excellent M13 along seepage face. Ochrous marly deposits.	Flush
35	Ditch. Area topographically lower and drier with brambles. Ditch vegetation incl blunt flowered rush, reeds, Cladium. Water logged improved pasture with soft rushes over boundary.	Ditch
36	Typha. Murky water. Signs of enrichment. Vegetation in area incl Filipendula, M22a with poor quality M13.	Ditch
37	Main drain (Afon Nodwydd). Typha, Equisetum.	Ditch
38	Spring discharge within upper reach of M10b flush community. Evidence of nutrient enrichment.	Spring
39	Spring discharge within upper reach of M10b flush community. Evidence of nutrient enrichment.	Spring
40	Possible seepage/ spring line that may correspond with fringe of the calcifugous MG5c sub-community between points 38 (spring) and 39 (spring). M22 and M24 downgradient very wet.	Spring
41	Very wet. M10b flush community. Low topographic position	Vegetation
42	Possible springs and seepage face on adjacent land. Flow pathway to the north-northwest.	Spring
43	Very wet area across majority of site downgradient of W23 (Ulex europaeus-Rubus scrub) and MG5 grassland community. Water level increases with north-northwest direction from spring/ seepage zones. Topogenous.	Swamp

ID	Description - sample locations
A	Off boardwalk near car park.
C	Shallow surface water pond.
D	Surface water at site boundary.
E	Channel with iron staining, coming from apex of field boundary.
F	Seepage face North of BD2 - standing water.
G	Central drain at bridge.
H	Seepage from fen to West of central drain.
I	Seepage from fen from Fly Orchid Spring.
J	Fly Orchid Spring.
K	Upwelling behind Fly Orchid Spring - sample taken from small hole.
L	Drain at side of site.
M	Dipwell 1.
N	Northwest corner - standing water in shallow channel.
O	Bodeilio Farm Pond Spring.
P	Spring head East of pond spring.
Q	Drain along West central part of site.
R	Vegetation/standing water 20 m East of Q.
S	Stone-capped well in hedge.
T	Schoenus/Cladium transition 30m into fen from South.
U	Spring at boundary of NNR/common land.
V	Springhead with Schoenus - silty water.
W	Fen drain immediately upstream of central drain.
X	Cladio-molinetum stand near Ynys.

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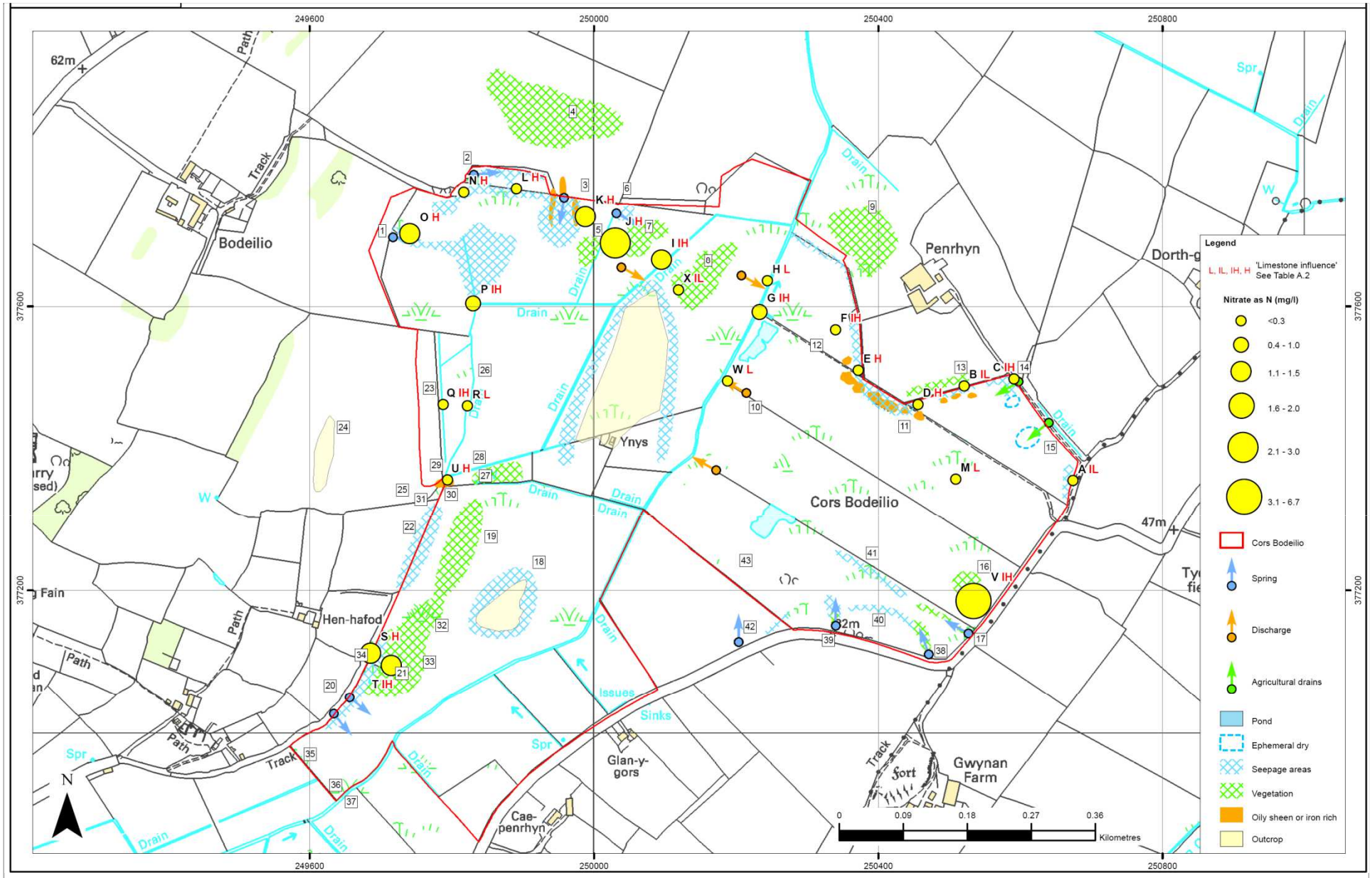
Hydroecological water features and locations of Vegetation Survey Quadrats



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Nitrate concentrations and 'limestone influence' overlain on the hydroecological map

Technique		Cost	Time	Benefit	
				Understanding	Decision/outcome
Drilling	shallow (dip wells)				
	deep				
Soil augering					
Window sampling					
GW Level monitoring	short term				
	long term				
GW Quality monitoring	short term				
	long term				
Geochemical surveys (Nitrogen isotope/age dating)					
SW level/flow monitoring	short term				
	long term				
SW Quality monitoring					
Walkover hydro-ecological surveys					
Ecological surveys	short term				
	long term				
Geophysical surveys					
Flow/nutrient Modelling					
Catchment audit					
Local knowledge					
multi-disciplinary review					
site conceptualisation	Wetmecs				
	S>P>R				
Cost Time Understanding		<£1K 1 month very useful	£1K-5K 1 year useful	>£5K > 1 year not really useful	

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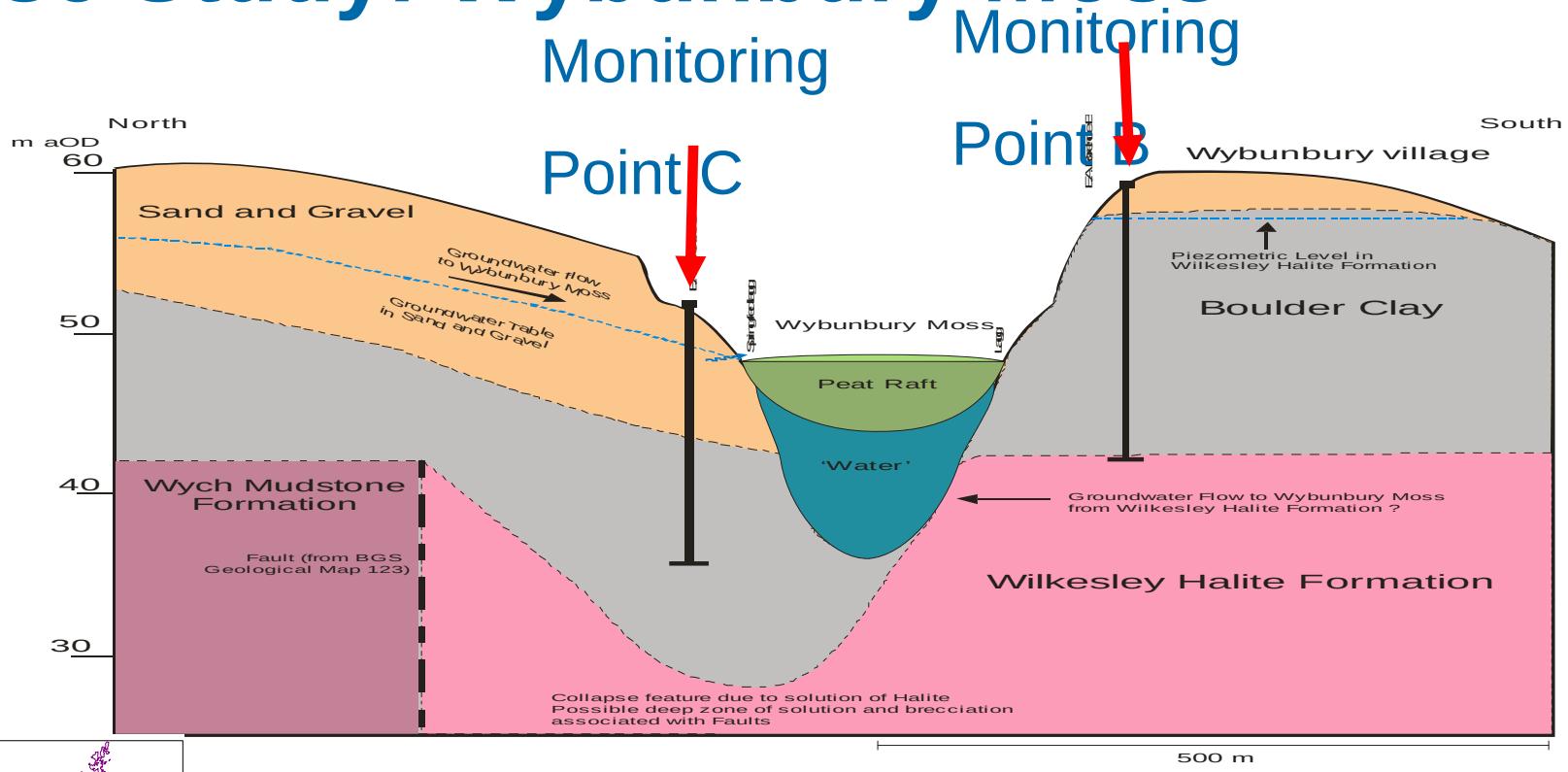
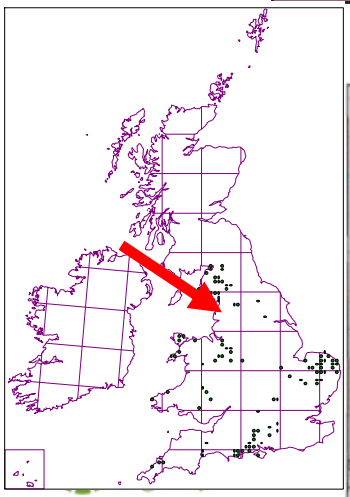
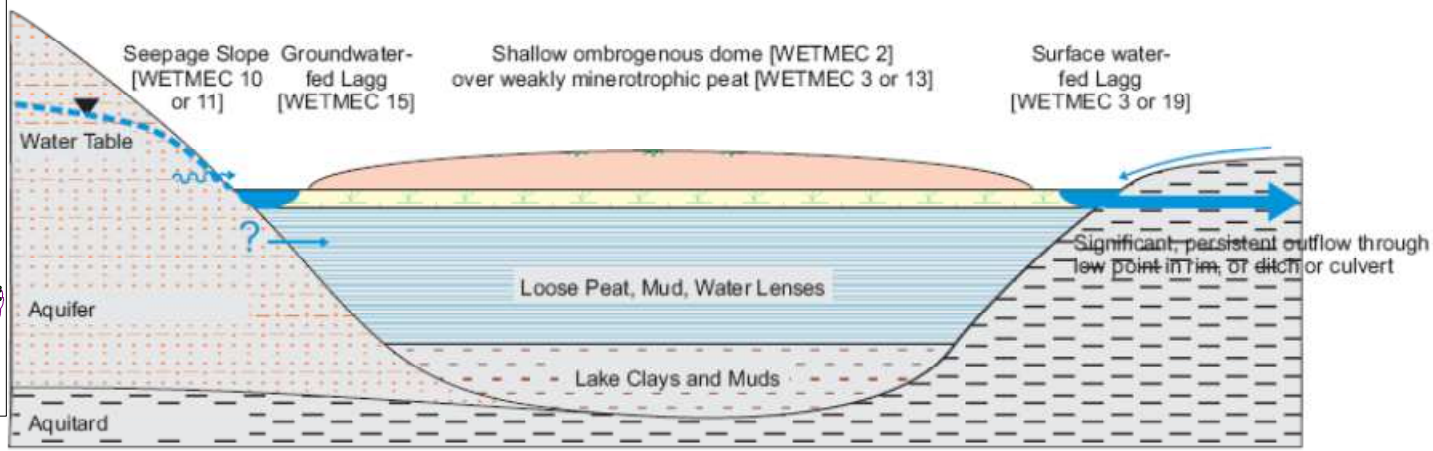
Case Study: Wybunbury Moss

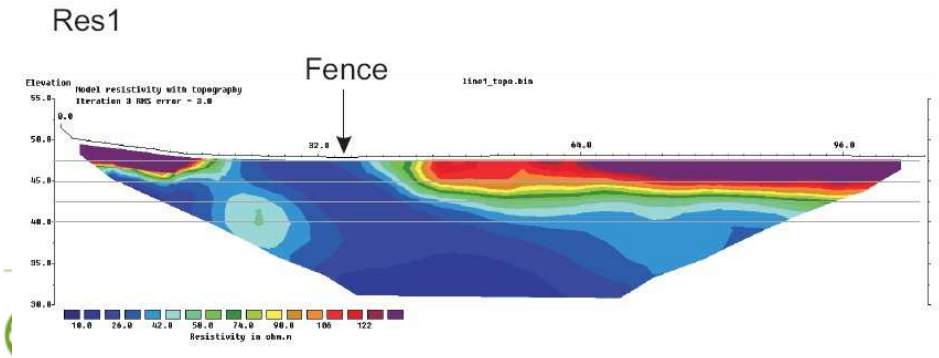




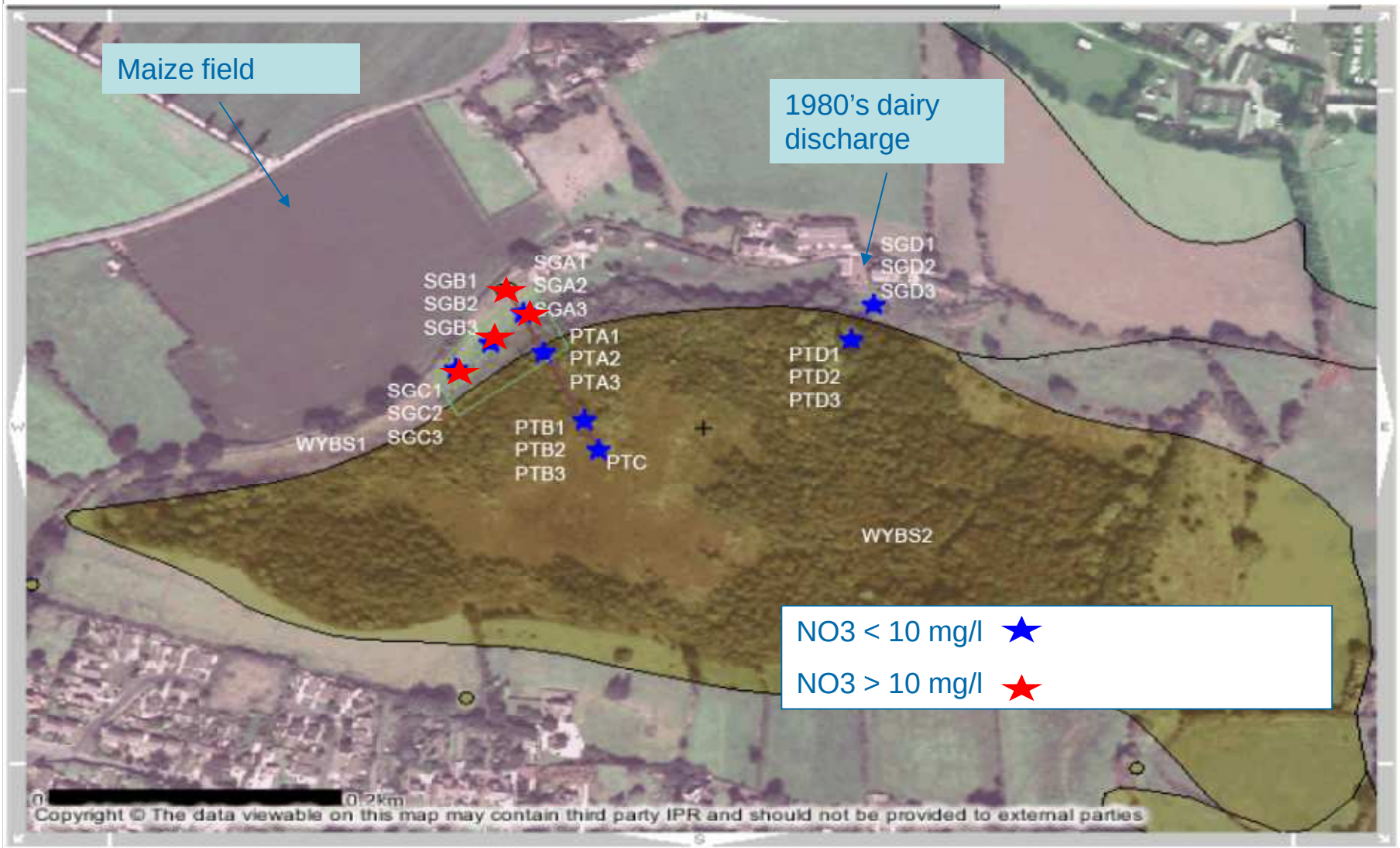


Case example: Wybunbury Moss

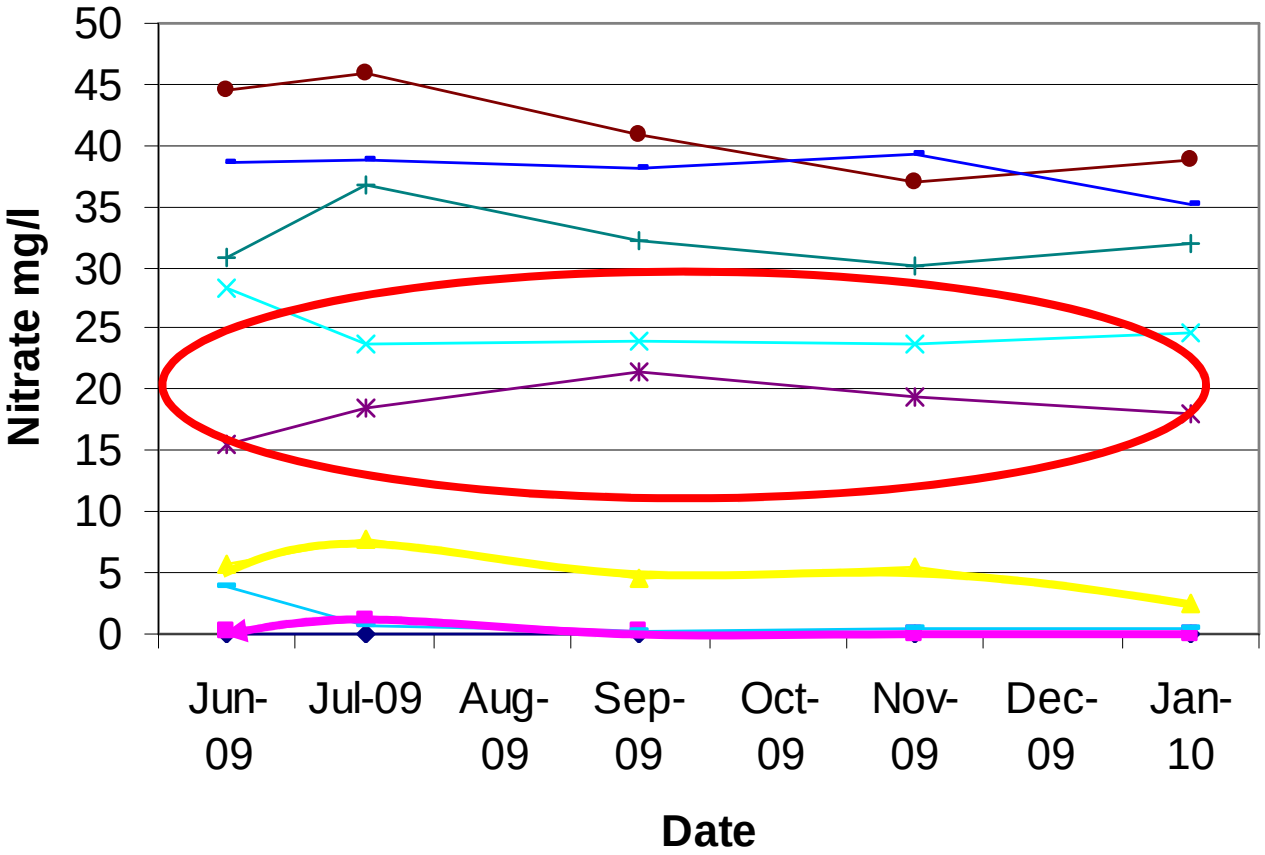
- Wetland feature = M18, M2, M22, M23,W4,W5 (peatbog & woodland on peatbog, quaking bog)
- Nitrate threshold = 2 mg/l nitrate as N
- 1st cycle National risk screening result = high risk



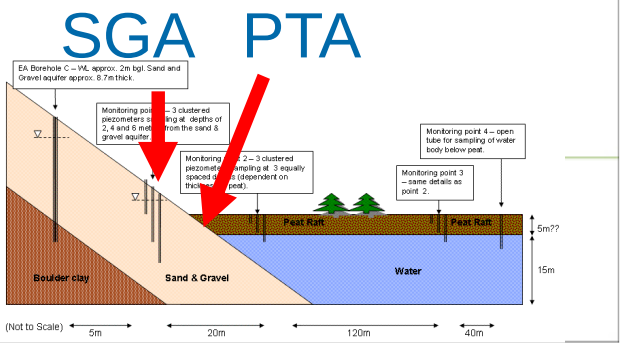
Chemical sampling



Nitrate Concentrations at Wybunbury Moss in Shallow Piezometers



PTA1	Shallow
PTA2	Intermediate
PTA3	Deep
SGA2	Intermediate
SGA3	Deep
SGB2	Intermediate
SGB3	Deep
SGC2	Intermediate
SGC3	Deep



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Revised conceptual model

Figure 5.1 Wybunbury Moss Revised Conceptual Diagram

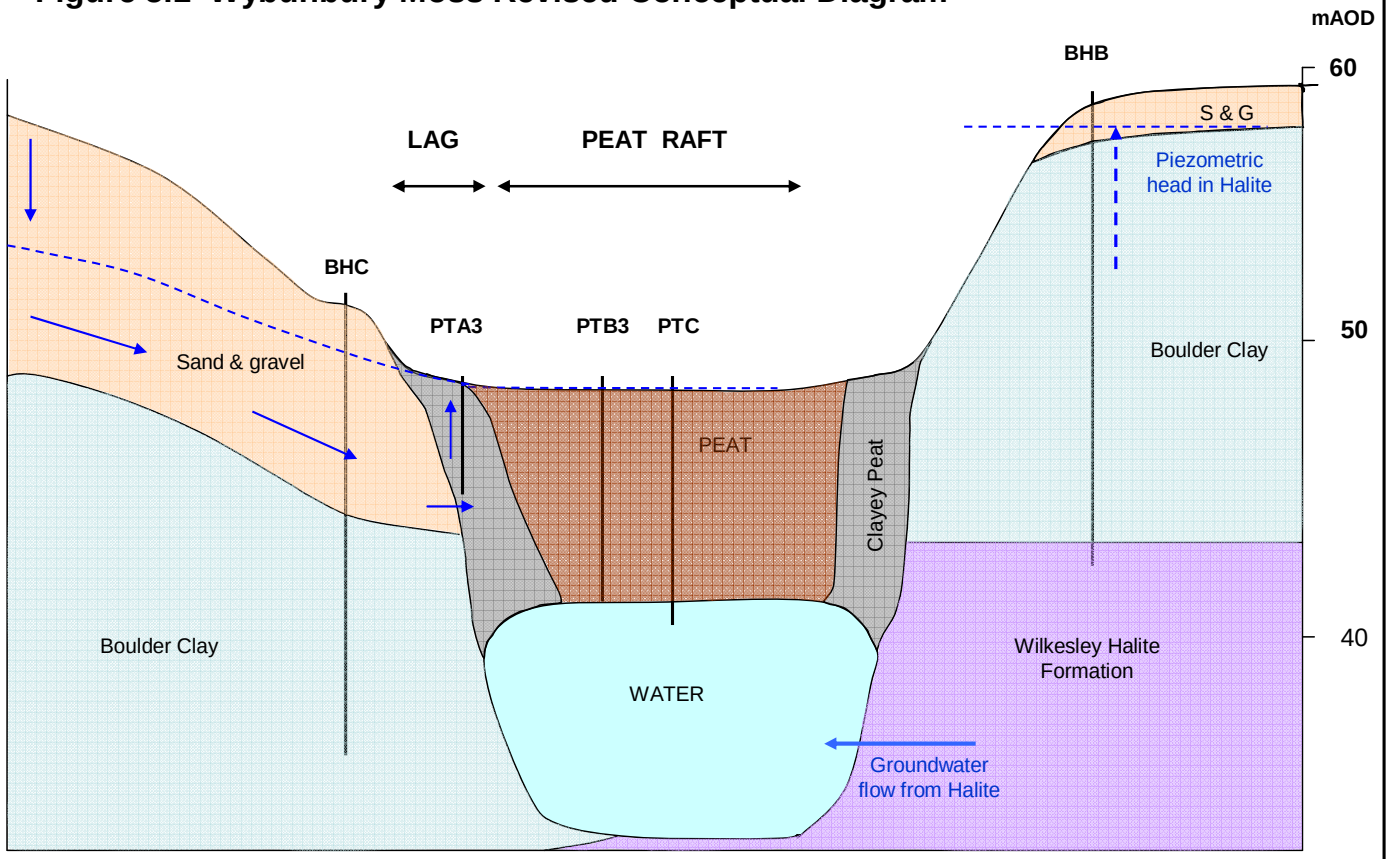

Figure drawn by Sarah Scott

Wybunbury Moss: conclusion

- 1st cycle risk screening – site at high risk
- Investigation confirmed source, receptor
- Pathway to lagg area but limited influence to centre of site
- Conclusion – site at medium to high risk

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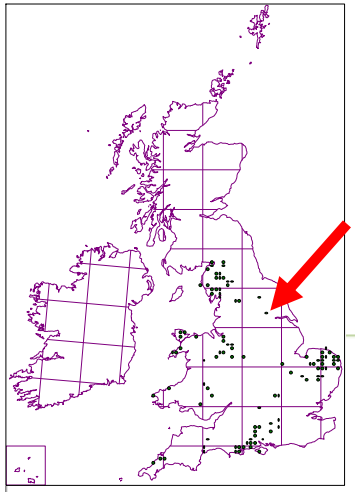
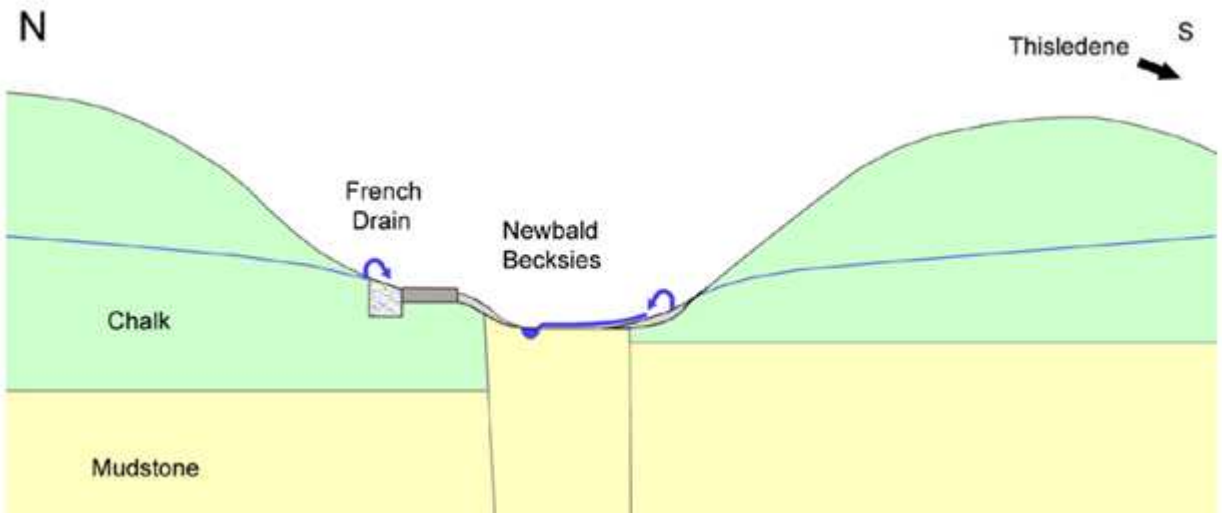
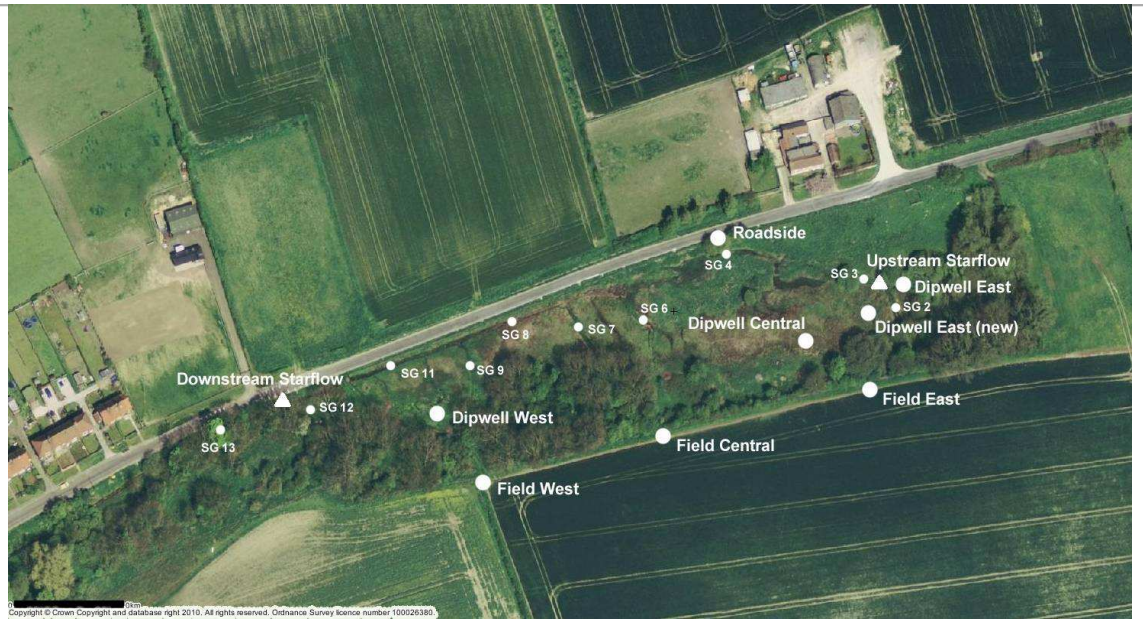
Case Example: Newbald Becksies

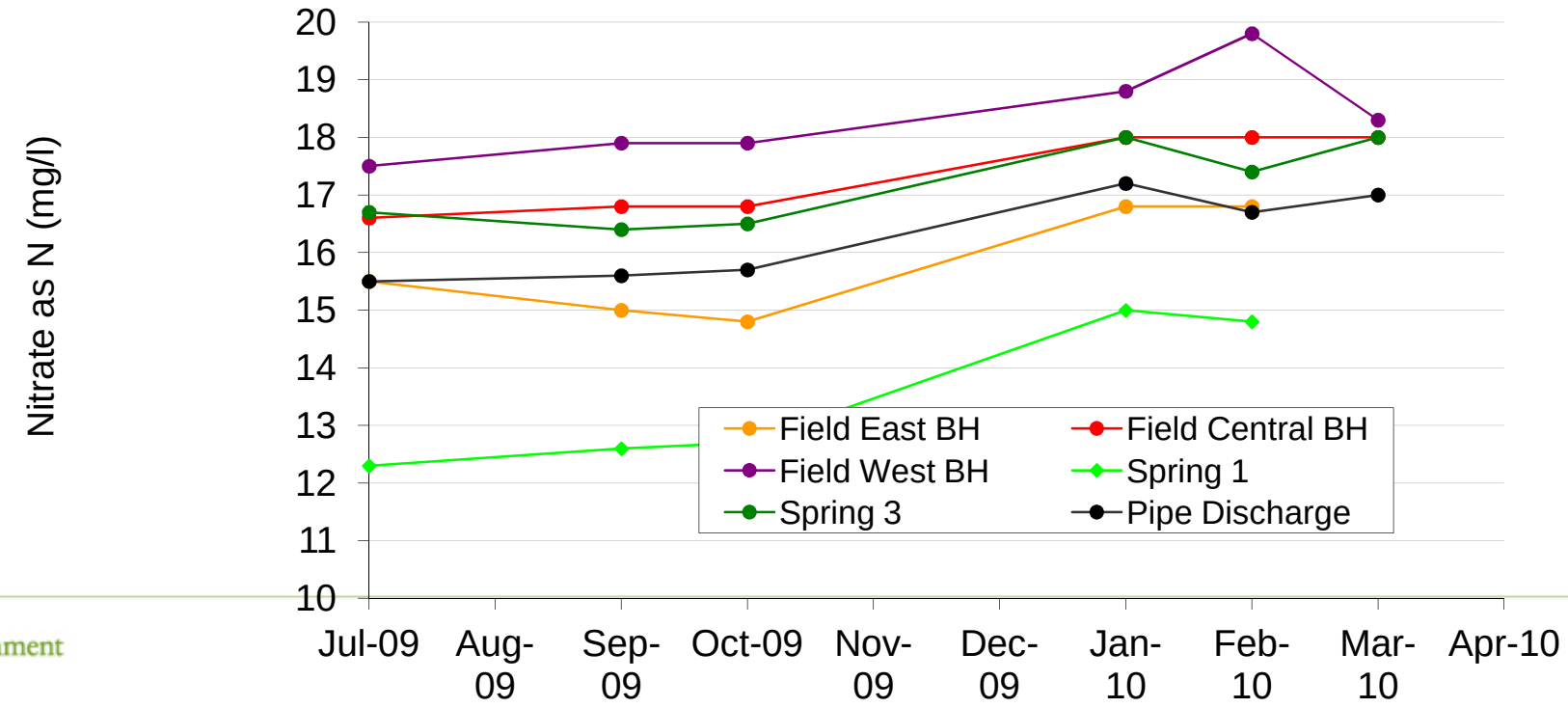
- Wetland feature = M22 ‘Mesotrophic fen/fen meadow’, M10, ‘Wetlands irrigated directly by spring or seepage’
- nitrate threshold = 2mg/l Nitrate as N
- 1st cycle National risk screening result = medium risk





Newbald Becksies nitrate monitoring





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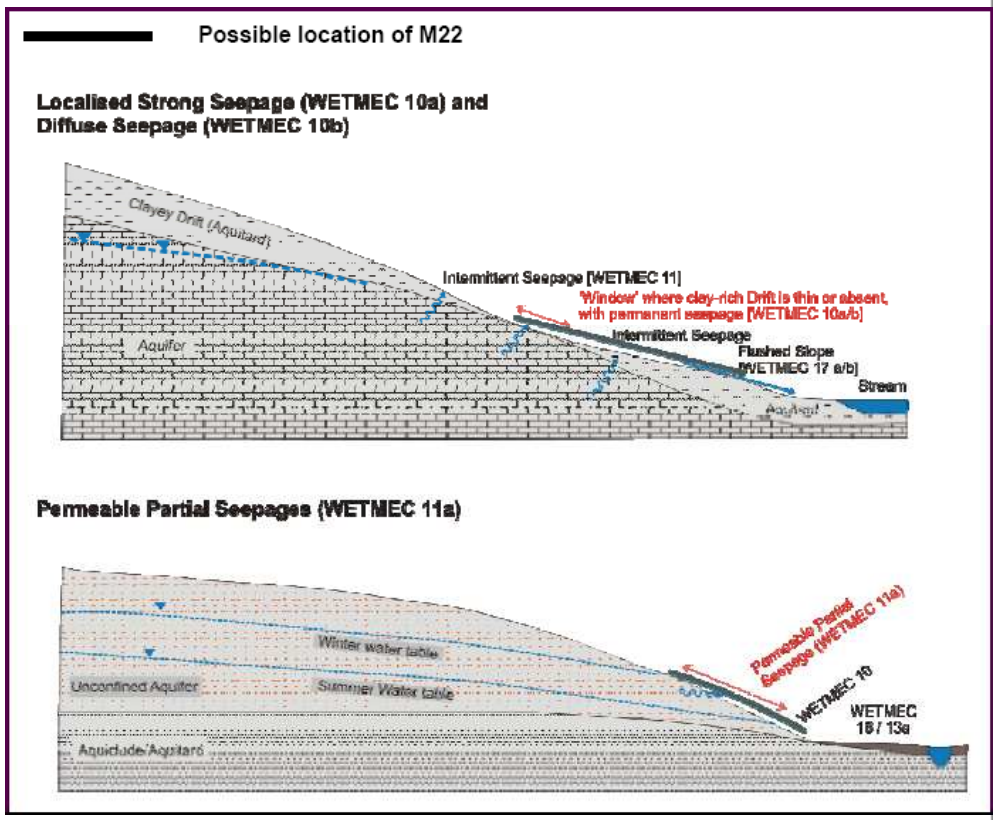
Newbald Becksies: conclusion

- Investigation showed nitrates above threshold
- Evidence for ecological damage
- Source-pathway-receptor links confirmed
- Site at high risk from chemical pressure



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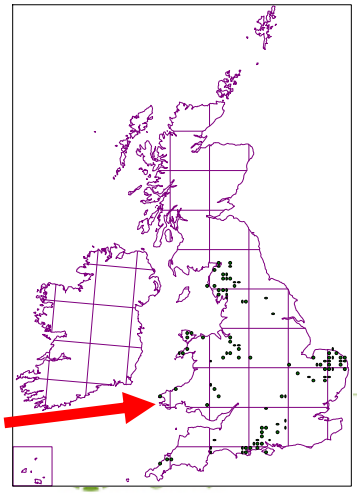
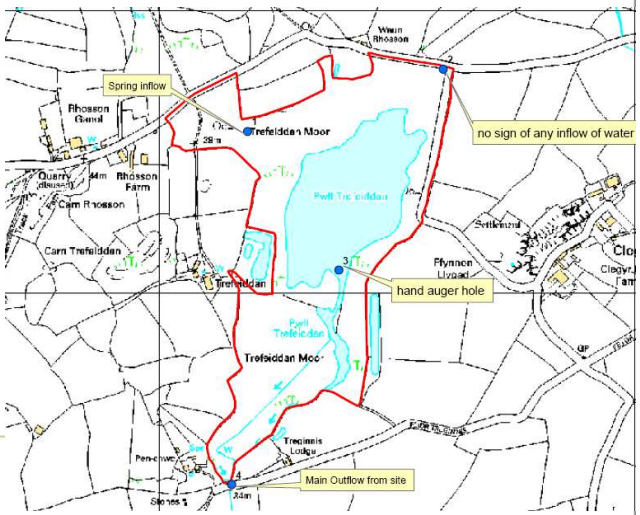
Case example: Pwll Treffeidan (report by Gareth Farr)

- Wetland feature = S27 (quaking bog, swamp (oligo- to mesotrophic))
- Nitrate threshold = 4 mg/l Nitrate as N
- National risk screening result = medium risk

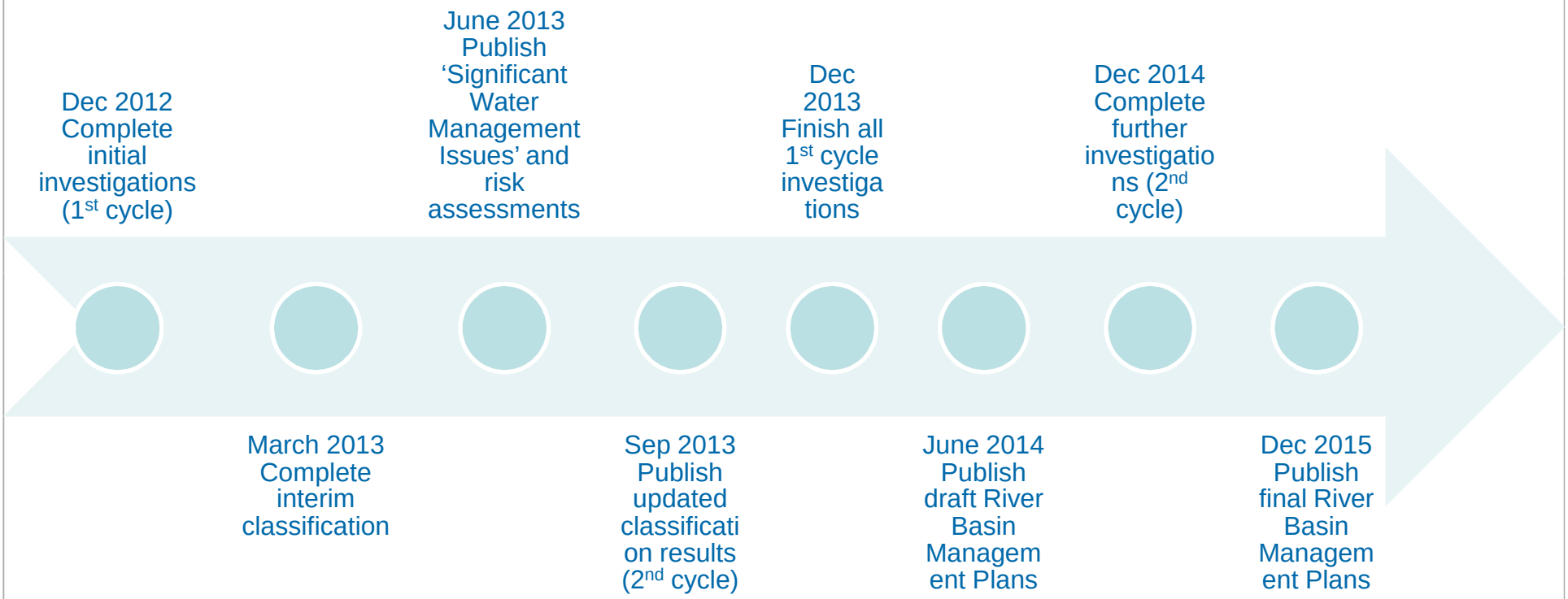




Pwll Treffeidan: conclusion

- Eco-hydrological walkover survey + chemical sampling
- Investigation shows nitrate values well below threshold (4 mg/l Nitrate as N), groundwater quality is good
- Site is at low/zero risk

WFD timetable



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Conclusions

- New nitrate thresholds risk screening methodology does not dramatically increase number of sites at high risk
- Targeted monitoring helps correctly identify sites at risk
- Site specific investigations provide local conceptual understanding

Thank you for listening !

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