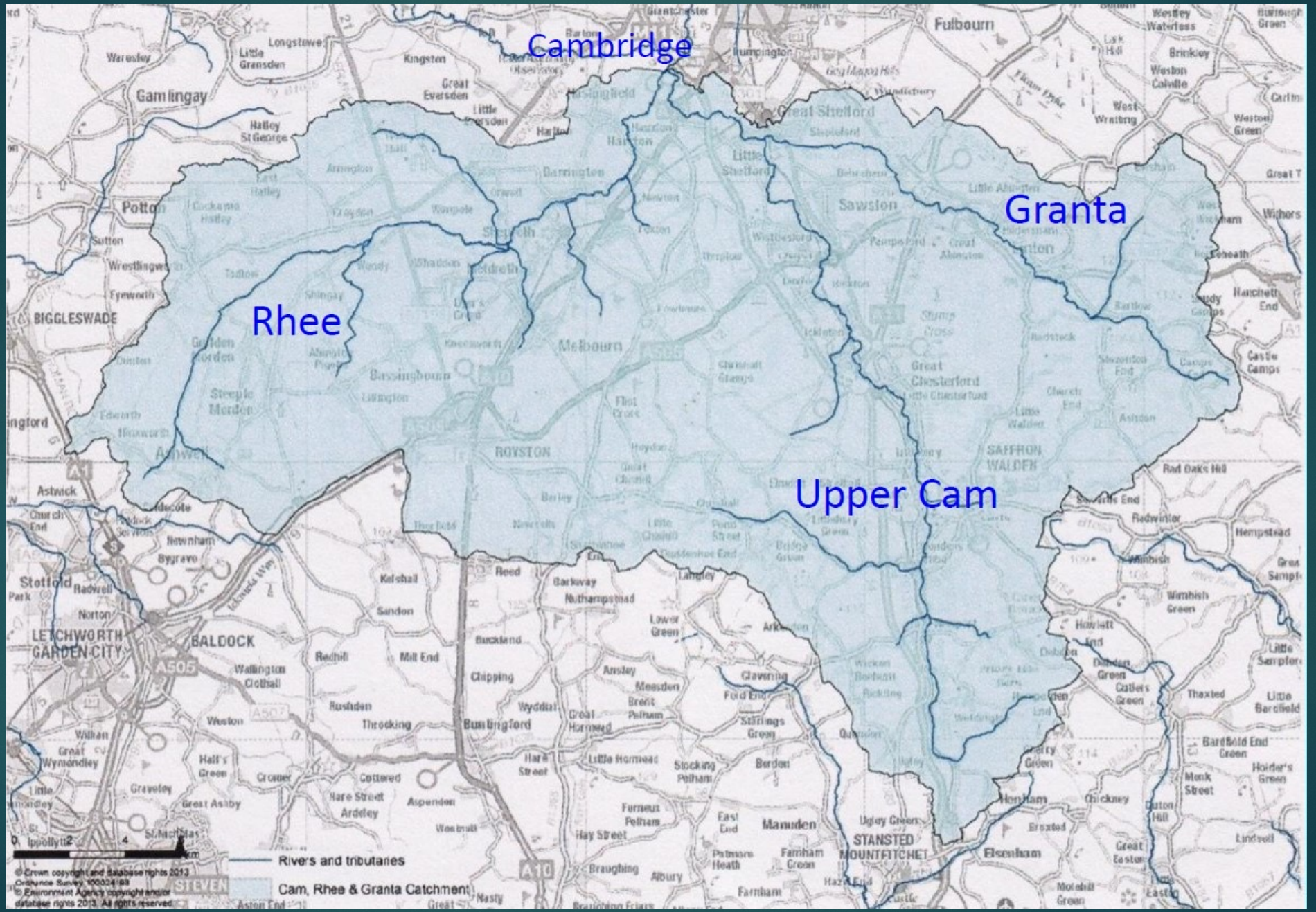
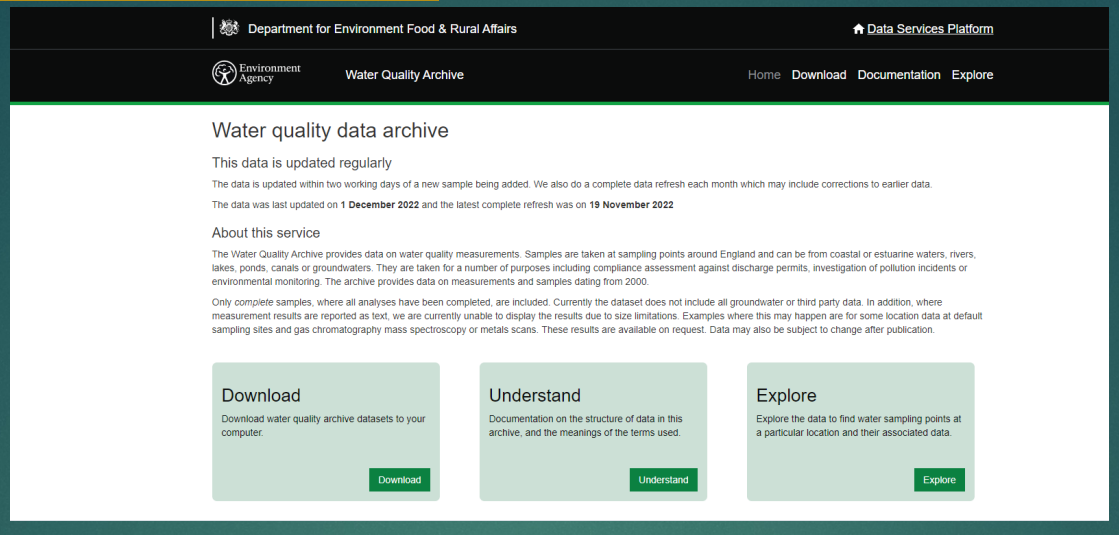
Cam Valley forum

Chalk Stream water quality: barriers to achieving higher classification

Mike Foley


Cambridge
Granta
Rhee
Upper Cam
Rivers and tributaries
Cam, Rhee & Granta Catchment

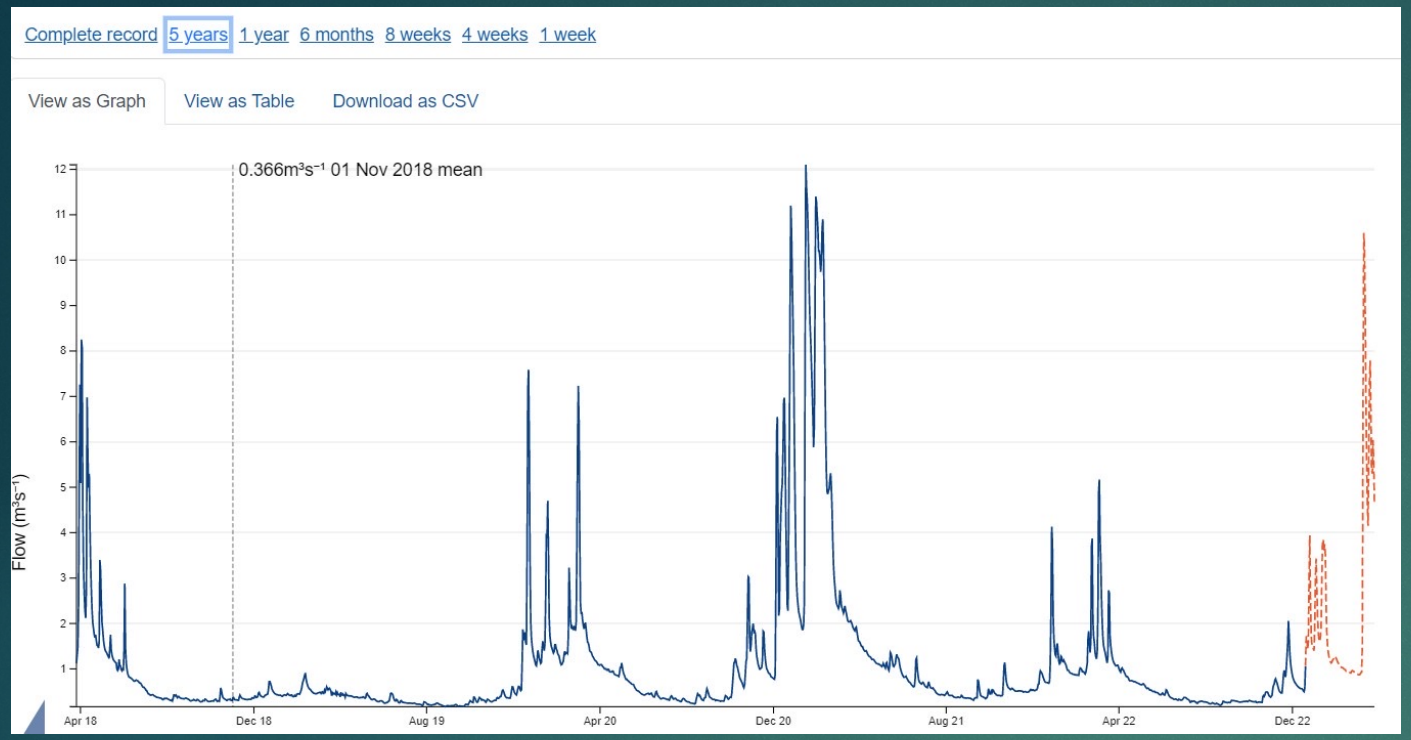
Historical lack of accessible data



Samples from 5 May 2022 to 1 Feb 2023

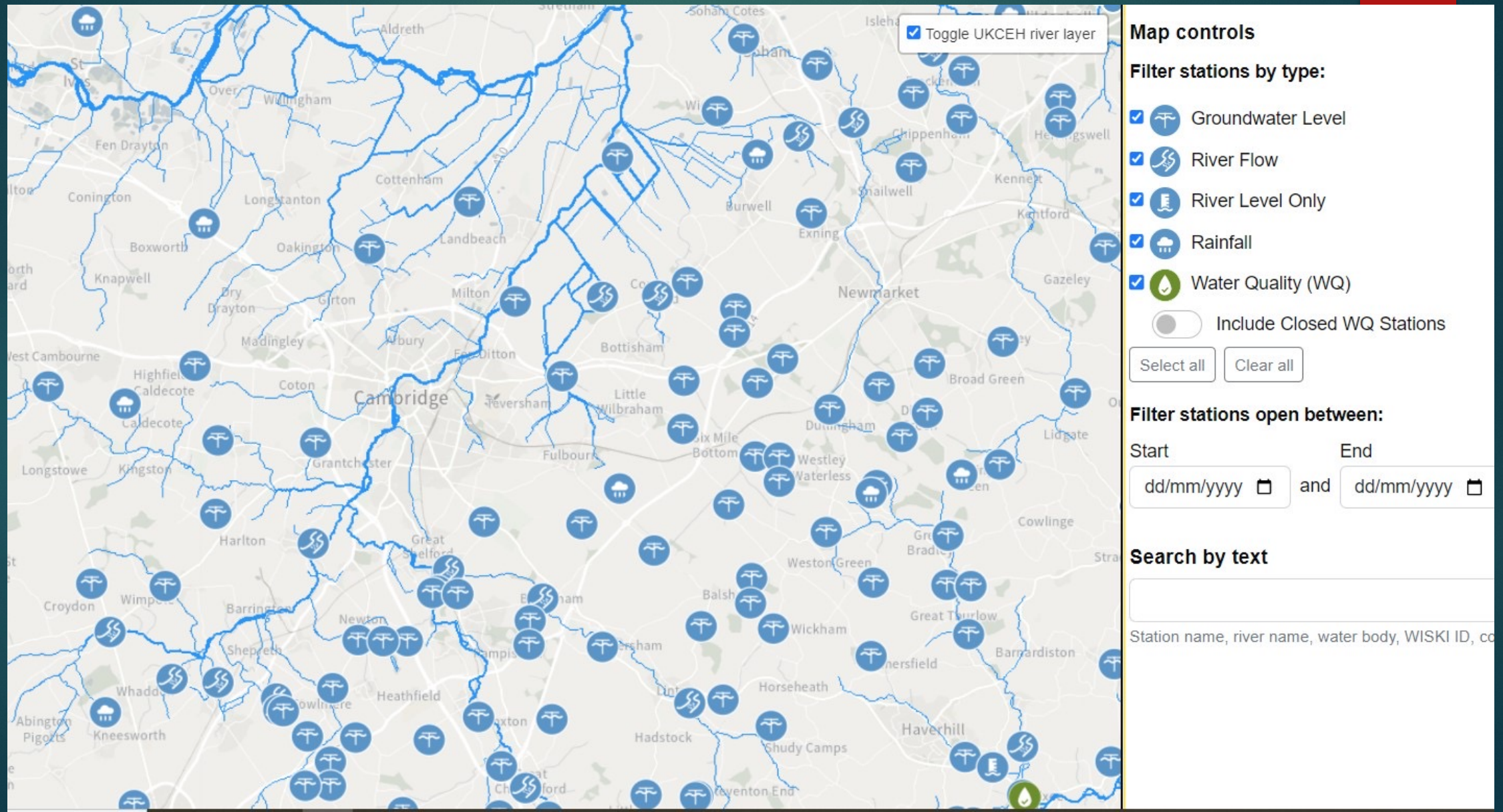
Notation	Determinand	Units	5 May 2022 10:03	6 Jun 2022 15:06	1 Jul 2022 09:20	4 Aug 2022 09:55	1 Sep 2022 08:52	14 Oct 2022 12:52	8 Nov 2022 09:58	6 Dec 2022 13:32	18 Jan 2023 11:32	1 Feb 2023 12:33
0061	pH		8.27	7.91	8.2	8.12	7.84	7.84	7.97	8	8.71	8.13
0076	Temperature of Water	°C	13.1	13.9	16	20.6	17.4	11.5	11.6	6.4	3.3	5.8
0077	Conductivity at 25 C	µs/cm	821	818	865	847	839	860	784	900	892	913
0111	Ammoniacal Nitrogen as N	mg/l	0.074	0.3	< 0.03	< 0.03	< 0.03	0.05	0.035	0.077	0.059	0.088
0116	Nitrogen, Total Oxidised as N	mg/l	10	9.6	10	9.4		12	12	11	15	13
0117	Nitrate as N	mg/l	9.93	9.51	9.95	9.34		11.9	12	10.9	15	12.9
0118	Nitrite as N	mg/l	0.067	0.088	0.049	0.056	0.063	0.068	0.033	0.058	0.042	0.056
0119	Ammonia un-ionised as N	mg/l	0.00169	0.00594	< 0.00085	< 0.00118	< 0.00066	0.00071	0.00067	0.00108	0.00066	0.00118
0162	Alkalinity to pH 4.5 as CaCO3	mg/l	240	240	240	230	220	240	210	250	250	250
0180	Orthophosphate, reactive as P	mg/l	0.23	0.37	0.43	0.52	0.53	0.46	0.39	0.22	0.14	0.19
9901	Oxygen, Dissolved, % Saturation	%	88.7	70.9	92.8	102	78.6	77.8	87.5	85.4	94.8	94.5
9924	Oxygen, Dissolved as O2	mg/l	9.3	7.3	9.14	9.14	7.51	8.46	9.5	10.5	12.6	11.8

Lack of easy access to valuable data



Date	Value	Unit	Quality	Completeness	Measure
26 Mar 2023	4.68	m^3s^{-1}	Unchecked	Complete	Daily mean Flow (m3/s) time series for Burnt Mill
25 Mar 2023	5.51	m^3s^{-1}	Unchecked	Complete	Daily mean Flow (m3/s) time series for Burnt Mill
24 Mar 2023	6.04	m^3s^{-1}	Unchecked	Complete	Daily mean Flow (m3/s) time series for Burnt Mill
23 Mar 2023	5.30	m^3s^{-1}	Unchecked	Complete	Daily mean Flow (m3/s) time series for Burnt Mill
22 Mar 2023	5.40	m^3s^{-1}	Unchecked	Complete	Daily mean Flow (m3/s) time series for Burnt Mill
21 Mar 2023	6.65	m^3s^{-1}	Unchecked	Complete	Daily mean Flow (m3/s) time series for Burnt Mill
20 Mar 2023	7.79	m^3s^{-1}	Unchecked	Complete	Daily mean Flow (m3/s) time series for Burnt Mill
19 Mar 2023	7.31	m^3s^{-1}	Unchecked	Complete	Daily mean Flow (m3/s) time series for Burnt Mill

Upgraded EA hydrology platform March 2023



INNS – non-native species

Invasive Floating Pennywort – superbly adapted for English conditions

Grantchester Mill Leat, October 2017

River Cam, summer 2017

Industrial Chemical pollution

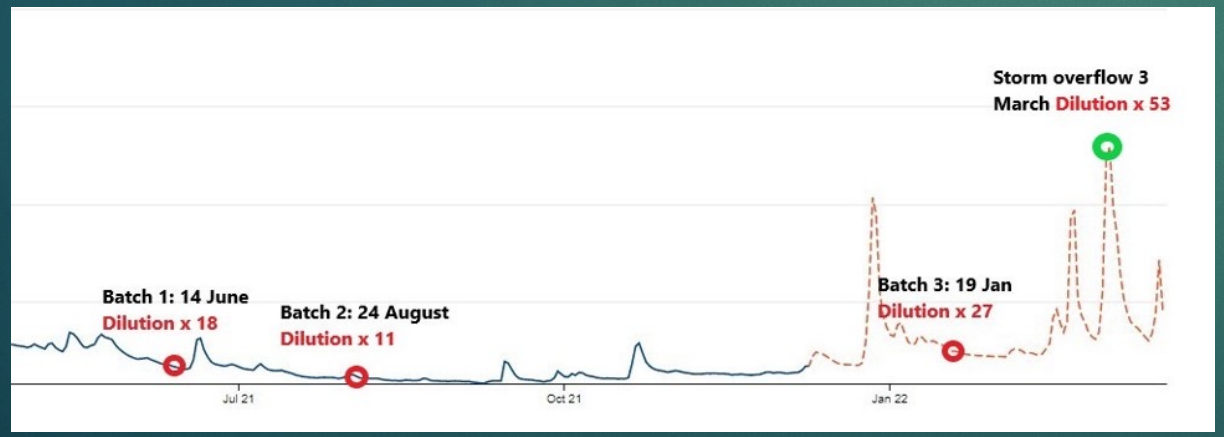
Vicar's Brook Chalk stream, Cambridge

Sewage pipe breakages and spills

Sewer pipe spill into Bourn Brook for 2+ days, 2022

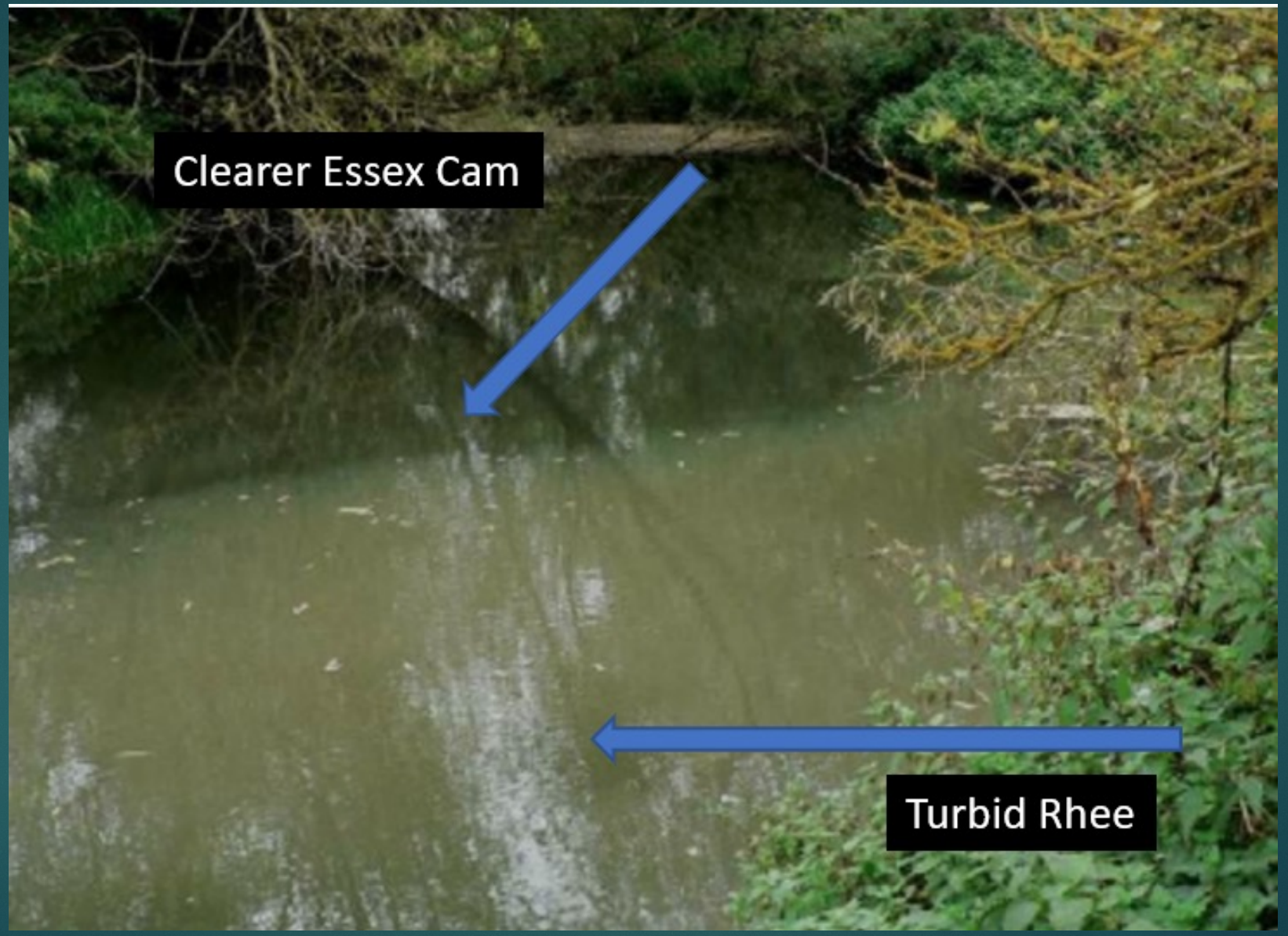
Storm overspills at sewage treatment works

Storm tank overspill 3 March 2022



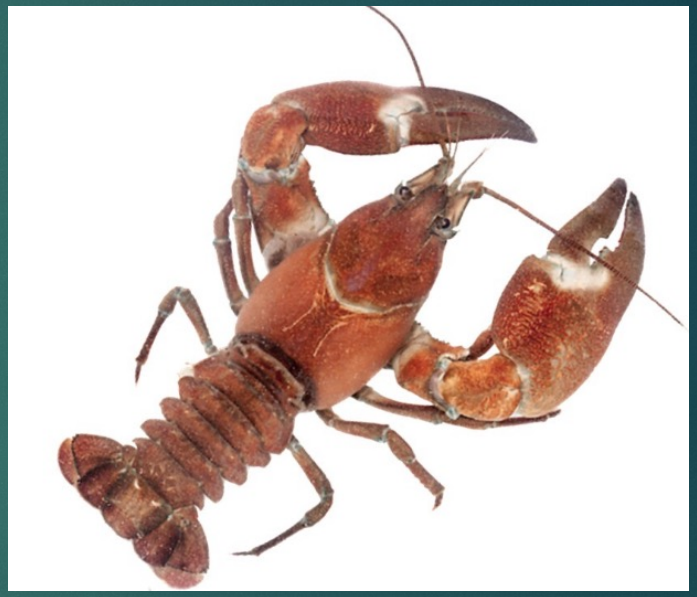
Confirmation: Anglian Water, HASLINGFIELD-STW ASCNF1094/V001 02/03/2022 20:45:00 04/03/2022 01:15:00 102600

High turbidity reduces all wildlife activity

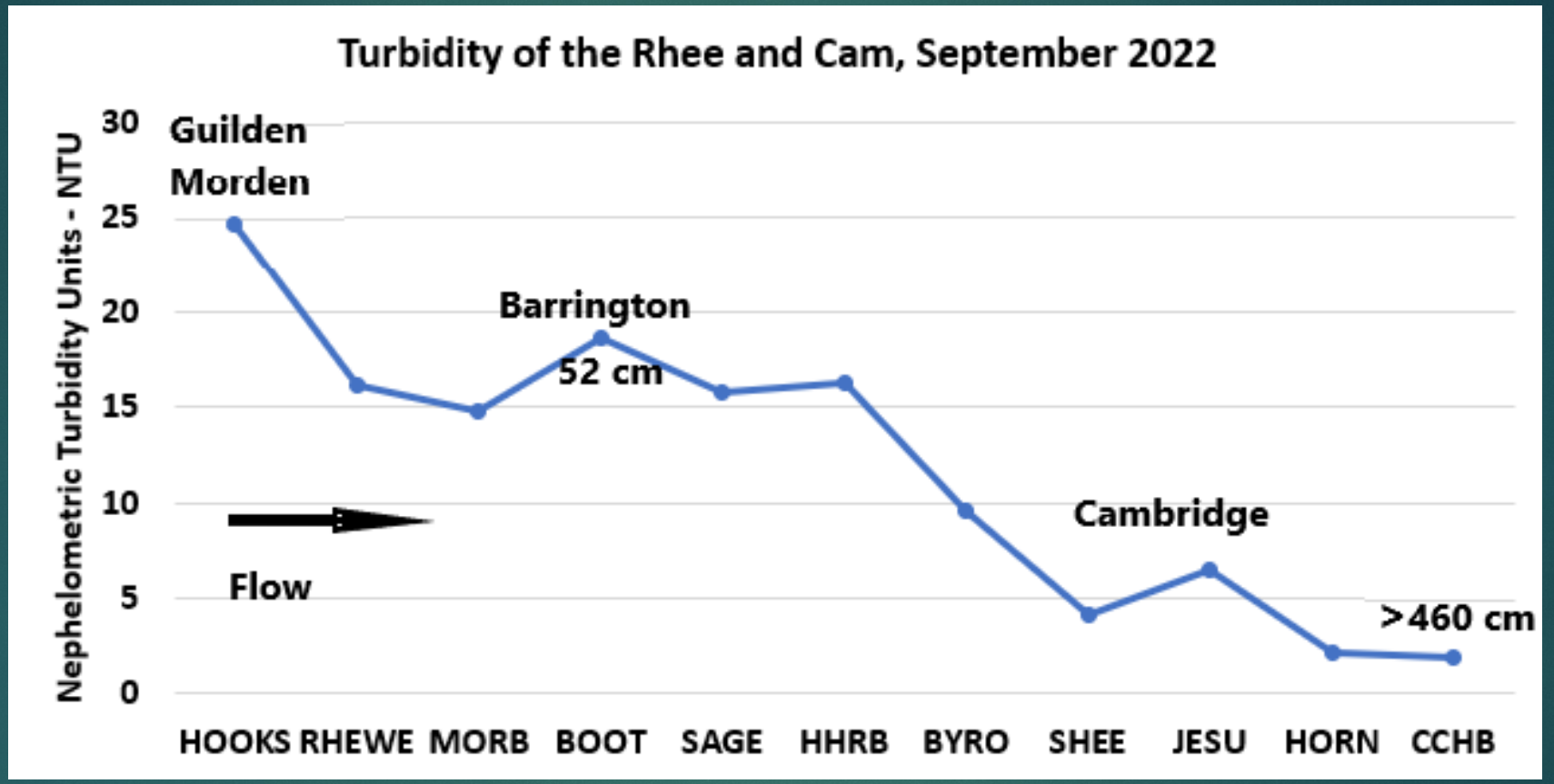


Rhee - turbidity high at Boot Lane, Barrington 06/10/22

Exacerbated by Signal Crayfish?



Credit: Wild Trout Trust


Turbidity of the Rhee and Cam, September 2022
Nephelometric Turbidity Units - NTU
30
25
20
15
10
5
0
Guilden
Morden
Barrington
52 cm
Cambridge
>460 cm
Flow
HOOKS
RHEWE
MORB
BOOT
SAGE
HHRB
BYRO
SHEE
JESU
HORN
CCHB

Knowledge of equipment barrier

For citizen scientist, lab analyses can be expensive (minimum costs, couriers)

CaBA list equipment with prices and comments

Advances mean frequent updates are necessary. More robust comments are needed

Myron Ultrapen PT5 dissolved oxygen tester

Fast and simple to use.

Indicative Cost: ££ Med (ca. £250).

More info: http://www.camlab.co.uk/myron-l-ultrapen-pt5-dissolved-oxygen-tester-p33525.aspx

Used by: Westcountry Rivers Trust. Simon Browning (simon@wrt.org.uk) says: *"despite difficulties changing the membrane without trapping air in behind (there seems to be no way to avoid this!) – it does seem to be giving decent results."*

EZ DO Dissolved Oxygen meter 7031

Fast and simple to use.

Indicative Cost: ££ Med (ca. £150).

More info: http://www.electronichealing.co.uk/dissolved_oxygen_meter.htm

Used by: Waterside Care (Contact lee.copplestone@keepbritaintidy.org)

Hanna HI-713 Phosphate Pocket Checker

Measures temperature, electrical conductivity, pH and total dissolved solids.

Indicative Cost: £ Low (ca. £50 + VAT, reagent packs ca. £10 + VAT for 25).

More info: http://www.hannainstruments.co.uk/pocket-checker-for-phosphate-testing.html http://www.advancedaquarist.com/2011/8/review

Used by: Waterside Care (Contact lee.copplestone@keepbritaintidy.org) and Westcountry Rivers Trust. Simon Browning (simon@wrt.org.uk) says: *"I have taken it out alongside the Hach DR900 – results were generally comparable. It is a little more fiddly as the reagent*

Credit: Catchment Based Approach / Rivers Trust

Eutrophication

Phosphate overload creating a eutrophic watercourse

Swaffham Bulbeck Lode - 31st May 2021

Credit: Liz Thompson

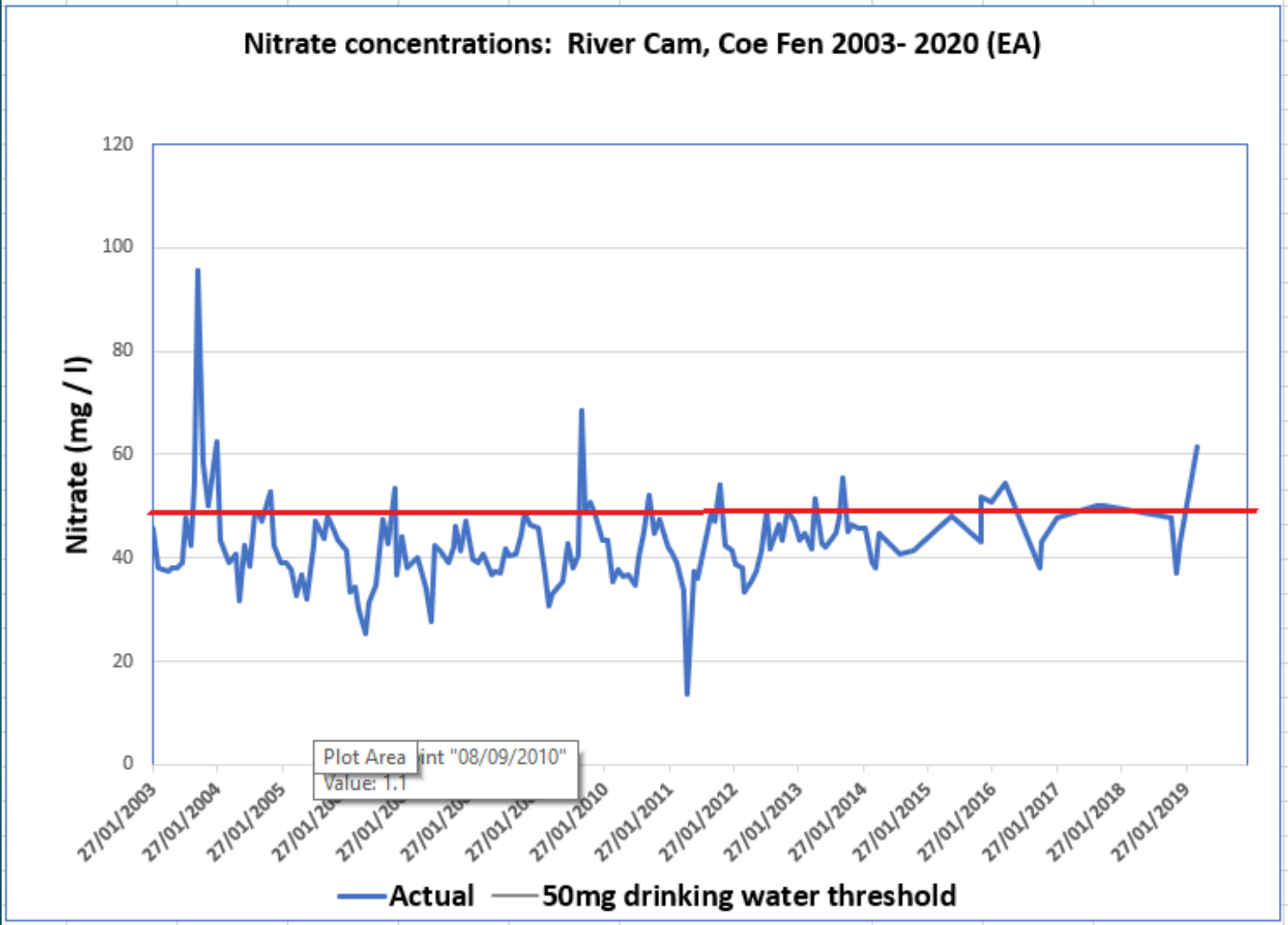
Benthic algal mats: River Cam, Byron's Pool, 27 July 2021

…. of the 62 native aquatic plant species which have been recorded in the study area since 1660, 40 (65%) were still present in the period 1985–1999 whereas 22 (35%) are apparently extinct…

…there is a striking relationship between the fate of species and their trophic requirements, with species of less eutrophic habitats having suffered disproportionately….

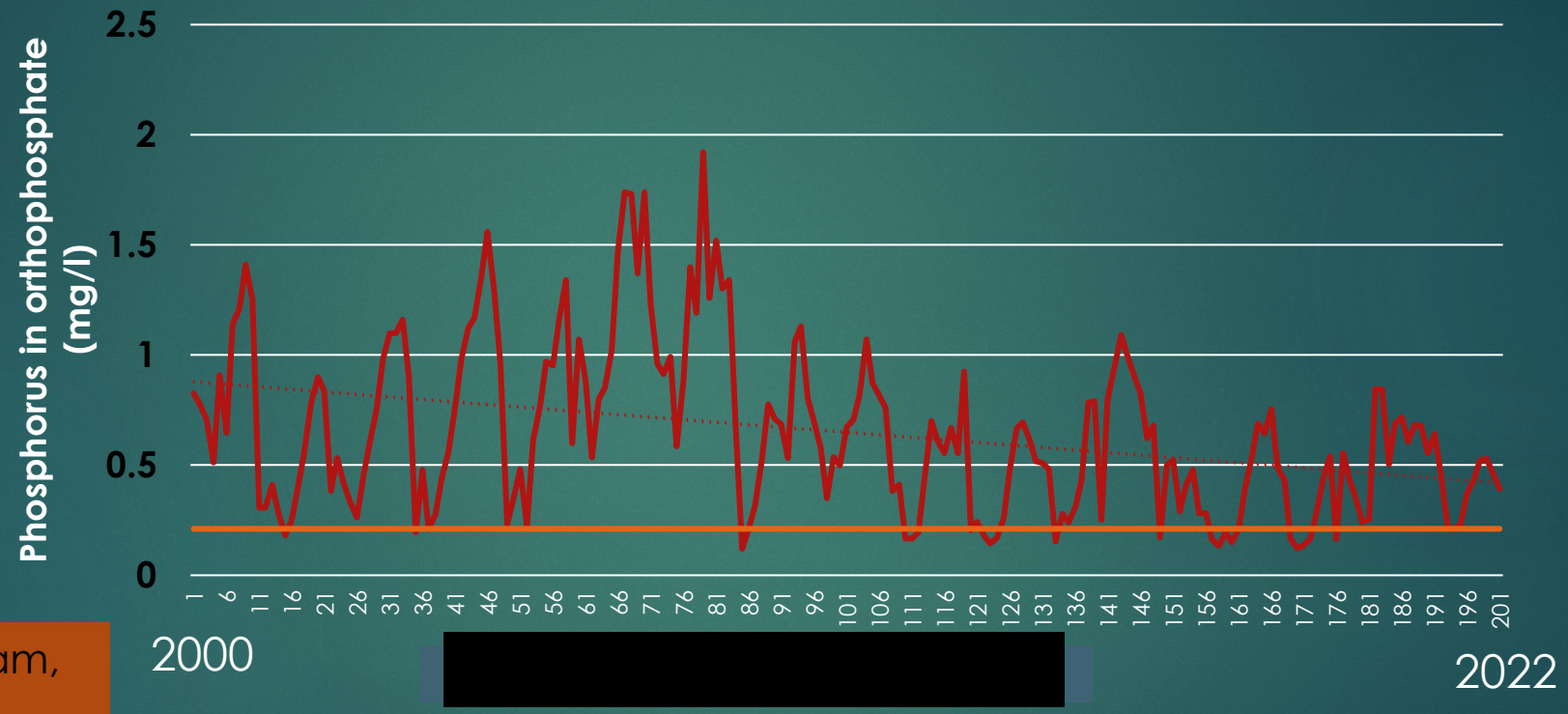
Source: Cambridge and the River Cam C. D. Preston, J. Sheail P. Armitage, J. Davy-Bowker (2001)

Sources of nitrate



Environment Agency Monitoring

Abundance of phosphate (reported as Phosphorus mg/l) in the Cam at Coe Fen, Cambridge 2000-2022



High status Chalk stream, phosphorus concentration:
less than 0.05 mg/l

Phosphorus standards in rivers: classification of river from poor to high

The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015

Phosphorus Standards in Rivers[i]	
Annual mean reactive phosphorus concentration (in µg per litre) is calculated as follows:	
High	10 to the power of ((1.0497 x $\log_{10}(0.702)$+1.066) x ($\log_{10}(RP_{ref})$ – $\log_{10}(3{,}500)$) + $\log_{10}(3{,}500)$)
Good	10 to the power of ((1.0497 x $\log_{10}(0.532)$+1.066) x ($\log_{10}(RP_{ref})$ – $\log_{10}(3{,}500)$) + $\log_{10}(3{,}500)$)
Moderate	10 to the power of ((1.0497 x $\log_{10}(0.356)$+1.066) x ($\log_{10}(RP_{ref})$ – $\log_{10}(3{,}500)$) + $\log_{10}(3{,}500)$)
Poor	10 to the power of ((1.0497 x $\log_{10}(0.166)$+1.066) x ($\log_{10}(RP_{ref})$ – $\log_{10}(3{,}500)$) + $\log_{10}(3{,}500)$)

[i]In this table, "Reactive phosphorus concentration" means the concentration of phosphorus as determined using the phosphomolybdenum blue colorimetric method. Where necessary to ensure the accuracy of the method, samples are recommended to be filtered using a filter not smaller than 0.45 µm pore size to remove gross particulate matter.

"RPref" represents the annual mean concentration of reactive phosphorus in µg/l estimated for the site under reference conditions using the equation: 10 to the power of (0.454 ($\log_{10}$Alkalinity) – 0.0018 (Altitude) + 0.476). If the value calculated for RPref using the equation above is less than 7 µg/l, it must be substituted for the purposes of calculating the standards for phosphorus by a value of 7 µg/l. For the purposes of calculating RPref:

Water Framework Directive standards for phosphate-phosphorus in lowland (<80m AOD), high-alkalinity rivers

	Status				
	High	**Good**	**Moderate**	**Poor**	**Bad**
Bands, P (mg/l)	0 - 0.050	0.051- 0.089	0.090 - 0.211	0.212- 1.089	> 1.089
	0 - 0.036	0.037 - 0.069	0.070 – 0.173	0.174 – 1.003	> 1.003

For Cambridge area

Based on median values from Locations nationally

EA uses the equation for their published classifications for high to poor

Knowledge confusion barrier

Total phosphorus

Reactive Phosphorus

SRP = Soluble Reactive Phosphorus

Soluble Unreactive Phosphate

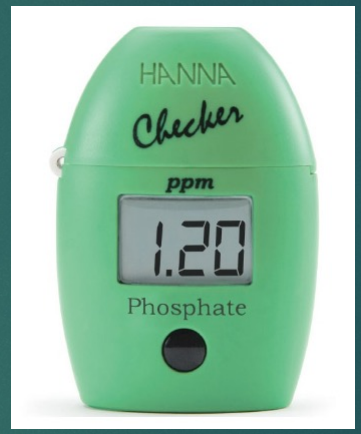
SRP = Soluble Reactive Phosphate

Phosphorus - SRP

PO_4^{3-}

Total Inorganic Phosphorus

PO_4^{3-} - P



Phosphate is sometimes reported but compared with Phosphorus standards

OrthoP, reactive as P" commonly referred to as Orthophosphate PO_4^{3-}.

OP

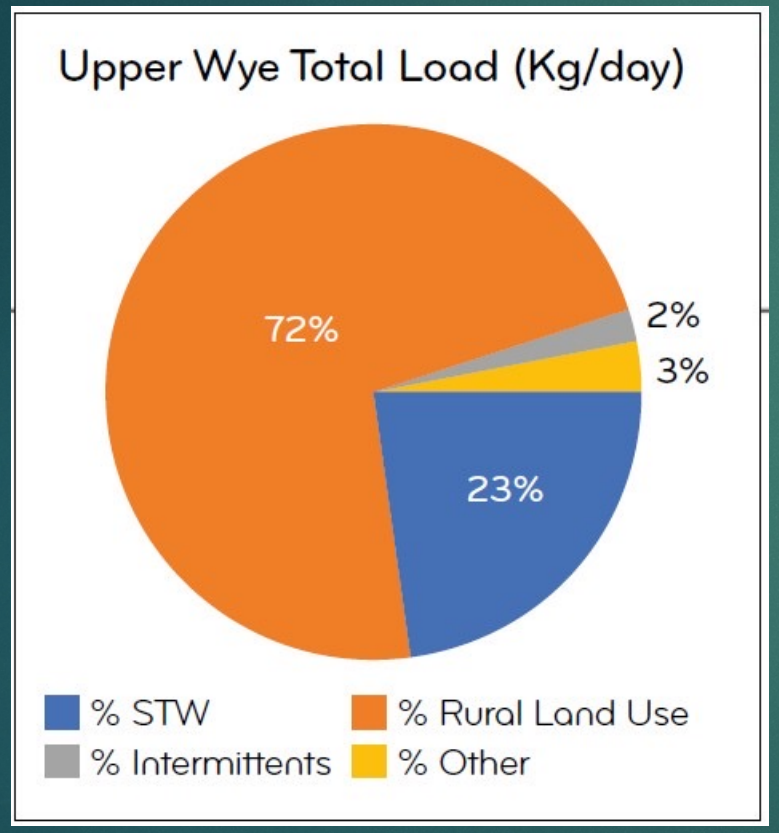
Orthophosphate (PO_4^{3-})

Extracted from a note from EA Water Quality to EA colleagues, 2010

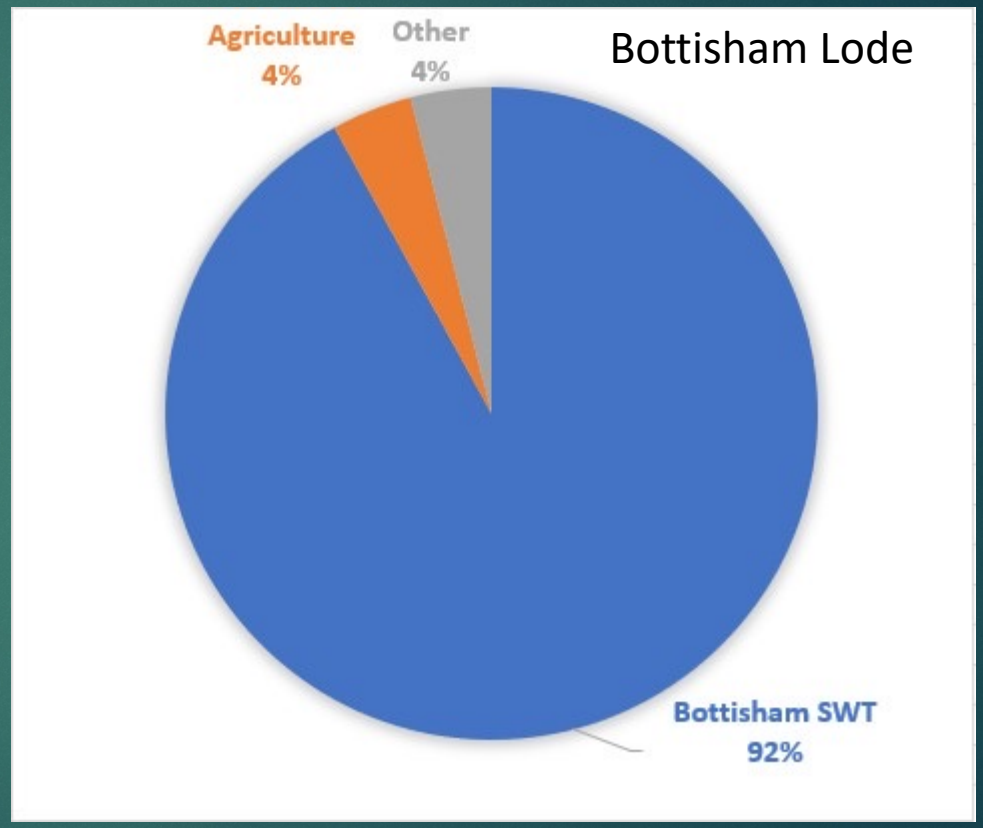
Hanna comment – comms between citizen scientists

Phosphorus load: agricultural versus wastewater sources

Apportionment Graphical Information System (SAGIS)



PHOSPHORUS SOURCE APPORTIONMENT SUMMARY: UPDATING THE SAGIS UPPER WYE MODEL



Source: Environmental Agency, 24/06/21

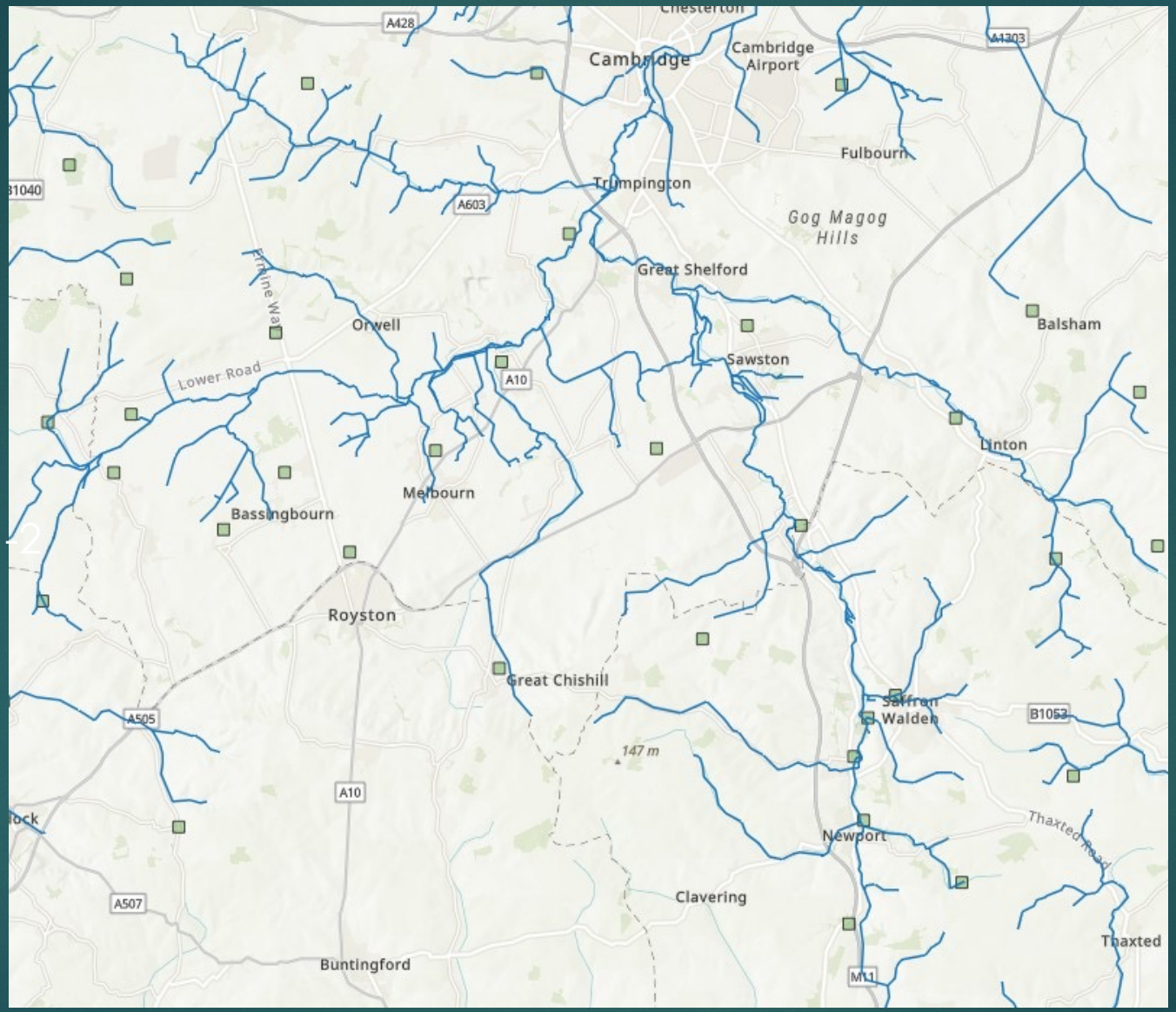
Dŵr Cymru Welsh Water

Cyfoeth Naturiol Cymru Natural Resources Wales

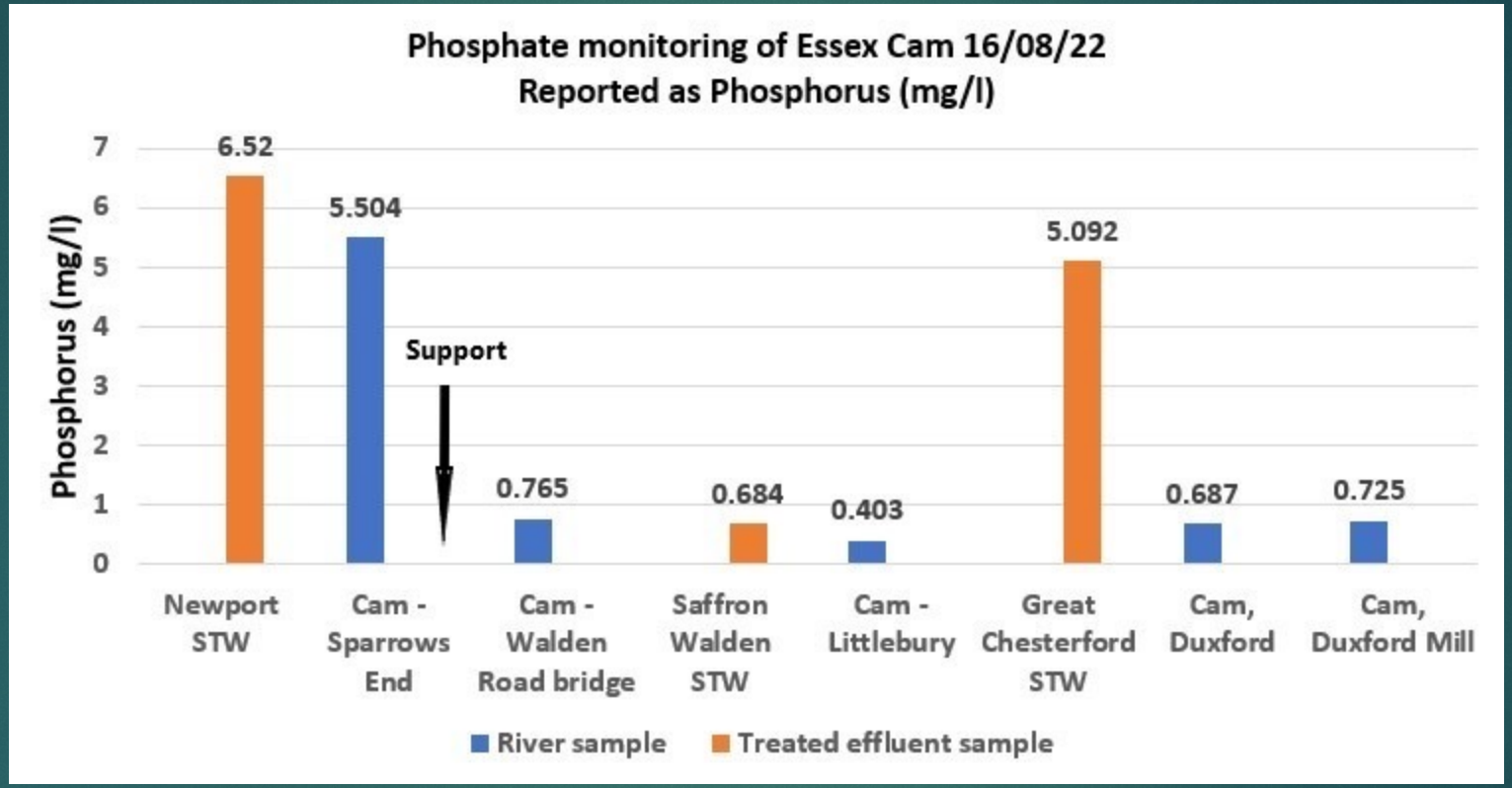
Anglian Water sewage treatment works in the Cam Catchment

Rhee - 11
Essex Cam – 10
Granta - 5
Cam - 2
Lodes – 5
Non Chalk streams - 2

Total 35

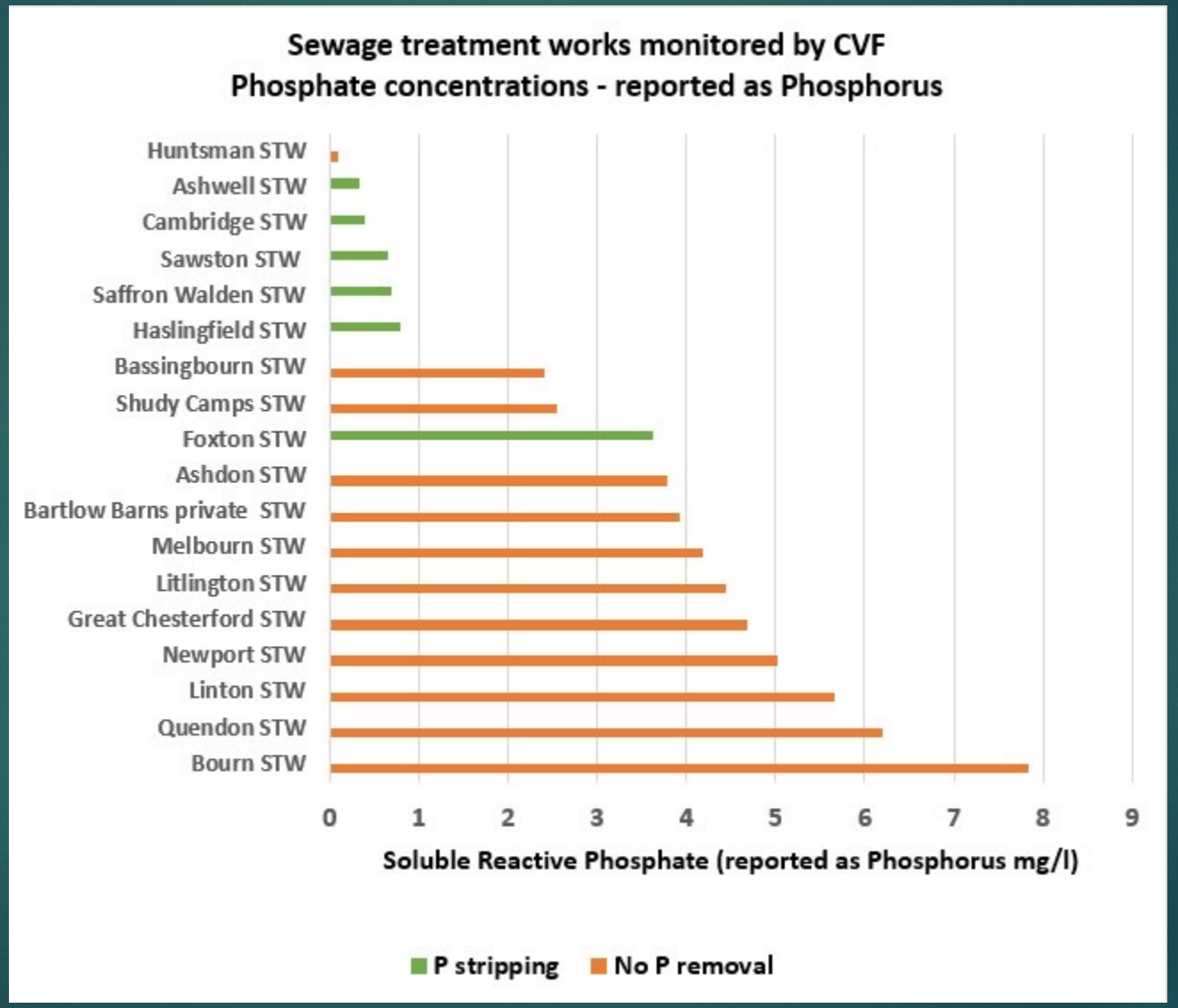


Source: Anglian Water



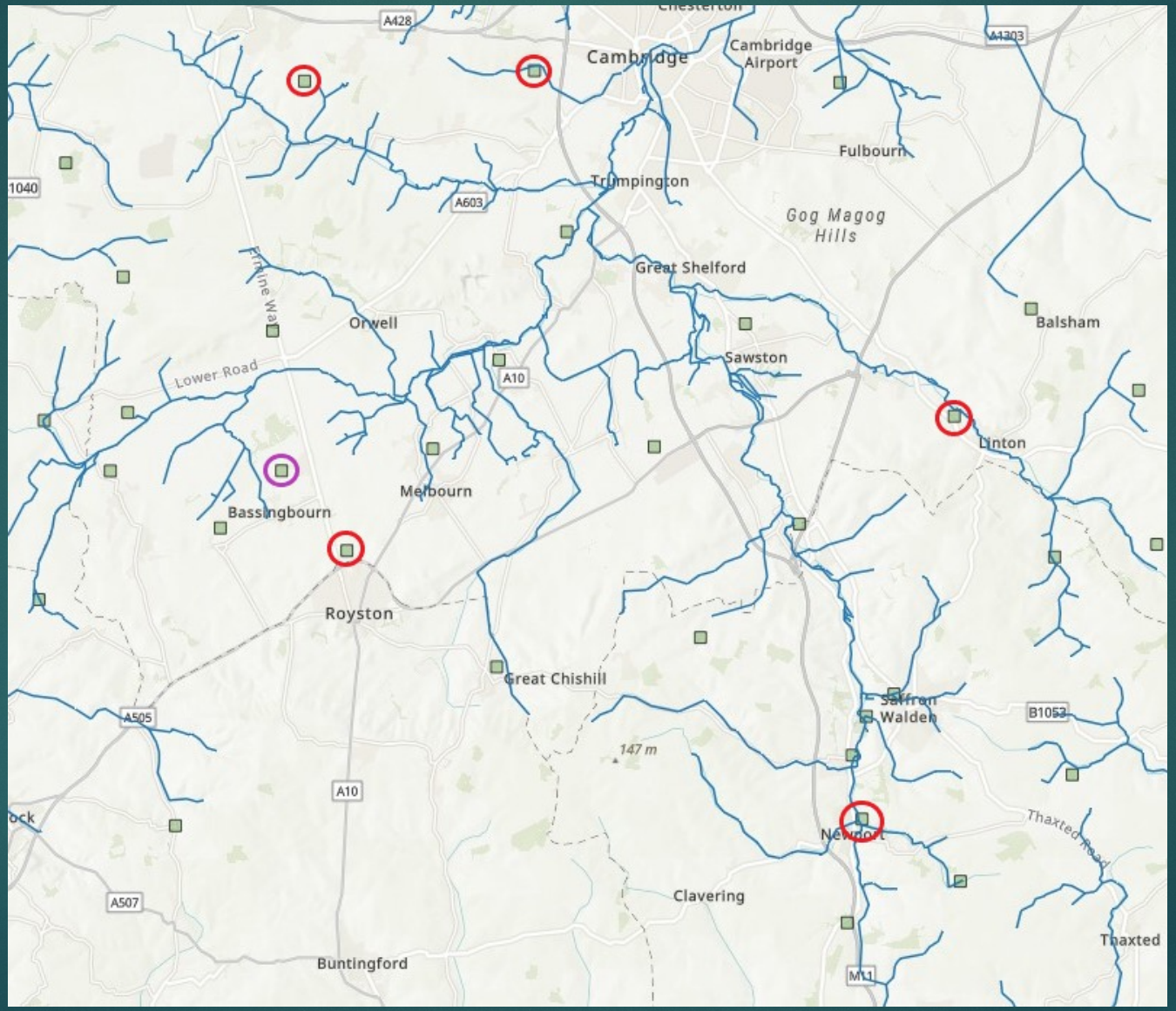
Sampler: CVF
Analysed at the UKAS Laboratory, South East Water

High concentrations of soluble reactive phosphate in effluent are typical at STWs without phosphorus stripping, 2021-22



Sampler: CVF

Analysed at the UKAS Laboratory, South East Water


A428
Cambridge
Cambridge Airport
A1303
Fulbourn
Trumpington
A603
Gog Magog Hills
Great Shelford
Balsham
Orwell
Sawston
Lower Road
A10
Linton
Melbourn
Bassingbourn
Royston
Great Chishill
Saffron Walden
B1053
A505
147 m
A10
Newport
Thaxted Road
A507
Clavering
Thaxted
Buntingford
M11

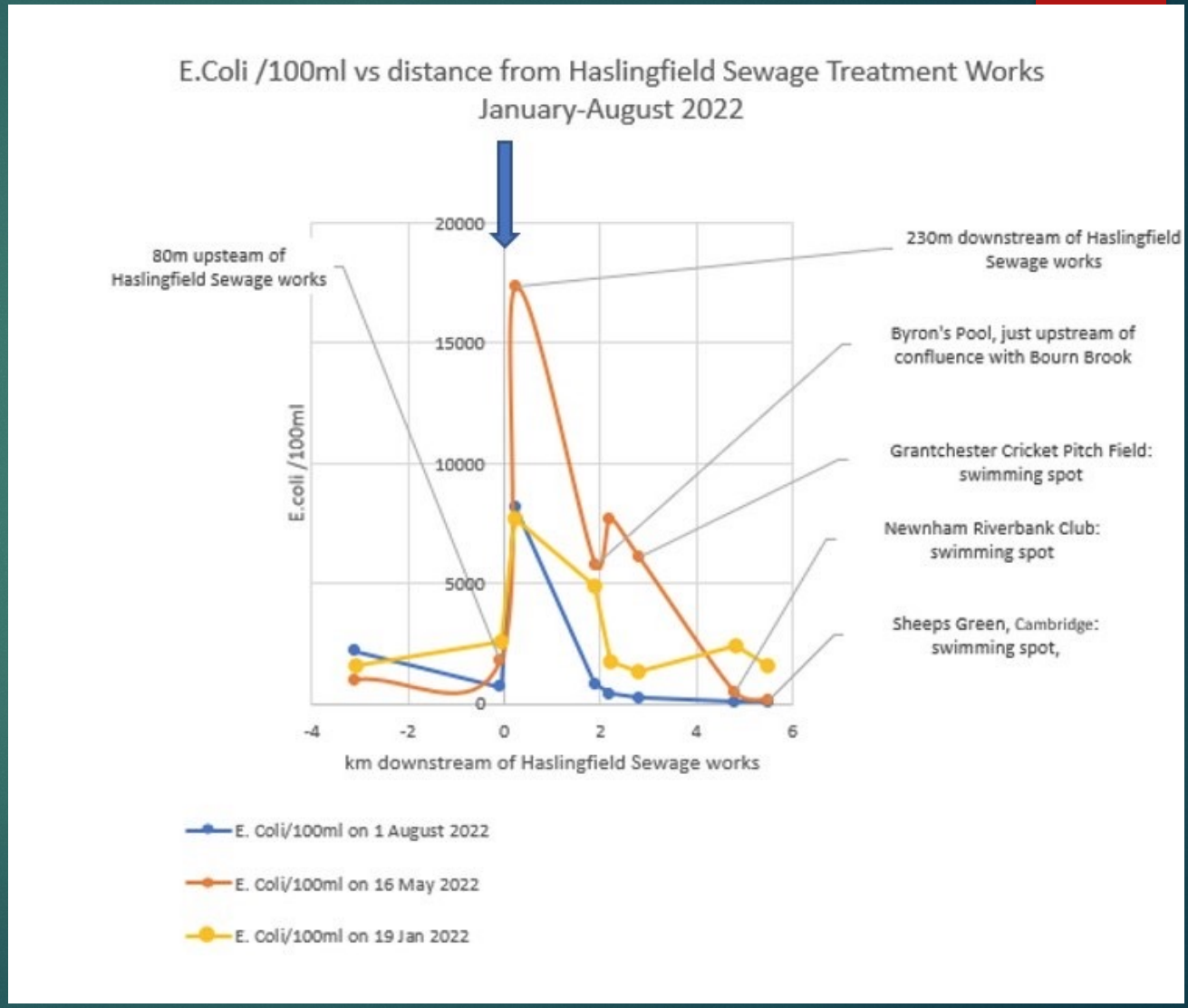
Health barrier due to faecal contamination

Faecal indicator bacteria monitored:

- *E. Coli*
- Intestinal enterococci

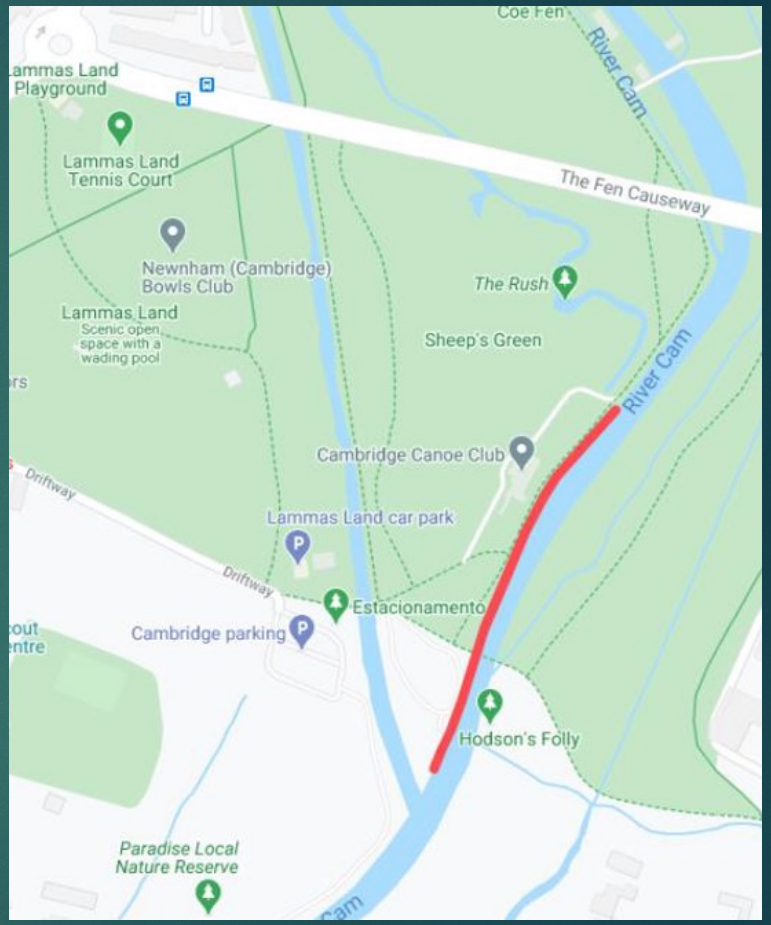
Grantchester Meadows. Credit: The Guardian

Core data from CVF sampling 2021-22



Cam Valley Forum Safer Swim Initiative

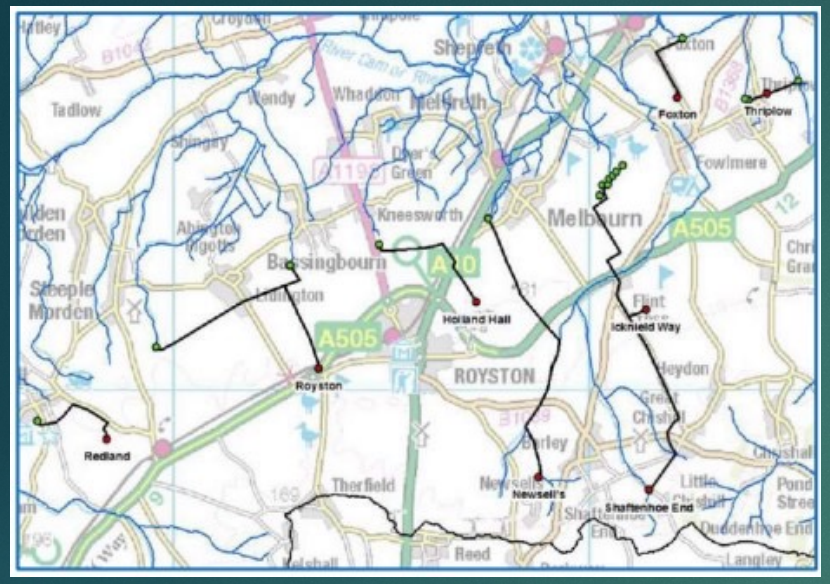
Main Cambridge swimming area - Sheep's Green, 1960's

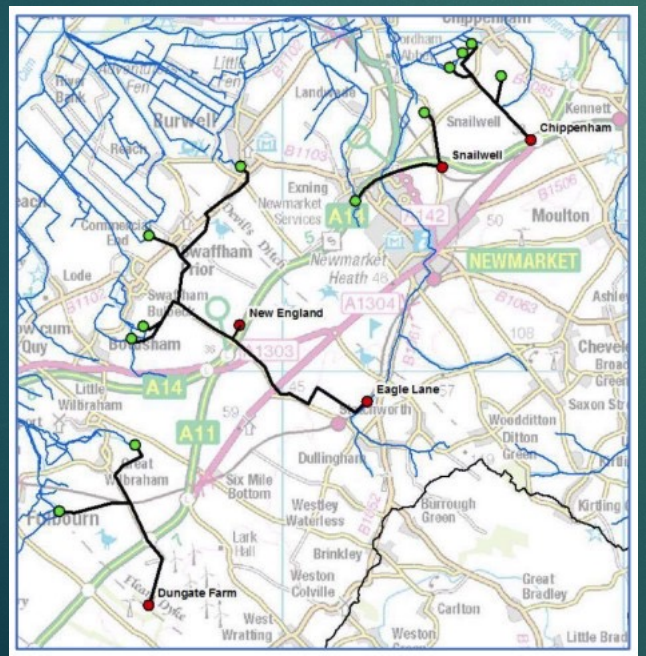


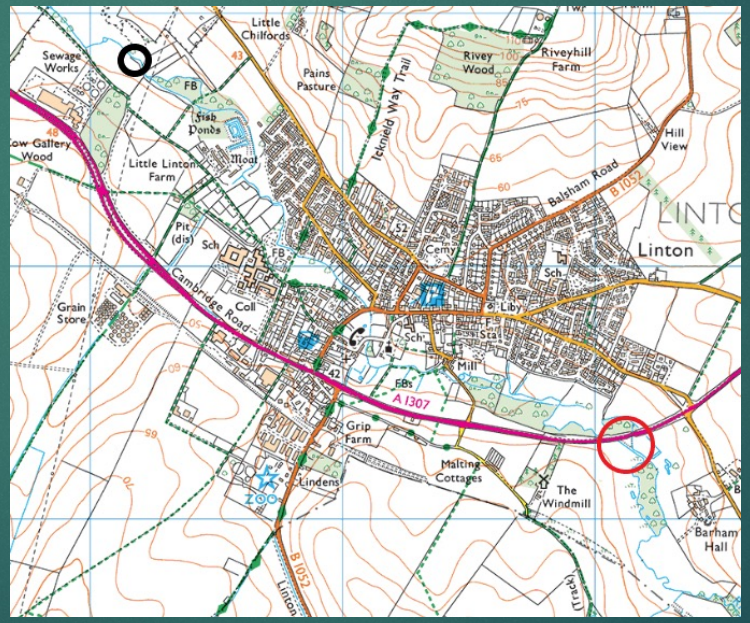
Sheep's Green, potential Defra-designated Bathing Water

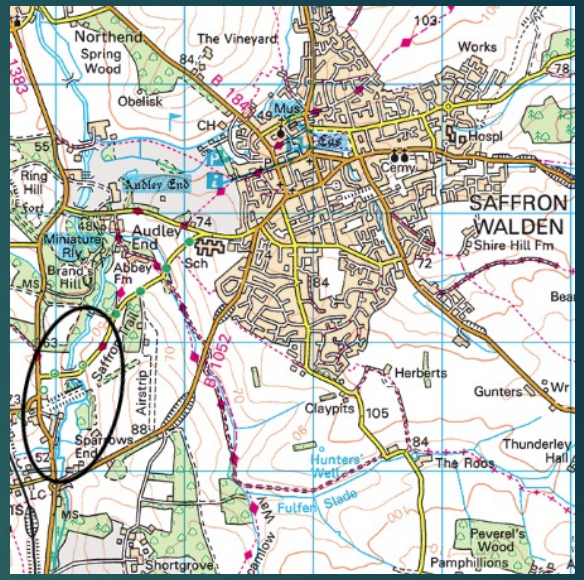
Low flows

Augmentation sites for Rhee, Iodes, Granta and Essex Cam









Interactions

High Nitrate (all)

High Phosphate (all)

High summer turbidity (Rhee / part Cam)

Invasive non-native species

Low flow (all)