Save the Teifi Community Group

Citizen Science Water Quality Results: Afon Teifi Summer 2024

Initial Results

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1.0 Save the Teifi Community Group

Ffynnon Community Resilience C.I.C. established the Save the Teifi Community Group in September 2022 to raise awareness of and seek resolution to the degradation impacting the Afon Teifi. The group has over 1,300 members with an overall aim to **Restore our River, Tributaries and Estuary to Health by 2030**. A steering group was established to organise activities and it can be contacted via the following e-mail addresses:

contact@teifi.one

volunteer@teifi.one

The Save the Teifi Community Group has signed up to the Charter for Rivers associated with RiverActionUK (**www.riveractionuk.com**).

In relation to the Teifi we are seeking to:-

1. End Sewage Pollution
2. Reduce the levels of harmful chemicals (e.g. nitrates and phosphates) to recommended limits (Biggs et al. 2016)
3. Bringing Nature back from the brink
4. Have bathing sites designated at key sites along the river
5. Control invasive species
6. Utilise Citizen Science to monitor river quality and holding polluters to account
7. Encourage regulators and political parties to take action
8. Work in partnership with the Teifi Nutrient Management Board, County Councils, communities, farmers, Dwr Cymru/Welsh Water, Natural Resources Wales and West Wales River Trust to restore the river

The Group raises awareness of water quality issues through community meetings, events, social media (Save the Teifi Facebook page) and via its Save the Teifi website (www.tiefi.one). Members have been active reporting pollution incidents and seeking action from key stakeholders. In 2024 it started to organise and deliver citizen science activities.

2.0 Approach to Citizen Science Activities

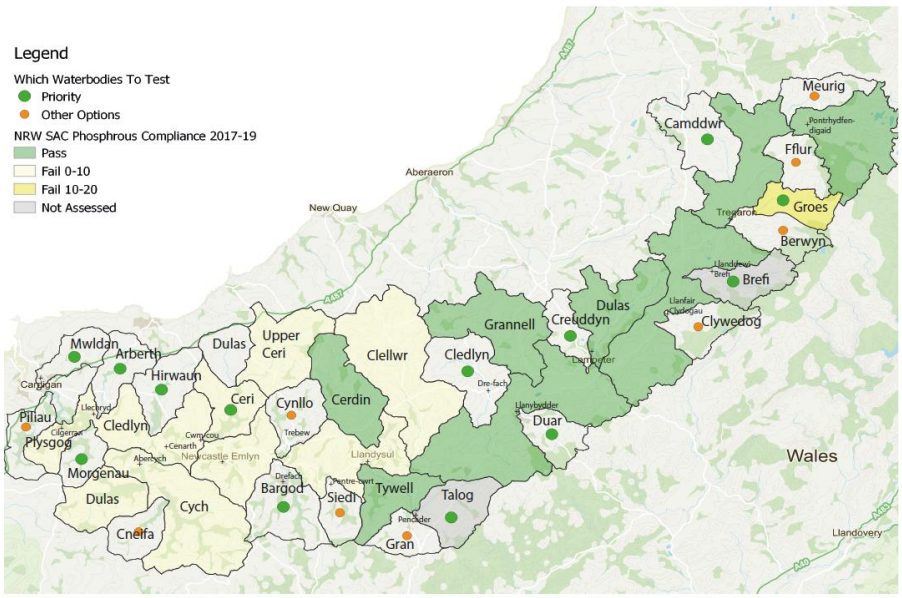
When the Save the Teifi Community Group was established there was a clear desire within the community to utilise citizen science to monitor water quality so that polluters could be held to account. The steering group sought advice from key stakeholders (e.g. Natural Resources Wales - NRW, West Wales River Trust) and was informed that reporting pollution incidents and undertaking support action (e.g. Adopt a Tributary) was the best way forward. Directly testing the quality of the water (e.g. nutrient and e-coli content) was not encouraged given the results would not be used or recognised by key authorities. On this basis the Steering Group agreed that water quality testing would not be progressed until there was an agreed protocol and that the results would be used by appropriate authorities. Members were directed to the activities being delivered by West Wales River Trust and encouraged to actively participate (e.g. Adopt a Tributary, Outfall Safari).

In response to the issues associated with high levels of phosphorous in the Teifi Ceredigion County Council in collaboration with the West Wales Nutrient Management Boards purchased phosphate water quality monitoring kits to be used by citizen scientists. The County Council and the Nutrient Management Board indicated that water quality testing undertaken by citizen scientists could help to extend the existing evidence base. On this basis the Save the Teifi Steering Group agreed to establish water testing citizen science activities given the results would be utilised. The Nutrient Management Board lent 4 phosphate testing kits to the Save the Teifi Group. A further 9 testing kits have been purchased by the group (from funds raised through donations from the members) as well as additional water quality testing equipment.

This report is a direct result of the tests carried out by our volunteers and could not be completed without their hard work and dedication. We continue to seek further volunteers to increase the distribution of sampling points.

3.0 Sampling Framework

Natural Resources Wales has a responsibility to monitor the health of waterbodies across Wales. There are 9 river catchments that have been designated as Special Area of Conservation (SACs) due to the presence of key species. All designated SACs are expected to reach high standards of environmental quality whilst non SAC waterbodies are expected to meet the good quality standards associated with the Water Framework Directive (WFD). The Teifi and some of it's tributaries have been designated as a SAC whilst the remaining tributaries are covered by the WFD. As part of its statutory duties NRW tests a variety of water quality parameters at SAC sections of the Teifi Teifi SAC and its tributaries, these tests being largely undertaken on a monthly basis. Given the available resources, NRW is only able to monitor a certain number of sites and these have been reduced in recent years. There was also limited monitoring during the Covid Pandemic and on occasion the time lapse between sampling and laboratory analysis means that the results are not reliable. This data, which has been collected for a number of years, has indicated that sections of the river and some of its tributaries do not meet the environmental targets expected of a SAC river, in particular annual mean orthophosphate concentrations in the lower Teifi and selected tributaries are higher than the required target and so require action. Fewer tests are carried out on non-SAC sections of the catchment and there are some tributaries where there is insufficient data available to assess the orthophosphate concentration..



On this basis the Nutrient Management Board identified 13 tributaries which it considered a priority for water quality monitoring (Fig. 1). A further 9 tributaries were identified as second order sites for testing.

Figure 1: The 1st and 2nd priority tributaries identified for water quality testing.

The NMB indicated that data collected by Citizen Scientists could enhance the evidence base by helping to monitor these 22 tributaries. It was agreed that the water testing sampling framework should attempt to monitor these tributaries as close to their junction with the Teifi as possible by making use of safe and publicly accessible sites. Further sites along the tributary would be useful (e.g. below and above a possible pollution point source, on sub-tributaries) if public access and resources (time/equipment) allowed. In addition the volunteers were encouraged to collect occasional samples from the main river (in particular close to County Council monitoring sites) and from sites where they believed pollution was an issue. The sampling should be undertaken at the same site at least once a month and if possible more frequently (e.g. weekly).

4. Water Quality Testing Equipment & Training Protocol

4.1 Equipment in Test Kits

a) Hanna Low Range Phosphate Checker (HI713) –

i. Range = 0.00 – 2.50 ppm (PO_4^{3-})
ii. Resolution = 0.01ppm
iii. Accuracy = ± 0.04 ppm ±4% of reading @ 25°C

Agencies such as NRW report concentrations in terms of PO_4^{3-}-P (orthophosphate as phosphorus) and this is also what phosphorus standards are most commonly set as (Hatton-Ellis & Jones, 2021; Anon, 2023). A molecule of orthophosphate (PO_4^{3-}) weighs 3.06 times more than a molecule of PO_4^{3-}-P orthophosphate as phosphorus. The PO_4^{3-}-P (orthophosphate as phosphorus) is calculated by dividing the Hanna instrument PO_4^{3-} (orthophosphate) result by 3.06.

b) Seiki Multifunction 5-in-1 Water Quality Tester (EZ-9909SP)

i. pH - Range 0.01-14.00pH, resolution 0.01pH, accuracy ± 0.05pH
ii. Electrical Conductivity (EC) – Range 0-1000 uS/cm, resolution 1 uS/cm, accuracy ±2%
ii. Total Dissolved Solids (TDS) – Range 0-1000ppm, resolution 1ppm, Accuracy ±2%
v. Temperature – Range 0-60°C, resolution 1°C, accuracy ±0.5
v. Salinity – Range 0.01-25%/0-10000ppm, resolution 0.01%/1ppm, Accuracy ±0.1%

c) Dissolved Oxygen Analyzer (DO9100)

i. Range = 0.0-30.0 mg/L 0.0-300.0%
ii. Resolution = 0.1 mg/L 0.1%
ii. Accuracy = ± 1.5%

The instrument can be calibrated each time by taking a measurement in air (100%). It is noteworthy that the instrument takes time to produce a stable result.

4.2 Training Protocol

The citizen science volunteers were trained in small groups (1-4 people with water samples being collected and tested in the field.). They were issued with the water sampling risk assessment that had been produced by Ceredigion County Council for the PRaM project. They were issued with the Save the Teifi Water Quality Data Collection waterproof leaflet which provided a step by step guide on how to collect the samples. They were taken through the procedures and given an opportunity to use the equipment.

They were also shown how to download the ArcGIS My Survey 123 app and the associated Save the Teifi Water Quality Testing form that is hosted by West Wales River Trust. They were encouraged to record the water quality testing data and the sample location in the field (although the data can be uploaded at a later date if no mobile signal is available.

The need to wash down the equipment with distilled water after use was outlined. Similarly the importance of ensuring the glass vials associated with the Phosphate Checker were cleaned with a lint free cloth during the measurement process (e.g. removing fingerprints, non-use of hand creams) was highlighted.

The volunteers were also told that if they required further training or a replenishment of resources (phosphate sachets, distilled water) they should contact the training team.

The instructions also outlined what good/excellent water quality readings would be and that they demonstrated when the river was in good health. It was also noted that the aim was to undertake testing over a prolonged period (1-2 years0 so that mitigation methods could be assessed.

The sampling protocol was explained to the volunteers and they were asked to work as a group to cover one or more tributaries on a weekly/monthly basis for a prolonged period of time. They were asked to swap the equipment between them to collect the data.

The first training session was held on the 11th July 2024 and by the 8th August eight groups had been trained. Training of a further 4 groups is still to be arranged.

5.0 Distribution of Testing Sites

Between the 11th July and the 3rd October 2024 (12 weeks) the 8 groups tested water quality in the Teifi catchment 147 times. The samples were collected from 45 different sites (Fig. 2). At some sites only one assessment has been made but at others up to 10 tests were carried out.

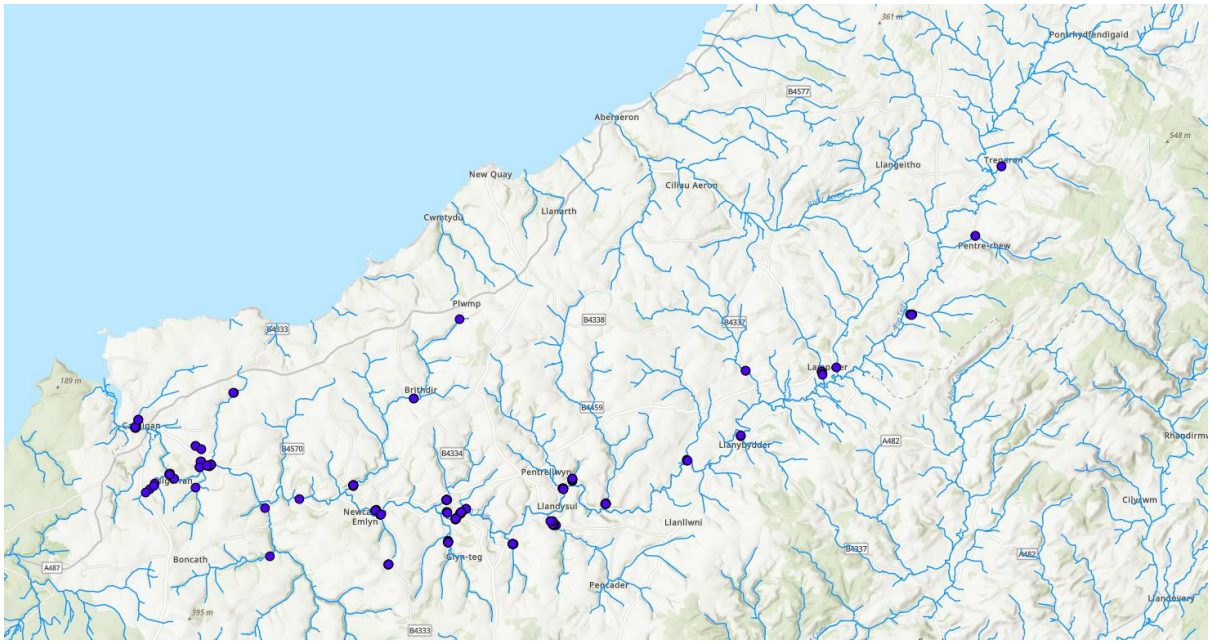


Figure 2: The Save the Teifi citizen science sampling points selected during the summer of 2024.

It should be noted that in a number of cases the sampling site location recorded by the ArcGIS Survey 123 app varied by as much as 20m between different sampling dates. Discussion with the sampling team has indicated that the water samples were collected from the same point on each occasion. As a consequence the water quality testing data set records both the apps proposed location (Latitude and Longitude) and an average OS National Grid Reference has been identified for the site.

The majority of the sample sites are located in the lower section of the Teifi. At present 9 of the priority 13 tributaries are being monitored and a further 3 of the 9 secondary sub catchments. In addition a further 10 sub-catchments, are being monitored with some of these including small streams that have not been measured by NRW in the past. The priority tributaries not being monitored are the Hirwaun, Talog, Groes and Camddwr. Of the 2nd priority tributaries the Piliau, Cneifa, Gran, Berwyn, Fflus and Meurig are not being monitored.

6.0 Results from Summer 2024 (11/7/24 to 3/10/24)

The 147 water quality tests events recorded, location, date and time and the following water parameters: temperature, pH, total dissolved solids, electrical conductivity, dissolved oxygen and orthophosphate concentration (PO_4^{3-}) which was subsequently converted to orthophosphate as phosphorus (PO_4^{3-}-P). The results have been reviewed and results where clarification is required identified (e.g. some values appear inconsistent) The detailed results are available on the Save the Teifi website and have been sent to staff at the Nutrient Management Board and the Lampeter Office of NRW. A brief assessment of the data is provided below.

6.1 – pH

The pH of the Teifi and its tributaries is largely alkaline particularly between Newcastle Emlyn and Lampeter where pH values between 8.0 and 9.5 are common. Test results with a pH value between 6.5 and 9.0 are representative of good water quality. Only two readings below pH 6.5 were recorded, these being on the Arad (south of Newcastle Emlyn) and the Cledlyn (Dre-fach), both at pH 6.35 . There are a number of readings above pH 9.0 including from the Cynllo, Bargod, Iago, Siedi, Tyweli, Gwenffryd, Clettwr and Cerdin.

6.2 – Electrical Conductivity and Total Dissolved Solids

The results of electric conductivity (EC) are twice the value of total dissolved solids (TDS). TDS values in the range of 100-200 ppm are considered normal for a river. TDS values below the Teifi confluence with the Cych are in the range of 100-200 ppm with a few samples above 250ppm (Mwldan, Coed Maidie, Isaf). TDS values above the confluence with the Cych are all below 100ppm, which is considered excellent water quality.

6.3 – Dissolved Oxygen

Healthy water should have dissolved oxygen concentrations of 6.5-8.0 mg/L (80-120%). In many cases the volunteers recorded dissolved oxygen in both mg/L and as a %. It is noteworthy that in some cases the % figure was low (below 70%) but the mg/L reading was within the healthy river range. The majority of readings were within the healthy river range. Notable exceptions were single readings on the Isaf (Llechryd) at 5.9 mg/L, Omerond (Llechryd) at 4.7 mg/L and Tyweli at 6.3 mg/L. The Arad (Newcastle Emlyn) and Iago (near Trebedw) had a number of readings below 75% but corresponding mg/L figures between 7.4-7.8 mg/L. Further analysis into the use and accuracy of the instrument will be undertaken to determine if one set of measurements is more reliable.

6.4 – Orthophosphate Concentrations as Phosphorus (PO_4^{3-} -P).

PO_4^{3-} -P (orthophosphate as phosphorus) values ranged from 0 to 0.693 ppm. The higher values (>0.08ppm) were mainly associated with samples collected from the lower Teifi and its tributaries below the confluence with the Cych (Mwldan,Plysgog, Omerond, Arbeth). There were only two readings above 0.08ppm above this point these being from the Ceri and the Teifi near Henllan. At a number of sites there were sufficient readings (4 or more) to assess if there were variations through time.

6.4.1 Arbeth

The PO_4^{3-} -P values vary from 0.036ppm to 0.111 ppm with no clear trend over this short time period (Fig. 3)

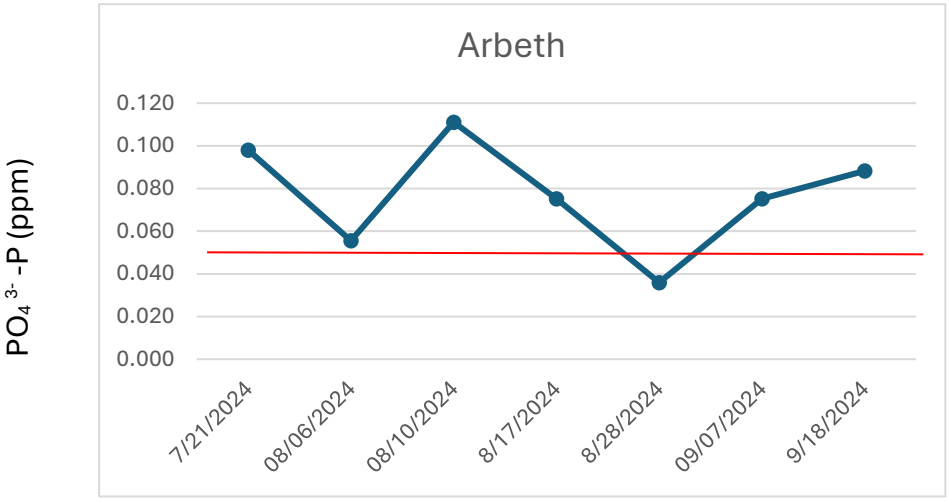


Figure 3: Orthophosphate Concentrations as Phospherous (PO_4^{3-} -P) for Arbeth Tributary between July and October 2024. Red line represents the NRW WFD good target concentration (0.054ppm).

6.4.2 Lower Ceri

The PO_4^{3-} -P values vary from 0.0ppm to 0.111 ppm with a general increase in values over this short time period (Fig. 4).

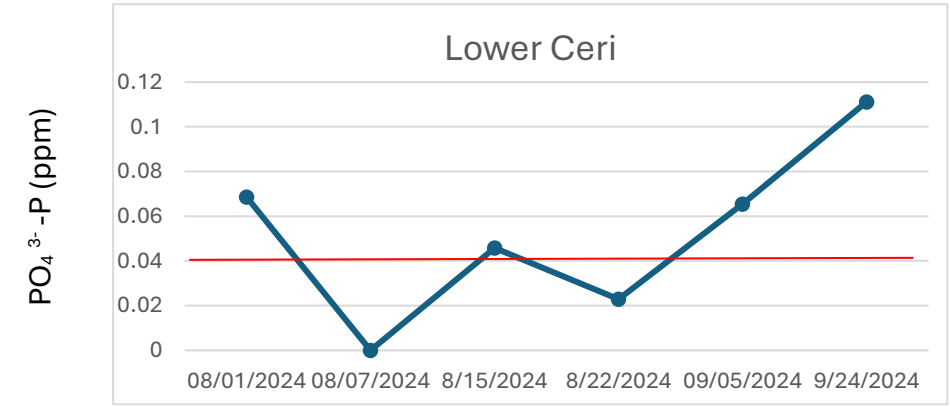


Figure 4: Orthophosphate Concentrations as Phospherous (PO_4^{3-} -P) forCeri Tributary between August and October 2024. Red line represents the NRW SAC target concentration (0.04ppm).

6.4.3 Teifi at Newcastle Emlyn

The PO_4^{3-}-P values vary from 0.013ppm to 0.059 ppm with no clear trend over this short time period (Fig. 5)

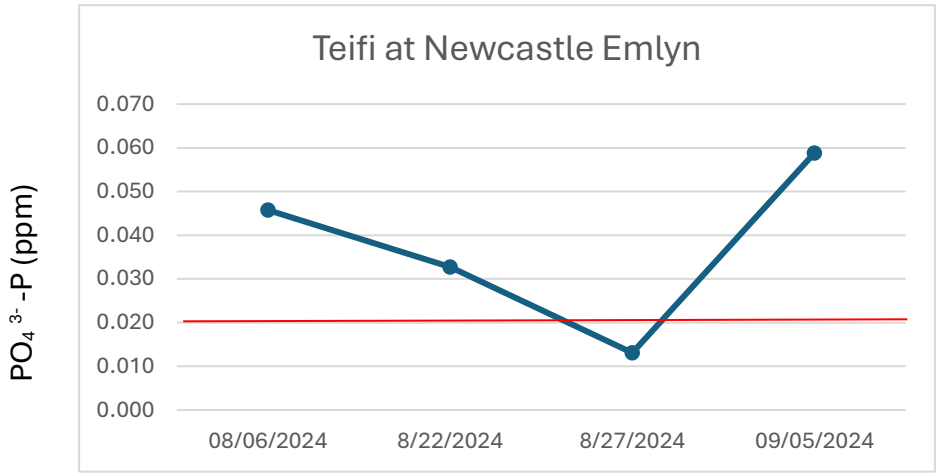


Figure 5: Orthophosphate Concentrations as Phospherous (PO_4^{3-}-P) for the Teifi at Newcastle Emlyn Castle between August and early September 2024. Red line represents the NRW SAC target concentration (0.02ppm).

6.4.4 Arad near Newcastle Emlyn

The PO_4^{3-}-P values vary from 0.0ppm to 0.02 ppm with no clear trend over this short time period (Fig. 6)

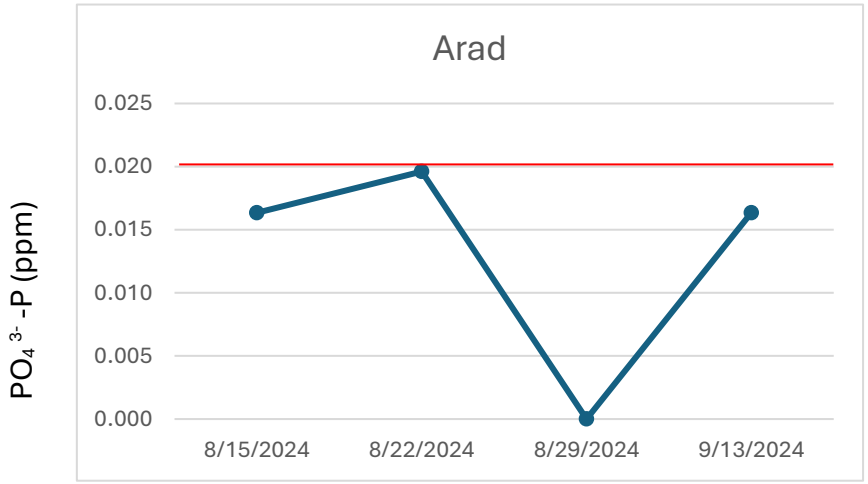


Figure 6: Orthophosphate Concentrations as Phospherous (PO_4^{3-}-P) for the Arad near Newcastle Emlyn between August and mid September 2024. Red line represents the estimated NRW target concentration (0.02ppm).

6.4.5 Cynllo

The PO_4^{3-}-P values vary from 0.016 ppm to 0.033 ppm with no clear trend over this short time period (Fig. 7)

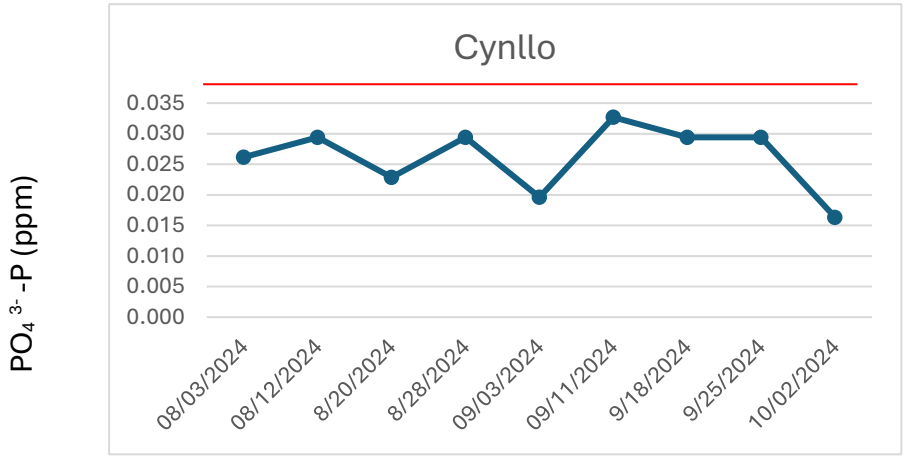


Figure 7: Orthophosphate Concentrations as Phospherous (PO_4^{3-}-P) for the Cynllo/Cwerchyr between August and October 2024. Red line represents the NRW WFD good target concentration (0.038ppm).

6.4.6 Bargod

The PO_4^{3-}-P values vary from 0.001 ppm to 0.036 ppm with no clear trend over this short time period (Fig. 8)

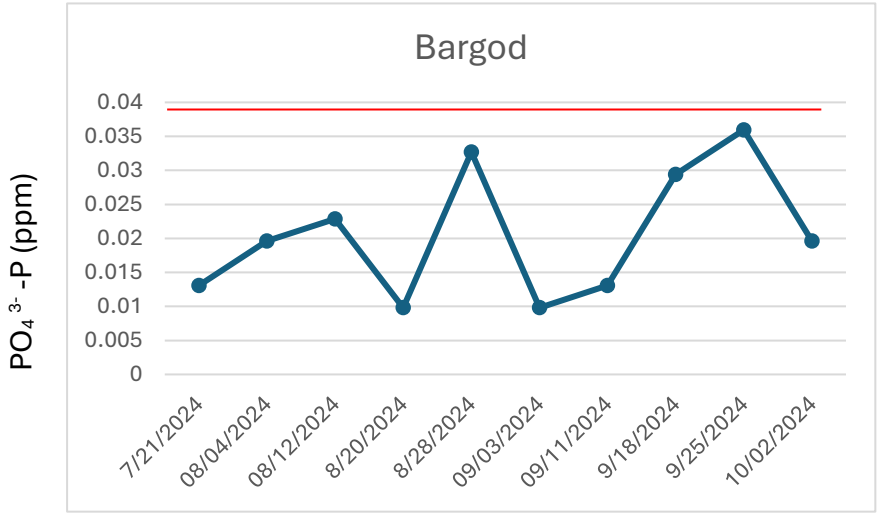


Figure 8: Orthophosphate Concentrations as Phospherous (PO_4^{3-}-P) for the Bargod between July and October 2024. Red line represents the NRW WFD good target concentration (0.039ppm).

6.4.7 Teifi at Henllan

The PO_4^{3-}-P values vary from 0.003 ppm to 0.088 ppm with increasing vales in late September/early October (Fig. 9)

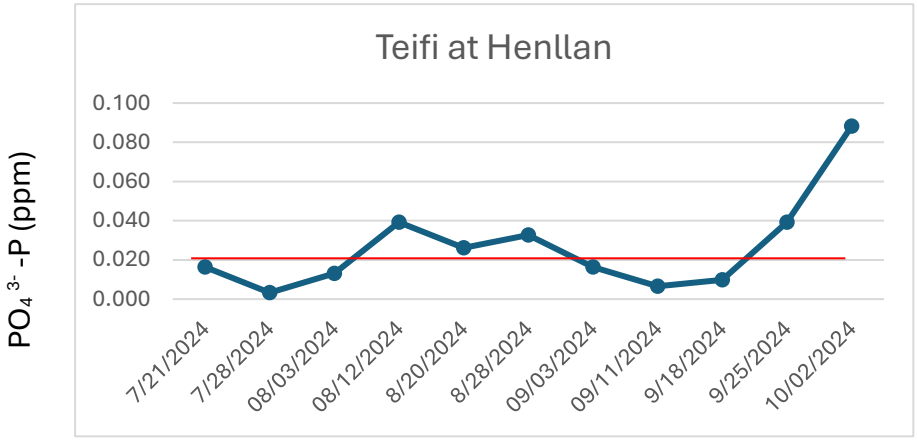


Figure 9: Orthophosphate Concentrations as Phospherous (PO_4^{3-}-P) for the Teifi at Henllan between July and October 2024. Red line represents the NRW SAC target concentration (0.02ppm).

6.4.8 Iago near Henllan

The PO_4^{3-}-P values vary from 0.016 ppm to 0.059 ppm with no overall trend visible (Fig. 10).

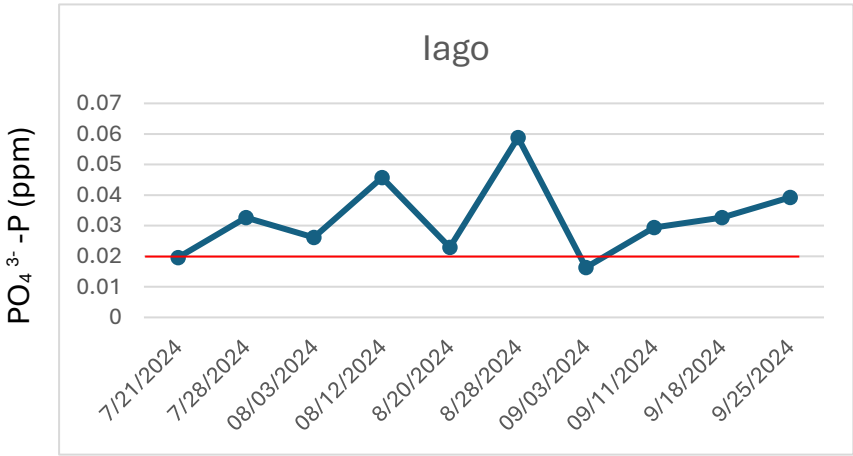


Figure 10: Orthophosphate Concentrations as Phospherous (PO_4^{3-}-P) for the Iago near Henllan between July and October 2024. Red line represents the estimated NRW SAC target concentration (0.02ppm).

6.4.9 Siedi

The PO_4^{3-}-P values vary from 0.01 ppm to 0.036 ppm with no overall trend visible (Fig. 11).

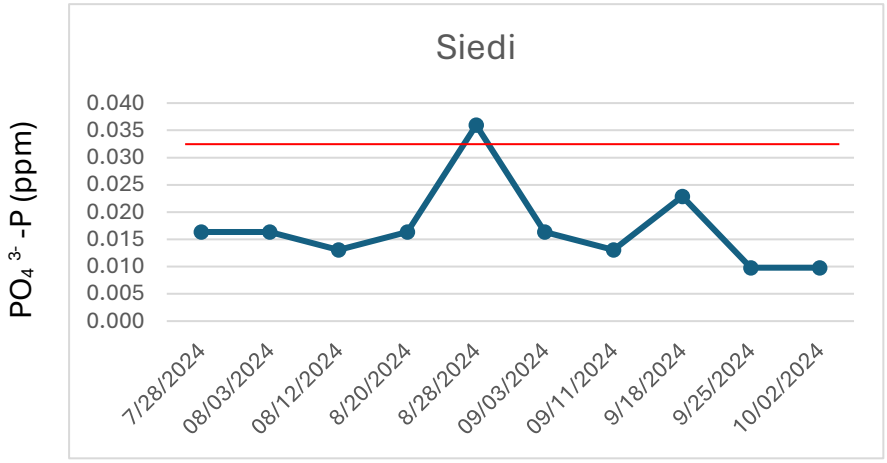


Figure 11: Orthophosphate Concentrations as Phospherous (PO_4^{3-}-P) for the Siedi between July and October 2024. Red line represents the estimated NRW WFD - good target concentration (0.032ppm).

6.4.10 Tyweli

The PO_4^{3-}-P values vary from 0.007 ppm to 0.052 ppm with no overall trend visible (Fig. 12).

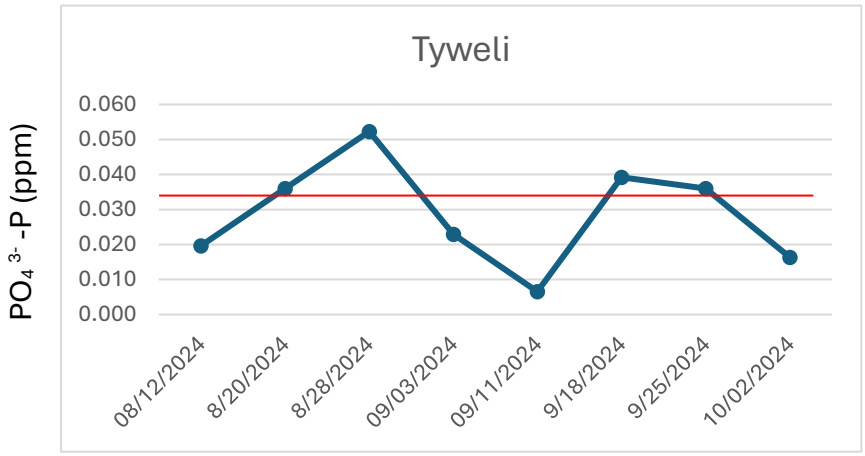


Figure 12: Orthophosphate Concentrations as Phospherous (PO_4^{3-}-P) for the Tyweli between August and October 2024. Red line represents the NRW SAC target concentration (0.034ppm).

6.4.10 Creuddyn

The PO_4^{3-}-P values vary from 0.00 ppm to 0.033 ppm with values decreasing through time (Fig. 13).

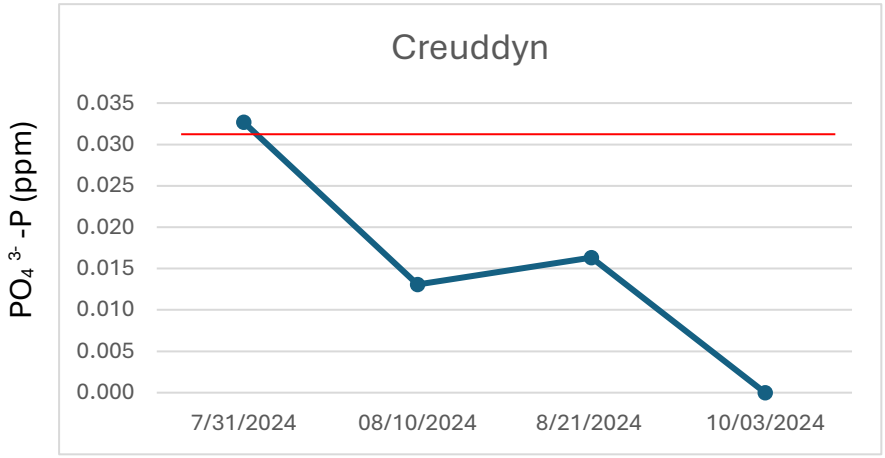


Figure 13: Orthophosphate Concentrations as Phospherous (PO_4^{3-}-P) for the Creuddyn between July and October 2024. Red line represents the estimated NRW WFD - good target concentration (0.031ppm).

7.0 Orthophosphate Concentrations Compared to NRW SAC Targets

NRW have assessed the concentration of Orthophosphate expected to occur in SAC rivers and identified mean annual target levels that should not be exceeded (Hatton-Ellis & Jones, 2021). For a particular SAC river the target levels vary along the river and from tributary to tributary. Target levels for non SAC sections of the catchment are determined by the Water Framework Directive – Good level. The target levels for the Teifi are illustrated in Fig. 14 with the detail provided in Appendix 1.

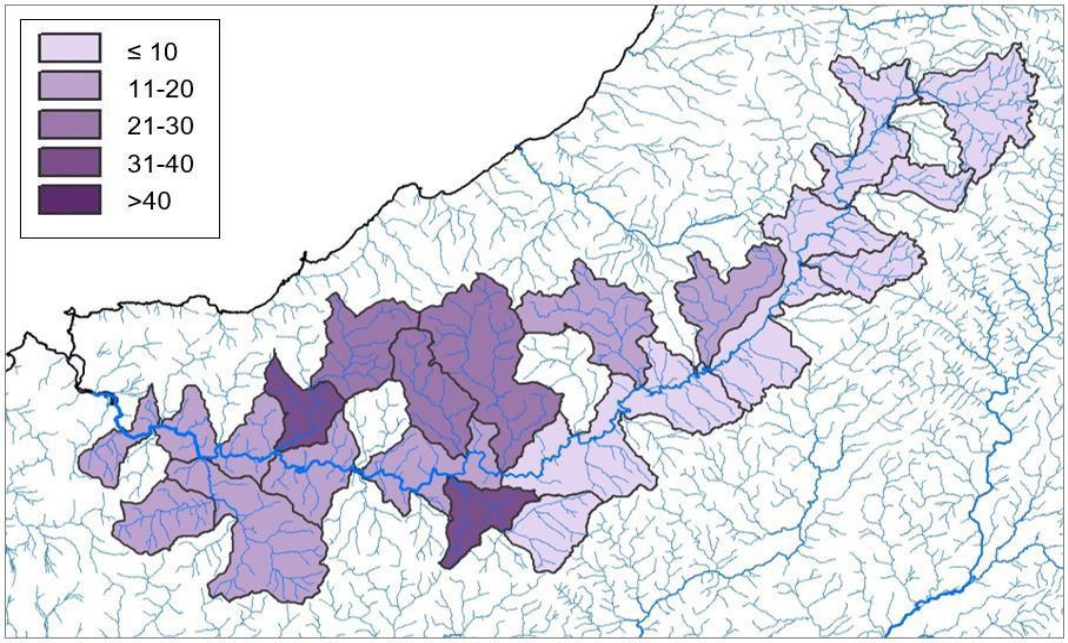


Figure 14. Map of phosphorus targets for Afon Teifi SAC. All concentrations are annual means and growing season means in µg l^{-1}. (From Hatton-Ellis & Jones, 2021).

NRW compare the target values against the annual mean and growing season mean determined from their measurements and if either of these values are higher than the target value that section of the river is considered to have failed its phosphorous compliance. Individual measurements that are above the target do not mean that that section of the river is failing.

There are some small Teifi tributaries (e.g. Arad, Iago) which are included in the SAC assessment but no NRW measurements have been taken. For this report the SAC targets have been adopted if the section of the river is included in Fig. 14. Guidance will be sought from NRW and the Nutrient Management Board to determine if these estimates are appropriate.

An initial comparison between the NRW and estimated target phosphate concentrations indicates that 67 of the Save the Teifi 147 (45.6%) water quality testing

measurements were above the proposed targets. These measurements have been collected over a short time period (2-3 months) which is insufficient to compare with the NRW annual or even the growing season means. Further data is required over the next 18-24 months before such comparisons can be made. Similarly the current report has not assessed the potential instrumental errors/accuracy of the equipment, which will be undertaken once more data becomes available. The data (e.g. Figs. 3-5, 8-10) does however indicate that there are some tributaries/sites where the target levels are frequently exceeded; these being:

Teifi at: Cilgerran, Newcastle Emlyn & Henllan

Tributaries: Plysgog, Coed Maidie (Llechryd), Isaf (Llechryd), Omerond (Llechryd), Arbeth, Iago. Tyweli, Gwenffryd, Clettwr

However, in some cases the number of measurements are limited. The majority of these river sections are in the lower Teifi, but this also reflects current distribution of sampling locations. Many of these tributaries have no Dwr Cymru/Welsh Water sewage treatment assets associated with them which suggests that the phosphates are coming from other sources.

8.0 Conclusions

The following conclusions can be drawn from the initial Save the Teifi citizen science water quality testing programme.

a) The citizen science volunteers can produce results which can add to the exiting evidence base by collecting data from sites which lack information.
b) Some of the results suggest that parameters such as pH and dissolved oxygen are good or satisfactory from the majority of river sections that have been measured by citizen scientists.
c) The phosphate concentrations measured by the volunteers and adjusted to be comparable to the NRW measurements (PO_4^{3-}-P) frequently exceed the phosphorous target levels, but further analysis is required.
d) Further data collected over the next 18-24 months is required before any comparisons can be made with NRW compliance assessments.
e) Further volunteers to test water quality along the Teifi and its tributaries are required, particularly in the upper catchment and for selected tributaries which have a lack of data.

9.0 References

Anon, 2023. Phosphorus information for Wye catchment citizen scientists. Prepared by CardiffUniversity on behalf of the Wye Catchment Collaborative Monitoring Network. (https://www.wyeuskfoundation.org/Handlers/Download.ashx?IDMF=e5d72bf9-dc2c-4eeb-b02c-15559452869a)

Hatton-Ellis, T. & Jones, T. 2021: *Compliance Assessment of Welsh River SACs against Phosphorus Targets*. Natural Resources Wales, Report No. 489.

(https://cdn.cyfoethnaturiol.cymru/media/693025/compliance-assessment-of-welsh-sacsagainst-phosphorus-targets-final-v10.pdf?mode=pad&rnd=132557227300000000)

10.0 Appendix 1: SAC Phospherous compliance for Afon Teifi

Waterbody ID	Waterbody Name	Sample Point	Target (µg l^{-1})	N Samples	Annual Mean (µg l^{-1})	Growing Season Mean (µg l^{-1})	Result	Status
GB110062039020	Tyweli - confluence with Talog to confluence with Teifi	83003	34	27	19	20	Pass	-
GB110062038980	Talog - headwaters to confluence with Tyweli	34198	10	-	-	-	Not assessed	-
GB110062039230	Grannell - headwaters to confluence with Teifi	83007	20	9	16	-	Pass	-
GB110062039140	Cerdin - headwaters to confluence with Teifi	34197	30	27	17	19	Pass	-
GB110062039240	Dulas - headwaters to conf Teifi	83006	20	27	15	14	Pass	-
GB110062043563	Teifi - Afon Ceri to estuary	34401	20	26	20^{X}	19	Fail	Confirmed
GB110062043564	*Teifi - Afon Clettwr to Afon Ceri**	*34401*	*20*	*26*	*20^{X}*	*19*	*Fail*	-
GB110062039110	Ceri - Dulas to conf Teifi	34486	40	28	42	38	Fail	Confirmed
GB110062039190	Ceri - headwaters to conf Dulas	34585	30	22	28	32	Fail	Confirmed

GB110062039220	Clettwr - headwaters to confluence with Teifi	83009	30	24	32	35	Fail	Confirmed
GB110062043490	Groes - headwaters to confluence with Teifi	89118	10	18	14	23	Fail	Unconfirmed
GB110062039010	*Dulas - headwaters to confluence with Cych**	*34488*	*20*	*26*	*25*	*29*	*Fail*	-
GB110062039041	Cych - headwaters to confluence with Teifi	34488	20	26	25	29	Fail	Confirmed
GB110062043565	Teifi - Afon Dulas to Afon Clettwr	34403	10	29	6	4	Pass	-
GB110062043566	Teifi - Afon Brennig to Afon Dulas	34403	10	29	6	4	Pass	-
GB110062039250	Brefi - headwaters to confluence with Teifi	87179	10	6	-	-	Not Assessed	-
GB110062043501	Teifi - conf Fflur to conf Brennig	34407	10	26	4	5	Pass	-
GB110062043540	Teifi – headwaters to the confluence with Meurig	83010	10	33	6	9	Pass	-

Derived from Hatton-Ellis & Jones, 2021