



DESC 5th Sep 2018

Filton Weather Station Closure

- The Met Office's Land Networks Quarterly Report provides a 'health check' on current weather stations.
- The report published in Jan 2018 indicated that Filton may be at risk of closure. Confirmation of closure in late September was provided to Xoserve during August.
- The industry has a document to refer to in such scenarios which is the Weather Station Substitution Methodology (WSSM). This is published in the following location on the Xoserve UK Link Secured Documentation site:
 - 18. NDM Profiling and Capacity Estimation Algorithms / Weather Station Substitution Methodology /
 - 2. Final Methodology / Final_Weather_Station_Substitution_Methodology
- The WSSM suggests the following:

'when looking to replace a closed station with a substitute, the aim may be for the substitute to be as representative of the closed station as possible. The representativity will depend on factors such as the distance between the two stations, the difference in terrain elevation and terrain shape at the two sites, and differences in the geographical surroundings at the sites'

Background cont...

- In the event of closure DESC agreed on the 24th July '18 that Yeovilton and St Athan should be the two sites analysed as suitable replacements for Filton.
- These stations were included in both the WSSM and Climate Change Methodology (CCM) datasets meaning historical data is readily available for demand modelling (up to 2012)

Objective of Meeting

- Review analysis of the potential substitute stations.
- Confirm DESC's decision for a substitute weather station.
- Agree follow up actions to ensure transition to the replacement station is smooth.

- It has been necessary to make the following assumption in developing the approach and undertaking the analysis
- It is assumed that:
 - the CWV parameters for the SW CWV calculations and the SW SNCWV are not going to change until the 1st October 2020.
 - This means a substitute station is required which can mimic Filton for a period of approximately two years.

- Our approach to the analysis has been structured around the guidance in the WSSM.
- The WSSM suggests using the following steps when a station closes and a replacement station needs to be chosen (*for full details please refer to pg. 51-52 within the WSSM*):
 - It is required that **temperature** should act as the **lead variable**
 - Identify a shortlist of potential substitute stations
 - Assemble historical time-series of hourly data for the required weather variables for the target and substitute stations
 - If there are at least 8766 hourly observations, calculate the **correlation coefficient, R**, between the target station and each of the substitute stations

Approach Cont...

- Rank the shortlisted stations by their R value to select the best substitute (highest value of R)
- If the substitute station that ranked the highest is at risk of closure, consider the next ranked highest station as the substitute (*bullet point 8 – pg 51*)
- Make an assessment of the bias with respect to the station being replaced
 - Temperature bias assessment should be monthly
 - Wind speed bias assessment should be overall

Distance Between Stations



Below is a table and map which shows the distance/geographical details between the target station (Filton) and the two possible substitutes (St Athan and Yeovilton).

Station Name	Elevation (m)	Terrain Shape (m)	Sea %	Urban %
Filton (Bristol)	59	6	9	74
Yeovilton	49	18	0	7
St Athan	20	-4	43	21

	Difference		
	Distance (miles)	Terrain Elevation	Terrain Shape
Filton vs Yeovilton	35.93	-10	12
Filton vs St Athan	38.34	-39	-10

- Data used:
 - Target Station (t) = Filton (FIL)
 - Substitute stations (s) = Yeovilton (YEO)
= St Athan (STA)
- Period of data used:
 - 01/01/2016 to 31/12/2017
 - Hourly observations
 - Local time data which was converted to the gas day (5am to 5am)
 - Temperature variable is in degree Celsius
 - Wind speed variable was converted to knots (whole number)
 - Industry weightings applied to derive a daily value for temperature and wind speed

- As suggested in the WSSM, the correlation coefficient (based on the hourly observations) was calculated to determine the class of the target station against the substitute station – for both temperature and wind speed. These results are displayed in the table below:

	Temperature	Wind Speed
FIL vs YEO	R = 0.968	R = 0.671
	Class 4	Class 6
FIL vs STA	R = 0.975	R = 0.744
	Class 3	Class 5

- The WSSM states that these are acceptable classes to be used as a substitute station. The table with the values for the class ranges can be found on the following pages within the WSSM:
 - Temperature pg. 28
 - Wind speed pg. 33

“Often there is a climatological bias between the target and substitute station, which may be caused, for example, by a difference in altitude. If possible the bias should be calculated from a period of overlapping data of at least one year”

As we had more than a year of overlapping data, the bias was calculated using the following formula:

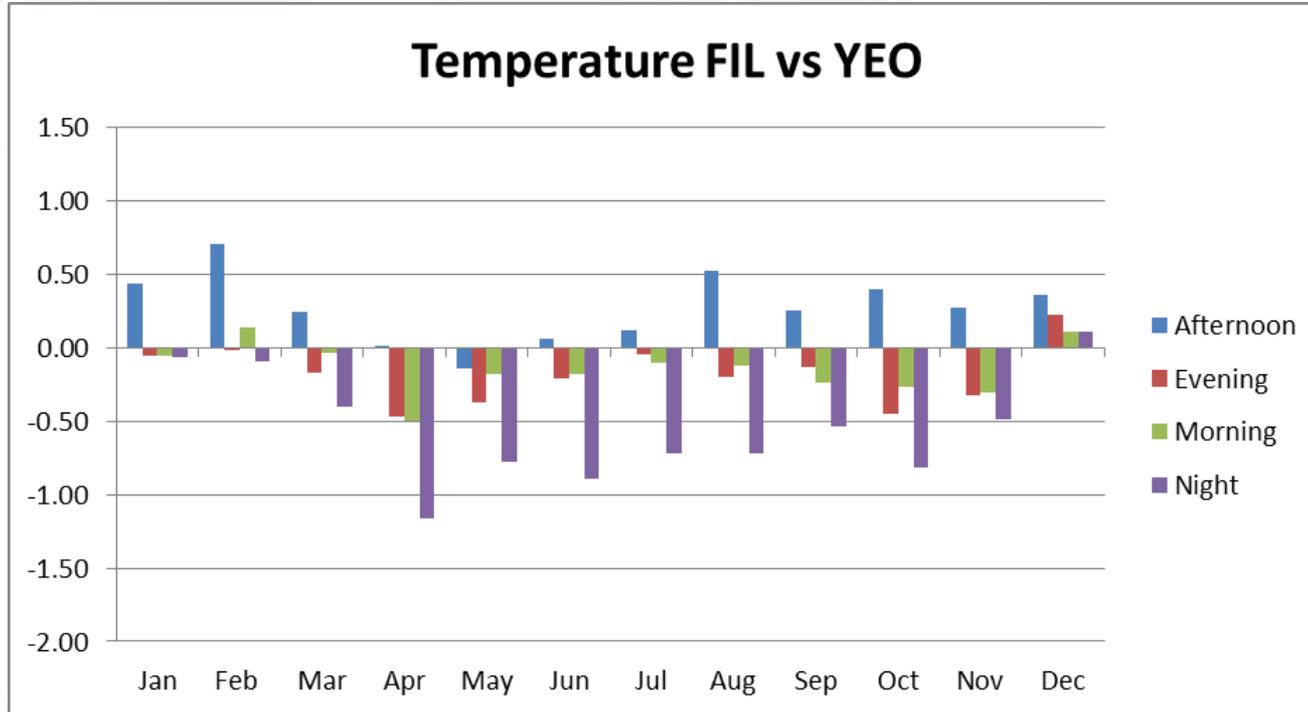
$$B_d = S - T$$

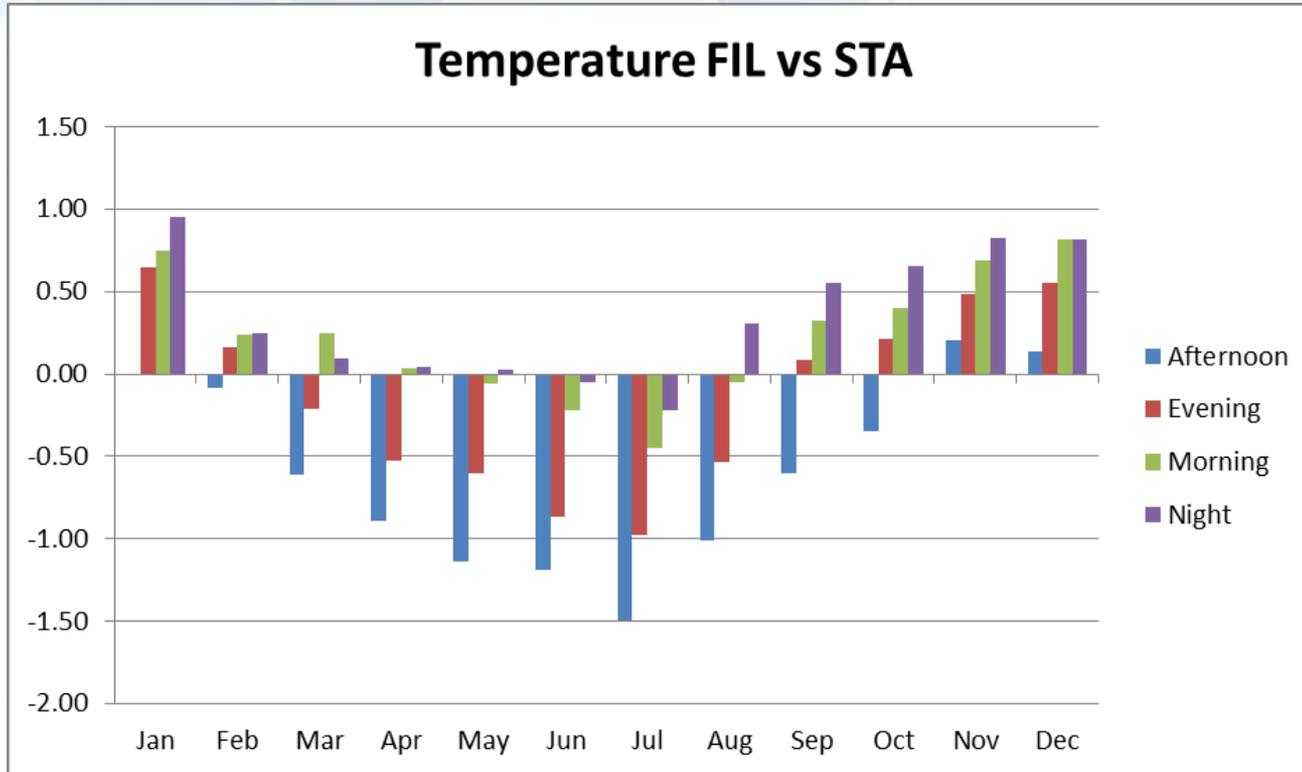
*where B_d = the bias, S = overlap mean for the substitute and
 T = overlap mean for the target station*

- When calculating the temperature bias, in order to reduce sampling variability, the day was split into four 6-hour periods (*pg. 22 WSSM*). These are as follows:
 - *00:00-05:00 Night*
 - *06:00-11:00 Morning*
 - *12:00-17:00 Afternoon*
 - *18:00-23:00 Evening*
- The bias assessment for temperature is monthly, and for wind speed is assessed overall. Wind speed bias values need to be applied as a whole number due to file format restrictions.
- The bias results are displayed on the following slide:

Bias Analysis

Temperature: FIL vs YEO					Temperature: FIL vs STA				
Month	Afternoon	Evening	Morning	Night	Month	Afternoon	Evening	Morning	Night
Jan	0.44	-0.05	-0.05	-0.07	Jan	-0.01	0.64	0.75	0.96
Feb	0.70	-0.02	0.14	-0.09	Feb	-0.09	0.16	0.24	0.24
Mar	0.25	-0.17	-0.03	-0.41	Mar	-0.61	-0.22	0.24	0.09
Apr	0.01	-0.47	-0.50	-1.17	Apr	-0.90	-0.53	0.03	0.04
May	-0.14	-0.37	-0.18	-0.78	May	-1.14	-0.61	-0.06	0.02
Jun	0.06	-0.21	-0.18	-0.89	Jun	-1.19	-0.86	-0.22	-0.05
Jul	0.11	-0.05	-0.10	-0.72	Jul	-1.49	-0.97	-0.45	-0.22
Aug	0.52	-0.20	-0.12	-0.72	Aug	-1.01	-0.54	-0.05	0.30
Sep	0.25	-0.14	-0.24	-0.54	Sep	-0.60	0.09	0.32	0.56
Oct	0.40	-0.45	-0.27	-0.81	Oct	-0.35	0.21	0.40	0.66
Nov	0.28	-0.32	-0.31	-0.49	Nov	0.20	0.49	0.69	0.82
Dec	0.36	0.22	0.11	0.11	Dec	0.14	0.55	0.81	0.82
Overall	0.27	-0.19	-0.14	-0.55	Overall	-0.59	-0.13	0.23	0.36
Wind Speed: FIL vs YEO					Wind Speed: FIL vs STA				
	Afternoon	Evening	Morning	Night		Afternoon	Evening	Morning	Night
Overall	0	0	0	-1	Overall	1	1	2	2



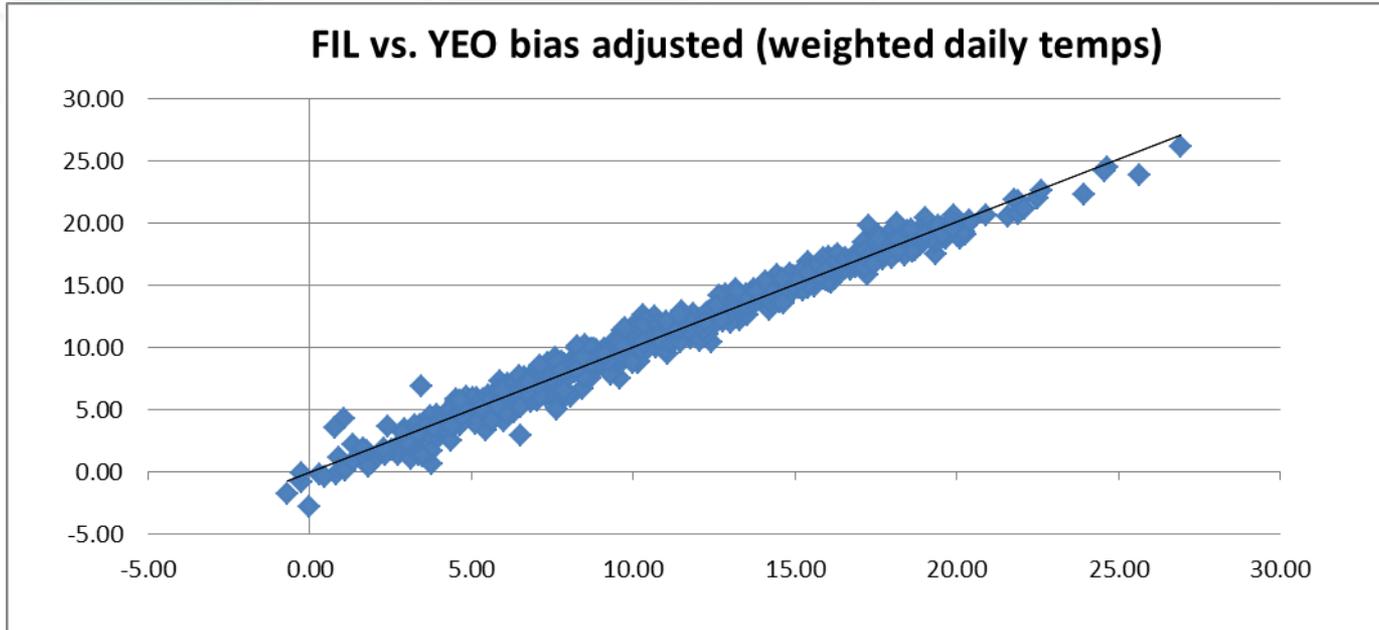


- The calculated bias values were then applied to the relevant month and time of day group to calculate a 'bias-adjusted' estimate.
- A daily weighted temperature / wind speed value is then calculated as per the CWV calculation.
 - For temperature there are 12 observations – 2 hourly intervals
 - For wind speed there are 6 observations – 4 hourly intervals
- The following tables summarise the average temperature / wind speed, before and after the bias adjustments were made.
- The scatter plots display the relationship between the target and substitute station based on the daily weighted temperature/wind speed.
 - Note – these show the R^2 value, which is not comparable to the correlation coefficient, R , which used to determine the class.

FIL vs YEO Temperature - Results

Month	Average of Yeo Weighted Temp	Average of YEO Bias Adj Weighted Temp	Average of FIL Weighted Temp
Jan	6.00	5.91	5.90
Feb	6.48	6.25	6.23
Mar	7.93	7.96	7.96
Apr	9.16	9.60	9.58
May	13.77	14.07	14.09
Jun	16.42	16.64	16.60
Jul	17.63	17.75	17.74
Aug	17.09	17.13	17.11
Sep	15.37	15.48	15.46
Oct	12.00	12.19	12.18
Nov	7.31	7.47	7.48
Dec	6.67	6.46	6.48
Overall	11.34	11.43	11.42

FIL vs YEO Temperature Results



FIL vs. YEO:

$R^2 = 97.43\%$

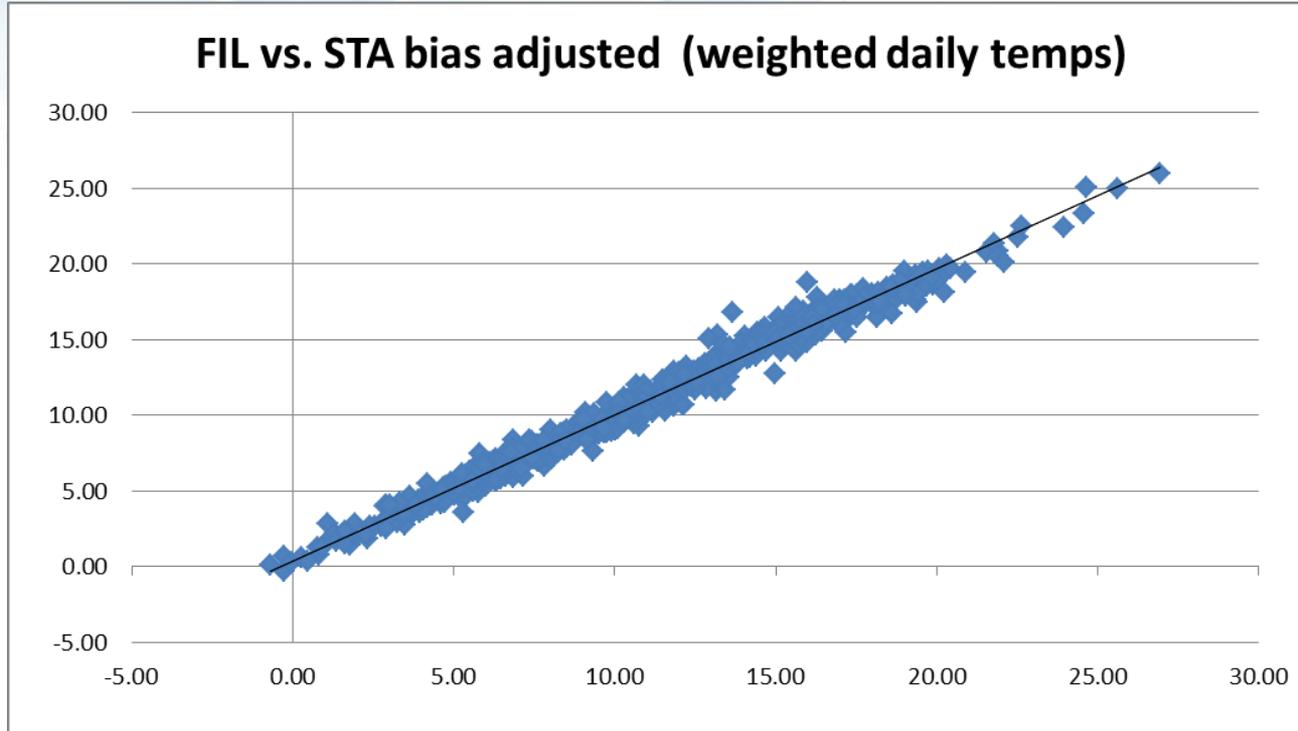
FIL vs. YEO bias adjusted (chart above):

$R^2 = 97.63\%$

FIL vs STA Temperature - Results

Month	Average of STA Weighted Temp	Average of STA Bias Adj Weighted Temp	Average of FIL Weighted Temp
Jan	6.42	5.89	5.90
Feb	6.35	6.23	6.23
Mar	7.80	7.95	7.96
Apr	9.15	9.54	9.58
May	13.55	14.05	14.09
Jun	15.92	16.57	16.60
Jul	16.83	17.69	17.74
Aug	16.66	17.06	17.11
Sep	15.46	15.44	15.46
Oct	12.34	12.17	12.18
Nov	7.95	7.44	7.48
Dec	7.01	6.46	6.48
Overall	11.30	11.39	11.42

FIL vs STA Temperature Results



FIL vs. STA: $R^2 = 98.18\%$

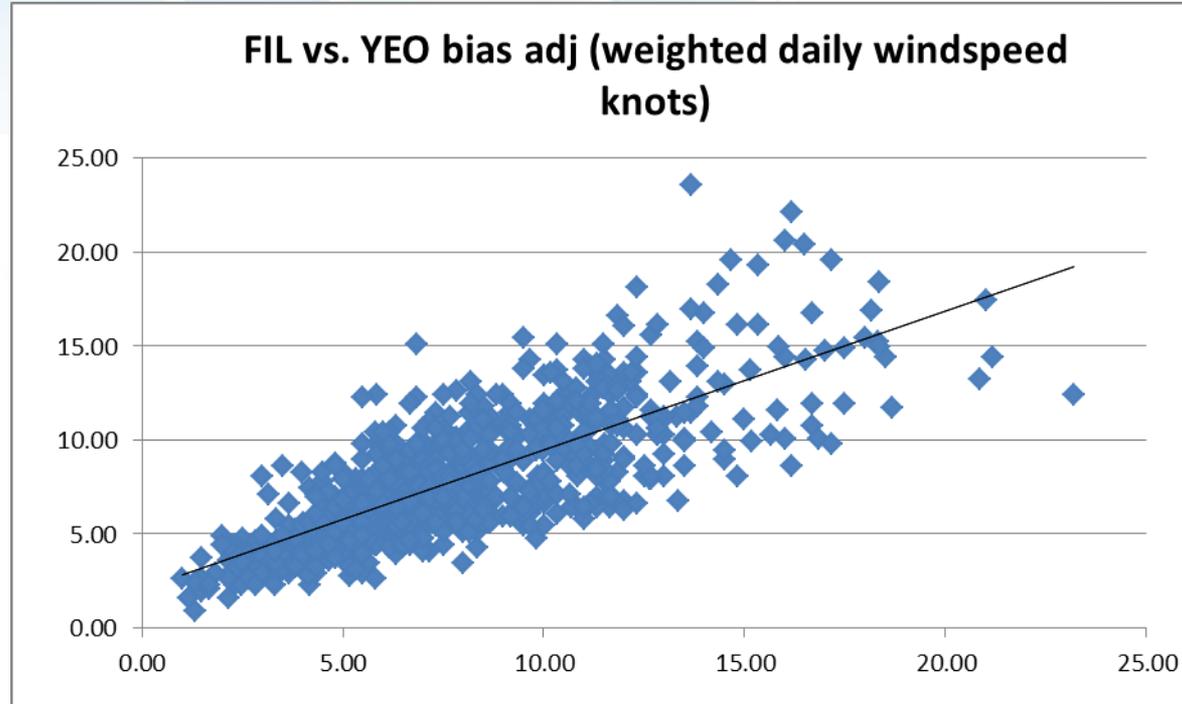
FIL vs. STA bias adjusted (chart above): $R^2 = 98.46\%$

FIL vs YEO Wind Speed - Results

Month	Average of YEO Weighted Wind	Average of YEO Weighted Wind adj	Average of FIL Weighted Wind
Jan	8.41	8.82	7.86
Feb	9.57	9.98	10.08
Mar	9.04	9.45	9.11
Apr	7.24	7.66	7.06
May	7.54	7.96	7.84
Jun	6.96	7.38	8.26
Jul	7.14	7.56	8.49
Aug	6.88	7.29	7.81
Sep	7.24	7.66	7.69
Oct	6.95	7.37	7.49
Nov	6.83	7.25	6.75
Dec	6.94	7.36	7.09
Overall	7.55	7.97	7.95

Note: the bias was calculated as an overall value for wind speed (not monthly). This table is for information only to show how each month performed on average.

FIL vs YEO Wind Speed - Results



FIL vs. YEO:

$R^2 = 59.30\%$

FIL vs. YEO bias adjusted (chart above):

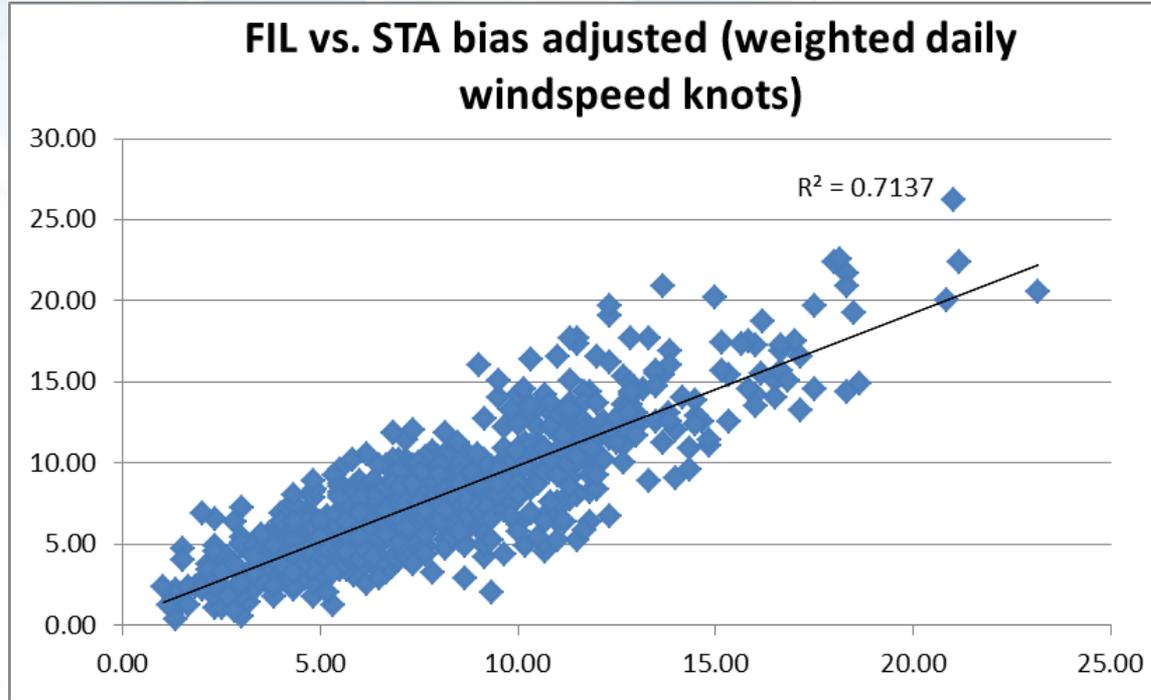
$R^2 = 59.30\%$

FIL vs STA Wind Speed - Results

Month	Average of STA Weighted Wind	Average of STA Weighted Wind adj	Average of FIL Weighted Wind
Jan	10.19	8.91	7.86
Feb	11.63	10.35	10.08
Mar	10.16	8.88	9.11
Apr	8.50	7.22	7.06
May	7.91	6.63	7.84
Jun	8.69	7.41	8.26
Jul	9.08	7.80	8.49
Aug	8.72	7.44	7.81
Sep	8.53	7.25	7.69
Oct	9.52	8.24	7.49
Nov	9.13	7.85	6.75
Dec	8.68	7.40	7.09
Overall	9.22	7.94	7.95

Note: the bias was calculated as an overall value for wind speed (not monthly). This table is for information only to show how each month performed on average.

FIL vs STA Wind Speed - Results



FIL vs. STA: $R^2 = 71.37\%$

FIL vs. STA bias adjusted (chart above): $R^2 = 71.37\%$

- Analysis using overlapping temperature data confirm both stations, YEO and STA are acceptable substitutes for FIL.
- Temperature bias adjustments have been calculated for both stations.
- Wind speed bias adjustments have also been calculated for both stations – YEO would only have a bias applied at night and STA would have a bias applied to all 4 time slots.

- Statistically, it appears that St Athan is the best substitute for Filton.
- Ultimately, the aim is to select the station which best mimics Filton until the time of re-optimising the parameters. There is the option of choosing St Athan for this role and then Yeovilton when we do CWV optimisation next year, to go live in 2020.
- The MET Office recommendations are as follows:
 - “*Lyneham is deemed too risky as there remains an ongoing risk of them shutting the building which gives us the power to that site.*
 - St Athan is moving from an MoD site to a civil aviation site and it is felt there are some risks around this as we are in negotiation to stay on site.*
 - Yeovilton seems the safest option”**
- DESC thoughts?

Next Steps

- Xoserve to engage with Wales & West Utilities and Meteogroup to make necessary arrangements
- Xoserve to provide further correspondence and publish bias adjustments asap.