Appendix D   Colocation: AQMesh vs Chemiluminescence

Figure D below shows the orthogonal regression between hourly mean nitrogen dioxide (NO_2) concentrations measured at the fixed monitoring sites detailed in Section 3.2 (chemiluminescence) versus NO_2 concentrations as measured by both the LOW and HIGH AQMesh samplers (note that LOW and HIGH are only used as labels for the samplers in this case – both samplers were measuring NO_2 at the same height as the chemiluminescence analyser). The results of this regression are detailed in Table D. A total of 315 data pairs were recorded by both LOW and HIGH samplers with calculated between-sampler uncertainties of 22.09 μg m^{-3} and 18.68 μg m^{-3}, and moderate r^2 of 0.577 and 0.505, respectively. Only two outliers were identified in the data set. The calculated slopes of the regression lines for the LOW and HIGH samplers are 1.641 and 1.333 with intercepts of -11.108 μg m^{-3} and -6.400 μg m^{-3}, respectively, all of which are determined as significant. All NO_2 data recorded by both AQMesh samplers were therefore corrected for both slope and intercept using the following equations:

$$C_{L-Adj} = \frac{C_L + 11.108}{1.641}$$

(D1)

$$C_{H-Adj} = \frac{C_H + 6.400}{1.333}$$

(D2)

Where:

C_{L-Adj} is the corrected NO_2 concentrations as measured by the LOW AQMesh sampler.

C_{H-Adj} is the corrected NO_2 concentrations as measured by the HIGH AQMesh sampler.

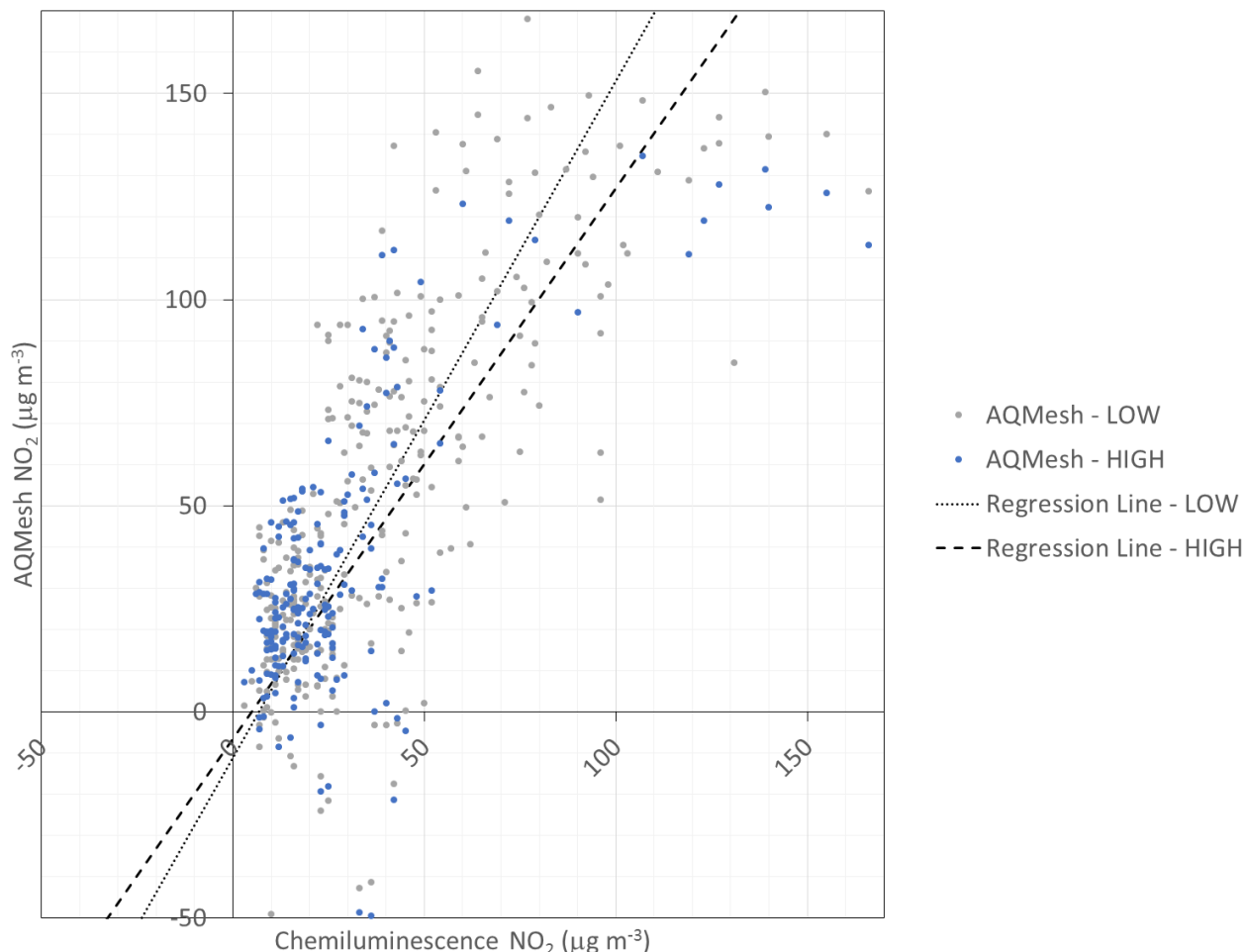**Figure D Chemiluminescence vs AQMesh Regression – NO$_2$**

Table D Chemiluminescence vs AQMesh Regression Results – NO$_2$

AQMesh NO$_2$	1 hour		Orthogonal Regression			No of Data Pairs Rejected
	n_{bs}	u_{bs}	r^2	Slope (b) ± u_b	Intercept (a) ± u_a	
LOW	315	22.09	0.577	*1.641 ± 0.054*	*-11.108 ± 2.602*	2 (0.6%)
HIGH	315	18.68	0.505	*1.333 ± 0.049*	*-6.400 ± 2.359*	2 (0.6%)

The corrected colocation data and associated regression results are shown in Figure D and Table D below. The calculated between-sampler uncertainties of the corrected LOW and HIGH sampler data are 22.09 μg m^{-3} and 18.68 μg m^{-3}, respectively. The calculated slopes of the regression lines for the LOW and HIGH samplers are 0.862 and 0.891 with intercepts of 5.288 μg m^{-3} and -0.634 μg m^{-3}, respectively.

The NO$_2$ sensor used in the AQMesh suffers from cross sensitivity with ozone (O$_3$) resulting in an overestimation of NO$_2$ concentrations at higher O$_3$ concentrations. This overestimation can be seen in the regression results above. It can also be seen in the corrected data in Figure D below that at higher concentrations the AQMesh samplers begin to underestimate NO$_2$ concentrations compared to the chemiluminescence analyser, inferring a non-linear response. However, due to the absence of accurate O$_3$ data to correct for the cross sensitivity, this approach has been determined as most appropriate. The associated relative

expanded uncertainty versus NO_2 concentration using the orthogonal regression corrected data is shown in Figure D. This corresponds to a relative expanded uncertainty of 31% and 32% at the hourly mean objective concentration of 200 μg m^{-3} as measured by the LOW and HIGH AQMesh samplers, respectively.

For completeness, a time series plot of hourly mean NO_2 concentrations at Glasgow Townhead, Glasgow Kerbside and corrected NO_2 concentrations measured by the AQMesh samplers is shown in Figure D. The plot is split into two colours depending on where the colocation was being carried out: blue for Glasgow Kerbside and orange for Glasgow Townhead. Numbers 1 to 4 at the top of the plot are the first 4 colocation exercises carried out on 14/02/2014, 25/04/2014, 17/07/2014 and 19/08/2014. In general, the AQMesh data follow the trends in NO_2 seen at the two fixed sites.

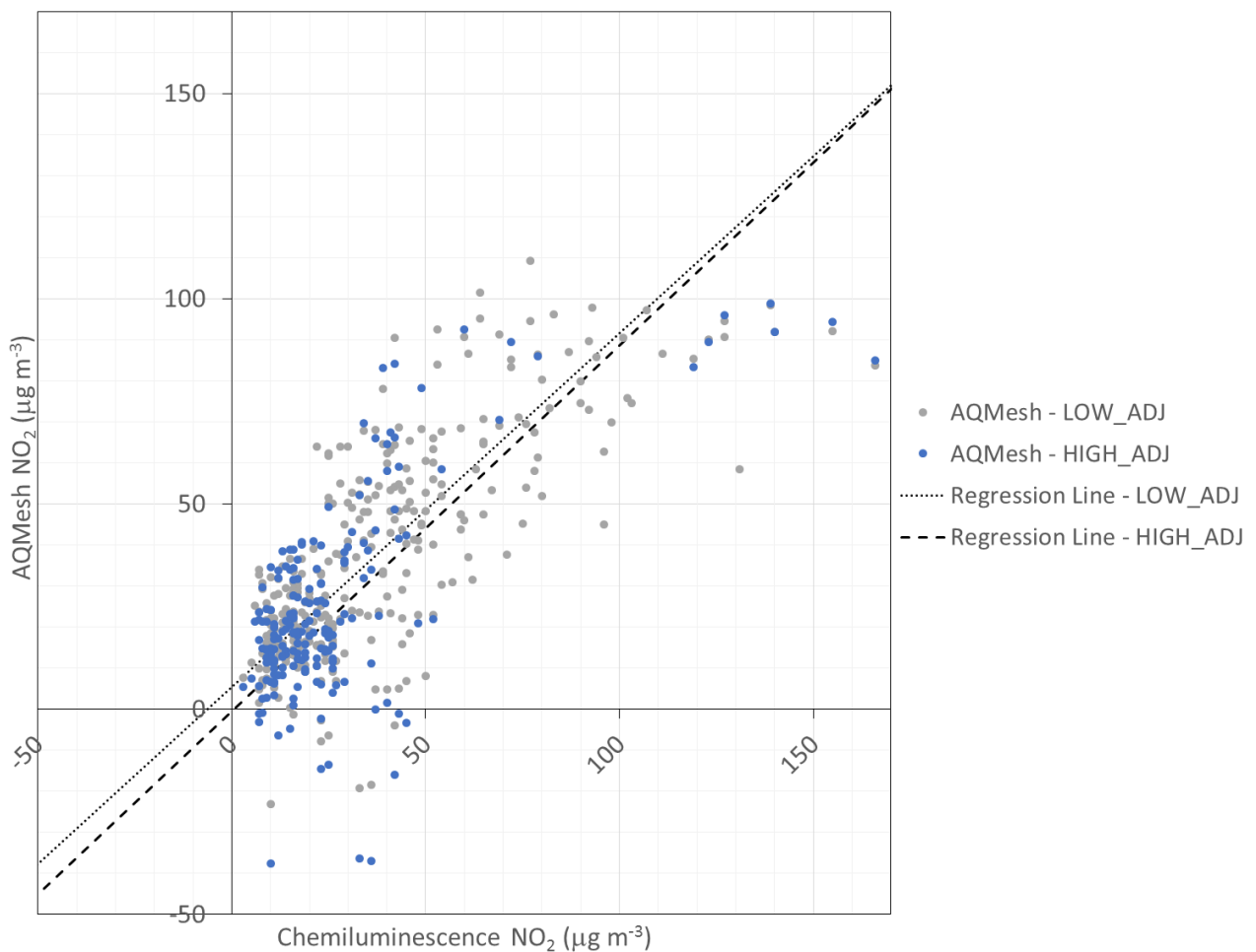*Figure D Chemiluminescence vs Corrected AQMesh Regression – NO_2*

Table D Chemiluminescence vs Corrected AQMesh Regression Results – NO_2

AQMesh NO_2	1 hour		Orthogonal Regression		
	n_{bs}	u_{bs}	r^2	Slope (d) $\pm u_d$	Intercept (c) $\pm u_d$
LOW_ADJ	315	13.78	0.577	0.862 ± 0.033	5.288 ± 1.586
HIGH_ADJ	315	15.62	0.505	0.891 ± 0.037	-0.634 ± 1.770

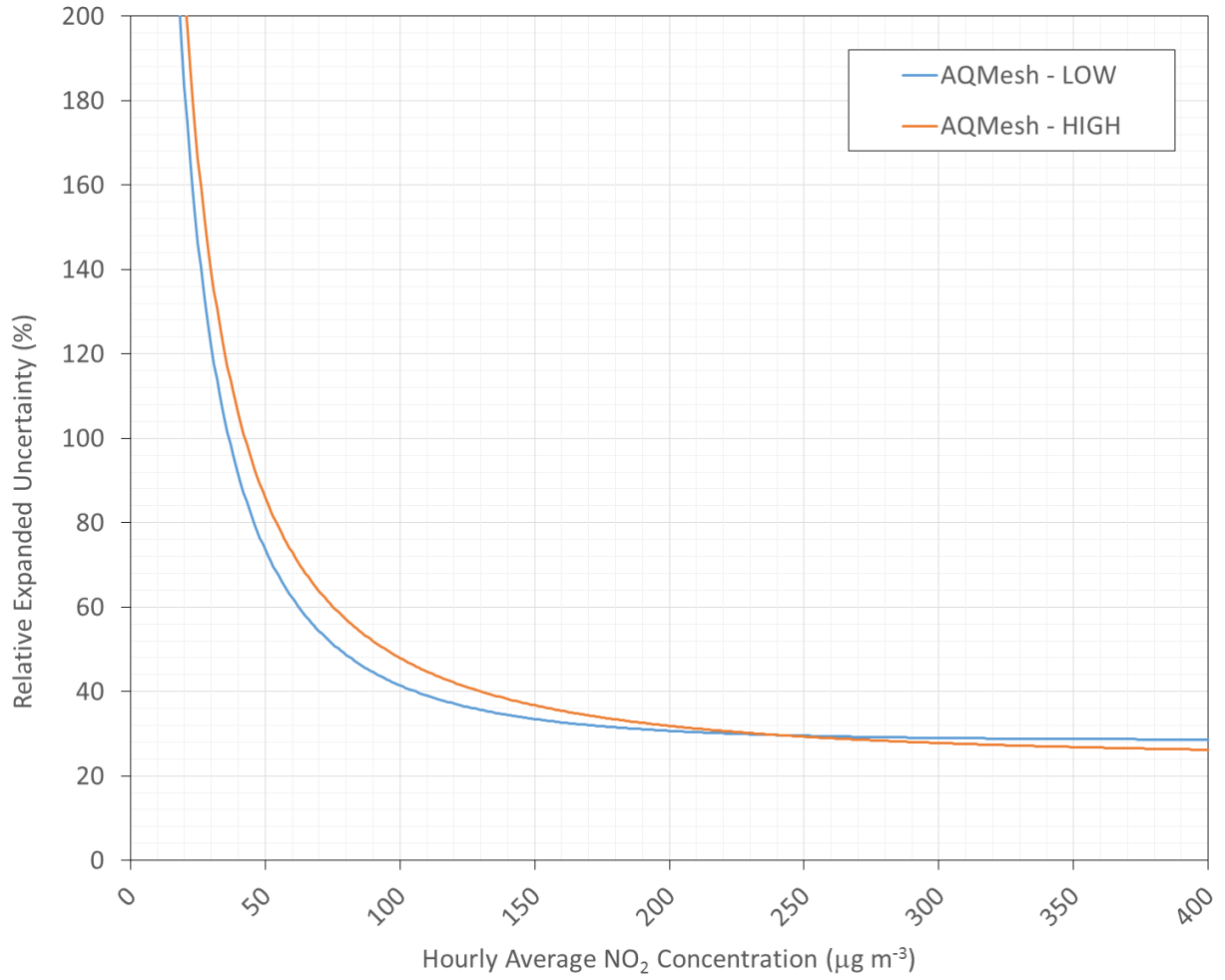**Figure D AQMesh Relative Expanded Uncertainty – NO₂**

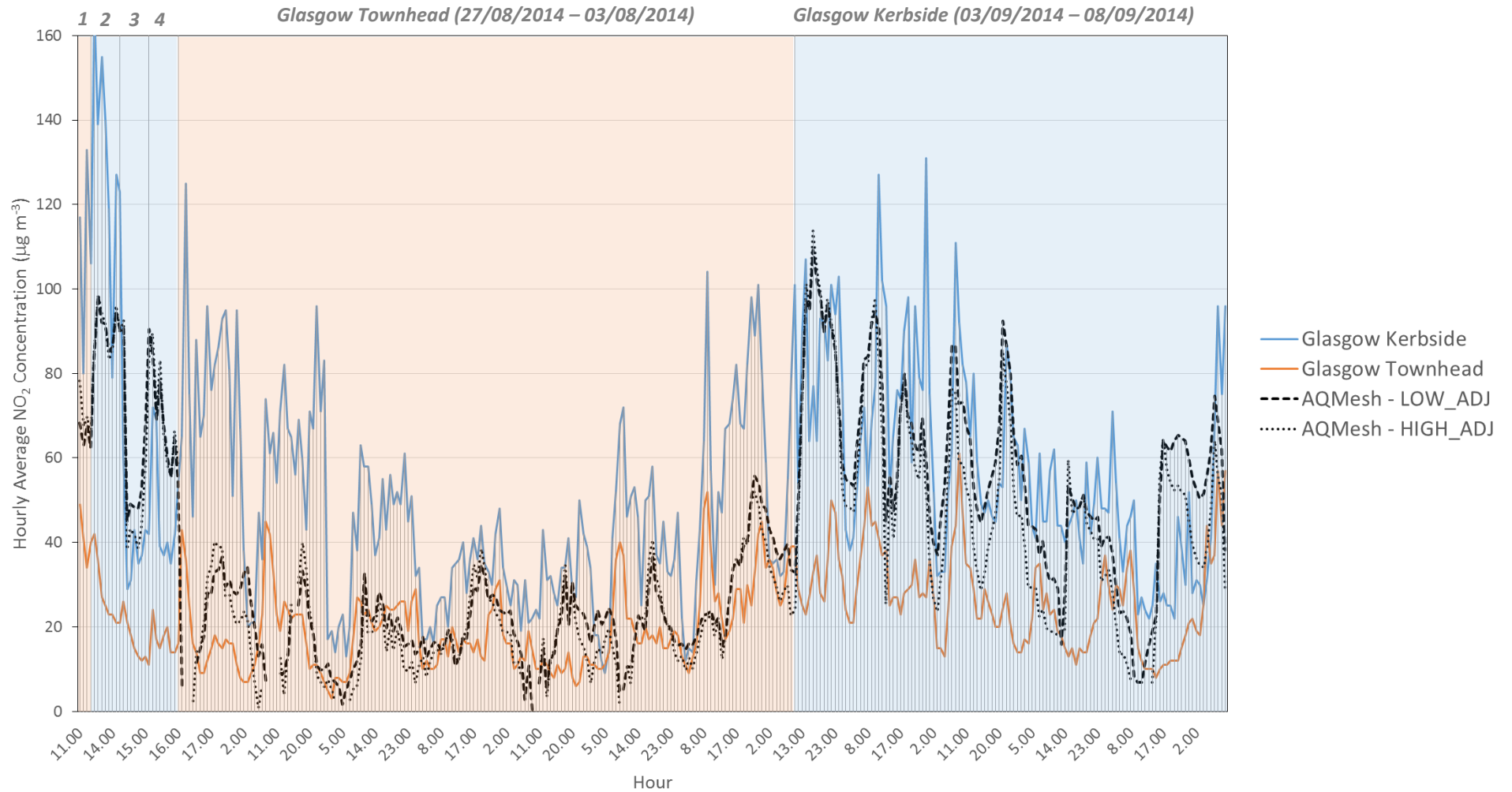*Figure D Chemiluminescence vs Corrected AQMesh Time-series – NO$_2$*

Figure D below shows the orthogonal regression between hourly mean nitric oxide (NO) concentrations measured at the fixed monitoring sites detailed in Section 3.2 (chemiluminescence) versus NO concentrations as measured by both the LOW and HIGH AQMesh. The results of this regression are detailed in Table D. A total of 326 data pairs were recorded by both LOW and HIGH samplers with calculated between-sampler uncertainties of 32.70 μg m^{-3} and 27.62 μg m^{-3}, and strong r^2 of 0.832 and 0.794, respectively. Only 5 and 10 outliers were identified in each data set. The calculated slopes of the regression lines for the LOW and HIGH samplers are 0.832 and 0.794 with intercepts of -18.514 μg m^{-3} and -8.098 μg m^{-3}, respectively, all of which are determined as significant. All NO data recorded by both AQMesh samplers were therefore corrected for both slope and intercept using the following equations:

$$C_{L-Adj} = \frac{C_L + 18.514}{0.832}$$

(E1)

$$C_{H-Adj} = \frac{C_H + 8.098}{0.794}$$

(E2)

Where:

C_{L-Adj} is the corrected PM$_{2.5}$ concentrations as measured by the LOW Lighthouse sampler.

C_{H-Adj} is the corrected PM$_{2.5}$ concentrations as measured by the HIGH Lighthouse sampler.

Figure D Chemiluminescence vs AQMesh Regression – NO

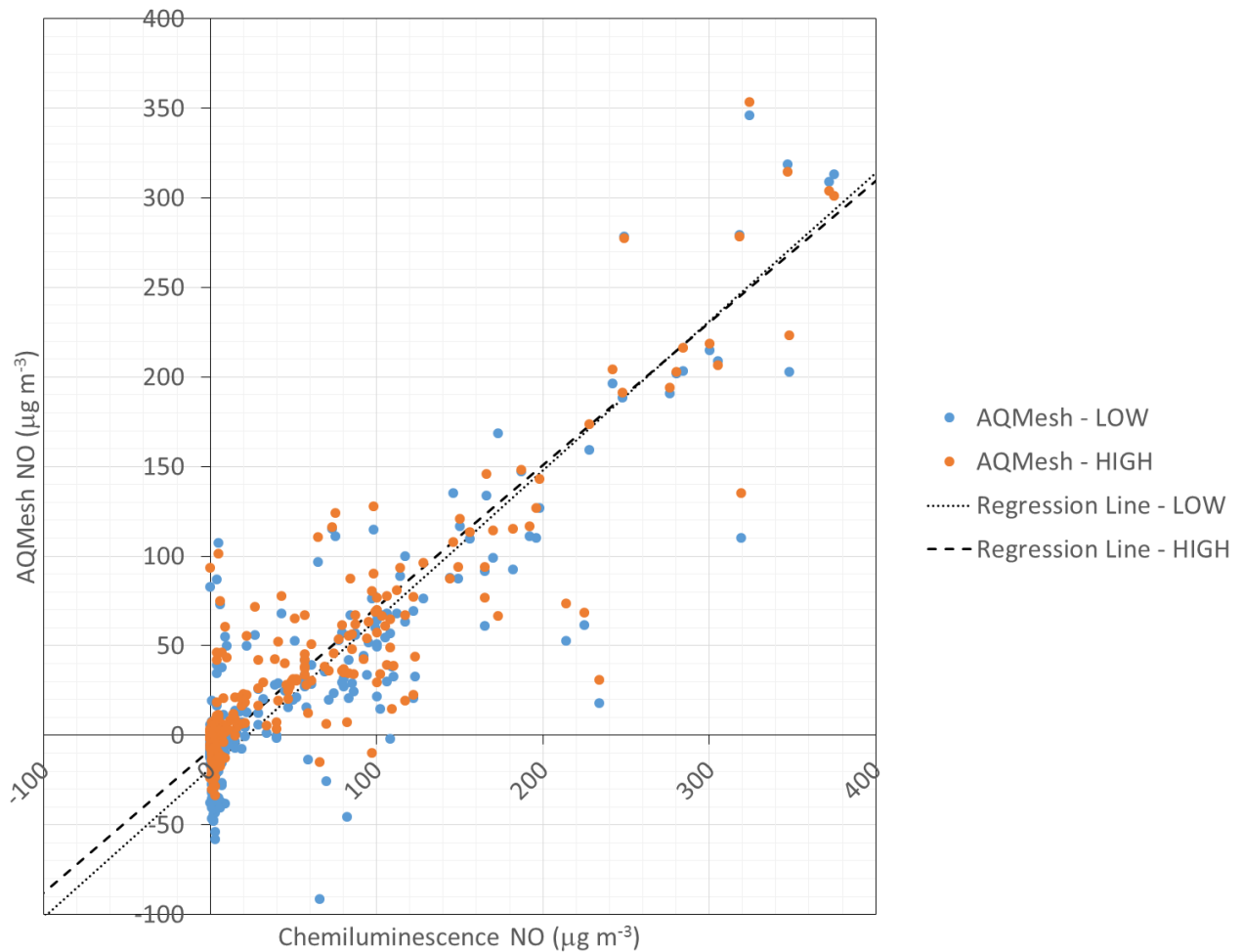*Table D Chemiluminescence vs AQMesh Regression Results – NO*

AQMesh NO	1 hour		Orthogonal Regression			No of Data Pair Rejected
	n_{bs}	u_{bs}	r^2	Slope (b) ± u_b	Intercept (a) ± u_a	
LOW	326	32.70	0.796	*0.832 ± 0.021*	*-18.514 ± 2.084*	5 (1.5%)
HIGH	326	27.62	0.838	*0.794 ± 0.018*	*-8.098 ± 1.772*	10 (3.1%)

The corrected colocation data and associated regression results are shown in Figure D and Table D below. The calculated between-sampler uncertainties of the corrected LOW and HIGH sampler data are 18.83 μg m^{-3} and 17.98 μg m^{-3}, respectively. The calculated slopes of the regression lines for the LOW and HIGH samplers are 1.012 and 1.016 with intercepts of 0.718 μg m^{-3} and -0.761 μg m^{-3}, respectively.

The associated relative expanded uncertainty versus NO concentration using the orthogonal regression corrected data is shown in Figure D. This corresponds to a relative expanded uncertainty of 27% and 26% at the hourly mean concentration of 200 μg m^{-3} as measured by the LOW and HIGH AQMesh samplers, respectively.

For completeness, a time series plot of hourly mean NO concentrations at Glasgow Townhead, Glasgow Kerbside and corrected NO concentrations measured by the AQMesh

samplers is shown in Figure D. The plot is split into two colours depending on where the colocation was being carried out: blue for Glasgow Kerbside and orange for Glasgow Townhead. Numbers 1 to 4 at the top of the plot are the first 4 colocation exercises carried out on 14/02/2014, 25/04/2014, 17/07/2014 and 19/08/2014. In general, the AQMesh data follow the trends in NO seen at the two fixed sites.

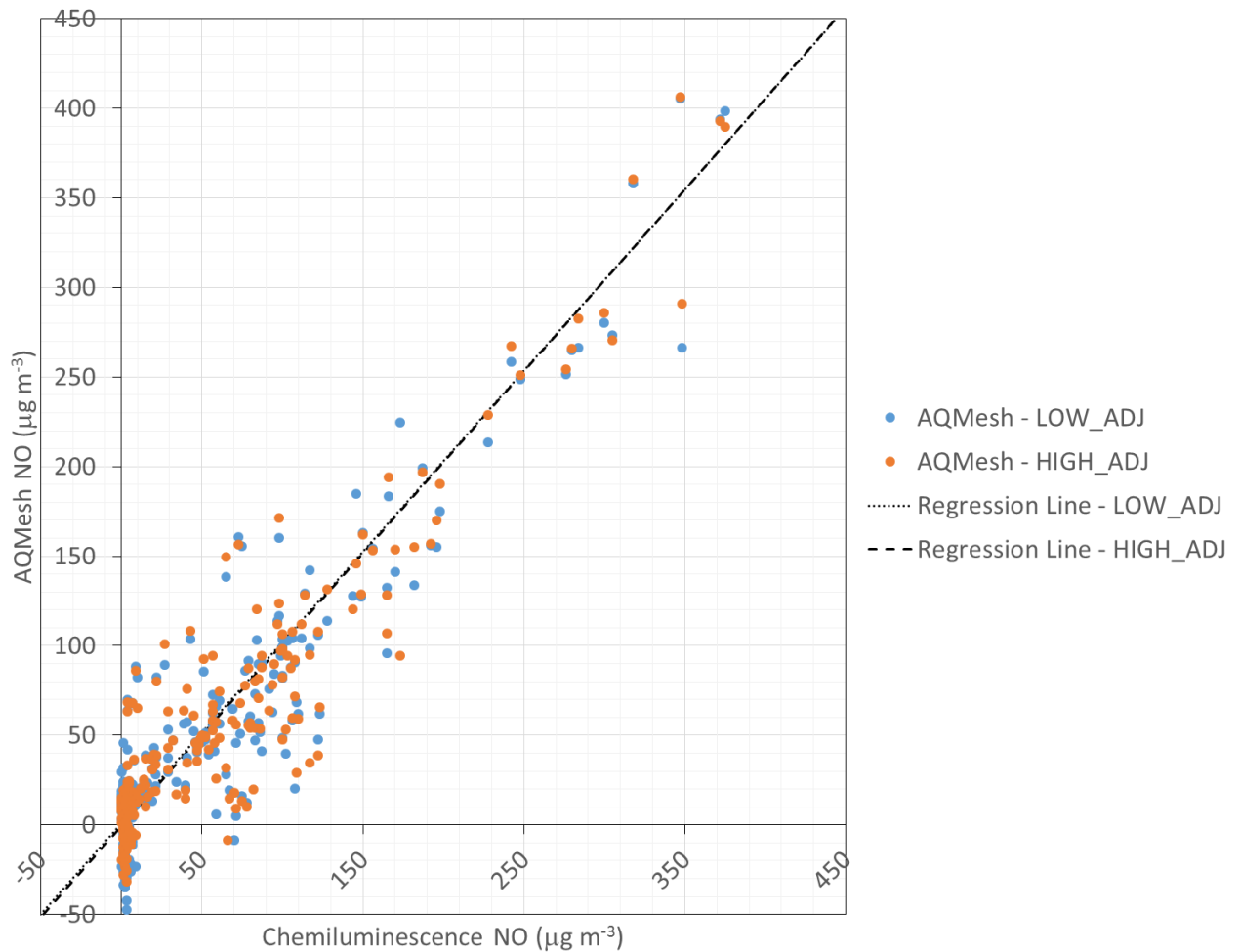*Figure D Chemiluminescence vs Corrected AQMesh Regression – NO*

Table D Chemiluminescence vs AQMesh Regression Results – NO

AQMesh NO	1 hour		Orthogonal Regression		
	n_{bs}	u_{bs}	r^2	Slope (d) ± u_d	Intercept (c) ± u_c
LOW_ADJ	326	18.83	0.895	1.012 ± 0.019	0.718 ± 1.776
HIGH_ADJ	326	17.98	0.903	1.016 ± 0.018	-0.761 ± 1.697

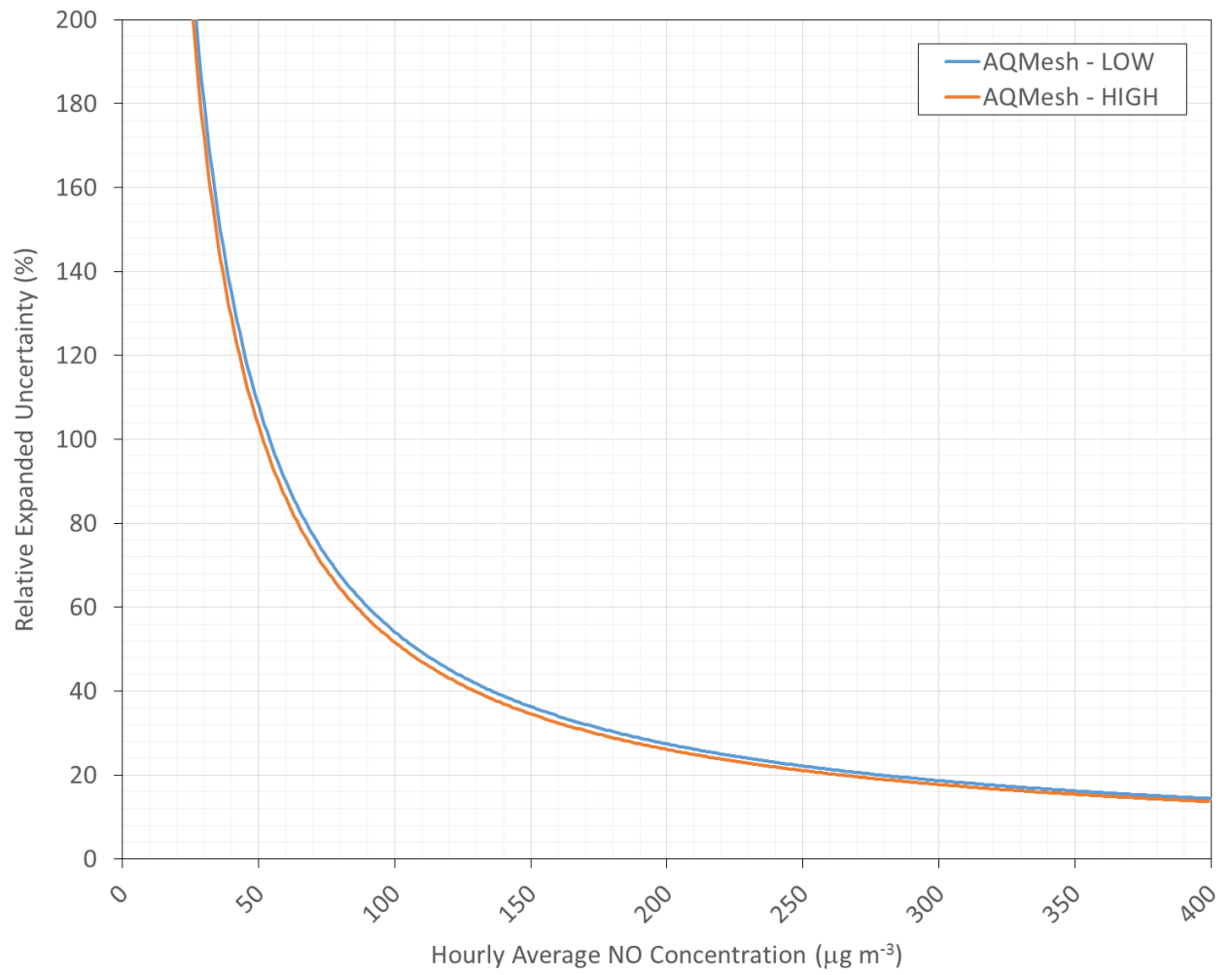*Figure D AQMesh Relative Expanded Uncertainty – NO*

Figure D Chemiluminescence vs Corrected AQMesh Time-series – NO