

Microscale Siting Study

AQMesh Pods

Introduction

The Breathe London stationary sensor network consists of 100 standard AQMesh monitoring pods mounted to various lampposts and buildings across the city. The pods that comprise the network are referred to as “candidate” pods. Some concern was raised during the first year of the project that the proximity of certain pods to building facades could affect the measured concentrations of some pollutants. Available, best-practice guidance on microscale siting of air quality sampling points indicates that when practicable, the inlet of a sampling probe shall be positioned metres away from the nearest building or obstruction and at least 0.5 m from the nearest building to represent pollution at the building line.¹

In order to determine if having a candidate pod that didn't meet the minimum of 0.5 m criterion affected the accuracy of the measurements the decision was made to co-locate an additional “gold” pod at three sites where candidate pods were mounted close, within 0.3 m or less, to the facade of buildings. Gold pods are standard AQMesh pods which have been previously co-located at one or more reference monitors, qualifying as transfer standards, and can be moved around the network to verify the performance of candidate pods. The gold pods installed at each location were mounted on an extendable arm that initially was retracted so that the pods were within 0.3 m of each other and within 0.3 m from the facade. The arm was then extended, which separated the pods by at least 1.2 m from both each other and the building facade. NO₂ and PM_{2.5} concentrations were compared at each of these three test locations. These pollutants were selected because measurements were displayed directly to the public in near-real time (within 1-hour of measurement) on the Breathe London platform.

Time series for each location and pollutant

Below are the characteristics of the three sites selected for the microscale siting study along with the corresponding time series comparing the gold and candidate pods, presented as one-hour averages of pre-scaled (uncalibrated) data. The hourly average concentrations for both before and after extending the pods away from the building facades are shown in the time series plots. Each microscale siting study was carried out for 4 - 10 weeks.

¹ Directive 2008/50/EC of the European Parliament and of the Council
<https://www.legislation.gov.uk/eudr/2008/50/annex/iii/division/c/adopted> (accessed 15/10/20)

1. Ellenborough Road, Haringey, London

- Urban background site located at a primary school.²
- Co-location began on 8th October 2019 and the gold pod was extended on 13th November 2019. The study period ended on 29th November 2019.

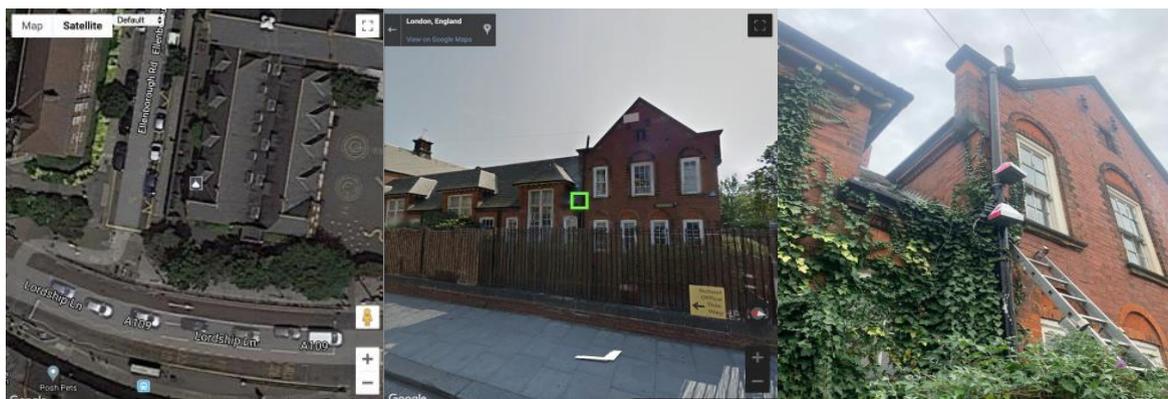


FIGURE 1

In order of left to right: Google Maps aerial view of the Ellenborough Road candidate pod site denoted by the white monitor icon near the centre of the image [51.59837° N, 0.095381° W]. The distance to the nearest road is 6.4 m. Google Maps street view with monitor identified by the green square near the centre of the image. The pod is located at 3.5 m above the ground. Photo of the candidate pod (bottom) co-located with a gold pod (top). The pods were mounted to a drainpipe and run off mains power supply. The pods are positioned 0.3 m apart (as shown) for an initial duration of 5 weeks.

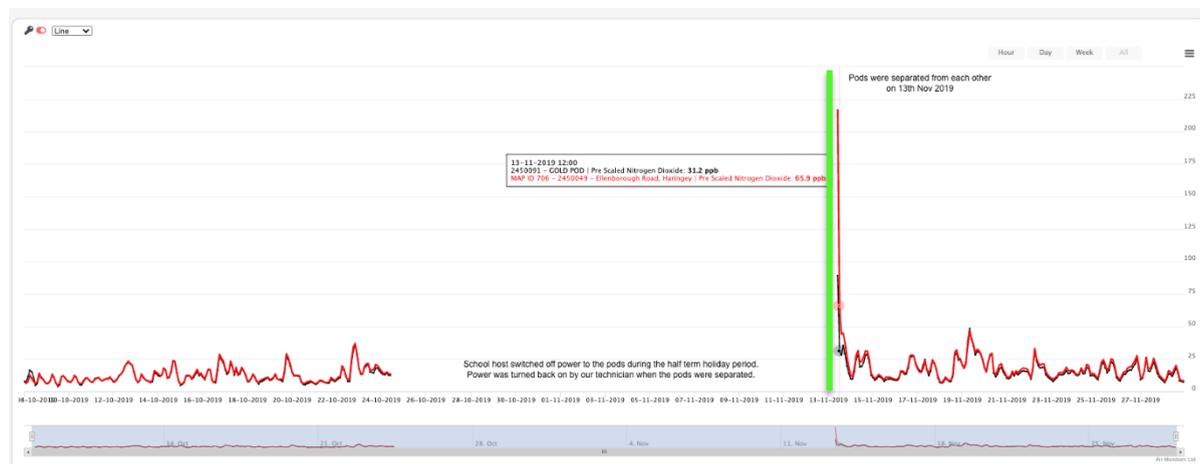


FIGURE 2

Time series of hourly averaged, pre-scaled (uncalibrated) NO₂ data (ppb) at the candidate pod (red line) and gold pod (black line) located on Ellenborough Road, Haringey, London between 8th October 2019 and 29th November 2019. The vertical green line shows the point at which the pods were separated from each other to more than 1.2 m, on 13th November 2019. The gap in the data is a result of the host switching off the power to the pods during the half term holiday period.

² Defined as an urban location distanced from pollution sources and therefore broadly representative of citywide background conditions.

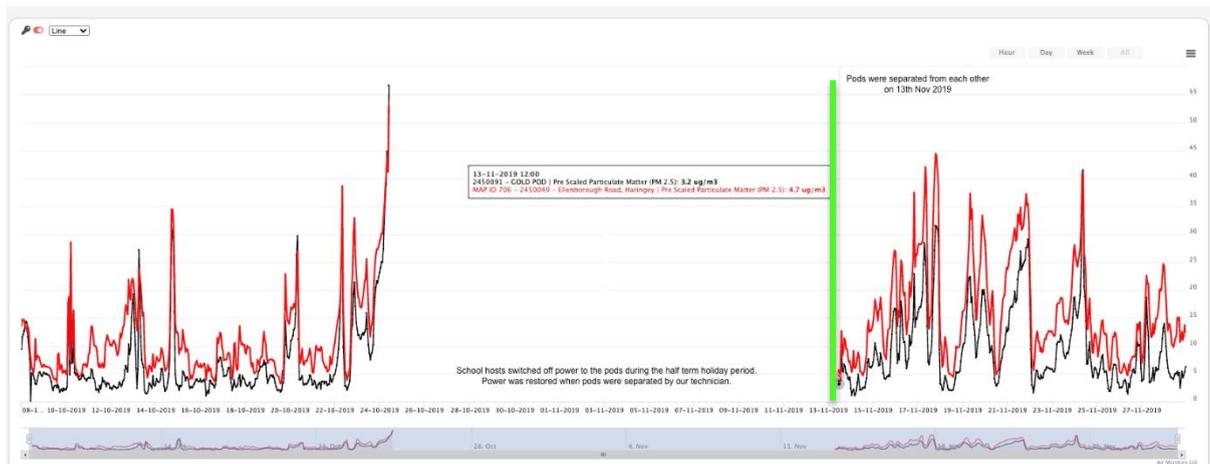


FIGURE 3
Time series of hourly averaged, pre-scaled (uncalibrated) PM_{2.5} data, in micrograms per cubic metre (µg/m³), at the candidate pod (red line) and gold pod (black line) located on Ellenborough Road, Haringey, London between 8th October 2019 and 29th November 2019. The vertical green line shows the point at which the pods were separated from each other on 13th November 2019. The gap in the data is a result of the host switching off the power to the pods during the half term holiday period.

2. Geraldine Street, Southwark, London

- Urban background site located at a primary school.
- Co-location began on 14th October 2019 and the gold pod was extended on 29th October 2019. The study period ended on 13th November 2019.

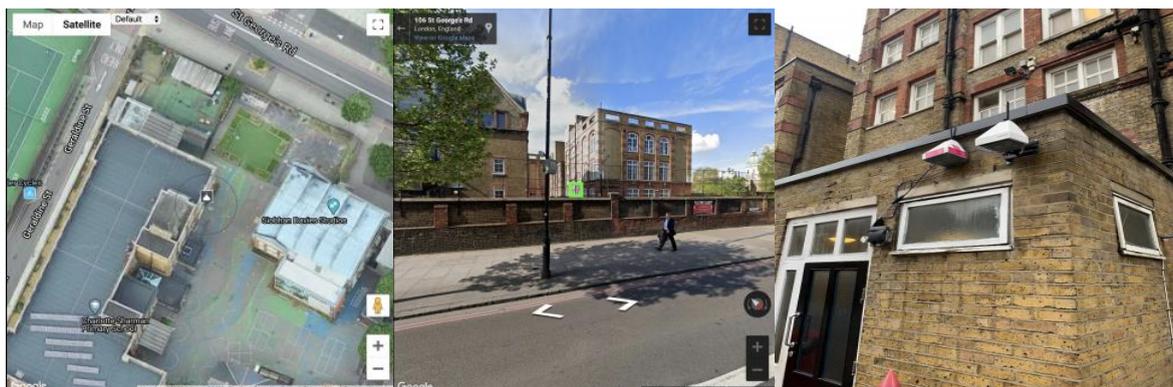


FIGURE 4
In order of left to right: Google Maps aerial view of the Geraldine Street candidate pod site denoted by the white monitor icon near the centre of the image [51.496114° N, 0.10559° W]. The distance to the nearest road is 21 m. Google Maps street view with monitor identified by the green square near the centre of the image. The pod is located at 3.5 m above the ground. Photo of the candidate pod (left) co-located with a gold pod (right). The pods were mounted to the building facade and run off mains power supply. The pods were located 2.2 m above ground and positioned 0.3 m apart (as shown) for an initial duration of 3 weeks.

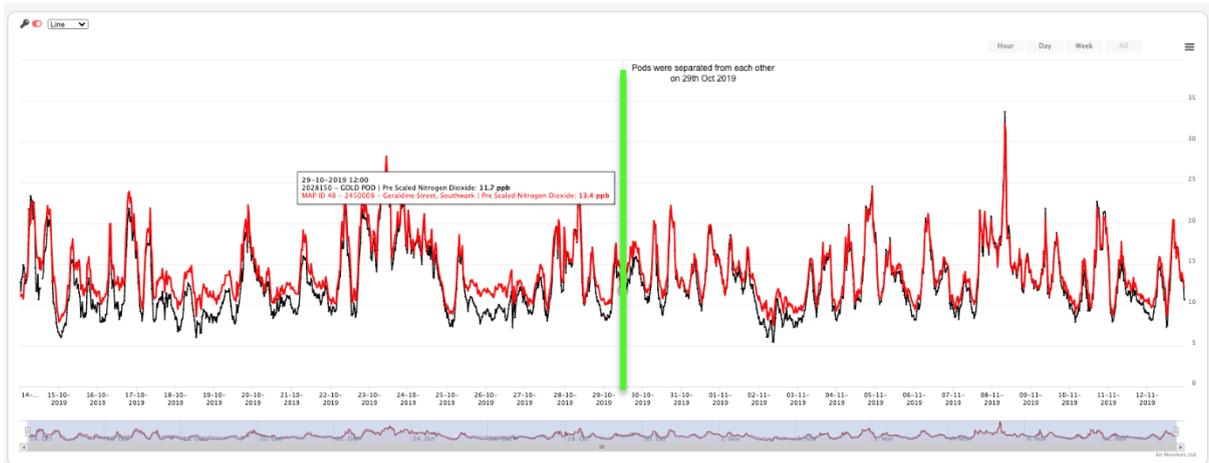


FIGURE 5
Time series of hourly averaged, pre-scaled (uncalibrated) NO₂ data (ppb) at the candidate pod (red line) and gold pod (black line) located on Geraldine Street, Southwark, London between 14th October 2019 and 13th November 2019. The vertical green line shows the point at which the pods were separated from each other on 29th October 2019.

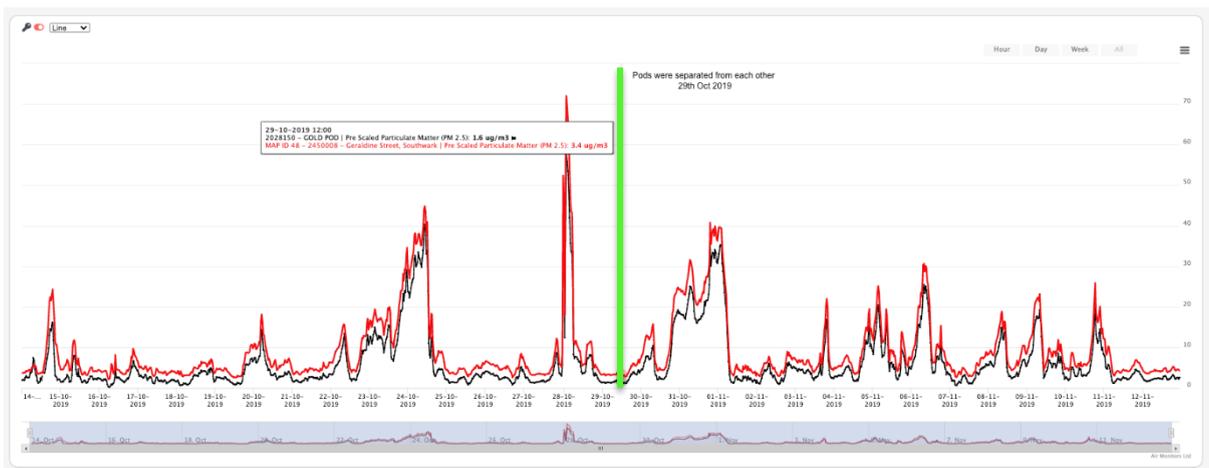


FIGURE 6
Time series of hourly averaged, pre-scaled (uncalibrated) PM_{2.5} data (µg/m³) at the candidate pod (red line) and gold pod (black line) located on Geraldine Street, Southwark, London between 14th October 2019 and 13th November 2019. The vertical green line shows the point at which the pods were separated from each other on 29th October 2019.

3. Beckenham Lane, Bromley, London

- Urban traffic site classification located at a primary school.³
- Co-location began on 16th September 2019 and the gold pod was extended on 13th November 2019. The co-location ended on 29th November 2019.

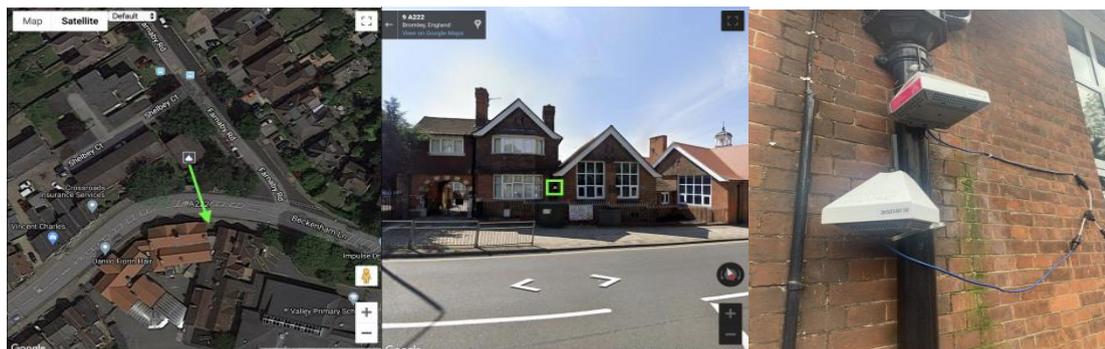


FIGURE 7

In order of left to right: Google Maps aerial view of the Beckenham Lane candidate pod site denoted by the white monitor icon near the centre of the image [51.4073728° N, 0.0057789° E]. The distance to the nearest road is 4 m. Google Maps street view of the monitor identified by the green square near the centre of the image. The pod is located 3 m above the ground. Photo of the candidate pod (top) co-located with a gold pod (bottom). The pods were mounted to a drainpipe and run off mains power supply. The pods were positioned 0.3 m apart (as shown) for an initial duration of 8 weeks.

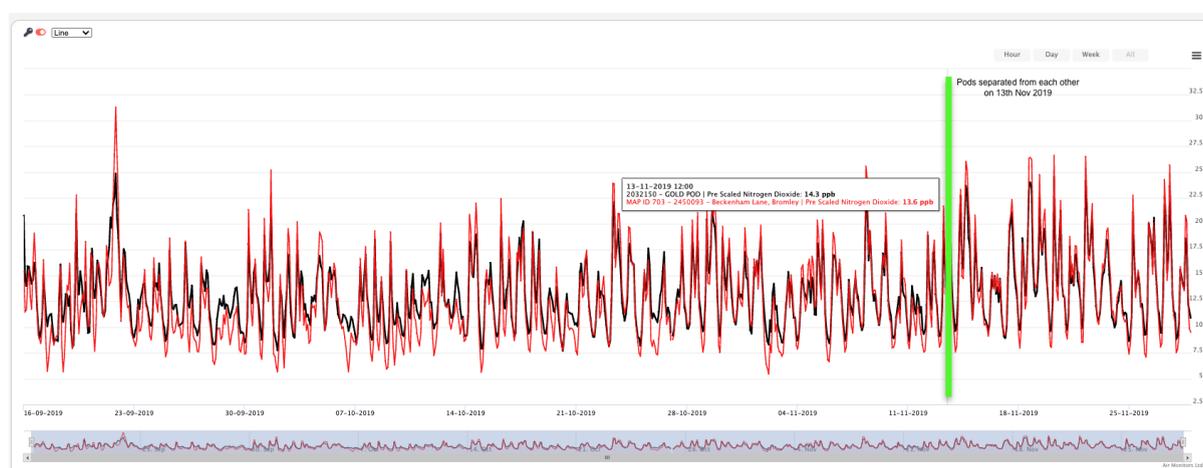


FIGURE 14

Time series of hourly averaged, pre-scaled (uncalibrated) NO₂ data (ppb) at the candidate pod (red line) and gold pod (black line) located on Beckenham Lane, Southwark, London between 16th September 2019 and 29th November 2019. The vertical green line shows the point at which the pods were separated from each other on 13th November 2019.

³ Defined as a site in an urban area at least 25 m from the edge of major junctions and no more than 10 m from the kerbside.

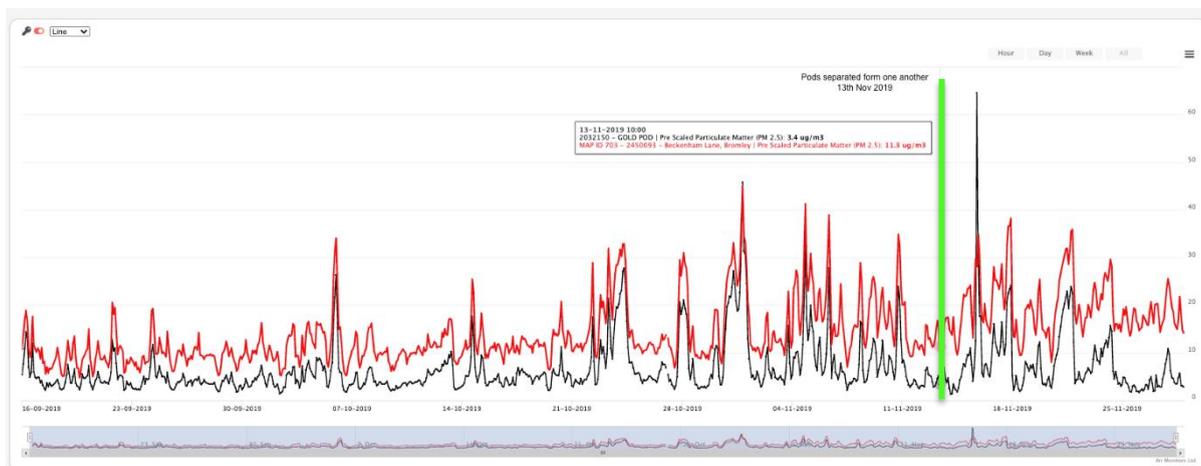


FIGURE 15
Time series of hourly averaged, pre-scaled (uncalibrated) PM_{2.5} data (µg/m³) at the candidate pod (red line) and gold pod (black line) located on Beckenham Lane, Southwark, London between 16th September 2019 and 29th November 2019. The vertical green line shows the point at which the pods were separated from each other on 13th November 2019.

Results, Discussion, and Conclusions

As can be seen there is no apparent step change in concentrations when the configuration of the pods was altered as would be the case if the results were significantly affected by the proximity to the building facade. In order to determine if there were more subtle differences at play, the data was analysed for both periods and the ratio between each pair of devices at each of the three locations was calculated (see Table 1).

The results of the study were inconclusive. Three of the pollutants studied increased slightly in concentration when extended away from the building facades and three decreased. Except for PM_{2.5} at Beckenham Lane, all changes were relatively small and most likely within the uncertainty of measurement, estimated to be in the region of 25% for NO₂ and 50% for PM_{2.5}.⁴ In other words, it is suspected that the uncertainty inherent in these sensors is greater than the effects seen by positioning the pods less than 0.5 m from the building facade. There is no clear explanation of why the Beckenham Lane pod ratio for PM_{2.5} decreased by almost 19%, indicating that this may require further investigation by using the network calibration method ([Appendix 2](#)). Overall, based on data collected during this study, and due to the substantial uncertainty of measurement estimated for these sensors, it has not been possible to ascertain whether there is a significant or systematic difference between measurements from pods located close to the building facade (within 0.5 m) with approximately 180 degrees of open aspect, and those extended more than 0.5 m away (approximately 1.2 m away), with at least 270 degrees of open aspect as stated in the UK and

⁴ Draft standards for small sensor systems carrying out indicative measurements by the European Committee for Standardization (CEN) Working Group 42 suggest allowed uncertainties will be in the region of 25% for each gaseous pollutant species and 50% for PM_{2.5}

EU good practice guidance.⁵ Further studies are recommended for a more extended period of time; across different times of year; at pods in areas where pollution levels are elevated and variable; and during high pollution events.

TABLE 1

Co-location ratios derived to show the overall percent (%) change between the average concentration measured by the gold pod and candidate pod when co-located (0.3 m distance) and separated (> 1.2 m) for both NO₂ and PM_{2.5}.

MICROSCALE SITING RESULTS		NO₂				
		Average Conc. (ppb)		Gold / Candidate Ratio		
Location	POD #	Co-Located	Separated	Co-Located	Separated	Change %
Ellenborough Road Candidate	2450049	24.13	34.3	0.95	0.92	-2.9%
Ellenborough Road Gold	2450091	22.85	31.53			
Geraldine Street Candidate	2450008	27.33	26.52	0.88	0.95	7.3%
Geraldine Street Gold	2028150	24.1	25.09			
Beckenham Lane Candidate	2450093	23.33	28.67	1.05	0.99	-6.0%
Beckenham Lane Gold	2032150	24.49	28.28			
		PM_{2.5}				
		Average Conc (µg/m ³)		Gold / Candidate Ratio		
		Co-Located	Separated	Co-Located	Separated	Change %
Ellenborough Road Candidate	2450049	11.3	17.12	0.61	0.62	1.4%
Ellenborough Road Gold	2450091	6.89	10.59			
Geraldine Street Candidate	2450008	8.5	9.7	0.66	0.70	6.0%
Geraldine Street Gold	2028150	5.62	6.8			
Beckenham Lane Candidate	2450093	13.23	19.5	0.49	0.39	-18.8%
Beckenham Lane Gold	2032150	6.43	7.7			

⁵ JRU-AQUILA Position Paper, Assessment on siting criteria, classification and representativeness of air quality monitoring stations, <https://www.legislation.gov.uk/eu/dr/2008/50/annex/iii/division/c/adopted>

