

## Diffusion Tubes

Diffusion tubes are small glass tubes which are mounted on clips onto posts or fences and contain a filter that absorbs the nitrogen dioxide in the air. They are left in situ for a minimum of 3 weeks to a maximum of 5 weeks. Once collected they then have to be sent to a laboratory who analyse the filters and email the data to you.

### Equipment

- Diffusion tubes – these need to be ordered from a science lab a couple of weeks ahead of siting them. They must be kept in a fridge in a sealed bag in a box. The tubes have a 12-week lifespan (including analysis time, which is usually a couple of weeks).
- Form to record exposure times (comes with diffusion tubes)
- Pen
- Stickers with unique number and QR code (come with diffusion tubes)
- Mounting clips – order these with the tubes
- Cable ties
- Scissors
- Sealable bag and box to store diffusion tubes
- Access to a refrigerator where the tubes can be stored without interference.
- Ladder (if you wish to place them above a height you can reach)
- Optional: Map of the school location (you can quickly generate a clear map by inputting school postcode into DorsetExplorer ([geowessex.com](http://geowessex.com)) and on the 'Bae maps' option which is second icon down on the right, select either 'Ordnance survey' or 'OpenStreetMap').

### Instructions

1. Keep the tubes in the fridge in a sealed plastic bag/ container.
2. Decide where to site the tubes (see recommendations) and get children to mark these on the map.
3. Use one tube as a blank – take it with you in its plastic tube when you put the tubes up and take them down but keep it in the fridge in a sealed bag in the meantime, don't take the cap off, and return to the lab with the others.
4. Once ready to site the tubes, remove one diffusion tube from its plastic tube. Keep the plastic tube and lid for the safe return to the lab. Place the sticker onto the tube and the duplicate sticker onto the recording form.



(Plastic tube containing the diffusion tube)

diffusion tube monitoring record					
Customer:		Contact:			
Address:		Contact email:			
		Contact Tel No:	Account No:		
		Lab Ref:			
Type of Tube:	Lot No:	Bar Codes:			
Purchase Order No:	SOR number:	Date of dispatch:			
TO BE COMPLETED BY CUSTOMER					
Email address for reports to be sent to:					
Contact Name:		Customer Reference/ Job Number:			
Inorganics - Analysis Required:					
Nitrogen Dioxide (NO <sub>2</sub> ) <input type="checkbox"/>	Nitric Oxide (NO <sub>x</sub> ) <input type="checkbox"/>	Nitrogen Dioxide/ Sulphur Dioxide <input type="checkbox"/>	Sulphur Dioxide (SO <sub>2</sub> ) <input type="checkbox"/>		
Hydrogen Sulphide (H <sub>2</sub> S) <input type="checkbox"/>	Ammonia (NH <sub>3</sub> ) <input type="checkbox"/>	Ozone (O <sub>3</sub> ) <input type="checkbox"/>	Fluoride (F) <input type="checkbox"/>		
Chloride (Cl) <input type="checkbox"/>	Bromide (Br) <input type="checkbox"/>	Phosphate (PO <sub>4</sub> ) <input type="checkbox"/>	Nitrate (NO <sub>3</sub> ) <input type="checkbox"/>		
Sulphate (SO <sub>4</sub> ) <input type="checkbox"/>	Tubes returned - Analysis not required <input type="checkbox"/>				
<b>Fast Track Analysis - An additional charge will apply</b> <input type="checkbox"/> Fast Track Analysis & Report 5 working days - Must be pre-arranged. <input type="checkbox"/> Premium Fast Track - Must be pre-arranged. Contact <a href="mailto:diffusion@grackco.com">diffusion@grackco.com</a> .					
Number of tubes returned: <input type="text"/>					
Sampling and Exposure Data					
Bar Code label	Location	Sampling		Exposure Time (Hours)	Other information
		Start date and time	Finish date and time		

(Form to record exposure details)

- Put the tube into a clip—the clip gives it extra distance from fences, etc. so it gets better airflow, and also ensures that you keep tubes in the same location.
- Take the white cap off (unless you have purchased tubes with the dust cap in which case leave it on) and leave the open end/white cap end pointing downwards.
- Tie the clip around a pole with a cable tie, as high up as you can so they aren't tampered with.



8. Repeat 4-7 with the remainder of your tubes
9. Leave the tubes in situ for a minimum of 3 weeks and a maximum of 5 weeks.
10. Collect the tubes, placing the white cap back (if removed for exposure) onto each one into the plastic tubes they arrived in and replace the lid. Record the time and date for each tube on the form.
11. Keep the tubes in the sealed bag and box in the refrigerator until you are able to post them
12. Post the tubes back to the lab and wait for an email with the results.

## Recommendations:

### Siting the tubes

- If the budget allows, place at least two tubes at each location so that you can check the results are accurate. The results from both tubes should be similar to one another.
- Encourage students to choose locations that will show the school community that there is more nitrogen dioxide near the school entrance or exit where cars drop off and less where there are no cars i.e., school playground. This is important so that you can encourage people that changing their behaviour could improve the air that the children breathe.
- You could put one inside to give a comparison of outdoor versus indoor levels.
- Ensure you set them up at a time that will ensure at least 3 weeks of exposure during term time.
- At each location, place them in a space where the air circulates freely (so not in a tiny alcove or in a bush) and not somewhere where it is really exposed to wind either.
- If placing near a building, make sure it isn't close to any ventilation.



### Maximising Success

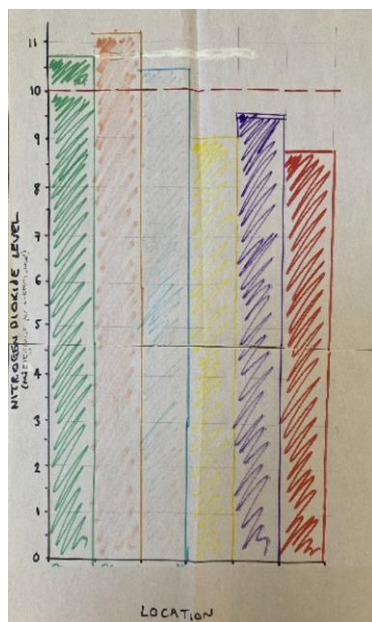
- Make sure you inform the adults in the school about the use of the tubes and what they look like so that they are not mistakenly removed.
- During the exposure, try to limit knowledge of the tubes to the students directly involved in putting them up, to minimise the risk of tampering.

### Understanding the results

- You will receive an email with the data in an excel spreadsheet which looks like this...

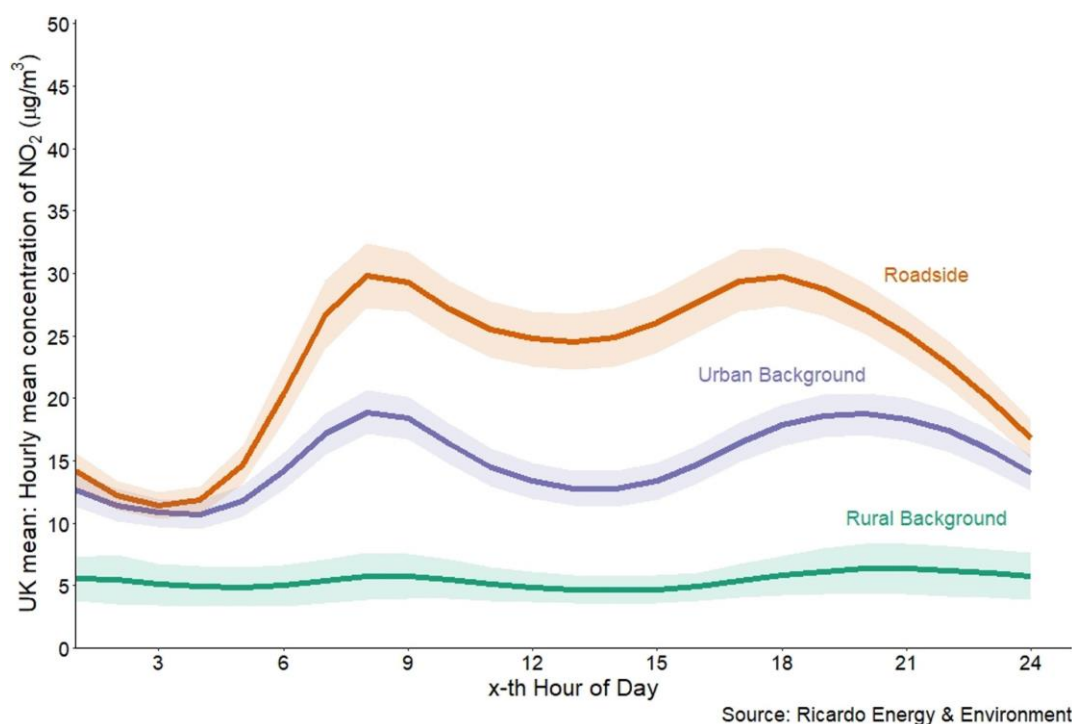
	A	B	C	D	E	F	G	H	I	J	K
2											
3		REPORT NUMBER W67AG89									
4		DATE SAMPLES RECEIVED 11/04/2022									
5											
6		Sample	Exposure Data								
7		Location	Number	Date On*	Date Off*	Time* (hr.)	µg/m <sup>3</sup> *	ppb *	µg NO <sub>2</sub>		
8									on tube		
9		On the road the school is on	1954819	17/03/2022	07/04/2022	508.67	12.55	6.55	0.42		
10		Lampost by staff car park	1954823	17/03/2022	07/04/2022	505.83	11.88	6.20	0.40		
11		Playing field	1954829	17/03/2022	07/04/2022	503.83	8.01	4.18	0.27		
12											
13		Laboratory Blank				508.67	0.30	0.15	0.010		
14											
15											
16		Comment: Results are not blank subtracted									
17		Result reported as <0.030 is below the reporting limit.									
18		Unlabelled tube not listed on exposure sheet was received. Number 1523302 was allocated & maximum exposure time was used.									
19		Customer noted missing tubes: 1954822 & 1954826.									
20		Results have been corrected to a temperature of 293 K (20°)									
21		Overall M.U.	±9.7%	Limit of Detection		0.030µgNO <sub>2</sub>					
22		a level of confidence of approximately 95%. Uncertainty of measurement has not been applied to the reported									

The column highlighted in yellow is the one you need to focus on. This tells you the average amount of nitrogen dioxide (in micrograms per meter cubed) in the air at that location over the period the tubes were in situ for.



In September 2022 the UK legal limit for the average annual concentration of nitrogen dioxide remains at  $40\mu\text{g}/\text{m}^3$ . New legal limits are expected soon. The World Health Organisation have set their annual average guideline limit at  $10\mu\text{g}/\text{m}^3$ . These are average levels worked out over a year and therefore are not directly comparable with the school's results, as they only represent a few weeks of a year. However when sharing the data with the school community, it can be helpful to use the WHO and national guidelines levels to help put the results from the school in context. You could give the children the WHO limit and then get them to guess whether the result for each location was 'higher or lower'. At the pilot schools the children enjoyed plotting the results on a large bar graph with ready drawn axis.

It's important to remind everyone that these are averages, so at certain times of the day there will be far lower concentrations than the average but at other times the concentration will be far higher. Ask when they think it would be lower .. and when they think it would be higher. Discuss that it's likely that the highest concentrations are at school drop off and pick up when everyone is arriving and leaving school.



**Note:**

Seasonality; wind conditions; tube placement and many other factors can affect the results. When authorities (like councils) use diffusion tubes to get average annual concentrations, they are set up many times a year and the results can then be adjusted mathematically to account for this. Setting the tubes up just the once doesn't allow for this to be done, but it gives you some good data to show everyone that nitrogen dioxide is present (even though it can't be 'seen') and raise awareness of the impact of the school run on the production of this air pollutant.