Air Quality Sensors – Lessons learned from a local authority perspective

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Fife Council

The Scottish Government
Riaghaltas na h-Alba

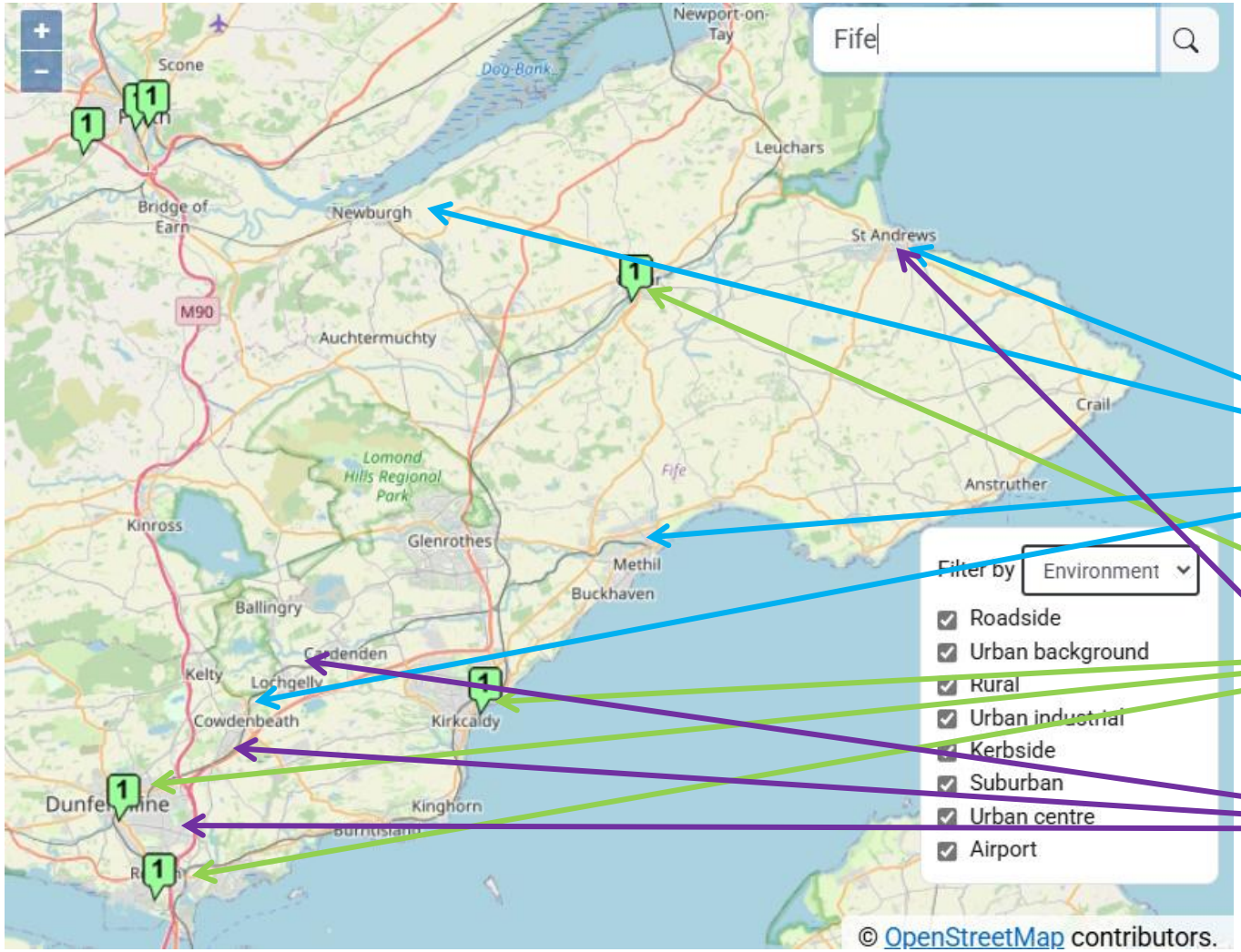
RICARDO

Air Quality Sensors -

lessons learned from a local authority perspective

Dr Donald Payne 26 March 2025

Background



Fife's air quality is generally good.

57 ×

4 ×

10 ×

Recent actions

Integrating Action on Air Quality & Climate Change

A Guide for Local Authorities

the-ies.org

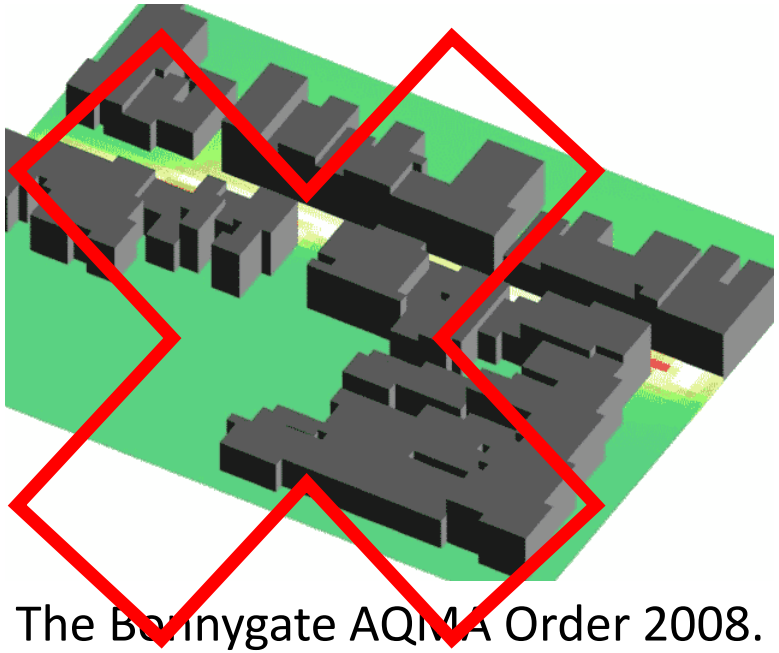
ROYAL COLLEGE of PHYSICIANS of EDINBURGH

ECOSTARS

FLEET SUSTAINABILITY SOLUTIONS

Management Areas

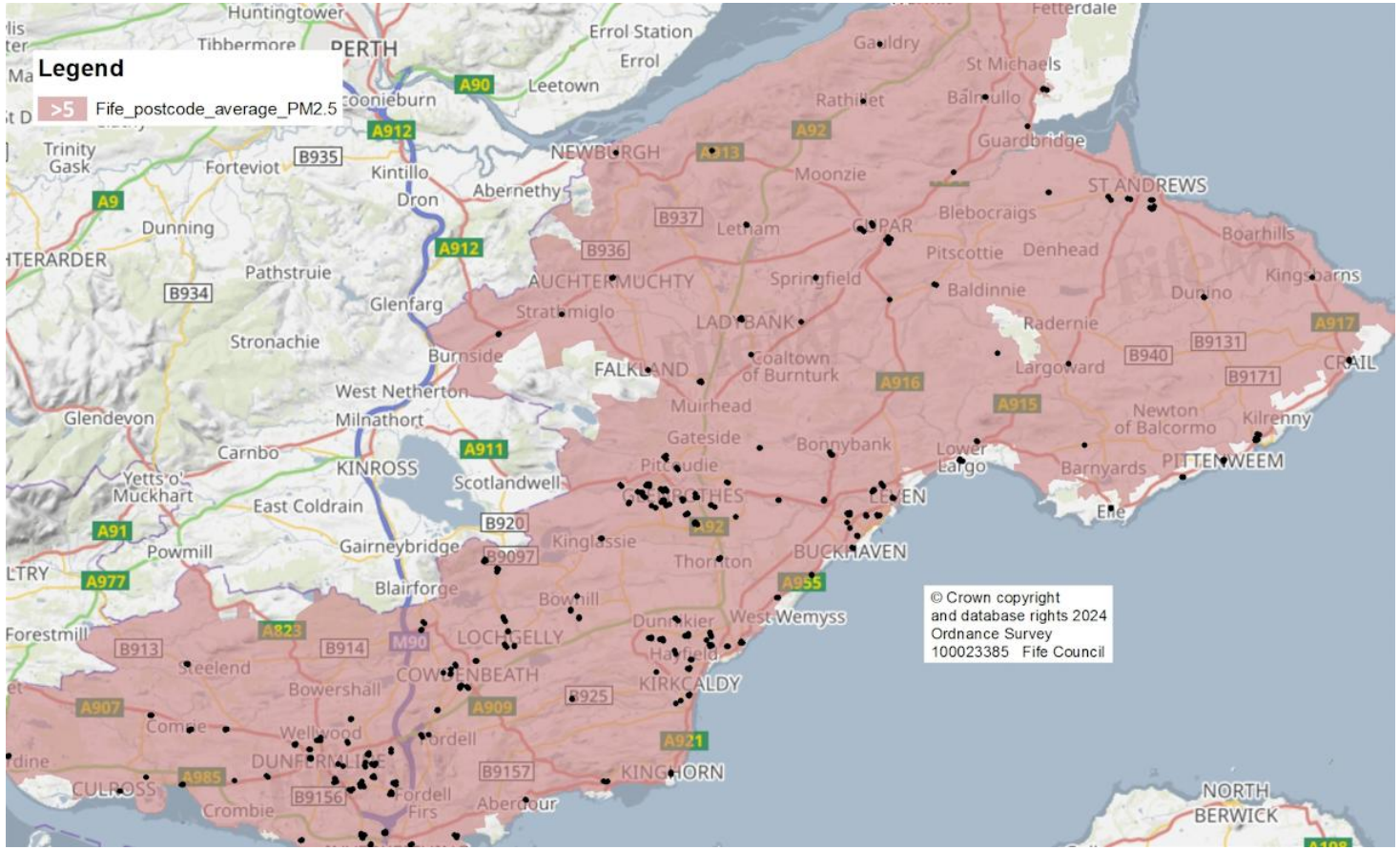
The Appin Crescent AQMA Order 2011.



The Bennygate AQMA Order 2008.

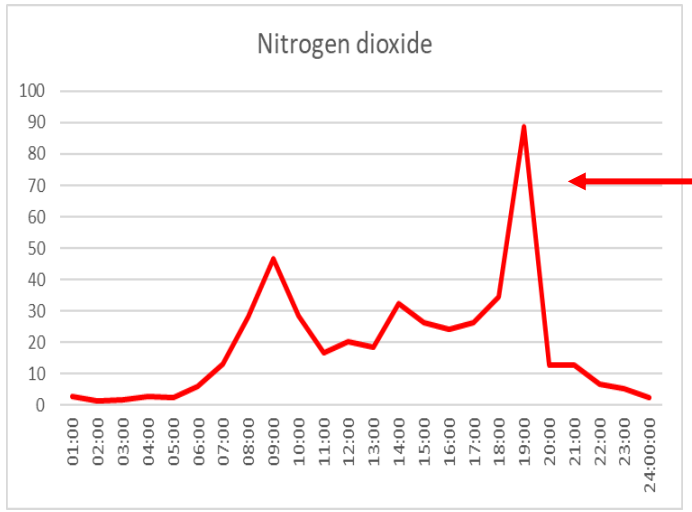
Both revoked in December 2023.

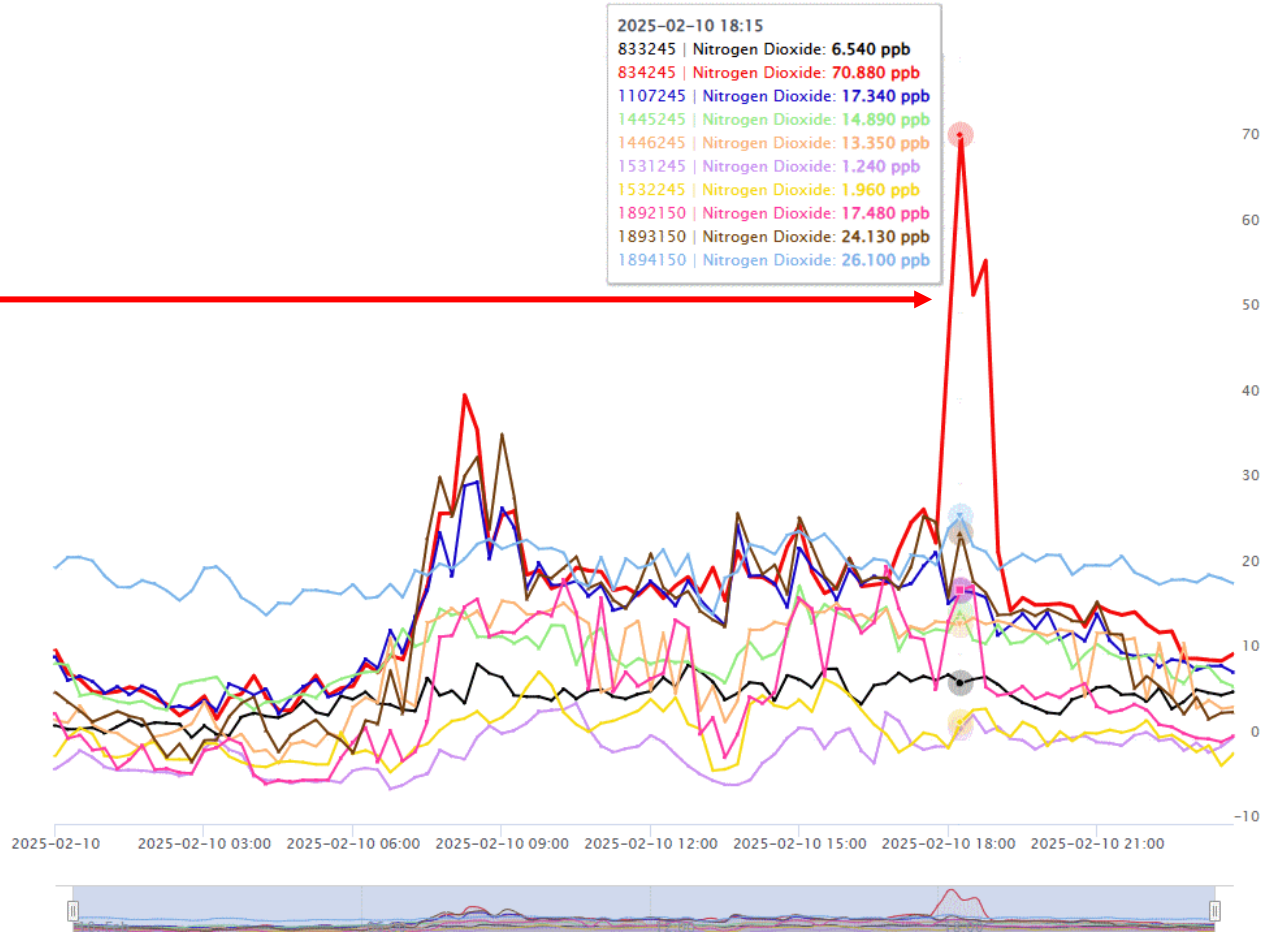
WHO guidelines



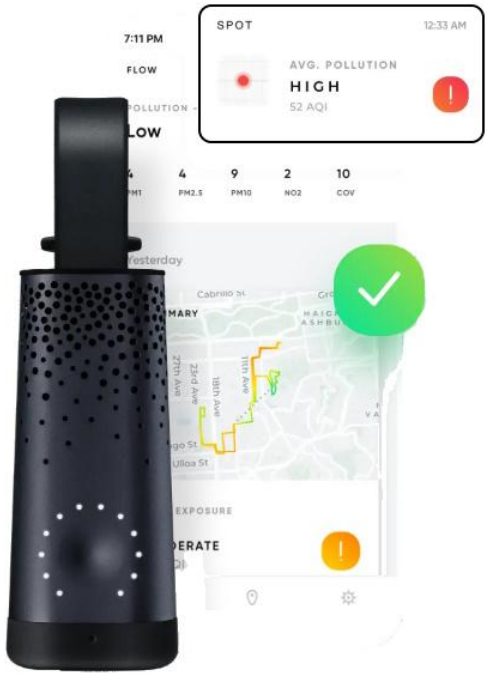
The shaded area represents 2019 modelled $PM_{2.5}$ greater than 5 µg m^{-3}.

Statistics, lies &c.





Low-low cost sensors



Sensor technology

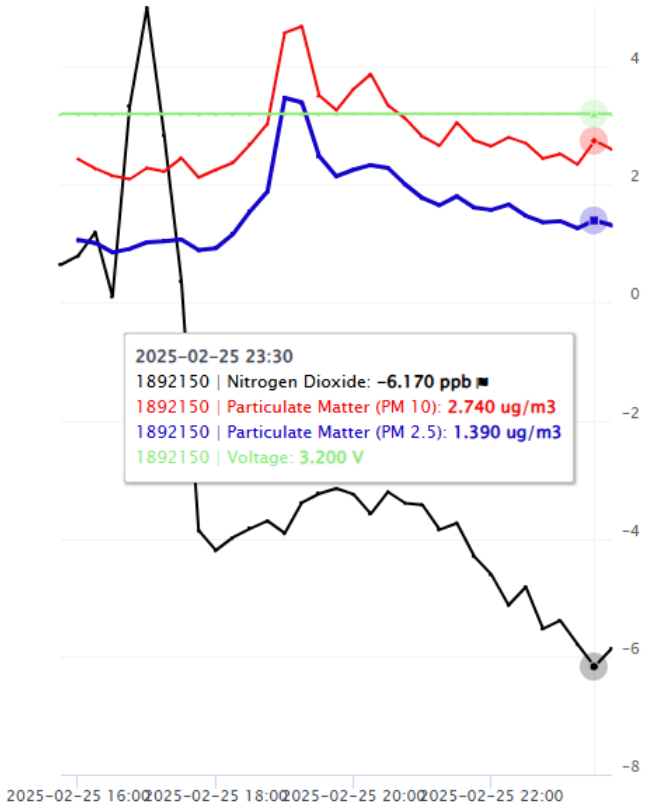
Deployable at the building façade…

…other brands are available!

Calibration requirements

Co-location period		Co-location frequency
7–10 days	every	3–4 months

- Pods should be put into co-location every few months, for about a week, to provide evidence for data ratification.
- This requirement has been relaxed for pods located in the same street as the reference analyser.



Whilst the absolute values are clearly wrong, the nitrogen dioxide 'signal' is still present.

Maintenance schedules

Determinand	Sensor type	Design life
NO_2 / NO / O_3	Electrochemical cell	2 years
PM_{10} / $PM_{2.5}$ / PM_1	Pump and laser	8500 hours

- Some electrochemical cells seem to have remained stable for up to four years.
- One pump failed after 12,800 hours (150%); two others are still going strong!

←Electro-chemical cell

Inlet →

Pump →→

Deliquescence is what you *don't* need.

Battery life

Version	Running time	Sample frequency	Telemetry reporting	Approx. battery life
2017 battery	30 seconds	15 minutes	hourly	300+ days
DC / solar	30 seconds	1 minute*	12 hours	satisfactory
2023 battery	5 seconds	1 minute*	12 hours	~90 days

- The particulates pump and the dial-up modem draw the most power.

**sample frequency now determined by firmware*

← Non-rechargeable battery: rainwater downpipe on north-facing façade.

← Solar-panel-powered trickle charger: have to keep the ivy in check!

Permanent mains for SEPA →

← Intermittent mains with backup battery

ELEXON BSC —*for apparatus on unmetered supplies*

Schools Project

Methodology:

- Diffusion tube at one school had been discontinued
- We had already installed tubes at another two schools
- Using dispersion modelling of NO_2, PM_{10} and $PM_{2.5}$

\+ GIS layer of "School Access Points"

= Spatial clip of predicted concentrations at the school gates

ROYAL COLLEGE of PHYSICIANS of EDINBURGH

4 April 2023

Dear Net Zero Committee,

RE: Air Quality Monitors around City Schools

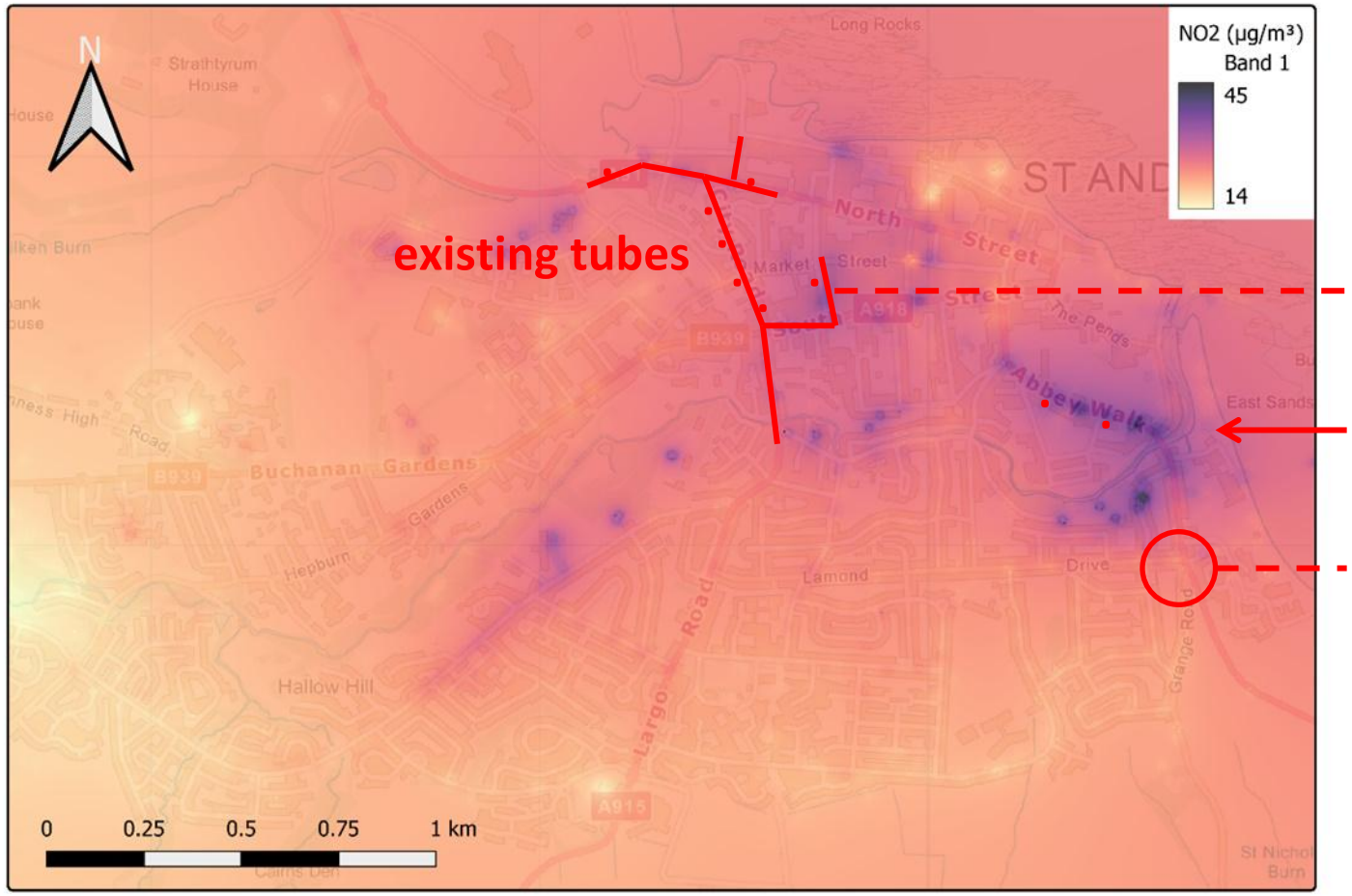
Implementation:

- Five new diffusion tubes installed at schools with highest predicted NO_2
- Five new sensor pods procured for schools with highest predicted PM_{10} and $PM_{2.5}$
- Shortlist of other schools for monitoring should re-deployment become an option

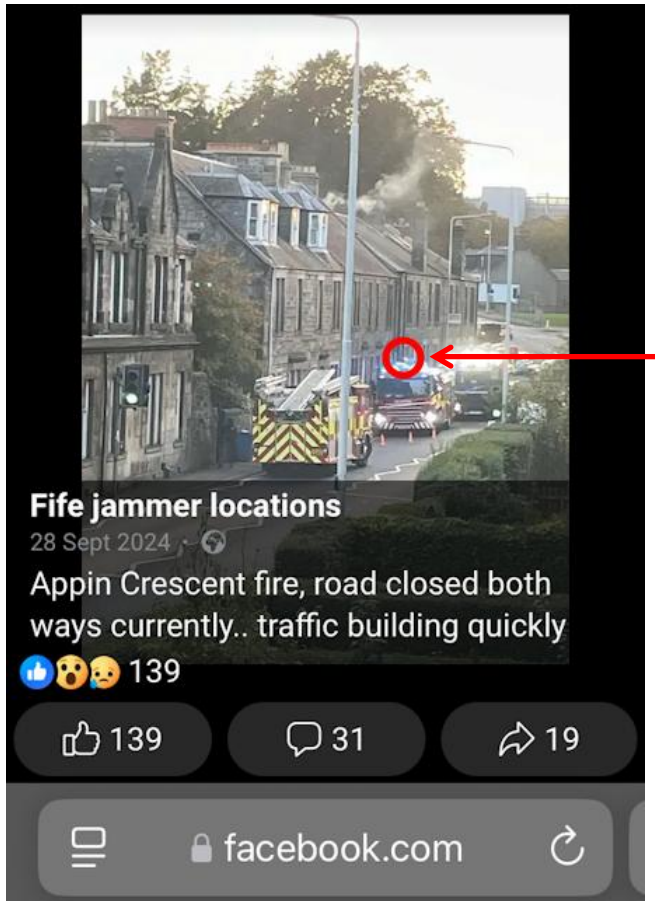
Collaborative working

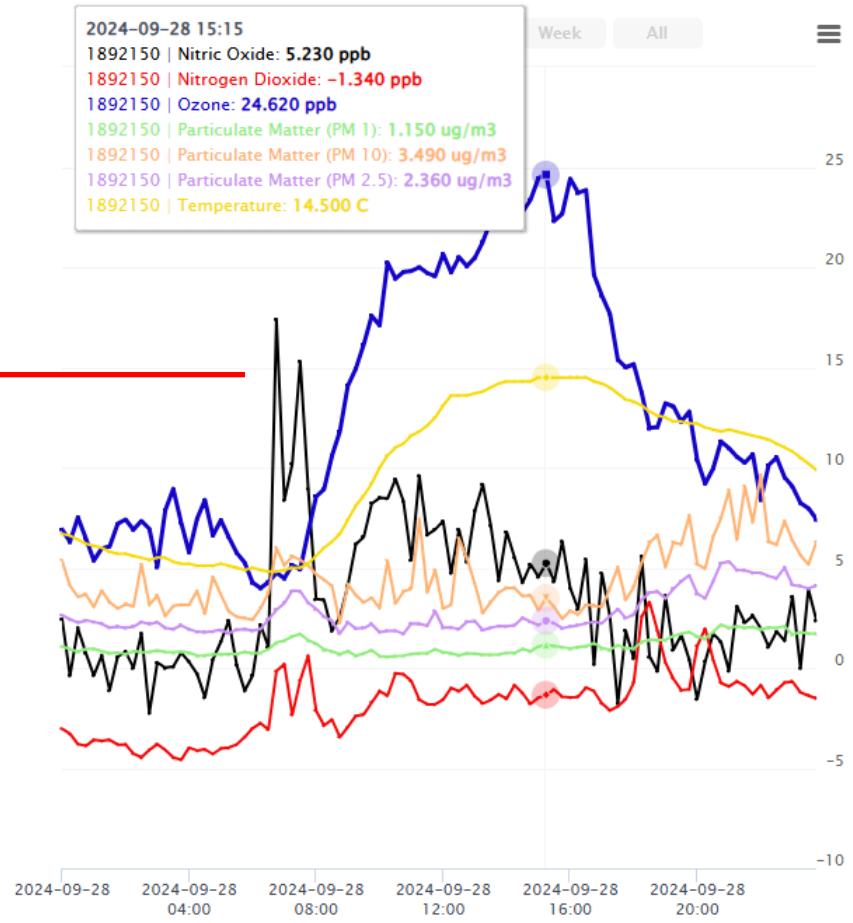
plume labs

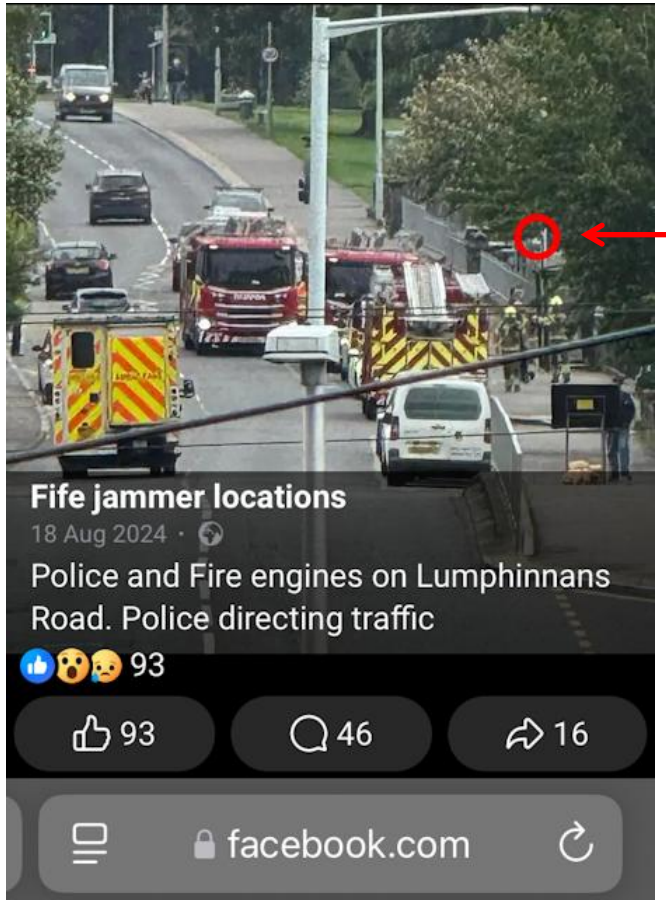
Four years of data collected by students walking the streets (Transition University of St Andrews, 2024).

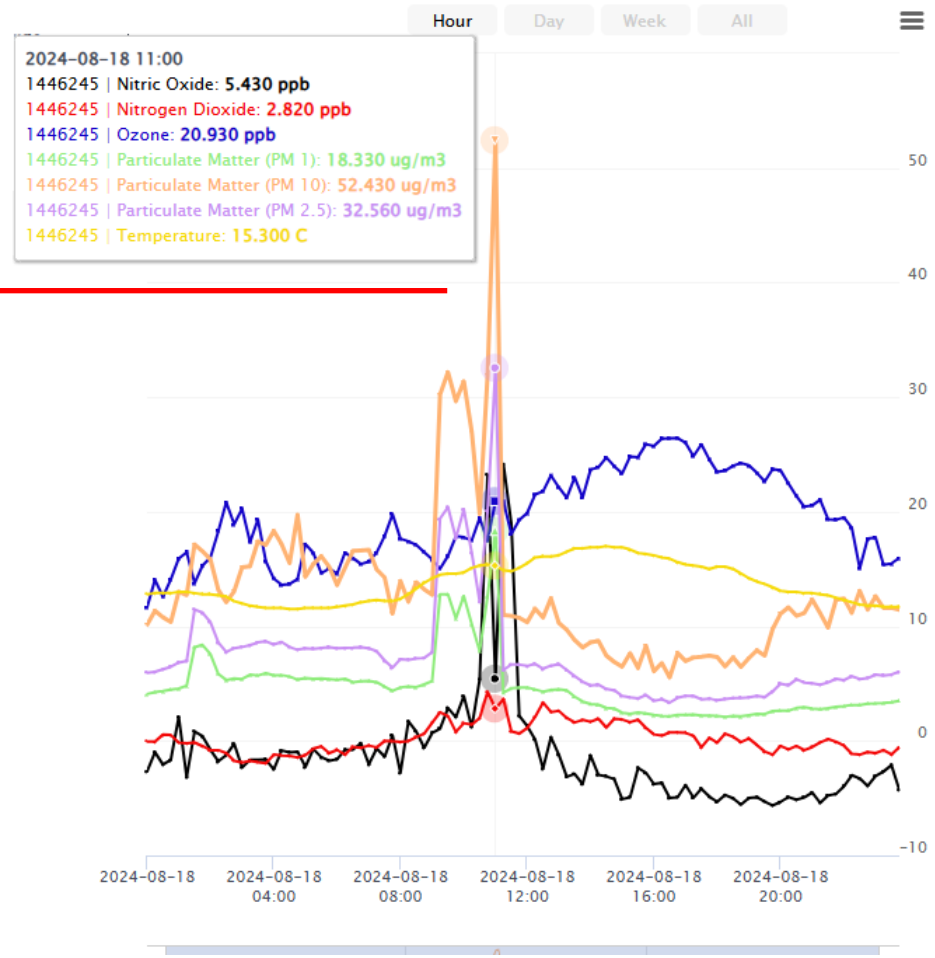


Discrete incidents

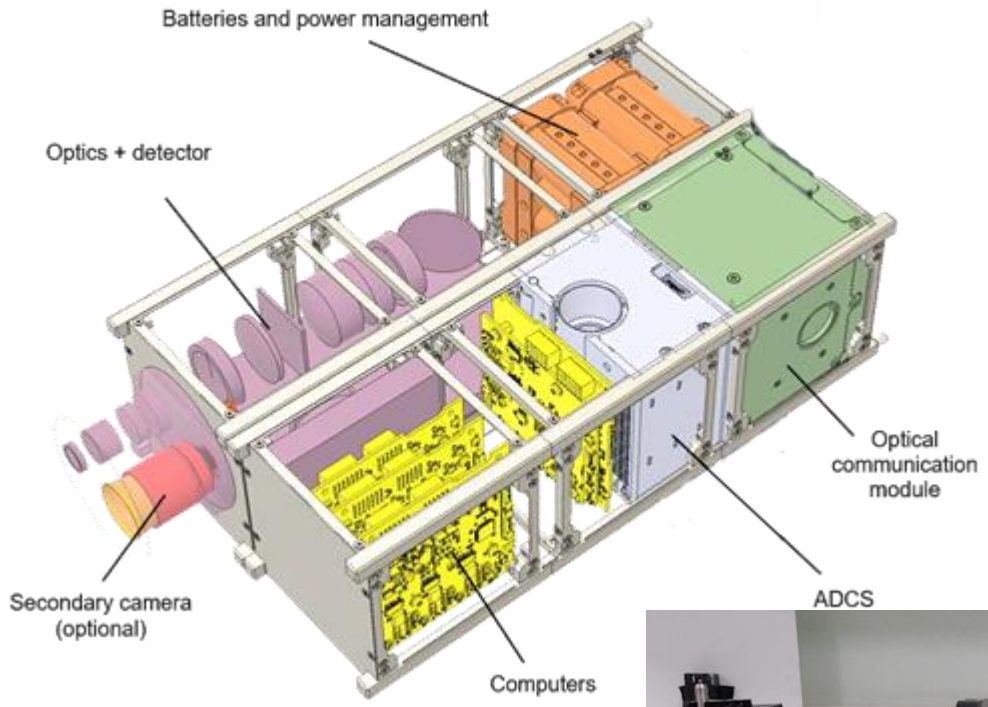





Fife jammer locations
18 Aug 2024 ·
Police and Fire engines on Lumphinnans Road. Police directing traffic
93
93
46
16
facebook.com


Hour
Day
Week
All
2024-08-18 11:00
1446245 | Nitric Oxide: 5.430 ppb
1446245 | Nitrogen Dioxide: 2.820 ppb
1446245 | Ozone: 20.930 ppb
1446245 | Particulate Matter (PM 1): 18.330 ug/m3
1446245 | Particulate Matter (PM 10): 52.430 ug/m3
1446245 | Particulate Matter (PM 2.5): 32.560 ug/m3
1446245 | Temperature: 15.300 C
50
40
30
20
10
0
-10
2024-08-18
2024-08-18 04:00
2024-08-18 08:00
2024-08-18 12:00
2024-08-18 16:00
2024-08-18 20:00

Remote sensing



Edinburgh Innovations (University of Edinburgh, 2024).

Source apportionment?

Summary of sensors

- ☑ Sensors allow measurement more relevant to sensitive receptors.
  - ☑ Running costs are modest.
  - ☑ Accuracy is manageable.
    - ☑ Sensors can be deployed quickly and easily, then moved if desired (several options for providing power).
      - ☑ Even unratified data can provide a useful proxy, prompting further monitoring, and new technologies are on their way.

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