EMSOL

Clean Air Villages 4 Project Butler's Wharf and Dartford Pier

March 2022

CROSS RIVER PARTNERSHIP
Delivering London's Future Together

Department for Environment Food & Rural Affairs

About CRP

Cross River Partnership (CRP) is a non-profit and impartial partnership organisation that has been delivering positive change for London's residents, businesses and visitors for over 25 years.

CRP's vision is to address sustainability challenges collaboratively in London and beyond. CRP is a test bed for designing and delivering innovative pilot projects with and for its partners, all of which are aimed at making London the best possible place it can be.

CRP is a partnership delivering environmental, economic and community focused projects. We support public, private and voluntary organisations to address creatively challenges around Air Quality, Transport, Placemaking and Wellbeing.

CRP's projects deliver services including: Business and Community Engagement; Partnership Working; Innovative Pilots; Programme Management; Communications Campaigns and Materials; Expert Advice; Training; Strategy and Policy Formulation; Monitoring and Evaluation; Fundraising.

Some of the current projects of CRP are Clean Air Villages 4, Healthy Streets Everyday, Clean Air Thames, Town Centre Futures, Electric Vehicle (EV) Fleet-Centred Local Energy System (EFLES), Lighting London Sustainably, to name a few.

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About CAV4

Clean Air Villages 4 (CAV4) is a Defra-funded project led by Westminster City Council in collaboration with 26 project partners to improve the air quality across different London ‘villages’, where both air pollution and population density levels are high.

CAV4 is building on the successes of the award winning CAV1 programme, as well as CAV2 and CAV3, which are all focusing on interventions to support businesses, communities and hospitals. CAV4 aims to deliver ambitious Freight Solutions for a Clean Air business recovery from COVID-19.

The CAV4 Freight Solutions that are being implemented will incorporate Consolidation, Distribution, Mode, Technology and Policy elements, trialled across different ‘Villages’.

Project Partners

About EMSOL

EMSOL empowers organisations to take steps every day to make a lasting difference in reducing pollution and meeting clean air targets. Companies need innovative methods to meet ever-tightening standards in sustainability, pollution management and ESG reporting. EMSOL intelligently combines air quality monitoring networks in conjunction with real-time asset location and identification technology to report exactly the who, what, when, where & why of air and noise pollution before it reaches safety limits.

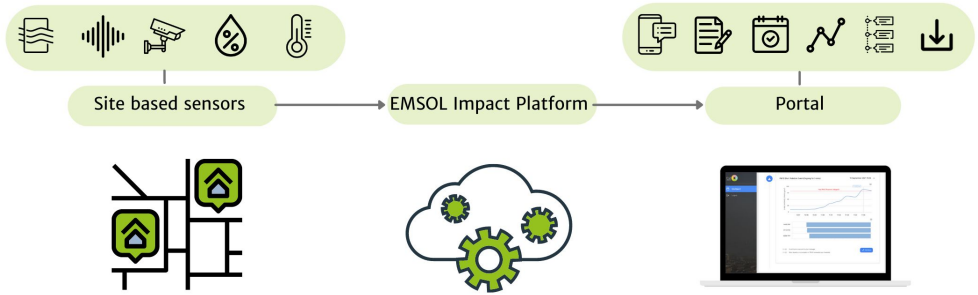

Figure 1 - The EMSOL solution

EMSOL installs air, dust and noise monitors along with camera analytics and asset location technology on a nominated site. Air, dust and noise data is collated with real-time asset location data and sent to be aggregated and analysed using the EMSOL platform. The Platform delivers pollution breach evidence - including immediate SMS notifications to on-site operatives that can report on and address the issue flagged up. Additionally, the issue can be analysed within the machine learning and analytics capability of the Platform. All users can login to the portal to access reports, mitigation recording, pollution analysis and historic data for referencing and trend tracking.

Armed with EMSOL's scientific data and impact reports, customers evolve from passive 'observers' into proactive advocates who can scientifically evidence reductions in emissions and progress with sustainability goals.

Executive Summary

Executive Summary

Pollution from road transport is a leading cause of pollution in the capital.[1] A Centre for London report states, "Freight represents 15% of total vehicle miles travelled in London, but 34% of nitrogen oxide and 27 per cent of fine particulate matter emissions from road transport come from freight vehicles."[2] Additionally, freight adds to both noise pollution levels and the number of noise complaints received in the city, reported to be approximately one every eighty seconds.[3]

Much of this delivery activity is required to keep services and businesses running, the challenge is to ensure that goods are delivered with minimal impact. Businesses have therefore looked for alternatives to heavy-goods vehicle delivery, such as electric vehicles, cargo bikes, and river transport.

[1]https://www.london.gov.uk/press-releases/assembly/air-pollution-from-londons-road-transport#:~:text=Approximately%20half%20of%20the%20NO2,massive%20increase%20compared%20to%202020.
[2]https://www.centreforlondon.org/reader/freight-deliveries-london/forewords/
[3]https://www.directlinegroup.co.uk/en/news/brand-news/2020/09062020.html

London needs innovative solutions to address and manage the air and noise pollution crisis in the city. The River Thames provides an opportunity for freight to be delivered while reducing the burden on the capital's road network. The River Thames is the busiest inland waterway in the United Kingdom, carrying 60% of all goods lifted on the UK's inland waterway network, amounting to five million tonnes of freight.[4] This reduces an estimated 265,000 lorry movements a year off London's congested roads. CRP wanted to explore if more could be done to reduce freight on London's roads by moving it to the river and to ascertain the air and noise pollution impacts of doing so.

While use of inland waterways presents an opportunity to reduce congestion and roadside pollution, it also presents a risk. The slower implementation of emission standards on inland vessels alongside a long in-service lifetime of the inland waterways fleet suggests the potential for high real-world pollution. Notably, a study conducted on the River Rhine identified that "all investigated motor ship types [were] above the threshold [emissions] values."[5] Monitoring that can attribute pollution to specific vessels could therefore help understand the impact of moving freight to inland waterways in London.

There is a clear need and opportunity to ensure that transport of goods on inland waterways is done sustainably and with a low impact on local air quality.

This trial was established to attribute air and noise pollution to specific vessels and therefore help to understand the real-world pollution impact of moving freight to inland waterways in London. The project presents the opportunity to assess and ensure that transport of goods on inland waterways is done sustainably, with a low impact on local air and noise quality whilst protecting the local communities from the effects of operations.

[4]http://www.pla.co.uk/Port-Trade/Moving-freight-by-water-on-the-River-Thames#:~:text=The%20River%20Thames%20is%20the,62%25%20on%20the%20year%20before.
[5](Kurtenbach et. al., Emissions of NO, NO2 and PM from inland shipping, Atmospheric Chemistry and Physics, 2016)

During the trial EMSOL:

- Identified emissions levels associated to vessel service activity
- Identified peaks and troughs of air and noise pollution associated with river freight activity
- Attributed air and noise pollution to specific river freight activity
- Referenced collected data against Defra and WHO air quality standards to show breaches of those recommended levels.
- Verified pollution hotspots and sites of poor air quality along the journey of the vessel and provided explaining factors.
- Proved that the NO2 pollution impact from river freight is more significant than the impact of particulate pollution
- Observed that particulate pollution from river freight is less than road freight possibly due to the humidity levels and absorption qualities of the river.
- Evidenced that the impact of noise pollution from river freight is less than the impact from road freight, promoting out-of-hours operations to reduce pollution peaks.
- Recommended behavioural and operational changes which could reduce air pollution impact from river freight activity
- Evidenced future scalable technology for air and noise pollution monitoring with river vessel tracking and attribution for piers along the River Thames

Key recommendations from the trial include:

Further projects are required to:

- Assess the impact of upgrading all vessel engine types using alternative fuel types such as HVO against use of traditional diesel engines/fuel.
- Ascertain optimum vessel operating speeds in relation to resulting polluting emissions with potential consideration to location along the river.
- Effectively measure the impact of mitigations and interventions

Standard and regulation setting:

- Use the identified ambient pollution levels identified by EMSOL as a baseline target for emissions control
- Enforcement by continuing to measure emissions and attributing, mitigating and reporting on specific river freight impact
- To ensure that the environmental impact of river freight keeps up with the improvements being made in the road and rail sectors and remains a sensible option for freight reduction on London's roads.

Consideration of alternative operating schedules including:

- Out-of-hours operations
- Weekend operations
- Operations during identified pollution troughs

Updating and issuing of operating procedures to include:

- Review of loading and unloading operations to maximise efficiency and reduce dock time
- Reduction of idling time
- Reduction in cold engine starts

Operator training to:

- Educate operators on the impact of river freight pollution and why mitigating measures are so important
- Reduce engine idling and dock time including adopting an approach to receive real time data on their impact and/or their compliance
- Create awareness and develop operating procedures to reduce the impact that higher vessel speeds have on pollution output.

Introduction of specific vessel focussed pollution mitigations including:

- Air Pollution dispersion technologies at hotspots
- Engine emissions outlet extraction and filtration during cold starts

Kate Fenton, Project Manager, CRP said, "Cross River Partnership is really pleased that this Air Quality monitoring report from Emsol will support the uptake of clean river freight, and contribute to reductions in the numbers of polluting vehicles on London's roads."

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Introduction

EMSOL, in partnership with CRP, monitored air pollution at Butler's Wharf Pier in Central London and at Dartford Pier in Kent as shown in figures 2a and 2b below:

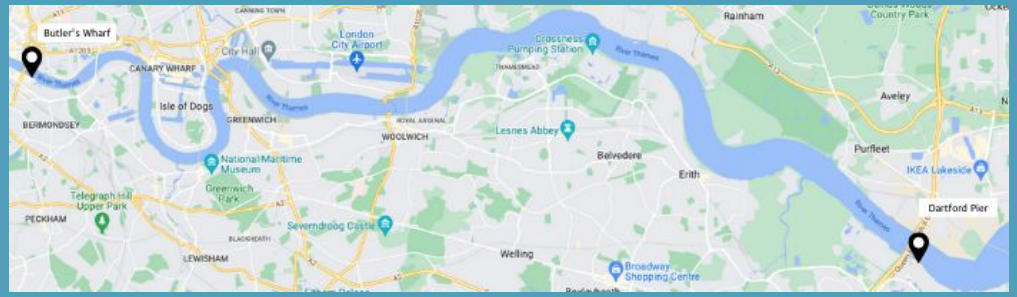


Figure 2a - Map overview of monitored locations

Figure 2b - Satellite overview of monitored locations

Introduction

EMSOL also monitored the air quality on the Equity boat of the Livett's Group as shown in figure 2c.

Figure 2c - Equity boat of Livett's Group

In early 2021, Livett's, in partnership with CEVA and Guy's and St Thomas' NHS Foundation Trust, launched a twice daily river service running from Dartford to Butler's Wharf Pier. This service allowed vessels to carry and deliver essential medical supplies and vital non-perishable equipment for the hospital. The final stretch of the journey – from the pier to Guy's & St Thomas' Hospital – is then completed by electric cargo bikes. The aim of this delivery method is to help reduce the hospital's carbon footprint, in keeping with their aim of reaching net zero carbon emissions by 2030, and contributing towards the Mayor of London's aim to reduce the number of lorries and vans entering central London by 10% by 2026.

During the monitoring period of four months, EMSOL measured air quality breaches, and analysed the air quality to recommended levels by the Department of Environment, Food and Rural Affairs (Defra) and the World Health Organisation (WHO). EMSOL also identified pollution hotspots by location and time of day along the journey of the boat and at the two pier sites of Butler's Wharf and Dartford. The aim has been to determine the nature of the real root causes of pollution and invest in the type of mitigation and control measures that may be possible to improve the air quality and sustain a river freight service offering.

Objectives of Trial

	Trial Objectives	Outcomes
1	Deploy & trial Air Quality monitoring sensors on 1 river freight vehicle to evaluate capability to provide useful AQ data.	Done and possible. Location is more vital Recommend tracking data
2	Compare with land freight vehicle/s	Descoped
3	Deploy & trial AQ sensors onto 2 piers & one additional location along river	Done - at two piers Successful model & recommendation as viable solution in the future
4	Analyse data to identify:	Done - fortnightly reports & analysis
4a	If river freight can provide AQ improvements in comparison to land-based delivery services.	Data available Questionable if improvements are possible - without mitigations & interventions
4b	Air pollution breaches above recommended levels.	Data available - consistent breaches - needs mitigations & interventions
4c	Sites of poor AQ along journey	Data available - piers, subject to site dispersion & bends in the river.

Methodology

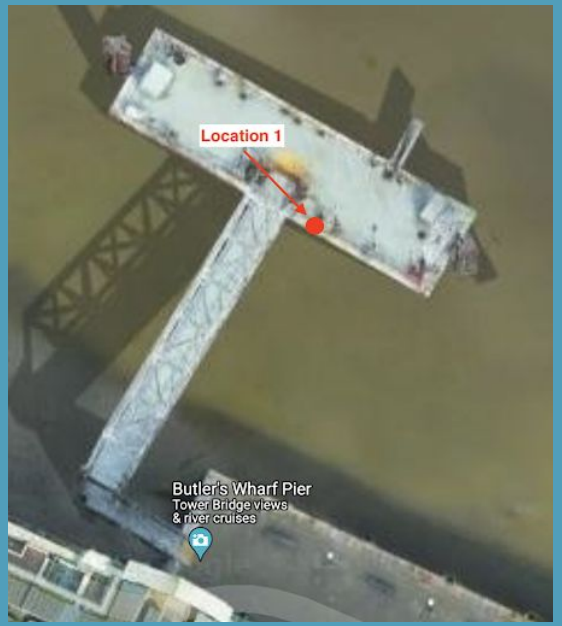
Implementation

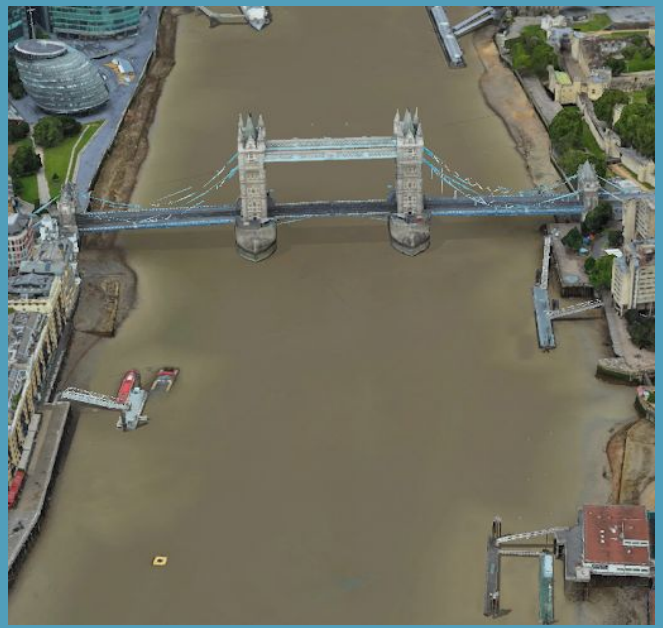
EMSOL installed an array of equipment to monitor emissions on the boat and two piers. A list of the equipment installed can be found below.

Equipment	Functionality	Technical Specifications	Number of assets
	Air Quality sensor Real time capture of: NO_2, CO, O_3, SO_2, $PM_{1, 2.5}$ & PM_{10}	5kg 250 x 140 x 205mm	3
	Noise sensor (Class 1)	1kg 127 x 360 x 66mm	2
	Ancillary Cabinet Incorporating data comms and edge compute capabilities	5kg 400 x 300 x 195mm	2

Site Deployment

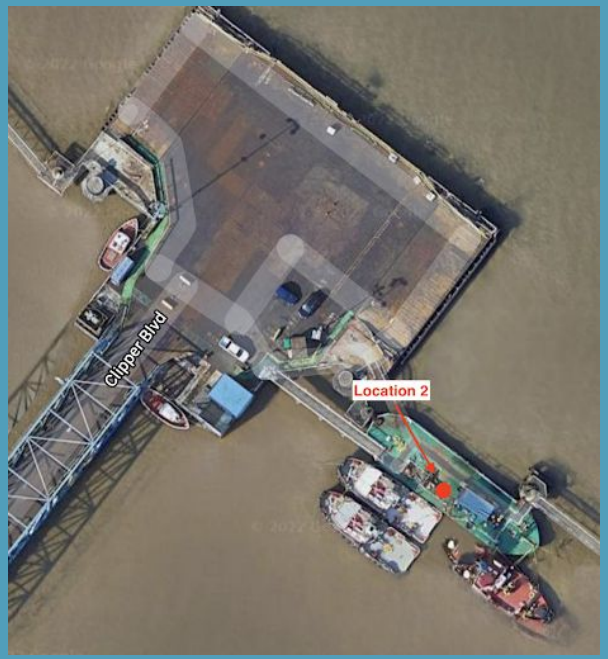
Site surveys were conducted to determine the ideal location of the equipment installation, as well as the power availability. Detailed location installation visuals can be found below:





Location 1 -
Butler's Wharf Pier

Site Deployment



Location 2 - Dartford Terminal Pier

Equipment deployed at each Pier includes:

- Ancillary cabinet
- Noise sensor
- Air Quality sensor

Site Deployment

Location 3 - Equity Boat

Air quality data (NO2, CO, O3, SO2, PM10, PM1 and PM2.5) was collected from air quality sensors every 10 seconds and noise data (LAeq and LAFmax) was collected from the noise monitor every 1 second.

The data analysis averaged the real time data into hourly and 24-hour periods for analysis and comparisons to compliance standards. The air quality data was analysed against the Defra and WHO threshold limits. New WHO threshold limits for NO2, PM10 and PM2.5 were also introduced in the analysis to judge the impact of these new limits on current pollution levels.

Pollution hotspots along the journey of the boat were obtained by correlating the position of the boat from the GPS data and the concentration of the pollutants from the sensor located at the boat.

Time Frame

The monitoring period for the trial was

13th September 2021

to

13th January 2022

Findings and Analysis

After analysing 4 months of air and noise pollution data from the Butler's Wharf Pier, Dartford Pier and the Equity boat, EMSOL reported 4 key findings given below:

1 Comparison against Defra and new (22/9/2021) WHO standards

Pollutant	Concentration measured as	Defra limit ($\mu g/m^3$)	WHO ($\mu g/m^3$)
NO_2	Hourly mean	200	
	24 hour mean		25
PM_{10}	24 hour mean	50	45
$PM_{2.5}$	24 hour mean		15

Findings and Analysis

Summarized below is the four-month overview of the quantity of compliance pollution breaches at each monitoring station and by UK (Defra) and International standard (WHO) (Appendix - Figure I - IV).

Number of breaches by Standard:		Defra	WHO
NO2 (Hourly Ave - Defra) (Daily Ave - WHO)	Butler's Wharf	0	16
	Dartford Pier		15
	Boat		52
PM10 (Daily Ave)	Butler's Wharf	4	4
	Dartford Pier	0	0
	Boat		
PM2.5 (Daily Ave)	Butler's Wharf	na	18
	Dartford Pier		14
	Boat		2

A key observation is that the NO2 pollution impact is more significant for River Freight compared to particulate emissions, although the PM2.5 levels are still concerning. The impact of particulates can be reduced by water-based treatment and higher humidity. Based on EMSOL's measurements of the river freight activity, there was a higher rate of absorption of particulates into the water compared to those related to road-based pollution which goes some way to explain the difference in significance between NO2 and particulate emissions.

EMSOL Findings:

1 Excess NO2 was observed during peak periods which present behavioural change opportunities by addressing long cold engine start idling and other excess idling at the Piers.

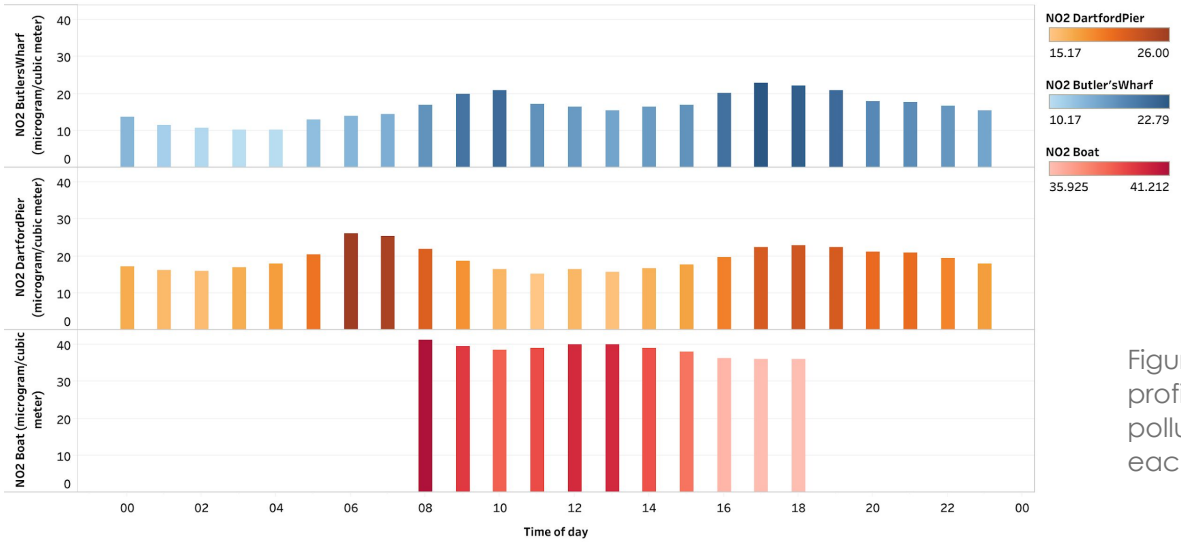


Figure 3 24 Hourly profile of NO_2 pollution intensity at each location

EMSOL Findings:

2. EMSOL was able to show that the Equity boat regularly contributed to NO2 pollution peaks as well as providing evidence of exceeding the new WHO limit for daily average NO2 emissions at both piers.

3. Although EMSOL was not able to compare the pollution generated from Hydrotreated Vegetable Oil (HVO) with data from a diesel vessel, EMSOL believes that updating the entire freight fleet from traditional diesel engines to HVO engines should facilitate a significant reduction of NO2 and particulates along the river and at the Piers. A further trial to explore this is under consideration.

4. EMSOL identified that there were 'troughs' of NO2 emissions in the pollution timeline between 0000-0500. This creates a powerful, scientifically evidenced argument for the scheduling and operating of river freight services on alternative days or within alternative time windows.

5. The project was able to prove that challenges exist with compliance to the new WHO thresholds. This is also evident on land-based locations monitored by EMSOL with transport pollution control measures.The new WHO thresholds are currently very hard to meet.

EMSOL Findings:

6 Additionally, EMSOL's view is that the current Defra standards may need to be updated to reflect the large body of evidence produced in recent years of the deadly harm caused to people by much lower levels of pollution than previously thought.

7 EMSOL recommends using ambient thresholds as the marker to compare with and to aim to meet with targeted mitigations. One approach worth considering is comparing weekday operations to the weekend, when no river freight services operate. The weekend period saw much lower emission levels and could be used as the ambient threshold to match.

8 As background pollution within the City drops, the ambient weekend threshold will continue to reduce. Monitoring of river freight emissions and adjusting threshold levels ensures freight services across Cities can always be inline with the changes and improvements made on the road and rail networks.

9 Analysis over the four-month duration of the trial proved that weekday variances between 18 to 24% were identified. These variances could be a useful benchmark to aim for and is achievable through various small and continuous changes to pollution mitigations. For example, consideration could be given to alerting pilots of excess idling on cold starts and excess idling at or near a pier. Additionally, more awareness of the impact of immediate and effective boat mooring vs running the engine to counter the river tide.

EMSOL Findings:

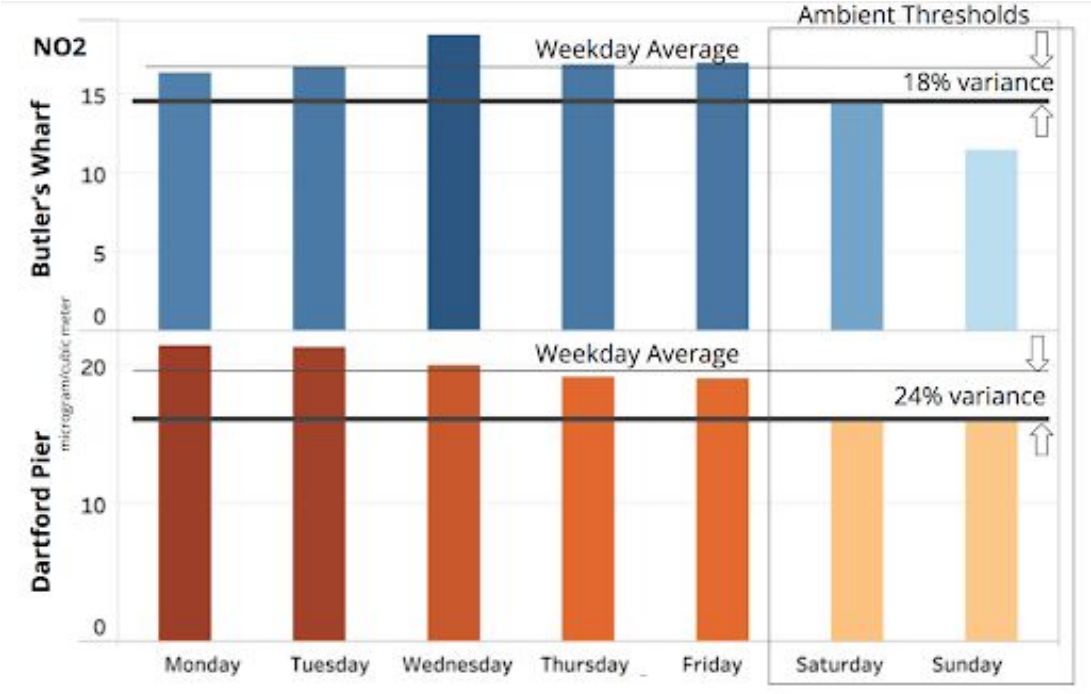


Figure 4 - NO2 pollution pattern over days of the week

EMSOL Findings:

10 Another opportunity is the training of personnel on the introduction of air pollution measurements, what they mean, the impact to human health and how simple actions such as excess idling can impact these scores. Further recommendations would include monitoring and comparing Operators on their pollution impact when operating at Piers.

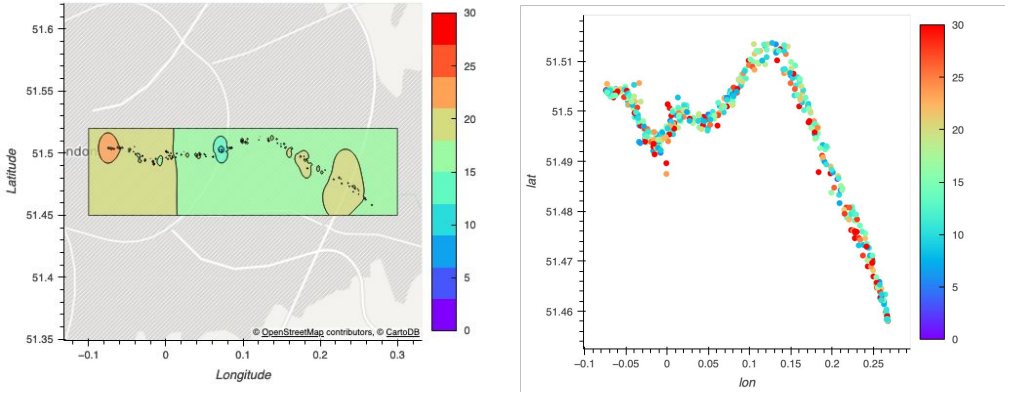
11 Additional solution-based recommendations include making the real-time data available to on site operatives as it will remind and aid day to day mitigations. Please note this was not tested during the pilot.

12 Further recommendations include shared data between all stakeholders (local residents, customers, Local Authority, Port Authority and supply chain operators) to encourage and evidence compliance to ambient thresholds or any new correlated thresholds (i.e., WHO by a weighting factor) and to have these as contracted standards by customers of the river freight supply chain, especially as the monitoring technology has been proven.

Findings and Analysis

2 Pollution caused by river freight activity

A. Identification of pollution hotspots



5.a 5.b

Figure 5(a). PM10 Contour Map and Figure 5(b) PM10 pollution hotspots along the journey of the boat.

The PM10 contour map of the air quality of the boat along its journey shows that the highest PM10 pollution was at Butler's Wharf Pier followed by the area near the Dartford Pier. In addition to the piers, the sharp bends of the river were also identified as pollution hotspots as shown in Fig. 5(b). Similar maps were obtained for NO2 and PM2.5 (Appendix - Figure V and Figure VI).

B. Faster boat speed correlated to higher emissions

The speed of the boat obtained from GPS data was correlated with the polluting emissions. It was observed that when the speed of the boat was over 18mph, a higher amount of pollution was generated.

Engine Idling at Butler's Wharf Pier produced the highest levels of emissions throughout the entire journey of the boat, with a similar trend recognised at Dartford Pier.

From collected data, EMSOL assessed that the flow of air at river bends was obstructed. As a result, the dispersion of polluting emissions was reduced and pollution hotspots were identified. Additionally, the slower speed of the boat through these areas meant polluting emissions were in place for longer.

C. Comparison with background pollution at Butler's Wharf

The PM10 pollution at Butler's Wharf was compared to the nearest London Air Quality Monitor at Southwark Tower Bridge which is located about 988 feet from Butler's Wharf and is situated at the side of A200 Druid Street. The comparison of 15-min average PM10 concentration showed several high peaks at Butler's Wharf Pier which were not recorded at the London Air Quality Network (LAQN) monitoring station. EMSOL deduces that those peaks were caused by river freight activities.

Findings and Analysis

D. Pollution impact caused by the boat.

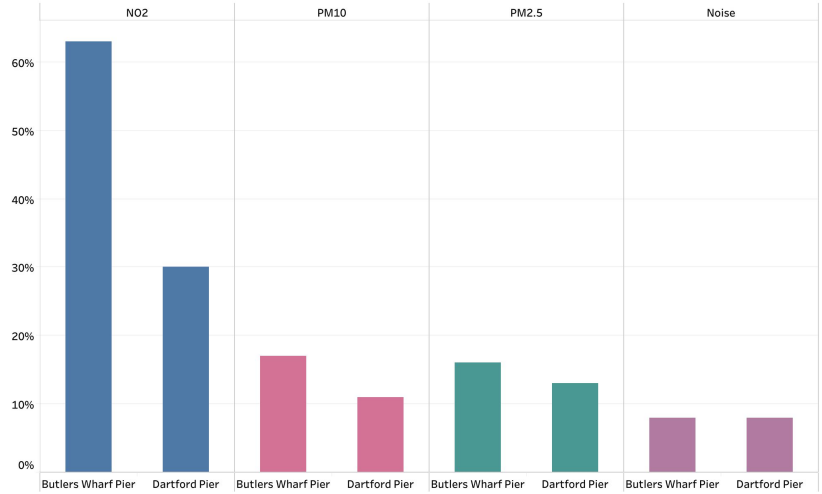


Figure 6. Comparison of pollution caused by the presence of the Equity Boat at the two Piers.

The comparison of the pollution levels at the two Piers before arrival and after the departure of the Equity boat against the pollution levels recorded during its presence confirms that the pollution at Butler's Wharf Pier was higher compared to the Dartford Pier. This is because the sensor's location was closer to the river at Butler's Wharf compared to the sensor location at Dartford Pier which enabled the sensor to better capture the emissions from the boat. The higher recorded changes in pollution at Butler's Wharf Pier was also caused by the effect of the 15-min idling time during each visit.

During the monitoring period of 13/09/2021 - 13/01/2022 the UK was still grappling with the operational effects of COVID-19 and the resulting lockdowns that further restricted movements. An important observation is that the number of river freight visits during this trial was very low, at 2 per day. This reduced activity level is attributable to the effects of COVID-19. However, even with just these twice daily servicing activities, the pollution impact was notable and recorded. EMSOL analyses that as management of the pandemic improves and effect on operations reduces, there will be a significant increase in activity that will have an even greater pollution impact and the recommended control measures will need to be adopted to avoid environmental health risks.

EMSOL Recommendations

EMSOL believes the following actions would facilitate a significant reduction of polluting emissions during the boat's journey along the river and at the Piers:

Vessel-based Operations:

- Introducing operator training and policy in regards to reducing engine idling.
- The Port of London Authority has imposed a strict limit of 12 knots (~ 14 mph) on the Thames. Consideration should be given to maintain a speed below this limit to help in reducing pollution generation.
- Further work to establish optimum boat operating speeds for the reduction of emissions.
- Additional trial work to establish the effectiveness of replacing diesel engines with newer engines using alternative fuel types.
- The deployment of monitoring sensors on boats is not essential as pier-based activity is more critical. Maritime tracking-based API's could be used to give accurate presence and position of all river freight crafts. That would help to identify which crafts using the river are significantly contributing to pollution spikes.

Pier-based Operations:

- Continued monitoring to ensure mitigating measures are effective and upheld.
- Supply chain operatives can be notified of the pollution spikes at each Pier.
- Operational review of the loading and unloading process at both Piers could reduce the length of time spent in dock and will reduce polluting emissions.
- Future projects to record river freight emissions should ensure sensors are located as close to the river as possible (where possible) for optimum results.

3 Site specific pollution comparison

The average air pollution at The Dartford Pier was found to be consistently higher when compared to Butler's Wharf for all of the measured polluting emissions. The difference in NO2 concentration between the piers was highest in the morning hours during 06:00 - 08:00 when the boat started from the Dartford Pier. EMSOL correlated this with the cold engine start time of the boat at Dartford Pier. The Dartford Pier is located near the corner of a bend in the river and as a result, the wind is obstructed which means pollution dispersion is reduced. Consequently, EMSOL observed a greater build up of emissions at this location.

Further comparison of pier-based monitoring with Saturday's baseline levels for NO2 showed the level was 18% and 24% higher at Butler's Wharf Pier and Dartford Pier respectively. These operational margins would work well as improvement targets for the Operators at each Pier.

EMSOL Findings:

EMSOL appreciates it is not realistic to entirely avoid cold starts of the engine. Possible mitigating actions could include changing the freight fleet engine type or using filter extraction technologies during a cold start to eliminate particulate matter from the pier in future.

One approach that could be effective is the sharing and comparison of pollution level data between piers. This could be an approach for driving competition between piers to fasten improvement and set local standards.

Real-time pollution monitoring and alerting systems can identify the causes of high peaks of pollution and if proper actions can be taken, the pollution could be reduced to the baseline levels. Consideration should be given for out-of-hours delivery to avoid peak pollution times which will help maintain the pollution level within recommended limits. Additional recommended measures include active visibility and notification of pollution spikes that could be mitigated by operational behaviours such as reduced idling.

Findings and Analysis

4 Noise Pollution caused by River Freight

The impact of noise pollution caused by the two daily deliveries was relatively marginal. See figure 7 for a month-on-month comparison.

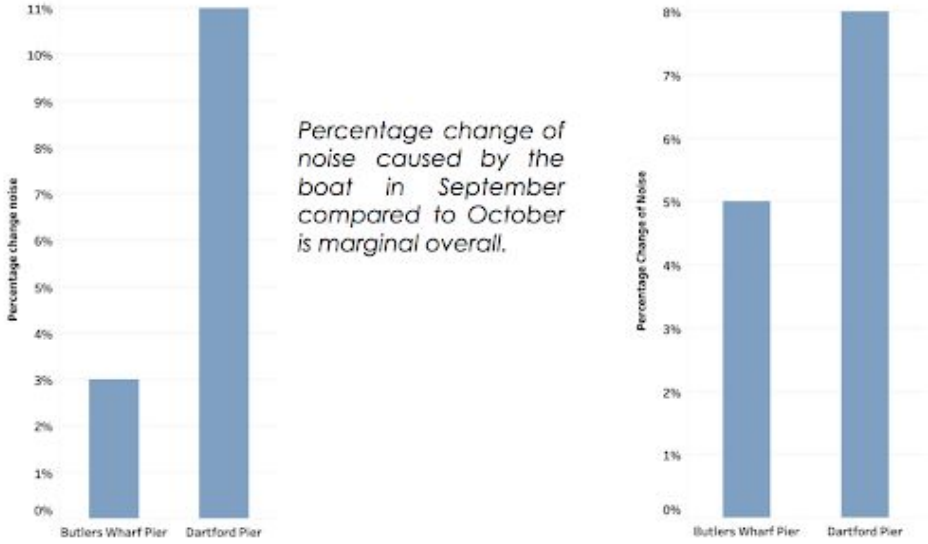


Figure 7 - Percentage change in noise caused by the boat in September/October

Findings and Analysis

Illustrated in Figure 8 are the noise levels over the four-month duration by time of day which illustrates the low level variance between day time working hours to late afternoon and evening timeframes.

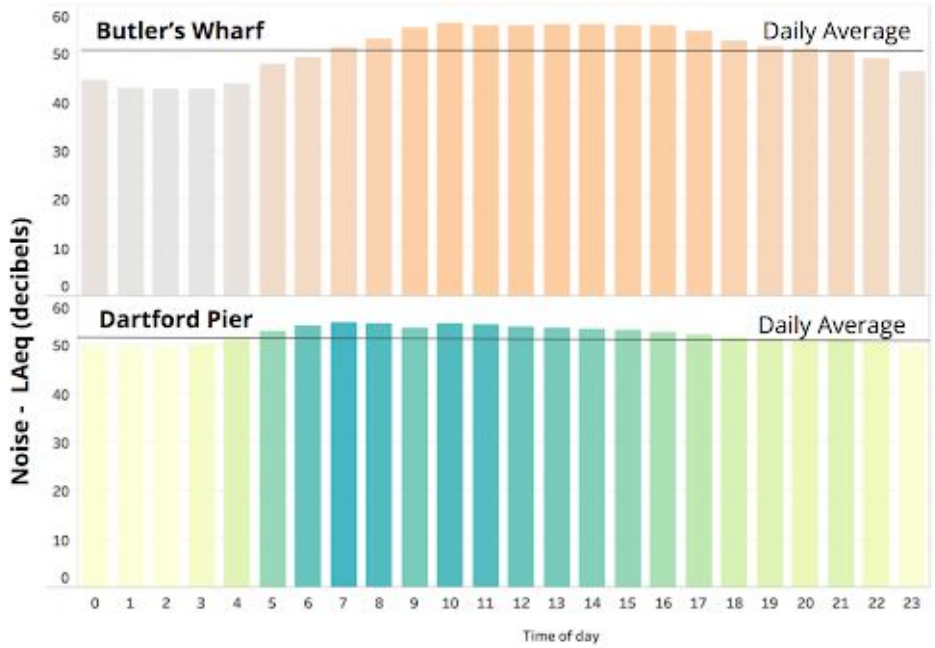


Figure 8 - Noise profile at each Pier by time of day for the duration of four-month trial period.

EMSOL Findings:

The low variance in noise pollution recorded by EMSOL presents an opportunity for river freight to operate out-of-hours which will assist with the reduction of air pollution. Moving river freight activity to out of hours would reduce the accumulation effect of air pollution at key sites and enable dispersion to be more effective, avoiding peaks and breaches of Defra and WHO air quality standards.

When EMSOL compares activity related noise pollution from surface fleet delivery activity to the river freight service activity we see that by servicing these deliveries by river freight there is less impact on ambient noise levels. Additionally, footfall along the river is reduced when compared to busy city streets so another finding is that the use of river freight has a reduced noise pollution impact on the surrounding communities.

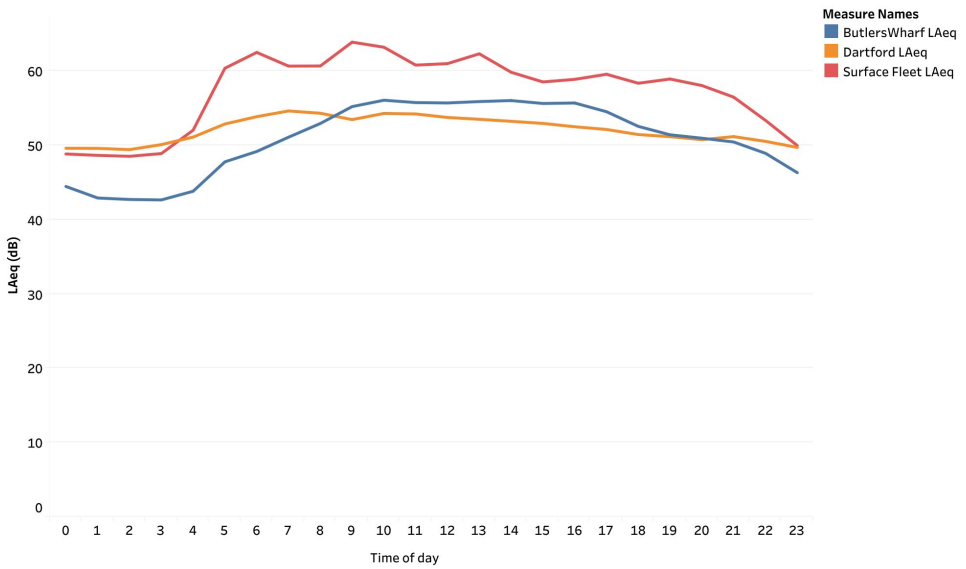


Figure 9 - Comparison of noise pattern at the Piers with a surface loading bay

Key Successes and Challenges

1

EMSOL was able to identify the pollution hotspots along the journey of the Equity boat by correlating the pollution data with the location of the vessel. EMSOL also pointed out the peak hours of pollution at the two piers and correlated those with the delivery schedule of the boat. The percentage changes of pollution caused by the boat at the two piers was also quantified by EMSOL.

2

The only KPI which is descoped in the project is the comparison of the river freight vessel with a land freight vehicle. As EMSOL's proposition does not cover measuring tailpipe emissions, it was not possible to quantify the pollution emissions from the freight along its journey and compare the same with the river freight emissions. CRP will produce this comparison separately.

3

EMSOL had challenges in getting power for the air quality and noise sensors at the Dartford Pier during the extension period of the project. CRP had contacted the Port Authority but the problem was not resolved. As a result of this, the data for the last month of the project is missing for the Dartford Pier.

4

CRP was also interested in comparing the air quality of the Equity boat with the new boat launched by Livett's - the Bravo Lima GB during the extension period of the project. But as the boat was not launched during the trial period of the project, the comparison could not be done.

Review of KPI's

	Requirements	Outcomes
1	Deploy & trial AQ monitoring sensors on 1 river freight vehicle to evaluate capability to provide useful AQ data.	Done and possible. Site locations are more vital and recommend using river craft tracking data.
2	Compare with land freight vehicle/s	Descoped
3	Deploy & trial AQ sensors onto 2 piers & one additional location along river	Done - at two piers. Successful model and recommendation as a viable solution in the future.
4	Analyse data to identify:	Done - fortnightly reports and analysis
4a	If river freight can provide air quality improvements in comparison to land-based delivery services.	Data available. Questionable if improvements are possible - without mitigations and interventions.
4b	Air pollution breaches above recommended levels.	Data available - consistent breaches - needs mitigations and interventions
4c	Sites of poor AQ along journey	Data available - piers, subject to site dispersion and bends in the river.

Conclusions

Monitoring air quality and noise emissions from river freight and at the piers was the newest accomplishment for EMSOL. During the four-month trial, EMSOL has achieved the following key things:

- Identified emissions levels associated to vessel service activity
- Identified peaks and troughs of air and noise pollution associated with river freight activity
- Attributed air and noise pollution to specific river freight activity
- Referenced collected data against Defra and WHO air quality standards to show breaches of those recommended levels.
- Verified pollution hotspots and sites of poor air quality along the journey of the vessel and provided explaining factors.
- Proven that the NO2 pollution impact from river freight is more significant than the impact of particulate pollution
- Observed that particulate pollution from river freight is less than road freight possibly due to the humidity levels and absorption qualities of the river.
- Evidenced that the impact of noise pollution from river freight is less than the impact from road freight, promoting out-of-hours operations to reduce pollution peaks.
- Recommended behavioural and operational changes which could reduce air pollution impact from river freight activity
- Evidenced future scalable technology for air and noise pollution monitoring with river vessel tracking and attribution for piers along the River Thames

Key recommendations

This project has provided an opportunity to scientifically assess the environmental opportunities and challenges associated with moving freight from road to river. EMSOL finds that there is a strong case to encourage the easing of the freight burden on London's roads by increasing levels of river freight. However, EMSOL recommends that the following actions and measures would be required to ensure the air and noise pollution impact is correctly managed:

Further projects are required to:

- Assess the impact of upgrading all vessel engine types using alternative fuel types such as HVO against use of traditional diesel engines/fuel.
- Ascertain optimum vessel operating speeds in relation to resulting polluting emissions with potential consideration to location along the river.
- Effectively measure the impact of mitigations and interventions

Standard and regulation setting:

- Use the identified ambient pollution levels identified by EMSOL as a baseline target for emissions control
- Enforcement by continuing to measure emissions and attributing, mitigating and reporting on specific river freight impact
- To ensure that the environmental impact of river freight keeps up with the improvements being made in the road and rail sectors and remains a sensible option for freight reduction on London's roads.

Consideration of alternative operating schedules including:

- Out-of-hours operations
- Weekend operations
- Operations during identified pollution troughs

Updating and issuing of operating procedures to include:

- Review of loading and unloading operations to maximize efficiency and reduce dock time
- Reduction of idling time
- Reduction in cold engine starts

Operator training to:

- Educate operators on the impact of river freight pollution and why mitigating measures are so important
- Reduce engine idling and dock time including adopting an approach to receive real time data on their impact and/or their compliance
- Create awareness and develop operating procedures to reduce the impact that higher vessel speeds have on pollution output.

Introduction of specific vessel focused pollution mitigations including:

- Air Pollution dispersion technologies at hotspots
- Engine emissions outlet extraction and filtration during cold starts

Future opportunities

This Pilot has evidenced future scalable technology for air and noise pollution monitoring with river vessel tracking and attribution for piers along the River Thames.

As river freight operators evolve it will be possible to independently track and record their emission footprint and impact. This data can be captured and shared with all parties from the pier-based monitoring technology. An effective, open and transparent monitoring and data engagement approach will enable the root causes of pollution spikes to be identified.

EMSOL has evidence that pollution spikes can be captured in real-time and the data shared instantly with the supply chains operating at any pier via SMS. This is an inclusive approach to solving day-to-day incidents when emissions have spiked. It is the collective reduction of these spikes that will bring the emissions to a viable, safe and compliant level.

Advances in river freight engines will be key and combined with the monitoring capabilities at the pier it will enable operators to justify the investment in the technology as it will enable them to secure contracts which will be judged on price and environmental impact.

Another important opportunity is to ensure that real-time river vessel tracking is available in ideally a structured API for all craft versus an API for every supply chain operator. However, this will evolve over time and in the meantime EMSOL video camera analytics has been proven as a viable capability to capture all activity present at piers during any of the pollution spikes.

Future opportunities that are important to the effective management of river freight emissions include addressing the pollution dispersion model for noise, PM and NO_2 on rivers, piers and at key sites. Additionally the inclusion of the impact from weather conditions and the facility to attribute other pollution sources detected by river based monitoring.

Finally, as data and insights become more readily available there is the opportunity to share the analysis and data with the local community so that they may be part of the mitigations, offering evidence to potential root causes. Transparency of data will lead to an approach of better informed and targeted mitigations and EMSOL will be able to evidence actions and the impact gains.

Thank You

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CROSS RIVER PARTNERSHIP
Delivering London's Future Together

Department for Environment Food & Rural Affairs

Appendix

Appendix

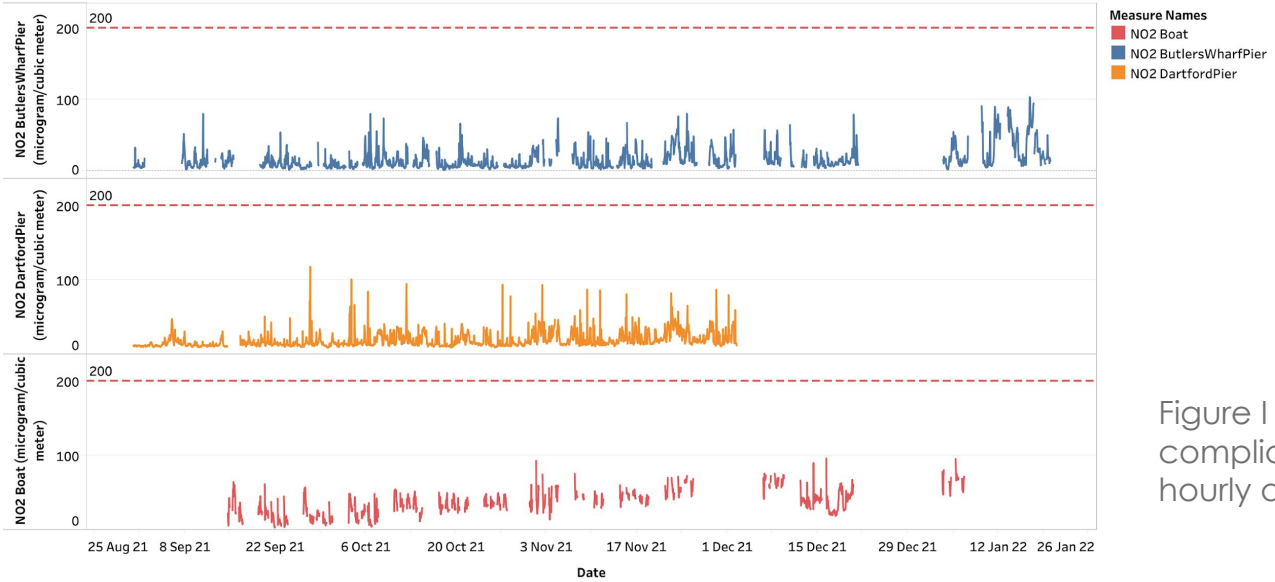


Figure I - Defra/WHO compliance for hourly average NO2

Appendix

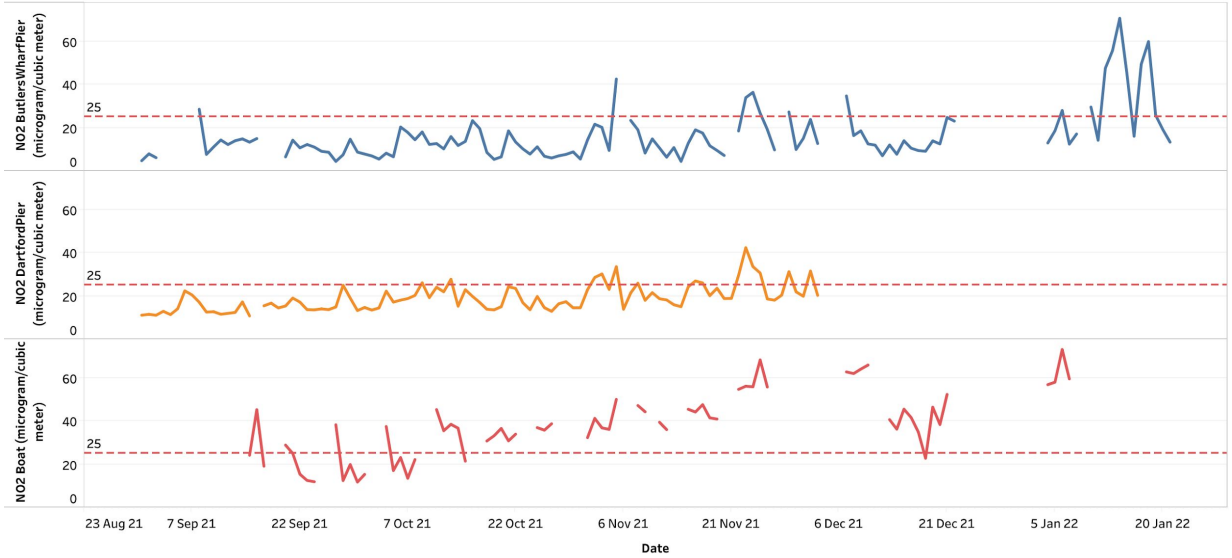


Figure II - WHO compliance for daily average NO2

Appendix

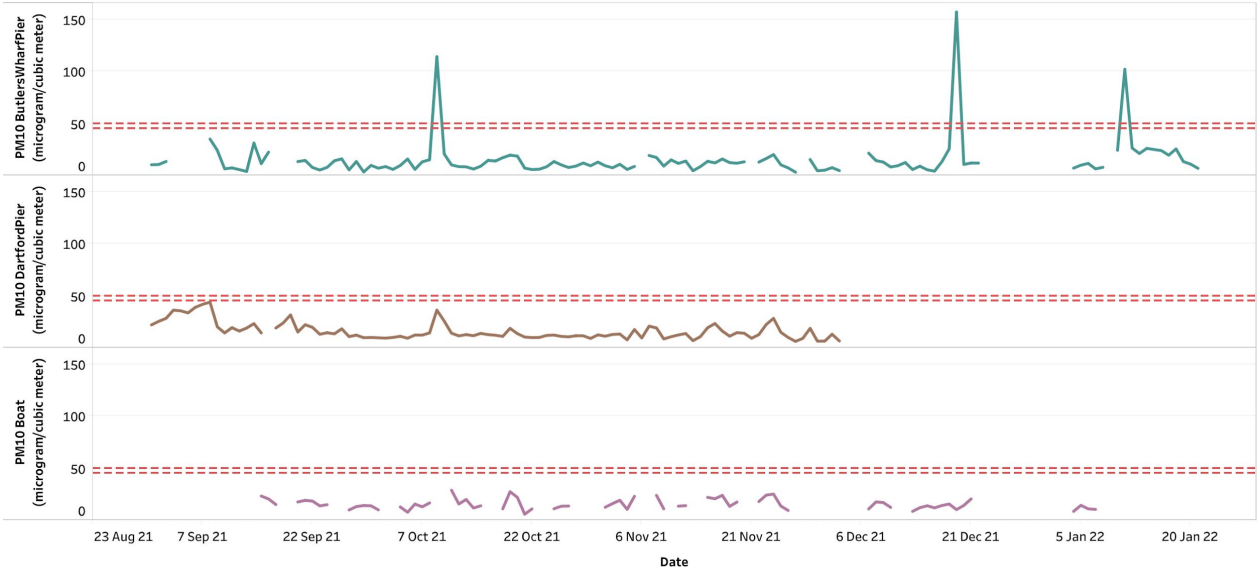


Figure III - Defra and WHO compliance for daily average PM10

Appendix

Figure IV - WHO compliance for daily average PM2.5

Appendix

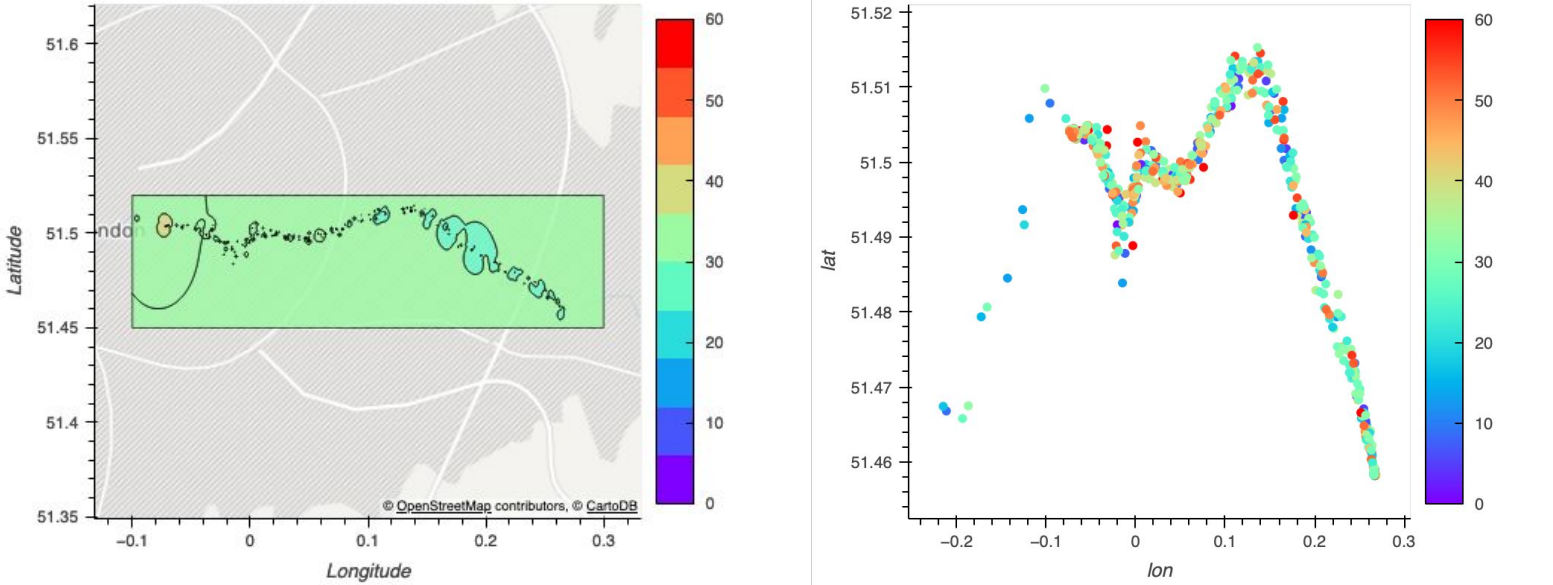
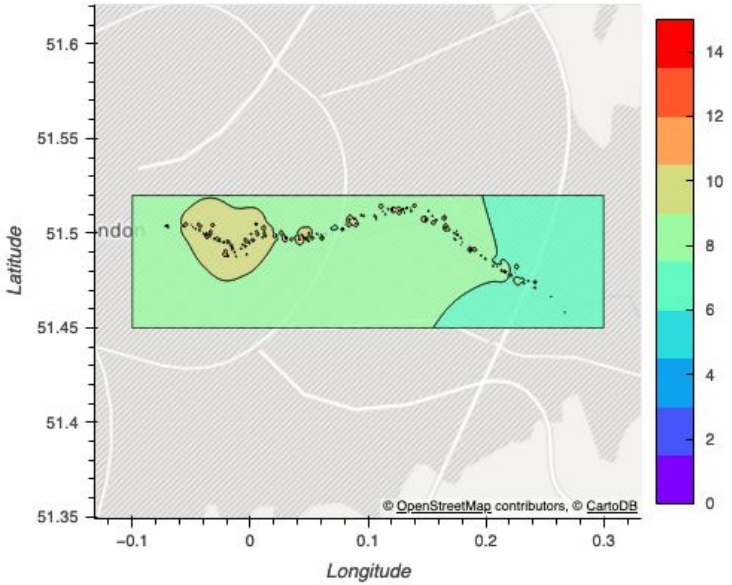


Figure V(a) - NO2 Contour Map and Fig V(b) - NO2 pollution hotspots along the journey of the boat.

Appendix



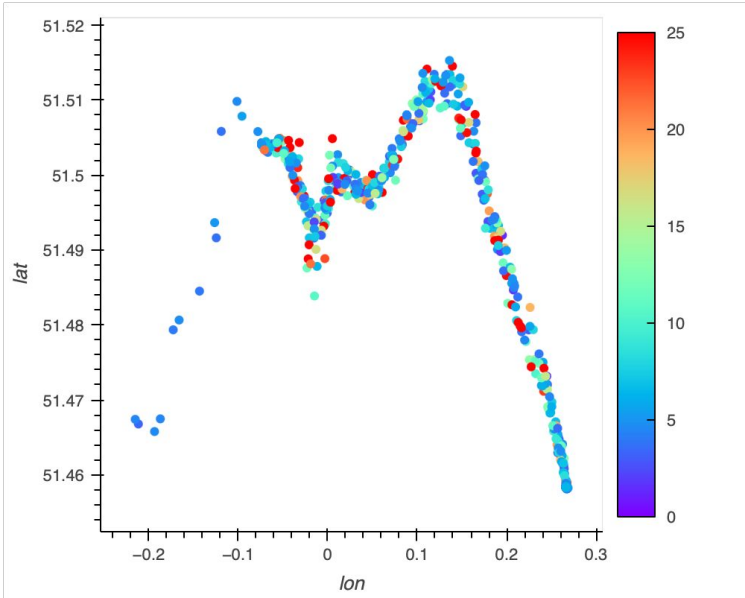


Figure VI(a) - PM2.5 Contour Map and Fig VI(b) - PM2.5 pollution hotspots along the journey of the boat.