CREEK-SIDE

BY CITIZEN SENSE
The Creekside area is adjacent to Deptford Creek, and is surrounded by busy roads, including Deptford Church Street. There are numerous construction sites in the area, as well as cultural spaces and low-rise and high-rise housing. Key findings indicate that automobile and HGV traffic are primary sources of PM$_{2.5}$ emissions, especially on Deptford Church Street. These emission levels are most likely made worse by extensive construction activity and construction-related traffic in the area.

This data story details below how citizen data, weather data and local observations reveal these specific pollution patterns. Drawing on workshops with local residents, the data story also suggests how best to address the problem, from planning for better transport to ensuring that dust management plans are adhered to for construction sites.
THE

LOCATION
Creekside is a residential and industrial area near the mouth of Deptford Creek in the Borough of Lewisham, Southeast London. Dustbox monitors are placed in a number of sites throughout Creekside as illustrated in the map below. Dustbox 103 is located in the centre of Creekside on a fourth-floor walkway in Crossfields Estate. Dustbox 109 is located on ground level at the west of the Art in Perpetuity Trust (APT) building, which is a large warehouse. Dustbox 137 is located on the roundabout at the entrance to the area in a third-floor garden. As a conservation area, Creekside and Crossfields Estate are recognised both for their historical and communal value.

As shown on the map below, Deptford Church Street (A2209) is to the west of the site, the A200 is to the north of the site and New Cross Road (A2) is to the southwest of the site. Also to the east of the site is the DLR trainline that runs from Deptford Bridge to Greenwich. Currently, sites to the north and southeast on Creekside are under construction for residential development. Two miles to the northeast of the site is Blackwall Tunnel Southern Approach, and just over five miles to the northeast is London City Airport.
LOCAL SOURCES OF PARTICULATE POLLUTION

The most immediate potential sources of PM2.5 are both the extensive arterial road networks and the construction sites that surround Creekside. As one participant’s map below shows, Deptford Church Street is a potential source of PM2.5 to the west. Creek Road to the north is another potential source for PM2.5, as is the New Cross Road southwest to southeast of Creekside.

In total, 30 monitors were distributed to participants. The monitoring period ran for over 9 months, until September 2017. During peak monitoring activity, there were 21 active Dustboxes.

Between November 2017 to March 2017, five large construction sites were active in the Creekside area. Dustboxes 103 and 109 were within 100 metres of the two easterly sites. Both Dustboxes were within a 250-metre range of all five construction sites. Additionally, there is a concrete works at the corner of Norman Road and Creek Road (northeast of Dustbox 103). The white line in the citizen map marks the route the concrete mixers use for road access.

Due to construction in the area, there is increased HGV traffic on Norman Road (east of Dustbox 103) and Creekside Road (east of...
Dustbox 103). Road works took place during a portion of the monitoring period, resulting in an increase in idling traffic as well as possible re-suspension of construction dust on Deptford Church Street (west of Dustbox 103).

LONDON-WIDE, REGIONAL AND GLOBAL SOURCES OF PARTICULATE POLLUTION

Particulate matter sources in London can be attributed to a broad range of emissions. Within London, PM$_{2.5}$ from transport (particularly diesel), industry, construction, cooking and heating all contribute significantly to London-wide levels. A significant amount
of PM$_{2.5}$ emissions also comes from heavy industry and agriculture outside the UK, particularly France, Belgium, the Netherlands, Luxembourg, Germany and Poland. These emissions are thought to account for an urban background of approximately 10 µg/m$^3$. The importance of these transboundary effects of PM$_{2.5}$ emissions from outside of the UK on the total London PM$_{2.5}$ can vary between 40% to 80% daily depending on weather conditions. When long-range pollution episodes do occur in London, they are generally carried on easterly winds. There are a number of global emissions, events and practices that contribute particulate matter to the total London PM$_{2.5}$, including fuel production, industrial and domestic combustion, transportation, waste disposal, and agriculture, although these are harder to quantify.

**OBSERVATIONS**
Residents have observed visible dust, sooty deposits on windows and surfaces, noise, active cranes, and idling delivery HGVs outside construction sites. Residents have also noted their respiratory health concerns.
IS THERE EVIDENCE OF A PROBLEM?
The Dustbox device used to monitor $\text{PM}_{2.5}$ is an “indicative” monitor. This means that measurements can give an indication of pollutant concentrations, but cannot be directly compared with national and international guidelines and standards in an “official” or regulatory sense. Despite this, indicative monitoring is a well-established method within atmospheric science for carrying out initial surveys of an area to establish whether a potential problem merits further investigation. Indicative monitors are also becoming increasingly available for citizen-based air-quality monitoring, similar to this study.

Where possible, the Dustboxes were co-located at the start and the end of the study to account for differences in the sensors and drift during the monitoring period. The co-location of Dustboxes in this data story indicates that there is a good similarity in measurements across the monitors used in this monitoring location, as well as with monitors in the extended community network, both at the start and end of the monitoring period.

Figure 1: Dustbox 103. Line graph time-series chart of 24-hour mean $\text{PM}_{2.5}$ concentrations from 2 November 2016 to 26 June 2017 (units: $\mu$g/m$^3$).
Indicative daily mean concentrations of PM$_{2.5}$ are shown as a time-series chart in Figure 1. The World Health Organisation (WHO) guideline of 25 µg/m$^3$ for 24-hour daily mean concentration of PM$_{2.5}$ is exceeded on a number of occasions at Dustbox 103, and this pattern is repeated in nearby Dustboxes, suggesting that further investigation may be merited. However, it is important to determine whether these breaches were caused by “local” sources of pollution close to the sensor (i.e., within 300 metres), or by regional sources affecting the whole area.

Local sources often augment regional sources, which can be revealed as a spike on top of a hump. In a general sense, this regional-local pattern occurs because pollution mixes in the atmosphere as it travels away from a source, smoothing the speed of changes in concentrations.

Figure 2 shows an extract of the monitoring data from the Dustbox 103 site presented as hourly mean concentrations of PM$_{2.5}$. Measurements from Dustbox 109 are shown for comparison. Regional sources of pollution appear as broad “humps” of elevated pollution affecting both sites. Local sources of pollution appear as short “spikes” typically affecting only one or the other site.

Figure 2 therefore indicates that there are significant local sources of particulate pollution elevating ambient concentrations well above those caused by regional sources across the monitoring period.
There are many possible sources of pollution in the area and we have to look at the measurements more closely to see if we can deduce which activities are causing these spikes. Knowing the source of pollution is important as some activities produce more toxic particulate matter than others, and actions to mitigate sources should be targeted to the cause of the problem.

Creekside construction.
CHARACTERIZING THE PROBLEM
WHEN IS THE SOURCE MOST EVIDENT?
Using time plots, it is possible to analyse time of day and day of week, as well as month, when pollution levels are elevated. Time plots aggregate PM$_{2.5}$ concentrations according to time, so that key patterns such as rush hours and traffic, as well as possible construction or industry sources, along with regional pollution events due to seasonal variation, are evident.

**Figure 3** investigates when elevated levels of pollution occur by grouping concentrations by hour, month and day of the week. Sources of pollution related to commuter or transit traffic typically show peaks in concentrations coincidental with peaks in traffic flow, i.e., morning and evening rush hour with notably lower levels at night and on Tuesdays, Wednesdays and Sundays. In this way, **Figure 3** shows evidence of early morning and evening peaks. However, it is clear the morning peaks are around 5 to 6 am, perhaps suggesting higher levels of particulates from earlier traffic, such as construction crews, delivery vehicles and commuter traffic.

These charts can be used to match patterns in the occurrence of spikes with working patterns of particulate-generating activities in the area. In a general sense, it should be noted that the weather plays a large role in particulate levels. For example, dust tends to be dispersed more slowly during the hours of darkness, as vertical and horizontal wind speeds are generally lower. This phenomenon may skew charts somewhat.
WHICH DIRECTION IS PM\textsubscript{2.5} COMING FROM?

Wind direction has a considerable influence on pollution measurements. A sensor will only record emissions from a particular source or activity if the wind blows it from the source towards the sensor. Therefore, we can investigate where a source of pollution is likely to be located by plotting wind direction against pollution concentrations.

Figure 4 shows how pollutant concentrations at Dustbox 103 site are influenced by wind direction. It shows the most regular high readings are from the northeast, east and southeast (20\degree to 130\degree), and from the southwest (240\degree).

A polar plot, as shown in the figures below, is a more intuitive way of looking at this relationship. These plots show colour contours of pollutant concentrations in relation to wind direction and wind speed, with zero wind in the centre, increasing up to 20 metres per second (ms\textsuperscript{-1}) at the outer ring. The highest mean concentrations are shown in red, the lowest are in blue.
Figures 5a: Polar plot showing mean PM2.5 concentrations during different wind conditions at the monitoring locations for Dustbox 103 from 2 November 2016 to 26 June 2017. The mean concentrations shown here are relative, e.g., for Dustbox 103 the highest mean concentration is approximately 70 µg/m³. Emissions levels are displayed on polar plots according to a gradient of low to high pollution levels. The colour coding refers to a different range of readings in each plot.

Figure 5a above and Figures 5b and 5c below highlight the fact that, on average, high pollution levels are regularly recorded at the Dustbox 103 and Dustbox 109 sites during northeasterly and southwesterly winds. As both sites show a source to the east, there may be a regional source of air pollution in that direction, which is detected by most sensors in the area. It should be noted, however, the PM$_{2.5}$ levels are still relatively high at the centre of the monitoring areas, ranging between 30 to 50 µg/m$^3$.

Figures 5b and 5c: Polar plot showing mean PM2.5 concentrations during different wind conditions at the monitoring locations for Dustboxes 103 and 109 from 15 November 2016 to 15 February 2017. The mean concentrations shown here are relative.
UNDER WHICH WEATHER CONDITIONS ARE PM$_{2.5}$ LEVELS MOST EVIDENT?

Different sources of pollution will behave in distinct ways according to the weather. For example, wind-blown dust will primarily occur during dry, windy conditions. Sometimes, you can learn about a source by characterizing this weather-related behaviour.

**Figures 6 and 7** indicate that some moderate PM$_{2.5}$ levels are possibly related to re-suspended or wind-blown dust due to elevated particulate levels during low to moderate wind speeds (**Figure 6**) and moderate humidity (**Figure 7**). However, the higher concentrations of PM$_{2.5}$ are unlikely to be wind-blown dust as they occur at high humidity, as shown in **Figure 7**.

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**Figure 6**: Dustbox 103. Scatter plot showing the relationship between mean PM$_{2.5}$ concentrations and wind speed from 2 November 2016 to 26 June 2017 (PM$_{2.5}$ units: µg/m$^3$).

**Figure 7**: Dustbox 103. Scatter plot showing the relationship between mean PM$_{2.5}$ concentrations and humidity from 2 November 2016 to 26 June 2017 (PM$_{2.5}$ units: µg/m$^3$).
DRAWING THE EVIDENCE TOGETHER
Using the tools provided through the Citizen Sense Airsift Dustbox Data Analysis Toolkit, we have characterized sources of particulate pollution detected by the Dustbox 103 and Dustbox 109 Deptford Creekside monitors as follows:

- While regional sources of pollution were detected, there was clear evidence of additional local source or sources, often at high levels.
- The strongest local source(s) appear to be to the northeast and southwest of the Dustbox 103 and Dustbox 109 sites. This is likely to be related to a London-wide pollution event.
- However, there is some evidence of local emissions combining with city-wide emissions. These local emission sources could travel from the A2 and Deptford Church Street, and from construction (with associated HGV traffic and idling trucks) on Creekside, as well as high levels of construction in the east in general.
- The local source or sources are strongest during the early hours before 6 am, and in the afternoon/early evening. The source or sources are possibly related to delivery, construction crew and commuter road traffic.
- PM2.5 levels are sometimes likely to be related to re-suspended or wind-blown dust due to elevated particulate levels during low to moderate wind speeds and moderate humidity. However, higher concentrations of PM2.5 are unlikely to be wind blown dust as they occur at high humidity.
- The high peaks shown in late January can be accounted for as two periods of poor air quality across London beginning 19 January 2017 and 23 January 2017, partly due to cold, settled weather slowing the dispersion of local pollutants.
ACTIONS
In relation to the evidence and findings from the Dustbox citizen monitoring study, preliminary actions are proposed here that take into account the neighbourhood context and existing community organisations and initiatives. The key areas for addressing air pollution include transport, construction, green infrastructure, and additional monitoring. These actions have been developed in consultation with monitoring participants and local area residents. Some actions are shared across the 7 data stories, while others are specific to this data story location:

TRAFFIC AND TRANSPORT

- Building on the Lewisham Council Local Implementation Plan, develop a traffic management plan for Deptford and New Cross in order to identify areas to improve pedestrian, cycle and public transport routes, and to understand the potential impact of the Ultra Low Emission Zone (ULEZ) on the area. Address the impact of new development and increasing population in the area, with a realistic projection of the likely numbers of new cars that will be in the area.
- Undertake an audit of delivery vehicles in the area, especially as they leave the DHL depot on Surrey Canal Road. Vehicles tend to leave in a fleet at 9 am, causing congestion and idling. Staggering deliveries could be one way to improve this.
- Restrict parking in the area in order to reduce the flow of cars through and into the area. Construction vehicles and company vans frequently use free parking around Deptford Park, and free parking encourages the use of private vehicles rather than alternative modes of transport.
- Encourage and support transportation pilots to trial improved roadway design and circulation. Highly successful projects are currently underway, including the partnership between Deptford Folk and Sustrans. Share best practices from transportation pilots, and extend these to other areas, such as pedestrianizing Scawen Road adjacent to the Sir Francis Drake Primary School and Deptford Park.
- Improve cycling opportunities in the area, and separate vehicle traffic from cycling traffic, including through the use of car-free green corridors. Encourage and support cycling initiatives such as the partnership between Deptford Folk and Sustrans.
- Post signs to encourage no idling. Signs that read ‘Turn your en-
gine off' and include images of people in pollution masks are more effective than text-only signs that read ‘No idling’.

- Encourage hybrid vehicles and buses, and investigate ways to integrate solar panels into the design of buses and bus stops. Allow for electric vehicle charging points to be requested by residents as part of community transport initiatives, and not only by those who own an electric vehicle.

**CONSTRUCTION AND DEVELOPMENT**

- Ensure the fulfillment of Air Quality Impact Assessments (AQIAs), both at the planning and implementation stage of new developments, in order to accurately gauge the effect of construction with new developments. Develop adequate monitoring and compliance mechanisms for possible breaches of AQIAs.
- Develop planning and regulatory mechanisms for addressing the accumulative effects from construction and new developments. Impacts from construction and new development can include air pollution from demolition and siteworks, traffic during construction, and higher densities of buildings, people and traffic from new developments. Require that all new developments are ‘air quality neutral’, and ensure transparent and legible processes are in place for ensuring neutrality.
- Join up traffic planning across existing and new developments to facilitate walking, cycling and public transport. In relation to Convoy’s Wharf, develop clear plans for the use of Grove Street. In the case of Timber Yard, outline how this development will integrate with existing roads and traffic patterns. In all cases, design for neighbourliness with pedestrianized and play streets.
- Encourage cross-borough collaboration on construction and new development. Pending developments at the edge of Deptford, including the Silvertown Tunnel, the Enderby Wharf cruise ferry terminal, the Knight Dragon development at North Greenwich Peninsula, and the Royal Docks Enterprise Zone could have a considerable effect on traffic in the area, especially along Evelyn Street.
- Include plans for managing construction traffic as part of providing planning approval for new developments. Ensure that construction traffic does not exceed set levels so as to avoid additional local pollution events.
• Address and prevent the loss of green space and public space due to new development. Green spaces can have a significant mitigating effect on air quality, and also provide a lower emission space in which people can spend time outdoors.

• Provide indicators for how to measure the effectiveness of dust measurement plans and practices at construction sites. Working with the London Low Emission Construction Partnership, provide mechanisms for enforcing dust management plans when they are not adhered to, and for reporting violations.

GREEN INFRASTRUCTURE

• Require an audit of green spaces in the borough, including an assessment of the suitability of green space as green infrastructure in relation to air pollution mitigation, and in relation to improving walkability and cycleability. Using existing London tree mapping resources, develop a tree plan for planting in the borough, and in relation to best guidance for trees suitable for minimising and lowering air pollution.

• Plant trees and preserve green spaces in relation to air quality guidance for vegetation. Encourage and support Evelyn 200, an initiative by Deptford Folk to plant 200 trees in 2018, as well as similar community initiatives for greening the area.

• Investigate opportunities for planting air quality enhancing vegetation in existing green spaces including Sayes Court, Deptford Park and Folkestone Gardens, as well as at schools, hospitals, playgrounds and key community sites.

• Provide guidance on planting for air quality, including preferred species, optimal planting arrangements, and best practices for maintenance.

• Host air pollution monitoring and awareness events in green spaces to raise awareness about the importance of urban design and planning in relation to mitigating and prevent air pollution.

AIR QUALITY MONITORING

• Prioritise air-quality audits of emission levels at Deptford and New Cross schools, in line with the Mayor of London’s initiative. Expand and provide courses in schools for children to learn about air quality and to undertake air quality monitoring in
their local area, including promoting actions for reducing air pollution such as walking to school.

- Provide resources for community organisations and residents to continue to monitor air quality over time in order to assess improvements from preventative and mitigating actions.
- Provide resources to undertake speciation to understand the composition and sources of particulate matter, including from roads, construction and other sources.
- Develop protocols and channels for citizens to provide monitoring data to local and GLA environmental health and planning officers, and require officers to act on identified exceedances in relation to air quality guidelines.
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These data stories are generated using the Citizen Sense Airsift Data Analysis Toolkit, which was developed to allow for citizen-led interpretation of datasets. The core data available for interpretation is the Dustbox PM2.5 sensor data. The Airsift toolkit also brings in air quality data from select sites in the London Air Quality Network (LAQN) for comparison with the citizen data.

In order to blur the exact monitoring locations, the monitoring locations are shown with large blue circles to indicate the approximate monitoring location. Additional citizen monitoring locations are anonymous, and are not included on the Airsift map.
At the start of the monitoring period, the Dustboxes were co-located with the Marylebone Atmospheric Observatory, and a scaling factor was applied to calibrate the devices. Because the sensors were co-located and calibrated during a time of low to moderate pollution, the scaling factor could slightly amplify higher readings in relation to the LAQN readings. However, this would require further testing to demonstrate, since when comparing Dustbox levels with nearby LAQN levels (where available), readings are often comparable.

This data story is prepared under the assumption that all pollutant, cartographic and meteorological measurements are valid and not sufficiently biased to cause misrepresentation of results. Please refer to the Airsift Data Analysis Toolkits and Terms of Use for further information.

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