Clean Air Zone Programme Board Report

Report Purpose: To explain traffic flow changes as a result of the pandemic

Meeting: CAZ Board Meeting

DATE: 07 January 2021

TITLE:	**Traffic behaviour 2019 - 2020**
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Decision/s Required: Accept the evidence presented and agree to use the technical data as an appendices to the Technical Note (agreed by CAZ Board on 02/12/2020 and revisions to be further considered by CAZ Board on 7/1/21)

Timescales:

- **It is intended to review the information within this report and for the technical data to form an appendix to the technical note (agreed by CAZ Board on 02/12/2020 and revisions to be further considered by CAZ Board on 7/1/21). It will then be reviewed alongside the consultation output (in Jan 2021) to enable Board to make an appropriate recommendation to Cabinet in February 2021 (date to be agreed).**
- **Full Business Case is to be submitted to JAQU on or before 26 February 2021.**

Purpose of Report:

1. To explain how the traffic flows have changed as a result of the pandemic, before, during and in-between the two periods of national lockdown due to the Covid-19 pandemic
2. To provide Board members with enough information so all can understand and see clearly the changes that have occurred
3. To ensure Board members feel there is adequate technical evidence for submission to JAQU, as an appendices to the updated Technical Note (agreed to be submitted to JAQU, for consideration and further review, by Board on 7 January 2021).

Introduction

This report is an appendix to the technical note; it was approved for submission by the CAZ Board on 7th January 2021 (subject to further refinement once reviewed by JAQU) and should be read in conjunction with the technical note. It provides Board with an overview of traffic volumes and air quality before, during and after lockdown periods.

As stated in the technical note, the Council's preferred outcome would be to not introduce a charging zone if the evidence supports this. The inclusion of the Street Space schemes provides an updated Baseline model against which the Clean Air Zone scheme requirements can be assessed. The introduction of the Street Space Schemes has wider aims than just air quality including; enabling social distancing, allowing businesses to use outdoor space and encouraging people to travel by sustainable modes as part of an active lifestyle.

To understand the potential impacts of the Small CAZ D, the Fast Track Measures have also been included in the Baseline in the assessment. The preliminary modelling results for the revised Small CAZ D option show a compliance year of 2023, this is covered in more detail in the technical note.

Evidence Base

The global pandemic: Covid-19 began to take hold in March 2020. This led to a nationwide lockdown in the UK. From

that moment, the traffic behaviour changed and with that, air quality improved across Bristol. Naturally, this led to calls for the CAZ to be reviewed in light of the improvements being seen which were largely as a result of the closure of schools, building sites, bars, restaurants and non-essential shops. While the improvement in air quality during this time was a welcome effect of the lockdown, in order to define an area as being *compliant* (within the legal limits set), the air quality is measured using an annual measurement: annual mean. Therefore it is not possible to officially state that Bristol had become air quality compliant at that time.

Following lockdown 1 when schools and businesses reopened, a gradual increase in traffic volumes was observed although these were not to levels experienced in previous years. Questions were raised as to the viability of the existing baseline and direction of the project, given the possibility that people may maintain the positive travel behaviours experienced during lockdown and potentially continue to work at home. Further encouraged as new technologies had been rapidly adopted by businesses and organisations during the lockdown, resulting in less commuting traffic (and therefore less pollution) and in recognition that lifestyles had changed. It was subsequently agreed with JAQU to begin a staged modelling process, which would explore new opportunities, capture the changes and highlight which measures would be most appropriate to reach legal compliance.

During lockdown 1, the Government released emergency funding for local authorities to facilitate social distancing measures: Emergency Active Travel Funding (EATF). In Bristol, this saw some road space removed and other key changes on some of the main CAZ corridors which were experiencing the worst air pollution. This further supported the need to urgently review the baseline (these are detailed in table 2.2 of the main Technical Note; Bristol SSS and Small CAZ D Report).

Data collection on traffic flows and air quality levels continue to be captured and analysed throughout the pandemic, to explore whether a charging CAZ would be required, given all the changes that had occurred as a direct result of the two national lockdowns and subsequent tier system. There is evidence that air quality improved during the first lockdown as movement around the city reduced and travel behaviour changed. The Council's preferred approach is to build on these behaviour changes and to encourage citizens and businesses to sustain the recent, less polluting travel behaviour that had been seen during the pandemic, without needing to implement a charging CAZ. The Council has supported this with improvements to roads around the city that make it easier to walk, cycle or use public transport. The Council is calling these the Street Space schemes (Government funded, using Emergency Active Travel Fund budget) and Fast Track measures (JAQU funded). On September 1st 2020, the Mayor issued a call to action during a Council Cabinet Meeting, stressing that in order for there to be a reasonable chance of avoiding a charging zone, people would need to modify their travel behaviour. He said:

We need to use this opportunity for people to transition onto public transport. We can have conversations with our bus providers to facilitate that and make sure people can do it in a safe way. But, that transition also helps us build the longer-term case for the mass transit system that we're also bringing through. This really is a call to action. This is not something that the council can deliver alone; this is about us as a city collectively engaging in behaviour change in the way we move around. If we collectively engage in that behaviour change, we can get ourselves to compliance in the shortest possible time in a way that does not further compound the economic woes faced by households and businesses in Bristol.

To achieve this, a clear understanding of traffic flows was required, to assess whether traffic volumes might not return to pre-lockdown levels. The Traffic Control Team were able to utilise data captured using SCOOT reporting, from the PowerBi system, to see patterns of behaviour and thus make some informed and experienced observations and recommendations about how traffic volumes may change going forward.

Data Analysis

The traffic data that is now becoming available does seem to be indicating that between lockdown 1 and lockdown 2 – the latter of which started on the 5 November 2020 and ended on 2 Dec 2020 – traffic levels rose but that they fell short of rising to pre-Covid levels by 18%. This could be, in part, attributed to the introduction of the Street Space Schemes and the different working behaviours that people adopted during lockdown 1 that may they have maintained. For example, when comparing October 2019 traffic volumes to October 2020, we can see that by October 2020 weekday traffic levels had risen to 82% of October 2019 levels, as demonstrated below, but not

returned to pre-Covid levels:

Location	Oct-19	Oct-20	% of 2019 flows
Newfoundland St Inbound	145,268	121,960	84%
Newfoundland St Outbound	178,968	146,040	82%
Marlborough St WB	66,200	54,888	83%
Perry Rd EB	42,324	31,368	74%
Total	**432,760**	**354,256**	**82%**

The above traffic data focusses on some of the key CAZ count locations, 'key' because they are within the potential clean air zone boundary; traffic levels in turn affect air pollution levels and ultimately compliance dates.

They key CAZ traffic count locations are:
St Michaels Hill SB - D07115
Lower Maudlin St Westbound @Lewins Mead – D01361
Marlborough St Westbound @ Dighton St - D07163
Newfoundland St Inbound - D02171
Newfoundland St Outbound - D02174
Perry Rd Eastbound/ Colston St - D07112

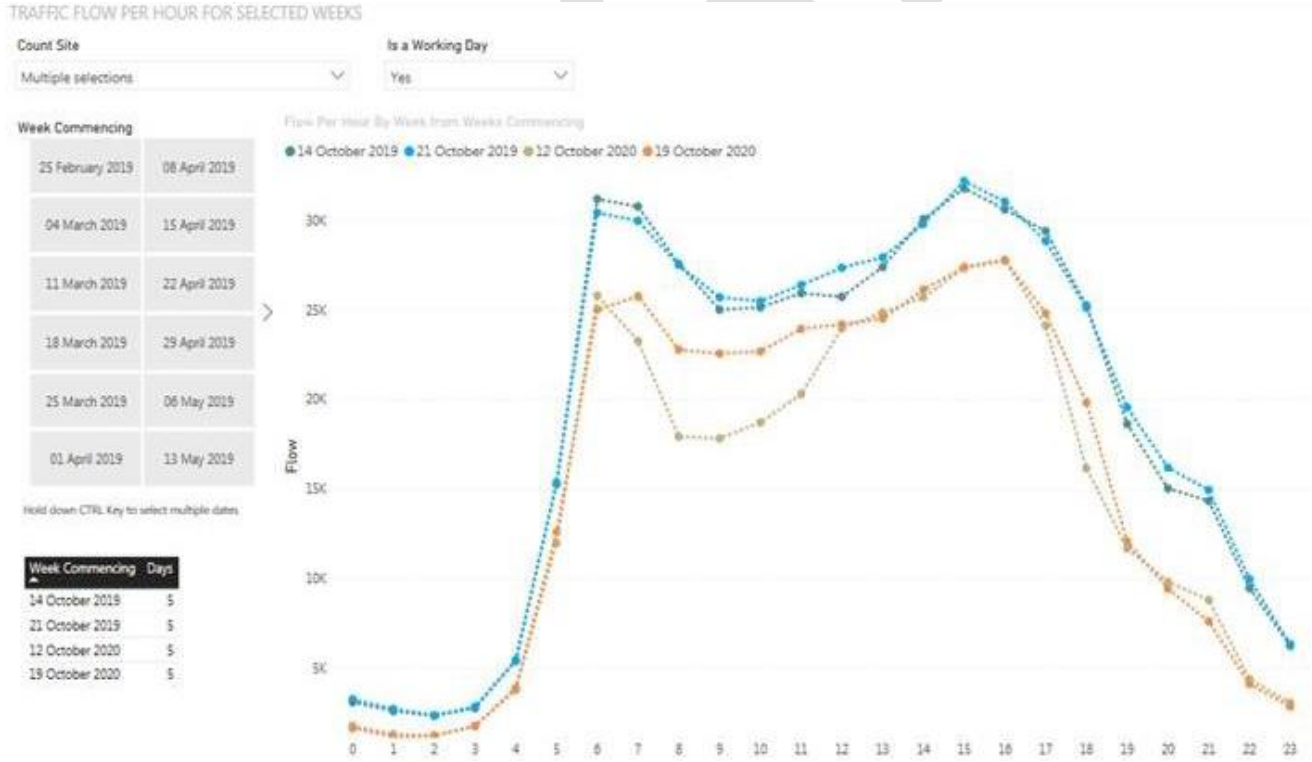
Please note that the St Michaels Hill Street Space junction changes took place on 27th September 2020. This involved a no left turn into St Michaels Hill and no right turn out of St Michaels Hill; a significant change to the road layout.

The following data / graphs show and compare traffic levels during and in-between the two periods of lockdown, to make some assumptions about what is likely to be the pattern post pandemic. It begins with a look back in comparison to levels pre, during and post the two initial lockdowns. This will be followed with some analysis of air quality over the same period of time. Ultimately, the decision about what this data indicates lies with JAQU as they consider what measures Bristol will be directed to implement by October 2021.

Pre, during and post lockdown data

Graph 1: Feb 2019 – Nov 2020; Traffic flows by year and month

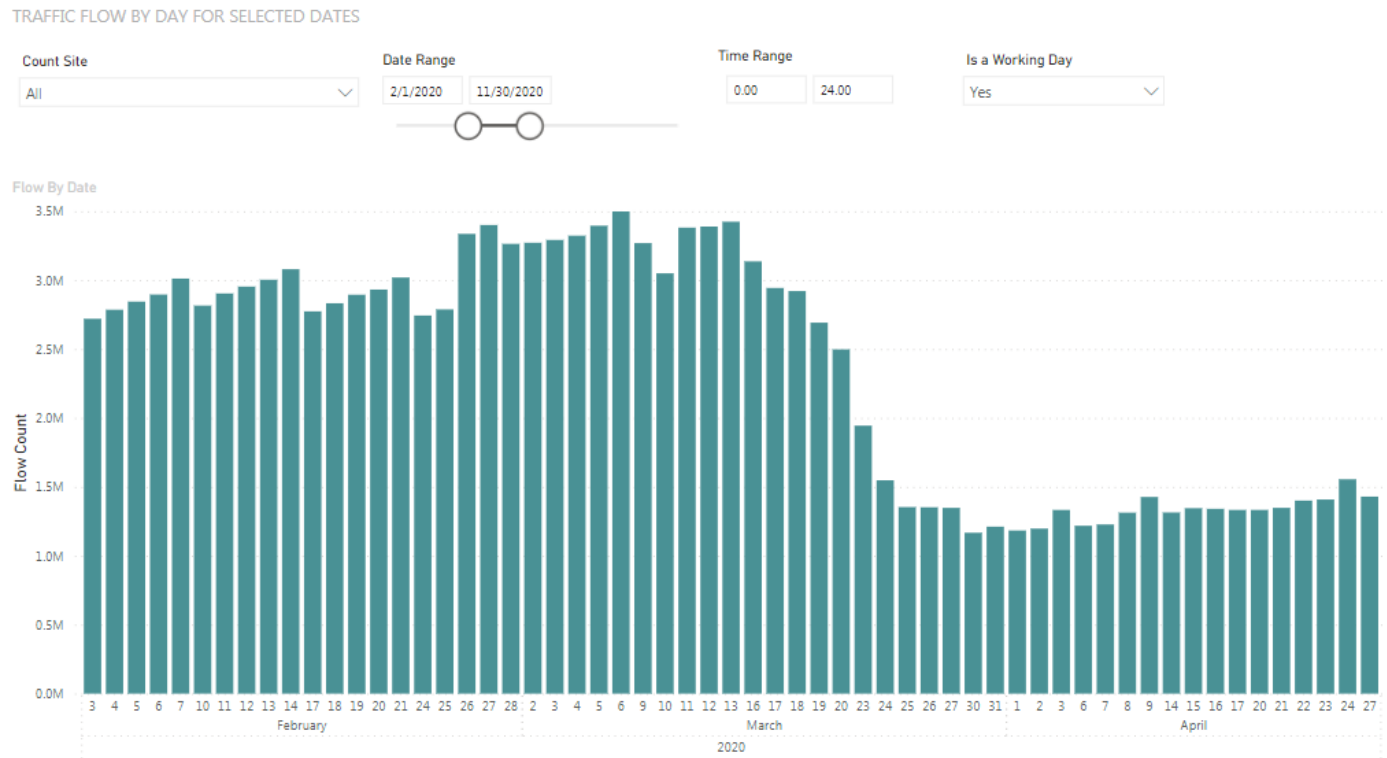
Graph 2: A comparison of traffic flows in October 2019 and October 2020



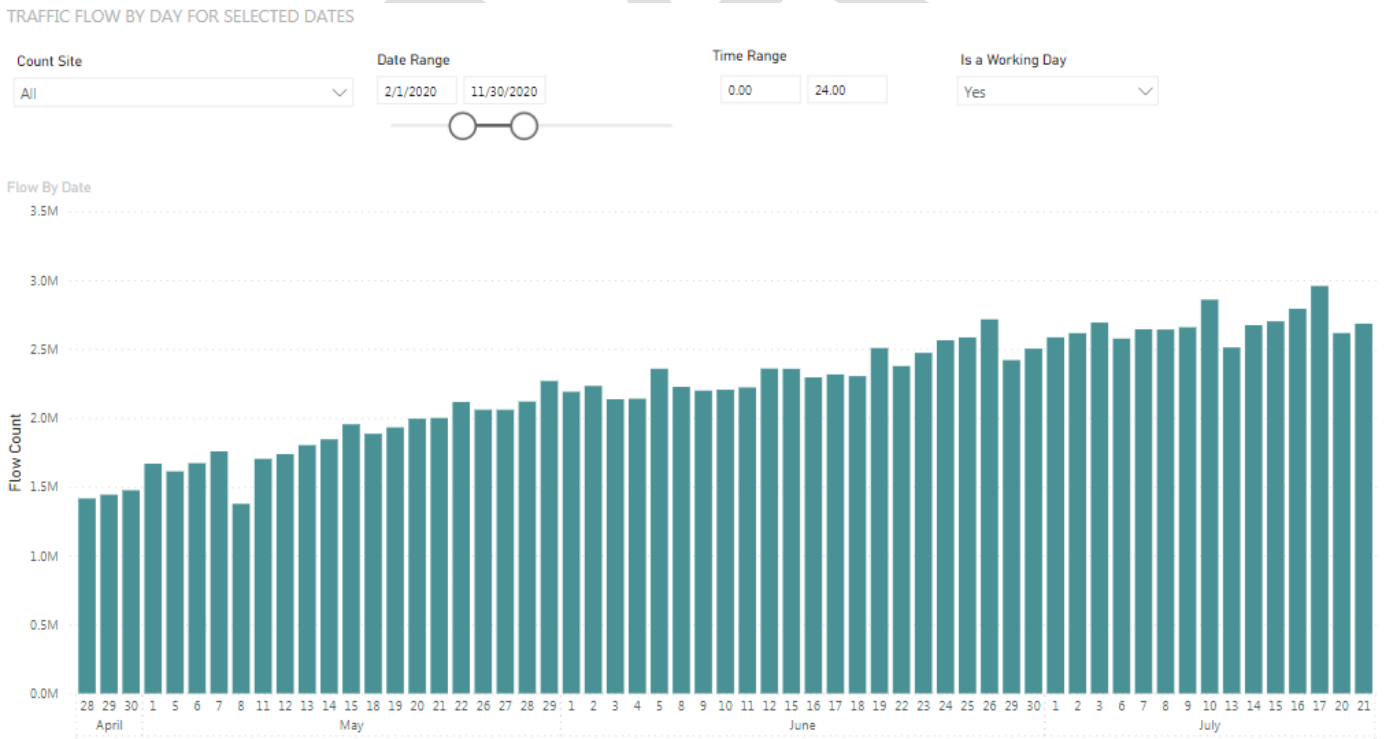
Graphs 3 – 6: Daily traffic counts pre, during and post lockdown in 2020

The following 4 graphs show the daily counts for Working Days (excluding bank holiday) from the 3rd February to the 4th December 2020

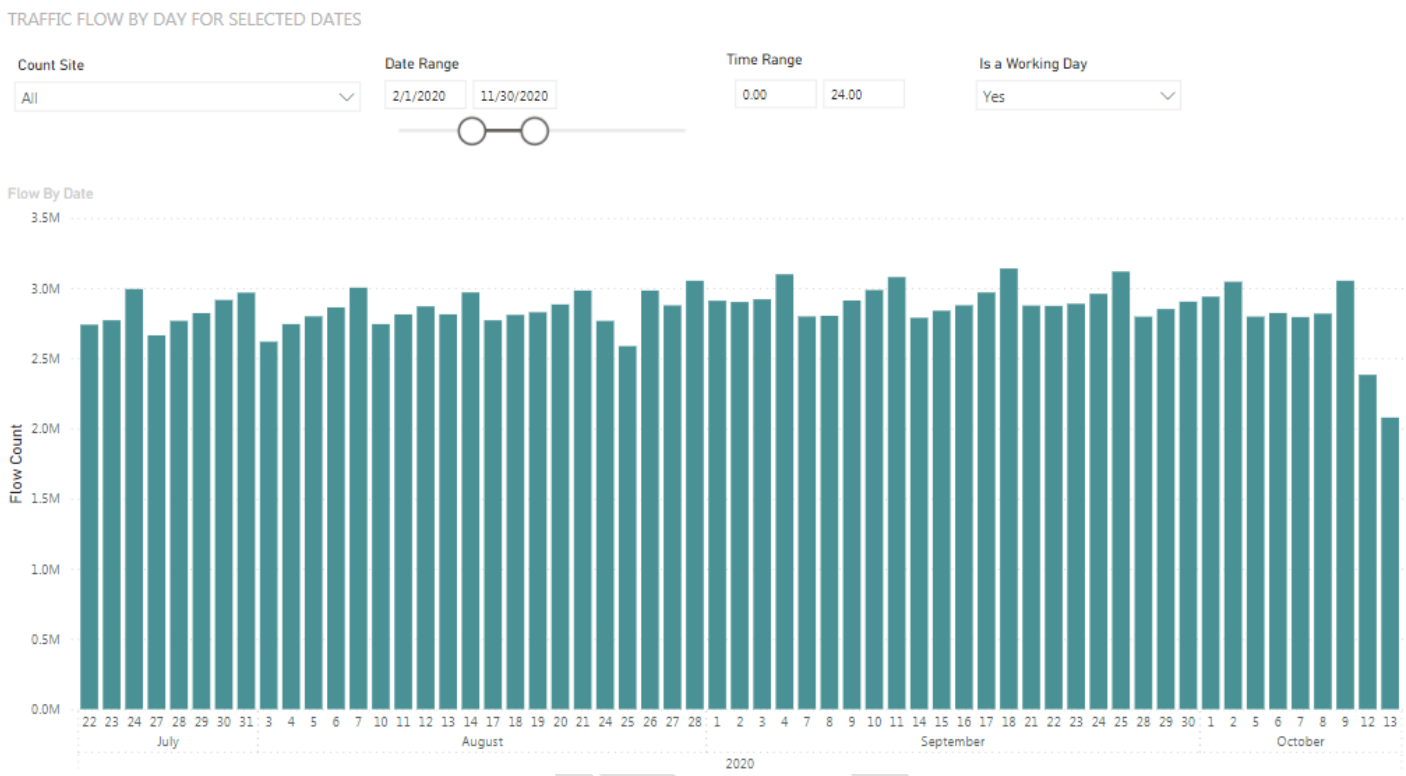
Graph 3: Feb 2020 – Apr 2020



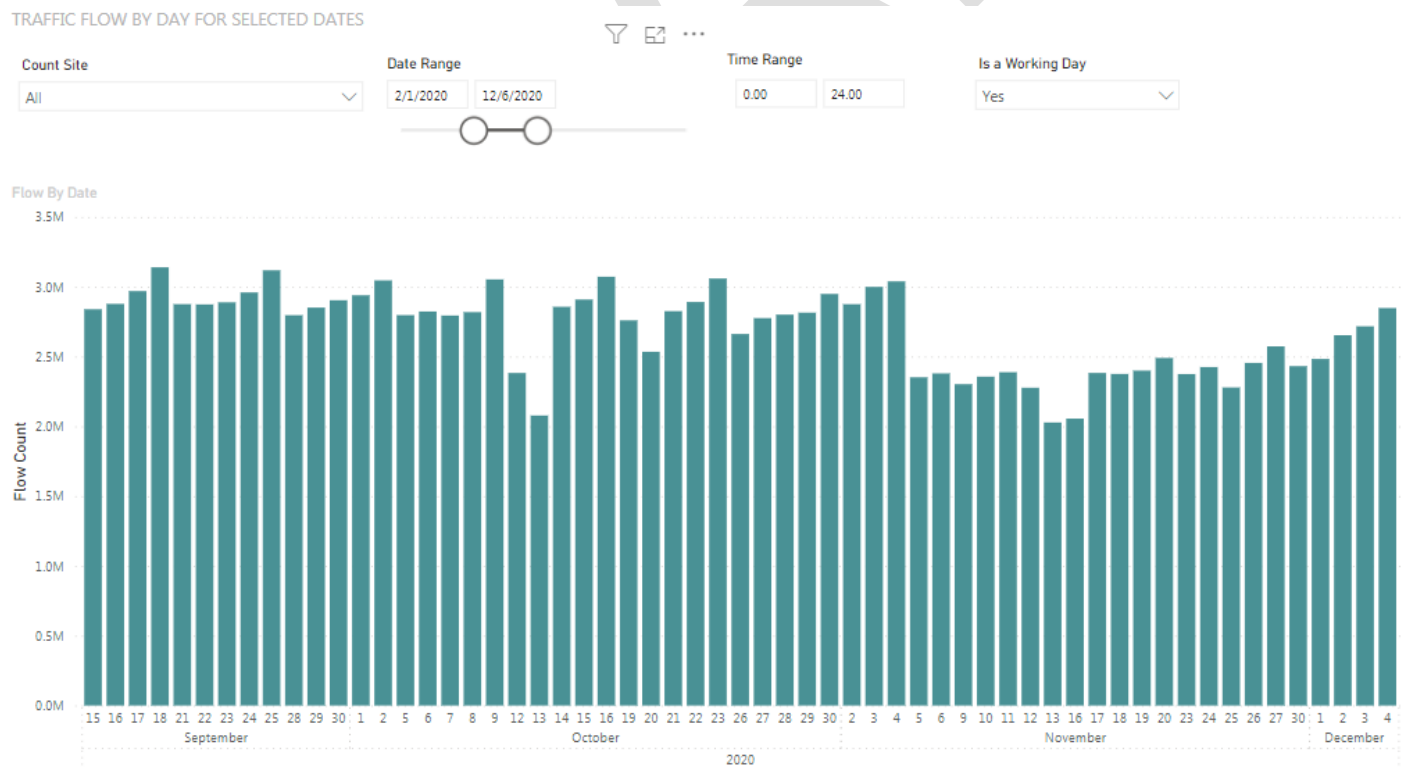
Graph 4: Apr 2020 – July 2020



Graph 5: Jul 2020 – Oct 2020



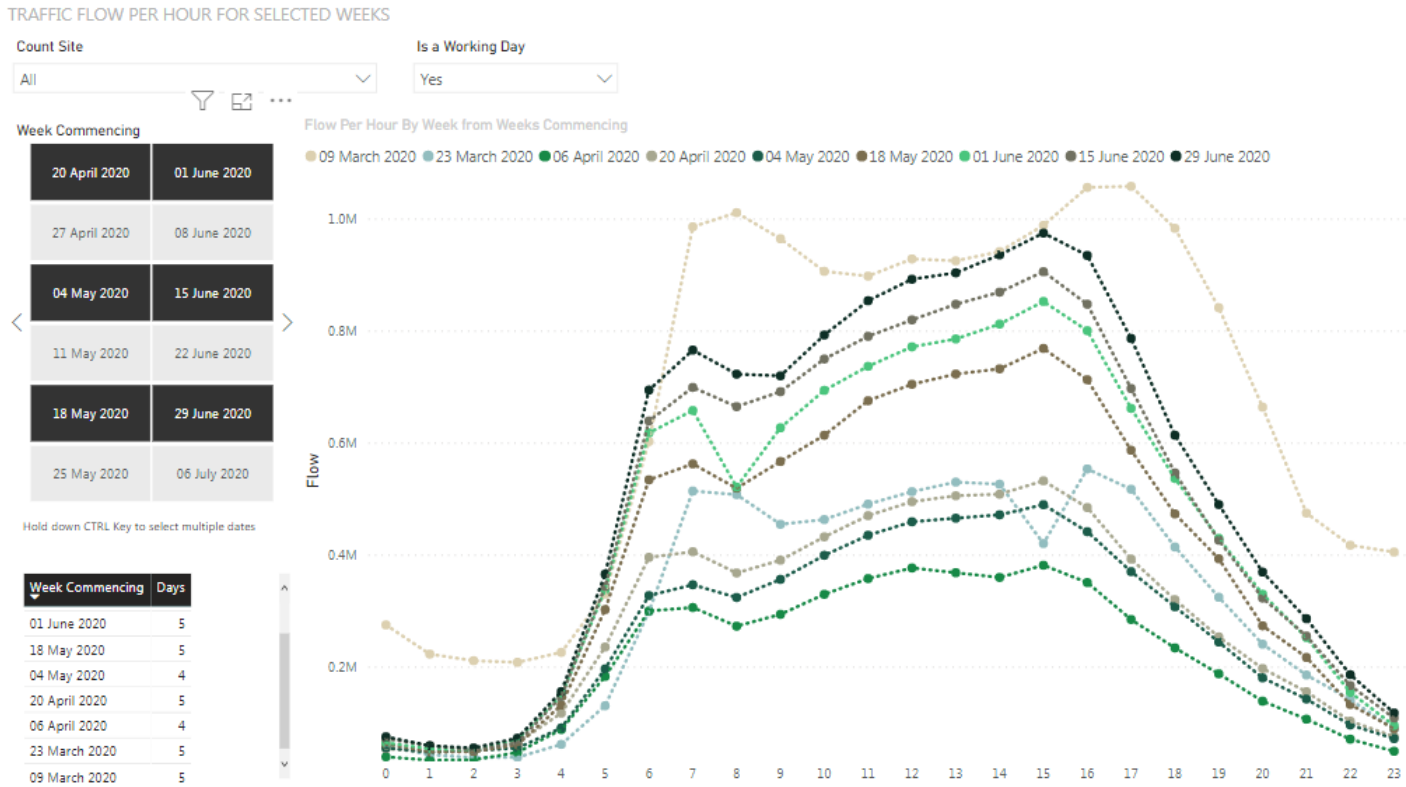
Graph 6: Sept 2020 – Dec 2020



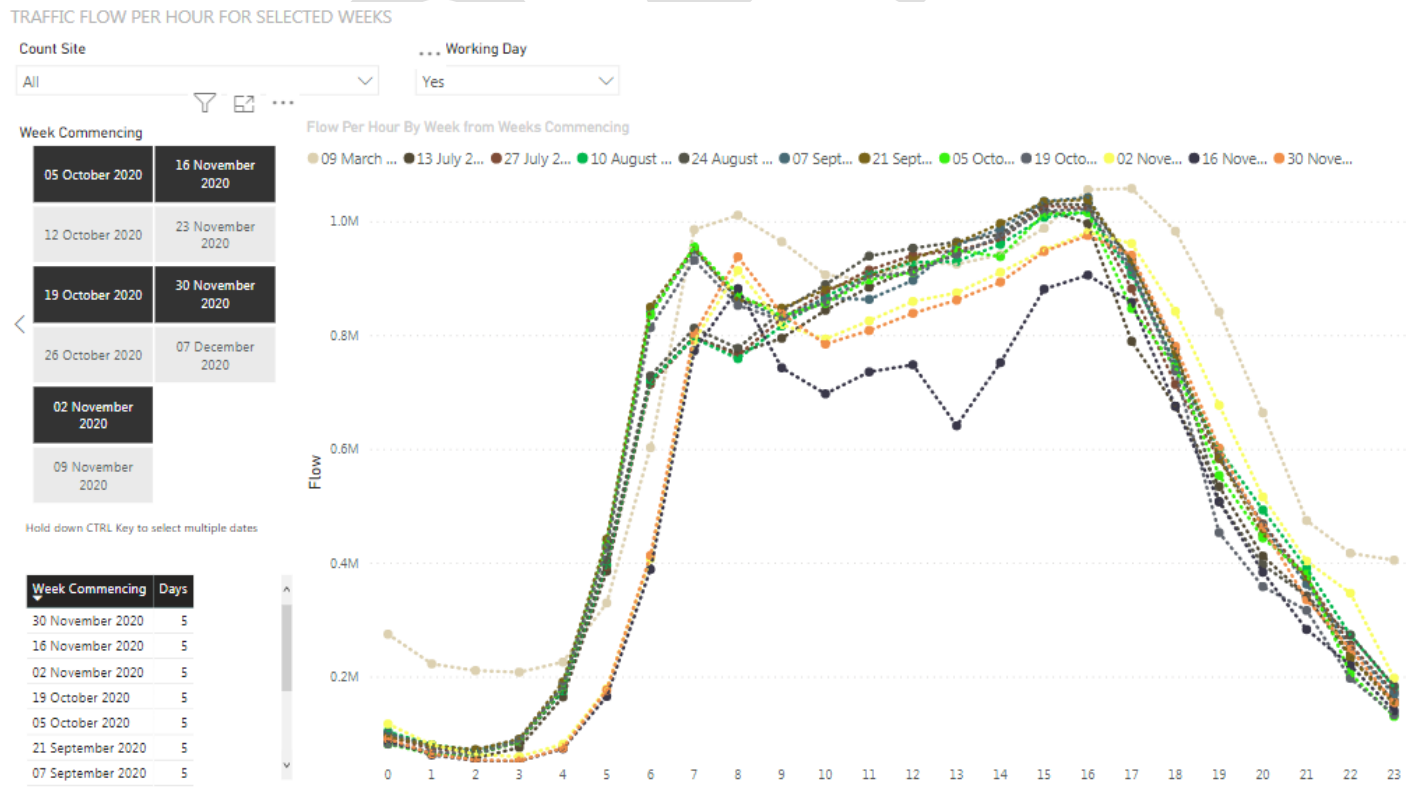
The above 4 graphs show the daily counts for Working Days (excluding bank holiday) from the 3rd February 2020 to the 4th December 2020 (axis names on the left; the Flow Count and along the bottom its year, month and date).

The following graphs summarise the traffic increases in two parts; Mar – June 2020 and Jul – Nov 2020.

Graph 7: Traffic flows Mar 2020 – Jun 2020



Graph 8: Traffic flows July 2020 – Nov 2020



The two graphs above show how the traffic has increased from pre-lockdown to November 2020. Data from every other week has been used to try and keep the graph readable.

Analysis of data: Lockdown 1 compared to lockdown 2

There is some debate as to when lockdown 1 actually started. The date varies between the 16th March 2020 when it was discussed in the House of Commons, the 23rd of March when the Prime Minister announced the restrictions to the country or the 26th March when the Health Protection Act became enforceable. For this report, the 9th March is being used as a pre-Covid-19 data set. This is to capture the full effect of the gradual move into lockdown and to ensure all relevant data is captured.

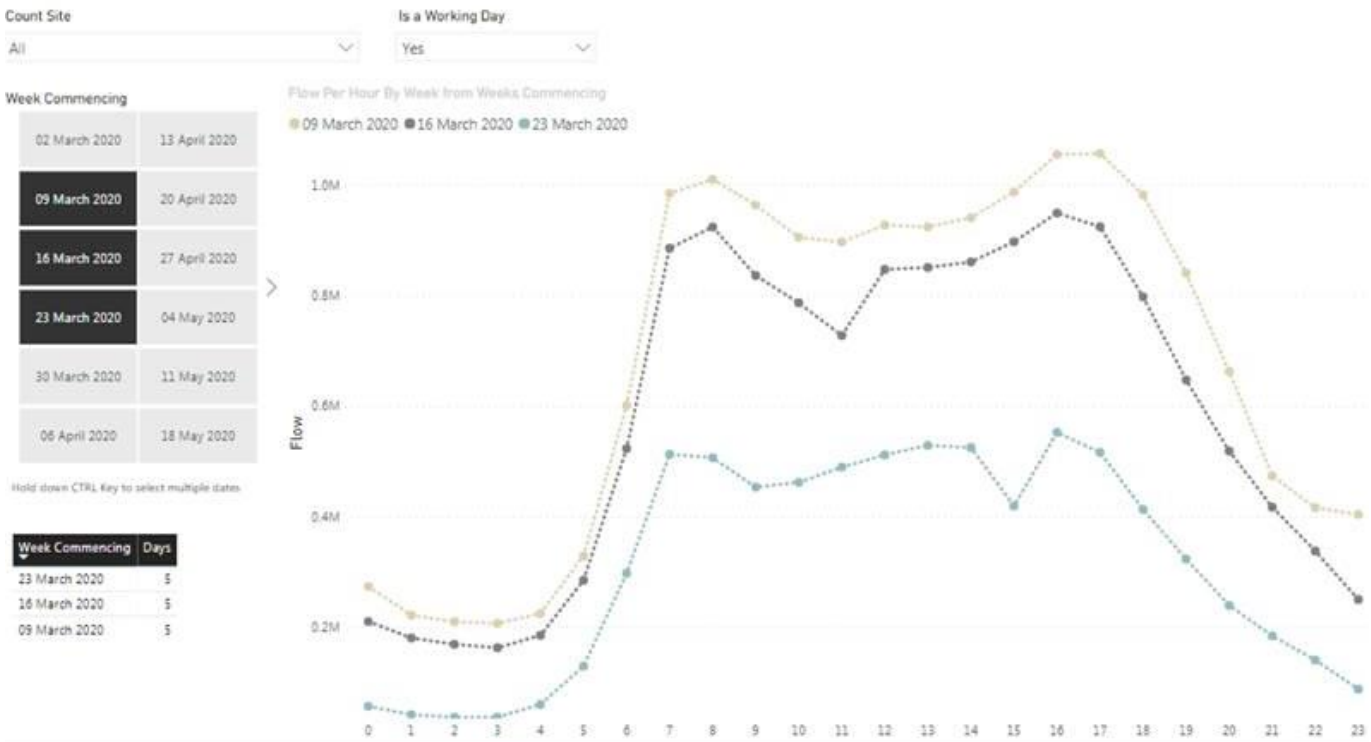
The start of lockdown 2 began on the 5th November. As this was towards the end of the week, it's best to use one full week of lockdown 2 so we are therefore counting the week beginning the 9th November.

Our latest data, as at 23/12/2020, shows that traffic is returning to the city, although not at pre-Covid levels. The week beginning 7th December shows higher traffic flows compared to all the previous four weeks. The week commencing 2nd November is a special case as only part of that week was in lockdown 2, as noted above. Prior to that, w/c 26th October was half term week, which is why it doesn't have an AM peak. The week beginning the 14th December saw a drop in traffic on both the AM and PM peaks. The previous week of the 7th December saw an increase in traffic compared to the weeks of the 23rd November and 30th November, so traffic was rising. The main difference between 2019 and 2020 traffic data is that the weeks with higher traffic flow have swapped; week 50 (9th December 2019 & 7th December 2020) and week 51 (16th December 2019 & 14th December 2020). The higher traffic in 2019 was week 51 but in 2020 it is week 50. This may be due to the way people are reacting to Covid-19 and the lockdown rules.

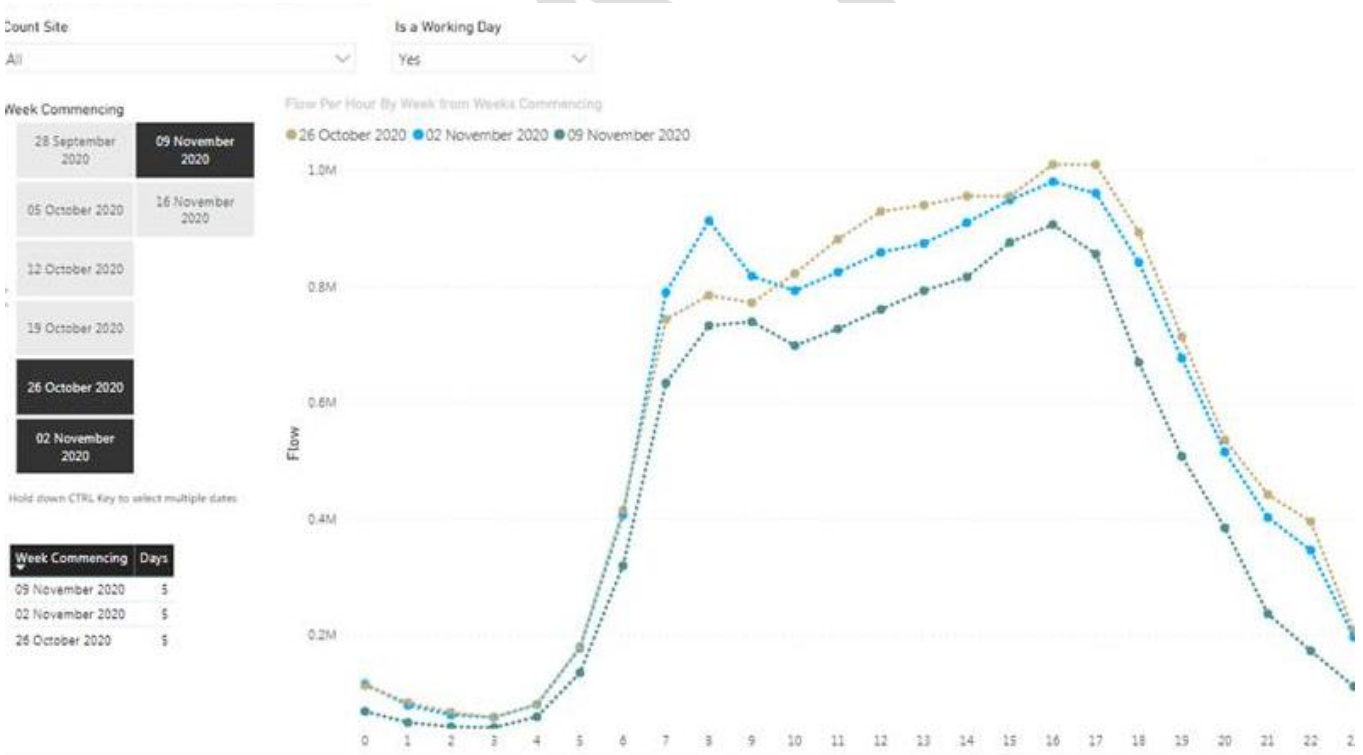
Looking ahead, if the week commencing the 21st December 2020 follows the same pattern as 23rd December 2019 then the traffic volumes will drop this week. Some of this is due to the number of working days within the week of 23rd December 2019 which had Christmas Day and Boxing Day in the working week, so there was only three days of work in the normal five day week; more people would be on leave from work during this week. Given the impacts of Covid-19 the number of people attending offices has dropped generally, so this week may not see that much of a traffic drop compared to the week commencing 14th December.

The graphs below aim to show how lockdown 1 differed to lockdown 2. The key observation being that the drop in traffic levels was less in lockdown 2 than lockdown 1.

Graph A: Beginning of Lockdown 1



Graph B: Beginning of Lockdown 2



Graph C: Lockdown 1 and 2 compared

The data above shows that traffic volumes dramatically dropped during the first lockdown. Numbers then began to steadily rise following the end of lockdown 1, but not yet reaching pre-lockdown levels. Lockdown 2 resulted in another reduction, this time 18% in comparison to an approximate 50% reduction during the first lockdown, again as noted at the beginning of this report.
It is reasonable to assume that traffic volumes will rise once more when tiered restrictions are lifted, but there are still many unknown factors which could affect this, including further lockdowns or tiered restrictions. Our latest data supports the assumption of a rise in traffic volumes as it already shows traffic levels beginning to rise at the end of lockdown 2, as well as acknowledging that levels did not dip as low as evidenced in the first lockdown.

Traffic flows at some sites may well have changed since the pandemic first took hold. These sites may never return to the pre Covid-19 levels particularly as there has been such a shift towards home working. The pattern of traffic flows at the present time is now more focussed on the outlying areas rather than the centre itself. However, whilst traffic levels in the central area appear to be lower than pre Covid-19, it is also the case that the traffic behaviour is now appearing more dispersed over the whole city rather than just in the central area. This could be because people are not travelling in to work within the central area as they were previously and are now spending more time in their local areas for shopping etc. They are still therefore making a similar amount of journeys but just not as part of a commute. This is why the monitoring data provided in this report is required; to best understand traffic volumes and to ensure we implement the necessary measures required, achieving compliance in the shortest possible time.

Air Quality data
This project must adhere to the legal definition of compliance. In line with the Air Quality Directive, everywhere within the city where there is public access should experience annual mean NO2 below the EU Limit, i.e. 40ugm-3. The project team agreed with JAQU, when initially legally directed in 2017, that this definition would include Bristol's LAQM (Local Air Quality Management) monitoring sites as well. 2020 clearly cannot be considered a typical year, not least due to the ongoing uncertainties, so seeking to represent compliance in 2020 as being representative is likely to be an unsuccessful strategy. It is likely that there will be at least some locations in 2020 that will exceed compliance, though it is obviously still too early to say for certain at this stage as we have to wait for the national monitoring data to be ratified; usually in June. This is because we use the national data to correct the diffusion tube data. Bristol City Council continued to monitor air quality throughout lockdown as this work was classed by the government as an essential activity.

Traffic levels declined rapidly from immediately before lockdown leading to a clear reduction in emissions of key pollutants. This is apparent for roadside and background sites.

Air quality changed during the lockdown period, but the changes in air quality characterised by comparisons of *raw* data between two periods cannot be solely attributed to the lockdown measures, because weather and other variables strongly influence ambient air quality. In order to account for the influence of weather and other covariates, a statistical modelling approach has been adopted which can remove the effect of the weather and identify the changes in concentrations which would arise if meteorological conditions and temporal effects are held constant.

This approach can be used to ascribe the changes in air quality to lockdown measures with more certainty than simply by comparing raw data between two periods.

Summary of changes

The comparison of raw data between 2019 and 2020 was for the period 25th March 2019 to 01st November 2019 and 24th March 2020 to 31st October 2020.

Analysis of air quality data from Bristol City Council's continuous air monitoring network comparing the lockdown period in 2020 to the same period in 2019 shows a significant change in nitrogen dioxide (NO2), a traffic pollutant, of a maximum -76% as a weekly average. Reductions in NOx (oxides of nitrogen), which can be considered a surrogate for direct exhaust emissions, fell even further with a maximum mean weekly change of -86%. These changes cannot be attributed solely to the lockdown measures because of the effect of weather and the small effect of changes in the vehicle fleet between the two comparison periods however accounts for a large proportion of it.

Measures of particulate matter (PM) - PM10 and PM2.5 also fell but the reduction was less. This is because the local contribution to ambient PM is a small part of the total. There are significant regional and background components present which are unaffected by the lockdown measures. For PM10 the roadside increment in 2019 was 27% when comparing a background and roadside site in the central city.
Ozone (O3) rose in the first lockdown when compared to the baseline period. This is expected because as NOx declines, less ozone is chemically reduced in the photochemical reaction between these two species (ozone is chemically reduced - loses an atom of oxygen in the photochemical reaction) and hence concentrations of ozone may rise. Unusually sunny weather also contributed to the higher than usual levels of ozone.
Data from the NO_2 diffusion tube network, which gives greater spatial coverage than the continuous network has been analysed. The changes in measured nitrogen dioxide for each month where we have data are shown. There is typically around a 6 week delay between the end of the month where tubes have been exposed, to receiving the results.

All of Bristol's air quality data is available through our open data portal.

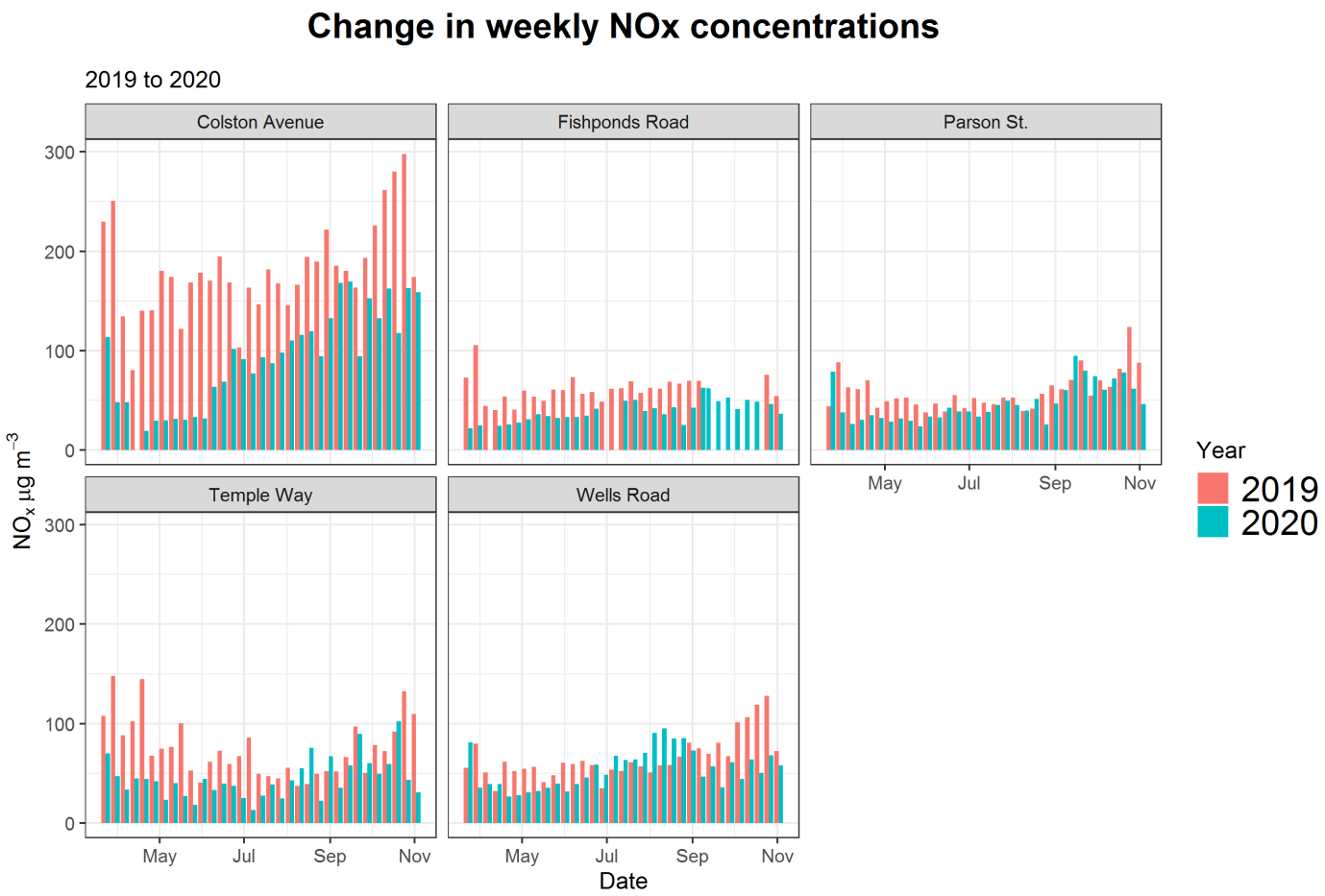
Summary of changes by pollutant

The table below shows the maximum percentage changes of weekly mean concentrations aggregated by site and pollutant. The dates are the week beginning of when the maximum change in each pollutant, at each site, was realised. Hence they are not regularly spaced. Roadside sites have been selected as these are the most affected and these will not necessarily match the key CAZ count sites noted in the traffic section of the report, as this is considering air quality rather than traffic data. The analysis compares weekly averages to the same week in the preceding year, i.e. 2019. While this does not take into account the effects of the weather on concentrations, it provides an indication of the extent of change and by using weekly means, noise* that would be apparent when using a daily mean value is reduced (*noise is used as in signal; meaning short term fluctuations due to weather that provide a misleading impression of the longer term trends). Bristol City Council's data are ratified according to processes detailed with our annual status reports. Data from the national network sites (Bristol St. Pauls and Bristol Temple Way) are not fully ratified at the time of writing.

Site ID	Location	Pollutant	Week Beginning	Percentage change
215	Parson St.	NO2	24/08/2020	-55%
215	Parson St.	NOX	06/04/2020	-59%
270	Wells Road	NO2	20/04/2020	-51%

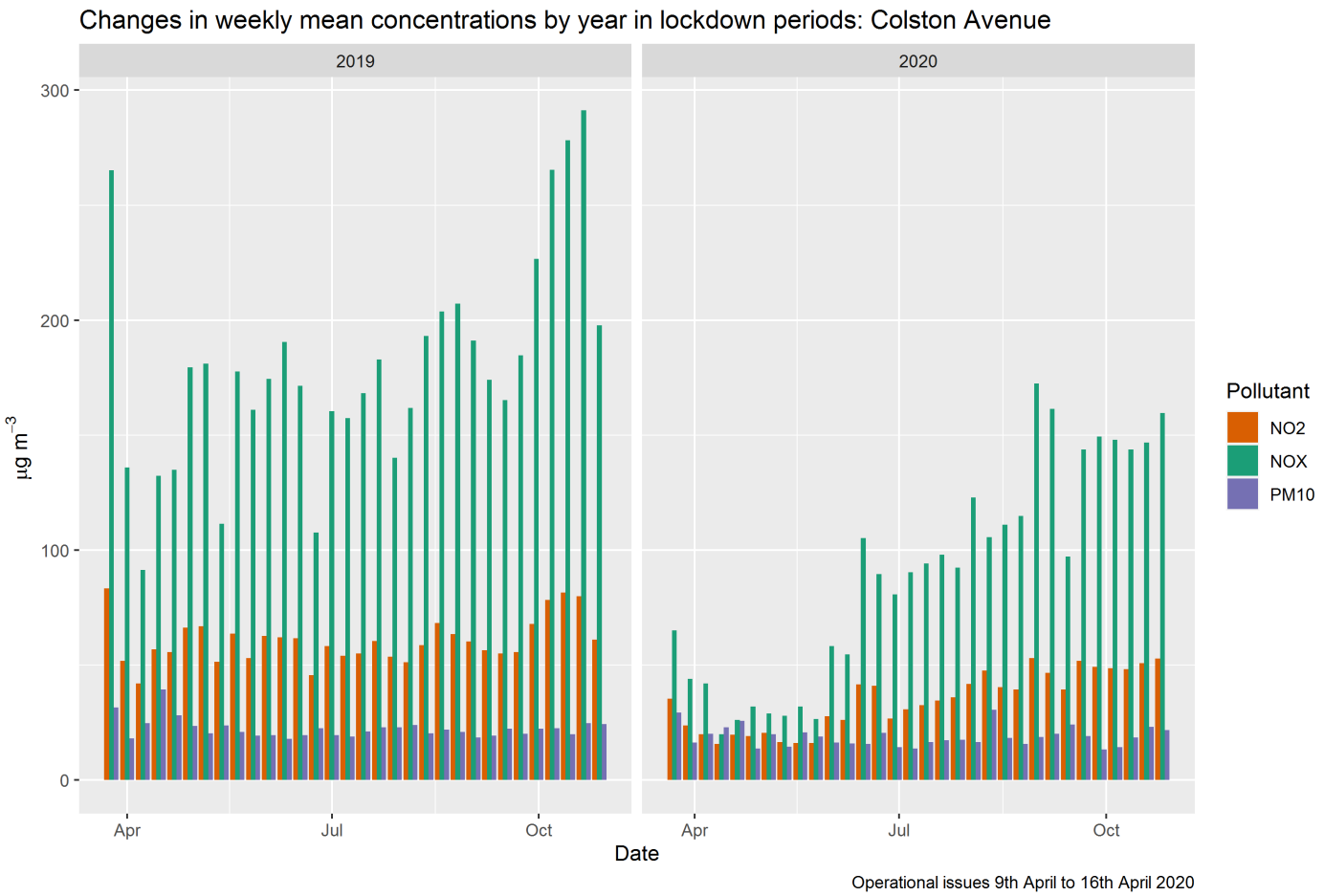
270	Wells Road	NOX	19/10/2020	-58%
463	Fishponds Road	NO2	23/03/2020	-75%
463	Fishponds Road	NOX	30/03/2020	-77%
500	Temple Way	NO2	06/07/2020	-76%
500	Temple Way	NOX	06/07/2020	-85%
501	Colston Avenue	NO2	20/04/2020	-76%
501	Colston Avenue	NOX	20/04/2020	-86%

The chart below shows the weekly mean concentrations of NOx at sites in 2019 and 2020. Not all sites measure all pollutants. NOx is selected as this pollutant is most closely associated with traffic emissions.

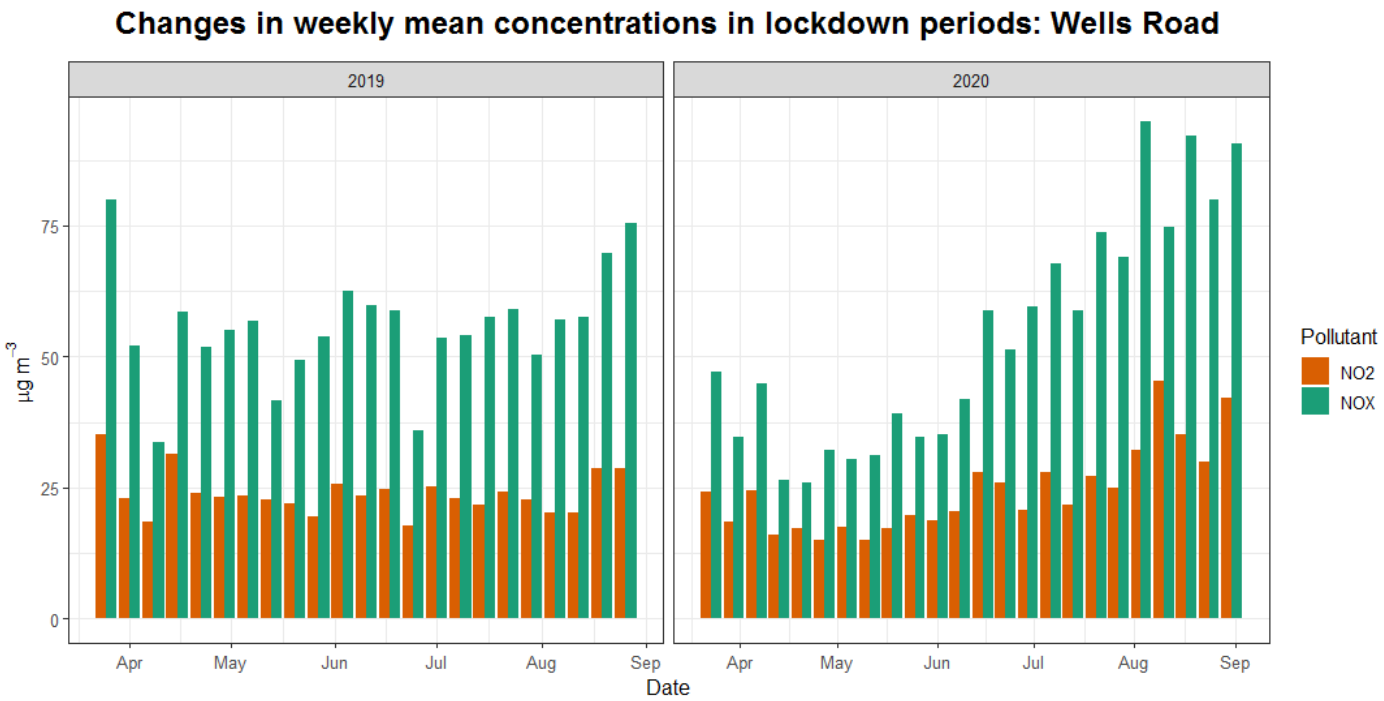


Changes in air quality at Bristol's continuous monitoring sites

Bristol's city centre site at Colston Avenue is the most polluted roadside site on the network and so is an interesting example of the reductions during the lockdown. The chart below shows weekly mean concentrations of NOx, NO2 and PM10 for the baseline and lockdown period. Operational issues between 9th April and 15th April mean that data is incomplete for this period.



Other sites on the network show similar patterns. For the Wells Road site, the difference in concentrations between the two periods was not as pronounced as for Colston Avenue.

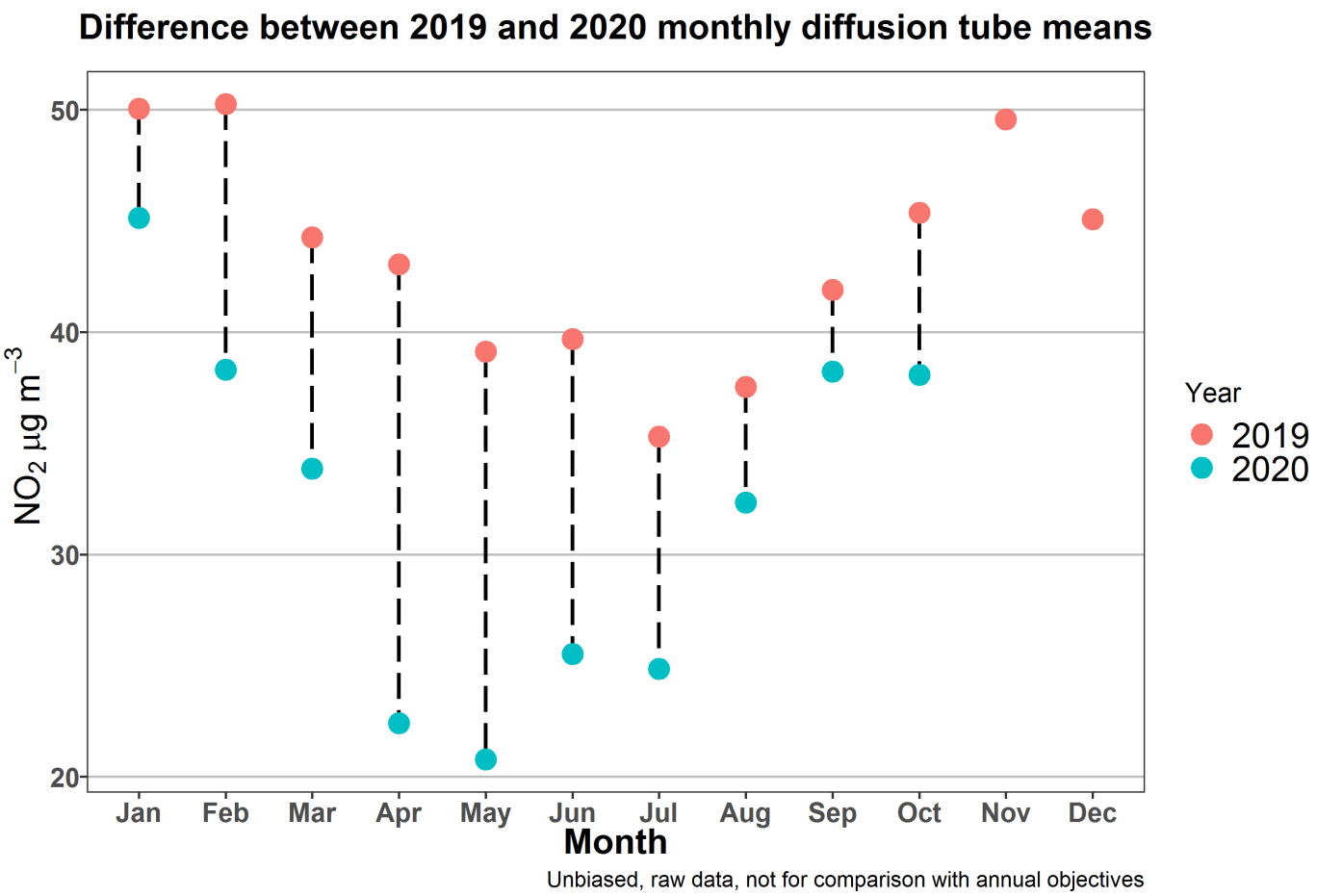


Changes in nitrogen dioxide at diffusion tube sites

Diffusion tubes are used to monitor ambient nitrogen dioxide. Nitrogen dioxide from the air diffuses into a metal grid in the tube and the tubes are sent for analysis in a laboratory. Diffusion tubes are placed according to a monthly calendar specified by Defra and BCC's diffusion tubes are exposed according to this calendar. April 2020 was the first

complete month where tubes were entirely exposed under the lockdown measures.

The chart below shows that the difference in concentrations between 2019 and 2020 increased dramatically as the first lockdown took effect and diminished as lockdown measures were eased during the summer.



De - weathering ambient air quality measurements

The de-weather functions of the openair package were used to remove the effect of the weather on concentrations of regulated pollutants measured by Bristol City Council's and Defra's monitoring sites in Bristol. The de-weather package uses a boosted regression tree approach for modelling air quality data. This technique builds a statistical model of the air quality data and thereby takes account of the many complex interactions between variables as well as non-linear relationships between the variables.

Predictions of daily mean concentrations are derived from the modelled hourly means of data that are aggregated by site type. The accepted classifications of "Urban Background" (distant from busy road) and "Urban Traffic" (close to busy road) were used, as well as a classification of "City Centre" to cover the most polluted site, Colston Avenue, as this site represents the most polluted air in the city. Sites with a data capture less than 90% are not used in the analysis. The table below shows the classes for each of the sites analysed.

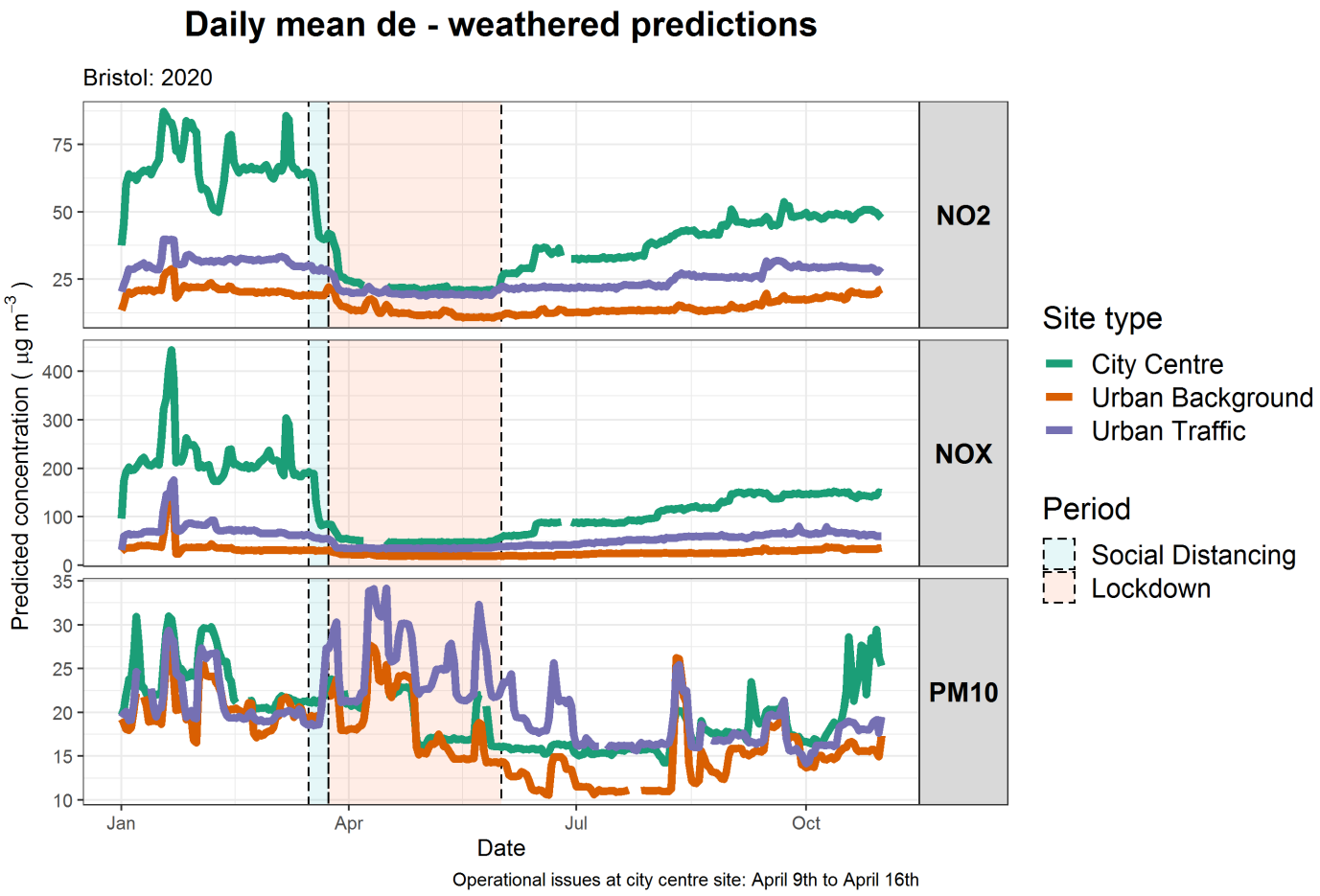
Site Class	Site Name
City Centre	Colston Avenue
Urban Background	AURN St Pauls
Urban Background	Brislington Depot
Urban Traffic	Parson Street School
Urban Traffic	Temple Way
Urban Traffic	Wells Road

The chart shown below is the predicted "de - weathered" concentrations of three pollutants grouped into site types. The removal of the influence of the weather indicates that the reductions in measurements of traffic pollutants are probably not due solely to the weather. Reductions in traffic emissions due to the Covid-19 lockdown measures are the likely explanation.

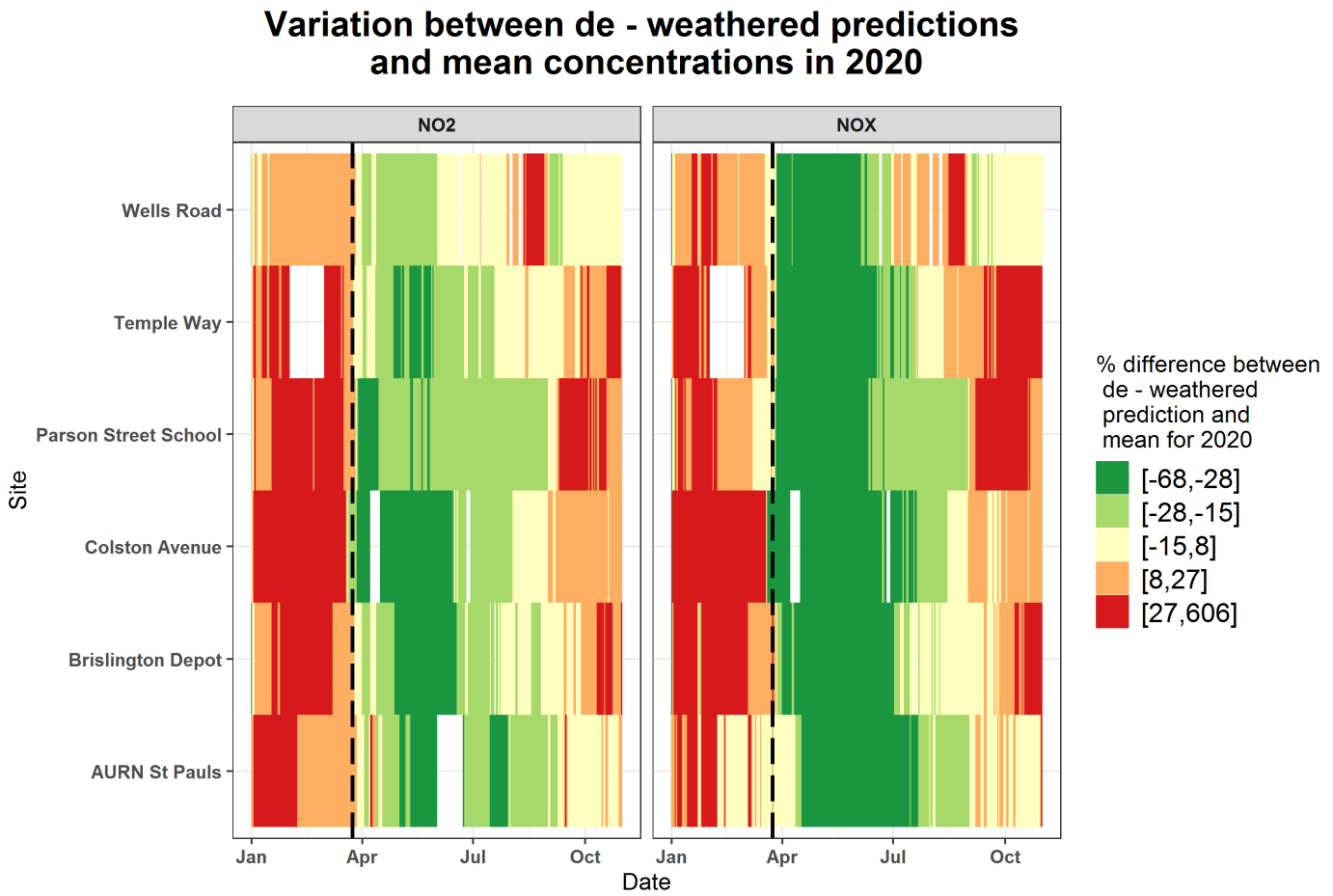
For NO2 it is noticeable that at the city centre site (Colston Avenue) concentrations started to decline around the 16th March, and continued to decline further in the days immediately following lockdown on the 24th March. The post - lockdown decline was also apparent in the urban traffic and urban background site classes. A small increase in NO2 at urban traffic and urban background sites was seen around 8th - 12th of April. This could be explained by a regional pollution episode that also increased PM10 concentrations during the same period. Unfortunately operational issues at the city centre site mean that data was unavailable from the 9th April to the 15th April.

For NOx, a similar reduction was seen at the city centre site after the 16th April and a small reduction in concentrations at urban traffic sites is apparent.

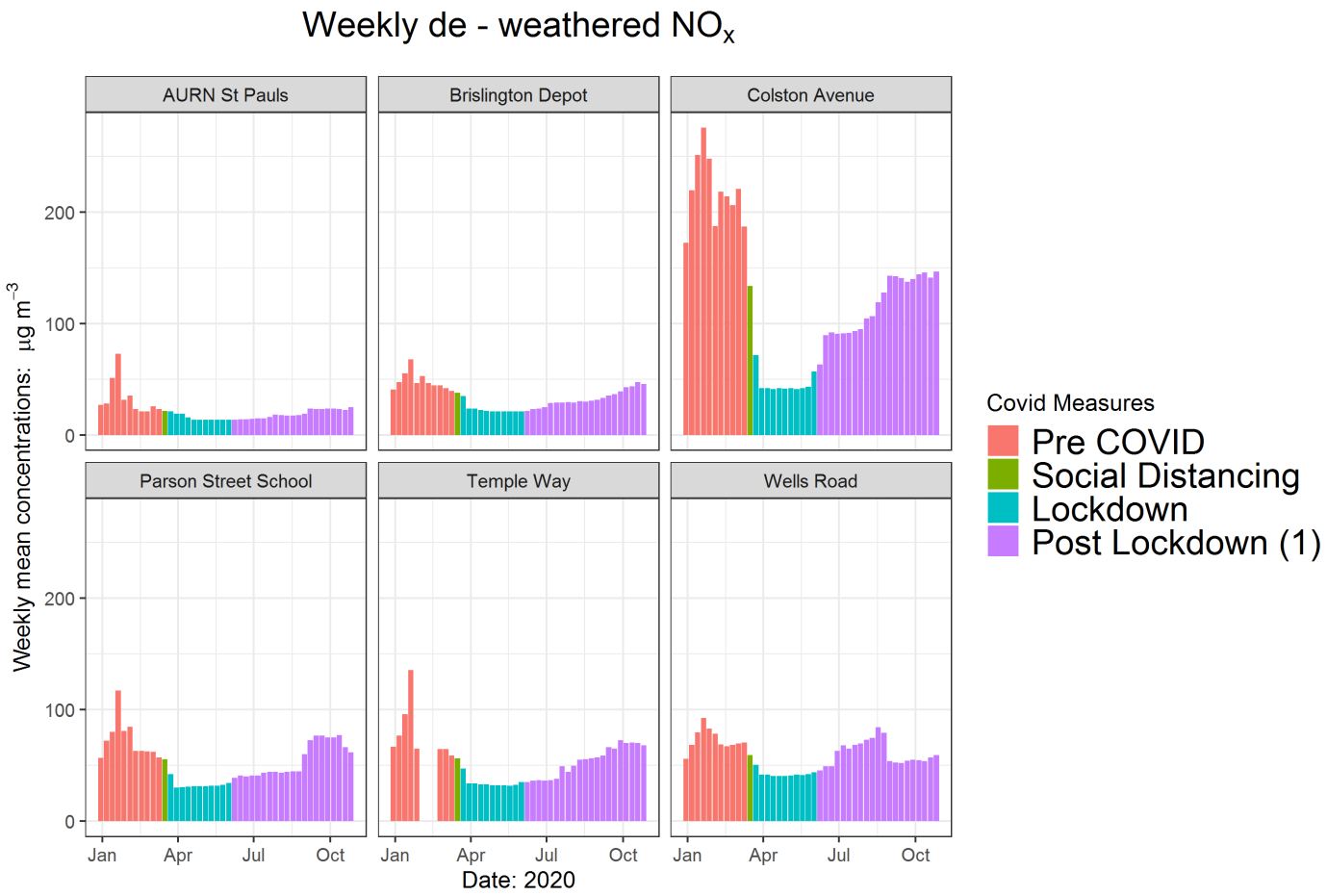
PM10 concentrations did decline in the immediate post - lockdown period but then rose steeply during the pollution episode over Easter weekend when polluted air from northern Europe moved over the southern half of the UK. This caused elevated concentrations of PM10, PM2.5 and ozone at sites in Bristol and across the south of the UK. The boosted regression tree model used in the de - weathering process take into account wind speed and direction but cannot account for elevated pollutant levels in the incoming air and hence are unable to remove the effect of regional pollution episodes such as the one that occurred at this time.



The de - weathering process can also be applied to individual sites. The chart below shows how the de-weathered daily predictions vary from the mean levels for traffic pollutants for 2020 for each site. It is clear that from the date of lockdown, significant reductions have occurred at all sites for NOx and NO2 and that these reductions are not primarily driven by weather. It can be seen that de-weathered concentrations start to rise from mid- June.



Plotting the weekly mean concentrations of the traffic pollutants NOx and NO2 shows the effect of lockdown rules on weekly concentrations by controlling for the effect of the weather. It can be seen from the plot below that concentrations remained low throughout May, despite some evidence that traffic levels had started climbing since mid- April. There is some evidence of rising concentrations towards the end of June though, particularly at Colston Avenue.



Report conclusions

Combining the evidence base available for both traffic volumes and air quality before, during and post lockdowns, it seems fair to conclude that this evidence shows a decline in traffic volumes and improvements to air quality during the first lockdown in particular. The second lockdown was less restrictive than the first and as such didn't lead to such a steep decline in traffic volumes but a not insignificant decline in traffic volumes was still observed.

For comparative purposes, data from October 2019 and October 2020 have been focussed on. October 2020 was the key period when traffic had most chance to return to normal levels; before lockdown 2 and the Christmas period changed things. This showed that traffic in the key locations during October 2020 was 82% of the same time the previous year. While this signifies a rise in traffic volume compared with the dramatic drop in levels seen during lockdown 1, it also demonstrates a sustained 18% drop in traffic volumes, which should not be understated. This could, amongst other things, be attributed to new ways of working resulting in less people needing to access the central location and potential positive effects following the implementation of the Street Space schemes.

Whilst we cannot say from this data that traffic levels and associated pollution levels will definitely return to pre COVID levels, we also don't have sufficient evidence to say otherwise. This data will be reviewed by the science team at JAQU as part of a full technical review of all the data submitted. JAQU will subsequently conclude what measures Bristol are required to implement.

Recommendations:

That the CAZ Board;

1. Agrees to the inclusion of the technical data in this report as an appendix to the final technical note and submission to JAQU.

Background Documents:

- N/A

Appendix A – Further essential background / detail on the proposal or to provide supporting information	**YES**
Appendix B – Details of consultation carried out - internal and external	**NO**
Appendix C – Summary of any engagement with scrutiny	**NO**
Appendix D – Risk assessment	**NO**
Appendix E – Equalities impact assessment of proposal	**NO**
Appendix F – Eco-impact screening/ impact assessment of proposal	**NO**
Appendix G – Financial Advice *(Financial officer must be the author of the advice)*	**NO**