THIRD WAVE LOCAL AUTHORITIES – TARGETED FEASIBILITY STUDY TO DELIVER NITROGEN DIOXIDE CONCENTRATION COMPLIANCE IN THE SHORTEST POSSIBLE TIME

Local authorities covered	Oxford City Council, Oxfordshire County Council

Further information on the content of each section is set out in the guidance.

Part 1: Understanding the problem

This section should set out background on the information about the road links projected to have exceedances in the PCM national model, in combination with source apportionment data, to provide a description of the severity of the NO2 exceedance and its possible sources and causes. It should set out the scale of the problem and the case for change. Maps and local data should be included. ***Each road link should be addressed in turn.***

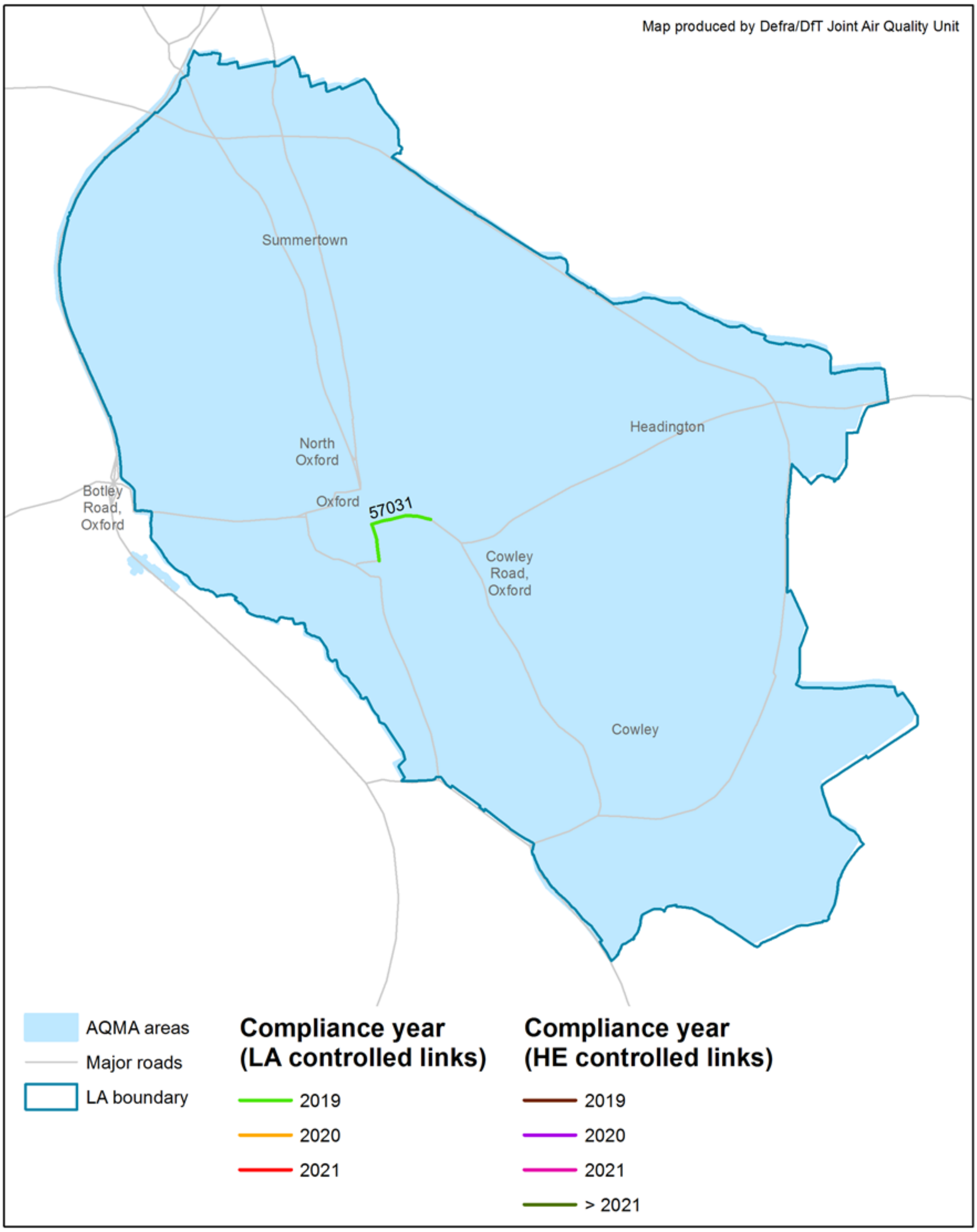
In Oxford one road link (Census ID 57031) is projected to experience exceedances up to 2019. The road link (A420) is managed by Oxfordshire County Council as Local Transport Authority and is located within Oxford City Council local authority area. The road is a key city centre road, which connects east and west Oxford. It is located in the commercial centre of the city, which has a population of 161,300 and welcomes over 7 million visitors each year.

The road link identified by the PCM national model as experiencing exceedances of NO2 can be viewed in Map 1 (below). The PCM modelling results for the road link is outlined below:

Roads in exceedance	**Census ID**	**2017**	**2018**	**2019**	**2020**	**2021**	**Source apportionment**
A420	57031	44	42	39	36	33	72% buses; 4% diesel cars; 4% LGV diesel; 2% HGVr; 1% petrol car

This feasibility study aims to identify measures which could reduce the concentration of NO2 on this road link as quickly as possible with the objective of bringing forward compliance in the shortest possible time. The objective could be achieved by reducing the NO2 concentration in 2018 by at least 2µg/m3. Data on actual measured annual mean is presented below.

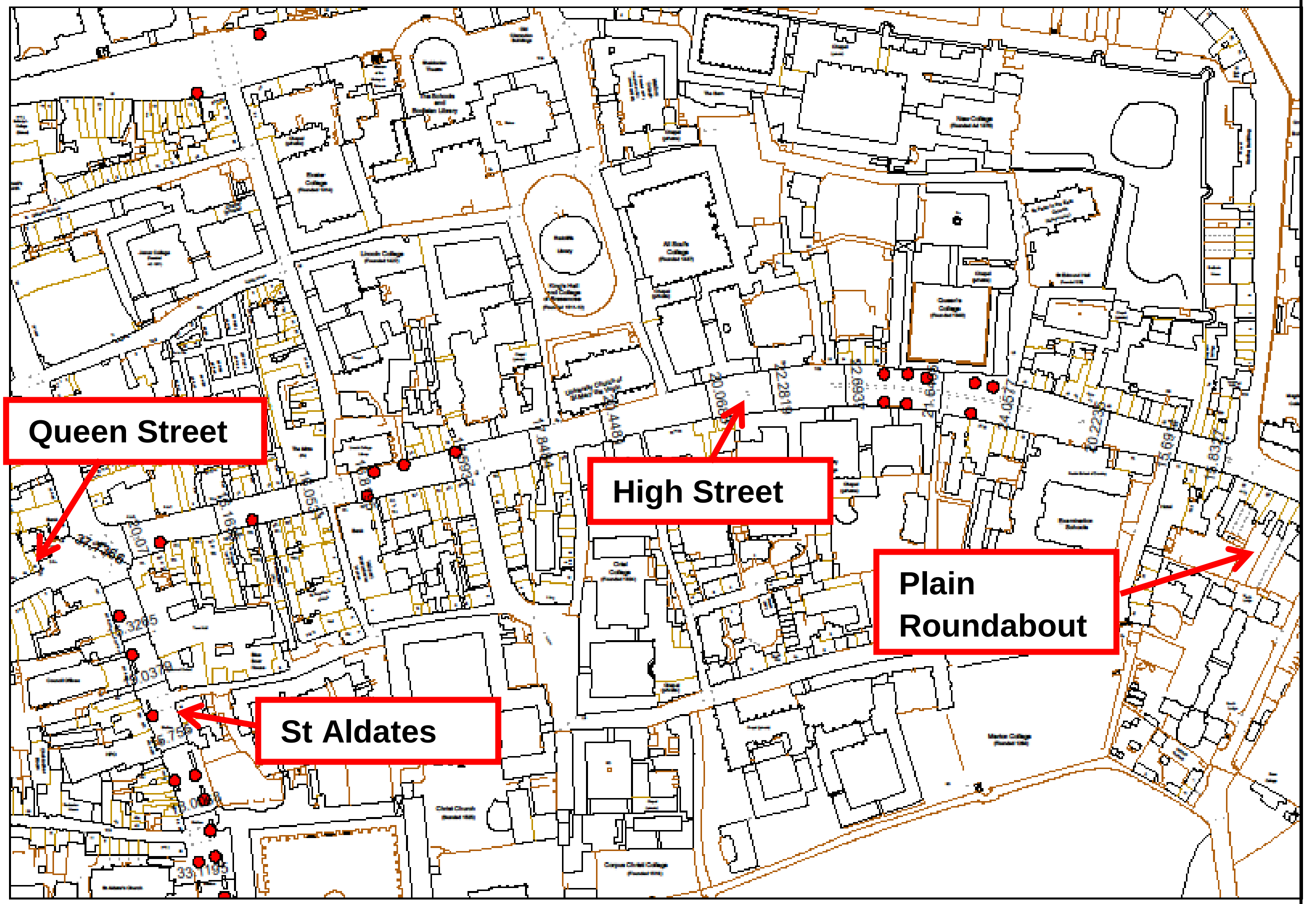
Map 1



The road link is made up of two distinct roads; St Aldate's and High Street which have slightly different traffic sources. The two roads and their specific characteristics are outlined in turn below.

High Street

High Street is a busy city centre street with shops located on each side of the street. It has a pavement on each side of the road, as well as several bus stops along its length. The road is well used by cyclists and has very high levels of pedestrian flow on pavements. A map of the road, including locations of bus stops (red dots) can be seen below.



High Street is covered by a bus gate which exclude several vehicles types for the majority of the day. Full details can be seen below:

Bus gate	Time	Vehicle types allowed through the gate
High Street	7.30am – 6.30pm	Local buses, taxis/licensed private hire (not private rental) and exempt emergency vehicles only
	6.30pm – 7.30am	Any vehicle type allowed.

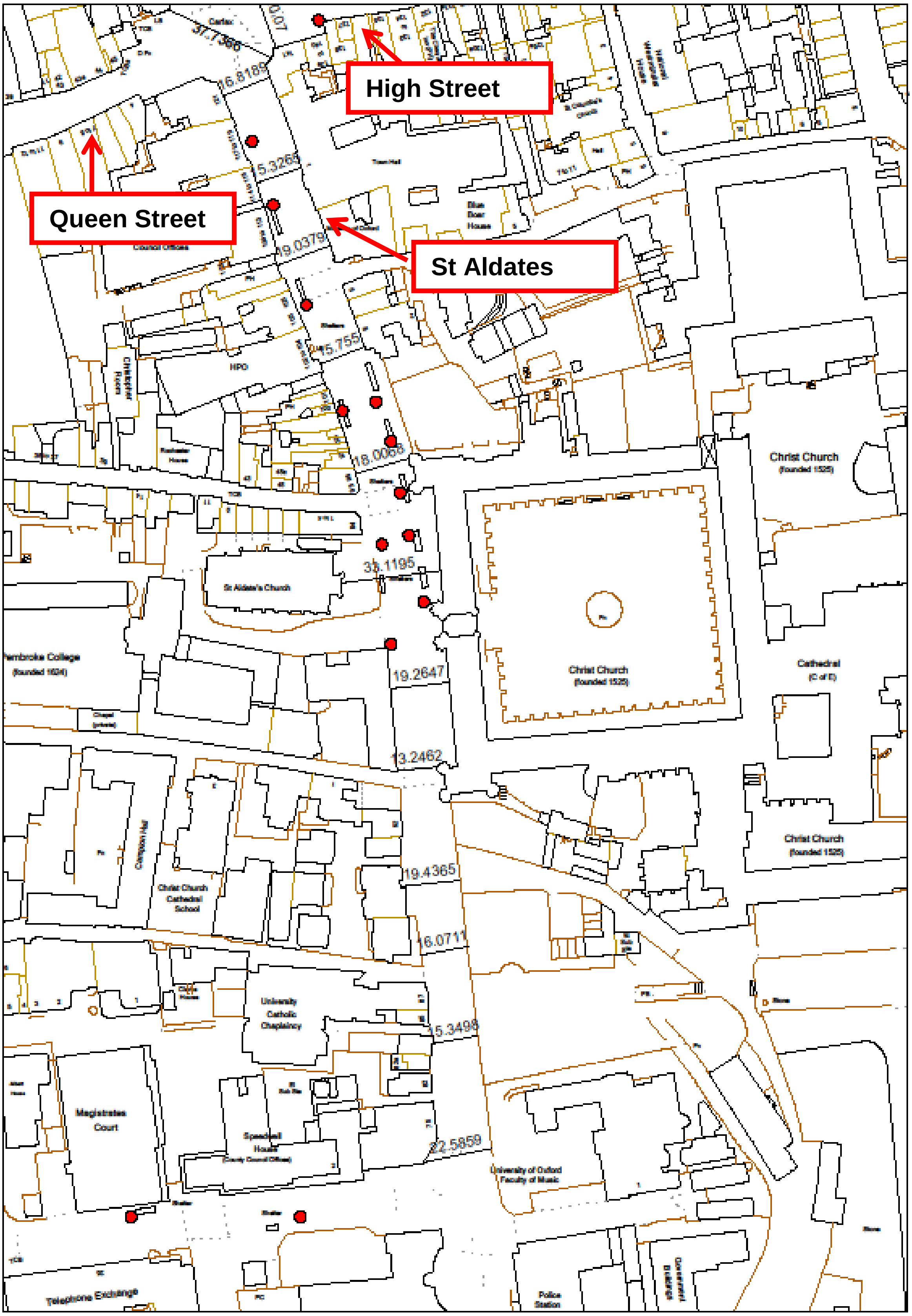
While vehicles are banned from going through the bus gate, they can enter the zone to make deliveries, for servicing and access purposes. Buses enter High Street eastbound from St Aldate's and Queen Street, whilst westbound flow is generated from the Plain roundabout.

Intensively used bus stops and the high number of delivery and servicing vehicles stopping leads to some congestion throughout the day; this impacts flows in both directions.

St Aldate's

St Aldate's is a busy street with a high number of pedestrians using the street to access the south of the city and the tourist attractions located there, including Christ Church. The street has relatively few shops, but does have a museum and the Town Hall which hosts several events. Like High Street

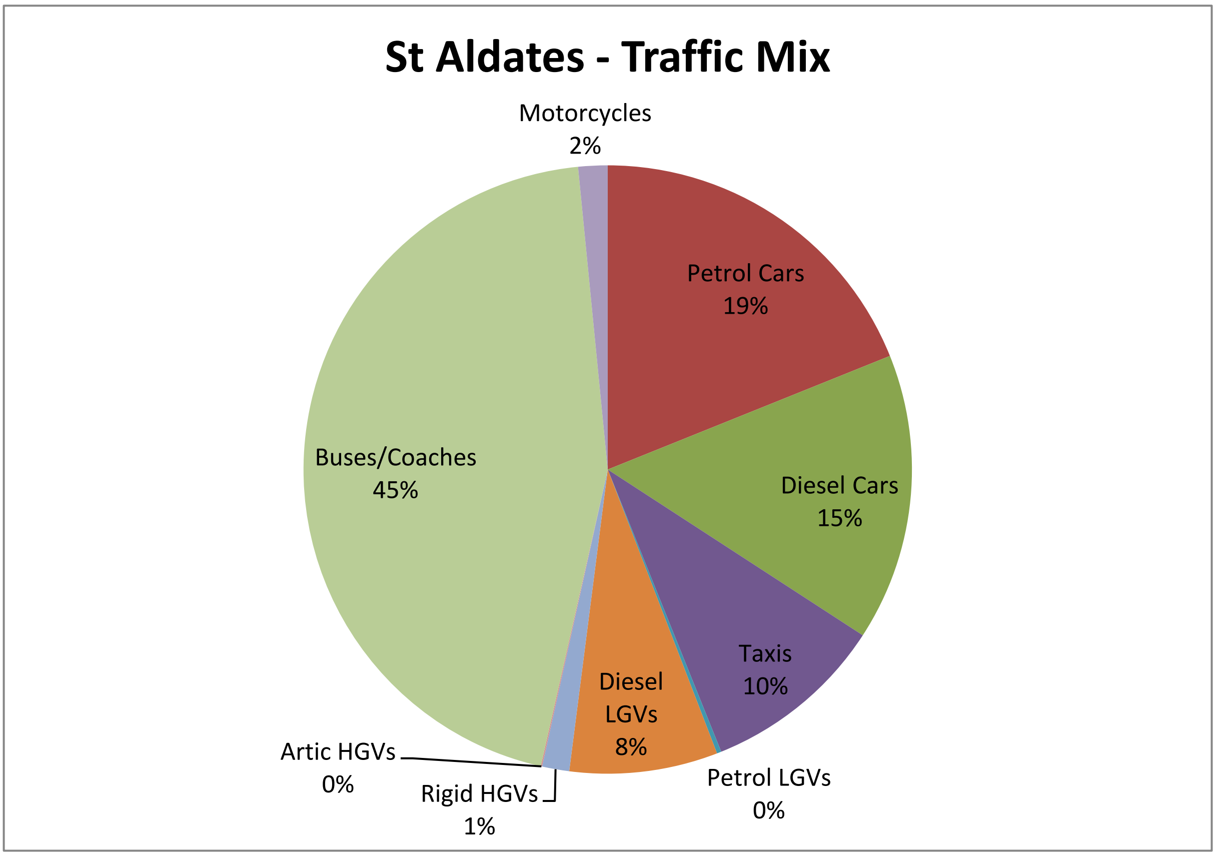
a high proportion of traffic through the street is buses, due to the impact of the High Street bus gate. Delivery vehicles, servicing vehicles and taxis also use the street. A map of the street, including location of bus stops can be seen below.

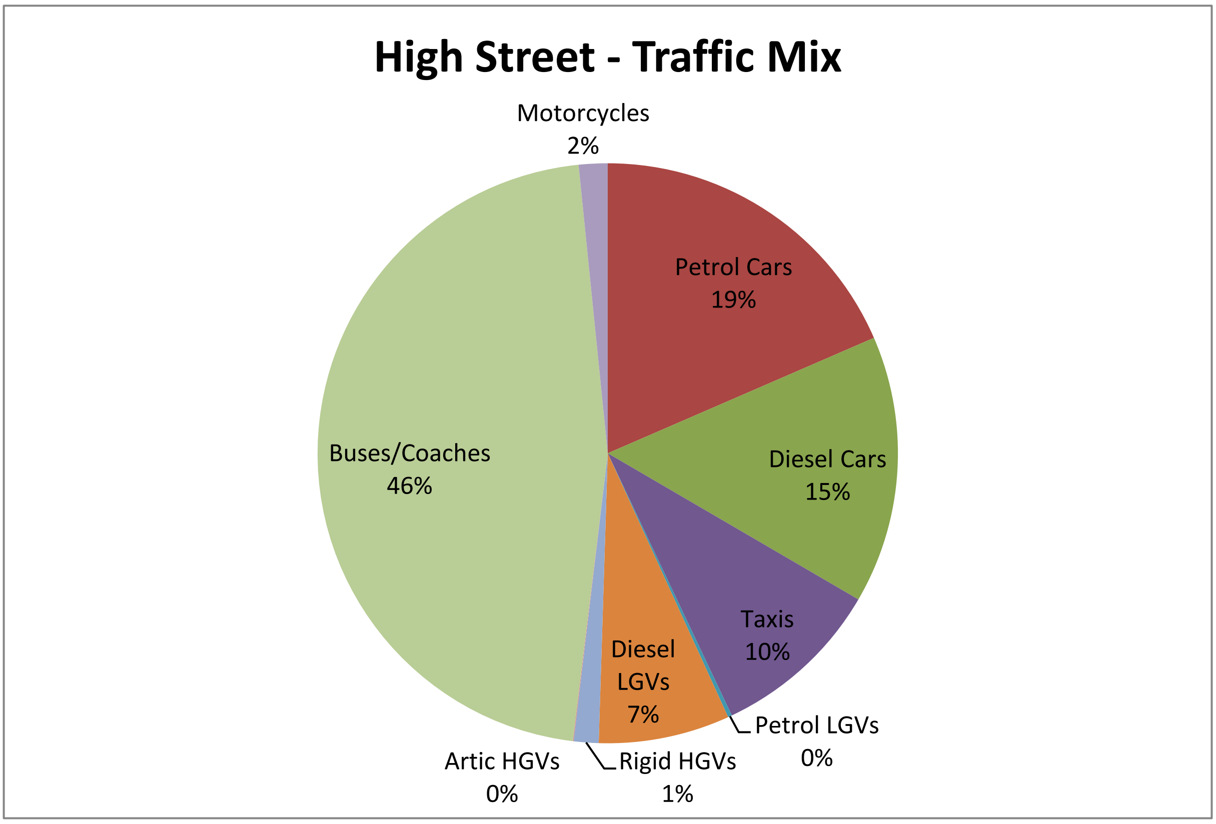


Like High Street the combination of bus stops and delivery and servicing vehicles leads to some congestion at times of the day, impacting on flows in both directions.

Traffic Counts

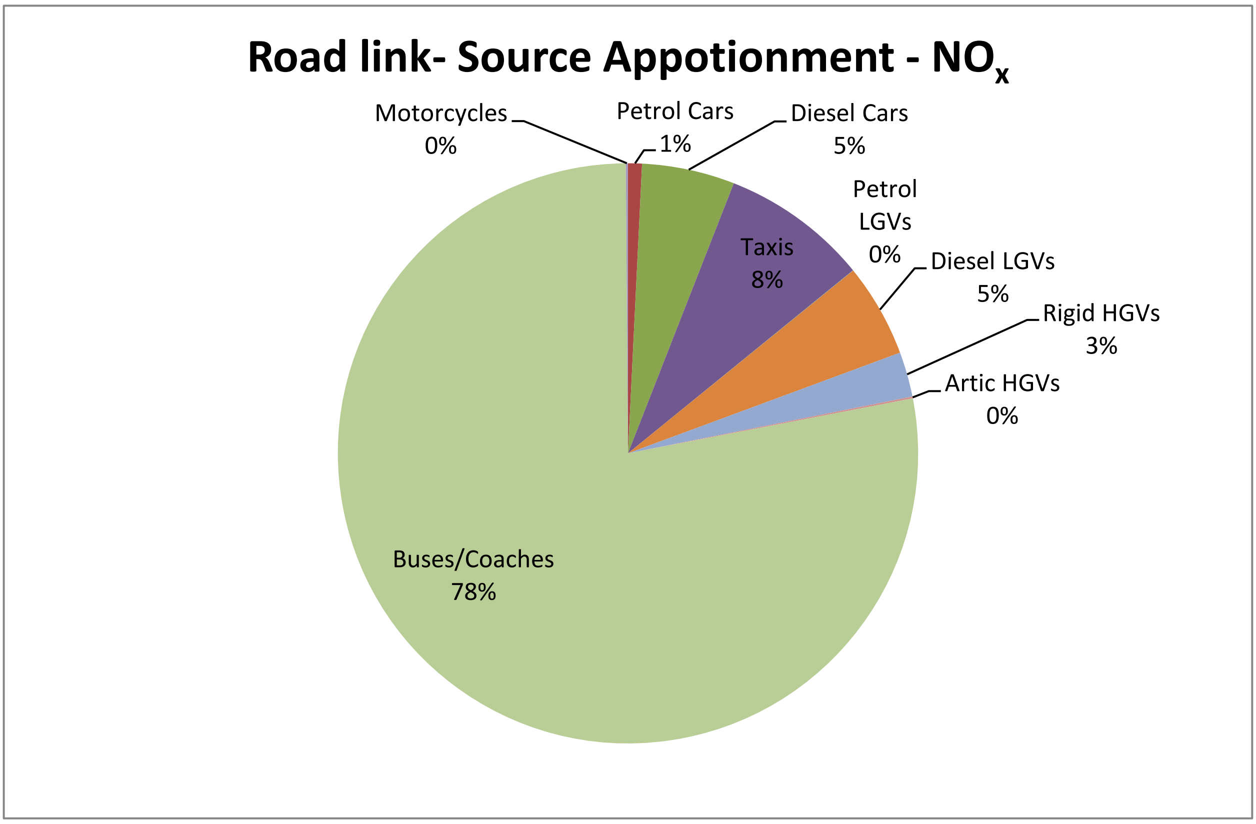
Detailed traffic counts, carried out in April 2018, for both streets can be found below. The traffic counts were undertaken specifically to inform this study.





Source Apportionment Data

Updated source apportionment data based on April 2018 traffic counts are showed below. This data confirms that buses contribute the majority of emissions in the road link.



Specific sources of local exceedances

As outlined above, the road link is covered by a 'bus gate' which prohibits through fare for vehicles other than buses and taxis for the majority of the day. The road is a key city centre street linking the east and west of the city. Due to the medieval layout of the city centre there are very limited options available for routing buses from one end of the city to the other.

As the source apportionment data show, buses make up the majority of emissions in the road link. This is as expected on this route where other traffic is generally banned. We do see some emissions from delivery vehicles particularly LCV, and while they do not travel through the full length of the road link due to the bus gate, they do enter the street to make deliveries and turn around to exit.

Oxford transport strategy promotes walking, cycling and public transport over the private car. The management of the road link reflects this as buses are the major traffic generator. Several measures have been implemented in partnership with bus companies to reduce the amount of buses operating in the city centre and their emission, this includes; joint ticketing and timetabling, introduction of double decker buses and the introduction of a bus based Low Emission Zone (LEZ) in operation in the road link. This has significantly reduced the amount of buses operating while the EuroV based LEZ has resulted in a reduction of emissions.

Emissions from buses are the focus of our long list of measures due to their majority contribution to NO2 in the road link. In order to avoid displacement of emissions from buses our work to reduce emissions from this sector has so far focused on improved standard of the fleet and traffic flow improvements.

Air Quality Data

Air quality monitoring in Oxford is carried out at 75 locations using three continuous monitoring stations and diffusion tubes. We have maintained between 40 and 75 monitoring points at any one time, and monitored at approximately 150 separate locations across the city over the last 15 years. As a result we have established the locations which may exceed the objective, based upon proximity to the busiest sources of road traffic, roundabouts on the ring road, areas with congested traffic, areas where there are street canyons, and areas close to local district centres.

The road link identified by the PCM model and the subject of this study has two automatic monitoring stations located on them; one on St. Aldate's (Oxford Centre Roadside AURN) and one on High Street. A map of the location of automatic monitoring and diffusion tubes can be seen below. The automatic monitoring station on St Aldate's is part of the AURN and referred to as Oxford Centre Roadside. The automatic monitoring station in High Street is not part of the AURN network, but it is used by Defra to verify the PCM model. It meets AQD siting requirements and undergoes the same process of maintenance, calibration and verification as the AURN sites in Oxford.

Data for the two automatic monitoring stations over the last 5 years can be viewed below.

Site Name	NO_2 Annual Mean Concentration ($\mu g/m^3$) [3]				
	2013	2014	2015	2016	2017
St Aldate's (Oxford Centre AURN)	**56**	**52**	**49**	**49**	40
High Street	**50**	**47**	**44**	**47**	39

As can be seen in the above table, compliance with the NO2 objective has been achieved for the High Street and St Aldate's (Oxford Centre AURN) in 2017. This data shows that the annual mean concentrations are lower than that predicted by the PCM model. **Based on measured data the objective has been met in 2017.**

From 2016 to 2017 we have seen significant reductions in NO2 across city centre sites. Analysis, comparing result with the St Ebbes Urban Background site AURN, suggest that weather and wind direction cannot explain the reduction seen from 2016 -2017, hence suggesting that the reduction in due to a change in traffic emissions. The streets have not seen significant changes to flow or road layout which can explain this reduction.

The major change in these streets has been the upgrade of buses to EuroVI. This upgrade has taken place from late 2014, majority coming on board in mid-late 2016 and is on-going, with the fleet euro standard split now **Euro V 61% and Euro VI 39%.** EuroVI buses achieve an estimated 99.5%

reduction in NOx compared to EuroV, which is likely to explain the reduction we have seen from 2016-2017.

As compliance has been reached in 2017, no further action is required in this road link. It has therefore been decided, in consultation with Defra, to discontinue the development of the feasibility study for this road link.

Road link with Local Evidence of Exceedances: A420 –St Clements Street

Monitoring of air quality in road link A420 – St Clements Street which is connected to the mandated road link shows that the annual objective of 40ug/m3 is being consistently exceeded. The road link has consistently showed the highest levels of exceedances in the city over the last 5 years. There is therefore a pressing need to consider measures for A420 -St Clements to improve conditions for people living and travelling through.

Air pollution levels are being monitored at this location using diffusion tubes and have therefore not been considered valid for use by the PCM national model. However, having completed a Local Air Quality Monitoring Checklist (attached in appendix 1) we received confirmation from Defra on the 25th July 2018, that the road link is eligible for inclusion in this feasibility study.

The road link is managed by Oxfordshire County Council as Local Transport Authority and is located within Oxford City Council local authority area. The road is a key city centre road, which connects east and west Oxford through The Plain Roundabout. It is located in the commercial centre of the city, which has a population of 161,300 and welcomes over 7 million visitors each year.

We have run our projections based on 2017 as the baseline year. However, in 2017 the road link at St Clements was closed for nearly two months during summer which had a significant impact on the NO2 annual mean in 2017. The annual mean was originally calculated as 47ug/m3. In order to calculate an annual mean value which was not artificially impacted by the road closure, adjustments were made to this value. We followed LAQM TG16 guidance which state that all data considered “erroneous” or not entirely representative of air quality can be discarded from the calculations for the annual mean. Because we still have 10 months of diffusion tube data available, annualisation is not required in this case. The new NO2 annual mean was calculated and bias adjusted for the 10 months of “good data”, and the final annual mean value obtained was of 51 (50.6) ug/m3. This was the value used to estimate our projections.

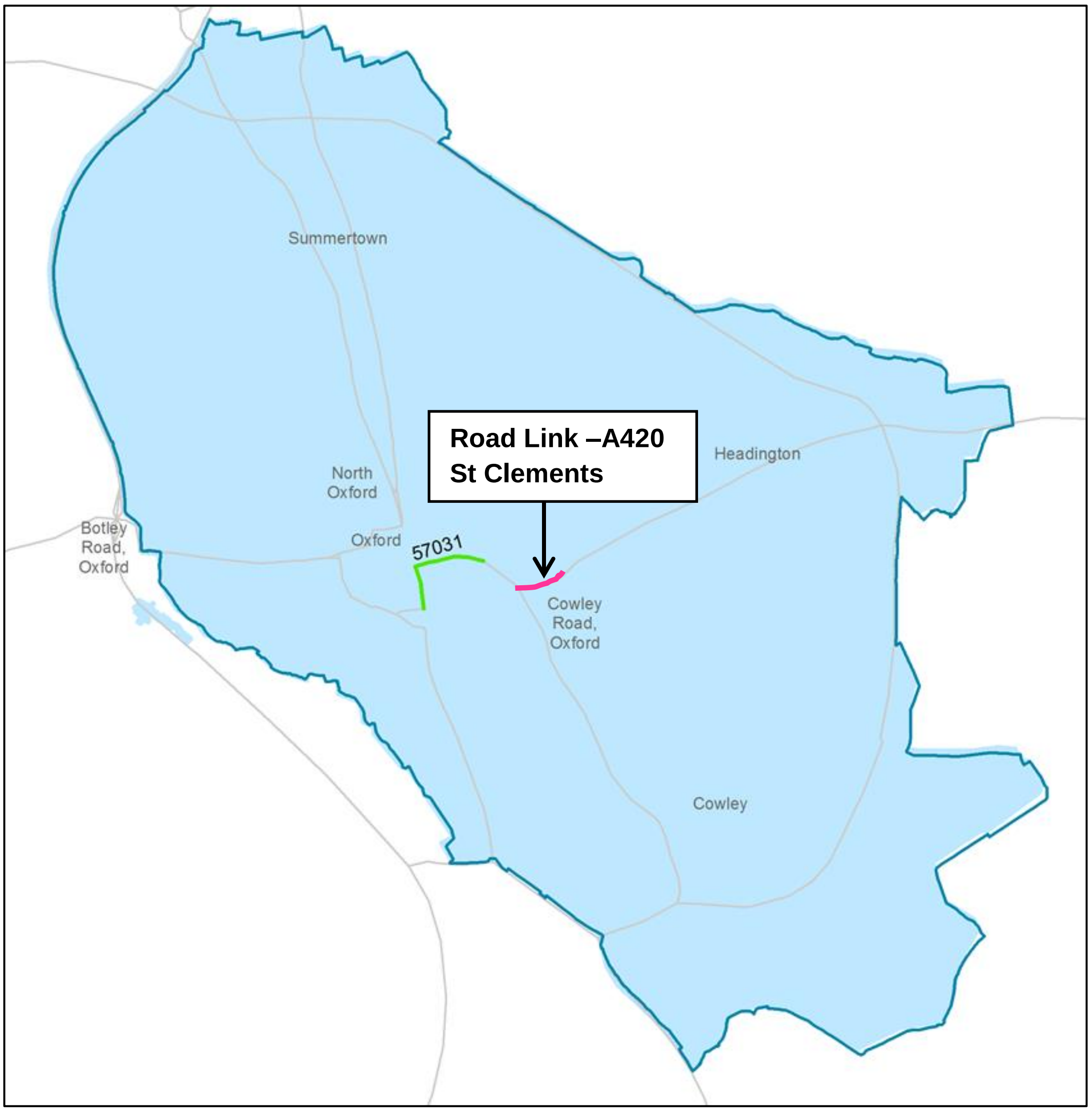
The results of the projection modelling can be found below.

Road in exceedance	2017 (Monitored Baseline)	2018	2019	2020	2021	2022	2023	2024
A420 – St Clements	51	48	46	43	40	38	36	34

This feasibility study aims to identify measures which can reduce the concentration of NO2 in this road link as quickly as possible with the objective of bringing forward compliance in the shortest possible time. This objective could be achieved by reducing the NO2 concentration in 2018 by at least 8 μg/m3. Data on actual measured annual mean is presented below.

The results of DEFRA’s projections show that if no significant measure to reduce the pollution levels of this road link is implemented, the area will not reach compliance with the annual mean limit value for NO2 until 2021.

Map 2

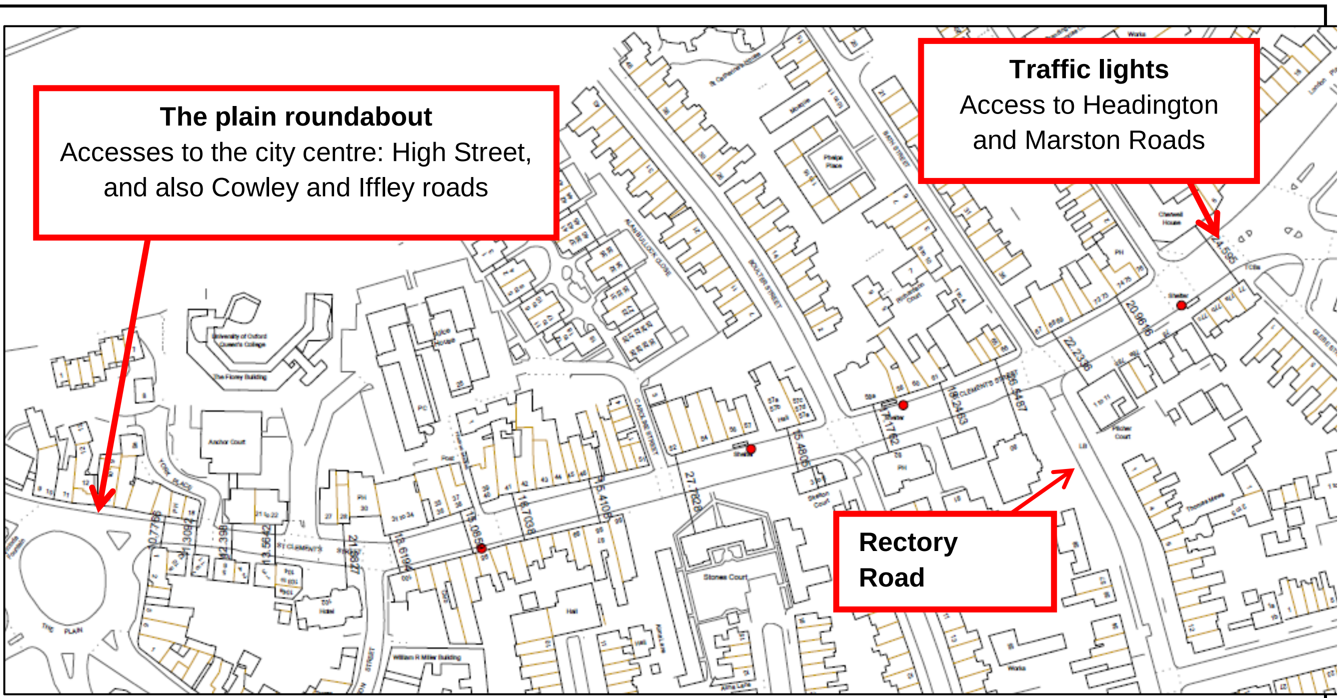


The specific characteristics of the road link are outlined in below.

A420 - St Clements

St Clements is a busy street with shops located on each side of the street. It has a pavement on each side of the road, as well as several bus stops along its length. The road is well used by cyclists and has medium levels of pedestrian flow on pavements. The street is narrow towards The Plain roundabout, with relatively high buildings on both sides which contributes to a street canyon effect. The road is a key city centre road, which connects east and west Oxford through The Plain Roundabout.

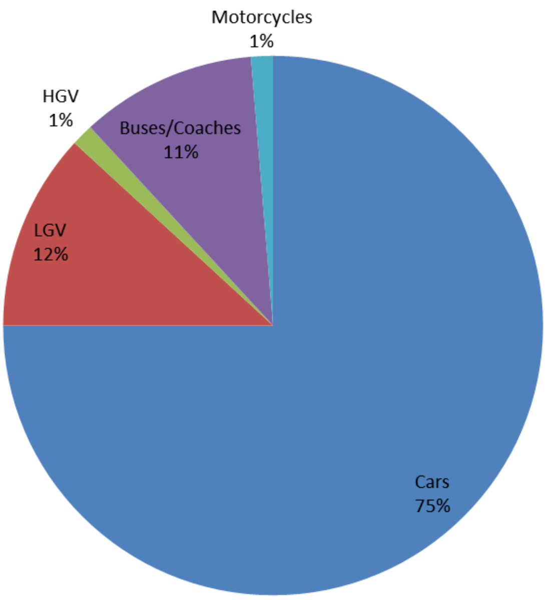
A map of the road link, including locations of bus stops (red dots) can be seen below.



Traffic Data

Detailed traffic counts, carried out in January 2018,can be found below.

St Clements -Traffic Mix

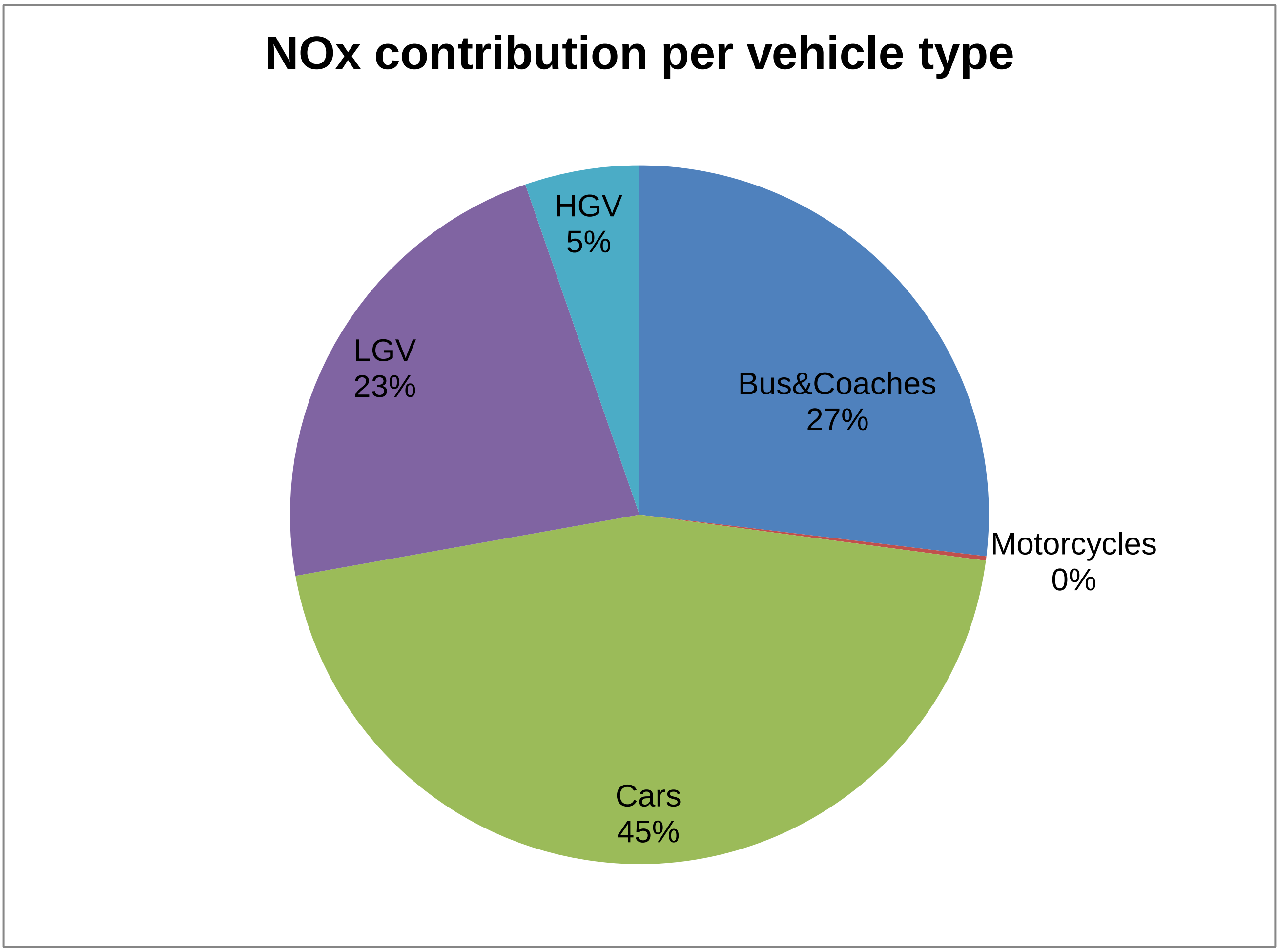


The results clearly show that cars are the biggest percentage of road users on St. Clements, followed by Light Good Vehicles and Buses/Coaches.

Source Apportioment

Source apportionment data based on January 2018 traffic counts are showed below. This was completed using Defra’s emission factor toolkit (EFT) version 8.0.1.

This data confirms that cars contribute the majority of single source emissions in the road link.



Source apportionment data shows that the main causes of poor air quality in St Clement's are cars which are the biggest single source of NO2 pollution. This is followed by buses and light commercial vehicles which makes up a total of 50% of emissions.

Specific sources of local exceedances

The road link is used by commuters who live in the east of the city, where St Clements street presents the most direct route to the city centre. Traffic builds up from St Clements towards The Plain roundabout with queues regularly extending beyond 125m. Several bus stops are located along the road link which accommodates local bus services. Coach services to London which provide a 24h service are also located in the street with stops located in both east and west going directions.

There is also a significant amount of delivery and service vehicles utilising this road as it serves as an access point from the east to and from the city centre with a high volume of business located which receive daily deliveries.

The main causes of poor air quality in this road link can be attributed to: the narrow street layout which favours pollutant entrapment, causing a street canyon effect, and the presence of obstructions to traffic flow; caused mainly by the use of 4 bus stops for local buses and coaches, daytime on street parking (by the Alms Houses) in the narrower section of the street west of Rectory Road, and the stopping of delivery and servicing vehicles that supply local retailers.

Bus stops are located where footways are narrow and so bus tailpipe emissions are close to pedestrians, residents and occupiers of shops and offices in those sections. Additionally, buses and coaches using these stops contribute to traffic congestion more generally by blocking flow (particularly of larger vehicles), as well as affecting comfort for cyclists. Scheduled coach services have a tendency to be at stops for longer whilst passengers board.

The combination of these factors leads to congestion throughout the day, impacting on flows in both directions, which is the main cause of air pollution in this road link.

Air Quality Data

The road link subject of this study has diffusion tube monitoring carried out at one location. A map showing the location of diffusion tube can be seen below.

Data for the diffusion tube monitoring location over the last 5 years can be viewed below.

Site Name	NO_2 Annual Mean Concentration (µg/m^3) (3)				
	2013	2014	2015	2016	2017
A420 –St Clements	**70**	**65**	**67**	**61**	**47**

From 2016 to 2017 we have seen significant reductions in NO2 across city centre sites. Analysis, comparing result with the St Ebbes Urban Background site AURN, suggest that weather and wind direction cannot explain the reduction seen from 2016 -2017, hence suggesting that the reduction in due to a change in traffic emissions. The streets have not seen significant changes to flow or road layout which can explain this reduction.

The annual mean measured in 2017 represents a reduction of 23% on 2016. This results need to be treated carefully however, as from June to August St Clements street had limited traffic due to disruptive sewer works being conducted on-site. The works resulted in pollution levels being halved during that period, which is reflected in the NO2 annual mean. A methodology was applied, to calculate what the NO2 annual mean would have been, if the road works had not been conducted. The results show a predicted annual mean of 51 μgm-3, which indicates that there was a clear reduction of pollution levels in St Clements, which is not directly related with the road works, but related instead with the overall reduction in levels observed across the city in 2017.

The major change in this street has been the upgrade of buses to Euro VI. This upgrade has taken place from late 2014, majority coming on board in mid-late 2016 and is on-going. Euro VI buses achieve an estimated 99.5% reduction in NOx compared to Euro V, which is likely to explain the reduction we have seen from 2016-2017.

Part 2: Developing a long list of measures for addressing the exceedances

Long List of Measures

The measures below apply to A420 –St Clements Road link only –due to Census ID 57031 showing compliance.

As the majority of emissions in the road link are generated by cars, followed by buses, LGV and HGV and as we have evidence that the road layout restrictions contribute to emission generation in this location, we focus on proposals which will improve traffic flow or which will improve the standard of the fleet.

The table below list already implemented measures, planned measures and possible additional measures to bring compliance in the shortest possible time.

Implemented since 2015	Planned implementation till 2020
Update of part of bus fleet operating in road link to Euro 6 standard	Clean Bus Technology Fund retrofit of a tot of 78 buses to Euro 6 standard and 5 to ful electric
Public Cycle Hire Scheme	Upgrade of bus fleet to Euro 6 as part of bu operators fleet planning
Anti-idling campaign and idling enforcement	Proposed Zero Emission Zone starting fro 2020 (subject to approval)
Possible Additional Measures	
Declaration of an Ultra-Low Emission Zone for buses and HGV's (Euro VI Standard)	Divert inbound car traffic along Dawson Stre
Traffic scheme including relocation of bus stops, removal of parking, tougher loading restrictions and traffic light changes, to improve flow and reduce congestion.	Pollution absorbing footway paving
	Freight Consolidation Centre/Last Mi Delivery

Implemented since 2015
A number of measures have been implemented since 2015 which has reduced air pollution in the road link. Reductions are mainly considered due to a change in the bus fleet, with a significant amount of the fleet now operating in the road link of Euro VI standard.

Planned implementation till 2020
There are further measures planned which are expected to reduce emissions in this road. Most notably is the further upgrade of the bus fleet, using funding from the Clean Bus Technology Fund to retrofit a total of 78 buses to Euro VI standard and 5 buses to fully electric. This project will deliver reduction in NO2 over the next 12 months, with order for retrofits having been placed already.

Possible Additional Measures
Our identified possible additional measures include the introduction of an Ultra-Low Emission Zone (Minimum Euro VI Standard) for buses and HGV's which would require all buses operating in the road link to be minimum Euro VI standard. We would consider introducing this for an area larger than the road link itself as we have local data showing exceedances in nearby roads which a possible ULEZ can help tackle.

As set out in the table, relocating bus and coach stops away from the narrower section of St Clements could potentially have a positive impact on congestion and associated air pollution. The impact would be improved if the on-street parking adjacent to the Alms Houses could also be relocated (at least during the daytime hours). Relocating bus stops and on street parking would also improve conditions for cyclists It would help further if the existing loading activity can be better enforced throughout the day, but particularly during peak hours. Tighter restrictions on loading more generally should be considered.

Part 3: Assessing deliverability/feasibility and delivering a short list

For each of the measures identified in part 2, local authorities should set out an assessment of deliverability including how long it would take to deliver each measure and whether it is practicably feasible to deliver. Based on this assessment of deliverability and feasibility, the local authority should develop a short list of measures to take forward to part 4 of the report.

Planned Measures

As outlined above, the planned measures are primarily targeted at buses as they contribute the majority of emissions in the city centre as whole. The measure likely to have the most significant impact on emissions is the Clean Bus Technology Fund (CBTF) retrofit programme which is projected to be complete by March 2019. Our calculations estimate that the retrofit project proposal, including both SCRT and Electric retrofits, will achieve a net saving of NOx emission of 57.2 tonnes/year and 285.8 tonnes over the life of the project. The estimated NO2 savings are 5.5 tonnes/year and a total of 27.6 tonnes over the lifetime of the project. As this is planned and going ahead we have included this measure on the shortlist to take forward to part 4. We will also include in the assessment the impact of the already planned bus fleet renewal as operators have placed orders already on some new Euro VI buses.

Oxford has plans to introduce a Zero Emission Zone in 2020. The road link is not directly impacted by the implementation in 2020 and hence this measure is predicted to only have limited impact on emission in the road link. The Zero Emission Zone feasibility study modelled the predicted impact of the ZEZ and found that for this road link it would only reduce annual mean concentrations with 1μgm-3, taking the predicted annual mean concentration in 2020 from 56μgm-3 to 55μgm-3. So while this measure does see some improvement, it is limited and further measures are therefore required.

New Measures

In this section we consider whether any of the measures included in the long list in part 2 of this study are practically deliverable in time to be able to bring forward compliance on this road link. As discussed in part 1 above, this road link is projected to become compliant in 2021 so any measure would, as a minimum, need to be deliverable by end of 2020 to be able to bring forward compliance at all.

New measures rejected due to deliverability issues

- Divert inbound car traffic along Dawson Street: While this measure will divert traffic away from the road link, this has been discounted as it displaces traffic, congestion and emissions to narrow section of Cowley Road and Dawson Street. It also introduces safety issues - conflict between cyclists, pedestrians and vehicles due to additional turning movements at either end of Dawson Street at Cowley Rd and St Clement's

- Pollution absorbing footway paving: We had initially considered a solution which replaced paving stones on the footway with a stone treated with a photo catalytic surface, which claims to be able to reduce NO2 by way of breaking it down to a different chemical composition. However following review of Defra published report "Paints and Surfaces for the Removal of Nitrogen Oxides" and advice from JAQU, we do not consider this measure to be suitable and it has therefore been discounted.

- Freight Consolidation Centre/Last Mile Delivery: This measure was initially thought as being a potentially good solution for the reductions of HGV and LDVs on the road link. However, this measure is unlikely to be fully delivered before 2021, which goes beyond the projected timeframe for baseline compliance.

Shortlisted Measures

We have included three of the measures from our long list above on our shortlist to take forward to part 4, reflecting the measures which can be delivered sufficiently quickly, which are practically feasible, and which we believe are most likely to bring forward compliance in this road link.

Each of these measures have been assessed in terms of practical deliverability taking into account factors such as the amount of time each will likely take to implement, whether there is sufficient space for the necessary infrastructure to be built, and any other practical limitations that would allow these measures to bring forward compliance. Compared to the other long listed measures that have not be discounted on feasibility grounds, we consider the following measures to be the most likely to bring forward compliance in the shortest possible time. Our
shortlisted measures are:

Existing Measures:

- **Retrofit and upgrade of bus fleet.** This measure will be completed by the end of 2019 when the CBTF project will be concluded.

Potential Additional Measures:

- **Declaration of an Ultra-Low Emission Zone (Euro VI standard) for buses and HGV's.** The speed of delivery will depend on operators' ability to change their operations, but we expect it to be implemented in 2019/2020.

- **Traffic scheme including relocation of bus stops, removal of parking, tougher loading restrictions and traffic light changes, to improve flow and reduce congestion.** Oxfordshire County Council as the transport authority has undertaken very early feasibility work on plans to conduct traffic layout changes, including moving of bus stops, parking and changes to lights. While this work is only in its early stages, similar projects from feasibility to full implementation have taken about 24-30months to complete. This means completion in 2020, which if found to be effective in part 4 in reducing emissions, will bring forward compliance with 1 year.

Part 4: Evidencing the short listed measures to identify options that could bring forward compliance

In this section, local authorities should set out the likely effectiveness of the shortlisted measures in bringing forward compliance. Local authorities should assess each option against the Primary Critical Success Factor.

In this section of the feasibility study we set out in more detail the assumptions that were used in the Emission Factor Toolkit for each one of the proposed scenarios. We also review the outputs of the PCM Model, with regards to which one of the measures are most likely to bring forward compliance in the shortest time possible.

Each of the scenarios that were modelled by the EFT is briefly described below. For specific details on the assumptions and calculations that support all the modelling work, please refer to the excel spread sheet *"Evidence EFT"* that is being submitted with this feasibility study.

Baseline Scenario (2017)

In this scenario, EFT was run for the period 2017-2024, with no alteration being made to any of the initial input variables, as the main objective was to see how much reduction of NOx we could achieve, if no measure is implemented until 2024 - the only factor responsible for the reduction in the baseline scenario is therefore the natural turnover of the national fleet during the period, which is automatically being taken into account in the EFT model.

ULEZ Euro VI Scenario 1

This scenario considers the implementation of a euro 6 ULEZ for HGVs, buses and coaches. It was assumed that the ULEZ would come into force in 2020, therefore all the euro proportions for these vehicles were set to 100% euro 6 from 2020 onwards, and that all the vehicles not compliant with the scheme would simply be banned. It was also assumed that the bus and HGV operators would start renewing their fleet from 2017, with linear increments in the % euro proportions of those fleets being considered for the years 2018 and 2019 (before full implementation).

ULEZ Euro VI Scenario 2

Similar to ULEZ Euro VI Scenario 1. The only difference was to assume that the bus and HGV operators would not start renewing their fleet from 2017. The scenario runs for the years of 2018 and 2019 are therefore equal to the ones of the baseline scenario, as the euro proportions for these vehicles will only be changed to full euro 6 in 2020.

ULEZ Euro VI Scenario 3

This scenario considers the implementation of a euro 6 ULEZ for HGVs, buses and coaches (as per the scenarios above), the only difference being that this would be implemented under a charging scheme, were non-compliant vehicles would be charged/fined. The impact of behavioural changes associated with the implementation of such charging scheme were taken into consideration and fed into the EFT. As per ULEZ Euro VI Scenario 1, it was also assumed that the bus and HGV operators would start renewing their fleet from 2017, with linear increments in the % euro proportions of those fleets also being considered for the years 2018 and 2019 (before full implementation).

ULEZ Euro VI Scenario 4

Similar to ULEZ Euro VI Scenario 3. The only difference was to assume that the bus and HGV operators would not start renewing their fleet from 2017. The scenario runs for the years of 2018 and 2019 are therefore equal to the ones of the baseline scenario, as the euro proportions for these vehicles will only be changed to full euro 6 in 2020.

Retrofit

This scenario considers the effect that the retrofit of 78 city buses (recently awarded by the clean bus technology fund) and future bus fleet turnover will have in the reduction of NO_2 emissions at St Clements. It is expected that this measure will be fully implemented by the end of 2019, with half of the retrofitted buses already being delivered by the end of 2018.

Traffic scheme 1 - speed >2kph + 6.5% cycle increase

This scenario considers the delivery of the following traffic scheme package in St Clements: Relocation of bus stops, Removal of on-street parking, changes to traffic light sequencing. It is considered that the combination of all these measures brought together will increase the traffic flow (by increasing the average speed of the road link by 2kph), which will have a direct impact on the total emissions of NO2. It also modelled the scenario of these measures leading to an increase of the amount of cyclists that currently use the road link by 6.5%.

Traffic scheme 2 - speed >1kph + no cycle increase

This scenario considers the delivery of the same traffic scheme package for St Clements referred to in Traffic scheme 1, but on this run, the potential increase of cyclists that would start using the road link is not being taken into account. The average speed of the road link is only increased by 1kph in this scenario.

Traffic scheme 3 - speed >2kph + no cycle increase

Similar to Traffic scheme 2 scenario, the only difference is the fact of the average speed increase in the road link that is being modelled is of 2kph, instead of 1kph. This was done to allow a sensitivity check to be performed, that could provide information to what the effect of a 1kph increase of the average speed on the road link could be translated to, in terms of NO_2 emissions reduction on the road link.

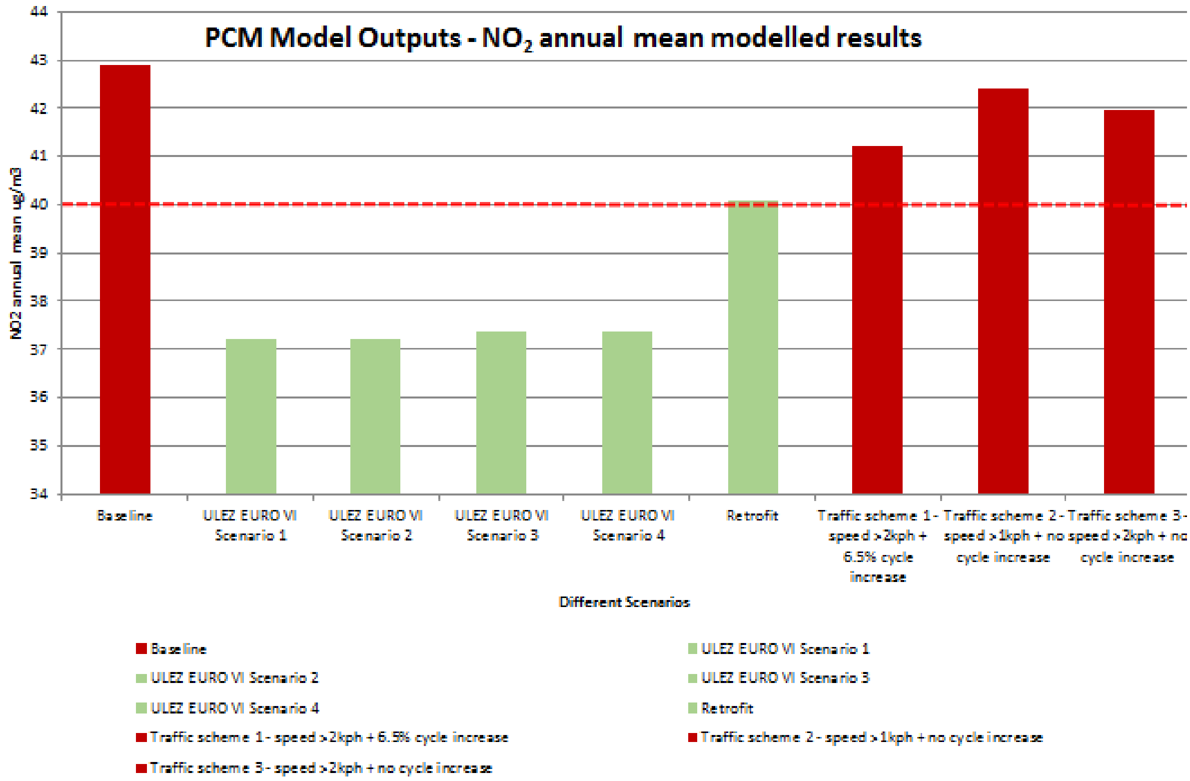
After including all the assumptions that needed to be considered and included in the EFT model for each one of the scenarios, the total emissions of NOx in tonnes/year were calculated for the years 2017-2024, and the results were sent to DEFRA's modelling team for validation.

After validation, the results were used to feed the governments Streamlined-PCM, for conversion of total NOx emissions into annual mean concentrations of NO_2.

The outputs given by the SL-PCM Model for each one of the scenarios can be seen in the table and chart below. The results below are only presented for the period 2017-2021, as all the measures are expected to deliver compliance with the annual mean NO2 by 2021 (even the baseline scenario).

Modelled Scenarios	**2017**	**2018**	**2019**	**2020**	**2021**
Baseline	**50.60**	48.00	45.50	42.90	40.30
ULEZ EURO VI Scenario 1		46.03	41.71	37.20	34.75
ULEZ EURO VI Scenario 2				37.20	34.75
ULEZ EURO VI Scenario 3		46.03	41.71	37.36	34.92
ULEZ EURO VI Scenario 4				37.36	34.92
Retrofit		46.60	42.70	40.10	37.49
Traffic scheme 1 (speed >2kph + 6.5% cycle increase)				41.22	38.71
Traffic scheme 2 (speed >1kph + no cycle increase)				42.41	39.84
Traffic scheme 3 (speed >2kph + no cycle increase)				41.95	39.39

The graph below refers to the modelled scenario of 2020, and provides a clearer view of the level of NO2 reductions that are expected by each one of the modelled scenarios. As it can be seen, only the ULEV and the Retrofit scenarios are expected to bring compliance with the annual mean NO2 limit value in 2020. **These two measures are therefore the only ones that are considered to be able to bring forward compliance in the shortest possible time**.



Part 5: Setting out a preferred option

In this section, local authorities should set out a summary of their preferred option to bringing forward compliance (where such measures exist). Where new measures have been identified that could bring forward compliance, local authorities should also assess a range of Secondary Critical Success Factors in order to identify the preferred option.

The EFT and PCM modelled results discussed and presented in Part 4 of this feasibility study have allowed the clear identification of the only 2 measures that are capable of bringing forward compliance with the NO2 annual mean limit value, namely;

The retrofit scenario predicts an NO2 annual mean value of 40.2 ug/m3 in 2020, and each one of the variations of the ULEZ scenario predict in general an NO2 annual mean value of 37 ug/m3

Although the modelled NO_2 results of retrofit scenario seem to indicate that no additional measure will be needed to bring the road link into compliance in 2020, Oxford City Council strongly believes that a more conservative approach should be adopted in this case. Our analysis of the data shows that uncertainties in the data mean that an additional measure of the introduction of an ULEZ will be required to guarantee compliance in the shortest possible time.

This is supported by the following evidence:

- The Retrofit scenario predicts an NO2 annual mean value for the year 2020 of 40.3 ug/m3. Although representing compliance, in reality this constitutes a border line value which has a high likelihood of leading to a non-compliant situation. This is a result of the significant uncertainties associated with both EFT and PCM Models. We therefore do not believe that we can fully rely on this measure to deliver compliance of St Clements road link with the NO2 annual mean limit value;

- Air Quality Models are historically known to under predict real monitored air quality concentrations.

- The huge level of discrepancy between the results obtained by the modelling work conducted by Ricardo, and DEFRA's model for the projections – described in the part 1 of this feasibility study (13 ug/m3 difference in the NO2 annual mean value for the year 2020) does not bring confidence to the modelled results;

- Any of the ULEV scenarios seems to bring the NO2 annual mean value to 37 ug/m3 – which gives us a much better error margin to account for any possible under prediction or uncertainty associated with the model (s) used in this study

- Delivering an ULEV is the measure that most quickly contributes for the reduction of human exposure to harmful concentrations of pollution – which constitutes one of the main priorities of the new clean air strategy.

Having assessed the options against the secondary success factors we recommend that a combined package of measures including Bus Retrofits and the Introduction of a ULEV for buses and HGV (EURO VI standard) is taken forward.

The summary of our preferred option to bringing forward compliance can be seen in the table below:

Road link	**PCM identified link?**	**Summary of exceedance**	**Measures identified that could bring forward compliance**	**For any new measures, please set out costs and timeframe**
Census ID57031	Yes – this link was identified as having an exceedance in the national PCM modelling	The national PCM modelling has projected that this link will be compliant in 2019. Summary of NO2 concentration projections: 2018: 42 µg/m3 2019: 39 µg/m3 2020: 36 µg/m3 2021: 33 µg/m3 However, 2017 monitoring results given by the AURN automatic air quality monitoring station at this location show that compliance has already been reached, and therefore further action is not required in this road link.	Not Applicable (NA) as the road link has already reached compliance with the annual limit value for NO2	Not Applicable (NA) as the road link has already reached compliance with the annual limit value for NO2
A420 – St Clements St.	No – this link was identified as having an exceedance using local monitoring data. A monitoring checklist has been approved by JAQU	DEFRA's model for projections and the PCM model both show that this link will be compliant in 2021 Summary of NO2 concentration projections: 2018: 48 µg/m3	The results of the PCM Model clearly identify 2 measures capable of bringing the road link in to compliance in 2020: The Retrofit scheme which is currently in	The bus retrofit is currently in implementation phase with the use of £1.7mil from the Clean Bus Technology Fund.

		2019: 46 µg/m3 2020: 43 µg/m3 2021: 40 µg/m3	implementation and a Euro VI ULEZ for both HGVs and Buses/Coaches	The development of a ULEV in this area is projected to cost a total of £3,717,500. This covers £350,000 for the cost of cameras including installation –the remaining cost represents back office and management costs which must be met by the Councils. These are estimates provided by Atkins consultants based on costs for the implementation of London congestion charge. It is hoped the final cost will be significantly less by utilising management processes set up to assist implementation of Clean Air Zones. Implementation is possible before 2020.