Combining incentives with regulation to reduce air pollution in cities: a revision of transportation policy in the City of Oxford, UK.

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Target audience: Policymakers at a County/City Council level

The UK government allows county/city councils significant freedom to individually design appropriate local policy to meet national objectives. It is councils' individual success or failure that collectively determines the state of the environment nationwide. Despite being a world-famous, idyllic, historic city of academic and architectural excellence, Oxford is failing environmentally. It requires solutions to common problems associated with high levels of car use.

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Executive Summary

Cities of varying size and context are facing similar environmental, economic and social issues associated with the modern-day trend of personal vehicle transportation. Oxford is no exception to this and despite decades of targeted policy, air pollution is plateauing above legal European levels. Under increasing pressure from Government, British councils are forced to consider more radical policies. With transport at the heart of the issue, Oxford's future transport plans will be assessed.

Despite positive measures to improve alternative transport methods, insufficient action is being taken to directly reduce personal car usage. This oversight tends to be driven by a common misconception that electric vehicles are a panacea. In fact, it is not cleaner vehicles that are needed, but fewer vehicles.

To correct this, alternative solutions are proposed; these include restricting access to vehicles and implementing a unified emissions and congestion charge. A balance is sought between indispensable regulation, and more favoured market-based incentives. Positive existing plans, such as bus low emission zones (LEZ), are more boldly developed. Practical recommendations are offered to maximise public approval and aid the policy's implementation. This case study provides underlying principles and practices that can be adapted by councils across the UK to suit their individual context.

High St (West) – Oxford. Access restricted to buses, pedal cycles, and authorised vehicles.

Empirical Analysis

High levels of pollutants such as Carbon Dioxide (CO_2), Nitrogen Oxides (NO_x), and Particulate Matter (PM) unbalance environmental processes. Rockström and co-authors[1] highlighted nine vital processes that are crucial to human life; pollutants disrupt two-thirds of these critical processes. Consequently, persistent pollution is likely to inflict irreversible damage at severe cost to humanity.

The UK is lagging behind Europe in combatting air pollution. It has the second highest number of NO_2 related deaths[2], and has been referred to the European Court of Justice for repeatedly taking insufficient action[3]. The issue is widespread across the country, with 200 local authorities required to create Air Quality Management Areas due to illegally high pollution levels[4]; Oxfordshire County Council (in partnership with Oxford City Council) has been forced into similar action.

Pollution is especially high in areas with road traffic[5], as vehicles contribute the majority of all NO_x and PM emissions[6]. Despite decades of transportation directed policy[7], Oxford was[8] and continues to be one of the most polluted cities in the UK: the WHO found Oxford to be the joint 8th worst polluted city in the UK for $PM_{2.5}$ particles[9], with the latest figures showing $PM_{2.5}$ levels are on the maximum limit[10]; Oxford has higher CO_2 levels than the national average[11]; and Oxford exceeded legal NO_2 levels at half of its monitoring sites in 2016, with these levels plateauing[12] (See Appendix 1). Long-term predictions warn that the NO_2 levels may next rise again[13].

High levels of NO_x and PM are associated with smog, serious health damage[14] (at a cost of £16bn annually[15]), architectural degradation, acid rain, damage to crops and vegetation[16], eutrophication, and reduced biodiversity[17]. This is especially hazardous in Oxfordshire, which contains world-renowned architecture, and many rare, nitrogen sensitive priority habitats[18]. Areas located outside of the immediate City are also at risk, with damage reported far from emission sources[19].

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1 (Rockström, et al., 2009)
2 (European Environment Agency, 2016)
3 (EU Energy and Environment Sub-Committee , 2018)
4 (DEFRA, 2007)
5 (Oxford City Council, 2017)
6 (DEFRA, 2007)
7 (Oxford Mail, 2013)
8 (Calor Gas (via The Guardian), 2004)
9 (WHO (Via Sky News), 2017)
10 (WHO (via BBC), 2018)
11 (Oxfordshire County Council, 2015)
12 (Oxford City Council, 2017)
13 (Department for Transport, 2004)
14 (WHO, 2013)
15 (DEFRA, 2013)
16 (Oxford City Council, 2017)
17 (DEFRA, 2007)
18 (Oxfordshire County Council, 2015)
19 (DEFRA, 2007)

The local authorities' collective vision for the future of transportation in Oxford has two main approaches[20]: encouraging the uptake of zero emission vehicles; and improved access to other modes of transport (such as cycling, buses, and trains). This includes establishing cycle corridors (complementing existing bike rental), re-developing the central train station, converting the eastern freight line to accommodate commuters, and (at an unspecified time in the future) constructing an underground tram network. Any such strategy should be shown scepticism; research was conducted into the true quality of proposed climate change strategies in 30 UK cities. It concluded that in many cases they prove ineffectual, with bold promises being nothing more than lip service[21].

The decision to improve alternative transport methods is sound. Increased cycling in Shanghai reduced CO_2 and NO_x by almost ninety tonnes, especially from commuter use[22]. Smaller cities can benefit too; each former car user commuting by bike across Oxford's diameter would save over 1500kg of emissions annually[23]. Key barriers to greater uptake are danger and fitness[24]. The introduction of electrically assisted bikes in Brighton addressed these fitness concerns[25], with similar health and environmental[26] benefits as they predominantly attract car users. To reduce danger, full segregation of bikes is key, with road deaths reducing by 30% with the removal of cars[27].

Oxford, High Street (East) – Unrestricted access.

[20] (Oxfordshire County Council, 2015) (Oxford City Council, 2017)
[21] (Heidrich, et al., 2017)
[22] (Zhang & Mi, 2018)
[23] (Department of Transport and Main Roads (Australia), 2017)
[24] (Woods & Masthoff, 2017)
[25] (Cairns, et al., 2017)
[26] (Winslott-Hiselius & Svensson, 2017)
[27] (Aldred, 2014)

Expansion (to outer sites) and greater efficiency from Rapid Transit Techniques are proposed for Oxford's P&R system (see Appendix 2). P&R reduces emissions of all pollutants[28], a key factor in uptake is reliability and speed of service[29], and outer sites reduce Vehicle Miles Travelled[30]. Case studies (including a previous study in Oxford) warn of P&R potentially worsening pollution without complementary policy though[31]. It cannot succeed on its own[32].

Firstly P&R <u>must</u> attract car users and achieve high utilisation[33]. Current plans improve public transport (PT) without ensuring P&R's suitable utilisation. Oxford's only planned threat to its majority of car commuters[34] is a workplace parking levy (WPL). Although this is a positive policy[35], undermining the convenience of the car will require more serious restraint measures, and is arguably unachievable alongside a free road network[36].

Additionally, such positive policy is sabotaged by renewed parking capacity in the centre encouraging motorists; a thousand spaces were replaced in the Westgate redevelopment[37]. Additionally, short stay parking charges in the centre are comparable to the P&R service. Two adults sharing a car and parking at the P&R site would cost £6.80 in total to reach Oxford City Centre; for just 20p extra they could park for four hours in this centrally located Westgate car park[38]. Thus, WPL alone is unlikely to bring the drastic change needed to guarantee the P&R's success, especially with contradictory parking practices.

Secondly, P&R <u>must</u> use low/zero emission vehicles, and not duplicate existing bus services[39]. A failure of Dublin's bus-only centre was that buses themselves were not an improvement on the cars they replaced[40]. This presents a risk in Oxford, with limited measures to remove polluting vehicles from the city centre, and bus fleets not to be fully electrified until 2035[41]. The only existing emission regulation is **regular** buses driving on **certain roads** within the centre must meet **2009 Euro V emissions** standards (See Appendix 3). Expansions on this are strictly limited, an approximately **0.05km^2** zero emissions zone being introduced from 2020 (which includes several currently pedestrianised/limited access roads[42]), with the aim to expand to an approximately 1km^2 area a decade later (See Appendix 4). Indeed, a report conducted in Oxford prior to the strategy warned that such measures would have minimal effect[43]. Furthermore,

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[28] (Gan & Wang, 2013)
[29] (Jackson, 2001) (Woods & Masthoff, 2017) (Nieuwenhuijsen & Khreis, 2016)
[30] (Meek, et al., 2010) (Oxfordshire County Council, 2015)
[31] (Meek, et al., 2010)
[32] (Rye & Ison, 2012)
[33] (Rye & Ison, 2012) (Gan & Wang, 2013)
[34] (Oxfordshire County Council, 2015)
[35] (DEFRA, 2007) (Jackson, 2001)
[36] (Oxfordshire County Council, 2015) (Rye & Ison, 2012) (Jackson, 2001)
[37] (Oxford City Council, 2018)
[38] (Oxford City Council, 2018)
[39] (Meek, et al., 2010) (Higginson, 2001)
[40] (E.A.King, et al., 2011)
[41] (Oxfordshire County Council, 2015)
[42] (Oxfordshire County Council, 2018)
[43] (Ricardo Energy and Environment via Oxford Mail, 2018)

other bus services presently duplicate the P&R, with this set to continue. Both inter and intra-city buses directly serve the city centre with centrally located stops (often also passing/serving stops along P&R routes).

The City's hopes are placed on electric vehicle (EV) technology making the problem disappear, without the need for less acceptable 'stick' policies - regulation. Regulatory measures are often unpopular with the public and therefore avoided by democratically elected bodies[44]. In this case the local authorities not only risk losing favour with voters, but also local employers from the motor industry (such as Mini).

Oxford are currently trialling EVs and car clubs to prove their viability to locals and guide investment. Car clubs are a positive, emerging trend; global users have increased fourteen-fold between 2006-2014[45], they alleviate parking issues, and users benefit from lower running costs alongside a 39% lower carbon footprint[46].

A local bus operating in oxford

An electric vehicle charging from a power point

[44] (Meek, et al., 2010)
[45] (Prieto, et al., 2017)
[46] (Prieto, et al., 2017)

Analysis of Evidence

Oxford, Radcliffe Square

Despite technological gains, emissions in the City are likely to increase due to traffic growth of 25% by 2031[47],and the adoption of EV technology being too slow[48]. It is not just the rate of change that is problematic though. Even if the transition to EVs was instantaneous, the link between reduced air pollution and EVs is far from clear cut; this was concluded by a comprehensive academic review of 65 studies on the topic[49].

A crucial misconception is that tailpipe emissions constitute the entirety of transport related pollution. In fact PM is primarily a non-exhaust pollutant[50] arising from road, tyre and break wear[51]. PM penetrates deep into the lungs, is classified by the WHO as a Group 1 carcinogen with no safe level of exposure[52], constitutes a leading environmental cause of cancer deaths[53] reducing average life expectancy

[47] (Oxfordshire County Council, 2015)
[48] (Department for Transport, 2004) (DEFRA & Department for Transport, 2017)
[49] (Requia, et al., 2018)
[50] (Nieuwenhuijsen & Khreis, 2016)
[51] (DEFRA, 2007)
[52] (WHO, 2013)
[53] (WHO, 2013)

by almost a year[54], and reaps the highest economic costs[55]. In this way, EVs will not address key pollutants and in fact there are even credible suggestions that EVs could worsen conditions (see Appendix 6).

Vehicles of all types bring broad negative effects which render them unsuitable for the urban context. Cars cause a significant number of accidents in Oxford[56], which also reduces cycling rates due to the danger[57], and car free cities benefit from significant reductions in noise pollution[58]. Oxford's individual context makes them especially inappropriate: Oxford's narrow historic layout is unsuitable for high levels of traffic, and heavy traffic detracts from Oxford's historical aesthetic, which supports a £3.1bn tourist industry[59]. With the presence of vehicles problematic, and EVs' environmental benefits questionable, policymakers must recognise that it is not just cleaner vehicles that are needed, but fewer vehicles[60].

Stricter measures to limit vehicle use can take the form of a Congestion Charge, as used in London. This policy is advocated by DEFRA[61] and the Department for Transport[62], especially in cases such as Oxford where lighter policies are not improving conditions adequately; it was also ranked as most effective policy in a survey of transport academics[63]. While there are complaints from the council that it is expensive to implement[64], estimates suggest that benefits far outweigh the costs[65]. Its successful implementation in London illustrates its feasibility, and even provides evidence of a substantial reduction in accidents[66], and a higher adoption of Low Emission Vehicles[67]. The UK government has pledged £255m towards the implementation of such measures, which includes the ongoing development of a national vehicle database and payment portal to facilitate charging[68].

While these charges are generally disliked by the public, studies have highlighted good practice in marketing them. Creating a rationale of those who use it need to pay for it, alongside clear public engagement proves successful[69]. Similarly, ring fencing revenue from the charges and locally investing it increases public support; this was sufficient to secure majority public approval in London[70]. Another important factor is having a clearly defined cordon and a small number of clear objectives for the charge[71].

[54] (WHO, 2013)
[55] (DEFRA, 2007)
[56] (Oxfordshire County Council, 2015)
[57] (Woods & Masthoff, 2017) (Nieuwenhuijsen & Khreis, 2016)
[58] (Nieuwenhuijsen & Khreis, 2016)
[59] (Oxfordshire County Council, 2015)
[60] (EU Energy and Environment Sub-Committee , 2018)
[61] (DEFRA, 2007)
[62] (Department for Transport, 2004)
[63] (Jackson, 2001)
[64] (Oxfordshire County Council, 2015)
[65] (Department for Transport, 2004)
[66] (Nieuwenhuijsen & Khreis, 2016)
[67] (Morton, et al., 2017)
[68] (EU Energy and Environment Sub-Committee , 2018)
[69] (Hysing & Isaksson, 2015)
[70] (Ye, 2012)
[71] (Hysing & Isaksson, 2015)

Success further relies on promulgating the link between vehicle use, air pollution and health; the indirect nature of the interaction means it is commonly overlooked[72].

Push-back from local businesses can often originate from concerns over decreased trade from difficulty accessing a car free city. Counterintuitively, case studies have shown that both footfall and sales can actually increase by a staggering 30-40% with the removal of vehicles[73]. Restrictions on cars in Cracow reaped similar benefits, with new public space attracting entrepreneurs and an increasing number of visitors; afterwards 75% of businesses stated they would like to keep the changes[74]. The inconvenience on residents of Oxford should be minimal; 50% of residents' commutes are presently made by cycling/walking, and car ownership is lowest within the City[75].

It is also worth recognising the sheer scale of potential benefits from a more concerted effort to remove cars from the City. When cars were temporarily banned in Leeds and Paris, NO_2 levels immediately dropped by 20% and 40% respectively. In Milan's congestion zone, Black Carbon (a type of PM) reduced by 28-40%, with full car free Sundays boasting a 75-78% reduction[76]. Oxford would be in good company, following in the footsteps of Oslo, Hamburg, Madrid and Helsinki (who have already started ambitious projects towards reducing cars). Cities who already implemented car free zones, such as Bologna and Lubeck, are benefiting from 60% fewer vehicles entering the centre[77].

Allowances must be made for delivery vehicles, with forecasts predicting 2,500 HGVs entering the city per day by 2031[78]. Potential solutions include consolidation points outside of the city (where low emission vehicles can then efficiently distribute the freight out of hours). This is realistic, with 46% of businesses expressing willingness to share facilities with another brand[79]. The UK government has also pledged £220m to mitigate any economic impact on businesses arising from tighter pollution measures[80].

Oxford, Bicycles parked on Magdalen Street

[72] (Bennett & Vijaygopal, 2018)
[73] (Nieuwenhuijsen & Khreis, 2016, p. 258)
[74] (Andrzej, et al., 2017)
[75] (Oxfordshire County Council, 2015)
[76] (Nieuwenhuijsen & Khreis, 2016, p. 255)
[77] (Nieuwenhuijsen & Khreis, 2016, p. 255)
[78] (Oxfordshire County Council, 2015)
[79] (Oliveira, et al., 2016)
[80] (EU Energy and Environment Sub-Committee , 2018)

Recommendations

Oxford, Pedestrianised square facing New College Lane

Oxford's two-tiered approach to both improve alternative transport methods and address car use is sound. The former practically entails the use of outer P&R sites and rapid transit techniques, alongside improved rail links, and renewed cycling infrastructure. Cycling can be most effectively encouraged by addressing danger and fitness; fully segregated cycle corridors and e-bikes should be explored. Collectively these form a key aspect of a successful policy.

For these efforts to truly have an impact on air pollution though, they must be coupled with the second tier: robust measures to reduce car use. It is this second aspect which renders Oxford's strategy ineffectual. While the principle to target car users is logical, existing plans misguidedly focus on a transition to EVs.

This second aspect to the strategy must instead entail a concerted effort to reduce vehicle use. Oxford have proposed a WPL to cover this. This is a positive step, but insufficient on its own. To accompany it must be a sizeable restricted access zone in the city centre, alongside a unified emission and congestion charge for the surrounding area, with strictly limited parking capacity. Research shows that business can benefit from this, and majority public approval can be gained. To do so, revenue must be ring-fenced for local spending, and marketing used to highlight the invisible threat that air pollution poses alongside a rationale of those who cause it pay for it. Practical aspects of payment/charging are currently being developed nationally to support such a policy.

This reduction in vehicles must extend to HGVs and PT. An outer distribution centre should be established to consolidate deliveries, and PT must not duplicate itself. To resolve the latter, inter-city PT should end at P&R sites, and intra-city PT should be replaced by P&R services. Practically, this involves two services being offered at P&R sites: a quick, direct P&R bus for commuters, and a slower bus covering all stops for intra-city travellers. Integrated ticketing should be used between inter-city PT and P&R when possible, and P&R parking charges should be separated from the bus fee to discourage driving to the site. Where buses and HGVs remain, they should be encouraged to be low or zero emission vehicles (with increasingly strict pollution regulations over time).

The practical implementation of this policy involves separating the City into three areas. The suggested zones (see Appendix 5), and their corresponding characteristics are outlined below.

Zone 1 – Immediate City Centre

- Restricted access:
  - 7am – 6:30pm
  - Monday - Sunday
  - Limited to Local Buses, Private Coaches (St. Giles only), Taxis, Emergency Vehicles, Residents
  - 20mph speed restriction
  - ANPR controlled barriers at the 6 key entrances to the area
- Convert surplus road into pedestrianised public space
- Low Emission Zone for regular buses (As soon as reasonably possible: minimum standards to be increased, LEZ to be extended to taxis & delivery vehicles, before becoming a Zero Emission Zone (ZEZ))
- Out of hours, shared deliveries
- Removal of existing high capacity car parks
- (e)Bike rental scheme
- Clearly segregated cycle corridors/lanes

Zone 2 – Within the Ring Road

- Emission & Congestion Charge (2x fees, billed together)
    - Congestion Charge
        - Monday – Friday
        - 7am – 6:30pm
        - Exempt: Residents (maximum of 2 cars per household), emergency vehicles, local buses, coaches, taxis, disabled (blue badge)
    - Emission Charge
        - Monday – Sunday
        - At all times
        - Fee calculated on age of vehicle (conforming to Euro IV (or below), V, VI, or Electric)
        - Residents pay a monthly fee at a reduced rate (discount slowly decreases over time)
        - Temporarily Exempt: Local buses, coaches, delivery vehicles, taxis
        - Permanently Exempt: Emergency vehicles
- Resident on street parking only (Permit holders)
- Limited short stay (30min) parking available on High-Streets (e.g. Summertown)
- Car share clubs available to residents (subsidised for low income households)
- WPL
- Free parking at P&R sites available on request for:
    - Residents who commute outside the Ring Road.
    - Guests of residents.
- Intra-city public transport replaced by P&R service
- Re-development of Oxford Station

Zone 3 – Outside the Ring Road

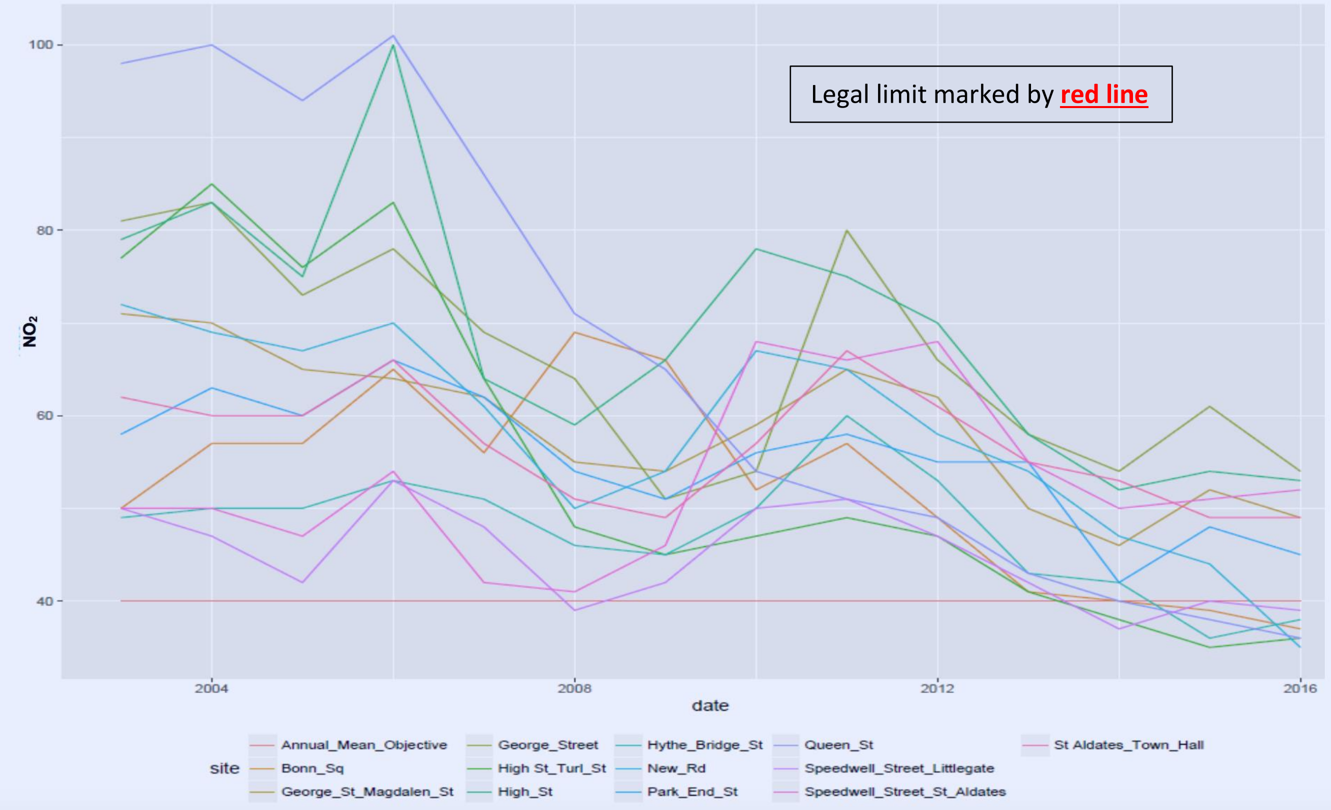
- Increased number of rural P&R options (locations and closures as proposed by OCoC (2015), see Appendix 2)
  - 2 bus services from each site (1x quick route direct to the centre, 1x slow route covering all stops for intra-city travellers)
  - Separate fee for parking and bus trips at the sites (encouraging public transport use to access the site)
  - Efficient service, utilising Rapid Transit Techniques
  - Relocation of Sandford P&R site to the Kassam Stadium (1600 existing spaces and closer to the unserved East) (see Appendix 2)
- Improve rail links (especially in the East) to offer alternative to P&R
- Rural and inter-city bus routes to end at P&R sites
  - Integrated ticketing for P&R (where possible)
- Marketing campaigns about public transport, the harm of air pollution and ring-fenced emission & congestion charges
- Delivery consolidation point

Oxfordshire County Council was given the opportunity to provide additional information and comment in relation to this piece, however no response was received.

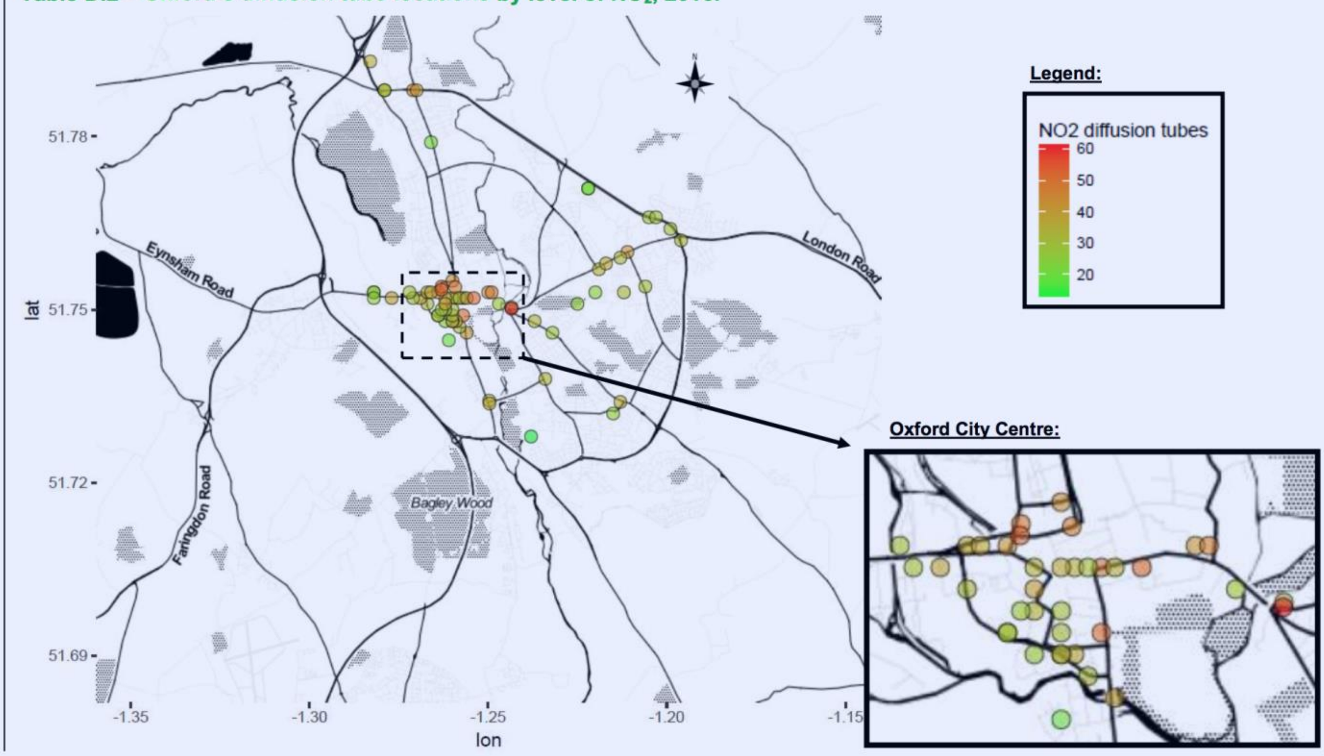
Appendices

Appendix 1 – NO_2 Trends in Oxford

~~Figure 3~~ – Long Term Trends in Annual Mean NO_2 (ugm^{-3}) at Oxford's diffusion tube monitoring locations, 2003-2016



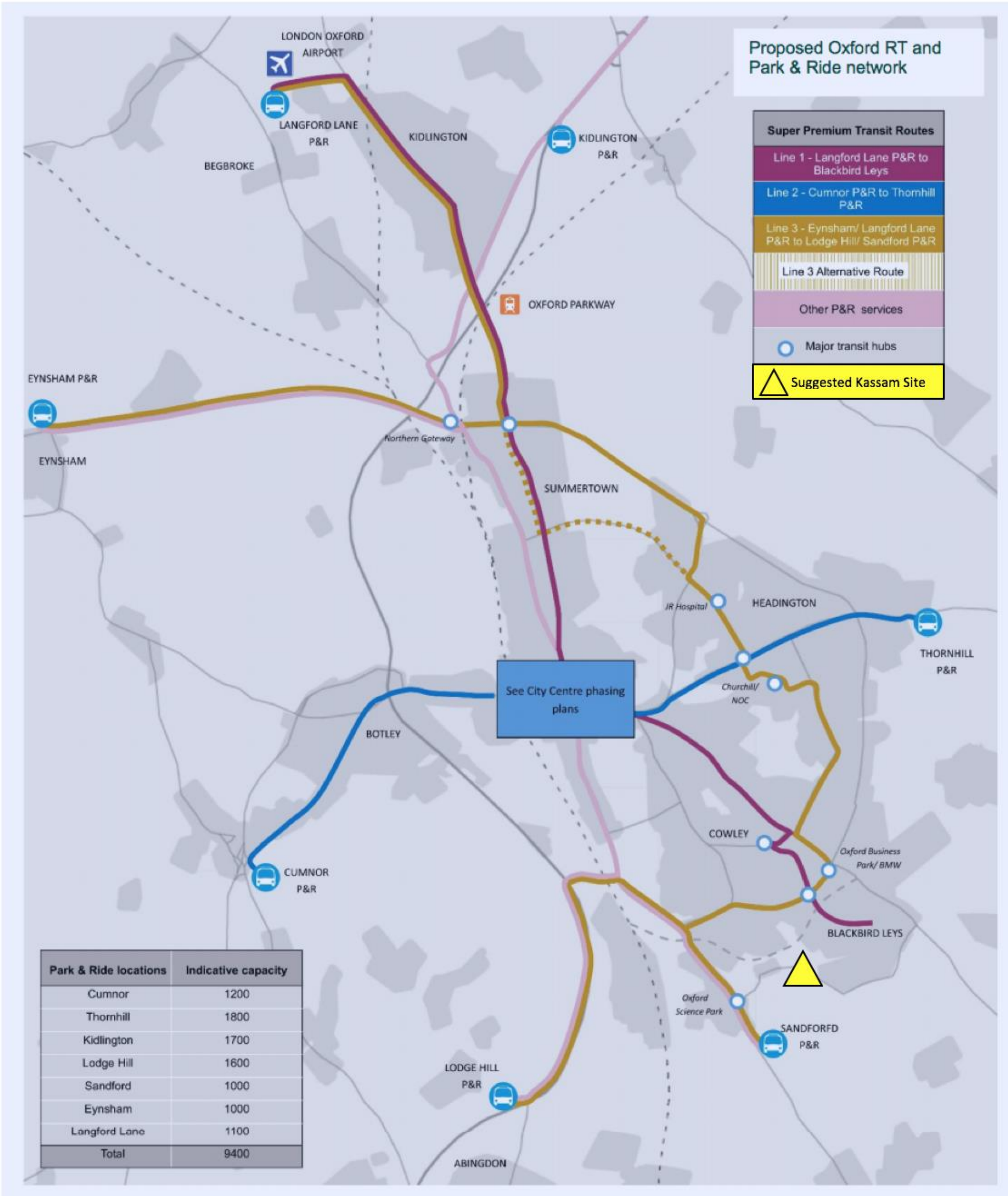
~~Table D.2~~ – Oxford's diffusion tube locations by level of NO_2, 2016.



Source: GGmap package for Rstudio[12]

(Oxford City Council, 2017)

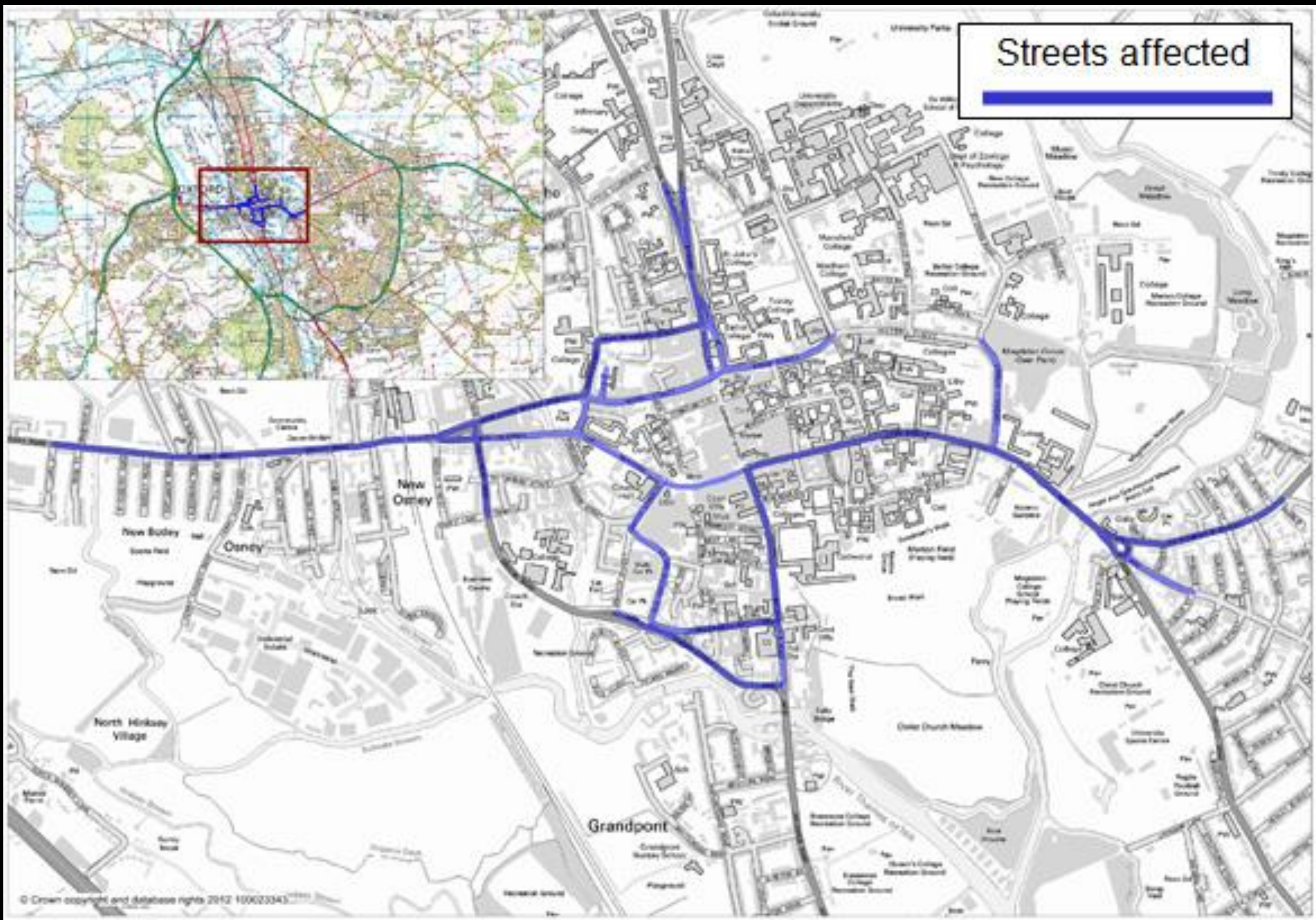
Appendix 2 – Planned P&R Sites, with Kassam



Park & Ride locations	Indicative capacity
Cumnor	1200
Thornhill	1800
Kidlington	1700
Lodge Hill	1600
Sandford	1000
Eynsham	1000
Langford Lane	1100
Total	9400

(Oxfordshire County Council, 2015)

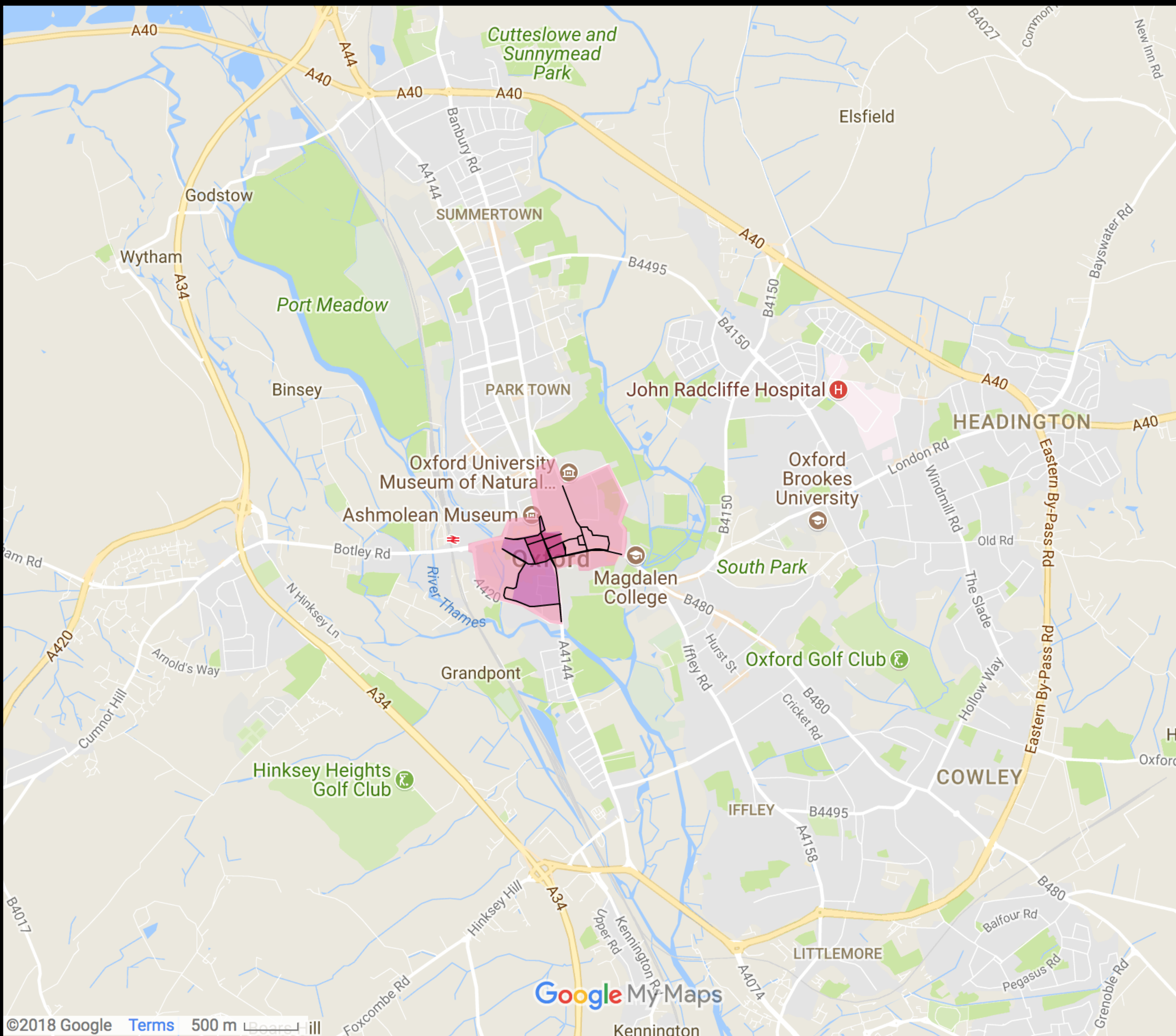
Appendix 3 – Oxford's LEZ: 2014-Present



(Oxford City Council, 2018)

Appendix 4 – Oxford's Planned ZEZ 2020-2035

Key:	
	2020 Zero Emission Zone
	2025 Zero Emission Zone
	2030-35 Zero Emission Zone
	Existing, noteworthy Limited Access Roads



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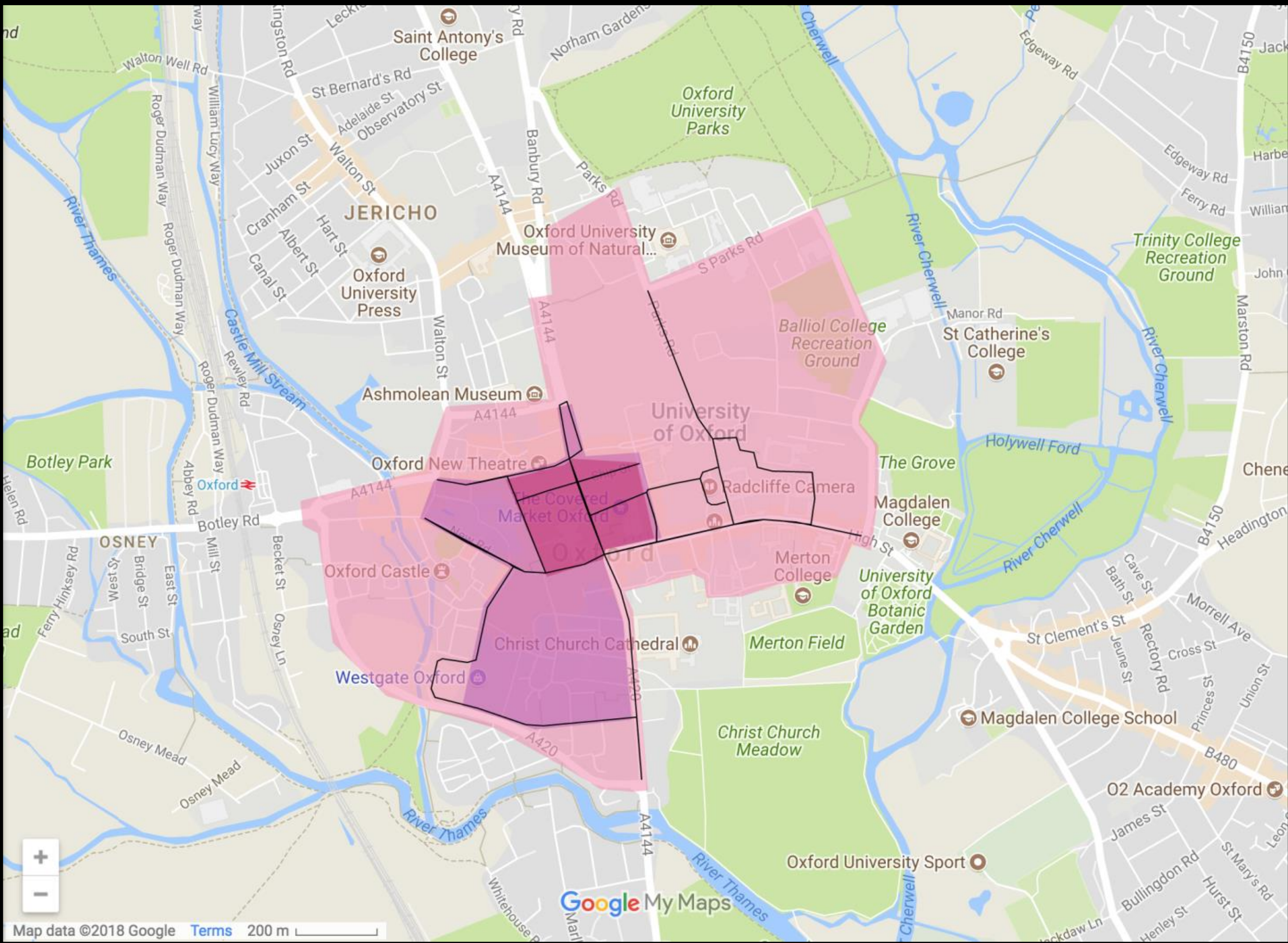
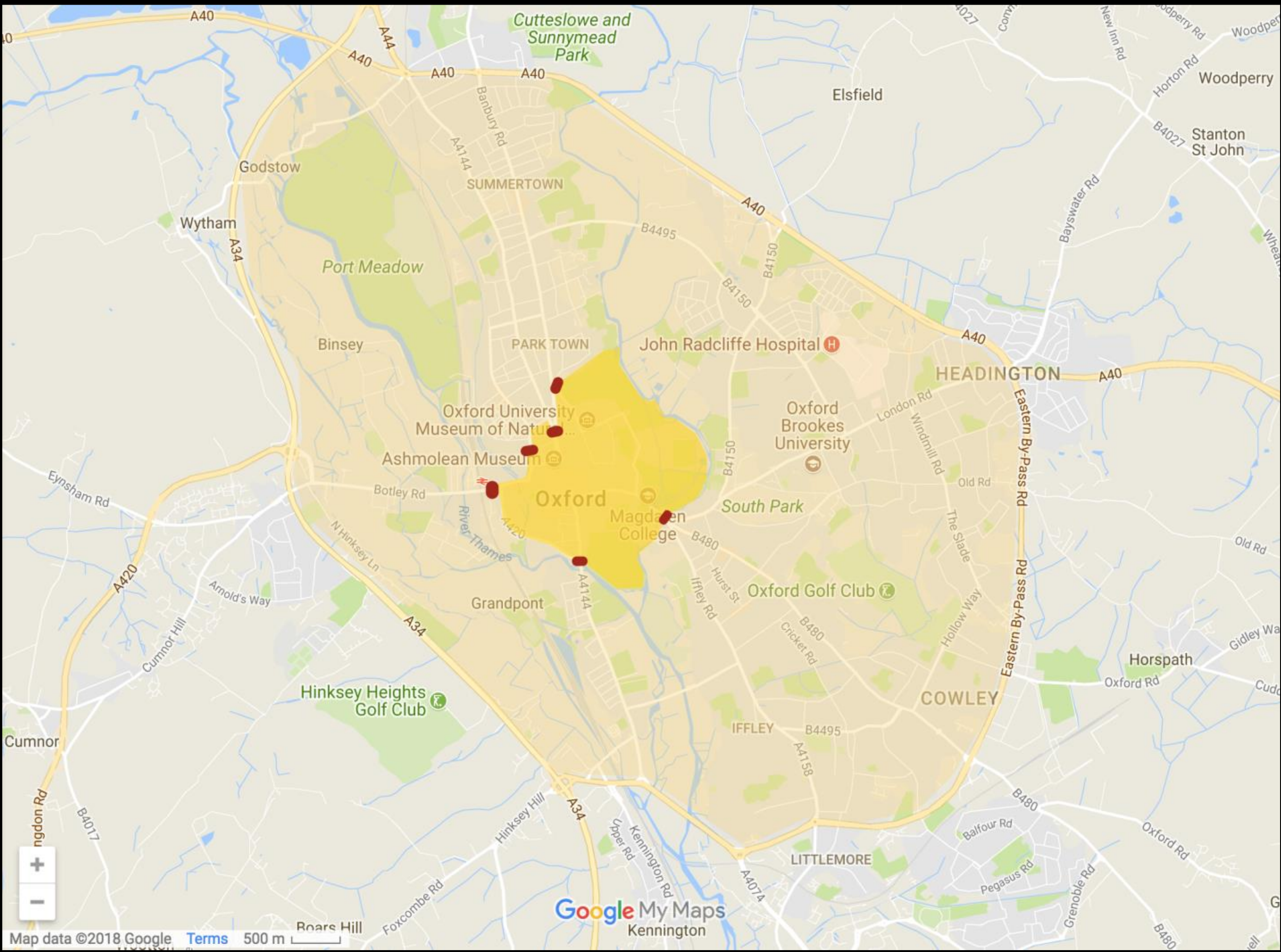

Saint Antony's College
JERICHO
Oxford University Press
Oxford University Parks
Oxford University Museum of Natural...
Ashmolean Museum
Oxford New Theatre
University of Oxford
Radcliffe Camera
The Covered Market Oxford
Oxford Castle
Christ Church Cathedral
Westgate Oxford
Balliol College Recreation Ground
St Catherine's College
Magdalen College
Merton College
University of Oxford Botanic Garden
Merton Field
Christ Church Meadow
Magdalen College School
O2 Academy Oxford
Oxford University Sport
Botley Park
OSNEY
Oxford
River Thames
River Cherwell
Holywell Ford
The Grove
Trinity College Recreation Ground
High St
St Clement's St
Botley Rd
Map data ©2018 Google
Terms
200 m
Google My Maps

Appendix 5 - Proposed Zones

Key:	
	Zone 1
	Zone 2
	Suggested Barrier Locations



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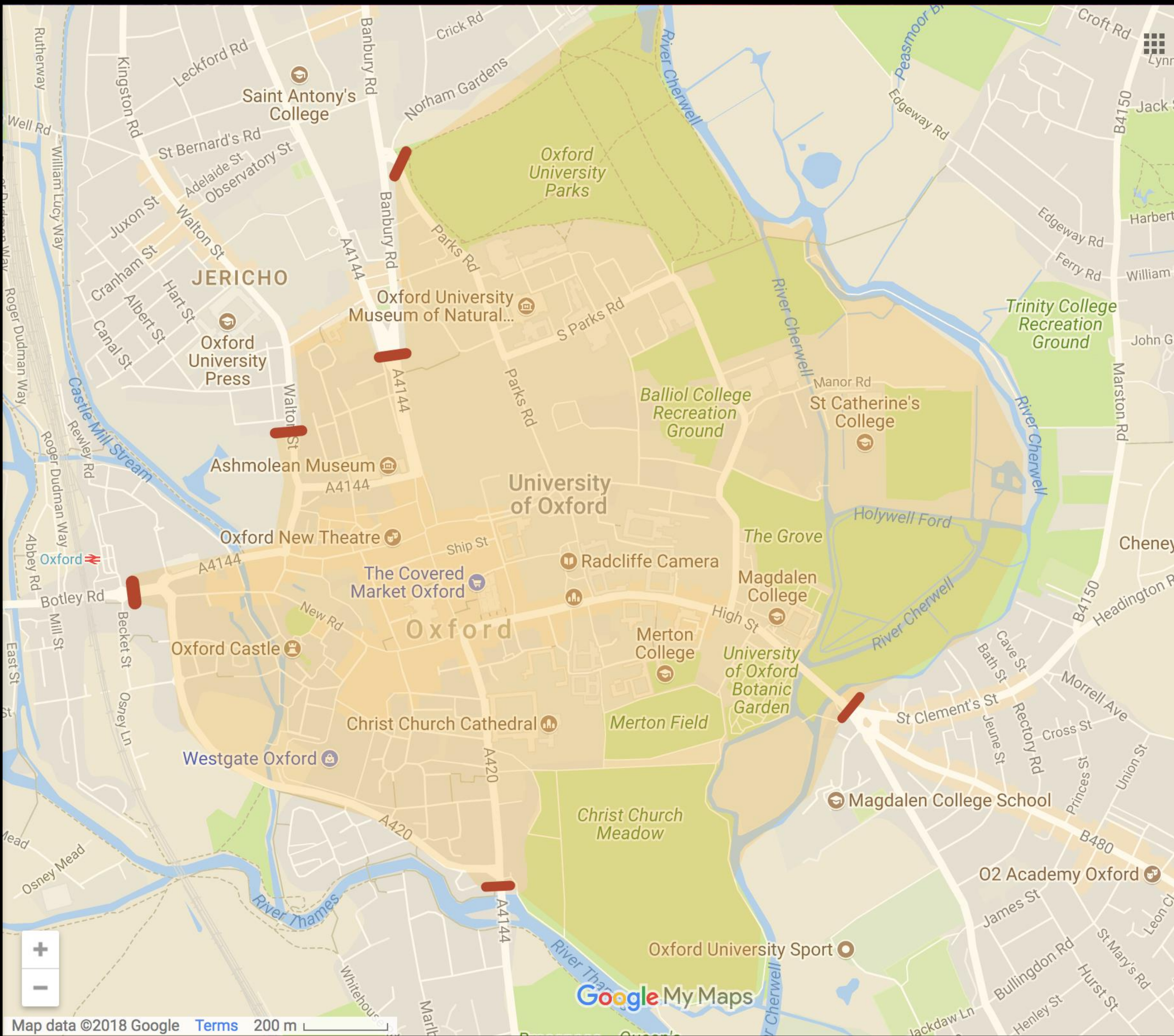
Oxford University Parks
JERICHO
Saint Antony's College
Oxford University Museum of Natural...
Oxford University Press
Ashmolean Museum
University of Oxford
Oxford New Theatre
The Covered Market Oxford
Radcliffe Camera
Oxford
Oxford Castle
Christ Church Cathedral
Westgate Oxford
Merton College
Merton Field
Magdalen College
The Grove
University of Oxford Botanic Garden
Balliol College Recreation Ground
St Catherine's College
Trinity College Recreation Ground
Christ Church Meadow
Magdalen College School
O2 Academy Oxford
Oxford University Sport
River Cherwell
River Thames
Castle Mill Stream
Holywell Ford
Banbury Rd
Parks Rd
S Parks Rd
Walton St
High St
St Clement's St
Botley Rd
A4144
A420
B480
B4150
Google My Maps
Map data ©2018 Google Terms 200 m

Appendix 6 – The shortcomings of EVs

EV's success at dealing with air pollution is uncertain, with a wide array of factors affecting the outcome[81]. This contravenes the common understanding that EVs and clean air quality go hand in hand. In reality this is overly simplistic, with unintended consequences and overlooked negative effects leading to an overestimation of EVs' impact. One study estimated that even if 50% of cars became electric, it would only reduce local NO_2 levels by as little as 5.5%[82]. The extent to EVs' benefits are that they relocate tailpipe emissions to rural power stations[83]. What is regularly overlooked is that the pollution from EVs remains – with the problem simply being brushed under the rural rug. Air pollution has vast and far-reaching damage[84] hence its relocation cannot remove serious indirect affects being felt by cities. Regrettably, it is not economical to convert power generation to renewable sources to address this; if it did, electricity prices would triple by 2050[85]. Electrical infrastructure would also need sizeable scaling up; the current network in Oxford is inadequate to support a surge in demand from EV use[86]. Equally non-tailpipe pollutants are not addressed by EVs, which includes incredibly harmful[87] PM.

In fact conditions could worsen, as EVs are accompanied by hidden environmental costs. The supply chain and production of EVs is much more environmentally damaging than its conventional counterparts. These effects are so severe that an electric Nissan Leaf and equivalent diesel Mercedes have an indistinguishable environmental effect over a 100,000-mile lifetime[88]. Uncertainties remain over battery degradation and the vehicles' decommissioning too[89], which could even render them more damaging. One such worsening could be possible for PM pollution, with research finding that EV owners actually increase their driving mileage[90]. The ironic cause is the environmentally friendly perception of EVs; this diminishes any moral obligation to reduce driving and utilise alternative methods such as PT, walking or cycling. The same study also found that EVs tended to be purchased as additional cars, not as substitutes for existing vehicles. Unfortunately scrappage schemes cannot be used to resolve this, with research showing the policy is ineffective[91].

[81] (Requia, et al., 2018)
[82] (Ferrero, et al., 2016)
[83] (Requia, et al., 2018)
[84] (DEFRA, 2007)
[85] (Safarzyńska & C.J.M.van den Bergh, 2018)
[86] (EU Energy and Environment Sub-Committee , 2018)
[87] (WHO, 2013)
[88] (Hawkins, et al., 2012)
[89] (Requia, et al., 2018)
[90] (Klöckner, et al., 2013)
[91] (Brand, et al., 2013) (DEFRA & Department for Transport, 2017)

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