Public Health England

Protecting and improving the nation's health

Review of interventions to improve outdoor air quality and public health

A guide to using the review to help choose or plan interventions

About Public Health England

Public Health England exists to protect and improve the nation's health and wellbeing, and reduce health inequalities. We do this through world-leading science, research, knowledge and intelligence, advocacy, partnerships and the delivery of specialist public health services. We are an executive agency of the Department of Health and Social Care, and a distinct delivery organisation with operational autonomy. We provide government, local government, the NHS, Parliament, industry and the public with evidence-based professional, scientific and delivery expertise and support.

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Executive summary

Public Health England published a Review of interventions to improve outdoor air quality and public health in March 2019. The review provides local practitioners and policy-makers with an indication of the broad range of available interventions across 5 focal areas:

- vehicles and fuels
- spatial planning
- industry
- agriculture
- people's behaviour

It outlines principles that can be applied to strategies and the design and evaluation of new interventions.

This document is a supplement to the review. It provides a guide for practitioners and policy-makers when choosing and implementing interventions, drawing from the principles, recommendations and findings of the review.

Introduction

Air pollution has a significant effect on public health, and poor air quality is the largest environmental risk to public health in the UK. Public Health England's (PHE's) Health matters: air pollution provides an accessible summary of the health impacts of air pollution, infographics and case studies to illustrate the scale of the problem and need for action.

PHE's review of actions that can be taken is comprehensive, and there is further detail in the 5 rapid evidence assessments that inform it. To guide readers to the content that is most relevant to them, this document is split into short sections that address:

- adopting general principles
- finding interventions within a particular sector
- finding more information about a specific intervention
- using interventions to address a problem
- comparing interventions
- common questions and answers

Throughout this document, hyperlinks to the documents referenced are indicated by coloured text (Ctrl+Click to follow links) .

The PHE review found that many interventions are not evaluated. To show the effectiveness of new interventions, it recommended that readers establish baselines and plan evaluation at the design phase. The review (page 44) summarises a simple approach to evaluate and compare interventions, while Annexe A8 provides further detail. PHE anticipates that more detailed guidance on evaluating interventions will be published in future.

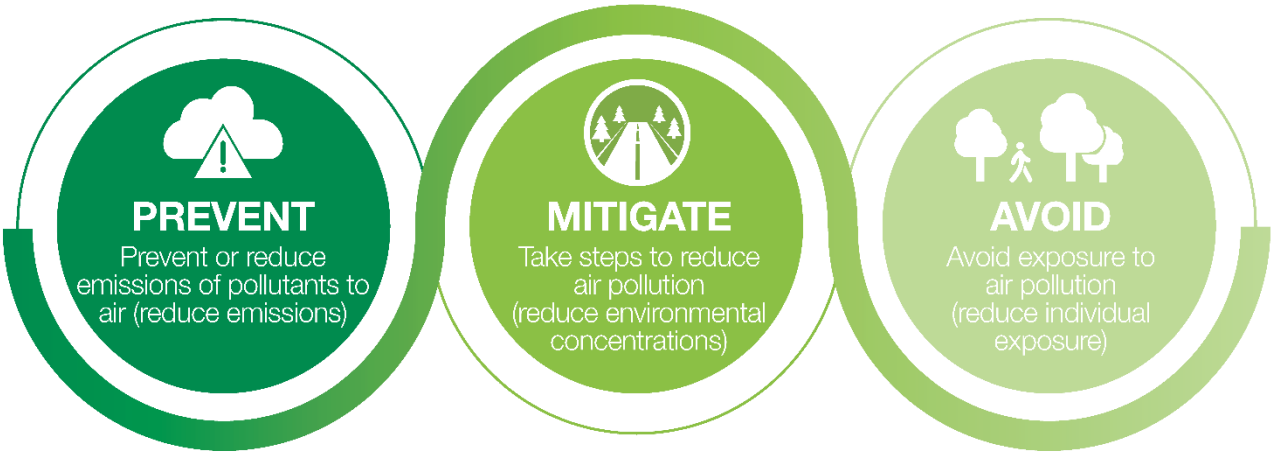
Principles

Three factors are relevant when considering the impacts of air pollution on health:

- emissions of pollutants.
- environmental concentrations of pollutants.
- exposure to pollutants (and susceptibility/vulnerability)

PHE's review recommends prioritising the prevention or reduction of polluting activities (emission reduction), in preference to only taking steps to reduce air pollution once it has occurred (concentration reduction) or relying on avoidance (exposure reduction) (Figure 1). Tables in the results chapters of the review can be used to identify intervention types.

Figure 1: Air pollution intervention hierarchy



The review also proposes a 'net health gain' principle when considering activities that could affect air quality and health (Figure 2). Ideally, any new programme of work should be designed to improve air quality and public health.

To begin to implement this in practice, the review (page 180) recommends actions to:

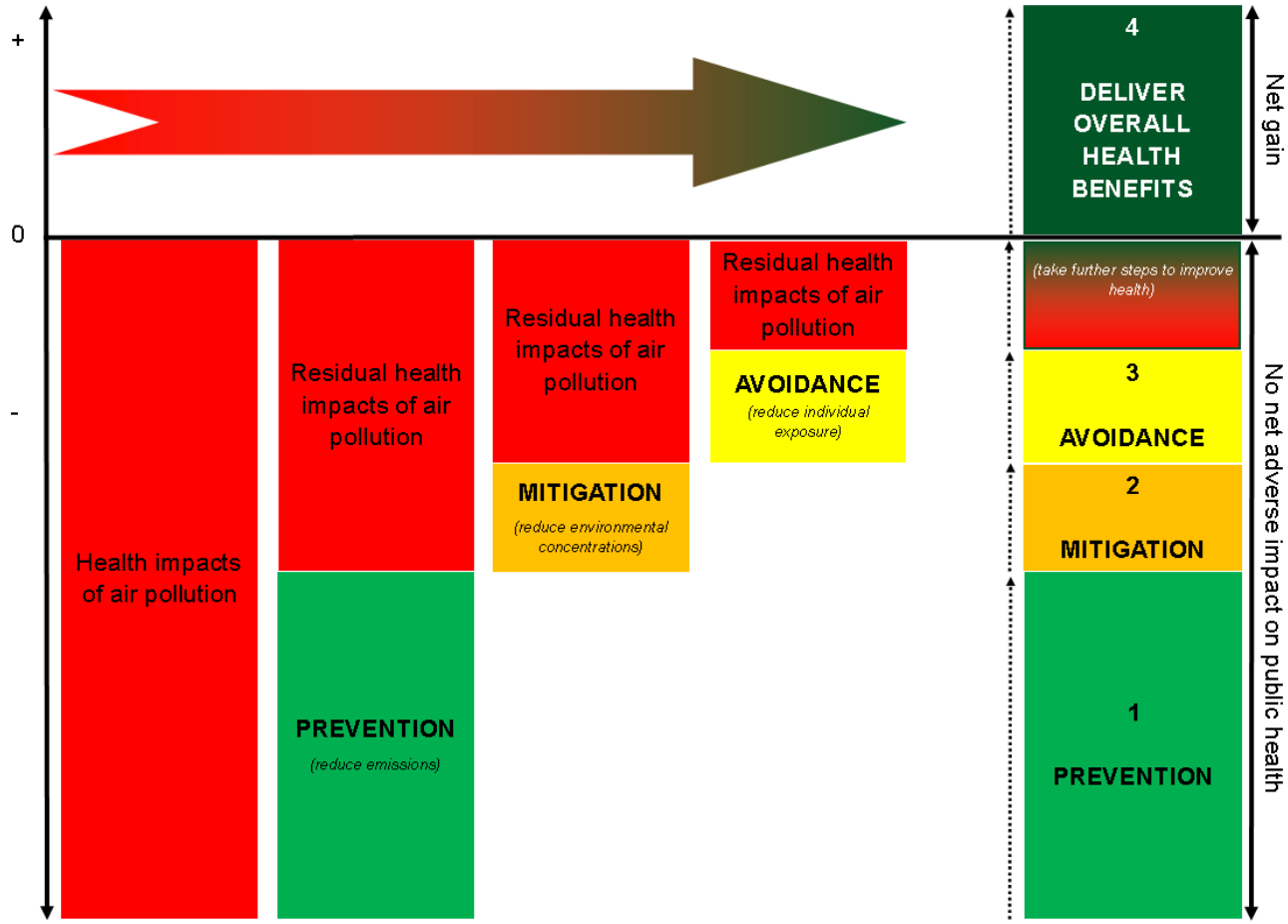
- prevent
- mitigate
- avoid exposure to air pollution under the intervention hierarchy, prioritising the prevention or reduction of emissions

The next step is to consider whether there is any unavoidable negative impact associated with residual air pollution that could be addressed by taking further steps to improve people's health to provide an overall net health gain.

Some interventions improve air quality *and* have 'co-benefits' for people's wider health and wellbeing, such as measures that increase walking and cycling, improve housing, or enhance local green spaces. Tables in the results chapters of the review can be used to identify them. These potential co-benefits are opportunities to increase the overall benefits to public health.

If taking further steps to improve health that move beyond interventions that improve air quality and deliver co-benefits, consider other environmental and social determinants of physical and mental health. This introduces a much broader perspective that includes noise, land and water quality, housing, healthcare and education services, amongst others outlined in the review (page 215). Public health professionals can provide further advice regarding national and local priorities and health inequalities.

Figure 2: The intervention hierarchy and net health gain



The review sets out and elaborates upon other general principles and recommendations, and pointers are summarised below:

- take a whole system approach (address all air pollutants together and work across different sectors)
- consider a range of interventions together and include smaller actions: they can add up

- focus on reducing people's long-term exposure to air pollution, but consider short-term exposures and additional action during episodes of poor air quality
- seek to lower population-level exposure and reduce everyone's exposure to air pollution, as well as targeting 'hotspots' (the most polluted areas) [1]
- reduce air pollutants below Air Quality Limits – lowering exposures to particulate matter and nitrogen dioxide will improve people's health because there is no evidence of a threshold for health effects
- consider the most vulnerable parts of the population and address inequalities in exposure to air pollution and adverse health outcomes
- help people understand the impacts of air pollution and what they can do to reduce their exposures, using recognised behavioural frameworks if implementing behavioural interventions
- plan for 'clean by design' places where people's exposure to air pollution is minimised in future, as well as addressing the present
- evaluate your interventions and share the findings with others – both of interventions that were effective and those that were not

[1] Within local authorities, public health teams can play an important role supporting air quality officers with the case for improving local air quality in general, as well as targeting 'hotspots'

Sectors

PHE commissioned 5 rapid evidence assessments of the existing evidence for interventions that reduce the impact of air pollution in 5 areas:

- vehicles and fuels (review, page 50; report, Annexe A4.1)
- spatial planning (review, page 71; report, Annexe A3.1)
- industry (review, page 86; report, Annexe A2.1)
- agriculture (review, page 101; report, Annexe A5.1)
- behavioural change (review, page 116; report, Annexe A6.1)

Over 100 individual interventions were identified. Table 1 sets out groups of (collated) interventions and the associated strength of evidence based on the number and quality of studies found, as judged by the contracted consultants who carried out the rapid evidence assessments.

Table 1: The intervention groups found by the rapid evidence assessments

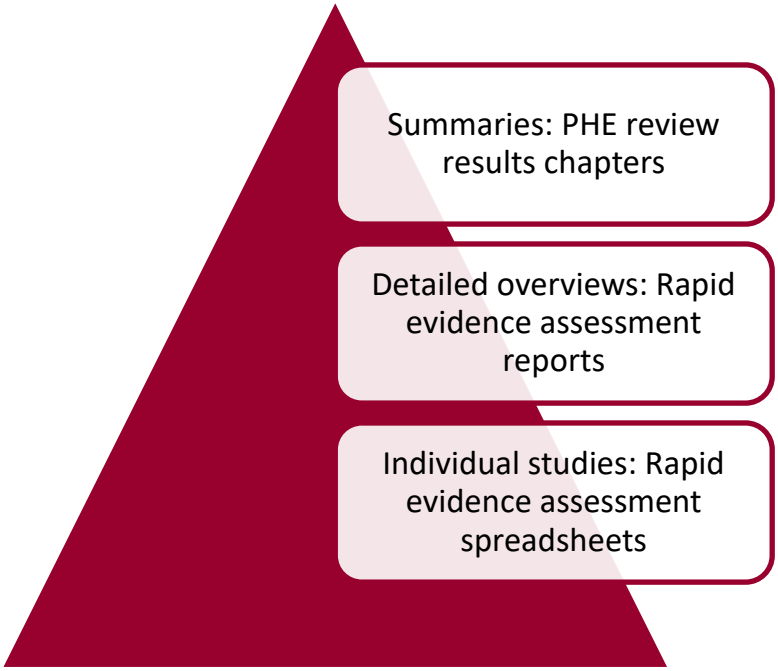
Sector	Intervention group	Number of interventions	Strength of evidence
Vehicle	Reduce demand for more polluting forms of road transport	15	Low
	Reduce emissions from existing road vehicles	9	Low
	Promote road vehicles with low emissions	10	Medium
	Displace pollutant emissions from road vehicles outside hot spots and populated areas	3	Low
	Operational interventions at airports and alternative fuels	6	Low
	Lower emission marine fuels and operational interventions at ports	4	Low
	Electrification of rail network & promotion of lower emissions from rolling stock	3	Low
Planning	Pollutant removal	2	Low
	Active transport	1	Low
	Motorised transport	6	Low to High
Industrial	Policy interventions	11	Low to High
	Technologies	7	Medium to High
Agricultural	Changes in livestock housing design or management	12	Medium
	Change in diet or feeding regime	4	High
	Changes in manure management/ storage/ processing	8	Medium
	Low emission manure application to land	2	Medium
	Fertiliser application changes	4	Medium
	Change land use/ consumption/ productivity/ genetic selection	5	Low
Behaviour	Behavioural interventions (all)	9	Low to Medium

Each of the 5 sectors are summarised in a corresponding chapter of the PHE review, with bullet-pointed, important messages on the first page of each chapter. These chapters address PHE's research questions, principles and strategies arising from the evidence, limitations, and further work emerging from the assessment.

Specific interventions

Readers seeking information regarding specific interventions have 3 options, summarised in Figure 3, according to the level of detail they require.

Figure 3: Sources of information about specific interventions



PHE review

The PHE review provides a high-level summary and interpretation of each rapid evidence assessment's findings and contains additional PHE evaluations (page 138) and a matching of problems with interventions (page 158).

The PHE review results chapters and rapid evidence assessments both address:

- how interventions are implemented
- effectiveness and strength of evidence
- health outcome evidence
- health inequalities evidence
- cost and cost-effectiveness
- interventions under development
- limitations

Rapid evidence assessment reports

The rapid evidence assessment reports address PHE research questions and the bullet point areas above in detail and summarise findings for each individual intervention.

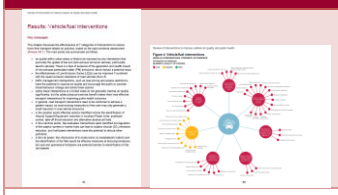
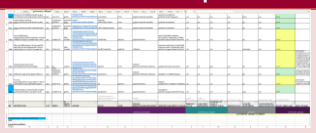
A notable feature of the rapid evidence assessment reports is that each one contains quick-reference summary tables for each individual intervention (Appendix B of the industry rapid evidence assessment report and within the body text of the other 4 reports).

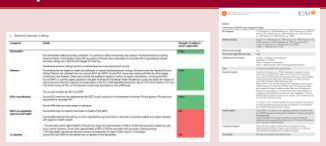
Individual studies

All the individual studies reviewed during the rapid evidence assessments are summarised in spreadsheets that can be searched to find studies related to particular interventions or intervention characteristics.

Table 2 summarises the information available and provides hyperlinks to individual documents (see bottom row).

Table 2: Review documents' content and level of detail

PHE review results chapters	Rapid evidence assessment reports	Rapid evidence assessment spreadsheets
		
High-level summaries for each of the 5 sectors	Evidence summaries for each of the 5 sectors	Document registers for each of the 5 rapid evidence assessments
Summaries and prioritisation of intervention groups	Summaries of each individual source of information	Summaries of each document reviewed
Summaries of each rapid evidence assessment's findings	Summaries of each individual intervention (including target pollutants)	Hyperlinks to each source document
Principles arising	Cost-benefit ratios (for some industrial interventions)	Content of each document (including intervention details and effects)
Strategies arising	Summary tables for each individual intervention (below)	Adequacy of each document (quality, accuracy, robustness)

PHE review results chapters	Rapid evidence assessment reports	Rapid evidence assessment spreadsheets
Further work		Relevance of each document
PHE evaluations		Assessment of each document (including inclusion/exclusion decision)
PHE matching of problems with interventions		
Vehicles and fuels (page 50) Spatial planning (page 71) Industry (page 86) Agriculture (page 101) Behavioural change (page 116)	Vehicles and fuels (Annexe A4.1) Spatial planning (Annexe A3.1) Industry (Annexe A2.1) Agriculture (Annexe A5.1) Behavioural change (Annexe A6.1)	Vehicles and fuels (Annexe A4.4) Spatial planning (Annexe A3.6) Industry (Annexe A2.2) Agriculture (Annexe A5.4) Behavioural change (Annexe A6.5)

Comparing interventions

PHE carried out evaluations to distinguish between interventions that seemed more likely to benefit public health from those that seemed less likely to benefit public health. The methodology is described in the review (page 44), which presents a basic framework that can be used by others to assess the potential health benefits of interventions (see Annexe A8 for full details).

The evaluation results are summarised in the review (Tables 16 to 22, page 140 onwards), and Table 3, below, presents a redacted version of the most promising interventions (full details in Tables 23 to 24, page 147 onwards). As PHE's evaluations were generalisations, further detailed assessments and cost-benefit analyses are required to inform options appraisals of national and local interventions.

Table 3: Interventions with multiple potential benefits

Intervention category	Intervention	Intervention type	Effectiveness		Wider public health benefits		Timescale to benefit
			Potential to improve air quality & public health		Potential for public health co-benefits	Potential to improve inequalites	
			At scale / nationally	Locally			
Planning	Co-implementation of various measures	Other					Medium
Planning	Green infrastructure - urban vegetation	Mitigation					Long
Transport	Subsidising public transport	Prevention					Medium
Agricultural	Strategic tree planting	Mitigation					Long
Agricultural	Biofilters	Prevention					Medium
Agricultural	Exhaust air scrubbing	Prevention					Medium
Behavioural	Exposure reduction programmes	Avoidance					Medium
Industry	Dust abatement (secondary)	Prevention					Long
Industry	Diffuse dust abatement	Prevention					Medium
Transport	Provision of school buses	Prevention					Long
Transport	National road pricing	Prevention				Negative?	Medium
Transport	Promote abatement retrofit	Prevention					Medium
Behavioural	Eco-driver training	Prevention					Medium
Behavioural	Public engagement	Avoidance					Medium
Industry	Inspections and enforcement actions	Prevention					Long
Industry	Installation concentration limits: BAT	Prevention					Long
Industry	Primary NOx/SO2 measures	Prevention					Long
Industry	NOx abatement (secondary)	Prevention					Long
Industry	SO2 abatement (secondary)	Prevention					Long
Planning	Encouraging walking and cycling	Prevention					Medium
Transport	Promote walking and cycling	Prevention					Medium
Planning	Road pricing / Congestion charge	Prevention				Negative?	Medium
Planning	Driving restriction	Prevention				Negative?	Immediate-short
Transport	Increase fuel duty/target at diesels	Prevention				Negative?	Medium
Transport	Promotion of low emission zones	Prevention				Negative?	Medium
Agricultural	Manure additives	Prevention					No/little evidence
Agricultural	Livestock building design	Prevention					Long
Agricultural	Rapid incorporation of solid manure	Prevention					Medium
Agricultural	Manure/slurry storage methods	Prevention					Medium
Agricultural	Low emission slurry spreading	Prevention					Medium
Agricultural	Poultry manure removal time	Prevention					Immediate-short
Agricultural	Cattle diet change	Prevention					Immediate-short
Agricultural	Choice of litter material	Prevention					Immediate-short
Behavioural	Investment in public transport	Prevention					Medium

PHE evaluation key			
Effectiveness (national & local)	**Impact on co-benefits & inequalities**	**Feasibility**	**Timescale to benefit**
No/little evidence	No/little evidence	No/little evidence	No/little evidence
Limited effectiveness	Limited effectiveness	Limited feasibility	Long term (years +)
Potentially effective	Potentially effective	Potentially feasible	Medium (months-yr)
Fully effective	Fully effective	Fully feasible	Imm.-short (weeks)
	Negative?		

The discussion section of the report summarises the most promising interventions in each of the 5 sectors at length, drawing from the rapid evidence assessments and evaluations undertaken by PHE.

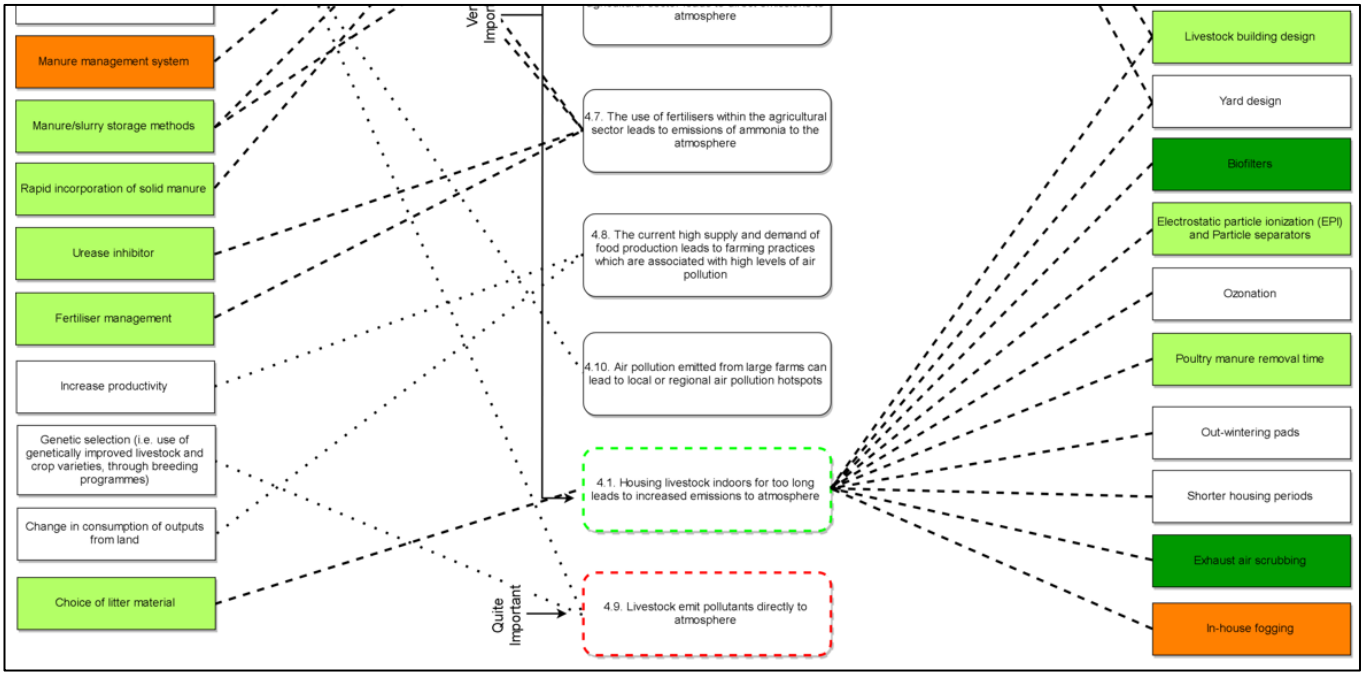
Addressing a particular problem

PHE carried out modified Delphi surveys[2] of stakeholders (page 43) to rank and match identified air quality issues with interventions that could address them. Full details of the approach are found in Annexes A7 and A8 of the review.

Readers can use the Annexes and corresponding results chapter of the review report to identify their own local problems or issues of interest and the importance assigned to them by PHE's Delphi respondents. Network diagrams (review, Figures 12 to 18, page 160 onwards) show whether the rapid evidence assessments identified interventions that might address them and their potential effectiveness and strength of evidence.

As an example, Figure 4 below is an excerpt from the agricultural sector[3]: emissions from livestock housed indoors (green-dashed box, centre, second-from-bottom) could be addressed by eleven of the interventions found by the rapid evidence review (boxes on the left and right connected to it by lines), of which biofilters and exhaust air scrubbing (dark green boxes) were thought to have the highest potential to improve local air quality and health.

Figure 4: Illustration of problem–solution matching for the agricultural sector



[2] The Delphi method is a systematic and iterative process for communicating with groups to obtain a consensus, and divergent perspectives, about a complex problem

[3] For a full key, refer to the legend in Figure 11 of the PHE review (page 159)

Questions and answers

Some questions and answers related to the recommendations of PHE's review are summarised below.

How can we ensure that interventions will be effective and improve health?

There are many sources of air pollution, and to improve the air pollution mix it is clear that a range of interventions are needed across sectors such as transport, industry, spatial planning and agriculture. PHE recommends that evaluation is embedded in the design and costing of future interventions.

The design and implementation of interventions locally can be optimised to maximise health benefits. The cumulative effect of a range of interventions to improve air quality has greater potential to improve health than any one intervention alone, and there is an extensive evidence base for the wider health co-benefits of physical activity and active travel.

Which populated areas should we concentrate on?

Local authorities need to know where air pollution is coming from in their areas so they can take effective local action, targeting those sources that they can do most about. The greatest benefit will be gained if air pollution can be reduced across wide areas that are densely populated, because more people's exposure to pollution can be reduced.

How can we ensure the poorest in society are not disproportionately affected by road transport interventions such as banning cars/charging drivers in town centres?

It is important that schemes are designed to prevent social inequality impacts (that is, reducing traffic emissions without unduly disadvantaging those in socially deprived or rural areas). This must be assessed when a local authority's policy is being developed. Measures such as charging exemptions or rebates, subsidising public transport or vehicle replacement could be used to redress costs.

How can we redesign cities without major disruption?

Redesigning cities to reduce people's exposure to air pollution is a long-term challenge and it takes time and effort to create healthy places. PHE's review proposes the adoption of a 'net health gain' principle in any new policy or work programme which affects air pollution. If this is adopted then any new development or proposal for change to existing developments will intend to deliver an overall benefit to people's public health. In effect this means that any new development should be clean by design.

There are many opportunities to design places that minimise air pollution when new development takes place, by building energy-efficiency houses that use cleaner energy, providing infrastructure for low emission vehicles and making it easier to walk, cycle or use public transport. But there are other opportunities to reduce exposure to air pollution in existing streets too, for example through measures such as changing road layouts and managing traffic flows, improving public transport and adding cycle and walkways, or by using barriers or vegetation to shield people from pollution.

PHE has published separate evidence reviews of Spatial planning for health and Cycling and walking for individual and population health benefits and guidance on planning-related topics such as healthy high streets and active travel. Readers registered on Knowledge Hub can request to join PHE's Healthy Places group, which signposts information and provides a platform to share expertise.

How can local planners ensure a net health gain when building new roads or housing developments?

Policies, programmes, plans and projects can prevent or reduce emissions of pollutants to air, take steps to reduce air pollution in our environments, and help people avoid exposure to air pollution.

A virtuous circle can be created if interventions both improve air quality and improve health through physical exercise, or access to green spaces. For example, new roads with cycle paths, walkways and green spaces could reduce congestion and increase active travel leading to lower air pollution and greater health benefits compared to existing road networks.

However, there may be some residual health impacts associated with exposure to pollution that cannot be avoided, and further improvements to health may be needed elsewhere. This could include investment in the promotion of health and well-being. Putting measures in place that improve health can go beyond just offsetting impacts and deliver a net health gain. Developing approaches to implement this in practice will require cross-sector working between planners and environmental and public health professionals.

Where can those in the public sector find out more about PHE work related to air quality and health?

To find out more about PHE's work to develop health evidence and support our stakeholders' actions to improve air quality and health, readers registered on Knowledge Hub can request to join PHE's Air Quality and Public Health Group, which signposts information and provides a platform to share expertise.