Mayor of London's

Draft Climate Change Adaptation Strategy

Sustainability Appraisal Report

Part B: Appraisal of the Draft Climate Change Adaptation Strategy

February 2010

Prepared for the Greater London Authority
by
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ABBREVIATIONS

ABI	Association of British Insurers
AQMA	Air Quality Management Area
BAP	Biodiversity Action Plan
BAU	Business as usual
BAU+50	Future business as usual in 50 years time
BME	Black and minority ethnic
BREEAM	BRE Environmental Assessment Method
CAMS	Catchment Abstraction Management Strategy
CCAS	Climate Change Adaptation Strategy
CCAS	Climate Change Adaptation Strategy
CEP	Collingwood Environmental Planning
CET	Central England temperature
CFMP	Catchment Flood Management Plan
CIWEM	Chartered Institution of Water and Environmental Management
CIRIA	Construction Industry Research and Information Association
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
COMEAP	Committee on the Medical Effects of Air Pollution
CREH	Centre for Research into Environment and Health
CSO	Combined sewer overflow
DCLG	Department for Communities and
DCLG	Department for Communities and Local Government
DEFRA	Department for Environment Food and Rural Affairs
DMA	District metering area
DTI	Department of Trade and Industry
EC	European Commission
EDS	Economic Development Strategy
EEA	European Environment Agency
EEC	European Economic Community
EqIA	Equalities Impact Assessment
EU	European Union
FoE	Friends of the Earth
GCSE	General Certificate of Secondary Education
GLA	Greater London Authority
GOL	Government Office for London
GP	General practitioner
HIA	Health Impact Assessment
HMG	Her Majesty's Government
HSE	Health and Safety Executive
IIA	Integrated Impact Assessment
IPCC	Intergovernmental Panel on Climate Change
km	Kilometre
LCCP	London Climate Change Partnership
LDA	London Development Agency
LDF	Local Development Framework
LDD	Local Development Document
LDEPA	London Fire and Emergency Planning Authority
LHC	London Health Commission
LSC	London Skills Council
LSDC	London Sustainable Development Commission
MEP	Member of the European Parliament
MPA	Metropolitan Police Association
MPS	Metropolitan Police Service
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
ODPM	Office of the Deputy Prime Minister
OFWAT	Office of Water Services
PLA	Port of London Authority
PM10	fine particulate matter
PPG	Planning Policy Guidance
PPS	Planning Policy Statement
RBMP	River Basin Management Plan
RFRA	Regional Flood Risk Appraisal
RPHG	Regional Public Health Group
SA	Sustainability Appraisal
SAC	Special Areas of Conservation
SEA	Strategic Environmental Assessment
SFRA	Strategic Flood Risk Assessment
SOER	State of the environment report
SPA	Special Protection Area
SPG	Supplementary Planning Guidance
SSSI	Sites of Special Scientific Interest
SUDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
TE2100	Thames Estuary 2100
TfL	Transport for London
UHI	Urban Heat Island
UK	United Kingdom
UKCIP	United Kingdom Climate Impacts Programme
UKCP09	UK Climate Projections 2009
UKWIR	UK Water Industry Research
WFD	Water Framework Directive
WHO	World Health Organisation
WRMU	Water Resources Management Unit

PART B: APPRAISAL OF THE DRAFT CLIMATE CHANGE ADAPTATION STRATEGY

4. LIKELY EVOLUTION OF THE SUSTAINABILITY BASELINE WITHOUT THE STRATEGY

Introduction

Overview of the contents of Part B of the SA Report

4.1 Sections 4 to 8 which make up Part B of the SA Report present the findings of the appraisal of the draft Strategy and in particular Stage B of the SA process – *Developing and Refining Options and assessing effects* (see Section 2 of the SA Report which describes the stages and tasks in the SA process). The contents of Sections 4 to 8 is summarised below:

- **Section 4:** likely evolution of the sustainability baseline and the effects of climatic changes in London in the absence of the draft Strategy (task A2, plus aspects of A3, B3 and B4, of the SA process);
- **Section 5:** predicting and evaluating the potential effects of the draft Strategy and alternatives at a strategic level (task B2 of the SA process);
- **Section 6:** testing the draft Strategy objectives against the SA objectives (task B1 of the SA process) predicting and evaluating the effects of the policies and actions included in the draft Strategy (tasks B3 and B4 of the SA process), mitigating the adverse effects and maximising the beneficial effects (task B5 of the SA process); and,
- **Section 7:** proposed measures to monitor the significant effects of the implementation of the Strategy and the next steps in the SA process and the development, adoption and implementation of the Strategy.

4.2 Note that the version of the draft Strategy appraised here was provided by the GLA on 28 January 2010. The appraisal also draws upon SA work carried out since 2007 as the draft Strategy evolved and in particular the appraisal of a draft of the Strategy provided by the GLA on 25 September 2009.

Overview of the contents of Section 4 of the SA Report

4.3 Section 4 describes the likely evolution of the sustainability baseline drawing on the context information included in Part A of the SA Report and summarises the appraisal of the potential sustainability effects of the predicted climatic changes in London in the absence of the draft Strategy. It includes the following:

- An overview of the sustainability and climatic change context, including:
  - the current sustainability baseline
  - the likely evolution of the sustainability baseline without the draft Strategy
  - the likely climatic changes in London in the medium and long-term
  - the existing and planned climate change adaptation.
- A summary of the appraisal of the potential sustainability effects of climate change on flooding, drought and overheating in London without the draft Strategy, including:
  - identifying the potential sustainability effects using causal chain analysis

- evaluating the potential sustainability effects using qualitative criteria, professional judgement and consultation with stakeholders and presenting it in an appraisal matrix.

Establishing the sustainability baseline and climatic change context

Current sustainability baseline

4.4 As set out in Section 1 (Part A) of the SA Report, the SA of the draft Strategy incorporates a health impact assessment and the requirements of the SEA Regulations[1]. The Regulations require that an SEA produces an Environment Report including an assessment of the relevant aspects of the current state of the environment, and the likely evolution thereof without the implementation of the plan. In this case, these SEA requirements were incorporated into the SA and the current and future baseline considered a broader set of sustainability issues, not just those relating to the environment.

4.5 Section 3 (Part A) of the SA Report sets out the current sustainability baseline. This information was structured into six broad topics created by grouping the 14 SA objectives (see Section 2, Box 16 below and Appendix 4). These topics were specifically chosen for the purposes of the SA of the draft Strategy, as they provided an appropriate structure for presenting the relevant contextual information. The information included in this section was selected to inform the appraisal of the potential sustainability effects of the draft Strategy and therefore some topics were considered in a greater level of detail than others.

Box 16: Coverage of sustainability appraisal objectives under topics within the context section

1. People and Health
- Governance
- Education and Awareness
- Health and Well Being
- Equality and Diversity
- Safety and Security

2. Place and quality of surroundings
- Liveability and Place
- Accessibility and Availability
- Landscape, Historic and Cultural Environment
- Biodiversity
- Air Quality

3. Climate Change
- Climate Change

4. Water management
- Water Quality and Water Resources

5. Waste and Resources
- Waste Management and Resource Use

6. Economy
- Economy

7. Cross-cutting issues

4.6 The sustainability baseline in Section 3 (Part A) includes summaries of existing and emerging policies, plans, programmes and strategies relevant to each topic area (which are also described in more detail in Appendix 6). These, together with the underlying pressures and drivers for change (such as a growing number of smaller households), will influence the evolution of the sustainability baseline in the future. With or without a climate change

[1] Environmental Assessment of Plans and Programmes Regulations 2004 No. 1633 which implements the requirements of the European Directive 2001/42/EC, known as the SEA Directive.

adaptation strategy, there are likely to be significant changes to the existing baseline over the strategy's intended timeframe[2].

4.7 Given the inevitable complexity and uncertainty when predicting future change, it was not possible to predict exactly what would happen to the baseline over time. However, Section 3 (Part A) seeks to draw out the likely key changes in the baseline under each topic over the draft Strategy's intended timeframe. Consideration of this future baseline is an important aspect of the SA, as it is only by developing an understanding of how implementing the draft Strategy might change the likely evolution of the baseline that a meaningful assessment can be made of its sustainability implications (i.e. what difference the draft Strategy might make over and above what would happen anyway).

4.8 This section builds upon the sustainability context set out in Section 3 (Part A) and represents an assessment of the likely evolution of the baseline in relation to each topic, based on reviewing the current baseline information, existing and predicted future trends, and the likely influence of other external policies, plans, programmes and strategies.

4.9 This section also sets out a summary of likely climatic changes in London in the medium-term (to the 2020s) and long-term (2050 and beyond). These projected climatic changes are also important in developing an understanding of how the implementation of the draft Strategy might influence the ability of London and Londoners to adapt to these changes, and therefore how the draft Strategy could help minimise negative, or maximise positive, sustainability effects of the climatic changes predicted over the medium and long-term.

Likely evolution of the sustainability baseline without the draft Strategy

4.10 Table 8 describes key predicted future trends and how these may influence the evolution of the sustainability baseline over the draft Strategy's intended timeframe (based on the sustainability context described in Section 3 (Part A)). These predicted future trends, and possible effects on the evolution of the baseline are divided into the topics set out in Box 16. There are some key drivers or pressures which are likely to have an influence across all of the topics, such as the projected growth in London's population, proposed housing development targets, and the predicted impacts of a changing climate. These high level drivers are discussed under the cross-cutting topic below and are also incorporated where appropriate within the topic specific trends.

Table 8: Summary of key trends and likely evolution of the sustainability baseline under each topic

Predicted future trends For further details see Section 3 (Part A)	**Likely evolution of the sustainability baseline**
People and health	
Positive change in some of the determinants of health.	Overall health is likely to improve, however it is likely that existing health inequalities, and inequalities relating to (for example) employment and access to education, will continue, and could increase.
Reduced winter deaths due to cold, however hotter summers may have negative health effects.	Warmer winters due to climate change may reduce the number of people (particularly elderly people) dying due to extreme cold. However overall future trends in health due to climate change are complex, and hotter summers, reduced cloud cover and heatwaves may have negative health effects.
Increased ill-health due to poor air quality.	Air pollution is likely to increase over the long-term, exacerbated by changing weather patterns due to climate change and the projected increase in London's overall population and density.
Increased frequency and	As flood events have a disproportionate effect on vulnerable groups, this may

[2] The introduction to the draft CCAS notes that it considers the climate over the century (i.e. to 2100), but particularly focuses on the period up to 2031.

Predicted future trends For further details see Section 3 (Part A)	**Likely evolution of the sustainability baseline**
severity of floods due to climate change, and increased development in areas at risk of flooding.	result in increased negative effects on these groups, increasing health inequalities in some areas and to some groups.
Place and quality of surroundings	
Overall projected population increase and a trend towards higher population densities in many areas.	A number of effects likely to arise from increased population and population density, including: - A rise in noise pollution and disturbance. - Air pollution due to increased need to travel and car journeys.
Increased levels of built development to meet housing and employment growth targets.	Increased levels of development will put pressure on existing land-uses, including: greenspaces and parks; habitats and areas of biodiversity value; and, sport / play spaces.
Heatwaves, the urban heat island effect and other impacts of climate change (such as flooding and heavy rainfall).	Higher average temperatures and heatwaves could adversely affect the liveability of London, for example making some open and public spaces less useable (e.g. due to a lack of shading), and may make the use of public transport less attractive (e.g. due to overheating, or inappropriate waiting areas exposed to sun and/or rain). Flooding and increased frequency and intensity of storms may also lead to disruption of life in London, for example through damage to essential infrastructure.
Climate Change	
Warmer drier summers.	Reduced reliability of water resources (river flows, groundwater recharge etc), potentially restricting options for supply, requiring more frequent drought actions and influencing the environmental and amenity value of watercourses. This overlaps with the Water Resources topic. More intense urban heat island effect, especially during hot summer periods. This overlaps with the People and Health topic.
Warmer wetter winters.	Increased risk of all types of flooding, reduced number of winter deaths attributable to cold. This overlaps with the People and Health topic.
Higher frequency and severity of storms and rainfall.	Increased risk of flooding, especially surface water, groundwater and river flooding. Increased risk of combined sewer overflows (CSOs). Disruption and damage to property and infrastructure. This overlaps with People and Health, Place, Water Resources and Economy topics.
Rising sea levels and more frequent and significant tidal surges.	Risk of tidal flooding effecting large areas of London. Potentially significant damage and disruption to infrastructure and property. This overlaps with People and Health, Place, Water Resources and Economy topics.
Implementation of the Climate Change Act and London Climate Change Strategy, as well as other initiatives and programmes.	Promotion of energy efficiency in new development, new technologies and raised awareness of climate change as an issue may lead to a decline in per-capita energy use and CO_2 emissions. However, overall energy consumption and emissions could rise due to projected increase in population and economic development. This overlaps with People and Health, Place and Economy topics.
Water Management	
Implementation of water regulations, especially the Water Framework Directive.	The chemical and biological quality of London's waterways is improving. Implementation likely to lead to improvements in the ecological quality of London' waterways, but potential improvements could be undermined by the effects of a changing climate (e.g. reducing Biological Oxygen Demand concentrations).
Introduction of measures to encourage water use efficiency (e.g. Code for Sustainable Homes).	May help reduce London's water deficit by reducing per-capita usage. However, if projected population and development growth outweighs improvements in per-capita use of water, overall water demand will rise, exacerbating existing deficits. Climate change is predicted to exacerbate London's water deficit.
Development of new water resources.	May help reduce London's water deficit by increasing supply, although significant new resource development may take up to two decades to plan and construct.
Replacement and repairs to water supply infrastructure.	Reduced leakage and thus water lost during supply, which is likely to help reduce London's water deficit.
Effects of a changing climate	Many effects, including:

Predicted future trends For further details see Section 3 (Part A)	**Likely evolution of the sustainability baseline**
(see Climate Change topic).	- Reduced river flows in hot / dry periods. - Increased incidence of all types of flooding, including combined sewer overflows. - Exacerbation of London's existing water deficit. See Climate Change topic for more detail.
Waste and resources	
Statutory waste management and recycling targets, and campaigns to encourage behaviour change.	Potential decrease in waste arisings and increase in recycling and composting levels. However, projected increase in population and construction will result in increased resource use and waste generation including: domestic and municipal waste; sewage sludge; and, construction and demolition waste. Dealing with this waste may pose a threat to water quality, such as through increased leachate.
Economy	
The effects of current economic downturn to continue for a number of years.	The effects of the ongoing economic downturn are likely to exacerbate economic inequalities, and restrict investment in new development and projects (including those related to adaptation).
In the long-term, London to continue to have a strong and dynamic economy.	Existing economic inequalities likely to continue and to increase over time.
Increased levels of housing and other built development.	Pressure on land for housing and other development has the potential to lead to developments encroaching further into areas at risk of flooding, as well as the loss of land permeability, increasing the risk of surface water flooding.
Climate change impacts, especially increased incidence and severity of floods.	Flooding can have significant negative economic and social effects, disrupting transport networks and other infrastructure, inundating homes and businesses, and impacting on physical and mental wellbeing of those affected, which in turn imposes an economic cost on society. Increased risk and incidence of flooding will increase the potential scale and risk of these costs.
Cross-cutting	
Population increases.	Relates to all topics. Significant effects on all aspects of water use, management and disposal in the capital, potentially increasing demand for water (even where per-capita use falls), increasing effluent requiring treatment and disposal, and putting ever greater pressure on existing sewage infrastructure. Increasing population is also likely to increase pressure on infrastructure and services, as well as increase exposure and vulnerability to risks such as flooding and overheating.
Increased housing and other built development.	Relates to all topics. Pressure to build new homes and commercial developments may lead to more homes and businesses being located in areas at risk of flooding, exacerbate flooding elsewhere and increase the number for properties, infrastructure and people vulnerable to flooding. Increased density and pressure on green infrastructure could exacerbate the urban heat island and overheating.
Climate change effects.	Relates to all topics, especially Climate Change. Has the potential to affect all aspects of life in London, and may impact particularly on water related uses such as flooding and the reliability of supply. London's transport infrastructure is also likely to be affected. Overheating, and the impact of higher temperatures on air quality may also affect health and quality of life.

Likely climatic changes in London in the medium and long-term

4.11 Table 9 below summarises London's current climate and the likely key effects of climate change in London in the medium-term (2020s) and in the long-term (2050s and beyond). These key climate effects are summarised under the broad headings of flooding, drought and overheating, corresponding with the three main policy areas included in the draft Strategy. Other key climatic impacts are also included: windstorms; subsidence and heave; and, air quality.

4.12 The climate projections included in Table 9 are drawn from the UK Climate Projections 2009 (UKCP09) "key findings"[3]. UKCP09 provides modelled projections of climate change in the UK in seven overlapping time-slices[4] up until the 2080s. The UKCP09 key findings represent headline climate change projections for three emissions scenarios (low, medium and high) for the periods 2020s, 2050s and 2080s. In Table 9 the quantified projections for the medium-term (middle column) corresponds with UKCP09 key findings for 2020's time slice under the medium emissions scenario. The long-term (third column) corresponds with UKCP09 key findings for 2050's time slice under the medium emissions scenario. However, the long-term column also includes consideration of effects over the period to the end of the century. Other sources of information (e.g. on water use in London) are included as footnotes to Table 9.

4.13 These timeframes were considered appropriate in providing the context for the appraisal of the draft Strategy as although many of the actions it includes are intended to be implemented in the short-term (by 2011 – 2012), most of these actions are preparatory, and will have longer term implications. In addition, the introduction to the draft CCAS states that it *"considers the climate over the century, but particularly focuses on the period up to 2031"*. The medium term, as presented in Table 9, is considered an appropriate basis for appraisal, as it considers the UKCP09 "2020s" projections, which corresponds with climate projections for the 30 year period 2009 – 2039.

4.14 Further description of the timeframes used in the appraisal is included in the introduction to Section 5 below.

Important considerations in the use of climate projections

Uncertainty and levels of knowledge

4.15 Although some climate change is now considered inevitable, due to the nature of predicting future events, the exact changes that are likely to occur globally and in London cannot be known with certainty. In particular there is a high level of uncertainty in predicting changes (and therefore the likely implications of these changes) over the long-term. In addition the models used to develop climate projections (such as UKCP09) while being based on sound science, at the same time make use of assumptions about certain future conditions. The methodology pages of the UKCP09 website[5] state that:

"The methods used to create UKCP09 have been reviewed by scientific experts and judged to be credible. However, our understanding of processes in the climate system is far from perfect: projections will continue to be improved as our understanding, modelling techniques and availability of computing power change in the future".

4.16 The UKCP projections are to be reviewed and updated on a regular basis (for example, UKCP09 projections replace previous projections: UKCIP02). Future revisions will reflect current state of knowledge, and it will be important that future versions of the Strategy reflect these changes in knowledge and understanding, and that the proposed policies and actions are modified as appropriate.

[3] UK Climate Projections 2009 (UKCP09) Key Findings: http://ukclimateprojections.defra.gov.uk/content/view/515/499/
[4] Although presented as being the average projections for a particular decade (e.g. 2020's) the time slices used in UKCP09 projections in fact correspond to 30 year time periods, each one overlapping with the next. The 2020's time slice in fact is based on projections over the 30 year period 2009 – 2039, and the 2050's equates to 2039 – 2069. Further detail on the methodology used in the UKCP09 projections can be found in the UKCP09 technical reports, available at: http://ukclimateprojections.defra.gov.uk/content/view/516/500/
[5] http://ukcp09.defra.gov.uk/content/view/13/5/

Climatic change and emissions scenarios

4.17 The UKCP09 projections predict climatic changes over each time period based on three principle emissions scenarios: low, medium and high. These are intended to enable organisations to plan for a range of eventualities.

4.18 Figure 9, which shows the projected increase in global mean temperature over the rest of the century based on the three emissions scenarios, indicates that in the medium-term (2020s) there is limited divergence in the projected changes based on low, medium or high emissions scenarios in UKCP09, however as the century progresses the projections become increasingly divergent, with the high-emissions scenario in particular indicating a much greater increase in temperatures towards the end of the century. These projected changes in temperature are reflected in increased severity of other climatic changes (e.g. flooding and drought).

4.19 The levels of future greenhouse gas emissions will depend on a large number of factors: possible global action to reduce emissions; the rate of technological change; and, the level of economic development in less developed nations. Recognising the complexity involved in understanding and predicting such future changes, the Intergovernmental Panel on Climate Change (IPCC) states that probabilities cannot be assigned to different emissions scenarios, and the UKCP09 FAQs suggest that organisations should use all three scenarios to support decision making, unless there are specific reasons not to do so[6].

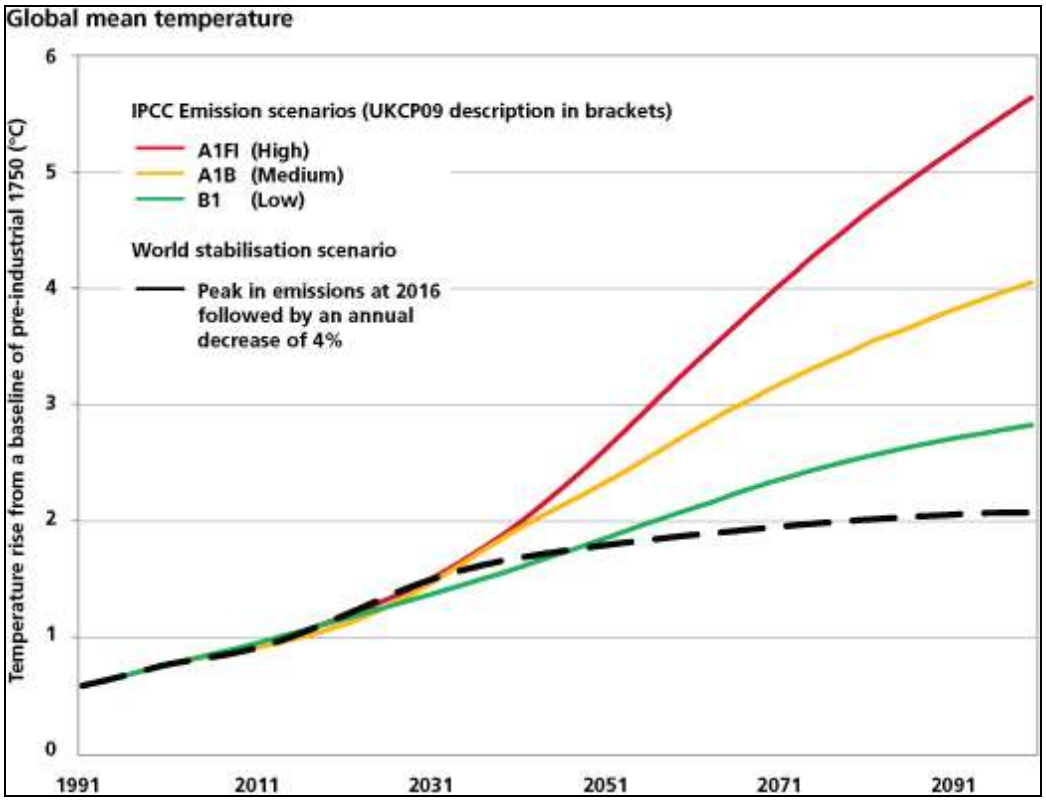
4.20 As noted above, the future climate for London presented in the draft Strategy, and the likely climatic changes presented in this section draw on the UKCP09 medium emissions scenario. Noting that the medium emissions scenario is neither more, nor less likely than the low, or high scenarios, this scenario was used by the SA as it was considered to provide a mid-level estimate of likely climatic changes. The use of one scenario to underpin the SA was considered appropriate given the strategic and qualitative approach adopted, and using the medium emissions scenario as opposed to the low emissions scenario was intended to reflect a precautionary approach.

4.21 In addition, as noted, the introduction to the draft Strategy states that it focuses particularly on the period to 2031. As indicated in Figure 9 the three emissions scenarios predict very similar changes in mean temperature (and associate climatic changes) over the period to 2031. The use of the medium emissions scenario to support the appraisal and as a basis for policy and action in the draft Strategy is therefore considered appropriate, and represents a proportionate approach.

4.22 However, given the potentially significant long-term implications of emission levels in line with the high emissions scenario, the SA explicitly considered what this could mean in terms of the effects of climate change in London, and for an appropriate long-term policy response.

[6] UKCP09 Frequently Asked Questions webpage: http://ukcp09.defra.gov.uk/content/view/9/9/

Figure 9: Influence of emission scenarios on projected global mean temperature



Source: UKCP09 emissions scenarios web-page: http://ukcp09.defra.gov.uk/content/view/23/5/

Table 9: Likely climatic changes in London

Current climate	Likely climatic changes – 2020s[7]	Likely climatic changes – 2050s+
Flooding		
Context		
• London is prone to flooding from five sources – tidal, fluvial (from rivers and tributaries), surface (from rainfall), sewer and groundwater. Flooding frequently happens from more than one source. • An estimated 1.25 million people and 481,180 properties are at risk of flooding in London[8]. 82% of these properties are 'low' flood risk, but 100,000 are 'moderate' or 'significant' risk.	• Projected population growth and increased development (housing and commercial) is likely to lead to more people, property and infrastructure being exposed to flood risks.	
Tidal flooding		
• More than £160 billion worth of property and 1.25 million people already live and work within the indicative tidal floodplain in the Thames Estuary. • A significant part of London lies within the Thames tidal floodplain and without the protection afforded by the current defences, many of these areas would flood twice a day, every day on each high tide (the degree of flooding depending on the tide height and freshwater flows). • The Thames Barrier has been closed over 100 times to protect London from flooding since 1982. • The defences would be overtopped by a tidal surge of a magnitude that might only happen in excess of once every 2,000 years (also defined as 0.05% per annum probability). • The barrier can also be closed to avoid fluvial flooding. Without the Thames Barrier, the flood defences upstream of the Barrier would need to be nearly three metres higher. • Sea levels are currently rising by 4mm a year.	• Rising sea levels and increasing tidal surges will mean that without further enhancement in the standard of defence, the current standard of defence will decrease, dropping to 1 in 1000 (0.1%) by the year 2030. However, it is considered unlikely that the Thames Barrier will need replacing before 2070[9]. • Sea levels are expected to rise by an average of 13.5mm (compared to 1990 levels) by 2030. • Climate change is also predicted to increase the frequency and intensity of weather conditions that cause tidal surges.	• Rising sea levels and increasing tidal surges will mean that without further enhancement in the standard of defence, the current standard of defence will decrease, dropping to 1 in 100 (1%) by the end of the century. However, it is considered unlikely that the Thames Barrier will need replacing before 2070[10]. • Sea levels are expected to rise by an average of 21.8mm (compared to 1990 levels) by 2050. • Climate change is also predicted to increase the frequency and intensity of weather conditions that cause tidal surges. Unless significant reductions in greenhouse gas emissions are achieved, these effects are projected to become increasingly significant towards the end of the century.

[7] Quantified projections in the second and third columns correspond with UKCP09 medium emissions scenarios for the 2020s and 2050s
[8] GLA (2009) The Mayor's Climate Change Adaptation Strategy
[9] Environment Agency (2009) Thames Estuary 2100 – consultation draft
[10] Environment Agency (2009) Thames Estuary 2100 – consultation draft

Current climate	Likely climatic changes – 2020s	Likely climatic changes – 2050s+
Fluvial flooding		
• There are about 100,000 properties in London that are currently considered as being at 'moderate' or 'significant'[11] risk of flooding from the fluvial rivers that drain into the tidal part of the River Thames. • In London, most of the tributaries to the Thames can be described as 'flashy'. This is because the catchments tend to be small, quite steep and heavily urbanised. Rain therefore runs-off very quickly from the impermeable surfaces into these rivers. Within London the catchments react so rapidly that there can be less than two hours advance notice before flooding occurs.	• Fluvial flood risk will increase in-line with the increase in rainfall. • The size of the area where there is little time to provide adequate warning and an effective response will increase with climate change.	• Fluvial flood risk will increase in-line with the increase in rainfall. By 2050, the high flood risk area (Flood Zone 3) will extend to cover areas currently at medium flood risk (Flood Zone 2) today. This will mean that 20-30,000 more properties could be at risk from a flood with a 1% chance of occurring in any one year • The size of the area where there is little time to provide adequate warning and an effective response will increase with climate change.
Other sources of flooding		
• There are currently 4,000 properties at risk of sewer flooding in London (a change in the way properties are classified as at risk reduced the figure from 9,000 properties). • Almost 700,000 properties are at risk of surface water flooding. • Heavy rainfall in London can lead to localised flooding such as that experienced in July 2007[12].	The UK Water Industry Research[13] concluded that even a small increase in rainfall could require the significant modification of drainage systems to maintain *current* service levels • In the medium term (2020s) winter precipitation is predicted to increase by an average of 6%. • There will also be an increase in the frequency and intensity of extreme weather including heavy rainfall.	The UK Water Industry Research[14] concluded that even a small increase in rainfall could require the significant modification of drainage systems to maintain *current* service levels • In the long term (2050s) winter precipitation is predicted to increase by an average of 14%. There will also be an increase in the frequency and intensity of extreme weather including heavy rainfall. Unless significant reductions in greenhouse gas emissions are achieved, these effects are projected to become increasingly significant towards the end of the century.

[11] 'Moderate' risk is defined as greater than a 1 in 200 years /0.5 percent chance of flooding in any one year, but less than 1 in 75 years. 'Significant' risk is defined as greater than 1 in 75 years / 1.3 percent).
[12] July floods – at a glance. BBC News website: http://news.bbc.co.uk/1/hi/uk/6911778.stm#london
[13] UKWIR (2004), Report 03/CL/10/2
[14] UKWIR (2004), Report 03/CL/10/2

Current climate	Likely climatic changes – 2020s	Likely climatic changes – 2050s+
Drought		
Water resources		

• In a dry year, London has a deficit of 200 million litres a day, equivalent to the daily demand of 1.2 million Londoners. London is among the driest capital cities in the world, with available water resources per head similar to that of Israel.
• In 2004, there were 600,000 more people living in London than in 1991. The Integrated Impact Assessment for the Mayor's draft Housing Strategy calculated that the new housing built in London over ten years would, alone, lead to the use of 66 million extra litres of water per day (not including leakage).
• There are five Water Resources Management Units (WRMUs) in the London CAMS that include both surface and groundwater. Of these, one WRMU is over-abstracted, one is over-licensed, two have a 'no water available' status and only one has a 'water available' status[15].
• There are three WRMUs in the Thames Corridor CAMS. Two of those are over-abstracted and the third has a 'no water available' status[16].
• Current abstraction levels in the Thames region are 10% higher than ideal from an environmental perspective[17].
	• The population of London is predicted to rise by a further 810,000 by 2026. Based on current water use, water companies will have to provide approximately an extra 130 million litres of water a day to meet the needs of population growth.
	• Climate change is expected to affect water availability by:
	  ○ Reducing summer river flows;
	  ○ Reducing groundwater recharge;
	  ○ Increasing evaporation;
	  ○ Increasing loss from broken water mains due to increasing subsidence; and,
	  ○ Increasing demand.
	• In relation to rainfall in the medium term (2020s):
	  ○ Summer precipitation is predicted to decrease by an average of 7%.
	  ○ Winter precipitation is predicted to increase by an average of 6%.
		• Current population projections for London only look forward to 2026. In the longer term it is hard to predict how population may change, however it is likely that the population will remain higher than it is now, and may continue to grow. This would continue to increase pressure on water resources.
		• Climate change is likely to make droughts like that of 2005/6, and floods like summer 2007, increasingly common.
		• Climate change is expected to affect water availability by:
		  ○ Reducing summer river flows;
		  ○ Reducing groundwater recharge;
		  ○ Increasing evaporation;
		  ○ Increasing loss from broken water mains due to increasing subsidence; and,
		  ○ Increasing demand.
		Unless significant reductions in greenhouse gas emissions are achieved, these effects are projected to become increasingly significant towards the end of the century.
		• In relation to rainfall, in the long term (2050s):
		  ○ Average summer precipitation is predicted to decrease by an average of 19%.
		  ○ Average winter precipitation is predicted to increase by an average of 14%.

[15] Environment Agency (2006) 'The London CAMS, Final Strategy Document'
[16] Environment Agency 'Thames Corridor CAMS, Annual Update 2005', www.environment-agecy.gov.uk
[17] Environment Agency officer cited in London Assembly Environment Committee 'Down the Drain, London's Water Usage and Supply', 2005

Current climate	Likely climatic changes – 2020s[7]	Likely climatic changes – 2050s+
Overheating		
Average temperatures		
• The Central England Temperature series (CET) began in 1659, and is the longest available instrumental record of temperature in the world. The CET, which is indicative of the signal of temperature change in the Thames region, shows a 0.6ºC rise over the twentieth century. • 16 of the 20 warmest 12-month periods since 1659 have occurred since 1990. • Summers in London are getting progressively warmer (at an average 0.77ºC per decade over the last thirty years), and the temperatures of the hottest days are rising more quickly (at 1.66ºC per decade) than the average rate of warming. The hottest nights are also getting hotter at a rate above the average rate of warming (at 0.87ºC per decade). • This rate of warming has increased over the last thirty years in comparison to the last fifty years. The number of consecutive hot nights above 18ºC is increasing and the frequency of heatwaves is increasing because of the warming.	• In the medium term (2020s): ○ Summer temperatures are predicted to increase by an average of 1.6ºC. ○ Winter temperatures are predicted to increase by an average of 1.3ºC. ○ Summer cloud cover is predicted to decrease by an average of 6%. • There is also predicted to be an increase in the frequency and intensity of extreme weather including high temperatures.	• In the long term (2050s): ○ Summer temperatures are predicted to increase by an average of 2.7ºC. ○ Winter temperatures are predicted to increase by an average of 2.2ºC. ○ Summer cloud cover is predicted to decrease by average of 10%. • Climate change is predicted to cause average summer temperatures to rise to a point where by the middle of the century, what is considered an extreme event today could be an average summer by the middle of the century, and a new set of extremes may be experienced. • There is also projected to be an increase in the frequency and intensity of extreme weather including high temperatures. Unless significant reductions in greenhouse gas emissions are achieved, these effects are projected to become increasingly significant towards the end of the century.
Urban heat island effect		
• On summer nights, the air temperatures in the centre of London can be up to 10ºC higher than the outlying rural areas. The difference in temperatures due to the UHI generally reaches a maximum between 2am and 4am. • The urban heat island effect is highly sensitive to weather conditions. The effect is strongest during anticyclonic weather (still, clear days) and is almost non-existent on cloudy and windy days. • London also experiences UHI during the winter, where temperatures in the city centre can be up to 4ºC warmer than the greenbelt. This winter UHI could be considered beneficial because it reduces winter heating requirements.	• Unless adequate adaptation and mitigation measures are put in place, London is projected to continue to experience progressively warmer summers and an increased frequency and intensity of very hot weather periods. • Climate change is also predicted to increase the frequency and duration of anti-cyclonic weather periods, so the frequency and duration of an urban heat island forming is expected to increase.	• As noted, London is projected to continue to experience progressively warmer summers and an increased frequency and intensity of very hot weather periods. • Climate change is also predicted to increase the frequency and duration of weather conditions which lead to an urban heat island effect. • Unless significant reductions in greenhouse gas emissions are achieved, these effects are projected to become increasingly significant towards the end of the century.

Current climate	Likely climatic changes – 2020s[7]	Likely climatic changes – 2050s+
Other climatic factors		
Windstorms		
• Since 1950, almost three-quarters of the UK's insured losses due to natural catastrophes have been caused by windstorms. The insurance industry's highest ever recorded claims years were in two years with extreme storm events - 1987 and 1990 (£1.4 and £2.1bn respectively). On average, some 200,000 buildings are damaged by high winds in the UK every year.	• The frequency and intensity of extreme weather events including windstorms are projected to increase due to the effects of climate change.	• The frequency and intensity of extreme weather events including windstorms are projected to increase due to the effects of climate change. Unless significant reductions in greenhouse gas emissions are achieved, these effects are projected to become increasingly significant towards the end of the century.
Subsidence / heave		
• Much of London sits on a bed of clay soil that swells (heave) and shrinks (subsidence) according to the water content of the soil. As this movement is rarely uniform, the differential movement can affect buildings and infrastructure. • As London has experienced several intense droughts this century, some development has suffered subsidence and heave. • Significant numbers of properties in London are affected by subsidence and heave, although many Victorian and pre-Victorian homes have shallow foundations, but because of their lime mortar construction are able to withstand a degree of soil movement. New development tends to be of lighter weight construction and sits on more solid foundations and is therefore more resistant to subsidence. High density, multi-storey development also tends to sit on pile driven foundations and is generally unaffected. • Subsidence is also a key factor in causing water mains breakages in London, as the pipes are both old and brittle (a third of mains water pipes are 150 years old and a half are a 100 years old). • The Royal Institute of Chartered Surveyors states that the sealing of an area, such as through paving, can prevent rain from percolating through the subsoil and can cause or intensify subsidence. Fractured drains, which can either allow water to saturate the ground causing it to heave, or can wash out the fine	• The increasing seasonality of rainfall, in combination with enhanced summer evaporation is projected to decrease the average soil moisture content, increasing the risk of subsidence and heave. • Hotter and drier summer conditions predicted due to climate change may also increase the demand for water from vegetation, principally trees, which may in some cases aggravate the risk of subsidence and heave.	• Unless significant reductions in greenhouse gas emissions are achieved, the effects predicted to the 2020s are projected to become increasingly significant towards the end of the century.

Current climate	Likely climatic changes – 2020s	Likely climatic changes – 2050s+
particles in the soil making the problem worse[18].		
Air quality		
• London has the worst air quality in the UK, which regularly exceeds national and EU air quality objectives for monitored air quality pollutants particulate matter (PM10) and nitrogen dioxide (NO_2). • In 2005 it was estimated that about one thousand premature deaths, and a similar number of hospital admissions occurred due to poor air quality in London[19]. Thousands more suffer less severe ill health, caused or exacerbated by air pollution. • Poor air quality is thought to have contributed to the high death toll during the 2003 heatwave.	• Climate change is projected to affect both the sources of air pollution and atmospheric chemistry, leading to a potential increase in summer air pollution episodes. • Climate change is likely to increase the frequency and duration of anticyclonic weather periods. Anticyclonic conditions are responsible for poor air quality episodes as the stagnant air conditions do not disperse the air pollution created in London. • It is understood that climate change can affect local and regional air quality directly through: o changes in the chemical reaction rates that cause air pollutants to form, or degrade; o changes in the boundary layer heights that affect vertical mixing of pollutants; and, o changes in the airflow patterns that govern international and intra-national pollutant transport. • A change in the seasonality in air quality problems is anticipated in the future: o A simulated decrease in the frequency of occurrences of poor air quality episodes associated with winter stagnation in the UK; o An increase in summertime photochemical smog linked to increasing temperatures and small reductions in cloud cover (and associated increase in solar radiation); o Increases in summertime ozone precursor biogenic VOC emissions linked to summertime temperature changes. • Climate change is also predicted to affect indoor air quality: o Higher summer temperatures will increase the need for ventilation to maintain comfortable	• Unless significant reductions in greenhouse gas emissions are achieved, the effects predicted to the 2020s are projected to become increasingly significant towards the end of the century.

[18] RICS (2006), Don't crack up in the heat (online article, www.rics.org.uk)
[19] *The London State of the Environment Report 2007*, Chapter 4: Pollution, GLA 2007 http://www.london.gov.uk/mayor/environment/soereport.jsp

Current climate	Likely climatic changes – 2020s[7]	Likely climatic changes – 2050s+
	internal temperatures. In noisy, or highly polluted areas or where fear of crime is high, residents may not wish to open windows, which may cause a build of indoor air pollutants, or an increased demand for retrofitted air conditioning devices; and, ○ Climate change induced poor air quality episodes will increase in summer and decrease in winter. There may be times when opening a window to provide cooling ventilation may lead to a decrease in indoor air quality.	

Existing and planned climate change adaptation

4.23 The draft Strategy once adopted will not be implemented in isolation. There are a number of existing initiatives and existing or planned policies, plans, programmes and strategies which are seeking to address aspects of climate change adaptation, either directly or indirectly. In order to inform the assessment of the likely effects of the draft Strategy on adaptation to climate change in London, it is important to understand current and planned adaptation in London. Table 10, Table 11 and Table 12 below summarise how key existing policies, plans, programmes and strategies as well as any other initiatives may facilitate adaptation to climate change in London relating to flooding, drought and overheating respectively.

4.24 The existing and planned adaptation described in Tables 10 – 12 is structured under four headings: Prevent; Prepare; Respond; and, Recover. This categorisation of actions or responses was developed by emergency planners and is used in the draft Strategy. It is described further in Box 17.

4.25 The policies, plans, programmes and strategies and other initiatives included in the analysis in Table 10, Table 11 and Table 12 are intended to highlight the likely key existing and planned adaptation. They are not intended to be exhaustive, but include significant national plans and regulations, and key plans and strategies prepared by the Environment Agency, utility companies or the Mayor of London. These tables draw on the full list of other policies, plans, programmes and strategies reviewed in Appendix 6 and listed in Section 3 (Part A).

Box 17: The Prevent, Prepare, Respond, Recover framework

The Prevent, Prepare, Respond, Recover (PPRR) framework used to structure Tables 10 – 12 is a useful way of describing the current and planned adaption. Classifying adaptation measures under the PPRR headings provides insight into the current risks faced by London, which risks are being addressed, and where the strategy should focus to be as effective as possible. The PPRR framework can be described as:

Prevent: actions taken to reduce the probability of an impact. For example, raising flood defences to prevent flooding, or removing flood sensitive development from the flood plain. The key preventative action is reducing greenhouse gas emissions to limit further climate change.

Prepare: actions taken to better understand the risk / opportunity ahead of the change occurring and to proactively enable an effective response and recovery. For example, undertaking a flood risk assessment, developing a contingency plan, insuring sensitive assets, and raising public awareness.

Respond: actions taken in response to an event to limit the impact of that event, for example, restricting non-essential water use during a drought, or providing emergency accommodation for people displaced by an extreme weather event.

Recover: actions taken after an event to enable a rapid and cost-effective return to normal, or a more sustainable state. For example, enhancing the flood resilience of a property when undertaking flood damage repairs, or providing counselling for flood affected residents.

Table 10: Current and planned adaptation – flooding

Current and planned adaptation to flooding[20]
Prevent
• London's existing tidal flood defences are predicted to provide a sufficient level of protection from floods, without requiring major changes for at least the next 20 years, and the draft Thames Estuary 2100 plan (TE2100) considers it unlikely that a new Thames Barrier would be required before 2070.
• To reduce the impacts of increased flooding and extreme weather events, specific actions are recommended in several key strategies/reports, e.g. TE2100, Making Space for Water, the Pitt Review (and the Government's response), the draft Flood and Water Management Bill, Thames Catchment Flood Management Plan (CFMP),

[20] Note: this summary presents an overview of existing and known planned adaptation policy and activity in relation to flooding in London. This overview is not intended to be exhaustive, and does not seek to predict future adaptation actions not currently known. It is highly probable that new policies / activities will be developed and adopted during the medium-term (to 2020s) period, however it is not possible to predict these, or the effects they may have on the level of adaptation.

Current and planned adaptation to flooding[20]
the London Plan.
Prepare
• The communication and management of flood risk, and the adequate funding of flood resilience measures, are important factors in preparing for flood events. Following the recommendations of the Pitt Review, the Environment Agency has a strategic responsibility for all forms of flood risk, and local authorities have an obligation to lead and co-ordinate local flood management activity. Local authorities who have adopted indicator NI188 (climate change adaptation) are required to carry out detailed climate risk assessments and develop adaptation plans accordingly, which should facilitate preparation for flood events.
• Local authorities have a responsibility to assess surface water flood risk and produce Surface Water Management Plans (SWMPs). The draft CCAS indicates that Richmond and Kingston are one of the first six areas in the country to have produced a SWMP. The draft CCAS also notes that through the Drain London Forum, the GLA is working with the Boroughs to support them in producing their SWMPs and encouraging Boroughs facing a shared risk to work together.
• An interceptor sewer, which will comprise the Thames and Lee tunnels (known as the London Tideway Tunnels), has been proposed. It is intended that construction will commence on the Lee tunnel in 2009 with completion in 2014, and that the Thames tunnel should be completed by 2020. This interceptor sewer will help prevent combined sewer overflows from contaminating the rivers Thames and Lee, improving water quality. Heavy rainfall in London leads to combined sewer overflows, resulting in the pollution of the rivers Thames and Lee with sewerage. The interceptor sewer is intended to prevent the projected increase in heavy rainfall leading to an increase in the frequency of contamination of the rivers Thames and Lee.
• Several key initiatives recommend actions to foster a coordinated approach to flood risk management and ensure that organisations, such as government agencies and local authorities, have the capacity to work together to manage increasing flood risk, e.g. the London Regional Flood Risk Appraisal (RFRA), draft TE2100 plan, Thames District draft River Basin Management Plan (RBMP) and the Pitt Review (and the Government's response).
• The nature of flood preparation demands that different organisations work together. Several existing policies and initiatives promote joint working in relation to managing long-term flooding (including surface water, fluvial and tidal flooding) and seek to reduce the threat to people and property from flooding, e.g. TE2100, Thames RBMP, Making Space for Water, PPS 25. These also address issues such as integrated urban drainage management and living with flood risk. The need to identify the organisations responsible for managing different types of flood risks is explicitly recognised by the draft Flood and Water Management Bill, which seeks to clarify responsibilities related to preparation for flood events.
• The quality of the water in London's rivers has significantly improved in recent years, and there are several co-ordinated actions, such as the Thames District draft RBMP, which implements the Water Framework Directive in the Thames District, underway to further improve water quality. Improving water quality is relevant to flooding in London as more frequent flooding is predicted to increase incidences of combined sewer overflows, and increase diffuse pollution due to increased surface water run-off and fluvial flooding.
• There is the potential for the negative consequences of flooding to have adverse impacts on vulnerable groups in London, and these negative impacts on equality target groups should be minimised. Planning for Equality and Diversity in London (London Plan SPG), and other guidance and standards relating to development and climate change, may help to minimise negative impacts on equality target groups.
• Decisions related to the spatial planning and the built environment (e.g. where new development is located and how resilient it is to flooding) are important factors in preparing for flood events. Developments recently or soon to be completed are likely to remain in use for at least the next 20 to 50 years, by which time flood risk in London may have increased significantly. Several plans and policies are intended to reduce flood risk to existing and new development, such as the London Plan and associated SPGs, PPS25, TE2100 and the Thames Region CFMP. These documents aim to ensure that flood risk is taken into account at all stages of the planning process, which could improve preparation for flood events and increasing flood risk. Local authorities also have responsibility for producing Strategic Flood Risk Assessments (SFRAs).
• In preparing for a flood event it is important that individuals and businesses at risk of flooding have adequate insurance. The uptake of insurance tends to be lower than average in low-income households. In the event of a flood, those without insurance may be less able to pay for replacement possessions, goods or stock or repair flood damage to homes and businesses.
• The Environment Agency, Defra and organisations such as the Association of British Insurers (ABI) have produced advice and guidance for households and businesses on identifying risk and being prepared for flooding. It is up to individuals and businesses to identify and follow these guidance documents.
Respond
• The Environment Agency provides a flood warning service called *Floodline Warning Direct*, where an automated flood warning is sent by fax or phone to people registered for the service when a flood is predicted. It has been estimated that uptake of this early warning is limited to 19% of Londoners living or working in areas

Current and planned adaptation to flooding[20]
of flood risk. Flood warnings are also communicated through the BBC weather service and local radio. • Following serious flooding in parts of the UK in 2007, the Government announced (December 2008) plans to fund a new flood forecasting centre to be run by the Met Office and the Environment Agency to complement existing flood warning measures. • The London Resilience Partnership has prepared a London Flood Response Strategic Plan, which has the main objective of ensuring a coordinated response to a flood to protect life and wellbeing, but also to reduce damage to the environment and to property. The Plan covers tidal and fluvial flooding, and the procedures also apply to surface water flooding resulting from excessive rainfall. • In the event of flooding, the emergency services (fire, police), Local Authorities and NHS primary care trusts are responsible for coordinating response at the local level. Where they exist, Local Resilience Forums may take a lead role. Each organisation may also have flood / emergency response plans on a case by case basis. • London Boroughs are also in the process of producing Multi-Agency Flood Plans, which will set how the Borough will work with the emergency services and other partners to manage a local-scale flood. These plans must be completed by March 2010.
Recover
• The London Resilience Partnership has developed (July 2008) the London Recovery Management Protocol, which sets out roles and responsibilities of agencies in London to facilitate recovery following a regional emergency. • Following a flood event Local Authorities generally have lead responsibility in clean up and recovery. However the ability of individual households and businesses to recover to the physical effects (e.g. from damage to property) will depend to a large extent on having appropriate insurance or other source of funds to recover from flood damage.

Table 11: Current and planned adaptation – drought

Current and planned adaptation to drought[21]
Prevent
• Although the Thames basin is the largest river basin in south-east England, and is therefore relatively robust in times of drought, London's water resources are currently under substantial pressure and climate change, together with projected population and demographic changes and development, are predicted to increase the frequency of droughts. The Environment Agency has estimated that without further action to manage water demand, new strategic water resources may be required for London by 2020. • The Office of Water Services (Ofwat) believes that Thames Water cannot achieve 'security of supply' without developing new resources, particularly the planned desalination plant in Newham (East London). Construction of the plant was approved in 2007 and the project is underway with completion planned for 2009/2010. Thames Water has proposed a major new reservoir near Abingdon in Oxfordshire to help cope with the projected future increase in demand for water from London, Swindon and Oxfordshire. This scheme at present remains under review and even if construction were to commence in the next few years it would not be delivered until 2020 at the earliest. The development of new water resources would help London prevent the negative effects of drought, reducing the impacts on drinking water availability, and potentially releasing water to rivers during low-flow periods. • Another important aspect of future water management is reducing demand for water and managing the predicted impacts of demographic changes on water demand and climate change on water quantity and quality. Several key initiatives recommend actions to protect against drought in a changing climate, such as the draft Flood and Water Management Bill, the Water Strategy for England (Defra 2008) and the Water Resources Strategy for England and Wales (Environment Agency 2009). • Several initiatives which aim to reduce the impact on water demand of the projected increase in London's population and the trend towards increasing per capita water consumption will be important in reducing water consumption and preventing droughts in London. The Code for Sustainable Homes, the London Plan and the Mayor's SPG on Sustainable Design and Construction contain standards for new developments which seek to improve water efficiency and reduce water consumption. The Mayor's draft Water Strategy contains a proposal to work with water companies and "other partners" to ensure the rapid introduction of water meters across London, including in new and existing buildings. Water companies have a duty to promote efficient use

[21] Note: this summary presents an overview of existing and known planned adaptation policy and activity in relation to drought in London. This overview is not intended to be exhaustive, and does not seek to predict future adaptation actions not currently known. It is highly probable that new policies / activities will be developed and adopted during the medium-term (to 2020s) period, however it is not possible to predict these, or the effects they may have on the level of adaptation.

Current and planned adaptation to drought[21]
of water by all of their customers. Thames Water, London's largest water supplier, plans to increase the penetration of water metering in London to 77% within 15 years, and has proposed beginning a 10-year programme of compulsory metering of households in 2010. Increasing the penetration of water meters may facilitate effective demand management.
Prepare
• Increased incidence of droughts will pose a threat to water quality, as low flow levels in rivers reduces dilution and increases the concentration of pollutants in water courses. Low flows also have environmental impacts, such as reduced oxygen levels causing fish deaths. The Environment Agency is collating information relevant to water management issues, under the requirements of the Water Framework Directive Regulations and related River Basin Planning guidance, which should help in the management of drought impacts and enable an effect response and recovery. • There is the potential for the negative consequences of droughts to adversely impact on vulnerable groups in London. Planning for Equality and Diversity in London (London Plan SPG), and other guidance and standards relating to water metering and charging, may help to minimise negative impacts on equality target groups. • Recent and current built developments as well as those completed in the coming years are likely to be in use for a minimum of 20 years, and some perhaps much longer, over which time drought risk in London may increase significantly. Several plans and policies are intended to improve the water efficiency of new development, such as the London Plan, the Mayor's SPG on Sustainable Design and Construction and the Code for Sustainable Homes which requires a water efficiency standard of 80 litres per person per day by 2016. Such standards could help reduce the demand for water and lower the impacts of drought periods. In addition the Mayor's draft Water Strategy, and Thames Water, intend to increase the penetration of water meters in new and existing buildings in London. However, per-capita improvements in water use may be outweighed by the projected rise in population in London. • Current abstraction levels in the Thames region are 10% higher than ideal from an environmental perspective, which is likely to increase as droughts become more frequent. In order to manage water resources and avoid over abstraction at the local level the Environment Agency prepares Catchment Abstraction Management Strategies (CAMS). CAMS set out a strategic assessment of water abstraction in each area (Thames Corridor, London etc.) and identify areas where water is, or is not, available for further abstraction. The CAMS form the basis for the granting of abstraction licenses by the Environment Agency. These are the key documents in relation to the management of water abstractions in the London area and could serve to protect London's water resources from over abstraction. Under the Water Framework Directive, the Environment Agency will be required to identify catchments where over abstraction is causing environmental damage, and reduce abstraction through amendments to abstraction licences. • Water companies produce Water Resources Management Plans outlining how they currently balance supply and demand for water and how they intend to provide sufficient water to meet demands and protect the environment over the next 25 years. These plans are updated every five years, when they are presented to the water regulator (Ofwat), along with proposals for the funding the water companies need to deliver these plans. In addition, the Environment Agency's water resources strategy for the Thames Region (Water resources for the future: A strategy for Thames Region (2001)) sets out the water availability, supply and use situation in the Region as well as mapping out future demand and climate change issues. Both of these strategies should help to prevent over abstraction of river and ground water, preventing adverse environmental effects.
Respond
• Communication with the public during drought periods is important to reduce non-essential water use as much as possible. The Environment Agency co-ordinates a communications and media strategy during a drought to help ensure the correct messages are being communicated to the areas affected. • In drought periods, over 75% of the freshwater flows in the Thames can be abstracted, reducing the normal flow of the river. During a severe drought, the government has the power to limit abstraction, or to permit water companies to abstract more water than would usually be allowed. Emergency legislation allowing further abstraction can reduce freshwater flows in the Thames to 10% of normal flows. • Key Environment Agency plans in the London area, such as the Thames Region Drought Plans and Catchment Abstraction Management Strategies for the Thames Region set out frameworks for the management of drought and abstraction in the Thames region. Defra launched a consultation in 2007 as part of a review of the scope of the legislative framework relating to non-essential water uses. Depending on consultation outcomes, this review may (among other related matters) lead to proposals for the expansion of the range of "discretionary" uses of water which companies may temporarily restrict or prohibit. Future legislative changes in this regard are therefore possible. • In addition to the government's powers in reducing water use, the Water Act 2003 requires water companies to have sound drought plans in place so that they can continue to supply water to their customers when resources are depleted. These drought management measures can be divided into: demand side measures

Current and planned adaptation to drought[21]
that seek to influence a voluntary reduction in demand from consumers before implementing legislative bans and restrictions on distribution and, supply side measures that seek to increase the amount of water in supply, and are important in responding to drought periods.
Recover
• When water supplies are replenished a drought period is over, however for groundwater resources and reservoirs repeated drought years can hinder replenishment to the extent that levels to not recover even during wet periods. This in turn can lead to depleted reserves and greater vulnerability to drought. Water company Water Resources Management Plans should include measures to ensure recovery of reservoir levels, for example by pumping water in order to artificially recharge reserves in winter months following a drought.

Table 12: Current and planned adaptation – overheating

Current and planned adaptation to overheating[22]
Prevent
• PPS1 (Delivering Sustainable Development), and associated supplement on climate change, seeks to encourage the delivery of new developments which will be adapted to the predicted implications of climate change, including higher temperatures. In addition, the London Plan has policies (4A.10 and 4A.11) which seek to ensure that new developments built in London are heat resilient, and that major developments have living roofs and walls. These policies may help to avoid the negative effects of overheating for new buildings, but will not prevent overheating effecting existing housing stock / developments. • The Mayor's Air Quality Strategy seeks to improve the capital's air quality, focusing particularly on particulate matter (PM10) and Nitrogen Dioxide. • Transport for London is seeking to ensure that tunnel and platform air temperatures on the London Underground network are maintained at 29°C during an average summer. This target temperature is based on a balance between thermal comfort and practicable cooling solutions. Using the 29°C criterion, and the 2-4°C temperature fluctuations experienced during the 2006 heatwave, this would mean that most stations during a heatwave would reach 31°C, with small sections of the network rising to 33°C. • Urban Greening programmes, such as the Great Outdoors, the Mayor's manifesto for public space, and the East London Green Grid, seek to provide more green space in London which should contribute to reducing the effects of high summer temperatures and the urban heat island.
Prepare
• The Engineering and Physical Science Research Council is funding two research projects to investigate the effect of a changing climate on London's urban environment. One of the projects, led by the University of Reading's Meteorology Department, is attempting to understand how London's existing and new buildings directly affect, and need to adapt to, climate change – with a specific focus on overheating. • The London Climate Change Partnership has the aim of helping to ensure London is prepared for climate change. The Partnerships objectives include collating and disseminating information on expected climate change and the promotion of suitable adaptation actions. The Partnership also publishes research and guidance on climate change adaptation as part of its awareness raising role. • The London Climate Change Partnership has prepared a number of reports such as one detailing possible actions which would assist in adapting London's biodiversity to the impacts of climate change, including a change in temperature[23]. Others include guidance on the role of public procurement in adapting to climate change and adapting London's commercial building stock. • English Heritage have published research and technical advice notes in relation to understanding and managing the effects of climate change on historic buildings. This includes the development of a website to provide guidance to help people understand the impact of climate change on older buildings and how they can be adapted safely and effectively.
Respond
• The Department of Health's *Heatwave Plan for England* sets out responsibilities and policy for responding to heatwave incidences in the UK. Although it does not contain any specific policy recommendations for London it does contain the threshold temperatures for London. • The Meteorological Office is generally able to forecast heatwaves at least 24 hours in advance. In addition, it

[22] Note: this summary presents an overview of existing and known planned adaptation policy and activity in relation to overheating in London. This overview is not intended to be exhaustive, and does not seek to predict future adaptation actions not currently known. It is highly probable that new policies / activities will be developed and adopted during the medium-term (to 2020s) period, however it is not possible to predict these, or the effects they may have on the level of adaptation.

[23] Gill, S., Goodwin, C., Gowing, R., Lawrence, P., Pearson, J. and Smith, P. (2009). Adapting to climate change: Creating natural resilience. Technical Report. Greater London Authority, London, UK

Current and planned adaptation to overheating[22]
operates a system called Heat-Heath Watch in England and Wales from 1 June to 15 September each year, in association with the Department of Health and the Welsh Assembly. The Heat-Health Watch system comprises four levels of response based upon threshold maximum daytime and minimum night-time temperatures. • The Strategic Emergency Plan for London contains details of the appropriate responses to an extreme heat event in London.
Recover
• No preparations have been identified in relation to recovering from overheating in London.

Appraisal of the potential sustainability effects of climate change in London without the draft Strategy

Identifying the potential sustainability effects - causal chain analysis

4.26 In order to assist the process of identifying the potential sustainability effects that could arise from the projected headline climatic changes described in Table 9, and which receptors could be affected, network or causal chain analysis was used. This is a very useful technique to identifying cause-effect pathways and to explore the potential for multiple effects on specific sustainability objectives or receptors. It was considered to be particularly appropriate for this SA given the strategic, long term and complex nature of the predicted climatic changes, and because all the potential sustainability effects of these changes are not always obvious. In addition, causal chain analysis can help start the process of identifying potentially significant cumulative effects (see cumulative effects below).

4.27 The headline climatic conditions described in Table 9 are illustrated in three causal chain analysis diagrams covering flooding, drought and overheating, see Figure 10, Figure 11 and Figure 12 respectively. The causal chain analysis diagrams identify the potential sustainability effects of the predicted climatic changes in London, and how these effects could impact on the SA objectives or receptors. These diagrams consider in particular the projected effects of climate change over the medium-term scenario (to 2020s), and are not intended to be comprehensive in the effects they identify.

4.28 The causal chain analysis diagrams do not identify the likely magnitude or significance of the potential effects, beyond there being a relationship. The magnitude and significance of the potential effects were explored in more detail as part of evaluating the effects.

4.29 Note that only the potential effects that were considered to be likely to be the most significant were included in the diagrams. In some instances where a potential effect was not considered to be significant, the causal chain was not followed through to identify subsequent effects / the relevant receptor(s). The causal chain diagrams are also not intended to be exhaustive, as it is not possible to identify all possible drivers and effects related to an issue, and their main purpose was to assist internal brainstorming amongst the SA team.

Figure 10: Causal chain analysis diagram illustrating the potential effects of increased flood risk in London due to climate change

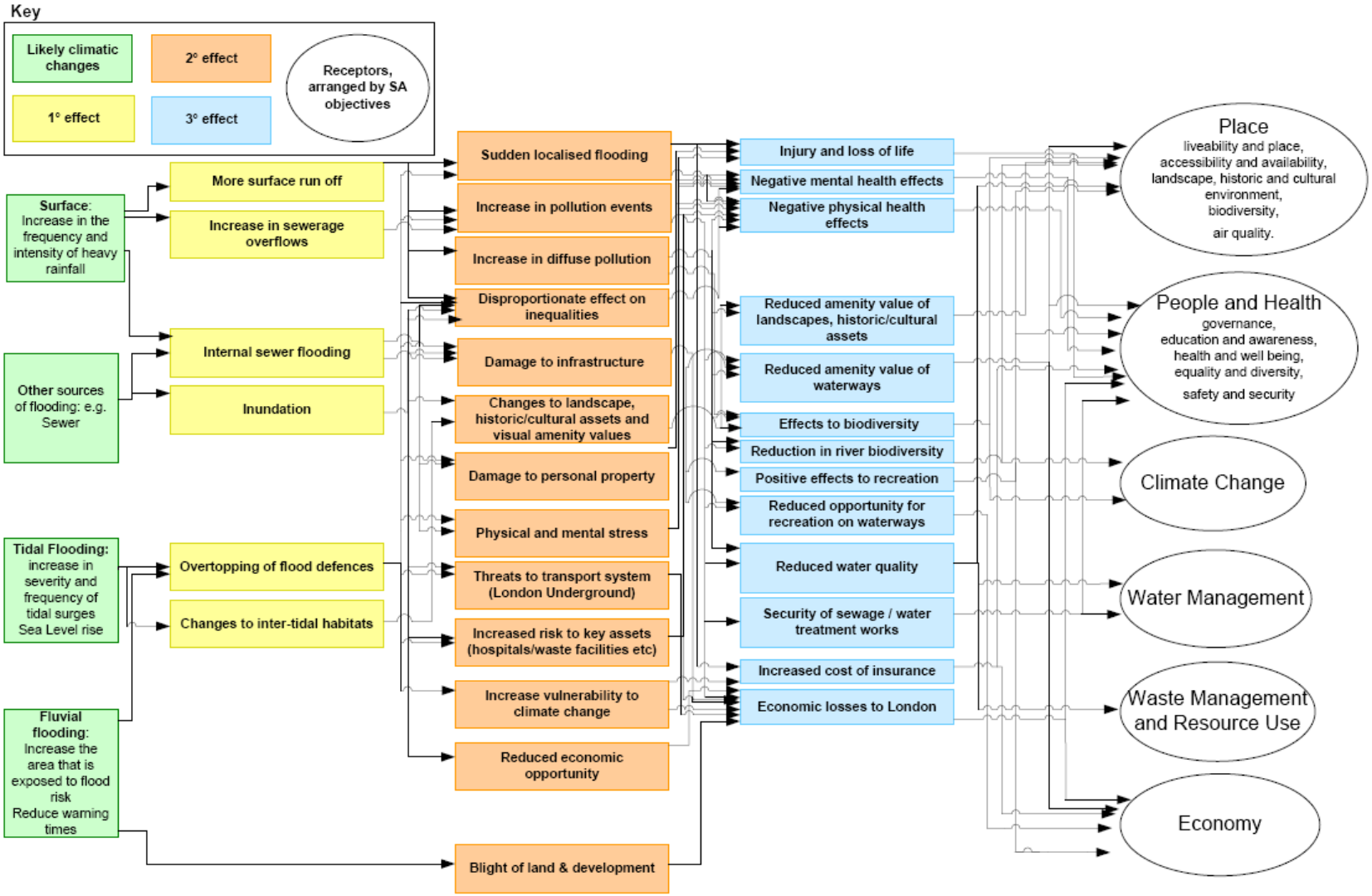


Figure 11: Causal chain analysis diagram illustrating the potential effects of increased frequency and intensity of drought in London due to climate change

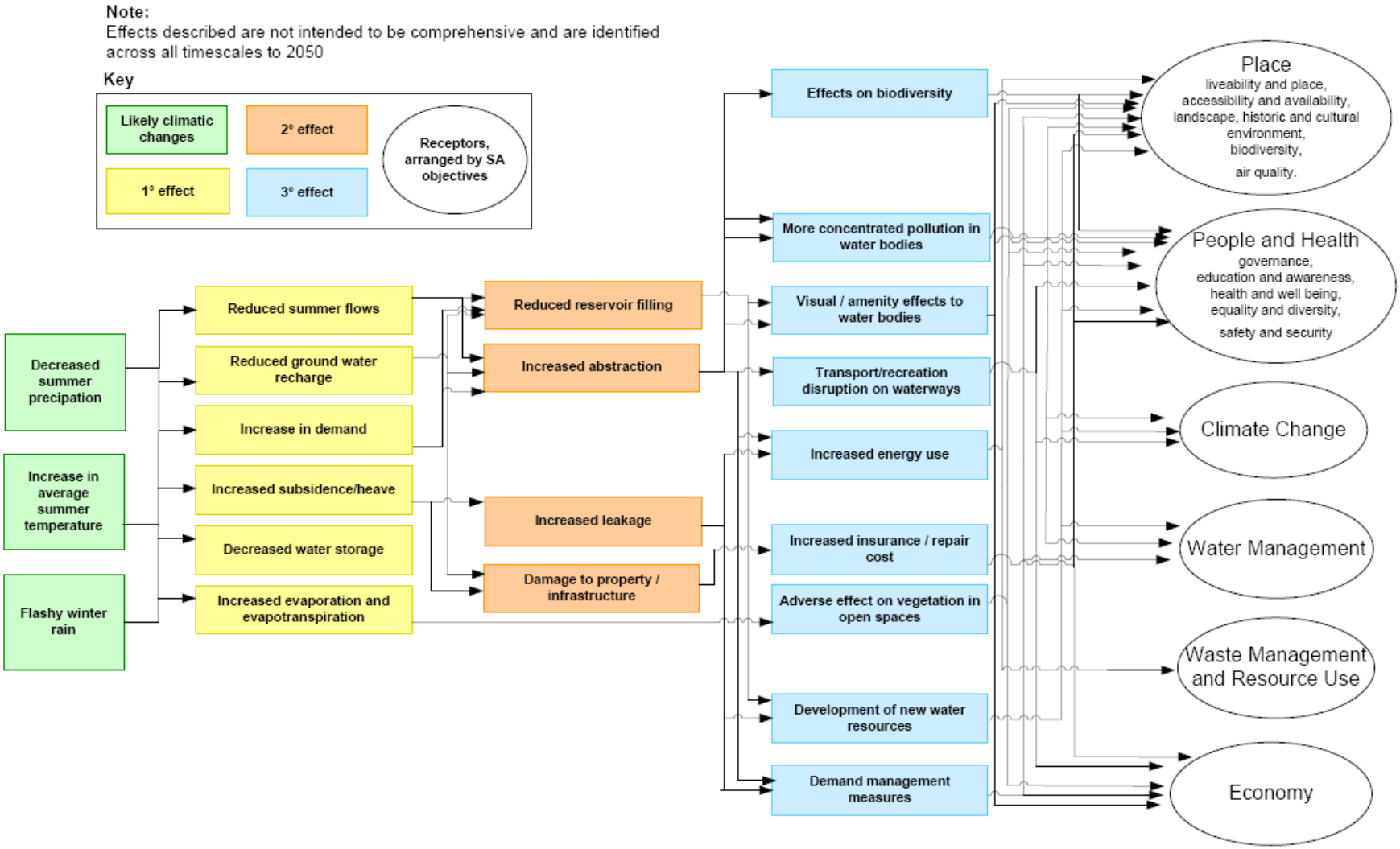
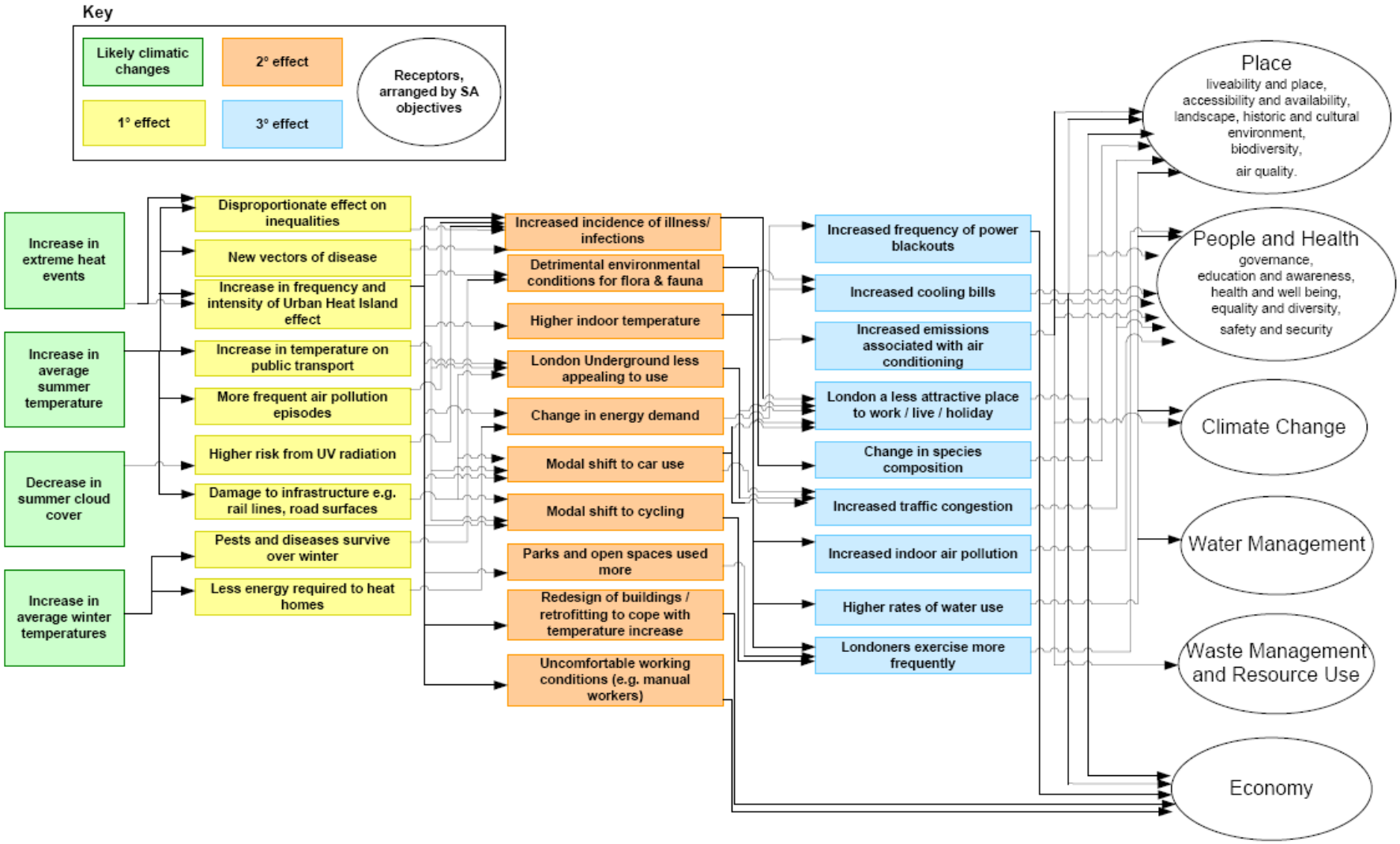


Figure 12: Causal chain analysis diagram illustrating the potential effects of increased likelihood of overheating in London due to climate change



Evaluating the potential sustainability effects

4.30 The causal chains analysis was used to help identify the potential sustainability effects of the projected climate change impacts on flooding, drought and overheating in London over the medium-term (2020s), and the long-term (2050s and beyond). The assessment went on to take into account the likely influence of existing and planned adaptation (as summarised in Table 10, Table 11 and Table 12), as well as considering the predicted sustainability effects of the climate change projections over the medium-term (2020s) in the absence of existing and planned adaptation to provide context to the appraisal.

4.31 The appraisal evaluated the potential sustainability effects of climate change in relation to flooding, drought and overheating on each of the SA objectives. The appraisal categorised the significance of the effects using a qualitative 5-point scale[24] and used the significance criteria developed for this SA (see Appendix 5) to help determine the significance of the effects. Matrices were completed to record the potential effects of flooding, drought and overheating, see Appendix 7. Table 13 presents a summary of these predicted effects (see Appendix 7 for further details and the justifications for the scores).

4.32 The matrices in Appendix 7 and the summary in Table 13 present an appraisal of:

- **Future climate change (medium-term - 2020s)**: the potential sustainability effects of the projected climate change impacts in London in the medium-term (to the 2020s) in relation to rainfall and flooding, drought and overheating in the absence of existing and planned adaptation (this is a hypothetical situation as adaptation already exists and is planned but this helped provide context for the appraisal).
- **Future climate change including existing and planned adaptation (medium-term - 2020s)**: the potential sustainability effects of the projected climate change impacts in London in the medium-term (to the 2020s) in relation to rainfall and flooding, drought and overheating including the influence of existing and planned adaptation.
- **Future climate change including existing and planned adaptation (long-term - 2050s+)**: the potential sustainability effects of the projected climate change impacts in London in the long-term (2050s – 2100) in relation to rainfall and flooding, drought and overheating including the influence of existing and planned adaptation. It is clearly likely that new policies / activities will be developed and adopted in the medium-term (to 2020s), however it is not possible to foresee these, or the effects they may have on the level of adaptation.

4.33 This represented an appraisal of the "*business as usual*" alternative to the draft Climate Change Adaptation Strategy as it considered the potential sustainability effects of the future baseline in relation to flooding, drought and overheating, without the draft Strategy, but considering the influence of other existing and planned adaptation policies, plans, strategies and initiatives (i.e. what would happen anyway, even if the Mayor decided not to produce a CCAS). See Section 5 for more information on the appraisal of the draft Strategy and alternatives.

4.34 In completing the matrices in Appendix 7, as summarised in Table 13, the SA drew upon:

- The likely evolution of the sustainability baseline topics without the draft Strategy (Table 8, and Section 3 Part A);

[24] major positive effect (++), minor positive effect (+), neutral effect (0), minor negative effect (-) and major negative effect (--). In addition, where the effects were uncertain (?) or mixed (e.g. +/-) these categories were also used

- Projections of future climate in London (Table 9);
- Summaries of existing and planned climate change adaptation (Table 10, Table 11 and Table 12); and,
- The predicted effects of flooding, drought and overheating in London due to climate change as identified by the causal chain analysis (Figure 10, Figure 11 and Figure 12).

Summary of potential sustainability effects

4.35 Overall the appraisal indicated that the projected climatic changes are predicted to have generally negative effects on the sustainability objectives, and in some case these could be of a major significance. The potential effects are also generally predicted to worsen in the long-term, due to the increasingly significant projected climate change impacts. In some cases, these potential effects are considered to be uncertain, especially those predicted in the long-term. See Table 13.

4.36 The appraisal also indicated that existing and planned adaptation is predicted to have generally positive sustainability effects (or at least reduce or mitigate the potential negative effects) compared to the predicted effects of climate change in the absence of any adaptation action. This reflects the role that existing and planned adaptation has in facilitating and influencing the ability of London to adapt to climate change (as set out in Table 10, Table 11 and Table 12). However, in many cases the overall sustainability effects predicted remain negative which suggests that there is a need for further action over and above existing and planned adaptation if these effects are to be further mitigated or even avoided. Section 5 addresses the question of whether the draft Strategy provides for sufficient additional adaptation in London to address the negative, and enhance positive, sustainability effects predicted to arise from the impacts of climate change.

4.37 A brief overview of some of the key potential sustainability effects is provided below. The matrices in Appendix 7 provide more detailed descriptions and explanations of these potential sustainability effects.

Table 13: Summary of the appraisal of the likely sustainability effects of climate change in London without the draft Strategy

	Sustainability Objectives													
	1. Governance	2. Education and Awareness	3. Health and Well-being	4. Equality and Diversity	5. Safety and Security	6. Liveability and Place	7. Accessibility and Availability	8. Landscape, Historic and Cultural Environment	9. Biodiversity	10. Air Quality	11. Climate Change[25]	12. Water Quality and Water Resources[26]	13 Waste Management	14 Economy
Flooding														
Future climate change (2020s)	+?	+	--	-	-	-	-	-	-	-/0	0/- -	-- --	-/0	--
Future climate change incl. existing adaptation (2020s)	+	+/++	-	-	-/0	-/0	-	-/0	-?	0?	- -/+	-? -?	-	-
Future climate change incl. existing adaptation (2050+)	+	++?	--?	-/--?	--?	-/--?	--?	-/--?	--?	-?	--? -?	--? --?	-?	--?
Drought														
Future climate change (2020s)	+?	+	-	-/0	-/0	-	-	-	-/--	-/0	-/0 -	-- --	0	-
Future climate change incl. existing adaptation (2020s)	+	+/++	-	-	-/0	-/0	-	-/0	-/+	-/0	- -	-/+ -	-/0	-
Future climate change incl. existing adaptation (2050+)	+?	++?	-?	-/--?	-?	-?	-/0?	-/--?	-/--?	-?	-/--? --/+?	-? --?	-?	-/+
Overheating														
Future climate change (2020s)	+?	-/+	--/+	-/+	-?	-/0	-/+	-	-	--	-/+ -	- -	-/0	-?
Future climate change incl. existing adaptation (2020s)	+?	-/+	--/+	-/+	-?	-/+	-/+	-/0	-	--	-/+ 0/+	- -	-/0	-?
Future climate change incl. existing adaptation (2050+)	+?	-	--/+?	--/+?	-?	-?	--/+?	-?	--?	--?	--/+? -?	-? -?	-?	-?

Key:

Major positive: ++ Minor positive: + Neutral: 0 Minor negative: - Major negative: -- Uncertain:? Mixed: -/+

For a description of "Future climate change (2020s)", "Future climate change incl. existing adaptation (2020s)" and "Future climate change incl. existing adaptation (2050+)" see paragraph 4.32.

Summary of the potential sustainability effects caused by flooding

4.38 **In the medium-term (2020s), in the absence of existing and planned adaptation** the impact of climate change on flooding is predicted to potential have:

- ***Negative effects of major significance on: health and well-being; water quality and resources; and, the economy***. These effects are predicted due to the impact floods can have on individuals, communities and businesses. Examples include physical and mental health impacts, travel disruption, and damage to infrastructure, business premises and stock;
- ***Negative effects of minor significance on all other SA objectives, except governance and education and awareness***. For example effects on equality as

[25] Objective split between (11.1) mitigation and (11.2) adaptation to Climate Change.
[26] Objective split between (12.1) water quality and (12.2) water resources.

vulnerable groups and individuals may be less able to respond to and recover from flooding, and liveability and place, as flooding can impact negatively on the public realm and damage essential infrastructure and amenities; and,

- ***Potential positive effects of minor significance on: governance; and, education and awareness***. These potential positive effects are predicted to arise in response to the significant increase in the frequency and intensity of all types of flooding which is likely to necessitate a coordinated, cross-sectoral response, potentially improving governance, and as the effects of climate change on flooding become increasingly apparent (due to events in, or outside of London), people and organisations may become more aware of flood risks.

4.39 **Existing and planned adaptation in the medium-term (2020s)** is considered likely to reduce the negative sustainability effects predicted from the projected climate change impacts on flooding. Where significant negative effects were predicted in relation to the climatic changes to the 2020s, the current and planned adaptation in most cases reduces the significance of these negative effects. However, in relation to all SA objectives except governance and education and awareness, the assessment predicts that residual negative effects will remain.

4.40 **In the longer term (2050+)** the projected increased severity of all climate change impacts associated with flooding are predicted to exacerbate the negative sustainability effects predicted in the medium-term. However, there is a high degree of uncertainty in predicting effects so far into the future, as the long-term adaptation responses and the exact nature of the effects of long-term climate change impacts on specific receptors cannot be known with certainty.

Summary of potential sustainability effects caused by drought

4.41 **In the medium-term (2020s), in the absence of current and planned adaptation** the impacts of climate change on decreased summer rainfall and increased risk of drought is predicted to potential have:

- ***Negative effects of major significance on: biodiversity; and, water quality and water resources***. These effects are predicted as more frequent and severe droughts may impact directly on habitats and species, as well as reducing river flows (reduced rainfall, increased abstractions, increased evapo-transpiration) which is likely to have a negative impact on the chemical and biological quality of London's waterways;

- ***Negative effects of minor significance are predicted on all other SA objectives, except governance, education and awareness and waste management***. These negative effects are predicted due to, for example, the impact of drought on the amenity of London's waterways, open and greenspaces (potentially effecting liveability and place, landscapes and the historic environment), and the need for emergency water management measures in severe drought periods (potentially effecting on health and equality); and,

- ***Positive effects of minor significance are predicted in relation to education and awareness and governance***, based on the assumption that the increasing visibility of climate impacts in relation to drought may lead to more people and businesses becoming aware of these effects and appropriate responses, and, that addressing drought risk is likely to require a coordinated cross-sectoral response. No significant effects are

predicted on waste management, although drought conditions could increase localised dust problems associated with waste management facilities.

4.42 **Existing and planned adaptation in the medium-term (2020s)** is generally considered likely to reduce the significance of the negative sustainability effects predicted in relation to the projected climate change impacts on drought to the 2020s. This is particularly the case in relation to the SA objectives covering environmental topics. However, in relation to health and well-being, accessibility and availability, economy and equality and diversity, current and planned adaptation is predicted to lead to no change or a minor worsening of the potential negative effects. This is due to the potential effects of measures to manage water demand and increase efficiency, such as reducing leakage or introducing compulsory metering.

4.43 Only in relation to governance and education and awareness is current and planned adaptation considered likely to lead to positive overall effects.

4.44 **In the long-term (2050+)** projected increases in the frequency and severity of droughts towards the end of the century is predicted to exacerbate the negative effects predicted in the medium-term. However, the long-term also provides the opportunity for more extensive adaptation responses, such as the construction of major new resources (such as a new reservoir) as well as improvements in water use efficiency and demand management. There is a high degree of uncertainty in predicting effects so far into the future, as the long-term adaptation responses and the exact nature of the effects of long-term climate change impacts on specific receptors cannot be known with certainty.

Summary of potential sustainability effects caused by overheating

4.45 **In the medium-term (2020s), in the absence of current and planned adaptation** the impacts of climate change on average temperatures and the frequency and intensity of heatwaves is predicted to potential have:

- ***Potentially negative and positive effects of minor significance on: health and well-being; education and awareness; equality and diversity; accessibility and availability; and, climate change mitigation***. In general, these effects reflect on the one hand the predicted effects of higher summer temperatures and heatwaves (resulting in generally negative effects), and on the other the milder winters (resulting in generally positive effects). For example, in relation to health, heatwaves can lead to high levels of mortality, especially in the elderly, however warmer winters will reduce the number of deaths associated with the cold.
- ***Negative effects of minor significance are predicted on: biodiversity; water quality and water resources; climate change adaptation; landscape, historic and cultural environment; waste management and, the economy***. Higher average temperatures, and heatwaves, can lead to reduced oxygen levels in rivers which will effect aquatic biodiversity, and a higher incidence of subsidence and heave potentially damaging property and infrastructure (such as water mains). Higher temperature may have negative effects on waste management for example due to potential changes in the profile and volume of municipal waste, impacts on waste infrastructure and the possibly an increased spread of disease.
- ***Negative effects of major significance on air quality***. These effects are predicted due to the combination of higher temperatures and decreased cloud cover (increasing solar radiation), which can significantly exacerbate existing air pollution problems.

4.46 **Existing and planned adaptation in the medium-term (2020s)** is in most cases not predicted to significantly influence the overall sustainability effects identified in relation to the projected climate change impacts on overheating. This is due to existing and planned adaptation relating to overheating remaining relatively limited both in number and scope. Although the Mayor's Manifesto for Public Space does include specific aspirations to increase tree planting and green cover in London over the period to 2050, it is not clear if these targets will significantly influence the overall effects predicted in the period to the 2020s. Those adaptations considered likely to have the most significant influence are those seeking to adapt new development to higher temperatures, and measures seeking to increase urban greening to reduce the effects of the urban heat island.

4.47 **In the long-term (2050+)**, the increasing severity of climate impacts on average temperatures and heatwaves is predicted to exacerbate many potential negative sustainability effects. However, in many cases the effects are predicted to remain minor in significance. All long-term effects are considered uncertain, as while there is increasing consensus in relation to climate change projections, the long-term adaptation responses and the exact nature of the effects of long-term climate change impacts on specific receptors cannot be known with certainty.

5. APPRAISAL OF THE DRAFT STRATEGY AND ALTERNATIVES AT THE STRATEGIC LEVEL

Introduction

Overview of the contents of Section 5 of the SA Report

5.1 Section 5 presents a summary of the appraisal of the potential sustainability effects of the draft Strategy and potential alternatives at a strategic level. This compares the potential sustainability effects of the predicted climatic changes in London in the absence of the draft Strategy, i.e. under a "business as usual" situation, the draft Strategy as currently proposed, and an alternative strategy which builds on the current draft but incorporates a greater level of adaptation including options across the full range of the *Prevent, Prepare, Respond, Recover* adaptation framework and actions to accelerate the implementation of adaptation measures within London.

5.2 This section includes the following:

- A description of the purpose of considering alternatives as part of SA;
- An overview of the main strategic alternatives considered;
- The approach to the appraisal of the alternatives; and
- A summary of the findings of the appraisal of strategic alternatives.

5.3 Section 6 of the SA Report provides a more detailed appraisal of the draft Strategy building on some of the findings of the appraisal of the alternatives in this section. It includes detailed recommendations for changes to the draft Strategy to minimise the potential negative sustainability effects and maximise the positive effects of the predicted climatic changes in London.

Purpose of appraising alternatives

5.4 The purpose of appraising alternatives is to ensure that the option(s)/strategy adopted is the most sustainable and, if the most sustainable options is not adopted, to enable the rationale behind the selected option to be adequately justified. There may be other reasons why the most sustainable strategy is not able to be taken forward. Given the timescale over which the Strategy is expected to operate (50-100 years) it may also be reasonable to expect certain actions to be included in this first version of the Strategy, and for other actions to come forward at a later date as a result of subsequent revisions and/or as a follow-up to planned preparatory work and/or increasing risks of climate change impacts over time. Given the strategic nature of the draft Strategy, some actions may also more appropriately be taken forward (and appraised) through more detailed or sectoral specific strategies or action plans at a lower level of the planning hierarchy. While the draft Climate Change Adaption Strategy is a high level strategy and might be expected to have a wide range of options available to it, those options are in practice limited because of the shared responsibility for climate change adaptation among a wide range of authorities and agencies, many of them outside the responsibility and remit of the Mayor of London.

5.5 The draft Strategy highlights the Mayor's limited powers and states that it seeks to provide a framework to identify and prioritise the key climate risks for London and to identify who is *"best placed to work individually or collaboratively to deliver actions to reduce or manage these risks"* (executive summary). However, some legitimate questions for the SA to explore

given the significance of some of the potential sustainability effects of climate change in London are:

- whether the draft Strategy should go further in the level of adaptation it proposes;
- whether it should put certain adaptation measures in place sooner; and
- whether these would be practical and appropriate for this strategy to adopt given the Mayor's limited powers.

5.6 A key way the SA tested these questions was by assessing strategic alternatives to the draft Strategy.

Main strategic alternatives considered

5.7 Two broad strategic alternatives were examined as part of the appraisal in addition to the draft Strategy as currently proposed:

- **Business as usual (BAU) alternative** – this alternative represents the future situation without the draft Strategy, but considering the influence of other existing and planned adaptation policies, plans, strategies and initiatives (i.e. what would happen anyway, even if the Mayor decided not to produce a climate change adaption strategy). A full description of this alternative, along with an appraisal of business as usual alternative over the medium-term and long-term is presented in Section 4 and Appendix 7, with a summary of the findings of that appraisal presented in this section.
- **Draft Strategy** – the draft Strategy as currently proposed, and in particular as expressed through the current set of visions, policies and actions included in the draft Strategy, provides a comparison for the other alternatives. With the actions in particular, this predominately focuses on the prepare dimension of the adaptation framework, with a few prevent and respond actions and no recover actions. A summary of the findings of a more detailed appraisal of the draft Strategy is presented in Section 6 and Appendix 8.
- **"Draft Strategy Plus" alternative** – this alternative builds on the current draft Strategy, but incorporates a greater level of adaptation which seeks to minimise the potential negative sustainability effects and maximise the positive effects of the predicted climatic changes in London across the breath of the *Prevent, Prepare, Respond, Recover* adaptation framework. This alternative would also set out a "roadmap" of how preparatory actions would need to be taken forward in the future after this first version of a London Climate Change Adaptation Strategy. A description of the characteristics of this alternative is presented in Box 18.

5.8 The potential sustainability effects of the draft Strategy and the two strategic alternatives were considered over both the medium-term (2020s) and the long-term (2050s and beyond).

5.9 Considering the business as usual alternative was particularly useful. It provided a benchmark against which to judge whether the draft Strategy was likely to make a significant difference compared with the potential sustainability effects that could occur over the medium-term and long-term as a result of projected climate changes with existing and planned adaptation. This was also used to inform the potential gaps in the draft Strategy which the "Draft Strategy Plus" alternative could incorporate, and indeed could be used to inform future revisions of the Strategy.

5.10 For the appraisal of the draft Strategy, each policy and their associated actions considered in the draft Strategy under flooding, drought and overheating were treated as a package. Generally the policies were relatively comprehensive and represented appropriate

aspirational statements of the approach required to adapt to climate change in London. However, it was important for the appraisal to see evidence in the draft Strategy of how the policies would be implemented and delivered in practice and for this the actions were taken as an indication of how the policies would be operationalised. If actions were not identified for every aspect of a particular policy this raised uncertainties over whether it would be delivered in practice and whether any positive effects would occur.

Box 18: Characteristics of the "Draft Strategy Plus" alternative

The "Draft Strategy Plus" alternative illustrates a potential strategic alternative to the current draft Strategy which seeks to minimise the potential negative sustainability effects and maximise the potential positive effects of the predicted climatic changes in London by:

- Ensuring the policies in the strategy on flooding, drought and overheating cover all dimensions of the *Prevent, Prepare, Respond, Recover* adaptation framework
    - *for example, whilst droughts cannot be prevented, reducing leakage and developing new resources may reduce the impacts - these dimensions of "preventing" droughts are not reflected in the current drought policy*
- Ensuring that proposals for actions included in the body of the text of the draft Strategy are followed through into firm actions with assigned responsibilities within the Strategy and a commitment is included to require their adoption
    - *for example, requiring the use of the bespoke London Design Summer Years for all new building in London, designating an Urban Heat Island Action Area where specific requirements to help mitigate the Urban Heat Island would be required*
- Seeking to maximise the opportunities to avoid the impacts of climate change where possible by either incorporating prevent actions now, where there is an immediate high risk, or where taking action now could avoid or mitigate a significant future risk due to the action's longevity
    - *for example, actions seeking the incorporation of adaptation to climate change into new built developments or infrastructure which whilst they may be suitable for today's climate are likely to have a lifespan of at least fifty years and therefore need to by designed for the likely future climate. Actions could also include working with the Environment Agency, boroughs and the London Development Agency (LDA) to identify and safeguard areas through the London Plan and LDF process for future flood storage (fluvial and tidal) identified through TE2100 and flood risk management strategies*
- Incorporating additional actions into the strategy which focus on the respond and recover dimensions of the adaptation framework
    - *for example, the Mayor to support the London Resilience Partnership to develop, test and implement a regional Heatwave Plan for London*
- Commit to a step change in policy in London to ensure that adaptation to the potential effects of climate change is integrated into wider policy-making and informed by long term futures thinking
    - *for example, commitment to the implementation of a policy of water neutrality in London.*
- Providing a "road map" which sets out an outline of the actions that are likely to be required in the future, given current knowledge of climate change impacts, which provides details of the likely next steps that will be required to be taken once the current focus on prepare actions is complete
- Prioritising adaptation actions in particular which seek to avoid or mitigate the impact of climate change on the most sensitive receptors, for example vulnerable groups in society, which are either likely to be least able to adapt or the consequences of any impacts are greatest
    - *for example, prioritising urban greening in areas of social and economic deprivations.*
- Ensuring the Strategy, given its long term view, provides an overarching strategic

adaptation framework for all other Mayoral strategies and plans, and the activities performed by the organisations within the GLA group, highlighting where these other strategies and plans may need to be amended or where further actions may be required at the more detailed level across the *Prevent, Prepare, Respond, Recover* adaptation framework

- *for example, propose and commit to specific amendments to the draft London Plan and Air Quality Strategy etc as necessary given the long term requirements of the Climate Change Adaptation Strategy.*

5.11 The "Draft Strategy Plus" alternative represents a composite of a series of options, which taken together provide an alternative to the draft Strategy. For the purposes of the appraisal it was considered reasonable to present this as a strategic alternative, although each of the individual elements described in Box 18 could be included or excluded as appropriate to provide different alternatives.

5.12 A limitation on the consideration of alternatives was that the climate change adaptation strategy development process has not to date considered long term futures thinking – i.e. some scenario planning about what London might look like in the future, not in climate change terms, but in terms of the whether it will continue to grow as currently, other driving forces that might influence its shape and character in 20, 50 years time as well as or in conjunction with climate change (which may well help shape other drivers, e.g. migration and population size). Ideally this would have been undertaken as part of the development of the draft Strategy, however, it could be something that could be included in the draft Strategy as a prepare action - this is discussed further in Section 6. The alternatives available for the appraisal to consider were therefore not able to include potentially more radical options that might emerge if a significantly different future were envisaged for the shape and character of London in say 2050. The draft Strategy has been largely premised on a continuation of the business as usual growth paradigm and more radical options could only be considered following more detailed futures scenario planning work.

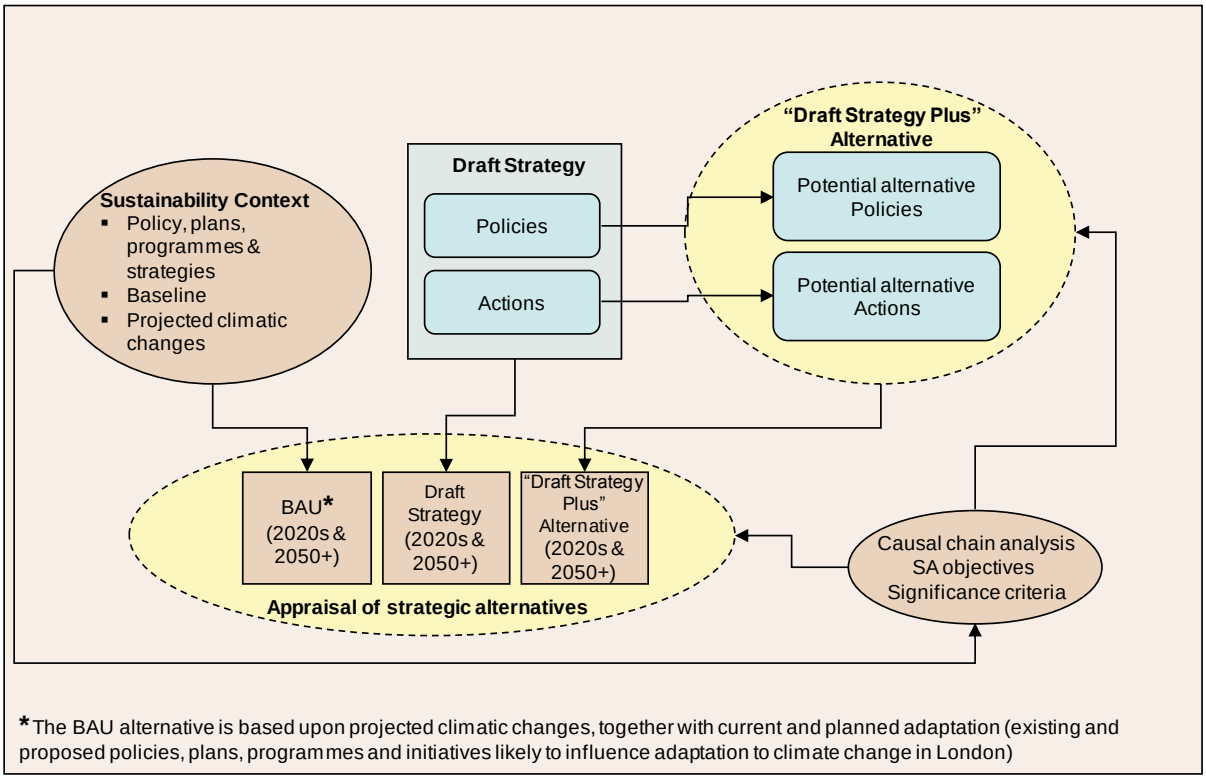
The approach to the appraisal of the strategic alternatives

5.13 The appraisal of the strategic alternatives presented some particular methodological challenges. Unlike many other types of strategy or plan (e.g. a spatial development plan or housing strategy), which often propose specific actions to meet defined targets over a specific timeframe, the draft Climate Change Adaptation Strategy is seeking to provide a policy framework to address the negative and positive effects (risks and opportunities) from climatic change, over a timeframe which spans the rest of the century[27]. There were also large areas of uncertainty in predicting the potential sustainability effects of implementing the draft Strategy, particularly in the long-term. The SA therefore sought throughout to be transparent wherever particular assumptions were used to support the assessment.

5.14 Figure 13 illustrates the approach to appraising the sustainability of the draft Strategy and alternatives at the strategic level.

[27] The introduction to the draft CCAS states that it "considers the climate over the century, but particularly focuses on the period up to 2031".

Figure 13: Appraisal of the draft Strategy and alternatives



5.15 The likely effects of the *Business as Usual* alternative and draft Strategy were appraised against the SA objectives (see Section 2 and Appendix 4). The appraisal of the business as usual alternative is presented in Section 4 and Appendix 7. The appraisal of the draft Strategy at the strategic level is presented in the tables and matrices included in Appendix 8 and 9. The "draft Strategy Plus" alternative was not appraised in detail against the SA objectives, instead it was compared against the appraisal of the draft Strategy and a judgement made on the potential of the characteristics proposed in Box 18 to change the effects identified, i.e. to address major negative effects and exploit opportunities arising.

Summary of the findings of the appraisal of strategic alternatives

5.16 In order to provide a comparison of the strategic alternatives, the predicted effects of the *Business as Usual*, draft Strategy, and "draft Strategy Plus" alternative were summarised in Table 14. This presents the effects over two time periods: the medium-term (2020's); and, the long-term (2050s and beyond). An explanation of these time periods is included in Section 4 (paragraphs 4.11 – 4.13).

Table 14: Summary of the appraisal of business as usual, the draft Strategy and "draft Strategy Plus" alternatives - Flooding

Climate change headline impacts and timeframe	Sustainability Objectives													
	1. Governance	2. Education and Awareness	3. Health and Well-being	4. Equality and Diversity	5. Safety and Security	6. Liveability and Place	7. Accessibility and Availability	8. Landscape, Historic and Cultural Environment	9. Biodiversity	10. Air Quality	11. Climate Change[28]	12. Water Quality and Water Resources[29]	13 Waste Management	14 Economy
Flooding														
Impacts of climate change in London (predicted effects of climate change on sustainability without the draft Strategy but with existing / planned adaptation i.e. Business as usual (BAU) alternative[30])														
Medium-term (2020s)	+	+/++	-	-	-/0	-/0	-	-/0	-?	0?	- -/+	-? -?	-	-
Long-term (2050+)	+	++?	--?	-/--?	--?	-/--?	--?	-/--?	--?	-?	--? -?	--? --?	-?	--?
Impacts of climate change in London with the draft Strategy (predicted effects of climate change on sustainability with the draft Strategy and existing / planned adaptation)														
Medium-term (2020s)	+/++	+/++	-	-	0/+	-/0	-	-/0	-?	0?	- +/0	-? -?	-	-
Long-term (2050+)	+/++?	++?	--?	-/--?	--?	-/--?	--?	-/--?	--?	-?	--? -/0	--? --?	-?	--?
Impacts of climate change in London with the "Draft Strategy Plus" (predicted effects of climate change on sustainability with the "draft Strategy Plus" and existing / planned adaptation)														
Medium-term (2020s)	+/++	+/++	-/0	-/0	0/+	-/0	-	-/0	-?	0?	- +	-? -?	-	-/0
Long-term (2050+)	+/++?	++?	-/--?	-/--?	-/--?	-/--?	--?	-/--?	--?	-?	--? +/-	--? --?	-?	-/--?

Key to effects:

Major positive: ++ Minor positive: + Neutral: 0 Minor negative: - Major negative: -- Uncertain:? Mixed: -/+

Overall comments (flooding):

Under the **BAU** scenario, based on known current and planned adaptation, the impacts of climate change projected over the period to the 2020s are still likely to have negative effects in relation to many of the SA objectives, in particular health and well-being, equality and diversity, accessibility and availability, climate change mitigation, waste management and economy, but also potentially biodiversity and water resources and water quality. In the longer term, the projected increased severity of all climate change impacts associated with flooding are predicted to exacerbate the negative effects predicted in the medium-term. However, positive effects are predicted for governance and education and awareness, based on the assumption that as climate impacts become more apparent, people and businesses will become more aware of flood risk.

The effects with the **draft Strategy** are in most cases likely to be very similar to the BAU in the medium and long-term. This reflects the fact that although the specific actions are intended to be delivered generally by 2010 / 2011, they are predominantly preparatory in nature which means they are not considered likely to have significant direct impacts in the short to medium-term; and, they are seeking to develop knowledge and understanding and promote partnership working, which are all likely to facilitate improved flood risk management in the long-term however these long-term effects are dependent on appropriate future actions and initiatives. However, more positive effects are predicted for governance in the medium and long term.

The **Draft Strategy Plus** illustrates that through additional actions to integrate adaptation to future flood risk more quickly into, for example the planning system, some mitigation of the negative effects predicted from climate change for health and well-being, equality and diversity, safety and security, climate change adaptation and economy in particular could potential be achieved.

[28] Objective split between (11.1) mitigation and (11.2) adaptation to Climate Change.
[29] Objective split between (12.1) water quality and (12.2) water resources.
[30] This corresponds to the appraisal of future climatic conditions in London taking into account current and planned adaptation, as presented in Section 4.

Table 15: Summary of the appraisal of business as usual, the draft Strategy and "draft Strategy Plus" alternatives - Drought

Climate change headline impacts and timeframe	Sustainability Objectives													
	1. Governance	2. Education and Awareness	3. Health and Well-being	4. Equality and Diversity	5. Safety and Security	6. Liveability and Place	7. Accessibility and Availability	8. Landscape, Historic and Cultural Environment	9. Biodiversity	10. Air Quality	11. Climate Change[31]	12. Water Quality and Water Resources[32]	13 Waste Management	14 Economy
Drought														
Impacts of climate change in London (predicted effects of climate change on sustainability without the draft Strategy but with existing / planned adaptation i.e. Business as usual (BAU) alternative[33])														
Medium-term (2020s)	+	+/++	-	-	-/0	-/0	-	-/0	-/+	-/0	- -	-/+ -	-/0	-
Long-term (2050+)	+?	++?	-?	-/--?	-?	-?	-?	-/--?	-/--?	-?	-/--? --/+?	-? --?	-?	-?
Impacts of climate change in London with the draft Strategy (predicted effects of climate change on sustainability with the draft Strategy and existing / planned adaptation)														
Medium-term (2020s)	+	++	-	-	-/0	-/0	-	-/0	-/+	-/0	- -/0	-/+ -	-/0	-
Long-term (2050+)	+?	++?	-?	-/--?	-?	-?	-/0?	-/--?	-/--?	-?	-/--? -/+?	-? --?	-?	-?
Impacts of climate change in London with the "Draft Strategy Plus" (predicted effects of climate change on sustainability with the "draft Strategy Plus" and existing / planned adaptation)														
Medium-term (2020s)	+	++	-	-	-/0	-/0	-	-/0	-/+	-/0	- -/0	-/+ -	-/0	-
Long-term (2050+)	+?	++?	-?	-?	-?	-?	-/0?	-?	-?	-?	-/--? -/++?	-? -?	-?	-?

Key to effects:

Major positive: ++ Minor positive: + Neutral: 0 Minor negative: - Major negative: -- Uncertain:? Mixed: -/+

Overall comments (drought):

Under the **BAU** scenario, based on known current and planned adaptation, the impacts of climate change projected over the period to the 2020s are still likely to have significant negative effects in relation to many of the SA objectives, in particular water resources, due to the impact drought periods would have on river flows and water supplies, equality and diversity, accessibility and availability and landscape and the historic environment, biodiversity and climate change. Positive effects are predicted in relation to education and awareness and governance, based on the assumption that the increasing visibility of climate impacts in relation to drought may lead to more people and businesses becoming more aware of drought. In the longer term, the projected increased severity of all climate change impacts associated with drought are predicted to exacerbate the negative effects. However, in the longer-term more extensive adaptation responses, such as the construction of major new resources (e.g. a new reservoir) as well as improvements in water use efficiency and demand management, are likely to have been implemented to address some of the impacts of drought.

The effects with the **draft Strategy** are in nearly all cases very similar to the BAU in the medium and long-term. This reflects the fact that tackling the key long-term effects of drought will depend to a large extent on the implementation of other plans. The actions in the draft Strategy are mainly preparatory and will therefore not have any direct effects in the short-term. The implementation of the Mayor's Water Strategy which seeks improved management of water in London, could lead to significant positive effects on some the sustainability objectives. Water efficiency improvements in existing homes is likely to have a positive influence on the overall effects predicted on education and awareness (in the medium-term) and climate change adaptation (in the medium and long-term). The positive long-term effects predicted on climate change adaptation assumes that the strategic planning proposed in draft Strategy, along with other plans and strategies, have a positive influence on drought risk reduction.

The **Draft Strategy Plus** illustrates that through additional actions to integrate adaptation to drought more quickly into, for example the planning system and through a positive commitment to work towards achieving water neutrality, and with a particular focus on vulnerability and equality issues associated with responding to drought as well as the adaptability / recovery of biodiversity from drought some mitigation of the negative effects predicted (particularly in the longer-term) from climate change for health and well-being, equality and diversity, landscape/townscape, biodiversity and water resources in particular could potential be achieved.

[31] Objective split between (11.1) mitigation and (11.2) adaptation to Climate Change.
[32] Objective split between (12.1) water quality and (12.2) water resources.
[33] This corresponds to the appraisal of future climatic conditions in London taking into account current and planned adaptation, as presented in Section 4.

Table 16: Summary of the appraisal of business as usual, the draft Strategy and "draft Strategy Plus" alternatives - Overheating

Climate change headline impacts and timeframe	Sustainability Objectives													
	1. Governance	2. Education and Awareness	3. Health and Well-being	4. Equality and Diversity	5. Safety and Security	6. Liveability and Place	7. Accessibility and Availability	8. Landscape, Historic and Cultural Environment	9. Biodiversity	10. Air Quality	11. Climate Change[34]	12. Water Quality and Water Resources[35]	13 Waste Management	14 Economy
Overheating														
Impacts of climate change in London (predicted effects of climate change on sustainability without the draft Strategy but with existing / planned adaptation i.e. Business as usual (BAU) alternative[36])														
Medium-term (2020s)	+?	-/+	--/+	-/+	-?	-/+	-/+	-/0	-	--	-/+ 0/+	- -	-/0	-?
Long-term (2050+)	+?	-	--/+?	--/+?	-?	-?	--/+?	-?	--?	--?	--/+? -?	-? -?	-?	-?
Impacts of climate change in London with the draft Strategy (predicted effects of climate change on sustainability with the draft Strategy and existing / planned adaptation)														
Medium-term (2020s)	+	0/+	-/+	-/+	-?	0/+	-/+	-/+	-/+	--	-/+ +	- -	-/0	-?
Long-term (2050+)	+?	-/+	--/+?	--/+?	-?	-/+?	--/+?	-/+?	--/+?	--?	--/+? -/+?	-? -?	-?	-?
Impacts of climate change in London with the "Draft Strategy Plus" (predicted effects of climate change on sustainability with the "draft Strategy Plus" and existing / planned adaptation)														
Medium-term (2020s)	+/++	+	-/+	-/+	-/+?	+	-/+	-/++	-/++	--/-	-/+ +	- -	-/0	-?
Long-term (2050+)	+/++?	+?	-/+?	-/+?	-/+?	-/+?	-/+?	-/++?	-/++?	--/-?	--/+? -/++?	-? -?	-?	-?

Key to effects:

Major positive: ++ Minor positive: + Neutral: 0 Minor negative: - Major negative: -- Uncertain:? Mixed: -/+

Overall comments (overheating):

Under the **BAU** scenario, based on known current and planned adaptation, the impacts of climate change projected over the period to the 2020s are likely to have both negative and positive potential effects on health and well-being, education and awareness, equality and diversity, accessibility and availability and climate change mitigation. Negative effects are predicted on biodiversity, water quality and resources, climate change adaptation, landscape, historic and cultural environment and the economy. In general, these effects reflect on the one hand the predicted effects of higher summer temperatures and heatwaves (generally negative), and on the other the milder winters (generally positive). For example, in relation to health, heatwaves can lead to high levels of mortality, especially in the elderly, however warmer winters will reduce the number of deaths associated with the cold. In the long-term (2050+), the increasing severity of climate impacts on average temperatures and heatwaves is predicted to exacerbate many negative effects predicted. The impact of overheating on air quality, and therefore health, is a key potential negative effect of major significance in the medium and long-term.

The effects with the **draft Strategy** are in most cases likely to be similar to the BAU in the medium and long-term. However, the policy and actions in the draft Strategy are predicted to have generally positive effects in addressing the sustainability implications of climate change on overheating in both the medium-term (2020s) and long-term (2050+). Most significant are the potential positive effects in relation to biodiversity and climate change adaptation due to the proposed increase in the amount of greenspace, planting of street trees etc and ensuring new development is adapted to higher temperatures. However in most cases some significant negative effects are predicted to remain, due to the potential significance of climate impacts, especially in the long-term, and the Mayor's limited powers. A potential positive influence on the overall effects is predicted on: governance; education and awareness; health and wellbeing; liveability and place; landscape, historic and cultural environment; biodiversity; and, climate change adaptation.

The **Draft Strategy Plus** illustrates that through additional actions to integrate adaptation to overheating more quickly into, for example the planning system and design standards, developing and implementing a heat wave plan for London and at a community level and through a positive commitment to focus on vulnerability and equality issues associated with responding to overheating as well as critically improving air quality over the long term, some mitigation of the negative effects predicted from climate change for governance, health and well-being, equality and diversity, safety and security, landscape/townscape, biodiversity, air quality and climate change adaptation in particular could potential be achieved.

[34] Objective split between (11.1) mitigation and (11.2) adaptation to Climate Change.
[35] Objective split between (12.1) water quality and (12.2) water resources.
[36] This corresponds to the appraisal of future climatic conditions in London taking into account current and planned adaptation, as presented in Section 4.

Overall comments on the appraisal of the alternatives

5.17 As discussed on Section 4, the overall appraisal of the *Business as Usual* alternative concluded that the projected climatic changes are predicted to have generally negative effects on the sustainability objectives, and in some case these could be of major significance. The potential negative effects are also generally predicted to increase in the long-term, due to the increasingly significant projected climate change impacts. In many cases these potential effects are considered to be uncertain, especially those predicted in the long-term.

5.18 Compared with the *Business as Usual* alternative, overall the draft Strategy is predicted to have the potential to positively enhance the sustainability effects of existing and planned adaptation to climate change, e.g. establishing the necessary governance and awareness to facilitate adaptation, especially in the short term. Overall the draft Strategy is also predicted to have the potential to reduce some of the negative effects on sustainability of climate change, e.g. reducing the potential health effects of overheating, especially in the short term (see Section 6).

5.19 The draft Strategy is predicted to especially make a difference over and above the *Business as Usual* alternative in relation to overheating. This is possibly in part due to the relatively low base of current and planned adaptation in relation to overheating and also the fact that the draft Strategy includes very specific actions for overheating including targets for green space, tree cover etc. In addition, the Mayor potentially has limited powers in some other areas such as flooding, where other organisations will have to play a critical role to deliver adaptation. As a result, the draft Strategy is predicted to be limited in how far it could reduce the negative effects and enhance the positive effects of climate change in the medium and long term compared with the *Business as Usual*. Clearly there is a high degree of uncertainty surround these predictions.

5.20 The draft Strategy Plus alternative illustrates how the current draft Strategy could be built on to incorporate a greater level of adaptation which seeks to further minimise the potential negative sustainability effects and maximise the positive effects of the predicted climatic changes in London and provide a clearer roadmap of the actions necessary beyond the predominately prepare dimension included in the current draft Strategy. As illustrated and discussed in Table 16, some mitigation of the negative effects predicted from climate change across many of the SA objectives could potential be achieved. This approach represents more of a step change on the way adaptation is being planned and implemented in London and something that needs to be considered in future versions of the Strategy.

5.21 The draft Strategy Plus alternative has helped to identify possible mitigation and enhancement recommendations where the appraisal of the policies and actions included in the draft Strategy concluded that there were residual significant negative effects or missed potential opportunities due to predicted climate change impacts, taking into account current and planned adaptation and the influence of the policies and actions included in the draft Strategy (see Section 6).

6. APPRAISAL OF THE DRAFT STRATEGY

Introduction to the appraisal of the draft Strategy

6.1 This section presents the findings of the appraisal of the different elements included within the draft Strategy (28 January 2010) as well as the draft Strategy overall. The appraisal concentrated on three aspects:

i) Appraisal of the compatibility of the **draft Strategy objectives** with the SA objectives;

ii) Appraisal of the **draft Strategy policies and actions**, including specific recommendations for mitigation and enhancement; and,

iii) Appraisal of the **draft Strategy overall**, including cumulative effects and effects relating to health and health inequalities.

6.2 Section 5 identifies the key sustainability effects of the policies and actions included in the draft Strategy at a strategic level and compares these to the business as usual and alternative Strategy. This section seeks to provide more detailed appraisal commentary on the draft Strategy's objectives, policies and actions and includes specific recommendations for mitigation and enhancement, as well as identifying potential omissions, which if included would help address negative sustainability effects identified, or enhance potential positive effects.

6.3 The appraisal of the policies and actions was based on an initial appraisal of an earlier draft version of the Strategy (received from the GLA on 25 September 2009) which was then amended to reflect the policies and actions as included in the draft CCAS for Public Consultation (28 January 2010) which included some relatively minor changes.

6.4 This section also provides an appraisal of the sustainability effects of the draft Strategy overall, including cumulative effects. This differs from an appraisal of individual policies and actions, as it seeks to identify how the potential effects of the policies and actions might interact with each other or act collectively to have significant positive or negative effects on certain receptors. This section also includes a summary of the potential effects relating to health and health inequalities, as well as an overview of the difference the SA has made to the draft Strategy.

Compatibility of the draft Strategy objectives and the Sustainability Appraisal objectives

Purpose of testing the compatibility of the objectives

6.5 The Government's SA guidance[37] recommends that a strategy's objectives are tested against the SA objectives to ensure they are consistent and to identify potential tensions. Whilst the aim should be to achieve consistency between the plan and SA objectives, in practice there may well be tensions between depending on the nature of the plan. Where win-win outcomes cannot be achieved, the Mayor will need to determine where the priorities should lie.

[37] ODPM (2005) *Sustainability Appraisal of Regional Spatial Strategies and Local Development Documents*

Objectives of the draft Strategy

6.6 The draft Strategy has the following overall objectives (as detailed in the introduction to the Draft Strategy):

1. to identify and prioritise the climate risks and opportunities facing London and understand how these change through the century
2. to identify and prioritise the key actions required to prepare London, and to define where responsibility for delivering and facilitating these actions lies
3. to promote and facilitate new development and infrastructure that is located, designed and constructed for the climate it will experience over its design life
4. to improve the resilience of London's existing development and infrastructure to the impacts of climate change
5. to ensure that tried and tested emergency management plans exist for the key risks and are regularly reviewed
6. to encourage and help business, public sector organisations and other institutions prepare for the challenges and opportunities presented by climate change
7. to promote and facilitate the adaptation of the natural environment
8. to raise general awareness and understanding of climate change with Londoners and improve their capacity to respond to changing climate risks
9. to position London as an international leader in tackling climate change.

6.7 These objectives have been amended during the SA process and the drafting of the Strategy. These changes include:

- The inclusion of *prioritisation* of climate risks and opportunities in objective 1.
- The introduction of a new objective (2) stating that a key objective of the draft Strategy is to prioritise key actions and define responsibility for these actions.

Compatibility of the draft Strategy and Sustainability Appraisal objectives

6.8 The results of testing the draft Strategy objectives against the SA objectives are presented in Table 17. The draft Strategy objectives were generally considered to be compatible (or neutral) when tested against the SA objectives, with no significant potential conflicts identified. There are therefore limited changes proposed to the objectives arising from any potential conflicts identified by the SA. However, some more general comments and recommended changes to the wording of the draft Strategy's objectives to strengthen their sustainability performance are detailed following Table 17.

Table 17: Compatibility of the draft Strategy objectives and the Sustainability Appraisal objectives

Climate Change Adaptation Strategy Objectives	Sustainability Appraisal Objectives													
	1. Governance	2. Education and Awareness	3. Health and Well-being	4. Equality and Diversity	5. Safety and Security	6. Liveability and Place	7. Accessibility and Availability	8. Landscape, Historic and Cultural Environment	9. Biodiversity	10. Air Quality	11. Climate Change[38]	12. Water Quality[39]	13. Waste Management	14. Economy
1. To identify and prioritise the climate risks and opportunities facing London and understand how these change through the century	+	+	0	0	0	0	0	0	0	0	0 +	0 0	0	0
2. To identify and prioritise the key actions to prepare London, and to define where responsibility for delivering and facilitating these actions lies	+	0	0	0	0	0	0	0	0	0	0 +	0	0	0
3. To promote and facilitate new development and infrastructure that is located, designed and constructed for the climate it will experience over its design life	+	+	+	+	+	+	+	0	0	0	0 +	+ +	0	+
4. To improve the resilience of London's existing development and infrastructure to the impacts of climate change	+	+	+	+	+	+	+	0	0	0	0 +	+ +	0	+
5. To ensure that tried and tested emergency plans exist for the key risks and are regularly reviewed	+	+	+	+	+	0	+	0	0	0	0 +	0 +	0	+
6. To encourage and help business, public sector organisations and other institutions prepare for the challenges and opportunities presented by climate change	+	+	+	+	+	0	0	0	0	0	0 +	0 0	0	+
7. To promote and facilitate the adaptation of the natural environment	+	+	+	0	0	+	0	+	+	+	0 +	+ +	0	+
8. To raise general awareness and understanding of climate change with Londoners and improve their capacity to respond to changing climate risks	+	+	+	+	+	0	0	0	0	0	0 +	0 0	0	+
9. To position London as an international leader in tackling climate change.	+	0	0	0	0	0	0	0	0	0	+ +	0 0	0	+

Key	Compatible:	+	Neutral:	0	Possible conflict:	-

[38] Objective split between (11i) mitigation and (11ii) adaptation to Climate Change
[39] Objective split between (12i) water quality and (12ii) security of supply and prudent management

Objective 1: To identify and prioritise the climate risks and opportunities facing London and understand how these change through the century

6.9 Comments and recommended changes to the first objective include:

- It could strengthen this objective if it also stated that those groups which may be most likely to be affected by the risks and opportunities predicted will be identified to help ensure resilience measures target those most at need.

Objective 2: To identify and prioritise the key actions to prepare London, and to define where responsibility for delivering and facilitating these actions lies

6.10 Comments and recommended changes to the second objective include:

- No changes are suggested to this objective.

Objective 3: To promote and facilitate new development and infrastructure that is located, designed and constructed for the climate it will experience over its design life

6.11 Comments and recommended changes to the third objective include:

- The construction of new development and infrastructure will lead to the use of resources and creation of waste, however the focus of the objective is to ensure developments are adapted to climate change over their design life, rather than facilitating development in itself.
- While this objective is considered generally positive in sustainability terms, the focus on "new development and infrastructure" limits its' scope and it could be strengthened by the inclusion of the public realm, for example.

Objective 4: To improve the resilience of London's existing development and infrastructure to the impacts of climate change

6.12 Comments and recommended changes to the fourth objective include:

- Construction and resource use associated with improving the resilience of London's existing development and infrastructure could conflict with the climate change mitigation and waste management objectives. However, more resilient development is likely to require (for example) less mechanical cooling, and less frequent maintenance. This objective is therefore predicted overall to be neutral in relation to climate mitigation and waste management SA objectives.
- While this objective is considered generally positive in sustainability terms, the focus on "existing development and infrastructure" in this objective potentially limits its' scope and it could be strengthened by the inclusion the public realm, for example.

Objective 5: To ensure that tried and tested emergency plans exist for the key risks and are regularly reviewed

6.13 Comments and recommended changes to the fifth objective include:

- While this objective is considered generally positive in sustainability terms, reference could be included to ensure existing and new plans also consider recovery from emergency events.

Objective 6: To encourage and help business, public sector organisations and other institutions prepare for the challenges and opportunities presented by climate change

6.14 Comments and recommended changes to the sixth objective include:

- While this objective is considered generally positive in sustainability terms the scope is potentially limited by only including "business, public sector organisations and other institutions" and it would benefit from being expanded to also include communities, households and individuals.

Objective 7: To promote and facilitate the adaptation of the natural environment

6.15 Comments and recommended changes to the seventh objective include:

- Whilst this objective is considered generally positive in sustainability terms, it could be strengthened by specifically including open, green and amenity spaces and other green infrastructure.
- This objective could be expanded to include not only the natural environment, but also the historic environment which is not currently covered by any of the objectives.

Objective 8: To raise general awareness and understanding of climate change with Londoners and improve their capacity to respond to changing climate risks

6.16 Comments and recommended changes to the eighth objective include:

- Whilst this objective is considered generally positive in sustainability terms, however, it is just limited to Londoners, and could be strengthened by including those people that do not live in London but still need to be aware of climate change and risks in London e.g. workers, tourists, visitors etc.

Objective 9: To position London as an international leader in tackling climate change

6.17 Comments and recommended changes to the ninth objective include:

- Whilst this objective is considered generally positive in sustainability terms, perhaps, as the draft Strategy is an adaptation strategy the objective should seek for London to become an international leader in "adapting to climate change" rather than "tackling climate change".

Potential omissions from the draft Strategy objectives

6.18 While the assessment presented in Table 17 has appraised the compatibility of the draft Strategy objectives with the SA objectives, the SA also considered if there were any potential key omissions from the draft Strategy objectives, in terms of setting a high-level framework for the draft Strategy. The following potential omissions were identified:

- The draft Strategy objectives would be strengthened by the inclusion of an objective relating to community resilience and adaptation, as well as specific text within a new, or existing objective relating to the need to understand risks to, and protect, in particular vulnerable communities and individuals.
- The introduction to the draft Strategy states that *"many of the opportunities [of climate change] will require action to realise the benefits"*. It is recommended that a specific

objective could be included setting out that the Mayor proposes to maximise the potential beneficial effects of a changing climate will be maximised.

Comments on the aim of the draft Strategy and the introductory section

Aim of the draft Strategy

6.19 The aim of the draft Strategy is "*assess the consequences of climate change on London and to prepare for the impacts of climate change and extreme weather to protect and enhance the quality of life of Londoners".*

6.20 Recommendations to improve the aim of the draft Strategy include:

- The aim could also incorporate and refer to the need to take advantage of and exploit any beneficial effects of climate change, rather than just referring to "impacts" which is likely to be interpreted as being negative.
- It is recommended that the aim should reflect the long timescales involved in adaptation and the period covered by the draft Strategy (i.e. the rest of the century), given the importance of considering the future changes in risks as well as the impacts that decisions made today have on future consequences.
- The concept of "building adaptation capacity" and "delivering adaptation actions" could be included within the aim, as, to "prepare for the impacts" will require both creating the information and conditions that enable adaptation actions to take place and taking actions that will help to reduce vulnerability to climate risks or exploit opportunities.

Other comments on the introductory section

6.21 This section includes a few further recommendations on the draft Strategy and in particular on the introductory section.

- The predominant focus of the draft Strategy is rightly on addressing the negative impacts of climate change. However the introduction and Chapter 1 *London's Future Climate* could provide more information and direction on what opportunities might arise from climate change, and how these may be exploited. This could be supported by additional policy and / or actions (see specific comments below).
- The introduction to the draft Strategy (page 18) states that the strategy *"considers the climate over the century, but particularly focuses on the period up to 2031"*. However, most of the Actions in the draft Strategy are intended to be delivered by 2011/2012, and it is not clear how the Visions and Policies will be implemented / achieved over the longer term, even 5-10 years in the future. A clear outline of a roadmap for future actions (beyond the specific short-term actions included in the draft) would enhance the draft Strategy significantly. Timescales could therefore be made clearer, in the introduction, and throughout the draft Strategy in the short, medium and long term.
- Under the "next steps" subsection of the Introduction (page 20) the question is asked how the strategy should be monitored and what key indicators used. It is recommended that the draft Strategy should include proposals on monitoring and consult on them rather than just asking consultees to suggest them.

Approach to the appraisal of the flooding, drought, overheating and cross-cutting sections of the draft Strategy

6.22 This section outlines the approach to the appraisal of the flooding, drought and overheating Policies and Actions included in chapters 3, 4 and 5 of the draft Strategy, as well as the cross-cutting actions relating to health, the environment, the economy and infrastructure included in chapters 6 – 10 of the draft Strategy. The comments and recommendations included in this section are based upon the key findings of the appraisal of the draft Strategy presented in this section and Section 5 and the appraisal matrices and comments included in Appendix 8 and 9.

6.23 The draft Strategy does not include visions or policies associated with the cross-cutting Actions and these were not appraised using appraisal matrices. However, comments and recommendations relating to the sustainability performance are included for these cross-cutting actions below.

6.24 The approach to the appraisal of the flooding, drought and overheating policies and actions is described in full in Section 2 and Section 5. In summary, the appraisal of the draft Strategy policies and actions was carried out in three iterative steps:

- Review of the evidence base around climate change and the issues addressed by each Policy (flood risk, drought and overheating) in London drawing on the draft Strategy and the context collated for the SA (see Section 3 (Part A) and Section 4);
- Use of causal chain analysis to identify the key potential pathways, effects and receptors in relation to the impacts of climate change on flooding, drought and overheating (see Section 4); and,
- An appraisal of the policies and actions against the SA objectives to evaluate the potential significance of the effects (see Appendix 8).

6.25 Health specific effects were investigated through causal chain analysis drafted for the Health Stakeholder Workshop held in March 2007 and further refined at the event, and throughout the appraisal. A report on the outcomes of the Health Stakeholder Workshop is available from GLA on request.

6.26 It should be noted that each of the policies were appraised in combination with the sets of actions which are intended to deliver them. While each action was not appraised individually, in appraising each policy the likely contribution and effects of the actions were considered in the overall effects predicted, and reflected in the SA comments in each appraisal matrix (see Appendix 8). In relation to some SA objectives, only one or a small number of actions were considered likely to have significant effects and therefore reference was made in the appraisal matrices to specific actions where considered appropriate.

6.27 The results of the appraisal of the effects of each policy has been summarised in the following sections. For a more detailed commentary and explanation on the scores, reference should be made to the significance criteria, causal chains analysis and detailed matrices / comments included in Appendix 5 (Part A), Section 4 and Appendices 8 and 9 respectively.

6.28 A vision is included in the draft Strategy for each of the key policy areas (flooding, drought and overheating). Specific comments on each of the visions are also included below.

Appraisal of the flooding policy and actions

6.29 The flooding vision, policy 1 and actions 1 – 9 from the draft Strategy are included in Table 18 below. The separate bullet points in the policy and the actions have been categorised according to the *Prevent, Prepare, Respond, Recover* adaptation framework. This framework was used in the development of the draft Strategy as well as to assist in the appraisal of the policies and actions. This adaptation framework and its use in the SA is described in Section 4.

Table 18: Summary and categorisation of flooding vision, policy and actions

	Adaptation type			
	Prevent	Prepare	Respond	Recover
FLOODING				
Vision: **London is resilient to all but the most extreme floods and has robust emergency plans to respond to, and recover from, flooding.**				
Policy 1: The Mayor will work with partners to reduce and manage current and future flood risk in London by:				
• Improving the understanding of flood risk in London and how climate change will alter the risks to improve our ability to manage flood risk.		●		
• Reducing flood risk to the most critical assets and vulnerable communities to target the greatest effort on London's most vulnerable assets.	●	●		
• Raising public awareness of flooding and individual and community capacity to cope and recover from a flood to improve London's resilience to flood events.		●	●	●
To improve our ability to predict and manage flood risk, further work is required to understand surface water flood risk and how climate change will increase all forms of flood risk:				
Action 1: The Mayor will work with the Environment Agency, Boroughs and other partners to improve the mapping of who and what is at flood risk from all sources of flooding today, and to predict future flood risk for all flood sources.		●		
Action 2: The Drain London Forum will develop a surface water management plan for London which identifies and prioritises areas at risk and develops more detailed plans for the priority areas.		●		
Action 3: The Drain London Forum will create an online data portal to allow flood risk management partners to more effectively share information and data analysis.		●		
Action 4: The Drain London Forum will create a flood incident reporting system that is adopted throughout London to improve our understanding of flood risk today.		●		
Action 5: The Mayor will work with boroughs through the Association of London Borough Planning Officers and the Local Resilience Forums to ensure that flood risk management is integrated across borough boundaries and within borough teams.		●		
In order to prioritise flood risk management actions we need to identify the most vulnerable communities and critical assets:				
Action 6: The Mayor will work with the Environment Agency, London Resilience and the London Climate Change Partnership to identify and prioritise critical infrastructure and vulnerable communities at flood risk.		●		
Action 7: To reduce the risk of local surface water flooding, the Mayor will work with TfL, London Boroughs and Thames Water to review their drain and gully maintenance programme, particularly in high risk areas.	●	●		
We will seek to raise individual and community level awareness of flooding and the capacity to cope and recover from a flood:				
Action 8: The Mayor will work with the Environment Agency to increase the number of Londoners signing up to the Floodline Warning Direct scheme and to raise awareness of the measures that individuals and communities can undertake to reduce the risks and manage the consequences of flooding.		●	●	
Action 9: The Drain London Forum will identify 2 communities at significant flood risk and work with them to develop bespoke community flood plans to build their capacity to manage flood risk.		●	●	

Comments on the vision for flooding

6.30 The vision for flooding is considered generally positive as it provides a good long-term vision for achieving adaptation to increased flood risk due to climate change. By expressing the need for London to be resilient to flooding, while at the same time ensuring emergency plans are in place to respond and recover from flooding, the vision is considered to address, at a strategic level, all of the aspects of the *Prevent, Prepare, Respond, Recover* adaptation framework.

6.31 The SA identified one recommendation for improvement, from a sustainability perspective:

- It is suggested that the vision could refer to flooding "from all sources", to ensure these are explicitly addressed.

Summary of the findings of the appraisal of the flooding policy and actions

6.32 Table 19 summarises the findings of the overall appraisal of the flooding policy and actions included in the draft Strategy.

6.33 The three sections of the summary presented in Table 19, and the equivalent tables for drought (Table 23) and overheating (Table 27) below, represent:

- **Business as usual (BAU):** This is an appraisal of the sustainability effects of predicted climate changes in London in the medium and long-term, taking into account likely evolution of the baseline without the strategy and current and planned adaptation. For more information on the appraisal of BAU see Section 4.
- **Draft Strategy (in isolation):** Represents an appraisal of the likely sustainability effects of the policies and actions included in the draft Strategy, in the medium and long-term, considered in isolation from the likely evolution of the baseline without the strategy and the current and planned adaptation.
- **draft Strategy (net the effects of climate change and current and planned adaptation):** This is an appraisal of the overall sustainability effects predicted over the medium and long-term of likely climate changes in London, with current and planned adaptation and the influence of the draft Strategy. This therefore represents the predicted net effects of climate change in London, even when the likely influence of the policies and actions included in the draft Strategy are taken into account.

6.34 The summary matrix draws on the more detailed appraisal presented in Section 5, Appendix 8 and Appendix 9.

Table 19: Summary of appraisal findings – flooding

	Sustainability Appraisal Objectives													
	1. Governance	2. Education and Awareness	3. Health and Well-being	4. Equality and Diversity	5. Safety and Security	6. Liveability and Place	7. Accessibility and Availability	8. Landscape, Historic and Cultural Environment	9. Biodiversity	10. Air Quality	11. Climate Change[40]	12. Water Quality and Water Resources[41]	13 Waste Management	14 Economy
Impacts of climate change in London (predicted effects of climate change on sustainability without the draft Strategy but with existing / planned adaptation i.e. Business as usual alternative)														
Medium-term (2020s)	+	+/++	-	-	-/0	-/0	-	-/0	-?	0?	- -/+	-? -?	-	-
Long-term (2050+)	+	++?	--?	-/--?	--?	-/--?	--?	-/--?	--?	-?	--? -?	--? --?	-?	--?
Impacts of the Draft Strategy in isolation (predicted effects on sustainability of the draft Strategy as an initial framework for adaptation)														
Medium-term (2020s)	+/++	+	0/+	0/+	+	-/+	0/+	-/+	-/+	0	-/0 +	+ 0/+?	0/-/+	0/+
Long-term (2050+)	+?	0/+	0/+	0/+	0/+	-/+	0/+	-/+	-/+?	0	- +	+ 0/+?	0/-/+	+
Impacts of climate change in London with the draft Strategy (predicted effects of climate change on sustainability with the draft Strategy and existing / planned adaptation)														
Medium-term (2020s)	+/++	+/++	-	-	0/+	-/0	-	-/0	-?	0?	- +/0	-? -?	-	-
Long-term (2050+)	+/++?	++?	--?	-/--?	--?	-/--?	--?	-/--?	--?	-?	--? -/0	--? --?	-?	--?
Key to effects: Major positive: ++ Minor positive: + Neutral: 0 Minor negative: - Major negative: -- Uncertain:? Mixed: -/+														

6.35 Policy 1 and associated actions 1 – 9 are predicted to have generally positive effects on the SA objectives, with only a few minor negative effects, or mixed positive and negative effects predicted. With the exception of governance, the effects predicted are all considered likely to be minor in significance. This reflects the preparatory nature of the flooding actions, as indicated in the categorisation of actions included in Table 18.

6.36 Potential positive effects predicted include:

- A number of the actions seek to encourage or facilitate collaborative working, communication and improved information (e.g. mapping), all of which are predicted to **improve the ability of organisations with responsibility for flood risk management to work together**, thus improving governance of flood risk.
- Positive effects are predicted on education and awareness due to the potential influence of a number of the actions relating to **increasing knowledge and information of flooding and flood risk in London**, as well as specific actions (8 and 9) directly seeking to raise **awareness of flood risks** and develop community flood risk plans.
- Minor positive effects are predicted in relation to a number of SA objectives due to the policy and action's focus on **reducing and managing flood risk**. For example, positive effects are predicted on health and wellbeing, due to the potential reduction in the negative health effects of flood events (where risks are reduced) as well as a potential reduction in the occurrence of mental health problems associated with flood events and recovery from flooding.

[40] Objective split between (11.1) mitigation and (11.2) adaptation to Climate Change.
[41] Objective split between (12.1) water quality and (12.2) water resources.

6.37 Potential negative effects predicted include:

- Direct intervention to reduce flood risks / implement flood risk management measures could lead to **potentially increased construction activity, noise disturbance, increased energy and resource use as well as waste generation**. In addition, additional physical flood defences constructed to reduce flood risk could lead to **changes in the landscape and cityscape of London and visual amenity**, with potential negative effects on landscape, the historic and cultural environment, biodiversity, climate change mitigation and waste and resources.

6.38 The summary appraisal indicates that the effects predicted are in most cases likely to be very similar in the medium-term (2020s) and the long-term (2050s). This reflects the fact that although the specific actions are intended to be delivered generally by 2010 / 2011, they are predominantly preparatory in nature which means that:

- they are not considered likely to have significant direct impacts in the short to medium-term; and,
- they are generally seeking to develop knowledge and understanding and promote partnership working, which are all likely to facilitate improved flood risk management in the long-term. These long-term effects are dependent on appropriate future actions and initiatives.

6.39 However, the net effects of climate change with the draft Strategy indicate that although policy 1 and associated actions are considered positive from a sustainability perspective, the influence they are predicted to have is not considered sufficient to alter the majority of predicted effects of the impact of climate change on flooding in London, both in the medium and long-term. It is only in relation to the governance, safety and security and climate change adaptation SA objectives that the draft Strategy is considered likely to significantly influence the overall effects of climate change on flooding in London.

6.40 This indicates that considerable additional intervention will be required to address these residual negative effects associated with future flooding in London. It is recognised that the Mayor has relatively limited powers in this area with the exception of spatial planning (through the London Plan and development control powers for example) and that the effective avoidance of negative impacts of climate change on flooding (i.e. adaptation) in the future will rely heavily on initiatives such as TE2100 being finalised, funded and implemented. The London Plan could also seek to provide a stronger policy lead in flood risk management, for example: ensuring development does not occur in flood risk areas; safeguarding storage areas; and. promoting temporary uses in at risk areas.

Comments on Policy 1: Flooding

6.41 Overall policy 1 is considered positive from a sustainability perspective. As a high-level policy for managing flood risk in London it addresses to some extent all aspects of the *Prevent, Prepare, Respond, Recover* adaptation framework, although its main focus is on the “prepare” dimension. If implemented fully, policy 1 is considered likely to provide adaptation, both over the medium and long-term. As a high-level Policy, the individual bullet points provide a framework for actions 1 – 9.

6.42 Specific reference to current and future flood risk, and the inclusion in the policy of a reference to vulnerable communities, as well as the need to raise capacity to recover from floods is welcomed from a sustainability perspective.

6.43 Table 20 includes specific comments and recommendations on the flooding policy (as summarised in Table 18). These comments and recommendations are based on the findings of the appraisal:

Table 20: Comments and recommendations on flooding policy

Policy 1: Flooding
Recommendations for changes (mitigation and enhancement)
Specific recommendations include: • The introductory text could provide examples of the key partners the Mayor intends to work with in delivering the policy, although it is noted these are included in specific Actions. • There is no reference in the policy (or actions) to the needs to conserve and enhance London's environment (including biodiversity, historic environment etc) in delivering the policy. This may be particularly relevant for the 2nd bullet point as certain aspects of reducing flood risk (e.g. enhancing / building new flood defences) will need to be done sensitively to not conflict with environmental objectives. Potential omissions include: • The policy could also seek to ensure that developments built in flood risk areas are appropriate to their location (given today's climate and as predicted in the future). • It is also suggested that flood risk avoidance (e.g. not allowing certain types of development in certain areas now, and in the future as flood risk changes) could be included as a concept. • The policy could seek to support London's businesses in realising any economic opportunities from adaptation, as is proposed in the Mayor's consultation draft Economic Development Strategy, Objective 3. It is recognised this is partially addressed by cross-cutting Action 31. • The policy could promote the important role of the insurance industry in flood preparation, response and recovery, and involve them actively in adaptation to flooding in London. • The policy could address the potential impacts on London's biodiversity, landscape, historic and cultural environment, as well as any opportunities that may arise. The appraisal identified potentially significant negative effects from flooding on the environment, as well as potential effects from some adaptation responses, such as improvements to flood defences. These improvements should be sensitive to the environment, and seek opportunities to improve it.

Comments on the flooding actions 1 – 9

6.44 Actions 1 – 9 are welcomed from a sustainability perspective. They in particular include specific actions and responsibilities in relation to the prepare dimension of the *Prevent, Prepare, Respond, Recover* adaptation framework. If implemented fully they would provide / facilitate the identification and development of information and knowledge to help understand flood risks in London. However, the categorisation of actions 1 – 9 in Table 18 indicates that only three actions partially addresses the respond dimension, two prevent and only one recover.

6.45 Although it is a key aspect of the policy (2nd bullet), there is limited specific action proposed to address the prevention of flooding. The Strategy potentially represents an opportunity to provide the impetus for a more radical rethink of planning and development in London in the medium to long-term. Consideration could be given to the inclusion of one or more actions which seek to address the approach to planning for flood risk in London, for example through the new London Plan.

6.46 Table 21 includes specific comments and recommendations on the flooding actions. These comments and recommendations are based on the findings of the appraisal:

Table 21: Comments and recommendations on the flooding actions (actions 1 - 9)

Flooding Actions
Recommendations for changes (mitigation and enhancement)

Specific recommendations include:
• Some of actions, such as those to improve the management of flood risk, and in particular surface water flooding may be addressed through the draft Flood and Water Management Bill. Has this been accounted for? These actions are considered positive, and it is not suggested they be removed, however their implementation may be strengthened by reference to the emerging Bill / Act[42].
• As most of the actions fall into the prepare category, it would be useful to set out in the Actions (or the roadmap in Part IV of the draft Strategy) an indication of the next steps that are likely to be required to take the action forward over the longer term.
• Action 1 could include text to state that improved flood risk mapping will be used to improve spatial planning in boroughs, and to inform the new London Plan.
• Action 2 appears to correspond to proposal 9 in the draft Water Strategy. However, the proposal in draft Water Strategy also sought action from London Boroughs to develop local level Surface Water Management Plans (SWMPs). Reference to borough level SWMPs could be included in Action 2.
• It is recommended that the flood incident report system referred to in action 4 should linked to captured health data to ensure health impacts of flooding are recorded and this information is used in future flood preparation, response and recovery.
• Action 6 could include a requirement for risk to critical infrastructure and vulnerable communities to be assessed now, but also to consider how risks will change over the period to 2031 (which is the period the draft Strategy is focussed on) and beyond, and that this risk assessment will be reviewed on a regular basis to account for improved knowledge and understanding of climate risks (e.g. every 2 years).
• In relation to action 7, how effective is pre-emptive drain and gully cleaning likely to be given the uncertainty over the exact location of heavy rainfall? Consideration should be given to whether the focus should be on ensuring drains and gullies are all cleaned to an appropriate standard all the time.
• Action 9 could usefully include detailed of the next steps if the two pilot communities are a success e.g. a commitment to roll out the development of bespoke flood plans across London.
 	
Potential omissions include:
• The vision seeks “robust emergency plans to respond to, and recover from, flooding”. However, there appears to be no Action related specifically to this. Although action 9 refers to “bespoke community flood plans” it is not clear if these would include emergency planning.
• Consideration could be given to the inclusion of additional actions that:
  ○ Encourage increased permeability and flood storage capacity in new and existing development.
  ○ Require all new development / retrofitting of existing development to account for flood risk over the planned lifespan of the development. This could be achieved by ensuring that Flood Risk Assessment’s on new developments consider flood risk under future climate conditions over the lifespan of the development.
  ○ Propose that the Mayor works with the Environment Agency, boroughs and the London Development Agency (LDA) to identify and safeguard areas through the London Plan and Local Development Framework process for future flood storage (fluvial and tidal) identified through TE2100 and flood risk management strategies to help manage future flood risk.
  ○ Support London’s businesses in realising any economic opportunities from adaptation, as is proposed in the Mayor’s consultation draft Economic Development Strategy, objective 3.
  ○ Promote the important role of the insurance industry in flood preparation, response and recovery, and involve them actively in adaptation in London.
  ○ Address the potential impacts on London’s biodiversity, landscape, historic and cultural environment – as well as any opportunities that may arise.

[42] For more information on the Bill see: http://www.defra.gov.uk/environment/flooding/policy/fwmb/index.htm

Appraisal of the drought policy and actions

6.47 The drought vision, policy 2 and actions 10 – 14 from the draft Strategy are included in Table 22 below. The separate bullet points in the policy and the actions have been categorised according to the *Prevent, Prepare, Respond, Recover* adaptation framework. This framework was used in the development of the draft Strategy as well as to assist in the appraisal of the policies and actions. This adaptation framework and its use in the SA is described in Section 4.

Table 22: Summary and categorisation of drought policy and actions

	Adaptation type			
	Prevent	Prepare	Respond	Recover
DROUGHT				
Vision: To achieve a sustainable supply and demand balance for water in London by 2030 and make London more robust to drought.				
Policy 2: The Mayor will work with partners to improve the sustainability of London's water supply and demand balance and make London more robust to drought by:				
• Taking a strategic view on London's water resources	●	●	●	●
• Reducing the demand for water in London	●	●		
• Improving our response to drought			●	
We need to take a strategic view on London's water resources:				
Action 10: The Mayor will publish and regularly review a London Water Strategy that presents a London-specific view of managing water resources, with the goal of improved water management – both the water we want (such as drinking water) and the water we don't (such as sewage and floodwater in the wrong place).		●		
Action 11: The London Water Group will undertake a study to define 'water neutrality' in London and explore how strategic scale water efficiency measures could make London more resilient to drought and long-term changes in water resources.		●		
Action 12: The Mayor will lobby the water utility regulator (OfWat) to encourage and enable the water companies to deliver greater household water efficiency savings and greater investment in London's water infrastructure.	●	●		
London must reduce the amount of water it consumes, both to reduce our impact on the environment of our demands for water and to improve our resilience to drought :				
Action 13: The Mayor will work with the Boroughs (through the Home Energy Efficiency Programme) to improve the energy and water efficiency of up to 1.2 million homes across London by 2015 and with businesses and the GLA estate managers to improve the energy and water efficiency of public and commercial buildings in London (through the Green 500, Building Energy Efficiency Programme and the Mayor's Green Procurement Code).	●	●		
In order to improve our response to droughts:				
Action 14: The Mayor recommends that the London Resilience Partnership should review the need for a London-specific Drought Plan.		●		

Comments on the vision for Drought

6.48 The vision for drought is considered generally positive from a sustainability perspective as it provides a good long-term vision for reducing the risk and impact of drought periods, which are predicted to increase in frequency and severity due to climate change, by seeking to ensure a sustainable supply and demand balance for water and make London more robust to drought. The vision is considered to broadly address, at a strategic level, all aspects of the *Prevent, Prepare, Respond, Recover* adaptation framework.

6.49 The SA identified a small number of recommendations for improvement, from a sustainability perspective:

- The vision could state that to be more robust to drought, London will need to be able to respond to and recover from drought periods. Although the draft Strategy states that once a drought is over, recovery occurs naturally, from a sustainability perspective planned recovery from drought periods could be important for the natural environment – such as trees, habitats and biodiversity, green spaces etc. Active intervention may be required to avoid significant losses to native trees and plants, and recovery will be an important aspect of this.
- It is recommended that working towards achieving water neutrality could be made a central theme of the vision, providing strategic level support to the action relating to this.
- The vision could also refer to the likely need to develop new water resources for London, especially in the long-term.

Summary of the findings of the appraisal of the drought policy and actions

6.50 Table 23 summarises the findings of the overall appraisal of the drought policy and actions included in the draft Strategy.

6.51 The summary matrix draws on the more detailed appraisal presented in Section 5, Appendix 8 and Appendix 9.

Table 23: Summary of appraisal findings – drought

	Sustainability Appraisal Objectives													
	1. Governance	2. Education and Awareness	3. Health and Well-being	4. Equality and Diversity	5. Safety and Security	6. Liveability and Place	7. Accessibility and Availability	8. Landscape, Historic and Cultural Environment	9. Biodiversity	10. Air Quality	11. Climate Change[43]	12. Water Quality and Water Resources[44]	13 Waste Management	14 Economy
Impacts of climate change in London (predicted effects of climate change on sustainability without the draft Strategy but with existing / planned adaptation i.e. Business as usual alternative)														
Medium-term (2020s)	+	+/++	-	-	-/0	-/0	-	-/0	-/+	-/0	- -	-/+ -	-/0	-
Long-term (2050+)	+?	++?	-?	-/--?	-?	-?	-?	-/--?	-/--?	-?	-/--? --/+?	-? --?	-?	-?
Impacts of climate change in London with the draft Strategy (predicted effects of climate change on sustainability with the draft Strategy and existing / planned adaptation)														
Medium-term (2020s)	0/+	+	0/+	-/+?	+	0/+	0/+	0/+	0/+	0/+	0/+ +	0/+ 0/+	0	-/+?
Long-term (2050+)	0?	+?	0/+?	-/+?	+?	0/+?	0/+?	0/+?	0/+?	0/+?	0/+? +	0/+ 0/+	0	+?
Impacts of the Draft Strategy in isolation (predicted effects on sustainability of the draft Strategy as an initial framework for adaptation)														
Medium-term (2020s)	+	++	-	-	-/0	-/0	-	-/0	-/+	-/0	- 0/-	-/+ -	-/0	-
Long-term (2050+)	+?	++?	-?	-/--?	-?	-?	-/0?	-/--?	-/--?	-?	-/--? -/+?	-? --?	-?	-?
Key to effects: Major positive: ++ Minor positive: + Neutral: 0 Minor negative: - Major negative: -- Uncertain:? Mixed: -/+														

6.52 Policy 2 and associated actions 10 – 14 are predicted to have generally non-significant and positive effects of minor significance in addressing the sustainability implications of climate

[43] Objective split between (11.1) mitigation and (11.2) adaptation to Climate Change.

change on drought, both in the medium-term (2020s) and the long-term (2050s). No effects of major significance are predicted. This reflects the predominant preparatory nature of the drought actions, as indicated in the categorisation of actions included in Table 22.

6.53 Potential positive effects predicted include:

- Action seeking to promote water efficiency is predicted to lead to **increased knowledge and awareness of droughts and appropriate drought responses**, such as the benefits of water efficiency.
- Improved understanding of and reduction in the impacts of drought in London is predicted to have potential positive effects as improved management of water resources could help **increased resilience to drought and decreased community and household / individual vulnerability**.
- Where drought risk is reduced and water use / supply efficiency is improved potential positive effects are predicted in relation to a number of SA objectives, including liveability and place, accessibility and availability and landscape, historic and cultural environment. These effects relate to **reduced impacts of drought on London's built and natural environment as well as the economy**.

6.54 Potential negative effects predicted include:

- Minor negative effects on equality are possible due to the **costs associated with some water supply and demand management measures**. These effects may be particularly the case where water bills rise.
- Potentially negative short and medium-term economic effects are also possible where investment in London's water infrastructure leads to **disruption and congestion, for example due to roadworks associated with mains repair.** However, such improvements could bring long-term economic benefits by reducing water loss, improving supply efficiency and reducing the need for abstractions, treatment and pumping.

6.55 The summary appraisal indicates that the effects are in most cases predicted to be very similar in the medium-term (2020s) and long-term (2050s). However, there is a high level of uncertainty in predicting the long-term effects of policy 2 and, in particular actions 11 and 14, as these actions propose respectively a study to define water neutrality and a review of the need for a London-specific Drought Plan. The long-term effects will therefore depend to a large extent on the results of these studies / reviews.

6.56 Although policy 2 and associated actions are considered generally positive from a sustainability perspective, the influence they are predicted to have is not felt sufficient to alter the majority of predicted effects of the impact of climate change on drought in London, both in the medium and the long-term.

6.57 As the central aim of policy 2 is to reduce and manage the risk of drought, and as action 13 specifically targets water efficiency improvements in 1.2 million homes (by 2015), a positive influence on the overall effects predicted on education and awareness (in the medium-term) and climate change adaptation (in the medium and long-term) are predicted. The positive long-term effects predicted on climate change adaptation assumes that the strategic planning proposed in actions 9 and 10 has a positive influence on drought risk reduction.

[44] Objective split between (12.1) water quality and (12.2) water resources.

6.58 The large number of residual negative effects associated with the impact of climate change on drought in London indicates that considerable additional intervention will be required. While it is recognised that the Mayor has relatively limited powers in this area, the effective implementation of the Mayor's draft Water Strategy (action 10) which seeks improved management of water in London, could lead to significant positive effects on some the sustainability objectives.

Comments on Policy 2: Drought

6.59 Overall the policy 2 is welcomed from a sustainability perspective. If implemented fully it provides a good high-level policy to manage and reduce the risk of drought, and addresses relatively fully the prevent, prepare and respond aspects of the *Prevent, Prepare, Respond, Recover* adaptation framework. However, there is nothing in the policy to encourage or facilitate recovery from drought.

6.60 It is noted that the content and scope of policy 2 overlaps considerably with the proposals and policies included in the Mayor's draft Water Strategy[45]. However, the timescales of the two strategies are considerably different, with the draft Climate Change Adaptation Strategy intended to address the longer-term. The relationship between the two strategies should be emphasised in the section on drought within the draft Climate Change Adaptation Strategy along with the need for longer-term policy response.

6.61 Table 24 includes specific comments and recommendations on the drought policy. These comments and recommendations are based on the findings of the appraisal:

Table 24: Comments and recommendations on drought policy

Policy 2: Drought
Recommendations for changes (mitigation and enhancement)
Specific recommendations include: • The intention of the first bullet which refers to "taking a strategic view" is not entirely clear. Alternative wording, such as: "developing and adopting a strategic approach to managing London's water resources to ensure long-term supply and demand balance", may be clearer. • The second bullet could be strengthened / broadened to include reference to the need to ensure efficiency and security of water supply (e.g. reducing leakage, repairing mains), as well as reducing demand. Potential omissions include: • It is recommended that an additional bullet could be included to provide high-level policy commitment to the implementation of the concept of water neutrality. As noted in comments on the Vision, this could become a central aspect of the Mayor's policy on tackling drought, and ensuring a sustainable supply and demand balance for water in London.

Comments on the drought actions 10 - 14

6.62 The five actions proposed to deliver the drought policy are generally welcomed from a sustainability perspective. However, only action 13 proposes a specific target, and it is unclear in this case why energy has been included in this drought related action. Action 10 and 14 relate to the publishing / review of two other strategic plans, the London Water Strategy, and a review of the need for a London specific Drought Plan. The impact of these

[45] Public Consultation draft London Water Strategy (GLA, 2009)

actions on managing drought risks and impacts will therefore depend on the implementation or development of these separate strategic plans.

6.63 The actions primarily address the prepare, and to a lesser extent prevent, dimensions of the *Prevent, Prepare, Respond, Recover* adaptation framework, with no actions proposed in relation to Respond or Recover. However, it is assumed that, if developed and adopted, a London Drought Plan (Action 14) would include all aspects of managing the impacts of drought in London, including responding to and recovering from a drought.

6.64 Table 25 includes specific comments and recommendations on the drought actions. These comments and recommendations are based on the findings of the appraisal:

Table 25: Comments and recommendations on drought actions

Actions 10 – 14: Drought
Recommendations for changes (mitigation and enhancement)
Specific recommendations include: • It is unclear why the figure of 1.2 million homes (included in action 13) was chosen and how it relates to the what needs to be achieved in terms of water efficiency within existing building stock by 2015. It is not clear if this is a target that, if met, will achieve the vision and policy aims, or if it will just make a partial contribution. In addition, the proposed delivery timescale included in the Roadmap to Resilience for action 13, proposes that a very high number of homes (over 1 million) will need to be retrofitted in the period 2012 – 2015. If delivered this would be very positive, however it also appears a very ambitious target in terms of how it can practically be delivered. • As most of the actions fall into the prepare category, it would be useful to set out in the actions (or the roadmap in Part IV of the draft Strategy) an indication of the next steps that are likely to be required to take the action forward over the longer term. • As noted above, it is unclear why references are included to energy efficiency action 13 given that this is an adaptation strategy. It is understood the proposal is that they are rolled out together as part of the same programme, but the emphasis given to energy efficiency seems inappropriate here. • The inclusion of an action (11) referring to water neutrality in London is welcomed, however from a sustainability perspective, the policy and action in the draft Strategy should be more ambitious. The concept of water neutrality is generally accepted (as reflected by reference to the Environment Agency's definition of the concept in the draft Strategy, page 63). It is therefore recommended that water neutrality should become a central aim of the draft Strategy approach to achieving the aim of balanced supply and demand for water, and could (for example) make a commitment to including policy in the new London Plan which requires water neutrality to be achieved in London. By taking a more proactive policy position, the Mayor would have an opportunity to take a leading role (in line with draft Strategy objective 9 to position London as a global leader) rather than potentially delaying the introduction and incorporation of water neutrality in development with further exploration and investigation of the concept. Potential omissions include: • An action could be included to ensure borough development plans require water efficiency in new development and retrofitting of existing development. Such an action could be linked to targets for water efficiency included in the draft Water Strategy for London. • The policy and actions concentrate on water (and energy) use and efficiency. However, increasingly frequent and severe droughts, due to climate change, will have much wider consequences for London, such as: impacts on habitat and biodiversity; soil subsidence and heave leading to infrastructure and building damage; tree destabilisation; etc. It is recommended that actions to address the broader sustainability effects of drought could be considered for inclusion. For example, text on page 68 under sub-heading "subsidence and heave" suggests that although some issues are beyond the Mayor's influence, there may be a Mayoral role in protecting transport infrastructure, and managing the perception that trees are responsible for causing subsidence and heave. It is recognised that cross-cutting action 33 seeks to ensure climate risks to London's transport infrastructure is considered.

Appraisal of overheating policies and actions

6.65 The overheating vision, policy 3 and actions 15 – 23 from the draft Strategy are included in Table 26 below. The separate bullet points in the policy and the actions have been categorised according to the *Prevent, Prepare, Respond, Recover* adaptation framework. This framework was used in the development of the draft Strategy and to assist in the appraisal of the policies and actions. This adaptation framework and its use in the SA is described in Section 4.

Table 26: Summary and categorisation of overheating policy and actions

	Adaptation type			
	Prevent	Prepare	Respond	Recover
OVERHEATING				
Vision: To make London a more comfortable city to live, work and play in and to ensure that a robust emergency plan exists for heatwaves.				
Policy 3: The Mayor will seek to reduce and manage the impact of hot weather on Londoners through working with partners to:				
• Improve the understanding of overheating risk in London by identifying who and what is affected and where is most at risk		●		
• Manage rising temperatures in London by increasing the amount of green space and vegetation in the city	●			
• Reduce the risk of overheating and the need for mechanical cooling in new and existing development and infrastructure	●	●		
• Ensure London has a robust heatwave plan		●	●	●
To improve the understanding of overheating risk and target priority areas:				
Action 15: The Mayor will work with partners to undertake a feasibility study into creating and maintaining a network of weather stations across London to improve our understanding of London's microclimate and the impact of urban greening measures on managing temperatures.		●		
Action 16: The Mayor will work with the SCORCHIO and LUCID projects to improve our understanding of how climate change will affect summer temperatures in the future and to identify and prioritise areas of overheating risk and risk management options.		●		
We believe that by increasing green space and vegetation cover in the city we can manage and offset rising temperatures (and manage flood risk) :				
Action 17: The Mayor will work with partners to enhance 1,000ha of green space by 2012 to offset the urban heat island effect, manage flood risk and provide biodiversity corridors through the city.	●			
Action 18: The Mayor will work with partners to increase green cover in central London by 5% by 2030 and a further 5% by 2050 to manage temperatures in the hottest part of London.	●			
Action 19: The Mayor will work with partners to increase tree cover across London by 5% (from 20 to 25%) by 2025.	●			
Action 20: The Mayor will work with partners to enable the delivery of 100,000m^2 of new green roofs by 2012 (from 2008-09 baseline).	●	●		
To reduce the risk of overheating and the need for mechanical cooling in new and existing development and infrastructure:				
Action 21: The Mayor and the Chartered Institution of Building Services Engineers will publish design guidance for architects and developers to reduce the risk of overheating, and encourage its use through the revised London Plan.		●		
Action 22: The Mayor has proposed a new 'cooling hierarchy' policy in the draft replacement London Plan to require developers to reduce potential overheating and the need for mechanical cooling	●	●		
Action 23: The London Development Agency will work with the Boroughs to map the opportunities for decentralised energy (power, heat and cooling) and with business through a range of energy efficiency programmes.		●		
Action 24: The London Climate Change Partnership will work with a social housing landlord to undertake a demonstration project to retrofit a social housing development to reduce risk of overheating using passive measures.	●			
Action 25: The Mayor will work with partners to assess and promote 'cool roof technology' (highly reflective, well insulated roofs) in London to reduce demand for mechanical cooling.		●		

	Adaptation type			
	Prevent	Prepare	Respond	Recover
We want to ensure London has a robust heatwave plan and that Londoners know what to do during a heatwave to stay cool and save energy:				
Action 26: The Mayor recommends that London Resilience Partnership should assess the benefits of having 'heatwave refuges' (publicly accessible cooled building) that can be used to provide temporary shelter during heatwaves.		●	●	
Action 27: The Mayor will review the lessons learned from developing the community flood plans (see Action 9) to determine how best to encourage and enable a community level response to heatwaves.		●	●	

Comments on the vision for Overheating

6.66 The vision for overheating is considered positive from a sustainability perspective as is it provides a good long-term vision for reducing the impact of overheating in London, and sets out clearly the desired long-term aspiration. It is considered to broadly address, at a strategic level, all aspects of the *Prevent, Prepare, Respond, Recover* adaptation framework, based on the assumption that the implementation of a "robust" emergency plan for heatwaves would effectively address the response to and recovery from heatwaves.

6.67 The SA identified a small number of recommendations for improvement, from a sustainability perspective:

- Rather than simply stating that an emergency plan should "exist", the vision could seek the effectively *implement and improve as necessary* such an emergency plan for heatwaves.
- The statement "make London a more comfortable city" is interpreted to mean more comfortable during extended periods of elevated temperatures / heatwaves. This could be stated explicitly in the vision. A literal reading of the Vision could be interpreted as making London more comfortable in other circumstances too.

Summary of the findings of the appraisal of the overheating policies and actions

6.68 Table 27 summarises the findings of the overall appraisal of the drought policy and actions included in the draft Strategy.

6.69 The summary matrix draws on the more detailed appraisal presented in Section 5, Appendix 8 and Appendix 9.

Table 27: Summary of appraisal findings – overheating

	Sustainability Appraisal Objectives													
	1. Governance	2. Education and Awareness	3. Health and Well-being	4. Equality and Diversity	5. Safety and Security	6. Liveability and Place	7. Accessibility and Availability	8. Landscape, Historic and Cultural Environment	9. Biodiversity	10. Air Quality	11. Climate Change[46]	12. Water Quality and Water Resources[47]	13 Waste Management	14 Economy
Overheating														
Impacts of climate change in London (predicted effects of climate change on sustainability without the draft Strategy but with existing / planned adaptation i.e. Business as usual alternative)														
Medium-term (2020s)	+?	-/+	--/+	-/+	-?	-/+	-/+	-/0	-	--	-/+ 0/+	- -	-/0	-?
Long-term (2050+)	+?	-	--/+?	--/+?	-?	-?	--/+?	-?	--?	--?	--/+? -?	-? -?	-?	-?
Impacts of the Draft Strategy in isolation (predicted effects on sustainability of the draft Strategy as an initial framework for adaptation)														
Medium-term (2020s)	+	0/+	+	0/+	0	+	0/+	0/+	+/++	+	0/+ +/++	0/+ 0/+	0	0/+
Long-term (2050+)	+?	+	+	0/+	0	+	0/+	0/+	+/++	+	0/+ +/++	0/+ 0/+	0	0/+
Impacts of climate change in London with the draft Strategy (predicted effects of climate change on sustainability with the draft Strategy and existing / planned adaptation)														
Medium-term (2020s)	+	0/+	-/+	-/+	-?	0/+	-/+	-/+	-/+?	--	-/+ +	- -	-/0	-?
Long-term (2050+)	+?	-/+	--/+?	--/+?	-?	-/+?	--/+?	-/+?	--/+?	--?	--/+? -/+?	-? -?	-?	-?

Key to effects:

Major positive: ++ Minor positive: + Neutral: 0 Minor negative: - Major negative: -- Uncertain:? Mixed: -/+

6.70 Policy 3 and associated actions 15 – 27 are predicted to have generally positive effects of minor significance in addressing the sustainability implications of climate change on overheating in both the medium-term (2020s) and long-term (2050+). Two potentially major positive effects are predicted, in relation to biodiversity and climate change adaptation. The effects predicted on biodiversity reflect the focus of policy 3 and in particular actions 17 – 20 which include specific targets relating to increasing the amount of green space, planting of street trees etc. Potentially major positive effects are also predicted on climate change adaptation, as this is the central focus of policy 3 and actions 15 – 27. No potentially negative effects are predicted.

6.71 Potential positive effects predicted include:

- Actions 15 and 16 which seek respectively to encourage specific research projects, and to explore the establishment of weather stations across London are considered likely to lead, in the medium and long-term to **increased understanding of and information relating to overheating in London, and the city's microclimate.**
- Where actions are successful in increasing the area of green space in London, this is likely to have beneficial health and wellbeing effects and effects on liveability and place, due to **increased access to green spaces for amenity, exercise and relaxation, improved air quality and increased access to shaded, comfortable outdoor areas** in times of high-temperature.

[46] Objective split between (11.1) mitigation and (11.2) adaptation to Climate Change.
[47] Objective split between (12.1) water quality and (12.2) water resources.

- Actions to increase the amount of green space, plant street trees and promote green roofs are considered likely to have positive effects on biodiversity, by **creating new habitats and protecting existing habitats / species from higher temperatures**.
- Increasing the amount of green space could also have multiple adaptation benefits for example in relation to **reducing flood risks, and providing opportunities for water storage**.
- Action 25, which seeks to encourage the market for "cool roof" technologies, could have quite specific **economic benefits for those working in environmental technology / construction**, although the net effect on the economy as a whole is likely to be limited.

6.72 The effects are in most cases predicted to be the same in the medium-term (2020s) and the long-term (2050s). This reflects the fact that although most of the actions are intended to be implemented by 2011/12, many are likely in practice to have long-term benefits, for example due to the long-term value of increased green space, and the likely lifespan of many buildings.

6.73 Due to the inclusion of specific targets within the overheating actions, and recognising that there is limited current and planned adaptation in relation to overheating in London (see Section 4, and the appraisal of climate change impacts on overheating in Appendix 7), the positive effects predicted are considered significant enough to have a positive influence on the overall sustainability effects of overheating in London due to climate change in relation to the following SA objectives: education and awareness; health and wellbeing; liveability and place; landscape, historic and cultural environment; biodiversity; and, climate change adaptation.

6.74 However, in relation to most SA objectives some significant negative effects are predicted to remain, due to the potential significance of climate impacts, especially in the long-term. This includes potential negative effects relating to air quality, health, equality, climate change mitigation for example. This also reflects the Mayor's relatively limited powers in this area.

6.75 Regarding the significant potential negative effects of climate change on air quality and resulting health and other impacts, the draft Strategy states "The Mayor's draft Air Quality Strategy sets out a range of measures to improve air quality in London. The strategy takes these impacts into consideration, including proposing more robust measures for ensuring that the vulnerable part of the population are aware of, and can avoid exposure to, air pollution episodes" (page 89). However, the appraisal concluded that the draft Air Quality Strategy was not sufficient to reduce the potential impacts of climate change on air quality and health identified in the medium-term (2020s) and long-term (2050+). This was because whilst the proposals in the draft Air Quality Strategy could have long term benefits, its focus is clearly on a much more immediate timescale, and in particular meeting the EU limit values for PM_{10} and NO_2 by 2011 and 2015 respectively, and there remains uncertainty over its implementation and the likely outcomes. The draft Air Quality Strategy does not consider the longer term effects of climate change in any detail and the longest projections included are to 2015 – it is understood that this is because long-term air quality modelling is difficult to carry out, as emissions factors for sources of pollution depend largely on technological developments and policy decisions, which cannot be easily predicted. The modelling for the Mayor's draft Air Quality Strategy therefore looks no further than 2015. However, the Mayor's draft Air Quality Strategy argues that road traffic, which is the main source of air pollution in London, is likely that the continued tightening of European standards for road vehicles will lead to further reductions in emissions from this source, and consequently improved air quality in London.

Comments on Policy 3: Overheating

6.76 Overall the overheating policy is welcomed from a sustainability perspective. If implemented fully it provides a good high-level policy framework for addressing high-temperatures and overheating (including the urban heat island effect). The categorisation of the policy bullet points included in Table 26 indicates that the policy broadly addresses the prevent and prepare dimensions of the *Prevent, Prepare, Respond, Recover* adaptation framework. The fourth bullet point relating to a robust heatwave plan is considered likely to address the respond and recover aspects of the framework, however this will depend on the content and implementation of the proposed heatwave plan.

6.77 Table 28 includes specific comments and recommendations on the overheating policies. These comments and recommendations are based on the findings of the appraisal:

Table 28: Comments and recommendations on overheating policies

Policy 3 and 4: Overheating
Recommendations for changes (mitigation and enhancement)
Specific recommendations include: • Managing overheating, and providing a comfortable environment in the city will depend on more than just an increase in green space and vegetation (although these can play an important role). The policy could also include reference to the importance of (for example) the orientation of buildings, provision of shade in public spaces etc. This could be addressed through a policy bullet which seeks to ensure that the public realm is improved to ensure it remains useable and comfortable even in heatwaves / periods of high temperature. • The third bullet could include reference to passive cooling, or as a last resort where mechanical cooling is required, for it to be low-carbon / low energy in nature. • The fourth bullet could require that the heatwave plan is developed, implemented and improved. This reflects the comment above on the overheating Vision. Potential omissions include: • Reference to the need to ensure that where mechanical cooling is necessary, low carbon / energy options are used. This is considered important from a sustainability perspective as it represents an example of "joined-up" policy making, where action to address adaptation also helps achieve mitigation. • Recognition that addressing overheating is likely to require more than just the creation of additional green space. While this is welcomed, proactive changes to the public realm (e.g. shading, cool pavements, installation of water fountains etc.) are likely to be required if the vision is to be achieved. A policy bullet could be included to reflect this need for a more coordinated / broad approach to addressing overheating. Shading can also reduce the requirement for mechanical cooling in buildings. • The policy does not include any reference to the term "urban heat island". It is assumed this is a deliberate omission, however given the wide recognition of this as a term / phenomena it is suggested its inclusion may help strengthen the policy.

Comments on the overheating actions 15 – 27

6.78 The 13 Actions proposed in relation to overheating are welcomed from a sustainability perspective. The categorisation of the overheating actions included in Table 26 indicates that they predominantly addresses the prevent and prepare dimensions of the *Prevent, Prepare, Respond, Recover* adaptation framework. Only one action (26) addresses the respond dimension, and this will depend on the outcomes of the "assessment" this action seeks.

6.79 Table 29 includes specific comments and recommendations on the overheating actions (as summarised in Table 26). These comments and recommendations are based on the findings of the appraisal:

Table 29: Comments and recommendations on overheating actions

Actions 15 – 27: Overheating
Recommendations for changes (mitigation and enhancement)
Specific recommendations include: • The relationship between the actions to address overheating in London, in particular actions 17 – 20 and the aims and ambitions of the London's Great Outdoors manifesto could be usefully clarified. • As many of the actions fall into the prepare category, it would be useful to set out in the actions (or the roadmap in Part IV of the draft Strategy) an indication of the next steps that are likely to be required to take the action forward over the longer term. • A commitment could be added to action 16 to the proposed next steps that will be taken to implement the findings of the research. • In action 17, the term "enhance" suggests improvements to *existing* green spaces. However, the achievement of the vision and policy aims will require the creation of additional green space. It is recommended the wording of this Action could be clarified. In addition, action 17 refers to 1,000ha of green space. It is recommended that the reason for this figure is explained - does this relate to the amount of green space required for the level of predicted warming or is it just a contribution and if so how much? Could it be more ambitious, perhaps by stating "at least" 1,000ha if additional green space is required to address predicted warming? Consideration should be given to how to identify UHI hotspots and prioritise development of green space in those areas suffering from high levels of deprivation. • In relation to action 19, there is a need for new trees to be appropriate to their settings and resilient to climate change. Reference to the GLA endorsed website Right Trees for a Changing Climate (http://www.right-trees.org.uk/) could be included. In addition to new trees, an action could usefully focus on protecting existing trees. • Green spaces and vegetation will provide evaporative cooling, thereby reducing the urban heat island. However, green spaces will only function in this way if they are kept irrigated - once grass turns brown it will begin to act like a hard surface and contribute further to the urban heat island (PAS Climate Planning Guidance Planning[48]). It is important therefore that drought actions / policy ensures that existing *and new* green space in London is provided with sufficient water to remain effective. • In relation to action 20, it is recommended that innovative approaches to encouraging green roofs could be explored. For example, New York City offers specific tax rebates for building owners who incorporate or retrofit green-roofs on their buildings[49]. • Action 21 – while guidance can play a role in encouraging new techniques, ideally this action would, and the revised London Plan would include a *requirement* for developers to follow technical specifications to ensure buildings are adapted to higher temperatures. • It is not clear how decentralised energy / energy efficiency programmes (Action 23) are expected to help address overheating. Although the action refers to "cooling" it is recommended that the role of decentralised energy in managing overheating is clarified. • There may be a danger that the encouragement of "cool roofs" (Action 25) could conflict with aims to encourage green roofs (Action 20). Although cool roofs may be more appropriate in some cases, green roofs are likely to be preferable from a sustainability perspective. It is suggest that text is included to ensure green roofs are preferred to cool roofs. • Action 26 recommends the assessment of the benefits of having heatwave refuges. This seems a somewhat ambiguous action, and it is recommended that the draft Strategy could require heatwave refuges to be made available. • It is recommended that Action 27 could follow the template of action 9 (flooding) and identify two pilot communities in which to develop community level heatwave plans. It is likely that many of the issues associated with overheating will differ from those related to flooding, and therefore the lessons learned from community flood plans may be of limited value.

[48] http://www.pas.gov.uk/pas/core/page.do?pageId=108854
[49] http://www.nyc.gov/html/dof/html/pdf/08pdf/green_roof_legislation.pdf

Actions 15 – 27: Overheating
Recommendations for changes (mitigation and enhancement)
Potential omissions include: • The introductory text to actions 26 and 27 refers to the ensuring London has a robust heatwave plan. Neither action 26 or 27 appear to support the development of such a plan. An action should be added for the London Resilience Partnership to develop and implement a London Regional Heatwave Plan. • An action requiring, through the London Plan, the use of the bespoke Design Summer Years developed for London for all new building in London (as referred to on page 81 of the draft Strategy but not included in an action). • An action to designate, through the London Plan, an Urban Heat Island Action Area where specific requirements to help mitigate the Urban Heat Island would be required. • An action to require all London boroughs to use their Open Space Strategies to manage the urban heat island by protecting local green spaces and identifying opportunities for urban greening. • An action requiring the Mayor to expand the Green Grid approach to the rest of London to deliver multifunctionality green space is kept at the heart of any plans. Whilst open, has intrinsic value, it will be most viable if it also delivers protection against flooding, green walking and cycling routes, and leisure space • The actions predominantly seek to understand overheating, provide additional green space and ensure development is adapted to higher temperatures. These aspects are important, however it is recommended that additional actions could be included to: ○ Encourage "softer" responses to overheating, such as ensuring drinking water fountains are available and maintained in buildings and public spaces. ○ Encourage a broader approach to adapting public space / the public realm to overheating, for example introducing more shading, including fountains etc. ○ Requiring street widths to be optimised to allow appropriate scale trees.

Comments and recommendations on the cross-cutting actions

6.80 The cross-cutting Actions (28 – 34) are included in Table 30 below. The actions have been categorised according to the *Prevent, Prepare, Respond, Recover* adaptation framework. This framework was used in the development of the draft Strategy and to assist in the appraisal of the policies and actions. This adaptation framework and its use in the SA is described in Section 4.

6.81 Note that there are no visions or policies included in the draft Strategy in relation to the cross-cutting issues.

Table 30: Summary and categorisation of cross-cutting actions

	Adaptation type			
	Prevent	Prepare	Respond	Recover
CROSS CUTTING ACTIONS				
Health				
Action 28: The London Climate Change Partnership will work with the London Regional Public Health Group to undertake a London-specific assessment of the impacts and opportunities of climate change on London's health services. The study will provide recommendations to the health sector on the priority risks and opportunities.		●	●	
Action 29: The Mayor will work with the Regional Public Health Group, NHS London and the London Primary Care Trusts to ensure that climate risks are addressed in their refurbishment programme and commissioning of health services.	●	●		

	Adaptation type			
	Prevent	Prepare	Respond	Recover
Environment				
Action 30: The Mayor will work with the Environment Agency and other partners to restore 15kms of London's rivers by 2015 through the London Rivers Action Plan.	●	●	●	
Economy				
Action 31: The Mayor will engage with business organisations and other key stakeholders to consider how to raise awareness of the need to integrate climate risks and opportunities into their routine risk management and planning and whether there is further practical assistance that can be given to businesses in London, including SMEs.		●		
Action 32: The Mayor will work with the insurance sector in calling for Government to amend building regulations to require buildings being rebuilt or renovated to be climate resilient.	●	●		
Infrastructure				
Action 33: TfL will undertake a climate risk assessment of their assets and operations and develop prioritised action plans for key climate risks.		●		
Action 34: The Mayor believes that London should have a resilient energy supply and will work with the Distribution Network Operator and the energy retailers to ensure that the distribution infrastructure is resilient to climate impacts and that energy suppliers can meet seasonal variations in demand.	●	●		

Comments on the cross-cutting actions

6.82 The cross-cutting actions are considered positive from a sustainability perspective. In addressing specific aspects of adaptation in relation to health, the environment, economy, and infrastructure, they are considered likely to help support some of the positive effects arising from the policies and actions relating to flooding, drought and overheating. Categorisation of the cross-cutting actions by the *Prevent, Prepare, Respond, Recover* adaptation framework indicates that they predominantly address the prepare dimension, although a number also potentially address the prevent and respond dimensions. This will depend on how the actions are implemented, for example for Action 28 to address the respond aspect would require the adoption of the recommendations arising from the study proposed. None of the actions are considered to address recover.

6.83 Table 31 includes specific comments and recommendations on the overheating actions (as summarised in Table 30).

Table 31: Comments and recommendations on the cross-cutting actions

Actions 28 – 34: Cross-cutting issues (health, environment, economy, infrastructure)
Recommendations for changes (mitigation and enhancement)
Specific recommendations include: • Chapter 6 – Health – refers to the potential significant health effects of poor air-quality, which is predicted to be exacerbated by the effects of climate change. Although it is recognised that the Mayor has developed a draft Air Quality Strategy, it is recommended that consideration should be given to the inclusion of a specific cross-cutting Action relating to air quality to address the longer term health issues raised by the impact of climate change on air pollution. • The boxes containing the actions at the head of each cross-cutting chapter could include cross-reference to policies and actions in chapters 3 – 5 which are of particular relevance to the issues of health, environment, economy and infrastructure respectively. This could help achieve the stated aim of the cross-cutting chapters which is *"to help decision makers working on these policy areas understand the climate risks and opportunities relevant to their policy area and highlight interlinkages with other chapters"*. • The appraisal of Policies 1 – 3 and Actions 1 – 27 indicates that other elements of the "environment"

Actions 28 – 34: Cross-cutting issues (health, environment, economy, infrastructure)
Recommendations for changes (mitigation and enhancement)
may warrant specific actions. For example, the need to ensure London's parks and gardens are able to respond to and recover from periods of drought; recognition of the need to ensure that green spaces are sufficiently irrigated to provide the cooling expected in policy 3. Chapter 7 recognises and discusses these issues in some detail, and it is recommended that additional actions are considered to raise the profile of these issues and the key role the environment can play in climate change adaptation. • Action 32 could be strengthened by a commitment from the Mayor to require new development in London to be climate resilient through the revised London Plan. • The relationship between the requirement on TfL set out in Action 33 and the responsibilities of TfL as a "priority reporting authority" under the Climate Change Act (which requires reporting on climate risks) could be clarified. The Climate Change Act reporting expectations include: *"an assessment of the current and predicted risks to that organisation, or its functions, presented by climate change; and a programme of measures to address the risks highlighted above, including any policies or practices that are already being implemented"*[50]. Potential omissions include: • An action to address air quality as a critical issue for health which is predicted to be exacerbated by the effects of climate change, particularly in the long-term. • Clear cross-references in chapters 6 – 9 to policies and actions in chapter 3 – 5 which are relevant to the cross-cutting issues. • Specific actions to promote and support the wider role the environment can play in climate change adaptation. While this role is recognised through the analysis and discussion in chapter 7, the one action included relating to the environment (Action 30) is relatively limited in its scope and is an existing commitment in the London Plan / The London Rivers Action Plan. • An action requiring the London Plan to consider the spatial implications of the need for transport systems to be resilient to current and future weather as part of an overall objective of providing access to jobs, opportunities and facilities.

Appraisal of the draft Strategy overall

6.84 This section provides a summary of the overall findings of the appraisal of the significant sustainability effects of the draft Climate Change Adaptation Strategy. It aims to bring together the findings of the appraisal of the policies and actions included in the draft Strategy as presented in the preceding sections.

6.85 As noted in Part A (Section 1) of the SA Report, the SA incorporating Strategic Environmental Assessment (SEA) and Health Impact Assessment (HIA). A separate Equalities Impact Assessment has been carried out by the GLA, however for clarity and to indicate how this appraisal has considered specific health and equalities effects, these are highlighted specifically in this section.

6.86 This section also provides a commentary on the difference the SA has made to the draft Climate Change Adaptation Strategy and why the draft Strategy has been selected as the preferred alternative.

Overall comments from the appraisal of the draft Strategy

6.87 The summary of the appraisal of the draft Strategy policies and actions relating to flooding, drought and overheating indicate that overall the draft Strategy as a standalone document has the potential to have a number of positive sustainability effects, although these are generally expected to be of minor significance.

[50] http://www.defra.gov.uk/environment/climate/legislation/reporting.htm

6.88 Specific potential overall **positive effects** identified include:

- **Improved governance of adaptation in London** through the focus of a number of policies and actions on encouraging or facilitating collaborative working, communication and improved information on climate change risks and responses.
- **Increased knowledge and awareness** of climate change impacts, and responses.
- Long-term **reductions in the negative impact of some of the effects of climate change** on particular receptors in London, such as the impacts of drought on the built and natural environment and overheating on health.
- Increased **green space and street trees** benefitting visual amenity and biodiversity.

6.89 Generally the implementation of the draft Strategy is predicted to have limited direct negative sustainability effects, particularly given its focus on preparatory actions. However, it does support the implementation of initiatives, such as flood risk management and water resource management strategies (e.g. the Environment Agency's TE2100 and the Mayor's draft Water Strategy), which are likely to lead to interventions which could have direct negative sustainability effects on particular receptors. For example:

- Measures to manage flood risk, may include the construction of physical defences for example, which could have **impacts on biodiversity, visual amenity and the landscape / townscape** of London.
- Measures to balance supply and demand for water (e.g. through leakage reduction, metering and retrofitting efficiency measures) may lead to **increased costs which could disproportionately affect vulnerable groups**.

6.90 The appraisal also predicted the potential influence of the draft Strategy policies and actions on the likely impacts of climate change in London over the medium-term (2020s) and long-term (2050s). Given the potential significance of the predicted effects of climate change, particularly in the long-term, the SA broadly concluded that the draft Strategy is unlikely on its own to avoid or significantly reduce many of the negative sustainability effects of climate change which are predicted. This is particularly the case in relation to flooding and drought. However, it is recognised that this is a first, and necessary, step in the development of London's adaptation strategy and in the future any updates will have the potential to have more significant positive sustainability effects. In addition, the process of developing the draft Strategy has also raised the awareness of adaptation within the GLA group and had wider benefits by influencing the policies in other mayoral strategies and plans.

6.91 Areas where a positive influence on the overall sustainability effects was predicted, in addition to on climate change adaptation which is clearly the central aim of the draft Strategy, included:

- In relation to overheating, the draft Strategy includes specific actions and targets for increasing green space and street trees, for example, which if delivered are considered to **potentially significantly reduce the negative sustainability effects predicted from overheating**.
- **Increased awareness of the importance and benefits of water efficiency**, in particular due to a specific action to target water efficiency improvements in homes in London.

6.92 However, while the effects predicted are relatively minor in significance and influence on the effects of climate change of the draft Strategy overall, the visions, policies and actions taken together do provide a clear strategic framework for the adaptation required in London to help

reduce the consequences of climate change. There are also a number of underlying reasons why the SA concluded that the current draft Strategy is likely to be limited in the overall influence it can have on adaptation in London, including:

- The SA appraised the draft Strategy in the context of the projected scale and significance of the sustainability effects of the predicted climatic changes and existing adaptation actions already included in other strategies, plans and initiatives etc, thus the additional actions the draft Strategy proposes are in many cases relatively insignificant in comparison;
- The Mayor's relatively limited powers in relation to many issues that need to be addressed to achieve adaptation and therefore the need for others actors to deliver many of the required actions; and,
- This draft Strategy is the first version of the strategy and contains a large number of actions which are addressing the prepare dimension of the *Prevent, Prepare, Respond, Recover* adaptation framework. As a result, the specific actions included in the draft Strategy are not, in themselves, predicted to have many direct sustainability effects. However, many of them potentially provide the basis for more actions in the future which will have more significant sustainability effects.

Recommendations arising from the overall comments

6.93 Overall the SA concluded that the draft Strategy on its own is unlikely to have a significant influence on addressing the negative impacts of climate change or maximising potential opportunities. The comments above indicate why this is the case, and this conclusion should not be interpreted as meaning the draft Strategy is not a "good" strategy. As a facilitation and coordination document for the key stakeholders and actors that need to be involved in adaptation, and as preparation for further adaptation that needs to be developed in the future, the draft Strategy does have an important and significant role to play. However, in itself it cannot deliver many of the key actions required to significantly reduce the potential sustainability effects of future climate change as a result of this first version.

6.94 However, the appraisal identified a number of ways in which the positive sustainability effects of the draft Strategy could be enhanced and the negative effects of climate change could be reduced. Specific recommendations for mitigation and enhancement are included in the sections above. Some more general recommendations include:

- Future revisions of the draft Strategy should include specific actions that address more of the ***Prevent, Respond and Recovery*** **dimensions of the adaptation framework** in order to adapt to flooding, drought and overheating etc. This would help strengthen the influence of the draft Strategy and improve the likelihood that it would help avoid or significantly reduce the negative sustainability effects predicted from climatic change in London.
- The draft Strategy provides an opportunity to establish an **overall strategic adaptation framework for other Mayoral strategies and the GLA group**. These other strategies should then provide more detailed actions and / or policies to implement adaptation within specific sectors or topics. The draft Strategy partially realises this opportunity, but it is recommended that more could be done to make the link with other strategies and organisations clearer and to set out what they need to deliver over the longer timescale that the draft Strategy is planning for.

- One of the overall positive effects predicted by the appraisal is the draft Strategy's potential influence on the governance of climate change adaptation in London. The draft Strategy rightly recognises and seeks to promote a coordinated approach to adaptation in London. Given the importance of such an approach, and the key role the **London Climate Change Partnership** (LCCP) should play in facilitating partnership working in London, it is recommended that the Mayor should continue to and potentially provide greater support to the LCCP to enable it to fully fulfil its role and for London to realise the Mayors' objective for the Strategy of London being an international leader in tackling climate chance.

- A number of the specific actions in the draft Strategy, and the commitments and targets they contain, are included in other plans and strategies (e.g. the draft London Plan, London Green Grid, The Mayor's manifesto 'London's Great Outdoors' and London Rivers Action Plan) and are therefore not new commitments. Ideally, given the long-timescales that the draft Strategy is planning for, the actions and targets it includes should also **take a long-term view, rather than just focussing on short-term actions and targets**. This would improve the sustainability performance of the draft Strategy as it would be addressing more of the medium and long term effects of climate change. It is further recommended that where specific actions from other strategies or plans appear in the draft Strategy, they should be clearly identified and presented in the context of to what extent their implementation would achieve the visions and objectives of the draft Strategy. The draft Strategy could use this contextual analysis to identify and detail how much more needs to be done, and indicate when it needs to be achieved.

- It is also recommended that consideration could be given to re-packaging the Strategy as two documents:

    - firstly, a **long-term strategic vision and policy document** with specific "targets" with dates to achieve them. This document could be more streamlined than the current draft Strategy, and focus on setting a high level, genuinely long-term strategic direction for London. However, the useful collation of evidence and justification on the predicted climatic changes in London and the need for adaptation included in the current draft should not be lost; and

    - secondly, a separate but accompanying **"adaptation action framework" or "adaptation action plan"** made up of the actions in the draft Strategy, with responsible organisations and timescales clearly stated as in the roadmap. This document could be updated more frequently than the overarching strategy to include progress on actions and new actions etc. as appropriate, as well as an indication of what future actions may be required and when.

- It is recommended that as part of the climate change adaptation strategy development process that consideration is given to **long term futures thinking** – i.e. some scenario planning about what London might look like in the future, not in climate change terms, but in terms of whether it will continue to grow as currently, other driving forces that might influence its shape and character in 20, 50 years time as well as or in conjunction with climate change (which may well help shape other drivers, e.g. migration and population size). The draft Strategy has been largely premised on a continuation of the business as usual growth paradigm and more radical options could only be considered following more detailed futures scenario planning work.

Potential cumulative impacts

6.95 There are different types of cumulative effects, but those of particular relevance to the appraisal of the draft Strategy are the total effects of multiple actions on a single 'receptor', which could be certain group within the population or people living in a particular locality, habitats and biodiversity, as well as effects that may be cumulative over time and in combinations with other plans and strategies. The sensitivity of the receptors also needs to be taken into account when evaluating the potential significance of cumulative effects. For instance, potential cumulative effects on health are important because they potentially affect particularly sensitive receptors such as certain vulnerable groups within the population.

6.96 It is worth noting that vulnerability can have many aspects and although not all of the individual members of a particular group may be vulnerable, there is a greater probability that members of such a group will be vulnerable compared to members of other, less vulnerable groups. For instance, the elderly '*may not be vulnerable just because of age, but when combined with living alone, not having a car, having a low income and disability, vulnerability may increase. Ethnic minorities may not be vulnerable because they are minorities but because they lack access to services and information, or because of language difficulties*'[51]. In addition, vulnerability is sometimes defined as being disconnected from networks and, for example, a recent review of the causes of human vulnerability concluded that these can include: a lack of access to resources, information and knowledge; limited access to resources to political power and representations, (lack of) resource availability and (lack of) access to services and social isolation[52].

6.97 Given the strategic level of the draft Strategy there is limited spatially differentiation that can be predicted between effects, in particular, so inevitably the potential cumulative effects identified are relatively generic. In addition as noted above in the predicted overall effects of the draft Strategy, due to the nature of the actions in the current draft Strategy limited direct effects have been identified, either positive or negative. Therefore limited cumulative effects are predicted. Possible exceptions include:

- The combined effects of a number of actions seeking to improve the level of knowledge of climate impacts in London and gather appropriate and accurate information to help understand climate risks may have a cumulative impact on the **awareness and understanding of adaptation in London, and what action is required**.
- Given the Mayor's limited powers in relation to many areas of adaptation, the draft Strategy seeks to play a key role in encouraging collaborative and partnership working to understand and address specific issues and risks. This is predicted to have a cumulative impact on **the governance of climate change adaptation in London**.

6.98 However, as the appraisal of policies and actions included in this section indicates, the likely effects of climate change in London in the medium-term and particularly the long-term has the potential for very significant cumulative effects. These cumulative effects may particularly impact upon certain sensitive or vulnerable groups or receptors. Examples include:

- Climate change impacts on flooding, overheating and drought leading to **cumulative negative effects on vulnerable communities in particular in relation to health and wellbeing and equalities**. Vulnerable communities may be least able to respond to flood

[51] Tapsell, S, Burton, R, Oakes, S and Parker, D (2005) The Social Performance of Flood Warning Communications Technologies. Technical Report. The Environment Agency, Bristol, UK.
[52] Tapsell S M, Tunstall S M, Green C, Fernández-Bilbao A (2005), Indicator set. Internal FLOODsite report (Task 11), Enfield: Flood Hazard Research Centre.

events, live in accommodation less able to cope with higher temperatures and heatwaves, and be disproportionately impacted by measures to reduce the impact of drought including the costs associated with these measures (such as water metering). Such cumulative effects may also exacerbate existing health and social inequality.

- **Habitats and biodiversity in London may be significantly negatively affected by the cumulative effects of drought and overheating**, potentially further exacerbated by flooding and/or flood risk management measures.

6.99 The draft Strategy may help to avoid or mitigate some of the cumulative effects of climate change through, for example, actions which seek to identify and prioritise vulnerable communities for flood risk management measures and emergency planning for heatwaves. However, as identified through the appraisal of the policies and actions, the majority of actions included in the draft Strategy are preparatory in nature, seeking to improve understanding, identify which key actors should be involved and plan for future adaptation. As a result the influence of the draft Strategy in directly reducing the key negative cumulative effects (and enhancing any positive cumulative effects) of climate change in London is expected to be relatively limited, although in undertaking these preparatory actions if these effects are borne in mind the needs of vulnerable groups etc could be integrated throughout adaptation planning.

6.100 The draft Strategy is intended to encourage new and complement existing plans and strategies developed by other organisations to deliver the range of adaptation needed within London, as well as promoting the implementation of targets and actions included in existing Mayoral strategies. The effects of the draft Strategy are therefore likely to be 'in combination' or cumulative with the influence, outcomes and actions included in these other relevant plans, strategies and organisational activities (see Part A, Section 3 and Appendix 6). This has been considered in developing the likely evolution of the sustainability baseline (see Section 4) and the appraisal of the draft Strategy and *business as usual* alternative which has included the potential influence of existing and planned adaptation (see Sections 4, 5 and 6). Some of the most significant policies, plans, strategies and activities relating to or with an influence on climate change adaptation include:

- The London Plan (GLA, 2008), and the draft replacement London Plan (GLA, 2009).
- The Mayor's draft Water Strategy (GLA, 2009).
- The Mayor's draft Air Quality Strategy (GLA, 2009).
- Mayor's draft Climate Change Mitigation and Energy Strategy (GLA, 2009).
- The outcomes of the LUCID and SCORCHIO climate change research projects.
- Activities of:
    - the London-wide and East London Green Grid Partnerships
    - the Drain London Forum
    - the London Climate Change Partnership
    - Transport for London
    - the London Water Group.
    - London Resilience

- London Boroughs and the Association of London Borough Planning Officers.

- The Mayor's manifesto "London's Great Outdoors" (GLA, 2009).
- The London Rivers Action Plan (London River Restoration Centre, 2009).
- Draft Flood and Water Management Bill (Defra, 2009).
- The Code for Sustainable Homes (DCLG, 2008) and future revisions to the Building Regulations proposed to ensure Code levels are met.
- Draft Thames River Basin District Management Plan (Environment Agency, 2009).
- Thames region Catchment Flood Management Plan (Environment Agency, 2009).
- Water Resources Strategy for England and Wales (Environment Agency, 2009).
- Thames Estuary 2100, consultation draft (Environment Agency, 2009).
- Water Resources Management Plans for each of the water companies serving London and Environment Agency Drought Plans covering the London area.
- Heat Wave Plan for England (Department of Health, 2009)

Key effects relating to health and health inequalities

6.101 As noted above, the SA of the draft Climate Change Adaptation Strategy incorporated Health Impact Assessment. As part of the SAs of both the Mayor's draft Water Strategy and Climate Change Adaptation Strategy a combined workshop with health experts and stakeholders was held in March 2007. This aimed to help identify the potential impacts of key aspects of the strategies on health determinants, health outcomes and health inequalities. A separate report of this workshop is available from the GLA on request. The findings of the workshop were used to inform both the development of the draft Climate Change Adaptation Strategy and its appraisal.

6.102 The draft Strategy includes a good overview in chapter 6 of the potential health effects of climate change. It also correctly emphasises that climate change is likely to increase existing health inequalities in London, for example it states that '*climate change will disproportionately affect those living in poor quality or overcrowded homes*' (page 92).

6.103 To aid the identification of key potential effects on health, the key health effects of climate change are set out in Table 32 below. Table 32 also identifies which wider determinants of health and target equality groups / other socio-economic groups that may in particular be affected by the key health and health inequalities effects predicted:

- The key determinants of health include factors such as: income; crime; quality of environment; transport; housing etc. Lifestyle variables, such as: recreation and physical activity; stress; accidents etc, will also influence health. Lifestyle variables and health determinants have an impact on demand for health and social care services and facilities.
- The GLA equality target groups are: women; Asian or Asian British; Black or Black British; people of mixed race; Irish people; Chinese and other minority ethnic communities; disabled people; older people (60+); children and young people (0 – 17); young adults (18 – 25); lesbians, gay men and bisexual people; trans people; and, faith groups.

- Other socio-economic groups could include: low income families; those with long-term illnesses; larger households, families with young children etc.

6.104 Note that Table 32 focuses on direct health effects, however climate change will also have other indirect effects for example on working conditions, education, living conditions etc and direct effects on the delivery of health services (including those people working within the health and social care sector, and also the buildings and infrastructure required to deliver these services).

Table 32: Key climate change effects relating to health and health inequalities

Broad categories of climate change impacts	Known effects of weather/climate on health	Health outcome	Health determinants and equality target / other groups potentially effected
Negative effects			
Overheating	• Deaths from heart- and lung-related diseases increase with hotter and colder temperatures (above/below certain temperature limits rather than monotonically).(should be listed in Health outcome column) • Heat-related illnesses (heat exhaustion and heat stroke) and death increase during heatwaves. [Note that whilst heat-related deaths could increase this is likely to be offset by milder winters leading to a fall in cold related winter deaths]	Heat related morbidity and mortality	*Determinants / variables:* Income; environment; housing; transport; recreation and physical activity; and stress. *Equality target / other groups:* All. Particular effects on older people and those with underlying health conditions
Overheating	• Weather affects air pollution concentrations. • Weather affects the distribution, seasonality and production of air-transported allergens.	Air pollution related morbidity and mortality	*Determinants / variables:* Environment; housing; and recreation and physical activity. *Equality target / other groups:* All. Particular effects on older people, young people and those with underlying health conditions
Flooding	• Floods cause direct effects (deaths and injuries), infectious diseases, long-term mental health problems, and indirect effects (temporary limitations on access to health and social care services).	Morbidity and mortality resulting from weather disasters	*Determinants / variables:* Environment; stress; transport; and housing. *Equality target / other groups:* Disabled; older people; young people; low-income individual and households.
	• Increase in the frequency of windstorms could lead to an increase in personal injuries and death from flying debris and falling trees and may in principle cause mental health problems (but there is no evidence of this).	Morbidity and mortality resulting from weather disasters	*Determinants / variables:* Environment; stress; and transport. *Equality target / other groups:* All.
Overheating	• Higher temperatures shorten the development time of pathogens in vectors and increase the potential transmission to humans.	Vector-borne diseases	*Determinants / variables:* Income; food waste; environment; and housing. *Equality target / other groups:* All.
Flooding / Overheating /	• Survival of important bacterial pathogens is related to temperature.	Water- and food-borne diseases	*Determinants / variables:* Food safety/management;

Broad categories of climate change impacts	Known effects of weather/climate on health	Health outcome	Health determinants and equality target / other groups potentially effected
Drought	• Increases in drought conditions may affect water availability and water quality (chemical and microbiological load) due to extreme low flows. • Extreme rainfall can affect transport of disease organisms into water supply.		recreational use of water; income; environment; and recreation and physical activity *Equality target / other groups:* All. Particular effects on older people, young people and those with underlying health conditions
Overheating	• More cloud-free days and higher temperatures may encourage potential risk of over-exposure to UV radiation.	Cataracts, skin cancers and sunburn	*Determinants / variables:* environment; recreation and physical activity *Equality target / other groups:* All.
Overheating	• Higher temperatures increase perspiration and evaporation so increase the risk of dehydration.	Dehydration	*Determinants / variables:* Environment; housing; recreation and physical activity; stress; transport. *Equality target / other groups:* Particular effects on older people, young people and those with underlying health conditions
Overheating	• Higher temperatures increase ambient noise exposure (since people open windows in their homes) and may keep people awake and increase stress.	Stress	*Determinants / variables:* Environment; housing; stress; and transport. *Equality target / other groups:* Particular effects on older people, young people and those with underlying health conditions
Positive effects			
Overheating	• Warmer summers	More physical activity, both for leisure, or walking and cycling	*Determinants / variables:* Income; crime; environment; transport; housing; recreation and physical activity; *Equality target / other groups:* All.
Overheating	• Warmer winters	Reduce the number of excess winter deaths	*Determinants / variables:* Income; environment; housing, *Equality target / other groups:* Older people; low-income individual and households; and those with underlying health conditions.
Overheating	• Warmer winters - reduction in snow and ice	Reduce slips and trips injuries in winter	*Determinants / variables:* Environment; transport. *Equality target / other groups:* Disabled and older people.

Sources: adapted from Adapted from Kovats et al (2005) Climate change and human health

6.105 London has experienced heatwaves with significant health effects and some flooding with unmeasured health effects in the past. These, and other effects on health, are likely to increase as a result of climate change however the risk of and magnitude of these effects with climate change is uncertain. The summary of the appraisal of the draft Strategy policies and actions relating to flooding, drought and overheating indicate that overall the effects of the draft Strategy on these risks is likely to be small although it does have the potential to have a some positive health and equality effects.

6.106 Specific overall potential **positive health and equality effects** identified include:

- **Reduced flood risk**, by implementing flood risk management policies and reducing the risk of surface water flooding, may have positive health effects particularly for vulnerable individuals and groups that are often more at risk and less able to respond and recover to flooding events when they occur.
- **Increased investment in water efficiency measures** is likely to have positive effects on equality, especially where low-income / vulnerable households are provided with direct support to implement efficiency in the home. However, some water demand / supply management measures (such as replacing mains, or installing water meters) may have negative effects on equality where water bills rise, or in large households where metering can increase water costs.
- **Measures to reduce the urban heat island** and its impacts, such as providing greenspaces and heatwave refuges, may help reduce the negative health impacts of heatwaves in London (although they will not reduce the likelihood of heatwaves occurring). In addition providing greenspaces, trees and green roofs may also have positive health and wellbeing effects, through improved amenity, positive effects on air quality, and potentially opportunities for exercise.

6.107 Generally the implementation of the draft Strategy is predicted to have limited direct negative health and equality effects, particularly given its focus on preparatory actions. However, it does support the implementation of initiatives, such as water resource management strategies (e.g. the Mayor's draft Water Strategy), which are likely to lead to interventions which could have direct negative health and equality effects on particular groups. For example:

- **Investment in water efficiency measures** is overall likely to have positive effects on equality, especially where low-income / vulnerable households are provided with direct support to implement efficiency in the home (see above), however some water demand / supply management measures (such as replacing mains or installing water meters) may have negative effects on equality where water bills rise or in large households where metering can increase water costs. Appropriate tariffs should be applied so low income groups are not disproportionally affected.

6.108 As discussed in the overall comments above, the appraisal also predicted the potential influence of the draft Strategy policies and actions on the likely impacts of climate change in London over the medium-term (2020s) and long-term (2050s). Given the potential significance of the predicted effects of climate change, particularly in the long-term, the SA broadly concluded that the draft Strategy is unlikely on their own to avoid or significantly reduce many of the negative sustainability effects of climate change which are predicted. This is particularly the case in relation to flooding and drought. This situation is also likely to be the case for health and health equality effects. As mentioned above, however, it is recognised that this draft Strategy represents a first, and necessary, step in the development

of London's adaptation response and future updates may have more significant positive sustainability effects.

6.109 Only under overheating was the draft Strategy predicted to have a positive influence on the overall health and equality effects:

- The specific actions and targets for **increasing green roofs, enhancing greenspaces, planting trees and developing design guidance**, may all have a positive influence on the effects of climate change on health and wellbeing in London over and above current and planned adaptation in the long-term.

6.110 The cross cutting actions on health (actions 28 and 29) are considered positive from a health and health inequality as well as sustainability perspective. Clearly they are quite specifically focussing on the health sectors response to climate change and the assessment of priority risks and opportunities (action 28) will need to be developed as an action to implement the findings once the preparatory stage is complete.

6.111 Health and equality related comments on actions (note these overlap to a degree with the comments under the flooding, drought and overheating actions above, but also include additional comments):

- Action 4 – the proposed flood incident reporting system should be linked to captured health data. If 'Drain London Forum' create a flood incident management system with a data capture form that collects flood incidents, a strategy/plan should be devised to capture health data relating to these. There are different options for instituting such health surveillance and key players are the Health Protection Agency, Primary Care Trusts and GPs. Health Protection Scotland has pioneered a (non flood) chemical incident reporting system which seeks to garner health data consequent to major chemical incidents. This type of surveillance system could be employed for flood incidents.

- Action 13 – water meters and potential health consequences to social/economically deprived groups associated with their widespread implementation is not mentioned in the draft Strategy (although it is covered in the draft Water Strategy and is a key effects considered in its SA). With the implementation of water meters it will be important to monitor the financial and potential adverse health consequences upon inequalities between consumer / population groups.

- Action 15 – this action is to create a network of weather stations across London. This should be designed with health effects and susceptible groups as a primary consideration rather than purely representative spatial spread. Those people living in the heat island and additionally in buildings likely to increase temperatures and the related health effects should be specifically identified and form a stratified sample with their own specific weather stations. A definition/criteria should be specified in advance of the implementation of such monitoring as to what level of temperature (and duration) merits some action to protect health. Should monitoring in high risk geographical and built form areas reveal that this criteria is met then a heatwave warning system by locality should be implemented analogous to the existing Flood Warning service and Floodline Warnings Direct service.

- Action 27 – it is suggested that this action also includes a proposal to pilot local level response plans to heatwaves in two communities analogous to action 9 on bespoke

community flood plans. There is no need to review lessons learned on developing flood plans as the issues associated will differ between flood and heat.

- Action 26 and 27 – there is a need for an action on developing and implementing a heatwave plan for London and integrating this with the consideration of vulnerable people. A pilot study to explore the practicalities of applying the proposed actions for Drain London Forum on flood incidents to heatwaves could be included with key players such as local authority Environmental Health Officers, Health protection Agency and GPs.

6.112 Other comments on the health text in the draft Strategy:

- The section on air quality in the draft Strategy (page 88) makes no mention of the public health effects consequent to changes in the number of exceedances of short-term air quality standards (and the likely magnitude of the exceedances). The public health effects of long term averages will be more significant than the episodes where short-term air quality standards are exceeded. However, susceptible individuals, for example those with pre-existing heart or lung disease, will be particularly at risk from short term exceedances and therefore some treatment of these is warranted in addition to the treatment given to annual averages.
- Page 91 of the draft Strategy contains a claim linking dehydration and allergies. There is insufficient evidence to make a strong claim of a causal pathway from dehydration to allergies and the evidence base for aetiology of allergies is large and complex. It is therefore recommended that this should be removed.
- Page 82 / Table 5.3 on cooling adaptation options and in-direct health effects page 91-92 - there is a compromise about managing air tightness and internal air quality. Any rise in indoor humidity will increase house dust mite allergen and moulds. Approximately 50% of asthmatics are sensitised to one or other of these and they will cause exacerbation of asthma. Asthma is a major public health problem and therefore this issue should be included in the health sections under 'Living conditions' or 'Overcrowding'. This is an important omission.
- It will be important to include relevant health indicators in the final Strategy to monitor its implementation and effects across all aspects of sustainability – the current draft Strategy just includes a question to consultees asking how to measure how well London is adapting to climate change and what key indicators should be used rather than setting out proposed monitoring arrangements.

Mitigation and enhancement measures

6.113 Specific mitigation and enhancement measures, many of which are in the form of recommendations for amendments and additions to the current draft Climate Change Adaptation Strategy, have been detailed in the preceding sections in relation to the objectives, principles, policies and proposals. These are not repeated here, however Table 33 sets out where specific recommendations are included in this report.

Table 33: Coverage of mitigation and enhancement recommendations

Draft Strategy element	Location of specific recommendations for mitigation and enhancement
Objectives	Paragraphs 6.9 – 6.18
Aim	Paragraph 6.20
Introductory section	Paragraph 6.21
Flooding vision	Paragraphs 6.31
Flooding policy	Table 20
Flooding actions	Table 21
Drought vision	Paragraph 6.49
Drought policy	Table 24
Drought actions	Table 25
Overheating vision	Paragraph 6.67
Overheating policy	Table 28
Overheating actions	Table 29
Cross-cutting actions	Table 31
Strategy overall	Paragraph 6.93 - 6.94
Health and equality	Paragraph 6.111 – 6.112

Why the draft Climate Change Adaptation Strategy has been selected as the preferred alternative

6.114 As described in Section 1, the development of the draft Strategy has been undertaken over an extended period and was initially started under the previous Mayor. Given that the Mayor has limited powers and responsibilities over some aspects of the adaptation needed to climate change, the approach and range of alternatives open to the Mayor are relatively narrow. There are also a large number of other organisations' policies, plans and strategies which potentially overlap with the draft Strategy, as well as potential overlap with other mayoral strategies like the London Plan, SPG on sustainable design, Water Strategy, Transport Strategy, Air Quality Strategy, Climate Change Mitigation and Energy Strategy, the Mayor's manifesto "London's Great Outdoors" and the London Rivers Action Plan.

6.115 As a result of the above, the Mayor has adopted the approach presented in the draft Strategy which generally seeks to complement other plans and strategies and pulls them together by presenting a London-specific view and promotes and facilitates partnership working. In places the draft Strategy also seeks to influence future revisions of these other plans and strategies by promoting tighter or more ambitious targets than already required, however also presents existing commitments rather than setting a new agenda for climate change adaptation in London.

6.116 The draft Strategy Plus alternative discussed in Section 5, illustrates some of the potential additional adaptation measures the Strategy could promote, many of which have been discussed with those preparing the draft Strategy as it has been developed. However, the Mayor has decided to take the approach of initially consulting upon a Strategy with a focussed set of actions over which he has more control and influence and to develop the Strategy further in the future with contributions from others. This is illustrated by the consultation process being used which is seeking to collected ideas and commitments from Londoners.

Difference the Sustainability Appraisal has made to the draft Strategy

6.117 The different stages and outputs from the Sustainability Appraisal process have influenced successive drafts of the Strategy. The key outputs / influencing points include the:

- Initial Sustainability Appraisal commentary in January 2007;
- Advisory Group meetings and other meetings with the GLA throughout the process;
- Health Stakeholder Workshop in March 2007;
- Sustainability Appraisal commentaries in August 2008 and November 2009; and,
- Ongoing dialogue and correspondence between the SA team and those responsible for the Strategy.

6.118 The key changes to the draft Strategy resulting from the SA process are listed in Table 34. It should be noted these include changes made to earlier versions of the draft Strategy (2008 and 2009) and it is possible that some changes have been reversed or omitted in the current draft (28 January 2010).

6.119 Note that due to the timing of the preparation and internal approval of the draft Strategy, the GLA has not been able to consider and reflect the recommendations included in this version of the draft SA Report within a further revised iteration of the draft Strategy. The changes recommended in this SA Report will be considered by the GLA during the public consultation period and incorporated as appropriate in a final Strategy. The SA may therefore result in additional changes than those listed below in Table 34.

Table 34: Key changes to the draft Strategy as a result of the Sustainability Appraisal process

Element of draft Strategy	Key changes resulting from the Sustainability Appraisal process
Overall structure, scope and context	• The SA played a key role in discussion and consideration of an appropriate typology for adaptation options. This contributed to the inclusion of the *Prevent, Prepare, Respond, Recover* adaptation framework as a guide for developing policy and action in the draft Strategy. • Introduction of an additional "task" to the scope of the draft Strategy set out in the Introduction. • Clarification and explanation of the structure chosen for the draft Strategy. • Various other points of clarification were added, such as the wording used in the draft Strategy aim. • Clarifications added regarding the timescale covered by the Strategy and how frequently it will be revised.
Strategy Objectives	• Changes to the wording of the first objective to include prioritisation of climate risks and opportunities. • Inclusion of an additional objective (2) to identify and prioritise the key actions required to prepare London, and to define where responsibility for delivering and facilitating these actions lies.
Policies	• Encouragement to cover all the dimensions of the *Prevent, Prepare, Respond, Recover* adaptation framework in the policies which led to several additions. • Adding clarity to the link between the policies and actions. • Reference added to introductory text to policy 1 that the intention is to manage "current and future" flood risk in London. • Inclusion of text to in policy 1 to seek to raise the capacity of individuals and communities to respond and recover from flooding. • Policy text included in policy 1 referring to reducing flood risk to the most vulnerable

Element of draft Strategy	Key changes resulting from the Sustainability Appraisal process
	communities added.
Actions	• Encouragement to cover all the dimensions of the *Prevent, Prepare, Respond, Recover* adaptation framework in the actions which led to several additions. • Comments and recommendations led to the amendment and addition of some specific actions, such as: o Inclusion of an action seeking the development of community flood plans / emergency plans. o The inclusion of an action relating to water neutrality under policy 2. o Addition of text referring to regular review of the Mayor's Water Strategy under Policy 2. • Cross-cutting actions included in the draft Strategy were not included in previous drafts. Some of these address issues raised by the SA, in particular: • Action 32 relating to the role of the insurance industry in adaptation. • Action 31 encouraging businesses and the private sector to take climate change into account in risk management and planning. • Action 33 relating to the role of TfL and importance of the need for adaptation action related to infrastructure.

7. IMPLEMENTATION AND MONITORING

Links to other tiers of plans and programmes and the project level

7.1 The draft Climate Change Adaptation Strategy is part of a broader hierarchy of plans, which will not be developed nor implemented in isolation. Links and relationships exist at the national, regional (London) and local levels. Because of the nature of the Strategy and the limited powers that the Mayor has to address the impacts of climate change including on flooding, drought and overheating, the Strategy will need to be co-delivered by a series of key stakeholders. These include:

- Association of London Borough Planning Officers
- business-to-business organisations
- Chartered Institute of Building Services Engineers
- Department of Communities and Local Government
- Department for Environment and Rural Affairs
- developers
- Drain London
- East London Green Grid Partnership
- Environment Agency
- homeowners
- London Boroughs
- London Climate Change Partnership
- London Councils
- London Development Agency
- London Resilience Partnership
- London Water Group
- Mayor of London
- Met Office
- NHS London
- Ofwat
- Regional Public Health Group
- River Restoration Centre
- Social housing provider
- TfL
- Thames Water
- Transport for London
- voluntary sector
- Water companies

7.2 In addition, the Strategy will need support from Londoners, and across the public, private and third sector as well as individuals and households and many others, to be delivered.

7.3 The Climate Change Adaptation Strategy is being developed with reference to a large number of national and regional plans and strategies. At the highest level they need to reflect the broad agenda set out in *Securing the Future - UK Government Sustainable Development Strategy*. It should also reflect the requirements set out in other key government strategies such as *Adapting to Climate Change in England – a framework for action* and *Making Space for Water* and *Future Water – the Government's Water Strategy for England.* At the regional (London) level the draft Climate Change Adaptation Strategy is linked to policies, strategies

and targets set out in other mayoral initiatives, strategies and the London Plan. The development of the Water Strategy and Climate Change Mitigation and Energy Strategy are also closely linked with that of the Mayor's Climate Change Adaptation Strategy for example. The implementation of the Strategy will rely heavily on local / borough, community and household level action. More local level plans such as Local Development Frameworks along with those new plans discussed in the draft Strategy such as community flood and heatwave plans, will have a key role to play in translating the Strategy into locally relevant action to implement adaptation.

Proposals for monitoring

7.4 A fundamental part of the SA process is to develop the monitoring proposals for the significant sustainability effects arising from implementing the Strategy. It is important to monitor performance against the sustainability objectives, which form the core of the appraisal process, and identify where they are being achieved and where they are not, so that appropriate remedial action can be taken.

7.5 The SEA Directive requires the significant environmental effects of a plan or programme to be monitored and that the Environment Report (which is incorporated into this SA Report) should include a description of measures 'envisaged' for monitoring the implementation of the plan:

- Annex 1(i) of the SEA Directive requires the Environment Report to include "a description of the measures envisaged concerning monitoring in accordance with Article 10".
- Article 10 (1) states that "Member States shall monitor the significant environmental effects of the implementation of plans and programmes…".

7.6 In addition to the monitoring requirements arising from the SA process, it is also important to include details on how progress on implementing a strategy will be monitored and what indicators and targets will be used to measure progress against in the delivery of its objectives.

7.7 The draft Strategy does not currently include proposals on how it will be monitoring or what indicators will be use, instead at the end of the Introduction it asks consultees "*how can we measure how well London is adapting to climate change? What do you think are the key indicators and who should measures them?*". It is recommended that details on how and by whom the Strategy itself will be monitored should be included in the final version. This should include indicators to be used to monitor its implementation, as well as targets where relevant. Many potential indicators are already collected on a regular basis by, for example, water companies, the Environment Agency, Defra, the London Boroughs, Department of Health and DCLG, and many indicators are included by the GLA in the state of the environment for London and used to monitor the London Plan. However, these indicators would need to be analysed specifically against the objectives of the Climate Change Adaptation Strategy and the policies and actions it contains to determine the success or otherwise of its implementation overall and of its constituent parts. In addition, the effects on sustainability of the implementation of the Strategy (both predicted by the SA and unexpected effects) should be monitored and reported on regularly.

7.8 An additional issue with some of the existing indicators is that they are likely to be only available for different areas not London, e.g. Environment Agency or water company regions, Water Framework Directive River Basin Districts, etc. Therefore, introducing monitoring /

disaggregating data for key indicators at the London level would be particularly valuable. Where gaps exist in the necessary data to monitor the Strategy, additional actions may need to be added to collate it the relevant data.

7.9 In the case of the Climate Change Adaption Strategy, there is likely to be considerable overlap between what needs to be monitoring in terms of sustainability effects and for the performance of the Strategy as its objectives are to reduce the impacts of climate change which are also largely sustainability impacts.

7.10 It is worth noting that there are three different types of indicators that can be used for monitoring :

- **Contextual indicators** – which provide monitoring of the background against which a strategy operates.
- **Output indicators** – which enable monitoring of specific proposals included in a strategy.
- **Significant effects indicators** – which provide monitoring of the important 'effects' of a strategy as identified by an SA.

7.11 Table 35 identifies potential indicators to monitor the significant sustainability effects of the draft Strategy / climate change. Note that there are several queries identified in the table relating to the availability of data. Feedback on monitoring from consultees responding to the SA Report would be welcome. More detailed on the SA monitoring proposals should be published as part of the Post Adoption Statement once the Climate Change Adaptation Strategy is finalised.

7.12 Note that in the table those potential indicators which were included in the London State of the Environment Report 2007 are referenced - "SOER07 indicator" – and those potential indicators for which data is currently thought not to be available are in *italics*.

Table 35: Potential indicators to monitor the significant sustainability effects of implementing the Climate Change Adaptation Strategy

Significant effects	Potential indicators	Comments / gaps and potential targets
N/A	**Background / context** • Population and demographical change [*source: Office for National Statistics*] • Housing developments permitted / completed (including breakdown by size of development) [*source: London Development Database*]	This background information would be important as context to the pressures on water management, the potential sustainability effects of the Strategy and to inform the monitoring of some of the proposals which include thresholds related scale of development etc.
Flooding		
Risk of flooding from all sources (surface water, sewer, groundwater, fluvial and tidal) (SA objective 3, 4, 5 and 11)	• *Surface water run-off from new development* [*potential source: Local planning authorities / GLA*]	Surface water run-off from new development may not be currently monitored for London; therefore it is a potential gap to fill. A mechanism to monitor this would need to be developed as it would require data from each permission / completion.
	• *Proportion of new development / volume discharging to combined or separate sewers* [*potential source: Local planning authorities / GLA / water companies / drainage authorities / Highways Agency*]	Proportion of new development / volume discharging to combined or separate sewers may not be currently monitored for London; therefore it is a potential gap to fill. A mechanism to monitor this would need to be developed as it would require data from each permission / completion.

Significant effects	Potential indicators	Comments / gaps and potential targets
	• *Number of people and properties at risk / affected by flooding from different sources* [*potential source: Local planning authorities / GLA / water companies / drainage authorities*]	The water industry monitors, for example, indicators on sewer flooding e.g. the number of properties at risk of sewer flooding and number of properties actually affected by sewer flooding are included in the Water UK Sustainability Indicators 2007/08. But disaggregated data for London is unlikely to be available; therefore it is a potential gap to fill. The Mayor's draft Water Strategy includes a proposal to work with partners through the Drain London Forum to create a strategic-level surface water management plan for London which will also assist Boroughs in producing their Surface Water Management Plans. These should provide more information on surface water flooding in London. Vulnerability / socio-economic deprivation and flood risk should be included under this indicator. The London Regional Flood Risk Appraisal (RFRA) contains extensive information about flood risk in London's local authorities. The RFRA makes numerous recommendations to reduce the risk of flooding in the capital. These recommendations could also inform this indicator.
	• *Number / proportion of key infrastructure assets at risk from flooding* [*potential source: Local planning authorities / GLA / utility companies / transport operators*]	Number / proportion of key infrastructure assets at risk from flooding may not be currently monitored for London; there it is potentially a gap to fill. A mechanism to monitor this would need to be developed as it would require data from each local authority. Strategic Flood Risk Appraisals prepared by London Boroughs have to be updated every 3 – 5 years. These documents identify areas of flood risk in a borough. This information, combined with Environment Agency data on areas of flood risk in London, and spatial information on key infrastructure assets, could provide a basis for this indicator.
	• *Number / proportion of new residential development schemes incorporating SUDS* [*potential source: Local planning authorities / GLA*]	Number / proportion of new residential development schemes incorporating SUDS may not be currently monitored for London; therefore it is a potential gap to fill. A mechanism to monitor this would need to be developed as it would require data from each permission / completion. The Draft Flood and Water Management Bill will require developers to include sustainable drainage, where practicable, in new developments.
	• *Number / proportion of new commercial and other development schemes (non residential) incorporating SUDS* [*potential source: Local planning authorities / GLA*]	Number / proportion of new residential commercial and other development schemes incorporating SUDS may not be currently monitored for London; therefore it is a potential gap to fill. A mechanism to monitor this would need to be developed as it would require data from each permission / completion. The Draft Flood and Water Management Bill will require developers to include sustainable drainage, where practicable, in new developments.
	• *Number / proportion of existing building stock incorporating SUDS* [*potential source: Local planning authorities / GLA*]	Number / proportion of existing building stock incorporating SUDS may not be currently monitored for London; therefore it is a potential gap to fill. A mechanism to monitor this would need to be developed as it would require data from each permission / completion.
	• *Progress of local authorities in delivering agreed actions to implement long term flood and coastal risk management plans.* *[potential source: Local planning authorities / Defra / Environment Agency]*	The Thames Catchment Flood Management Plan (TCFMP) outlines options for managing the risk of fluvial flooding over the long term (50 to 100 years). The Environment Agency is working with London boroughs to agree the local actions necessary to implement the options identified. Progress towards delivering these agreed actions is monitored by government through National Indicator 189, and could be used as an indicator.
Reduced incidents of illness and death caused by flooding (SA objective 3, 4, 5 and 11)	• *Number of people suffering illness / number of deaths caused by flooding* [*potential source: Environment Agency / Health Protection Agency*]	Not currently monitored (it is generally difficult to attribute mortality and morbidity to flooding, other health effects of flooding (both physical and psychological) are well documented but not consistently monitoring and often underreported). Therefore it is a potential gap to fill.

Significant effects	Potential indicators	Comments / gaps and potential targets
Enhanced wildlife and habitat (SA objective 8 and 9)	• *New habitats created / improved habitats through flood schemes, SUDS and other enhancements* [*potential source: Local planning authorities / Environment Agency / GLA*]	Not currently monitored, therefore it is a potential gap to fill. One of the Mayors biodiversity targets is to restore 15kms of London's rivers by 2015. Progress towards meeting this target could be used as a basis for this indicator, but it is likely that additional information would also be required on SUDS and other enhancements etc.
Awareness of flood risk / flood warning (SA objective 2 and 11)	• *Number of people signed up to Floodline Warning Direct* [*potential source: Environment Agency*]	The Environment Agency keeps a record of the number of people signed up its early warning system – Floodline Warning Direct, although it is not clear how frequently this information is published.
Economic costs of flooding (SA objective 11 and 14)	• *Number of working days lost to flooding* [*potential source: ABI / Office for National Statistics*]	The number of working days lost to flooding may not be currently monitored for London; therefore it is a potential gap to fill. The Association of British Insurers, or the Office for National Statistics, may hold national data. However a method to establish disaggregated data for London would have to be established.
	• *Cost of flood damage in London* [*potential source: ABI*]	The cost of flood damage is calculated by the Association of British Insurers; however it is not clear if disaggregated data for London is available or how frequently the ABI prepare and publish this information. In order to monitor this for London it would be necessary to work with the ABI to establish if the necessary data is available and the frequency of its publication.
	• *Average household and business insurance* [*potential source: ABI*]	The ABI prepares property insurance statistics which includes information on insurance premiums. The ABI charge for the information and it is not clear whether this information is available on a disaggregated basis for London. Thus a mechanism to monitor this would have to be established with the ABI.
Drought		
Improved water efficiency (SA objective 12)	• Level of leakage in London [*source: Water companies / Ofwat*] [*SOER07 indicator*]	The leakage targets set by Ofwat for Thames Water for the remainder of the 2005-10 price review period is 690 Ml/d (2009-10). Disaggregated data not likely to be available for just London (water companies only).
	• *Water use in new residential developments* [*Potential source: Local planning authorities / water companies*] • Domestic water use in London (per capita / household) [*source: Ofwat / water companies*] [*SOER07 indicator*]	All publicly funded developments are now required to attain Code Level 3 (equal to or less than 105 litres per person per day (l/p/d)) and will be required to meet Code Level 6 (80 l/p/d) from 2016 onwards. Other housing has to meet less stringent standards under Part G of the Building Regulations which, from October 2009, will set a maximum daily usage standard of 125 l/p/d). Water use in new residential developments specifically may not be currently monitored for London; therefore it is a potential gap to fill. A mechanism to monitor this would need to be developed as it would require data from each permission / completion.
	• *Water use in new commercial development* [*potential source: Local planning authorities / water companies*]	Water use in new commercial developments specifically may not be currently monitored for London; therefore it is a potential gap to fill. A mechanism to monitor this would need to be developed as it would require data from each permission / completion.
Increased awareness of water consumption and reduced water use (SA objective 12)	• Penetration of metering in London (proportion of households) • Number / proportion of existing properties metered, both houses and flats, in London [*source: Water companies / Ofwat*]	Disaggregated data not likely to be available for just London (water companies only).
	• *Water use (disaggregated spatially and by different groups)* [potential *source: Water companies / Ofwat / Environment Agency / Mayor of London*]	The Mayor and the Environment Agency have jointly undertaken a study of the likely social effects of the widespread introduction of domestic water metering in London and in the wider area of water stress in the south east and east of England. Data on water use within different vulnerable groups would be useful, including information on where use is below minimum recommended levels. This is not currently monitored for London, therefore it is a potential gap to fill.

Significant effects	Potential indicators	Comments / gaps and potential targets
	• *Household awareness of water consumption* [*potential source: Water companies / Ofwat / Defra*]	This may not currently be monitored, therefore it is a potential gap to fill. It would be useful to collect information on awareness for London regularly via surveys. For example, a question could be included in Defra's Environmental Attitudes survey which already includes several questions on water consumption in the household and has disaggregated statistics for London.
Improved security of water supply (SA objective 12)	• Security of supply index [*source: Water companies / Ofwat*]	Thames Water has a target of achieving security of supply by 2009-10, but this target depends on their ability to achieve leakage targets and develop new schemes. Disaggregated data not likely to be available for just London (water companies only).
	• Supply and demand balance areas in water surplus / deficit [*source: Water companies / Ofwat / Environment Agency*]	
	• *Average water pressure and minimum levels* [*potential source: Water companies / Ofwat / Defra*]	Thames Water's supply in London is divided into more than 800 different 'district metering areas' (DMA), each of which has different pressure at different times of the day depending on changes in levels of demand[53]. Therefore, pressure can be reduced in some areas and not in others. The Water Industry Act 1991, requires the water undertakers to provide a supply of water sufficient for domestic use, but they are not required to provide water at a height greater than that to which it would flow by gravitation from the reservoir or tank from which the supply is taken. A minimum pressure of 0.7 bar[54] has to be maintained in pipes under the Water Supply and Sewerage Service (Customer Service Standards) Regulations 1989. Nevertheless, Ofwat's service standards establish 1 bar as the minimum and much of London exceeds this rate and has approximately 3 bars pressure[55].
	• *Proportion of water supplied on site from new development* [*potential source: Water companies / Ofwat / Local planning authorities / GLA*] • *Amount of water reclaimed for non-potable sources in new development* [*potential source: Water companies / Ofwat / Local planning authorities / GLA*]	Proportion of water supplied on site from new development may not be currently monitored; therefore it is a potential gap to fill. A mechanism to monitor this would need to be developed as it would require data from each permission / completion.
Increased water costs (SA objective 4, 12 and 14)	• *Percentage of income spent on water and sewerage in London / percentage of households spending more than 3% of disposable income on water and sewerage bills* [*potential source: Water companies / Ofwat / GLA / Defra*]	No measure of 'water affordability' is available, but there is a Government sustainability indicator that households should not spend more than 3% of their income on water and sewerage bills. Data on water affordability would be useful. This is not currently monitored; therefore it is a potential gap to fill.
	• Number of households applying for / receiving help under the Vulnerable Groups Regulations in London [*source: Water companies / Ofwat*]	Ofwat publishes figure by water company, but ideally data disaggregated for London would be available.
	• *Indicator(s) developed to monitor tariff arrangements and financial effects on different sections of the London community* [*source: Water companies / Ofwat*]	Not currently monitored; therefore it is a potential gap to fill. A mechanism to monitor this would need to be developed.
	• *Cost of metering for water*	Not currently monitored; therefore it is a potential gap to fill. A

[53] London Assembly Health and Public Services Committee Report 'Under Pressure', 2005.
[54] 1 bar is the pressure needed to raise water to a height of 10 meters, approx. 2 storeys high.
[55] London Assembly Health and Public Services Committee Report 'Under Pressure', 2005.

Significant effects	Potential indicators	Comments / gaps and potential targets
	companies (installation and reading meters) [*source: Water companies / Ofwat*]	mechanism to monitor this would need to be developed.
Water related habitats and wildlife (SA objective 8 and 9)	Possible indictors to monitor the effect of abstraction for public water supply within London on habitats and species (inside and outside London), including: • Low flow rivers • Condition of water depending SSSIs affected by abstraction • Indicator species affected by abstraction [*source: Natural England / Environment Agency / local wildlife groups*]	Current monitoring may not be suitably disaggregated to monitor impact of London.
Reduced affordability of new homes (SA objective 4 and 14)	• *Percentage of costs of new "affordable" home in London spent on water efficiency and supply features* (consider also whole life costs, not just installation costs?) [*potential source: Water companies / Ofwat / Local planning authorities / GLA*]	Not currently monitored; therefore it is a potential gap to fill. A mechanism to monitor this would need to be developed.
Increased incidents of water related illness (SA objective 3, 4 and 11)	• Possible indicators to monitor the occurrence of water borne diseases in London. *[source: Data concerning the microbiological and chemical quality of water is collected by the Drinking Water Inspectorate, surveillance of specific infectious disease is undertaken by the Health Protection Agency]*	The routine microbiological quality of drinking water is considered to be high and any specific incidents in the breakdown of water quality management could be reported by the Water Companies to Primary Care Trusts and the Health Protection Agency for assessment of potential health consequences. Illness related to recreational use of water is difficult to monitor as few individuals are likely to be affected. A mechanism to gather this information would have to be established. It may be possible for the GLA to work with those responsible for management of water bodies for recreational use to give consideration to preventing conditions conducive to enhance risk from microbiological agents (i.e. appropriate management measures), especially during periods of higher temperatures when more people may be at risk.
Increased energy use / emissions from water supply (SA objective 10 and 11)	• Energy used (and related emissions) from water supply to London (including energy used in pumping, treatment etc) and proportion from renewable energy [*source: Environment Agency / Energy Saving Trust / water companies / Water UK / Office of National Statistics*]	Water industry energy use is monitored - the water industry consumes 2% of the total energy in the UK[56]. For example, an indicator is included in the Water UK Sustainability Indicators 2007/08. But disaggregated data for London is unlikely to be available, therefore it is a potential gap to fill.
Overheating		
Average and peak temperatures / heatwave events	Context indicators for London *[potential source: Met Office / GLA]*	The Met Office is records temperature in London, but the scale this data is collected on may not adequately reflect the effects of the urban heat island, an important factor during a heatwave. The draft Strategy proposes undertaking a feasibility study of creating and maintaining a network of weather stations across the capital. The indicator should also take account of inadequate built form and social inequality, as both are important in determining the health effects of high temperatures.
Average and peak temperatures on public transport (SA objective 3, 6, 7 and 11)	Possible indictors to monitor temperature on public transport in London (particularly underground) [*source: health authorities / TfL*]	Indicators to monitor temperature on public transport in London may not be available. However, as the hot weather programme on the London Underground is triggered when the temperatures reach 24°C, it is likely that London Underground monitors temperatures on the Underground network, at least during warm

[56] http://www.water.org.uk/home/policy/climate-change/mitigation

Significant effects	Potential indicators	Comments / gaps and potential targets
		periods. However it is not clear if temperatures are routinely monitored on other forms of public transport. Thus for this to be monitored a mechanism to gather information on the temperature of various public transport modes would have to be established.
Increased / reduced incidents of heat related illness and deaths (SA objective 3, 4 and 11)	Possible indictors to monitor the occurrence of heat related illness and death, including reduction in winter deaths in London [*potential source: health authorities / Met Office*]	Hospital admissions for specific causes (ICD coded) and G.P consultations by READ code are available, but a mechanism to gather this information would have to be established. The Met Office Heat-Health Watch may provide useful information on the *threat* of heat related illness and death.
Increased incidents of air pollution related illness / deaths (SA objective 3, 4, 10 and 11)	Possible indictors to monitor the occurrence of air pollution related illness and death in London [*source: health authorities / local authorities*]	Real-time data of pollutants covered by air quality regulations and standards are available from the LA air monitoring stations. In addition, Hospital admissions data (by ICD code) and G.P consultations (by READ code) are available. However it is not clear if air pollution events in London could be directly linked to illness / death. A mechanism to gather this information would need to be established.
Increased incidents of vector-borne diseases (SA objective 3, 4 11)	Possible indictors to monitor the occurrence of vector-borne diseases in London [*potential source: health authorities*]	Communicable disease consultants of Health Protection Units can be consulted for information on this. A mechanism to collect this information would have to be established.
Increased incidents of cateracts, skin cancers and sunburn (SA objective 3, 4 11)	Possible indictors to monitor the occurrence of cateracts, skin cancers and sunburn in London [*potential source: health authorities*]	The Cancer Registries collect data on skin cancer, and the National Radiological Board has responsibilities relating to ultraviolet radiation. In addition, for severe sunburn injury records kept by Accident and Emergency departments may be useful. A mechanism to collect this information would need to be established.
Increase tree cover and green space (SA objective 6, 8, 9, 10 and 11)	Possible indictors to monitor new green space created (net) in London [*potential source: Local planning authorities / GLA*]	New green space created may not be currently monitored for London; therefore it is a potential gap to fill. A mechanism to monitor this would need to be developed as it would require data from each permission / completion.
	Possible indictors to monitor tree cover and green cover (net) in London [*potential source: Local planning authorities / GLA*]	New tree cover / green cover may not be currently monitored for London; therefore it is a potential gap to fill. A mechanism to monitor this would need to be developed as it would require data from each local authority in London.
Increase in green roofs (SA objective 6, 8, 9, 10 and 11)	Possible indictors to monitor new green roofs and walls created (net) in London [*potential source: Local planning authorities / GLA*]	The draft Strategy contains a proposal to increase the amount of green roofs in the capital from the 2008/09 baseline. Thus it is likely that data exists to monitor this. However it is not clear how frequently this data is updated. A mechanism to monitor this could be developed based on data from each permissions / completion.
Awareness of heatwave plan / warning (SA objective 2 and 11)	Possible indictors awareness of heatwave plan / warning in London [*potential source: Health Protection Agency*]	Not currently monitored; therefore it is a potential gap to fill. A mechanism to monitor this would need to be developed. The health input is the responsibility of the Primary Care Trusts.
Economic costs of heatwaves (SA objective 11 and 14)	• *Number of working days lost to heatwaves* [*potential source: ABI*]	Not currently monitored; therefore it is a potential gap to fill. A mechanism to monitor this would need to be developed.

Next Steps

7.13 The key next steps and outputs from the draft Strategy and Sustainability Appraisal processes should be as follows:

- Three months of public consultation to enable representations to be made following the publication of the draft Strategy and Sustainability Appraisal Report (9 February 2010)
- Amendments to the consultation version of the Climate Change Adaptation Strategy in light of consultation responses received
- Sustainability Appraisal of any significant changes, leading to either revisions to the Sustainability Appraisal Report, or if changes are minor a supplementary note to the Sustainability Appraisal Report
- Adoption of the final version of the Strategy by the Mayor (likely to be autumn 2010)
- Sustainability Appraisal Post Adoption Statement – prepared by the Mayor of London to notify the public that the Strategy has been adopted. This will include information on the main issues raised during consultation on the strategy and sustainability appraisal and how these were taken into account in developing the final strategy, details on monitoring and other information required as part of the sustainability appraisal
- Ongoing monitoring and review of the Strategy and monitoring of the sustainability effects.