

Climate Adaptation Plans for Schools

Overview Report

June 2023



Supplier

Arup

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Introduction

Why climate change adaptation matters for schools in London

Children, especially very young children and those with special educational needs and pre-existing health conditions, are vulnerable to the impacts of climate change. This is because they are less able to respond quickly to extreme weather events, have relatively limited experience of dealing with changing conditions, lack knowledge about how to adjust their behaviours and are dependent on teachers and other adults for guidance. Older children without special educational needs may be less vulnerable and dependent on adults, but are still affected by the disruption caused by extreme weather events. More specifically, high indoor temperatures not only have adverse effects on health and wellbeing but also affect cognitive performance and the ability to learn¹.

From a schools and early years perspective, planning to adapt and be more resilient to a changing climate is vital to ensure the health, safety and wellbeing of students and staff, and to ensure educational outcomes do not suffer.

The UK Climate Change Risk Assessment Summary for England (2021)² states that due to climate change:

- the 21st century has so far been warmer overall than any of the previous three centuries;
- there has been a greater incidence of hot summer maximum temperatures and extreme hot weather events, or heat waves;
- sunshine hours have increased;
- annual average rainfall has increased slightly, with more rainfall in winter and less in summer; and
- the frequency of extreme rainfall events has increased.

In July 2022, a national Level 4 Heatwave Alert was triggered for the first time ever in England³, and an Extreme Heat Warning was put in place for all of England and Wales, and parts of Scotland for at least two days. This was considered a major incident requiring emergency response.

1

https://www.researchgate.net/publication/233004128_The_Effects_of_Moderately_Raised_Classroom_Temperatures_and_Classroom_Ventilation_Rate_on_the_Performance_of_Schoolwork_by_Children_RP-1257

² <https://www.ukclimaterisk.org/wp-content/uploads/2021/06/CCRA-Evidence-Report-England-Summary-Final.pdf>

³ <https://news.sky.com/story/what-is-a-national-heatwave-emergency-and-what-could-it-mean-for-the-uk-this-week-12650436>

The 2018 UK Climate Projections⁴ state that these changes in climate and weather, that we are evidently already experiencing, are projected to continue and intensify for the rest of this century based on current rates of greenhouse gas emissions.

In London, increased temperatures, more intense rainfall events and greater water stress cause overheating, flooding and water scarcity impacts. The seemingly extreme 40°C temperatures, heatwaves, surface water flooding and drought all experienced in London during summer 2022 will increasingly become more frequent due to climate change. The observed and projected impacts of these changes in climate and weather in London are exacerbated by: the urban heat island (UHI) effect⁵; a high proportion of impermeable surfaces; a growing population; high population density; high demand for water; and extremes of deprivation and health inequalities⁶.

Therefore, climate change is intensifying existing pressures on London's buildings, critical infrastructure and services, and the natural environment. These pressures and impacts are being felt in schools and early years buildings and grounds.

Given this, a range of practical climate change adaptation and resilience measures are needed to enable schools, and their buildings and grounds, to prepare for, respond to and recover from extreme weather events and more gradual climate change impacts.

In addition, climate change adaptation and resilience measures within and around schools can: contribute to co-benefits for air quality, biodiversity, carbon reduction and energy efficiency; reduce inequalities; create better learning and play environments; improve educational and health outcomes; reduce operational costs; and support a more vibrant and resilient school community. Ultimately, investment in climate change adaptation and resilience measures for schools can contribute to the economy through improved productivity.

However, schools face many challenges such as limited resources and funding; competing priorities, ageing buildings that can be difficult to adapt; new buildings that can be difficult to operate; and knowledge and experience barriers. These can affect schools' ability to plan for both short term extreme weather events and longer-term climate change impacts.

4

https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18_headline_findings_v4_aug22.pdf

⁵ The urban heat island (UHI) effect is the phenomenon of higher air and land surface temperatures experienced in towns and cities compared to rural surroundings. It is particularly felt at night-time as the heat retained by artificial and dark surfaces is slowly released, keeping urban temperatures higher than those in the countryside. This is combined with other impacts such as the reduced cooling effect of vegetation in urban areas (i.e. less of it), and the compounding effect of anthropogenic heat emissions (e.g. from car engines and air conditioning units).

⁶ <https://www.london.gov.uk/programmes-and-strategies/environment-and-climate-change/london-environment-strategy>

Supporting schools to adapt and be resilient to climate change

In response to these challenges, the GLA Climate Resilient Schools (CRS) programme, co-funded by the Mayor of London, the Department for Education (DfE) and Thames Water, is working with 95 schools in London identified as most exposed and vulnerable to the three main impacts of climate change for London – overheating, flooding and water scarcity. The 95 schools were selected and prioritised for the CRS programme based on three main criteria:

- school is within the Thames Water catchment area (five London boroughs are not within this catchment area, and some boroughs are only partially within it);
- school has a high ranking in the DfE surface water flooding risk to school buildings database; and
- local area of school has a high relative score for Overall Climate Risk, Heat Risk or Flood Risk on the GLA Climate Risk Map⁷ (this map includes a range of environmental and demographic metrics which give an indication of exposure and vulnerability to climate change impacts).

The Climate Adaptation Plans (CAPs) for Schools project is one of four workstreams within the CRS programme. The other three are: Smarter Business Visits (delivered by Thames Water); Sustainable Drainage System (SuDS) Rain Planters (delivered by Delatim); and Monitoring and Education Resources (delivered by AmbioTEK CIC in partnership with Kings College London). Arup, a global firm of built and natural environment designers, engineers and consultants, were commissioned to deliver the CAPs for Schools project.

Building upon recommendations contained in previous GLA guidance on ‘How Schools and Early Years Settings Can Adapt to Climate Change’ (2020)⁸, and aligning with the DfE’s ‘Sustainability and Climate Change Strategy’ (2021)⁹, the key objectives of the CAPs for Schools project were to:

- Produce bespoke Climate Adaptation Plans (CAPs) for each school which:
 - identify the most pressing climate change impacts and risks, with a focus on overheating, flooding and water scarcity;
 - recommend physical and operational or behavioural measures to adapt and increase resilience to these impacts and risks;
 - cost these climate change adaptation and resilience measures and differentiate ‘quick-wins’ from ‘longer-term’ actions; and

⁷ <https://www.london.gov.uk/programmes-and-strategies/environment-and-climate-change/climate-change/climate-adaptation/climate-risk-map>

⁸ <https://www.london.gov.uk/programmes-and-strategies/environment-and-climate-change/environment-publications/how-schools-and-early-years-settings-can-adapt-climate-change>

⁹ <https://www.gov.uk/government/publications/sustainability-and-climate-change-strategy>

- signpost schools towards potential sources of funding, guidance and support to further inform and implement these measures.
- Produce an Overview Report for project partners, which:
 - summarises the key findings from the CAPs;
 - provides an evidence base on how prepared schools in London are for a changing climate and potential funding need;
 - provides the policy context for the implementation of climate change adaptation and resilience measures in London schools; and
 - sets out strategic recommendations for the CRS steering group to consider.

In addition, Arup has developed an illustrated 'Compendium of adaptation and resilience measures for schools'. It contains the full range of 41 physical measures which have been recommended within the CAPs, with descriptions, maintenance requirements, co-benefits and indicative cost ranges. It is intended to serve as a reference document for this project and all other schools in London. The compendium is provided as **Appendix 1** of this report.

The CAPs for Schools project has engaged with and undertaken site surveys at 60 of the 95 schools within the CRS programme. These 60 schools were responsive to emails informing them of the project and offering them the opportunity to have a site survey which would inform a bespoke CAP for their school. The other 35 schools either did not respond at all (25 schools), responded initially but then did not get back to us to confirm a site survey (6 schools), or said they did not want to have a survey (4 schools). Based on these site surveys, bespoke CAPs have been developed for each of the 60 schools.

What the Climate Adaptation Plans (CAPs) cover

Each CAP summarises relevant information about climate change impacts and risks for one of the 60 schools along with recommendations for climate change adaptation and resilience measures. These are practical things that schools can do to adjust to, prepare for, respond to, and recover from these impacts and risks. The CAPs have been informed by the following components:

- an online survey completed by school stakeholders;
- a site survey of each school undertaken by an Arup surveyor accompanied by school stakeholders comprising three parts:
 - an interview;
 - an external walk round school grounds identifying 'wet spots', 'hot spots' and 'dry spots' (external areas which have experienced flooding, overheating or water scarcity impacts respectively) and any existing climate change adaptation and resilience measures;

- an internal walk round school buildings identifying wet spots, hot spots, dry spots and existing measures (internal areas which have experienced flooding, overheating or water scarcity impacts respectively) and any existing climate change adaptation and resilience measures; and
- expert multi-disciplinary review from Arup's Technical Advisory Group to identify appropriate climate change adaptation and resilience measures covering 'quick win' and 'longer term' physical measures, and behavioural and operational measures. Wider measures for consideration were also identified for some schools.

A more detailed overview of the methodology and approach to the CAPs, and the identification of measures, is provided in **Appendix 2** 'Methodology and approach' of this report.

The intended uses of the CAPs by each school are to:

- highlight key climate change related impacts and risks for the school;
- identify the most relevant and appropriate climate change adaptation and resilience measures for the school;
- feed into any capital expenditure or refurbishment projects for the school;
- focus any fundraising efforts undertaken by the school;
- provide basic information to enable the commissioning of further technical, design or engineering surveys by qualified built environment professionals as appropriate;
- support any business continuity or contingency planning for the school;
- inform conversations with the Local Authority, Board of Governors and/or the Parents and Staff Association; and
- guide communications with school staff, students, families and community, and take an approach which engages the whole school.

The CAPs do not constitute detailed technical, design, engineering or cost plans for the schools, but are intended to inform potential further work to develop such plans. The intention is that schools keep and share the CAPs with school staff, governors and wider school community. They may be useful to refer back to when future funding is released, or as school improvement opportunities arise.

Potential sources of funding, guidance and resources to help schools to implement the recommended physical, behavioural and operation measures are summarised in the **Findings** section of this report.

Compendium of adaptation and resilience measures for schools

To inform and add value to the CAPS and this project Arup developed a 'Compendium of adaptation and resilience measures for schools' (see **Appendix 1**). This document sets out five categories of physical climate change adaptation and resilience measures relevant to schools in London, which can help to address the three main climate change impacts and risks of overheating, flooding and water scarcity. Physical climate change adaptation and resilience measures are measures which relate to the form and function of school buildings and school grounds, and require a combination of capital funding, professional technical expertise, and time to install. These measures have been included in the compendium informed by the following criteria:

- a presumption in favour of passive design, nature-based solutions, and adherence to the 'cooling hierarchy'¹⁰ wherever possible in line with Greater London Authority (GLA) and Department for Education (DfE) sustainable development and climate change policies and strategies;
- measures which provide a significant reduction in climate change risk, address more than one climate change risk and have other environmental, social and economic co-benefits;
- consideration of measures which makes a noticeable difference to educational outcomes, inequalities, and the health, safety and wellbeing of students, staff and families; and
- would be cost effective, represent value for money, and minimise disruption on site during the academic year.

Indicative capital cost ranges have been provided for all measures, along with consideration of installation and maintenance requirements. It should be noted that the full costs of professional fees required to plan, design and install bespoke versions of measures at each school have not been included.

The five categories within the compendium are listed below and contain 41 physical measures in total. These have been developed from existing good practice technical guidance and an understanding of the most relevant measures for schools based on the site surveys.

- Sustainable Drainage Systems (SuDS) measures (10 measures);
- Hard flood resilience measures (6 measures);
- Ventilation and cooling measures (12 measures);
- Solar shading measures (11 measures); and
- Water efficiency measures (2 measures).

¹⁰ The cooling hierarchy is: 1. Minimise internal heat generation through energy efficient design; 2. reduce amount of heat entering a building through orientation, shading, albedo, fenestration, insulation and provision of green roofs and walls; 3. manage heat within building through exposed internal thermal mass and high ceilings; 4. provide passive ventilation; provide mechanical ventilation; and 5. provide active cooling systems.

Legislation, policy, guidance and research context

International level

Legislation

The United Nations Framework Convention on Climate Change (UNFCCC) is the global legal framework for tackling climate change¹¹. The ultimate objective of the UNFCCC is to stabilise global greenhouse gas concentrations at a level that would prevent dangerous anthropogenic (human induced) interference with the climate system. The UK is one of the 198 countries that have signed up to and ratified the Convention and as a result is required to report regularly on its climate change policies and measures. The Paris Agreement is a legally binding international treaty on climate change, within the UNFCCC. It was adopted by 196 countries at the UN Climate Change Conference of Parties (COP21) in Paris, France in December 2015. It entered into force in the UK in November 2016¹². As a Party to the UNFCCC and the Paris Agreement, the UK submitted its first Adaptation Communication in December 2020¹³. This report sets out what the UK is doing to prepare for the effects of climate change at home and to support those facing impacts overseas.

Policy

At the international level, the two main policy frameworks relevant to climate change adaptation and resilience of school buildings and grounds in London are the United Nations (UN) Sustainable Development Goals (SDGs)¹⁴ and the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6) Synthesis Report (2023)¹⁵.

The UN SDGs most relevant to climate change adaptation and resilience of school buildings and grounds in London are summarised below:

- SDG 3 Good health and wellbeing;
- SDG 4 Quality education;
- SDG 6 Clean water and sanitation;
- SDG 7 Affordable and clean energy;
- SDG 10 Reduced inequalities;
- SDG 11 Sustainable cities and communities;
- SDG 13 Climate action;
- SDG 15 Life on land; and
- SDG 17 Partnerships for the goals.

¹¹ <https://unfccc.int/process-and-meetings/what-is-the-united-nations-framework-convention-on-climate-change>

¹² <https://unfccc.int/Transparency>

¹³ <https://www.gov.uk/government/publications/the-uks-adaptation-communication-to-the-united-nations-framework-convention-on-climate-change-unfccc-2020>

¹⁴ UN SDGs <https://sdgs.un.org/goals>

¹⁵ IPCC AR6 Synthesis Report (2023) <https://www.ipcc.ch/report/ar6/syr/>

The IPCC AR6 Synthesis Report headline statements¹⁶ most relevant to climate change adaptation and resilience of school buildings and grounds in London are summarised below:

- A.3 Current Progress in Adaptation and Gaps and Challenges;
- B.2 Climate Change Impacts and Climate-Related Risks;
- B.4 Adaptation Options and their Limits in a Warmer World;
- C.2 The Benefits of Near-Term Action;
- C3. Mitigation and Adaptation Options across Systems;
- C.4 Synergies and Trade-Offs with Sustainable Development;
- C5. Equity and Inclusion; and
- C.6 Governance and Policies.

National level

Legislation

The UK Climate Change Act 2008 is the legal basis for the UK's approach to tackling and responding to climate change¹⁷. It requires that emissions of carbon dioxide and other greenhouse gases are reduced, and that climate change risks are adapted to. It establishes the framework to deliver on these requirements through the UK Climate Change Risk Assessment (CCRA)¹⁸ and the NAP¹⁹.

The design of new buildings and some building refurbishment projects are subject to the Building Regulations. Of most relevance to climate change adaptation and resilience of school buildings and grounds in London are: the Building Regulations Approved Documents²⁰ Part F on Ventilation (2022)²¹; and Part L2 on Conservation of Fuel and Power: Buildings other than dwellings²² (2023).

Policy

At the national level, the main policies and strategies relevant to climate change adaptation and resilience of school buildings and grounds in London are: the National Planning Policy Framework (NPPF)²³; the UK Climate Change Act 2008²⁴; the UK Climate

¹⁶ IPCC AR6 Synthesis Report, Headline Statements (2023)

<https://www.ipcc.ch/report/ar6/syr/resources/spm-headline-statements>

¹⁷ <https://www.theccc.org.uk/what-is-climate-change/a-legal-duty-to-act>.

¹⁸ <https://www.gov.uk/government/publications/uk-climate-change-risk-assessment-2022>

¹⁹ <https://www.gov.uk/government/publications/climate-change-second-national-adaptation-programme-2018-to-2023>

²⁰ <https://www.gov.uk/government/collections/approved-documents>

²¹ <https://www.gov.uk/government/publications/ventilation-approved-document-f>

²² <https://www.gov.uk/government/publications/conservation-of-fuel-and-power-approved-document-l>

²³ <https://www.gov.uk/government/publications/national-planning-policy-framework--2>

²⁴ <https://www.legislation.gov.uk/ukpga/2008/27/contents>

Change Risk Assessment²⁵; the National Adaptation Programme (NAP)²⁶; and the Department for Education's (DfE) 'Sustainability and Climate Change Strategy' (2021)²⁷.

The planning and design of the built and natural environment in England is subject to the NPPF which sets out government's planning policies, in accordance with legislation, and how these are expected to be applied. The most directly relevant sections of the NPPF to climate change adaptation and resilience of school buildings and grounds in London are:

- Section 8 'Promoting healthy and safe communities';
- Section 12 'Achieving well-designed places';
- Section 14 'Meeting the challenge of climate change, flooding and coastal change'; and
- Section 15 'Conserving and enhancing the natural environment'.

The UK CCRA is undertaken every five years and assesses current and future risks and opportunities relating to climate change. The third, and current CCRA was published in 2022²⁸. It sets out sixty-one UK-wide climate change risks and opportunities cutting across multiple sectors of the economy and prioritises eight risk areas for action. The most directly relevant Priority Risk Area for climate change adaptation and resilience of school buildings and grounds in London is 'Priority Risk Area 7: Risks to human health, wellbeing and productivity from increased exposure to heat in homes and other buildings'. This is supported by evidence and analysis in 'Technical Report Chapter 3: Natural Environment and Assets'²⁹; 'Technical Report Chapter 5: Health, Communities and the Built Environment'³⁰ and the Summary for England³¹, which sets out a number of risks. The seven most relevant risks are summarised below:

- N1 Terrestrial species and habitats;
- H1. Health and wellbeing - high temperatures;
- H3. People communities and buildings - flooding;
- H5: Building fabric;
- H7. Changes in indoor and outdoor air quality;
- H9. Food safety and food security;
- H10. Health - poor water quality and water supply interruptions; and

²⁵ <https://www.gov.uk/government/publications/uk-climate-change-risk-assessment-2022>

²⁶ National Adaptation Programme (NAP) <https://www.gov.uk/government/publications/climate-change-adaptation-policy-information/climate-change-adaptation-policy-information>

²⁷ DfE's Sustainability and Climate Change Strategy (2021)

<https://www.gov.uk/government/publications/sustainability-and-climate-change-strategy/sustainability-and-climate-change-a-strategy-for-the-education-and-childrens-services-systems>

²⁸

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1047003/climate-change-risk-assessment-2022.pdf

²⁹ <https://www.ukclimaterisk.org/wp-content/uploads/2021/06/CCRA3-Chapter-3-FINAL.pdf>

³⁰ <https://www.ukclimaterisk.org/wp-content/uploads/2021/06/CCRA3-Chapter-5-FINAL.pdf>

³¹ <https://www.ukclimaterisk.org/wp-content/uploads/2021/06/CCRA-Evidence-Report-England-Summary-Final.pdf>

- H13. Delivery of education and prison services - extreme weather.

Risk H13 within Section 5.14 of the 'Technical Report Chapter 5: Health, Communities and the Built Environment' has a specific focus on schools. It states that whilst there is evidence of planning and designing for adaptation of school buildings, further adaptation measures are essential to avoid 'lock-in' with new building designs and to ensure existing school buildings can adapt and be resilient to future risks of overheating, flooding, water scarcity and other climate hazards.

In response to the CCRA, the UK government is required to produce a National Adaptation Programme (NAP). The NAP sets the actions that government and others commit to take in order to adapt to the challenges of climate change in the UK. Since 2013, the NAP has published a strategy every five years which summarises these actions. The second, and current, NAP strategy (NAP2) was published in 2018³². The most directly relevant actions for schools within the NAP2 are:

- 4.3 Flood and coastal erosion risk management;
- 4.5 Overheating in buildings (specifically sub-action 4.4.5 Schools); and
- 4.6 Delivery of health social care services.

The third NAP strategy (NAP3) is due to be published in summer 2023 and is anticipated to contain more specific actions on schools.

The most recent Progress Report from the Climate Change Committee, submitted to Parliament in March 2023³³, states the following key messages:

- the second National Adaptation Programme (NAP2) has not adequately prepared the UK for climate change, with limited evidence of implementation of adaptation at scale;
- the impacts from extreme weather in the UK over the last year highlight the urgency of adapting to climate change; and
- the next National Adaptation Programme (NAP3) must make a step change and focus on the delivery of effective adaptation.

The DfE Sustainability and Climate Change Strategy has five 'action areas' for delivery:

- 1. Climate education;
- 2. Green skills and careers;
- 3. Education estate and digital infrastructure;
- 4. Operations and supply chains; and

³²

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/727252/national-adaptation-programme-2018.pdf

³³ <https://www.theccc.org.uk/publication/progress-in-adapting-to-climate-change-2023-report-to-parliament/>

- 5. International.

Action area 3, 'Education estate and digital infrastructure' is the most directly relevant to the CAPs for Schools project. Other relevant initiatives to support the strategy and the CAPs for Schools project are:

- the National Education Nature Park³⁴; and
- the National Climate Education Action Plan³⁵.

See Table 3 in the 'Built and natural environment industry activities' section for a summary of these two initiatives.

Guidance

The main technical guidance documents relevant to climate change adaptation and resilience in London schools are: the DfE's 'Employer's Requirements Part B: School Output Specification Generic Design Brief'³⁶, particularly the 'S21 DfE Output Specification'; 'Building Bulletin 101: Ventilation, thermal comfort and indoor air quality' (2018)³⁷; 'Energy efficiency: guidance for the school and further education college estate' (2022)³⁸; 'Good estate management for schools' (2022)³⁹, and 'How Schools and Early Years Settings can Adapt to Climate Change' (2020)⁴⁰. The S21 DfE Output Specification include requirements for:

- all designs for new and refurbished buildings funded by DfE to use Design Summer Years that match the IPCC 2°C and 4°C global warming scenarios; and
- higher floor to ceiling heights, plus the mandating of cross-flow or stack ventilation and increasing resilience to higher temperatures by passive means rather than active cooling.

Technical guidance documents relating to the design of school grounds include: 'The good school playground guide'⁴¹; and 'Schools for the future: designing school grounds'⁴².

³⁴ <https://educationhub.blog.gov.uk/2022/11/10/what-is-the-national-education-nature-park-and-how-are-we-working-with-the-natural-history-museum-to-teach-children-about-climate-change-your-questions-answered/>

³⁵ <https://www.reading.ac.uk/planet/climate-education/climate-education-plan>

³⁶

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1120244/GDB_GenericDesignBrief_Publication-A-C16.pdf

³⁷ Building Bulletin 101: Ventilation, thermal comfort and indoor air quality (2018)

<https://www.gov.uk/government/publications/building-bulletin-101-ventilation-for-school-buildings>

³⁸ Energy efficiency: guidance for the school and further education college estate (2022)

<https://www.gov.uk/government/publications/energy-efficiency-guidance-for-the-school-and-fe-college-estate/energy-efficiency-guidance-for-the-school-and-further-education-college-estate>

³⁹ <https://www.gov.uk/guidance/good-estate-management-for-schools>

⁴⁰ <https://www.london.gov.uk/programmes-and-strategies/environment-and-climate-change/environment-publications/how-schools-and-early-years-settings-can-adapt-climate-change>

⁴¹ <https://lfl.org.uk/wp-content/uploads/2019/03/the-good-school-playground-guide.pdf>

⁴²

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/276691/schools_for_the_future_-_designing_school_grounds.pdf

However, these do not specifically refer to planning and designing school grounds to adapt and be resilient to climate change.

Research

The main national research programme relevant to climate change adaptation and resilience of school buildings and grounds in London is the UK Climate Resilience Programme⁴³. Within this programme the most relevant current research project is the University College London (UCL) and DfE project 'ARID: School buildings adaptation, resilience and impacts on decarbonisation in a changing climate'⁴⁴.

UCL and the London School of Hygiene and Tropical Medicine (LSHTM) have funding from the Engineering and Physical Sciences Research Council (EPSRC) for 'ASPIRE: Advancing school performance, resilience and educational outcomes'⁴⁵ informed by a data modelling platform for UK school buildings^{46,47,48}.

The DfE is working on the Condition Data Collection 2 (CDC2) programme⁴⁹. From 2021 to 2026 this programme will visit every government funded school and further education (FE) college in England to collect data about the condition of their buildings. This data will provide a comprehensive picture of the condition of the school and FE college estate in England.

DfE is also undertaking research to address climate change risks while planning for a zero-carbon school estate. This is providing the evidence for DfE trials of flood prevention and overheating amelioration measures and wider sustainability measures across several schools.

Other relevant research includes a paper on the history of environmental design in UK schools⁵⁰.

⁴³ UK Climate Resilience Programme <https://www.ukclimateresilience.org/about/faqs-quick-guide-to-ukcr/>

⁴⁴ <https://www.ukclimateresilience.org/projects/arid-school-buildings-adaptation-resilience-and-impacts-on-decarbonisation-in-a-changing-climate/>

⁴⁵ <https://www.ucl.ac.uk/bartlett/environmental-design/research-projects/2022/feb/aspire>

⁴⁶ <https://www.sciencedirect.com/science/article/pii/S235271022201542X>

⁴⁷ <https://discovery.ucl.ac.uk/id/eprint/10138870/>

⁴⁸ <https://iopscience.iop.org/article/10.1088/1742-6596/2042/1/012099/meta>

⁴⁹ <https://www.gov.uk/guidance/condition-data-collection-2-cdc2-programme>

⁵⁰ <https://www.sciencedirect.com/science/article/abs/pii/S1364032115001008>

London level

Policy

The two key policy documents of relevance to climate change adaptation and resilience of school buildings and grounds in London are the London Plan (2021)⁵¹ and the London Environment Strategy (2018)⁵².

The most relevant chapters of the London Plan are:

- Chapter 1 Good growth;
- Chapter 5 Social infrastructure;
- Chapter 8 Green infrastructure; and
- Chapter 11 Funding the London Plan.

The most relevant policies within these chapters are summarised in Table 1 below:

Table 1: London Plan relevant policies

Relevant chapter and paragraphs	Relevant policies	Summary of relevance to climate change adaptation and resilience of schools
Chapter 1 Good growth	Good growth policies: 1 Building strong and inclusive communities; 2 Making the best use of land; 3 Creating a healthy city; and 6 Increasing energy and efficiency.	Schools play a fundamental role in meeting these good growth policy objectives.
Chapter 5 Social infrastructure (paragraphs 5.3.10 – 5.3.12)	Policy S3 Education and childcare facilities.	Schools are considered as social infrastructure.
Chapter 8 Green infrastructure (paragraph 8.8.2)	Policy G8 Food growing.	School grounds form part of green infrastructure networks and can accommodate small food growing plots.

⁵¹ The London Plan <https://www.london.gov.uk/programmes-strategies/planning/london-plan/new-london-plan/london-plan-2021>

⁵² London Environment Strategy <https://www.london.gov.uk/programmes-and-strategies/environment-and-climate-change/london-environment-strategy>

Relevant chapter and paragraphs	Relevant policies	Summary of relevance to climate change adaptation and resilience of schools
Chapter 11 Funding the London Plan (paragraphs 11.1.34 - 11.1.35)	Policy DF1 Delivery of the Plan and Planning Obligations	Schools are considered as education infrastructure or social infrastructure which requires capital funding.

Chapter 11 of the London Plan states there is a growing need for school places in London. Central government provides majority of capital funding to create school places and carry out capital maintenance and repair work to existing school buildings. This is supplemented by capital contributions from London boroughs. Analysis suggests that London will need: approximately £11 billion up to 2050 to fund new primary and secondary school places; and an additional £12 billion to undertake renewals on both new and existing school facilities. This investment will need to be made by increasing Government contributions and from sources raised locally e.g. through the Community Infrastructure Levy (CIL) or Section 106 contributions.

The most relevant chapters of the London Environment Strategy are:

- Chapter 4 Air quality;
- Chapter 5 Green infrastructure;
- Chapter 6 Climate change mitigation and energy; and
- Chapter 8 Adapting to climate change.

The most relevant policy objectives within these chapters are summarised in Table 2 below.

Table 2: London Environment Strategy relevant policies

Relevant chapter and paragraphs	Relevant proposals, policies and objectives	Summary of relevance to climate change adaptation and resilience of schools
Chapter 4: Air Quality	Proposal 4.1.1.b The Mayor will aim to do more to protect London's young and disadvantaged people by reducing their exposure to poor air quality, including at schools, nurseries, other educational	Actions to improve internal and external air quality in and around at schools and nurseries have co-benefits for adaptation and resilience.

Relevant chapter and paragraphs	Relevant proposals, policies and objectives	Summary of relevance to climate change adaptation and resilience of schools
	<p>establishments, care homes, and hospitals.</p> <p>Policy 4.3.4 Work to reduce exposure to indoor air pollutants in the home, schools, workplace and other enclosed spaces.</p>	
Chapter 5: Green infrastructure	Proposal 5.1.1.c The Mayor aims to improve access to green space and nature by identifying those areas of the city that should be greener, and developing green infrastructure programmes and projects especially in major regeneration areas: through the Mayor's Transport Strategy, the Walk London network will be protected, improved and promoted.	School grounds, and routes to schools, can form part of green infrastructure networks, and can be an important point of access to nature for young people.
Chapter 6: Climate change mitigation and energy (London's new and existing buildings, pages 222 and 236)	<p>Policy 6.1.3 Improve the energy efficiency of London's workplaces and support the transition to low carbon heating and power.</p> <p>Proposal 6.1.3.a Provide direct technical support and assistance to help reduce CO2 emissions and energy within the public sector, including leading by example in the GLA group estate.</p>	<p>Schools are workplaces and many schools are considered to be part of the public sector estate.</p> <p>Actions to improve energy efficiency and reduce carbon emissions in and around at schools and nurseries have co-benefits for adaptation and resilience.</p>
Chapter 8: Adapting to climate change	Policy 8.2.3 Increase the amount of sustainable drainage, prioritising greener systems across London in new	Actions to increase SuDS, improve water efficiency, and reduce heat risk in and around schools and

Relevant chapter and paragraphs	Relevant proposals, policies and objectives	Summary of relevance to climate change adaptation and resilience of schools
	<p>development, and also retrofit solutions</p> <p>Proposal 8.2.3.a The London Plan includes more ambitious requirements for sustainable drainage in relation to new development</p> <p>Proposal 8.2.3.b Implement the actions in the London Sustainable Drainage Action Plan to retrofit more sustainable drainage for London</p> <p>Proposal 8.2.3.c The Mayor will consider a range of mechanisms to encourage sustainable drainage retrofit on non-residential properties</p> <p>Objective 8.3: Ensuring efficient, secure, resilient and affordable water supplies for Londoners.</p> <p>Proposal 8.3.1.c Support delivery of water saving measures through Energy for Londoners</p> <p>Objective 8.4 London's people, infrastructure and public services are better prepared for and more resilient to extreme heat events.</p> <p>Policy 8.4.2 Ensure critical infrastructure providers and occupants of homes, schools, hospitals, and care homes are aware of the impacts of increased temperatures and the</p>	<p>nurseries have direct benefits for adaptation and resilience.</p>

Relevant chapter and paragraphs	Relevant proposals, policies and objectives	Summary of relevance to climate change adaptation and resilience of schools
	<p>Urban Heat Island, to protect health and reduce health inequalities</p> <p>Proposal 8.4.2.a Provide locally specific data and modelling to demonstrate and evidence the impacts of the Urban Heat Island</p> <p>Policy 8.4.3 Minimise the risk of new development overheating</p> <p>Proposal 8.4.3.a The London Plan includes policies to minimise the risk of new developments overheating, and reduce their impact on the Urban Heat Island.</p>	

The London Environment Strategy states that by 2050 over ten million square metres of new schools, hospitals and workplaces are needed in London⁵³. This will ‘lock in’ emission patterns and climate adaption and resilience potential for 60-120 years (the average building and infrastructure lifespan). Therefore not only will these buildings need to reduce their energy consumption through better insulation and by using more energy efficient products, but they will also have to increase their adaptive capacity and resilience to climate change impacts and risks.

Cross cutting funding programmes

The GLA and the Mayor of London have recently had, and/or currently have, a number of cross cutting funding programmes, which respond to the policies outlined above. Some of these cross cutting funding programmes have direct relevance to climate change adaptation and resilience in London schools. Others have a different primary policy focus, but have climate change adaptation and resilience co-benefits. They are listed below as a snapshot of London level policy related funding programmes, but it should be noted that not all of these funds have continued into the financial year 2023/24.

⁵³ London Environment Strategy, Chapter 6: Climate change mitigation and energy. London’s new and existing buildings, pages 222 and 236.

- Recent and/or current cross cutting funding programmes with direct relevance and benefits
 - Climate Resilient Schools: <https://www.london.gov.uk/programmes-strategies/environment-and-climate-change/climate-change/climate-adaptation/climate-resilient-schools>
 - Green and Healthy Streets Fund: <https://www.london.gov.uk/programmes-and-strategies/environment-and-climate-change/parks-green-spaces-and-biodiversity/green-and-healthy-streets-fund>
 - Grow Back Greener Fund: <https://www.london.gov.uk/programmes-and-strategies/environment-and-climate-change/parks-green-spaces-and-biodiversity/green-space-funding/grow-back-greener-fund-2021>
- Recent and/or current cross cutting funding programmes with different primary focus and co-benefits
 - Mayors Energy Efficiency Fund <https://www.amberinfrastructure.com/our-funds/the-mayor-of-londons-energy-efficiency-fund/>
 - Retrofit Accelerator – Workplaces (RE:FIT) <https://www.london.gov.uk/programmes-and-strategies/environment-and-climate-change/energy/low-carbon-accelerators/retrofit-accelerator-workplaces/refit-london-story-so-far>
 - Public Sector Decarbonisation Programme
<https://www.gov.uk/government/publications/public-sector-decarbonisation-scheme-phase-3>

GLA approach of 'policy to pilot to implementation at scale'

The approach of the GLA Environment team to achieving the objectives of the London Environment Strategy is to develop pilot programmes and projects from manifesto commitments and evidence based policies. Then, if the pilot programme or project is successful, hand it over to others (e.g. other GLA teams or independent consultants) to scale up and implement, including sourcing funding and identifying means of delivery.

Built and natural environment industry activities

The main, current, built and natural environment industry activities relevant to climate change adaptation and resilience of school buildings and grounds in London are summarised in Table 3 below.

There is lots of positive, but seemingly disparate, activity. Therefore, there is great potential to integrate efforts and consolidate learning and resources to help schools in London plan and design for, and prepare and respond to, overheating, flooding and water scarcity. The collective knowledge from these activities has a vital role to play in the successful implementation of the climate change adaptation and resilience measures needed in London's schools.

Table 3: Built and natural environment industry activities relevant to climate change adaptation and resilience of school buildings and grounds in London

Spatial scale	Summary of activity
International	<p>C40 'Cooling Schools': a short report with recommendations and case studies from six cities that are implementing measures to cool their schools - Accra, Barcelona, London, Madrid, Paris and Rio de Janeiro, all members of C40's Cool Cities Network.</p> <ul style="list-style-type: none"> • https://www.c40knowledgehub.org/s/article/Cooling-schools-Experiences-from-C40s-Cool-Cities-Network?language=en_US <p>'Cool Schools' is an applied-research project which aims to generate opportunities for uptake of nature-based climate shelters approach by schools, neighbourhoods and cities. Initial focus cities are Brussels, Barcelona, Paris and Rotterdam.</p> <ul style="list-style-type: none"> • https://coolschools.eu/ <p>International Schools Grounds Alliance (ISGA): a global network of organisations working to enrich children's learning and play through improving the way school grounds are designed and used. The starting point is that the wellbeing of children and the ecological diversity of their learning landscapes are intrinsically linked.</p> <ul style="list-style-type: none"> • https://www.internationalschoolgrounds.org/

Spatial scale	Summary of activity
National – governmental initiatives	<p>The 'National Education Nature Park': a partnership project, championed by DfE, led by Esri UK and the Natural History Museum, working with the Royal Horticultural Society, the Royal Society, Royal Geographical Society (with IBG)), Learning through Landscapes, Manchester Metropolitan University and additional supporting partners. Aims to work with the education sector in England to map, manage and enhance all land across the education estate, creating one, vast, virtual, nature park. The project seeks to increase engagement with nature for children and young people and to improve the biodiversity of their school grounds. Also comprises 'the climate action award scheme', to help children and young people develop skills and knowledge in biodiversity and sustainability. It will also celebrate and recognise their work in protecting the local environment.</p> <ul style="list-style-type: none"> • https://educationhub.blog.gov.uk/2022/11/10/what-is-the-national-education-nature-park-and-how-are-we-working-with-the-natural-history-museum-to-teach-children-about-climate-change-your-questions-answered/ <p>The 'National Climate Education Action Plan': a partnership action plan, championed by DfE and led by the University of Reading. Focuses on climate education for children and young people aged 8 to 18 to ensure they, and generations to come, are equipped and empowered with the knowledge and understanding to respond to and tackle the climate and ecological crisis facing our planet. The plan acknowledges that pressures on ecology and biodiversity are strongly linked with climate change. Implicit in the plan is that better climate education is needed and that this should be delivered through all school subjects and activities as climate change touches all areas of society.</p> <ul style="list-style-type: none"> • https://www.reading.ac.uk/planet/climate-education/climate-education-plan

Spatial scale	Summary of activity
National – professional institutes	<p>Royal Institute of British Architects (RIBA) ‘National Schools Programme’: aims to help children explore and understand the built environment: its impact on people and communities; how it is shaped and developed; and why good design is important. Materials include a film for KS3-4 students to explore climate change and the built environment.</p> <ul style="list-style-type: none"> • https://www.architecture.com/education-cpd-and-careers/learning/riba-national-schools-programme • https://www.architecture.com/knowledge-and-resources/resources-landing-page/key-stage-3-and-4-building-the-future-film <p>Landscape Institute (LI) ‘The Playground Project’: encouraged school students to think about landscape practice by exploring their school’s outdoor space with a member of the LI and redesigning their playground. Participating schools received a budget for materials, access to relevant online resources and a guidance pack. Potential to link to the LI’s climate crisis action plan, Landscape for 2030, which outlined how the LI will respond to the climate change and biodiversity emergencies.</p> <ul style="list-style-type: none"> • https://www.landscapeinstitute.org/education/the-playground-project/ • https://www.landscapeinstitute.org/policy/climate-change/ <p>Royal Town Planning Institute (RTPI) ‘Resources for Teachers’ and ‘Future Planners’ programme: resources for teachers and ambassadors who volunteer to help promote planning in schools and to young people.</p> <ul style="list-style-type: none"> • https://www.rtpi.org.uk/become-a-planner/resources-for-teachers/ <p>RTPI and Town and Country Planning Association (TCPA) ‘The Climate Crisis: a guide for local authorities on planning for climate change’. Co-authored guidance for councillors, planners, and other practitioners trying to prioritise addressing climate change as a primary objective of planning and placemaking.</p> <ul style="list-style-type: none"> • https://www.rtpi.org.uk/news/2023/february/use-planning-system-to-soften-climate-impacts-councils-told/

Spatial scale	Summary of activity
National – industry bodies	<p>UK Green Building Council (UKGBC) ‘Climate Resilience and Nature Programme’ and ‘The Nature Recovery and Climate Resilience Playbook’: This is a programme of work to help the built environment adapt to the impacts of climate change, embrace nature and promote biodiversity, by prioritising the use of Nature-based Solutions. The programme is supported by a playbook designed to empower local authorities and planning officers to enhance climate resilience and better protect nature across their local area. It demonstrates how this can, and should, be embedded into decision-making at every level within local government. It offers interventions across housing and planning strategies, from cross boundary collaboration with neighbouring authorities to local planning policy.</p> <ul style="list-style-type: none"><li data-bbox="395 907 1364 943">• https://www.ukgbc.org/ukgbc-work/climate-resilience-and-nature/<li data-bbox="395 987 1410 1061">• https://www.ukgbc.org/ukgbc-work/the-nature-recovery-and-climate-resilience-playbook/

Spatial scale	Summary of activity
National - charities	<p>Learning through Landscapes ‘Climate Ready School Grounds’: This guidance document seeks to address the shortage in detail and guidance around how to create new spaces or adapt existing spaces to meet the challenge of climate change. This project takes a collaborative approach to designing and creating spaces which will contribute to efforts to adapt to our changing climate whilst reducing its impacts. Initially focussed on Scottish schools, there are plans to publish a UK wide version.</p> <ul style="list-style-type: none"> • https://lfl.org.uk/projects/climate-ready-school-grounds/ <p>Keep Britain Tidy ‘Eco-Schools Programme’: This programme provides a simple framework, comprising ten topics and seven steps, that helps schools and young people understand how to tackle environmental issues, such as climate change and biodiversity loss. It also empowers young people to make a difference in their school, local community and beyond. Schools connect their activities to three or more of the Ten Eco-Schools Topics. These topics break large, global issues like climate change into more manageable and directed themes and Seven Steps that prompt young people to consider positive environmental changes they can make in their school and everyday lives.</p> <ul style="list-style-type: none"> • https://www.eco-schools.org.uk/about/what-is-eco-schools/ <p>Trees for Cities ‘Trees for Schools’: This programme aims to transform urban school grounds into leafy green oases for children currently at school and for future generations. It is delivery-focused and specialises in innovative design, high-quality planting and landscaping, and inclusive engagement of the school community. Working in partnership with children and schools, urban playgrounds are reimagined and redesigned with the introduction of trees⁵⁴, forest gardens, food-growing, outside classrooms, woodland play areas, mini-forests and wildlife habitats. Tarmac playgrounds are transformed into natural green environments that are adapted to the changing climate, enabling creative education and connecting children to nature, supporting their mental health and wellbeing.</p> <ul style="list-style-type: none"> • https://www.treesforcities.org/our-work/schools-programme

⁵⁴ Guidance exists on appropriate tree species to plant in and around schools to avoid triggering allergies and asthma in children e.g. <https://www.allergyuk.org/types-of-allergies/hayfever/birch-pollen-and-allergies/>

Spatial scale	Summary of activity
London	<p data-bbox="395 387 1430 663">London National Park City (LNPC) ‘National Park City Schools’: a network for London's schools and educators, to help all London's children become greener, healthier and wilder. A fast-growing community of schools, committed to supporting the LNPC goal of connecting 100% of London's children to nature. Brings together the organisations that support schools to get outdoors, develop nearby outdoors space and get London schools greener and wilder.</p> <ul data-bbox="395 703 1177 741" style="list-style-type: none"> <li data-bbox="395 703 1177 741">• https://www.nationalparkcity.london/schools-network <p data-bbox="395 786 1430 1218">Groundwork London ‘Climate Proofing Housing Landscapes’: Groundwork London led a design team including EPG Ltd and the Green Infrastructure Consultancy, and the University of East London to retrofit a multitude of Nature Based Solutions (NBS) across three social housing estates in Hammersmith & Fulham. The three estates were chosen in order to demonstrate how green infrastructure adaptation can be implemented in a range of typical urban housing settings. The aim of the project was to demonstrate how a wide range of Nature Based Solution could be used to create a better environment for residents and make the housing estates more climate resilient. Potential to transfer the learning from this project to a range of school landscape typologies.</p> <ul data-bbox="395 1263 1366 1339" style="list-style-type: none"> <li data-bbox="395 1263 1366 1339">• https://www.groundwork.org.uk/projects/climate-proofing-housing-landscapes/ <p data-bbox="395 1384 1430 1697">C40 ‘Schools Reinventing Cities Programme’: this programme is part of Design Future London, a city-wide challenge for students aged 11–24. Both primary and secondary school students will be given the chance to use Minecraft to build solutions that revitalise Croydon Town Centre, an area designated as a an ‘Opportunity Area’ in London. Potential to transfer the learning and software from this programme to re-design schools, and the local areas around them, to be more adapted and resilient to climate change impacts and risks.</p> <ul data-bbox="395 1742 1302 1818" style="list-style-type: none"> <li data-bbox="395 1742 1302 1818">• https://www.c40reinventingcities.org/en/schools/participating-cities/london-1686.html

Findings

This section summarises and synthesises the key findings from the GLA CAPs for Schools project. Findings are presented under three categories of information:

- **Climate change impacts and risks** experienced by schools to date, or likely to be experienced by schools in the future. This information was primarily obtained from the online survey and the school stakeholder interviews, supported by a desktop assessment of local climate data, including surface water flood risk and sun path.
- Information about the **characteristics of schools' buildings and grounds**, as related to the schools' vulnerability and exposure to climate change impacts and risks, and their opportunities and constraints for taking action. This information was primarily obtained during the site survey and walk rounds, supported by a desk top assessment using Google Earth 3D data.
- An overview of the **recommended climate change adaptation and resilience measures** across all 60 of the surveyed schools, identifying cost implications for their implementation.

Overview of key findings

Headline findings are summarised below, with further detail available in the following subsections.

Climate change impacts and risks - summary

- Overheating was the most widespread and pronounced climate change impact experienced by surveyed schools.
 - 56 of 60 (93%) schools reported overheating as an issue they experience.
 - 47 of 60 (78%) schools reported that overheating has had a significant impact on students' learning, productivity or behaviour, or has interrupted normal school activity in another way.
 - 26 schools (43%) experience severe overheating that occurs 'multiple times' or 'continuously' throughout the summer term.
- During the 2022 summer heatwave alone, 47 of the surveyed schools which reported significant overheating impacts experienced a total of 33 closed days, or an estimated >22,000 student-days of lost learning.
- Flooding from all sources was reported to affect 45 of 60 (75%) surveyed schools.

- 24 schools (40%) reported that flooding has had a significant impact on students' learning, productivity or behaviour, or has interrupted normal school activity in another way. 8 of these schools (13% of 60) reported that flooding occurs 'multiple times' throughout the school year.
- In the past 10 years, 3 of the surveyed schools reported they have had to close for a total of 11.5 days or approximately 2,700 student-days due to flooding.
- Schools are generally less aware of risks or impacts posed by water scarcity. Whilst 29 of 60 (48%) schools reported to have been affected by water scarcity (mostly relating to London-wide hose-pipe bans), only 4 schools (7%) reported that water scarcity has had a significant impact on students' learning, productivity or behaviour, or has interrupted normal school activity in another way.⁵⁵
- Of the 4 schools that report to have been significantly impacted by water scarcity, 2 report to experience impacts every 2-3 years, 1 school reported to experience impacts over 10 years ago, and 1 school did not report the frequency of water scarcity impacts.

School site data and characteristics - summary

- Rain planters represent the most commonly identified existing or planned measure across the 60 surveyed schools. 46 of the 60 (77%) surveyed schools have received SuDS rain planters under the GLA Climate Resilient Schools (CRS) Programme. This is broadly equivalent to the 72 out of 95 (76%) CRS schools which have received SuDS rain planters.
- The most common desired measures identified by schools relate to increased provision of shading.
- Based on high-level mapping of land-use information conducted during site surveys, approximately 90% of the area within school boundaries is made up of impermeable surfaces, and 10% permeable.

Recommended climate change adaptation and resilience measures - summary

- Overall, 500 physical measures were recommended across all schools
- 242 or roughly half of recommended measures predominantly address heat risk, 177 measures predominantly address flooding (though 107 of these are SuDS measures, many of which carry heat resilience benefits as well) and 81 measures address water scarcity.

⁵⁵ It is important to note that water scarcity differs from the other two risk types in that impacts are rarely felt on a site-specific basis, unless there are water use restrictions in place. The focus relating to water scarcity is on a wider societal effort to reduce water use to help support collective water supply resilience in future.

- Grounds shade sails and linear rain gardens were the most frequently recommended measure across all schools, each recommended 43 times.
 - Implementing all 43 grounds shade sails (within 37 schools) would likely have a capital cost in the range of £116K to £228K (£2,700 - £5,300 per measure)
 - Implementing all 43 linear rain gardens (within 40 schools) would likely have a capital cost in the range of £64K to £129K (£1,500 – £3,000 per measure)

Please note that these are indicative capital costs, based on assumptions for each measure contained in **Appendix 1** 'Compendium of adaptation and resilience measures for schools'. The individual CAPs for each of the 60 schools do not constitute detailed technical, design, engineering or cost plans for the schools, but are intended to inform potential further work to develop such plans.

Behavioural and operational measures – summary

42 behavioural and operational measures in total were recommended to all schools. These comprised actions to address common maintenance or operational challenges that exacerbate climate change impacts, and practical behavioural change opportunities to reduce vulnerability to climate change risks. These measures were grouped by climate change risk type (flood, heat and water scarcity), and divided into three categories of 'times to act':

- **Plan ahead:** actions to take proactively to build resilience to extreme weather events
- **React and respond:** actions to take during and in the immediate aftermath of an extreme weather event to reduce impacts and decrease the time and cost burden to return to normal operations
- **Learn and transform:** actions to take after an extreme weather event to help schools learn and adapt to changing climatic conditions in the longer-term

27 of the behavioural and operational measures address heat risk only, 6 address flooding only, 6 address water scarcity only, and 5 address multiple risk types.

These measures are summarised later in this section.

Wider measures - summary

Opportunities for schools to engage with other stakeholders to implement measures beyond the school site boundary and/or school stakeholders' direct control were also identified during the project. Whilst not within the scope of the individual CAPs, a range of potential 'wider measures' have been included within this section of the report for further consideration. These measures may require discussion and collaboration with the local authority or other public sector and private sector organisations in order to implement them.

Five types of potential 'wider measures' were identified:

- **schools with School Streets** – enhancements to improve spaces outside school gates;
- **schools next to main roads** - air quality, road safety and noise co-benefits;
- **schools next to rivers or canals** – integrated flood risk management and enhancement;
- **schools with surface water flooding issues related to adjacent land uses** - integrated area based approach to SuDS; and
- **schools who share buildings and grounds with other organisations** – co-ownership and stewardship of measures.

Climate change impacts and risks

Schools' experiences of overheating, flooding and water scarcity were gauged during the online survey and the interview component of the site survey, captured using the *Survey 123* questionnaire (see **Appendix 2** 'Methodology and approach' for further detail).

The information reported by schools was supported by desk-top analysis of climate data and climate change risk during the adaptation measures decision-making process. This was to enable a more comprehensive understanding of schools' exposure to climate change risk, and to fill any reporting gaps.

Overheating

Reported frequency and severity of overheating events

Overheating was the most widespread and pronounced climate change impact experienced by surveyed schools. 56 of 60 (93%) schools reported overheating as an issue they experience.

To gauge the severity of overheating experienced, schools were asked the below question:

Have high temperatures or overheating related issues ever significantly impacted students' learning, productivity or behaviour, students' and/or staff's health, safety, wellbeing, comfort or ability to rest, play and recover during breaks, or interrupted normal school activity in another way?

47 of 60 (78%) schools responded 'yes' to this question. The remaining 9 schools which stated that they do experience overheating to some extent answered 'no' to this question, indicating that the impacts they experience are not severe.

Figure 1 provides a summary of the reported frequency of overheating events in the 47 schools that claim to experience 'significant' overheating. Figure 2 provides the same breakdown for the 9 schools that experience 'minor' overheating. Of the 47 schools experiencing 'significant' overheating impacts, 43 experience impacts on a yearly basis.

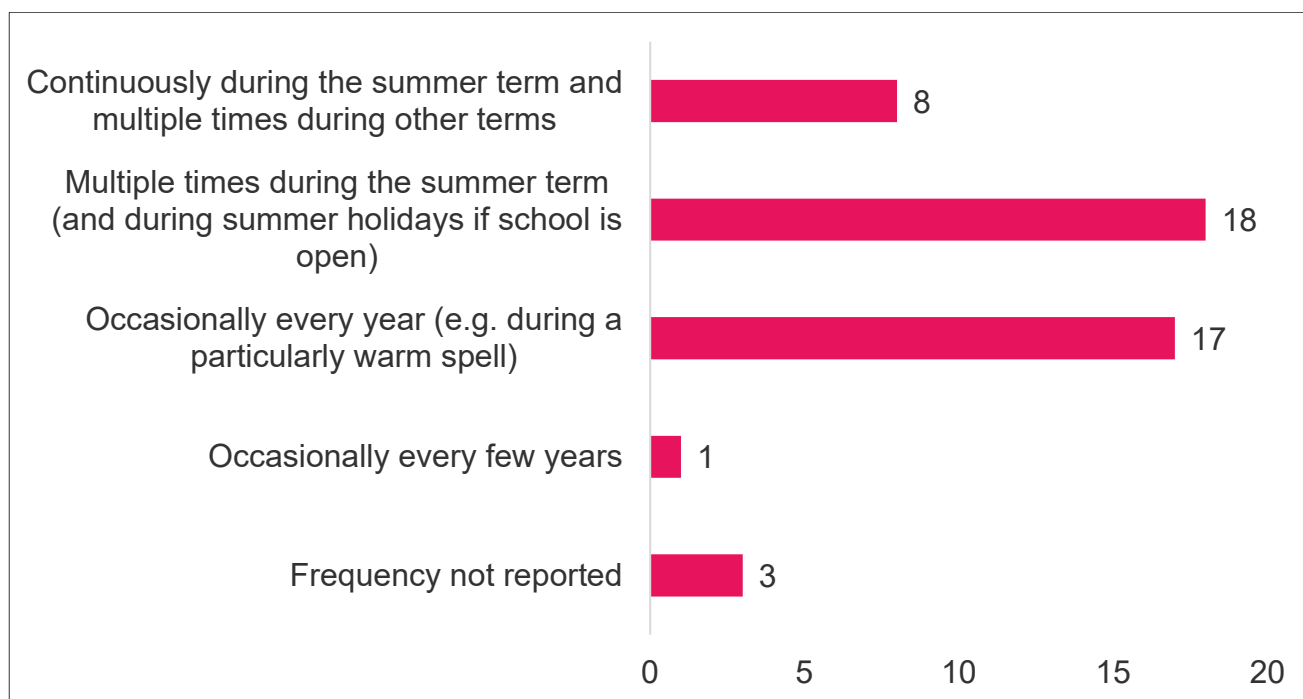


Figure 1: Reported frequency of overheating in schools that have experienced interrupted learning and school operations due to overheating. Total schools reporting significant overheating = 47

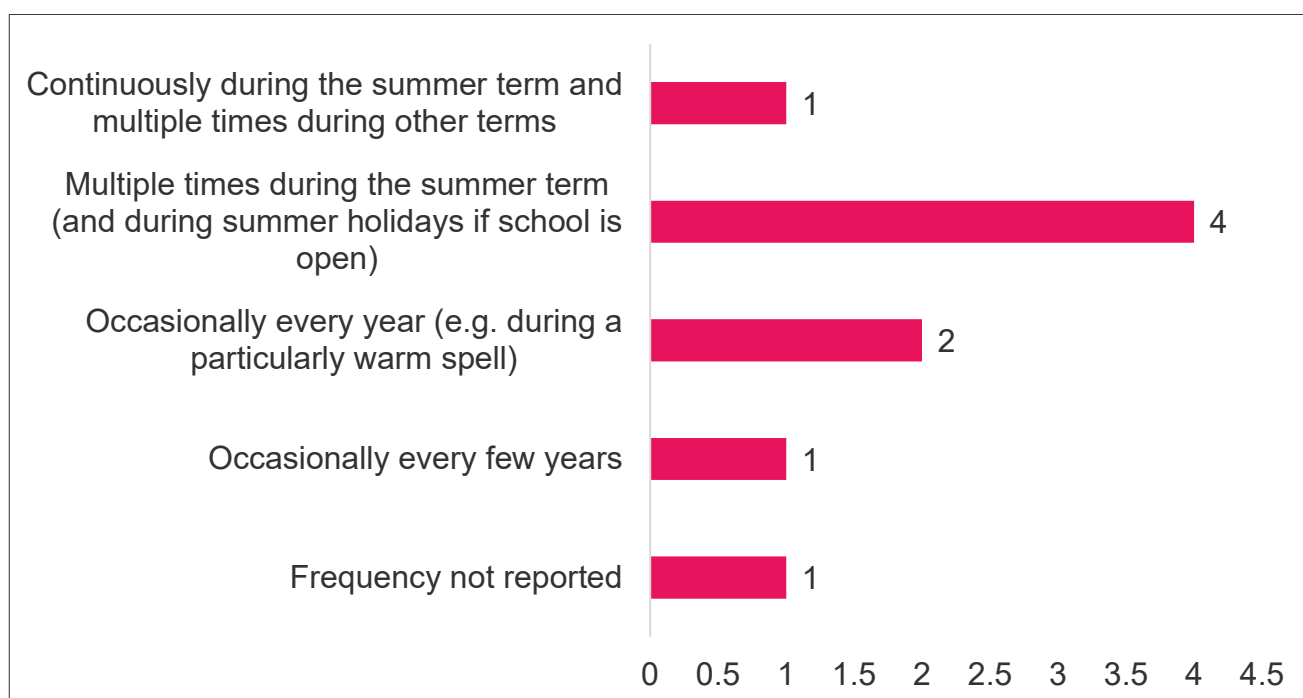


Figure 2: Reported frequency of minor overheating in schools that have not experienced interrupted learning and school operations due to overheating. Total schools reporting minor overheating = 9

Impacts experienced from overheating events

Schools reported a range of negative impacts on students, staff and school operations as a result of overheating. In general, the worst effects were felt during the summer of 2022 heatwave, with many schools closing for the first time due to high temperatures. Experienced impacts are summarised below.

- **School closure**

In total, 18 of the surveyed schools reported having to close due to high temperatures in the past 5 years, with 15 of these during the 2022 heatwave. The remaining 3 schools did not specify when closures occurred within the past 5 years.

Schools' approach to closure varied, for example some schools finished early across a number of days or weeks, whilst some schools had to close completely on the worst affected days. Many schools reported staying open due to their role in the community as a safe space and due to their provision of meals to children. Some schools reported that the school buildings were likely to be cooler than some of their students' homes. Some of these schools remained open whilst giving parents the opportunity to collect children after lunch if desired.

Surveyed schools closed for a total of 33 days during the 2022 heatwave, amounting to an estimated >22,000 student-days of lost learning. A further 4 days were lost across schools that did not specify when school closure occurred during the last 5 years, totalling an additional ~1,000 student-days missed.

- **Students' wellbeing, behaviour and productivity during lessons**

A number of schools reported that internal air temperatures in classrooms and other spaces often reached well above 30°C during hot weather and heatwaves. One school reported internal air temperatures of >40°C and one school reported internal air temperatures of >50°C during the 2022 heatwave. Many schools reported that learning was 'impossible' or 'unbearable' in certain areas of the school buildings during hot weather and heatwaves.

Schools reported significant impacts on students' behaviour and ability to learn during these periods of hot weather, including for example lethargy, poor mood, lack of concentration and significant discomfort.

Many schools noted that they rotated classes to enable children to recover in cooler areas of the school. Whilst a necessary response, this also contributed to disrupted learning.

Schools commonly mentioned that rules and class programmes were relaxed to accommodate distracted students. Some schools noted that their uniform policies were relaxed during heatwaves.

- **Students' ability to rest and play**

Many schools noted that heatwaves have restricted the ability of students to play outdoors during break times due to high temperatures and lack of shading.

Some schools adopted reduced outdoor break times, or implemented measures such as banning all running during breaks, whilst some schools did not allow children outdoors at all during the hottest days. One school noted that they instead allowed indoor 'wet play' to help children cool down, as an alternative to playing outdoors. Another school reported that there were incidences of students fainting in the playground during the heatwave of 2022.

- **Impacts on staff wellbeing**

Negative impacts on staff health and wellbeing were also reported by schools as a result of extreme high temperatures. One school noted that some staff were unable to come in on the hottest days due to underlying health conditions, and instead worked from home. Another school reported that a member of staff had to be given lifts home from work by a colleague during the heatwave of 2022, as they were unable to travel on foot and by public transport.

Flooding

Reported frequency and severity of flooding events

Flooding represents an important issue and concern for schools, though approximately half as many schools experience 'significant' flooding impacts compared with overheating.

Flooding from all sources was reported to affect 45 of 60 (75%) surveyed schools. To gauge the severity of flooding events experienced, schools were asked the below question:

Have flooding events ever significantly impacted students' learning, productivity or behaviour, students' and/or staff's health, safety, wellbeing, comfort or ability to rest, play and recover during breaks, or interrupted normal school activity in another way?

24 schools (40%) reported that flooding has had a significant impact on students' learning, productivity or behaviour, or has interrupted normal school activity in another way. 8 of these schools (13% of 60) reported that flooding occurs 'multiple times' throughout the school year.

Figure 3 provides a summary of reported frequency of flooding events in the 24 schools that report experiencing 'significant' flooding impacts. Figure 4 provides the same breakdown for the 21 schools that experience 'minor' flooding or water logging. Of the 24 schools experiencing 'significant' flooding impacts, 16 experience impacts on a yearly basis.

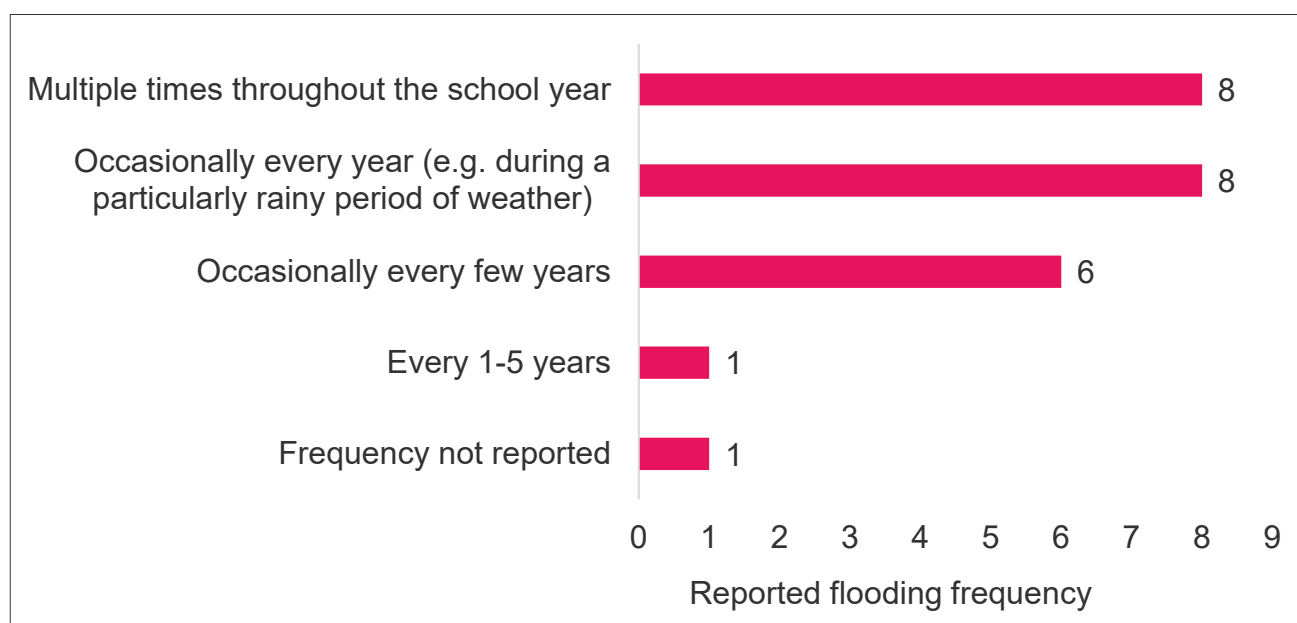


Figure 3: Reported frequency of flooding in schools that have experienced interrupted learning and school operations due to flooding. Total schools reporting significant flooding = 24

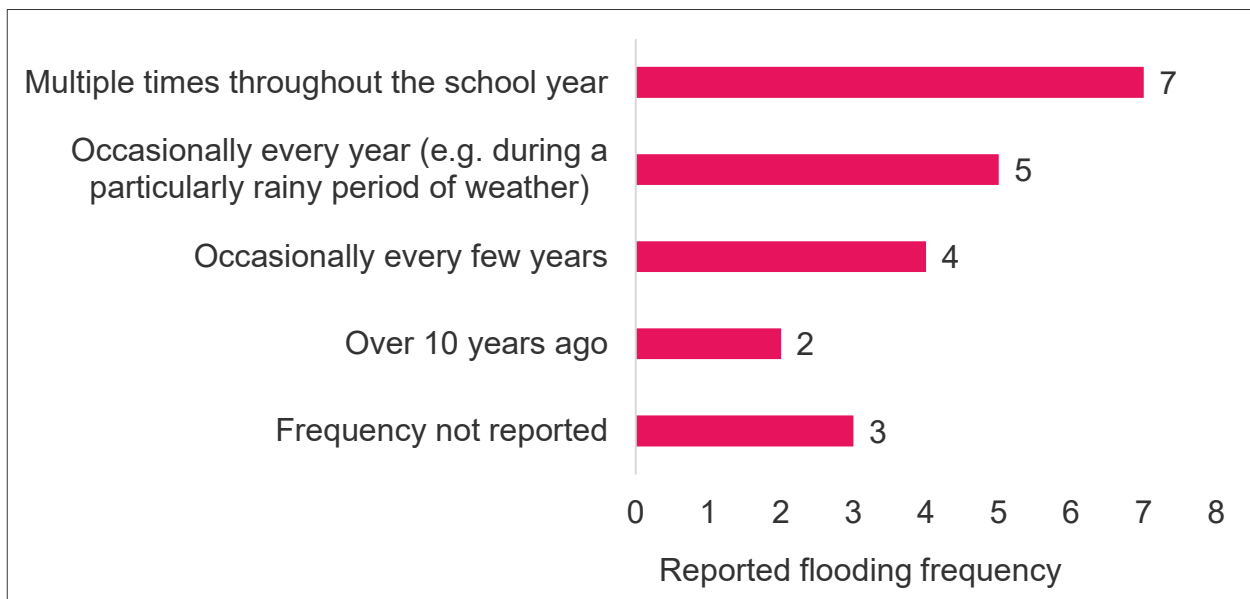


Figure 4: Reported frequency of minor flooding events that have not experienced interrupted learning and school operations due to flooding. Total schools reporting minor flooding = 21

Impacts experienced from flooding events

Of the schools surveyed, the most common flooding impact reported was reduced accessibility of playground areas during periods of heavy rainfall, and associated safety issues. These impacts were often exacerbated during cold weather as these areas froze over too. A number of schools also experienced flooding of specific buildings during surface water flood events across the school site. However, a small number of schools have experienced very significant and costly flooding impacts. The most impacted school experiences major flooding events on a yearly basis, whereby whole indoor and outdoor areas of the site are inaccessible. Experienced flooding impacts are summarised below.

• School closure

In the past 10 years, 3 of the surveyed schools reported they have had to close for a total of 11.5 days or approximately 2,700 student-days. In these schools, closures were required in the immediate aftermath of flooding events as the site was deemed unsafe and/or unusable.

In one school, one of the buildings remained closed for 6 months and children had to attend a different school nearby. Another school reported that at times flooding events lead to the closure of downstairs rooms which affects after-school care. One modern school built in 2016 experienced significant indoor and outdoor flooding in 2021 leading the school to close for one day. Since then, they still experience relatively regular flooding, however they have not had to close.

• Playground areas inaccessible

At least 9 of the schools surveyed reported that playground areas experience significant water logging during periods of heavy rainfall, including playing fields and hardscaped areas, reducing or altogether inhibiting the ability of children to use these areas during breaktimes. One school reported dramatic, but short duration, flash flooding events due to local topography, with water frequently flowing rapidly through the school playground. Often schools report ineffective or insufficient drainage as a significant factor, and indicated that existing drains are not regularly surveyed or maintained.

- **Class interruption and movement of pupils and staff**

For schools that experience flooding inside their buildings, the interruption and 'nuisance' was reported on several occasions to be the most significant impact. For example, relocating classes into different classrooms, blocking off well used areas of the school and clearing up.

- **Building damage**

5 schools noted significant building damage as a result of flooding events. The most affected school surveyed recorded one 'catastrophic' event each year, with additional less severe floods throughout the year. This causes significant and costly damage to school buildings, and the school stakeholder noted that their insurance company may be unwilling to renew their policy as a result.

One school reported flooding of up to 25cm, affecting the basement, school canteen and other ground floor areas. This occurs on average every 2-3 years. Another school reported one major flooding event over 10 years ago that flooded the entire school hall and required the fire brigade to assist, however improvement works have been done since then. One of the schools that closed in 2016 for a week due to a major flood reported building damages that took 6 months to fix, during which time students needed to be relocated to a different school nearby.

Many other schools reported less severe but ongoing leaks through the roof and windows that have led to damages and disruption over a longer period of time.

Water scarcity

Reported frequency and severity of water scarcity impacts

Schools are generally less aware of and concerned by risks or impacts posed by water scarcity. Whilst 29 of 60 (48%) schools reported to have been affected by water scarcity (mostly relating to London-wide hose-pipe bans), only 4 schools (7%) reported that water scarcity has had a significant impact on students' learning, productivity or behaviour, or has interrupted normal school activity in another way.

Figure 5 provides a summary of reported frequency of water scarcity impacts in the 4 schools that claim to experience 'significant' impacts, and Figure 6 provides the same breakdown for the 25 schools that experience 'minor' water scarcity impacts. Of the schools that reported 'significant' impacts, none experience impacts on a yearly basis.

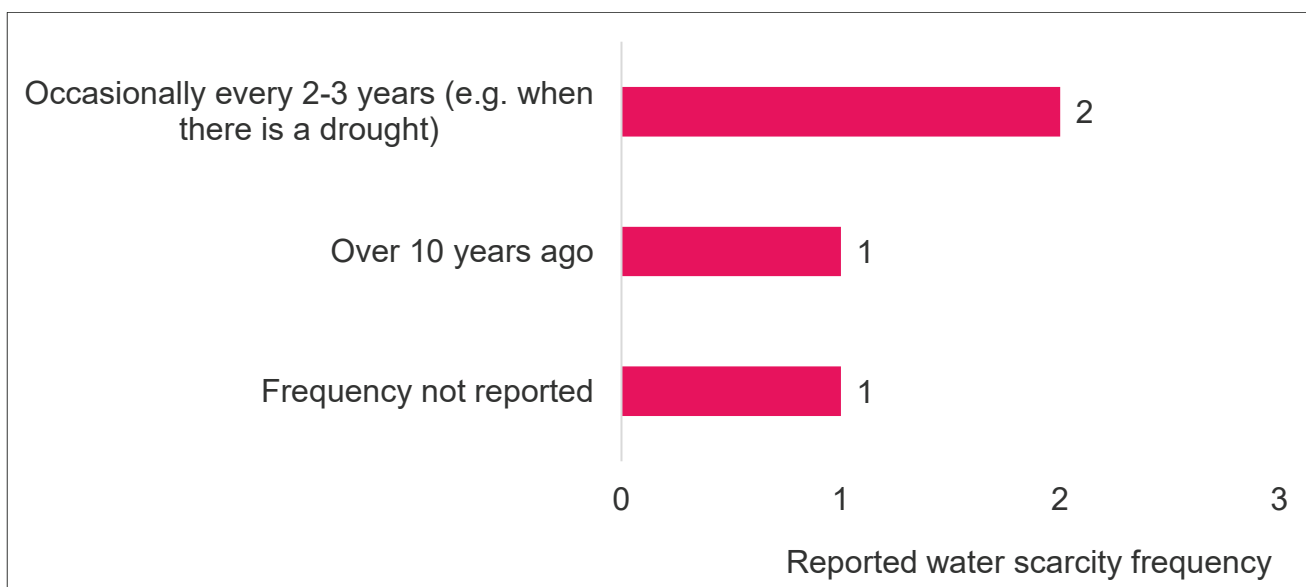


Figure 5: Reported frequency of water scarcity impacts in schools that have experienced interrupted learning and school operations due to water scarcity. Total schools reporting significant water scarcity impacts = 4

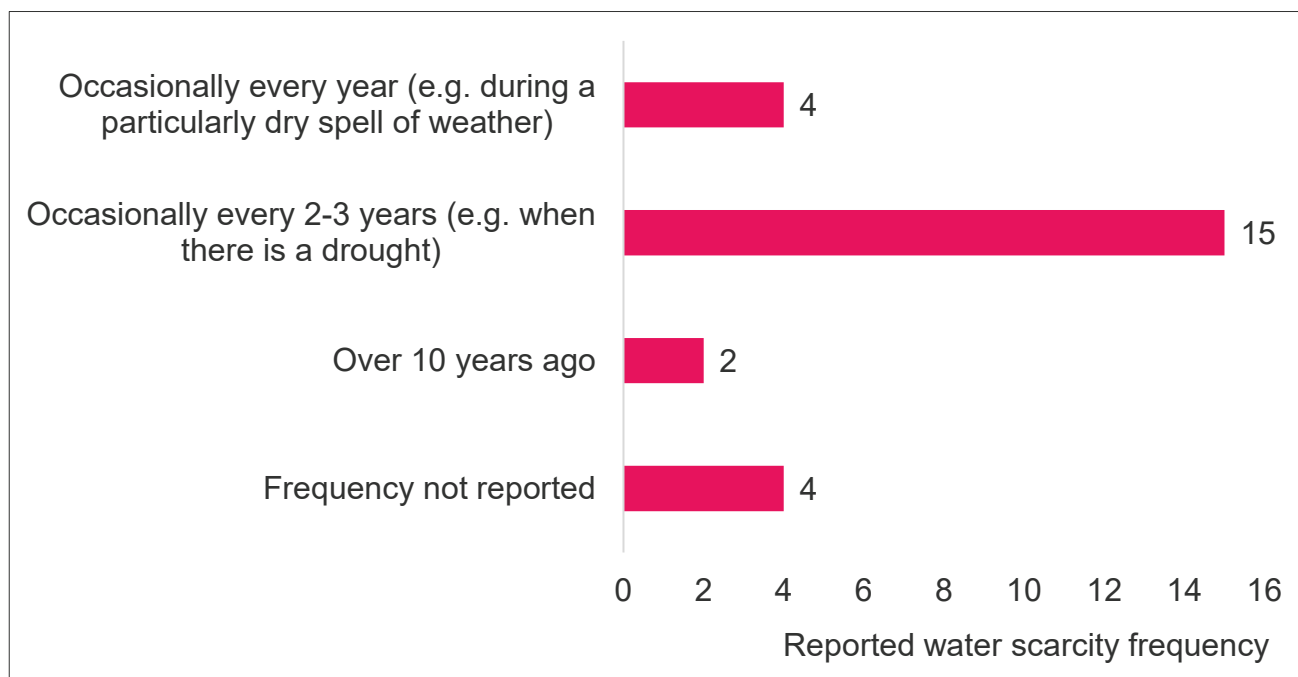


Figure 6: Reported frequency of minor water scarcity impacts in schools that have not experienced interrupted learning and school operations due to water scarcity. Total schools reporting minor water scarcity impacts = 25

Impacts experienced from water scarcity

4 schools experience water scarcity impacts that have a significant impact on school activities and operations.

One of these schools collects rainwater for the irrigation of plants and vegetable gardens that are used grow fruit and vegetables for the school community. This school noted that during periods of water scarcity, and particularly during hosepipe bans when they are unable to water their gardens using mains water, their ability to grow food and provide for the local community is significantly impacted.

One school noted that on one occasion in the past 10 years their pond dried up which they had to refill several times.

Many schools mentioned that areas of grass and vegetation have dried out during periods of low rainfall and hot weather. However, most often they reported that these areas tend to recover. One school reported severe cracking of clay soils in certain areas of its grounds due to the drought in 2022. This resulted in health and safety issues for students using this area.

One school noted the rising cost of water bills as a concern relating to water scarcity and an incentive to collect rainwater onsite.

School site data

As described in **Appendix 2** 'Methodology and approach', data and information about the school buildings and grounds was collected during the site survey and logged using Field Maps, including:

- locations of experienced climate change impacts (using 'hot spots', 'wet spots' and 'dry spots' icons);
- existing, planned and desired climate change adaptation and resilience measures onsite;
- land use coverage of the school grounds; and
- high-level information about the building structure and thermal performance.

Figure 7 provides a screenshot of an example of the data and information collected for one school.

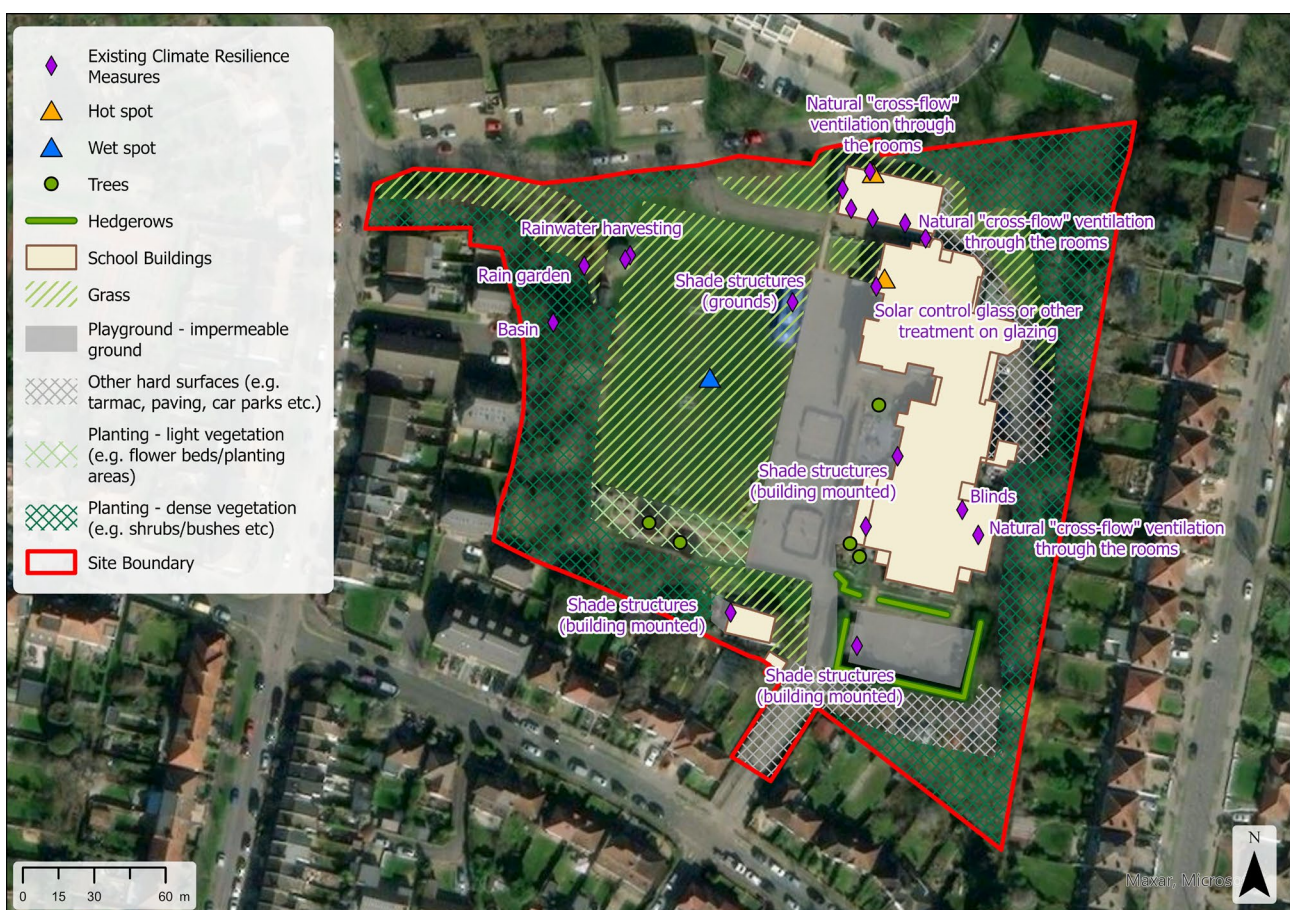


Figure 7: Example Field Maps data collection for one school in London

Figure 8 provides an overview of the existing measures reported across all schools. It should be noted that the 'Shade structures' identified also include plastic weatherproof structures predominantly used to provide shelter from rain. School stakeholders frequently identified these as having minimal or negative effects on temperature control. The most

reported existing measure of planned measure, 'Rain planters', includes a combination of the SuDS rain planters installed under the GLA Climate Resilient Schools Programme which are connected to downpipes, and others installed by the schools which are often not connected to downpipes. 46 of the 60 (77%) surveyed schools have received SuDS rain planters under the GLA Climate Resilient Schools (CRS) Programme. This is broadly equivalent to the 72 out of 95 (76%) CRS schools which have received SuDS rain planters.

Figure 9 shows the measures that schools indicated they are planning to implement, of which the vast majority are rain planters. Figure 10 summarises the measures that the school stakeholders indicated they would like to see installed on the site, but for which there are no current plans to do so. Note that each time a measure has been identified as 'desired' by schools, it has been recorded as one instance of the measure (though in practice schools may desire more than one of each measure on their site). The most common desired measures identified by schools relate to increased provision of shading.

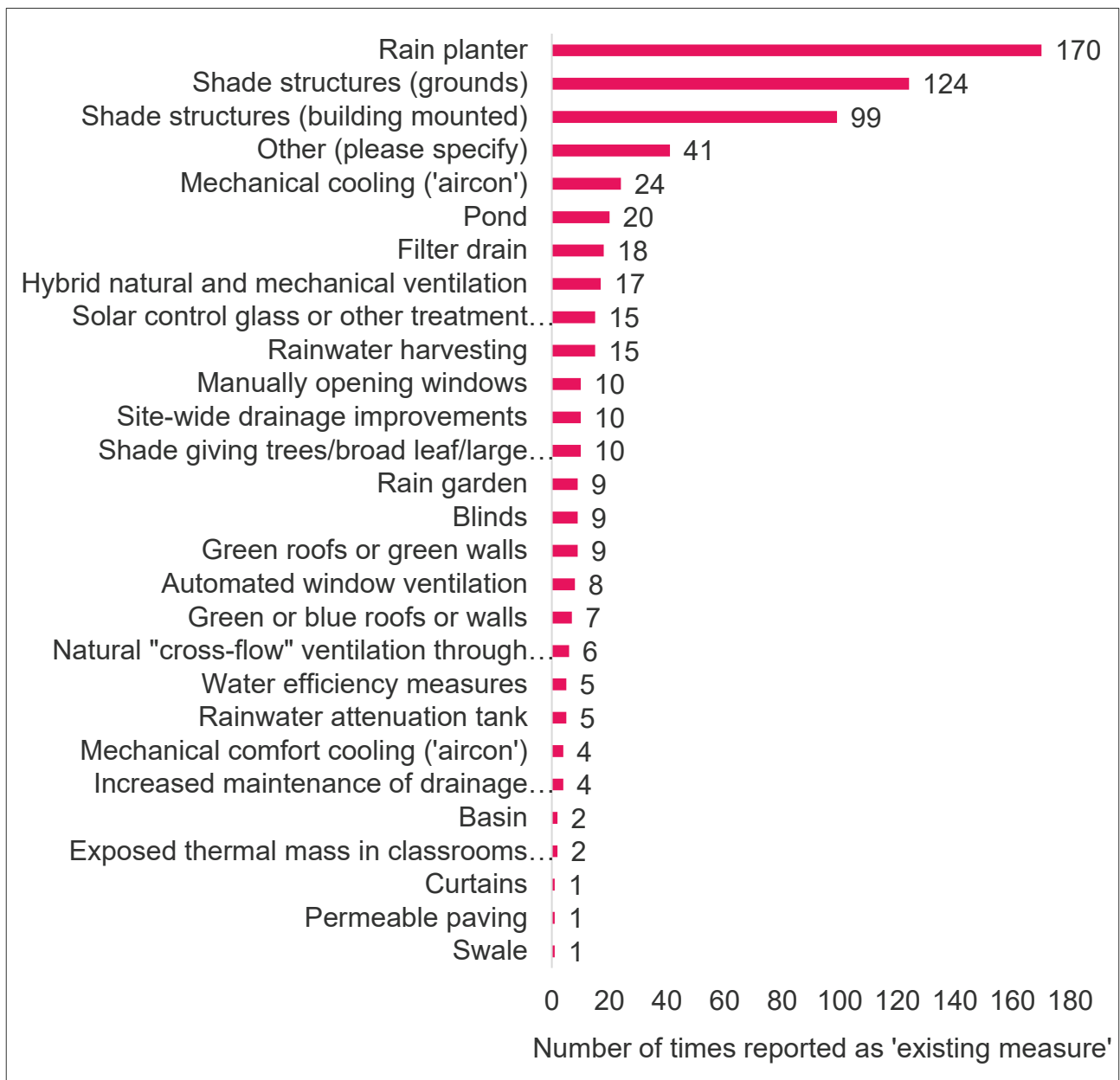


Figure 8: Overview of 'existing measures' recorded in Field Maps for all schools

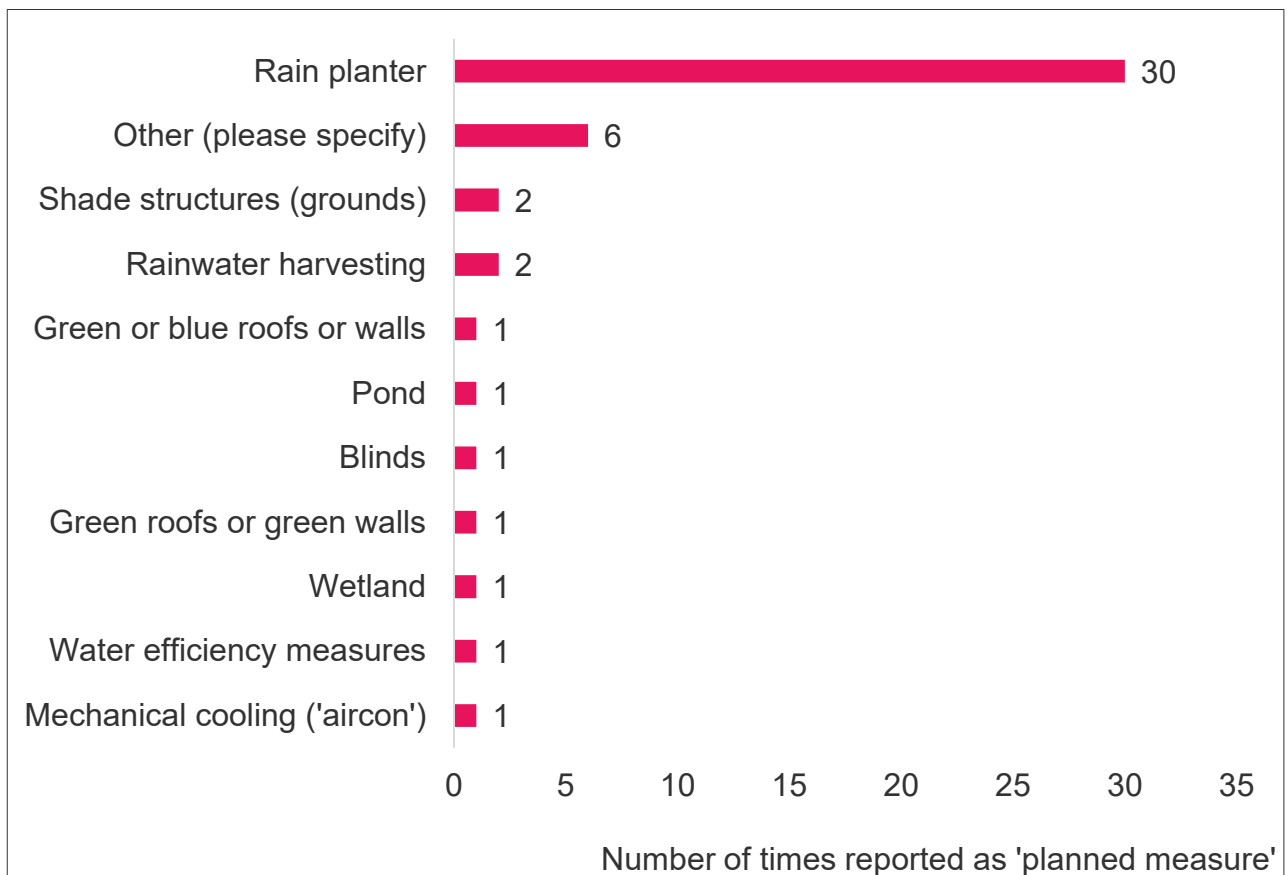


Figure 9: Overview of 'planned measures' recorded in Field Maps for all schools

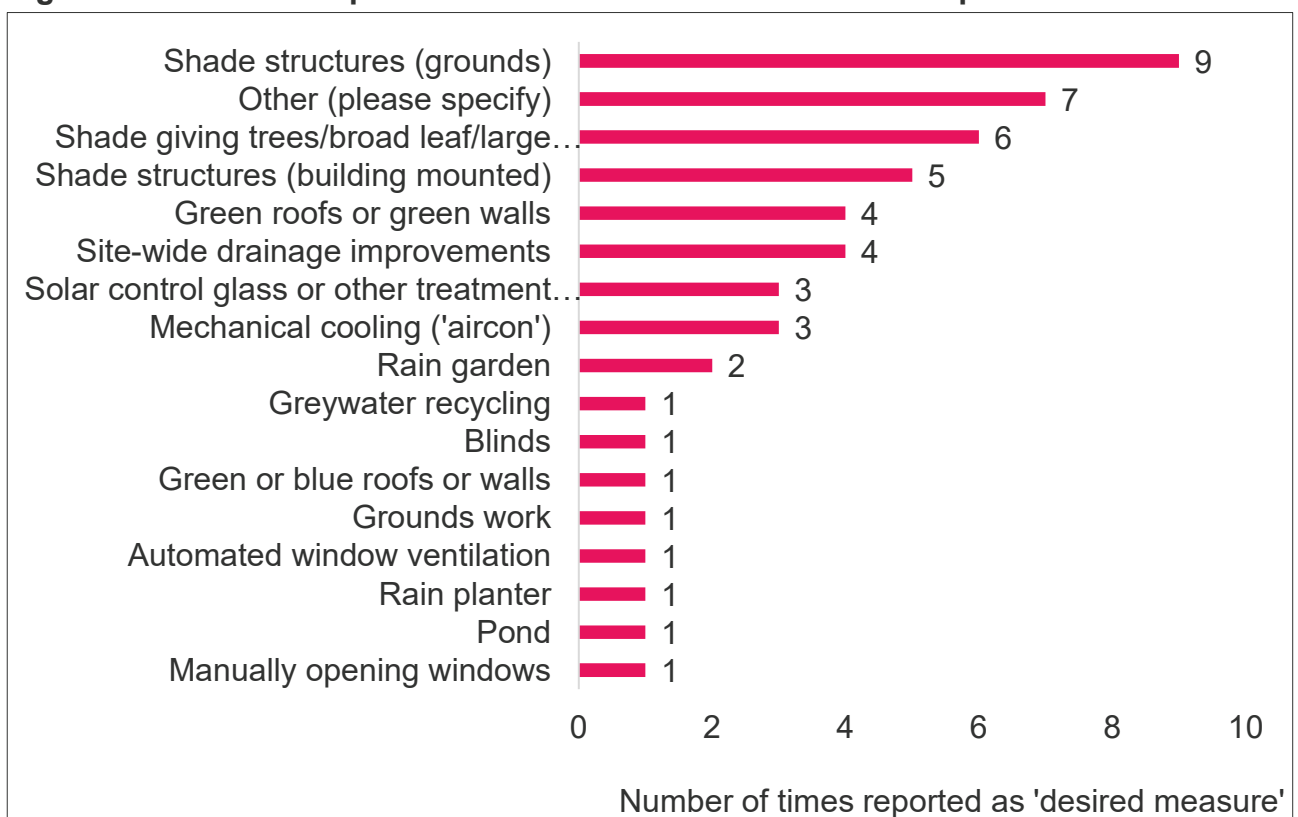


Figure 10: Overview of 'desired measures' recorded in Field Maps for all schools

Figure 11 shows a breakdown of hot spots, wet spots and dry spots recorded in Field Maps across all schools. Hot spots and wet spots dominate the point locations of experienced impacts each making up an even share.

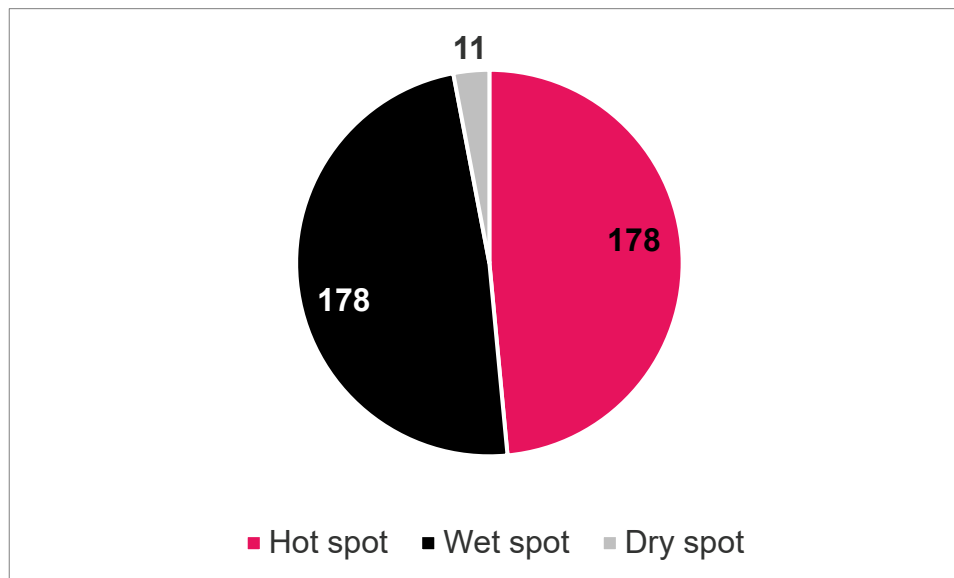


Figure 11: Summary of hot, wet and dry spots identified in schools

Figure 12 shows a breakdown of the land use areas recorded during the school surveys in Field Maps (for an example of this data), across all schools. Note that 'Other areas on site' represents the difference between the recorded land use areas and the total school site areas, and therefore includes the building footprint areas and areas of the grounds not otherwise visited or recorded by the surveyors.

Figure 13 shows the breakdown of impermeable and permeable land uses across all schools. For the purposes of this figure, it is assumed that the 'Other area on site' category is impermeable, however this is not certain.

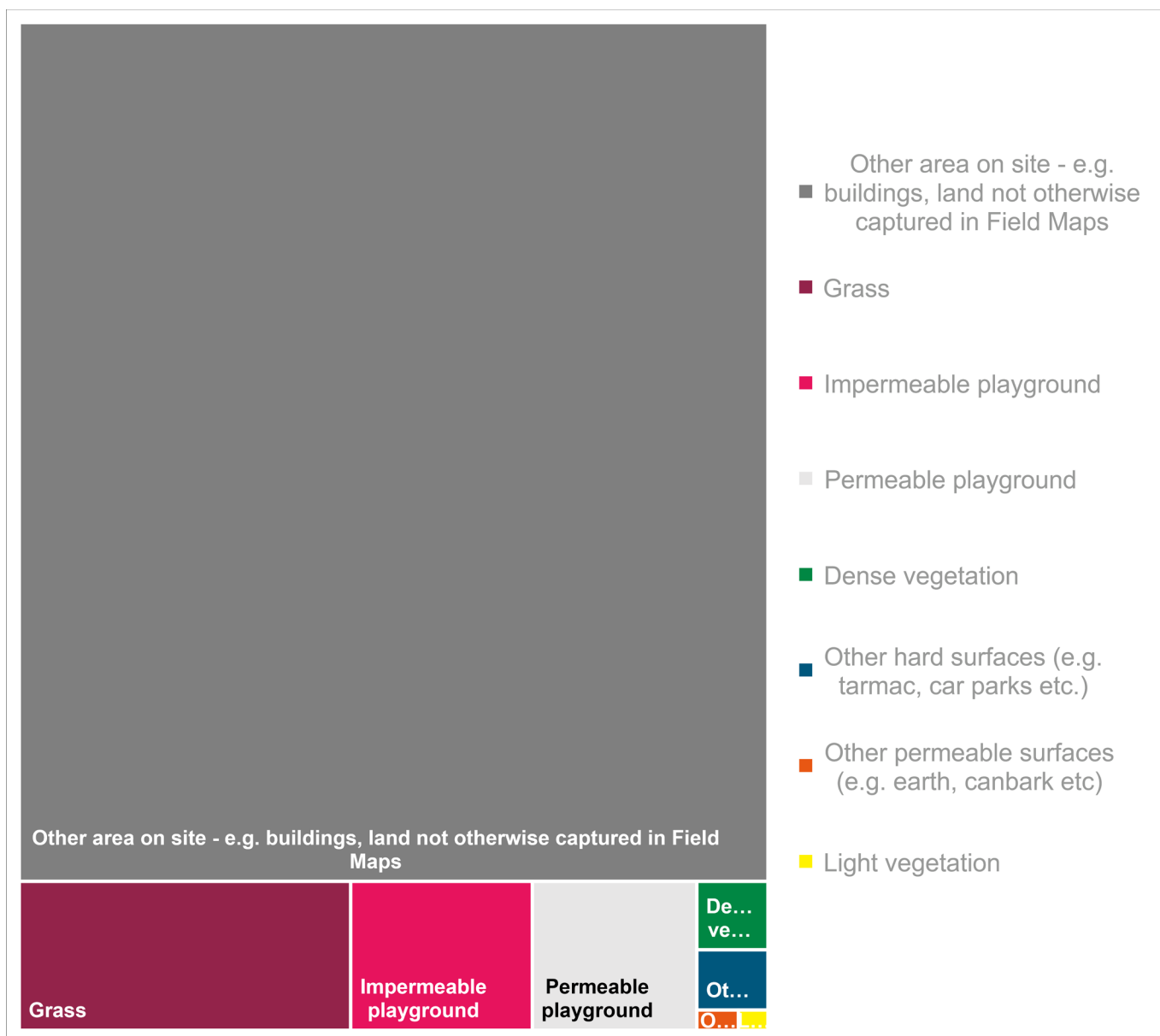


Figure 12: Breakdown of land uses on school sites recorded in Field Maps



Figure 13: Breakdown of impermeable and permeable surfaces on school sites reported in Field Maps

Recommended climate change adaptation and resilience measures

This section provides an overview of the recommended physical measures included in the CAPs for all 60 schools, and an indication of commonly reported measures' aggregate costs.

Overall, 500 physical measures were recommended across all schools. 242 or roughly half of these measures predominantly address heat risk, 177 measures predominantly address flooding (though 107 of these are SuDS measures, many of which provide heat resilience benefits as well) and 81 measures address water scarcity.

Figure 14 shows a summary of the number of times each measure was recommended across all schools.

'Grounds shade sails' and 'Linear rain gardens' were the most frequently recommended measure across all schools. These measures are effective in addressing heat risk and flood risk, are relatively low cost, and can be easily accommodated within the differing space requirements and constraints of schools.

The two measures are closely followed by the two water scarcity measures: 'Internal water efficiency measures' and 'Rainwater harvesting water butts'. It should be noted that often the school stakeholder was not aware of whether these had already been adopted; in these instances they were recommended, explaining the frequency of recommendations across schools.

The remaining commonly recommended measures include a mix of SuDS, solar shading measures, ventilation and cooling measures and hard flood resilience measures.

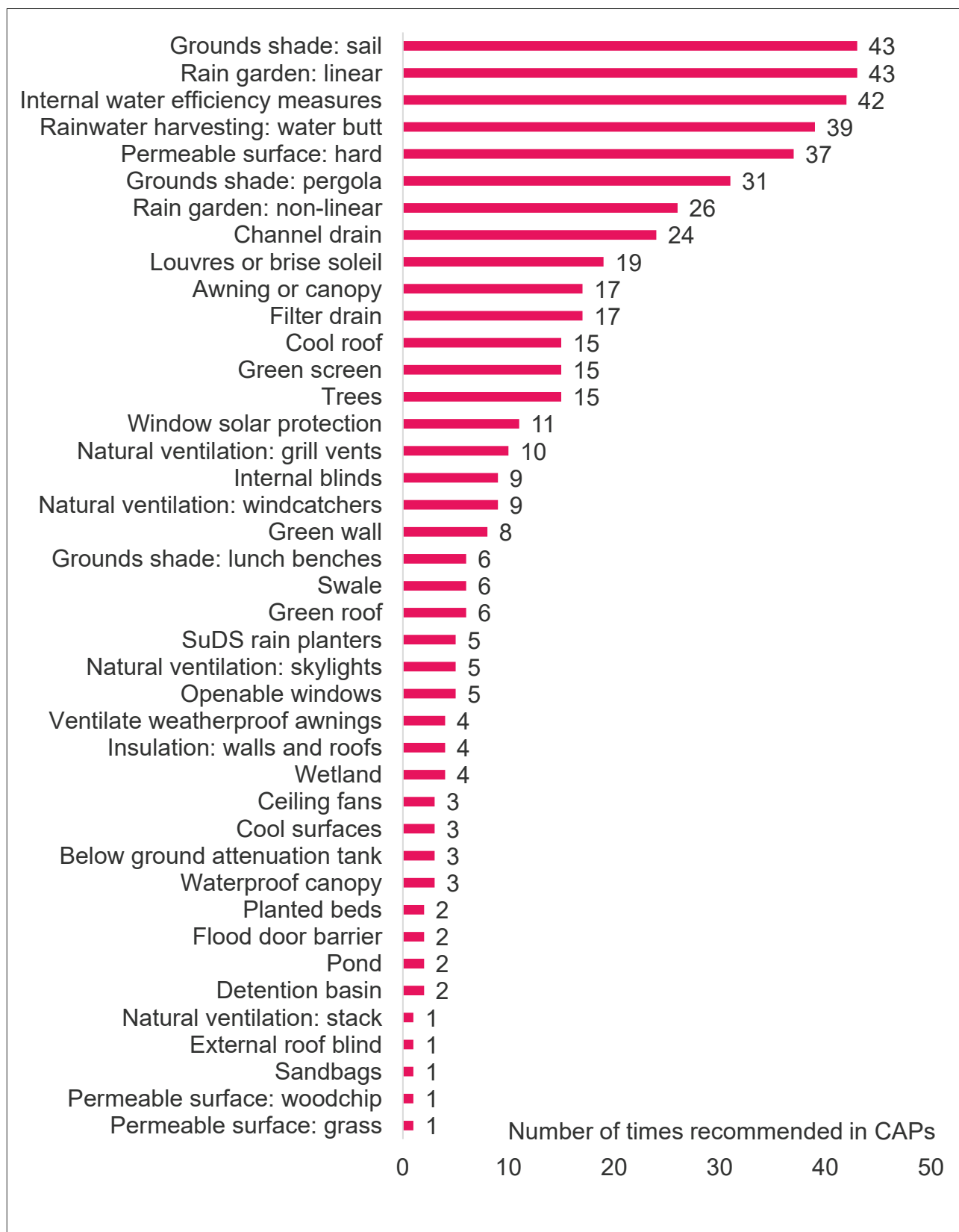


Figure 14: Recommended climate change adaptation and resilience measures count

Figure 15 shows a breakdown of all recommended measures by category of measure. For more details about which measures fall into each category, please see **Appendix 1** ‘Compendium of adaptation and resilience measures for schools’.

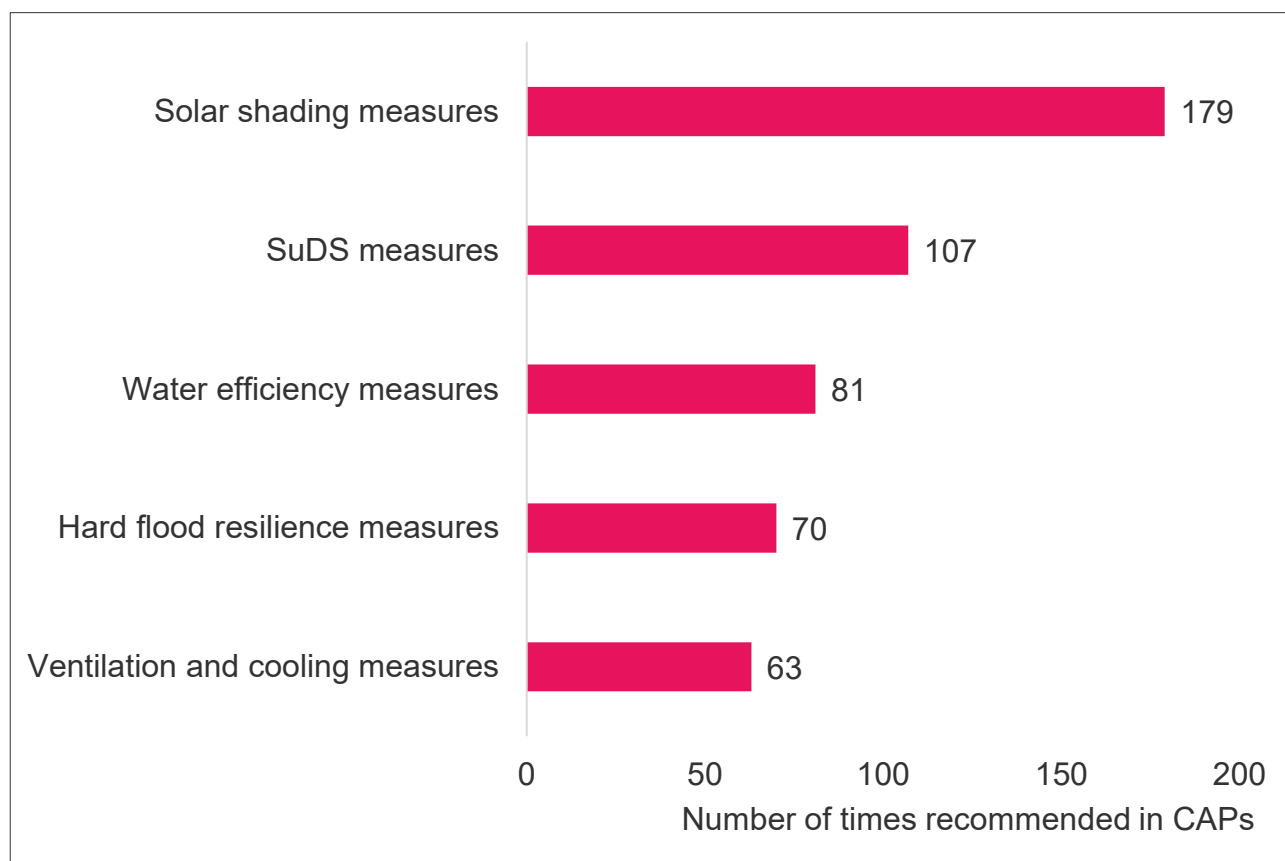


Figure 15: Recommended climate change adaptation and resilience measures – total numbers per category

Table 4 identifies indicative lower and upper capital cost estimates associated with implementing a selection of commonly recommended measures, assuming that measures recommended in the CAPs are implemented. The table includes some key assumptions relating to each unit cost. It should be noted that:

- all physical measures will also require an appropriate operation and maintenance schedule; and
- the full costs of professional fees required to plan, design and install bespoke physical measures at each school have not been included.

More detailed information and assumptions relating to the cost ranges for these and all other measures can be found in **Appendix 1** ‘Compendium of adaptation and resilience measures for schools’.

Table 4: Indicative capital cost ranges for a selection of commonly recommended measures

Measure	Cost range per measure	Number in CAPs	Lower total cost estimate	Upper total cost estimate	Scale assumptions*
Rain garden: linear	£60/m ² - £120/m ²	43	£64,500	£129,000	Assuming 25 m ² per measure
Grounds shade: sail	£2,700 - £5,300	43	£116,100	£227,900	Assuming metal frame structure, approx. 3m x 3m
Internal water efficiency measures	£2,000 - £12,000	42	£84,000	£504,000	Assuming 10 items upgraded (e.g. kitchen sink, cleaners sink or the like for taps) per measure
Rainwater harvesting: water butt	£380 - £860	39	£14,820	£33,540	Assuming water butt of approx. 1300 L
Permeable surface: hard	£140/m ² - £290/m ²	37	£518,000	£1,073,000	Assuming 100 m ² per measure
Grounds shade: pergola	£1,800 - £3,400	31	£55,800	£105,400	Assuming frame structure of approx. 3m x 3m per measure
Rain garden: non-linear	£30/m ² - £60/m ²	26	£78,000	£156,000	Assuming 100 m ² per measure
Channel drain	£250/m - £488/m	24	£6,000	£11,712	Assuming approx. 8m long x 0.1m wide x less than 0.3m deep
Filter drain	£4,000 - £7,800	19	£68,000	£119,000	Assuming approx. 8m long x 1m wide x 3m deep
Awning or canopy	£800 - £1,500	17	£13,600	£25,500	Assuming 2.5m-3.0m wide by 2.0m-2.5m deep per measure

Trees	£210 - £2,000	17	£3,150	£30,000	Assuming one tree with 4 m ² pit area
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*For more detailed assumptions used for costing please see **Appendix 1** 'Compendium of adaptation and resilience measures for schools'.

Behavioural and operational measures

A series of behavioural and operational measures were also recommended consistently across all CAPs. These comprised actions to address common maintenance or operational challenges that exacerbate climate change impacts, and opportunities for practical behavioural change to reduce vulnerability to climate change risks. These measures were grouped by climate change risk type (flood, heat and water scarcity), and divided into three categories of 'times to act':

- **Plan ahead:** actions to take proactively to build resilience to extreme weather events
- **React and respond:** actions to take during and in the immediate aftermath of an extreme weather event to reduce impacts and decrease the time and cost burden to return to normal operations
- **Learn and transform:** actions to take after an extreme weather event to help schools learn and adapt to changing climatic conditions in the longer-term

Table 5 summarises the behavioural and operational measures recommended in school CAPs.

Table 5: Summary of behavioural and operational measures recommended in CAPs

Risk addressed	Measure	Who is responsible	When to act
Flood risk	Maintain roofs, gutters, drains and below ground drainage infrastructure	Site or premises manager	Plan ahead
Flood risk	Register for flood alerts from the Environment Agency or weather warnings from the Met Office	Site or premises manager	Plan ahead
Flood risk	Review flood insurance policies	Business manager	Plan ahead
Flood risk	Engage with external groups to run educational sessions	Teachers or member of the Senior Leadership Team	Plan ahead
Flood risk	Consult asbestos management plan	Site or premises manager	Plan ahead

Heat risk	Subscribe to receive UK Health Security Agency's Heat-Health Alerts	Member of Senior Leadership Team	Plan ahead
Heat risk	Service ventilation systems prior to summer term when needed the most	Site manager	Plan ahead
Heat risk	Provide free sun hats or suncream for students	Business manager	Plan ahead
Heat risk	Turn electrical appliances off when not required	Site manager and teachers	Respond and react
Heat risk	Maximise ventilation in classrooms and halls	Site manager and teachers	Respond and react
Heat risk	'Slip, slap, slop' campaigns (or similar)	Member of Senior Leadership Team	Respond and react
Heat risk	Have less vigorous PE lessons or activities on very hot days	Member of Senior Leadership Team	Respond and react
Heat risk	Amend or relax school dress code during hot spells	Member of Senior Leadership Team	Respond and react
Heat risk	Amend lesson plans and rotate classrooms	Member of Senior Leadership Team	Respond and react
Heat risk	Stay hydrated	Teachers	Respond and react
Heat risk	Complete a heat audit	Site manager or STEM teacher	Plan ahead
Water scarcity	Complete Thames Water's 'business water saving calculator'	Business manager	Plan ahead
Water scarcity	Complete a water audit	Site manager or STEM teacher	Plan ahead
Water scarcity	Communication of risks and responsibilities to staff and students.	Member of the Senior Leadership Team	Plan ahead
Water scarcity	Choose drought-tolerant plants for most exposed areas	Site manager or gardener	Plan ahead
Water scarcity	Engage with Thames Water for water efficiency measures	Site manager and business manager	Plan ahead
Water scarcity	Request a water talk from Thames Water	Business manager	Plan ahead

Wider measures for consideration

Wider measures are climate change adaptation and resilience measures beyond the school site boundary, or school stakeholders' direct control, but which would have benefits for the school. These measures may require discussion and collaboration with the local authority or other public sector and private sector organisations in order to implement them.

Some site surveys and conversations with school stakeholders identified needs and opportunities for wider climate change adaptation and resilience measures to be implemented. However, as this was not consistent across all schools, and as these wider measures are often beyond the direct control of school stakeholders to implement, they were not included as a specific section within the individual CAPs.

Instead, a summary of the types of wider measures identified and discussed with some school stakeholders is provided below. It is intended that these types of measures will be useful to all schools with CAPs who share relevant characteristics.

- **Schools with School Streets – enhancements to improve spaces outside school gates**
 - Shade structure or canopy outside main gates – this could provide additional shade and cooling for these well used areas just outside the school boundary at drop off and pick up times during hot weather. It would also provide some shelter from heavy rain. Benches could also be provided for parents and carers to wait or just meet for a chat.
 - Rain garden or other SuDS measure in public space outside main gates – this could address issues of surface water pooling outside schools' main entrances, and would contribute to cooling these well used areas. It could also improve the visual amenity and biodiversity of these shared spaces. Benches could also be provided for parents and carers to wait or just meet for a chat.
- **Schools next to main roads - air quality, road safety and noise co-benefits**
 - Perimeter fence air quality improvements – for schools adjacent to main roads adding / enhancing a 'vegetated barrier' or 'green screen' on both sides of the perimeter fence can help filter fumes. Depending on type of barrier or screen, this could also help to reduce heat impacts and risks, may contribute to sustainable urban drainage (if planted solutions are used), could increase biodiversity and could improve visual amenity within the local environment.
 - Other potential 'road side' measures to be discussed with local authority could include introducing a 20 mph zone, priority bus lanes and improved walking and cycling routes along main road, or creating a 'parklet' along pavement with additional vegetated barriers or green screens along the curb edge. This could further improve

local air quality, reduce the risk of poor air quality in playgrounds and buildings and contribute to safer roads.

- **Schools next to rivers or canals – integrated flood risk management and enhancement**

- Talk to Environment Agency, Thames Water or Canals and Waterways Trust about integrated management and enhancement of adjacent rivers or canals to reduce impact and potential risk of flooding on school site, and to increase the local area's resilience to future flood events.

- **Schools with surface water flooding issues related to adjacent land uses - integrated area based approach to SuDS**

- Talk to relevant local authority departments (e.g. planning, housing, highways, allotments or parks), or adjacent land owners or tenants (e.g. registered social landlords, developers, sports clubs, allotment plot holders, supermarkets or car park operators) about integrated area based SuDS solutions. This may result in a greater impact on reducing surface water flood risk in the local area, not just for the school.

- **Schools who share buildings and grounds with other organisations – co-ownership and stewardship of measures**

- Talk to relevant organisations (e.g. farmers markets, food banks, language schools, school holiday camps) about the kinds of measures which would be most effective for all organisations. This would encourage co-ownership and stewardship of measures which have the potential to benefit all.

Strategic recommendations

This section of the Overview Report sets out eight strategic recommendations for the consideration of the Climate Resilient Schools programme Steering Group (which comprises the GLA, the DfE and Thames Water) and its delivery partners. They are informed by the analysis of the data obtained for, and summarised within, the 60 CAPs and presented in the Findings section above.

If these strategic recommendations are acted upon, the 60 schools who now have CAPs will be better able to implement relevant climate change adaptation and resilience measures and therefore be more resilient to climate change impacts and risks.

Strategic recommendations have been grouped into **three geographic and administrative levels** of effectiveness:

- most effective if acted upon at a London-wide level, with potential national level co-benefits;
- most effective if acted upon at a borough-wide, Diocese-wide or education trust-wide level; or
- most effective if acted upon at the individual schools level, with support and guidance.

For each strategic recommendation (SR) a potential lead owner and supporting stakeholders have been identified along with **type of SR, relative cost / resource input level, an adaptation / resilience benefit level** to London schools' buildings and grounds, and a **timescale for action**. See below for definitions of SR types, input and benefit levels and timescales:

- the type of SR is either primarily about **awareness raising and capacity building or delivery and environmental enhancement**;
- the relative cost / resource input level for lead owner and supporting stakeholders is either **low, medium or high**;
- the adaptation / resilience benefit level to London schools' buildings and grounds is either **moderate or significant**; and
- the timescale for action is either **short term** or **medium term**.

The timescales for action are defined as:

- **short term** being within the next financial year **2023-24** - to inform the NAP3 strategy and imminent DfE capital programmes; and

- **medium term** being within the **next 2-3 years** – before **2025** the DfE Sustainability and Climate Change Strategy deadline for all schools, colleges and other education providers in England to have a Climate Action Plan in place.

Overview of strategic recommendations

Table 6 below, sets out the eight strategic recommendations (SRs) based on the categories outlined above. The four strategic recommendations deemed to be most pressing for the CRS Steering Group (which comprises the GLA, the DfE and Thames Water) to consider acting upon are summarised below.

- SR1. CRS Steering Group to consider extending CRS programme and capital funding. Future work to include a focus on installation of priority 'quick win' physical measures to reduce heat risk for relevant schools e.g. shade sails and/or shade pergolas in playgrounds, and cool roofs on buildings. This SR is based on the findings of the CAPs for Schools project that overheating is the top climate change impact and risk for London schools, these measures are most frequently recommended in the 60 CAPs, and they are relatively cheap and easy to install with minimal disruption to school activities.
- SR2. CRS Steering Group to consider undertaking a triage review of the 10 CAP schools with the most significant overheating, flooding and water scarcity issues respectively. This would inform further analysis, modelling and engagement to inform design, implementation and monitoring of measures.
- SR5. CRS Steering Group to explore with UK research council and relevant universities jointly developing or supporting funding opportunities for applied and collaborative research projects. These would focus on how to design, implement and monitor the effectiveness of priority climate change adaptation and resilience measures in London's school buildings and grounds.
- SR7. DfE to consider using the findings and recommendations from the 60 CAPs for London schools, and the Overview Report, to inform the design and delivery of DfE funded school retrofit projects in England.

Table 6: Strategic recommendations for CRS Steering Group members and delivery partners

Strategic recommendation (SR)	Type of SR	Potential lead owner and supporting stakeholders	Geographic / administrative level	Cost / resource input for owner and supporters	Adaptation / resilience benefit for London schools	Timescale for action
SR1. CRS Steering Group to consider extending CRS programme and capital funding. Future work to include a focus on installation of priority 'quick win' physical measures to reduce heat risk for relevant schools e.g. shade sails and/or shade pergolas in playgrounds, and cool roofs on buildings. This SR is based on the findings of the CAPs for Schools project that overheating is the top climate change impact and risk for London schools, these measures are most frequently recommended in the 60 CAPs, and they are relatively cheap and easy to install with minimal disruption to school activities.	Delivery and enhancement	<ul style="list-style-type: none"> CRS Steering Group (i.e. GLA, DfE and Thames Water) 	London-wide	High	Significant	Short term

Strategic recommendation (SR)	Type of SR	Potential lead owner and supporting stakeholders	Geographic / administrative level	Cost / resource input for owner and supporters	Adaptation / resilience benefit for London schools	Timescale for action
SR2. CRS Steering Group to consider pairing up all 60 CAP schools in London with a STEM Climate Ambassador to support on the implementation of CAP measures.	Delivery and enhancement	<ul style="list-style-type: none"> CRS Steering Group (i.e. GLA, DfE and Thames Water) University of Reading 	London-wide	Low	Moderate	Short term
SR3. CRS Steering Group to consider undertaking a triage review of the 10 CAP schools with the most significant overheating, flooding and water scarcity issues respectively. This would inform further analysis, modelling and engagement to inform design, implementation and monitoring of measures.	Delivery and enhancement	<ul style="list-style-type: none"> CRS Steering Group (i.e. GLA, DfE and Thames Water) Built and natural environment designers, engineers and consultants 	London-wide	Medium	Significant	Short term
SR4. CRS Steering Group to explore with UKGBC potential launch of second round of 'climate resilience innovation challenges'. This would include a specific focus on climate change adaptation and	Delivery and enhancement	<ul style="list-style-type: none"> CRS Steering Group (i.e. GLA, DfE and Thames Water) 	London-wide National co-benefits	Medium	Significant	Short term

Strategic recommendation (SR)	Type of SR	Potential lead owner and supporting stakeholders	Geographic / administrative level	Cost / resource input for owner and supporters	Adaptation / resilience benefit for London schools	Timescale for action
resilience in school buildings and grounds.		<ul style="list-style-type: none"> UK Green Building Council (UKGBC) 				
SR5. CRS Steering Group to explore with UK research councils and relevant universities jointly developing or supporting a funding call for applied and collaborative research projects. These would focus on how to design, implement and monitor effectiveness of priority climate change adaptation and resilience measures in London's school buildings and grounds.	Delivery and enhancement	<ul style="list-style-type: none"> CRS Steering Group (i.e. GLA, DfE and Thames Water) UK Research and Innovation (UKRI) Economic and Social Research Council (ESRC) Natural Environment Research Council (NERC) Arts and Humanities Research Council (AHRC) 	London-wide National co-benefits	High	Significant	Medium term
SR6. CRS Steering Group to consider supporting Learning through Landscapes to develop more detailed guidance on 'Climate	Delivery and enhancement	CRS Steering Group (i.e. GLA, DfE and Thames Water)	London-wide National co-benefits	Medium	Significant	Short term

Strategic recommendation (SR)	Type of SR	Potential lead owner and supporting stakeholders	Geographic / administrative level	Cost / resource input for owner and supporters	Adaptation / resilience benefit for London schools	Timescale for action
Ready School Grounds' drawing from international good practice. This would set out what London schools, and UK schools more widely, need to do in order to be adapted for, and resilient to, climate change, while providing opportunities for learning across a range of subjects.		Learning through Landscapes Groundwork Royal Horticultural Society International School Grounds Alliance				
SR7. DfE to consider using the findings and recommendations from the 60 CAPs for London schools, and the Overview Report, to inform DfE funded school retrofit projects in England.	Delivery and enhancement	DfE	London-wide National co-benefits	Medium	Significant	Short term
SR8. GLA 'London Schools Atlas' - add data from the GLA CAPs for Schools project to the 60 schools in the Atlas with CAPs. Consider collecting this data for all other schools in the Atlas.	Awareness and capacity building	<ul style="list-style-type: none"> GLA 	London-wide	Low	Moderate	Short term

Conclusions and next steps

What have we learned and what needs to be done now?

In conclusion, the CAPs for Schools project, one of four workstreams within the wider GLA Climate Resilient Schools (CRS) Programme, has:

- identified the most pressing climate change impacts and risks for 60 schools in London, with a focus on overheating, flooding and water scarcity;
- recommended physical and operational or behavioural measures for these 60 schools to adapt and increase resilience to these impacts and risks;
- costed these climate change adaptation and resilience measures and differentiate 'quick-wins' from 'longer-term' actions; and
- signposted schools towards potential sources of funding, guidance and support to further inform and implement these measures.

This Overview Report for the CAPs for Schools project has

- summarised the key findings from the CAPs;
- provided an evidence base on how prepared schools in London are for a changing climate and potential funding need;
- provided the policy context for the implementation of climate change adaptation and resilience measures in London schools; and
- made eight strategic recommendations for the consideration of the CRS Steering Group.

The headline findings from the CAPs are summarised below:

Climate change impacts and risks

- Overheating was the most widespread and pronounced climate change impact experienced by surveyed schools.
 - 56 of 60 (93%) schools reported overheating as an issue they experience.
 - 47 of 60 (78%) schools reported that overheating has had a significant impact on students' learning, productivity or behaviour, or has interrupted normal school activity in another way.
 - 26 schools (43%) experience severe overheating that occurs 'multiple times' or 'continuously' throughout the summer term.
- During the 2022 summer heatwave alone, the surveyed schools reported a total of 33 closed days, or an estimated >22,000 student-days of lost learning.

- Flooding was reported to affect 45 of 60 (75%) surveyed schools.
- 24 schools (40%) reported that flooding has had a significant impact on students' learning, productivity or behaviour, or has interrupted normal school activity in another way. 8 of these schools (13% of 60) reported that flooding occurs 'multiple times' throughout the school year.
- In the past 10 years, 3 of the surveyed schools reported they have had to close for a total of 11.5 days or approximately 2,700 student-days due to flooding.
- Schools are generally less aware of risks or impacts posed by water scarcity. Whilst 29 of 60 (48%) schools reported to have been affected by water scarcity (mostly relating to London-wide hose-pipe bans), only 4 schools (7%) reported that water scarcity has had a significant impact on students' learning, productivity or behaviour, or has interrupted normal school activity in another way.
- Of the 4 schools that report to have been significantly impacted by water scarcity, 2 report to experience impacts every 2-3 years, 1 school reported to experience impacts over 10 years ago, and 1 school did not report the frequency of water scarcity impacts.

School site data and characteristics

- Rain planters represent the most commonly identified existing or planned measure across the surveyed schools. Mainly of these schools have received SuDS rain planters under the GLA Climate Resilient Schools Programme.
- The most common desired measures identified by schools relate to increased provision of shading.
- Based on high-level mapping of land-use information conducted during site surveys, approximately 90% of the area within school boundaries is made up of impermeable surfaces, and 10% permeable.

Recommended climate change adaptation and resilience measures

- Overall, 500 physical measures were recommended across all schools
- 242 or roughly half of recommended measures predominantly address heat risk, 177 measures predominantly address flooding (though 107 of these are SuDS measures, many of which carry heat resilience benefits as well) and 81 measures address water scarcity.

- Grounds shade sails and linear rain gardens were the most frequently recommended measure across all schools, each recommended 43 times.
 - Implementing all 43 grounds shade sails (within 37 schools) would likely have a capital cost in the range of £116K to £228K (£2,700 - £5,300 per measure)
 - Implementing all 43 linear rain gardens (within 40 schools) would likely have a capital cost in the range of £64K to £129K (£1,500 – £3,000 per measure)

Please note that these are indicative capital costs, based on assumptions for each measure contained in **Appendix 1** 'Compendium of adaptation and resilience measures for schools'. The individual Climate Adaptation Plans for each of the 60 schools do not constitute detailed technical, design, engineering or cost plans for the schools, but are intended to inform potential further work to develop such plans.

Based on the findings from the CAPs for Schools project, suggested next steps for the GLA and the CRS Steering Group are: to consider the strategic recommendations carefully; and to take an integrated approach to determining the feasibility and benefit of acting upon them.

In order to do this, it is proposed that a series of facilitated workshops could be organised to engage relevant stakeholders and potential funders to identify the best way to take the strategic recommendations forward.

If these strategic recommendations are acted upon, the 60 schools who now have CAPs will be better able to implement relevant climate change adaptation and resilience measures and therefore be more resilient to climate change impacts and risks.

Glossary

Behavioural and operational measures - these are climate change adaptation and resilience measures which do not require capital funding, but do require awareness, engagement and action from school stakeholders in order to be effective. They can support the effectiveness of physical measures, and can be taken before, during and/or after a climate change impact or an extreme weather event.

Climate change adaptation - the process taken to adjust to actual or expected climate change and its effects.

Climate change adaptation and resilience measures - practical things that can be done to adjust to, prepare for, respond to, and recover from climate change impacts and risks.

Climate change impacts – the consequences of climate change, both expected and experienced, for natural and human systems and environments.

Climate change resilience - the capacity to prepare for, respond to, and recover from climate change impacts and risks, with minimal damage to human health and wellbeing, the economy and the environment.

Climate change risk – the potential for climate change to create adverse consequences for natural and human systems and environments in the future.

Cooling hierarchy – a hierarchy of measures for cooling and reducing overheating of buildings in London: 1. minimise internal heat generation through energy efficient design; 2. reduce the amount of heat entering a building through orientation, shading, albedo, fenestration, insulation and the provision of green roofs and walls; 3. manage the heat within the building through exposed internal thermal mass and high ceilings; 4. provide passive ventilation; provide mechanical ventilation; and 5. provide active cooling systems.

Longer term measures - are priority physical measures that may require more funding and/or a major refurbishment opportunity for schools to implement.

Nature based solutions (NbS) - harness the power of nature to enhance natural ecosystems, biodiversity and human health in order to address major issues, including climate change.

Passive design - uses building layout, form and fabric to reduce need for mechanical cooling, heating, ventilation or lighting.

Physical measures – these are climate change adaptation and resilience measures which relate to enhancing the form and/or function of school buildings and school grounds. They require a combination of capital funding, technical expertise and time to install.

Quick win measures - are priority physical measures for reducing relevant climate change impacts and risks with relatively low cost and effort for schools; and

Sustainable Drainage Systems (SuDS) - are designed to maximise the opportunities and benefits of surface water management. Can take many forms, above and below ground.

Urban heat island (UHI) effect - this is the phenomenon of higher air and land surface temperatures experienced in towns and cities compared to rural surroundings. It is particularly felt at night-time as the heat retained by artificial and dark surfaces is slowly released, keeping urban temperatures higher than those in the countryside. This is combined with other impacts such as the reduced cooling effect of vegetation in urban areas (i.e. less of it), and the compounding effect of anthropogenic heat emissions (e.g. from car engines and air conditioning units).

Wider measures – these are climate change adaptation and resilience measures beyond the school site boundary, or school stakeholders' direct control, but which would have benefits for the school. These measures may require discussion and collaboration with the local authority or other public sector, private sector or charity sector organisations in order to implement them.

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Appendix 1: Compendium of adaptation and resilience measures for schools

Appendix 2: Methodology and approach

Overview of methodology and approach

Arup's methodology and approach to the CAPs for Schools project is summarised below:

The Arup project team

The Arup project team comprised a core Project Management team (comprising a Project Director, a Project Manager and a Deputy Project Manager), a multi-disciplinary Technical Advisory Group (comprising 13 experts in their respective fields) and a Surveyor Team (comprising 14 early career engineers, landscape architects, environmental consultants and planners). The project team was supported by a dedicated site survey logistics coordinator. See Figure 16 for the Arup project team organogram, showing the relationships with the client team and school stakeholders.

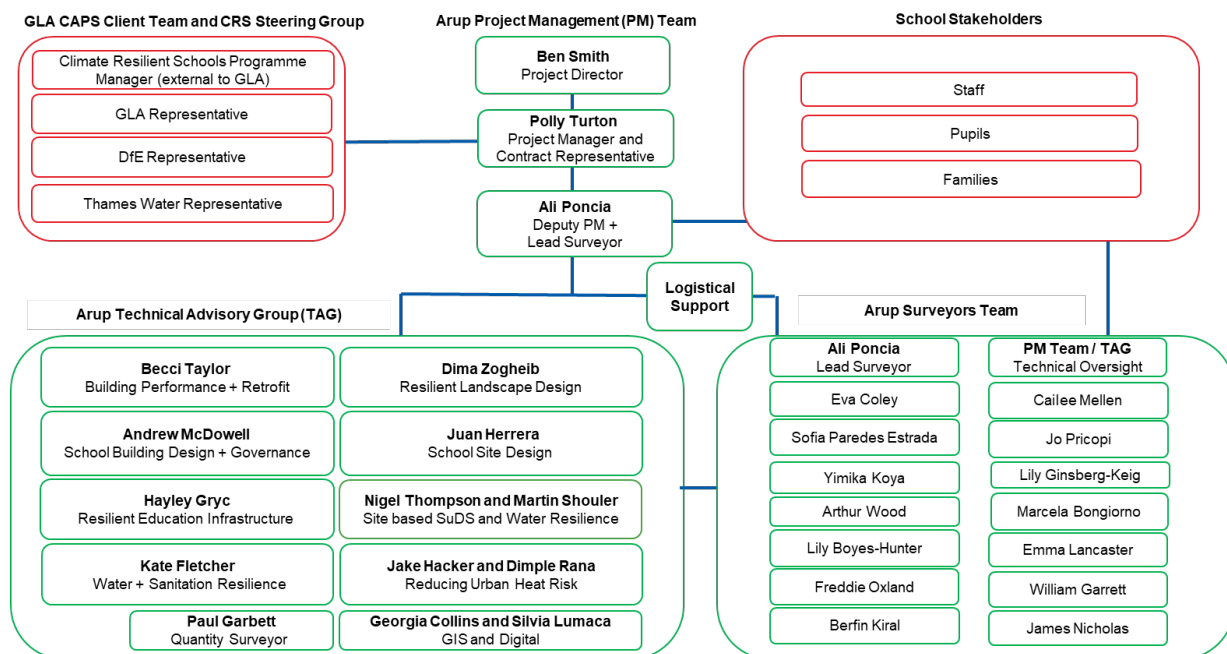


Figure 16: Arup project team organogram

Pre-site survey

Scheduling site surveys

A key component of the project methodology involved undertaking site surveys at 60 of the 95 CRS schools. But in order for these site surveys to be undertaken successfully and effectively, a considerable amount of logistical coordination was required beforehand. This involved:

- The identification of 8 ‘pilot schools’ who would be willing and able to be the first schools to have a site survey undertaken. Choosing 8 schools meant that all 14 of the Arup Surveyor Team would be able to undertake a site survey accompanied by either the PM or Deputy PM. The pilot schools were selected based on: their responsiveness to the CRS programme to date; the proximity of these schools to the Project Manager and Deputy Project Manager (north and east London) who would be attending all pilot school site surveys; and a ‘first come first served’ basis to emails asking if they would like to be pilot schools to inform a bespoke Climate Adaptation Plan (CAP) for their school.
- An initial approach to all 95 school stakeholders from the CRS programme manager informing them of the project and the opportunity to have a site survey to inform a bespoke CAP for their school.
- A follow up standard email to responsive school stakeholders from the Arup survey logistics coordinator offering a range of dates and times based on the availability of members of the Arup Surveyors team.
- Once the school stakeholder responded to the first Arup email, a standard email was sent out by the Arup survey logistics coordinator confirming the date and time of the survey, the name of the Arup surveyor and requesting the following prior to the site survey:
 - completion of an online survey created using Microsoft Forms (see Figure 17); and
 - confirmation of presence of any asbestos and corresponding asbestos registers.
- The relevant Arup Surveyor was then required to undertake a desk-based Site Specific Risk Assessment (SSRA) relating specifically to their allocated school in accordance with Arup Health, Safety, Environment and Quality policy requirements.
- Online survey data and the SSRAs for each school were reviewed by either the PM or the Deputy PM prior to each site survey.
- Non-responsive schools were chased politely throughout the scheduling phase and, from a long list of 95, we ended up with 60 schools who committed to having a site survey to inform a bespoke CAP for their school.

GLA Climate Resilient Schools - Climate Adaptation Plans

Online survey for school stakeholders to inform site survey and Climate Adaptation Plan.

You, and any other members of staff, or members of the Parents and Staff Association, are invited to respond to this online survey which will inform the site survey due to be undertaken at your school. It will also contribute to the development of a bespoke Climate Adaptation Plan for your school.

The results of this online survey will be reviewed by the Arup team *before* the site survey to help us focus our efforts, and will be analysed with the findings of site survey *after* it has taken place.

This survey contains **4 sections** ('Your school and your role', 'General Health and Safety at your school', 'Weather and Climate Impacts for your school' and 'Governance and Decision Making in your school') and about **30 short questions**. It will take approximately **10 minutes** to complete if you answer all questions.

* Required

Your school and your role

1. What is the name of your school? *

Enter your answer

2. What is your job title and/or role within the school? *

Enter your answer

Figure 17: Screen shot of the online survey issued to school stakeholders prior to the site surveys.

Site surveys

Undertaking site surveys

Once the Arup Surveyor arrived on site, the site surveys comprised of a three stage process: an interview with the school stakeholder; a walk round school grounds; and a walk round school buildings.

Two applications or 'apps' were used to gather information on site: the standard version of Esri ArcGIS Survey 123⁵⁶ for the interview with the school stakeholder; and a bespoke version of Esri ArcGIS Field Maps⁵⁷ developed specially for this project, for the walk rounds.

During the walk rounds Arup Surveyors visited the school's grounds and buildings, highlighting areas of interest and relevance including existing climate change adaptation and resilience measures, and internal and external areas where climate change impacts have been experienced. These were referred to as '*hot spots*' (areas of high temperatures or overheating), '*wet spots*' (areas of flooding, leaking or water pooling) and '*dry spots*' (areas of visible water scarcity impacts).

⁵⁶ <https://survey123.arcgis.com/>

⁵⁷ <https://www.esri.com/en-us/arcgis/products/arcgis-field-maps/overview>

Surveyors also collected basic information on the school buildings such as: age of construction; building typology; construction materials; ventilation, heating and cooling systems; and marked out the different land uses that make up the school grounds.

Recommended measures

The identification of appropriate priority climate change adaptation and resilience measures for each school began with the data and information collected during the site surveys and was then guided and informed by the following activities:

- a technical multi-disciplinary review and assessment of what the priority climate change impacts and risks (i.e. hot spots, wet spots and dry spots, plus any other climate change impacts or risks, or any other issues facing the school) are for each school involving the relevant Arup Surveyor, members of the TAG and either the PM or Deputy PM.
- an analysis of additional relevant data relating to the school (e.g. is school within a flood risk area, what is the flood risk level, Index of Multiple Deprivation ranking, is school within a Conservation Area, and is school a listed building).
- cross checking of the priority climate change impacts, risks and additional relevant data for each school using:
 - Google Earth 3D site images for each school (see Figure 18);
 - topographical models created using Rhino software (see Figure 19);
 - surface water flow diagrams (see Figure 20); and
 - sun path diagrams (see Figure 21).
- a presumption in favour of passive design, nature-based solutions, and adherence to the 'cooling hierarchy'⁵⁸ wherever possible in line with Greater London Authority (GLA) and Department for Education (DfE) sustainable development and climate change policies and strategies;
- measures which provide a significant reduction in climate change risk, address more than one climate change risk and have other environmental, social and economic co-benefits;
- consideration of measures which makes a noticeable difference to educational outcomes, inequalities, and the health, safety and wellbeing of students, staff and families; and
- would be cost effective, represent value for money, and minimise disruption on site during the academic year.

⁵⁸ The cooling hierarchy is: 1. Minimise internal heat generation through energy efficient design; 2. reduce amount of heat entering a building through orientation, shading, albedo, fenestration, insulation and provision of green roofs and walls; 3. manage heat within building through exposed internal thermal mass and high ceilings; 4. provide passive ventilation; provide mechanical ventilation; and 5. provide active cooling systems.

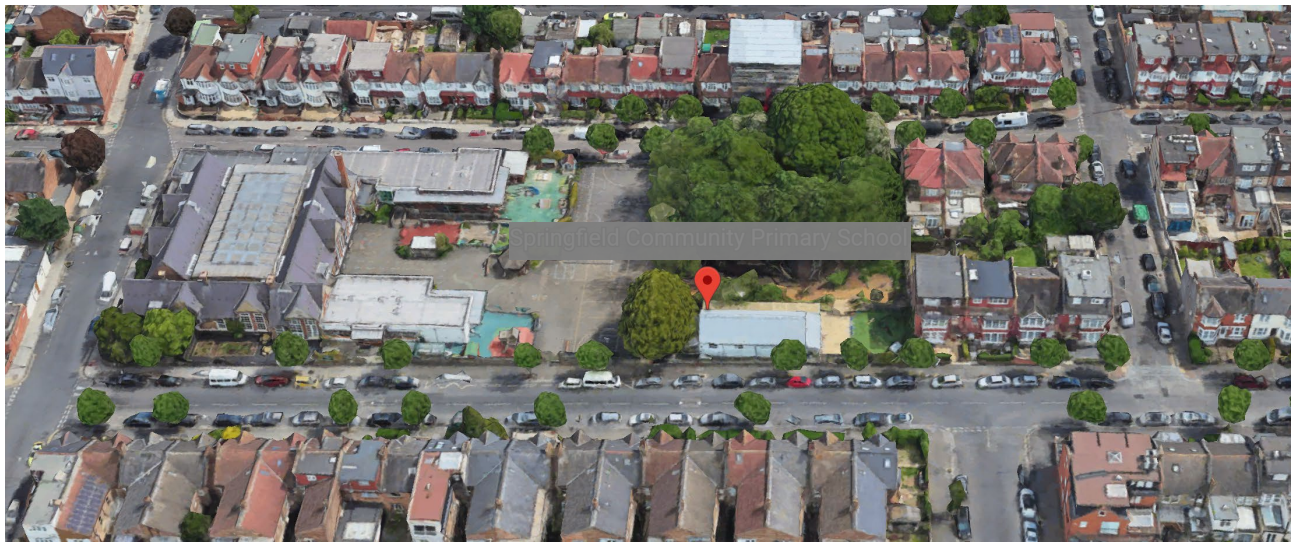


Figure 18: Google Earth 3D image

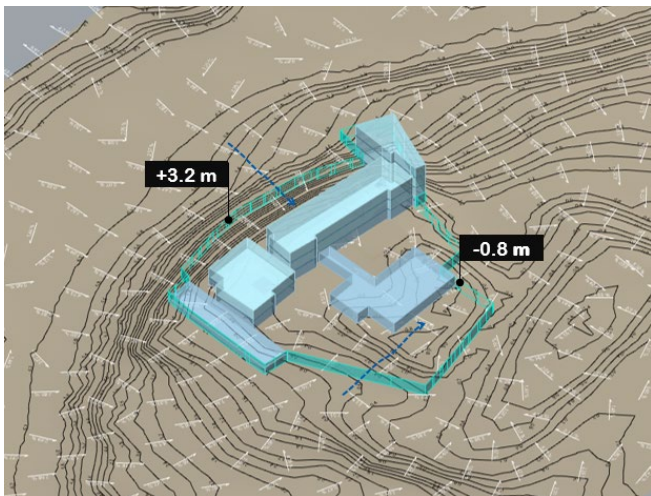


Figure 19: Topographical model

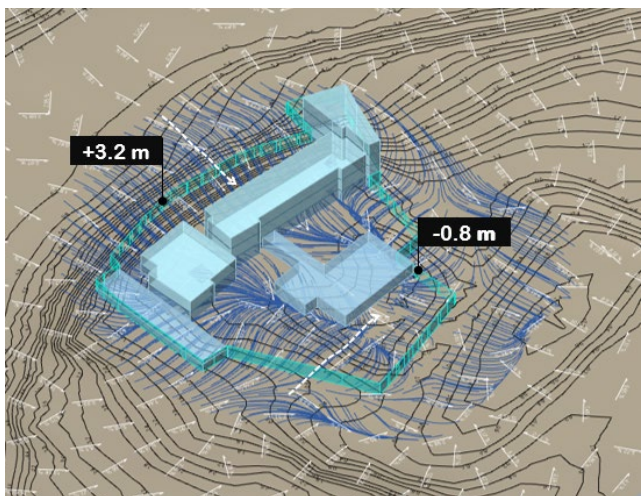


Figure 20: Surface water flow diagram

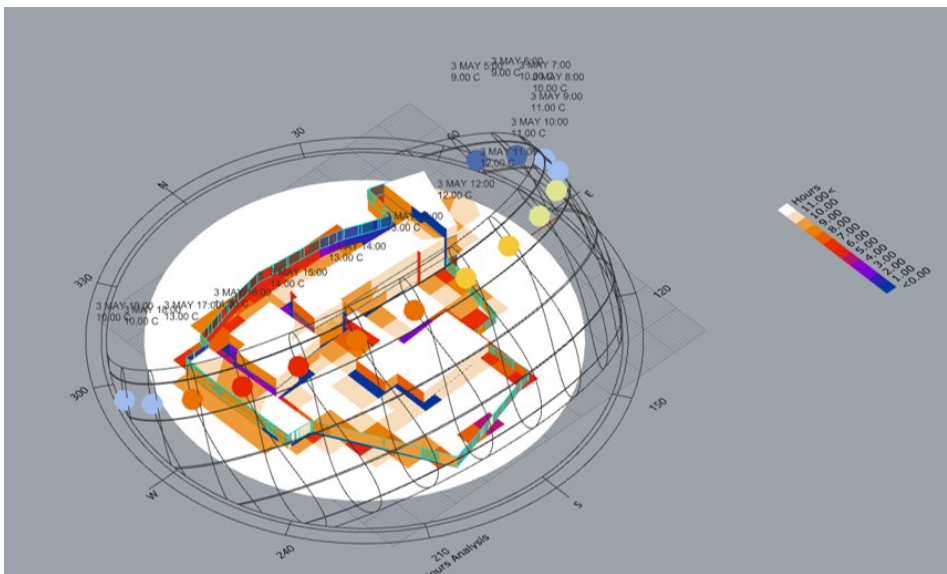


Figure 21: Sun path diagram

Within the CAPs, physical measures have been further categorised into either 'quick win' measures or 'longer-term' measures for each school.

- Quick-win measures are priority physical measures for reducing relevant climate change impacts and risks with relatively low cost and effort for schools; and
- Longer-term measures are priority physical measures that may require more funding and/or a major refurbishment opportunity for schools to implement.

Indicative capital cost ranges have been provided for all physical measures, along with consideration of installation and maintenance requirements. It should be noted that:

- all new physical measures will also require an appropriate operation and maintenance schedule; and
- the full costs of professional fees required to plan, design and install bespoke physical measures at each school have not been included.

Relevant behavioural and operational measures were also recommended within the CAPs for each school. These are measures which do not require capital funding, but do require awareness, engagement and action from school stakeholders in order to be effective. They can also support effectiveness of the physical measures. Behavioural and operational measures can be taken before, during and/or after a climate change impact or an extreme weather event. These measures are summarised in the Findings section of this report.

Please see **Appendix 1** 'Compendium of adaptation and resilience measures for schools' for further details of physical measures.

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