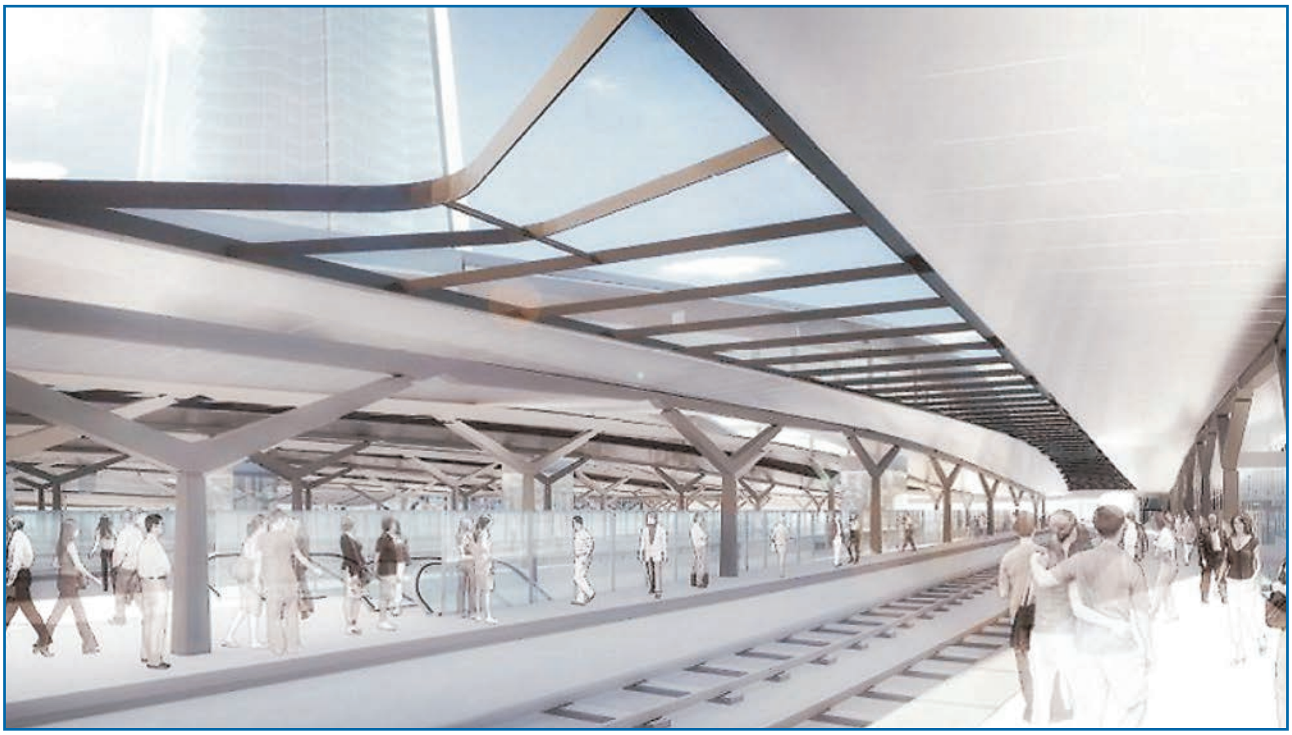
Design for future climate: adapting buildings competition project factsheets, *Building a resilient future*, Phase 1 and 2, 26 February 2014

This publication has been put together as a supplement for the Technology Strategy Board Design for future climate competition conference taking place on 26 February 2014, in association with the Modern Built Environment Knowledge Transfer Network (MBE KTN).

The enclosed project factsheets provide an overview of the projects funded as part of the competition. Phase 1 of the competition was in 2010–2011 and Phase 2 ran from 2011–2012. Each factsheet gives an insight into the approaches taken to consideration of climate change effects in the design of real-life construction and building refurbishment projects. The factsheets are hosted on the Climate Change Adaptation Group page on the MBE KTN webpage as part of the connect platform.

The website can be accessed at: https://connect.innovateuk.org/web/climate-change-adaptation/



CIBSE Engineering a sustainable built environment

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Phase 1 Project factsheets

		Type of project
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Factsheet 2	Trowbridge County Hall (Matthew Payne, Built Ecology)	Offices
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Factsheet 20	Technical Hub @ EBI (Giorgia Franco, AECOM)	Offices
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Factsheet 33	St faith's School Masterplan (Estelle Littlewood, Daniela Muscat, Verve Architects Limited)	School
Factsheet 34	Princes Park (Ian McHugh, Triangle Architects Ltd)	Housing
Factsheet 35	Cliftonville (Rebecca Bullivant, Thanet District Council)	Housing
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Factsheet 44	University of Salford Climate Change Adaptation (Alex Trebowicz, Buro Happold)	University building
Factsheet 45	The Co-operative Head Office (Mei Ran, Buro Happold)	Offices
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Phase 1

D4FC Factsheet 1:

The London School of Hygiene and Tropical Medicine

Contact details

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General project information

Name of project:	The London School of Hygiene and Tropical Medicine
Location of project:	London
Type of project:	Major retrofit of the Keppel St building
Cost of project:	About £10m

Project team

Client:	LSHTM
Architect:	Day England Stevenson Marsh (DESM)
Engineering design:	AECOM
Cost consultant:	Davis Langdon (an AECOM company)

Project description

The LSHTM is a world-renowned educational and research facility with over 3000 students. The case study building (Keppel Street) is Grade II listed and situated within the Bloomsbury Conservation Area of London. It comprises a multi-storeyed block with laboratories, teaching and research facilities and social space, and is in constant use. The building is therefore heavily serviced and major elements of the mechanical and electrical service infrastructure now require significant replacement and modernisation due to their poor condition and inability to meet the School's requirements.

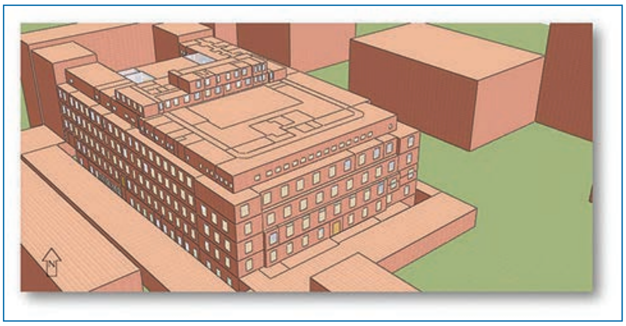
The School commissioned AECOM to undertake a feasibility study to assess the current performance of the building's service infrastructure and identify opportunities for improvement, to be presented as a suite of options taking account of planning, building fabric and structural constraints. In parallel, AECOM are developing a climate change adaptation strategy for the School, in order to future proof its operations against projected climate change.

Project timescales and dates

Design and assessment period (pre-planning): RIBA Stages A–B: September 2010 to May 2011, RIBA Stages C–D: to be determined based on results of feasibility study

Construction period (post-consent): TBD

Operation and monitoring period: TBD



Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- externally, the building currently experiences and adds to the effects of the urban heat island due to its central London location. Internally the building already suffers from overheating and adapting the building to be able to withstand future hotter summers without imposing greater quantities of air-conditioning will be a challenge
- the Prometheus probabilistic design summer year weather tapes developed by Exeter University were used to assess future climate in terms of temperature, cloud cover, radiation, precipitation and air moisture. Analysis of this data in an IES model of the building using cooling degree days and hours above a baseline temperature showed that overheating will continue to be the key future risk for many occupied spaces in the building
- using the IES models we conducted detailed analysis of alternative strategies to mechanical cooling to reduce the risk of overheating. In terms of climate adaptation artificial cooling should be seen as last resort and can be considered 'maladaptation' because of the increased energy use and the extraction of excess heat into external environment, increasing the urban heat island effect, if heat recovery is not used
- the first step was to minimise solar and internal gains by improving the window glazing and reducing energy consumption of lighting and equipment in offices. We modelled the potential reductions in overheating using natural ventilation and the following design solutions:
  - improved glazing (reduce g-value from 0.87 to 0.38)
  - improved lighting (from 15W/m² to 10.8W/m² including occupancy sensing)
  - less small power (from 25W/m² to 10W/m²)
  - the use of night purge to ventilate and cool building over night
- the building is also subject to risks associated with scarcity of water, surface water flooding from roof, further facade damage and maybe even structural damage due to soil shrinkage. Discussion with AECOM technical experts in these areas has helped informed understanding of these risks and how best to mitigate them.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

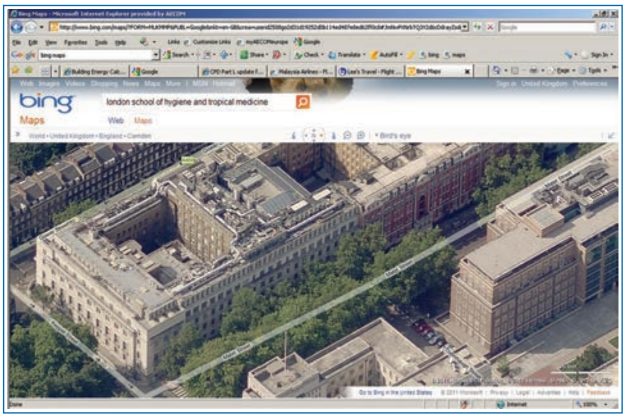
- we have used a range of graphical representations and tables to communicate the extensive data to the client
- we have also carried out an interim presentation and plan to deliver a full presentation highlighting the key findings and recommendations upon completion of the project.

3 What tools have you used to assess overheating and flood risks?

- IES Virtual Environment thermal modelling software
- Prometheus weather files (based on UKCP09)
- in-house modelling tool for assessing flooding (developed by one of our PHD research students).

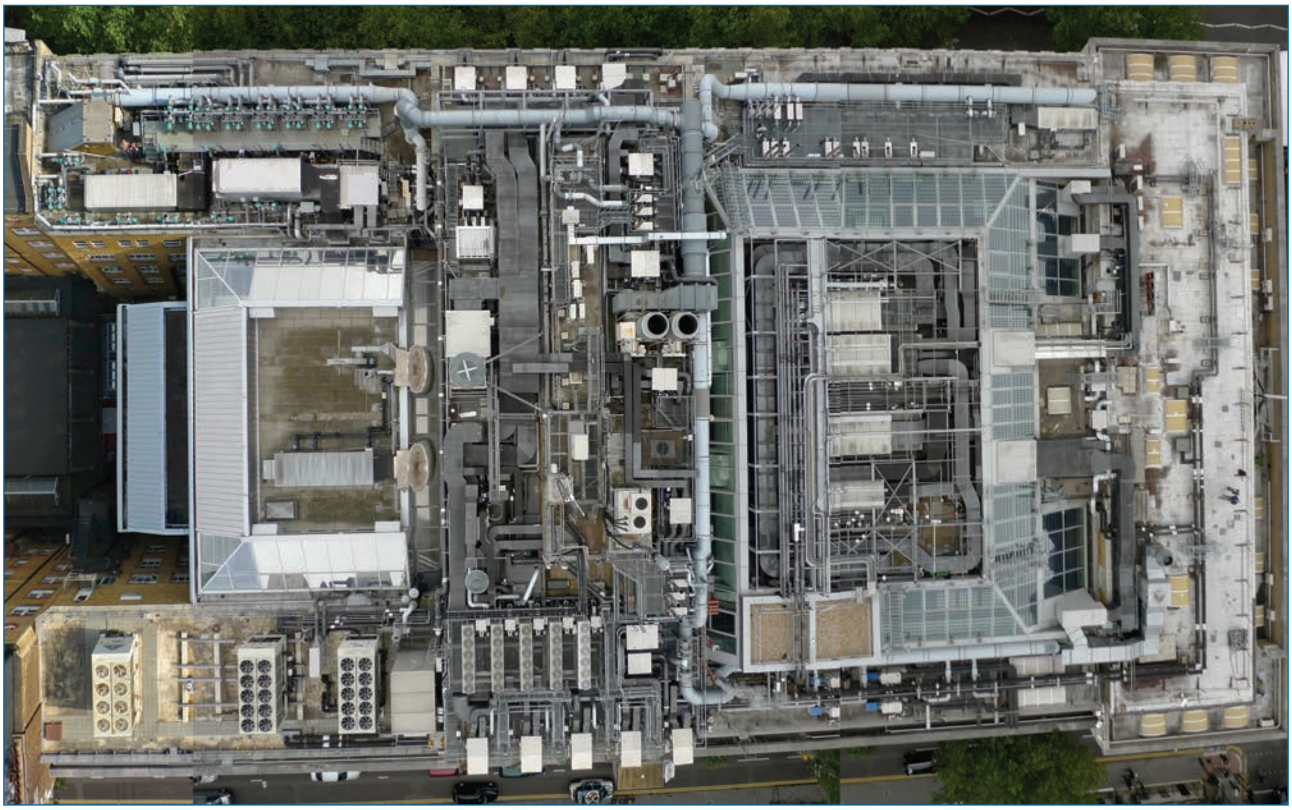
4 What has the client agreed to implement as a result of your adaptation work?

- the strategy is still under development, however it is anticipated that recommended measures will be adopted as part of the School's refurbishment programme, which includes a requirement to achieve a BREEAM Very Good to Excellent rating
- it is also anticipated that measures relating to reducing small power will be incorporated into the School's strategic procurement policies.



5 What were the major challenges so far in doing this adaptation work?

- working within the significant physical and planning constraints of the building. Many solutions that could normally be applied to a new building (or a less constrained existing building) were not suitable for this building
- the programme for the CCA work was dependent on the programme of the parallel feasibility study. Delays to the feasibility study (due largely to understating the complexity of the building and the client's needs) resulted in delays to the CCA work
- the overheating modelling took far longer than first anticipated due to the number of runs required for modelling such a complex building and the testing required for each adaptive solution.



6 **What advice would you give others undertaking adaptation strategies?**

- get to understand the building (if existing) or design (if new build) and its likely complexities as much as possible, and as soon on in the programme as possible
- allow for flexibility in your programme if your work is dependent on other projects being carried out in parallel.

D4FC Factsheet 2:

Trowbridge County Hall

Contact details

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General project information

Name of project:	Trowbridge County Hall
Location of project:	Trowbridge
Type of project:	Primarily retrofit with new link building and atrium roof
Cost of project:	£25m

Project team

Client:	Wiltshire Council
Designer:	Stride Treglown, WSP
Contractor:	Currently tendering

Project description

The original County Hall was of traditional stone construction built circa 1935 with timber sash windows and cellular bespoke design. It contains approximately 15 000 m² of office space including committee rooms and member rooms.

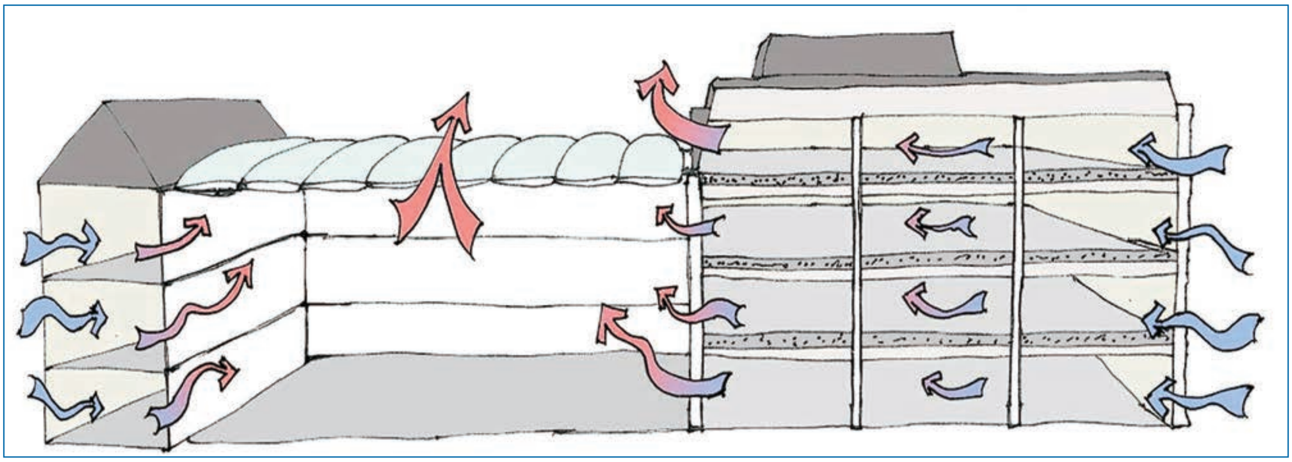
The four storey County Hall has a 7 m width floor plan on the east and west wing and a 16 m width floor plan for the main section up to the second floor with a 7 m width for the main section on the third floor. The County Hall is on a main road and near a train line where acoustic issues are present. A major extension to the County Hall was completed in the 1970s and consists of a four storey office block. It is constructed from a concrete frame with aluminium windows and is mostly open plan. The extension has a deep floor plan of around 30 m.

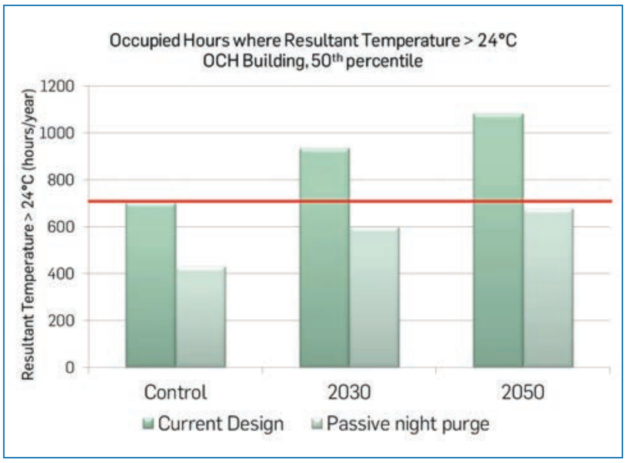
Project timescales and dates

Design and assessment period (pre-planning): October 2010 to February 2011

Construction period (post-consent): April 2011 to October 2011

Operation and monitoring period: N/A





Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- risks were assessed using a rating of probability and impact resulting in a rating between low and extreme
- where possible risks were quantified in terms of their impact on the building under different climate scenarios
- some adaptation ideas were generated at the CCA focus session held with the client and design team early in the process. Additional ideas were generated as the project progressed by the CCA team.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- we have provided results both in report and presentation formats, both of which have contained sketches to communicate design concepts and graphs to communicate the outcomes of design modelling
- we have found with the bulk of material generated that the presentations have been more successful than the reports owing to the length and content of the reports.

3 What tools have you used to assess overheating and flood risks?

- we have used TAS modelling software with weather data generated by the Prometheus project at the University of Exeter to assess overheating
- flood risks used a range of published resources including the IPCC technical paper on climate change and water, UKCP09 climate projections and climate south-west.

4 What has the client agreed to implement as a result of your adaptation work?

- the client has agreed to the following modifications and investigations:
    - design building fabric to exposure category 4
    - assess structural strength of wall ties
    - rainwater recycling for MECH building
    - water use awareness campaign
    - relocation of some equipment from basement
    - relocation of office space from basement.
    - other strategies under consideration:
    - greywater recycling for OCH building
    - more tree planting.

5 What were the major challenges so far in doing this adaptation work?

- we believe to realise value for the client there needs to be an emphasis on being able to quantify the impact of climate change scenarios to understand whether immediate or delayed investment is necessary. This can be done with some certainty for risks to thermal comfort however construction and water risks require additional support to enable quantification
- there is a wide range of potential climate change impacts. The challenge is to direct the funding to areas that will yield the most benefit for the client in terms of increasing asset resilience to climate change effects.

6 What advice would you give others undertaking adaptation strategies?

- get early client engagement with a climate change adaptation focus workshop with the aim to:
    - educate the client on the range of CCA issues
    - highlight design opportunities
    - help narrow the focus of the study
    - be systematic and careful to keep the focus of the study on genuine climate change adaptation issues and not just general design issues.

D4FC Factsheet 3:
Extra Care 4 Exeter

Contact details

Name:	Emma Osmundsen/ Jason Fitzsimmons
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General project information

Name of project:	Extra Care 4 Exeter
Location of project:	Exeter, Devon
Type of project:	New build, 50 unit extra care scheme (including high level dementia care) and associated accommodation and facilities
Cost of project:	Budget of £6m

The project is currently at RIBA Workstage C/D

Project team

Client, project manager, structural and civils engineers: Exeter City Council

Designer:	Gale & Snowden Architects Ltd
Contractor:	TBC

Other organisations involved (and their role): Exeter University (building physicists and dissemination), Jenkins Hansford Partnership (quantity surveyors and cost consultants)

Project description

The client project brief is to design and build a new state of the art and non institutional, low energy extra care home including 50 self contained accommodation units plus supporting communal facilities and staff accommodation. The building is:

- to be low in energy and to maintain adequate comfort levels throughout its lifespan with a passive design. Passivhaus standards are to be considered for the accommodation units
- to incorporate healthy building design principles, including reducing VOCs, dust mites, emfs.

The main CCA risks identified, focusing on overheating and comfort levels, are:

- increased internal and external temperatures
- unstable/changing surface temperature levels resulting in uncomfortable internal conditions
- unstable internal temperatures and fluctuating humidity levels.

Additional CCA risks to also be investigated include:

- increased weather severity – wind and rain
- reduced rainfall in summer, increased rainfall in winter
- increased pollen count, airborne particles and manmade pollutants
- flooding.

Project timescales and dates

Design and assessment period: November 2010 to July 2011

Construction period: 2013 TBC

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

The following methodology has been used to assess risks so far:

Overheating and comfort

- review of the team's previous projects including:
  - thermal modeling a current project using future climate change files 2030, 2050, 2080 at 50 and 90 percentiles
  - cost and construction matrix information for a range of projects were used to assess heavy versus light weight construction.

Before design, this identified the levels of CCA risk and allowed the design team to agree on the levels of future weather climate risk to be designed to (50 percentile). The key passive and low cost design criteria were established before commencing design work.

- literature review – CIBSE guidance on overheating, internal and external planting, green roofs and façade greening in terms of temperature and water attenuation, NASA effect of plants internally and externally, ASHRAE, heat stress papers and current research
- case studies UK and abroad (including German Passivhaus elderly care projects)
- various forms of thermal modelling of design throughout the design process from initial concept
- establish a sensible way forward based on the way people are currently treated in buildings to ensure that in the future this building (as currently designed) would pass future regulations.

Changing rainfall patterns:

- assess existing ground conditions, characteristics, topography, and environmental impact on sub-soils
- assess flood risk using EA maps and ECC SFRA
- review construction techniques/options
- awareness of peripheral development and future access requirements.

Adaptation measures to mitigate the potential climate change risks under consideration at present are as follows:

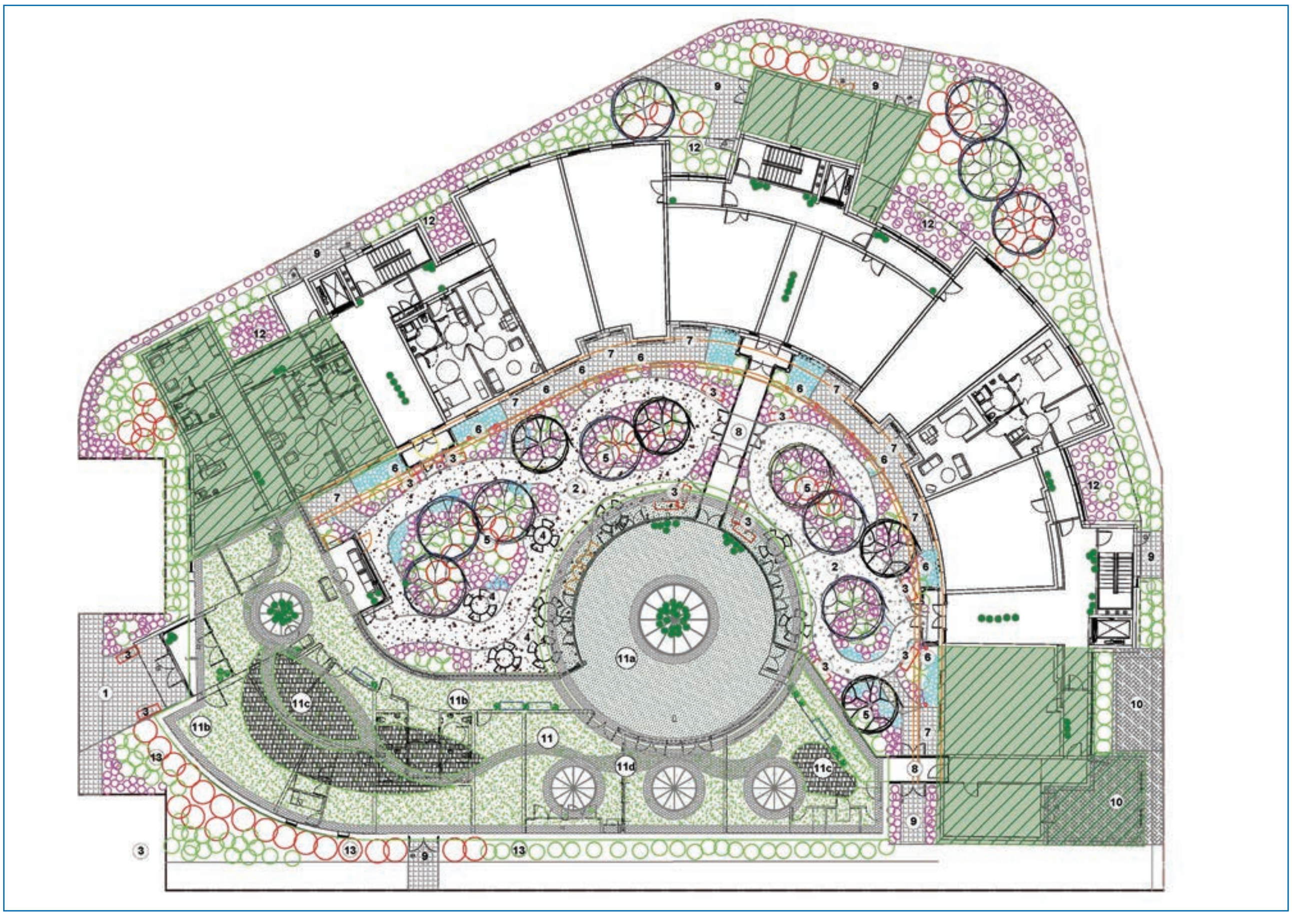
- **overheating internally including unstable internal temperatures:** Mitigation building strategies include introduction of natural summer cross ventilation, super-insulation and air tight building fabric. Other occupant orientated strategies include introduction of water drinking points throughout the communal areas (to aid respiration/cooling evaporation), future introduction of ceiling room fans to accommodation units, introduction of plants, staff heat stress training, providing the café reduces the need for cooking in individual apartments in sustained hot periods. Heavy weight construction appears to perform better provided that night cooling can take place. Lightweight structure can also be made to work with good ventilation control and shading
- **overheating external areas:** mitigation strategies include shading from structures and deciduous leaf cover and use of non hard landscape surfaces, such as green roofs to create reduced temperature micro-climate adjacent building
- **changing rainfall patterns:** mitigation strategies include attenuation measures to hold rainfall on site are currently under consideration
- **localised air pollution:** the effects and mitigation strategies are currently under consideration
- **flooding:** mitigation strategies are currently under consideration.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

CCA risks and communication have been communicated to the clients as follows:

- the clients are part of the design team and attend all meetings. They are fully informed on all aspects of the project
- notes of meetings and building precedent case studies are disseminated to the team including the clients.

The presentation of thermal modelling using computer graphics has worked well to graphically show the client what effects future climates could have on the building design.



3 What tools have you used to assess overheating and flood risks?

- **IES:** to thermally assess building design and fabric options
- **PHPP:** to assess the building design against Passivhaus criteria and cross reference the IES findings to compare results
- IES to assess the impact external planting can have on internal temperatures
- thermal modeling exercise and analysis is still ongoing
- **flood risks:** consulted with EA regarding flood risk from the main river
- review of strategic flood risk assessment to identify flood zone
- this is a small site (about 0.3ha) so manual and spreadsheet calculations allowing for climate change have also been used.

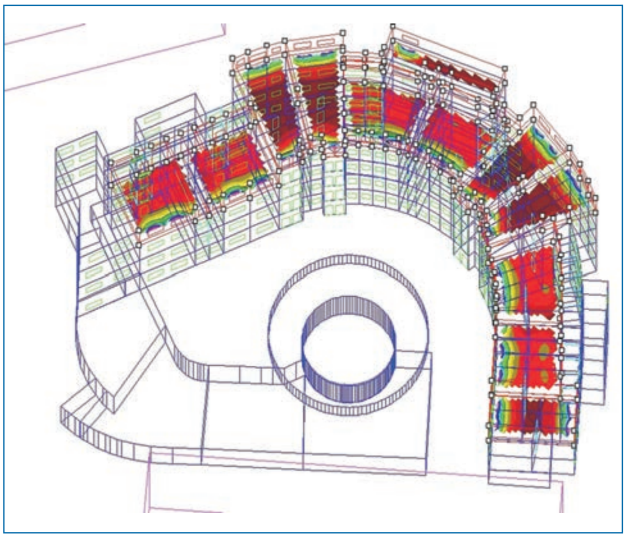
4 What has the client agreed to implement as a result of your adaptation work?

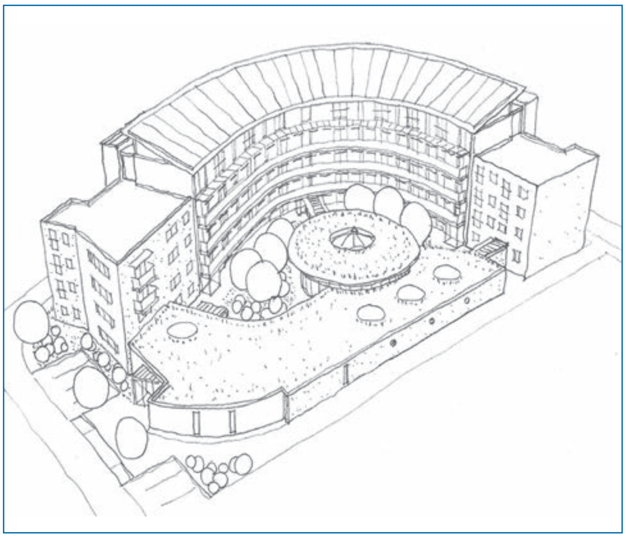
At present the project costs are under consideration so no decisions have been made to what is or is not to be incorporated into the building. Subject to the above, it has been agreed that the following will be implemented:

- cross ventilation layout for accommodation units
- solar shading to double up as access way and balconies
- deciduous planting for external landscaping for creating reduced micro climate adjacent the building in summer
- super insulated envelope to reduce solar gain and maintain stable and consistent internal temperatures
- localised extract (via MVHR) in spaces where high internal heat gains occur, ie the kitchen and appliances
- to minimise internal heat gains to the apartments by locating equipment such as boilers, hot water cylinders, washing machines etc in centralised plant rooms outside the habitable space.

5 What were the major challenges so far in doing this adaptation work?

- to determine the most appropriate construction technique. The client and team have experience of building a super heavy weight building which had its pros and cons when being built. Three construction techniques have been investigated: heavy weight, medium weight and light weight. They all have various pros and cons and costs associated with them. One method might appear cost effective in terms of materials but may take longer to build, and achieve weather tightness, and to dry out during construction. Another may introduce acoustic issues and associated on costs. The IES assessment indicates that thermal mass performs better with the future climate data, but this is reliant upon good ventilation control
- the client has a fixed budget and the team's experience of similar apartment buildings means they are fully aware that there is limited funding to invest in adaptation strategies at the start. The strategies investigated are ones that are simple and cost effective





- compatibility with building regulations. Achieving cross ventilation in achieving building regulations and innovative solutions were required in both the layout of the building and the detail of the design
- previous planning requirements. Outline planning approval restricted the building and landscape design including the massing of the building
- site restrictions. The limited size of the site restricted the design of the building and restricted the use of certain CCA strategies, eg ground cooling
- planting is a living building material. When considering the climate change scenarios to 2080, it is unclear on how plant species will or not adapt or succumb to pest and diseases with gradual change. So it was considered appropriate to concentrate on the structure and principles of the external design and associated characteristics of the plants, for future climate change and adaptation/management strategies
- specific plant species were considered based on their required use, location and likely growing conditions resulting from climate change. There is more opportunity to adapt planting over the buildings life time through regular maintenance, provided the infrastructure is in place
- incorporating the surface water storage needs of future extreme events
- other people's perceptions with not wanting to deal with future climate change as it currently is not part of the building regulations
- lack of clear guidance (building regulations, CIBSE, government) on what weather files and overheating criteria building designs should adhere to.

6 What advice would you give others undertaking adaptation strategies?

- a simple passive approach at concept stage can provide a high degree of CCA mitigation, eg layout of the building to allow cross ventilation
- consider simple people orientated measures to help reduce apparent heat in buildings by, for example, encouraging users to drink sufficient water, incorporating plant and room fans to increase people cooling via evaporation
- passivhaus principles provides a robust approach to future climate change
- incorporate controllable solar shading devices where necessary
- if the site and budget allow it, build in the possibility for using active cooling systems. For example. MVHR systems can use ground cooling to reduce excessive heat build up in prolonged periods of high external temperatures
- introduce thermal modelling at concept stage and use it as a design tool and not a compliance tool
- consider the role the landscape and external planting can play at introducing micro-climates and dealing with changing rain fall patterns at the start.

D4FC Factsheet 4:
Ellingham Primary School

Contact details

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General project information

Name of project: Ellingham Primary School

Location of project: Kingston, London

Type of project: New build primary school

Cost of project: £7m

Project team

Client: Royal Borough of Kingston

Designer: ECD Architects

Contractor: Willmott Dixon

Other organisations involved (and their role): Centre For Alternative Technology (specialist consultant), Keegans (cost consultants and project managers), Clark Smith Partnership (structural engineers), EDA & Silcock Dawson Partners (M&E engineers).

Project description

The expansion of the school is to provide one additional form of entry through the demolition of the existing school and reconstruction of a new building. The basis for the design of the new school building is that the school expansion should not limit the future use of the school and its grounds. Construction of the new building has been located and phased to minimise disruption to the school teaching session. The proposals was created in consultation with the school stakeholders including teachers and staff as well as the local community, students and parents, and co-ordinated with the nearby SEN school and the neighbouring community college. The environmental brief is to achieve BREEAM Very Good status.

CO_2 emissions will be reduced by 60 per cent in relation to an equivalent building built to 2002 Building Regulations standards. This is achieved as follows: 40 per cent improved fabric and services, 20 per cent on-site renewable.

Project timescales and dates

Design and assessment period (pre-planning): August 2009 to July 2010

Construction period (post-consent): January 2011 to August 2012

Operation and monitoring period: August 2012 to August 2072

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- model the existing using dynamic simulation software (IES) to assess current energy use and overheating risks.
- simulations where then repeated using probabilistic climate change data for 2030, 2050 and 2080 (TRY and DYS) with medium and high emission scenarios. BB87 guidelines were used to establish overheating limits (up to 80 hours >28ºC). Overheating above this threshold has been indentified from medium and high emission scenarios in 2050 and 2080. Adaptation measures to be modeled include Increased ventilation, operable panels/vents (manual or automatic), shading effectiveness, shading and daylighting (light energy and heat gains), CO_2 emissions – winter heating vs summer cooling, thermal mass (exposing ceilings, partition wall options, mass floor, and, chilled water system). In parallel the building has also been redesigned to meet the Passivhaus standard to see if this reduces the vulnerability of the building to climate change.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- we have yet to communicate the results to the client as the project is ongoing. However we plan to use workshops and presentations.

3 What tools have you used to assess overheating and flood risks?

- dynamic simulation using IES for overheating assessment in conjunction with Prometheus probabilistic future climate data
- flooding risks will be assessed using UKCP09 scenarios for rainfall.

4 What has the client agreed to implement as a result of your adaptation work?

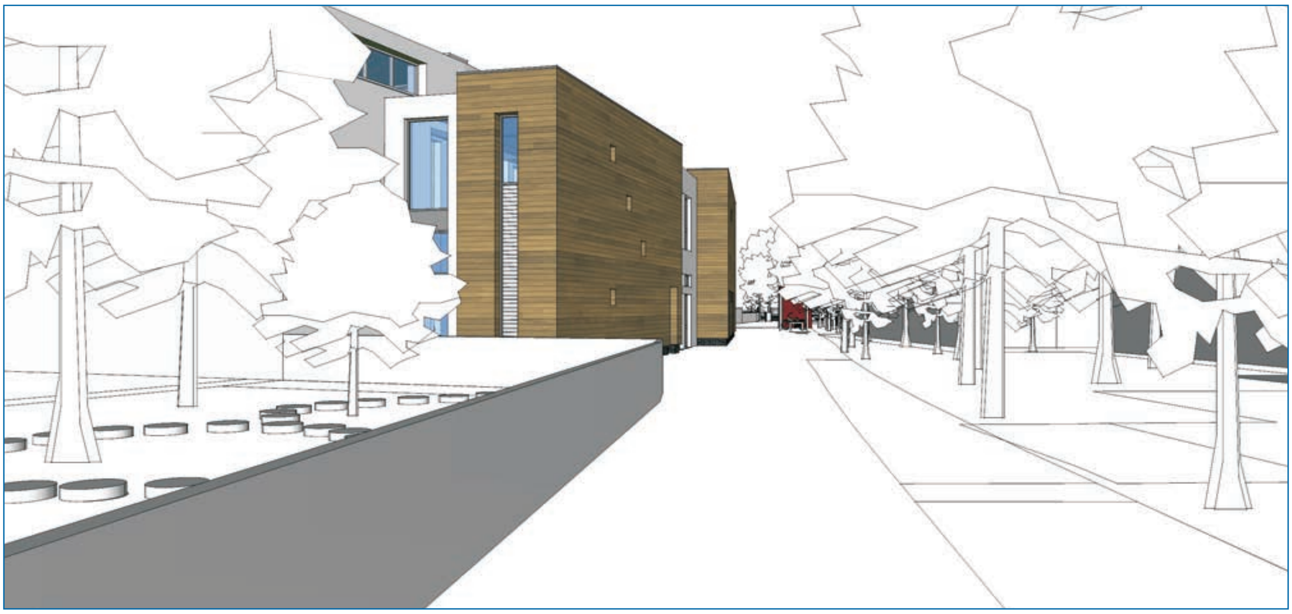
- we have yet to inform the client with the results, however they have agreed in principle to incorporate the findings of this report into the current project subject to programme and budgetary constraints, and where possible on all other existing schools within the borough, and on any new schools to be developed in the future.

5 What were the major challenges so far in doing this adaptation work?

- determining the main focus of the project, overheating, increased rainfall, flooding, windstorms, fossil fuel security (or all of the above)
- establishing overheating thresholds, BB 87 and BB 101 give conflicting guidelines.

6 What advice would you give others undertaking adaptation strategies?

- determine the main focus of the project early on as it may not be possible to cover all aspects of climate change and adaptation.



D4FC Factsheet 5:

Great Ormond Street Hospital Phase 2B

Contact details

Name:	Matthew Payne
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Tel (mobile):	07824 328391

General project information

Name of project:	Great Ormond Street Hospital Phase 2B
Location of project:	London
Type of project:	New build using part of the existing structure
Cost of project:	£45m

Project team

Client:	Great Ormond Street Hospital
Designer:	Llewellyn Davies Yeang, WSP
Contractor:	Not yet tendered

Project description

The building project is for a new cardiac wing at Great Ormond Street Hospital for Children. Included in the development works are the demolition of Levels 4 and above of the existing building, a refurbishment of the remaining existing levels and the construction of new Levels 4 to 7. The existing 9000 m^2, narrow rectangular building is a concrete framed structure, whereas the new construction will be steel framed.

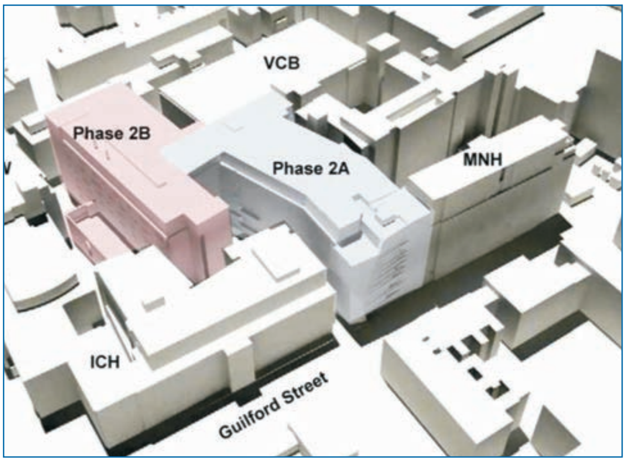
The building is located on Great Ormond Street Hospital site in the centre of London. The building is part of a four phase redevelopment of the entire site, of which the new cardiac wing is Phase 2B. The four phase redevelopment program intends to redevelop many of the site's old (circa 1930s) buildings to a modern standard and also upgrade the site's energy and servicing infrastructure, some of which is also included in Phase 2B.

Project timescales and dates

Design and assessment period (pre-planning): February 2011 to July 2011

Construction period (post-consent): 2012 to 2016

Operation and monitoring period: N/A



Further project details

1 **What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?**

- risks were assessed using a rating of probability and impact resulting in a rating between low and extreme
- where possible risks were quantified in terms of their impact on the building under different climate scenarios
- some adaptation ideas were generated at the CCA focus session held with the client and design team early in the process. The CCA team generated more ideas as the project progressed.

2 **How have you communicated the risks and recommendations with your client? What methods worked well?**

- we have provided results both in report and presentation formats, both of which have contained sketches to communicate design concepts and graphs to communicate the outcomes of design modelling
- we have found with the bulk of material generated that the presentations have been more successful than the reports owing to the length and content of the reports.

3 **What tools have you used to assess overheating and flood risks?**

- we have used TAS modelling software with weather data generated by the Prometheus project at the University of Exeter to assess overheating.

4 **What has the client agreed to implement as a result of your adaptation work?**

- the project is not yet at a stage where recommendations and implementation has been agreed.

5 **What were the major challenges so far in doing this adaptation work?**

- we believe to realise value for the client there needs to be an emphasis on being able to quantify the effect of climate change scenarios to understand whether immediate or delayed investment is necessary. This can be done with some certainty for risks to thermal comfort, however construction and water risks require more support to enable quantification
- there is a wide range of potential climate change impacts. The challenge is to direct the funding to areas that will yield the most benefit for the client in terms of increasing asset resilience to the effects of climate change.

6 **What advice would you give others undertaking adaptation strategies?**

- involve the client early with a climate change adaptation focus workshop that aims to:
  - educate the client on the range of CCA issues
  - highlight design opportunities
  - help narrow the focus of the study
  - be systematic and careful to keep the focus of the study on genuine climate change adaptation issues and not just general design issues.

D4FC Factsheet 6:

University of Greenwich, Stockwell Street

Contact details

Name:	Eimear Moloney
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Tel:	01865 339756

General project information

Name of project:	University of Greenwich, Stockwell Street
Location of project:	London
Type of project:	New build
Cost of project:	£60m

Project team

Client:	University of Greenwich
Designer:	Heneghan Peng Architects
Contractor:	Unknown

Other organisations involved (and their role): Hoare Lea (M&E consultant), Alan Baxter (structural engineer), Fanshawe (cost consultant)

Project description

The project comprises the relocation of the School of Architecture and Construction, currently situated at Eltham, to Greenwich. It also creates a new learning resource centre on the same site, to improve its facilities and accommodate a growing numbers of students. The development will be undertaken on a brownfield site in Stockwell Street, Greenwich and proposes to provide 17 000m² of new buildings 10 000m² for the School of Architecture and Construction and 7000 m² for the learning resources centre

Project timescales and dates

Design and assessment period (pre-planning): project was submitted for planning in February 2011

Construction period (post-consent): construction is due to begin in summer 2011 and will take about two years

Operation and monitoring period: this will occur for 12 months post-completion

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- we held several workshops at which each member of the design team and the client attended. Climate related design and operational risks were identified and adaptations options and strategies developed. Each adaptation measure and its application to the University of Greenwich project was discussed
- where data was available further numerical modelling was undertaken otherwise a "what if" approach was taken.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- the client has been in attendance at each workshop and as such, is fully aware of all adaptation measures that will be recommended. The client has been involved in all areas of the design for the adaptation measures. Some of the students from the college are also getting involved outside of the workshops.

3 What tools have you used to assess overheating and flood risks?

- the University of Manchester were appointed to analyse the UKCIP09 data and to provide the team with the following:
    - design limit data for heating and cooling systems
    - design summer year (DSY) for overheating analysis for Greenwich for present, 2020s, 2040s 2080s. This data was used IES thermal modelling analysis software
    - test reference year (TRY) data energy use analysis for Greenwich for present, 2020s, 2040s 2080s.
    - peak rainfall data from the University of Manchester was given, in terms of mm/hr for storm water flooding risk calculations
- the TSB design checklist was developed further to aid discussion and structure the design analysis at the workshops.

4 What has the client agreed to implement as a result of your adaptation work?

- The adaptation measures were discussed with the client and it has been agreed to implement the following:
    - permanent flood protection to basement areas
    - add access control to the standby generator
    - include adaptable door frames for door dams
    - connect drainage system to the BMS
    - build-up above the attenuation tank to avoid flotation
    - an increase to the number of bike storage spaces
    - allow for an increase in plant and riser space
- this equates to a cost uplift of the original cost plant of £149 000 from £42 570 000 to a new total of £42 719 000.

5 What were the major challenges so far in doing this adaptation work?

- a large degree of uncertainty remains surrounding the design basis and the context in which the effects of climate change can be assessed. The availability of credible future weather data is fundamental to an analytical assessment of the impacts. The nonexistence or unreliability of specific data relating to key risk factors such as rainfall and wind reduces confidence in the analysis. As a result, clients and design teams are less

likely to commit to added expenditure in response to potential risks

- the UKCIP09 weather data has the potential to provide high resolution weather data for projects but as yet is generally unusable by the property sector.
- ultimately the implementation of adaptation measures will affect costs and this need to be balanced against budget
- the second major challenge was identifying the risks and briefing the design team. There was a degree of scepticism and initial defensiveness but gradually this was overcome.

6 What advice would you give others undertaking adaptation strategies?

- many of the adaptations and those of most significance are strategic in nature and affect the space planning and structure of the building. As such the climate related risks need to be identified and analysed at an early stage in the project
- based on the experience of the team the following design strategy could be adopted for other buildings:
    - measures that required structural alteration were recommended to be undertaken immediately irrespective of their actual required implementation time
    - measures that required changes to system or component capacity were only to be implemented when required but consequential structural and space planning issues were implemented (as in the first point)
    - each measure was considered in terms of its impact on the current design and modifications immediately introduced to facilitate a future retrofit
    - those measures that were identified but for which the UKCIP09 weather data provided no firm direction were assessed on their merits and measures introduced on a risk management basis. This particularly applied to the risk of flooding
    - adaptation measures for future years were triggered by the crossing of key thresholds such as thermal capacities of plant, indoor and external design criteria temperature criteria.
- ultimately the implementation of adaptation measures will impact upon costs. A building that is inherently flexible and “loose fit”, and has good passive design features, is likely to be easier and less costly to adapt over its lifetime.

D4FC Factsheet 7:

Oxford University Press Offices D Wing Extension

Contact details

Name: Eimear Moloney

Company: Hoare Lea

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General project information

Name of project: Oxford University Press Offices D Wing Extension

Location of project: Oxford

Type of project: Part refurbishment, part new build

Cost of project: £11m

Project team

Client: Oxford University Press

Designer: Berman Guedes Stretton

Contractor: Unknown

Other organisations involved (and their role): Hoare Lea (M&E consultant), Price & Myers (structural engineer), Baqus Sworn King (cost consultant)

Project description

Refurbishment and extension of existing OUP cellular office space into 4000 m² of high spec open plan offices in order to create an additional 100+ workstations.

The proposal retains the existing office building, D wing and the “old pub” on Walton Street and demolishes the remaining buildings forming C wing.

A new three storey with basement building will be constructed on the south of C wing with a new atrium using the same structural grid and floor levels as the existing D wing, creating a large combined open plan office space. The configuration of the new building has been developed to reduce any overlooking and amenity issues with the adjoining residential properties.

The building will have to comply with the Oxford Councils NRIA and 20 per cent renewables requirement. This will be achieved through a combination of a vertical borehole ground source heat pump system and roof mounted PV cells.

Project timescales and dates

Design and assessment period (pre-planning): project will be submitted for planning in August 2011

Construction period (post-consent): construction is due to begin in summer 2012 and will take about one year

Operation and monitoring period: this will occur for 12 months post-completion

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- we held several workshops at which each member of the design team and the client attended. Climate related design and operational risks were identified and adaptations options and strategies developed. Each adaptation measure and its application to the OUP project was discussed
- where data was available additional numerical modelling was undertaken otherwise a "what-if" approach was taken.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- the client has been in attendance at each workshop and as such, is fully aware of all adaptation measures that will be recommended. The client has been involved in all areas of the design for the adaptation measures.

3 What tools have you used to assess overheating and flood risks?

- the University of Manchester were appointed to analyse the UKCIP09 data and to provide the team with the following:
    - design limit data for heating and cooling systems
    - design summer year (DSY) for overheating analysis for Oxford for present, 2020s, 2040s 2080s. This data was used IES thermal modelling analysis software
    - test reference year (TRY) data energy use analysis for Oxford for present, 2020s, 2040s 2080s.
    - peak rainfall data from the University of Manchester was given, in terms of mm/hr for storm water flooding risk calculations
- the TSB design checklist was developed further to aid discussion and structure the design analysis at the workshops.

4 What has the client agreed to implement as a result of your adaptation work?

- the client has agreed in principle to the following adaptation measures:
    - alteration to the roof design on the west end of the building to allow for a future plant mezzanine
    - the addition of thermal mass to the top floor ceiling of the existing building to increase the thermal mass
    - exposed concrete ceilings could be coffered with blanked pipes contained within. To allow a future chilled ceiling system to be installed with minimal impact to the structure.
    - the inclusion of a "knock-out panel" next to the south east riser to allow for future services
    - the boilers to be more modularised to allow for easier adaptation to future changes in climate
    - three further drinking points to be provided in the quad and on the roof
    - increase the level of the render start point so more of the building has a flood tolerant finish
    - alteration to the roof design to allow for future storage of storm water
    - increasing the diameter of the rainwater downpipes
    - inclusion of weirs in the roof upstand to account for future increase in rainfall
    - the door frames in the basement to be deepened to allow for future retrofitting of flood barriers
    - addition of a step from the auditorium into the plantroom to reduce the impact of any flooding
    - the increase in the amount of stormwater attenuation
    - an increase in the number of PV panels to the south facade
    - the inclusion of empty PVC ducts between the pub and the basement plantroom to allow for future plant connection to the pub basement

However the project is currently under review and a final decision is yet to be made.

The current cost plan, without any climate change adaptation or risk reduction measures, has a construction cost of £10 900 000. The cost of the 15 adaptation measures is £965 000 (at current prices).

5 What were the major challenges so far in doing this adaptation work?

- there does remain a large degree of uncertainty surrounding the design basis and the context in which the impacts of climate change can be assessed. The availability of credible future weather data is fundamental to an analytical assessment of the impacts. The nonexistence or unreliability of specific data relating to key risk factors such as rainfall and wind reduces confidence in the analysis. As a result, clients and design teams are less likely to commit to added expenditure in response to potential risks
- the UKCIP09 weather data has the potential to provide high resolution weather data for projects but as yet is generally unusable by the property sector
- ultimately the implementation of adaptation measures will impact upon costs and this need to be balanced against budget.

6 What advice would you give others undertaking adaptation strategies?

- many of the adaptations and those of most significance are strategic in nature and affect the space planning and structure of the building. As such the climate related risks need to be identified and analysed at an early stage in the project
- based on the experience of the team the following design strategy could be adopted for other buildings:

  - design with good solar control and openable windows
  - include the capability to facilitate night cooling and with sufficient planned riser and plant space to accommodate a future mechanical cooling system
  - ensure all windows are openable even with mechanically ventilated building to enhance resilience
  - avoid the use of internal rainwater drainage and consider design detailing for protection against intense rainfall and provide attenuation to lessen the risk of local flooding.
  - consider the impact of changes to ground water conditions on foundations
  - consider the resilience of the building to interruptions to energy supply
- ultimately the implementation of adaptation measures will impact upon costs. A building that is inherently flexible and “loose fit”, and has good passive design features, is likely to be easier and less costly to adapt over its lifetime.

D4FC Factsheet 8:
University of Sheffield Grad School

Contact details

Name:	Andy Sheppard
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Tel:	01142 833709

General project information

Name of project:	University of Sheffield Grad School
Location of project:	Sheffield
Type of project:	New build higher education building

Project team:

Client:	University of Sheffield
Designer:	Bond Bryan Architects
Contractor:	Grahams

Other organisations involved (and their role): Arup SMEP

Project description

Examining the effect of alternative internal layouts and highly optimised form and massing on the ability of a building to cope with future extremes of temperature. Also examining the effect of compromises on the acoustic environment of the building. Detailed façades study to examine optima for shading and to appraise a wide range of façade alternatives for robustness when considering increased volatility of future weather events.

Project timescales and dates

Design and assessment period (pre-planning): to mid-2011

Construction period (post-consent): mid 2011 to late 2013

Operation and monitoring period: ongoing

Further project details

1 **What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?**

- risks were initially assessed using Arup's Climate Change Appraisal Framework, which provides a structure for considering the often disparate effects of climate change. Measures were identified by using thermal modelling to determine problem areas and by carrying out a detailed analysis of the façade options.

2 **How have you communicated the risks and recommendations with your client? What methods worked well?**

- communication with the client was continuous, often through our parallel team working on the 'main' design. The best method is frequent communication to ensure that the project and its findings remain visible to the decision makers.

3 **What tools have you used to assess overheating and flood risks?**

- IES was used to assess overheating risk using the Prometheus Weather files for the location. The overheating criteria are defined using an adaptive comfort threshold instead of a fixed threshold. This is in order to try and capture the effects of people becoming more accustomed to warmer weather in the future. Flood risk is not an issue due to the location of the site.

4 **What has the client agreed to implement as a result of your adaptation work?**

- due to the fact that this research project was running parallel to the main design with similar teams, it is hard to attribute implementations directly to this work. However, reduced g-value glazing, night ventilation with thermal mass and increased daytime ventilation rates and open areas were incorporated. In addition, the use of future weather files into the main overheating reports added to communicate the ability of the building to cope with increased temperatures.

5 **What were the major challenges so far in doing this adaptation work?**

- the main challenge surrounded trying to carry out the adaptation study alongside the main project. It was a fine balance between waiting for design decisions to be made in order to make our study more relevant and it being too late to influence the design of the building.

6 **What advice would you give others undertaking adaptation strategies?**

- make sure that the team involved are fully bought into the adaptation study as when running it alongside the main project, there is a danger that resource will be diverted away. This can also be helped by having a fully informed client that is aware of the potential benefits of the adaptation study who should be kept updated with outputs.

D4FC Factsheet 9:

British Trimmings Extra Care Home

Contact details

Name: Ian McHugh

Company: Triangle Architects Ltd

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Tel: 0161 272 3500

General project information

Name of project: British Trimmings Extra Care Home

Location of project: Leek, Staffordshire, UK

Type of project: New build (design and build contract)

Cost of project: £10m

Project team

Client: Harvest Housing Group

Designer: Triangle Architects

Contractor: TBA

Other organisations involved (and their role): Leeds School of Architecture (sustainability concepts and landscape design), The Energy Council (energy and thermal modelling), ABA Consulting (structural and civil engineering), SI Sealy (M&E engineering), SDA Consulting (cost advice)

Project description

The project is for an Extra Care Home for elderly people with a range of support needs. The proposal comprises 87 self contained flats and a range of communal and public facilities. The primary aim for this study is to consider the effects of climate change on, and appropriate adaptation strategies for, elderly people in an extra care setting. In particular, how to ensure thermal comfort and safety for this vulnerable group. Other climate change factors relevant to the building and site such as site stability, flooding and water autonomy have been considered and integrated into the study and design solutions approached comprehensively. The study aims to provide a range of solutions that will be of direct use to this project now and in the future and to develop a toolkit methodology to guide client decision making on this and other projects.

Project timescales and dates

Design and assessment period (pre-planning): project started in March 2009 and received planning consent in October 2010

D4FC design and study: October 2010 to July 2012

Design revisions and minor planning amendments approved: December 2011

Detailed design finalisation and D&B tender period: December 2011 to August 2012

Construction period (post-consent): October 2012 to April 2014

Operation and monitoring period: building occupied from May 2014

Monitoring not within remit of study but report will recommend client monitoring relevant to uptake of measures and to compare with other properties if possible.

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- analysis of future weather data
- review of heat related mortality studies
- psychrometric charts to assess cooling strategies
- comparative thermal modelling of existing proposals, alternative specifications and redesigns investigating effects of thermal mass, insulation, ventilation, shading, evaporative cooling and ground cooling
- twin approach of limited 'adapted design' and more radical 'rationalised design' including replaceable façade options
- focus on future-proofing where possible to avoid paying now for uncertain future scenarios
- assessment of superstructure, foundations and site stability issues on designs
- calculation of site rainfall, flood risk, water autonomy requirements, and storage capacity
- design concept and appraisal of M&E systems to meet performance targets identified.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- client involvement in design team meetings from outset – essential for two way understanding
- interim review with client – to check priorities and commercial parameters
- summary presentation to client and local extra care interest group – clear visualisation/diagrams, characterisation of technical information rather than too many graphs and tables
- post study presentation feedback to full client development team.

3 What tools have you used to assess overheating and flood risks?

- University of Exeter Prometheus: database of future climate models
- IES software: thermal modelling
- Climate Consultant 5.0: weather modelling including Psychrometric charts.

4 What has the client agreed to implement as a result of your adaptation work?

- the client is very interested in the study and how it could be applied but has severe budgetary constraints as a public funded scheme. Clear benefits had to be demonstrated within a 30 year financial 'horizon' for the project and set against risks within that period or otherwise be no or low cost solutions.
- adaptations accepted had to be within the existing planning constraints. Significant recommendations agreed for implementation are:
  - thermal mass to attenuate temperatures and reduce overheating with brick and block with wet plaster finishes selected over timber frame
  - piled foundations extended to whole building to reduce risk of ground heave/shrinkage and allow closer proximity of shading trees
  - landscape redesigned to increase green spaces and shading for a cooling effect to the micro-climate and increased bio-diversity
  - integrated surface water attenuation and SUDs
  - linking of automated fire ventilation systems with ventilation for communal spaces and corridors
  - provision to split water distribution to allow for future rainwater recycling installation
- the more adventurous 'rationalised design' options will not be adopted on this project but will inform the client's briefing for future schemes, eg introducing enhanced performance criteria, decision 'toolkit' approach.

5 What were the major challenges so far in doing this adaptation work?

- difficult for sub-consultants to give a fixed service and price at the outset of an exploratory project. Relies a lot on flexibility and trust

- research took longer than anticipated and programme of work much less of a linear sequence than anticipated
- planning will not allow much visual difference from the approved scheme without requiring a new application
- difficult to get more than general cost advice on relative merits of design approaches until worked up. Life cycle costing very notional when including for new or future technologies and energy costs
- future energy saving payback periods were a low client priority since savings would largely benefit tenants not the client and therefore not 'pay-back' directly
- design and build process meant delivery team were not fully 'on board' with design thinking and various inconvenient adopted features were ignored or even omitted by agreement
- performance specifications and thermal modelling criteria were not properly understood by tendering contractors leading to problems with sequencing of detailed design information and costs.

6 What advice would you give others undertaking adaptation strategies?

- engage the client fully in the risk assessment process
- present risk and performance appraisals clearly to raise client awareness
- relate performance evaluation to the client's economic 'horizon'
- understand that the building must perform in response to 'weather' not 'climate'
- understand that weather projections offer a range of possibilities and try to allow for future adaptability – 'long life, loose fit'
- integrate design strategies as early as possible eg. Water attenuation and landscape, orientation and shading, floor plans and ventilation routes
- specify enhanced performance standards against projected weather data for design and build contracts
- encorage continuity of approach with project delivery team.

D4FC Factsheet 10:

North West Cambridge (NWC)

Contact details

Name:	Andrew Turton
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General project information

Name of project:	North West Cambridge (NWC)
Location of project:	Cambridge
Type of project:	New build mixed use urban extension
Cost of project:	About £1bn

Project team

Client:	University of Cambridge
Designer:	AECOM
Contractor:	TBC (likely to be several)

Project description

North West Cambridge (NWC) is a major urban extension to Cambridge being bought forward by the University. The main driver for the development is to provide 1500 staff houses for the University and 100 000 m² of new academic and research facilities. The site will provide 1500 market houses, a food store, hotel, and community facilities.

The strategic nature of the site and location in the green belt has meant that high sustainability standards have been set in the area action plan requiring several sustainable design aspects to be addressed. These include Code for Sustainable Homes Level 5 for all homes, the inclusion of a district heating system, and extensive sustainable urban drainage systems (SuDS).

Project timescales and dates

Design and assessment period (pre-planning): the masterplan for the development has been progressed since 2005 and the project is nearing outline planning application in summer 2011. The CCA assessment work will be conducted on Phase 1 of the masterplan (about 1000 homes and other non-domestic facilities including a local centre) expected to be designed in the second half of 2011. So no detailed analysis has started yet.

Construction period (post-consent): it is expected that planning consent for phase 1 will be gained during 2012 and that Phase 1 of the site will be constructed between 2013 and 2016. The overall site is expected to be completed during the 2020s.

Operation and monitoring period: there are significant proposals for ongoing monitoring of the site post construction, with links to academic research in the University. A long-term strategy for this is currently being developed by the University.

Further project details

Note that information in the following sections is relatively limited because work has not yet started on the project.

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- detailed analysis of risks for phase 1 of NWC have not yet started. However the following risks have been highlighted during the masterplanning stages due to the nature of the development
- overheating in dwellings. There are proposals for a large number of flats, some that may be single aspect. With potential ventilation restrictions imposed by noise from the neighbouring M11, there could be a risk of overheating in some of the dwellings
- external temperatures. The dense urban nature of some areas of the site could increase external temperatures, but the inclusion of SuDS and green spaces provides an opportunity for mitigating this. The CCA work will examine how maximum benefits can be gained through careful design and layout of green infrastructure
- drainage. Part of the site is clay based and drains into a small brook which floods further downstream. An important aspect of the design is therefore based around reducing run-off levels through the inclusion of significant SuDS infrastructure across the site.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- at present, CCA issues have been brought up at a high level during workshops and design sessions. These have been well received due to the aspirations for NWC to be an "exemplar" of sustainable development
- high level CCA design principles have been included in the outline planning statement relating to SuDS, water conservation, and overheating. These set standards that all phases of the development should adhere to.

3 What tools have you used to assess overheating and flood risks?

- at present, no detailed analysis has been conducted. However the following are proposed:
  - thermal modelling of dwellings using SAP and dynamic simulation tools
  - scenario analysis for flood modelling
  - CFD analysis of green infrastructure and external temperatures.

4 What has the client agreed to implement as a result of your adaptation work?

- in general the principles of CCA have been agreed to through the inclusion in the outline planning documents. These are seen as important aspects to the sustainable design of the site, and considering that the University will remain as landlord for the majority of buildings, important aspects in the future operation of the development.

5 What were the major challenges so far in doing this adaptation work?

- N/A.

6 What advice would you give others undertaking adaptation strategies?

- it is important that high level CCA design principles are discussed at the earliest possible stage to ensure that the evolving masterplan is designed to be compatible with the adaptation measures (for example, no single aspect dwellings)
- the long-term benefits to residents and owners need to be emphasised to ensure that the client sees the benefit of conducting CCA analysis and the cost benefit this work can bring.

D4FC Factsheet 11:

The Wyre Forest Primary Schools Programme

Contact details

Name:	Patrick Travis
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General project information

Name of project:	The Wyre Forest Primary Schools Programme
Location of project:	Kidderminster, Worcestershire
Type of project:	New and refurbished primary schools
Cost of project:	£12m

Project team

Client:	Worcestershire County Council
Architects and engineers:	Worcestershire County Council
Consultant engineers:	Max Fordham
Consultant architects:	Sjölander da Cruz
Climate change consultant:	Dr G Cavan
Landscape architects:	Grant Associates
Structural engineers:	Shire Consulting
Quantity surveyors:	Bridgewater & Coulton

Project description

The project involves two new primary schools and one refurbished primary school in the Wyre Forest area of Worcestershire. The projects were completed in 2012.

By grouping three schools into one adaptation study, it has been possible to investigate a range of issues which relate not only to these schools, but also to a wider range of similar buildings throughout the UK.

The project has concentrated on strategies to reduce summertime overheating. Areas of study have included the effect of external shading, improved ventilation, revised fenestration and a wider review of the influence of landscape. Adaptations were linked to a timeline to allow for incremental additions to suit changing climatic conditions

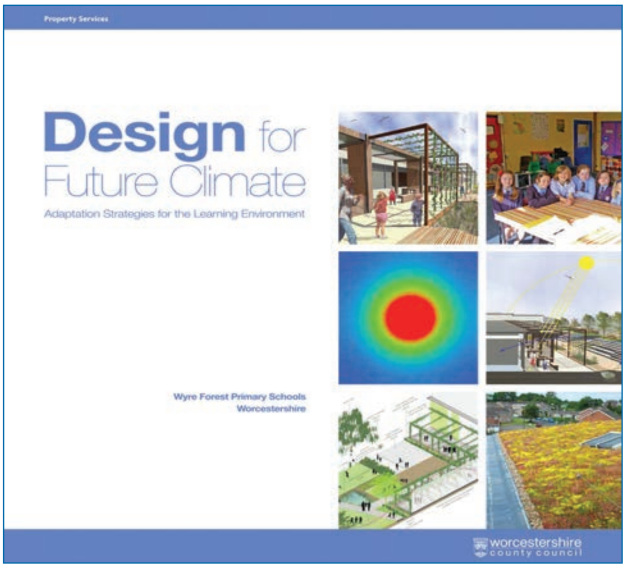
The study also reviewed the interpretation of acceptable environmental conditions, and considered the effect of varying the hours of occupation of the buildings, involving an earlier daily start and finishing time.

The final report is available at: **http://data.axmag.com/data/VIP/201310/U105249/F246679/index.html**

Project timescales and dates

Design and assessment period (pre-planning): February 2011 to April 2012

Construction period (post-consent): April 2011 to July 2012



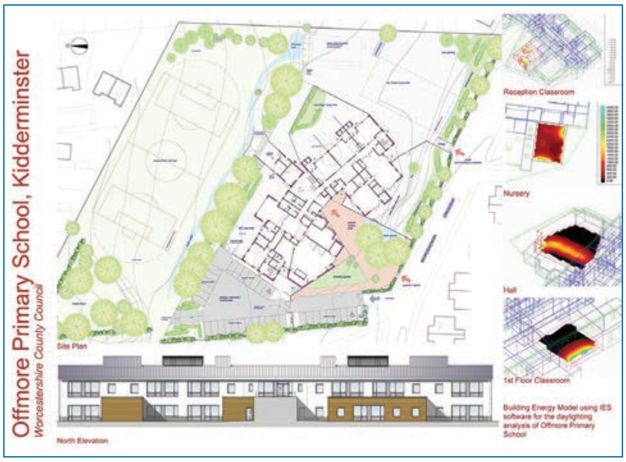
Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- initial meetings were held with the school staff and pupils, to assess their perception of risk and to identify critical issues which would have the greatest effect on the operation of the school. The evaluation included reference to recent severe weather events, and how they had affected the school. The results informed the design team discussions, and helped to identify the most appropriate adaptation measures and the anticipated timeline for installation.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- risks and recommendations were discussed with the school. Discussions with staff included reference to the D4FC Report and the results of the climate projections. The teachers involved pupils in project work, which included identifying the areas of the building most susceptible to the effects of climate change
- the project introduced the concept of climate change to the pupils and provided the basis for valuable learning opportunities.



3 What tools have you used to assess overheating and flood risks?

- climate change predictions were based on UKCP09, and the analysis used the 2011 version of the weather generator
- data was produced to the end of the century
- modelling was undertaken using IES software and Prometheus data.

4 What has the client agreed to implement as a result of your adaptation work?

- the results of the study have shown that adaptations will not be required in the two new schools until them middle of the century
- recommendations have been made for adaptations at the refurbished school, but funding is not currently available.

5 What were the major challenges so far in doing this adaptation work?

- identifying the most appropriate weather files to use for IES modelling, including the emissions scenario, the probability level and the time period that most closely matched the users view of the consequences of extreme weather events on their school
- developing a cost effective strategy that could also be applied to other similar buildings.

6 What advice would you give others undertaking adaptation strategies?

- consider the potential for extending the application of adaptation strategies to a wider range of buildings
- consider affordability and the potential for incremental adaptations to suit both climate change and the availability of funding
- effective solutions do not necessarily have to be complex.

D4FC Factsheet 12:
Church View

Contact details

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General project information

Name of project: Church View

Location of project: Doncaster

Type of project: Refurbishment and conversion of a 1930s art college

Cost of project: £6.4m

Project team

Client: Doncaster Development Community Trust

Designer: Bauman Lyons Architects

Contractor: Houlton Building ContractorsLtd

Other organisations involved (and their role): Arup (engineers), Estell Warren (landscape architecture), Latz and Partners (landscape design), Prof Sue Roaf, (ACT) CSM (facilities management advisors)

Project description

The key research questions for the conversion of a 1930s art college into managed workspace are:

1 **Can the building be adapted to prevent overheating in 2080?**

2 **Can the adaptations be implemented incrementally room by room?**

3 **Can the adaptations be implemented within the maintenance cycle?**

4 **Are the adaptations commercially viable – what is the payback period?**

5 **Can the conflicts between conservation and climate adaptation be resolved?**

The following design solutions were considered:

- adaptations to windows
- adaptations to fabric
- adaptations to natural ventilation
- adaptation through use of soft landcape and water
- adaptation through managing internal gains
- adaptation of behaviour.

We also considered the impact of “anti-adaptation” trends: icreasing occupancy and increasing hours occupancy/day.

We have chosen to use the UKCIP02 weather files as they are robust and understood sources.

As a metric we are using the recently developed adaptive comfort threshold.

We used IES to model eight rooms within the building with varied conditions.

Project timescales and dates

Design and assessment period (pre-planning): planning permission obtained in March 2010

Construction period (post-consent): construction period of phase one November 2009 to March 2011

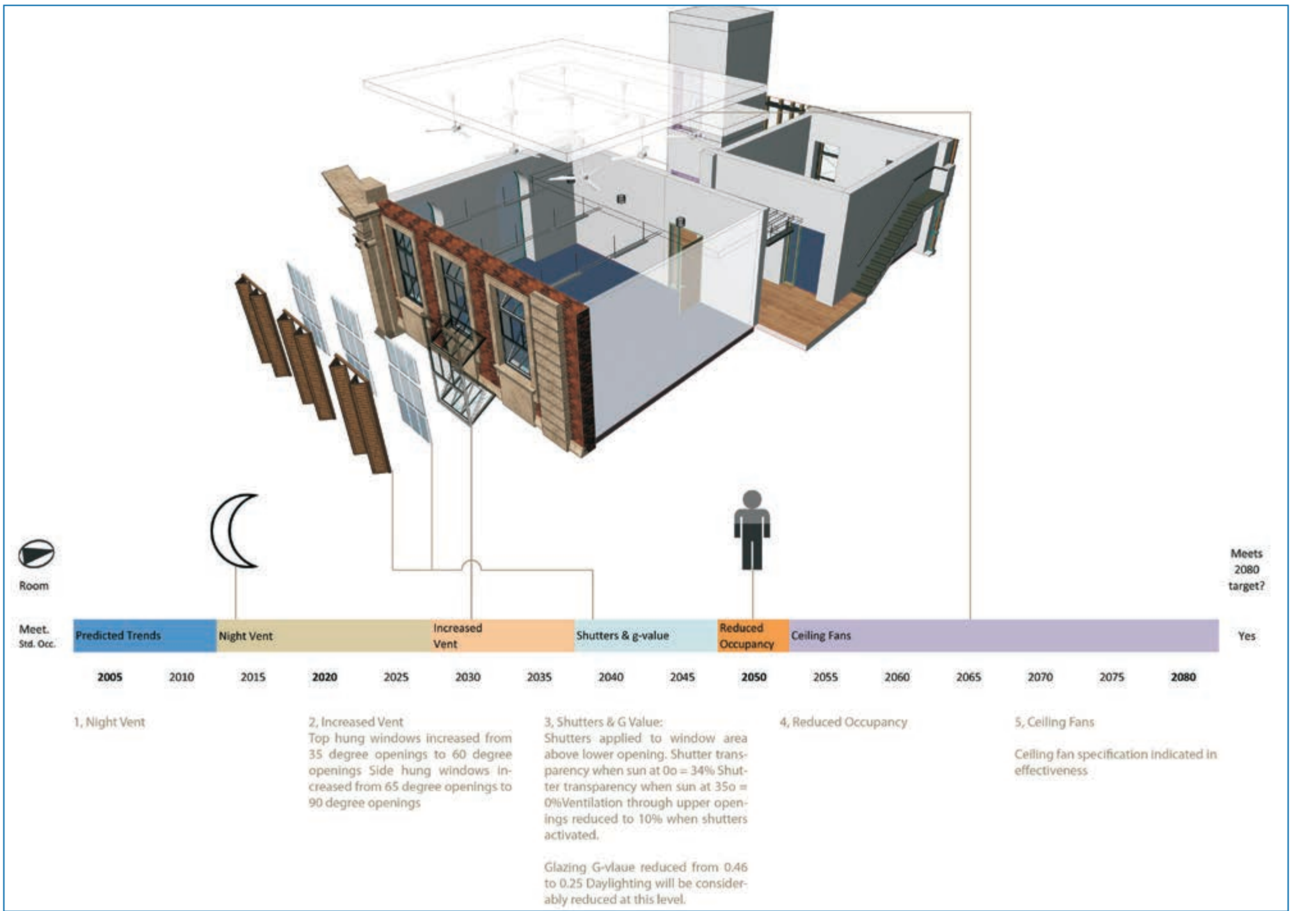
Phase 2 funding awaited.

Operation and monitoring period: N/A

CIBSE Engineering a sustainable built environment

Technology Strategy Board Driving Innovation

Knowledge Transfer Network Modern Built Environment



Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- we have chosen to use the UKCIP02 weather files as they are robust and understood sources. We are using the Nottingham information as opposed to Leeds as required under regulations. This is due to the fact that the building is about equidistant between the two and Leeds is an understood to be anomalous when considering overheating. It is felt that the Nottingham file represents a more accurate prediction of future conditions
- as a metric we are using the recently developed adaptive comfort threshold. We feel that this more accurately represents the human perception of overheating and reflects the fact that people will be generally more accustomed to higher temperatures in the future
- robust methodologies have also been developed to measure the impact of adaptation interventions that are not directly able to be modelled in building physics software. These include the concept of assigning overheating metrics to individuals rather than rooms to enable the effect of behaviour change to be quantified.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- we started the project by facilitating a “bunker day” workshop for all design team, client, specialists, FM, planners and building control officers to launch the project and establish key issues. The day was exceptionally successful, a great learning curve for all and a common agenda was established. Also the client expressed full support for the project
- after completing phase one of modelling we held a second meeting, in February 2011, with the client, business planners, facilities management advisor, and the design team to discuss the outcomes.

3 What tools have you used to assess overheating and flood risks?

- our projects was about overheating only
- the tools we used are software Archicad for 3D model and su studies and IES for overheating modelling.
- we also used UKCIP02 weather files and adaptive comfort thresholds.

4 What has the client agreed to implement as a result of your adaptation work?

- in response to outcomes of phase one modelling the client instructed us to investigate incorporation of tree shading, ceiling fans and vertical blinds into phase one of the project that was due to be completed on site in April 2011
- the blinds and fans were installed but the trees required planning application due to proximity to the boundary wall and there was insufficient time available to implement this.

5 What were the major challenges so far in doing this adaptation work?

- the IES model is prone to simplification of understanding-many adaptations such as Albedo effect and cooling from plants and form ceiling fans, cannot be measured. This means that some of the accuracy is lost when making assumptions to substitute for actual data
- many reiterations were required of modelling as assumptions were refined and gremlins removed from the modelling
- the unknown aspects of future technologies and behaviour will require a degree of guesswork that will require this research to be frequently updated
- base data, such as weather files for Leeds, contains misleading information and requires adjustments of assumptions
- the learning for the whole team is greater than originally anticipated.

6 What advice would you give others undertaking adaptation strategies?

- a bunker day model to kick off the project and/or review the findings
- staged modelling strategy that allows environmental modelling results to be fed back into early design/ adaption strategies
- cross checking modelling assumptions with the whole design team and especially the FM team regarding how the building will be used, this is vital when considering future trends. Standard practice rules of thumb can be significantly different to how the specific building is expected to be used and will often have a huge implication on performance.

D4FC Factsheet 13:

Harnessing nanotechnology to combat climate change

Contact details

Name: Paul Williams

Company: Stanton Williams Limited

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General project information

Name of project:	Harnessing nanotechnology to combat climate change – using a multi disciplinary approach to design an effective adaptation solution for the built environment, initially through a case study project the new UAL campus at King's Cross London
Location of project:	King's Cross Central, London
Type of project:	Both new buildings and some Grade II listed structures
Cost of project:	About £120m

Project team

Client:	Central Saint Martins College, University of the Arts
Designer/architect:	Stanton Williams
Developer:	Argent Group, Kings Cross Central site developer

Other organisations involved (and their role): Atelier Ten (environment engineers), Nanoforce technology (materials research and development), Central Saint Martins College (researcher and designers)

Project description:

This interdisciplinary project is investigating the potential of nanotechnology and advanced material engineering to provide innovative and cost effective climate change adaptation solutions for future retrofitting. The case study project the Central Saint Martins (University of the Arts) King's Cross campus covers about 40 000sqm and is to be operational in September 2011. The building aims to be an exemplar for a 21st century learning environment. Great importance has been placed on ensuring the building embodies best practice in sustainable design and has been designed to allow maximum scope for adaptation.

The client brief requesting high flexibility of usage of space and best natural light provides clearly defined specific challenges and the team is exploring two main themes:

- how to capitalise on nanotechnology solutions to sustain/increase daylight capacity while reducing infra-red penetration into the building envelope during hotter summers
- how to capitalise on nanotechnology to increase thermal mass capacity during hotter summers.

The innovative aspect of this project lies in the interdisciplinary nature of the team, which brings together nanotechnologists, engineers, architects and designers at the same table. The client and end user is also integrated into the team.

Project timescales and dates

The case study project at King's Cross started construction on site in January 2009 (following enabling works) and is due for completion in July this year.

Design period: basebuild concept design work started in 2006. Planning/Listed Building permission was granted April 2008.

Operation and monitoring period: the aim is to monitor building performance over the next few years. The replacement of glass and ETFE is assumed at a later date. Key criteria should be to maintain the quality and colour of the light within environment of an arts college.

Further project details

1 **What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?**

- several different climate change models were reviewed and the team settled on the CIBSE future weather data predictions for London. Atelier Ten has undertaken a detailed analysis of the CIBSE future weather datasets to investigate the changes in temperature and other weather conditions and their efefcts on the CSM/UAL building
- identification of key opportunities for intervention in the King's Cross building were defined in the first mapping workshop.

2 **How have you communicated the risks and recommendations with your client? What methods worked well?**

- the consortium is benefiting from the contribution of an academic from Central Saint Martins College, who is also providing a communication channel to the head of college and other relevant individuals. This is one of the strong aspects of this project as the team benefits from the involvement of a group of students who will be future users of the building. A set of meetings with the Head of College was also agreed at the start of the project to ensure a two-way discussion around the future of the building.

3 **What tools have you used to assess overheating and flood risks?**

- this project was only looking at the overheating aspect of climate change in hotter summers. The focus was broken down into two specific challenges: management of light versus heat and thermal mass of the building. These are the challenging areas where nano technology can be used
- Atelier Ten conducted various modelling of adaptation technologies to the current constructions to evaluate how the building can be adapted in future. Computer modelling was used for heat/light distribution through one of the studios.

4 **What has the client agreed to implement as a result of your adaptation work?**

- as the technologies recommended are not yet commercialised and the strategy is for 2050 and further, they will not be adopted in the immediate future.

5 **What were the major challenges so far in doing this adaptation work?**

- how to maintain good colour rendering while reducing infrared, critical to an art college environment
- understanding what nanotechnology is and can offer (language barrier)
- communication of technological information and climate data to cross disciplinary consortium (language barrier)
- cost and reliability of new materials
- conservativeness of building industry in use of novel materials
- limited time for development of materials.

6 **What advice would you give others undertaking adaptation strategies?**

- having a focus and to be aware of the communication barriers because of working in a team from multi disciplinary backgrounds. Also having a cross sector consortium and working with individuals from different industries can be greatly beneficial in exploring new ideas and creating technology fusions while finding new applications for existing technologies.

D4FC Factsheet 14:

Climate Adaptation Plan

Contact details

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General project information

Name of project:	Climate Adaptation Plan
Location of project:	Metro Centre, Gateshead
Type of project:	Retrofit
Cost of project:	£10m (confidential)

Project team

Client:	Marks and Spencer Plc
Project manager:	Currie & Brown
Architects:	Darton EGS
Building services engineer:	Troup Bywaters & Anders
Quantity surveyor:	Gleeds
Structural engineer:	WSP
Refrigeration consultants:	Oaksmere

Project description

The project is to undertake a refurbishment of a retail store in the Metro Centre in Newcastle. The gross internal area is approximately 130 000 sq ft.

This will involve the first MEP (mechanical, electrical and plumbing) overhaul in nearly 20 years and includes replacement of plant, décor, flooring and some lighting, for example:

- new lighting systems and controls (except for food hall) And new concept lighting
- new MEP system for cafe (heat pumps boilers, ground source heat pumps). Aiming to decrease volume of air
- reduction of the food area
- replacement/addition of ceiling tiles
- extension of the M&S cafe (will be largest café in any M&S store)
- addition of fitting rooms
- connection of the new toilet and cafe drainage system to the current supply.

Project timescales and dates

April to November 2011

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- identify key climate vulnerabilities to generic M&S stores and infrastructure:
- assessing key climate risks using the University of Reading's Walker Institute to provide data on climate science
- speaking to various people within the wider business, eg business continuity, MEP team (mechanical electrical plumbing), risk management to understand the key vulnerabilities for the business
- identifying how these risks relate to the specific M&S store in Gateshead, through discussions with the design team.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- use of the M&S corporate risk matrix such that the climate risks are measured in the same way as other business risks
- undertaking cost benefit analyses wherever possible.

3 What tools have you used to assess overheating and flood risks?

- this has been done by the Walker Institute at the University of Reading to allow us to model specific scenarios, eg number of consecutive days over a certain temperature.

4 What has the client agreed to implement as a result of your adaptation work?

- we are still at the planning stage.

5 What were the major challenges so far in doing this adaptation work?

- understanding what the key business risks are and the company's current level of resilience.

6 What advice would you give others undertaking adaptation strategies?

- for corporate organisations, ensure you speak to the various business areas affected to assess key vulnerabilities and current resilience levels. This helps to ensure that any recommendations are commercially viable

- risks should be measured and recorded in the same way as other business risks to allow climate risk to be understood by the wider business.

D4FC Factsheet 15:
PortZED

Contact details

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General project information

Name of project:	PortZED
Location of project:	Shoreham Port, Hove, East Sussex
Type of project:	Mixed use (new build and retrofit) Code for Sustainable Homes Level 6 zero carbon new development comprising 67 residential apartments above ground and lower ground commercial space.
Cost of project:	£15m

Project team

Client:	BohoGreen (also the applicant and project lead)
Designer:	APZED (Alan Philips Architects and ZED Factory joint partnership)

Other organisations involved (and their role): ZEDFactory Ltd (design), Hemsley Orrell Partnership (HOP) (consulting engineers), Monson (flood risk assessment), Phlorum (contamination), Acoustic Associates (acoustic consultancy), Hayes Mackenzie (acoustic consultants), Bobby Gilbert & Associates (environmental consultants)

Project description

PortZED is a mixed use CSH Level 6 seafront development situated at the eastern end of Shoreham Port in the City of Brighton & Hove. The six elliptical shaped buildings are designed to maximise energy systems appropriate for this seafront location while creating a visually pleasing design characterised by the helical wind turbines.

The scheme comprises c.15 000 sq ft commercial space for offices, retail and community, and c.48 000 sq ft of residential space housing 67 highly sustainable residential apartments, all with balconies allowing flexibility for inside/ outside spaces in summer and winter.

Key to the PortZED development will be the visitor centre also housing the Green Business Hub. This will nurture green start-up companies as well as developing established businesses already in the area, and will provide a focal point and information resource for local environmentally active organisations while creating local employment opportunities.

Project timescales and dates

Design and assessment period (pre-planning): August 2006 to December 2010

Construction period (post-consent): autumn 2011 to autumn 2013

Operation and monitoring period: autumn 2012

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- using climate tapes and Bill Gething's adapting to climate change report, we assessed the site against various climate scenarios that could occur in the future. Some of these had more relevance than others. We chose a wide ranging set of parameters that would affect the building and designed in adaptation strategies so that various scenarios could be accommodated in the future. Any changes that led to mitigation were taken in the course of the design work.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- the design team informed the client of mitigation measures and these have been largely agreed at the design stage of the project. Regular meetings are held between the client and design team to discuss progress, risks and opportunities. We are in the process of establishing what mechanisms and more importantly, the size of equipment that may be required at a future date. The impact of these changes and a cost benefit analysis has been undertaken to inform the client.

3 What tools have you used to assess overheating and flood risks?

- we have requested a great deal of information from various authorities including the Environment Agency, OFWAT and future climate tapes
- it has been necessary to extrapolate some of this data from incompatible sources, and in other cases there has been no data available. In particular we will need to use energy plus modeling with future climate tapes for overheating, to determine when the installation of active cooling will be required in the building. We have already taken mitigation steps on shading and increasing the thermal mass of the units
- regarding the development's flood risk, we are using EA data to find out the risks to 2115 as stated in PPS15. We have looked at the areas affected and established scenarios of when the units can be adapted and at what point abandonment has to take place. Even in this case "wash through constructions" are being designed to enable the buildings to be inhabited as soon as flood waters recede
- a flood risk assessment has been carried out that follows the guidance in PPS25 and the accompanying practice guide (published in December 2009). Its format follows the FRA pro-forma included in the practice guide. Reference is made to the Environment Agency's flood maps and the Brighton and Hove strategic flood risk assessment.

4 What has the client agreed to implement as a result of your adaptation work?

- the client has agreed that all matters that are cost neutral or a cost saving will be taken within the project. Items that cost money will be assessed by a cost benefit analysis to ascertain the long term benefits and added value in terms of sales/rent. The business case for each item will be written and a decision taken on that basis compared to business as usual and potential damage from one of these weather events taking place.

5 What were the major challenges so far in doing this adaptation work?

- the scale of risk taken is difficult to establish, ie should the design take into account a 1 in 50, 1 in 200 or 1 in 1000 storm event on a current basis when climate change is accelerating? We have obtained a range of weather tapes to use in simulations but these are based on various climate change scenarios. It is easy to choose the most severe, but it is difficult to justify why this is required as opposed to more moderate scenarios
- a key challenge is where is the point at which the cost of the extra design erode the developer's profit so as to adversely affect its commercial viability
- the pace of technological advancements is another challenging aspect for example the size of ducts and other equipment allowed for now may not be the same in 50 or 100 years time.

6 What advice would you give others undertaking adaptation strategies?

- design out as many of the problems identified as quickly as possible in terms of mitigation. This will work out cheaper than allowing more space for future installation of ductwork and equipment that has a more adverse effect on the design and operation of the building. Any equipment chosen should be reliable in as much as there are very few technologies that exist in buildings today that did not exist at the time of the oil crisis in the 1970s.
- it is important to acquire enough data to justify to the client a return on the increased investment.


PortZED
Blooming Futures

D4FC Factsheet 16:
100 City Road

Contact details

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General project information

Name of project:	100 City Road
Location of project:	100 City Road, London
Type of project:	New build 15 storey speculative office block on City Road, London
Cost of project:	Undisclosed

Project team

Client:	Derwent London
Architect:	Allford Hall Monaghan and Morris (AHMM)
M&E engineer:	Arup
Contractor:	Yet to be appointed
Quantity surveyor:	Davis Langdon

Other organisations involved in project (and their role): Adams Kara Taylor II (structures) and Jackson Coles (project manager)

Project description

The Old Street Yard development consists of a new build 16 storey office building (known as the White Collar Factory), and a group of five lower rise mixed use buildings, combining new build with refurbishment. This project concentrates on analysing suitable adaptation options for the White Collar Factory office building (see Figure 1).

Ten additional adaptation options for the planning stage building design were identified at the beginning of the TSB funded phase of the project. These have each been modelled using a weather file for the current climate (Test Reference Year 2005), and weather files for the 2020s, 2050s and 2080s based on both the UKCIP02 and the UKCP09 high emissions scenario at the 90 per cent probability level.

The 10 adaptation options identified were as follows:

1 Relaxing thermal comfort criteria.
2 Limiting solar gains – shading.
3 Limiting lighting load heat gain.
4 Limiting computer equipment heat gain.
5 Modifying/optimising building fabric.
6 Adjusting thermal mass.
7 Adjusting room height and air distribution system.
8 Night time cooling.
9 Mixed mode ventilation.
10 Increased natural ventilation potential.

(note that these have been graphically illustrated in Figure 3).

For each strategy, the impact of future climate on energy consumption and comfort criteria within the buildings was analysed individually.

Outputs from these analyses have been used to make recommendations for consideration by Derwent London to potentially be incorporated into the actual building design.

Figure 1 Exterior visualisation of 100 City Road

Project timescales and dates

Design and assessment period (pre-planning): Feb 2010 to September 2010

Design and assessment period (planning): October 2011 – mid to late 2014

Construction of prototype/show suite building: completed February 2013

Operation and BMS (building management system) monitoring of prototype/show suite building: February 2013 to February 2014 with summer time environmental monitoring July 2013 to September 2013

Construction period: completion expected 2016.

Operation and monitoring period: start date to be determined

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- a workshop format was used to bring the original building team and the DfFC team together to identify the major climate change risks for the project. Potential overheating as a result of increasing external air temperatures was identified as the major risk for a building of this type in this location. This workshop was used to brief the team on projected climate change scenarios and impacts for London and on the concept design for White Collar Factory. Case studies of similar or comparable projects were also presented
- attendees included the Arup Buildings team and lead mechanical services engineer, the Arup environmental physics team and lead building physicist, and the AHMM architectural team. Sub-groups then discussed options for adaptation strategies on the project, with a plenary session to rank the suggested options and identify a package suitable for analysis. The adaptation package was then circulated to the team for final comment, and the chosen options taken forward for further analysis and modelling.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- the most effective method of communication of risks and recommendations with Derwent London is direct presentations to the client team
- for White Collar Factory, three presentations have taken place during the course of the TSB funded aspects of the project. The first took place in November 2010 to raise awareness of the project, set out the scope of the project to the client team, and collate suggestions about the adaptation options identified for analysis
- a second presentation took place on 10 May 2011 to summarise the methodology, report on the progress of the project and provide feedback on emerging analysis results
- a final presentation of recommendations was given to the client on 21 February 2012 for them to consider and take forward, where appropriate, on the actual planning stage building design
- the client team will also be given the opportunity to comment on the final draft TSB report before it is submitted on 31 July 2012
- we have found the three presentations an effective method of communicating with the client, as they

Figure 2 Interior visualisation of 100 City Road

stimulated genuine interest and generated useful feedback, questions, discussion and input to this and related ongoing projects
- information about climate change risks, the range of likely scenarios and possible adaptation options has been well received by the client. They are very interested in better understanding the implications of climate change for their building projects and are responsive to suggested adaptation strategies.

3 What tools have you used to assess overheating and flood risks?

To assess overheating risks the following software tools were used:

- IES Virtual Environment
- Oasys BEANS Suite
- Ansys CFX

The project focuses on overheating, as flood risk is not considered to be an issue for the site.

4 What has the client agreed to implement as a result of your adaptation work?

Following the third and final presentation to the client, two of the ten adaptation options are currently being developed further by AHMM at the client's request. These are:

- increase openable areas in the opaque area of the façade (not the glazed area so as to avoid additional solar gain) to enhance natural ventilation potential as analysis indicates an energy/comfort/cost-benefit, which could be realised now through modifying current designs
- investigate the potential to integrate external shading devices at a later date in the future as analysis indicated there was no energy/comfort/cost-benefit until the 2050s.

Since the TSB funded aspects of the project have concluded, the following climate change adaptation related activities have been undertaken by the client and the design team:

- construction of a prototype space/show suite for WCF building at Old Street Yard in February 2013
- use of prototype/show suite as event space and marketing tool for Derwent London
- development of site wide sustainability strategy for public space and roof areas
- further thinking about how best to meet BREEAM and LEED targets for water efficiency/management and biodiversity provision
- presentation to the London Climate Change Partnership (LCCP)/London Sustainability Exchange (LSX) Commercial Buildings event (3 December 2013).

5 What were the major challenges so far in doing this adaptation work?

Challenges at the start of the TSB funded aspects of the project included:

- the definition and agreement of a package of discrete adaptation options, that included 'realistic' variations on the planning stage building design, as well as more aspirational 'blue sky' options
- selecting strategies that hadn't been considered by the design team already, as the original design (with exposed thermal mass, embedded pipe work, opening windows, reduced glazing and tall floor heights) was already more resilient and better adapted to warmer temperatures than most buildings
- selecting and limiting the number of different future climate scenarios to analyse/weather files to use so that the results are informative and comparable yet concise and digestible.

Challenges towards the end of the TSB funded work on the project have been:

- to present all 10 of the individual analyses as a coherent package of adaptation options, with clear distillation of outputs and key messages to the client
- costing and valuing these analyses as the necessary level of detailed information for each option is limited at this stage of the building project.

Figure 3
Graphical illustrations of the 10 adaptation options analysed

6 What advice would you give others undertaking adaptation strategies?

Engage with, clarify and understand the client's vision for the project as early on as possible in the design process. Identify the targeted end-users and audience that the client is focusing on. This will effectively set the context for how and if any meaningful adaptation considerations and measures can be integrated into the project.

Focus on and communicate the reasons for undertaking analysis of climate risk, developing of adaptation options and strategies, and making decisions based upon them, namely:

1 Legislative and regulatory drivers for doing it (have to), ie Climate Change Act 2008, CLG Building Regulations, Local Planning Authority requirements.
2 Financial drivers for doing it (should do), ie capital costs versus operational savings, retaining market value of assets over time, reduced exposure to risks.
3 Reputational and responsibility drivers for doing it (want to), ie 'USP', good risk/asset management, marketing material, attracts responsible buyers/tenants, contributes to well-being, productivity and satisfaction of owners/occupants.

Think about the comfort, energy, carbon and cost relationships for all adaptation options and strategies for addressing overheating risk.

Think scientifically and seriously but also creatively and visually. Adaptation measures need not constrain design ambitions nor limit design flexibility if risks and opportunities are considered early on and ideas are presented coherently and convincingly to the project team.

Recognise that strategies can be operational or management focused and may not physically affect a design or structure.

If possible and feasible, build a mock-up or prototype of any new spaces or systems before building at full scale and cost to test design assumptions and results of modelling analysis.

Integrate thinking about building engineering and design into wider sustainability strategies for site and surrounding public spaces.

D4FC Factsheet 17:
Harris Academy, Purley

Contact details

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General project information

Name of project:	Harris Academy, Purley
Location of project:	London
Type of project:	New build and retrofit
Cost of project:	About £20m

Project team

Client:	Willmott Dixon (applicant's client)/ Harris Federation and London Borough of Croydon (final client)
Designer:	Aedas Architects
Contractor:	Willmott Dixon Construction (Cobham)

Other organisations involved (and their role): Aedas R&D (applicant) VZDV (MEP) (applicant) VZDV (MEP)

Project description

The aim of this project was to carry out research on a live construction project to evaluate climate change risks up to the end of the century and implement an adaptation strategy to address these risks. The architects of the project were Aedas, working alongside the mechanical engineers Van Zyl & de Villiers and contractors Willmott Dixon. The end user was the Harris Federation whose architectural brief included the refurbishment of an existing school building as well as the construction of new-build school blocks.

The research team joined the main project at the detail design stage with a brief to investigate practical recommendations for design adjustments that were cost and programme neutral. A range of impacts were investigated in the areas of thermal comfort, construction resilience and rain water management. The study built on recent research in occupant expectations, thermal modelling methodologies as well as the results of evaluations carried out for five schools as part of the TSB's Building Performance Evaluation Programme.

Project timescales and dates

Design and assessment period (pre-planning): November 2010 to February 2011

Construction period (post-consent): March 2011 to September 2012

Operation and monitoring period (not confirmed): January (2014)

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- thermal comfort was identified as a priority with particular emphasis on reducing the risk of overheating. The research team used the UKCIP02 'low carbon emissions' scenarios to study how 'minimal' changes to external temperatures will impact on current design solutions. This approach was used to communicate to the client that should the building overheat under the 'best case' future scenario, it will likely overheat under all future climate predictions
- existing solutions for natural ventilation were reviewed with the main design adaptation measures investigated including glazing performance, thermal mass and 'ventilation free areas'
- the research demonstrated that under future scenarios, when assessed against BB101 and BREEAM overheating criteria, individual design changes were unlikely to be sufficient in preventing overheating. Only a combination of all proposed adaptation options would meet the overheating criteria used to assess school buildings, even for the most optimistic future emissions scenarios.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

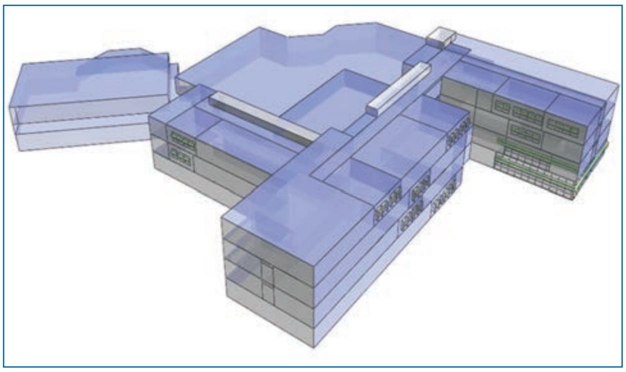
- the research team attended numerous design team workshops to understand the context of the project programme and made both formal and informal recommendations. The team also worked closely with the building services engineers to develop a research thermal model to allow the study to run in tandem with the contract work
- using the most optimistic future emissions scenarios, a case was made for the recommended adaptation measures to be retained by the contractors as a minimum requirement. This approach may be suitable for other projects when entered at the detail design stage and where short-term financial priorities override long-term risks
- the impact of issues related to building management was also studied. Under future climate scenarios, these aspects will bear increasing importance alongside design adaptations. Furthermore, the researchers carried out interviews and surveyed the project team and the school's pupils to gauge the views of designers and occupants on their subjective experience of overheating and views of various adaptation measures. This naturally extended to engagement with pupils and staff in the academy.

3 What tools have you used to assess overheating and flood risks?

- flood risks were not considered a risk item due to the geography of the site. The research team therefore focused primarily on overheating and used IES software to create a separate 'research' thermal model from the contractual thermal model. The model was used to test potential adaptation options under future climate scenarios.

4 What has the client agreed to implement as a result of your adaptation work?

- The research team's recommendations were only partially adopted, however, a significant improvement from the original design items to those procured was evidenced. Advice based on a predicted increase in rainfall levels and one in one hundred year storm scenarios directly influenced the size and number of rainwater outlets specified. Ventilation free areas were also improved. The recommended increase of the high level top hung window opening distance to 400mm was adopted, whilst a 250 mm opening distance was ensured to the low level openable windows. Glazing g-values did not meet the recommended value of 0.32, however, were improved from 0.4 to 0.37 with no additional capital cost to the project. Internal finishes moved from lightweight plasterboard construction to heavier density fibreboard but not to the recommended cementitious board. The design team made a robust defense of maintaining the proposed floor to floor heights, which in theory would allow for the adoption of mechanical ventilation in the future. The argument was that a lower floor to floor height could render the building uncomfortable in 20 to 30 years, should ambient temperatures rise significantly within the design life of the building. The team also looked at the way in which resilience issues were addressed by current design standards. In particular, the team analysed the sensitivity of the overheating results to unregulated energy use. The impact of a range of internal gains and hampered night ventilation were studied. The results indicated that the impact of these are potentially greater than the improvements that can be achieved by the chosen adaptation measures. This highlighted the importance of considering climate change early on in the design process and agreeing on realistic modelling assumptions in both the current and future climates. The question remains whether a more robust analysis method that includes the impact of occupancy should be developed to ensure that buildings are more resilient to climate change.



5 What were the major challenges so far in doing this adaptation work?

- as the core research team was based within an architectural practice, a research thermal model of the building was required to be built as intellectual property rights prohibited the building services engineers from sharing their contractual thermal model. Adaptations and risks were tested in the research model before being simulated in the contract model by the building services engineers. While this process proved useful for the core research team in understanding the intricacies of the design adaptations, it was timely and required assistance from a simulation specialist. This highlights both the need for transparency of computational models within the industry and the need for custom simulation tools of reduced complexity that cater for the needs of architects
- Furthermore, the pressured programme and cost driven value process coupled with minimum briefing requirements set by design guidance and regulatory standards has made the adoption of some of the recommendations difficult.

6 What advice would you give others undertaking adaptation strategies?

- this research commenced almost one year after outline proposals were submitted and part way through the detailing stages of the building procurement process. The limitations of joining the project at this later stage were that early design and briefing decisions could not be influenced. Early communication with the client, of the significance of future climate adaptations, is also important in order to fully incorporate an adaptation strategy into the contract and design workflow. It is therefore recommended that future climate adaptations studies begin at the briefing stages of a project. Nevertheless, this research has demonstrated that the basic design assumptions of a project can be re-assessed at the detailing stages and successfully integrated into a future climate adaptation strategy. Despite budget restraints, this has enabled critical features, such as the glazing specification and internal finishes, to be improved
- a primary benefit of the work has been to increase the overall awareness and understanding of this subject across the practice. The research was led by architects who worked closely with researchers from University College London (UCL), building services engineers VZDV and cost consultants Davis Langdon. A key lesson has been the value of such collaborations for live design projects and the need for issues such as climate change to be approached from a multi-disciplinary perspective
- this project has helped highlight how increased transparency with regards to product performance and modelling techniques can assist efficiencies within the build process. The importance of suitable occupant engagement, maintenance and management systems in providing robust buildings in use, moving into a future climate, has also been a key lesson.

D4FC Factsheet 18:
Welland Primary School

Contact details

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General project information

Name of project: Welland Primary School

Location of project: Peterborough

Type of project: New build

Cost of project: £6.3m

Project team

Client: Peterborough City Council Children's Services

Project manager: Rider Levett Bucknall

Client advisors: Enterprise Peterborough and AECOM (during early design)

Contractor: Kier Eastern

Mechanical and electrical engineers: Mott McDonald (through Kier Eastern)

Structural engineers: PEP Civil and Structures (through Kier Eastern)

Architects: Woods Hardwick (through Kier Eastern)

Landscape architects: ACD Landscape Architects (through Kier Eastern)

Cost consultants: Davis Langdon AECOM (through Kier Eastern)

Project description

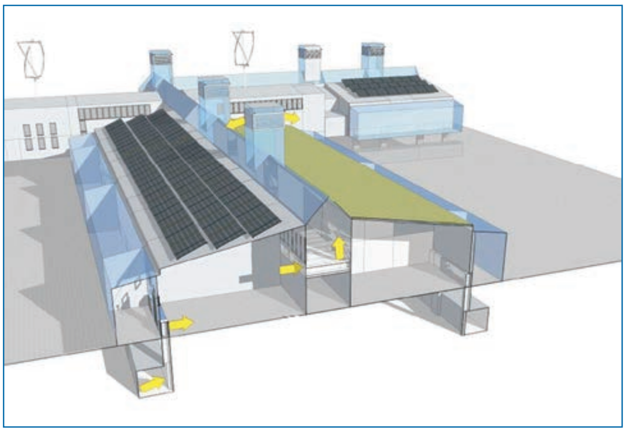
The redevelopment plan for Welland Primary School was to replace an existing school with a completely new building within the current school boundary, but with doubled teaching accommodation. Further to the 'conventional' design work, this project examined the possible impacts of projected climate change on the new building. Following on from the findings, adaptation strategies and related design options for the building were suggested. Whole life costs for the various design options proposed to address the relevant climate change risks were then estimated. To justify the 'business case' for adapting the design to take account of climate change, comparisons were made between the performance and whole life costs of a number of case studies based on adapting the design at various RIBA workstages.

Project timescales and dates

Design and assessment period (pre-planning): January 2010 to March 2011

Construction period (post-consent): June 2011 to August 2012

Operation and monitoring period: September 2012 onwards



CIBSE Engineering a sustainable built environment

Technology Strategy Board Driving Innovation

Knowledge Transfer Network Modern Built Environment

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- during the conceptual stage, principal risks for the building location were identified from the report *Design for future climate: opportunities for adaptation in the built environment*
- the following climate change related risks were assessed to be significant: overheating of internal spaces during summer, the outdoor environment, heating system design, structural stability of foundations, structural stability above ground, durability of construction materials, and above and below ground drainage. In addition, water conservation measures were considered.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- the 'business case' for adaptation to address climate-related risks was presented using detailed design case studies that included whole life costs. The detailed findings were also summarised in a short report using less technical language to assist with communicating the results.

3 What tools have you used to assess overheating and flood risks?

- for overheating, ClassCool and ClassVent (**www.teachernet.gov.uk/iaq**) were used to set the initial strategy and then *Virtual Environment* 6.2.0.1 from Integrated Environmental Solutions was used for detailed modelling, along with weather data from the Prometheus project based on UKCP09 projections
- flood risk was not considered as part of this project.

4 What has the client agreed to implement as a result of your adaptation work?

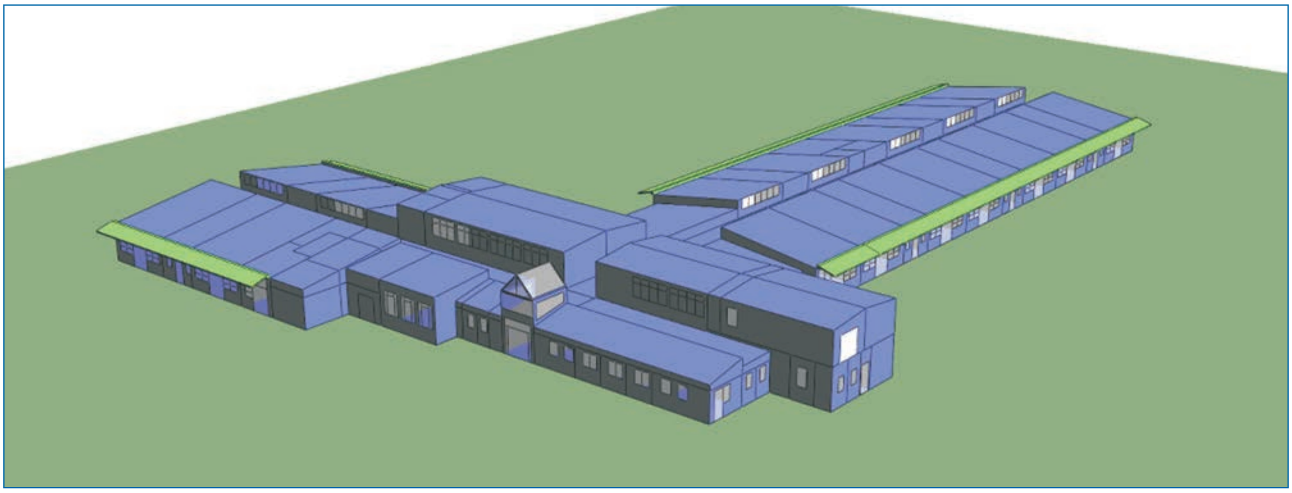
- from the start, it was agreed with the client to incorporate certain adaptation measures in the design, but it was not originally intended to explicitly evaluate them in terms of a business case
- as permitted by the overriding requirement to open the new building on schedule, the project has adopted a number of design features that provide a reasonable degree of climate change adaptation.

5 What were the major challenges so far in doing this adaptation work?

- lack of industry standard guidance on how to assess the various climate change related risks for the design
- the UKCP09 projections were not entirely consistent with the data needed to set design assumptions. For example, average rainfall values are presented in UKCP09, while extreme values are needed for design
- the 'integrated' approach taken has been more challenging in practice than anticipated at the project outset. Each climate change risk may require adaption measures to be introduced for more than one design issue. This has included the necessity to create or standardize terminology and draw out interactions, common aspects or differences between the various design considerations.

6 What advice would you give others undertaking adaptation strategies?

- it is recommended that that the climate change related risks to be addressed in a design should be agreed as early as possible and assessments then carried out immediately: RIBA Stage C would be ideal, although some implications may not become apparent until more detailed design information becomes available
- certain design adaptations may have no or low impact on overall construction costs. But, to achieve this generally requires proper consideration at an early stage
- early client agreement is necessary about the extent to which each climate change related risk should be mitigated, as constrained by the available budget
- it is sometimes possible to defer adaptation to later in the building life cycle, for example during routine replacement of building components
- the whole life cost implications of adaptation and any residual risks should be assessed alongside design options to provide additional information with which to evaluate those options.



D4FC Factsheet 19:
11–16 Phase School

Contact details

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Company: Building Design Partnership

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Tel: 01179 299 881

General project information

Name of project: 11–16 Phase School

Location of project: The Works, Ebbw Vale, Blaenau Gwent, Wales

Type of project: New build school for 1200 students

Cost of project: Circa £27m

Project team

Client: Blaenau Gwent County Borough Council

Designer: Building Design Partnership (Multi-Profession)

Contractor: Willmott Dixon

Other organisations involved (and their role): Davis Langdon (cost planning and project management), ARUP Fire (fire strategy), David Bonnet (access consultants)

Project description

As part of the wider redevelopment of the former steelworks site at Ebbw Vale in Blaenau Gwent, BDP has been commissioned to design the 11–16 Phase of the 3–16 School within the framework of the masterplan carried out by Alan Baxter Associates. The new build school is designed for 1200 students and will be regarded as an educational resource with regard to sustainability, promoting a positive environmental curriculum. The building design comprises four main elements: a series of two-storey teaching "clusters" running north/south, a central heart space (main hall and dining), a linear hub and LRC space and a three-storey "ribbon" building containing the specialist teaching facilities facing the main street.

Project timescales and dates

Design and assessment period (pre-planning): January 2010 to May 2011

Construction period (post-consent): March 2012 to July 2013

Operation and monitoring period: TBA

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- our approach draws from the UKCP09 future climate projections to identify the future hazard combined with current local climate impacts, exposure of the site and potential building features that may ameliorate or exacerbate future impacts, and understanding of the vulnerability of people who would occupy the school. Potential risks identified include overheating and flooding. The risks then led to the identification of adaptation measures appropriate for tackling these risks that consider the details of the site, potential exposure, the occupants of the school, and minimisation of potential CO_2 emissions as a result of development.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- our client has fully supported our involvement with the TSB research project and has been kept regularly up to date during each RIBA stage. At the end of each stage, following the submission of a multi-professional report and drawing set there has been a presentation to the client and stakeholders. It has been during these presentations that both have been informed of progress and likely recommendations
- regular updates to the client during design team meetings have worked well as a way to keep the client informed and able to be part of the ongoing process. The meetings include the design team, construction team and cost consultants which has enabled the issued to be discussed in the detail required in order for the client monitor the research.

3 What tools have you used to assess overheating and flood risks?

- overheating has been assessed using IES (virtual environment) software.
- flood risk is likely to be assessed using WinDes software with revised rainfall data.

4 What has the client agreed to implement as a result of your adaptation work?

- the client is currently in the process of evaluating the cost of the project with the design and construction teams. They have requested that further cost analysis is carried out (by their own team) before any further decisions are made. However, we can confirm that the recommendations regarding the envelope design are to be fully adopted.

5 What were the major challenges so far in doing this adaptation work?

- our challenge to date has been aligning the programme of the initial research element of our work with the main project programme and budget constraints
- during the latter stages of the design the challenge has been the increasing financial pressures restraining the client with regards to capital expenditure. It is a difficult time to encourage further spending despite the predicted long-term benefits.

6 What advice would you give others undertaking adaptation strategies?

- the process is ongoing and we feel that it is appropriate that advice should be offered at a future stage of the project build.

D4FC Factsheet 20:
Technical Hub @ EBI

Contact details

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General project information

Name of project: Technical Hub @ EBI

Location of project: Hinxton, near Cambridge

Type of project: New build, providing office and studio space, training suites and communal space

Cost of project: £23m

Project team

Client: The Wellcome Trust, European Bioinformatics Institute

Designer: Abell Knepp

Engineering and sustainability: AECOM

PM/cost consultants: Turner & Townsend

Project description

The Technical Hub @ EBI will deliver a productive and enjoyable workplace for 225 staff. The requirement is for office space suitable for computational research work, with appropriate internal and external networking and training capacity.

The Hub is part of the Masterplan for the Wellcome Trust Genome Campus near Hinxton in South Cambridgeshire.

In addition to the office accommodation, the Technical Hub will provide a training suite and a bioinformatics translational suite to allow collaborative working between researchers. An extension to the existing Cairn's Pavillion is also included in the proposed design.

The building was designed to achieve BREEAM Excellent. The M&E strategy included air conditioning and considerable external shading in order to meet Part L 2010 of the Building Regulations requirements.

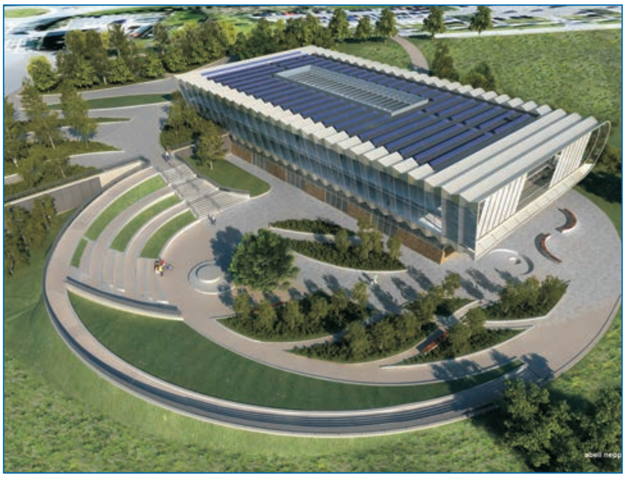
The River Cam runs along the campus however the Hub building is located outside the river flood zone.

Project timescales and dates

RIBA Stage D: 2011

Construction period (post-consent): TBD

Operation and monitoring period: TBD



Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- AECOM's adaptation methodology was applied to the proposed design. The key climate impacts for the building and its wider context were identified, using background information, UKCP09 and EA flood maps
- there was then a considerable amount of work undertaken to develop a methodology that allowed the application of the UKCP09 projections in modelling for overheating and flooding. Once this was established, a series of adaptive measures were compared to the baseline (current) design to develop an understanding of their effectiveness
- a limited number of measures were required due to the high quality of the baseline design. The results have been analysed
- an adaptation strategy was developed, with recommendations of measures to include in the design and actions to consider in the medium and longer term.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- we used a basic 'risk framework' to communicate with the client and the design team about climate risks relevant to the building
- we have provided interim updates and have presented the final adaptive recommendations to the client and design team upon completion of the modelling and costing work
- the risk framework worked well as it is a simple and familiar concept.

3 What tools have you used to assess overheating and flood risks?

- IES Virtual Environment thermal modelling software
- Prometheus weather files (based on UKCP09)
- in-house modelling tool for assessing flooding (developed by one of our PhD researchers).

4 What has the client agreed to implement as a result of your adaptation work?

- our assessment and modelling found the building to be well designed and in a favourable location resulting in limited risks associated with climate change
- the only 'hard' measure recommended for integration in the design was an improvement in the lighting specifications to reduce the very limited potential overheating risk. The client decided not to change the lighting specifications at the present time as the temperature benefit was too small to lose the advantage in ease of supply and maintenance associated with consistent lighting specifications across the whole campus. The client may however choose to upgrade the lighting specifications across the whole campus once the light fittings start needing replacement

Original building state

[00] Basecase building in current climate condition (6190baseline)

	Location	Dry resultant temperature (°C) - % occupied period in range > 24	> 25	> 26	> 27	> 28	> 29	> 30	> 31	> 32
North	R1	86.1%	30.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R2	57.5%	1.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R3	56.1%	14.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R4	73.5%	6.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R5	75.4%	5.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R6	75.3%	5.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R7	75.7%	5.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R8	74.8%	5.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R9	73.7%	4.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R10	71.5%	4.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R11	60.5%	6.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R12	59.1%	9.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R13	56.4%	5.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R14	69.4%	7.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R15	69.2%	7.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R16	67.8%	9.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R17	69.5%	7.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R18	69.5%	7.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R19	69.6%	7.7%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R20	66.1%	10.6%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
East	R21	55.6%	23.2%	2.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
	R22	58.3%	31.7%	5.0%	2.1%	1.0%	0.5%	0.3%	0.1%	0.1%
	R23	64.9%	16.8%	3.2%	1.4%	0.5%	0.4%	0.1%	0.1%	0.1%
	R24	65.3%	15.1%	3.2%	1.3%	0.5%	0.2%	0.1%	0.1%	0.0%
	R25	58.7%	16.0%	2.9%	0.9%	0.2%	0.0%	0.0%	0.0%	0.0%
	R26	70.9%	31.6%	5.4%	2.9%	1.5%	0.8%	0.6%	0.5%	0.3%
	R27	69.8%	30.3%	5.2%	2.9%	1.5%	0.8%	0.6%	0.5%	0.3%
South	R28	33.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R29	52.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R30	52.6%	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R31	46.4%	0.5%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R32	81.2%	15.4%	0.4%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
	R33	81.8%	15.4%	0.5%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
	R34	82.0%	15.4%	0.5%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
	R35	81.7%	15.4%	0.5%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
	R36	81.4%	15.3%	0.4%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
	R37	79.2%	16.5%	0.4%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
	R38	75.0%	13.1%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R39	67.8%	15.3%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R40	76.7%	21.7%	2.4%	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%
	R41	78.5%	20.2%	2.4%	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%
	R42	78.5%	20.4%	2.3%	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%
	R43	78.6%	20.3%	2.4%	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%
	R44	78.2%	20.3%	2.4%	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%
	R45	78.4%	20.2%	2.4%	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%
	R46	72.5%	20.2%	1.5%	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%
West	R47	73.7%	21.3%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R48	53.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R49	45.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R50	58.3%	18.1%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	R51	63.3%	25.1%	3.7%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
	R52	54.7%	4.7%	0.5%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
	R53	56.8%	21.9%	2.7%	0.9%	0.2%	0.0%	0.0%	0.0%	0.0%
	R54	63.0%	30.4%	6.9%	1.5%	0.1%	0.0%	0.0%	0.0%	0.0%
	R55	56.8%	18.2%	1.8%	0.6%	0.3%	0.1%	0.0%	0.0%	0.0%

- the impact of affecting users' perceptions and behaviour resulting in the acceptance of higher internal temperatures was considered. The modelling showed that considerable energy and carbon savings can be achieved by changing the cooling set point to a higher temperature. The client was interested in this outcome and will consider the implementation of such a change during the operation of the building.

5 What were the major challenges so far in doing this adaptation work?

- maintaining strong communication with the modellers has been extremely important due to the amount of work involved. Defining 'where to stop' is very important as there are many simulation opportunities but it can be difficult to judge their added value
- with such a high quality design it has sometimes been difficult to assess the true impact of adaptive measures as the baseline is quite high
- keeping active engagement with the design team has been challenging. They were working to their programme that couldn't be stopped or slowed down to give full consideration to the outcomes of the adaptation work.

6 What advice would you give others undertaking adaptation strategies?

- ensure that adaptation issues start being considered at early design stage (Stage B ideally)
- ensure that the design programme includes enough time to allow the adaptation modelling to take place and feed into the process.

D4FC Factsheet 21:
The Mill

Contact details

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General project information

Name of project:	The Mill (with the Welsh Assembly Government)
Location of project:	Cardiff
Type of project:	Masterplanning and architectural advice on a demonstration project located in Cardiff with the outcome of a guidance document and design adaptations to be implemented by the preferred bidding team
Cost of project:	£100 000 consultancy project, construction value £100m

Project team

Client:	The Welsh Assembly Government
Designer:	White Design Associates

Other organisations involved (and their role): The Welsh Assembly Government (client for 'The Mill' land disposal and coordinating the outputs from the adaptation research and disseminating these to the bidding teams), Forum of the Future (climate scenario development and advisor on strategic responses to climate change), Faithfull and Gould (cost consultants), Savills (legal, contractual and financial advisors)

Project description

The project parameters were established using FFtF and UKCIP scenarios based on a 'changing world' adopting the 2050 medium emissions scenario and an 'extreme reality' 2080 high emissions scenario. Workshops with the adaptation team, the Welsh Assembly Government and Cardiff City Council were held to establish the climate priorities of the study and whether these can be addressed through design adaptations on 'The Mill' site.

The study addressed both physical and behavioural changes that may be necessary to make the community more resilient in the face of climate change and suggest urban design and architectural measures to be implemented at the design stage.

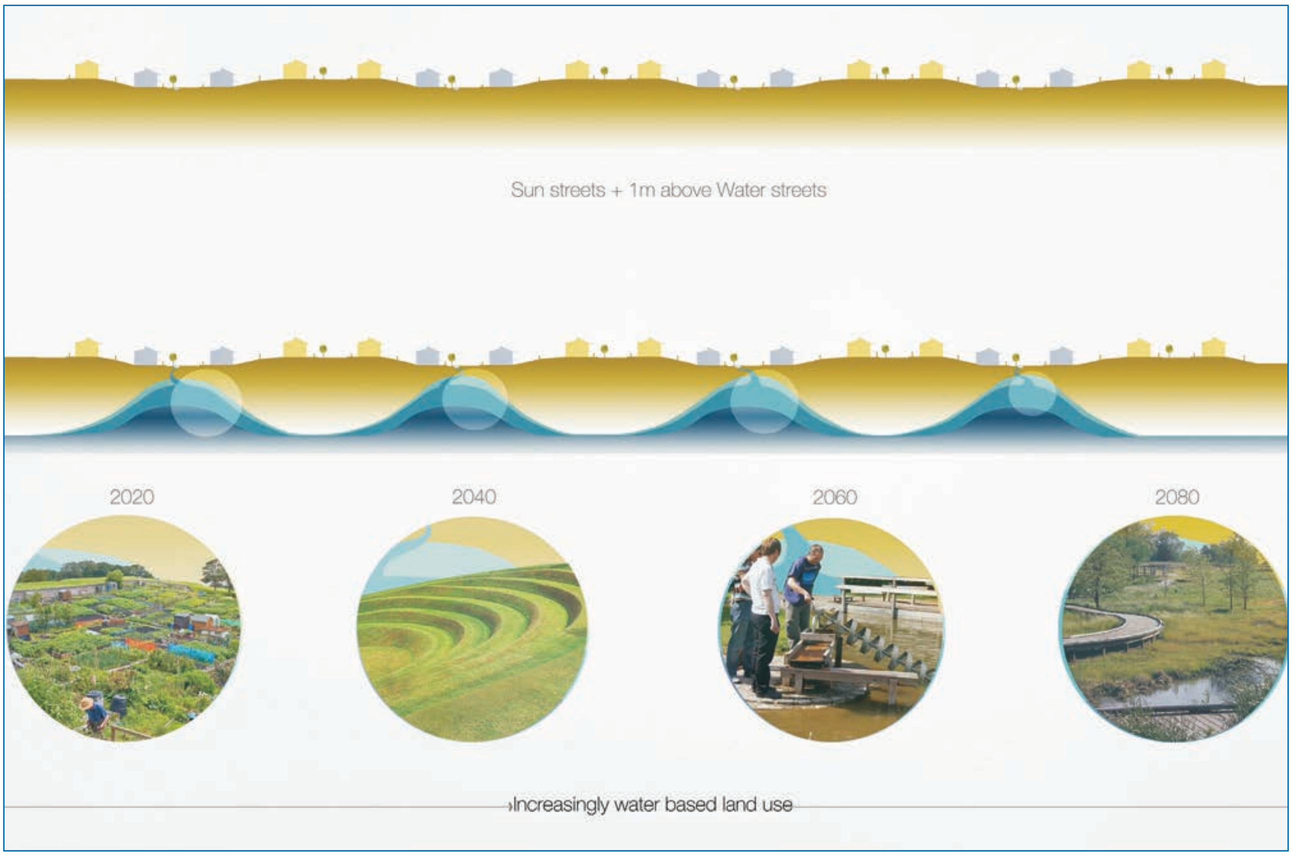
The design adaptations were assessed by the team to ensure policy consistency, value for money and contractual compliance.

The design code for the Mill appended with a new 'future design code.' These design code measures are being evaluated at present.

Project timescales and dates

Design and assessment period (pre-planning): initial research and scenario testing four months to June 2011

Bidder process halted due to changes in public sector policy and the site disposed of via private sale. This has delayed the production the design code measures to Spring 2012. The Future Design code was completed at the end of May 2012. A series of dissemination events in Cardiff, Bristol and London were held between January and May 2013.



Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- Forum for the Future identified key issues to be addressed for two potential future scenarios using the UKCIP data. FFtF analysed the potential risks and presented 12 themes and possible outcomes from these climate scenarios at a workshop held in February 2011 with the wider research group. The climate risks were then prioritised according to the design codes ability to influence design adaptations within 'The Mill' site boundary.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- the February 2011 workshop was held over a day and a half and included key members of the Welsh Assembly Government, Cardiff City Council and UKCIP
- the research team presented the 2050 to 2080 scenarios and then undertook workshops to discuss and prioritise the risks
- the team presented real time scenarios using comparable climate data from Southern Europe and America and Australasia to illustrate the possible precedents for future in changes to the natural and built environment
- the design code measures were drafted and circulated to the wider team and client
- a subsequent workshop was held in April 2012 to review the design code measures in relation to both the design impact and the cost associated with each measure as a percentage of the overall build cost.

3 What tools have you used to assess overheating and flood risks?

- overheating was assessed using EIS software at an individual house scale
- an Environmental Impact Assessment was undertaken for the outline planning application and the flood risk has been assessed and recommendations have been made for flood levels on the site
- the 2050 scenario is provided for by the outline planning flood risk assessment. Regional strategies will be required to address the flood risk connected to the 2080 scenario as this would affect Cardiff City as a whole and large scale regional responses cannot not be included in this study. However, the proposed water management strategy on the site provides additional storm water storage and Ely River edge capacity.

4 What has the client agreed to implement as a result of your adaptation work?

- the study prioritises the aspects of the WAG client led design code that demands a code level 5 development and zero carbon energy infrastructure. It will emphasise those aspects of the design code that both provide the potential for adaptation to future climate scenarios and the work will form part of the Design Code setting benchmarks for design and performance on the site
- the client is supporting our approaches to the new potential private developer to attempt to implement the adaptation measures
- the second part of the study tested which adaptation measures could be considered viable by the

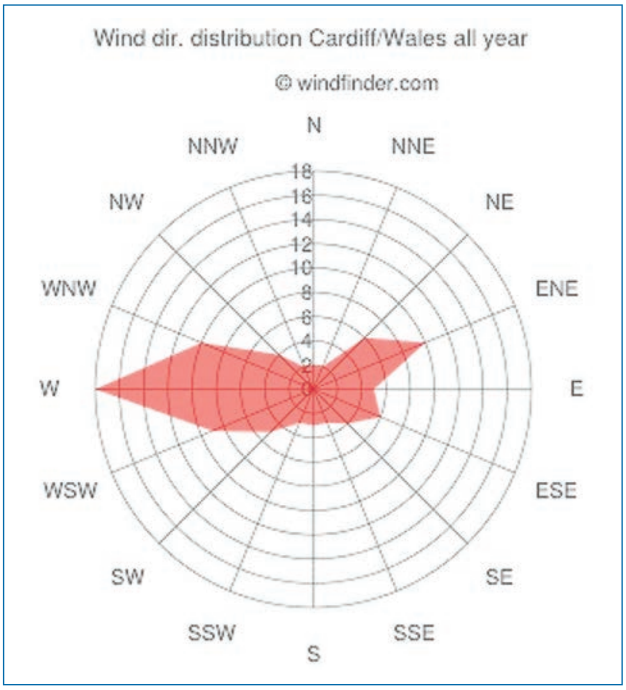
development consortia in addition to those prioritised within the existing design code.

5 What were the major challenges so far in doing this adaptation work?

- the two climate scenarios have potentially different, and at times conflicting, design responses required at a strategic and an architectural detailing level. The study needs to address both possible outcomes, however, the diverse set of requirements present a challenge
- the real time climate data studies have shown that a direct comparison to the 2080 dataset is difficult, at present, no direct comparison can be found. This may indicate that the scenario is unprecedented and therefore currently available architectural strategies may need to be modified.

6 What advice would you give others undertaking adaptation strategies?

- a wide range of input is required to achieve results in a short timeframe and early advice and discussion with key team members is crucial
- workshops are a valuable source of direct feedback and enable complex ideas and levels of information to be discussed at length. It is particularly useful for prioritising the inputs and evaluating proposals
- partnering with a university or engineering company to assess both wind effects, masterplan heat patterns and individual building responses would be beneficial to refine the strategies
- we have found that the design influences the resilience more than bolt solutions and that by embedding flexibility in the layout and buildings allows the users to adapt to many climate scenarios.
- the success of this type of work is dependent on the values of the client and there are client groups who welcome the adaptation measures.
- many suggested adaptations are in fact today's best practice and is therefore familiar and quantifiable. This is a good starting point for discussions with developers.



D4FC Factsheet 22:

The Royal Academy for Deaf Education

Contact details

Name: Mark Skelly

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General project information

Name of project: The Royal Academy for Deaf Education

Location of project: Exeter, Devon

Type of project: New build

Cost of project: £18.1m

Project team

Client: The Royal Academy for Deaf Education Exeter

Designers: dRMM Architects and Skelly & Couch LLP (M&E, environmental and sustainability)

Contractor: Not yet appointed

Other organisations involved (and their role): The Royal Botanic Gardens, Kew, University of Kent, Ansys UK Ltd

Project description

The project is to rebuild a residential through school (preschool to further education) for profoundly deaf children and young adults, including additional services and facilities to support the deaf community. The main academy building is to be a new build single volume form, comprising of 6000 m² over the three levels.

The accommodation is provided underneath an ETFE/timber gridshell umbrella that unites the students of all ages under a single roof around two landscaped courtyards. Beneath the gridshell, the form of construction is anticipated to be an in situ concrete "table" with a below ground air labyrinth integrated into the substructure to provide pre-heated and pre-cooled air to the occupied areas of the tempered courtyards. A separate student housing building on the other side of the learning campus provides 120 beds in a single volume that is articulated with a roofline to resonate the terrace typology.

Project timescales and dates

Design and assessment period (pre-planning): June 2011 to January 2012

Construction period (post-consent): November 2012 to June 2014

Operation and monitoring period: July 2014 to July 2017

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- the start of the study has been delayed by the need to change the site for the building due to an issue with closing out the purchase of the original site and the fact that the new site is still subject to lengthy negotiations. We have not yet started this part of the study, however, our initial pre-study estimates are that the main risks will be:
    - a 3°C or 4°C rise in average annual, summer and winter temperatures, which increases the risk of overheating in all of the building spaces, particularly underneath the lightweight gridshell canopy
    - a 20 per cent reduction in summer rainfall, which reduces the water available for irrigation of the plants needed to keep the building cool in the summer
    - a 20 per cent increase in winter rainfall, resulting in potential stormwater flooding issues on site and potential flooding of the labyrinth, and potential increase in rain noise under the canopy
    - higher wind speeds that expose the large opening vents on the roofs to larger loads
- we propose to assess likely range of these risks and quantify the potential impact for the client using modelling and regression techniques couple with the use of linguistic fuzzy logic terms
- we will then look into mitigating measures for each level of risk.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- we are yet to reach this stage.

3 What tools have you used to assess overheating and flood risks?

- we are proposing to use a dynamic thermal and energy modelling tool produced by EDSL called TAS
- in addition we propose to model the main volume under the grid shell using Ansys' Fluent CFD software. This model will look at air and moisture movement and temperature variations in the space
- finally we will model external landscaping options using a microclimate modelling tool.

4 What has the client agreed to implement as a result of your adaptation work?

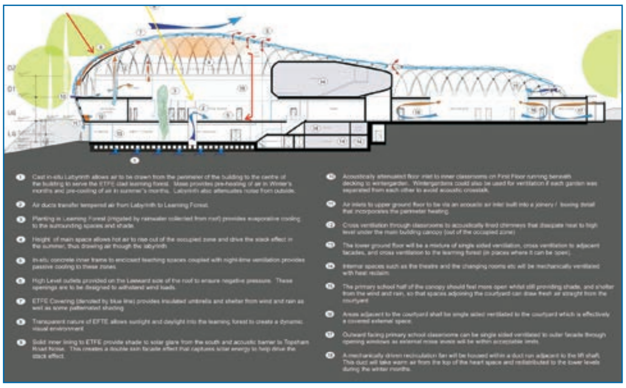
- we are yet to reach this stage. However, previous iterations of the design have resulted in the inclusion of the thermal massive internal structure, extra height to the grid-shell to help remove the hot air, the thermal labyrinth and the use of planting.

5 What were the major challenges so far in doing this adaptation work?

- our main challenge to date has been the change of the site a few months after securing the funding. The land purchase of the new site and the client's understandable reluctance to commit funds to progress the building design on this new site until the land purchase is secured and the subsequent delay to our start.

6 What advice would you give others undertaking adaptation strategies?

- the advantage of the project moving site is that it shall result with a completely new look at the building form and fabric. This will give us the opportunity to have more of an impact on the design that previously expected, so we would recommend that they try to do their studies at as early a stage as possible in the design process.



D4FC Factsheet 23:

New Admiral Insurance Headquarters

Contact details

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General project information

Name of project:	New Admiral Insurance Headquarters
Location of project:	Cardiff
Type of project:	New build office
Cost of project:	About £25m

Project team

Client:	Admiral Insurance c/o Stoford (Cardiff) Ltd
Designer:	Glenn Howells Architects
Contractor:	TBC

Other organisations involved (and their role): BRE, BRE Trust/Cardiff Uni, Arups, Hoare Lea

Project description

Based on the new build office development of 200 000 sqft for Admiral Insurance's headquarters (FTSE100 company), a 90 year adaptation plan using client, design and agents to ensure uptake and wider industry dissemination

Project timescales and dates

Design and assessment period (pre-planning): currently in for planning; this period just starting for the project

Construction period (post-consent): not started

Operation and monitoring period: not started

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- the building is being modelled in a future climate (2100) and checked, then the changes rolled back to present day, with each step towards current day having the changes checked to see if they are still required.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- not yet undertaken. A workshop will be held with the client group to agree what the changes to the building should be, and through involving the client this should communicate both risks and recommendations.

3 What tools have you used to assess overheating and flood risks?

- the building has been modelled using IES for the overheating assessment, using climate files from the Exeter University project.

4 What has the client agreed to implement as a result of your adaptation work?

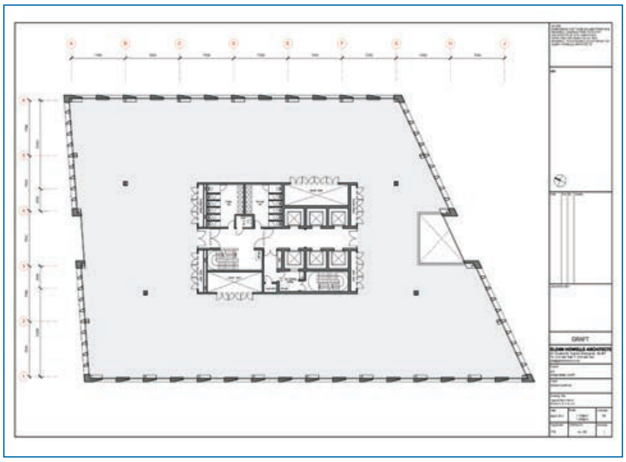
- not yet at this stage

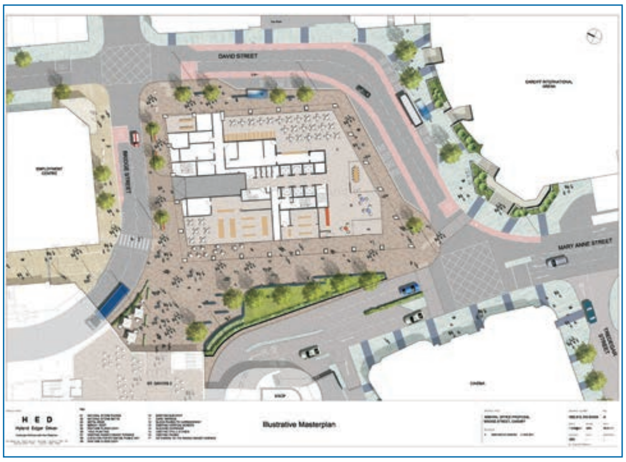
5 What were the major challenges so far in doing this adaptation work?

- not yet at this stage.

6 What advice would you give others undertaking adaptation strategies?

- N/A.





D4FC Factsheet 24:
NW Bicester Eco Development

Contact details

Name:	Philip Harker
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Tel:	020 3014 9030

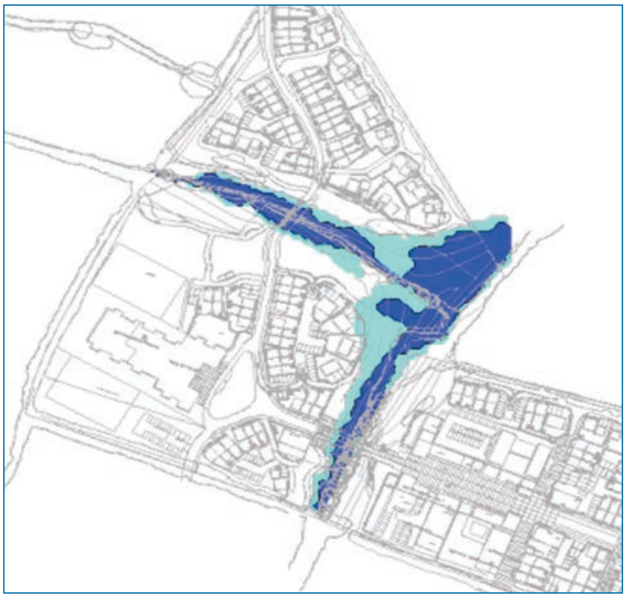
General project information

Name of project:	NW Bicester Eco Development
Location of project:	Bicester, Oxfordshire
Type of project:	Eco development comprising of 5000 homes, schools, community hubs and employment
Cost of project:	£1.2bn

Project team

Client:	P3 Eco (Bicester) Ltd and A2 Dominion Group
Designer:	Terry Farrell & Partners
Contractor:	TBC

Other organisations involved (and their role): Hyder Consulting (UK) Ltd (engineering and environmental Consultants), Oxford Brookes bioregional (advisors)



Project description

The NW Bicester Eco Development is planned to deliver 5000 homes over the next 25 years. The £100m first phase development of around 400 homes will also provide a primary school, business innovation centre, community centre and general retail/convenience store.

Masterplanning for the whole scheme is running in parallel with detailed design of the first phase. The initial findings from this D4FC project are being used to support both the first phase application and inform the wider masterplan.

Working with Oxford Brookes UKCP09 data was used to generate probabilistic weather projections, and spatial and temporal downscaling, to provide 5 km grid information more specific to the site and identify threshold data regarding key climate change risks related to:

- higher summer temperatures
- changing rainfall patterns
- higher intensity storm events
- impact on comfort levels and health risks.

Work continues to define the mitigation and adaptation measures in relation to these.

Project timescales and dates

Design and assessment period (pre-planning): current 2010 to June 2011

Construction period (post-consent): first phase circa 2011 to 2015–2016. Remaining phases continuing circa 25 years

Operation and monitoring period: beginning 2012–2013

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- the approach is underpinned by the UKCP09 future climate projections to identify the future hazard combined with current local climate impacts, exposure of the site and potential building features that may ameliorate or exacerbate future impacts
- this is analysed within the context of the vulnerability of those who would occupy the domestic and non domestic buildings
- potential risks identified include overheating, increased surface water flooding and ground stability issues
- the risks then led to the identification of initial adaptation measures appropriate for tackling these risks that consider the details of the site, potential exposure, the residents and occupants of buildings, and minimisation of potential CO_2 emissions because of development.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- written report and incorporated initial findings into sustainability statement (supporting planning application)
- planned stakeholder workshop – using tested workstream format to transfer knowledge and agree future approach to integrating adaptation measures.

3 What tools have you used to assess overheating and flood risks?

- flood risk has been modelled using ISIS, with 1:20, 1:100, 1:100 +CC and 1:1000 year events modelled, with +/- 20% sensitivity testing
- all development was located outside the 1:1000 year event, within Zone 1.

4 What has the client agreed to implement as a result of your adaptation work?

- SuDS comprising soakaways, swales and ponds, plus adopting innovative drainage system that uses overland flow as a predominant pathway. Control of both flow and volumetric discharge to improve baseflow of the ephemeral watercourse
- aim towards water neutrality, to relieve water resource stress, through rainwater harvesting, grey and possibly black water recycling (although further work is still to be undertaken)
- ongoing discussions with client will continue once further adaptive measures have been identified.

5 What were the major challenges so far in doing this adaptation work?

- programme issues delaying the start of the work and progress to date
- revised programming will enable catch up and integration of outputs into the detailed design of the first phase.

6 What advice would you give others undertaking adaptation strategies?

- ensure compatible programmes and client objectives
- ensure the scale of proposed project/development is manageable within the timeframe.

D4FC Factsheet 25:
Edge Lane: TIME Project

Contact details

Name:	Bob Wills
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General project information

Name of project:	Edge Lane: TIME Project. Development of a mental health facility with 85 beds at the “Gateway to Liverpool”
Location of project:	Edge Lane, Liverpool (former Skelly car showroom)
Type of project:	New build mental health inpatient facility
Cost of project:	About £23.5m

Project team

Client:	Liverpool & Sefton Health Partnership Ltd (LSHP)
Designer:	Medical Architecture & Art Projects Ltd
Contractor:	Farrans Heron Joint Venture (FHJV)

Other organisations involved (and their role) Arup (structural engineering and MEP services), Tony Danford (landscape architecture, hard), Camlin Lonsdale (landscape Architecture, soft), Robertsons FM (facilities management)

D4FC consultants: Low Carbon Building Group, Oxford Brookes University (strategic and climate change modelling etc) and Mott MacDonald Fulcrum (thermal modelling)

Project description

This is one of five new proposed local mental health inpatient facilities to be procured through public-private-partnership to replace inadequate existing stock. The new facilities will reduce stigma and improve inclusion and accessibility, in comfortable, safe, non-clinical and healing environments that support recovery and care. The Mental Health Needs Index for central Liverpool is more than twice the national average and indicates a high and growing level of mental health need.

The Edge Lane project is on a brown-field site adjacent to a major arterial road into Liverpool. It lies on a ridge enjoying views of central Liverpool and is described as being at a ‘gateway’ into the city. The site contains contamination from earlier glass and paint manufacture, a dye works, and a used car showroom.

Project timescales and dates

Design and assessment period (pre-planning): April 2010 to July 2011

Construction period (post-consent): site relocated and project on hold

Operation and monitoring period: project on hold

CIBSE Engineering a sustainable built environment
Technology Strategy Board Driving Innovation
Knowledge Transfer Network Modern Built Environment

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- knowledge of current best practice was gathered from the expert team, previous projects, and desktop studies
- risks were assessed in the light of maintenance costs and a holistic approach was taken to the future-proofing of the engineering and super-insulated fabric of the buildings
- the process included all stakeholders and designers.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- as the process has been open and collaborative to date with key stakeholders present at meetings, communication has been straightforward
- dedicated BREEAM assessment meetings and the use of a dedicated web portal has been useful
- having designers, sub-contractors and FM providers together at the same table has worked well
- BREEAM success was achieved at the BREEAM 2013 Awards ceremony at ECOBUILD 2013 where the project won the BREEAM Healthcare award for 2013.

3 What tools have you used to assess overheating and flood risks?

- the use of BIM software to model the buildings at an early stage in the design has facilitated the thermal modelling of the scheme design. VE Pro was used for initial and later work (interoperability of Revit and IES software was explored but later abandoned)
- Oxford Brookes have used UKCP09 tools: the weather generator tool, the threshold detector tool (to establish heating and cooling design days), The adaptation wizard to assess vulnerability, and the local climate impact profile data to understand the exposure
- working with the rest of the design team, Arup have designed the drainage system to store the water from a 1 in 100 year storm event with no flooding, plus a 20 per cent allowance for climate change in accordance with EA guidance. They have used microdrainage software.

4 What has the client agreed to implement as a result of your adaptation work?

- flat roofs with additional loading capacity for sedum planting or additional renewable energy systems
- high parapet roof upstands to safely accommodate additional renewable energy systems out of sight
- standardised single bedrooms with ensuites for adaptable use for non-medical or other medical uses with different care methods
- super-insulated envelope and local heat recovery
- individual controls of heating, ventilation and water for each bedroom
- underfloor heating that can be used for summer cooling
- extensive soft landscaping.

5 **What were the major challenges so far in doing this adaptation work?**

- it has been difficult to embed the culture of future-proofing in a public-private-partnership context where client requirements are necessarily very specific and capital costs are kept low
- technical solutions conflicting with clinical requirements (eg openable windows in super-insulated buildings)
- we have struggled to undertake as many iterations as we would like to test ideas, because of the team's reluctance to do potentially abortive work and because of cost constraints.

6 **What advice would you give others undertaking adaptation strategies?**

- the important thing is to have adaptation on the agenda at the earliest stage of any project. Give it an equivalent and interlinked status as BREEAM and post occupancy evaluations
- encourage longer term thinking in terms of 'sweating the asset' when building a facility that is likely to have a continuing or residual value beyond the current use profile
- discourage short term thinking that will inevitably cost money, time and energy resources in the future, when the building will be redundant or inefficient to use
- review the potential interoperability of any predictive BIM modelling tools such as Revit (Autodesk) and IES when commissioning thermal models as the technology will change.

D4FC Factsheet 26:

Cornwall Council Office Rationalisation Programme

Contact details

Name: Peter Woodford

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Tel: 01872 326970

General project information

Name of project:	Cornwall Council Office Rationalisation Programme
Location of project:	Camborne (Dolcoath office), Truro (County Hall) and Bodmin (proposed new office)
Type of project:	Alteration and refurbishment at Camborne and Truro and new build at Bodmin
Cost of project:	About £29m

Project team

Client:	Cornwall Council Property Services
Project management:	Cornwall Council PM team
Designer:	HLM Architects at Camborne, Poynton Bradbury Wynter Cole Architects at Truro and Bodmin
Contractor:	Mansells at Camborne, Keir at Truro (TBA)

Other organisations involved: EC Harris (cost consultants at Camborne and Truro), Cyril Sweett (cost consultants at Bodmin), Parsons Brinkerhoff (M&E consultants at Camborne and Bodmin), Hoare Lea and Partners (M&E consultants at Truro), Centre for Energy and the Environment, University of Exeter, (TSB D4FC technical partner with Cornwall Council)

Project description

Remodelling of two 1960s offices to provide 'modern working' environments and design of a new office facility, in order to offer better use of property holdings and to reduce the council's property portfolio and liability.

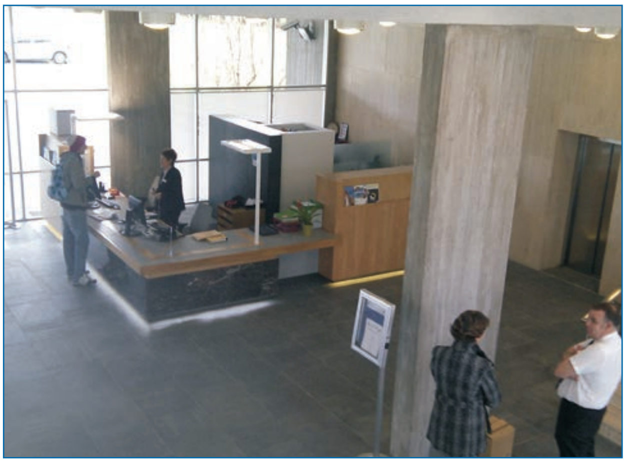
This releases asset value for reinvestment and reduction of corporate carbon footprint by disposal of inefficient building stock. Work involves internal remodelling (essentially to create open-plan flexible work areas and drop-in areas), as well as better public interface facilities, improved internal environmental performance and higher occupancy ratios.

Project specific

The contract at Camborne undertook wholesale remodelling and refurbishment of the complete four-storey building. This allowed greater flexibility of work spaces, and also allowed decant of staff to this building from a number of smaller offices in the Camborne and Penzance areas.

The work at County Hall (Grade II listed building) is divided into two phases. Phase one (valued at £1.8m) refurbished the main entrance and infill an undercroft to create a new 'public link' area, with reception, meeting rooms and social areas for public interaction with council staff and services enquiries. Phase two which was undertaken in a series of work tranches around the multi-storey building) carried out significant internal alterations to implement new office layout and 'modern working' scenarios.

A new office facility (initially targeted at Passivhaus standards but down graded to provide low carbon/ low energy) will centralise Cornwall Council facilities in the Bodmin area. This will allow the disposal of nine separate properties (both lease and freehold) which are currently scattered across a wide geographical footprint and offing office facilities housed in poor and inefficient accommodation.



Project timescales and dates

Design and assessment period (pre-planning): Camborne – completed mid 2012, Truro (Phase 1) – completed April 2011, (Phase 2) in four tranches to early 2014, Bodmin – detail design started October 2013

Construction period (post-consent): March 2014 to April 2015

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- increase solar gains from increasing high-pressure dominant weather patterns
- limited night-time cooling due to reduced diurnal cycle
- milder winters which may improve the cost effectiveness of biomass boilers
- more intense rainfall
- higher summer temperatures with higher peak temperatures
- greater fluctuations in weather patterns.

These key considerations were factors in developing proposals based around adding insulation to external walls, solar shading via brise soleil, solar shading using window films, reducing occupancy, and incorporating night-time ventilation.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- we used a range of graphical presentations, diagrams and tables to covey the technical data to our client
- as work progressed, we will develop a more comprehensive presentation, which will be used to inform the wider audience within Cornwall Council as well as form the basis of a presentation to teams in Cornwall Council Consultancy Framework.

3 What tools have you used to assess overheating and flood risks?

- the Prometheus probabilistic design summer year weather tapes developed by University of Exeter and base thermal model created in IES Virtual Environment software
- custom weather files for the specific areas are being generated, as the UKCP09 weather generator would normally use weather files based on Plymouth (60 miles to the east)

4 What has the client agreed to implement as a result of your adaptation work?

- a biomass boiler was installed at the Camborne project
- other features will be considered more fully as the work at Bodmin and Truro moves through detail design:
  - natural ventilation
  - solar shading options
  - heating/cooling strategies.

5 What were the major challenges so far in doing this adaptation work?

- working within the construction and structure of the existing building stock, and the Listed Building consent influence
- variation of the nature and levels of occupancy
- creation of location specific weather files can be time consuming
- timetable for the live building project is not related to the TSB timetable, and intervention from the D4FC team was seen as a distraction for the project design team.

6 What advice would you give others undertaking adaptation strategies?

- establish clear roles and responsibilities
- ensure that D4FC/TSB representatives are there to help, and are not seen as a burden on the design teams
- budget setting is critical to project successes – D4FC/TSB roles must reflect the potential to add value to the processes, not just add cost.

Design for future climate: adapting buildings competition project factsheets, *Building a resilient future*, 26 February 2014

Phase 2

CIBSE
Engineering a sustainable built environment

Technology Strategy Board
Driving Innovation

Knowledge Transfer Network
Modern Built Environment

D4FC Factsheet 27:
Project Angel

Contact details

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General project information

Name of project:	Project Angel
Location of project:	Northampton
Type of project:	New build, office led development
Cost of project:	About £44m

Project team

Client:	Northampton County Council
Architect:	CPMG
Structural/M&E engineers:	Capita Symons
Main contractor:	TBC
Sustainability consultants:	Waterman Energy Environment & Design
Cost consultants:	Evolve2consult
Communication consultants:	London Sustainability Exchange
Material consultants:	BRE

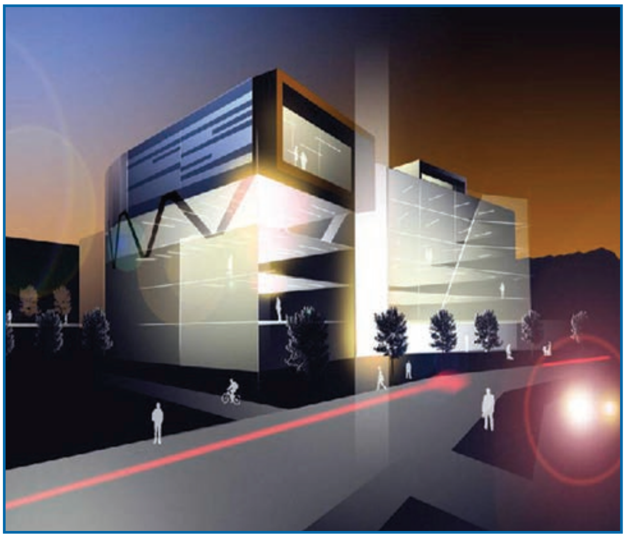
Project description

The site is located on the edge of Northampton City Centre, located on Angel Street and is a previously developed site which is currently used predominantly for surface level car parking. The proposals are at the early design stage and currently include provision for approximately 23 000 m^2 gross external area (GEA) of office space. Other uses within the building could include a café, retail and cultural uses. Car parking and new public realm also form part of the proposals.

It is proposed that the development will house Northamptonshire County Council Offices in a new exemplar sustainable building.

Project timescales and dates

Design and assessment period (pre-planning): February 2011 to September 2012



Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

The following methodologies where used to identify and assess and adaptation measures:

Academic/industry review

Reviewing research into predicted changes in climate such as information published by the IPCC and UN.

Reviewing literature into the effects of Climate change on buildings including CIBSE, UKGBC, BRE and work from other countries including that published by DGNB and USGBC.

A review of the possible climate change adaptation (CCA) strategies from a variety of sources including a review of the teams previous projects, case studies from around the globe, and a review of new innovative CCA strategies. A comprehensive review of the Technology Strategy Board's reports: *Design for Future Climate* and *Opportunities for Adaptation in the Built Environment*.

Risk assessment

The probability of certain climate changes occurring was determined using UK Climate Projections (UKCP09) data, which provides probabilistic projections. The shape of the probabilistic distributions can be used to provide information about the relative likelihood of the extent of the projected change.

The risk ratings have been considered under three main categories applicable to the built environment and specifically considers Project Angel (ie an office building within Northampton):

- designing for comfort
- construction
- managing water.

Building design

The energy and thermodynamic modelling is currently being undertaken on the options identified as a result of the risk assessment and workshops. The options being tested include:

- percentage of glazing and G values (with potential future replacement with solid panels)
- variations of shading on the east and west elevations
- base scheme has been future proofed to allow M&E retrofit in the future (space allocation for extra plant). Investigate the tipping point for M&E retrofit and the effect accepting higher internal comfort criteria would have on the life of the M&E plant
- use of phase change materials for future internal partitions
- investigate the affect differing sizes and type of green roof has on overheating (and other climate change adaptation benefits such as sustainable drainage).

2 How have you communicated the risks and recommendations with your client? What methods worked well?

CCA risks and adaptation strategies have been communicated to the client as follows:

- meeting minutes are circulated between the design team and the client
- the client forms an integral part of the design team, attending meetings so being fully involved throughout the design.

3 What tools have you used to assess overheating and flood risks?

- IES: dynamic building physics simulations have been used and continue to be used throughout the design to investigate different fabric and building systems CCA adaptation strategies focusing on internal temperature, daylight and energy use
- ENVI-met: micro-climate simulation has been used to model the effects of various "greening" strategies on the building envelope and surrounding area. This has primarily looked at the effect on external temperature and surface temperature of the building fabric
- consulting EA and other bodies regarding resources
- review of geological surveys etcetera carried out prior to the planning/submission
- modelling will be used throughout the building design process to ensure the design reflects the CCA strategies adopted.

4 What has the client agreed to implement as a result of your adaptation work?

- at this stage the client has not yet agreed to any strategy as they are still in development. However, the client is fully aware of the strategies that are being investigated in particular the use of phase changing materials and green roofs in adapting to increased temperatures and rainfall.

5 What were the major challenges so far in doing this adaptation work?

- the major challenged faced has been team coordination, particularly the dovetailing of work from different parties ensuring an efficient design and research process
- a fixed/tight budget for the development alongside the limited funding available to invest in adaptation strategies meant that the strategies investigated are ones that are simple and cost effective rather than the most innovative.

6 What advice would you give others undertaking adaptation strategies?

- don't over complicate strategies. Often buildings are overdesigned with many complex systems that work well in theory. However in practise the systems when used in conjunction with one another are less efficient than when used in isolation

- by using dynamic simulation tools such as IES from stage C it is possible to use the software as a design tool and model the effects of changes in building layout, fabric and systems on the building performance
- ensure the adaptation strategy is embedded in the building design. Keep referring to the strategy and bear in mind the reason why the strategy is in pace
- keep the client involved throughout the design, and ensure CCA strategies are communicated in a way that they can understand. Use images and a graphically representations of different scenarios to show the effect of strategies in a language they can understand
- view the whole building and its surrounding area, including the buildings around it, vegetation and landscaping as one whole system. Try not to see the building in isolation as there is many external contributing factors to the performance of the building and the relevance of different CCA strategies.

D4FC Factsheet 28:

PassivOffices 4 Devon at Devonshire Gate

Contact details

Name:	David Gale and Tomas Gaertner
Company:	Gale & Snowden Architects

General project information

Name of project:	PassivOffices 4 Devon at Devonshire Gate
Location of project:	Samford Peverell, Devon
Type of project:	New build office
Cost of project:	£12 250 000

Project team

Client:	David Disney, Devonshire Gate
Designer:	Gale & Snowden Architects

Other organisations involved (and their role): Exeter University (building physicists and dissemination), Jenkins Hansford Partnership (quantity surveyors and cost consultants)

Project description

The building project is the design and build of a new state of the art pioneering office development to Passivhaus standards in Devon off a main highways route and next to a major train station. The building project is funded by a private client whose existing business owns the site and rents office space to various businesses from the existing buildings on site. One of the main aims of the project is for it to be passively designed and not require air conditioning in both the current and future climate change scenarios. Another aim is for the building to have a noticeable positive impact on productivity and health. Office buildings are increasingly becoming unhealthy places to use, suffering from Sick Building Syndrome SBS and can be contaminated with high levels of VOCs, ozone, pollutants, chemicals and poor fresh air quality particularly in offices which are sealed and air conditioned. The proposed office building is designed to meet Passivhaus certification.

Main climate change risks this project aims to address are:

Designing for comfort

- increased internal and external temperatures
- unstable/changing internal surface temperature levels resulting in uncomfortable internal conditions
- increased pollen count, air borne particulates and manmade pollutants due to higher external temperatures and at times less wind to help clear localised air quality.

Construction

- increase temperatures and UV on building envelope
- increased weather severity on building fabric – wind and rain.

Managing water

- reduced water availability in summer
- increased rainfall in winter
- flooding.

Project timescales and dates

Design and assessment period (pre-planning): autumn 2011 to spring 2012

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

To identify and assess potential climate change risks for this building project a site independent, generic, qualitative risk assessment has been prepared. Potential risks were based on the *Design for Future Climate* report, and Gale & Snowden's experience from their work on a previous D4FC project. The risks were structured in three main sections ie comfort, construction and water management. Each risk was rated on a scale of one to five for its probability and impact and as a result of the multiplication of these two factors was given a risk magnitude. A graphical analysis of all individual risk magnitudes was used to identify the overall vulnerability of this building type to specific aspects of climate change.

This assessment was then used to also inform the decision on the selection of appropriate weather files from Exeter University's Prometheus project.

Methods to assess thermal comfort:

- various forms of thermal modelling of design throughout the design process from initial concept
- literature review – guidance on overheating (EN7730, EN15251, CIBSE, ASHRAE), internal and external planting, green roofs and façade greening in terms of temperature and water attenuation
- case studies UK and abroad.

Methods to assess water management:

- assess water use and potential savings
- assess existing ground conditions, characteristics, topography, and environmental impact on sub-soils
- assess flood risk using EA maps
- review landscape mitigation options (surface water retention and rainwater harvesting)
- review construction techniques/options.

Methods to assess impacts on construction:

- literature review – guidance on detailing for extreme weather (British Standard, Trada, Building Regulation etc)
- case studies UK and abroad – visit to Solar XII passive cooled building in Portugal and Passivhaus offices in Germany
- review of design guidance from countries experiencing more extreme weather events like Northern Norway, New Zealand etc.

The following mitigation measures are currently being considered:

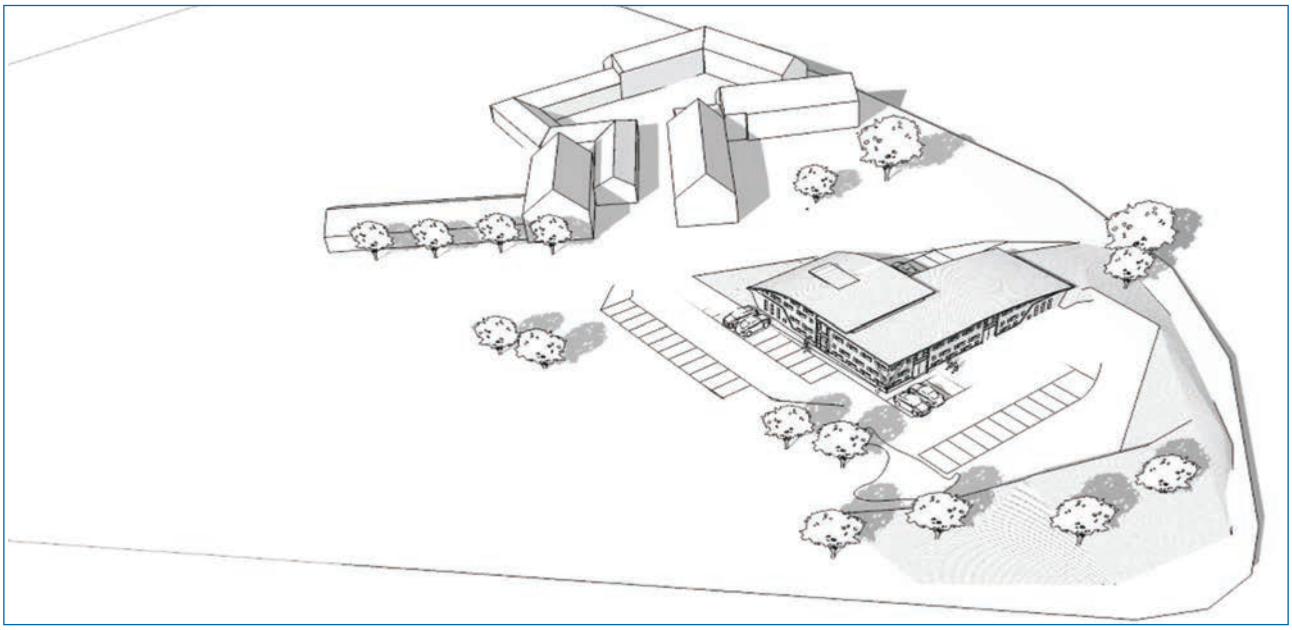
Thermal comfort

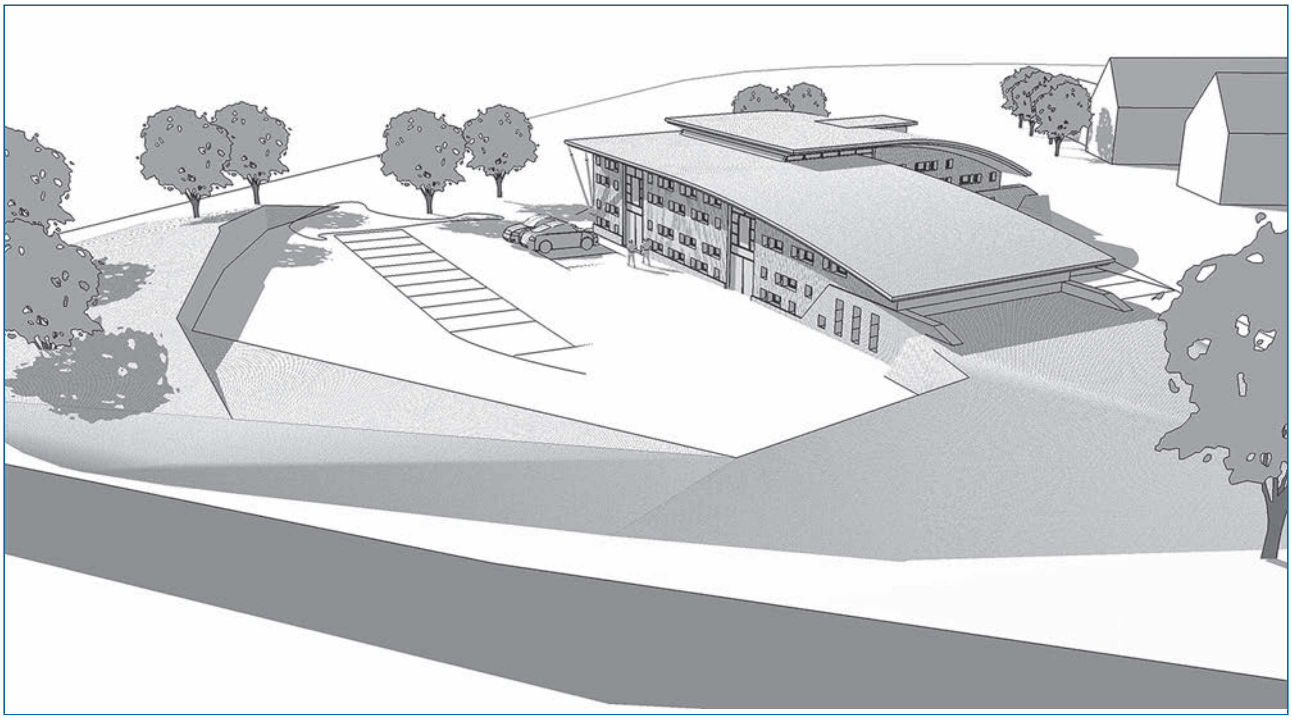
- external shading
- cross flow and stack ventilation through the office
- intermediate or heavy weight construction
- ground cooling via earth tube or soil to brine heat exchanger
- reduction of internal gains by relocating plant outside the thermal envelope
- landscape design and green roof to moderate microclimate and to introduce external work spaces for extreme weather events.

Water management

The following measures are currently being investigated to address the risk of flooding/droughts under future climate scenarios:

- inclusion of green roofs and landscape design that allows to retain water on site using pemaculture design principles
- rainwater harvesting and storage
- inclusion of SuDS
- use of water saving appliances for showers, toilets etc to reduce water demand.





2 How have you communicated the risks and recommendations with your client? What methods worked well?

CCA risks and communication have been communicated to the clients as follows:

- the clients are part of the design team and attend all meetings so are fully informed on all aspects of the project
- notes of meetings and building precedent case studies are disseminated to the team including the clients.

The presentation of thermal modelling using CGI has worked well to graphically show the client what effects future climates could have on the building design.

3 What tools have you used to assess overheating and flood risks?

- PMV/PDD method in accordance with BS EN 7730 to analyse comfort range
- IES dynamic modelling to assess energy use and overheating
- PHPP to assess energy use and overheating and to show compliance with the Passivhaus methodology
- consultation with EA to identify flood risk.

4 What has the client agreed to implement as a result of your adaptation work?

At present the project costs are under consideration so no decisions have been made to what is or is not to be incorporated into the building. Subject to the above, it has been agreed that the following will be adopted:

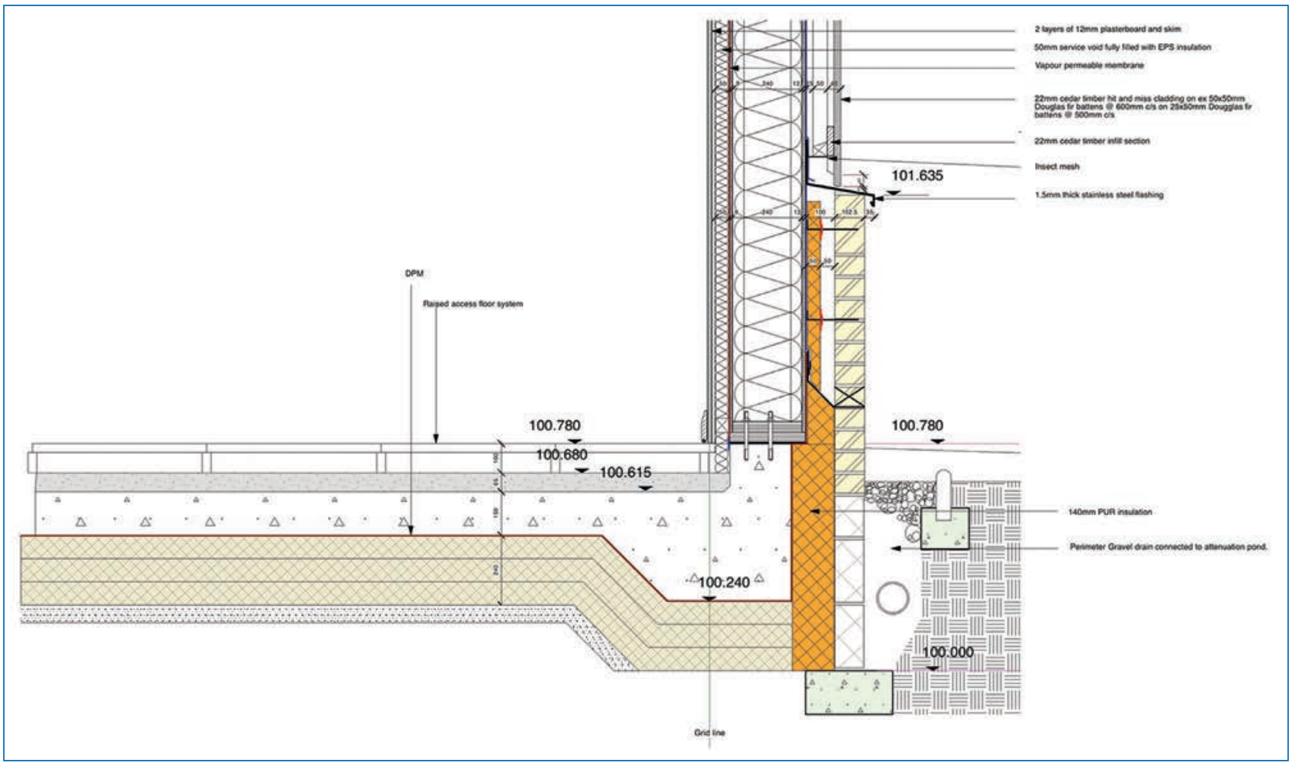
- Passivhaus design methodology
- optimised solar orientation and daylight strategy
- cross flow and stack ventilation
- night cooling strategy
- intermediate weight construction
- low water use appliances
- rainwater harvesting
- green roof for rainwater attenuation
- rainwater attenuation pond
- ground cooling via earth tube or soil to brine heat exchanger.

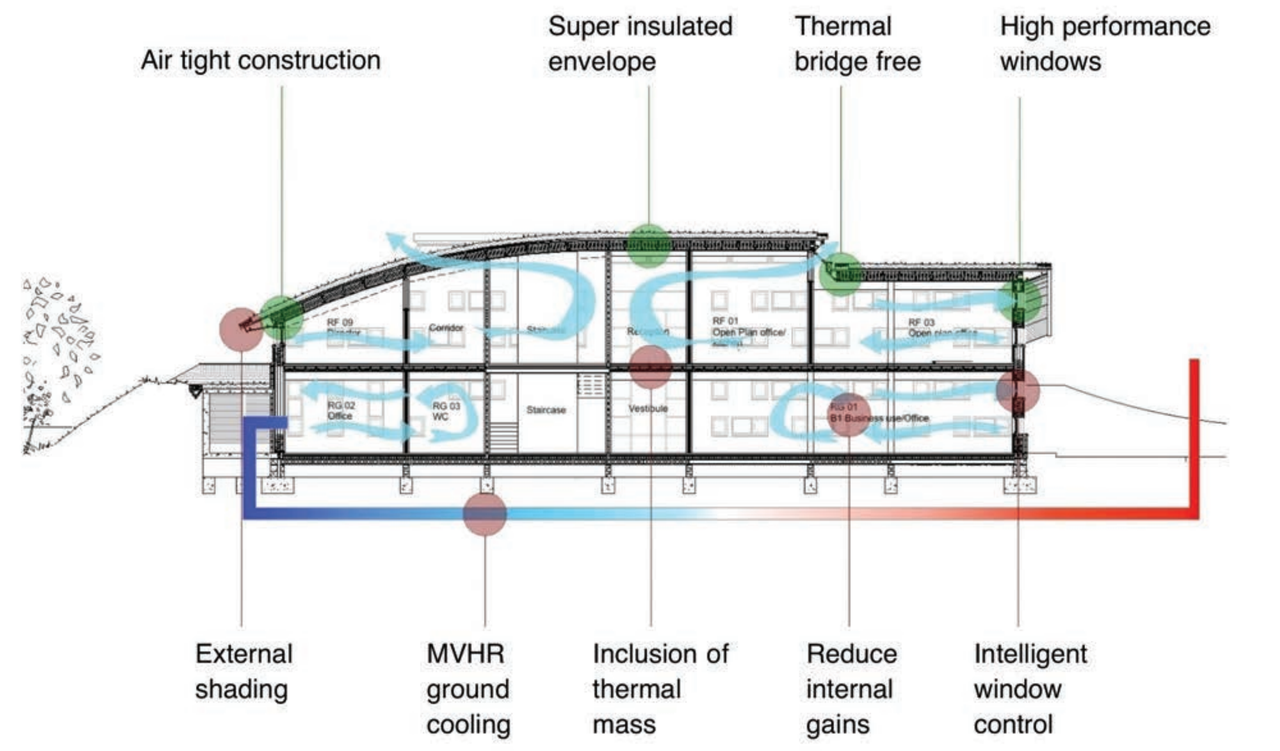
5 What were the major challenges so far in doing this adaptation work?

- lack of guidance: currently there is limited literature or good practice guidance on upper acceptable temperature levels in office buildings
- compatibility with current design and good practice guidance: a high performance building envelope that fulfils the Passivhaus standard requires minimal thermal bridging. Standard structural engineering solutions for foundation details often do not achieve this level of thermal performance and re-thinking from all design disciplines is required to develop new more appropriate solutions
- planting is a living building material: when considering the climate change scenarios to 2080, it is unclear on how plant species will or not adapt or succumb to pest and diseases with gradual change. So it was considered appropriate to concentrate on the structure and principles of the external design and associated characteristics of the plants, for future climate change
- site restrictions: the limited size of the site restricted the design of the building and restricted the use of certain CCA strategies, eg ground cooling, incorporating the surface water storage needs of future extreme events, extensive landscaping to successfully moderate the microclimate.

6 What advice would you give others undertaking adaptation strategies?

- a simple passive design approach at concept stage can provide a robust strategy to mitigate impacts from future climate scenarios, eg layout of the building to allow cross ventilation and to control solar and internal gains
- Passivhaus principles provide a robust approach to future climate change
- introduce thermal modelling at concept stage and use it as a design tool and not a compliance tool
- consider the role the landscape and external planting can play at introducing micro-climates and dealing with changing rain fall patterns at the outset
- if the site and budget allow it, build in the possibility for using active cooling systems. For example, MVHR systems can use ground cooling to reduce excessive heat build up in prolonged periods of high external temperatures
- a detailed study of built examples and construction approaches in different climates has proven helpful.




Air tight construction
Super insulated envelope
Thermal bridge free
High performance windows
External shading
MVHR ground cooling
Inclusion of thermal mass
Reduce internal gains
Intelligent window control

D4FC Factsheet 29:

Queen Elizabeth II (QEII) Hospital

Contact details

Name:	Adedayo Omikunle
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General project information

Name of project:	Queen Elizabeth II (QEII) Hospital
Location of project:	Welwyn Garden City, Hertfordshire
Type of project:	New build
Cost of project:	Floor area about 8500sq m for £21m budget

Project team

Client:	Assemble Community Partnership procured under the Local Initiative Finance Trust (LIFT) programme
Designer:	Penoyre and Prasad LLP
Contractor:	Mansell Construction Services Ltd

Other organisations involved (and their role): Low Carbon Building Group, Oxford Brookes University (responsible for undertaking climate change risk assessment and appraisal of adaptation strategies)

Project description

The project is a new 8000 sqm purpose built healthcare facility on the site of an existing hospital, which has reached the end of its useful life.

The new QEII will make use of 2ha of an existing 8.5ha site. A largely residential re-development masterplan for the whole site has been progressed in parallel with the new QEII hospital. This has ensured that there is a robust and sustainable development strategy for the whole site.

The building is made up of three “L” shaped clinical wings arranged around a central soft-landscaped courtyard to maximise daylighting, natural ventilation and access to green external spaces.

The design will include:

- renewable energy in the form of air source heat pump (ASHP), solar thermal and PV panels
- rainwater harvesting
- solar glazing to south and east façades
- green roofs.

Project timescales and dates

Design and assessment period (pre-planning): February 2010 to March 2012

Construction period (post-consent): September 2012 to July 2014

Operation and monitoring period: due to start September 2014

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

The methodological approach is based on the risk triangle developed to understand the implications of climate change for the insurance industry. With this approach, adaptation is successful when it is able to eliminate or reduce any one side of the triangle. Risk is eliminated when the structure of the triangle collapses. Adapting this approach to the QEII study involves assessing the hazards and the effects of climate change, exposure of the site and vulnerability of the potential occupants, so as to arrive at tested, technically-feasible and practical adaptation measures appropriate for future construction. To develop appropriate adaptation strategies, three steps were taken:

- the hazards for the site were quantified at an appropriate scale, this entailed analysis of probabilistic climate change projections developed by the UKCP09
- climate change impacts were defined
- the local environmental features (LEFs), which can exacerbate or ameliorate the impacts, were defined for their potential influence and finally the general adaptation strategies were detailed. Also, mitigation strategies that share synergistic relationships with specific adaptation strategies were identified.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- the client will be invited for workshops in which risks, adaptation and their benefits will be presented
- the project has started recently, so no methods have yet been tested.

3 What tools have you used to assess overheating and flood risks?

- UKCP09 Weather Generator, UKCP09 Threshold Detector, IES VE, Matlab, MS Excel will be used assess overheating
- Environment Agency flood map will be used assess flooding
- UKCP09 Threshold Detector will be used assess drought.

4 What has the client agreed to implement as a result of your adaptation work?

- the project has started recently, so adaptation work is yet to be done.

5 What were the major challenges so far in doing this adaptation work?

- the project is at the beginning stage, and we have faced no major challenge so far.

6 What advice would you give others undertaking adaptation strategies?

- this will be reported when the project is in final stage.


Queen Elizabeth II Hospital

D4FC Factsheet 30:

Dragon Junior School for the Future

Contact details

Name:	Adrian Kite
Company:	Ridge and Partners LLP
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Tel:	01993 815126

General project information

Name of project:	Dragon Junior School for the Future
Location of project:	Oxford
Type of project:	New build
Cost of project:	Floor area about 2060 m^2 for £5.6m budget

Project team

Client:	Dragon School, Oxford
Designer:	Ridge and Partners LLP
Contractor:	TBC

Other organisations involved (and their role): Low Carbon Building Group, Oxford Brookes University (responsible for undertaking climate change risk assessment and appraisal of adaptation strategies)

Project description

New low energy junior school for the Dragon School to accommodate 200 children between the ages of 7 to 9 (years three and four). It is designed as a school with classrooms, informal learning spaces, library IT facilities a school hall and dining area, changing rooms, play and garden spaces.

Project timescales and dates

Design and assessment period (pre-planning): June 2012 to June 2014

Construction period (post-consent): June 2015 to October 2016

Operation and monitoring period: October 2016 to October 2018

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- the methodological approach is based on the risk triangle developed to understand the implications of climate change for the insurance industry. With this approach, hazards and impacts of climate change are assessed along with exposure of the site, and vulnerability of the potential occupants
- to demonstrate this approach, firstly the hazards for the site were quantified at an appropriate scale, this entailed analysis of probabilistic climate change projections developed by the UKCP09. Secondly, climate change impacts were defined. Thirdly the local environmental features (LEFs), which can exacerbate or ameliorate the impacts, were defined for their potential influence and finally the general adaptation strategies were detailed. Mitigation strategies that share synergistic relationships with specific adaptation strategies were also identified.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- the client has been involved in a workshop in which risks, adaptation and their benefits were presented
- all adaptation measures were well received as they were presented as design development.

3 What tools have you used to assess overheating and flood risks?

- UKCP09 Weather Generator, UKCP09 threshold detector, IES VE, Matlab, MS Excel were used assess overheating
- three distinct metrics were selected to evaluate overheating risks of different building types and they are:
  - Departments of Education's Building Bulletin 101
  - Chartered Institution of Building Services Engineers Guide A
  - Adaptive Thermal Comfort Standard (BS EN 15251 /CIBSE TM 52)
- Environment Agency flood map was used assess flooding
- UKCP09 threshold detector was used assess drought.

4 What has the client agreed to implement as a result of your adaptation work?

- based on the cost benefit analysis of all these measures, clients are in favour of following measures, as they could potentially have significant amount of savings over building life time.
  - secure and bug free night time ventilation
  - enhanced solar shading
  - triple glazing in order to reduce solar gain
  - enhanced construction details
  - rainwater catchment systems
- all building adaptation measures were adopted for the planning application and are to be reviewed as part of the project cost plan.

5 **What were the major challenges so far in doing this adaptation work?**

- the challenges were ameliorated by the detail design assessment necessary to comply with current Part L and current overheating analysis such as Building Bulletin 101. So adapting for future climate conditions is simply an extension of the current strategy with a different set of base criteria
- through this work, it has been realised that to have confidence in overheating risk assessment for future climate, there is a need to have consistent metrics for all projects. This includes agreeing on an appropriate overheating risk criterion, a standardised calculation method for assessing risk and future climate data (for different locations in the UK)
- the metrics may differ for building typologies and occupant categories but would still have a common approach. A consistent approach to overheating analysis is required if the central/local Government and professional bodies would like to incorporate a requirement for designers and developers to undertake overheating risk analysis for new buildings against future climate, as part of future building regulations or planning requirements
- it also has been realised that cost benefit analysis (CBA) isn't the only way to determine the uptake of adaptation measures. CBA tends to work for those measures which have energy implication. For the measures which don't have energy saving but improve thermal comfort, thermal comfort and its health benefit should also be considered. There is a need to develop a methodology to quantify the health benefits of adaptation measures.

6 **What advice would you give others undertaking adaptation strategies?**

- we have developed a robust and replicable methodology for climate change risk analysis based on UKCP09 Weather Generator, described in more detail in Climate Change Hazards and Impacts Report. Such methodological approaches could be applied to other building projects.

D4FC Factsheet 31:
Management before fabric

Contact details

Name:	Irena Bauman
Company:	Bauman Lyons Architects
Email:	irena@baumanLyns.co.uk
Tel (mobile):	07957 820 677

General project information

Name of project:	Management before fabric
Location of project:	Bradford, Yorkshire
Type of project:	Refurbishment and retrofit. Refurbishment and conversion of a complex of three buildings: Central Library, National Media Museum, Pictureville cinema dating from early 1960s
Cost of project:	Phase 1: £1.2m Overall lightwave project estimated £45m

Project team

Client:	NMSI
Designer:	Bauman Lyons Architects
Contractor:	N/A

Other organisations involved (and their role): ARUP (environmental engineers, thermal modelling, behaviour consultants), BWA Cost Consultants (capital costs and life cycle costs).

Project description

In the near future the knowledge of how to adapt buildings for climate change will be as well understood as heat conservation is understood today. However major barriers to adaptation still exsist in the form of current facilities management practice, occupant behaviour and especially institutional structures. Work needs to be done to enable organisations to adapt so that they are empowered to adapt their buildings. While the need to reduce carbon omissions is urgent there is time to adapt to overheating providing we are ready to do so when the need becomes more pressing. We suggest that the best approach to an adaptation strategy for overheating is to start the process now with behaviour and low cost building adaptations. We called this strategy *Management before fabric*.

Project timescales and dates

This is a nine month project, which started in November 2011:

Quarter 1: establish base information and data on the building and the organisation

Quarter 2: option appraisal for adaptation and design development with thermal modelling

Quarter 3: develop climate change strategy including management structure and behaviour change

Quarter 4: dissemination

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

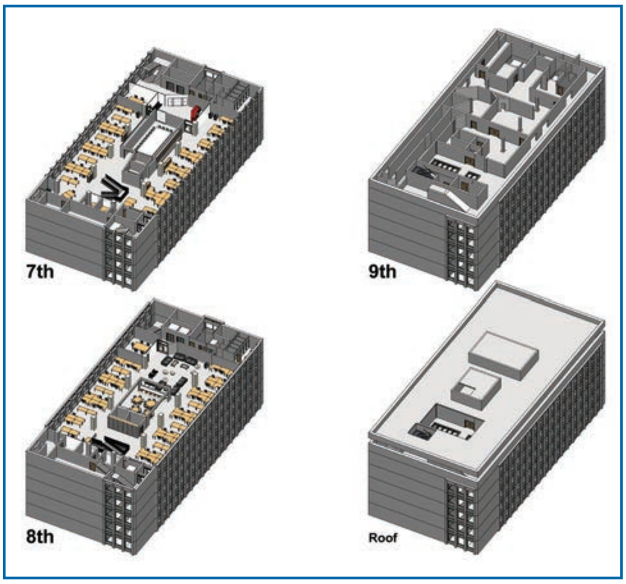
- the building is on high ground, which will not be affected from flooding either from watercourses or because of local topography. It is not at significant risk from the effects of climate change on drainage and flooding. However, there is use of water to maintain the correct humidity for the exhibits and in general water use for the toilets and we will consider whether on site water conservation can satisfy this demand as climate change increases the chances of water shortage and drought albeit as a secondary consideration to the main focus of the study, which is comfort
- the building has a high risk of not achieving acceptable comfort levels in the future. The library has large glazed façades facing both to the north and south, which creates problems with both heat loss and solar gain. There is limited solar gain protection in the form of films applied to 1960s single glazed units. Some of the spaces of the museum are conditioned. There is a large north-west facing glazed atrium to the front of the museum that overheats significantly at present. This will cause severe problems to maintaining comfort as climate change produces extremes of temperature
- higher temperatures will be felt more due to the urban heat island effect because the site is in central Bradford. Out of the three scenarios for greenhouse gas omissions used in UKCP09 we will use the medium omission and a time span up to 2080
- we know from the previous TSB project, Church View, that it would be possible to adopt the fabric in response to the climate change in terms of overheating. However, we also know that the biggest barriers to developing and adaptation are not physical but structural to do with the management structures and the aims of the cultural sector that are not “climate change” aware.
- we have included management structure as one of the risks and also one of the mitigation measures that needs to be addressed.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- we carried out BUS (building user survey) for all the staff and presented the findings in a workshop with senior management staff. This was very effective and led to a second workshop with larger team of senior management to examine the problems and possible solutions in terms of management and behaviour change.

3 What tools have you used to assess overheating and flood risks?

- our projects was about overheating only
- the tools we used are software Archicad for 3D model and sun studies and DesignBuilder for overheating modelling.
- we also used Prometheus weather files.



4 What has the client agreed to implement as a result of your adaptation work?

- still in progress

5 What were the major challenges so far in doing this adaptation work?

- many reiterations were required of modelling as assumptions were refined and gremlins removed from the modelling
- the unknown aspects of future technologies and behaviour will require a degree of guesswork that will require this research to be frequently updated
- taking into account humidity levels greatly complicates modelling there does not seem to be an agreement across the TSB projects regarding the variables that should be included in the modelling
- the lack of robust environmental strategy within the client organisation
- the lack of data in terms of energy use in the building.

6 What advice would you give others undertaking adaptation strategies?

- agree variants to be included in modelling in a methodical manner and look at what others have done
- develop robust methodology for recording the modelling assumptions as you go along
- ascertain from the start what quality of data is available
- ask the right questions – adaptation strategy needs to be in keeping what can be achieved in terms of management.

D4FC Factsheet 32:

Swim4Exeter

Contact details

Name:	Emma Osmundsen, David Gale, Tomas Gaertner
Company:	Exeter City Council, Gale & Snowden Architects
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Tel:	01392 279220

General project information

Name of project:	Swim4Exeter
Location of project:	Exeter, Devon
Type of project:	New built public swimming pool
Cost of project:	£10m

Project team

Client:	Exeter City Council
Designer:	Gale & Snowden Architects
Contractor:	N/A

Other organisations involved (and their role): Exeter University (building physicists and dissemination), Jenkins Hansford Partnership (quantity surveyors and cost consultants)

Project description

The project involved the assessment of three sites for future climate and the design and build of a new state of the art indoor public pool facility in Exeter, including a main national/county standard swimming pool and a learners' pool with supporting facilities together with dry sports facilities.

It will set itself apart from other public swimming pools in the UK with its energy-saving Passivhaus design. This will be achieved by a compact design, a high standard building envelope and the highly efficient building services equipment – it is intended that the building will be the first Passivhaus certified swimming pool in the UK. The client's intention is to provide a low environmental impact building that employs best practice in low energy and healthy building design meeting the needs of the Exeter Community.

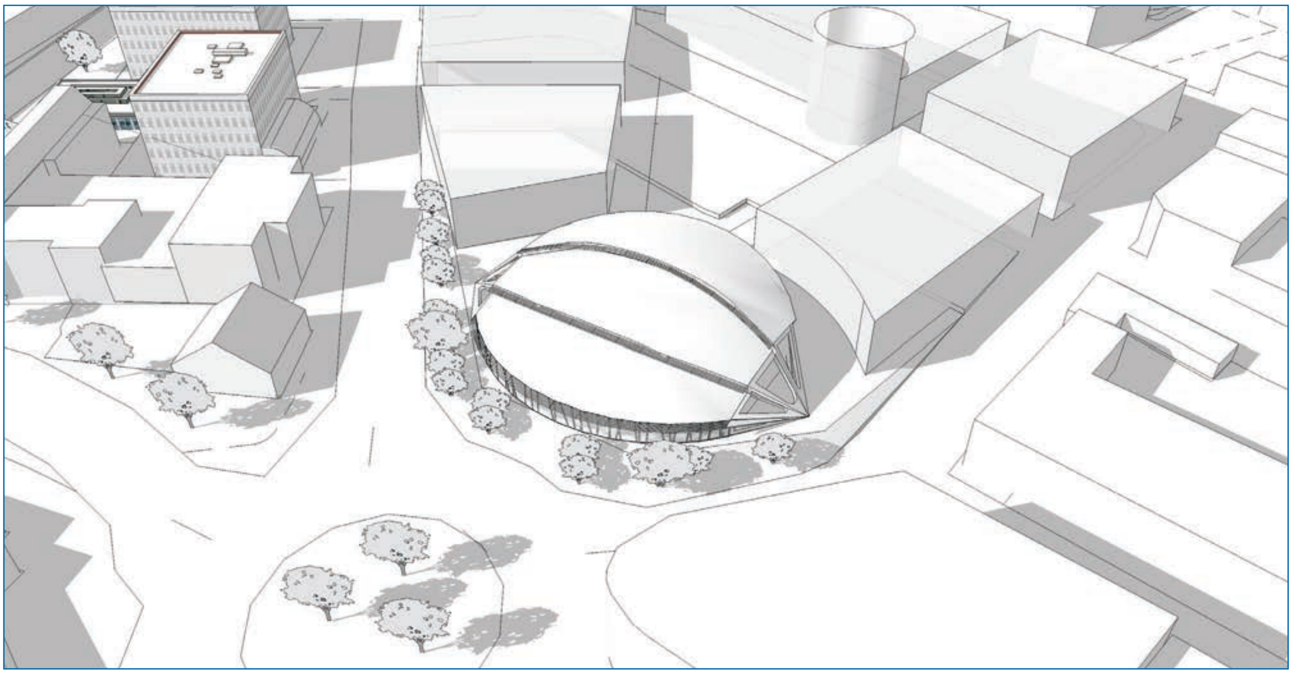
The passive design approach paid particular attention to the sun cycle around highly glazed facades and the swimming pool's responsiveness to changing temperature conditions. Glazing ratios and building form have been assessed to maximise daylight and optimise solar gains. Shading strategies, various ventilation strategies, innovative low energy cooling strategies such as ground cooling (earth tubes, piped exchangers), radiative night sky cooling and phase change materials have been investigated together with various integrated landscape design opportunities that help moderate the micro climate.

Project timescales and dates

Design and assessment period (pre-planning): autumn 2011 to autumn 2012

Construction period (post-consent): TBC

Operation and monitoring period: TBC



Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- to identify and assess potential climate change risks for this building project a site independent, generic, qualitative risk assessment has been prepared. Potential risks were based on the *Design for Future Climate* report and Gale & Snowden's experience from their work on a previous D4FC project. The risks were structured in three main sections, ie comfort, construction and water management. Each risk was rated on a scale of one to five for its probability and impact and as a result of the multiplication of these two factors was given a risk magnitude. A graphical analysis of all individual risk magnitudes was used to identify the overall vulnerability of this building type to specific aspects of climate change
- this assessment was then used to also inform the decision on the selection of appropriate weather files from Exeter University's Prometheus project.

Thermal comfort

- various forms of thermal modelling of design throughout the design process from initial concept
- literature review: guidance on overheating (EN7730, EN15251, CIBSE, ASHRAE), internal and external planting, green roofs and façade greening in terms of temperature and water attenuation, evaporation from pool water and relative humidity in swimming pools
- swimming pool case studies UK and abroad (including the first German Passivhaus swimming pool).

Water management

- assess water use and potential savings
- assess existing ground conditions, characteristics, topography, and environmental impact on sub-soils
- assess flood risk using EA maps and ECC SFRA
- review landscape mitigation options (surface water retention and rainwater harvesting)
- review construction techniques/options (low water use treatment and filtration techniques, options to reuse water, rainwater/greywater harvesting, low water use appliances, SuDS, water storage on site).

The following mitigation measures are currently being considered:

Thermal comfort

The wet areas can be designed in a way that solar gains will be beneficial almost all year round. However, the dry sports facility has been identified as the most vulnerable part with regards to internal thermal comfort and rising temperatures under future climate scenarios. The following strategies have been identified to be successful in limiting the risk of overheating:

- internal zoning taking regard of different temperature requirements with super insulated compartment walls between, eg the wet area and the dry sports area
- north orientation of dry sports area and south facing wet areas
- cross flow and stack ventilation to dry sports area
- intermediate or heavy weight construction
- ground cooling via earth tube or soil to brine heat exchanger
- reduction of internal gains by relocating plant outside the thermal envelope
- landscape design and green roof to moderate microclimate.

Water management:

The following measures are currently being investigated to address the risk of flooding/droughts under future climate scenarios:

- inclusion of green roofs and landscape design that allows to retain water on site using permaculture design principles
- rainwater harvesting and storage
- inclusion of SuDS.

Reduction of potable water use. The water demand of a swimming pool building is a combination of water used for water treatment (refilling and backwashing of filters), evaporation from pool water and water used for hygiene (showers, toilets).

Under this project the following water saving measures to reduce the water demand are being investigated:

- increased internal humidity to reduce evaporation rates
- reuse of water for backwashing
- recouping of water and latent heat from exhaust air via post MVHR heat pump systems
- use of water saving appliances for showers toilets etc
- use of water saving filtration techniques.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

CCA risks and communication have been communicated to the clients as follows:

- the clients are part of the design team and attend all meetings and so are fully informed on all aspects of the project
- notes of meetings and building precedent case studies are disseminated to the team including the clients.

The presentation of thermal modelling using CGI has worked well to graphically show the client what effects future climates could have on the building design.

3 What tools have you used to assess overheating and flood risks?

- PMV/PDD method in accordance with BS EN 7730 to analyse comfort range for various internal temperature zones
- IES dynamic modelling to assess energy use and overheating
- PHPP to assess energy use and overheating and to show compliance with the Passivhaus methodology
- Exeter City's strategic flood risk assessment and consultation with EA to identify flood risks for all three sites.

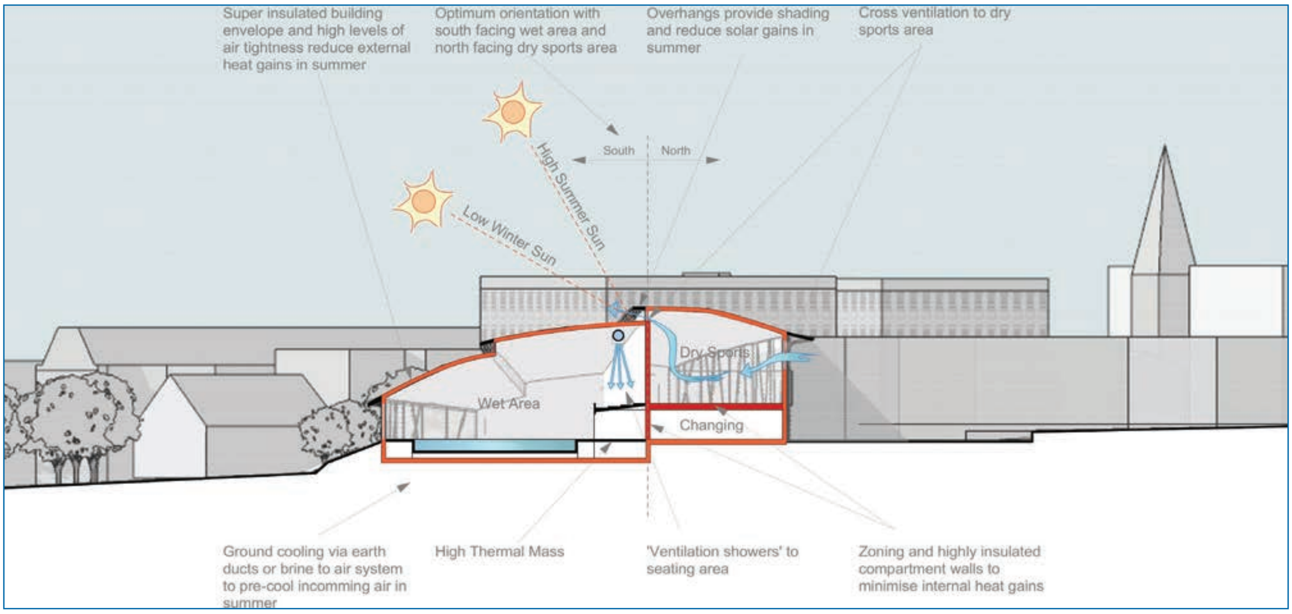
4 What has the client agreed to implement as a result of your adaptation work?

At present the project costs are under consideration therefore no decisions have been made to what is or is not to be incorporated into the building. Subject to the above, it has been agreed that the following will be adopted:

- Passivhaus design methodology
- optimised solar orientation with south facing wet areas and north facing dry sports area
- internal zoning and super insulated compartment walls between different temperature zones
- cross flow and stack ventilation
- night cooling strategy
- high mass construction
- optimisation of internal humidity levels to reduce evaporation rates
- low water use ultra filtration in combination with UV treatment
- low water use appliances
- storage and reuse of water for backwashing
- inclusion of movable floor construction and covers to pools to reduce evaporation.

5 What were the major challenges so far in doing this adaptation work?

- methods for accurately modelling the effect from evaporation on energy demand and comfort level in IES or PHPP were not readily available and needed to be investigated



- lack of guidance. Currently there is hardly any literature or good practice guidance on thermal comfort levels in swimming pools and leisure buildings
- compatibility with current design and good practice guidance. A high performance building envelope with no thermal bridging in combination with a low chemical filtration system will allow to operate the pool at higher humidity levels without detrimental effect to the building fabric or its users. However, this is a diversion from current good practice and it will expose the client and designers to additional risks if the building is not constantly monitored for its performance.
- planting is a living building material. When considering the climate change scenarios to 2080, it is unclear on how plant species will or not adapt or succumb to pest and diseases with gradual change. So it was considered appropriate to concentrate on the structure and principles of the external design and associated characteristics of the plants, for future climate change
- site restrictions. The limited size of the site restricted the design of the building and restricted the use of certain CCA strategies, eg ground cooling, incorporating the surface water storage needs of future extreme events.

6 What advice would you give others undertaking adaptation strategies?

- a simple passive design approach at concept stage can provide a robust strategy to mitigate impacts from future climate scenarios, eg layout of the building to allow cross ventilation and to control solar and internal gains
- Passivhaus principles provide a robust approach to future climate change
- introduce thermal modelling at concept stage and use it as a design tool and not a compliance tool
- consider the role the landscape and external planting can play at introducing micro-climates and dealing with changing rain fall patterns at the start
- if the site and budget allow it, build in the possibility for using active cooling systems. For example MVHR systems can use ground cooling to reduce excessive heat build up in prolonged periods of high external temperatures
- a detailed study of built examples and construction approaches in different climates has proven helpful.

D4FC Factsheet 33:
St Faith's School Masterplan

Contact details

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General project information

Name of project:	St Faith's School Masterplan
Location of project:	Cambridge
Cost of project:	£5350m

Project team

Client:	St Faith's School Cambridge
Designer:	Verve Architects Limited
Contractor:	ISA Build (Phase I) Godfrey & Hicks (Phase IIA) Phases IIB – V to be determined

Other organisations involved (and their role): Roger Parker Associates (consulting engineers), Andrew Firebrace Partnership (structural and civil engineers), Marstan BDB (cost consultants), The Hucks Partnership (landscape architects), Centre for Sustainable Development, University of Cambridge (climate data conversion and dissemination)

Project description

The project is an education sector retrofit and new-build Masterplan to deliver 3480 sqm of improved facilities for St Faith's School, Cambridge. The works are divided into five phases spanning from 2010 to 2020 all using a traditional procurement route.

The existing buildings range in type from Victorian detached villas built circa 1885, single-storey classroom buildings built in the 1970s to more recent additions.

The aim of this project is to create an adaptation strategy for the School that will significantly reduce its overall energy consumption and enable it to cope with climate change, and extending the buildings' design life. A key driver for the study is to provide an exemplar retrofit scheme, the lessons from which could be applied to other buildings of this kind across the UK.

Project timescales and dates

Design and assessment period (pre-planning):

Phase II B – Victorian Villa retrofit and "access for all" upgrade. Project status: at RIBA Stage C–D planning

Phases III V – Project status: at RIBA Stage B pre-planning. Design work is scheduled for 2013 to 2017 and on site 2014 to 2020

Construction period (post-consent):

Phase II A: new classroom block with facilities adjoining Phase I. Project status: at RIBA Stage K construction. Completion scheduled August 2012.

Operation and monitoring period:

Phase I: 1970s single storey classroom block retrofit and extension project. Project status: completed 2011

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- literature and case studies reviews: research is ongoing to ensure that the team is adequately informed of the latest technologies to combat climate change
- risk assessment workshop: during this workshop, all consultants discussed the risks associated with the project using the categories laid out in the *Design for Future Climate* report (Rated Table 1 Section 5) based on the three climate adaptation design challenges namely designing for comfort, construction and water
- risk assessment register: this was developed as a working tool. The output of the risk register was then transformed into a risk vs risk magnitude bar chart
- TAS and PHPP modelling: using Prometheus weather data for the current weather scenario and future files for 2030, 2050 and 2080. The existing buildings and current designs have been tested for three probabilities of occurrence (of climate change) 10, 50 and 90 per cent. Test reference year (TRY) data for the **high** emissions scenario was used in all of the modeling
- SWOT analysis: strengths, weaknesses, opportunities and threats were assessed for a wide range of adaptations. This, along with a cost benefit analysis, assisted the team to collectively agree on the most promising measures to take forward for further testing, modelling and costing.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- client participation: the client is part of the project team and participates in all of the workshops
- concise PowerPoint presentations: the outcomes from Milestone A1 have been presented to St Faith's School during two of the team workshops (no 3 and 4). The presentations took the form of concise PowerPoint presentations with graphs, graphics and results of TAS and PHPP models. The outputs of the modeling of the buildings under study were very effective in highlighting specific problem areas within each building

- minutes of meeting: all meetings are recorded and minutes distributed to the team
- the client proposed using drop box to share the information and results as they were being obtained. All TAS and PHPP models were uploaded onto drop box and this encouraged more interest within the team
- the use of a collaborative medium for communication has provided for an efficient and time critical mechanism to relay key project information.

3 What tools have you used to assess overheating and flood risks?

Comfort

- PHPP (Passivhaus planning package) to establish building performance against PHPP criteria
- climate data convertor (CfSD): new software developed for this project that converts EnergyPlus weather files (.epw) to a format directly applicable to the Passive House Planning Package (PHPP). The convertor provides the climate data, heating loads W1 and W2 and daily temperature swing. CfSD are working on generating data for the cooling loads for future climate scenarios
- TAS (Thermal analysis simulation) to thermally assess the building designs and identify problem areas and cross check results with PHPP results. PHPP considers the building in its entirety and does not focus on particular rooms. TAS modelling has been used to identify the problem areas, in particular which rooms are overheating
- dynamic thermal property calculator (ver 1.0) (Arup) was used to determine thermal mass properties of different forms of construction under study and check against manufacturer's data.

Construction

- trial holes: site base investigations to determine soil profiles
- NHBC data for statistical risks of trees near buildings
- assessment of potential lowering of existing water table.

Water

- EA consulted in respect of flood areas: low risk so not part of the study
- water sensitive landscaping: the Huck Partnership have conducted a visual site survey to update the overall picture of the health of existing planting and trees. The existing vegetation was assessed for drought tolerance.

4 What has the client agreed to implement as a result of your adaptation work?

The client is keen to adopt adaptation measures which have a high cost benefit and are simple to implement providing the client with long-term resilience to climate change. A low embodied carbon design also plays a major role in influencing these decisions.

Detailed design work on the most promising options has only just started (April 2012). However, because of the tight programme, with the second stage of Phase IIA going on site this summer, the client is keen that detailed design of some of the adaptations recommended by the team are concluded in time for incorporation into the building contract. The following adaptation measures are likely to be adopted or have already been incorporated into the detailed design:

Comfort

- natural ventilation (cross ventilation, passive stack and night purging). A fresh planning application is being prepared for Phase IIB Southfield where results from the TSB study are being incorporated into the new design
- mechanical ventilation with heat recovery is currently being tested for incorporation into the Phase IIB Southfield design. Coupled with more effective thermal design, findings from the research have shown that this approach is likely to reduce carbon footprint in the

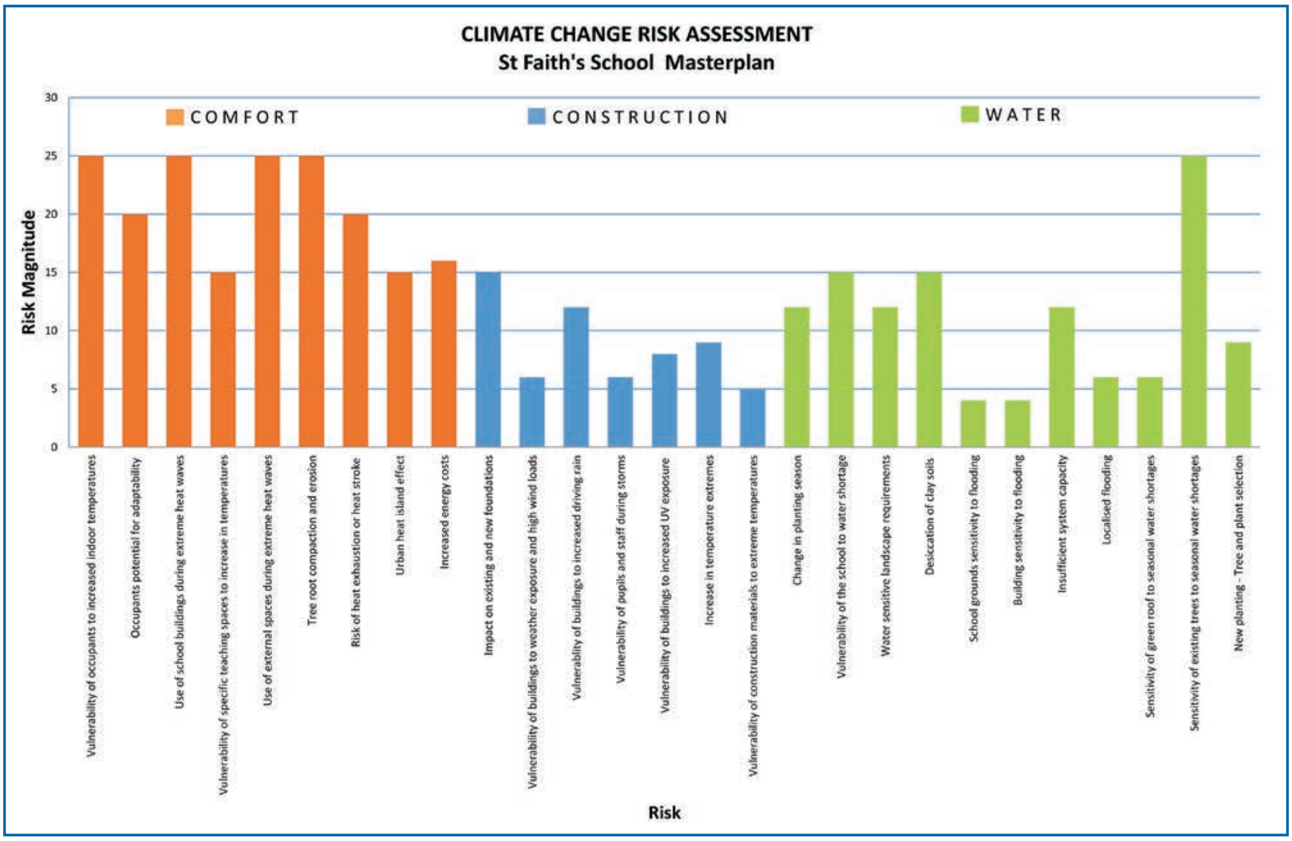
longer term and reduces heating loads, which is still an important consideration for the school in the future.

Water

- water conservation – rainwater harvesting: the school is located in the driest region in the UK and will suffer from reduced rainfall in the future. The client is keen to adopt a water conservation strategy. AFP structural engineers together with THP Landscape Architects have investigated the opportunities to incorporate the proposed pond within the surface water disposal system. Initial design work has identified that this is difficult to achieve due to relative levels at the proposed pond position and Phase IIA classroom extension. Further investigation into finding a workable solution to harvest the rainwater off the roofs and combine it with the pond design is ongoing
- green roof: Verve Architects have investigated the optimum type (mat, plug planting, seed, drainage system, substrate composition and thickness) and pitch for the proposed green roof to minimise need for irrigation on a south facing slope. Manufacturer's Bauder and Blackdown have been consulted. They provided advice, literature and results from independent research on the benefits of different design options. As a result of this study, the proposed roof pitch has been reduced to 9 degrees, plug planting with 70 mm substrate and a drainage system has been selected and incorporated into detailed design for construction. Options for retrofitting onto existing roofs are still ongoing
- future tree and plant selection: the client has agreed to select any replacement trees, shrubs and ground covers from a list of plants adapted to the future climate. Replacement planting will be positioned to ensure the continuing availability of shade essential in keeping the external play areas cool in summer and maintaining biodiversity.

5 What were the major challenges so far in doing this adaptation work?

- establishing thermal conductivity values for existing materials: both TAS and PHPP software require the input of U-values for each building element. Determining the thermal conductivity values of certain existing materials was in some instances difficult
- simulating the true benefits of green roofs: PHPP and TAS software are both not designed to model the benefits of green roofs. The software uses the thermal conductivity values of the soil and drainage mat layers in the U-value calculation. However, this does not describe the energy transfer through evaporation, reflection, convection and thermal mass
- converting the EnergyPlus weather files to a format directly applicable to the Passive House Planning Package (PHPP). The Centre for Sustainable Design (CfSD) has created the Climate Data Convertor, which provides the climate data, heating loads W1 and W2 and daily temperature swing.
- CfSD found that "when the convertor is tested using the Prometheus current weather file (1961 to 1990) for the 4 UK locations, the results show significant over estimation of sky temperatures…As a result of the higher infrared radiation intensity the convertor, using the Prometheus data, has consistently overestimated the sky temperature by a large margin. This finding raises a concern over the quality of the Prometheus infrared radiation intensity data. In order to provide a robust estimation of the sky temperature based on the Prometheus weather data, alternative methods which use input variables other than infrared radiation intensity are sought"
- the convertor adopts Aubinet's three-variable model for sky temperature calculation as this outperformed all other models tested and its prediction error is practically always lower than four per cent
- establishing cooling load data for future climate data: The models currently use the cooling load data from the PHPP climate data for East Anglia (available from the BRE website) for all of the future weather scenarios. The PHPP models are therefore using static cooling load data the quality of which is undetermined. So, CfSD are working on generating data for the cooling loads for future climate scenarios for inclusion in the PHPP models



- verifying the thermal mass properties of construction methods under consideration, eg Tradical Hemcrete and Tradis system using Warmcel insulation
- budget constraints: the client has a fixed budget for every phase of the masterplan. The team is aware that there are limited funds to invest in expensive and complex adaptation strategies. So the strategies taken forward are the most cost effective and simple to adopt
- programme constraints: Phase IIA has a fast-track programme, with insufficient time to incorporate any potential below ground structural adaptations into the foundations. The design required an off-site prefabricated system that could be erected within two weeks, which limits superstructure options
- limited information on predicted wind speeds
- rainfall predictions – data is not specific. It is also not clear how long prolonged dry periods will occur for predicting future water table levels.

6 What advice would you give others undertaking adaptation strategies?

- model the design in thermal modelling software as early as possible, and use it as a tool to test and develop the design to help achieve a building that is more resilient to climate change
- early integration of simple cost effective solutions where appropriate, eg cross ventilation, thermal mass, superinsulation, and orientation of buildings. Passivhaus principles provide resilience to climate change
- ensure that building designs can be adapted in the future as part of the building maintenance cycle and for example using windows for night purging
- do not underestimate the role of green and blue spaces in keeping the external spaces cool especially where these form an important part of the building use, eg play areas in schools
- consider other non-building design related measures too, eg changing the occupancy patterns where the building use permits
- certain areas within the building may need individual solutions, primarily dependant on orientation, size of room and use.

D4FC Factsheet 34:
Princes Park

Contact details

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General project information

Name of project:	Princes Park
Location of project:	Liverpool
Type of project:	New build social housing
Cost of project:	Up to £24m

Project team

Client:	Plus Dane Group
Designer:	Triangle Architects
Contractor:	TBA

Other organisations involved (and their role): Queens University Belfast, School of Architecture (sustainability concepts), The Energy Council (energy and thermal modelling), Sutcliffe Consulting (structural and civil engineering), Markhams (cost advice)

Project description

This project investigates the effects of future climate change on a large social housing development in Liverpool. The development itself involves the design of over 100 houses on a brownfield site within a masterplan of around 240 new houses.

The study explores the opportunities and constraints of using industrialised timber building systems in the context of climate change and the client's aim to deliver high quality, affordable housing. It considers innovative volumetric modular systems with best practice timber frame and will seek to develop both concepts in designing for climate change adaptation.

Assessment was made not only of the performance of the building systems, but also of the effect of siting, shading and external envelope design on thermal performance. Alternative Masterplan studies also consider the effects of the urban layout on flood risk, and wind patterns.

Project timescales and dates

Design and assessment period (pre-construction): the project started in 2004 and has undergone various stages of redesign with a number of developers due to changing political and financial circumstances. The scheme received Planning Approval in July 2013 but has been called in by the Secretary of State. A Public Inquiry will be held in June 2014 with a decision later in the year.

D4FC2 design and study: Sep 2011 to Mar 2014

Construction period (post-consent): Phase 1 Oct 2014 to Apr 2016 (est.)

Operation and monitoring period: building occupied from Apr 2016

Monitoring not within remit of study but report recommends client monitoring relevant to uptake of measures and to compare with other properties if possible.

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

The study is approximately 95 per cent complete subject only to submission of final report. Initial research stages focussed on:

- analysis of projected future weather data
- psychrometric charts to assess cooling strategies
- comparative thermal modelling of a baseline scheme
- future energy modelling (including potential air conditioning loads)
- review of performance and risks of baseline masterplan for ground stability, flooding and wind
- assessment of superstructure, foundations and site stability issues on designs
- review of timber construction systems market and appraisal of selected systems
- climate change risk assessment for a baseline scheme with a focus on high impact risks – the 'crash test'.

The project followed two alternative design adaptation strategies:

- proposals for 'near to market' adaptations, many of which are now incorporated in the approved scheme and tender proposals
- proposals for a more idealised 'future market' solution. This has been developed into a concept design for a climate resilient industrialised housing product called 'IDEAhaus'.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- client involvement in preparing the competition bid and in design team meetings from the start – essential for two-way understanding
- client involvement in setting appraisal criteria and risk assessment
- clear presentation of technical data, eg extent of overheating modelled in baseline scheme houses using projected future weather sets
- meeting with the client's government funding body, the HCA to win political support for the study
- summary presentation to whole client development team on this study and a previous D4FC study

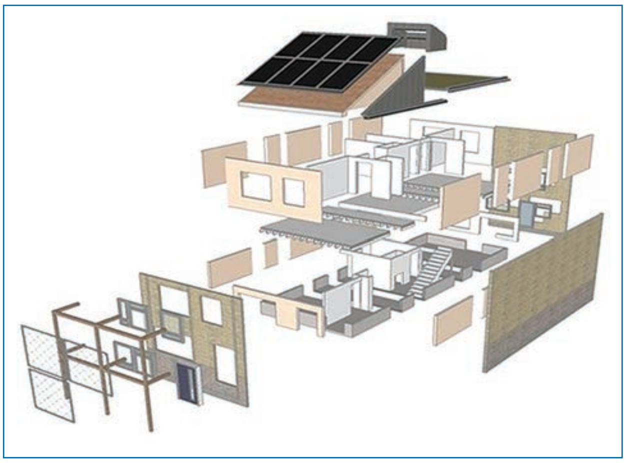
3 What tools have you used to assess overheating and flood risks?

- University of Exeter 'Prometheus' database of future climate models
- IES software – thermal modelling
- Climate Consultant 5.0 – weather modelling including Psychrometric charts

- Sefaira Concept – energy modelling with projected weather files (including potential air conditioning loads)
- Sketch Up – masterplan modelling.

4 What has the client agreed to implement as a result of your adaptation work?

- a longlist of 118 specific recommendations were made to adapt the existing pre-planning design. Of these, a total shortlist of 37 items have been accepted by the client for inclusion in the approved planning scheme and tender stage designs and specifications.
- examples of passive cooling measures adopted include:
  - adding rooflights over stairwells for improved ventilation
  - higher bedroom ceilings to increase stratification of air
  - blockwork construction for thermal mass
  - appropriate tree planting for shade to houses and external spaces
- examples of flood resistant measures adopted include:
  - use of green space, site levels and swales to attenuate and relocate flood risk
  - raise internal services to 750 mm AFFL
  - flood resistant construction and materials
  - no return valves to sewers
  - increased gutter and drain sizes
- a further shortlist of 20 potential future adaptations has been identified which largely involve retrofit or replacement of features due to current financial constraints
- the client is very interested in the study and how it could be applied to this project and at a policy level it will inform their strategy for future construction and setting design performance requirements



- they are interested in possible long-term relationships with building system manufacturers to increase the efficiency of their housing delivery
- there are recognised budgetary constraints in this sector and clear benefits would normally be demonstrated within a 30 year financial 'horizon' for the project and set against risks within that period or otherwise be no or low cost solutions. However, there have also been some discussions around the way both energy/carbon saving measures and climate resilient features are funded and whether new business cases could be developed to increase their viability
- as anticipated, adaptations accepted on this development are from the 'near to market' solutions offered
- the IDEAhaus design concept developed for the 'future market' options was presented at the influential Passive Low Energy Architecture (PLEA2013) conference in Munich which awarded it Best Paper for research. This concept has now been awarded a TSB Smart Fund grant to carry out proof of market research by new business, Green Triangle Studio, in 2014.

5 What were the major challenges so far in doing this adaptation work?

- the 'Prometheus' weather files are very useful but still project a smoothed picture of the future weather and do not describe more extreme events such as storms with maximum gust speeds and a future 1:100 year flood which are important design criteria. The team have had to invest in additional research and supposition to explore these risks further
- the housing sector has little experience of thermal modelling or rainfall analysis and its view of climate change risk assessment is as varied as that of the public at large. There would be greater likelihood of more fundamental design recommendations being implemented if the research and option appraisal stages were more in advance of the client's delivery programme, or if local 'rules of thumb' could be developed to establish new baseline assumptions about building performance.

6 What advice would you give others undertaking adaptation strategies?

- start research and option appraisal as early as possible in order to be ahead of the development timetable and influence the project briefing
- engage the client fully in the risk assessment process
- present risk and performance appraisals clearly to raise client awareness
- relate performance evaluation to the client's economic 'horizon'
- understand that the building must perform in response to 'weather' not 'climate'
- understand that weather projections offer a range of possibilities and try to allow for future adaptability – 'long life, loose fit'.

D4FC Factsheet 35:
Cliftonville

Contact details

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General project information

Name of project:	Cliftonville
Location of project:	Thanet, Kent
Type of project:	Retrofit of existing Victorian and Edwardian, four to five storey terraced properties
Cost of project:	$22m

Project team

Client:	Thanet District Council
Designer:	Stephen Donald Architects/Daedalus Environmental Limited/Studio Engleback
Contractor:	TBC

Other organisations involved (and their role): WT Partnership (QS/cost modelling), Radius Regeneration (project co-ordination)

Project description

The project has been developed with the aim of regenerating areas of both Margate and Cliftonville which have some of the highest levels of deprivation in the region. It involves the purchase and refurbishment of a number of large properties to help facilitate the regeneration of the area by (amongst other projects):

- the reinstatement of hotels to provide high quality tourist accommodation for the area
- the conversion of HMOs and other low grade residential accommodation, retrofitting them to a far higher standard, and then creating a management structure using an intergenerational model of living.

It also includes the remodelling of public open space, specifically Dalby Square, in the heart of the area.

The properties themselves are of consistently exceptional architectural merit, typical of coastal towns developed from the Victorian era and into the Edwardian period. They are typically very large, four to five storey terraced properties, typical of seaside towns.

Project timescales and dates

Design and assessment period (pre-planning): January 2012 to October 2012

Construction period (post-consent): 2013 to 2022

Operation and monitoring period: any monitoring will run for a period of two years after the first property is complete

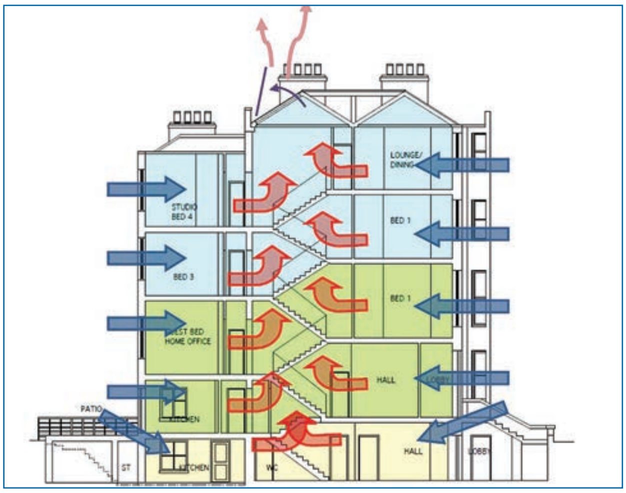
Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- the project is addressing both built form (the existing Victorian and Edwardian buildings) and the external public realm. In order to assess the buildings, we carried out a number of baseline thermal modelling exercises against predicted weather data for 2080 under the high and medium emission scenarios, at 50 and 90 per cent confidence intervals. For each of those scenarios, we assessed:
  - a five storey HMO to be renovated to a single property for intergenerational living
  - a five storey HMO to be renovated to create a high quality boutique hotel
  - a four storey house currently occupied
  - the same four storey house facing the opposite direction (on the opposite side of the square)
- it was decided early on to use 2080 data – the modelled properties are already around 120 to 150 years old and it is expected that they will remain there into the distant future. They also lie within a recently constituted conservation area
- by applying the thermal modelling tests, using IES VE, and the Exeter University Prometheus data, we have been able to identify potential areas of risk in the designs for both the renovations as well as the existing four storey property
- we have also carried out a demographic study and agreed assumptions to take forward as part of the study. This has been coupled with work carried out by TDC in relation to the cultural heritage and history of the area, to understand how the area has developed to date and what the likely changes in the future may be
- the landscape/public realm assessment has not been carried out using software, but by trying to develop an understanding of the impacts of climate change at different scales (micro, meso and macro), and then applying that understanding to this specific location. This work has been carried out by Luke Engleback and his team
- identifying measures has been a team effort. At this stage in the process there was nothing that was 'out of bounds', and we created a scoring matrix that we used as a professional team to prioritise key measures and refine the list into something practical and manageable. Each potential measure was assessed against a number of criteria, at a high level, for example, ease of installation, availability, efficacy at adaptation, financial savings, benefits to local economy etc. From that we were then able to develop the options appraisal.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- Thanet District Council is the client and contracting party with the TSB. The project is co-ordinated by others, however, so in order to ensure delivery and progress, and to make sure that the work, data and results are communicated effectively, we have regular team meetings to discuss everything in detail
- we are keen to ensure that this work and the results of the study are integrated seamlessly with the wider regeneration activity planned for the area, so it is essential that the two workstreams carry on hand in hand.



3 **What tools have you used to assess overheating and flood risks?**

- the software used for the thermal analysis is IES VE: this has been and is continuing to be used to assessed building fabric and other design options.
- the external public realm work has been based on the Ecourbanist approach to design, part of which incorporates the need to understand multifunctional environmental design. This, in essence, seeks to show the multiple benefits environmental interventions can add to a scheme, and seeking to understand and inform the total environment and how people use it. Part of this is trying to understand how climate change will affect the environment, and how measures used primarily for other things, can help adaptation. Tree planting is a simple example – the primary driver may be aesthetic improvement or ecological enhancement, but they also provide shading in a much warmer climate.

4 **What has the client agreed to implement as a result of your adaptation work?**

- the report was endorsed by the Thanet District Council Cabinet system
- it is an aspiration to use the report to inform the Cliftonville Design Code.

5 **What were the major challenges so far in doing this adaptation work?**

- it is too early in the process to reach conclusions on this point.

6 **What advice would you give others undertaking adaptation strategies?**

- it's difficult at this early stage to give advice, however a couple of things are clear: make sure you all agree early what your assumptions about climate change will be, not only in terms of predicted weather data, but also in terms of the community for which the strategy is being developed. You need to make informed and realistic assumptions about how the demography will change, how the building use will evolve, and if possible about how society will work.

D4FC Factsheet 36:

London Bridge Station Redevelopment

Contact details

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General project information

Name of project:	London Bridge Station Redevelopment
Location of project:	London Bridge
Type of project:	Retrofit
Cost of project:	£350m

Project team

Client:	Network Rail
Designer:	Grimshaw
Contractor:	TBA

Project description

London Bridge Station is one of the oldest in London and has developed over many stages such that it currently operates on several levels and areas with complex congested interchange facilities. It is the UK's fifth busiest station and handles about 120 000 passengers at peak time between 8.00am and 10.00am. It can become significantly overcrowded during this and other periods of time.

The project includes the redevelopment and reconfiguration of London Bridge Station including concourse with retail spaces, station accommodation, tracks and platforms, in order to provide an interim and new station layout that accommodates the passenger demand forecasts up to 2076 and to improve access to the station.

Project timescales and dates

Design and assessment period (pre-planning): now

Construction period (post-consent): 2013 to 2017

Operation and monitoring period: 2017 onwards

Further project details

1 **What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?**

- risks were assessed using a rating of probability and impact resulting in a rating between low and extreme
- where possible risks were quantified in terms of their impact on the building under different climate scenarios
- some adaptation ideas were generated at the CCA focus session held with the client and design team early in the process. Additional ideas were generated as the project progressed by the CCA team.

2 **How have you communicated the risks and recommendations with your client? What methods worked well?**

- risks and recommendations were communicated to the client using a combination of text, graphics and numerical data in presentation and discussion settings and more formally in printed reports
- the most mutually beneficial interactions were roundtable discussions of the issues, implications and likely solutions to the problem. The complexity, uniqueness and originality of the climate change risks meant that the pertinent issues can be lost in the weight of data and explanation.

3 **What tools have you used to assess overheating and flood risks?**

- to assess comfort we have used TAS modelling software with future weather files provided by the Prometheus project at the University of Exeter
- assessing flooding issues EPA flood map resources and the Environment Agency's guidelines documents, BS 8515:2009, the *RainCycle calculator for rainfall harvesting*, CIRIA C644 *Building Greener for guidance on green roofs* and UKCP09 rainfall data
- construction risks were assessed and informed by UKCP09 wind and rainfall data, BS 6399-2:1997 and BS8104:1992.

4 **What has the client agreed to implement as a result of your adaptation work?**

- from the design analysis and climate change risk review the team has agreed to pursue the following measures as part of the strategy, pending the cost plan review:
  - future improvements in concourse equipment efficiencies to reduce internal gains and lower temperatures
  - design review of openable areas to facilitate sufficient natural ventilation air changes while avoiding adverse comfort effects of wind
  - rainwater harvesting
  - raising the level of mechanical and electrical equipment to minimise flood risk.

5 **What were the major challenges so far in doing this adaptation work?**

- so far the adaptation work has run smoothly. We believe to realise value for the client there needs to be an emphasis on being able to quantify the impact of climate change scenarios to understand whether immediate or delayed investment is necessary. This can be done with some degree of certainty for most risks however some construction and water risks require further technical support to enable quantification and enable confident decision making
- the complexity of the station, the limited space available and the limits of the project budget meant that adding extra resiliency and redundancy was a challenge as was the co-ordination of rainwater harvesting pipework and green roof.

6 **What advice would you give others undertaking adaptation strategies?**

- to some extent the station design is intrinsically resilient and it is worth noting why to highlight what could be done on other projects:
  - sufficient openings for effective natural ventilation flow
  - dual layered platform awning to limit the effect of radiant heat from exposed roof surfaces to platform occupants
  - chiller (retail) and heat rejection capacity designed to 35°.

D4FC Factsheet 37:
Brighton New England Quarter

Contact details

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General project information

Name of project: Brighton New England Quarter

Location of project: Brighton

Type of project: New build project containing residential, hotel and office space

Cost of project: £25m

Project team

Client: Hyde

Designer: E3 Ltd/Yelo Architects

Contractor: TBC

Other organisations involved (and their role): Mendick Waring (M&E consultant), Philip Pank Partnership (QS)

Project description

Site J of the New England Quarter (NEQ) is a large mixed use development adjacent to the railway station in the centre of Brighton. Site J comprises of 147 residential units, a hotel, office and retail floor space (including a café) and a public square as outlined below:

- residential: 147 units at a density of 260 dwellings/ha
- hotel: 98 bedrooms
- office space: 3000 m^2
- public square: 1200 m^2
- retail: 240 m^2

The site is very visible in the centre of the city, and project partners are aiming to achieve high standards of sustainability. The residential units are split into two blocks of eight storeys in height with other uses located on the ground floor. All elements of Site J will form part of the assessment for the Technology Strategy Board project.

This is a fantastic opportunity to examine climate change adaptation in an integrated way, considering a range of measures suitable for residential, office, retail, hotel and open space uses.

Project timescales and dates

Design and assessment period (pre-planning): December 2011 to October 2012

Construction period (post-consent): January 2013 to July 2014

Operation and monitoring period: July 2014 onwards

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- the risk assessment was based on an analysis of the 2080, high emissions scenario weather data (at 90 per cent confidence interval), looking at key factors in relation to a building of this type, and the associated uses. The geography/terrain of the site was also critical in the analysis given the extent of the surrounding buildings and the density of the site. The approach to identification of measures and the options appraisal is based on a collaborative approach between the thermal modellers, the architect and the M&E consultant, to establish a broad spectrum of options and ideas that will be iteratively narrowed following ongoing dialogue with both the client and the QS, who is carrying out a full lifecycle costing exercise on the ideas and design generated.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- the risks were discussed in detail at project meetings with the client – the risk assessment itself was based on an analysis of the Prometheus weather data. A face to face approach seems the most effective means, combined with strong visual images derived from both the weather data and the thermal modelling. Any communication needs to be coupled with an understanding of the investment/cost and benefit to have a meaningful impact.

3 What tools have you used to assess overheating and flood risks?

- the primary tools used during the project include IES VE with associated modules for dynamic thermal modelling and assessment. We are primarily focusing on the building related, thermal comfort issues, and therefore are focusing on the building materials, design and overall M&E strategy. The weather files used were from the University of Exeter's Prometheus project. In addition, we used SWOT analysis and lifecycle cost assessment to look at the risks and the associated cost benefit analysis of proposed solutions.

4 What has the client agreed to implement as a result of your adaptation work?

- the client is examining the recommended solutions as part of the ongoing development of the scheme. The simpler recommendations – such as exposed concrete finishes – are simpler to implement and are ultimately straightforward to carry out. The more complex design solutions for natural ventilation – the Cool Box – need further research and development before implementation.

5 What were the major challenges so far in doing this adaptation work?

- the major challenges relate to the ability to provide design solutions that are cost effective in the long term, irrespective of whether there are solid logical arguments for implementation. Despite the fact that changes to the climate are arguably already being felt, investment strategies for construction – both residential and commercial – invariably do not span the 30 to 70 years into the future which recommendations and design solutions may require to warrant implementation. The fact is, if the solution doesn't 'stack up' now, the relatively short sighted nature of commercial decisions, it is unlikely to be progressed.

6 What advice would you give others undertaking adaptation strategies?

- compelling arguments from using climate science and predictions are very important, but to establish this relatively straightforward message in practice, a great deal of research and assessment needs to be carried out on a building by build basis in advance. We believe there are some key features of a design team that need to be in place to get to this point:
    - be highly competent and understand the interrelationships and the impacts of a changing climate
    - be able to explain the concepts clearly
    - make fully informed decisions about the impact of the measures proposed
    - needs to be able to gain consensus on the assumptions used, and agreement on these from the client
- be able to sell the benefits in a compelling manor
- be entirely open about the limitations to any climate change assessment

D4FC Factsheet 38:
Carrow Road, Norwich

Contact details

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General project information

Name of project:	Carrow Road, Norwich
Location of project:	Norwich, Norfolk
Type of project:	New build river frontage development of about 46 flats above commercial unit on the ground floor
Cost of project:	About £6m

Project team

Client:	Broadland Housing Association
Designer:	Ingleton Wood
Contractor:	TBC

Other organisations involved (and their role): University of East Anglia (climate change data and dissemination), North Norfolk District Council (local authority perspective), David Daniels (Passivhaus consultant), Rossi Long (consulting engineers), Sheils Flynn (landscape architects) and Aecom (cost consultant)

Project description

Broadland Housing Association is preparing proposals for a new build riverside development of 250 apartments and commercial uses. The scheme is being designed to Passivhaus standards.

Passivhaus evolved in Sweden and Germany that have different climates to Norfolk. The intention of the D4FC project is to model future climate change on the first phase of approximately 46 flats and a commercial unit to develop a future proofed Passivhaus standard for the East of England climate.

Learnings from the project shall be incorporated into Broadland Housing Association's wider development programme.

This is a client led project.

Project timescales and dates

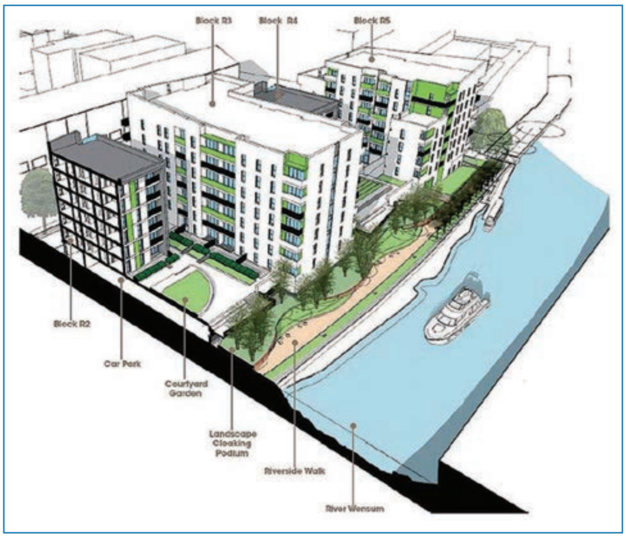
Design and assessment period (pre-planning): September 2010 to December 2012

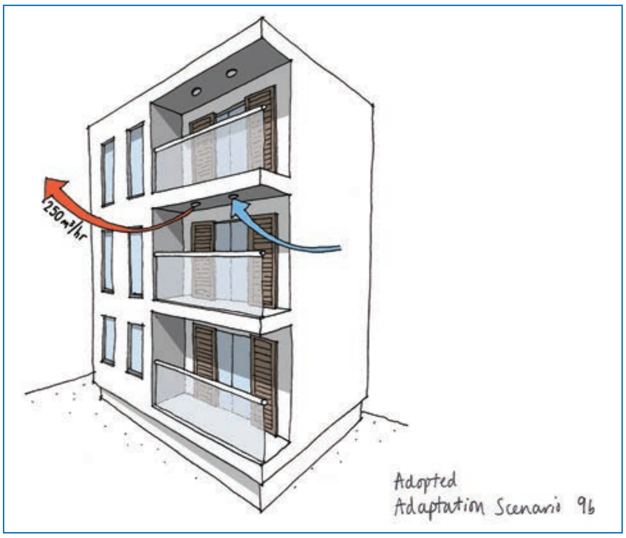
Progress with the development proposals has been hampered by a protracted planning application process. The outline planning consent was eventually granted in June 2013 (15 months after submission) and reserved matters approved in November 2013.

The design has been progressed to RIBA stage E in order that the reserved matters consent includes relevant adaptations required to deliver Passivhaus.

Construction period (post-consent): 2014 to 2016

Operation and monitoring period: TBC





Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- the project is still at an early stage
- the full design and technical team from the Carrow Road development has been commissioned to be involved in the D4FC, so as to ensure maximum integration of learnings into the project and maximise dissemination throughout our consultant base
- consultants were required to research future climate issues within each of their professions and review available D4FC1 reports to ensure a good base level of knowledge
- findings were presented to the wider group at an initial workshop that led to a brief for the University of East Anglia to prepare future climate data
- consultants then considered the relevant parts of Bill Gething's three areas of climate impacts to highlight risks and propose options for adaptations
- this was presented to the project team at a second workshop where potential adaptations were shortlisted in terms of costs, practical application and likely buy-in from the client.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- the consultant team has just embarked on designing adaptations for costing by the quantity surveyor. These will then be presented to the members of the client team who control the budget. The project manager is also a member of the client team and so has been able to offer direction and keep other members of the client team informed of general progress to increase the likelihood of buy-in.

3 What tools have you used to assess overheating and flood risks?

- comfort: the climate change data is relatively confident of increased temperatures. This has allowed the architect and Passivhaus consultant to undertake risk assessments of increases in temperatures on the building. The project has recently acquired TAS BIM software to allow the architect to model these scenarios in more detail
- construction: the climate change data appears unable to predict changes to wind speed and rainfall. Incremental increases of five per cent and 10 per cent have been modelled for wind speed. Cladding material manufacturers have been consulted on adapting to higher wind speeds. The use of timber cladding and window reveal detailing are being reviewed to mitigate the impact of greater driving rain
- water: the project fronts the River Wensum whose catchment covers much of the Norfolk. It is estimated that over a third of rain falling in Norfolk will eventually join the river upstream and pass the site making it susceptible to flooding. In the absence of climate change data for rainfall five per cent and 10 per cent increments in flood levels have been modelled. The 1 in 100 flood level has been overlaid and found to accord with the highest flood in modern history that took place almost 100 years ago in 1912. The design of the residential element of the building above a commercial unit means it will not be directly affected by higher flood levels. However, it will be effected by flooding of the means of escape from the building to dry land
- consulting engineers have advised that the site and Norfolk generally lacks the London clay soils associated with heave during droughts. East Anglia has always had a semi-arid climate and been dependent on plant selection and irrigation for forestry and agriculture. Droughts are forecast to increase. The landscape architect is reviewing landscape design, plant selection and irrigation.

4 What has the client agreed to implement as a result of your adaptation work?

- the project has yet to formerly report to the client
- experience of working with the Code for Sustainable Homes for many years shows that clients, construction teams and end users are often confused by unclear

climate data and overtly academic and impractical technical solutions

- where possible the project team is adopting practical and cost effective approach to risk assessments and adaptations to ensure that methodology and findings are easily comprehended by the client. Where possible the aim is to devise straightforward and rule of thumb solutions that can be simply disseminated to the wider client and consultant base.

5 What were the major challenges so far in doing this adaptation work?

- obtaining credible climate change data
- keeping the project team focused and not allowing consultants to get into too much detail in their own specialist areas
- financial pressures on the client in the current economic climate.

6 What advice would you give others undertaking adaptation strategies?

- do not let your consultants get too carried away with the what-if scenarios for climate change. Climate change forecast need to be based on sound data or simple plausible predictions to have credibility with clients
- being realistic about the size of budget that a client is likely to entertain for adaptations
- providing clear and concise data and recommendations to the client to allow climate risks to be assessed and decisions made amongst the many other issues that need to be considered.

D4FC Factsheet 39:

Climate Adaptive Neighbourhoods (CAN) Project

Contact details

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General project information

Name of project: Climate Adaptive Neighbourhoods (CAN) Project

Location of project: Norwich

Type of project: New build residential

Cost of project: £8.3m

Project team

Client: Serruys Property

Designer: Baca Architects

Contractor: TBC

Other organisations involved (and their role): Lanpro (planning), Atelier Pro (masterplan), JBA and Total Flood Solutions (flood risk)

Project description

The Climate Adaptive Neighbourhoods (CAN) project is a holistic design initiative to climate adaptive domestic buildings in flood prone areas.

The study site is part of a major regeneration proposal for a site in Norwich, partly located on the floodplain. An innovative approach to floodrisk has already been adopted, in which the site is allowed to flood. The buildings have been carefully positioned to minimise the risk of flooding and where flood risk still exists the buildings are planned to be resistant to floodwater. The CAN project will assess how future climate will affect the development and how measures to address floodrisk may be combined with other measures to simultaneously address a wider range of climate issues that could emerge in the next 70 years.

Project timescales and dates

Design and assessment period (pre-planning): 2010 to 2012

Construction period (post-consent): TBC

Operation and monitoring period: TBC

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

The following method was used to assess risks so far:

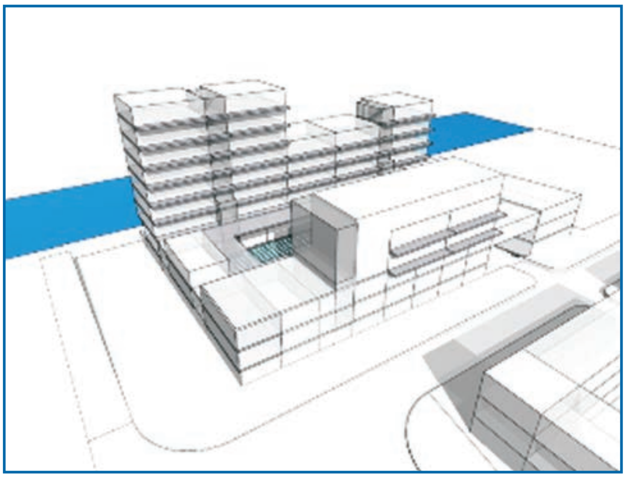
- **Weather Generator Project:** to assess the future climate for the high emissions in 2030s and the medium emissions for the 2080s between the 10th and 90th percentiles. This was combined with Environment Agency predictions for the Anglian Region. This enabled a range of future predictions and average to be identified all of which were carried forward for assessment of options
- an initial assessment of adaptation options as given by the TSB was carried out in the context of the climate risks to the site, against previous projects/experience within the team and other literature. These measures were set out in a matrix against the headline issues and further appraised to enable certain options to be ruled out and 18 identified for detailed consideration
- appraisal of adaptation measures was then carried out across three sections: site (the layout and orientation of the buildings and the external works), layout (the internal layout and uses of rooms in the building), construction (the materials and construction details). This involved a technical and cost review of products, precedents and options (UK and international).
- from this three options were identified for most of 18 measures, with about 50 options in total. Multi criteria analysis of the measures/options was then carried out to identify a suite of best options. A set of assessment criteria was agreed with the team and client and then weightings, were contributed by a range of individuals and stakeholders.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- the client and employers agents are invited to each workshop to participate in and contribute to discussions and progress
- additional interim reports have been developed to document the process
- 3D modelling and graphic representation of options being considered (often just photographs of precedents/examples) is the most effective way of communicating.

3 What tools have you used to assess overheating and flood risks?

- Environment Agency: flood flow predictions to input flows into Tu-flows 2D flood model
- 2D flood model: used to assess future flood depths, velocity and hazard impacts (ongoing)
- assessment of daylight and sunlight impacts using BRE guidelines (to be considered)
- drought was assessed based on the number of events with consecutive days without rain



- the soil investigation was reviewed against the possible foundation options.

4 What has the client agreed to implement as a result of your adaptation work?

A set of preferred options has yet to be identified, therefore no decisions have been made as to what to include/integrate into the design. Some of the likely considerations will be:

- pile foundations
- increased tree cover to provide future shading
- deck access to provide solar shading
- stairwells to provide flood flow paths
- resilient building materials
- raised floor levels
- ventilated void
- external shading
- below ground storm water attenuation.

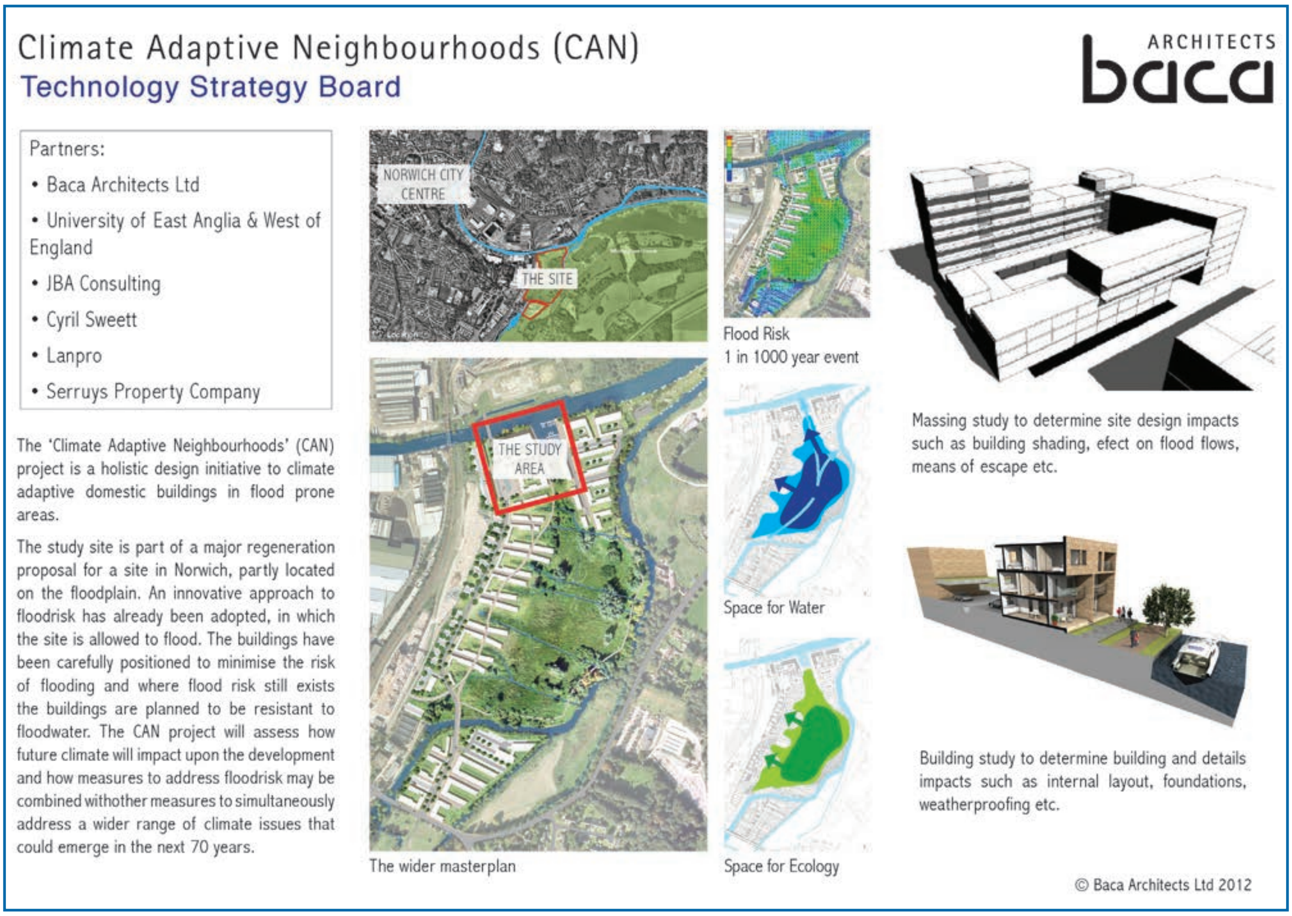
5 What were the major challenges so far in doing this adaptation work?

The most difficult challenges have been:

- to rule out options for further consideration and to focus on the key issues for this project
- compatibility of regulations, for instance achieving level thresholds where it may be better to raise internal floor levels to provide barriers to water ingress
- lack of guidance on drought criteria in UK and duration, therefore capacity of rainwater harvesting/grey water recycling required
- providing space at ground level along with parking, access, bin stores etc to increase rainwater harvesting or SuDs storage below ground level.

6 What advice would you give others undertaking adaptation strategies?

- the future climate predictions were far less dramatic than we first anticipated. Some simple changes to the building design to facilitate future control measures to be added



- solar orientation of buildings is still going to be an important consideration, however, in flood risk sites the orientation and relation to the water environment must take priority
- it is important to consider adaptation measures in the round so that passive benefits can be taken from active measures required to respond to the environmental conditions, such as access and shading, flood storage and natural ventilation or SuDs storage and green space for cooling.

D4FC Factsheet 40:

Oakham North

Contact details

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General project information

Name of project: Oakham North

Location of project: Oakham, Leicestershire

Type of project: 135 new build homes, phase 1 of a 1200 home urban extension to Oakham

Cost of project: Estimated £26m for phase 1

Project team

Client: Larkfleet Homes

Designer: LDA Design

Other organisations involved: Wormald Burrows (drainage engineering), Buro Happold (thermal modeling) and Capita Symonds (structural engineering and QS)

Project description

The project is looking at the impacts of design, services and the public realm on the resilience of new timber-framed homes to climate change. The key climate change risks that are being explored are:

- thermal comfort, internal and external
- surface water flooding
- clay soils with a high shrink-swell potential
- water availability for domestic use.

The project aims to:

- recognise the uncertainty in the severity of climate change impacts
- be sensitive to commercial realities and to give confidence in the costs and benefits of the strategy
- make use of adaptation measures that result in a wider positive benefits for the development.

The design of adaptation measures along with evidence of their costs and benefits will help the developer to take the impacts of climate change into account and will provide valuable lessons for the Government and the wider construction industry.

Project timescales and dates

Design and assessment period (pre-planning): outline consent has been given and detailed design and production information under development

Construction period (post-consent): three year construction period for phase 1 starting in 2012

Operation and monitoring period: feedback will be received from client sales team and from new homeowners

CIBSE Engineering a sustainable built environment
Technology Strategy Board Driving Innovation
Knowledge Transfer Network Modern Built Environment

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- we have used a risk-based methodology to identify the most important risks to mitigate through designs
- we recognise the uncertainty implicit in future emissions trajectories and in the climate projections. Over-adaptation as well as early adaptation should be avoided. We are aiming to incorporate the flexibility needed to respond to new information and increasing certainty over time
- at the same time several low regret measures are best designed in from day one. It is important that these are identified.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- our client has a good understanding of climate change issues and has contributed to our analysis of site-specific and construction risks
- we have been keeping the client up-to-date with our emerging findings by circulating meeting minutes. We will be engaging with them in forming the strategy, and in developing guidance for the wider industry through a series of workshops.

3 What tools have you used to assess overheating and flood risks?

- we are using IES with the Prometheus weather tapes produced by Exeter University to build thermal models for three house types and to assess changes to the microclimate from increased green cover. The findings are sensitive to occupancy assumptions and we will be testing these to better understand actual building performance:
  - during periods of overheating, are there cooler spaces in the home that can act as a refuge?
  - will the home be comfortable for families with different lifestyles?
  - what do alternative metrics of thermal comfort show?
- we are also using the Met Office's projections of changes in the frequency of extreme rainfall events with Micro Drainage modeling software to evaluate the existing drainage design and the appropriateness of the Environment Agency's current guidance on flood risk.

4 What has the client agreed to implement as a result of your adaptation work?

- we have not reached this stage of the project as the options appraisal and cost assessment have not been completed.

5 What were the major challenges so far in doing this adaptation work?

- the masterplan layout and other features of the development cannot be altered at this stage, limiting some types of intervention
- while there are clear adaptation (and wider) benefits to integrating additional green infrastructure into the masterplan, there are a number of legitimate concerns which we are trying to address:
  - potential conflicts with Secured by Design criteria
  - development density –developing street sections which include trees and other services without decreasing development density
  - local authority commuted sums as a disincentive
- ensuring that there is a plan for managing and maintaining the adaptation measures upon which the whole development is dependant:
  - bringing flooding infrastructure into the public realm
  - community ownership and governance issues
- timber framed buildings have low embodied energy but they are inherently lightweight, making them more vulnerable to overheating.

6 What advice would you give others undertaking adaptation strategies?

- the strategy needs to be realistic about what measures are likely to be commercially viable for the developer
- the strategy should focus on low cost, low regret measures that reduce the cost of future adaptations. Also, measures that improve the marketability of quality of the development in other ways should be prioritised.

D4FC Factsheet 41:

Westbrook Primary School (Andrew Ewing School)

Contact details

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General project information

Name of project:	Westbrook Primary School (Andrew Ewing School)
Location of project:	Hounslow
Type of project:	New build
Cost of project:	£8.6m

Project team

Client:	Hounslow Council
Designer:	Pollard Thomas Edwards Architects
Contractor:	out to tender

Project description

Located in the London Borough of Hounslow, Westbrook Primary School provides education to primary school students aged 3 to 11 years. The project includes the demolition of the existing facility and the erection of new school buildings at an alternative location on the site. A main challenge of the site is its location under the Heathrow flight path and the acoustic issues it presents to natural ventilation and energy efficiency requirements. One solution employed by the project is the use of a thermal labyrinth. The labyrinth is used to provide outside air that has been thermally modulated by the earth rather than actively conditioned, giving potential energy and acoustic benefits and an intrinsic long-term resilience to the effects of climate change.

Project timescales and dates

Design and assessment period (pre-planning): now

Construction period (post-consent): July 2012 onwards

Operation and monitoring period: September 2013 onwards

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- risks were assessed using a rating of probability and impact resulting in a rating between low and extreme
- where possible risks were quantified in terms of their effect on the building under different climate scenarios
- some adaptation ideas were generated at the CCA focus session held with the client and design team early in the process. More ideas were generated as the project progressed by the CCA team.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- risks and recommendations were communicated to the client using a combination of text, graphics and numerical data in presentation and discussion settings and more formally in printed reports
- the most mutually beneficial interactions were roundtable discussions of the issues, implications and likely solutions to the problem. The complexity, uniqueness and originality of the climate change risks meant that the pertinent issues can be lost in the weight of data and explanation.

3 What tools have you used to assess overheating and flood risks?

- to assess comfort we have used TAS modelling software with future weather files provided by the Prometheus project at the University of Exeter
- assessing flooding issues EPA flood map resources and the Environment Agency's guidelines documents, BS 8515:2009, the *RainCycle calculator for rainfall harvesting* (WaterScan), *Building Greener for guidance on green roofs* (Early *et al*, 2007) Win-Des MicroDrainage for site drainage calculations and UKCP09 rainfall data
- construction risks were assessed and informed by UKCP09 wind and rainfall data, the site investigation report, the Eurocodes (BS EN 1990, 1991) and BS8104:1992.

4 What has the client agreed to implement as a result of your adaptation work?

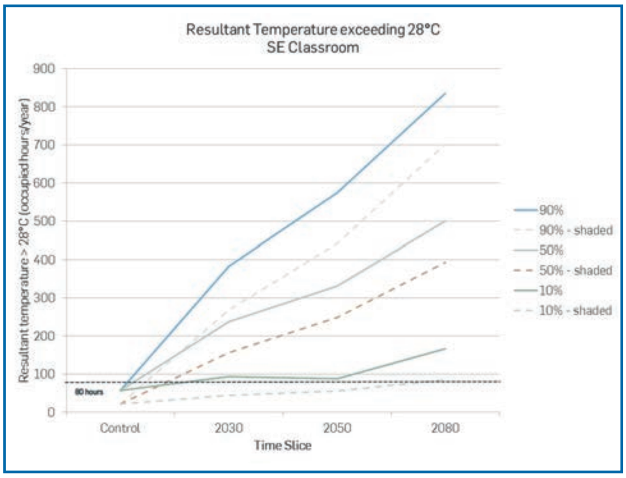
- the client has agreed to all proposed modifications pending the cost impact as provided by the competitive tender. Specifically, the following has been noted as part of the tender package addenda:
  - widening of the earth tubes
  - provision of structural fixing points to allow ease of shading retrofit in future
  - planting of additional trees
  - provision of an extensive green roof on flat roof locations
- rainwater collection from central pitched roof location and reuse in toilet flushing.

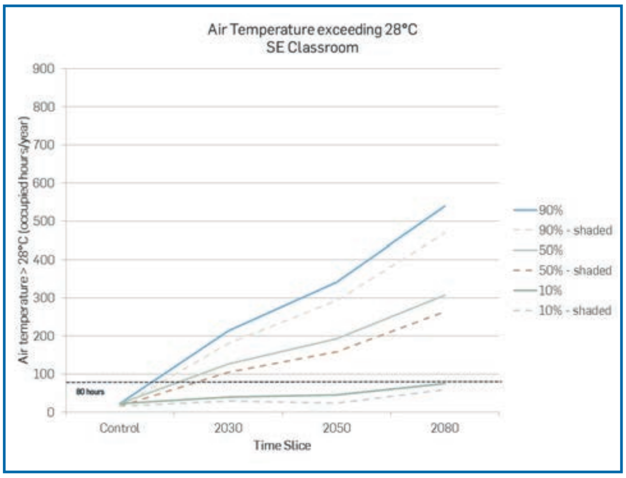
5 What were the major challenges so far in doing this adaptation work?

- so far the adaptation work has run smoothly. We believe to realise value for the client there needs to be an emphasis on being able to quantify the impact of climate change scenarios to understand whether immediate or delayed investment is necessary. This can be done with some degree of certainty for most risks however some construction and water risks require further technical support to enable quantification and enable confident decision making.

6 **What advice would you give others undertaking adaptation strategies?**

- where possible, the use of thermal labyrinths are a great way of smoothing out the extreme effects of climate change in a passive way. This is a strategy that is intrinsically very resistant to the temperature effects of climate change.





D4FC Factsheet 42:

Environmental Sustainability Institute

Contact details

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Tel:	01752 671430/01392 724143

General project information

Name of project:	Environmental Sustainability Institute
Location of project:	Penryn, Cornwall
Type of project:	New build
Cost of project:	£30m

Project team

Client:	University of Exeter
Designer:	Stride Treglown
Contractor:	Leadbitter

Other organisations involved (and their role): Method (M&E), Halcrow (structural engineers), University of Exeter (building physicists and dissemination)

Project description

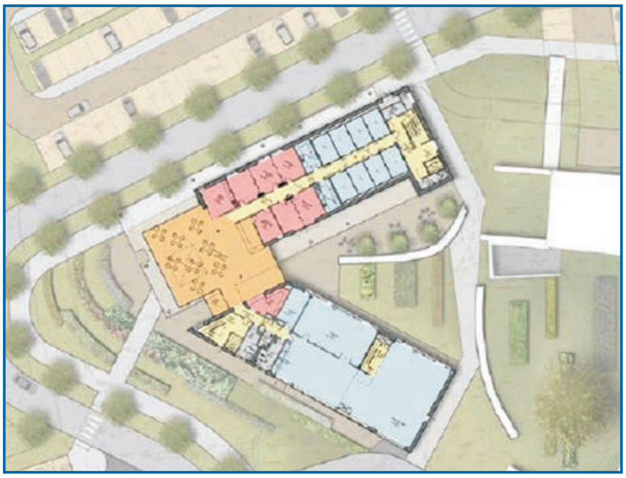
The University of Exeter's Environment and Sustainability Institute (ESI) is a £30m interdisciplinary centre leading cutting-edge research into solutions to problems of environmental change. It is based on the University's Cornwall Campus, near Falmouth. Its aim is to facilitate teaching, research and commercial application of environmental and sustainability knowledge. As such, it is being built to the highest sustainability standards (BREEAM Outstanding) and will have to be "living proof" of its credentials. This extends to being fully adaptable to the effects of climate change. The building will contain a mix of spaces including offices, laboratories, communal and workshop spaces, and as such the specific challenges to each of these spaces will make the findings of this work directly relevant to a large number of future buildings. The total gross internal area of the building is about 3200 sqm.

Project timescales and dates

Design and assessment period (pre-planning): August 2009 to April 2010

Construction period (post-consent): April 2011 to August 2012

Operation and monitoring period: August 2012 to July 2013



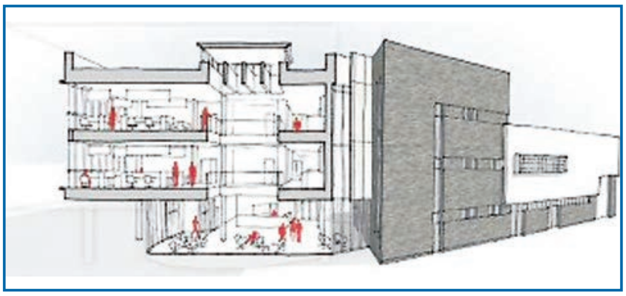
Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- broad adaptation risks taken from TSB Design for Future Climate and the ESI project was assessed against those risks
- magnitude of climate impacts at the site were taken from site specific (5 x 5 km) climate projection data based on UKCP09 data using the University of Exeter Prometheus project
- the A1FI climate change scenario was chosen as it best represents the current status quo and takes a worst case scenario approach
- worst case climate change was assumed for building related risks. This implied using either the 10 per cent or 90 per cent probability scenarios depending on the parameter
- a more lenient approach was taken for landscaping issues, ie 33 per cent or 67 per cent scenarios as consequences of landscape failure were deemed to be less critical
- the“expect the best, plan for the worst, and prepare to be surprised” maxim was used as a useful guide
- the main risks identified for the project were overheating of the building/keeping cool both internally and externally, water stress due to reduced summer rainfall, increased risk of flooding downhill of the site and risks to the ability of the landscape and ecology to adapt to the future climate.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- the client was present at the risk assessment workshop which was used to discuss identified risks and potential adaptation measures. This was felt to be crucial to both inform and engage the client, manage expectations and steer adaptation proposals towards meaningful and realistic ends for the project scope and stage within the schedule
- adaptation risks and adaptations have been investigated as individual sub-tasks within the project. Output from each of these tasks has been communicated from the task investigator via the principal contractor and client project manager. RFIs have been produced where it has been agreed by the client to make changes to the design. This element of the project was communicated mainly through email, which was found to work well
- the adaptation study on this building was undertaken during the construction phase of the project. Under ideal circumstances adaptation would have been considered at this level of detail far earlier in the design stage. Had this been the case design team meetings would have been expected to play a greater and more useful role for communicating risks and recommendations.



3 What tools have you used to assess overheating and flood risks?

- thermal comfort: risks assessed by modelling of proposed initial design under future climates using the IES Virtual Environment using UKCP09 adapted weather files produced by the University of Exeter. Adaptation measures were investigated using parametric investigation of each of these issues using IES under 2030, 2050 and 2080 climates
- rainwater harvesting: risks were identified by analysing the rainfall distribution probabilities under present and future climates. 3000 years’ of probabilistic data was used for each time horizon. Calculations were performed using a macro based Excel tool written specifically for this project. This allowed a rainwater tank to be iteratively sized such that the same proportion of rainwater would be met under future climates as under today’s climate (sized for BREEAM credit compliance)
- drainage: the impact of climate change in return periods for storm events. These increased risks of flooding were analysed using the commercial software MicroDrainage to design potential uprated systems
- landscape and ecology: the key potential changes to critical environmental factors such as temperature, humidity, cloud cover and rainfall for summer and winter. These were then applied to the proposed landscape scheme, and alternative schemes were proposed based on existing published literature on different species types.

4 What has the client agreed to implement as a result of your adaptation work?

- the work is still ongoing and so a full list of recommendations has not been finalised
- for adopting recommendations, the client has agreed to the installation of a larger rainwater harvesting tank in order for expected performance of the system to be the same under future climate (and also extended dry periods) as under today’s climate
- recommendations were made that would have required significant updating of the site drainage, however this was rejected by the client because it would not have been feasible at this stage.

5 What were the major challenges so far in doing this adaptation work?

- as with any project, incentivising performance that goes beyond minimum regulatory standards (of which there are none specifically aimed at adaptation, though there are some overlapping issues) is always a challenge. Some of this barrier was addressed by targeting BREEAM innovation credits as an incentive to implement innovative adaptation

- some adaptation measures would have direct future benefit to the building, while others may be beneficial in a wider context, though not necessarily to the building itself. For example, runoff from flooding may not be critical on the site though could be increasingly detrimental to housing located downhill from the site. Whilst there is a challenge in capturing the future benefits occurring on-site, there is an even greater challenge when the measure does not even directly benefit the site. This is a similar problem as climate change mitigation where local action is needed to address a global problem
- aside from the additional capital cost of implementing adaptation measures, simply affording the time to investigate these issues would not have been possible without support of the TSB funding. It is unlikely that this depth of analysis could therefore be undertaken in future projects unless incentives or regulation change
- the adaptation study was started with the project already on-site. Clearly this has had a strong impact on what could practically be implemented either now or as part of a future refurbishment. Although the work is still in progress, it would seem likely that adaptation should be considered no later than RIBA Stage C.
- some potential future adaptation measures may not actually exist yet. For example, heat reduction from more efficient LED lighting is likely to occur, but actual design values have had to be estimated for the analysis in this project. Similarly, technologies such as phase change material constructions cannot be handled using existing tools such as IES
- as the issue of adaptation is not considered through the regulations, there is no definitive guidance on performance standards, which leads to uncertainty and unilateral decision making required at a project scale.

6 What advice would you give others undertaking adaptation strategies?

- the TSB Design for Future Climate document represents a good framework for considering the main issues
- adaptation should be considered early in the design stage – ideally by RIBA Stage C in the first instance
- while the depth of analysis taken on these TSB funded studies would not typically be realistic on most projects, testing the thermal comfort of the proposed design (which is likely to be the biggest climate change risk to the building) is straightforward for projects already using thermal modeling. The future weather files are free to download and running an extra few simulations would not take long. Clients should be encouraged to ask for this as part of their project brief
- even if no further adaptation measures are adopted now, consideration should be given to what future interventions could be made. The building as designed for today's climate should not preclude future modification and implementation of adaptation measures. It is likely that such an approach using changes to the design during maintenance and refurbishment periods is likely to be a more realistic approach rather than the building being climate change ready now.

D4FC Factsheet 43:

Acton Gardens Climate Adaptation Strategy

Contact details

Name:	Giorgia Franco
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General project information

Name of project:	Acton Gardens Climate Adaptation Strategy
Location of project:	South Acton, Ealing, west London
Type of project:	Masterplan for the regeneration of the South Acton Estate. The masterplan is to provide about 2600 new homes and some community uses, while retaining many of the existing trees and open green spaces
Cost of project:	About £325m

Project team

Client:	Acton Gardens LLP, a limited liability partnership formed by Countryside Properties and London and Quadrant Housing Trust (L&Q)
Masterplan designer:	HTA Architects
Contractor:	Countryside Properties

Flood and drainage design: SKM Colin Buchanan

Climate change mitigation/adaptation consultant: AECOM

Project description

The South Acton Estate currently includes around 1800 dwellings in generally poor condition. Buildings on the estate rise many storeys higher than surrounding development with tower blocks surrounded by green space.

There are a significant number of mature Category A trees on site and the estate surrounds a hub of three primary schools and additional well used community buildings.

The site is in the Environment Agency Flood Zone 1, ie at low risk of fluvial flooding, and features shallow secondary A and secondary undifferentiated aquifers in sand/gravel overlaying London Clay.

The main areas of risk identified for the site are building overheating and surface water runoff flooding.

The adaptation strategy is being developed on two levels:

- input has been provided during the development of the outline masterplan planning submission
- building modelling is being carried out to provide guidance for the detailed design of the individual development phases.

Project timescales and dates

Design and assessment period (pre-planning): outline masterplan to January 2012

Detailed design: TBC

Construction period (post-consent): TBC

Operation and monitoring period: TBC

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- based on the headline impacts for London from UKCP09 we carried out an initial qualitative risk assessment using a likelihood vs. consequence matrix. This assessment found overheating (at masterplan and building level) and surface water flooding to be the main risks for the site
- modelling was carried out with the aim to quantify the cooling benefit of integrating green and blue infrastructure at masterplan level. The aim was to compare the cost and benefit of different measures
- modelling is being carried out on a house and a flat to quantify the cooling benefit of different measures (eg shutters, ventilation, thermal mass). The aim is to compare the cost and benefit of different measures and determine at what stage in the lifetime of the building the design measures would have to be integrated in the design
- other areas, such as water consumption and materials resilience are considered important to ensure adaptability to climate change, however were not considered to require detailed modelling. In these cases qualitative guidance was provided during the development of the masterplan. Guidance will also be provided for the detailed design of future phases of the masterplan.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

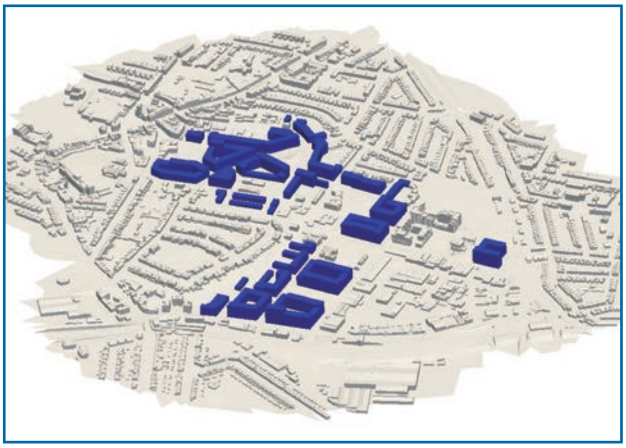
- during the development of the masterplan two workshops were held with the design team to discuss the climate risks and potential design solutions to be integrated into the masterplan
- as the teams for the detailed design of the masterplan phases are yet to be appointed, the intention is to use the building scale analysis being carried out at present to produce a guidance document applicable to the Acton Gardens masterplan. The guidance is expected to include priority lists and checklists to guide the design teams in giving due consideration to adaptive measures during the design process
- the workshops were effective to discuss opportunities and constraints with the design team.

3 What tools have you used to assess overheating and flood risks?

- ENVI-met modelling was used to assess green infrastructure benefits at masterplan scale
- IES modelling with Prometheus future weather tapes (based on UKCP09) was used to model overheating risk at building scale.

4 What has the client agreed to implement as a result of your adaptation work?

- the work is still in progress. A strategy is evolving as part of the masterplanning and building typology development.



5 What were the major challenges so far in doing this adaptation work?

- progressing the adaptation strategy at a suitable pace to provide input into the masterplan design
- finding an effective way of applying the impacts of masterplan level measures to the building level modelling (in relation to urban heat island effect and overheating)
- finding ways of using the climate projections available to model future surface water runoff risk.

6 What advice would you give others undertaking adaptation strategies?

- start thinking about adaptation at masterplanning stage, considering passive measures such as road and building orientation at early stages
- the time required for modelling of adaptive measures should be included in the design programme and take place at concept design stage.

D4FC Factsheet 44:

University of Salford Climate Change Adaptation

Contact details

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General project information

Name of project:	University of Salford Climate Change Adaptation
Location of project:	Salford, Greater Manchester
Type of project:	Campus masterplan, University of Salford
Cost of project:	~£300m

Project team

Client:	University of Salford
Designer:	Various
Contractor:	TBC

Other organisations involved (and their role): N/A

Project description

The University of Salford (UoS) campus masterplan includes a number of buildings that have been considered for this study:

- a proposed new-build arts building
- a library refurbishment
- a new-build student residences.

The masterplan is being delivered in phases, some of which were at the detailed design stage during this study.

The climate change adaptation study focused on the analysis of building occupant comfort and site wide flood risk, leading to investigation of future climate adaptation measures. It has enhanced the design work already completed, expanding the understanding of how future climate projections may impact on the campus. Dynamic thermal modelling software (utilising UKCIP09 data) and drainage network simulation tools were used to examine the impact of the future climate projections on the design strategies.

The study has allowed the design team to make informed decisions with the client on trade off solutions for achieving an appropriate level of future resilience/flexibility, and the current investment levels required.

Project timescales and dates

Design and assessment period (pre-planning): 2010

Construction period (post-consent): started in 2013

Operation and monitoring period: TBC

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

The approach took the following stages:

Stage 1: Scoping study

- development of a matrix to highlight which climate risks will affect design strategy, and how this risks are likely to manifest
- identification of key areas of risk associated with the buildings/areas of public realm to be tested
- the potential impacts were rated in terms of risk, and guidance was provided as to which adaptation measure areas were likely to be of greatest benefit to the buildings/campus (and their occupants/users). Four scenarios were highlighted as high risk:
  - hotter summer
  - wetter winter
  - heat wave summer
  - increased downfall in winter.

Stage 2: Assessment of buildings/site to future climate

- scenario analysis ('response to current and future climate') of the buildings/site was carried out against current and future climate conditions, indicating comfort performance against four climate files
- the scenario analysis outputs were a series of options used to develop adaptation measures for testing. Given the range of building types analysed, a bespoke set of adaptation measures for testing were developed for each building.

Stage 3: Assessment of adaptation measures

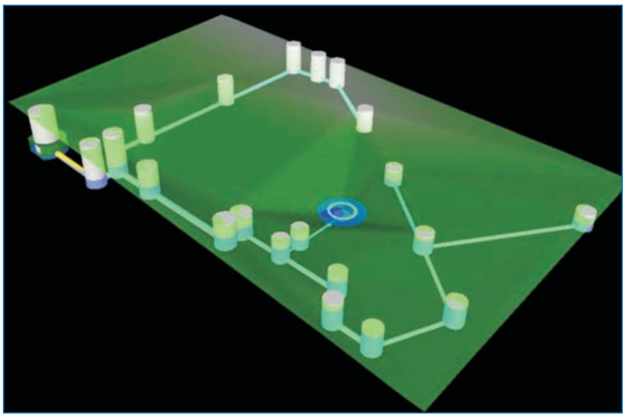
- the chosen adaptation measures were investigated/tested in terms of their effectiveness of improving the resilience of the buildings and campus to the risks associated with climate change. Consideration of the scale/level at which measures were applied was used to develop costing
- particular focus was given to passive design measures, building services design, storm-water management systems, adaptive thermal comfort and green infrastructure.

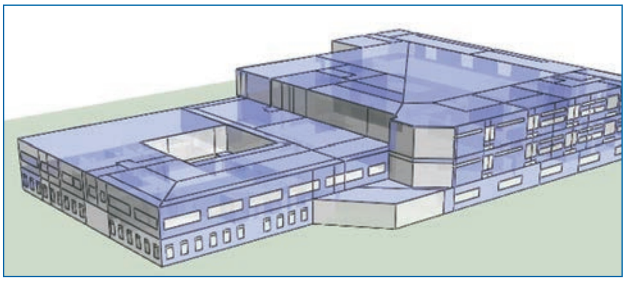
Stage 4: Cost analysis

- cost benefit analysis for the tested adaptation measures was carried out to ensure that the measures proposed within implementation timelines were both technically and economically feasible.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- potential risk exposure from the scoping study was discussed with the client team. The initial results from the 'response to current and future climate' (primarily impact on naturally ventilated spaces) were discussed.





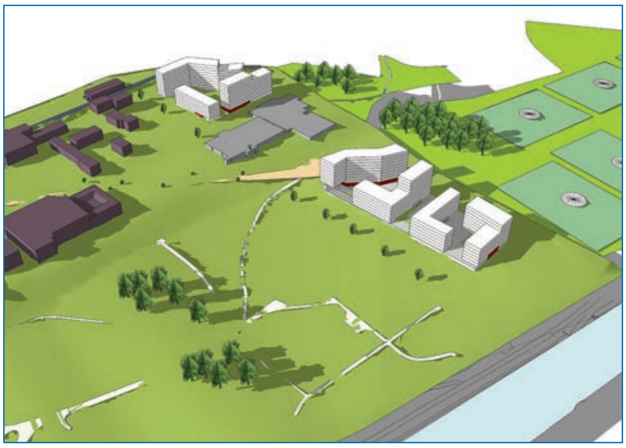
- the University aims to improve the flexibility of their spatial planning within the proposed arts building. The introduction of more shared spaces means it is crucial to consider mixed mode ventilation strategies where possible. Flexible and intelligent operation of the building (in terms of both systems and occupancy) was considered one of the cost effective adaptation measure to adapt to rising temperatures.

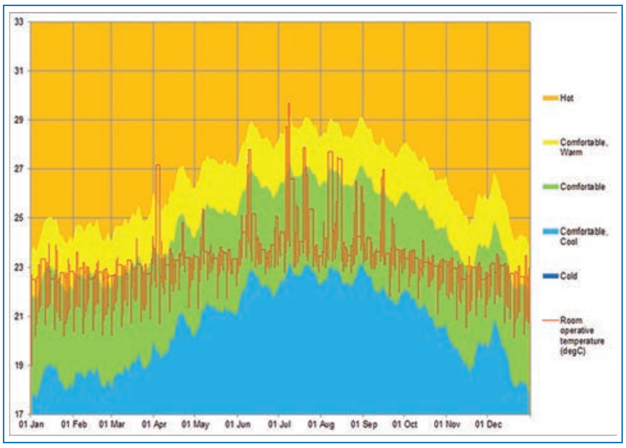
3 What tools have you used to assess overheating and flood risks?

- Integrated Environmental Solutions (IES) was used to assess overheating risk of proposed academic building, library refurbishment and proposed student residences
- Micro Drainage was used to assess flooding risk
- CIBSE adaptive thermal comfort

4 What has the client agreed to implement as a result of your adaptation work?

- provide a climate change adaptation case study for the Higher Education sector
- where economically and technically viable, integration of recommended adaptation strategy into the campus masterplan and new build programme
- the arts building and student residences are predominantly naturally ventilated, with both aiming to achieve a BREEAM Excellent rating. The findings of this study will impact how the natural ventilation strategy will be enhanced and evolve. For instance, the Arts Building has a number of shared spaces with varying occupant densities. One of the adaptation measures proposed for future operation will be to maximise the use of flexible spaces through intelligent room booking to reduce overheating risk in south facing spaces





- stimulation of future research topics and investigations in the University of Salford.

5 What were the major challenges so far in doing this adaptation work?

- limited guidance is available for methodologies for addressing analysis of comfort criteria in relation to future climate, or existing guidance (eg CIBSE TM36, 2005) not recently updated
- DEFRA guidance of using additional rainfall intensity to account for climate change is considered to lack in clarity in some areas
- persuading organisations to be aware of/address climate change as a significant risk to future operation – this is in some ways being made easier through legislation and an increasing evidence base/acceptance of climate change related risks and consequences.

6 What advice would you give others undertaking adaptation strategies?

- university buildings often experience high occupancy density in spaces with intermittent occupancy (ie lecture theatres). By intelligently managing and operating the spaces in conjunction with their time tables, buildings could adapt to rising temperatures in the future
- consideration of mixed mode ventilation strategy for spaces where high but intermittent occupant density occurs can reduce energy and carbon consumption and provide an effective way of achieving comfort in a changing climate
- critical stormwater management to deal with increased downfall needs to consider surface water retention as well as distribution network. This is crucial for a site with large variations in topography.

D4FC Factsheet 45:
The Co-operative Head Office

Contact details

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General project information

Name of project:	The Co-operative Head Office
Location of project:	Manchester
Type of project:	New build headquarter
Cost of project:	£100m

Project team

Client:	The Co-operative
Designer:	3DReid/Buro Happold
Contractor:	BAM

Project description

The Co-operative launched an international design competition for their head office in 2008. The design brief called for a 30 000m^2 office of high quality specification in Manchester City Centre, with a minimum of 5000 m^2 expansion space and a minimum of 2000m^2 floor plates. The new Head Office aspires to achieve the highest energy standard that is economically viable. The environmental targets such as BREEAM Outstanding, EPC A, DEC A as well as stringent energy benchmarks have been achieved during the detailed design stage, and the targets are also on track currently at the construction stage.

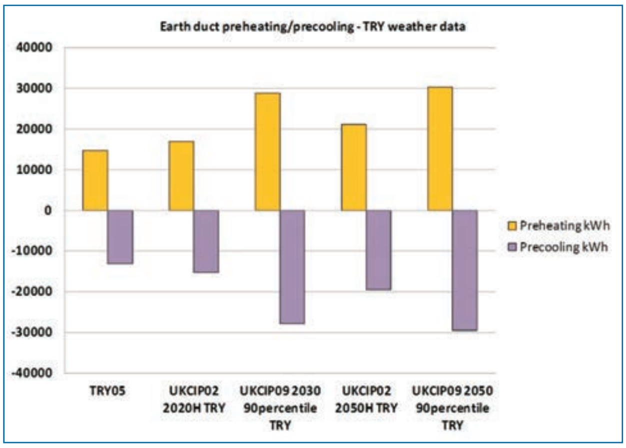
Comprehensive analysis has been undertaken at the design stage. This included checking the design against the future climate data using UKCIP02 morphed weather tape. This Climate Change Adaptation study has focused on assessing the impact of climate change on passive design measures and how management regimes can help adapt the building and its occupants further. Results have been provided with comparisons between the use of UKCIP02 and UKCP09.

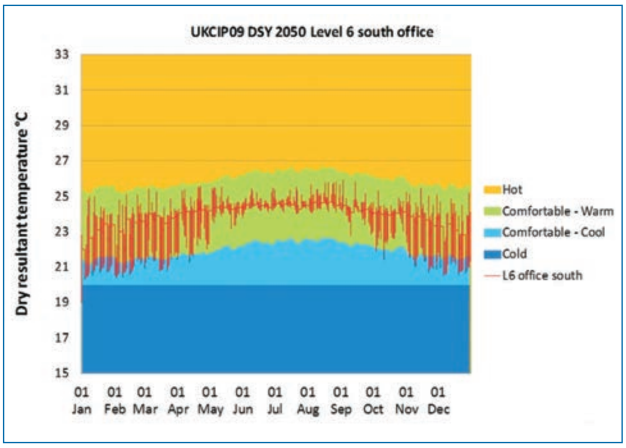
Project timescales and dates

Design and assessment period (pre-planning): 2008 to 2009

Construction period (post-consent): completed in 2012

Operation and monitoring period: started in 2012





Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

Approach taken by the study was to follow these steps of evaluation and consultation:

- scoping study to identify potential exposure to climate change
- assessment of current passive design against projected climate change scenarios
- assessment of adaptation measures
- cost-benefit analysis.

Based on the initial analysis, the following scenarios have been rated as 'high' risk exposure for the head office:

- hotter summer/heat wave
- wetter winter/increased downfall in winter.

Overheating due to rising summer temperatures:

The building has incorporated earth tubes and a double skin façade. These passive design measures have been analysed in detail.

- the study has demonstrated that earth tube is an effective and robust adaptation design measure. It is effective now and its performance will improve further due to the rise of ground temperature always at a much slower rate than ambient temperatures in future climate
- the double skin façade is effective in reducing cooling energy due to its ability of removing hot air in the cavity after it absorbs solar gains.

Stormwater management due to increased downfall:

- the building has been designed with 55 m^3 surface water attenuation tank based on 1 in 100 year event with a 30 per cent allowance for climate change
- additional tests on 1 in 200, 300, 500 and 1000 years return periods have demonstrated that no further increase in surface water attenuation is required for the building.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- based upon assessing UKCIP02 climate change scenarios, potential risk exposure from the scoping study was further analysed. Results show that the most effective adaptation measure is management, operation and occupant behavioural change to adapt to rising temperatures. Potential barriers to these measures have been explained, discussed with the project team and the client. These barriers require not only organisational changes but also institutional changes. For instance, BCO's design guide has not formally adopted adaptive thermal comfort.

3 What tools have you used to assess overheating and flood risks?

- UK Adaptation Wizard
- IES to assess overheating risk of the building including specialist tool to assess earth duct performance
- CFD was used to detailed analyse double skin façade for design development
- CIBSE adaptive thermal comfort
- MicroDrainage to assess flooding risk.

4 What has the client agreed to implement as a result of your adaptation work?

- the Co-operative has implemented flexible working hours policy for their staff. The findings of this study will help the Co-operative to further extend and promote this policy, and develop an effective and dedicated flexible working policy to deal with heat wave and rising temperatures. State-of-the-art smart grid has been installed in the head office to facilitate the implementation of the flexible operation of the building
- the Co-operative is keen to explore the feasibility of the adoption of adaptive thermal comfort with institutions such as BCO
- the Co-operative is also keen to research into the impact of adaptive thermal comfort on productivity and heath wellbeing within the workplace.

5 **What were the major challenges so far in doing this adaptation work?**

- UKCP09 provides the probabilistic approach for climate projections. Lack of guidance on how to choose climate projections in the construction industry
- climate change for buildings has not been put on high agenda for many organisations. Lack of awareness in the industry
- lack of guidance on thermal comfort criteria for future climate, from CIBSE and institutions such as BCO.

6 **What advice would you give others undertaking adaptation strategies?**

- a passive approach works well in the current climate and it can work even more beneficially in reducing overheating risk due to future rising temperatures
- management and operation measures to encourage flexible working with flexible desks are effective in adapting to rising temperatures
- smart grid and intelligent system installed in the office building can facilitate the implementation of flexible operation of the building
- engagement with BCO and institutions to promote the adoption of adaptive thermal comfort standard for office buildings.

D4FC Factsheet 46:

Betws Washery

Contact details

Name: Philip Kassanis

Company: Kassanis+Thomas

Tel (mobile): 07899 710142

General project information

Name of project: Betws Washery

Location of project: Ammanford, Carmarthenshire

Type of project: New build

Cost of project: £14.7m

Project team

Client: Quadrant Estates Ltd (developer)

Designer: Kassanis+Thomas

Contractor: Not yet appointed

Other organisations involved (and their role): Daedalus Environmental (sustainability), Waterman International (London) (engineering), Parkwood Consultancy Services (landscape), Davis Langdon (cost), CA Group (envelope)

Project description

This is a mixed use scheme on 5.5ha of land in Ammanford, Carmarthenshire. It comprises:

- a foodstore
- petrol filling station
- drive-thru restaurant
- a retail terrace
- starter units
- doctors surgery
- retirement complex
- a residential scheme.

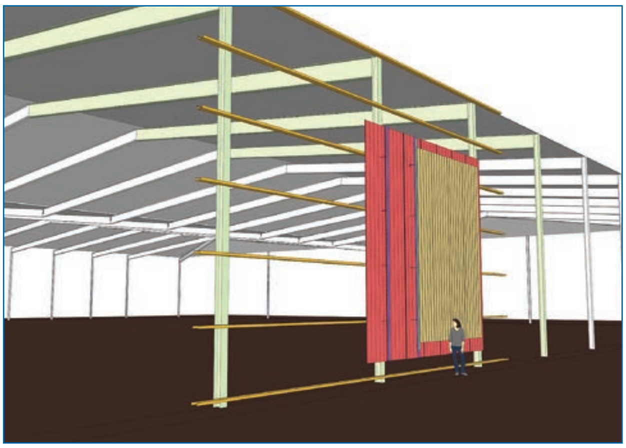
The study investigates the effects of climate change on buildings constructed with a frame and lightweight cladding. It focuses on the foodstore, and retail terrace because they were to be built in this way and the land as a whole.

Project timescales and dates

Design and assessment period (pre-planning): Feb 2011 to late 2014 (best guess dependent on viability given changing market conditions)

Construction period (post-consent): likely to be phased over three to four years starting in 2015

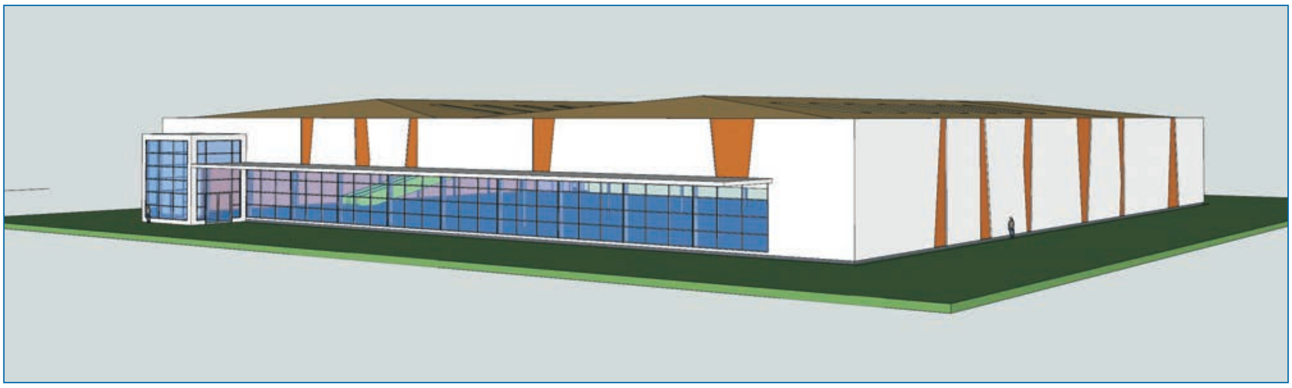
Operation and monitoring period: TBA

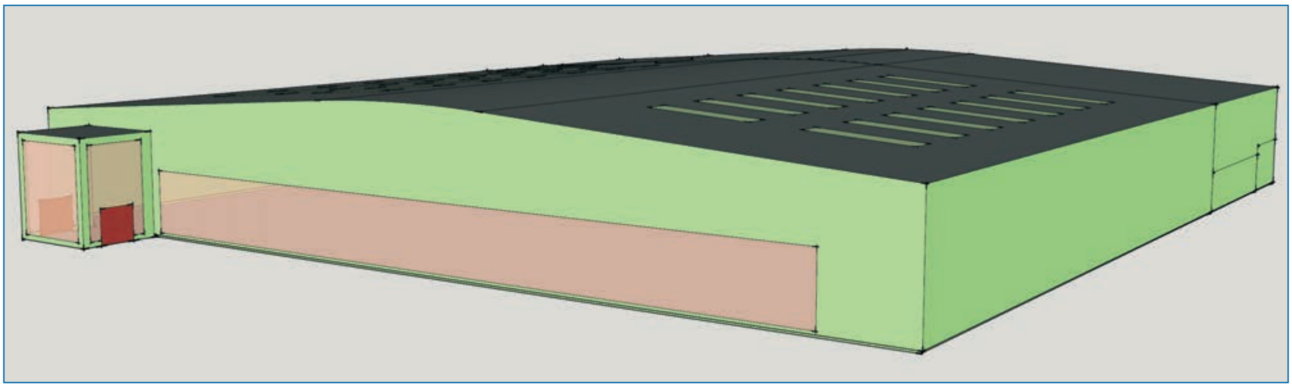


Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- weather trends were analysed using UKCP09 probabilistic data. The 2050 high emissions scenario with a 90 per cent confidence interval was chosen because it has the right order of magnitude compared with the control data for assessing risk to this type of property – it erred on exaggerating the effect for the purposes of teasing out vulnerabilities and opportunities for adaptation
- the effect these weather trends would have on the foodstore, retail units and the external areas was then examined using a number of techniques. This exposed vulnerabilities in three thematic areas:
  - thermal comfort and energy use
  - water management
  - green infrastructure.
- twenty-three potential adaptations were explored during the study. Most were conceived at the risk assessment stage as part of the process of understanding the vulnerabilities but others emerged as the work progressed in more detail. The impact of each was assessed and cost-benefit analysis carried out. This process generated 46 separate conclusions, which became the material for shaping the strategy
- the strategy comprised grouping the adaptations into 5 recommendations geared to the way these buildings are procured in this sector and the respective interests of the various parties involved:
  - **Recommendation 1** is designed to appeal directly to the developer without any need to refer to other demand side parties because practically all the adaptations produce added value with a negligible cost implication therefore not needing justification via cost benefit analysis. They represent good design and should become standard practice throughout the industry
  - **Recommendation 2** has adaptations that do incur cost, which although modest as a proportion of the total capital cost, would be sufficient to make them vulnerable to cost engineering. Again the recommendation is designed to appeal to the developer without reference to other demand side parties because the two adaptations make it easier to obtain statutory consents
  - **Recommendation 3** reflects adaptations that solely affect fit-out and of no financial interest to the developer or investor. The benefits are very direct because they affect the operational costs of the building. The question is not so much whether they should be done but when. The vulnerabilities exposed by climate change are in the long term and, because the major re-fit cycle is approximately 10 years, it makes no sense to implement them





now unless there are co-benefits to warrant it. The recommendation is to pass on the learning about these adaptation on to the tenant through, say, the building manual

- **Recommendation 4** has adaptations that have potential but need to be explored with more R&D to see whether this is the case. Although initially directed at the developer client, these are more focused on the supply side of the industry – designers/engineers, and manufacturers. Can good solutions be developed to offer to investors and tenants? The development and take up of these potential adaptations in this category is not simply a technical matter because they straddle the divide between passive built-in measures that the investor pays for, and the fit-out plant side that the tenant is responsible for. So the solutions also need to address procurement, financing and lease questions
- **Recommendation 5** is a set of measures that all bring so many benefits that they cannot be ignored but they either raise difficult issues, or are too expensive to be easily recommended. They all fall into a position where the developer would need to champion the cause. As such they are presented as optional extras.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- copied into relevant correspondence and reports
- one to one briefing meeting
- workshop session with client and whole team
- SurveyMonkey questionnaire
- the last three worked well.

3 What tools have you used to assess overheating and flood risks?

- PROMETHEUS weather files produced by Exeter University
- selected literature review
- TSB knowledge sharing
- the checklist provided by the TSB as part of the contract
- Thermal modelling software IES VE
- SBEM
- Modeller software for translating CAD drawings into the format for IES modelling.

4 What has the client agreed to implement as a result of your adaptation work?

- Client agreed with:
  - Recommendations 1 to 4
  - from Recommendation 5: only 1 out of the 5 adaptations was agreed (removal of rooflights).

5 What were the major challenges so far in doing this adaptation work?

- the working methods for the adaptation project are more akin to research than to professional practice and therefore unfamiliar to the team even though they are experienced practitioners in their respective fields. So the team required a lot of leadership and management in a way that wouldn't be necessary for normal familiar project work. There are several consequences:
  - management time consumes resource, which then becomes unavailable for the content of the study

A1 curved ridge - p.X3/43

figure 30 initial design for Betws Washery foodstore

Many buildings in the frame and light-weight cladding category are designed to have the simple box aesthetic. An example of a leading high end operator's recent sensitive design for a conservation area is shown in figure 43, p.X3/43 and is not visually uncommon in this sector.

The initial design for this project is no exception (figure 30).

This form of roof is usually at a low pitch of about 4° and involves ridges, hips, valley gutters and boundary wall gutters behind a parapet (figure 44, p.X3/43).

Construction details and components have been developed that work satisfactorily for current climatic conditions. However increasing storm intensity renders: (a) the ridges and hips, which are made of cover flashings, prone to the ingress of wind driven rain; and (b) the outflow of the gutters insufficient leading to over-topping the inside rim and water entering the interior of the building.

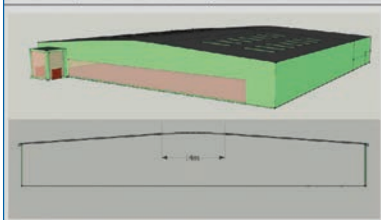


figure 31 adapted roof - section and massing

The adaptation is to have a curved roof with a "natural" curve on a profiled sheet over the apex (c.14m) lapping over a flat sheet at 4° that runs out to the eaves (figure 31). The eaves over-sail the edge of the building.

There is no cost for either the foodstore of the retail units.

Conclusion 36

A simple, cost neutral measure that is completely effective at removing a considerable vulnerability inherent with the typical form of this building type.

- it was difficult for team members to delegate parts of the work because its nature is not a matter of routine practice. This made it difficult to manage the competing demands of other projects in the office with a tendency for the D4FC project to be put aside temporarily
- resuming work that is put aside is not efficient because it take time to retrace thinking especially since it is so non-routine, all of which compounds the tendency for delays.

- the variety of methods that need to be married up coherently:
  - quantitative approaches use tools that all have certain flaws, so a qualitative overview is required to make sure that the results and conclusions make sense
  - qualitative approaches need to include pragmatic ways of estimating size of effect to have an understanding of their significance.

6 What advice would you give others undertaking adaptation strategies?

- narrow the scope of the field as much as possible to keep the team size as small as possible to maximise the amount of resource available for producing content as opposed to management.

G1 - robust plot structure - p.X3/9

figure 11 baseline scheme

figure 12 re-configured with sub-divisible plots

Adaptation at the scale of the whole building in contrast to just parts of it.

If this were to happen, the main thing that would give the land the most flexibility for future options would be to make sure that the large plots associated with this sort of development are sub-divisible to cater for other uses, primarily residential. The main characteristic of this approach would be that underground infrastructure and trees are routed along lines that anticipate future sub-division

Conclusion 1

For awkwardly shaped sites, a purely commercially driven scheme can tend to generate a layout that does not lend itself to future subdivision, which would be beneficial if climate change (and/or other influences) create a need to change the use of the site to a use that has a different building form. Site planning with a more robust plot layout, to counteract this, will inevitably reduce the developable area and hence the real estate value. Using the case study to generate an illustration shows the effect to be somewhere between £7,000 and £13,000 - an almost negligible figure when compared with the value of the overall development.

Conclusion 2

A more rationalised layout means that the irregular pieces of land will tend not to be used for car parking and are available to increase the GI. Thus creating a more robust plot layout not only has the benefit of allowing more flexibility for the future but it also helps with the other climate change adaptation - to increase the amount of GI (see discussion under SuDS, p.X3/49 ahead).

D4FC Factsheet 47:

Hinguar Primary School

Contact details

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General project information

Name of project:	Hinguar Primary School
Location of project:	Shoeburyness, Essex
Type of project:	New build primary school, nursery and associated landscaping
Cost of project:	£ 5.2m (construction budget, excluding ICT and FF&E)

Project team

Client:	Southend-on-Sea Borough Council/ Hinguar Primary School
Designer:	Space Craft Architects
Contractor:	Kier Eastern

Other organisations involved (and their role): Norman Bromley Partnership (M&E consultant), Marstan BDB (quantity surveyor), Dewhurst Macfarlane & Partners (structural engineers), Entec (flood risk consultants), WSP (highways specialists)

Project description

The proposal for the Hinguar Primary School project for Southend-on-Sea Borough Council comprises a new school building (about 2877 m^2 gross internal accommodation in Phases 1 and 2) and associated playgrounds, swimming pool, landscaping, on site car parking and vehicular/ pedestrian accesses. The school design was developed in close collaboration with the stakeholders, including pupils, parent and staff as well as Southend Borough Council's education and property departments.

Initially the building will provide accommodation for 300 pupils aged 4 to 11 years and 26 nursery places. It has been designed as a phased development to allow for four additional classrooms to be constructed in Phase 2.

The building has achieved a BREEAM Very good in the Design Stage Assessment and a 38 per cent reduction in CO_2 omissions when compared with the requirements of the 2002 Building Regulations. It has also been awarded a Green Apple Award.

The new school is located in Shoeburyness, Essex. The site is in an exposed costal location, approximately 500 m away from the Thames Estuary and in a flood risk zone

Project timescales and dates

Design and assessment period (pre-planning): March 2009 to February 2011 (the extended planning period was due to the significant re-design/value engineering. This became necessary when funding for the school build was cut as part of the general government savings)

Construction period (post-consent): July 2011 to June 2012

The construction of the first phase was completed in June 2012 and the school and nursery have been fully occupied since September 2012.

A date for the construction of the second phase has not yet been set, but it is likely to be within the next five to 10 years.

Operation and monitoring period: monitoring was carried out during the first academic year of the school (October 2012 to June 2013) using temperature data loggers and information obtained from the BMS.

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- the team reviewed the quantitative and quantitative impact of risks under the three main headings of climate change: comfort and energy (overheating), construction and structural integrity and water conservation. Risks were rated based on the likelihood of them occurring, and based on their impact on the scheme and school operations. This includes both the project as a building structure, as well as the possible disruption caused to teaching and learning
- in early discussions within the team and with the end-users (school and council), a rise in internal temperatures and the resulting overheating of teaching spaces emerged as a dominant risk. Providing a suitable internal environment for learning and teaching (in terms of temperature, acoustics, day-lighting etc), while retaining the flexibility of the spaces is essential for any education project, but in particular primary schools, which cater for the youngest learners
- the team adopted a two stage approach to identify the adaptation measures to be developed in more detail. In the first stage the team collated a range of potential ideas for adaptation measures, structured under the main climate change design challenges of thermal comfort, water and construction
- further research, costing and modelling was carried out in the second stage on all potential options, resulting in a final shortlist of adaptation measures that the team will be developing in more detail in the next stage of the study. The selection process took into account the weighting of the climate risks, an assessment of the financial cost to the project, the likely effectiveness of the measure, potential negative impacts on the building/school and other project specific issues.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- during the design and construction period, the D4FC project was integrated into the agenda of the monthly core group meetings, which include the school, the contractor and the client (Southend-on-Sea Borough Council). This led to interesting workshops and discussions about the potential climate change risks to the project and allowed us to keep the school and council updated on the progress of the study
- on completion, the findings were presented in form of a lunchtime CPD to a wider audience at Southend Council, including project managers, M&E engineers and sustainability officers. This successful event was a good opportunity to involve 'decision makers' within different areas of the council and extend the reach of the study beyond the Hinguar School project
- on the basis of our findings, we developed a *Design toolkit for climate change future proofing* that we also presented to the client. The toolkit aims to provide project teams with the beginnings of a 'compendium of measures' that can be integrated into the design at an early stage and often at no or limited additional cost, in order to facilitate adaptation in the future. The toolkit is not intended as a complete document but has been developed as a 'working paper', which can be added to and extended further research and development is collected
- throughout the study we worked closely with the school and in particular its sustainability club (Hinguar Eco Worriers) in form of regular updates and workshop as. We felt it was important to keep the end-users engaged in the process, as they will be affected by the potential climate change risks.

3 What tools have you used to assess overheating and flood risks?

- **comfort and energy performance – overheating internally and externally:** site specific Prometheus weather data was provided by Dr Matthew Eames at the Centre for Energy and the Environment, University of Exeter. Using IES Virtual Environment software this data was used by NPB to produce internal temperature and solar gain predictions within the school. The criteria set out in Building Bulletin (BB) 101 have been used to assess whether a selection of representative teaching spaces on north- and south-facing sides of the building will be 'over heating'

- **construction and structural integrity – clay shrinkage:** analysis provided by the site specific soil investigation report and further discussions with the structural engineer
- **water shortages and increased rainfall:** the rainfall data available on UKCIP09 gives an average monthly rainfall (measured in mm/hr), but this does not directly translate into the intensity of the rainfall/storm. We felt that it would nevertheless be important to investigate these risks further on the basis of the overall trend predictions
- **rise in sea water, surface water and ground water levels:** flood risk assessment carried out by Entec UK and further discussions with the flood risk assessor.

4 What has the client agreed to implement as a result of your adaptation work?

- the end of our study coincided with the completion of the construction project and final account negotiations. Whilst the client was very interested in our findings and in particular the design toolkit, the increasingly tight budgets in the education construction sector meant that no measures were implemented in Phase 1 so far
- due to the changes in birth-rate predictions in Shoeburyness, there are no immediate plans for Phase 2. However, from the feedback received from the client we are confident that many of the findings in this study will be very valuable in influencing the final detail design of the extension and considered for implementation by the client – both for Phase 2 of this project as well as other future building projects
- some of the key measures for future implementation identified in our study were the retrofitting (Phase 1) and integration into the design (Phase 2) of electrical fans in ventilation shafts/roof light upstands to assist the natural ventilation scheme. The study also proposed the introduction of a ground source heat pump as part of the Phase 2 extension, which would allow reverse cooling through the UFH

- other measures recommended by the study include the introduction of external fabric roller blinds to allow for the teaching spaces to be extended into shaded external balcony areas, the installation of rainwater harvesting systems and the development of an 'external teaching kit' to encourage increased use of external teaching areas.

5 What were the major challenges so far in doing this adaptation work?

- identifying a suitable (and limited) range of measures to be developed in more detail to ensure that the work will be focused
- restrictions imposed on Phase 2 development through planning and structure/foundations already in place
- from the outset we were aware that the limited budget available posed the main challenge to any adaptation work. This is likely to become even more relevant with the current trend to reduce funding for education buildings. Carrying out a careful cost–benefit analysis is important in order to allow the client to make informed decisions on adaptation measured. This needs to include running costs and maintenance costs.
- feeding our findings back into the construction and procurement process. It might have been beneficial to involve a representative of the client as a team member for the study, as this would have given us a more regular and direct link for feedback and decision making process. Hopefully the *Decision making toolkit* will prove a useful tool to overcome this challenge for future projects.

6 What advice would you give others undertaking adaptation strategies?

- the extent range of ideas collected by the team was initially very wide and had to be narrowed down quickly to allow us to move on – try and focus your research early on (we identified overheating as the main risk)
- obtaining site specific Prometheus weather data for use in the thermal model proved extremely helpful. It allowed us to test possible adaptation measures, both for the Phase 1 areas already under construction and Phase 2, quickly and in detail, rather than based on general trend predictions

- integrating the use/function of the spaces in the investigations rather than just focusing on the physical building opened up an interesting angle of discussion and research (eg can flexible teaching spaces help to reduce internal heat gain, how can we make most of the shaded outdoor spaces, timetables and siestas)
- discussion with the stakeholder played an important role in this
- setting benchmarks and carrying out cost-benefit analysis to assess the different mitigation options against (eg installation of GSHP with reverse UFH cooling vs. Installation of AC units) was a very useful tool, which helped us to weigh up the different measures and communicate them to the council/school.

D4FC Factsheet 48:

A Climate Change Adaptation Strategy for Octavia Housing

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General project information

Name of project:	A Climate Change Adaptation Strategy for Octavia Housing
Location of project:	London (West)
Type of project:	Adaptation retrofit strategy for social housing
Cost of project:	£99 967

Project team

Collaboration between Octavia Housing, University of Greenwich and Pellings

Project description

Climate change will have a major impact on the performance of the UK's social housing sector, which comprises 2.5 million housing units across 1500 social housing providers. Octavia Housing is responsible for 4000 of these homes, centred in West London and provides the organisational setting for this work.

This project used an adaptation framework model to translate climate risks into meaningful impact scenarios for asset managers. It integrated these into a performance-based built asset management model to establish a series of performance thresholds and triggers to prioritise future adaptation interventions. A range of generic adaptation solutions to flooding and overheating have been collated and reviewed against typical housing unit archetypes. An outline adaptation plan has been developed that prioritises adaptations that address current climate threats and provides for the routine re-evaluation of future threats. Such an approach should ensure that Octavia's homes continue to support their tenants well-being.

Project timescales and dates

Design and assessment period (pre-planning): December 2011 to December 2013

Further project details

1 What approach did you take in assessing risks and identifying adaptation measures to mitigate the risks?

- **risk assessment:** publically available documentation based on UKCP09 projections was consulted, georeferenced and analysed alongside georeferenced stock condition data to distinguish properties vulnerable to flood, heat wave and subsidence risks
- **adaptation measures:** generic adaptation measures for flooding and overheating were identified from publically available documentation and their applicability to Octavia's stock was assessed against typical housing unit archetypes.

2 How have you communicated the risks and recommendations with your client? What methods worked well?

- climate risks were communicated through a series of impact scenarios which were used to identify the vulnerability and coping capacity of housing unit archetypes to flooding and overheating
- the impact of the climate risks on performance of those archetypes that were highly vulnerable and had a low coping capacity were communicated through sample building survey reports
- the implications of the climate risks were extrapolated across Octavia's housing portfolio and the consequences were communicated through a series of impact grids
- the recommendations for adaptation and further investigation were communicated through an outline adaptation strategy
- all the above worked well although the extrapolation from typical archetypes to portfolio level impacts left many unanswered questions.

3 What tools have you used to assess overheating and flood risks?

- the climate impact scenarios for flooding and overheating were derived from publically available toolkits that had used the UKCP09 projections to evaluate the adaptation risks of London's housing (eg the EPSRC CREW project, The London Adaptation Strategy, local authority flood risk assessments etc). Octavia Housing's stock condition database was used in conjunction with GoogleEarth, GoogleStreetview and ArcMap to identify those properties that were at risk of flooding. Building level surveys of typical archetype housing units were used to assess the effectiveness of a range of adaptations to reduce vulnerability and improve resilience of Octavia's housing units
- the impact of overheating was assessed using London wide predictions for future temperature profiles and HNS for England heat wave thresholds. The CREW Project Retrofit Adaptation toolkit was used to assess the potential for a range of adaptations to reduce overheating in the archetype housing units
- Octavia address subsidence through their responsive maintenance programme and water consumption through their mitigation programme.

4 What has the client agreed to implement as a result of your adaptation work?

- the client has instigated detailed evaluation of the cost effectiveness of flood resilience measures for its highly vulnerable basement flats and introduced a tenant briefing regime for those tenants in such properties

- the client has agreed to enhance its stock condition survey process to collect additional data that will allow it to regularly monitor the vulnerability and resilience of individual housing units rather than relying on typical archetypes.

5 What were the major challenges so far in doing this adaptation work?

- the main climate risk to Octavia is pluvial flooding. However, pluvial flood risk maps are not yet widely available. As such much of the risk assessment had to be based on assumptions of flood risk. This reduces the currency of projections and leads to a responsive approach to adaptation planning where only immediate risks are prioritised. This runs counter to the goals of long term adaptation of the built environment.

6 What advice would you give others undertaking adaptation strategies?

- make use of publically available information to assess current climate risks that your properties face and then extrapolate the potential impacts that climate change may have. In this way you can develop an adaptation strategy that deals with current problems whilst you gather the information, both in house, and from UK wide sources, to allow longer term adaptations to be programmed into a built asset management plan
- adaptation work can be expensive. To minimise this built asset management plans should look to undertake works as part of planned works or reinvestment/ improvement programmes. For example, we have found that there is synergy between proposed energy efficiency and climate change adaptations.