BETTER PLACED

ENVIRONMENTAL DESIGN IN SCHOOLS

Making schools feel and work better

NSW GOVERNMENT | Education
School Infrastructure

GOVERNMENT ARCHITECT NEW SOUTH WALES

Design objectives for NSW

This manual draws on the seven objectives for the design of the built environment set out in **Better Placed: An integrated design policy for the built environment of NSW.**

Better fit
contextual, local and of its place

Better performance
sustainable, adaptable and durable

Better for community
inclusive, connected and diverse

Better for people
safe, comfortable and liveable

Better working
functional, efficient and fit for purpose

Better value
creating and adding value

Better look and feel
engaging, inviting and attractive

Cover image: Marrickville West Public School
Image: Tyrone Branigan

GA

N

SW

Bellevue Hill Public School
The combination of an existing large tree and new building provides shading to a new landscaped play area.
Architect: Group GSA
Image: Tyrone Branigan

Government Architect NSW and School Infrastructure NSW acknowledge the Traditional Custodians of the land and pay respect to Elders past, present and future. We honour Australian Aboriginal and Torres Strait Islander peoples' unique cultural and spiritual relationships to place and their rich contribution to our society. To that end, all our work seeks to uphold the idea that if we care for Country, it will care for us.

1.
About environmental design

This document has been prepared by Government Architect NSW (GANSW), in collaboration with School Infrastructure NSW (SINSW).

1.1
About this document

Schools are a vital part of any healthy and thriving community. There is growing appreciation of the significant role that good design can play in education, with increasing evidence that student learning outcomes are closely related to the quality of the environment in which they learn.

Factors such as air quality, ventilation, natural lighting, thermal comfort, and acoustic performance have been shown to have a profound impact on teacher wellbeing and student attentiveness, attendance, and overall performance. There are many things that existing schools can do to maximise these factors through environmentally conscious design.

Cronulla South Public School
A mural created by students outlining reduce, re-use, recycle principles.
Image: Tyrone Branigan

Aims for this design manual

This manual aims to provide school principals and school communities with a holistic understanding of environmental design. It presents strategies for passive design as opportunities for making positive, sustainable change in the building or running of a school.

The document explains how reducing environmental impact can help schools to optimise their value as social, environmental, and economic assets for new or established communities. It demonstrates how schools can incorporate environmental design principles and passive design strategies in existing school grounds.

Who is this document for?

The document captures several key features of environmental design that can be used by school principals, teachers, students, parents and interested citizens. It can also help the wider school community better understand environmental design.

The manual can support and advise:
— principals who are looking to understand environmental and passive design, and how this can be used to improve their existing buildings and grounds
— principals who are considering making changes to their school buildings or grounds
— staff and teachers who want to optimise their learning environments
— students who want to understand how their natural environment and built environment influence each other
— P&C committees who are looking to evaluate options for new additions to schools.

How to use this manual

This manual contains three parts:

Part One introduces the important role environmental and passive design plays in creating high-quality education environments.

Part Two provides examples of environmental and passive design strategies being used in school buildings across NSW.

Part Three provides strategies that can be implemented within school learning spaces, buildings and school grounds.

Where this manual fits in

This manual can be read alongside the GANSW **Design Guide for Schools** which provides guidance on new schools and major upgrades in NSW, and accompanies State Environmental Planning Policy (Educational Establishments and Child Care Facilities) 2017 (the Education SEPP).

GANSW's **Better Placed** and **Greener Places** policies are also useful reference documents. The GANSW Greener Places guides and manuals provide more detail on how to achieve good environmental design outcomes for your school.

The Design Guide for Schools provides guidance on how to meet the Education SEPP Design Quality Principles. These are:
1. Context, built form and landscape
2. Sustainable, efficient and durable
3. Accessible and inclusive
4. Health and safety
5. Amenity
6. Whole of life, flexible and adaptive
7. Aesthetics.

While the Design Guide for Schools can be used by everyone, it also provides technical guidance for architects, engineers, and planners.

This manual gives greater advice to support the Education SEPP, including the Design Quality Principle 2: **Sustainable, efficient and durable**, and outlines how schools can apply environmentally conscious design to improve their learning spaces, buildings, and school grounds.

1.2
What is environmental design?

Environmental design is a way of thinking about the design of buildings and landscapes that focuses on improving both the built and natural environments.

Buildings and landscapes can be designed to respond to their natural surroundings, and to have a positive impact on each other and on the behaviour of those who use them. Environmental design explores and understands the connection between people, nature, and buildings, and can be applied at the earliest stages of the design process or throughout the life span of a building or place.

By consciously designing with the environment in mind, we can improve the quality of the spaces in which we live, work, and play, and reduce our environmental impact. Environmental design helps to ensure that our buildings and places are comfortable, work better, and are better connected.

Bringelly Public School
Children connecting and engaging with their natural environment fosters a sense of ownership and care.
Image: Tyrone Branigan

Where do we start?
There are three main steps that can help us to improve our built and natural environments:

1. **Understand our physical surroundings**
    Understand the connection between our built and natural surroundings by looking at the elements that make up a building and place, such as the materials used and the setting within the landscape, including trees, parks, proximity to other buildings or features, and exposure to elements like sun and wind.

2. **Understand how our surroundings affect people**
    Understand how people use, move, and feel in our buildings and places so we can enhance natural and built features that provide for human comfort.

3. **Adopt strategies that will benefit people and our surroundings**
    Understand and use the environmental design strategies suitable to our physical surroundings and school community. These are outlined below, and explained in more detail in Section 3.

Strategies for environmental design
Environmental design strategies can help us to create innovative buildings and landscapes that are functional and visually attractive.

There are many strategies that can be used to improve our use of resources, and reduce our impact on the natural environment. Some strategies can be implemented simply and easily through behavioural change, while other strategies require expert help. Some environmental design strategies important to schools are:

Passive design
Examples include: thermal mass, cross-ventilation, and passive heating/cooling.

Biophilic design
Examples include: indoor planting and green walls.

Specialist environmental design
Examples include: covered outdoor learning areas (COLA), installing solar panels, and new building design.

Parts 2 and 3 of this manual outline some simple and useful environmental design strategies that can be implemented at any school, focusing in detail on passive design.

Feel better: improve the comfort of learning spaces to provide optimal conditions for teaching and learning.

Work better: reduce running costs, and foster more sustainable practices.

Air
Good air quality can improve student wellbeing and academic performance. It can assist in preventing mould and dust and removing pollutants.

Comfort
Good learning spaces need to be comfortable for all staff, students, and visitors. The key considerations are indoor and outdoor air temperature and quality, humidity, air movement, radiant heat and activity levels.

Light
Daylight or natural light can minimise electricity usage. Direct sunlight is different. This brings unwanted heat gain during warmer times and should be avoided. Balancing natural light and sunlight reduces the need for artificial lighting, which reduces operating costs and saves energy.

Noise
Noise can have an impact on student performance. Noise can be tempered by reorganising classrooms or learning environments to cater for specific activities.

Water
Taking care and responsibility for water usage within schools promotes awareness of the importance of water conservation.

Energy
Simple strategies such as turning off lights and being aware of indoor comfort levels can save energy use during and after school hours.

Landscape
Landscaping can play an important part in reducing environmental impact, promoting biodiversity and instilling in students a love for nature. Every school ground is part of a local ecosystem.

Materials
Constructing or upgrading buildings uses a lot of resources and materials. Durable, robust materials last a long time. This reduces the amount of embodied energy used to make products and reduces the amount of materials going to landfill.

Throughout this manual, blue is used to highlight elements that influence how our built environment feels, and green is used to highlight elements that influence how our built environment works.

1.3 What is passive design?

Passive design is an important component of environmental design.

Introducing passive design principles can help to control or maintain the comfort level within a building by using natural resources for heating and cooling, such as the sun or cool breezes.

Passive design principles can be used to make indoor and outdoor environments more comfortable and sustainable. At a larger scale, passive design principles can inform the design of a new building or group of buildings, for example by appropriately orienting a building on its site and designing the roof, walls, windows, and floors to optimise natural daylight, shade, and breezes.

Passive design needs active users
Everyone can share responsibility for making their environment comfortable and sustainable. This means giving people the tools and an understanding of how they can make changes to their learning environments on a daily or seasonal basis.

By understanding how passive design principles apply to their surroundings, people can make small but significant changes, from day to day and across the year, that help buildings to feel better and work better.

Elements of passive design
Part 1.5 of the manual outlines the elements of passive design in detail. Passive design relies on understanding these key elements:
— your climate region
— the orientation of your buildings in relation to:
    — the height and location of the sun, and therefore the amount of direct sunlight that either enters a space or is shaded
    — the prevailing winds
— the materials that your buildings are made from.

Once understood, there are a range of passive design strategies you can use to make your buildings feel better and work better:
— passive heating and cooling
— thermal mass
— cross-ventilation
— stack ventilation
— external and natural shading
— glazing transmission and radiation.

1.4
Why is environmental design important in your school?

Good environmental design can improve learning outcomes, student and teacher health and wellbeing, reduce greenhouse gas emissions, and generally improve school buildings so they work well for their whole life span. Our schools, like our wider built environment, must be resilient to change and adapt to suit new conditions.

Schools provide students with skills and capabilities to thrive in a rapidly changing and interconnected world. School environments are now being designed to suit modes of learning such as collaboration, discussion, experimentation, and reflection. Students are further developing critical thinking skills to understand complex problems and become mindful global citizens.

School buildings are a social, environmental, and economic asset. For our students to feel, perform, and connect better with a changing world, our buildings must respond so our learning environments are community assets and places of world-class education.

Environmental and passive design strategies can improve our physical learning spaces, so they work better, provide greater levels of user comfort, and reduce environmental impact. As well as enhancing indoor learning spaces, there are a number of strategies that can be adopted around school buildings and within school grounds that can benefit school students and teachers, as well as the environment.

Our actions can also encourage responsible behaviour towards the environment. Environmental stewardship and responsibility can begin at school but will continue across generations for the benefit of all. Behaviour change in response to a better understanding of environmental design can help our schools reduce their running costs and improve the way their buildings work, which may decrease maintenance costs over time. Making changes that improve school environments can better equip students to aspire, learn, and achieve.

School Infrastructure NSW can help your school to adopt environmental design strategies.

Environmental design can positively influence:

Health and wellbeing
Our schools are healthy when they are filled with natural light and fresh air. Students need environments that balance noisy areas with quiet areas. Introducing natural elements into learning spaces, such as indoor plants and landscaped elements, can help concentration by improving air quality in classrooms. Healthy buildings can reduce absenteeism because of fewer illnesses (Green Building Council of Australia 2009). Schools that consider health and wellbeing also have lower staff turnover rates and better user satisfaction.

Learning outcomes
Fresh and free-flowing air in our learning environments can impact student concentration levels. There is research showing that just being able to see plants and trees can reduce student's mental fatigue (Lohr 2010). In most situations it is easy to change the amount of fresh air and daylight coming into our learning spaces, and such a simple change can have an influence on overall student performance.

Cost saving
Buildings that integrate environmental design principles can generally reduce running costs, as well as reducing the need for mechanical heating and cooling systems, such as air conditioning.

Heat-island effect
The urban heat-island effect occurs when buildings and hard surfaces absorb the sun's heat and then send it back into the atmosphere. Environmental design features such as introducing trees, landscaping, and more natural, porous surfaces can assist in cooling our schools for the comfort and health of staff and students.

Heritage, character, and place
Schools are part of a larger local community, and can positively influence an area's local character, values, and history. In this sense, school buildings affect not only the people using them but the wider community.

Local character is what makes a neighbourhood distinctive. How a school looks and feels can contribute to a community's identity. Many aspects of the school's appearance – its buildings, trees, and open spaces – add to a place's local character. When buildings respond to the natural environment and history of a place, people's association and attachment to the area is increased.

Simple ways schools can reinforce heritage and place include planting trees, conserving heritage (natural and built), and embracing local landscapes.

Trees in particular create attractive urban places, providing seasonal variation and creating memorable landmarks for local areas.

Encouraging environmental responsibility through design:

Introducing or improving elements of environmental and passive design can promote greater environmental awareness and responsibility – at school and beyond.

Magnifying the learning

By actively encouraging and supporting environmental design principles, schools can inspire the school community and the wider community and instil a sense of environmental responsibility, caring, and connection. Schools are a place for everyone to learn. In bringing the community in to schools, the opportunity for learning is magnified.

Connecting with place

Introducing or improving environmental design principles can help schools embrace their local setting and cultural history and identity, including Aboriginal cultural heritage. Schools are encouraged to connect with their local Aboriginal community to better understand their deep-rooted connection to and caring for Country. In turn, learning about local cultural heritage can help students to better connect with their natural environment.

Values and goals

Schools are caring, inclusive, and participatory communities. By promoting environmental design, schools can actively demonstrate these values in a very tangible way, reinforcing a sense of duty towards and awareness of both the built and natural environment.

Environmental design can encourage students to learn skills and develop habits that will benefit them throughout their lives. Where a teacher provides guidance, or passes on knowledge to children, schools can show the community how to embrace environmental design principles.

O'Connell St Primary School
This new school has modified existing heritage buildings, positively contributing to the local character and history of Parramatta.
Architect: Tonkin Zulaikha Greer Architects
Image: Brett Boardman

1.5
Elements of passive design

Introducing or improving passive design elements helps to create a comfortable and sustainable environment.

School Infrastructure NSW can help your school to adopt environmental and passive design strategies.

Understanding the climate and human comfort
An important first step in passive design is to understand NSW's distinct climate zones and conditions. Some parts of our State have hot and dry summers while others can experience alpine conditions in winter.

Comfort can be related to both our physical and mental wellbeing, with a range of factors affecting how people feel including temperature, humidity, air movement (breeze or draught), exposure to radiant heat sources, and exposure to cool surfaces.
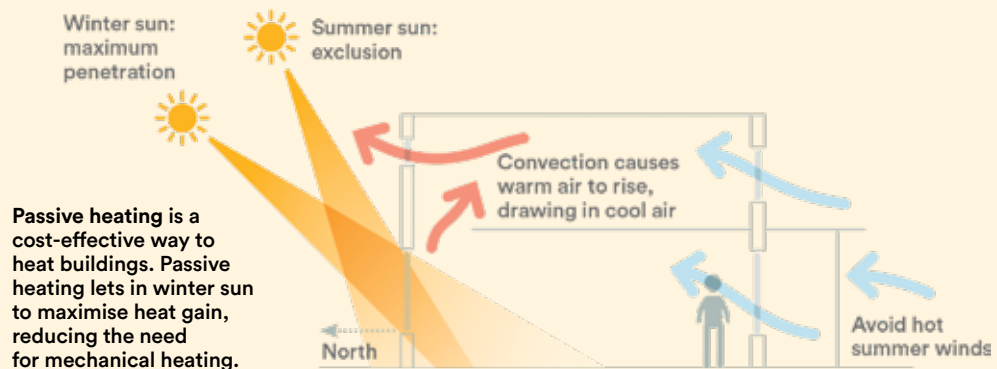
For information on your climate see http://www. abcb.gov.au/Resources/Tools-Calculators/ Climate-Zone-Map-Australia-Wide

Building orientation
The orientation of your school buildings can be determined from a map or a compass, or by noting the early morning or late afternoon position of the sun. This can tell you which windows and walls are facing north (to maximise winter sunlight) and what needs to be blocked from harsh western sun.

Sun
The sun rises in the east and sets in the west. During the summer, the sun is naturally higher in the sky and in winter, the sun's position is naturally lower.

Passive heating is a cost-effective way to heat buildings. Passive heating lets in winter sun to maximise heat gain, reducing the need for mechanical heating.

Winter sun: maximum penetration

Summer sun: exclusion

Convection causes warm air to rise, drawing in cool air

North

Avoid hot summer winds

Wind
Cross-ventilation uses cool breezes to push hotter air out of rooms. You can understand where your cool breezes will come from by understanding your building's orientation.

Passive cooling is an efficient manner of cooling buildings in summer, without incurring costs. Passive cooling acts by cooling both the space and the people using it and does so by using cool breezes during warmer days.

**Roof ventilators can also be used to remove hot air that rises through the room.**

Stack ventilation

Cross-ventilation
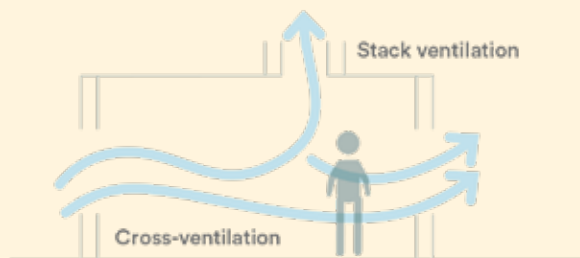
Materials
Thermal mass is the ability of a building material to absorb and store heat energy for use during cooler times. Concrete, bricks, and tiles have high thermal mass. Timber has low thermal mass.

Thermal mass absorbs heat during the day and re-radiates warmth back into a building throughout the night.

Cool night breezes draw out stored heat energy. During the day, thermal mass can be protected from excess summer sun using shading and insulation.

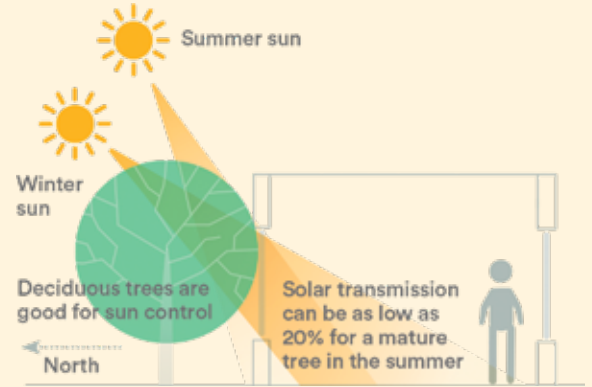
Winter sun

Heat stored

Heat released

Summer sun

Heat released
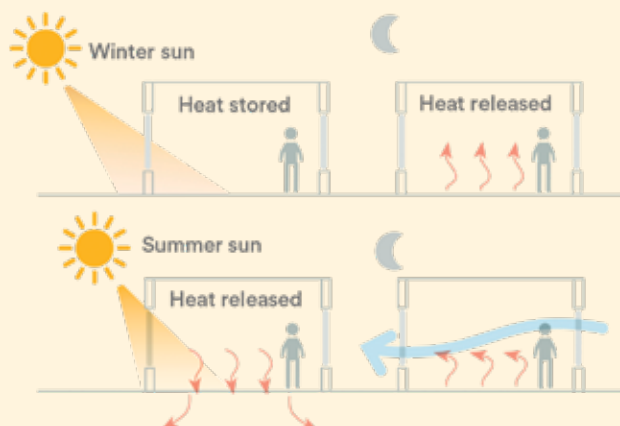
External shading
Shading buildings and outdoor spaces reduces summer temperatures, improves comfort, and saves energy.

Summer sun

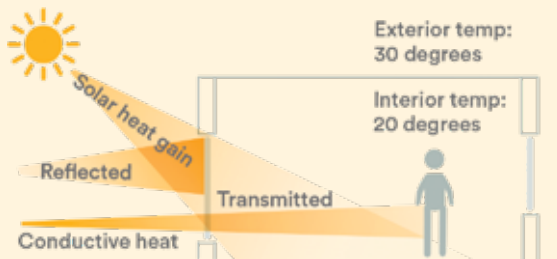Winter sun

Shading on north-facing windows

North
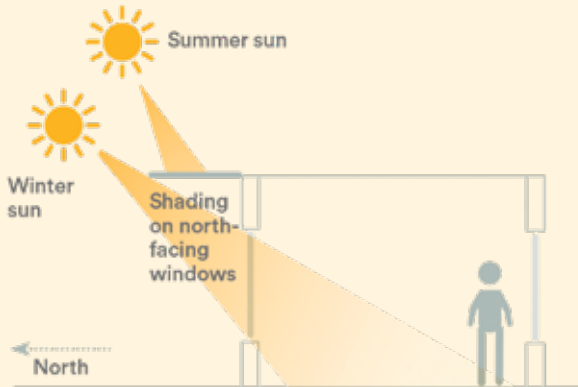
Natural shading devices
Planting trees or installing trellises with vines are both good passive design strategies for shading and can also help reduce the temperature of prevailing breezes.

Summer sun

Winter sun

Deciduous trees are good for sun control

Solar transmission can be as low as 20% for a mature tree in the summer

North

Heat transfer through windows
The types of glass used in your windows can lead to unwanted heat gain in summer and heat loss in winter, or help retain heat in winter and limit unwanted heat gain in summer.

Exterior temp: 30 degrees

Interior temp: 20 degrees

Solar heat gain

Reflected

Transmitted

Conductive heat

Radiation
Sunlight can impact the temperature of internal learning environments by increasing the heat through direct or reflected radiation.

Direct radiation

Reflected radiation

Reflected radiation

Sand or concrete surface

Reflective /light-coloured surface
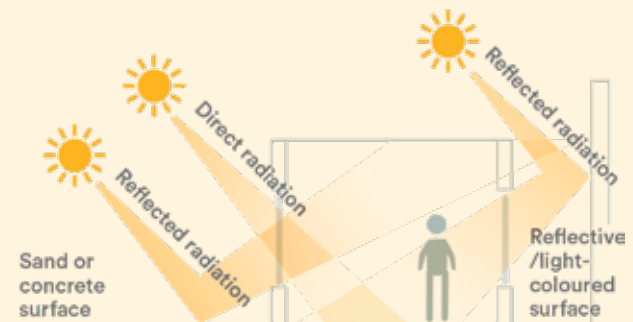
Skylights
Skylights can make a major contribution to energy efficiency and comfort. They are an excellent source of natural and diffused light. Daylight and natural light is different to sunlight. Daylight filters into a space, minimising electricity usage.

Winter sun

Summer sun

Diffuse radiation

South

North
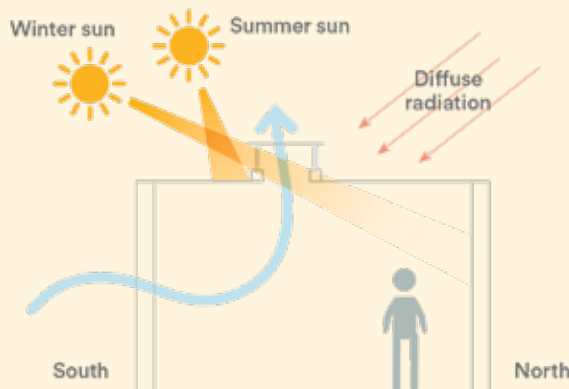
Sealing
Sealing your school against air leaks is one of the simplest upgrades to increase comfort while reducing energy use. **Common leakage points** include air vents, exhaust fans, vented skylights, gaps around air conditioners or heaters, gaps around windows and doors, and gaps between floorboards.
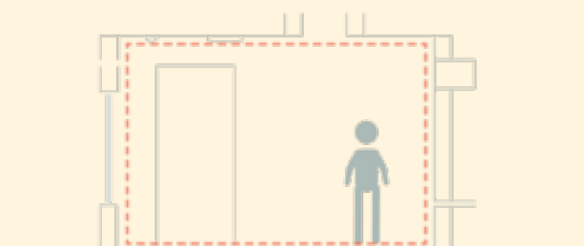
2. Showcasing environmental design in schools

New and upgraded school buildings

Many new and upgraded schools are demonstrating high-quality environmental design. New buildings are being designed with the future in mind, with climate-responsive designs offering inspiring and resilient learning environments for our children. Some of these examples are highlighted below.

These examples showcase a range of passive and biophilic design strategies that can be adopted in any school.

External sun shading devices reduce glare and heat

Harbord Public School
Where required, external louvres can be installed in front of windows (but not usually on the south face) to minimise solar heat exposure and glare.
Architect: Government Architect NSW
Image: Gavin Jowitt

Passive cooling through cross-ventilation

Anzac Park Public School
Opening windows on both sides of the classroom encourages air flow and pushes hotter air outside.
Architect: TyrrellStudio/Willie Phelps
Image: Gavin Jowitt

Adequate daylight to improve student performance

Wentworth Point Public School
Natural daylight, through windows, skylights, and doors, is provided in all learning spaces to improve the indoor environment quality, encourage learning, and reduce energy use.

Architect: Group GSA
Image: Tyrone Branigan

Ensuring adequate noise levels for student performance

Harbord Public School
Soft, sound-absorbing materials are used as wall panels to minimise noise in the learning spaces.

Architect: Government Architect NSW
Image: Gavin Jowitt

Water-efficient design

Mowbray Public School
Water-efficient appliances such as bubblers and flow restrictors are installed in bathrooms and other areas, to minimise water wastage.

Architect: Government Architect NSW
Image: GANSW

Solar design
Melville High School
Solar panel systems work well for schools where energy is needed mostly during the day, when the power generated can be used on site.
Image: Coffs Solar Energy

Life cycle design
Wilton Public School
Whole-of-life analysis is done on materials and products used in construction to ensure they have low adverse environmental impacts throughout their life cycle.
Architect: Lahznimmo Architects
Image: Brett Boardman

Bringing nature and buildings together
Bellevue Hill Public School
Biophilic landscaping of school playgrounds and outdoor learning areas can connect students with nature around them.
Architect: Group GSA
Image: Tyrone Branigan

Building materials from sustainable resources

Victoria Avenue Public School
Recycled timber, or timber from plantations or sustainably managed regrowth forests has been used.

Architect: DRA Architects
Image: Gavin Jowitt

Active travel to schools

O'Connell St Primary School
Provision of bike racks, repair stations and storage encourages active travel to school, and reduces car dependency, pollution and carbon emissions, and traffic congestion in your local area.

Architect: Tonkin Zulaikha Greer Architects
Image: Brett Boardman

Improving building performance

Rowland Hassall School
The Department of Education's Educational Facilities Standards & Guidelines (EFSG) suggests ways to improve environmental performance, integrating shading, natural landscapes, and passive design.

Architect: Lahznimmo Architects
Image: Brett Boardman

Roof ventilators
Wilton Public School
Hot air rises. Roof ventilators help hot air to escape from the roof space, allowing for passive cooling of the building.
Architect: Lahznimmo Architects
Image: Brett Boardman

Sharing spaces
Bourke Street Public School
Vegetable gardens encourage community involvement and improved health outcomes for students. SINSW has a Share our Space program for community use of grounds during the school holidays.
Architect: Group GSA
Image: Tyrone Branigan

Landscaped learning spaces
Anzac Park Public School
Outdoor learning spaces can be designed to offer a variety of spaces for different activities, encouraging outdoor learning and play.
Architect: TyrrellStudio/Willie Phelps
Image: Gavin Jowitt

3. Strategies for environmental design

Introducing some simple environmental design strategies can help you to improve school rooms, buildings, and grounds.

In many cases these strategies can make a big impact at a relatively low cost. These improvements can make schools feel better and work better, and can encourage students to take an active role in caring for the environment.

Anzac Park Public School
Colourful flexible seating and planting provides informal learning opportunities and connection to nature. The surrounding building arrangement allows for passive cooling through cross-ventilation.
Architect: TyrrellStudio/Willie Phelps
Image: Gavin Jowitt

3.1
Simple changes for school rooms

Staff and students can make a big difference to their comfort, and to the environmental performance of classrooms and other school rooms and learning spaces, through making some small cost-effective changes. Simple, everyday actions like closing blinds to exclude early morning sun, or opening windows to catch an afternoon breeze, can have a big impact.

O'Connell St Primary School
Existing buildings can be modified for comfort including removing ceilings, providing roof ventilation, adding ceiling fans, and removing partitions to support cross-ventilation.
Architect: Tonkin Zulaikha Greer Architects
Image: Tyrone Branigan

1. Use passive cooling and heating

Start with the windows

In summer, natural air flow can be a very effective way to cool indoor spaces at a fraction of the cost of mechanical cooling. For the best cooling effect, open windows on opposite sides of a room to get cross-flow ventilation. This will push hot air outside. Well-ventilated classrooms can also assist in preventing mould and removing pollutants.

If you have window coverings, use them to block out unwanted summer sun (east-facing windows in the morning, and west-facing windows in the afternoon). In winter, close window coverings at the end of the day to help rooms stay warmer over night.

Use fans to move air around

If you have ceiling fans, you can use them to control the room temperature by moving air around. In summer, with the windows open, ceiling fans can help to push hot air outside. In winter, with the windows shut, if you have high ceilings and mechanical heating, ceiling fans can help to make a room feel warmer by gently pushing warm air down from the ceiling level.
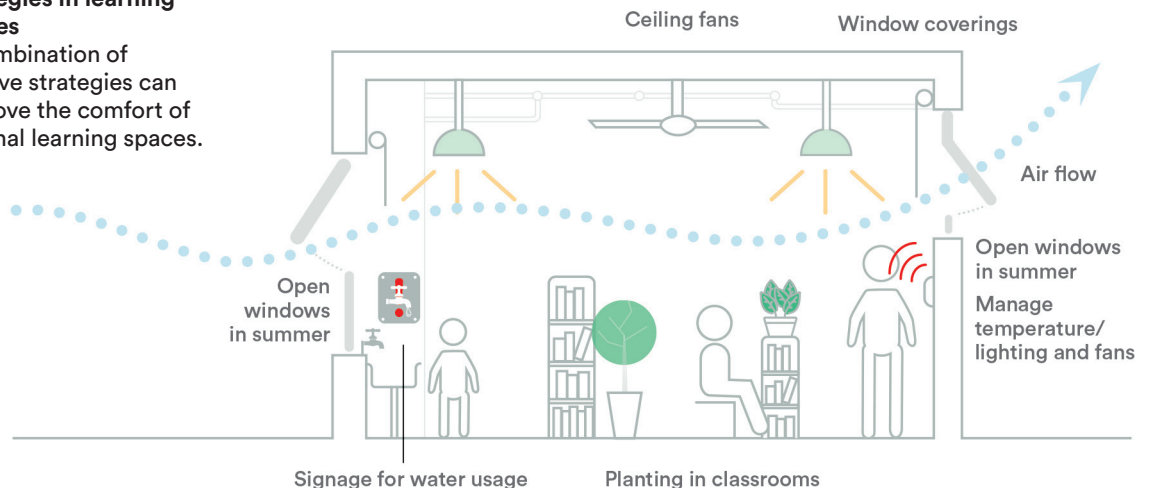
Use air conditioning efficiently

If you do use mechanical heating or cooling, keep the set temperatures within a narrow range. For optimal use, set the temperature to 18 degrees in winter and 25 degrees in summer. These temperatures will be comfortable – and by keeping within this range you can save money on running costs. If possible, use a timer to ensure the unit is not left on after hours.

> **Did you know?** Changing set temperatures on your air conditioning by just one degree (warmer in winter or cooler in summer) can add 10 per cent to the running costs of your unit (Sustainability Victoria 2015).

(top) Wentworth Point Public School
This COLA can encourage outdoor learning activities in a shaded environment.
Architect: Group GSA
Image: Brett Boardman

(above) Harbord Public School
Soft furnishings can help create quiet spaces within larger flexible learning spaces. Ceiling fans can support passive cooling.
Architect: Government Architect NSW
Images: Gavin Jowitt

Combining passive strategies in learning spaces
A combination of passive strategies can improve the comfort of internal learning spaces.

Ceiling fans
Window coverings
Air flow
Open windows in summer
Manage temperature/ lighting and fans
Open windows in summer
Signage for water usage
Planting in classrooms

2. Re-design learning experiences

Create noisy and quiet spaces

You can change your classroom's acoustic environment by including soft furnishings or surfaces, like wall treatments or floor rugs. These may need to be incorporated alongside passive strategies, for example, opening windows.

Consider zoning the use of spaces relative to noisy or quiet activities. For example, quiet reading areas require different acoustic qualities than spaces for dynamic collaboration, and are best with some form of separation between them.

> **Did you know?** Soft furnishings or surfaces could reduce noise by as much as 40–50 per cent. You could get specialist help from an acoustic technician.

Bring plants into the classroom

Biophilic design is the practice of incorporating natural materials, natural light, vegetation, nature views and other experiences of nature into buildings. This can improve indoor air quality and benefit student learning outcomes.

> **Did you know?** Integrating nature with learning spaces has been found to improve indoor air quality and benefit student learning outcomes (Lohr 2010).

Expose building services

Simple strategies such as colour coding exposed pipework can be used to help students become more aware of building services like heating or water supply. This can be a step in learning about how we use resources to control our environments.

Work outside

Consider conducting some classes outside in the shaded parts of the school grounds, to get students engaged with nature in their school playgrounds.

3. Communicate careful use of resources

Find ways to save more

Encourage staff and students to use less water and take responsibility for the school's overall water usage. Install simple signage to remind students to reduce their water usage.

Make sure lighting and other electrical equipment is used economically, and switched off when it's not in use.

Display data

Collating and displaying data on energy and water usage and waste generation can help the school community to monitor their usage and consider how to improve environmental conditions. This can be done through incorporating signage into your buildings, or by installing sensors that monitor air quality, movement (to control lights), or daylight entering the building (through louvres). Data can be brought into lessons including maths, science or Human Society and its Environment (HSIE).

> **Did you know?** Sensors that monitor carbon dioxide levels can be used as an indicator of air quality. These sensors can act as a cue for users to open a window.

O'Connell St Primary School
Large eave overhangs can support indoor–outdoor learning by creating shaded spaces. This also supports passive cooling of indoor spaces.
Architect: Tonkin Zulaikha Greer Architects
Image: Brett Boardman

3.2
Adapting your school buildings

Schools, together with their Parents and Citizens Associations (P&Cs), can make positive changes to improve the environmental performance and comfort of school buildings. Some of these improvements can be small and inexpensive, and can be managed by the school.

Before undertaking building upgrades, check with your asset management unit within SINSW to discuss any risks involved and confirm whether the work requires technical, building, or project management expertise beyond the school's capability.

If the school can contribute but not afford the total cost of an upgrade, SINSW may be able to suggest an alternative solution, to achieve a similar result within your budget.

Dapto High School
Large trees can provide canopy cover to shade play spaces and buildings, lowering energy costs.
Image: Chris Bennett

1. Control heat gain

The first step is to understand the orientation of the school buildings in relation to daily and seasonal variations in the sun's movement – and how this is affecting heat gain. For example, if unwanted afternoon summer sun is a problem, you may require additional shading on west-facing building elements.

Glazing film
Adding glazing film on west-facing windows can reduce heat gain through the glass.

Internal blinds
Blinds can be adjusted to control the amount of unwanted direct sunlight coming into an internal space. A combination of 'block out' and translucent blinds are most suitable. Schools should consider adjustable shading to allow variable sunlight in spring and autumn.

> **Did you know?** Controlling daylight in school buildings improves student performance. Faster progression is noted in mathematics (20 per cent increase) and reading (26 per cent increase) where classrooms received adequate daylight. (Green Building Council of Australia 2009).

External sun shading
For controlling heat gain, external shading is generally more effective than glazing film on windows or internal blinds. It can effectively control the amount of direct sunlight and natural light entering rooms. Northern sides of buildings can have horizontal shading, while west-facing aspects can have vertical shading, or may benefit from vertical fins. The design of the shading needs to vary depending on the aspect, and may need to vary between seasons, depending on your local climate. Shading should not restrict views from windows or block natural light when it is needed.

Natural shading
Trees that shade walls and windows can help to cool internal spaces. Solar transmission can be as low as 20 per cent for a mature tree in the summer. Before planting trees, schools should check the EFSG for suitable distances between trees and buildings.

**Mowbray Public School**
The type of external shading that will be most effective varies from one side of a building to another, depending on which way the windows are facing.
Architect: Government Architect NSW
Image: GANSW

Understanding elements that can improve school building performance
The external environment can help improve the comfort, light quality, and air quality inside rooms.
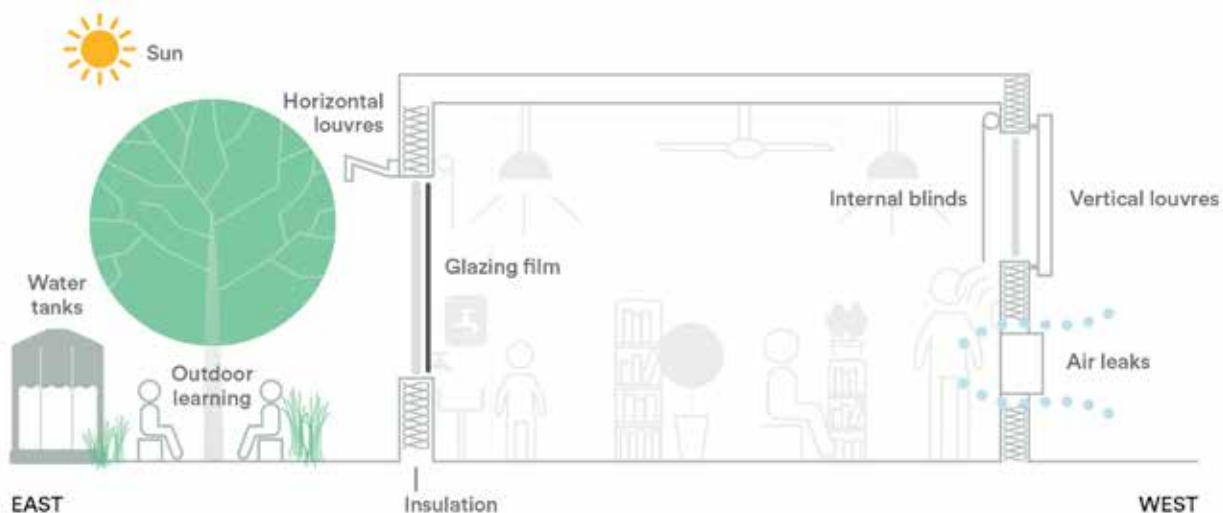
2. Combine water-sensitive design

Greywater tanks

Where possible install greywater tanks, and re-use the water for gardening or flushing toilets. Special detergents should be avoided so the water can be effectively re-used. Greywater is not fit for drinking.

> **Did you know?** Greywater is the water generated from sinks, showers, and washing machines. This can be re-used. This is distinct from blackwater, which cannot be re-used as it comes from toilets. Speak to your asset management unit about installing tanks.

Water efficiency

Understanding water use and adopting water-sensitive strategies can make a big difference to your school. Look at your school fixtures and toilets to ensure they are water-efficient, make sure they are not dripping, and plant low-irrigation trees. All of these water-efficient features can be displayed through signage to make staff and students aware of the potential water savings for their school.

3. Improve your energy efficiency

Insulation

Understand how your school buildings are insulated. This helps to retain heat in winter, and reduce heat gain in summer.

Insulation can be put in the ceilings, walls and under the floor of your buildings. Specialist consultants such as architects and environmental consultants can help select the appropriate insulation if you are renovating or replacing a roof or walls.

Air leaks

Check for air leaks, for example where air conditioning units are attached to building materials. This is one of the simplest upgrades you can make, and will improve comfort while reducing energy bills.

> **Did you know?** Insulation can save 45–55 per cent of heating and cooling energy. (Sustainable Energy Authority Victoria 2006)

Solar panels

Solar panels (installed on the correct orientation) can lower energy costs and be a source of power generation on your school site. Discuss this with your asset management unit within SINSW.

Bringelly Public School
Rainwater tanks are an excellent way to re-use water within school grounds for gardening or flushing toilets.
Image: Tyrone Branigan

3.3
Activating your school grounds

Environmental design can improve the comfort, appearance, and amenity of the school's outdoor areas, extending opportunities for learning and recreation, and improving the local environment.

School grounds can be the ideal place for schools to demonstrate and encourage environmental awareness. They can provide opportunities to instil a sense of responsible environmental citizenship in students.

Victoria Avenue Public School
Planting, trees, and landscaping are important elements to incorporate in environmental design.
Architect: DRA Architects
Image: Gavin Jowitt

1. Encourage physical activity

Walking and cycling

Active travel plays a vital role in getting kids active as part of their daily routine and setting up good habits for life. Increasing community education and awareness also plays a role, encouraging solutions that include the whole family, schools, and government agencies.

Active lifestyles help to reduce car dependency, pollution, carbon emissions, and traffic congestion in your local area.

Provide end-of-trip facilities for staff, and bike racks for staff and students. Bike workshop spaces could also be installed to teach students how to repair and maintain their bikes.

National programs such as Ride2School Day and National Walk Safely to School Day are great ways to promote active travel.

> **Did you know?** Studies show that children who cycled or walked to school perform measurably better on tasks demanding concentration, such as solving puzzles, as opposed to those traveling by car or public transport. (Goodyear 2013)


Dapto High School
Providing bike racks and storage can encourage active transport to schools. Dapto High School re-purposed a shipping container as a bike shed, equipped with tools to fix and secure their bikes.
Image: Chris Bennett

Understanding the components of environmental design across your school
This diagram outlines the network of elements that can be deployed across a school. Additional trees, shade elements, water strategies, and active transport strategies all improve environmental performance.
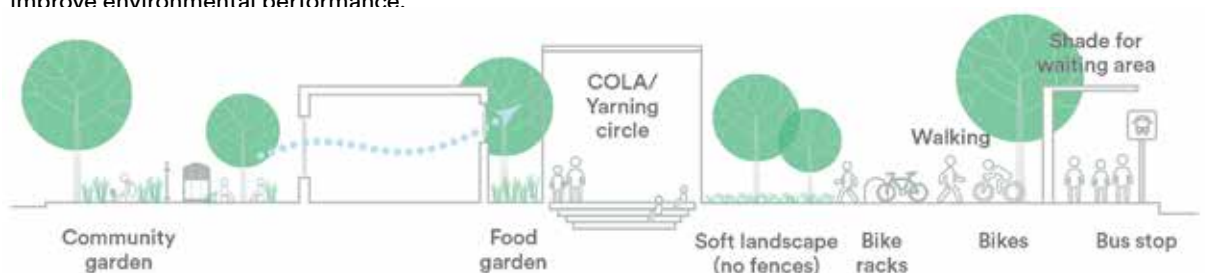
2. Learn outdoors

Covered outdoor learning areas

Covered outdoor learning areas provide shade and shelter for learning and recreation. These can be sited and designed to make the school environment more diverse and promote students' engagement with nature and outdoors.

Soft landscaping

Introducing turf, shrubs, flowers, and native planting can enliven outdoor learning areas and improve spaces for play. Including raised planter beds with small trees and shrubs can provide shade and outdoor seating for students. Soft landscaping can make a big improvement to learning areas, without involving construction.

Selecting dry-weather resistant trees and plants that are locally native to your area reduces the need for watering. Local councils are often able to provide advice. Remember to use mulch in planters to help retain water within the soil.

> **Did you know?** Access to open space, nature, and gardens has a range of social, environmental, and economic benefits including improved health and wellbeing, productivity, air quality, and biodiversity. (GANSW 2018)

Australia Street Public School
This COLA provides a new shaded play and learning space to maximise outdoor activities.
Architect: Scale Architecture
Image: Brett Boardman

Community garden · Food garden · COLA/Yarning circle · Soft landscape (no fences) · Bike racks · Bikes · Walking · Shade for waiting area · Bus stop

3. Share environmental knowledge

Learning about our natural and cultural environment

Aboriginal people have a long heritage of connecting with our land and caring for Country. Recognising and celebrating the heritage and culture of a school's specific location can help students to understand and learn more about their past, present, and future. For example, "Welcome to Country" could be incorporated at the school entrance, and Aboriginal Elders yarning circles can be used to celebrate cultural heritage and double as an outdoor learning space. Interpretive signage referencing Aboriginal words, places, animals, and plants can enhance a student's connection to their natural and cultural environment.

> **Did you know?** Indigenous landscapes can encourage native birds and provide habitat for native animals, supporting local biodiversity.

Learning from the community

Engaging community elders, including Aboriginal Elders, helps to develop strong associations with cultural diversity and heritage, and can give members of the school community a sense of ownership and shared responsibility for their immediate environment. Many schools can use their food gardens to acknowledge local cultural groups.

Indigenous landscaping can promote understanding of bush tucker, Aboriginal seasonal changes, and the relationships between plants and animals.

> **Did you know?** The Dharrawal Calendar celebrates six seasons in Sydney with specific indigenous animal and plant life having prominence within each of these seasons. The Dharrawal are traditional Aboriginal custodians of the lands south of Sydney Harbour to Shoalhaven River and from Wollondilly River to the eastern seaboard.

Community gardens

School gardens can be open to the community, creating a shared zone for students, the school community and the broader community to work together and share knowledge. School gardens and gardening activities can provide the focus for many lessons. We can learn from our local, diverse communities.

4. Share community assets

Open schools

As our cities densify, open public space becomes increasingly important for communities.

Creating shared spaces or green open spaces, accessible to the community outside school hours, improves social cohesion and benefits the wider community.

Schools may reconsider the attributes of their perimeter fencing and secure line strategies to help with shared space provision.

This may lead to new community spaces that are accessible, maintained, and managed by the school and its community. School grounds could provide green, open spaces for many local residents.

> **Did you know?** SINSW has a Share our Space program to encourage community use of school playgrounds and sports fields during the school holidays.

5. Contribute to the local environment

Capturing run-off

School grounds can be designed to capture rainwater, e.g. through a rainwater garden. Stormwater can be filtered, reducing run-off and capturing the water to enhance landscaping.

> **Did you know?** Stormwater is the excess rain that moves across the ground surface rather than being absorbed into the soil. If not managed well, stormwater run-off can carry pollutants and cause erosion. Run-off can be reduced by replacing hard surfaces with more porous surfaces, such as planting beds or permeable pavers.

Cooling the air temperature

School grounds can improve the heat-island effect by providing shade and porous, natural ground materials. Replacing hard outdoor surfaces such as asphalt with soft landscaping and permeable paving can also reduce heat gain, as well as improving stormwater run-off.

Trees, green walls, and vegetation can help reduce urban heat-island effects by shading building surfaces, deflecting radiation from the sun, and releasing moisture into the atmosphere.

> **Did you know?** Lighter surfaces generally absorb and retain less heat than darker surfaces.

Supporting biodiversity

Grounds can provide habitat for plants, animals, birds, and insects, supporting local biodiversity. Biodiverse gardens and plants can improve climate resilience, water supply, pollination, food, shelter, and health outcomes for your school.

Marrickville West Public School
Children are supporting
biodiversity learning through
an earth kids garden.
sImage: Tyrone Branigan

6. Understand the importance of trees

Trees make our schools look and feel better, and can help create conditions where children can thrive. Trees create a sense of place that makes people feel more comfortable. They bring delight by changing colour over the seasons, modulating light through shadow patterns, and framing views and buildings.

Our schools are part of a green network
Trees also play a role in climate-proofing our neighbourhoods and supporting human health and wellbeing. The network of trees across our schools performs a critical function for our environment, and provides an array of health benefits including limiting exposure to sun, and improving mental health.

The GANSW Urban Tree Canopy Manual provides targets for tree canopy coverage for the whole of NSW. Schools can play an important part in helping local areas to meet these targets.

Heating, cooling, and shade
Trees provide natural shade and cooling – an essential component in reducing the heat-island effect. They influence ambient temperatures around buildings by providing shading from the sun and shelter from dominant winds, which can reduce energy usage for both heating and cooling. Trees also improve air quality, absorb carbon and rainfall, cool local environments, and support wildlife.

> **Did you know?** Deciduous trees play an important role in passive heating and cooling. By shedding their leaves in winter they allow more sunlight to reach ground and wall surfaces, contributing to passive heating. In summer, leafy tree canopies create shade, helping to cool buildings and outdoor play spaces.

Maintaining healthy trees
Mature planting in our schools provides natural shade and cooling. Establishing tree management and maintenance priorities with your school staff and incorporating student activities can foster ownership of trees as essential elements of environmental design.

Choosing the right tree to plant
Choosing the right trees for your school based on your location and climate will improve the chance of your trees growing into a mature landscape. It is important to consider:
—What benefits do you want from the tree? These might include shade, colour, habitat or other attributes. Do you want a deciduous tree or an evergreen tree?
—What will the mature tree look like? Consider tree size, texture, colour and seasonal changes in relation to your buildings and landscape.
—Are there attributes you need to avoid, like pollen, or trees that are too large or block light?
—Which types of trees grow well and belong in your area? Will you plant the same types, or choose species that add diversity to the local tree population?
—Is the site right for tree planting? Consider soil type, amount of sun, available space above and below ground, impact on surrounding spaces and buildings.

> **Did you know?** Different trees will prosper in different regions of NSW. You can talk to your local council about the types of trees that will work best for your climate. Planting new trees is best after winter as the weather begins to warm.

Which trees will we plant?
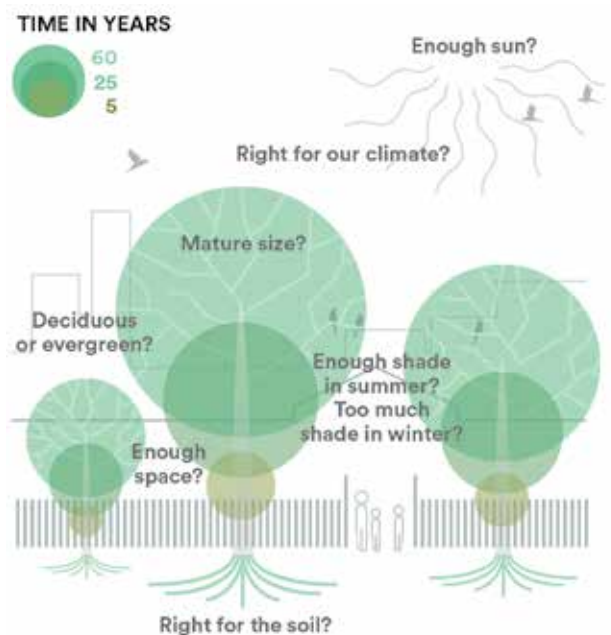
4. Glossary

B

Biodiversity
Biodiversity or 'biological diversity' is the variety of life on Earth. It includes all the plants (trees, shrubs, mosses and lichens), animals (mammals, birds, reptiles, frogs, invertebrates) and microorganisms such as bacteria. Biodiversity supports life on Earth, creating clean air and water, fertile soil and healthy ecosystems.

Biophilic design
Biophilic design looks to incorporate natural materials, natural light, vegetation, nature views and other experiences of the natural world into our buildings.

Built environment
Comprises the extent of our human-made environment, as distinguished from the natural environment. It includes all aspects of our surroundings made by people that provide the places for human activity. The built environment includes cities, towns, neighbourhoods, parks, roads, buildings, infrastructure, and utilities like water and electricity.

D

Deciduous tree
Trees and shrubs that lose their leaves and become dormant during the winter.

E

Environmental design
Designing buildings, spaces and landscapes that respond to their natural surroundings and climate, minimise negative environmental impacts, and conserve resources, while supporting health and wellbeing and providing thermal comfort, shelter, safety, and amenity.

Evergreen tree
A tree or plant that doesn't shed its leaves in the winter, but stays green all year.

G

Greenhouse gas emissions
Emissions of gas, such as carbon dioxide and methane, that create a 'greenhouse' effect by trapping heat in the Earth's atmosphere, affecting the global climate system.

Green wall
A wall that is covered with planting that includes soil or a lining, and an irrigation system for water to help the plants grow. A green wall is sometimes called a **living wall** or **vertical garden**.

Greywater
Water from sinks, showers, and washing machines. If a greywater system is well-designed and well-maintained, the water can be re-used for purposes like gardening, but is not drinkable. Greywater systems needs to comply with council requirements. Greywater does not include water from toilets, but it can be used to flush toilets.

H

Heat-island effect
Increased urban temperatures due to buildings and hard surfaces which absorb and hold heat. This effect can be reduced by introducing more natural, porous surfaces and trees.

P

Passive design
An important and cost-effective aspect of environmental design, passive design is the use of 'passive' elements such as building orientation, building materials, shading, and natural ventilation to maintain temperatures within a comfortable range. Passive design is based on understanding how local and seasonal conditions (climate, the movement and angle of the sun, prevailing breezes) interact with the built environment.

S

Sustainability
The endurance of systems, buildings, spaces, and processes – their ability to be maintained at a certain rate or level, which contributes positively to social, environmental, and economic outcomes.

T

Thermal mass
Any mass which absorbs and holds heat energy such as concrete or brickwork. Thermal mass can be beneficial in providing a stable temperature within spaces by absorbing heat from the sun during the day and radiating it back out at night when temperatures outside have dropped.

Tree canopy
This can refer to the extent of an individual tree crown (including branches and leaves) or the combined canopy area of a group of trees. Urban tree canopy includes trees on public and private land within urban areas, including parks, gardens, road and rail corridors, private gardens and school grounds. Urban tree canopy can help to lower summer temperatures by reducing the heat-island effect.

5. More information

GANSW, Design Guide for Schools
www.governmentarchitect.nsw.gov.au/
guidance/design-guide-for-schools

NSW Department of Education,
Educational Facilities Standards and Guidelines
https://efsg.det.nsw.edu.au/

NSW Department of Education,
sustainability curriculum
https://education.nsw.gov.au/
teaching-and-learning/curriculum/
learning-across-the-curriculum/sustainability

Green Building Council of Australia, Green Schools
https://new.gbca.org.au/advocacy/
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https://sustainabilityinschools.edu.au/

Office of Environment and Heritage,
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www.environment.nsw.gov.au/
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Green Diary, Australia
www.greenlanediary.org

Cool Australia
https://www.coolaustralia.org/

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7. Credits

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