

Appendices

Occupiers liabilities and the risks for public authorities

The risks to the public from exposure to UVR in sunlight may give rise to a number of liability issues for public authorities (including local councils) where they have the care, control and management of public land and facilities. A number of decisions handed down by the courts have established that local authorities have a responsibility to visitors to their land or users of their facilities. Where people are injured at a swimming pool or sports ground for example, through the perceived failure of a council to take appropriate preventive action, the council may be held liable.

This 'duty of care' is further reinforced in South Australia where Section 17c of the Wrongs Act 1936 clearly states that the general principles of negligence will be applied in determining the liability of an occupier of premises for injury, damage or loss associated with the state or condition of those premises. To this end, a council is deemed to be the 'occupier' of premises if it is the owner or is in control or occupation of them. To paraphrase the legislation, in a claim against a council for personal injury, damage or loss, the court will take into account:

- (a) the type of premises in question
- (b) the type and extent of the danger which might arise from the state or condition of the premises
- (c) how the claimant became exposed to the danger
- (d) the age of the claimant and the ability of that claimant to appreciate the danger of the premises
- (e) whether (and to what extent) the occupier (in this case an authority) was aware or ought to have been aware of:
 - (i) the danger
 - (ii) the presence of the claimant on the premises
- (f) what steps were taken to eliminate, reduce or warn of the danger
- (g) whether (and to what extent) it was reasonable to expect the occupier to take measures to eliminate, reduce or warn against the danger and
- (h) any other matters that the court thinks relevant.

As a consequence, councils, like all occupiers, must be mindful of the presence of persons on their property or on premises over which they have care, control and management and must be mindful of the duty of care which is owed to such people. For example, local authorities would be aware that parents and children visit and use swimming pools and playground facilities, which have been provided for use by the general public.

Where does this leave a local authority with regard to the public being exposed to UVR from sunlight whilst using local facilities? On the one hand, it is clear that for liability to attach to a local authority there must be a causal nexus between their actions or failure to act and the injury complained of, ie could an incidence of skin

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cancer or melanoma later in life be directly attributed to the lack of shade in a playground? On the other hand, it can be argued that 'protection' should match the current state of knowledge and awareness of a particular issue. With the current information relating to the effects of exposure to the sun it would seem to make sense that some form of protection from damaging UVR is provided where it is expected that children will become exposed to sunlight, particularly at times of high UVR levels.

It should be noted that knowledge of the risks of UVR exposure is not confined to local authorities. Indeed, evaluations of recent mass-media campaigns and sun protection promotions indicate that knowledge of personal sun protection measures is widespread in the community. Thus, whilst local authorities can contribute to the protection of the public by providing shade, such authorities will not necessarily be held liable for all cases of UVR-related injury incurred at local government facilities.

In summary, it is clear that for local authorities to discharge their duty of care in the provision of facilities for the use of the public (and for children in particular), they have a responsibility to provide them in a way that does not expose the public to any undue risks. To this end, however, it would be unreasonable to expect that every park, reserve or outdoor recreational facility be protected from exposure to UVR. As indicated by the Wrongs Act, occupiers are required to eliminate, reduce or warn of the dangers associated with their premises. Elimination is often difficult to achieve without removal of the facility. This leaves either reduction or warning or a combination of them. The provision of trees and/or shelters accompanied by warnings bringing to the attention of patrons the need for them to provide some form of personal protection would go a long way towards local authorities fulfilling their obligations and to providing a safer outdoor play environment.

Dennis Cock

Risk Manager

Local Government Association
Mutual Liability Scheme

Appendix B

Professional and industry contacts

Archicentre (Australia) Pty Ltd

1 King William Road
Unley SA 5061
Ph: 1300 134 513
Website: www.archicentre.com.au

Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)

Melbourne Office
Lower Plenty Road
Yallambie VIC 3085
Ph: 61 3 9433 2211
Fax: 61 3 9432 1835
Website: www.arpansa.gov.au

Royal Australian Institute of Architects (SA Chapter)

1 King William Road
Unley SA 5061
Ph: 8272 7044
Website: www.raia.com.au

Australian Institute of Landscape Architects (SA group)

PO Box 1584
Adelaide SA 5001
Website: www.aila.org.au/sa/index2

Lightweight Structures Association of Australia

Faculty of the Built Environment
LSRU, Building 9
22-32 King Street
Randwick NSW 2031
Ph: (02) 9385 0352
Website: www.fbe.unsw.edu.au/units/LSRU/ssa

TREENET (Tree and Roadway Experimental and Educational Network)

Coach House Science centre
University of Adelaide—Waite Campus, PMB 1
Glen Osmond SA 5064
Ph: (08) 8303 7078
Fax: (08) 8303 6826
Email: treenet@waite.adelaide.edu.au
Website: www.treenet.com.au

The EcoDesign Foundation

PO Box 369
Rozelle NSW 2039
Ph: (02) 9555 9412
Fax: (02) 9555 9564
Website: www.edf.edu.au

South Australian Urban Forest One Million Trees Program

Ph: (08) 8372 0180
Website: www.urbanforest.on.net

Mount Lofty Ranges Catchment Program

Upper Level, Mann Street (cnr Walker)
Mount Barker SA 5251
Ph: (08) 8391 7500
Fax: 8391 7524
Website: www.mlrcp.sa.gov.au

Greening Australia

Ph: (08) 8372 0120
Website: www.greeningaustralia.org.au

Trees For Life

Ph: (08) 8372 0150
Fax: (08) 8372 0199
Website: www.treesforlife.org.au

The South Australian Indigenous Growers and Revegetators Association (SAIGRA)

PO Box 10082
Gouger Street
Adelaide SA 5000
Free Call: 1800 065 363
Email: saigra@picknowl.com.au

The Threatened Species Network (TSN, South Australia)

120 Wakefield Street
Adelaide SA 5000
Ph: (08) 8223 5155
Fax (08) 8232 4782
Email tsnsa@ozemail.com.au
Website www.ccsa.asn.au/tsnsa

Conservation Volunteers Australia

Ph: (08) 8212 0777

Qualities of shade materials

metal roof sheeting
steel, aluminium, zinc, copper

Roofing and walling; steep or low pitches; curved and straight forms. Typically used for permanent fixed shade structures, although may be used as adjustable louvres. Most suited to summer shading where cool shade is required.

Excellent protection, UPF 50+.

Yes.

Opaque.

Thermal resistance if insulated. Lighter colours reflect heat.

Adequate 'tie-down' must be designed according to the wind code. Consult professional designer.

Material readily available; easily re-fitted.

Subject to moisture or condensation conditions. Ensure all metallic particles are swept from roof on completion of installation to prevent staining and corrosion.

Long life if well maintained. Fixings and flashing materials should have a lifetime similar to that of the roof covering material.

Strongest of roofing and walling materials available. Long lengths and range of 'profiles' available. Can be cut to length. Some profiles can be curved.

Available in sandwich panels for increased insulation. Is often finished/coated to extend life span, eg. galvanised, colourbond, stainless steel, or coated with plastics, eg. PVC. Long life spans mean less environmental impact in terms of material replacement. However, they need considerable support structure. Made from non-renewable resources. All high embodied energy although to differing degrees, aluminium is extremely energy intensive. All produce pollutants during manufacture (including coatings) but are generally contained. All are recyclable: steel and aluminium are commonly recycled and often contain recycled content. The potential of steel, copper and aluminium to be re-used is very good, especially if designed for disassembly. Steel and aluminium are good for collecting rainwater if properly sealed. The corrosion of copper and zinc may cause contamination of nearby water and soil.

Economic for both small and large structures. Timber or steel frame required for support.

Qualities of shade materials

roof tiles
concrete, clay, slate, fibre cement

suitability	Mainly roofing. Typically used for permanent fixed shade structures. Most suited to summer shading where cool shade is required.
UVR protection	Excellent protection, UPF 50+.
waterproof	Yes.
light transmission	Opaque.
solar heat gain	Better thermal performance if lined.
structural implications	Requires substantial support structure. Must be fixed to manufacturer's specification.
ease of replacement	Material readily available; easily fitted.
life span	Long. Fixings and flashing materials should have a lifetime similar to that of the roof covering material.
environmental considerations	All tiles have impacts during manufacture, are made of non-renewable resources, and require a comparatively large volume of material. Using locally reclaimed tiles lessens these impacts. Slate has the lowest manufacturing impacts, however it is usually imported, which increases its embodied energy; reclaimed slate is preferable. Clay has high embodied energy, however this may be offset by long life use, as it is more durable than concrete. Concrete tiles with slag instead of cement are preferable.
relative cost	Low, but support structure cost may be significant

	timber
suitability	Pergolas, trellis, lattice, screens, vertical or horizontal louvres. Suitable for use in combination with natural shade elements. Generally used in fixed permanent structures.
UVR protection	Solid sections provide excellent protection, UPF 50+. Other situations depend on density of construction, eg lattice or covering vegetation.
waterproof	Depends on detailing and use.
light transmission	Depends on detailing.
solar heat gain	Does conduct heat, but this is lessened in open air situations.
structural implications	Design for appropriate wind code.
ease of replacement	Usually readily available; ease of re-fitting depends on type of construction.
maintenance requirements	Guard against termites. If using preserved or treated timber care must be taken in handling. Painting or other protective treatment will extend life span.
life span	Longevity will depend on: ongoing maintenance and servicing; types of treatments; grade of timber used; type of timber, eg hardwoods/treated softwoods, as well as its detailing (how it is fixed).
particular properties	Available in a wide range of sizes and strengths. Can be also in sheet form, eg plywood.
environmental considerations	Timber is a renewable resource but only if forests are managed correctly. It generally has low embodied energy (depending on transport energy) but some wastage to produce building materials. The main issue with timber and environmental impact is its sourcing - preference should be given to sustainable managed forests or plantation resources. Timbers with the longest life span are hardwoods that are often unsustainably harvested. Look to use recycled/reclaimed timbers. Treatments which extend life span for timber are often highly toxic, especially copper chrome arsenic (CCA). As ammoniacal copper quaternary (ACQ) has less heavy metals than CCA, it is preferable; both treatments mean that timber cannot be burnt. Use of hardwoods can avoid this environmental problem, however they are often from old growth forests. Life span can be extended beyond its initial use by keeping pieces in long lengths and designing for disassembly. For plywood sheeting, ensure facing is a sustainably grown local product and specify marine grade; other grades have higher volatile organic compounds in glues.
relative cost	Depends on design lengths, proposed usage, etc. Readily available, economical material.

Qualities of shade materials

	concrete precast or in-situ, concrete blocks, autoclaved aerated concrete, fibre cement sheet
suitability	Walls, roofs, louvres, sunhoods. Suitable for permanent fixed structures.
UVR protection	Excellent protection, UPF 50+.
waterproof	Yes.
light transmission	Opaque.
solar heat gain	Absorbs heat slowly and re-transmits as air temperature falls.
structural implications	Requires substantial support and footings.
ease of replacement	Materials readily available; re-fitting depends on form of material—large pre-cast units and cast in-situ forms, eg suspended reinforced concrete slabs, very difficult to replace; smaller pre-manufactured units, eg fibre cement sunhoods or block walls, easily replaced.
maintenance requirements	Low.
life span	Long.
particular properties	Flexible material in many forms. Slow heat absorption.
environmental considerations	Uses a high volume of material with high embodied energy. Concrete (pre-cast, in situ or blocks) can be used as a thermal mass. All finite resources—scarcity is becoming an issue in some localities. Production of the critical ingredient (cement) is a major contributor to CO ₂ emissions (also nitrous oxides and sulphurous oxides emissions). Concrete aggregates may be supplemented with slag to reduce overall impact. Large volumes of water required in manufacture/construction. Possibility for down-cycling.
relative cost	Low, but support structures cost may be significant.

	masonry clay bricks, rammed earth, mudbricks, straw bale
suitability	Walls. Suitable for permanent fixed structures.
UVR protection	Excellent protection, UPF 50+.
waterproof	Yes.
light transmission	Opaque.
solar heat gain	Absorbs heat slowly and re-transmits as air temperature falls.
structural implications	Requires substantial support and footings.
ease of replacement	Materials readily available; re-fitting usually straightforward.
maintenance requirements	Low.
life span	Generally long; rammed earth and straw bales durable if protected by eaves.
particular properties	Slow heat absorption. Straw bales have far less thermal mass than others.
environmental considerations	Made from finite resources (although not scarce), these materials can also be used as an energy store (see Thermal mass in the Glossary). As walling, these materials use a high volume of material. Locally sourced natural stone, mudbricks, straw bale, and rammed earth have extremely low environmental impact. More traditional clay bricks have impacts in manufacturing of high embodied energy, contribution to acid rain, and the possible release of toxic gases. Re-used bricks or natural stone are therefore preferable and often available. Use soft mortar with clay bricks so that bricks can be re-used later.
relative cost	Low, though substantial footings required.

Qualities of shade materials

expanded metal mesh

suitability	Adjustable or fixed screens and wind deflectors. Openable roofs and walls.
UVR protection	Forms an effective shield depending on the position of the slit opening.
waterproof	No.
light transmission	Moderate transmission of light.
solar heat gain	Barrier to direct solar radiation while allowing ventilation.
structural implications	Can span quite large openings. Must withstand lateral forces. No uplift forces.
ease of replacement	Readily available.
maintenance requirements	Should be galvanised to ensure low maintenance.
life span	Very durable. Specify for appropriate life span, ie coatings and hole size to minimise rust.
particular properties	Depending on angle of mesh, will let air through.
environmental considerations	Requires less structural support than solid sheet metal and uses a low volume of material. Usually made from steel, also can be made from aluminium (which requires more energy to produce) and copper (which has some problems with nearby soil and water contamination). Different finishes usually applied pre-purchase: often galvanised, plastic coated, eg PVC, or painted. Can be recycled and re-used, especially if designed for disassembly.
relative cost	Low.

perforated metal sheet

suitability	Screens, awnings and sunhoods. Use for both permanent and adjustable systems.
UVR protection	Varies as only solid sections provide barrier to UVR.
waterproof	No.
light transmission	Modulates light.
solar heat gain	Cuts direct solar radiation and allows ventilation.
structural implications	Must be strong enough to span required opening.
ease of replacement	Readily available; easily replaced.
maintenance requirements	Should be galvanised. Pre-painted sheets require low maintenance unless in a highly corrosive environment.
life span	Very durable. Specify for appropriate life span, ie coatings and hole size to minimise rust.
particular properties	Holes will allow air through.
environmental considerations	Non-renewable, however it could contain a percentage of recycled content. Small amount of waste material in production. Requires less structural support than solid sheet metal and uses a low volume of material. Usually made from steel, also can be made from aluminium (which requires more energy to produce) and copper (which has some problems with nearby soil and water contamination). Different finishes usually applied pre-purchase: often galvanised, plastic coated, eg PVC or painted. Can be recycled and re-used, especially if designed for disassembly.
relative cost	Low.

Qualities of shade materials

glass

suitability	Roofs or walls. Use where light and/or visibility is required. Generally permanent fixed structures.
UVR protection	Depends on thickness and type. Ordinary window glass offers little protection from UVR. Laminated glass can absorb almost all UVB; by contrast, toughened glass transmits some UVR. Additives during manufacture and reflective surface laminates can affect UVR penetration.
waterproof	Yes.
light transmission	High depending on tint.
solar heat gain	Less heat gain if tinted.
structural implications	Talk to manufacturer to select glass appropriate to the job.
ease of replacement	Usually readily available and easily re-fitted.
maintenance requirements	Needs regular cleaning. Breakage and safety issues if not toughened or laminated.
life span	Long life if it doesn't sustain impact or over-pressurisation.
particular properties	Transparency allows wide range of uses, eg windbreaks.
environmental considerations	High embodied energy although small volume of material required. Additives and coatings required to provide UVR protection made of oxides of metals: iron, nickel, cobalt, silver halide which complicate the recycling of glass and may have disposal complications. Glass used in buildings is not currently recycled and has very little recycled component.
relative cost	Reasonably high compared to other translucent materials. May require more sophisticated support structure.

polycarbonate sheeting

suitability	Roofing, walling, louvre systems, awnings, skylights and canopies. Typically used for permanent fixed shade structures, although could be used as adjustable louvres. Most suited to winter shading where warm shade is required.
UVR protection	Very high protection.
waterproof	Yes.
light transmission	High. Differs according to thickness, profile and colour. Clear or opal transmits more light and heat than darker tints.
solar heat gain	High. Becomes warm and produces a heating effect.
structural implications	Design structure for wind uplift. Requires safety mesh beneath.
ease of replacement	Readily available; easily re-fitted.
maintenance requirements	Low maintenance. Impact resistant.
life span	About 10 years. Material may become brittle and discolouration may occur sooner than 10 years.
particular properties	Long lengths; range of profiles and colours available.
environmental considerations	<p>The environmental problems associated with plastics such as polycarbonate sheeting occur in their manufacture and disposal—they cause fewer problems during construction and use. Toxicity during manufacture depends on the stabilisers used (which is what protects polymer from solar degradation so is necessary for shade provision). These are often environmentally dangerous (especially phosgene).</p> <p>Solvents used in polymer manufacture are problematic—the most common, methylene chloride, is a suspected carcinogen. Made from non-renewable resources, high embodied energy offset by low amount of material needed. Can be recycled, but generally down-cycled. Because of long life span and durability, potential for re-use high; specify shapes/mouldings and support structures with this in mind. Will not decompose. Disposal is to landfill. Good for water collection. Requires less structural support materials.</p>
relative cost	Low.

Qualities of shade materials

fibreglass sheeting teflon coated, silicone coated

suitability	Roofing, walling, louvre systems, awnings, skylights and canopies. Typically used for permanent fixed shade structures, although could be used as adjustable louvres. Most suited to winter shading where warm shade is required.
UVR protection	Very high protection. Differing UV stabilisers and coatings will change level of UPF.
waterproof	Yes.
light transmission	High. Various tints, UV stabilisers and coatings will change level of light transmission. Clear or opal transmits more light and heat than darker tints.
solar heat gain	High. Becomes warm and produces a heating effect.
structural implications	Design structure for wind uplift. Needs safety mesh below
ease of replacement	Readily available.
maintenance requirements	Low maintenance. Impact resistant.
life span	Coatings (such as teflon/silica) protect the resin/glass fibres from weathering and will extend the life span, as will detailing. Weathering will gradually make material more opaque.
particular properties	Fibreglass sheeting consists of glass fibres mixed with polymer resins. Can be bought in sheets or moulded for specific applications.
environmental considerations	Material uses non-renewable resources. High embodied energy as well as problems with toxicity and volatile organic compounds in manufacture, although manufacturers are increasingly following best practice initiatives. Pollution and waste during manufacture depends on type of plastic resin and stabilisers used. Currently not recycled in Australia; re-use dependent on design specification, ie whether bought in sheeting or hand-moulded.
relative cost	Low.

Qualities of shade materials

canvas
or similar tightly woven cloths

suitability	Good for adjustable, short-term fixed and demountable structures. Not suitable for large projects.
UVR protection	Good protection when new. Prolonged or severe weathering may reduce UPF.
waterproof	Watertight up to saturation point. Greater protection can be achieved using coatings.
light transmission	Lighter colours transmit greater light.
solar heat gain	Darker colours gain more heat.
structural implications	Guy ropes cause obstruction.
ease of replacement	Readily available. Ease of replacement of individual panels usually means that the whole structure would need to be dismantled.
maintenance requirements	Lacks self cleaning properties. Is not mould resistant. Life span can be extended by regular maintenance and proper drying to inhibit rotting. Will still retain strength even if partially affected by rot.
life span	Limited. Susceptible to break down due to UVR exposure.
particular properties	Wide range of colours and fabric designs; also wide range of proprietary products available using canvas.
environmental considerations	Usually made from low grade (otherwise waste material) canvas, although can be made from hemp and flax. Renewable resource although high use of water, fertilisers and pesticides in production. Canvas (especially for outdoor application) usually finished with a waterproofing agent such as aluminium or plastic sprays such as polyurethane (which have high toxic volatile organic compound emissions) to extend life. Low volume of material in relation to area covered, and low volume of structural support material needed. At end of life will degrade but waterproof coatings may cause leaching problems in landfills.
relative cost	Material cost low, though some proprietary products may be relatively expensive on a square metre basis.

Qualities of shade materials

PVC coated polyester fabric

suitability	Canopies and side panels. Highly curved structures - not suitable for flat surfaces. Typically used for fixed permanent structures though can be retractable or demountable. Most popular material in use for construction of fabric structures.
UVR protection	Very good.
waterproof	Yes.
light transmission	High.
solar heat gain	Heat transmission is similar to glass.
structural implications	Structures must resist wind load, especially uplift.
ease of replacement	Fully imported material, though readily available. Ease of re-fitting depends on use; 'structural' fabrics may require dismantling of structure for full replacement. Can be readily patched.
maintenance requirements	High gloss self-cleaning surfaces.
life span	Minimum 7–8 years in zones experiencing intense UVR. Effective life is very dependent on location and environment; in excess of 20 years likely in areas of low pollution. Pollution acts as a corrosive agent on PVC surface causing erosion. Vehicle emissions are among the worst polluting agents. Manufacturers usually provide 5 year guarantee.
particular properties	Usually white or light cream in colour. Usually coated with clear Tedlar film which assists cleanability and prolongs the life of the PVC medium. Easy to work with. Fire resistant—fabric will char or holes will be formed if placed over a flame source but is not likely to ignite.
environmental considerations	PVC and polyester are from non-renewable resources. Problems in production due to stabilisers/additives such as fire retardants, which may also leach in landfills. High pollution and toxicity during manufacture of PVC (though closed systems can minimise escape of dioxins). Support structure needed is minimal and volume of material is small in relation to the area covered. After use, product can be re-used unless is too degraded. PVC can theoretically be 'downcycled' and polyester recycled, but combination of the two cannot be recycled. Both are thought to release dioxins in landfill.
relative cost	Relatively expensive.

teflon coated fibreglass fabric (PTFE)

suitability	Large span canopies—able to achieve lower curvatures than PVC coated polyester. Fixed permanent structures—not recommended for retractable systems or flat surfaces.
UVR protection	Very high.
waterproof	Yes.
light transmission	Translucent.
solar heat gain	Less heat gain if tinted.
structural implications	Structures must resist wind loads, especially uplift.
ease of replacement	Fully imported. Consider using smaller panels for ease of replacement in the case of damage and to ensure continuous use of the covered space.
maintenance requirements	Beware of potential for water ponding in sudden downpours.
life span	Very durable. Design life of 20 to 30 years.
particular properties	More difficult to fabricate and erect than PVC polyester. Non-combustible—satisfies Building Code requirements for fire protection in enclosed spaces eg shopping malls. Resistant to UVR exposure and airborne pollution.
environmental considerations	Non-renewable resource. High embodied energy in production. Low volume of material needed in relation to area, and minimal support structures. Toxicity in production, though is generally contained. Cannot be incinerated or recycled, usually goes to landfill where there may be some problems with leaching.
relative cost	About two to three times the cost of PVC coated polyester fabric structures.

Qualities of shade materials

knitted polyethylene
(shade cloth)

suitability	Proprietary products such as canopies and freestanding pavilions. Commonly used for shade in car yards.
UVR protection	UPF varies according to colour, fabric density and degree of stretch. Only the solid sections form a barrier to UVR. Typically, cover factors vary from less than 50% UVR protection to more than 90%. Shade cloths with a rating of 90% give only medium UVR protection or UPF 10. Double knits or double layers may give a higher UPF. Use only fabric that provides 94% or greater protection from direct UVR.
waterproof	Porous, lacks rain protection.
light transmission	Lighter colours allow more light but reflect and scatter more UVR.
solar heat gain	Darker colours are hotter but reflect less UVR.
structural implications	Minimal down or uplift force due to porous nature of the material.
ease of replacement	Readily available—many different sources and countries of origin. Re-fitting generally easy.
maintenance requirements	Keep clear of tree debris to avoid sagging problems. Susceptible to mould growth and dirt pick-up.
life span	About 5 years depending on location. It should be noted that shade cloth may be characterised by poor durability if used in a location that is subject to windy conditions. Prone to vandalism.
particular properties	Easier to fabricate than solid fabrics. High stretch fabric. Curved surfaces can be formed easily.
environmental considerations	Non-renewable resource, made in Australia and imported. Contains no chlorides however additives to ensure low flammability are often highly toxic and can emit volatile organic compounds. Short life span means regular replacement. Less structural material needed due to small weight. After use it is too degraded to be recycled and usually goes to landfill; it can be incinerated depending on additives. Easily transported. Not suitable for water collection/other uses.
relative cost	Inexpensive. Cost of different cloths is directly proportional to quality.

Qualities of shade materials

woven PVC coated yarn
(shade cloth)

suitability	Adjustable and fixed systems, outdoor furniture and other proprietary products.
UVR protection	UPF varies according to colour, fabric density and degree of stretch. Only the solid sections form a barrier to UVR. Typically, cover factors vary from less than 50% UVR protection to more than 90%. Shade cloths with a rating of 90% give only medium UVR protection or UPF 10. Double knits or double layers may give a higher UPF. Use only fabric that provides 94% or greater protection from direct UVR.
waterproof	Porous, lacks rain protection.
light transmission	Lighter colours allow more light but reflect and scatter more UVR.
solar heat gain	Darker colours are hotter but reflect less UVR.
structural implications	Minimal down or uplift force due to porous nature of the material.
ease of replacement	Readily available, many different sources and countries of origin. Re-fitting generally easy.
maintenance requirements	Keep clear of tree debris to avoid sagging problems. Susceptible to mould growth and dirt pick-up.
life span	About 5 years depending on location. It should be noted that shade cloth may be characterised by poor durability if used in a location that is subject to windy conditions. Prone to vandalism.
particular properties	Easier to fabricate than solid fabrics. High stretch fabric. Curved surfaces can be formed easily.
environmental considerations	PVC is made from non-renewable resources. The type of yarn used may either be renewable or non-renewable. High toxicity during manufacture of PVC (though closed systems can minimise escape of dioxins). Its short life span means regular replacement and thus more material. Volume of material is small in relation to the area covered. After use, this product is usually too degraded to be recycled. Not suitable for water collection/other uses.
relative cost	Inexpensive. Cost of different cloths is directly proportional to quality.

Qualities of shade materials

shingles and shakes timber, fibre-cement

suitability	Roofing and walling. Aesthetic suitability in some contexts. Fixed permanent structures.
UVR protection	Excellent protection, UPF50+.
waterproof	Yes.
light transmission	Opaque.
solar heat gain	Better thermal performance if lined.
structural implications	Structural framework required.
ease of replacement	Material may not be readily available; high degree of skill required.
maintenance requirements	High. Shingles may require fireproofing treatments.
life span	Long.
particular properties	Available in timber, usually Western Red Cedar, or fibre-cement.
environmental considerations	Timber shingles may be derived from a renewable source (which depends upon timber source). They require little energy in manufacture, are biodegradable and able to be re-used. Fibre-cement products (both shingles and sheets) have relatively minimal environmental impact and are otherwise resource efficient. As they are durable they should be used in long life applications as their potential for re-use and recycling is poor.
relative cost	Expensive, labour intensive to install.

thatch

suitability	Roofing, screens and windbreaks. Suitable for fixed permanent structures.
UVR protection	Excellent protection, UPF 50+.
waterproof	Yes.
light transmission	Opaque.
solar heat gain	Excellent thermal insulator, cool in summer.
structural implications	Structural framework required.
ease of replacement	Material may not be readily available, special skill required.
maintenance requirements	Relatively high.
life span	Greatly depends on the type of reed or grass used and the craftsmanship in construction. Life span of 50 years or more, which is comparable with metal sheet, fibre cement and concrete tiles.
particular properties	May attract insects and termites. Excellent insulating properties.
environmental considerations	Environmentally advantageous material as it is renewable and often a locally available resource. No manufacturing impacts and is extremely low in embodied energy (especially if sourced locally). As an organic material it is easily disposed of, and can act as a nutrient. Possible problems with flammability in dense urban areas.
relative cost	Reasonable. Material is inexpensive though labour component during fixing is intensive and costly.

The Shade Inventory

What is the Shade Inventory?

The Shade Inventory can be used to prioritise the need for protective shade. It is most useful for organisations that are responsible for a large number of outdoor locations. For example, councils have a large number of sites within their local government area for which they are directly responsible. A Shade Inventory will provide the framework for a strategic plan that will allow funds to be directed, in the first instance, to the sites of greatest need.

The Shade Inventory can also be a useful tool in situations where sites are so large that they become a collection of individual settings, each requiring its own shade assessment, eg universities and hospitals. The Shade Inventory lists and prioritises settings in order of need, allowing the organisation to allocate funds and plan the provision of protective shade in an orderly and effective manner.

Using the Shade Inventory

To prioritise a range of sites according to their need for protective shade, two factors must be considered and assessed:

- site usage patterns, which help to determine the extent to which users are likely to be exposed to harmful solar UVR (solar risk), and
- the extent of existing shade.

Assessing usage patterns

User group

The characteristics of the user group, particularly age, are important in determining the risk of UVR-related skin damage. Research indicates that children and adolescents exposed to large amounts of solar UVR have a significantly greater chance of developing skin cancer later in life. Accordingly, sites where children and adolescents are the main users would be a high priority for solar protective shade.

Time of use

The period of greatest daily UVR intensity is usually between 11am and 3pm daylight saving time (10am and 2pm eastern standard time). Sites with high usage between these times have an increased need for protective shade.

The period of greatest seasonal UVR intensity is summer. Therefore, sites used extensively in summer have greater priority shade needs than those used predominantly in winter.

Duration of use

The length of time over which the outdoor activity takes place is an important factor. This is because the longer the period of exposure to solar UVR, the greater the risk of harm. It should be noted that in summer, sunburn can occur in as little as 12 minutes.

Level of usage

Sites that enjoy high levels of usage would generally be expected to take priority over less utilised sites. However, usage patterns can change over time.

If usage level is a determining factor in deciding priority, periodic checks should be made to see if the usage levels have changed. Should the level of usage of a site change significantly, its priority grading should be reconsidered.

Likelihood of risk behaviour

In situations where outdoor activity is likely to occur in minimal clothing, such as beaches and swimming pools, the priority for shade would be high.

Also, children at play may be more likely to engage in risk behaviour than adults, who may seek out shade for protection or comfort. Even in situations where children may be under the supervision of an adult, it should not necessarily be assumed that their behaviour will be low risk, as the supervising adult may not be aware of the need for solar protection, or indeed enforce solar protection strategies.

Assessing existing shade

A detailed assessment of the adequacy of existing shade would not be undertaken at the Shade Inventory stage. Rather this would be done during the Shade Audit. However, two sites having a similar degree of solar risk can be prioritised by comparing the extent of existing shade. The site observed to have the least shade would be graded as having a higher need for shade.

See Chapter 5, The Shade Project, for a full discussion of the Shade Audit process.

Example of a completed Shade Audit undertaken for a school

Introduction

Aims

The aims of this Shade Audit are to:

- assess the existing external environment of the school
- evaluate shade availability and needs
- identify achievable solar protection opportunities by provision of shade.

It is hoped that the Audit will become an integral component of an overall school solar protection policy.

The policy would include the following elements:

- the provision of adequate shade
- scheduling of outdoor activities to minimise UVR exposure between 11am and 3pm daylight saving time (10am and 2pm eastern standard time)
- a sun-protective school uniform
- the use of sunscreen when appropriate
- a sun protection education/awareness program for children and parents.

Expected UVR levels

Sydney, at latitude 34° south, has high levels of UVR. Summer levels are considerably higher than winter levels, due mainly to lower solar altitude angles in winter. Cloud cover can significantly affect solar UVR levels, with heavy cloud reducing UVB to less than 5% of the clear sky value.

On cloud free days, the maximum UVB level occurs at solar noon (1pm daylight saving time). In summer, 50% of the total UVB received during the course of the day occurs within two hours either side of solar noon, or in the period 11am to 3pm (daylight saving time).

On a summer day with clear skies, a time of around 11 minutes in the sun will result in potentially damaging exposure to UVB. In winter, it will take longer to exceed recommended levels.

Site description and use

The school is located on the corner of Harry and Milly Streets. The southern boundary adjoins Thea Avenue with the western boundary adjoining residential properties. A site plan is shown on page 176.

For the purposes of this study, the landscaped area on Harry Street, in front of the school, has been excluded, though this forms an important part of the external environment used by school children. As access to this area is restricted, its inclusion would give an inaccurate impression of the shaded area normally available to the children.

Pattern of use

Classes are conducted in accordance with Department of School Education timetable, comprising four terms per year, of approximately ten weeks duration per term. Holidays during the mid-summer period mean that the school is closed during late December and most of January, when the highest levels of solar radiation are encountered.

Typically, the playground is used as follows:

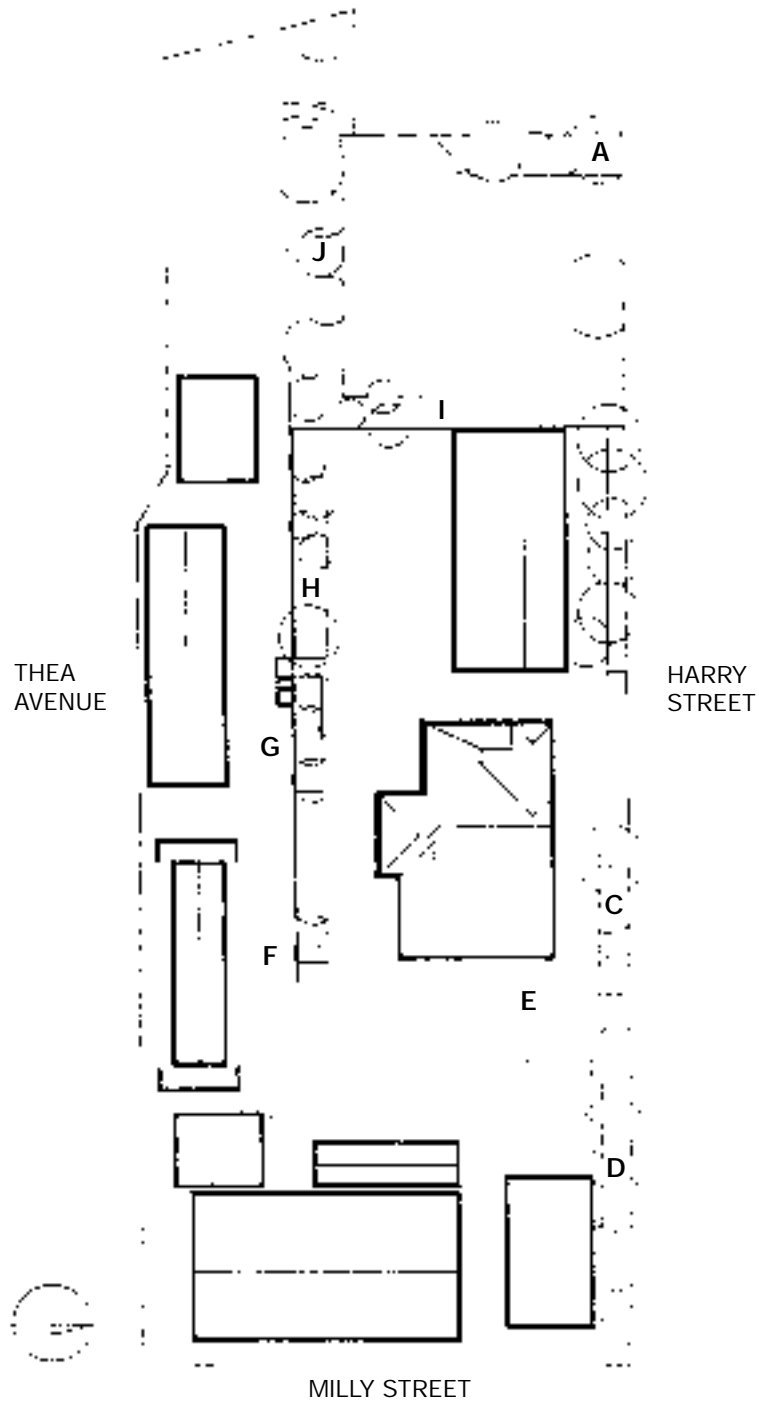
- prior to 9.25am free play
- 9.30am children form into class groups
- 11.15am morning break
- 1.20pm lunch, taken seated in playground
- 1.55pm free play

In addition, classes undertake external sport and fitness activities, including dance, during the teaching period of the day.

The school caters for approximately 330 children, ranging in age from five to twelve years and employs 15 staff.

note

This sample Shade Audit was prepared for a Sydney primary school by a shade consultant. Although the issues to be addressed in Shade Audits will vary widely according to the location and use of the site, the general format and content of the sample provide a useful guide.



site plan

Sections of the playground are 'out-of-bounds' to children. These areas comprise narrow spaces behind buildings and space under the demountable buildings. It is not considered that these areas provide opportunities for additional shade as no change in playground management is likely to make their use acceptable. Accordingly, these areas have been excluded from calculations.

The balance of the playground comprises four open sports areas, where cricket, handball and team games are played. Any shade structure that required the construction of columns within these areas would be inappropriate.

Assessment

The solar protection offered by the site was assessed by preparation of shade diagrams and calculation of both shaded and unshaded areas. Existing summer and winter shade are considered, with noon summer and winter shade shown on pages 178 and 179

The critical protection time has been selected at 1pm on 27 November, when children are required to sit to eat their lunch in the playground. At this time, 330 children must share the available shade. Given that it takes only 11 minutes to exceed maximum UVB exposure levels at this time of year, solar protection is essential.

Quantity of shade

Analysis of existing summer shade at the site (see Table 1) shows useable shaded area per child of 2.09 m², compared to a preferred minimum of 2.5 m².

The quantity of shade is 135 m² less than that recommended for a school of 330 children.

Table 1—Area and shade data

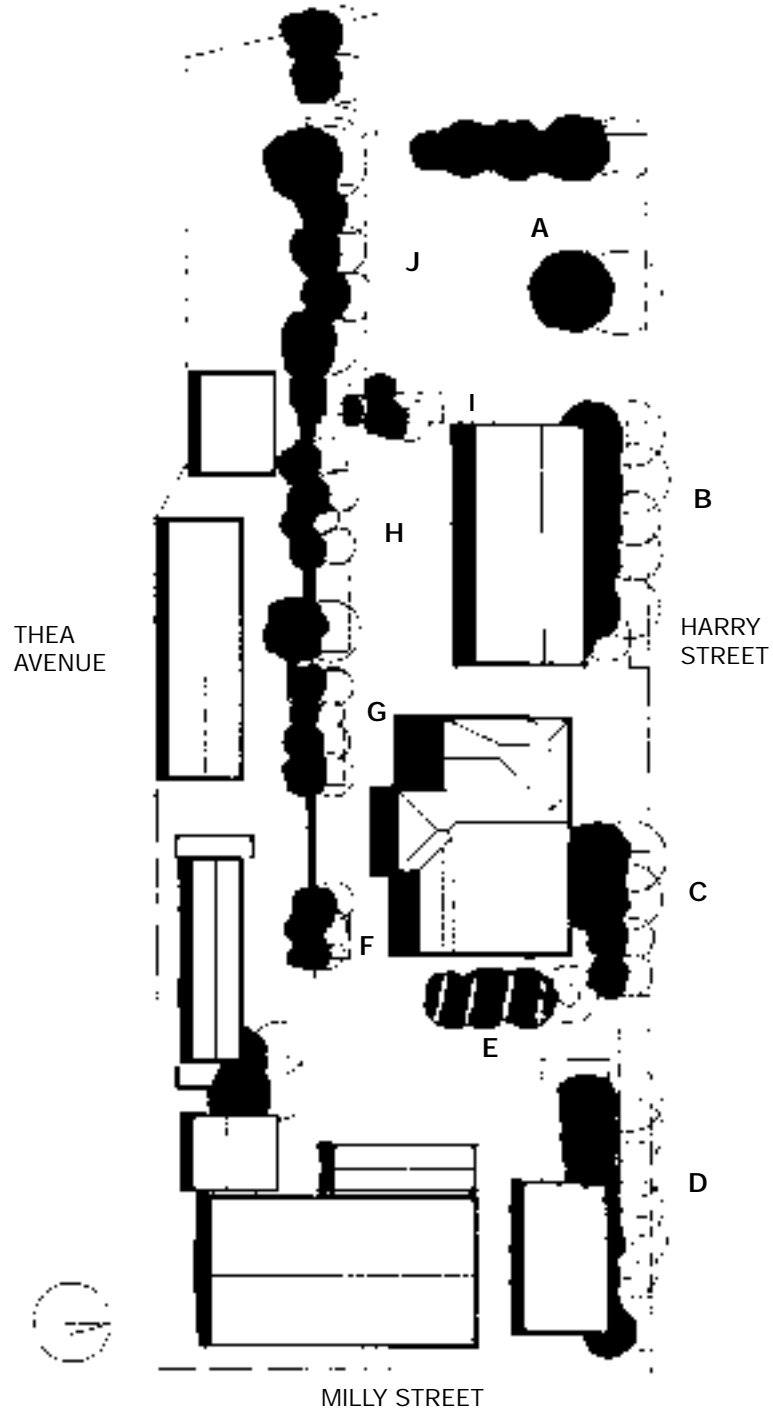
critical protection time	1pm on 27 Nov
total playground area	2945 m ²
total shaded area	1000 m ²
useable shaded area	690 m ²
% playground with useable shade	24%
% shade useable	69%
useable shade area per child	2.09 m ² approx
recommended minimum area per child	2.50 m ²
additional shade recommended	135 m ²

Sources of shade

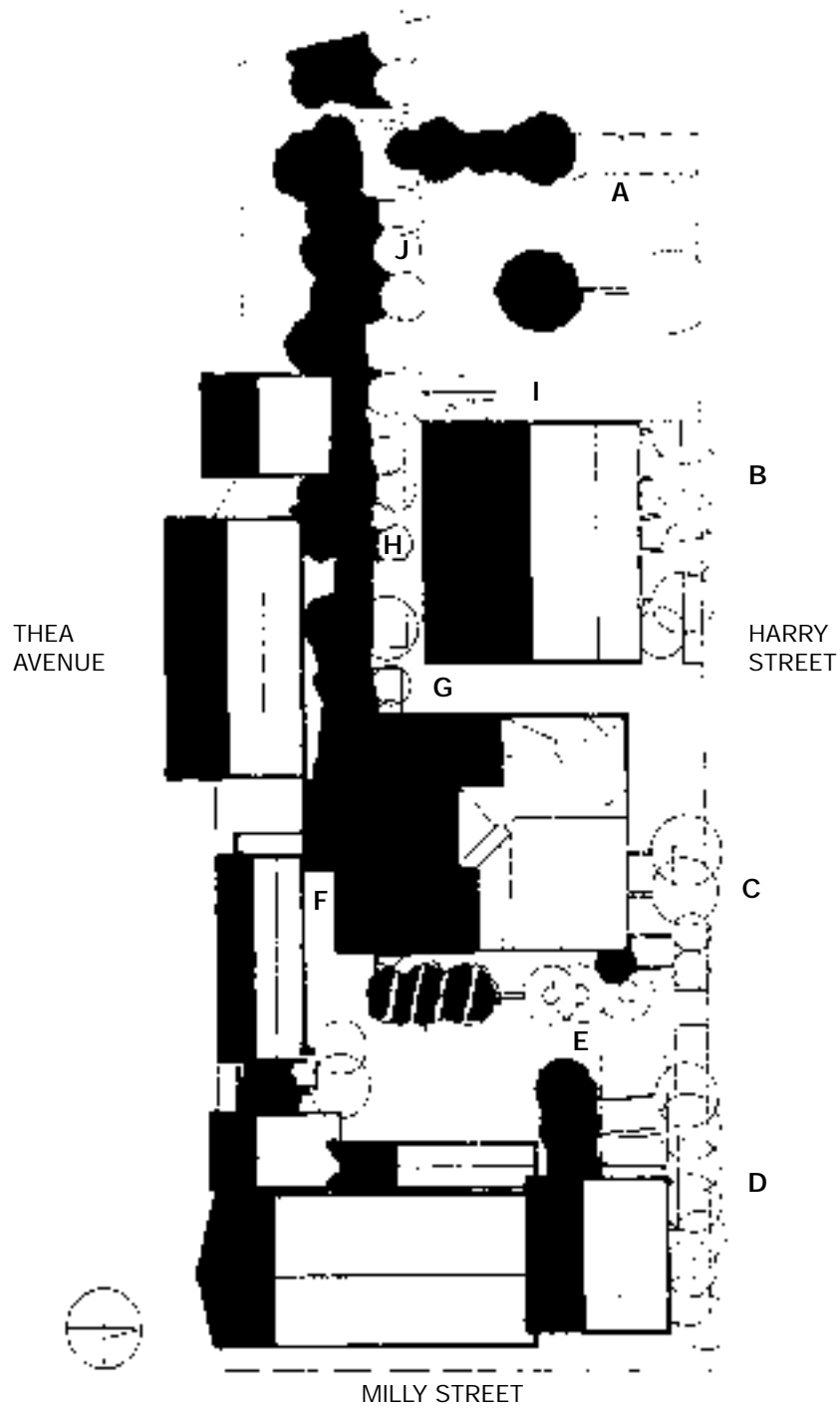
The playground receives shade from four sources: school buildings, the new shelter, verandahs and vegetation.

Though not extensive, shade cast by the buildings is of good quality, with the east/west orientation of buildings creating shade at the critical solar noon period. The new shelter adjacent to the hall, the hall verandah and the verandah of the two storey building, all provide good solar protection.

Shade trees provide the balance of the existing shade. Their type and shade quality, which varies according to the nature of the foliage, are set out in Table 2 on the following pages.



summer shade



winter shade

Sample audit

Useability of shade

Of the available shade, there is considerable variety in its useability. As previously noted, shaded areas are currently inadequate to allow all children to eat lunch in the shade. Seating in some locations is well shaded; other seats have no shade.

Access to shaded gardens is obstructed by low vegetation, preventing full usage of shade in some areas.

The play structure, a critical area for shade, enjoys moderate protection. However, areas where active sport is played are poorly shaded in summer, due in part to the need to retain unobstructed playing areas. As children spend many hours in these areas, some form of summer shade would be beneficial, though careful consideration of the need for winter warmth is required.

Table 2—Schedule of shade trees

area	comments about area	species (E)–evergreen (D)–deciduous	comments about species (condition good unless noted)
A	6 canopy trees of good height and width, with shrub understorey	<i>Allocasurina torulosa</i> (E) <i>Eucalyptus robusta</i> (E) <i>Acacia floribunda</i> (E) <i>Eucalyptus maculata</i> (E) <i>Banksia integrifolia</i> (E) <i>Eucalyptus</i> species 3 <i>Eucalyptus</i> species <i>Tristania laurina</i>	
B	Soil compaction is a problem in this area. New 100x50mm timber edge, 2m from boundary, with heavy mulch and fertilizer would help.	<i>Eucalyptus scoparia</i> 3 <i>Eucalyptus</i> species (red bark)	Very young, medium and mature trees. Good top branching spread.
C	4 major trees with shrub understorey. Very sandy soil, requiring edge, mulch and compost.	<i>Metrosideros</i> (E) <i>Eucalyptus</i> species <i>Hibiscus tiliaceus</i> (E) <i>Acacia longifolia</i> (E) <i>Harpephyllum kaffrum</i> (E)	Canopy very open and sparse. Near end of its life cycle. Will mature to 8m high x 8m wide.

Table 2—Schedule of shade trees

area	comments about area	species (E)–evergreen (D)–deciduous	comments about species (condition good unless noted)
D		5 <i>Eucalyptus eximia</i> <i>Hibiscus tiliceus</i> (E) <i>Melaleuca armillaris</i> (E) <i>Acacia longifolia</i> (E) <i>Callistemon</i> species	Past its prime. Extensive planting of young specimens.
E		3 <i>Eucalyptus</i> species <i>Tristania laurina</i>	Recent planting—will mature to 10m x 4m. Recent planting—will mature to 5m x 3m. 4-5 years before shade-producing.
F	Damaged top foliage of <i>Eucalyptus</i> possibly due to salt burn—replace with more suitable species.	<i>Eucalyptus scoparia</i> <i>Grevillia</i> species (E) <i>Callistemon</i> 'Captain Cook'	Will mature to 10m x 8m.
G	Add mushroom compost and mulch to soil.	<i>Eucalyptus maculata</i> <i>Eucalyptus</i> species <i>Hakea salificola</i> <i>Banksia integrifolia</i> <i>Leptospermum laevigatum</i>	Good canopy.
H	Overgrown with Kikuyu.	<i>Phoenix canariensis</i> (E) <i>Agonis flexuosa</i> (E) <i>Mulberry</i> (D)	
I		<i>Eucalyptus robusta</i> (Swamp mahogany) <i>Acacia floribunda</i> (E)	Prone to drop limbs—not recommended. Very sparse canopy—requires more water. <i>Acacia longifolia</i> (E)
J		<i>Eucalyptus nicholii</i> <i>Agonis</i> species <i>Eucalyptus</i> species (white bark)	Bank covered with copse of low <i>Agonis</i> . Multi branching, canopy sparse.

Recommendations

It is clear that the school is already implementing a solar protection strategy. Students, staff and parents are increasingly aware of the dangers of sun exposure and, due to this awareness, a satisfactory outcome seems likely.

As this consultant has not been involved in sun protection planning at the school to date, it is likely that some of the measures suggested to combat sun exposure may have already been considered or be in hand.

Goals to achieve

As a result of the inspection of the school and calculations of existing and recommended shade, it is recommended that planning for solar protection by way of shade should focus in two areas:

better use of existing summer shade

The easiest, cheapest and most achievable goal, which would improve summer solar protection without reducing winter sun.

additional summer shade to playing areas

with minimal loss of winter sun.

Methods for achieving goals

Better use of existing summer shade could be achieved by:

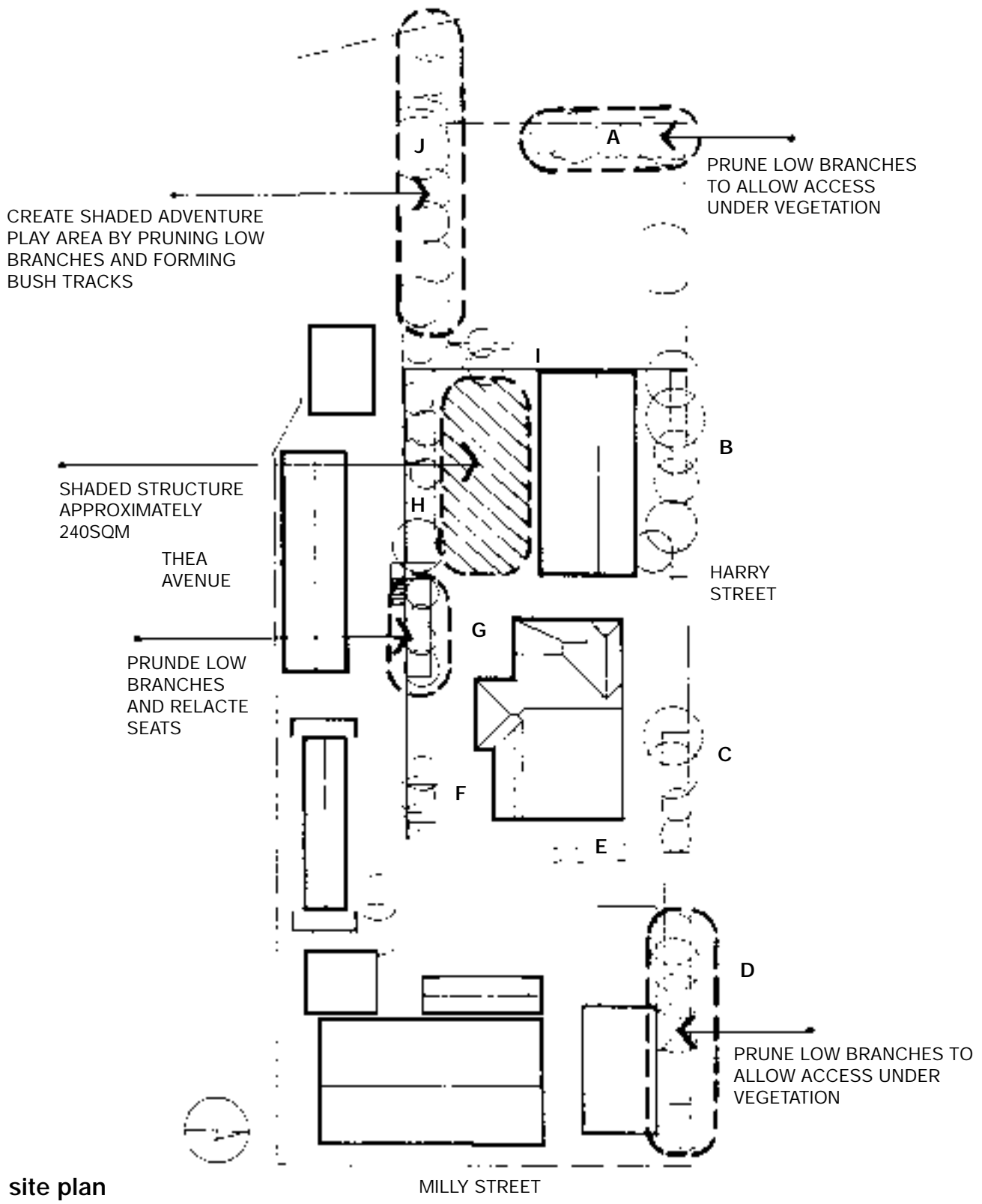
- relocation of seats from unshaded locations to areas with summer shade and, where possible, winter sun.
- modification of garden beds at bases of trees to provide seating areas. Several areas have good shade that falls mostly onto garden beds. These areas have the potential for shaded seating and, with minimal pruning of low branches, could be utilised.

- the garden area designated as J could become a shaded adventure play area by trimming the low branches of the Agonis and creating a tunnel maze. As play in this area is likely to be very attractive to children, it offers solar protection for long periods of playground use.
- additional summer shade to the playing area between garden H and the 'new' two storey building would be beneficial, as this area is intensively used.

Comprising some 240 m², this would provide a substantial shaded area for play and outdoor educational activities and exceed the additional area recommended in Table 1. An additional factor in favour of shading this area rather than others, is that the area is hard paved, so creation of shade will not be detrimental to lawn growth.

Any structure needs to be planned so as to permit games to continue free from obstruction by columns and support structures. By utilising the existing building as one line of support and spanning across the area to a row of poles at the edge of garden H, a series of low tensile shade sails could provide shade without interference to the playing area below.

- In order that winter sun to garden H is retained, the sails could be removed during the winter months. Being a low tensile structure, removal and re-erection would be easily achieved using voluntary parent labour.
 - Sail fabric should provide at least 94% protection from direct UVR; a range of suitable fabrics, in a variety of colours, is available.
- If well-designed, these sail elements would make a positive and exciting aesthetic contribution to the school grounds.
- Such a structure could be erected for some \$8,000–\$10,000.



site plan