ENVIRONMENT DESIGN GUIDE

PERMACULTURE

PART A – INTRODUCTION AND URBAN FARMING
PART B – PRINCIPLES AND APPLICATION

Jenny Donovan and Peter Cuming

Summary of

Actions Towards Sustainable Outcomes

Environmental Issues/Principal Impacts

- Current practices for design and operation of the built environment lead to inefficient and wasteful use of energy and resources. Urban areas often don't allow people to efficiently or equitably meet their needs. This makes it difficult to produce and access local foods and materials and share resources, for example.
- Urban areas rely on a 'hinterland' much larger than their own area to provide the resources that support the levels of consumption they promote, a concept described as a town's or city's 'ecological footprint'. With increased globalisation an urban area's ecological footprint can literally extend across the globe, consuming several times more than the planet is capable of sustainably providing, and as expectations and populations rise these impacts are growing.
- Permaculture is about establishing conditions that enable people to meet their needs through more harmonious integration and utilisation of the natural world with their built and social environments.

Basic Strategies

In many design situations, boundaries and constraints limit the application of cutting EDGe actions. In these circumstances, designers should at least consider the following:

- Observe how natural processes affect a site and its surroundings, and design effective solutions that utilise these, rather than simply applying conventional solutions.
- When designing urban spaces think about the links between each space and how they can meet people's needs, and support the wider biological community upon which we depend. If a design doesn't add benefit then the design may not provide the best use of the land.
- Think about the health, social, aesthetic and resilience benefits of urban farming. This can increase the capacity of urban areas to meet people's needs, add interest, provide a focus for community and personal development, and reduce the dependence and impact of areas further afield.
- Ensuring that natural opportunities such as access to cooling breezes and solar warming are utilised rather than relying on artificial means. Similarly catch and use water onsite a number of times before releasing it.

Cutting EDGe Strategies

- Facilitate development that produces little or no waste through using cyclical systems rather than lineal systems, where the output of one system could become the input of another.
- Replicate natural processes in designs so that spaces exhibit self regulating mechanisms and require minimal intervention.
- Encourage productive places where vertical and horizontal edges, overlaps, margins, and gateways create opportunities in time and space for greater yields in terms of edible and enjoyable landscapes.
- Design for both natural and human needs and be aware of how these link to adjacent places so that the designed elements function as part of a whole. Supporting these beneficial relationships and traditions can bring responsive evolution and a sense of belonging.

Synergies and References

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- *Environment Design Guide*
  - GEN 3: Biodiversity and the Built Environment
  - GEN 39: Ecosystem Services for Regional Sustainability

ENVIRONMENT DESIGN GUIDE

PERMACULTURE
PART B – PRINCIPLES AND APPLICATION

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This paper is the second part of a two part paper intended to introduce the concept of permaculture and urban farming to built environment professionals. These papers seek to challenge the perception that permaculture principles are just for the 'veggie patch' and draw attention to their potential to be used to design places that are better equipped to meet people's needs, now and in the future. The first paper entitled: Part A – An Introduction and Urban Farming *discusses the philosophical basis of permaculture and urban farming. This paper discusses the principles of permaculture and provides a few indicative examples of its potential application in urban environments. It is not intended to document the range of applications of permaculture or their respective technical merit, rather it is intended to provoke interest and invite professionals new to this philosophy to explore this matter further.*

This paper was originally published in August 1996 as GEN 9: An Introduction to Permaculture and Urban Farming. *It was revised by Peter Cuming in May 2002, and has been substantially expanded and revised by the co-authors to its current form.*

Keywords:
permaculture, urban design, wild energies, care for the earth

Figure 1 Permaculture gardens integrated with urban medium density housing

The Winslow Co-housing Community, Seattle, USA integrates the design of the circulation network with permaculture gardens to provide seasonal foods, shade and amenity, privacy buffers and micro-climate control.

(Photo: P. Cuming)

1.0 INTRODUCTION

As discussed in Part A of this paper, our world is one of increasing competition for scarce resources. As both population and demand grow, so does the pressure on the environment to provide the basis for social and economic development. The way we design our towns and cities influences the opportunities available to people who share that environment. This in turn influences people's ability to access the qualities and experiences of their environment they depend on to meet their needs, thrive and fulfil their potential.

Built form is one of the most significant influences on patterns of consumption (Newman and Kenworthy, 1999). The way cities are designed can be seen as influencing not just the amount of resources cities consume, but also how the benefits and costs of that consumption are distributed among the people that share those cities. This paper explores permaculture and urban farming as two related strands of thought that may be useful in addressing this waste and inequity.

2.0 PERMACULTURE PRINCIPLES

The following section considers the principles underpinning permaculture design (Mollison, 1991) and offers some suggestions about their potential application into the design of the built environment.

2.1 Relative Location

Permaculture stresses the importance of relationships between various elements of a functioning system and using the characteristics and synergies they create to good effect. Elements should be placed in relation to other elements, with consideration of the needs, tolerances, products and other characteristics they have that will influence other elements. For example, planting appropriate trees or other landscaping where it can benefit from stormwater run-off from hard surfaces, via a swale or rain garden, can provide the landscape with an improved chance of long term survival without the need for artificial irrigation.

2.2 Each Element Performs Many Functions

This principle considers how the characteristics of an element can be used to serve incidental purposes. This will better enable that element to meet multiple needs and so improve the efficiency of the design of which it is a part. For example, a single tree chosen and located appropriately could provide shade in summer, a buffer against wind or obtrusive artificial lighting, habitat for a range of life-forms, pleasant scent, edible fruit, help control erosion and manage groundwater and so on. At a larger scale the design of an element such a street landscaping as a whole can provide additional benefits such as:

- being a source of bio-fuel
- assist in broad-scale erosion and stormwater control
- offer privacy
- enhance the aesthetics and the amenity of the street and community
- provide educational social possibilities through being interpretive material or part of community management programs
- a source of mulch
- enhance the area's economic value by adding character and amenity
- a fertile environment for a sense of community to develop

Adding plantings along the sides of transport corridors such as railway lines may be used to create parallel wildlife corridors as well as provide a visual buffer between potentially incompatible uses.

A rule of thumb in permaculture is to seek to design at least three uses for every element of the system. This can save space, time and complication within a project (SEED, undated).

2.3 Each Important Function is Supported by Many Elements

This principle is similar to the principle of 'built-in redundancy' found in many mechanical systems, whereby the system is not dependent on any one element. By using multiple methods to support each function within the system, a synergy is built so that the whole system is protected when one or more elements fail. This reduces dependence on one element which diminishes vulnerability if that element becomes unavailable. This also increases the potential for elements to serve a broader range of incidental needs. For example, whilst the prevalent approach to drainage might be seen as relying largely on highly engineered infrastructure that is dedicated to that purpose, permaculture places an emphasis on holistic planning where the choice and layout of buildings, landscape, changes to landform and effects on water courses are all considered in their effect on the drainage system, the way in which drainage waters maybe used to enhance the development and site, and this overall contribution to the area's ecological health.

2.4 Zone Planning

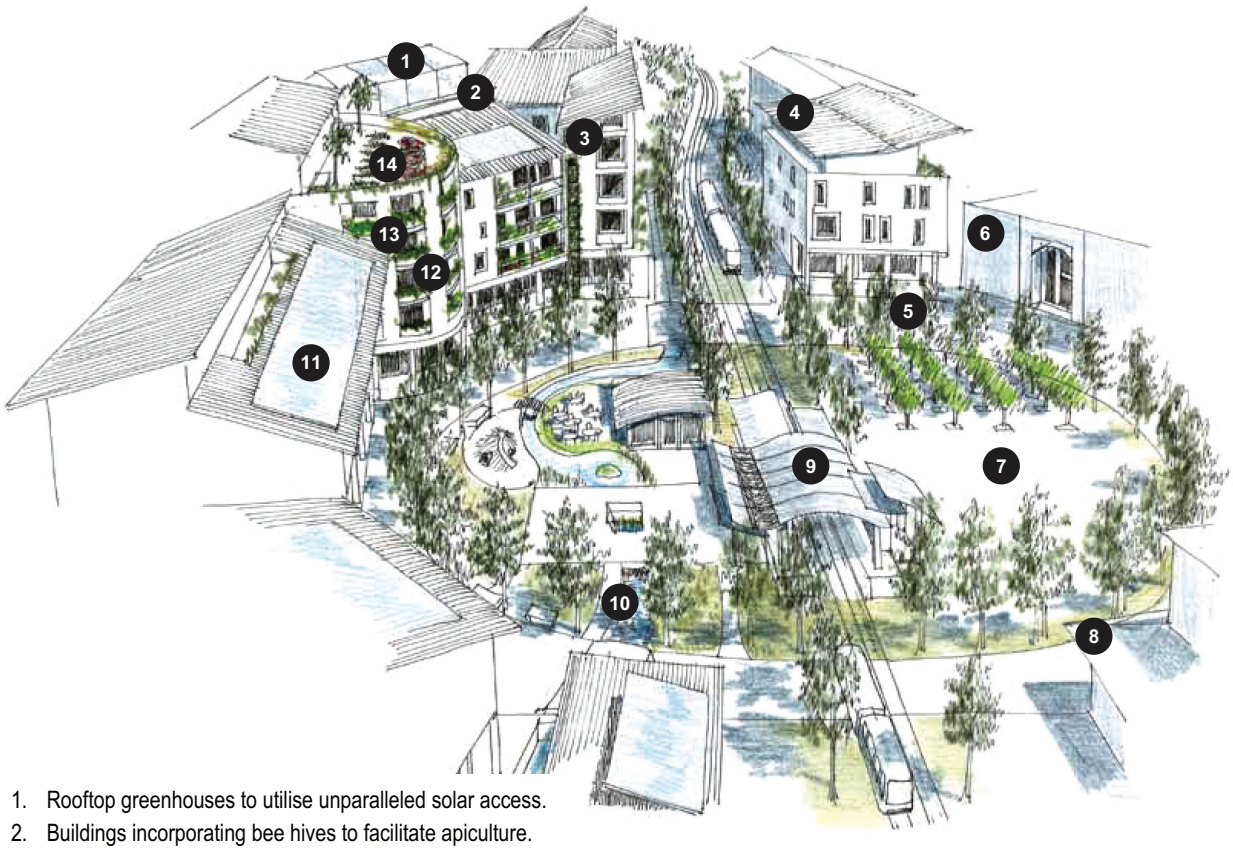
In permaculture terms, a numbered hierarchy of various sized **zones** are used to strategise where things will be placed in a landscape according to their access and seasonal needs. This allows the energy that is needed to be invested to access these resources to be considered and minimised. 'Zone 0' focuses on the outer and inner needs of the individual, 'zone 1' involves places they visit and use daily or are close to (e.g. their house and garden), moving out progressively from neighbourhood to precinct to 'zone 5' which they may only visit or utilise occasionally, or perhaps not all, but the value of these places is acknowledged (e.g. a recreation or wilderness area).

"To plan what elements to put in various zones, consider how many times per year they will be visited. Put what you use most near to your house or the centre of activity. Put those things which are visited least and need the least maintenance in areas farthest from the centre of activity" (Permaculture Research Institute, undated). An example of this is domestic garden design would be to grow herbs and vegetables close to a backdoor or kitchen for daily access, and fruit and nut trees down at the end of the garden or in the street where they are accessed seasonally.

A common parallel in urban design is the co-location of public open space such as parks adjacent to existing pedestrian flows to minimise the opportunity cost of enjoying that space.

2.5 Sector Planning

The term **sector planning** is used differently in permaculture from the way planners and architects would typically use it. In permaculture, sector planning means grouping uses or activities according to the natural or **wild energies** (such as sun, wind and water flow) that influence the subject site, and each part of it.



1. Rooftop greenhouses to utilise unparalleled solar access.
2. Buildings incorporating bee hives to facilitate apiculture.
3. 'Vertical garden' of passionfruit vines or similar to provide a landmark, help insulate buildings and facilitate air filtering as well as providing a crop.
4. Buildings incorporating rain tanks to assist in maintaining a reliable supply of water.
5. Orchard trees incorporated into the square to showcase productive landscape and utilise their landscape potential to frame views and emphasise seasonal change.
6. Educational establishment where people can learn about food production and share techniques.
7. Open space for use as 'market festival' place amongst other celebrations.
8. Farmers market to provide outlet for fresh food and facilitate comparison shopping.
9. Good public transport to facilitate access to opportunities to grow food and diminish demand for lands for roads etc.
10. Water Sensitive Urban Design (WSUD) feature and interpretive material incorporated into town square to demonstrate how storm water treatment and its use in sustainable irrigation can provide an aesthetic and ecological reserve.
11. Solar panels incorporated into north facing roofs.
12. Significant component of apartment living to facilitate a more compact city, reducing demand for low density housing at the periphery.
13. North facing apartment incorporating 'vertical garden' to insulate building, help clean air and assist in carbon fixing.
14. Productive roof gardens protected by wind break planting.

Figure 2 Indicative model of a multi-functional space, Oasis place

Oasis place is a conceptual model of a town square that reconciles a wide range of social, ecological and environmental objectives and allows the urban population to enjoy the health, social, ecological and economical benefits that arise from participating in the production and equitable access to good food.

(Source: Jenny Donovan, 2009)

This means planning a site conscious of the way people experience, and will be affected by these energies, such as what we see, hear and feel. As a result the design can consider how comfortable the user will be, what they are best equipped to do in that space, and how they could take advantage of, or mitigate these energies. This process requires consciously placing elements in different sectors according to their ability to make use of the raw energy or collect, store and manage energy and alter the micro-climate where necessary to ensure a space provides the best environment for an activity. Relevant examples include:

- ***Blocking out, screening, and modifying the incoming 'energy'*** – Examples of this type of sector planning are creating firebreaks or use of a modifying element such as a waterway in a fire sector to protect it from fire energy, planting windbreaks to protect against or take advantage of wind energy, or an unwelcome view etc.

- ***Collecting and channelling energy*** – green roofs can collect rainfall and solar energy to support gardens that help insulate the building below, treat pollution, add to urban amenity by providing green space, and provide a source of food.
- ***Designing to capture incoming energy*** – Examples of this include locating open space in a cool climate area to maximise access to sunshine and light, or incorporating rain water tanks and/or raingardens into a design. Other urban expressions of this principle include framing vistas with landscaping.

2.6 Emphasis on Biological Resources

This principle emphasises using natural elements (plants, animals, microbes) in a symbiosis that are supportive of the system design. The Permaculture Research Institute provides the following example of using biological resources:

"Compost worms like to decompose organic matter. While doing this they make holes in the soil which allows the movement of air and water (saves you from having to dig). They also leave natural fertiliser in the soil as they move through it, which feeds the plants making them stronger against pests and more nutritious to eat. Worms make healthy soil (healthy soil = healthy plants = healthy people). Therefore help the worms do the garden digging and fertilising for you by returning organic matter (their food) to the soil and by mulching the soil thus protecting their home (the topsoil)."

In urban design terms this suggests carefully thinking about how nature can work for us with biological elements and processes chosen for their multiple, synergistic and ongoing benefits. An example of utilising natural elements in this way might be designing a stormwater system that uses plants to control erosion, mitigate extreme run-off, clean the water of pollutants for reuse and recycling, and provide habitat for plants and animals that are food sources and provide natural pest control.

Effective utilisation of biological resources requires the designer to first, be aware of them in relation to a site, and then identifying or introducing and building up those that benefit us through the design process. This requires that landscapes and relationships between built elements are created that do not preclude useful plant or animal habitats or damage the cycles and systems of biological resources which are beneficial to mankind, and maintain symbiotic relationships.

2.7 Energy Cycling

Permaculture systems seek to extract the greatest benefit from the flow of nutrients and energy onto, within, and through the site. That is, to reduce the flow of nutrients and energy off-site until they are no longer required, or where possible turn them into cycles utilised on site, or within the functional region. Catching, storing and using everything before, and in some cases as it degrades, maximises resource efficiency (e.g. compost and natural leaf mulch). Drawing on locally available

Figure 3: A village on Isle of Capri, Italy

Whitewash houses, visitor accommodation, restaurants, community places and centuries-old buildings are backed and surrounded by multi-purpose and highly productive intergenerational gardens. The gardens include orchards of figs, olives, citrus and stone fruits, trellises of grape and tomato above crops of corn, greens, root crops and herbs, providing seasonal sustenance for local people and visitors, and shade for farm animals and humans alike. Intermittent rains are harvested from cobble paths into gardens across property boundaries, and soils are renewed with local organic composts to maintain fertility.

(Photo: Peter Cuming)

resources or energy and reusing them wherever possible provides an opportunity to utilise resources disposed of, not readily available to, or not considered by conventional systems. This minimises the need to import external energy and often creates additional leverage and symbiotic opportunities that provide benefits to site users. Green roofs that utilise household or commercial grey-water for garden irrigation are an example of this principle in action. Plant roots take up nutrients from the greywater which could otherwise pollute waterways, and convert them into food, cleansing the water in the process. Roof gardens also provide insulation that reduce a building's dependence on external heating and cooling and thus the energy and infrastructure that mechanical heating and cooling entail. Another example is recycling food scraps and other organic matter to return these on-site nutrients to the soil and thus minimise the need for off-site resource-heavy, expensive fertiliser.

2.8 Small Scale Intensive Systems

A key characteristic of permaculture is efficiency. One of the ways this can be achieved is to ensure every bit of our constructed environment is effective at meeting a range of needs whilst minimising the demands on the 'natural' environment and conflicts between social applications. The same piece of land can be used to meet multiple needs of the people who live nearby, such as for example, the common Northern Australian practice of elevating a house on columns creates potentially usable areas in the under-croft which can be used for storage, recreation and car parking.

In urban design terms an example of this efficiency can be seen in many towns and cities in public squares with many overlapping layers of function. Such squares are often seen to offer different uses for a variety of visitors, such as a place to relax, a place that commemorates an event or the contribution made by particular people to that community, a landmark for navigation or a place of trade, among others. This variety of experiences in the same place means that the space can contribute to meeting the diverse needs of many people at several different times, depending on their changing needs and priorities. A further example would be incorporating a multi-purpose play area into the same square to allow a variety of sports to occur at different times.

Another example of a small scale intensive system is locating housing overlooking open spaces, where the householders enjoy the amenity of a direct relationship with the open space and the people walking through the open space enjoy the reassurance of the passive surveillance from the people in the dwellings (Jacobs, 1961).

Placing elements that supply needs close to the user and close to one another minimises the commitment of energy needed to get the resource to the user. This creates a more direct, personal relationship between the end user and the source of the energy or resource, which tends to lead to a greater value being placed by the user on the energy provided. This relationship can be further enhanced if the design incorporates ways for people to understand the value and nature of the element in relation to their lives. For example, rainwater tanks that allow residents to see the water level will give them a better sense of seasonal change and water abundance/scarcity.

Small-scale, intensive, local systems can benefit from direct connection to the people who utilise them who may be able to offer **sweat equity** (inputs of time, effort, and emotional capital) that are not typically available to more conventional systems. This reduces the level of imported resources necessary to meet people's needs. An example of this is the sense of ownership, pride in their work and commitment to a good outcome that people get from contributing physical and/or intellectual labour to a local project. Most forms of volunteerism rely heavily on this asset. Emotional capital is the stake that people have in a given place. To invest emotional capital in a place means that it means something to them. They feel connected to, are responsive to, and feel responsible for that environment.

2.9 Stacking in Time and Place

Permaculture promotes the approach of using a single space in multiple ways over time to provide for efficiency, multiple use, and diversity. This is applied to both natural systems such as are seen in urban farming techniques, as well as to human habitat and social development, as seen in varied uses for a single building or place. This approach strengthens interdependence and symbiotic relationships, which support natural and community resilience and adaptive capacity, as well as providing a range of services, and benefits from a defined space.

An example of this principle in urban farming would be to use a defined area to grow a range of ground crops, tree crops and climbers where each gains the support, light and nutrients it needs in the planting arrangement, sharing the same space and support from the gardener. Rather than homogenous batch production with periodic, singular outputs, combining these different elements generates ongoing food, flowers and other resources as well as landscape amenity from the same place. This practice results in greater efficiency over time, and allows ongoing benefit from the production of previous elements. For example, composting and mulching helps to build and replenish soil health, and trees and plants support the exchange of nutrients in the soil involving **mycorrhizae**, tiny fungi associated with their roots.

In relation to human settlement, 'time stacking' requires that the same area of land should be designed to serve different purposes at different times. An example of this would be an office hours car park which can serve as an evening outdoor cinema, and a market place or a setting for sports on weekends when not in use as a car park. Space stacking for example could be having the car park mentioned above set under or alongside a building complex including housing, office space, as well as shops, community facilities and the productive multi-layered gardens.

2.10 Accelerating Succession and Evolution

Nature uses the natural succession of ecosystems to create the optimum conditions at the close of one stage which benefit the next cycle of growth and production. By directing and accelerating this process people's needs can be met using planting and cropping patterns which set the conditions for the ultimate crop. Entropic materials contributed in the growing and cropping process provide residue soil nutrients, mulch and compost for each phase, ensuring that the biological health of the soils and general environment remain robust and evolutionary. For vegetation choosing appropriate plants to support others is a key design element. Permaculture advocacy group SEED International cite the following example: *"When establishing a garden or orchard, delicate plants need to be protected from harsh sun, wind and rain. Use hardy and fast-growing pioneer species to create a good environment for their growth and to provide protection."*

In planning terms, national garden festivals (National Garden Festivals, Wikipedia, undated) are examples of accelerating the process of reclaiming land that has become derelict in order that it can again contribute to the wellbeing of the people who live nearby. The festivals were temporary users on a site that were the culmination of a program of site preparation, advance landscaping, and the creation of socially valued infrastructure into an area. They comprised a coordinated series of celebratory events over a defined period of a few months, such as concerts, shows, markets, fairground rides, etc. After this period the area around the retained and improved landscaping and areas of open space would be made available for development, though with a much higher level of amenity and a much more positive profile in the wider community.

The concept originated in Bundesgartenschau, Germany in the post-war period where it has continued every two years until the present day. The idea was taken up in the UK in a series of National Garden Festivals during the 1980's and early 90's that sought to reclaim derelict post industrial land in five festival locations and give these sites new meaning (and hence increase their value) in order to make them a flagship for greater investment in the area. *"(the 1988 Glasgow National Garden Festival) proved to the world Glasgow was worth developing, worth investing in. And the people of Glasgow started to believe it too"* (Leadbetter, 2008).

2.11 Diversity

The principle of 'diversity' presents human needs and human health as fundamentally tied to ecological health and stresses the importance of many different components supporting other components. This means land use should be designed and managed to support multiple uses (poly-cultures), rather than monocultures unless the latter reflects nature in its true form. Diversity can be maintained by using co-operative elements or species, that is, elements or species that form inter-dependent and supportive relationships that promote tolerance and cooperative competition, symbiotic and multi-functional activities.

An example of this in the built environment is designing neighbourhoods that offer areas of functionally cooperative mixed uses (i.e. not conflicting). Where people live close to or preferably within walking distance to a variety of recreational, social, educational or employment opportunities, this optimises their chance of finding the opportunities and activities they require to meet their needs. Such environments:

- minimise the number of people that are precluded from enjoying these opportunities because they can't or won't drive
- can be tied together by infrastructure that is more geared to walking and cycling than vehicle use
- allow pedestrian orientated infrastructure which takes up much less space, exposes the user to fewer risks and requires much fewer resources to build/ maintain

This is characteristic of many traditional urban areas and has been described as the quality of "close grain" (Bentley, et al, 1985) and is recognised as an important element of a successful urban area (Duany and Plater-Zyberk, 1996).

2.12 Edge Effects

In many fields of inquiry, such as in architecture and botany, edges are considered as vulnerable points of attack or erosion, and thus the edge between two elements is seen as presenting a problem. However in permaculture the unique interactions between elements and energies found at edges is considered an opportunity. Edges are places of varied ecology, vibrancy, and overlap, and in nature are often settings for distinctive ecologies, such as mangroves. Mangroves play an important role in protecting and supporting the ecologies on each side of them and which they are part of, which may often be even richer and diverse than the mangroves, but couldn't exist without them. They contain elements and activities of each ecology and act as a buffer and integrator, filter and pathway. They are places of stability as well as contrast, and can handle great fluctuation such as tidal changes and wetting and drying.

The principle of 'edge effects' in permaculture emphasises the potential of using the specific characteristics of interfaces between different elements to better meet our needs, to extract additional value and invite adaptation. An example of considering such edge effects would be considering what to plant next to a north facing wall in the Southern Hemisphere. Typically such an environment is sheltered from the wind, and has exceptional solar access that should influence what is planted there. Ideally something that can extract the potential of this edge location and provide a range of values to benefit the environment and community in that area.

In a permaculture system edges represent a potential resource for enabling people to take advantage of the natural drift of materials and energies that gather and are shared in these places. A common example of this for the built environment is the placing of cafes and other active uses on northern edges where a comfortable, year-round microclimate which is controlled through use of planting, verandas etcetera, can be enjoyed and thus is conducive to people gathering. Walls can also be used to enclose and define a place. The greater the sense of enclosure the more the place feels distinctive.

3.0 APPLYING PERMACULTURE PRINCIPLES

Appendix A outlines some indicative questions that are raised when considering permaculture principles at different levels of development within the built environment. These lists are not intended to be comprehensive, nor will it be always be possible to answer the questions asked in the affirmative. However they should be asked by designers wanting to implement permaculture into the urban environment as they represent some of the key markers of permaculture principles.

It is worth designers making a list of the principles they would like to apply to a given project and then investigating alternatives for each. This can be done through websites or better still by connecting with local and non-local permaculturalists to learn what opportunities may be possible in the design and development process.

There are recent and older examples of the integration of food, materials, and energy into housing and other building projects in cities, suburbs, rural and regional areas, especially where migrant and relocating cultures to Australian cities and towns have successfully integrated their traditional food-growing into the urban landscape. Ideas and examples need to be chosen that suit the climate and context of a project's settings, and concepts that have been proven to work need to be adopted and adapted. By becoming a part of a growing network of practitioners integrating the key permaculture principles of caring for the earth, caring for people and sharing of resources to support a more sustainable future, designers can share the successes and challenges of their resultant solutions with others and thus multiple the benefits obtained.

Figure 4: Principles of 'edge in action' within a residential community

Links and gateways to intimate and public spaces are created by buildings, paths and vegetation side-by-side at the Winslow Co-housing Community. This provides multiple edges which incorporate a wide range of plant materials stacked in time and space, and which draws runoff from the minimised hard surfaced access paths.

(Photo Peter Cuming)

4.0 CONCLUSION

One of the most pressing contemporary challenges facing society is protecting the liveability of our settlements at a time when more people are competing for diminishing resources. Architects, planners and others responsible for the design of our towns and cities have an influential say in the application and allocation of these resources, consumption patterns, and the capacity of cities and towns to provide for themselves. Applying permaculture principles to the way we plan our settlements and housing helps equip people to utilise natural processes to meet their needs where they are and reduce their dependence on non-renewable fossil fuels and commoditised, mechanical resources. Permaculture importantly provides the opportunity to 'reconnect to the earth' and, and to each other in order to benefit from a feeling of being 'grounded' in a mutually beneficial relationship, which is becoming increasingly necessary to deal with these challenges.

Applying permaculture principles can increase the resource base available to all in the city environment by harnessing wild, domesticated and synergistic materials and energy and through applying the principles of caring for the earth, caring for each other and equitably sharing with others, any surplus to that required to meet our needs. In this way permaculture can help to reduce our ecological footprints and aggressive impact on the planet.

Applying permaculture principles to the design of the built environment can be seen in two ways; at one level it is just a matter of a change of emphasis. Most of the techniques mentioned in this paper would be familiar to architects, landscape architects, planners and urban designers at some level. Yet they tend not to get embedded in the design decisions when priorities are decided and different considerations are weighed up. A fundamental shift is required to ensure that these techniques are applied in an informed way.

Such a shift requires a greater awareness of our impacts on our surroundings and each other. This is only possible if the designer has an in-depth and thorough understanding of the site in question and its local context, and the known and likely social and natural processes the site is subject to. This understanding can only come from careful observation by the designer, and a commitment to seeing a site and its natural energies and symbiotic relationships holistically; not just in terms of narrow objectives (to make a profit, to fit the desired building on the lot etc), but as natural place. This means considering it as subject to natural and elemental forces within a context of adjacent and nearby places that are influenced by and linked to what happens on that site.

Traditionally these 'energies' have been seen as constraints, however in permaculture they are seen as challenges to meet and opportunities to embrace the inspiration of creative design. In the words of Bill Mollision (1988): "We are surrounded by insurmountable opportunities."

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BIOGRAPHY

Jenny Donovan, BSc (Hons), Dip UD, MA, MPhil, MPIA is an urban designer and principal of the Melbourne based urban design and town planning practice of David Lock Associates.

Email: jennyd@dlaaust.com

Peter Cuming, BUrb Reg Plan (Hons), Dip Permaculture, MPIA, sustainability planner and educator, is founder and managing director of Sustainable Futures Australia, established in 1987, and based at Byron Bay, NSW. (www.sustainblefutures.com.au)

Email: peterc@sustainablefutures.com.au

APPENDIX A – DESIGN CONSIDERATIONS

This section outlines some indicative questions that are raised when considering permaculture principles at different levels of development.

When considering a single lot:

- Have you considered how the placement and design of a building or space manages the penetration of natural energies to maintain it at a comfortable level?
- Have you considered the natural energy the garden receives, is there shade? Is the site steep? What way does the surface drainage fall? Can you harvest this water and use it onsite? Is it windy – how could you use this energy to advantage? Each circumstance creates opportunities and establishes a range of appropriate design responses.
- What measures have you put in place to capture natural energies? This could be done 'actively' with rainwater tanks and solar panels, or use of soils for growing foods, or 'passively' by designing to utilise sun-light, and cool or warm breezes).
- How have you made use of the edges between elements, such as boundary, building and retaining walls, roofs, edges of planting beds, and responded to the specific circumstances in that location (e.g. shade, shelter, the availability of unique resources for the site, etc.)?
- How have you facilitated people to contribute to meeting their own needs (such as opportunities to grow food in gardens, on balconies, walls, or on the roof)?
- How have you made sure there is no wasted space, and that each part of the site supports the well being of incoming residents and the wider biological community?
- How have you sought to protect or enhance the site's intrinsic ecological values?

When considering multiple lots:

In addition to the above for single lots, the creation of multiple lots raises other questions, including:

- How have you considered the potential to share facilities and combine spaces between lots for shared facilities? This may include party walls, shared access or driveways, neighbourhood heating and cooling systems, collecting water, productive gardens or open space.

When considering a staged development:

- How have you ensured the land committed for future development can serve the well being of the community through a temporary use rather than just left vacant?
- How have you sought to protect or establish a pleasant and ecologically rich environment in advance of when the land is developed?
- Can the garden areas be increased and food production capabilities enhanced as an area develops to accommodate additional residents and maintain productivity?

When considering the design and layout of the public realm:

Creating new streets and areas of open space also provide opportunities to apply permaculture principles that invite the following questions, among others:

- How have you revealed and celebrated natural processes to residents and the passer by? This may include rain gardens, swales and other drainage systems that create the opportunity to use water as a feature in its own right and as a means of supporting a high standard of landscape and suitable trees, herbs and shrubs for seasonal food production.
- How have you sought to make walking or cycling not just possible but preferable by minimising distances to key destinations and improving the quality, legibility and perceived safety of the public realm?
- What opportunities have you facilitated for people to share resources/excess production, forge the bonds of community and make connections with one another?
- How have you made sure that roads are not dominated by a single use?
- How have you made sure the landscape choices you have made can be maintained in the long term and can support the area's ability to provide habitat for indigenous wildlife?
- How have you ensured the layout of the public realm and private landscape supports an integrated network of green infrastructure that connects people and habitat areas to surrounding green assets in order to support the settlements ecological health?

APPENDIX B – FURTHER INFORMATION

General reading about permaculture	
Anne C. Bellows, PhD Rutgers, The State University of New Jersey; Katherine Brown, PhD Southside CommunityLand Trust; Jac Smit, MCP The Urban Agriculture Network	
Community Food Security Coalition (CFSC), North American Initiative on Urban Agriculture Committee	www.foodsecurity.org
Mollison, B, 1988, *Permaculture a Designers Manual*, Tagari, Tyalgum, New South Wales.	
Mollison, B, 1991, *Introduction to Permaculture*, Tagari, Tyalgum, New South Wales.	
Permaculture Research Institute	http://permaculture.org.au
Federation of City Farms & Community Gardens	www.farmgarden.org.uk/farms-gardens
SEED website	www.seedinternational.com.au/ www.communitygarden.org.au
Federation of City Farms & Community Gardens	www.farmgarden.org.uk/farms-gardens
Permaculture website	www.permaculturereactivist.net/index.html
Specific to the built-environment	
Hough, 1995, Cities and Natural Processes, Routledge, London, UK.	
Day, 2002, Spirit and Place, Architectural Press, Oxford, UK.	
Case studies	
These places represent examples of many of the principles of permaculture;	
Christie Walk Urban Eco-Village ecovillage	www.greenlivingpedia.org/Christie_Walk_
Village Homes, Davis, California	www.villagehomesdavis.org
Corbett, Judy and Corbett, Michael, (2000), *Designing Sustainable Communities: Learning from Village Homes*, Island Press, Washington, DC, USA.	
Sewage treatment Plant at Worme Hofgemeinschaft Handelhoh Dreisetil, H, 2001, Waterscapes, Birkhauser, Berlin.	
Resources	
Some suggested contacts for courses and examples include:	
Permaculture Research Institute, NSW	www.permaculture.org.au
Permaculture Institute, Tasmania	www.tagari.com
Permaculture College Australia, at Djanbung Gardens Permaculture Centre, NSW	www.permaculture.com.au
Crystal Waters Permaculture Village, Queenland	www.crystalwaterscollege.org.au
CERES Sustainability Hub, Melbourne, Victoria	www.sustainability.ceres.org.au
The Permaculture Association of Western Australia (PAWA)	www.permaculturewest.org.au
The Permaculture Association of South Australia	www.permaculturеinternational.org
The Global Ecovillage Network	www.ecovillage.org
Urban Ecology Australia	www.urbanecology.org