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Low Impact Urban Design and Development Principles for Assessment of Planning, Policy and Development Outcomes

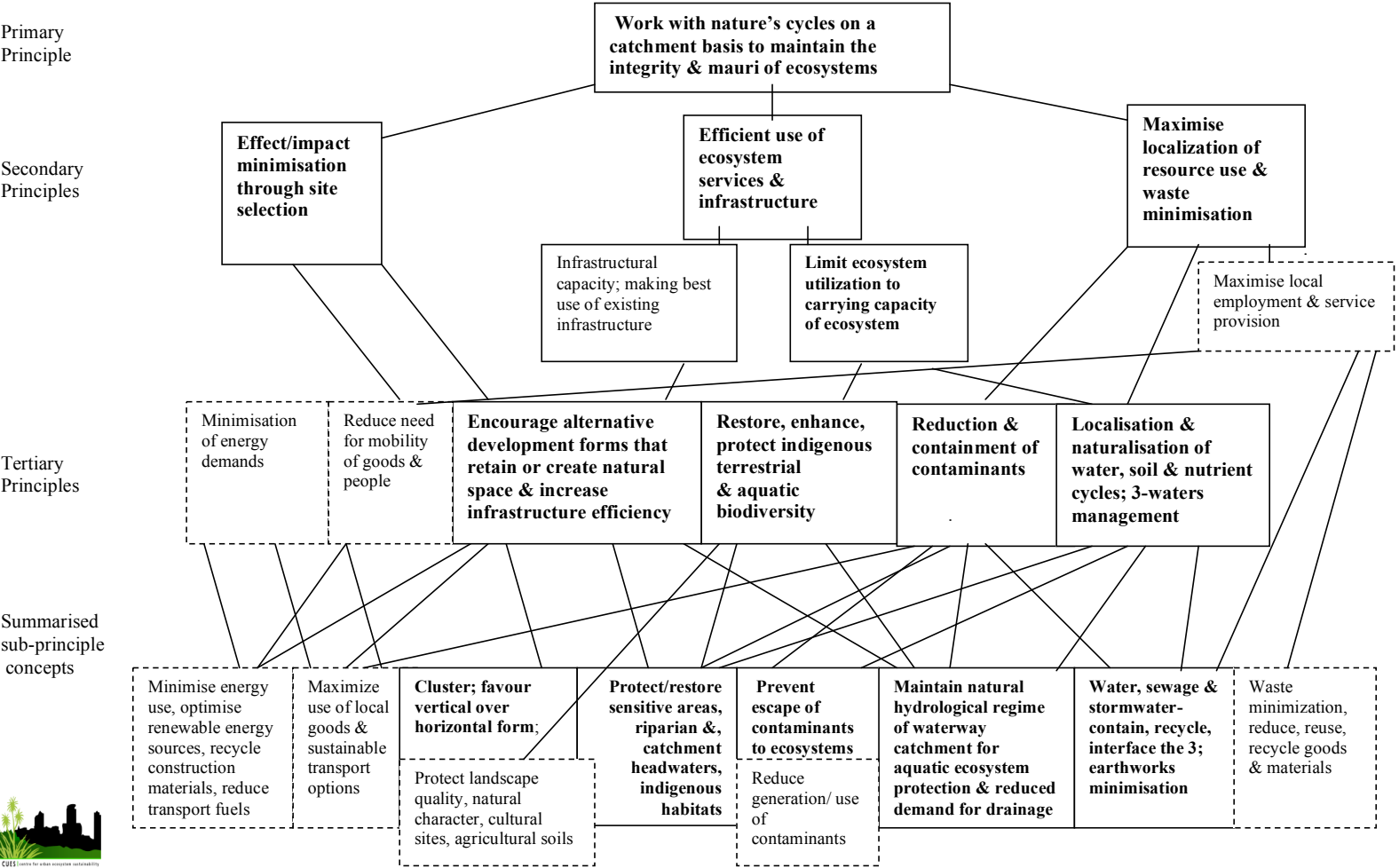
Marjorie van Roon<sup>1</sup> and Henri van Roon<sup>1</sup>  
Centre for Urban Ecosystem Sustainability.  
27 June, 2005

Working Paper 051 of the Centre for Urban Ecosystem Sustainability (CUES – a research partnership between the University of Auckland and Landcare Research Ltd)


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<sup>1</sup> Centre for Urban Ecosystem Sustainability and Department of Planning, University of Auckland, Private Bag 92019, Auckland, New Zealand. Email: [m.vanroon@auckland.ac.nz](mailto:m.vanroon@auckland.ac.nz) and [hvanroon@ihug.co.nz](mailto:hvanroon@ihug.co.nz)


**Figure 1: Hierarchy of Principles of LIUDD. Principles in bold are the dominant focus of this LIUDD, FRST funded, programme. Principles in dashed boxes are complementary, but outside this programme. Figure 1 is a partial representation of Table 1 (van Roon and van Roon, 2005)**




**Table 1: CUES FRST funded LIUDD programme: checklist of LIUDD principles for assessment of planning, policy and development outcomes** (van Roon, M & van Roon, H. 2005)  
 Sub-principles denoted by X or XX, rather than A - K, are not the focus of the LIUDD programme. By including these extraneous sub-principles in the table we wish to convey the fact that we have not overlooked their importance in achieving objectives that arise from these principles.


Principles	Sub-principles	Detailed description & Rationale	Examples of Implementation Alternatives
<b>Primary principle</b> 1 Work with nature's cycles on a catchment basis to maintain the integrity & mauri of ecosystems & minimise ecological footprints.	<b>Cycles &amp; catchments</b> 1A Support cyclical ecological processes. 1B Use catchment context as design & management framework. 1C Recognise & provide for the long-term nature of natural cycles.	Use integrated knowledge systems including scientific and maatauranga Maori as bases to manage cyclical processes that determine distribution & influence of water, soil, plant nutrients, contaminants, organisms & energy. Human & cultural wellbeing are a significant by-product of the above being done effectively. Functionality of cyclical processes is essential for internalisation of effects & reduction of resource demand, that together make urban or rural-residential developments 'low impact'. Design within catchment context provides opportunities to support natural cycles (van Roon & Knight, 2004).	Use guidelines, district plan provisions, covenants, & the promotion of collaborative projects between, e.g. local government, community groups, tangata whenua, and private agencies that support natural ecosystem function, and promote effective management. Encourage recycling of water, wastes, materials & energy through co-location of complementary activities (1.1), innovative infrastructure (1.2) & technologies (1.3) preventing discharges to ecologically sensitive environments. Use catchment context for design & management (1.4).
<b>Secondary principle</b> 2.1: Effect/impact minimisation through site selection.	<b>Spatial/Strategic Planning Approaches</b> 2.1A Site selection used to avoid /minimize negative impacts thereby removing need for mitigation. 2.1B Adopt 'least regrets' strategy to minimise risk.	Select areas for development & screen out inappropriate areas with avoidance of sensitive areas to minimise ecological, cultural & economic costs, as this is more effective than remedial work. The 'least regrets' approach provides a basis for remedial action, as a type of insurance policy, in case there are unforeseen consequences resulting from development.	Prior to development or re-development identify & delineate areas that are ecologically sensitive (2.1.1) & define limitations or constraints at a regional scale (2.1.2). Develop criteria for assessment & basis for decision-making in selection of development areas & convert to Regional Plan provisions (2.1.3) or District Strategic Plan provisions (2.1.4) <sup>2</sup> . Ensure the protection of culturally significant or culturally sensitive landscapes or sites for appropriate forms of design and development, where these values converge with or enhance natural processes or cycles (2.1.5).
	2.1X Protect sites of cultural significance. 2.1XX Protect landscape quality & natural character.	These are essential components of appropriate site selection for development.	Whilst an integral part of wise site selection these are not elements of LIUDD FRST-funded programme. They may, however, benefit indirectly from the application of Principle 2.1 & other LIUDD principles. They are in fact key elements to achieving successful outcomes of the overall LIUDD process. Therefore, encourage appropriate forms of development and design in culturally and visually significant areas.
<b>Secondary principle</b> 2.2 Efficient use of ecosystem services & infrastructure 	<b>Efficiency</b> 2.2A Maintain ecosystems in optimum condition to ensure ongoing capacity to support human needs. 2.2B Maximise use of existing infrastructure.	Degraded ecosystems lack the resilience & capacity to process wastes, accommodate resource extraction or otherwise cope with human use. The use of existing infrastructure is maximised so as to make best possible use of prior capital investment.	Develop & use economic instruments which price ecosystem services fairly and on an ongoing basis, taking account of all externalities including life cycle pricing (2.2.1). Provide comparative costing of ecosystem services versus conventional infrastructure, to achieve the same outcomes (2.2.2). Use this approach as a basis for the design & construction of alternative infrastructure (2.2.3).


<sup>2</sup> It could be argued that this could be generalised to 'plans and policy documents' but Regional and District are the 'spatial context'.

<b>Secondary principle</b> <b>2.3</b> Maximise localisation of resource use & waste minimisation.	<b>Localisation</b> <b>2.3A</b> Maximise containment of local water & contaminant cycles	Minimises impact on areas adjacent to catchment, reduces ecological footprint. Minimises downstream effects such as bioaccumulation in receiving waters.	Maximise use of local water (see below). Minimise contaminant export from catchment (2.3.1).
	<b>2.3X</b> Reduce, reuse, recycle goods & materials locally. <b>2.3XX</b> Maximise opportunities for local employment & service provision	Minimises impact on areas adjacent to catchment, reduces ecological footprint and energy consumption. Local energy capture & use is desirable from, for example, solar, wind & wave sources.	Not part of LIUDD programme brief.
<b>Tertiary (3<sup>rd</sup>) principle</b> <b>3.1:</b> Encourage alternative development forms that retain, restore or create natural space & increase infrastructure efficiency	<b>Plan in catchment context</b> <b>3.1A</b> Cluster activities whilst absolutely & permanently prohibiting intensification or structures on “balance” land. <b>3.1 B</b> Retrofit brownfield developments to encourage vertical over horizontal form & naturalise the resultant open space.	Concentration of compatible activities through clustering or vertical intensification can reduce capital costs, lowers ongoing maintenance & operating costs, whilst allowing for increased densities overall. It also facilitates the maintenance or restoration of natural hydrological regimes thereby protecting the integrity of aquatic ecosystems and reducing the demand for drainage construction and upgrading. Creation or retention of open space caters for amenity and recreational needs, human wellbeing needs, food production areas, catchment runoff protection and provides opportunities to protect and maintain culturally significant sites (e.g., wahi tapu, mahinga kai, habitat of flora and fauna taonga).	Prior to development or re-development identify & delineate local areas that are ecologically significant (3.1.1) thereby defining limitations or constraints within the catchment (3.1.2). Similarly identify appropriate prime development locations (3.1.3) including areas with spare infrastructure capacity (3.1.4). Develop criteria for assessment & basis for decision-making in selection of development areas (3.1.5) & convert to District plan provisions (3.1.6) & covenanting (3.1.7) or other protective methods.
	<b>3.1X</b> Restore or enhance landscape quality & natural character.	As LIUDD principles are founded on working within nature’s processes, improved landscape quality & natural character are certain byproducts of LIUDD approaches.	3.1X is not part of the LIUDD programme in its own right but its protection & enhancement are an integral byproduct of LIUDD approaches. In effect adequate provision for protection of landscape values will facilitate the effectiveness of the core programme.
	<b>3.1XX</b> Encourage appropriate forms of development & design in culturally significant areas where cultural values converge with natural cycles	For example, convergence of LIUDD principles with Maori values & concepts leads to a convergence of LIUDD structure plans & preferred development styles of urban Maori & tangata whenua groups. Culturally appropriate forms of LIUDD ‘style’ should be encouraged & followed in culturally sensitive areas (e.g. pa, marae, papa kainga, mahinga kai, and ngahere).	3.1XX is only indirectly aligned with the LIUDD programme but the inseparability of ecological & Maori cultural objectives means that in most such developments LIUDD principles will largely be adhered to.

<p><b>3<sup>0</sup> principle</b></p> <p><b>3.2:</b> Localisation &amp; naturalisation of water, soil &amp; nutrient cycles. Optimise recycling, minimise external demand &amp; discharges. Optimise ‘integrated three (or four) waters management’ within local catchment.</p>	<p><b>Stormwater</b></p> <p><b>3.2A</b> Minimise generation of stormwater, localise at source. <b>3.2B</b> Reduce ‘effective’ impervious surface area to less than 15% of catchment. <b>3.2C</b> Maintain/ re-create catchment flow characteristics as if under previous “natural vegetation” (hydrological neutrality). <b>3.2D</b> Utilise stormwater wherever possible as a secondary water supply <b>3.2E</b> Maximise groundwater recharge with stormwater following contaminant removal.</p>	<p>To identify what constitutes healthy waters based on scientific &amp; cultural values. To ensure the natural functioning of healthy receiving waters, maintain the hydrological regime and water quality, minimize effects on the mauri, &amp; avoid nutrient enrichment &amp; contamination of kaimoana areas. Avoid capital costs &amp; maintenance of reticulated systems. Minimize downstream surge &amp; scour effects as well as trap contaminants &amp; nutrients. Aim at zero discharge from properties. No development on upper &amp; riparian catchment areas so as to ensure maintenance of the environment &amp; water quality. Minimisation of runoff from catchment headwaters. Upper catchments act as reservoir for species to allow ongoing re-colonisations of habitat effected by development. Supported by sub-principles 3.2F to 3.2K</p>	<p>Use “ natural processes” streams &amp; wetlands as infrastructure (3.2.1). Avoid curb &amp; channel storm water reticulation systems (3.2.2) &amp; provide pipes only for overflows, not for base flow (3.2.3). Protection (3.2.4) &amp; re-vegetation (3.2.5) of the riparian corridors. Identification, protection or re-creation of indigenous habitats, including wetlands, forests, springs, &amp; streams - both perennial &amp; ephemeral (3.2.6). Identification, protection, rehabilitation, re-creation, &amp; maintenance of culturally significant natural areas e.g. mahinga kai, kaimoana, taonga (3.2.7). Provide financial, rating or other incentives to encourage developers &amp; land owners to retain or create these natural features (3.2.8). Re-vegetate upper catchments (3.2.8) &amp; all erosion prone areas (3.2.10). Encourage high biomass vegetation systems to trap rain &amp; species with high evapo –transpiration capability (3.2.11). Adopt narrow roads (3.2.12), swales (3.2.13), rain gardens (3.2.14), biofiltration (3.2.15), porous paving (3.2.16), onsite detention tanks (3.2.17), ecoroofs (3.2.18). Provide for ongoing maintenance of stormwater control devices (3.2.19). Camber all impervious surfaces, including roads, to direct run-off to above devices or to natural vegetation areas on pervious soils (3.2.20). Use organic soils &amp; compost to optimise function of raingardens (3.2.21). Protect &amp; enable overland flow paths (3.2.22) &amp; flood plains (3.2.23).</p>
	<p><b>Wastewater</b></p> <p><b>3.2F</b> Minimize volume &amp; recycle for dual water supply <b>3.2G</b> Nutrient strip sewage <b>3.2H</b> Encourage adoption of dry waste systems &amp; reduced use of water-born systems.</p>	<p>Provide reticulated waste water systems or advanced treatment package plants. Adapt for improved environmental &amp; cultural simultaneous outcomes, including waste water management sensitive to the values of Maori groups such as tangata whenua &amp; urban Maori &amp; by avoiding gradual cumulative unwanted effects of nutrient &amp; contaminant buildup in waterways &amp; soils, degradation of aquatic ecosystems, &amp; loss of mauri.</p>	<p>Use of modern systems of Clivus multrum (3.2.24), compost toilets with flush pan (3.2.25), wetland treatment systems (3.2.26) as well as large scale sewage treatment plants with effluent recycling to land (3.2.27) or to dual water supply (3.2.28). Consider reticulated grey water systems (3.2.29) in lieu of full sewage reticulation.</p>
	<p><b>Water supply</b></p> <p><b>3.2I</b> Minimise potable water usage &amp; demand, reduce extraction from natural waterways. <b>3.2J</b> Harvest or recycle water</p>	<p>Reduce overall water use &amp; utilize rainwater &amp; recycled water for appropriate purposes as part of an overall approach. This provides the potential for savings in both treatment costs and the exposure of the human population &amp; receiving water ecosystems to treatment chemicals.</p>	<p>Dual Water supply (3.2.30), use of water tanks (3.2.31) &amp; water efficient appliances (3.2.32). Low flow tap fittings (3.2.33), recycle grey water for toilet &amp; outside use 3.2.34). Gardens designed to favour indigenous vegetation adapted to local climate conditions (3.2.35). Provide systems which treat/sterilise rainwater for hot water use (3.2.36). Use of tailored plumbing systems to prevent cross-connection of potable &amp; non-potable systems (3.2.37).</p>

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	<b>Urban earthworks management</b> <b>3.2K</b> Minimum site disturbance.	Respect the intactness of whenua (land). Avoid detrimental earthworks or management practices related to development, which have a significant (to be defined) impact on soil structure & the functioning of adjacent receiving waters & ecosystems. Minimum site disturbance; sediment containment - building sites. Minimise site works to reduce development costs & compaction problems. Carrying out subdivision & building site earthworks simultaneously is more economic, reduces compliance costs & facilitates monitoring & remedial work if needed.	Restrict earthworks on slopes identified in planning documents as unsuitable for development (3.2.38), and on significant ecological areas (3.2.39).  Use techniques such as clustering to concentrate buildings on suitable soil types & slopes leaving areas naturally unsuitable for construction in a vegetated & undisturbed condition (3.2.40).  Implementation of Principle 3.1 is supportive of these actions.
<b>3<sup>0</sup> principle</b> <b>3.3:</b> Reduction & containment of contaminants	<b>3.3X</b> Minimise generation of transport & industrial contaminants.	This would require changes in: transport modes & fuels; industrial processes, sustainable business, industrial ecology. This is the most effective means of reducing air, soil & stormwater contamination. Subprinciples 3.5X and 3.5A are supportive.	Not part of LIUDD programme brief.
	<b>3.3XX</b> Prevent /minimise escape of contaminants via atmosphere.	This is the most effective means of reducing air, soil & stormwater contamination.	Not part of LIUDD programme brief. This is implemented under the requirements & provisions of the Resource Management Act, 1991.
	<b>3.3A</b> Prevent escape of contaminants via water cycle.	Damage to ecosystems & human health reduced by containment.	Strip contaminants from stormwater before discharge to natural waterways (3.3.1).
	<b>3.3B</b> Reduce contaminant-loaded materials used in construction industry.	Damage to human health & ecosystems reduced by lower exposure to toxins in buildings/construction waste	Encourage the construction of 'green buildings' (3.3.2) Comply with requirements of the Building Act, 2004 (3.3.3.), building code (3.3.4) & council development construction guidelines (3.3.5).
<b>3<sup>0</sup> principle</b> <b>3.4:</b> Restore, enhance, protect indigenous, terrestrial & aquatic biodiversity. 	<b>3.4A</b> Protect existing, restore or recreate indigenous habitats. No net loss of habitat. <b>3.4B</b> Protect &/or revegetate environmentally sensitive areas within catchment i.e. riparian corridors, steep slopes, ridgelines.	This supports the objectives of the NZ Biodiversity Strategy: promote natural ecosystem functioning within development catchments (e.g. by maintaining & enhancing water & soil cycles), maintain & enhance indigenous flora, fauna & habitats, recognise Maori aspirations to protect, rehabilitate & enhance indigenous ecosystems, reduce development pressures on indigenous biota.	Favour indigenous revegetation of stormwater management corridors with locally appropriate stock (3.4.1). Priority use of indigenous species when planting rain gardens, biofiltration systems & trees in swales (3.4.2). Provide incentives for indigenous vegetation planting (3.4.3) & retention on private lots (3.4.4). Maintain instream values to protect aquatic ecosystems from damage by structures (3.4.5) e.g. dams & culverts Promote biodiversity protection & restoration by Maori organisations including iwi & hapu (3.4.6) with support from local government and Nga Whenua Rahui (3.4.7).

	<b>3.4C</b> Maintain or restore natural hydrological regime of waterway catchment for aquatic ecosystem protection.	Volumes & periodicity of discharges from catchments are determinants of habitat conditions in receiving water ecosystems including rivers, wetlands, lakes & estuaries. Changes to hydrological regime are determinants of major changes in aquatic ecosystem composition & function.	Retain (3.4.8), restore (3.4.9) or recreate (3.4.10) natural balance of vegetation cover, especially proportion of catchment in forest. Limit (greenfield, 3.4.11) or revert to (brownfield, 3.4.12) 'effective' impervious surface areas to <15% of catchment. Achieved also through implementation of principle 3.2A – E.
	<b>3.4D</b> Protect or restore appropriate riparian vegetation. Protect reservoir of species in catchment headwaters for stream recolonisation.	Riparian vegetation filters contaminants, provides shade for temperature control, bankside habitat & carbon supply. Headwaters terrestrial & stream habitats required for different life cycle stages.	Use covenants (3.4.13) or district plan provisions (3.4.14) to protect riparian strips. Use covenants (3.4.15) or district plan provisions (3.4.16) to protect headwater terrestrial-aquatic habitat combination.
<b>3<sup>0</sup> principle</b> <b>3.5:</b> Reduce need for mobility of goods & people.	<b>3.5X.</b> Maximise proximity of residential & employment bases. Optimise regional transport flows & public transport	Security, cost & availability of transport fuels are questionable. In addition to costs there is concern about air pollution & run-off quality. Favour rail & water-borne transport over road transport on environmental & economic efficiency grounds – low import of hydrocarbons to catchment.	Not part of LIUDD programme brief
 CUES   Climate Urban Ecosystems	<b>3.5XX</b> Maximise local availability & use of: goods, services & neighbourhood sustainable transport options.	The sourcing of construction materials & food locally, reduces transport demand for goods & people. Compost generated locally could be input to raingardens for stormwater treatment (see 3.2.14). Riparian corridors protected or restored under sub-principle 3.4B provide space for cycling & walking paths. Note that implementation of these measures would achieve sub-principle 3.5 whilst supporting achievement of sub-principle 3.2B.	Not part of LIUDD programme brief

<p><b>3<sup>0</sup> principle</b></p> <p><b>3.6:</b> Minimisation of energy demands</p>	<p><b>3.6A</b> Minimise Energy use</p>	<p>Improve building design for solar heat capture, insulation &amp; use of passive solar energy &amp; wind. Reduce imbedded energy in materials.</p>	<p>Double glazing (3.6.1) &amp; high level insulation (3.6.2) for new &amp; existing structures. Thermal mass/ materials in buildings for heat storage (3.6.3). House design to use (3.6.4) or avoid (3.6.5) solar input. Skylights (3.6.6) with or without link to fibre optics (3.6.7) for light transfer to other parts of building. Protect sunlight sight lines (3.6.8) for solar hot water, solar voltaics &amp; passive solar heating.</p>
	<p><b>3.6X</b> Optimise renewable energy sources <b>3.6XX</b> Reduce use of transport fuels <b>3.6XXX</b> Recycle construction materials</p>	<p>Reduces running costs to end user of energy. Reduces need to generate electricity &amp; environmental impact thereof as well as transmission issues. Reduces travel costs. The sub-principles could be met by providing a residential access layout that minimizes the need for car travel &amp; encourages non-mechanised transport options such as walking &amp; cycling. This necessitates the creation of compact &amp; functional urban areas with good public transport. Other provisions might include outside laundry drying areas, wind power generation as a permitted use, firewood tree cropping as an integral part of design/layout, local recycling depots/collection &amp; composting areas as part of reducing energy-mobility requirements.</p>	<p>Not part of LIUDD programme brief</p>

**Maori terms used in Table 1 and this paper:**

Maori: Indigenous people of New Zealand

tangata whenua: people of the land, used in reference to Maori associated with particular parts of New Zealand

mauri: The life force and unique personality of all things animate and inanimate.

rahui: a form of restriction set up over a resource by a hapu or its chief for spiritual, social, or economic reasons.

tikanga: customary correct ways of doing things

maatauranga Maori: traditional knowledge

whenua: land

wahi tapu: sacred place

urupa: burial ground

pa: fortified village

marae: meeting ground

papa kainga: village associated with a pa

mahinga kai: cultivation

ngahere: forest

waiora: healthy, clean water with high mauri

kaimoana: sea foods

iwi: Maori tribal groups

Nga whenua rahui: a fund to support voluntary protection of indigenous biodiversity on Maori land



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