Appendix 4: Sustainable Ecosystem Options for low-income developments

Option	Information	Financial: Capital cost	Financial: O&M	Environ impact	User acceptability	Established technology?	Ease of implement	Social, employment	CDM / carbon $ potential	Overall rating w.r.t. sustainable developments: (Critical, Important, Beneficial, or Unimportant)
PLANNING & COMMUNITY	The location and planning of developments has a significant impact on the sustainability of settlements and welfare of occupants, although the impacts thereof are often difficult to quantify. It has implications for resource use, economic sustainability and various environmental concerns.									
Location in urban area	Developments should consider proximity to employment opportunities and major public transport services.									
Settlement layout / orientation	Overall settlement layout should allow buildings to be oriented 'facing' north, which allows for effective passive solar design (thermal efficiency) of buildings – increasing their comfort levels and reducing energy needs for little or no additional cost.									
Settlement density	Density: low density residential areas are recognized as inappropriate in most cases as this leads to sprawling cities which are expensive and difficult to service effectively. A more appropriate urban expansion mode is through densification of settlements, implying increased use of double or multi-storey residences. This also allows more people to be located in prime areas of the city close to employment opportunities and other facilities.									
Multi-use settlement	Needs of communities should be met locally where feasible, and thus the inclusion schools, recreation facilities, shops and employment opportunities needs to be considered. This reduces transport costs (a significant burden to many residents) and helps build a sense of 'community'.									

Criteria ranking system:

Rating	Number
Very positive	3
Positive	2
Slightly positive	1
Neutral	0
Slightly negative	-1
Negative	-2
Very negative	-3

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Transport access	In order to participate in the urban economy effectively, access to affordable, safe public transport options is critical. Either ensuring that settlements are located near major public transport facilities or developing such facilities (e.g. interchanges, BRT or train links) thus becomes important, and requires coordination with transport planning authorities.									
Community involvement	Involving communities in decisions around community layout, facilities and housing options is important to direct resources to best meet needs and foster a sense of ownership.									

Criteria ranking system:

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Positive	2
Slightly positive	1
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	Criteria ranking system:									
ENERGY	Energy efficiency and renewable energy use is a critical component of sustainable developments. Energy use is linked to air pollution and global warming, and currently uses non-renewable resources. A well designed sustainable house will use less than 50% of the energy of a conventional one, with no sacrifice of lifestyle.									
Bulk services: Streetlight efficiency	Street lights are a significant component of bulk services cost, and impact on the quality of the development. Standard options are: Centralized High-Mast Lighting – which is often not preferred by communities, is not effective in more dense settlements, and is more expensive per erf to install and operate than other options; and High-pressure sodium streetlights (70W) - more efficient than the old mercury vapour lights. Can use the poles for electricity reticulation. Efficient options are (1) Compact Fluorescent (CFL) streetlights – cost effective and more efficient than hi-pressure sodium lights. Can use poles for electricity reticulation, (2) Light Emitting Diode (LED) streetlights – these are being piloted, but appear very effective and life-cycle cost-competitive. Can use poles for electricity reticulation.	-1	2	1	2	0	0	0	1	Important
Bulk services: Electricity reticulation ADMD reduction	Energy efficient housing may reduce After-Diversity Maximum Demand (ADMD) and reduce overall reticulation costs. Reduced amperage supply is also being re-introduced in some municipalities (reduced from 60Amp to 40Amp, as opposed to the old 20Amp low-income option). This tends not to reduce overall costs by a large percentage however, as it just tends to reduce transformer costs. It does encourage energy saving in households to some extent though.	1	0	2	-1	2	2	0	0	Beneficial

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Passive solar house/building design	The energy use over the house/building lifetime is greatly reduced by applying basic passive solar design principles. Although many technical options can be considered, some are unlikely to be effective when comparing cost of the intervention with energy use/comfort improvements. Reduction in heating and cooling energy requirements of around 50% is achievable.									
	Ceiling: Most effective single option for moderating both summer and winter temperature.	-1	2	2	3	2	-1	0	3	Critical
	Ceiling & insulation: Significantly further improves the thermal performance of houses.	-2	2	2	3	2	-1	0	1	Important
	North orientation with roof overhangs and N window area: Moderately effective, mainly in winter due to increased access to sun's warmth on some days. Small cost implication with roof overhang.	-1	1	1	2	2	-1	0	0	Important
	Double skin wall: Very effective, but expensive	-3	2	2	2	2	-2	0	0	Beneficial
	Exterior light colour (roof and wall): Marginal impact. Reduces summer temp but house becomes colder in winter.	0	1	0	1	1	2	0	0	Unimportant
	Deciduous tree planting: Small impact. Provides some coolth in summer, but can reduce sunshine marginally in winter too.	-1	0	1	2	1	-1	1	1	Unimportant
	Shared walls (e.g. semi-detached houses): Moderate impact. Houses 'keep each other' warm in winter and cool in summer – but also reduces solar gain in winter. *Further modeling required.*	1	?	?	-1	1	1	0	0	Beneficial (but further modeling required)

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Building 'embodied energy' and local materials	Embodied energy is the sum of all energy required to mine, manufacture, and transport all the materials used in building. Embodied energy is often equivalent to the total operating energy of the building over its lifetime. Sustainable design attempts to reduce this by (1) careful choice of materials, (2) use of local materials, and (3) considering recycled material use where suitable (e.g. recycled SABS approved brick).	1	0	2	-1	0	-1	1	0	Beneficial
Solar water heaters (SWH)	This technology is well established and is generally sensible for new residential buildings. Compared with normal geysers, reductions in water heating energy requirements of about 50% can be expected. However low-income houses often do not have geysers, and may not spend enough on water heating to ensure financial feasibility through SWH energy savings.	-1	2	1	1	2	-1	2	3	Important
Well insulated hot water system	If geysers are installed, by using geyser blankets (may not be necessary with modern cylinders) and insulating all hot water pipe runs, savings of 5 to 10% of water heating energy can be achieved.	-1	1	1	1	2	-1	0	0	Beneficial
Daylighting	Levels of daylighting of well over 75% are usually achievable in residential designs, although this may have an implication for window sizes and therefore cost.	-1	1	1	1	1	-1	0	0	Important
Efficient lighting	Lighting typically demands over 20% of total domestic energy consumption in low-income households. Efficient lighting (e.g. CFLs and LEDs) reduce this by at least three quarters, without affecting the quality of lighting.	-1	2	2	0	2	0	0	2	Critical
Renewable electricity generation	Renewable electricity generation (solar PV or wind generation sources are often the most feasible) represents a significant commitment to a sustainable development. Costs are often relatively high for community-scale systems, even considered over	-3	1	3	0	2	-2	1	2	Beneficial (NB: costs vary significantly between options - requires more disaggregated assessment -

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(PV, wind…)	system lifetime (although they are reducing steadily). Systems may be (1) stand alone – where each house generates power and stores it in batteries for own-use, (2) mini-grid – where houses share generation sources, or (3) grid-tied – where power not used by the development automatically feeds back into the area electricity network, and the development is credited accordingly. The latter is most financially feasible, as it allows maximum power extraction from the renewable system, and allows use of grid power during peak times. Hydro generation is potentially a low-cost electricity source if adequate perennial water flow is assured. *Caution: Local authority position on feed-in of renewable power to existing grid needs to be established (this is a relatively new concept for many of them, although it is being done in several cities)*									costs of some renewable options are also reducing fast – becoming increasingly viable)
Biogas energy	Methane production from organic waste materials or sewage is an option where adequate waste is produced. Methane gas generated can be used for cooking, heating, or even electricity generation. *Caution: Acceptability of local sewage biogas systems may be an issue in developments. Costs need clarifying in feasibility analysis.*	?	?	2	-1	-1	-2	1	1	Beneficial (tho' feasibility analysis needed)
Electricity appliance provision / bulk purchase	Appliances such as fridges consume a significant amount of energy (around 25% of household energy for fridges in low-income houses). It may be feasible to establish a bulk purchase or other facility to provide low-cost efficient electrical appliances such as fridges, lights and heaters. This could potential be a community cooperative (although the practicalities of running such coops are often difficult).	-3	1	1	2	-1	-2	2	1	Beneficial

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WATER	South African houses are typically water wasteful. Savings of 30% to 60% are realizable with sensible design, gardens and fittings, without sacrificing health or comfort.									
Bulk services: Water demand reduction	Water efficient housing and facilities, and rainwater storage, can reduce overall supply needs. This has limited impact on infrastructure costs, though it does reduce resource use in the settlement (water and energy for pumping). This is dealt with in the below options.	0	1	1	0	0	2	0	1	Beneficial
Bulk services: Stormwater runoff reduction	Stormwater runoff should be minimized via promotion of porous rather than impermeable paved surfaces. Some local retention ponds may also be feasible. This could reduce overall drainage infrastructure needs, but is unlikely to have a significant impact on the cost.	1	0	1	0	-1	0	0	0	Beneficial
Rainwater harvesting	Rainwater harvesting from building roofs is an environmentally sensible option, although the cost of adequate rainwater storage is often relatively high, resulting in a slow payback.	-2	1	1	1	3	-1	0	0	Beneficial
Efficient toilet flushing: Dual or multi-flush toilets	This option reduces water consumption volume substantially (toilets often use at least 30% of household water – this can be cut in half, or more, by efficient toilet flushing systems). System functionality or health is not compromised.	-1	2	2	0	2	-1	0	0	Important

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Efficient showerheads	Many efficient showerheads are available which reduce flow significantly, without affecting shower comfort (surprising, but true). Shower consumption can be around 15% of household water use, and reductions of a third to a half of shower water volume are easily achieved. Shower water reduction also reduces hot water energy needs, adding to the financial viability. *Caution: Ensure that showerheads chosen are well designed and do not compromise the quality of the shower.*	-1	1	2	0	2	0	0	1	Important (significant benefit for little cost)
Tap flow reducers	Although taps usually compromise a relatively small part of total domestic consumption, flow reducers may be appropriate for kitchen sinks.	-1	1	1	0	3	0	0	0	Beneficial
Efficient irrigation	Choice of food garden or sports field irrigation system affects water consumption greatly. Drip irrigation systems, although substantially more expensive, save over 80% or water compared with conventional sprinklers, for example.	-2	1	2	1	1	-1	0	0	Beneficial (significant saving, but can be significant cost)
Grey-water re-use	Grey water (washing, shower, bath, handbasins) can be used for garden irrigation, but is not suitable for food garden use. Plumbing needs to facilitate grey water system installation in the construction phase, as retrofitting is usually difficult. *Caution: Grey water is not to be used for food garden irrigation. Local authorities may have concerns around grey water use, particularly near rivers (internationally there is still debate around suitability of untreated grey water use).*	-2	1	1	-1	1	-1	0	0	Unimportant (uses from grey water limited)

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Black water (sewage) treatment	Several systems exist for on-site treatment of sewage other than through piped sewerage systems and centralized treatment plants. These include 'Biolytix' systems, dry composting systems, local bacterial treatment and reed bed systems. Some systems are very expensive, others more financially viable. Costs need to be compared to centralized mainstream treatment options. *Caution: Authorities are particularly sensitive to black water release into the ground near rivers. Dry composting systems need to be considered in the light of user perceptions.*	-2	-1	1	-1	1	-1	0	0	Unimportant (some benefits, but costs may be significant, and impact on groundwater is an issue)
WASTE REDUCTION/ RECYCLING	Households produce significant quantities of waste, and the standard solution of simply removing it to landfill is recognized as unsustainable. Waste volume reduction of 60% can be realised in a sustainable settlement.									
Bulk services: Sewage reduction	Water efficient houses and facilities will reduce sewage waste significantly, which can reduce infrastructure costs to some degree (on-site processing is unlikely to be viable given practicalities and current bylaws, unless linked to and energy generation from biogas). Reduction in sewage volumes has design implications, such as sewer slopes etc.	1	0	1	0	-1	-1	0	1	Beneficial
Facilities for organic waste composting	Dumping of organic waste to landfill is environmentally nonsensical. This should be composted and nutrients returned to the soil, preferably for use in food gardens (or possibly used for methane production – see earlier). Facilities for composting of organics should be considered – either centrally for the whole development, or on a per-household basis. *Caution: Fly and other pest control around composting facilities may require some attention.*	-1	0	2	1	2	-1	1	0	Important (link with food gardens)

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Facilities for recycling	Recycling (tins, paper, glass, metal and possibly plastics) should be promoted – considering both centralized collection depots as well as within the residences. Here various bulk bin systems are available. Recycling collection, sorting and sales can provide an employment creation opportunity.	-1	0	1	1	0	-1	1	0	Important (particularly employment creation potential)
CHEMICALS /TOXINS	The steady accumulation of harmful synthetic compounds is a cause of global concern, and the long-term impacts on ecosystems are still mostly unknown. Sustainable developments should seek to minimize the use of such chemicals.									
Solvent free paints & finishes	There are several good quality, environmentally preferable masonry and wood finishes on the market in the country. Solvent content in paints and wood treatment products are to be avoided. Water and cement-based alternatives should rather be considered.	1	0	1	1	1	-1	0	0	Beneficial
Household chemical alternatives	Chemicals used in normal suburban house typically have significant harmful content – both for humans (surprisingly) as well as for the natural environment. Households can be encouraged to choose more environmentally sound options, especially if grey and or black water is being processed and released locally.	0	1	2	-1	1	-1	0	0	Beneficial
Organic gardens and food production	Use of non-organic pesticides, herbicides and fertilizers is to be discouraged. Proven organic options are available.	0	-1	2	0	2	-1	0	0	Beneficial

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LOCAL BIODIVERSITY	Biodiversity and ecosystem preservation is central to sustainable settlements.									
Trees and food gardens	Both trees and food gardens preserve and promote a measure of natural biosystems in a settlement. Trees can help with beautification as well, but specific attention is needed to maintain them in their early years.	-1	-1	1	2	0	-1	1	1	Important
LOCAL ECONOMY	A sustainable development should explicitly promote local economic growth and poverty alleviation.									
Local food production	This should be seriously considered where there is available land for communities to grow their own food. Not only can it improve nutrition, but can ease the financial burden of households, gainfully occupy the unemployed, and even be a source of income for householders via produce sales. The alternative is to buy in food –typically from out of town – with associated environmental and cost implications. Organisations such as Abalimi Bezehaya could be invited to work with local communities to this end.	-1	1	2	2	1	-1	2	0	Critical
Employment creation	Construction, recycling systems, and food gardens are all opportunities to maximize local employment creation. In addition, options listed elsewhere, such as solar water heaters, generate significantly more employment than conventional alternatives. It must be remembered that construction employment is a short-term benefit. Unemployment is a huge national priority, and needs to be a clear factor in any sustainable development.	-1	0	0	0	0	-1	3	0	Important

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