CURRENT STARfish BENCHMARKS

Introduction

The 3 tiers of benchmarks are listed separately. First, the 1st tier (basic, generic) benchmarks are described for all 7 major impact categories. Next, the 2nd tier benchmarks are listed, followed by an example of 3rd tier benchmarks. The latter are for use in complex projects. They can be added by the user where, for example, a particular sustainability issue requires extra attention. The three separate sliders in the STARfish - for red (negative), green (regenerative/restorative), and blue (net-positive) impacts - are essential to avoid greenwashing.

1. 1st tier (general) benchmarks in STARfish

1.1 Outline of general benchmarks

1. Ecology/biodiversity
2. Materials/waste
3. Efficiency/energy
4. Greenhouse/carbon (sequestration)
5. Health/life quality
6. Planning/spatial relationships
7. Socio-cultural/community

1.1 Description of general benchmarks

1. Ecology/biodiversity (eg. carrying capacity, biodiversity, ecosystem functions)

Building form, design, siting and components should aim to increase ecological carrying capacity, biodiversity and ecosystem functions at all stages of production in urban as well as rural areas. In addition, developments should aim to correct ecological deficits on a regional basis by, among other things, supporting native ecosystems and biodiversity incubators or nature corridors. To be cost-effective, this usually requires multifunctional, adaptable design that increases nature, in addition to human health, environmental amenity and other benefits.

Relevant SMT Analyses: Ecological Transformation (ET) Analysis; Highest Ecological Use (HU) Analysis (see Chapters 7-8 in the book).

-10 = The resulting development uses a supply chain that destroys ecosystems and environmental quality at the sites of resource extraction (eg, mining, forestry) and/or construction (eg. land clearing). Most projects have adverse ecological impacts in several locations. (Again, restorative or mitigation activities are not deducted from negative impacts.)

-5 = The sites of resource extraction and construction are not irreversibly damaged, but the project is located near an ecologically-sensitive site or on a greenfield site, involves the demolition of otherwise viable buildings, or damages natural ecosystems in the process, such as native forests or grasslands, streams or wetlands.

50% = There is some ecological restoration or regeneration, but it only amounts to, for instance, restoring the left-over land around the building with native landscaping, which would not likely compensate for the ‘ecological waste’ created during construction - the resource recovery time.

100% = The restorative or regenerative actions leave the ecological conditions on the development site the ecologically equivalent of its ‘pre-construction’ state (not preurban or pre-industrial). This is the traditional weak goal of ecologically sustainable design.

+5 = Compensatory onsite/offsite actions offset many unavoidable adverse ecological impacts of the development and/or improve environmental conditions in the area. The impacts of any (preferably multifunctional) structures to support ecological functions should also be minimized (which are recorded in other impact categories).

+10 = The project increases total eco-services and carrying capacity beyond pre-industrial/pre-urban conditions on a floor area basis (ie. not just pre-purchase conditions or land area). Ideally, the ecological space provided would reverse the project's portion of the total ecological damage caused by all development in the city.

Note that the Ecology/biodiversity impact category has 6 sub-categories (below). Sub-categories for the impact categories appear as satellites on the STARfish diagram.

2. Materials/waste (eg. resource depletion, waste, toxins)

Building materials/products should have socially constructive uses, appropriate durability or lifespans, minimal 'designed waste' (that which locks in waste during usage) and be reused, regrown and/or eco-cycled. Likewise, to reduce material usage, the building and its components should be adaptable, demountable, biodegradable or at least recyclable, and designed for ease of retrofitting. The amount of waste that is recycled is usually less important than the total amount of materials that are not recycled or eco-cycled.

Relevant SMT Analyses: Ecological Waste (EW) Analysis; Reverse Sunk Cost (SC) Analysis; Designed Waste (DW) Analysis (see Chapters 7-8 in the book).

-10 = The resulting development or component causes beyond average waste, it is likely to be demolished within 50 years (the typical lifespan of modernist buildings), or it lacks a socially or environmentally beneficial end use, as this wastes resources. Building products designed for 'planned obsolescence' are inherently wasteful.

-5 = The basic plan/concept uses products/materials that do not have excessive waste but also do not have function-appropriate durability, are non-recyclable or disposable, or include luxuries (eg. marble walls and gold faucets). Mined materials involve significant waste but can be necessary, long-lasting and recyclable with good design.

50% = Most of the development products/materials have appropriate recyclability and durability in relation to their functions but there is only partial compensation for the downstream or upstream waste caused during material sourcing, production or use.

100% = The materials are organic/biodegradable where possible (eg. mycelium, hemp or bamboo based), and most of the mined materials used are necessary. Most building products are recycled or recyclable throughout their supply chain and lifecycle.

+5 = The construction products/materials have minimal impact during mining, forestry or agriculture operations, have appropriate durability and recyclability, are adaptable to future retrofitting needs and are healthy in situ. Designed waste is avoided, and unavoidable waste is upcycled if not eco-cycled.

+10 = In addition, any embodied pollution or indirect impacts of the material/product choices are minimized by design. For instance, a low-impact 'timber skyscraper' might use native forest timber that is replaced by a plantation, or bio-based materials might use agricultural land that replaces a valuable ecosystem.

3. Efficiency/energy (eg. energy and resource minimization)

Energy efficiency concerns fossil fuel avoidance as well as energy and resource minimization, whereas the Greenhouse/carbon STARfish mainly concerns carbon sequestration. The source of energy or materials is often more significant than the efficiency of its use. For example, fossil fuels are 'inefficient' as they take thousands of years to produce, have irreversible long-term consequences and entail huge opportunity costs. In sustainable design, it has long been recognized that efficiency is not enough, even though it is an essential dimension.

Relevant SMT Analyses: Development/Design Functions (DF) Analysis; Designed Waste (DW) Analysis; Source of Energy (SE) Analysis (see Chapters 7-8 in the book).

-10 = The resulting development uses fossil fuels in building operation as well as production of the development, and energy or materials are used inefficiently or for harmful purposes. Single functions, redundancy, rebound effects, excess embodied energy and anti-social functions all waste energy, so they are inherently inefficient.

-5 = Fossil fuels are used in the supply chain, not necessarily in building operation, and the energy is not used for responsible purposes (eg. cigarette factory, racetrack). Even if a product or building uses renewable energy or is efficient in production, it may create inefficiencies downstream (eg. a car dependent suburb).

50% = Potential 'rebound effects' of the building and components are minimized, the source of energy is largely renewable, and the development has some social value relative to energy usage. Very efficient projects using fossil fuels can delay the transition to renewable energy systems which reduce its gains (due to the opportunity costs).

100% = The energy produced through renewable systems equals the energy used in post-construction operation (the conventional standard in sustainable design). Energy production should be at an efficient scale. For instance, both domestic and centralized energy plants may be less secure or effective than community-scale systems (eg. solar disks).

+5 = Although energy cannot be 'increased', the use of appropriate materials, efficient technology and multifunctional design can multiply the benefits of the energy and materials used (eg. hemp building products can provide both insulation and passive thermal benefits). Most rating tools do not count the energy embodied in construction.

+10 = In addition, the development adds public benefits relative to the resources and energy used (without reducing the value or benefits to occupants). It is important to not only use less energy to perform work but to provide multifunctional design elements that increase positive public gains.

4. Greenhouse/carbon (sequestration) (eg. fossil fuel avoidance, carbon sequestration)

Each development should be expected to contribute to carbon sequestration, oxygen production and urban climate mitigation. This is seldom the case, but it would not be as difficult as many assume. Greenery has been considered inconsequential, but substantial, permanent building-integrated vegetation can sequester a building's entire lifecycle emissions within years (and produce oxygen). Development should also be designed for future consequences of past carbon emissions (eg. tornados, sea level rise, droughts).

Relevant SMT Analyses: Passive Maximization (PM) Analysis; Resource Security (RS) Analysis; Risk Avoidance (RA) Analysis (see Chapters 7-8 in the book).

-10 = The resulting development is carbon intensive compared to the norm. Virtually all buildings increase the urban heat island (UHI) effect, fail to future proof the development against climate change, sequester any carbon or increase urban oxygen. Few buildings aim to reduce greenhouse impacts beyond their own added emissions.

-5 = The basic plan/concept does not have excessive carbon emissions in materials and landscaping relative to typical projects, but it still contributes to net carbon emissions and its multifarious adverse impacts, such as extreme weather events, the UHI effect, floods and droughts.

50% = Renewable energy usually only reduces the need or demand for fossil-fuel-based power or equipment. A building that operates entirely on renewable energy still creates greenhouse emissions in production (even in the production of its renewable energy systems). Therefore, carbon sequestration is essential.

100% = Greenhouse/carbon neutrality is where the carbon emissions caused over the building lifecycle are offset or sequestered (the usual goal in sustainable design is only to sequester post-construction emissions). Some passive solar design materials (eg. hempcrete, agri-waste) can sequester carbon while supporting renewable energy.

+5 = The development sequesters more than its own embodied and operating carbon emissions, and thus contributes to a (small) reduction of climate change and urban climate risks, such as extreme weather events and overheating caused by existing levels of excess atmospheric carbon.

+10 = The development sequesters its share of total urban carbon emissions and oxygen, to mitigate the urban climate. In regions with few emissions, new projects should still sequester more carbon than emitted by development as a whole. Net-positive offsetting measures might include contributing to urban/rural reforestation programs.

5. Health/life quality (eg. physical/mental wellbeing, environmental quality/amenity)

Most 'healthy' buildings still merely aim to make indoor environments and people less unhealthy, instead of making buildings tangibly health giving. Development should address priority local health issues, which vary widely. In disadvantaged regions, for example, air quality often suffers from poor sanitation or air pollution from indoor cooking and heating. In wealthy regions, many 'modern' buildings still off-gas harmful chemicals (eg. formaldehyde, volatile organic compounds, radon) and/or cause nature deprivation disorder.

Relevant SMT Analyses: Negative Space (NS) Analysis; Ecological Space (ES) Analysis (see Chapters 7-8 in the book).

-10 = The resulting development or component materials/products will have significant adverse health impacts during construction, operation and/or occupancy (as do typical buildings) or it is located in a highly polluted location, as is the case in many urban areas around the world.

-5 = The basic plan/concept is harmful to health but is within acceptable (eg. World Health Organization) health standards. Treating existing toxins in a brownfield site is often a good investment (raises property values), but that is not enough to avoid negative health impacts during construction and operation.

50% = Most things that can shorten average human lifespans are mitigated, such as poor air, water, or soil quality, unhealthy materials, and anything that is likely to increase rates of cancer, disease, accidents or stress among building users. (Sustainable building design has addressed health for decades.)

100% = As well as eliminating any foreseeable environmental and human health risks, the building provides significant levels of environmental amenity and greenery, as these are known to be an important factor in maintaining health and wellbeing. (Green social activity spaces should be provided in office buildings.)

+5 = In addition, the development tangibly improves the health of most building occupants within a reasonable period (eg. a year). Individual health improvements can now be assessed in real time with various individual monitors, so this assessment is not onerous, and could stimulate community building.

+10 = The long-term occupants improve their overall biological (versus chronological) health and/or increase their life expectancy and the project contributes to community health. For instance, building design can make exercise fun, such as by providing climbing walls, exercise tracks or play-gardens.

6. Planning/spatial relationships (eg. ethics, equity and environmental space)

Since development usually reduces future land use options, resources, environmental quality and space, a lack of eco-positive planning outcomes is negative. Affirmative planning action is therefore necessary. Site planning, building forms and landscaping can increase the public estate and ecological base. Currently, many indirect subsidies to developers, such as public investments in infrastructure, are not reciprocated. Nonetheless, where developers make environmental contributions to the public (and save public funds) they could be reimbursed via planning mechanisms.

Relevant SMT Analyses: Costs of inaction (CI) Analysis; Resource transfer (RT) Analysis (see Chapters 7-8 in the book).

-10 = The resulting development fails to provide for basic public needs, amenities or socio-ecological diversity, creates unnecessary land use risks (eg. building on a flood plain) or conflicts with the intention of current international sustainability policies, such as those promulgated in the New Urban Agenda.

-5 = The basic plan/concept does not substantially increase adverse safety, security, equity, diversity and amenity impacts, but it nonetheless greatly exceeds the average 'environmental space' (eg. per capita resource consumption). For example, this would be the case in a gated community for mansions.

50% = The development mitigates any adverse (otherwise unavoidable) planning impacts through measures that provide for onsite environmental security and access to basic needs (eg. food, shelter, water), has no major negative planning impacts (eg. traffic congestion) and actively supports sustainable urban planning objectives.

100% = The development provides diverse, reversible land uses (eg. design for deconstruction or retrofitting) that increases resource and environmental security for the wider community. Any negative impacts of infill development are counterbalanced with adequate environmental amenity and public space.

+5 = The base development plan and site planning improves conditions in the wider community in terms of the amount and distribution of social and environmental benefits and addresses regional social deficiencies or any disparities in local environmental justice.

+10 = The development achieves the above with less than its environmental space allocation (eg. rainwater, energy or timber divided by the relevant population). Planners should determine the allocation for various resources based on average per capita or floor area consumption, building type and function, occupant numbers and so on.

7. Socio-cultural/community (eg. citizen participation, heritage, local traditions, accessibility)

Relevant SMT Analyses: Negative Space (NS) Analysis; Multifunctional Space (MS) Analysis; Development Functions (DF) Analysis (see Chapters 7-8 in the book).

The socio-cultural dimension of the built environment is crucial to sustainability. Urban environments must improve conditions for all people and other species in the entire bioregion. Cities must be safe, democratic, inclusive, for everyone, regardless of their income, race, gender or national origin. Citizen participation is vital to community empowerment and sense of place, as well as preserving and respecting traditional values, culture and local knowledge.

-10 = There is no citizen participation mechanism in the design and management processes, the project does not take into account the social or historical context, its actions may damage the city's tangible and intangible heritage, or it disadvantages minority groups or vulnerable individuals.

- 5 = The project involves research that allows for understanding the social, historical, or economic context, but it does not involve local participation. The outcomes may represent some risk to cultural assets or disadvantaged groups, but their effects are reversible.

% 50 = The project offers some public space or infrastructure that benefits the local community, and it considers local participation in the process. However, although it meets minimum standards for universal accessibility, it may not be accessible to all potential visitors.

% 100 = The project creates safe social spaces that are inviting, support the complexity and diversity of the community, and stimulate cross-cultural exchange and learning. This is made possible by conducting research and citizen participation.

+ 5 = The project also plays a central role in the preservation of the collective memory and contributes social gains for the wider community. It encourages community engagement processes directed at community improvement and establishes a ‘conflict resolution by design’ process.

10 = In addition, the project has the potential to become a social centre that strengthens ties between citizens and reinforces the community bonds, and also provides a place for innovation, exchange and creativity that will be a platform for the cultural development of future generations.

2. 2nd tier benchmarks in Satellites

2.1 Outline of 2nd tier benchmarks

1. Satellite STARfish for Ecology/biodiversity (eg. carrying capacity, biodiversity, ecosystem functions/services)

1.1 Eco-restoration of sites

1.2 Building-integrated eco-services

1.3 Ecological space

1.4 Environmental threat/risk reduction

1.5 Air quality (environmental)

1.6 Water quality (biological)

2. Satellite STARfish for Materials/waste (eg. resource depletion, waste, toxins)

2.1 Recycling systems

2.2 Biodegradable materials

2.3 Modular/durable components

2.4 End use eco-cycling (circularity)

2.5 Multifunctional materials

2.6 Construction waste

3. Satellite STARfish for Efficiency/energy (eg. energy and resource minimization)

3.1 Renewable/passive energy

3.2 Scale of energy systems

3.3 Sources of energy

3.4 Design for adaptability

3.5 Positive public functions

3.6 Spatial optimization

4. Satellite STARfish for Greenhouse/carbon (eg. fossil fuel avoidance, oxygen, carbon sequestration)

4.1 Carbon offsetting

4.2 Building-integrated sequestration

4.3 Industrial-scale sequestration

4.4 Urban vegetation

4.5 Rural (soil) sequestration

4.6 Micro-climate mitigation

5. Satellite STARfish for Health/life quality (eg. physical and mental wellbeing, environmental quality/amenity)

5.1 Onsite/offsite health gains

5.2 Construction health impacts

5.3 Exercise/lifestyle options

5.4 Environmental justice

5.5 Materials sourcing

5.6 Resorts and eco-tourism

6. Satellite STARfish for Planning/spatial relationships (eg. ethics, equity and environmental space)

6.1 Local deficits addressed

6.2 Urban infill

6.3 Appropriate mixed uses

6.4 Developer contributions

6.5 Multifunctional emergency facilities

6.6 Environmental space (reduced consumption)

7. Satellite STARfish for socio-cultural/community gains (eg. cultural heritage and community building)

7.1 Local history and heritage

7.2 Citizen participation

7.3 Social interaction and engagement

7.4 Accessibility and usability

7.5 Intergenerational users

7.6 Sense of place, identity, and belonging

2.2 Description of 2nd tier benchmarks

1. Satellite STARfish for Ecology/biodiversity (eg. carrying capacity, biodiversity, ecosystem functions/services)

See Tier 1 for general description. The following is an example of how the 6 main STARfish diagrams can expand into more detail (Tier 2). Any of the Tier 2 benchmarks can be expanded in a similar fashion to Tier 3.

1.1 Eco-restoration of sites

Merely restoring the landscape left-over after construction to pre-construction conditions would seldom be impact neutral. Onsite multilayered landscaping can make biodiversity more resilient and compensate for some past ecological losses in the bioregion. The eco-restoration of landscapes or eco-positive retrofitting on other sites can help to offset some of the unavoidable impacts of the project, but biodiversity offsets should reduce a region's total ecological deficit.

-10 = The resulting development or building component introduces or increases feral species, diseases, soil degradation, erosion, compaction and/or other ecological damage, or the existing site is seriously degraded.

-5 = The basic plan/concept contributes somewhat to already degraded environmental conditions and/or reduces ecological carrying capacity, biodiversity or ecological space or limits mitigation measures.

50% = The development restores the site and/or preserves some ecologically appropriate onsite landscapes, and provides some new ecological space within, on or around the building(s).

100% = The equivalent of pre-construction site conditions is preserved or restored, and onsite biodiversity is increased using a range of elements such as green roofs, walls or atriums and vertical landscaping.

+5 = The development provides for substantial new ecosystems and/or habitats or, where this is impossible, undertakes the remediation of another site or the eco-positive retrofit of another building to achieve a net improvement.

+10 = Further, the outcome exceeds (the ecological equivalent of) pre-settlement/pre-industrial conditions. This may require creating urban ecosystems (eg. Green Scaffolding over low-scale warehouses) via net-positive offsetting.

1.2 Building-integrated eco-services

Environmental amenities and most ecosystem services primarily benefit people by, for example, reducing urban heat, noise and glare (although these harm animals as well). 'Eco-services' not only reduce ecological damage and benefit humans, they benefit nature as well. Care should be taken that new environmental amenities for people (eg. outdoor recreation areas, green walls/atriums or gardens) also support compatible native biodiversity and ecosystems.

-10 = The resulting development or component reduces urban eco-services which cause adverse ecological impacts during its lifecycle, or otherwise harms or reduces local ecosystems or biodiversity.

-5 = The basic plan/concept does not reduce eco-services beyond the norm (typical buildings do not provide structures and spaces that benefit nature) but limits mitigation measures.

50% = The development provides some eco-services that produce, increase or otherwise benefit urban ecosystems and biodiversity, in addition to their ecosystem services (ie. building and human environment functions).

100% = The development provides the equivalent eco-services and natural systems as the site would have done if it remained undeveloped - or pre-construction conditions.

+5 = The building supports adequate eco-services and natural systems to improve the resilience of nature in the bioregion, such as reintroducing threatened species that are at risk due to local urban development.

+10 = In addition, the project undertakes net-positive biodiversity offsetting on other sites to achieve more eco-services than in pre-settlement times. Better than building regulations, existing conditions or best practices is not net positive.

1.3 Ecological space

Reducing pollution, protecting biodiversity and restoring environmental media is essential as ecological damage tends to bioaccumulate and/or biomagnify. Simply replacing natural resources like forests or wetlands will seldom neutralize the damage as biodiversity may not recover. Increasing total ecological space is therefore necessary. A project can restore/increase environmental media and ecological space through designed-in features (eg. Living Machines).

-10 = The resulting development eliminates existing ecological space, or the amount and quality of space, habitats and environmental media for ecosystems that once supported native biodiversity in the region.

-5 = The basic plan/concept does not have excessive onsite or offsite biodiversity impacts, but it reduces the ecological space that once supported onsite ecosystems and biodiversity or limits mitigation measures.

50% = The development project preserves or rehabilitates the remainder of the site after construction and provides some ecological space in the building and landscape structures.

100% = The project rehabilitates or regenerates the equivalent ecological space that existed onsite before the project was built (pre-construction conditions) through, for example, green roofs and walls.

+5 = The development creates sufficient ecological space to exceed the equivalent ecosystems and habitats that existed before settlement through, for example, vertical landscapes or floors dedicated to native gardens (in a large building).

+10 = The volume of ecological space is equivalent to the floor area of the building, which may be supplemented by reserving an existing wilderness area, creating an eco-education or ecological research facility.

1.4 Environmental threat/risk reduction

Cities and buildings have generally increased the impacts of floods, fires, earthquakes, landslides, drought, storms and other natural events. For example, floods exacerbated by development (eg. weirs, dams and other barriers to natural flows) kill innumerable plants and animals, which can take decades to recover. The human, social and economic costs are also immense and cannot be compensated for by insurance. The risks can only be avoided or mitigated by design.

-10 = The resulting development will exacerbate environmental risks by, for instance, locating on a steep slope even if allowed by regulations, and/or create new risks (eg. withdrawing excess water from the land creating sink holes).

-5 = The basic plan/concept does not create new risks, but it perpetuates environmental risks that are possible in the area (eg. building in a potential fire or flood prone site, even if legal) or limits mitigation measures.

50% = The development is not located in an area subject to foreseeable environmental risks and also undertakes design actions that reduce the impacts of any foreseeable yet unlikely environmental risks.

100% = The development is in a safe and appropriate location and is designed to be as resistant and resilient as practicable in the face of possible floods, storms, fires, earthquakes and so on.

+5 = Further, the development provides measures that reduce the potential for environmental risks in the wider area (eg. providing substantial water storage for helicopters instead of relying on fire trucks reaching remote areas on time).

+10 = The development also reduces an environmental risk in another region via net-positive offsetting (eg. contributing to the diversion of flood waters into a reservoir for firefighting and supporting biodiversity).

1.5 Air quality (environmental)

Here, air quality refers to the natural environment, since indoor and urban air pollution that affects human health is recorded in the health category. (Indoor air quality is often miscounted as an ecological gain.)

Where measures improve both outdoor and indoor air quality, they may count in both health and ecological categories to incentivize multifunctional design. Once air pollution is emitted, it is perhaps most efficiently addressed by vegetation.

-10 = The resulting development reduces urban air quality beyond the norm, and/or the resource extraction, construction or transport processes deteriorates outdoor air quality (eg. emits dust, exhaust or toxins).

-5 = The surrounding environment is not highly polluted, but the basic plan/concept reduces overall urban air quality and circulation, as is the case with most typical buildings or limits mitigation measures.

50% = The development provides substantial vegetation or other natural features to improve air quality and air movement in the urban area, such as green roofs, walls and landscaping.

100% = Further, due to the design, materials and landscaping, the air leaves the site at least as clean as it enters, and there is a maintenance plan for (eg. recycling plants or cleaning filters as required).

+5 = The design elements such as toxin-absorbing materials and plants not only clean the air from the building and surrounding street traffic but reduce urban air pollution to some extent.

+10 = Due to the design (eg. new green space, oxygen production and negative ions), air on the site and surrounding streets is as healthy as in pre-urban times and is supplemented by net-positive offsetting in more polluted areas.

1.6 Water quality (environmental)

In the Ecological/biodiversity STARfish, water quality refers to the ecological health of outdoor ponds, natural waterways and the like. This includes preserving or enhancing biodiversity in streams, rivers and lakes, not just water pollution prevention or treatment. Water should be used for environmental functions (drinking water quality for building users would count in the health category). Water not recycled back to the environment has no ecological benefit.

-10 = The resulting development reduces the amount of water naturally entering or pre-existing on site and/or that used during production is polluted, wasted or not returned to the environment.

-5 = Water entering or pre-existing the site is not seriously contaminated, but the basic plan/concept withdraws water from the environment, pollutes or otherwise reduces its ability to support biodiversity, or limits mitigation measures.

50% = Water restoration/remediation designs or actions clean most of the water used by the development. Elements such as Living Machines or vertical wetlands may be used to clean and deliver healthy water back to the environment.

100% = In addition, the equivalent water quantity/quality and biota that would exist on site under natural conditions (ie. pre-construction conditions in the case of greenfield development) is achieved.

+5 = The development improves water quality/biota in the wider catchment and compensates for its embodied water. Information on water embodied in construction materials is available but does not consider growing water scarcity.

+10 = Ideally, projects could offset their portion of water depletion/degradation due to all development in the area. For example, water can be drawn from air (in a humid climate) using passive evaporative collectors to support ecosystems.

2. Satellite STARfish for Materials/waste (eg. resource depletion, waste, toxins)

See Tier 1 again for general description.

2.1 Recycling systems

Recycling of materials/products reduces waste, pollution and resource consumption. It should also be substantially cheaper than procuring raw materials from mines or forests. Nonetheless, recycling can involve substantial reprocessing, energy, packaging and transport impacts. Sometimes toxic waste materials are shipped to other countries where recycling is cheaper, but workers suffer health consequences and/or the new products are sold back that embed toxins.

-10 = The resulting development uses many products over the life of the project that are not recycled or recyclable and generates substantial waste during resource extraction, building construction and/or operation.

-5 = The basic plan/concept has a relatively low portion of recycled and recyclable materials compared to similar buildings, generates avoidable waste during construction and/or operation or limits mitigation measures.

50% = A high portion of recycled and recyclable materials are used, and waste is minimized throughout the construction process where practicable.

100% = In addition to minimizing waste, a waste management plan is followed that includes product stewardship (responsible supply chain) and upcycling where realistic as well as recycling.

+5 = Most materials used are upcycled and upcyclable, or preferably eco-cycled to a higher social purpose where possible (rather than just to a higher economic value as is often the aim).

+10 = Eco-cycling is maximized in all stages of the project where feasible, which could require setting up new waste networks (nutrient food webs). Net-positive offsetting should result in an overall reduction in material flows.

2.2 Biodegradable materials

Building demolition and replacement with a new building nearly always creates more waste and pollution than retrofitting. Use of biodegradable or compostable materials enable either retrofits and/or future demolition to occur with fewer environmental and human health impacts. Organic/biodegradable materials are low impact, often sequester some carbon, are recyclable or compostable and are regrown quickly (eg. strawboard, bamboo, timber, mycelium).

-10 = The resulting development uses a large amount of industrial materials (concrete, steel and aluminum) that are high in embodied carbon and energy, or derived from unsustainable forestry, mining, or farming practices.

-5 = The basic plan/concept uses unnecessary amounts of industrial materials/products that do not increase the project lifespan (durable materials can have long-term problems such as cracking from earth movement).

50% = Many industrial materials are substituted by biodegradable materials where practicable (ie. apart from structural elements and equipment) to reduce adverse impacts.

100% = All materials in the base building are biodegradable where feasible and the building is designed for ongoing maintenance. Homes have been constructed entirely of bamboo or non-narcotic hemp-base projects, for example.

+5 = The design elements ensure ease of repair and maintenance. For instance, Green Scaffolding could allow for the inexpensive maintenance, replacement and eco-cycling of healthy, biodegradable components over time.

+10 = Further, sensitive ecosystems are not damaged during the production of the materials. The products used are regrown and nutrients/biota removed from the soil are replenished (based on bioregional-scale analysis and planning).

2.3 Modular/durable components

While durable buildings can be costly to adapt, repair, remodel or rearrange, durable modular building components can be designed for deconstruction to facilitate repurposing or even moving. For instance, modular roof or wall planters reduce the maintenance of integrated (multifunctional) vegetation systems. Enabling building expansion or contraction over time to meet changing needs can substantially reduce demolition waste and maintenance costs over the lifespan.

-10 = The resulting development is likely to cause premature demolition compared to similar projects, due to the lack of modular or adaptable structures that enable the base building to expand, contract or be modified as needs change.

-5 = The materials/products required by the basic plan/concept increases the likelihood of premature demolition or extra remodeling impacts (eg. lacks modularity) and limits mitigation measures.

50% = Modular components are used where practicable to reduce the likelihood of demolition due to changing needs, or the impacts of demolition that results from capricious economic forces or other contextual changes.

100% = The modular components are also designed to facilitate maintenance and retrofitting over time, to aid climate adaptation and accommodate unpredicted technological, social or other forces of change.

+5 = The design and modular structure allows for building expansion and contraction, as well as ease of repair or replacement of parts, to avoid future demolition and extend the useful life of the development.

+10 = The project also provides innovations that are transferrable to other situations or locations, such as modifying development to meet sea level rise, or providing other major future proofing needs via net-positive offsetting.

2.4 End use eco-cycling (circularity)

Eco-cycling, again, is recycling that creates public value, as opposed to merely adding economic value, since this often indirectly increases overall material flows. The end uses of buildings or component products must not be socially or environmentally harmful since this wastes resources. Likewise, the end projects/products (even if recyclable and recycled) should not increase overall material consumption, encourage disposability or create downstream waste.

-10 = The resulting development or substantial component has no public benefit (eg. tavern, racetrack or casino) and it cannot be converted to a beneficial purpose in the future (eg. its components contain toxins).

-5 = The basic plan/concept may not cause clear public harm, but it contains major non-functional elements (eg. material intensive signage or symbols), creates unnecessary consumerism or consumption or limits mitigation measures.

50% = The project with only private functions is designed so that, in the future, it can be repurposed, or its components can be eco-cycled, when its original economic function expires.

100% = The design also ensures that the building or components have social or ecological benefits in the first place. Adding recycled materials to score higher on a green building rating tool does not increase its public value.

+5 = The project has positive purposes and plans are developed to enable the building or components to be upgraded to public end uses (eg. warehouse structures can be designed to be easily converted to urban farms).

+10 = In addition, positive public functions are incorporated in another development to meet a public need through multifunctional design (eg. pollution absorbing façade materials) via net-positive offsetting.

2.5 Multifunctional materials

Multifunctional, adaptable design can reduce more waste over time than the use of recycled and recyclable materials. Single-function products often have a poor ratio of materials to functional benefits. For example, free-standing water tanks can have fewer benefits per unit of material than water storage walls that multi-task as thermal mass, noise/heat insulation and fire-fighting supplies. Using recycled materials for a single function with little value is wasteful in itself.

-10 = The resulting development, such as its form, products and/or design features, have only single functions where additional designed-in private or public benefits are possible (ie. resources are used for little gain).

-5 = The basic plan/concept or component may have more than one function (eg. facades provide shelter, rain proofing and insulation), but their design does not add benefits (eg. facades that also reduce urban pollution).

50% = A few of the building products and/or design elements have multifunctional features that increase their use value and/or reduce the total amount of materials needed to achieve these functions.

100% = Many of the building products and/or design elements provide for multiple functions that increase private and/or public benefits per unit of resource.

+5 = Through multifunctional, synergistic design, the development produces public benefits in addition to reducing waste (eg. Green Scaffolding can provide basic structural or façade tasks while supporting many eco-services.

+10 = Further, the development contributes net benefits to the wider community and environment in relation to the materials used and/or adds value to another site via net-positive offsetting.

2.6 Construction waste

Despite some moves toward healthier building materials, construction waste is a serious pollution problem in terms of both volume and toxins. Many paints, varnishes, glues and other chemicals used in construction still end up in the soil or at landfill sites where they leach into the environment. Construction waste management plans often focus more on how the waste is stored than on how it is reduced during the construction process, as the latter requires design thinking.

-10 = The resulting development causes significant construction waste and/or most waste from the construction process is buried onsite or goes to the tip, incineration or other harmful form of disposal (the norm).

-5 = The basic plan/concept causes less construction waste than the norm (or is within current legal standards) but the waste is nonetheless disposed of in a harmful way, or it limits mitigation measures.

50% = A waste management plan is followed that reduces waste at all stages of construction (eg. timber wastage in harvesting, storage, transport and offcuts). A 'plan' to not recycle is not a valid waste reduction plan.

100% = Further, tangible actions are undertaken to prevent waste in the first place by design, as well as to mitigate any pollution or other impacts of any unavoidable construction waste.

+5 = Any construction waste that cannot be avoided through better design is properly upcycled or eco-cycled (eg. timber waste going to a charity that makes toys instead of being sold for wood fire heaters).

+10 = In addition, design, management and systems innovations reduce net waste in the local building industry as a whole by, for example, creating industrial ecology networks, or other forms of net-positive offsetting.

3. Satellite STARfish for Efficiency/energy (eg. energy and resource minimization)

See Tier 1 for general description.

3.1 Renewable/passive energy

An efficient building would at least produce renewable energy, maximize passive energy and be 'fit for purpose'. A building may be considered energy neutral for practical purposes (energy cannot be increased) if it provides as much clean, renewable energy as it uses during its lifecycle (including embodied energy and energy used in future interior fit-outs). However, buildings are still often called energy neutral if they merely generate their own operating energy.

-10 = The resulting development makes almost no use of renewable or passive solar energy, and most of its electricity is ultimately (even if indirectly) sourced from fossil fuels or nuclear power.

-5 = The basic plan/concept does not require energy sourced from fossil or nuclear power but uses little passive solar energy or renewable energy and limits mitigation measures.

50% = The development's operating energy is purchased from ecologically-sound renewable sources and much of its HVAC energy is provided by passive solar design.

100% = Enough renewable and passive solar energy is produced by the design to supply all the operating energy used by the development. This is the conventional standard for 'zero-energy' building.

+5 = Enough renewable and passive solar energy is produced by the development over time to pay back the energy costs of production, construction and operation, or the full lifecycle energy demand of the project.

+10 = Further, 'surplus' energy is used to produce other positive public purposes, such as providing energy for nearby community centers or charitable organizations.

3.2 Scale of energy system

Scale is usually an important consideration in efficiency. Generating electricity at a neighborhood scale (eg. a community thermal disk or wind generator) is usually more efficient than individual rooftop photovoltaic systems). Where energy production is centralized, transmission losses must be accounted for. In efficiency matters, the resources used/lost to deliver a given amount of energy to the site should be given more weight than relative prices.

-10 = The resulting development relies almost entirely on energy from a large, centralized energy plant, so the distribution system may be exposed to disruptions due to blackouts, arson, vandalism or natural catastrophes.

-5 = The basic plan/concept relies on a centralized power source, but disruptions to the energy supply can be corrected relatively quickly (eg. there are energy backup systems).

50% = Energy system maintenance and management is at an efficient scale, is not wholly dependent on a grid that could be disrupted, and losses in energy transmission are reasonable.

100% = There is a diversity of clean energy sources and backup systems (eg. autonomous community scale systems) so people in the development cannot be exposed to risk in an emergency (eg. oxygen machine dependent people).

+5 = The development provides energy for the community at an efficient, diverse and resilient scale, so everyone has energy/electricity security (eg. energy cannot be withheld for political or financial reasons).

+10 = In addition, any energy taken from or sent to a grid, is used only for constructive public purposes. Efficiently produced and delivered energy that is then used for harmful, wasteful or anti-social purposes is inefficient by definition.

3.3 Sources of energy

There are many renewable sources of energy. Low-impact and healthy sources of energy can be more significant to overall project performance than the amount of energy used. Fossil fuels should not be used to supply a building's heating and cooling energy demand, even if offset, since this can be met by renewable energy and passive solar design. Retrofitting buildings with passive design features can reduce current urban energy usage at no net cost.

-10 = The resulting development or major components use fossil-fuel-based energy sources. Note that impacts of fossil fuel use may count in more than one impact category, given their many, diverse societal consequences.

-5 = The basic plan/concept may not use much fossil fuel but calls for or relies on a source of energy that has negative impacts (eg. a new dam that destroys valuable ecosystems, biodiversity, farmland, and so on).

50% = Renewable energy systems are incorporated in the design. The relatively small impacts of renewable sources of energy are reduced (eg. inappropriate location of wind generators or toxic rare earth elements in solar cells).

100% = The development uses no offsite sources of energy, and its HVAC demand is supplied entirely by passive and renewable energy (averaged over the year). This is the conventional standard in energy-efficient design.

+5 = The basic HVAC demand of the development is met by passive solar energy design alone, although it may have office equipment that requires additional renewable energy to support. Extreme climates provide a partial exception.

+10 = The building is energy autonomous, uses minimal resources, and generates 'surplus' energy for positive public functions. Energy cannot be net positive (due to laws of physics) but a whole system could be deemed as such.

3.4 Design for adaptability

Adaptable design is an essential element of whole-system efficiency. Design for retrofitting can be more effective in lifecycle performance than setting higher efficiency standards for new buildings. It means designing buildings that are easily modified or upgraded in the future to meet changing occupants, social needs, uses or contextual conditions. A so-called energy efficient building, designed for the current climate or context, will need retrofitting in the near future.

-10 = The resulting development prevents efficient and low impact modifications to meet changing needs or conditions (eg. the building is overly durable, and its components are not, or even worse, are designed for obsolescence).

-5 = The basic plan/concept limits efficient future retrofitting to meet foreseeable changing standards, occupant needs or environmental conditions, such as climate change, or limits other mitigation measures.

50% = The development can be modified efficiently to facilitate interior modifications with minimal impact to accommodate changing uses that occur in the regular course of events (eg. rental turnover).

100% = The development is designed to be adaptable to changing social and technological demands, as well as to minimize any unavoidable remodeling or demolition impacts.

+5 = The development is designed to adapt efficiently and effectively to extreme climatic conditions that may occur in the far future (eg. sea level rise, two degrees of global warming, long-term droughts).

+10 = In addition, the development is prepared to address continued population growth or radical decline, forces such as urban consolidation or climate refugees, or other issues currently being ignored (eg. GMOs and G5 radiation).

3.5 Positive public functions

In whole-system efficiency, long-term consequences must always be anticipated. For example, narrow and short-term understandings of 'price efficiency' have prioritized expediency and locked in resource inefficient and unsustainable systems of resource exploitation. Stylistic changes that are technically efficient in themselves may not improve overall public safety/security or reduce net material flows. Many 'efficient' products are redundant or have no public value.

-10 = The resulting development or major components have superfluous or redundant functions or design features, adverse social or environmental impacts or unnecessarily extravagant design that privatizes valuable resources.

-5 = The basic plan/concept is inefficient, uses materials or products with unnecessary levels of embodied resources or energy, lacks fitness for purpose or otherwise has no real public benefit, and limits mitigation measures.

50% = The project provides some public benefits, conserves energy and avoids design changes which are mainly stylistic or may cause a rebound effect (ie. where the savings from efficiency is spent or used elsewhere).

100% = In addition, the development substantially reduces energy, materials or carbon emissions in relation to the public benefits that it provides, instead of, for instance, the net cost of the energy produced.

+5 = The development provides more public benefits per unit of energy, as opposed to its efficiency relative to similar buildings, and the design encourages conservation behaviors (eg. sharing equipment or spaces).

+10 = Further, the project supports positive community functions and lifestyles which reduce energy consumption in the region (eg. reduces car usage by providing public transport, entertainment and local employment).

3.6 Spatial optimization

Often, interior space is reduced to save heating/cooling costs and/or exterior space is reduced to save land and transportation costs. However, since the reduction of space often reduces adaptability and increases future construction or remodeling costs, the costs of future urban sustainable retrofitting/upgrading (which is necessary) will be increased. Multiple uses of space (as well as of materials) can increase public gains relative to total energy consumption.

-10 = The resulting development lacks public and/or private open space and thus may increase the costs required to mitigate climate impacts and social change, along with the impacts of dense urban development, in the future.

-5 = The basic plan/concept does not have adequate flexible private or public open space to facilitate future change, or to increase the multiple mixed uses/amenities of the spaces over time, or otherwise limits mitigation measures.

50% = The site and floor planning create flexible indoor-outdoor spaces, provide amenity and will likely reduce the costs and impacts of recurrent remodeling or upgrades. For example, open-plan design may facilitate retrofitting.

100% = The planning, design and landscaping provides more space per person than typical buildings to enhance life quality and environmental amenity, facilitate adaptation.

+5 = Further, the interior-exterior layout increases in the multiple benefits of spaces (eg. daylighting, views, access to nature, natural ventilation) and optimizes the potential of (multifunctional) public-private spaces.

+10 = In addition, the design increases average public open space in the area and optimizes the materials required to frame those indoor-outdoor multifunctional spaces.

4. Satellite STARfish for Greenhouse/carbon (eg. fossil fuel avoidance, oxygen, carbon sequestration)

See Tier 1 for general description.

4.1 Carbon offsetting

Most carbon assessments pertaining to buildings only count the carbon emitted during its operation, not manufacturing (embodied carbon). This means that many buildings labelled carbon neutral or carbon positive increase overall carbon emissions. Similarly, carbon trading schemes just slow the rate of increasing emissions. Accounting schemes should ensure overall (global) carbon emissions are reduced, or not represent reductions in relative carbon emissions as zero.

-10 = The resulting development produces more carbon emissions in manufacturing, construction and operation than similar projects, or the maximum permitted, if and when applicable regulations are adopted.

-5 = The basic plan/concept may produce fewer carbon emissions than typical projects of a similar nature but does not design-in carbon sequestration features, or otherwise limits mitigation measures.

50% = The development emits little carbon in operation and contributes to carbon offset or trading programs that offsets the carbon emitted during operation.

100% = The development emits little carbon in production as well as operation and contributes to carbon offset or trading programs on an ongoing basis after construction.

+5 = The development is carbon neutral through the use of energy reduction measures, low-carbon materials and construction methods and contributions to carbon offsetting and trading schemes.

+10 = The development is carbon neutral in production and operation and contributes to reducing overall urban carbon emissions through retrofitting other buildings via net-positive offsetting.

4.2 Building-integrated sequestration

Organic building components (eg. hempcrete, timber, agri-waste) can sequester carbon. When concrete or brick and mortar are necessary, there are varieties of such products that can sequester carbon. Developments in high-density urban areas should have permanent building-integrated vegetation/landscaping for multiple benefits as well as carbon sequestration (eg. biochar in planting containers sequesters carbon and also benefits plant/soil productivity).

-10 = The resulting development has no materials or building-integrated vegetation that sequesters carbon, and the development is high in carbon emissions compared to similar projects.

-5 = The basic plan/concept is comparatively low in carbon emissions during production, construction and/or operation, but little or no materials or building-integrated vegetation are used to sequester carbon, or it limits mitigation measures.

50% = The development emits relatively little carbon and incorporates some materials and design features that sequester carbon and provide other functions (eg. insulate the building, reduce cooling loads, produce oxygen).

100% = The development is designed to sequester its own operating emissions over its lifespan in addition to reducing carbon emissions during production and operation.

+5 = The development sequesters its own lifecycle carbon emissions (in manufacturing, construction and operation) with extensive permanent vegetation, carbon-absorbing materials and/or other measures over its lifecycle.

+10 = The building-integrated vegetation and other features sequester more than the project's full lifecycle carbon emissions within two decades and contributes to a reforestation or other 'natural' sequestration action.

4.3 Industrial scale sequestration

If geo-sequestration or in-ground carbon storage (or contributions thereto) are used to offset emissions, it should be guaranteed that collateral damage from geological changes, as happens, is not possible. There are now mega-industrial sequestration machines, but they are generally single function, and their construction and operation impacts may cancel out much of their sequestration gains. Urban design and reforestation actions can have more positive functions.

-10 = The resulting development has significant emissions due to its design, compared to similar projects, regardless of offsets, onsite sequestration or other mitigation measures.

-5 = The basic plan/concept produces carbon emissions and relies on credits from mega-industrial or in-ground carbon storage schemes, as opposed to design solutions, or otherwise limits future mitigation measures.

50% = The development mitigates its carbon emissions, and offsets some remaining emissions (eg. buys credits) from an industrial geo-sequestration project.

100% = The development has low carbon emissions using renewable energy, efficiency, vegetation and so on, and offsets its remaining emissions by contributing to an industrial geo-sequestration program.

+5 = The development compensates for more than its own carbon emissions (reduces total emissions) by contributing to a large-scale sequestration program(s) after optimizing design measures.

+10 = Further, the development offsets its portion of all emissions in the city or region via geo-sequestration. (Planners could define total urban emissions by floor area and other criteria that accounts for project types and so on.)

4.4 Urban vegetation

Urban vegetation can sequester carbon, reduce the oxygen deficit and treat air pollution in inner city or industrial areas, while using little energy. The carbon emissions embodied in the materials and irrigation systems for supporting and watering plants also needs to be considered. There is no accepted rule of thumb for how many trees are needed to supply each person's oxygen needs, but a figure can be established by planning authorities in consultation with experts.

-10 = The resulting development makes no contribution to urban vegetation for carbon sequestration (ie. it is not designed in), and the natural landscape has been depleted or removed due to the development.

-5 = The basic plan/concept does not contribute additional vegetation beyond that which was originally on site, although some vegetation may be retained in the surrounding landscape, and limits mitigation measures.

50% = Substantial permanent landscape vegetation ('greenery') is added by the development which exceeds the carbon emissions due to the landscaping (eg. irrigation and outdoor structures).

100% = The greenery/vegetation added by the project (onsite or offsite) offsets the carbon emissions caused during the building's operation (which is far less with passive solar design and renewable energy).

+5 = Enough permanent landscape vegetation is provided to (eventually) sequester the total carbon emissions over the building lifecycle and produce enough oxygen to support the needs of building occupants.

+10 = The building-integrated vegetation and landscaping sequesters the full lifecycle carbon emissions of the development within two decades and the development contributes more oxygen than it consumes.

4.5 Rural (soil) sequestration

Using vertical composters for food waste in cities, when sprayed on agricultural land, can increase agricultural productivity and reduce atmospheric carbon. Vertical vegetable farms in rural or urban areas could eventually aid in returning a portion of degraded agricultural land to nature reserves. Investments in rural carbon sequestration and soil regeneration programs should also be socio-economically re-distributive and revitalize rural communities/economies.

-10 = The resulting development removes/covers fertile soil, and its materials production and/or construction damages soil productivity offsite and/or onsite.

-5 = The basic plan/concept provides no designed-in composting systems to facilitate soil production or productivity (even if the occupants are encouraged to compost organic waste) or otherwise limits mitigation measures.

50% = The development establishes a system for composting that is sufficient for use in onsite landscaping to improve soil fertility and/or carbon sequestration (relative to occupancy).

100% = The composting system is adequate to treat all organic waste produced in the development, and systems for delivery to gardens or rural farm sites is established (depending on the scale of the development).

+5 = Further, the development creates or contributes to a soil carbon sequestration/productivity program that can reduce land clearing or increase wilderness reserves (rather than increasing conventional broadacre farming).

+10 = The development provides or contributes to a large-scale vertical urban composter that distributes healthy soil to urban or rural farms. In the case of small developments, it provides a neighborhood-scale composting system.

4.6 Micro-climate mitigation

Design for urban climate mitigation should protect buildings against extreme weather events, as these are partly caused by building carbon emissions. For example, wind-proof shading structures using carbon sequestration materials can support integrated solar cells or vegetation while mitigating harsh urban temperatures or wind tunnel effects. Building-integrated water sprinkling systems can combat extreme urban overheating events and cool the surrounding streets.

-10 = The resulting development increases urban climate impacts and risks (eg. overheating and storms) due to carbon emissions that are largely avoidable by design.

-5 = The basic plan/concept does not create harsh urban micro-climate conditions but increases risks from extreme weather events, temperature inversions, or lacks cross breezes and the like, or limits mitigation measures.

50% = The development, through a combination of design measures, mitigates the impacts of urban weather conditions, such as the urban heat island effect, harsh winds, and excessive exposure or deprivation of sunlight.

100% = The development improves the urban climate/weather on the site by proactive design measures such as vegetated screens with drip irrigation, shade paved areas and creating cool breezes (eg. using the Venturi effect).

+5 = The design mitigates the impacts of extreme urban weather/climate, such as wind tunnels, stagnant air and urban overheating in the wider urban area (eg. landscaping that blocks harsh winds but causes air circulation).

+10 = In addition, the design reverses the impacts of urban climate change (eg. improves temperatures, air quality and oxygen) in another building or city block through net-positive offsetting.

5. Satellite STARfish for Health/life quality (eg. physical and mental wellbeing, environmental quality/amenity)

See Tier 1 for general description.

5.1 Onsite/offsite health gains

Buildings should not be given positive points for ‘not doing harm’ (eg. not locating in a greenfield site or polluted area). Likewise, projects should not rely on proximity to healthy environments for health credits since building users benefit from working in locations near health-giving natural surroundings - regardless of their design. However, if a development contributes improvements to those health-giving environments, such actions should be credited.

-10 = The resulting development is located in a polluted area or contaminated site, its design is harmful to environmental health, and/or it lacks access to nearby parks and green open spaces.

-5 = The basic plan/concept is not located in an unhealthy environment, but it contributes to adverse urban health impacts in the area (as do typical buildings) or limits mitigation measures.

50% = The development eliminates existing unhealthy environmental conditions on the site (eg. treats incoming urban air and water) and reduces offsite health impacts (eg. treats outgoing urban air and water).

100% = The development improves overall human health conditions relative to pre-construction conditions (eg. air and water quality is better on site after construction).

+5 = The development results in indoor and outdoor conditions that are as health as in pre-urban times (assuming no pre-existing hazards) adequate to improve occupant health over time.

+10 = The development contributes to the improvement of health conditions in the wider area (eg. improves offsite urban water or air quality) and/or provides net-positive health improvements in another more polluted area.

5.2 Construction health impacts

Public health standards should not be sacrificed by workers or neighbors during construction. Measures aimed at improving the health and comfort of building users should not externalize impacts. For example, exhaust from air conditioning units can harm neighbors, and reflective wall/window surfaces in hot cities can increase urban overheating. Conventional construction materials and methods impose health impacts on the wider community, such as toxic dust.

-10 = The resulting development uses conventional construction methods or materials that have adverse human and environmental health impacts.

-5 = The basic plan/concept has negative health impacts for neighbors or risks for workers during construction, even if not excessive compared to the norm, or otherwise limits mitigation measures.

50% = The design uses healthy materials and construction methods which reduce levels of noise or light pollution, congestion, pollution, dust and other nuisances that commonly affect worker and public health during construction.

100% = The design reduces construction impacts (as listed above) in the wider area as well as on site, so that neighbors do not experience beyond normal urban negative health impacts.

+5 = In addition to improving health conditions during construction, the project provides health support for workers with health problems. (A hospital, in itself, is not a health benefit here as this concerns construction).

+10 = The design proactively supports the health of workers (if not surrounding residents) during construction, by looking after worker health and wellbeing generally (eg. providing for social interaction and sense of community).

5.3 Exercise/lifestyle options

Unhealthy lifestyle choices and obesity cannot be controlled by built environment design alone. However, buildings can make more healthy food and exercise choices available and provide stress-reducing garden environments. Exercise facilities and green spaces are increasingly common in office buildings and hotels. Multifunctional design can make exercise opportunities affordable in office buildings or residential structures (eg. exercycles that double as desks).

-10 = The resulting development reinforces unhealthy lifestyle choices (eg. people must drive to access a gym, bike track or garden walk) or it is in a 'food desert' with little healthy produce choices, as is still often the case.

-5 = The basic plan/concept is not near parks or recreation and exercise facilities and does not provide for healthy food and exercise choices for its occupants, or limits mitigation measures.

50% = The design provides a healthy environment and is in a location that offers healthy lifestyle choices but does not actively support healthy living (eg. onsite recreational facilities).

100% = The design supports active living, social interaction, discourages car travel, and provides a low-stress work or living environment, including easy access to sport or exercise facilities or gardens.

+5 = In addition to facilities for exercise and community-building social activity, the development actively encourages healthy food choices (eg. provides community gardens or roof food farm).

+10 = The development not only encourages but demonstrates health improvements or increases in longevity as indicated by monitoring the vital signs of occupants (especially for office workers or residents in large developments).

5.4 Environmental justice

Urban design and development could counteract many negative consequences of poorly designed economic systems. Environmental justice can be increased by healthy public environments or developments that create healthy jobs, environmental amenities and access to nature for the disadvantaged. Offsetting that provides low-cost but healthy housing in poorer districts can have trickle-up socio-economic benefits that reduce overall public health costs.

-10 = The resulting development increases the reality and/or perception of disparities of wealth and/or injustice (eg. use of ostentatious materials, displays of conspicuous consumption, gated communities).

-5 = The basic plan/concept maintains disparities of wealth and/or injustice on the site or surrounding area, even if it does not adversely affect public health or environmental equity directly, or limits mitigation measures.

50% = The development design provides or contributes to affordable housing and avoids indirect segregation by class, income level, race or other forms of discrimination - now recognized to harm public health and wellbeing.

100% = The development also contributes to environmental justice by increasing social equity in the wider area through tangible measures such as employing disadvantaged people in building construction, maintenance or operation.

+5 = Among the development's primary functions is to increase social equity and environmental justice in the region, such as incorporating affordable housing units (designed to complement the design and environmental quality).

+10 = In addition, the project makes measurable improvements to environmental justice and life quality in another disadvantaged area via net-positive offsetting.

5.5 Materials sourcing

Once the health benefits to development users/neighbors are optimized, offsetting schemes could for provide health improvements in developing nations where materials are often sourced from. It should be guaranteed that building products do not embody toxic wastes or slavery. Benefits to recipient communities should be equitable as well as be sustainable. For example, pumping clean water for some villagers should not deplete local aquafers for others.

-10 = The resulting development contributes to poor health anywhere by, for example, using building products that involve child labor, deplete resources in disadvantaged regions, exploit migrant laborers or underpay for resources.

-5 = The materials sourcing for the basic plan/concept may exploit impoverished people, pollute their environment or extract local resources that they themselves need, or there is inadequate compensation (underpricing) of resources.

50% = The project supports materials extraction and sourcing practices that do not exploit or discriminate against workers, impose safety hazards or environmental risks, or otherwise affect their health adversely.

100% = In addition, building components have certifiable origins, and the health and safety of any disadvantaged workers involved in resource extraction, or communities from which project materials are sourced, is ensured.

+5 = The development guarantees ethical sourcing of materials and safe working conditions, and the well-being of disadvantaged workers that are involved in resource extraction and their communities is improved.

+10 = In addition to the above, the development makes a significant contribution to social equity and environmental justice in a socio-economically disadvantaged region via net-positive offsetting (eg. habitat for humanity).

5.6 Resorts and ecotourism

Environmental remediation projects in priority regions and eco-tourist programs can include activities such as remediating damaged environments, restoring local water quality, monitoring biodiversity or conducting environmental education or research programs. These can deliver health benefits to participants as well as to the host communities. Eco-tourist programs should ideally have a lower ecological footprint than if the participants stayed home.

-10 = The resulting development damages environmental health, especially in undeveloped areas. Resorts in disadvantaged regions tend to be profitable due to environmental beauty, lower labor costs and pollution standards.

-5 = The basic plan/concept for the development is not unusually destructive, but has adverse impacts on a natural area, increases travel impacts or has other adverse socio-cultural impacts caused by tourism on the host community.

50% = The development is sensitive to its socio-ecological and economic context and does not disrupt the local culture, especially where the traditional culture and natural environments are still intact.

100% = The development also compensates (physically) for any impacts due to travel and any (otherwise unavoidable) impacts on the local community, culture or environment through its associated eco-tourism activities.

+5 = The development and eco-tourism activities increase the health and wellbeing of the local community, reduce poverty in the area, support its positive traditional customs and increase environmental conservation.

+10 = The development contributes to eco-positive community development (or elsewhere if appropriate) and the eco-tourism activities have a positive ecological footprint.

6. Satellite STARfish for Planning/spatial relationships (eg. ethics, equity and environmental space)

See Tier 1 for general description.

6.1 Local deficits addressed

The allowable 'environmental space' or resource consumption per capita or floor area (below) should be determined by planners in order to identify socio-ecological needs/deficits in the area that positive development could address (as often done for economic factors). Here, planning actions that support sustainability policies are credited where they benefit disadvantaged populations (eg. locating near transport or shopping hubs only benefits stakeholders).

-10 = The resulting development and/or site plan greatly increases local or regional socio-ecological needs/deficits, creates inequities or causes planning related risks for residents (eg. being in a bushfire or liquefaction prone area).

-5 = The basic plan/concept exacerbates socio-ecological needs/deficits or the siting, design or project functions conflict with accepted sustainable planning policies (eg. New Urban Agenda), or it limits mitigation measures.

50% = The development and site planning support local and regional sustainable policies and priorities that aim to address socio-ecological deficits and improve life quality (ie. not just efficiency).

100% = The development proactively also improves socio-ecological conditions and equity, or environmental justice in the urban area (eg. providing access to basic needs).

+5 = The development plan is based on a socio-ecological needs analysis as outlined in SMT analyses in chapters 7-8 in *Net-Positive Design*.

+10 = The development plan addresses each of the relevant social and ecological SMT analyses. These could be shown in a Satellite STARfish (forthcoming).

6.2 Appropriate urban infill

Infill urban renewal projects often make cities more compact and efficient and stimulate the local economy. However, densification often also causes ecological damage, gentrification, social dislocation, congestion, pollution, urban overheating and so on. Hence, infill development must also improve the urban environment (eg. provide public open space, views, sunlight, environmental amenities, access to parks or riverfronts, increased natural security and so on).

-10 = The development greatly increases the impacts of undesirable forms of infill development (eg. densification, congestion and overcrowding, social dislocation, security or lack of equity in access to basic needs).

-5 = The basic plan/concept does not disadvantage occupants but reduces amenities for people in the surrounding area by reducing public open space, environmental amenities, and adaptability to future change.

50% = The infill development uses an urban site identified by planners as more suitable for infill development than as open space, nature reserves or other public uses.

100% = In addition, the infill development revitalizes the area without contributing to the collateral damage of densification (as listed above) and provides benefits and amenities.

+5 = The infill development increases the environmental and social equity and amenities not just onsite but in the surrounding urban area to more than offset the loss of space and its potential multiple benefits.

+10 = The project actively counteracts the impacts of past insensitive urban densification in the wider urban area, which might involve net-positive offsetting actions (eg. public open space and access to nature).

6.3 Appropriate mixed uses

Most land uses are single function and based on private economic analyses, without considering community and ecological needs. Mixed use development has long been recognized for its potential to increase spatial efficiency, improve socio-economic impacts and revitalize urban areas. In collaboration with planning agencies, appropriate mixed uses can be determined (eg. public open space, social facilities, public amenities) that also enhance the private uses.

-10 = The resulting development is a single-use function that limits social activity or environmental amenity in the urban area and therefore impedes its vitality, security, diversity and other public benefits of urban spaces and activities.

-5 = The basic plan/concept is a single-use function, but the site is near mixed-use development, or mixed-uses would conflict with the project function and not improve local socio-economic vitality.

50% = The development design includes private or/public mixed-uses that contribute to economic resilience and social interaction in the area or produces other added benefits.

100% = The mixed-uses incorporated in the development also increase urban vitality by contributing to cultural richness and local character or help to create a unique sense of place and identity.

+5 = In addition, the development includes a mix of community benefits such as accessible open space, community meeting rooms and facilities, exercise and social spaces, or increase social diversity and interaction.

+10 = The mixed-use development not only includes public social benefits but a mix of green spaces (including ecological functions which count in the Ecological/biodiversity STARfish).

6.4 Developer contributions

Developer contributions/exactions have often been used by planners to offset the public infrastructure costs of private development, but these seldom cover the full public costs. They are usually de facto subsidies. Further, they do not compensate for resource consumption or for withdrawing land/resources from future public use. Conversely, if contributions meet public needs and save the public money, they could be compensated for by the community.

-10 = The resulting development increases public infrastructure costs (eg. the construction of roads, sewerage and electricity to the site which were previously off these ‘grids’) which are not offset, or its infrastructure is not sustainable.

-5 = The basic plan/concept imposes minor public infrastructure costs (beyond those indirectly paid for through council fees and property taxes), its infrastructure is as unsustainable as the norm, or it limits mitigation measures.

50% = Development exactions/contributions cover most of the direct and indirect public infrastructure costs of the development and the project planning and infrastructure is consistent with core sustainable planning objectives.

100% = The development is largely resource autonomous (collects its own energy and water and treats its own sewage on the site, etc.) but does not compensate for the land/resources it withdraws from the public domain.

+5 = The development contributes to sustainable planning objectives and compensates for the public costs of the development, such as any reduction in ecological carrying capacity, land, water flows, or ecosystem services.

+10 = In addition, the development compensates physically for the reduction of future options due to land consumption (eg. loss of forest, mineral or agricultural options or eco-service).

6.5 Multifunctional emergency facilities

The disabled, elderly, poor and otherwise less-mobile people may need accessible emergency community facilities, such as flood-proof structures with secure attic or roof spaces, storm shelters for cyclones, or fire-proof bush/forest bunkers - depending on the region. Integrated accessible (multifunctional) mini shelters would create safe places for evacuees in instances of civil strife, earthquake, tornadoes, floods, food system breakdowns or extreme weather events.

-10 = The resulting development creates potential risks or emergencies (eg. being sited in an earthquake, fire or flood zone or where extreme weather is possible in the future) without any provision for the subsequent conditions.

-5 = The basic plan/concept does not create added risks, but it is in an area where access to basic needs may be cut off after an environmental, technological, economic or civil crisis, or it limits mitigation measures.

50% = The development is designed to provide for security after crises such as pandemics, breakdowns in food, energy or other delivery systems or lack of access/transport to safe places.

100% = The development also provides for basic needs onsite and ensures supplies for the residents/employees in case of climatic, health or civil emergencies and trains the occupants or workers for emergency situations.

+5 = In addition, the development provides shelter with basic needs for the wider community (eg. autonomous food, water and electricity) adequate to cover a serious climatic, geological, environmental, civil calamity or pandemic.

+10 = The development also provides future proofing measures in a disadvantaged region that is more vulnerable to extreme events (due to poverty or other circumstance) via net-positive offsetting.

6.6 Environmental space (reduced consumption)

Development should reduce the average 'environmental space' (equitable resource allocation) in the region. This means limiting consumption to the region's per capita renewable resources (or average material flows in case of finite resources) per person or unit of floor area - as determined by planning authorities. Resource efficiency means little if resource consumption per capita or per building is increasing, especially without a reduction in population.

-10 = The resulting development greatly exceeds its environmental space allocation with respect to several finite and renewable resources (eg. iron ore, water, timber).

-5 = The basic plan/concept exceeds its environmental space allocation in some areas, but not more than a typical building of the same kind, and/or it limits mitigation measures.

50% = The development only exceeds its environmental space allocation in resources that are not yet scarce, or there are mitigating circumstances (eg. it is for a public facility as opposed to a commercial, residential or office building).

100% = The development meets its environmental space allocation per person or per floor area and/or sponsors an increase of renewable materials (eg. bamboo, mycelium, timber).

+5 = The development is under its environmental space allocation with regard to scarce materials (which requires different construction materials/products) and sponsors an increase in renewable materials.

+10 = In addition, the development provides net-positive offsetting (eg. the ecological retrofitting of another building) to reduce the overall environmental space of the town or region.

7. Satellite STARfish for Socio-cultural/community gains (eg. cultural heritage and community building)

See Tier 1 for general description.

7.1 Local history and heritage (eg. heritage preservation, historic landscapes, local traditions)

Any new project, regardless of its scale or function, should respect local culture and traditions, as well as enhance its tangible and intangible heritage. The design and process should respect existing populations, especially indigenous people and their cultures which are often still vulnerable or invisible. This can be partly achieved by incorporating local know-how and materials and including local inhabitants in carrying out research concerning the historical and cultural value of a place or landscape.

-10 = The project, for practical purposes, destroys historical buildings or places, cultural or natural landscapes, or local indigenous cultures.

-5 = The project diminishes the historical values of a place or landscape, or conflicts with the local identity, vernacular traditions, or cultural heritage of the region.

50% = The project respects local traditions and heritage and uses local skills, knowledge, artistry and labour where possible.

100% = In addition, the project actively supports some local traditions and enhances local identity and conditions in the area, based on local knowledge and documented research.

+5 = The project has a clear strategy for implementing the research findings and plan for the preservation and enhancement of the cultural heritage of the city or region and includes an educational component.

+10 = In addition, the project plays a central role in the preservation of the collective memory. It contributes a substantial public gain by maintaining, caring for, and educating future generations about the accumulated knowledge that the site, city or region represents.

7.2 Citizen participation (eg. surveys, meetings, calls to action, public hearings, design workshops)

Citizen participation is a fundamental pillar in the construction of a fair and democratic system or built environment. Involving people in decision-making on issues that concern their community and wellbeing is imperative. There are several tools that facilitate this, from surveys, public hearings and voting to participatory design processes that include real opportunities for critique before basic decisions are made. The transparency of these processes is essential to ensure accountability.

-10 = The project ignores the needs of local citizens and community representatives and does not provide for meaningful local participation in the design of the development.

-5 = The project undertakes some research or surveys regarding the preferences of the population but does not meaningfully incorporate the findings in the final design or excludes a relevant sub-culture.

50% = The project provides some mechanism of community participation in the design or development process, and materially responds to some of the views expressed.

100% = This project respects the community's needs and preferences by conducting research and a citizen participation process from preliminary design to long-term maintenance issues.

+5 = As well as providing for genuine community engagement in design and development, it establishes a 'conflict resolution by design' process that can improve social welfare in the future.

+10 = The project also creates a permanent space and social platform for activities that inculcates social responsibility, the democratisation of public spaces, and community-based socio-cultural institutions.

7.3 Social interaction and engagement (eg. multifunctional spaces, community engagement, easy access to existing health and educational facilities)

Public life is the essence of cities. Therefore, public spaces and buildings should proactively facilitate social interaction among the city's diverse population to overcome past economic and social segregation and the isolation of some of its members. A city with a social life is a more diverse, safe and innovative city. Adequate space should be provided where feasible to enable social engagement and contribute to urban vitality. Flexible, multifunctional and human scale spaces, and pedestrian-friendly areas can help to achieve these goals.

-10 = The project removes space from the public domain, does not allow or provide space for meaningful social interaction, or creates an increased unmet need for public space (eg. through increased population density).

-5 = The project provides some shared spaces to accommodate its occupant's social needs, but not those of the general public, or the design does not actively support social interaction.

50% = The project offers some public space or infrastructure that benefits the local community, but it is insufficient to meet its share of the space needed for social interaction in the vicinity.

100% = The project offers spaces or infrastructure for social interaction that takes into account local social deficits and increases opportunities for community-building activities in the vicinity.

+5 = The project creates a safe place or places that encourages public social gatherings and provides appropriate infrastructure and resources to generate recreational, cultural, or artistic activities in the wider community, on or off site.

+10 = In addition, the project has the potential to become a social centre that provides innovative activities and spaces that develop and strengthen ties between citizens and reinforce the social fabric of the neighbourhood.

7.4 Accessibility and usability (eg. safe routes and conditions, amenities for the disabled, avoidance of barriers)

A place that is difficult to access or unsafe to use can effectively exclude some people and create sometimes invisible social barriers. Each new project should be fully integrated into the urban fabric through its design and create a human scale to create a sense of belonging. Where possible, its siting should consider proximity to educational, health and other public facilities. As well as avoiding any risk or inconvenience to the disabled or others, it should be accessible, well-signposted, well-lit and have well-maintained routes and spaces.

-10 = The project presents risks to the health or wellbeing of the users or general public, and especially marginalized groups such as indigenous, elderly, disabled or homeless people.

- 5 = The project does not provide for universal accessibility (eg. is inconvenient for blind people or wheelchair users) or does not accommodate the special needs of different potential visitors.

50% = The project meets minimum standards for universal accessibility but may not be accessible to all potential visitors, such as lacking clear signage for hearing impaired or blind people.

100% = The project meets the physical requirements of all potential users and complies with best-practice accessibility standards.

+5 = The project also creates accessible spaces and infrastructure that are clearly defined, safe and convenient for all users or visitors, and support their physical and mental wellbeing.

+10 = In addition to being convenient for people of all abilities (eg. provide braille), the project is designed to actively promote positive interactions between different groups of people, such as disabled or otherwise marginalized people.

7.5 Intergenerational users (eg. all day use, proximity to complementary facilities, daycare needs, green spaces)

Spaces and buildings often unintentionally exclude elderly users or children. Projects that accommodate all age groups in multifunctional spaces can reinforce the community's social fabric, as well as create new opportunities and experiences. Senior citizens are often marginalized when they could add value in most social contexts. Many projects could involve the elderly, such as assisting children in daycare centres, babysitting in rooms open in the evening, serving at information desks, or guiding people through historic buildings or precincts, etc.

-10 = The public areas of the project create psychological or physical barriers that unnecessarily excludes potential diverse users, such as children or elderly.

-5 = The public areas of the project have the potential to exclude particular age groups where there are no nearby facilities that provide for intergenerational uses.

50% = The public areas of the project do not discriminate or impede access or use by any user group based on age, but do not provide spaces that are inviting for them.

100% = The public areas of the project are designed to create social spaces that are inviting and address the complexity and heterogeneity of visitors from every age group.

+5 = The project actively encourages intergenerational social engagement on or offsite, such as multifunctional 'green spaces', play gardens or daycare facilities to include children and the elderly as well as building users.

+10 = In addition, the project provides such spaces within the development and creates a place of mutual learning and the exchange of experiences between different generations, regardless of their class origins, race, gender, or culture.

7.6 Sense of place, identity, and belonging (eg. artistic platforms, educational facilities, culture centres)

Just as cities are constantly evolving, their community's expressions of local identity also evolve. Development projects should promote diversity through autochthonic cultural expressions that emerge in a tolerant, respectful, and creative environment. The evolution of new and diverse community identities can enrich a democratic, socially innovative, and empathetic society. Conversely, tourist ventures, chain stores or corporate buildings that promote the standardization or commercialization of experiences and places can vitiate that sense of belonging.

-10 = The public areas of the project or its social spaces offend or effectively censor local cultural expression, violate the sense of belonging or deny the existence of an ethnicity, religion, gender, age, or other social group.

-5 = The public areas of the project create a barrier to cultural expression or the expression of alternative (positive) community values, such as a tourist attraction that conflicts with its cultural context.

50% = The project provides a public space or spaces that enable cultural expression and make it visible in a way that enriches cultural diversity, such as a public facility that complements the local culture.

100% = In addition, the project creates a public space or spaces that support cross-cultural exchange and learning, including learning about the socio-ecological evolution of the site or region.

+5 = The project also provides a public space or spaces that have the potential to be a generator of new local artistic expression for future generations or that contribute to the local sense of identity and place.

+10 = In addition, the public space or spaces created by the project has the potential to create a new urban landmark or a social platform that supports the representation and dissemination of positive cultural values.

3. Example of a 3rd tier set of benchmarks (Ecology/ biodiversity)

This Satellite is extended into 'third tier' Satellite STARfish in the Complex Version provided in the computer app. It demonstrates how design ideas and criteria can be expanded (in a fractal pattern) to expose more design opportunities and synergies. The other 5 STARfish are only extended out into the second tier. The user can add more impact factors (legs on STARfish) or add new Satellite STARfish.

These Tier 3 criteria provide opportunities to improve the development and the score. Users cannot award themselves a neutral impact for doing nothing in a category that has relevance to their project. However, they suggest design synergies where multifunctional design actions affect two or more impact categories.

The following outline lists the Tier 3 impact categories in the Ecological/biodiversity STARfish (shown in the Complex Version in the computer app.). To see the negative, restorative/regenerative and positive/net-

positive) benchmarks for each in one place, open the app, go to settings, select ‘Complex Version’, go to the data section and press ‘Report’.

3.1 Outline of 3rd tier ecology/biodiversity benchmarks

1.1 Eco-restoration of sites

1.1.1 Rehabilitation/revegetation
1.1.2 Disease control measures
1.1.3 Feral species elimination
1.1.4 Endangered species and pollinators
1.1.5 Improved soil health (composting)
1.1.6 Erosion, runoff and compaction reduction

1.2 Building-integrated eco-services and amenities

1.2.1 Passive solar systems
1.2.2 UV radiation levels and heat stress
1.2.3 Heat island effect
1.2.4 Decibel levels
1.2.5 Light pollution from the site
1.2.6 Glare and reflected heat

1.3 Ecological space and functions

1.3.1 Ecosystem enclaves and biodiversity incubators
1.3.2 Nature corridors and steppingstones
1.3.3 Volume of ecological space
1.3.4 Dedicated nesting sites and habitats
1.3.5 Wilderness restitution

1.4 Environmental threat/risk reduction

1.4.1 Flood prevention and diversion
1.4.2 Urban fire prevention systems
1.4.3 Earthquake, landslide, sinkhole protection
1.4.4 Tornado, storms and lightning protection
1.4.5 Drought reduction

1.5 Air quality (environmental)

1.5.1 Urban forests and parks
1.5.2 Green roofs
1.5.3 Vertical landscaping
1.5.4 Urban air circulation
1.5.5 Pollution absorption materials

1.6 Water quality (biological)

1.6.1 Integrated water storage
1.6.2 Natural purification/filtration waterscapes
1.6.3 Eco-productive aquatic environments
1.6.4 Monitoring and management systems
1.6.5 Embodied water reduction

3.2 Description of 3rd tier Ecology/biodiversity benchmarks

1.1 Eco-restoration of sites

See Tier 2 benchmarks for description.

1.1.1 Rehabilitation/revegetation

Most homes and buildings are still not landscaped in ways the benefit native species and biodiversity. Woodlands are still being converted into suburban-style lawns and ‘foreign’ plants, some of which become invasive species. Even where green open space remains, the roads and buildings continue to degrade the ecology. Some schemes give credits for ‘not using’ greenfield or ecologically sensitive sites so uncertified projects use them.

-10 = The resulting development will destroy native ecosystems, vegetation or nature on the site or surrounds, and/or introduce invasive plants, insects or other feral species.

-5 = The develop basic plan/concept degrades the site or the new landscaping is incompatible with native ecosystems, amounting to more ecosystem damage or depletion than under pre-construction conditions.

50% = The site and spaces surrounding the new building are remediated and landscaped in ways that support regionally appropriate vegetation, habitats and native species.

100% = The land coverage of the building is also compensated for (eg. via green roofs and layered landscaping) and there is little offsite ecological damage due to production processes, materials extraction and so forth.

+5 = The total 'land footprint' or ground cover everywhere (eg. including forest felling and access roads) is compensated for or restored with appropriate ecosystems and habitats.

+10 = The new ecological space and restoration actions, combined with net-positive offsetting as required, compensate for the project's full ecological footprint (where measurable) or exceeds the building floor area (rule of thumb).

1.1.2 Disease control measures

In many areas, whole forest ecosystems have been slowly dying off. This dieback is where the peripheral parts of trees are killed by things such as pathogens, drought, changes in water table or drainage, parasites or acid rain. Stressed trees are less resistant to borers or insects, especially in cities. Urban areas can provide native shrubs to support a diverse range of insect-eating birds, mammals, lizards, parasitic wasps and so on, to create long-term natural pest control.

-10 = The resulting development and/or landscaping greatly increases the risks of disease (eg. monocultural planting schemes, ecological disturbances, invasive plant species).

-5 = The basic plan/concept increases the risk of existing or potential diseases on site or in the surrounding area (eg. Dutch Elm disease, dieback, animal population imbalances).

50% = The site plan incorporates strategies to reduce foreseeable risks of disease and to increase ecosystem resilience, as certified by a horticulturalist or ecologist.

100% = As well as site planning and landscaping that minimizes the risks of disease, a management/maintenance plan is instituted to maintain ecosystem health and resilience over time.

+5 = The site planning, landscaping and design features also work to recreate native ecosystems that are self-managing and resistant to threats and diseases.

+10 = In addition, the development undertakes net-positive offsetting activities to improve disease resistance and resilience in other areas more vulnerable to disease.

1.1.3 Feral species elimination

There is little advantage in providing building-integrated ecosystems if feral species then corner the native species in these isolated spaces (eg. a tunnel for animals to cross a freeway that attracts feral cats). If not properly designed, nature corridors may also create habitats and escape routes more suited for feral species than natives. In collaboration with building neighbors and councils, invasive plant and animal species should be proactively designed out.

-10 = The resulting development or landscaping effectively encourages the occupancy of the site by invasive species (eg. providing easy access to the nesting sites of native species by predators).

-5 = The basic plan/concept does not support invasive species but does not provide barriers or design features that would discourage their activities.

50% = The site planning or management plan reduces threats from non-native species that might exist in the wider region (including seeds from invasive plant species).

100% = The design of the structures and landscape actively supports native plant and animals (eg. habitats tailored for particular threatened species) and discourages invasive species.

+5 = An invasive species and a management plan is also implemented to support and monitor threatened native species on the site and/or surrounding area.

+10 = In addition, the project sponsors or contributes to a feral species control or native species protection program at an urban level or where problems are more serious via net-positive offsetting.

1.1.4 Endangered species and pollinators

While cities can provide ecological space and eco-services, ecological expertise is needed to determine what species should be supported in any given area. Increasing ecological carrying capacity, habitats and nature corridors are essential steps, but not enough. Structures and spaces should be designed to ensure that habitats, refuges and nesting sites will increase numbers of threatened species and pollinators, to enable the bioregion to be repopulated.

-10 = The resulting development threatens indigenous and endangered species or eliminates their support systems such as food sources, access to mates for genetic diversity, nesting sites, escape routes and so on.

-5 = The basic plan/concept lacks support systems for indigenous or threatened species or permits species that undermine the food chain (eg. wasps that attack pollinators).

50% = The development provides habitats and food chains designed to attract or support endangered or threatened species (eg. plants that attract certain insects, beehives on the roof).

100% = The design also provides substantial and ecologically appropriate habitats with food chains that are equivalent to those that existed onsite before settlement.

+5 = Positive actions are taken to at least compensate for biodiversity losses during materials procurement for the project as well as site development, and to reintroduce the most appropriate indigenous or threatened species.

+10 = In addition, net-positive actions are taken to protect and/or reintroduce indigenous species and pollinators elsewhere, enough to compensate for the project’s portion of habitat losses due to urbanization in general.

1.1.5 Soil health and biota (composting)

Large urban developments can support vertical composting systems (using aerobic fermentation equipment which avoids odors) for treating urban organic waste and increasing soil fertility. They can produce high-quality fertilizer in a short period of time and avoid transporting urban organic waste to rural garbage tips. In smaller developments, onsite composting containers can provide fertilizer for food or flower gardens in atriums, roofs, facades, yards or balconies.

-10 = The resulting development destroys the topsoil, or the soil is already seriously degraded, and organic waste produced by the development is taken to the tip, burnt or otherwise disposed of, instead of composting.

-5 = The basic plan/concept depletes or degrades the soil, or the development covers much of a site without first removing and remediating the topsoil for eco-productive uses.

50% = The development provides composting systems to assist occupants in composting organic waste for purposes of improving soil health in onsite gardens or landscaping or nearby urban farms.

100% = All organic waste is collected, treated and used productively at the project appropriate scale to improve soil health for food production or land remediation.

+5 = In additions, enough soil is rehabilitated through onsite composting or soil rehabilitation measures to support new (above-ground) native gardens in or around the building on balconies, atriums, green roofs and the like.

+10 = The project compensates for its portion of past losses of fertility in the urban area via net-positive offsetting (eg. providing or contributing to vertical urban composters or remediating land elsewhere).

1.1.6 Erosion, runoff and compaction reduction

Soil compaction (loss of pores) is common in urban areas, and can reduce soil aeration, drainage, nutrient cycling and plant growth. Erosion decreases soil quality and increases phosphorous and nitrogen in the water. Runoff from urban development and compacted soil or storm-water overflow pollutes downstream waterways. There are many ways of reducing these impacts in urban areas through building form and landscaping onsite or at a larger urban scale.

-10 = The resulting development will result in excessive soil erosion, compaction, runoff or other forms of land degradation caused by a new construction on a greenfield site or ecologically sensitive site.

-5 = The basic plan/concept contributes little to compaction, runoff, erosion, or uses non-permeable paving but the site is already damaged (eg. covered with concrete or a building).

50% = The building form and siting reduces erosion and compaction, and land management practices are adopted to prevent these conditions or improve them where they already exist.

100% = In addition, the building form and design (eg. façades, roofs, landscapes) prevent runoff and store excess water for landscape irrigation during dryer periods.

+5 = The building form, siting and footings help restore pre-urban environmental flows in the area (eg. constructed above or below ground) such as exposing and restoring a creek that previously crossed the site.

+10 = The development also contributes to offsite land remediation that treats existing erosion, runoff and/or compaction problems elsewhere via net-positive offsetting.

1.2 Building-integrated eco-services and amenities

See Tier 2 benchmarks for description.

1.2.1 Passive solar systems

Passive solar design is a very efficient way to avoid external sources of energy that harm ecosystems (eg. coal). It also reduces upstream ecological damage since building materials are sourced locally where possible. In contrast, mechanical equipment needs regular maintenance and replacement, and usually entails more embodied energy which compounds during mining, manufacturing and transport processes and, in turn, affects ecosystems and biodiversity.

-10 = The resulting development relies on mechanical heating, ventilating and cooling (HVAC) systems and added insulation materials, and the project located in an area with temperature extremes.

-5 = Due to location, the basic plan/concept does not need excess mechanical equipment, but it still requires external sources of energy (not integrated passive solar design or natural systems) or limits mitigation measures.

50% = The design employs some minor passive strategies such as cross ventilation to reduce its HVAC demands, but does not provide its own basic HVAC needs. (Extreme climates may be given some dispensation.)

100% = The design provides all its basic HVAC needs (on a yearly average) through passive solar design. This is the conventional aim of sustainable thermal design.

+5 = The passive solar systems are integral to the basic building design and provide adequate storage for self-sufficient HVAC year-round. Extra office equipment may be supplied by integrated renewable energy systems.

+10 = In addition, the project supplies heat or cooling to an adjacent building or undertakes a passive solar retrofit of a building elsewhere to reduce urban energy consumption, via net-positive offsetting.

1.2.2 UV radiation levels and heat stress

UV radiation causes eye damage and skin cancer. Heat stress and dehydration can lead to death or stroke. While these are largely seen as human health issues, they also affect urban ecosystems and biodiversity. For instance, high radiation levels can damage plants directly, and cause soil to lose nutrients and become compact, which reduces plant growth. UV radiation can be greatly reduced by design (eg. building-integrated shading, screening and vegetation).

-10 = The resulting development will expose visitors and occupants to excessive ultraviolet radiation or heat stress due to the local climate and building form or design.

-5 = The basic plan/concept has outdoor open spaces (eg. accessible roof areas or plazas or outdoor social areas) that create exposure to ultraviolet radiation and heat stress and/or make mitigation difficult.

50% = The design provides some shaded outdoor areas to block excess UV radiation and heat that may be occupied by people, plants or animals.

100% = The shading options provided by the design have controls for limiting the exposure of open spaces to UV radiation and heat stress in different seasons.

+5 = Versatile screening elements (automatically) cool the environment by shading or generating breezes (eg. using the Venturi effect) during changing temperature and sunlight conditions (diurnal and seasonal).

+10 = Net-positive offsetting is used to help reduce heat stress or UV radiation in another urban area, especially where micro-climatic conditions are excessive.

1.2.3 Heat island effect

The urban heat island (UHI) effect is in part caused by hard surfaces such as roads and building materials that store heat. Cities are now often several degrees higher than their surrounding areas. This has led to more energy and mechanical equipment being used for building air conditioning. Further, it correlates with growing air pollution and ground level ozone levels. It also increases the temperature of storm-water runoff which damages downstream aquatic ecosystems.

-10 = The resulting development, due to building materials and forms, greatly increases the urban heat island (UHI) effect beyond the norm for similar buildings.

-5 = The basic plan/concept increases the UHI effect on site or in the surrounding urban area to a degree typical of similar buildings, and/or makes mitigation difficult (eg. requires concrete).

50% = The development reduces the usual addition to the UHI of similar buildings, due to the selection of materials, water features, shading elements, building forms and so on.

100% = The development greatly reduces heat retention on site so that the UHI is reduced compared to pre-construction conditions.

+5 = The development lowers the UHI in the surrounding urban area as well using, for example, water walls, breeze generation, outdoor solar fans, extensive greenery or sun-responsive shading.

+10 = In addition, net-positive offsetting is undertaken in a disadvantaged region or a part of the urban area that has an excessive UHI problem.

1.2.4 Decibel levels

Many human health problems are caused or exacerbated by noise pollution, such as illnesses associated with stress. Research has now shown that high noise levels also harm animals as well. Since animals such as birds, fish, bugs and frogs use sound to communicate with their own species for finding mates, warning about predators or keeping track of their young, as well as finding food, urban noise levels are contributing to biodiversity and species losses.

-10 = The resulting development causes noise levels that, in combination with other background urban noise, are damaging to humans and other animals as noise causes stress (not just hearing damage).

-5 = The basic plan/concept contributes to urban noise levels, but the decibels produced by the project site are not deemed unhealthy for people or animals (under 85 decibels).

50% = Environmental noise levels are below 70 decibels (considered safe so far), but during the development construction phase the noise levels are higher.

100% = The environmental noise levels during construction are within safe decibel levels, onsite as well as beyond the site boundaries.

+5 = Not only are noise levels during construction safe but, after construction is completed, environmental noise levels are lower on site than before construction.

+10 = Noise levels are below pre-urban conditions or net-positive offsetting actions are undertaken elsewhere (eg. noise and pollution absorbing materials are added to street or facades where urban noise is excessive).

1.2.5 Light pollution from the site

Light pollution at night (sky-glow) is disrupting the circadian rhythms of animals as well as humans. It adversely affects bats, migratory birds, preventing sea turtles from lay eggs, causing stress and so on. Such light is often costly and/or unnecessary for safety purposes. For instance, light from advertising billboards or security lights that face upwards, office buildings that keep lights on all night and poorly designed streetlighting waste energy and money.

-10 = The resulting development emits more light to the sky at night than necessary for safety or other functional purposes or compared to similar buildings.

-5 = The basic plan/concept emits relatively little sky glow compared due to its uses, function or building type, or a lack of security lighting, or the design makes mitigation difficult.

50% = Design elements eliminate sky-glow other than required for security or pedestrian safety through, for example, multifunctional shading elements above windows or security lights directed downwards.

100% = The design eliminates most sky-glow produced by the development without sacrificing any security or pedestrian safety (ie. provides adequate visibility at night for building users or passersby).

+5 = The design elements eliminate night light from the development and light from street lighting on the streets around the building.

+10 = In addition, the development reduces night light elsewhere in the urban area, especially where it is excessive and/or most effective to do so, via net-positive offsetting.

1.2.6 Glare and reflected heat

Shiny building facades can cause glare and reflected heat. For instance, sunlight is often reflected off glass and metal facades, which causes discomfort to passersby. Drivers have been blinded by glare and hit pedestrians. Animals blinded by glare can end up as roadkill, sometimes killing drivers in the process. Shiny roof materials reflect some heat toward the sky which lower the building's heat gain, but adversely affect some taller buildings and even urban temperatures.

-10 = The resulting development has facade materials that create glare and/or reflected heat on the site and surrounds as is often the case with modernist urban buildings (eg. metallic or curtain wall facades).

-5 = The basic plan/concept has basic forms, design or materials that do not create excessive urban glare and reflected heat, but urban overheating is a priority issue in the urban area, or it limits mitigation measures.

50% = Glare and reflected heat are demonstrably reduced by design, building forms and materials selection compared to typical urban buildings (the UHI effect, in contrast, concerns heat absorbing materials).

100% = The building form, design elements and materials eliminate virtually all glare or reflected heat within or from the development, including signage, plazas, decorative features and so on.

+5 = Vegetation on façades or screens or other shading and light filtering measures are incorporated to soften the sunlight on sunny days and prevent glare from adjacent structures affecting the site.

+10 = In addition, the development provides net-positive offsetting actions where public open space elsewhere in the urban area is adversely affected by glare from existing buildings.

1.3 Ecological space and functions

See Tier 2 benchmarks for description.

1.3.1 Ecosystem enclaves and biodiversity incubators

Society might decide to resolve the climate crisis and restore the remaining natural environment, but it will be too late for most ecosystems and biodiversity (eg. 50% of the world's biodiversity was lost in 50 years and 30% of the world's reefs were lost in 30 years). Urban design could drive change rapidly. Space for mini ecosystems in developed areas and larger natural buffers in peri-urban areas can help to reseed and repopulate the bioregions in the future.

-10 = The resulting development destroys biodiversity and/or threatened species, adds invasive plant and animal species, or otherwise damages locally appropriate ecosystems over its lifecycle.

-5 = No ecosystems, biodiversity incubators or habitats currently exist or are preserved on the site, even if some parks or biodiversity refuges may exist near the site, and the design makes their addition difficult.

50% = Spaces for ecologically appropriate ecosystems are provided on the site or structures to compensate for some of the unavoidable ecological impacts of construction, and the development supports some locally threatened species.

100% = The locally threatened ecosystems and biodiversity supported by the development are equivalent to what existed onsite before construction. This is the current goal of design for urban biodiversity.

+5 = The new ecosystem enclaves or biodiversity incubators (in roofs, facades, green scaffolding, atriums or layered landscape structures, etc.) support bionetworks, and a biodiversity management plan is implemented.

+10 = In addition, the development supports more native ecosystems, species and bionetworks than originally existed on site or are provided for via net-positive offsetting in other priority areas (as determined by planners and ecologists).

1.3.2 Nature corridors and steppingstones

Nature corridors and steppingstones enable species to move to places where more food may be available, to escape predators, to find each other for romantic purposes, to ensure genetic diversity or increase prospects of withstanding disease. These elements can be designed in to provide the connectivity that enables animals move to greener pastures through green roofs, walls, onsite mini parks and so forth, or by contributing to well-distributed large urban parks.

-10 = The resulting development has forms, surfaces and design elements that block the vertical and/or horizontal movement of native species across the site, disrupt bionetworks, or enable access to habitats by feral predators.

-5 = Some corridors or steppingstones exist in the vicinity, but the basic plan/concept disrupts these and does not restrain access by feral predators into these natural areas.

50% = The development provides new nature corridors and/or steppingstones which compensates for any barriers to animal mobility created by the development, nearby grey infrastructure or surrounding buildings.

100% = These corridors and steppingstones are designed to favor threatened species to provide for the equivalent mobility, refuges and escape routes that existed in pre-urban times.

+5 = More vertical and/or horizontal nature corridors and/or steppingstones are provided than existed before settlement, and these are designed to deter any known feral predators.

+10 = In addition, the development contributes to an offsite bionetwork formed by parks, nature reserves or urban ecosystems and to urban feral species reduction programs via net-positive offsetting.

1.3.3 Volume of ecological space

Ecological space refers to eco-productive spaces in the built environment that provide ecological functions and serve as a safety factor for biodiversity protection. For example, many important medicinal plants are becoming extinct globally, due to climate change, war and ignorance. They could be preserved in urban buildings in lieu of other plants that are mainly decorative. These spaces can simultaneously support building and environmental services to offset costs.

-10 = The resulting development eliminates ecological space that supported natural systems or formed eco-productive parts of urban bionetworks and/or creates no significant new ecological space.

-5 = The basic plan/concept reduces ecological space or replaces it with landscapes that are largely decorative (not eco-productive) and does not contribute to the preservation of local ecosystems or makes their inclusion difficult.

50% = Ecological spaces are provided in the building(s) that make a tangible contribution to environment protection and restoration (eg. breeding threatened butterflies, producing particular bugs for threatened birds).

100% = The volume of ecological space provided equals the land area occupied by new development (eg. through green roofs, atriums, balconies and the like). This is a typical sustainable design goal.

+5 = The volume of new ecological space provided by the development equals the gross floor area of the building (where the ecological base cannot be assessed) **-** which may require several floors of native gardens.

+10 = In addition, productive ecological spaces are provided in environmentally deprived urban areas through net-positive offsetting (eg. using Green Scaffolding or green rooftops of other buildings).

1.3.4 Dedicated nesting sites and habitats

Even when land is reserved, attention must be paid to the spatial needs of unique animal species. With the reduction of terrestrial and aquatic environments, for example, many species lack adequate ranges to support viable populations. Similarly, with the replacement of old growth forests with plantations, nesting spaces in old trees and logs are greatly reduced. Therefore, it is necessary to provide nesting sites in peri-urban environments and new green spaces.

-10 = The resulting development destroys existing nesting sites and habitats onsite and/or reduces total habitats during resource extraction, production and construction (eg. strip mining).

-5 = The basic plan/concept destroys natural habitats or nesting sites over the lifecycle, but they are recoverable (eg. selective forestry can have far less impacts than plantation or old growth forestry).

50% = The development uses materials/products that do minimal environmental damage during resource extraction (eg. mycelium bricks) and provides new habitats for appropriate native or threatened species.

100% = The development preserves an area that is the ecologically equivalent of the site area of the new development. This is a common goal in sustainable design.

+5 = The development provides new habitats and nesting sites that can support an increased number of a threatened species in the bioregion and a biodiversity management program is implemented.

+10 = In addition, the development increases ecological carrying capacity beyond pre-urban conditions and increases the actual numbers of specific threatened species (onsite or offsite).

1.3.5 Wilderness restitution

Design and construction practices could reduce the amount of land necessary for producing building materials. While bio-based building products (using agri-waste) are relatively benign, they can take up extensive land area. However, there are also new materials, formed with mycelium, that require far less land to 'grow'. If land for construction materials is reduced (and vertical farming is increased) some farmland could eventually be returned to wilderness conservation.

-10 = The resulting development requires materials and production processes that damage a wilderness area (bush, forest, desert, etc.) in its supply chain or is sited in a pristine greenfield area.

-5 = The basic plan/concept is sited near a wilderness, ecologically valuable environment, a stream that feeds into these areas and so on, even if it does not damage such areas directly.

50% = The development is somewhat near a sensitive natural environment, but a buffer zone is preserved, created or contributed to that helps to preserve or expand the wilderness area in perpetuity.

100% = The development is not near a sensitive natural environment, yet the project contributes to a wilderness preservation program (eg. preserves a wilderness area or increases a buffer zone).

+5 = The equivalent amount of degraded land as that occupied by the development is restored to pristine wilderness conditions (not just reserved).

+10 = The development effectively converts the equivalent amount of land used throughout the whole lifecycle of the development (ie. ecological footprint) back to wilderness.

1.4 Environmental threat/risk reduction

See Tier 2 benchmarks for description.

1.4.1 Flood prevention and diversion

The land coverage of buildings and streets in dense cities, or lack of permeable surfaces in less dense areas, has often exacerbated flood damage by channeling and speeding up water flows in low lying urban areas. This not only results in property damage, but the flood water often runs off quickly, so its productive uses are lost. Runoff also causes pollution and other harm to ecosystems along riverbanks and downstream aquatic habitats that can take many years to recover.

-10 = The resulting development greatly increases the risk of flood or storm water damage, or it is in a 100-year flood zone since these are now often flooding (and need to be re-evaluated due to climate change).

-5 = The basic plan/concept somewhat increases the likelihood of urban flooding or storm water events in the area, due to land coverage, paving, siting and so on, which exacerbate the impacts of floods.

50% = The design and siting of the development make the surrounding area more resistant and resilient to urban flooding events (eg. have swales, sumps or natural drainage systems).

100% = The development and surrounds are impervious to even unusual flooding events and the landscaping slows down storm water for use in eco-productive purposes before returning it to the environment.

+5 = The development removes the potential for flooding in the urban area by, for example, channeling surplus flows into a reservoir with a large-scale Living Machine for treatment (before returning to rivers).

+10 = The development is not subject to flooding but reduces or diverts potential flooding or storm water events in another region that is more prone to flooding problems via net-positive offsetting.

1.4.2 Urban fire prevention systems

Even if a property has fire prevention measures, little can be done to protect individual properties in the path of a large fire storm as often happens, for instance, in Eucalypt forests. Therefore, planners and property owners should have a plan for fire prevention and firefighting (or fleeing) suited to the specific context. For example, in rural and suburban areas, dams can supply large fire-fighting sprays, while integrated water tanks with external sprinklers may serve in cities.

-10 = The resulting development is in a fire-prone area and increases fire risks by, for instance, having building forms and landscape structures that could catch embers (despite meeting regulations).

-5 = The basic plan/concept is not in a fire-prone area and meets the local fire code but is not protected from fires that come from external sources, such as embers from bush fires or neighboring buildings.

50% = The development includes water storage tanks or ponds, and exterior (façade or landscape supported) sprinkling systems, plans for evacuation and firefighting supplies (eg. extinguishers) beyond code requirements.

100% = The development also provides backup systems independent of external pipes and power (eg. fire pumps), shelters or bunkers and fire escapes or slides protected from radiant heat.

+5 = Further, the development supports firefighting efforts in the wider region (eg. provides fire towers or a substantial pond from which helicopters can collect water as appropriate).

+10 = Actions are also undertaken to increase the firefighting potential in more high-risk areas, especially in urban or wilderness areas that are difficult to access by trucks on time, via net-positive offsetting.

1.4.3 Earthquake, landslide, sinkhole protection

Zoning provisions often discourage development where there may be landslides, flood plains, subsidence, sink holes, swamps or other geological issues. Nonetheless, many developments already exist in areas that are subject to such risks (eg. being built on reclaimed bay water or among steep hills). Buildings near oceans will be subject not only to sea level rise but groundwater contamination. Their demolition will increase material flows and ecological damage.

-10 = The resulting development (due to terraforming, building location, inappropriate foundations, etc.) increases the risk and impact of landslides, subsidence, dust storms or earthquakes damage and so on.

-5 = The basic plan/concept is not located in an area where earth movement is common, and meets code provisions, but the design is subject to events that happen anywhere (eg. earthquakes, sinkholes).

50% = The site planning and design reduces the potential impacts of earth movement, such as earthquakes, through appropriate engineering of foundations (eg. base isolation technology) or use of cables.

100% = The siting, design and/or landscaping also minimizes land coverage on the site (eg. using elevated construction or underground construction) as required to reduce earth disturbance (and maintain natural landscapes).

+5 = In addition to being safe from unusual geological events, the development provides some refuge in case the local community is subject to earthquakes, mudslides or avalanches or similar crises.

+10 = The project also supports a program of stabilizing homes in earthquake-prone and impoverished villages via net-positive offsetting (eg. bamboo Green Scaffolding, cables to reinforce mud brick huts).

1.4.4 Tornado, storm and lightning protection

Extreme weather events are not preventable without international climate action, but their impacts are greatly increased by poor design. Today, there are relatively few storm shelters or basements in suburban homes to offer even limited security in tornados. Further, flying building materials in severe storms can have environmental and human, as well as financial, costs. Retrofitting buildings and roofs for greater storm and lightning resistance is not excessively costly.

-10 = The resulting development is not resistant to strong winds, lightning, snow loads or other extreme weather events, beyond code, that are likely to occur in the region.

-5 = The location does not currently have extreme weather conditions, but the basic plan/concept does not offer protection from the effects of (future) climate change or limits mitigation measures.

50% = The development and landscape elements minimize damage from unusual weather events or their consequences (eg. securing trees or roofs with cables, establishing wind breaks, underground building or rooms where appropriate).

100% = Further, the development can withstand extreme '100 year' storm events, and the site is safe for passersby that might need temporary refuge or protection from sudden storms or flying materials.

+5 = The development is safe for neighbors as well as occupants and is designed to provide tornado shelters for the wider area (which can be combined with fire bunkers and other emergency functions).

+10 = In addition, the project supports the retrofitting of structures in disadvantaged regions for storm, lightning and tornado proofing via net-positive offsetting.

1.4.5 Drought reduction

In drought-prone regions, natural landscapes can be altered to increase water retention, as done in 'natural sequence farming'. While these techniques are more relevant to farmlands, the principles can be applied in peri-urban and suburban areas. In a changing climate, absorbing rainwater and avoiding runoff through ecologically sensitive modifications to the urban landscape will be necessary to avoid drought impact and maintain vegetation.

-10 = The resulting development, due to the existing topography or terraforming for the development (eg. cutting roads through hills) or other earthmoving, contributes to potential drought conditions in the region.

-5 = The location is not especially vulnerable to drought or runoff problems, but the basic plan/concept prevents rainwater from being stored or absorbed to reduce drought conditions or limits other mitigation measures.

50% = The site plan includes water-efficient landscaping and rainwater collection, treatment and storage features for drought proofing the site (eg. terracing, ponds, permeable paving, xeriscape gardens where suitable).

100% = The site plan and landscaping also include major multifunctional water features such as bioretention ponds that double as water treatment and storage.

+5 = The landscape water storage features contribute to the drought resistance of adjacent landscapes through the storage and use of rainwater for irrigation or for cooling sprays in dangerously hot weather.

+10 = In addition, the project contributes to the restoration of other drought-impacted landscapes via net-positive offsetting.

1.5 Air quality (environmental)

See Tier 2 benchmarks for description.

1.5.1 Urban forests and parks

In recent decades, the value of urban forests has become widely appreciated. They regenerate contaminated areas where industrial development once existed while providing land for recreation and leisure in the interim. They are a means of reducing urban air and water pollution as well. Generally, however, they are used for converting more land to development, rather than for providing permanent land for ecological and social regeneration in dense urban areas.

-10 = The resulting development reduces urban environmental quality (eg. degrades air or soil quality, reduces open space and access to nature, lacks environmental amenity) and there are no nearby urban forests or parks.

-5 = The basic plan/concept does not reduce urban environmental or air quality beyond the norm, but its occupants do not have access to urban forests or parks (and thus increase the need for such environmental resources).

50% = The contributions (financial or physical) to urban forests, parks, bushland and so on, are adequate to offset the deficiencies of the development in terms of air quality or environmental amenity.

100% = Onsite green public open space and contributions to public parks/forests is sufficient to offset any reduction of air quality or environmental amenity compared to pre-construction conditions.

+5 = The development contributions to urban forests, parks and green public open spaces result in the whole urban district have amply biophilic properties (ie. sense of wellbeing created by being in a natural environment).

+10 = The development also contributes to urban forests, parks and green public open spaces in an impoverished or polluted area in a disadvantaged urban area via net-positive offsetting.

1.5.2 Green roofs

Green roofs provide multiple benefits (eg. noise and thermal insulation, runoff reduction, roof longevity, biodiversity, social space). Here, green roofs can be credited for measurable air cleaning functions, while their other benefits may be recorded in other impact categories. However, the design elements should work together to purify urban air pollution beyond what most green roofs normally achieve, since they are often just grass or sedum (lacking vertical elements).

-10 = The resulting development has no green roof, or the green roof provides virtually no air cleaning or oxygen producing functions (eg. it is largely ornamental or does not have vertical elements to filter the air).

-5 = A proper green roof is not appropriate for the current use, or the overall air quality impacts in the region are small, but the basic design/concept unnecessarily limits the potential for a green roof in the future.

50% = The green roof absorbs the equivalent carbon dioxide emitted by the building's occupants as well as producing the equivalent oxygen that they use.

100% = In addition, the green roof is adequate to absorb the equivalent pollution emitted during building operation by, for instance, using vertical vegetated structures that work as filters.

+5 = The green roof compensates for or absorbs the equivalent air pollution and oxygen consumption caused during construction as well as during building operation.

+10 = The green roof improves overall urban air quality (air comes out cleaner when exiting the property) or, if not feasible, retrofits other building roofs (which their owners can fund or offset) via net-positive offsetting.

1.5.3 Vertical landscaping

Green Scaffolding is a 3D structure that can stand alone (ie. is not just part of a facade or roof), or it can form the structure of building walls. It contains spaces within the structure that provide multiple functions, such as supporting ecosystem services, vertical wetlands or passive solar elements. Free-standing scaffolding could create above-ground spaces (eg. over a mini park, sky bridge or parking lot) for biodiversity habitats, air and water filtration and so on.

-10 = The resulting development has blank walls or dead/sterile open spaces around it, which is a lost opportunity to increase air quality as well as provide a range of amenities and ecosystem or building services.

-5 = The basic plan/concept creates dead spaces where multifunctional spaces, structures or scaffolding for air cleaning and various environmental benefits cannot be added, or otherwise limits mitigation measures.

50% = The development provides vertical scaffolding in the landscape or on the façade that, among other functions, is designed to filter the air.

100% = The vertical landscape scaffolding or other structures are adequate, in themselves, to offset the equivalent air pollution caused during building operation.

+5 = The vertical landscaping compensates for the equivalent air pollution emitted during manufacturing and construction as well as operation.

+10 = The project not only improves air quality and environmental amenity for the whole urban block or area, it provides vertical landscape scaffolding in a more polluted urban area via net-positive offsetting.

1.5.4 Urban air circulation

Urban and building form and design features can cause harsh wind tunnels or, conversely, can provide for urban air flow to cool hot areas, provide gentle breezes, improve air circulation and/or avert cold winds. Trees and planting strips at street level or Green Scaffolding structures can promote vertical air circulation to reduce stale, hot or polluted air or even heat inversions, as well as providing other benefits such as biodiversity habitats, oxygen and environmental amenities.

-10 = The resulting development increases air flow problems such as wind tunnel effects, air stagnation or cold winter winds in a site already lacking in good air circulation.

-5 = The site is not exposed to poor air flow conditions, but the basic plan/concept increases poor air circulation and/or makes mitigation measures difficult.

50% = The building form and landscaping prevents stagnant air on site, reduces polluted air entering the site, and serves to block or dissipate cold or hot winds.

100% = Further, the form and landscape improve onsite air circulation, air quality levels and/or similar conditions (eg. use of solar fans, cross ventilation, screens, baffles or the Venturi effect) beyond pre-construction conditions.

+5 = The design elements actively improve urban air circulation and outdoor comfort or air quality levels in the surrounding streets (eg. reduce temperature inversions).

+10 = In addition, the development improves air circulation to avoid heat inversions or stagnant air at an urban scale, and/or improves a higher priority area via net-positive offsetting.

1.5.5 Pollution absorption materials

Noise and pollution affect urban biodiversity as well as people. There are many solutions. Panels of pollution absorbing materials (eg. replaceable planter boxes, sunscreens), can be added to or integrated with facades to remove pollutants, in addition to absorption by the plants. They could be retrofitted onto existing buildings in dense urban areas, but they need to be accessible for replacement, cleaning or safe recycling (ie. avoid washing pollution into water systems).

-10 = The resulting development uses materials that are highly polluting during production, construction or operation and the materials do not absorb toxins from the urban air.

-5 = The basic plan/concept and materials have excessive embodied pollution, but do not off-gas toxins (eg. volatile organic compounds). Titanium has negative impacts in production but absorbs pollutants.

50% = The building materials are not highly polluting in production or off-gassing, and some air pollution absorption (and noise) reduction materials are used in the design.

100% = The use of pollution absorption materials is adequate to offset any toxins (unavoidably) emitted during the production or use of building materials (eg. cork is renewable and can absorb pollutants).

+5 = In addition, the materials absorb air pollution from the street or surrounding area and provisions are made for ongoing maintenance (cleansed or recycled without polluting soil, water or air).

+10 = The pollution and noise absorption materials used in the structures or design features are adequate to offset the development's portion of total urban air pollution, aided by via net-positive offsetting if necessary.

1.6 Water quality (biological)

See Tier 2 benchmarks for description.

1.6.1 Integrated water storage

Development involves substantial embodied water, which has only been appreciated in recent decades. Water quality in this category is not about drinking water. It is about the water quality and quantity needed to support appropriate biota in urban and regional streams, ponds, lakes or rivers, as determined by ecologists. Development should restore and return water quality/quantity for plant and animal communities as well as provide ecosystem services for people.

-10 = The resulting development depletes local waterways (streams, lakes, water table, etc.) during its lifecycle, and/or water in the region is already depleted.

-5 = The basic plan/concept reduces water quality and quantity over the development lifecycle, but it is in a region that has significant water storage in the landscape.

50% = Natural water storage and treatment is provided for through design elements (eg. Living Machines, vertical wetlands or biofiltration ponds) that are adequate to support aquatic biodiversity in times of drought or heat waves.

100% = A natural water storage area is created onsite to support native aquatic species with a management plan for maintaining or enhancing water biota or biodiversity over time.

+5 = Restorative actions return water flows and storage ponds in the landscape to pre-urban conditions or as ecologically appropriate (eg. 'stream lightening' uncovers urban streams buried under development).

+10 = In addition, new water ecosystems are created to address prior damage elsewhere in the watershed and support increased biodiversity, with plans in place for ongoing management, via net-positive offsetting.

1.6.2 Natural purification/filtration waterscapes

Wetlands have been lost at a great cost to society. Artificial or engineered wetlands are seldom satisfactory substitutes, and should not be considered full offsets, even if the new area is much larger than the one that is damaged or destroyed. Nevertheless, new biodiverse wetlands in suitable places can provide many functions. Similarly, vertical wetlands in or around buildings can provide practical water treatment functions while supporting urban biodiversity.

-10 = The resulting development destroys wetlands or water filtration landscapes (onsite or offsite) as a direct result of the development's design and construction.

-5 = The basic plan/concept indirectly damages wetlands or landscapes that purify water somewhere along the supply chain during resource extraction and manufacturing.

50% = Wetlands or similar landscape features are preserved or created, but these are not adequate to fully compensate for the development's lifecycle water pollution or consumption impacts.

100% = The development provides or contributes enough to wetlands or other water purification landscapes to compensate for the impacts of the development on wetlands or waterways.

+5 = New/rehabilitated wetlands or landscape features restore wetlands or water filtration landscapes that have been lost or damaged in the watershed and they are designed to support native biodiversity.

+10 = The development also contributes to the construction or restoration of wetlands in regions that have been damaged by other developments via net-positive offsetting.

1.6.3 Eco-productive aquatic environments

In addition to storing water for drought, firefighting and so on (elsewhere), eco-productive water environments should support terrestrial aquatic ecosystems for biodiversity. These may be small fishponds and waterfalls in the building's landscape, or large moats that surround the entire building as a major design feature that provides substantial eco-services and environmental amenity. What counts here is their eco-productivity, not just storage or filtration functions.

-10 = The resulting development seriously damages the eco-productivity of onsite or offsite natural pond/lake ecosystems or native aquatic species during construction or operation.

-5 = The basic plan/concept does not directly destroy the eco-productivity of natural aquatic ecosystems, but it has indirect adverse impacts on aquatic ecosystems.

50% = The development provides a small eco-productive aquatic waterscape, relative to project size, that compensates for some of the aquatic ecosystems damaged during the project lifecycle.

100% = The development creates a large natural waterscape, around or through the site that supports a healthy eco-productive water ecosystem with native aquatic species.

+5 = In addition, the aquatic ecosystem produces a food chain of species (eg. bug, lizard, frog and bird) that is designed to help regenerate the bioregion by providing habitats and refuges, especially for local threatened species.

+10 = The development also protects, improves or expands a degraded aquatic ecosystem elsewhere, where water environments are under threat via net-positive offsetting.

1.6.4 Monitoring and management systems

Landscapes and waterscapes require maintenance systems, just as does mechanical equipment. Waterscapes often need more management and monitoring than terrestrial ecosystems, but they offer an opportunity to add education, research and community activities that aid maintenance. Major waterscapes could enlist the cooperation of community groups or environmental education programs that advocate for sustainable water ecosystems (eg. Waterwatch).

-10 = The resulting development involves operations or land uses that degrade existing onsite or offsite waterscapes and does not provide for ongoing monitoring and management of water ecosystems.

-5 = The basic plan/concept does not greatly degrade existing waterscapes but limits the potential for waterscapes and management or monitoring systems to support future biodiverse water ecosystems.

50% = An onsite waterscape is created, and a management system is put into operation that averts threats or barriers to the evolution of a biodiverse aquatic ecosystem.

100% = In addition, the management and monitoring system includes plans for the continuous improvement and involvement of educational, research or community activities.

+5 = The management and monitoring system is linked with organizations concerned with the eco-restoration of the catchment conservation of local aquatic species and includes educational components (eg. school tours).

+10 = The management and monitoring system is also geared to provide research data and opportunities for the wider scientific community (eg. cooperation with a university).

1.6.5 Embodied water reduction

Embodied water, here, refers to the amount of water used or polluted during production. Although substantial water is consumed in the extraction and manufacturing of building materials, it is somewhat difficult to account for differing water sources (eg. water extraction may have more impacts in a desert region). Since freshwater is disappearing globally, improvements in water-efficient construction are essential (not just water-efficient plumbing).

-10 = The resulting development is needlessly high in embodied water, meaning it has more square meters of water per square meter of gross floor area compared to typical buildings.

-5 = The basic plan/concept uses many materials or operations with a large water footprint (eg. steel and concrete) but no worse than similar buildings (generic embodied water data is available), and/or limits mitigation measures.

50% = Practical measures are undertaken to reduce the water footprint of the building, such as avoiding the use of carpets, which have high embodied water due to the need for frequent replacement.

100% = Since embodied water cannot be avoided, the embodied water required by building production and operation is low compared to similar buildings. This is the conventional goal for water efficient construction.

+5 = In addition, the development substitutes most conventional materials with alternatives that have a low water footprint, in addition to being water efficient in operation (eg. self-cleaning windows, efficient plumbing fixtures).

+10 = The development uses innovative ways of framing spaces with minimal materials that are collectively low in embodied water. (Some crops such as hemp are less water intensive than others.)