Sustainable Urbanism Performance-based SmartCode Module

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You never change things by fighting the existing reality. To change something, build a new model that makes the existing model obsolete.

R. Buckminster Fuller

ARTICLE 3

ZERO NET ENERGY BUILDINGS

This section activates Table SU1, Table SU2, and Table SU3. The Architecture 2030 Challenge, which has been put forward by the non-profit organization Architecture 2030 (www.architecture2030.org) is used in those tables as a benchmark goal for building energy use reduction. It proposes that all new buildings produce no greenhouse gas emissions by the year 2030. Buildings are responsible for 48% of all energy consumption in the United States, making them the single largest contributor to greenhouse gas emissions. The baseline to establish reductions should be taken from an established regional average by the applicable building type (e.g., edgeyard house, rearyard building, mixed use building) from a set year, such as the year of the code adoption.

These goals should be applied on the Building Scale per each Transect Zone. However, communities seeking a particular city-wide goal may consider requirements for District Energy Generation. For that reason Article 3 Standards are included.

See Table SU1 for additional standards and annotations.

See Table SU2 for details on Surface to Volume Ratio and Building Orientation.

See Table SU3 for details on Shading of Glazing.

PUBLIC DARKNESS

This section activates Table SU4, which addresses standards at the light source to maintain desired general ambient light levels across the Transect. Lighting standards protect against glare, preserve the night sky, and reduce unnecessary energy use from overlighting. Rural zones tend to be darker, while higher levels of outdoor lighting may be more suitable in mixed use urban zones.

See Table SU4 for additional standards and annotations.

VEHICLE MILES TRAVELED

This section activates Table SU5, which adapts the 2030 Community Campaign benchmarks to each Transect Zone for reduction in Vehicle Miles Traveled (VMT).

The 2030 Community Campaign is based on sustaining us as "a nation of neighborhoods." The Intent section of the SmartCode spells this out. The average American family is dependent on cars to meet its daily needs, driving on average 21,500 miles a year. Vehicle miles traveled by Americans is expected to grow 2.5% per year, increasing energy consumption and carbon omissions contributing to climate change. Additionally, obesity and other side effects of inactive lifestyles are predicted to shorten life span as much as five years per American.

Base VMT to establish the percentage decrease should be calculated from local or regional community data from 2005. (National baseline from 2005 per the American Planning Association, the Environmental and Energy Study Institute, and the 2030 Community Campaign, is 8,000 VMT per person).

Methods recommended to achieve the goal are listed in Table SU5 as more appropriate or more efficient for some Transect Zones, though many of the methods may be utilized across the Transect. Development patterns contribute to reducing VMT as do policies and strategies for Transportation Demand Management (TDM).

See Table SU5 for additional standards and annotations.

TREE CANOPY COVER

This section activates Table SU6, which provides a goal for minimum tree canopy cover by Transect Zone as well as methods to achieve these goals. Tree canopy cover cools the urban environment, traps air pollutants, absorbs carbon dioxide, and intercepts rainwater to reduce stormwater runoff. The minimum tree canopy coverage goals for each zone in this table have been developed as a benchmark for the local community. The amounts should be calibrated to the community, based on the climate. The methods are standards to achieve these goals and promote tree health and survival.

See Table SU6 for additional standards and annotations.

ARTICLE 3. NEW COMMUNITY SCALE PLANS

3.X. ZERO NET ENERGY BUILDING STANDARDS

3.X.1. General

a. Communities and their buildings shall be designed and constructed to reduce energy consumption to the percentages defined in Table SU1. Performance goals shall be met by projects approved on or after January 1 of the year listed in the left column.

b. Methods provided in Table SU1, Table SU2, and Table SU3 are intended for guidance in reaching these goals.

c. The development's annual electricity purchased from renewable sources through an energy contract shall be limited to the percentage listed in Table SU1 for each Transect Zone. Any such contract shall specify a minimum term of two years.

d. See Article 5 standards in this Module for specific requirements for buildings.

3.X.2. Specific to zones T2, T3, T4

a. A minimum of 70% of Lots shall be oriented within 30 degrees of true east/west.

3.X.3. Specific to zones T5, T6

a. A District Energy system shall be installed for any development of two or more buildings.

3.X. PUBLIC DARKNESS

3.X.1 General to all Zones T1, T2,T3, T4, T5, T6 and SD

a. All exterior lighting shall conform to the shielding, brightness and curfew standards defined in Table SU4.

3.X. VEHICLE MILES TRAVELED

3.X.1. General

a. Communities shall be designed to reduce Vehicle Miles Traveled (VMT) to the percentages defined in Table SU1. Performance goals shall be met by projects approved on or after January 1 of the year listed in the left column.

b. Methods provided in Table SU1 are intended for guidance in reaching these goals.

c. A bicycle system shall be incorporated into New Community Plans. See the Thoroughfare Module for Tale 4C and the Cycling Module.

d. At least one of the Community Scale Transportation Demand Management policies listed in Table SU5 shall be provided.

3.X. TREE CANOPY COVER

3.X.1. General

a. Standards listed in Table SU6 shall be met in order to establish a minimum tree canopy cover over a New Community.

b. Existing trees may be utilized to meet the canopy requirements. When existing trees do not meet the requirements, new trees of species appropriate for the bioregion and form appropriate for the Transect Zone shall be planted. See Table 6 Public Planting.

STORMWATER MANAGEMENT (ARTICLE 3)

This section activates Table SU7, which establishes standards for managing rainwater as close to where it falls as is reasonable. Limiting the change in stormwater runoff volume, in addition to runoff release rates, is a fundamental practice to avoid overtaxing community and regional stormwater infrastructure and to preserve the health of waterways. Incorporating stormwater management features into the design of the city and its open spaces maximizes land use without the need for retention basins that are only utilized for holding water during a storm event.

See Table SU7 for additional standards and annotations.

ZERO NET ENERGY BUILDINGS (ARTICLE 5)

This section activates Table SU1, Table SU2, and Table SU3. It is also possible to use this text section, with some modification, without a table. The Architecture 2030 goals should be applied on the Building Scale per each Transect Zone. However, communities seeking a particular city-wide goal may consider requirements for District Energy Generation. For that reason Article 3 Standards are also included on Page M5.

See Table SU1 for additional standards and annotations.

See Table SU2 for details on Surface to Volume Ratio and Building Orientation.

See Table SU3 for details on Shading of Glazing.

3.X. STORMWATER MANAGEMENT

3.X.1 General

a. A District Stormwater System shall manage stormwater on site to serve all or a portion of the community. The system shall meet the standards listed in Table SU7. Lot Level standards may contribute to the total.

b. If the District Stormwater System serves more than one Transect Zone, the standards for the largest Transect Zone in area shall be followed.

c. A development may follow the standards of a lower Transect Zone, but shall never follow the standards of a higher Transect Zone.

d. If the Community Scale standards are met without Lot Level standards, then the Lot Level standards may be waived.

ARTICLE 5. BUILDING SCALE PLANS

5.X. ZERO NET ENERGY BUILDING STANDARDS

5.X.1 General to all zones T2, T3, T4, T5, T6 and SD

a. The following minimum R values shall be utilized for all buildings:

i. Walls: [established for locale]

ii. Roof: [established for locale]

iii. Windows: [established for locale]

b. Fifty percent of the windows on a building shall be operable. The operable windows should be distributed to maximize the direction of prevailing breezes.

c. A minimum daylight factor of 2%, per USGBC LEED for New Construction requirements, shall be provided in 75% of regularly occupied interior areas.

d. There shall be a direct line of sight to glazing from 90% of all regularly occupied spaces.

e. The Solar Reflectivity Index for flat roofs shall be a minimum of 78. The Solar Reflectivity Index for sloped roofs shall be a minimum of 29.

f. The Solar Reflectivity Index for pavement shall be a minimum of 29.

g. All south facing windows shall be shaded. See Table SU3 for appropriate methods.

h. The use of wind turbines and solar photovoltaic/solar thermal energy systems is permitted.

i. Any building's annual electricity purchased from renewable sources through an energy contract shall be limited to the percentage listed on Table SU1 for each Transect Zone. Any such contract shall specify a minimum term of two years.

5.X.1 Specific to zones T2, T3, T4 and SD

a. Buildings should be oriented as provided on Table SU2.

b. Buildings should meet Surface-to-Volume Ratios as provided on Table SU2.

PUBLIC DARKNESS (ARTICLE 5)

This section activates Table SU4, which addresses standards at the light source to maintain desired general ambient light levels across the Transect. Exterior lighting of the private frontage affects Public Darkness, so this brief Article 5 reference to Table SU4 is important.

Lighting standards protect against glare, preserve the night sky, and reduce unnecessary energy use from overlighting. Rural zones tend to be darker, while higher levels of outdoor lighting may be more suitable in mixed use urban zones.

This section and Table SU4 should replace the older SmartCode Lighting Module for Article 5.

VEHICLE MILES TRAVELED (ARTICLE 5)

The 2030 Community Campaign provides a benchmark for reduction in Vehicle Miles Traveled (VMT). This section for Article 5 activates portions of Table SU5 that address the Building Scale.

TREE CANOPY COVER (ARTICLE 5)

This section activates Table SU6, which provides a goal for minimum tree canopy cover by Transect Zone as well as methods to achieve these goals. Trees on private property are counted toward Community Scale canopy cover, therefore this Article 5 section is included. The amounts on the table should be calibrated to the community, based on the climate. The methods are standards to achieve these goals and promote tree health and survival.

See Table SU6 for additional standards and annotations.

STORMWATER MANAGEMENT (ARTICLE 5)

This section activates Table SU7, which establishes standards for managing rainwater as close to where it falls as is reasonable. The Lot Level standards apply at the Building Scale of Article 5. See Table SU7 for additional standards and annotations.

5.X. PUBLIC DARKNESS

5.X.1 General to all Zones T1, T2,T3, T4, T5, T6 and SD

a. Exterior building lighting shall conform to the shielding, brightness and curfew standards defined in Table SU4.

5.X. VEHICLE MILES TRAVELED

5.X.1. General to all Zones T1, T2,T3, T4, T5, T6 and SD

a. Parking requirements shall be waived for car-free housing and reduced for Transit-Oriented Development (TOD).

b. All non-residential buildings with more than [x] occupants shall provide bicycle amenities (racks, lockers, and showers) per the Cycling Module.

d. All non-residential buildings with more than [x] occupants shall provide a minimum of three of the Transportation Demand Management policies listed in Table SU5.

5.X. TREE CANOPY COVER

5.X.1 General to all Zones T2,T3, T4, T5, T6 and SD

a. Standards listed in Table SU6 shall be met in order to establish a minimum tree canopy cover over a New Community or Infill Community.

b. Existing trees may be utilized to meet the canopy requirements. When existing trees do not meet the requirements, new trees of species appropriate for the bioregion shall be planted. See Table 6 Public Planting.

5.X.2 Specific to zones T4, T5, T6

a. Structural soil shall be utilized adjacent to tree pits.

5.X. STORMWATER MANAGEMENT

5.X.1 General

a. Lots shall meet the standards for Lot Level runoff volume and Runoff Release Rate as listed in Table SU7, unless such standards are waived due to District Stormwater Management accomplishing the district goal.

b. A Lot may follow the standards of a lower Transect Zone, but shall never follow the standards of a higher Transect Zone.

TABLE SU1 - ZERO NET ENERGY BUILDINGS

The Architecture 2030 Challenge, which has been put forward by the non-profit organization Architecture 2030 (www.architecture2030.org) is used in this table as a benchmark goal for building energy use reduction. It proposes that all new buildings produce no greenhouse gas emissions by the year 2030. Buildings are responsible for 48% of all energy consumption in the United States, making them the single largest contributor to greenhouse gas emissions. The baseline to establish reductions should be taken from an established regional average by the applicable building type (e.g., edgeyard house, rearyard building, mixed use building) from a set year, such as the year of the code adoption.

These goals should be applied on the Building Scale per each Transect Zone. However, communities seeking a particular city-wide goal may consider requirements for District Energy Generation.

Methods recommended to achieve the goal are listed as more appropriate or more efficient for some Transect Zones, though many of the methods may be utilized across the Transect. The first step is to reduce the need for the energy through efficient building methods. Secondly, increase efficiencies by generating energy as close to the use as possible, through on-site energy generation or District Energy. Finally, utilize renewable energy sources to reduce, and eventually eliminate, the use of fossil fuels for energy generation. These methods are defined based on the typical central city in the United States and should be calibrated for the specific municipality's regional climate and character.

Method: Energy Demand Reduction

Building energy use reduction is achieved by combining traditional site specific building practices with current material technology. The passive building methods listed below need to be calibrated with building types to maximize energy savings.

Surface to Volume Ratio

Surface to Volume Ratio is the amount of surface exposed to the outside per volume of building unit. Fewer exterior wall surfaces per unit, or smaller surface-to-volume ratios, minimizes heat gain in the summer and heat loss in the winter. See Annotation for Table SU2.

Building Orientation

Building orientation describes buildings sited for passive energy use. See Table SU2.

Building Envelope Efficiency

A highly efficient building envelope significantly reduces the energy usage of a building. Efficiency is measured by its "R-value," which refers to the resistance to heat flow of the wall, roof, door, window, floor, or foundation membrane. There are many methods for insulating against heat flow and these vary by region and structure type. Minimum R-Values for the parts of the building envelope should be determined for the location and established as part of the code.

Natural Cooling

Natural Cooling refers to the process of building design to allow cool air to enter the building during warm months and hot air to exhaust without mechanical means, i.e. through a thermal chimney.

Appropriate Glazing

Appropriate glazing refers to a regionally-appropriate amount of glazing per building face for optimum passive solar heating and cooling. Typically, a building with 40-50% of its glazing on the south building facade and less than 20% glazing on all other facades will optimize passive solar. Appropriate glazing can typically reduce energy use by up to 20% and is most applicable where southern light is not obstructed. Communities may consider more explicit glazing requirements according to their location.

Operable Windows

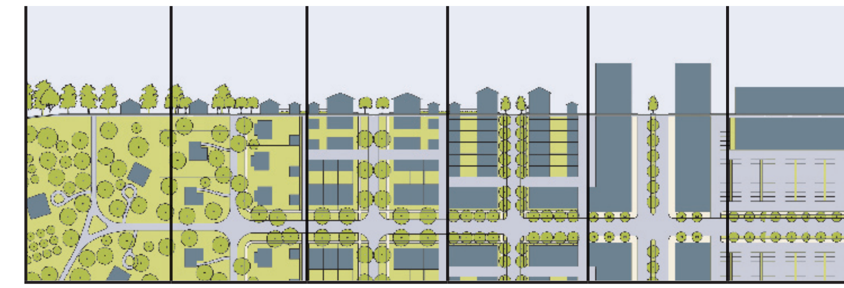
Natural ventilation through operable windows reduces energy use by approximately 15%. Typically, buildings should be required to have a minimum of 50% of the glazing to be operable, distributed to maximize use of prevailing breezes on the site.

Shading of Glazing

Shading of glazing should be utilized for preventing excess heat gain in warmer months. See Table SU3.

(continued)

Table SU1: Zero Net Energy Buildings. This summary table provides goals for achieving Zero Net Energy buildings within each Transect Zone. Projects must achieve an energy savings goal of the percentage of baseline energy used. Additionally, methods are recommended for Transect Zones where they will meet the goals most efficiently, though many of the methods may be utilized in all Transect Zones.



ARCHITECTURE 2030 CHALLENGE: GOAL FOR ZERO NET ENERGY	T2	T3	T4	T5	T6	SD
Projects approved prior to 2010	60%	50%	50%	50%	50%	100%
Projects approved in or after Year 2010	80%	70%	60%	60%	60%	100%
Projects approved in or after Year 2015	100%	80%	80%	70%	70%	100%
Projects approved in or after Year 2020		100%	90%	80%	80%	100%
Projects approved in or after Year 2025			100%	90%	90%	100%
Projects approved in or after Year 2030				100%	100%	100%
METHOD: ENERGY DEMAND REDUCTION - BUILDING SCALE (ARTICLE 5)						
Surface to Volume Ratio (see Table SU2)			▪	▪	▪	▪
Building Orientation (see Table SU2)	▪	▪	▪			▪
Building Envelope Efficiency	▪	▪	▪	▪	▪	▪
Natural Cooling	▪	▪	▪	▪	▪	▪
Appropriate Glazing	▪	▪	▪	▪	▪	▪
50% Operable Windows	▪	▪	▪	▪	▪	▪
Shading of Glazing (see Table SU3)	▪	▪	▪	▪	▪	▪
Daylighting	▪	▪	▪	▪	▪	▪
High Albedo Roofs (sloped > 29, flat > 78)	▪	▪	▪	▪	▪	▪
High Albedo Pavement (>29 SRI)	▪	▪	▪	▪	▪	▪
Landscape Siting	▪	▪	▪			▪
METHOD: BUILDING/LOT RENEWABLE ENERGY GENERATION (ARTICLE 5)						
Wind Energy Generation	▪	▪	▪			
Solar PV	▪	▪	▪			
Solar Thermal	▪	▪	▪	▪		
Groundsource Heat Exchange (Geothermal)	▪	▪	▪	▪	▪	
Biomass	▪	▪				
METHOD: DISTRICT ENERGY GENERATION - COMMUNITY SCALE (ARTICLE 2, ARTICLE 3 & ARTICLE 4) & MULTIPLE BUILDINGS (ARTICLE 5)						
Non-Renewable Heat and Cool				▪	▪	▪
Combined Heat and Power				▪	▪	▪
Groundsource Heat Exchange (Geothermal)			▪	▪	▪	▪
Biomass			▪	▪	▪	▪
Other Renewable			▪	▪	▪	▪
METHOD: LONG TERM CONTRACTING (MINIMUM TWO YEAR CONTRACT)						
Maximum Amount of Power	10%	15%	15%	20%	20%	20%

▪ Method is appropriate and most efficient toward achieving the goal within this Transect Zone.

(cont.Table SU1 - Zero Net Energy Buildings)

Daylighting

Daylighting refers to the use of daylight as a primary source of general illumination in a space, providing opportunities for energy savings. A minimum daylight factor of 2%, per USGBC LEED for New Construction requirements, should be provided in 75% of regularly occupied interior areas as well as a direct line of sight to vision glazing from 90% of all regularly occupied spaces. The result of this practice will typically be narrower buildings. Daylighting techniques should be coordinated with Shading of Glazing techniques in warm climates so they do not conflict.

High Albedo Roofs

High albedo surfaces have both a light color for high solar reflectance and high emittance, an ability to reject heat back into the environment. High albedo roofs prevent heat absorption; this cooling effect can reduce energy use within the building by 13 -15%. In most US climates, flatter roofs should have a minimum Solar Reflective Index rating of 78. For sloped roofs, the Solar Reflective Index can be lower, with a minimum of 29.

High Albedo Pavement

Similar to high albedo roofs, high albedo pavement surrounding the building has a cooling affect on the environment, reducing the heat island effect and the energy required to cool buildings in the area. For most US climates, the Solar Reflective Index rating for pavement should be minimum of 29.

Landscape Siting

Landscape design can impact building energy use. Locating or maintaining existing evergreen vegetation on the north side of a building can block winter wind, reducing the need for additional heating. By the same token, deciduous material that shades buildings from the summer sun reduces the need for additional cooling. Energy savings are site-specific and vary according to micro-climate and region.

Building/Lot Energy Generation

On-site energy generation is energy generated for the use of a single building. Excess energy can feed back into the grid, but a connection to the grid is not necessary for individual production. Lower Transect Zones tend to be more conducive to on-site energy systems where their use will not impose on, or be impeded by, neighboring uses and buildings.

Wind Energy Generation

On-site wind energy consists of one large or several smaller turbines, either pole mounted on a lot or mounted on the roof of a building. As a means of achieving reduction of fossil fuel use, on-site energy generation is currently best suited for larger lots with ample wind levels and less demand. In the higher Transect Zones where there is more density, the amount of energy generated from wind is in limited proportion to the energy used by the high number of multiple users in the building. As technology improves, on-site wind energy generation may become a more significant factor in the T-5 and T-6 zones. See the Wind Power sub-module by Jaime Correa and Associates at www.smartcodecentral.org.

Solar Photovoltaic / Solar Thermal

Solar Photovoltaic energy systems require access to solar radiation and the roof area, to install enough panels for the building's energy demands. This is most often the case in lower Transect Zones up to T-4. Solar Thermal for water heating does not require as many panels per user, and is therefore an option for some buildings with solar access and limited roof area, typically up to T-5.

Groundsource Heat Exchange (Geothermal)

A Groundsource Heat Exchange system or geothermal system uses the consistent temperatures below the earth's surface to provide heating and cooling services. In winter, pipes buried in the ground near the building bring heat from the relatively warmer ground into the house. In summer, hot air from the house is pulled into the relatively cooler ground and reduces the amount of energy needed to cool the already cooler air. This type of system can be utilized in any Transect Zone.

Biomass

On-site biomass energy is produced by burning organic matter, such as a woodchip burning stove. Biomass production is an alternative for lower T-zones and is most effective by burning waste products. In higher T-zones, on-site biomass energy generation is much less efficient than other forms of energy or district biomass energy generation.

(continued)

(cont. Table SU1 - Zero Net Energy Buildings)

District Energy Generation

District Energy systems produce thermal energy for heating, cooling and hot water at a central plant, for use in the immediately surrounding community. District Energy facilities, both renewable and non-renewable, have less carbon output because there is less energy loss due to shorter conveyance distances. District Energy systems typically consume 40% less fuel and produce 45% less air emissions than conventional energy generation. These systems can serve small developments or larger areas up to several miles; however, the energy demand must support the cost of construction and running the system. It is best utilized in higher T-zones where there are energy loads sufficient to justify the infrastructure installation, as well as both day and evening energy users.

Non-renewable Heat and Cool

Non-renewable fuels, such as natural gas, are the most common and traditional form of District Energy. As discussed above, the use of district generated heating and cooling, even non-renewable, significantly reduces energy consumption.

Combined Heat and Power

District Combined Heat and Power plants, also known as cogeneration plants, recover normally wasted heat from electrical generation processes to heat nearby buildings, doubling the efficiency of the facility. It is well suited to institutional, commercial, industrial, and large residential developments.

District Groundsource Heat Exchange (Geothermal)

A District Groundsource Heat Exchange system is similar to a building geothermal system, but serves more than one building or lot. A centrally located groundsource heat exchange system can serve several users. Other forms of geothermal energy, such as very deep wells tapping the hot rock or water below the earth's surface, are typically larger in scale, but can be utilized for District Energy generation in some areas of the country.

Biomass

Biomass District Energy, produced from burning organic matter, is best used where a fuel source is readily available. The fuel is typically a waste product such as urban or industrial wood waste and agricultural residues. District biomass plants can provide better filtration of emissions than individual systems. Biogas plants use methane released from decomposing organic garbage or manure.

Other Renewable Sources

New options for renewable District Energy sources are growing, including solar and micro-hydro facilities. Technology improvements in small scale plants make these rapidly developing renewable energy sources accessible to businesses and communities. They should always be considered to achieve the goal of Net Zero Energy development.

Method: Long Term Contracting

Long term contracting is a method for purchasing renewable energy from a large energy provider, where the renewable energy is not for that particular building or development, but is fed into the entire energy grid. At the present time, it can be difficult for buildings, especially in the T-6 zone, to achieve Zero Net Energy through energy use reductions and energy generation. Therefore, long term contracting helps these buildings achieve their goals, while encouraging large energy providers to utilize renewable energy sources. The contract should be long term, ensuring utilization of the renewable energy into the future. Should the contract expire, new methods should be incorporated to make up for the loss of savings. This portion of the table is intended to require that no more than a certain percentage of the annual electricity from renewable sources should be credited by such a contract. Percentages are allocated by Transect Zone.

These annotations are advisory only. The SmartCode itself appears only on the right side of each spread.

TABLE SU2 - SURFACE TO VOLUME RATIO AND BUILDING ORIENTATION

Surface to Volume Ratio and Building Orientation are most applicable at the Building Scale. On the Community Scale, however, lot and even block orientation can result directly in a particular building orientation, particularly in combination with the SmartCode's requirement for facades to be parallel to the thoroughfare in higher Transect Zones. In addition, lot dimensions combined with allowable numbers of stories and story heights can result in particular surface to volume ratios.

Surface to Volume Ratio

Surface to Volume Ratio is the amount of surface exposed to the outside per volume of building unit. Modeling performed by Alan Chalifoux has demonstrated that energy savings can be maximized by reducing the surface to volume ratio as much as possible. Energy use is decreased through each successive decrease in surface to volume ratio. Fewer exterior wall surfaces per unit, or smaller surface to volume ratios, minimizes heat gain in the summer and heat loss in the winter. A unit with two shared walls uses approximately 14-28% less energy (depending on the region) than a detached unit.

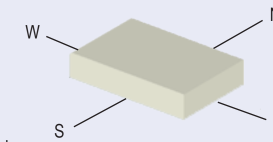
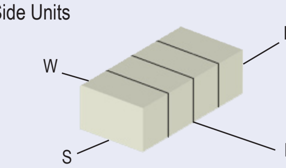
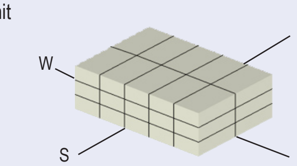
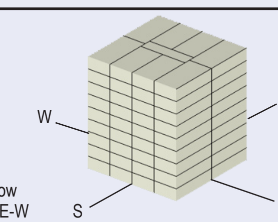
Building massing and stacking can reduce the number of exterior walls per unit; therefore, the multi-unit buildings in higher Transect Zones are typically more efficient than single-unit buildings. However, in high-rises the added systems such as elevators and water pumps may increase overall building energy use. This is one reason the model SmartCode caps T-6 at eight stories.

Building Orientation

Building orientation describes buildings sited for passive energy use. Typically, orienting the building or unit on an east-west axis provides smaller eastern and western exposures. The longer southern exposure allows passive heating in the winter, and shading the glazing from the higher summer sun reduces cooling needs.

Building orientation can reduce energy use by 15-30%. This method is most applicable in lower T-zones with larger lots and greater solar access, though orientation should be considered in all cases. New Comunity Plans should take thoroughfare and block orientation into account.

Table SU2: Surface to Volume Ratio and Building Orientation. This table shows the most basic building types and the level of their Surface to Volume Ratio and recommended orientation to achieve lowest energy use. The black lines on the building envelopes indicate shared walls. Each shared wall reduces a unit's surface-to-volume ratio.

	T2	T3	T4	T5	T6	SD
Single-unit one story  S/V Ratio: High Orientation: E-W	▪	▪	▪			▪
Side-by-Side Units  S/V Ratio: Medium Orientation: N-S			▪	▪		▪
Multi-unit  S/V Ratio: Low Orientation: E-W				▪	▪	▪
High-rise  S/V Ratio: Low Orientation: E-W					▪	▪

▪Typically utilized in these Transect Zones.

Chart information for the single unit and townhouse building adapted from energy modeling performed by Alan Chalifoux.

TABLE SU3 - SHADING OF GLAZING

The table illustrates multiple methods for shading glazing. Shading should be utilized to prevent excess heat gain in summer months. Southern facing windows should be shaded during summer months. However, shading should not interfere with walkability in mixed use areas by blocking views into shopfronts nor should they compromise safety by removing "eyes on the street." Shading techniques should be coordinated with Daylighting techniques so they do not conflict.

Trees

Mature deciduous trees, grown in favorable conditions, can shade glazing, especially for one to three story buildings that would occur in the lower Transect Zones. While trees can provide shading of lower stories of buildings in higher Transect Zones, their impact on reducing energy consumption in these taller buildings is minimal. In the higher zones, species should be selected with high canopies that do not block visual access to shopfronts nor interfere with "eyes on the street." In the base SmartCode, very narrow urban thoroughfares in T-5 and T-6 are exempted from tree requirements, so conflicts should be avoided in calibration of the code with this Module. See Section 3.7.3 and Section 5.11 of the base code for Public Frontages and Landscape Standards.

Awnings

Awnings provide levels of shading similar to trees, in that they have more impact on energy use of shorter buildings. Awnings are particularly helpful for shopfronts, reducing reflections in the windows and providing shelter for window-shoppers. Some types of awnings can be retracted in winter months to provide daylighting. See Section 5.7 of the model SmartCode for awning standards.

Porch

Porches, galleries, and arcades provide significant shading of windows on the ground floor. Balconies and double galleries can provide shading for upper story glazing. See Table 7 Private Frontages in the model SmartCode for Gallery and Arcade frontages.

Roof Overhang

Providing an appropriate roof overhang is a common method for providing shading of glazing. In most climates, the overhang should be designed to shade the angle of the sun during summer months, while allowing the sun to penetrate the glass during the winter months.

Exterior Shade

Exterior shades can be utilized in extreme circumstances on the upper floors of the building. Use of exterior shades on lower floors can result in a hostile pedestrian environment. See options above for more appropriate lower floor shading devices. Louvered exterior shades can also be used to provide a friendlier facade.

Light Shelf

Interior and exterior light shelves can be utilized to divert the rays of the sun from penetrating the glazing directly, while providing indirect daylighting.

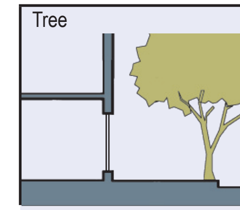
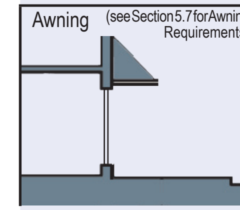
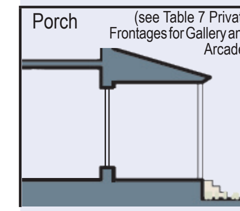
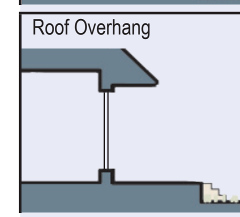
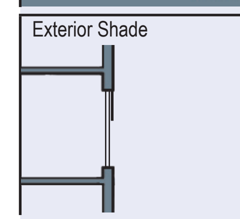
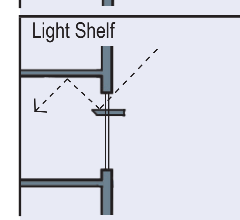
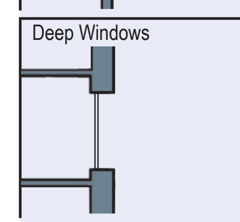
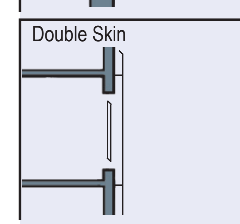
Deep Windows

Setting windows in deep frames is a traditional method for providing shading of glazing. The depth of the window can reduce the amount light penetrating the window in summer months, while permitting lower sun angles to light and warm the interior during colder months. Deep windows may also add to visual interest and three-dimensionality on a facade.

Double Skin

Double-skinned buildings are used more widely in Europe; however, use of a double skin can provide unique passive heating and cooling opportunities. The cavity between the two building skins allows for trapped, solar heated air to be circulated into the interior space during winter months. During summer months, the cavity provides protection from solar heat gain on the interior to reduce cooling needs. Additionally, windows on the interior can be open without exposure concerns, such as wind and rain, and for safe nighttime cooling. Use of responsive controls also can optimize the thermal performance of this system.

TABLE SU3: Shading of Glazing This table illustrates methods to achieve high levels of shading glazing within each Transect Zone.

	T2	T3	T4	T5	T6	SD
Tree 	•	•	•			•
Awning (see Section 5.7 for Awning Requirements) 			•	•	•	•
Porch (see Table 7 Private Frontages for Gallery and Arcade) 	•	•	•			•
Roof Overhang 	•	•	•	•		•
Exterior Shade 			•	•	•	•
Light Shelf 			•	•	•	•
Deep Windows 	•	•	•	•	•	•
Double Skin 				•	•	•

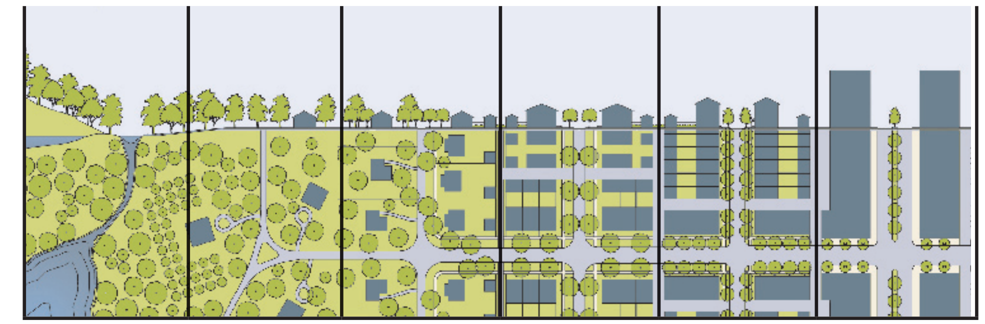
PUBLIC DARKNESS

The Public Darkness table defines standards to maintain desired general ambient light levels across the Transect. Lighting standards protect against glare, preserve the night sky, and reduce unnecessary energy use from overlighting. Rural zones tend to be darker, while higher levels of outdoor lighting may be more suitable in mixed use urban zones. See Table 5 of the base SmartCode and the Lighting and Lighting Design Modules at www.transect.org.

Lighting is regulated by the type of lamp and the effective brightness, or lumens. A "full cutoff" luminaire does not allow light above a horizontal plane and directs light downward without allowing light to escape upwards where it is no longer useful. Dimmers and other similar methods of managing light output assist in reducing energy usage and lowering the impacts on the dark night sky.

"Initial lamp lumens" is a measure of how much light the lamp is emitting near the beginning of its life, as most high-efficiency light sources decline in light output over time. Shielded luminaires limit light trespass beyond the property line and prevent the lamp from being directly visible. A lighting curfew promotes a dark night sky by restricting commercial lighting during late-night non-business hours. This may occur after the official close of business to allow employees to leave the building safely.

TABLE SU4: Public Darkness. This table outlines standards for preserving public darkness. They apply to the Public Frontage and the Private Frontage.



	T1	T2	T3	T4	T5	T6
Ambient Light Levels	none	very low	very low	low	medium	high
STANDARDS						
Maximum Lighting Standards	Minimal electric lighting; should be turned off most of the time	Minimal lighting, all Full Cutoff, controlled with motion sensors	Minimal lighting, all Full Cutoff, controlled with motion sensors	Full Cutoff lighting, controlled with dimmers, time switch or motion sensors	Full Cutoff lighting, some low wattage, non-Full Cutoff lighting; controlled with dimmers, time switch or motion	Full Cutoff lighting, some non-Full Cutoff lighting; controlled with dimmers, time switch or motion sensors
Maximum Allowed Initial Lamp Lumens/sf	1.25- 1.6 lu/sf	2.5-3.2 lu/sf	2.5-3.2 lu/sf	3.3-4.2 lu/sf	7.6-9.7 lu/sf	10.9-13.9 lu/sf
Maximum Lamp Allowance (Lumens)	6500 lu	17,000 lu	17,000 lu	24,000 lu	44,000 lu	60,000 lu
Required Shielding	Fully shielded Luminaire with no uplight or better	Fully shielded Luminaire with no uplight or better	Fully shielded Luminaire with no uplight or better	Shielded Luminaire or better	Partially shielded Luminaire or better	For best practice, do not exceed T-5 requirements
Lighting Curfew for Non-Residential	8 pm or close of business, whichever is later	10 pm or close of business, whichever is later	10 pm or close of business, whichever is later	10 pm or close of business, whichever is later	12 am or close of business, whichever is later	12 am or close of business, whichever is later

Chart information compiled from: Model Lighting Ordinance (draft),Nancy Clanton, Clanton & Associates

TABLE SU5 - VEHICLE MILES TRAVELED

The 2030 Community Campaign provides a benchmark for reduction in Vehicle Miles Traveled (VMT). This table adapts that benchmark to each Transect Zone.

The 2030 Community Campaign is based on sustaining us as "a nation of neighborhoods." The Intent section of the SmartCode spells this out. The average American family is dependent on cars to meet its daily needs, driving on average 21,500 miles a year. Vehicle miles traveled by Americans is expected to grow 2.5% per year, increasing energy consumption and carbon omissions contributing to climate change. Additionally, obesity and other side effects of inactive lifestyles are predicted to shorten life span as much as five years per American.

Base VMT to establish the percentage decrease should be calculated from local or regional community data from 2005. (National baseline from 2005 per the American Planning Association, the Environmental and Energy Study Institute, and the 2030 Community Campaign, is 8,000 VMT per person).

Methods recommended to achieve the goal are listed as more appropriate or more efficient for some Transect Zones, though many of the methods may be utilized across the Transect. Development patterns contribute to reducing VMT as do policies and strategies for Transportation Demand Management (TDM).

Methods: Built measures - Community Scale (Article 2, Article 3, and Article 4)

Increase Transit and Provide Transit-Supportive Densities

Part of increasing mobility options is providing access to efficient public transportation. Each transit type requires some level of residential density to support an efficient, useful system. Appropriate "origin" Transect Zones are provided based on typical situations and industry studies, though their associated densities should be calibrated to the municipality. Local studies may take into account drivership or bus lines feeding to a rail station, but access from the pedestrian shed should be prioritized. A range of values is inclusive of varying levels of transit service. Though the table may designate a type of transit appropriate for the Transect Zone, in many cases other destination zones are required. For example, commuter rail is suitable at T-3 densities, but likely requires numerous stops and a T-6 destination. An origin station may also be a destination station if it is mixed use, thus changing the recommended densities. Commuter rail is even more difficult to prescribe by the Transect, as one rail line may stop in the T-5 zones of several towns and neighborhoods to collect riders for the ultimate destination. See the Transit Oriented Development (TOD) SmartCode Module at www.transect.org for more precise tools.

Create Walkable Neighborhoods

Small block sizes and high street connectivity, as defined by number of intersections in a square mile, are the basis for a walkable community. The number of intersections required per square mile should be calibrated by region and should be applied per quarter-section (160 acres) to correspond to SmartCode Community Unit sizes. Maximum block sizes are essential, because the Transect Zones are fine-grained and an average interpolated from a square mile may permit some overlong blocks. See Table 14c for model SmartCode maximums, to be locally calibrated if necessary, and see the Place Types in Comprehensive/General Lans Module for other baseline performance measures.

See Article 3 of the SmartCode and Appendix XI of the *SmartCode v9 and Manual* for additional information on block configuration.

A mix of daily uses for complete neighborhoods, such as corner stores and child care, supports a pedestrian lifestyle by reducing the need for trips outside the neighborhood. Commercial nodes should be provided every quarter mile to serve each pedestrian shed or quarter-section.

Pedestrian oriented streetscape improvements increase the safety of pedestrians, contribute to a more pleasant walking environment, and encourage longer and more frequent trips on foot. The appropriate private frontages can provide transitional spaces between the public sidewalk and the private interior of the building. Buildings oriented to the pedestrian provide interest, accessibility, and "eyes on the street" for safety. See Table 7 Private Frontages, Section 5.6 Building Disposition, and Section 5.7 Building Configuration in the base code.

Transit-Oriented Development (TOD) is development located within a half mile of a rail or Bus Rapid Transit (BRT) station, typically with higher densities to support increased amounts of retail and services as well as ridership. Additionally, automobile parking should be significantly reduced, if not eliminated, in TODs. See Section 3.2 and Section 3.3.4 of the model SmartCode.

(continued)

Table SU5: Vehicle Miles Traveled. This table establishes goals for reducing vehicle miles traveled (VMT) as a percentage of current average VMT for the region. Additionally, the table provides methods to reduce trips per Transect Zone.

2030 COMMUNITY CAMPAIGN: VEHICLE MILES TRAVELED (VMT) REDUCTION GOALS	T2	T3	T4	T5	T6	SD
prior to 2010	10%	10%	10%	10%	20%	
Year 2010	10%	10%	20%	20%	30%	
Year 2015	20%	20%	30%	40%	50%	
Year 2020	30%	30%	40%	50%		
Year 2025	40%	40%	50%			
Year 2030	50%	50%				
METHODS: BUILT MEASURES - REGIONAL SCALE (ARTICLE 2) , COMMUNITY SCALE (ARTICLE 3 & ARTICLE 4)						
Increase Transit & Provide Transit-Supportive Densities (origin stations shown)	1 DU/ 20 AC	4-8 DU/ AC	6-36 DU/ AC	18-48 DU/ AC	36-96 DU/ AC	
Bus		■	■	■	■	■
Bus Rapid Transit (BRT) or Light Rail			■	■	■	■
Rapid Rail			■	■	■	■
Commuter Rail		■	■	■	■	■
Create Walkable Neighborhoods						
Block Perimeter (See Table 14)		■	■	■	■	■
Daily Uses within 1/4 Mile			■	■	■	■
Public Frontage (Streetscape) Improvements			■	■	■	■
Buildings Oriented to the Pedestrian			■	■	■	■
Transit Oriented Development				■	■	■
Create Bikeable Neighborhoods						
Bicycle System		■	■	■	■	■
Bicycle Amenities (locker, shower etc.)			■	■	■	■
Bicycle Parking			■	■	■	■
Bicycle Rental/ Bicycle Share Program			■	■	■	■
METHODS: TRANSPORTATION DEMAND MANAGEMENT POLICY - REGIONAL SCALE (ARTICLE 2), COMMUNITY SCALE (ARTICLE 3 & ARTICLE 4)						
Transit Passes	■	■	■	■	■	■
Carshare (per hour car rental)			■	■	■	■
Taxi Service		■	■	■	■	■
Permit Home Occupation Uses	■	■	■	■	■	■
Shopping Parking Charges				■	■	■
METHODS: TRANSPORTATION DEMAND MANAGEMENT POLICY - BUILDING SCALE (ARTICLE 5)						
Provide Incentives for Transit Use						
Transit Passes	■	■	■	■	■	■
Guaranteed Ride Home	■	■	■	■	■	■
Convenient Park & Ride	■	■				
Support Ridesharing/Carpooling						
Rideshare/Carpool Parking	■	■	■	■	■	■
Rideshare/Carpool Programs	■	■	■	■	■	■
Reduce Trips						
Compressed Work Week	■	■	■	■	■	■
Telework/Telelearning	■	■	■	■	■	■
Manage & Reduce Parking						
Car Free Housing			■	■	■	■
Inclusion of Street Parking Counts in Parking Minimum Requirements		■	■	■	■	■
Off Street Maximum Parking Requirements	■	■	■	■	■	■
Shared Parking Among Users (see Table 12)				■	■	
Unbundle Parking from Rent	■	■	■	■	■	■
Workplace Parking Charges	■	■	■	■	■	■

(cont. Table SU5 - Vehicle Miles Traveled)

Create Bikable Neighborhoods

Neighborhoods, especially in the higher Transect Zones, should incorporate a system of bicycle lanes, trails, or routes into the larger regional system. Standards for bicycle parking along with bicycle amenities create bicycle friendly environments. See the Cycling for Complete Streets Module for bicycle parking standards, based on dwelling units or number of employees, and the Complete Streets Module for thoroughfare types and lane widths appropriate for each Transect Zone.

Methods: TDM Policy - Community Scale

Transit passes can be issued by a company or agency to cover transit costs at a discounted rate and to make using multiple modes more convenient.

Carshare rental programs are similar to a standard car rental except that use is scheduled by hour and not by day, allowing rental on a per trip basis. Many successful carshare programs have been implemented in major cities, becoming very popular in the higher Transect Zones.

Improvements in taxi service availability and reliability support transit options. They can be used for Guaranteed Ride Home programs or in case of emergencies.

Home occupations reduce vehicular trips substantially by eliminating the commute to the office. The SmartCode permits a variety of home occupations even in the more residential zones. See Table 10 and Table 12 in the base code.

Pricing parking on its availability has been shown to reduce the need for construction of additional parking spaces, especially in shopping areas.

TDM Policy - Building Scale

Provide Incentives for Transit Use

Transit passes can be issued by a company or agency to cover transit costs at a discounted rate and to make using multiple modes more convenient.

Guaranteed ride home programs support alternative transit by providing an occasional subsidized ride in the case of an emergency or when normal transit options are unavailable. This provides peace of mind to employees who might otherwise not want to sacrifice the flexibility of an individual car.

Convenient Park and Ride locations are part of a commuter rail system. These facilities should be accessible for drivers, cyclists, and pedestrians.

Support Ridesharing/Carpooling

Several people going to the same location, or nearby, can ride together in one car. Buildings or companies can encourage this with preferred parking spaces or parking fee discounts to rideshare/carpool vehicles. A system for ridesharing can be set up at the destination, to help riders connect with drivers.

Reduce Trips

Several methods have been shown to reduce overall trips in a community and can work across the Transect. Many of these methods would be tied to the user of a development. A compressed work week means that employees work fewer but longer days to make up the 40 hour work week, reducing the number of days of commuting.

Telework/Telelearning uses phone, internet, and fax connections to substitute for face-to-face interaction. Jobs that are information-based are ideal for telework options. In a five-day work week, two days of telework reduces commuting trips by 40 percent.

Manage & Reduce Parking

Efficient use of parking reduces driving and helps to maintain and incentivize compact building patterns. Where other types of transportation are available, car-free housing that does not require parking should be permitted and encouraged, and provided in conjunction with other TDM practices, such as a carshare program.

On-street parking should be counted towards minimum parking requirements to reduce the need for off-street parking and to cut down on unnecessary impervious surface and lighting. Parking maximums are recommended to prevent excess parking in higher Transect Zones where transit is an option. Allowing shared parking reduces redundant parking spaces for users who park at different times. These strategies have financial benefits to property owners and improve walkability by reducing curb cuts and the degradation of urban spatial definition from surface lots. See Table 11 in the base code for the Shared Parking Matrix.

Pricing parking on its availability reduces the need for additional parking spaces. Unbundling parking fees from rental payments, especially in higher Transect Zones, exposes the real cost of the parking and allows the user to opt for no parking, possibly living car-free. Workplace and shopping parking charges are similar, in that they shift the cost of parking to the driver and relieve or reimburse non-drivers. Parking cash-out programs are one form of this strategy, in which employers reimburse employees who choose not to use employer subsidized parking.

TREE CANOPY COVER

This table provides a goal for minimum tree canopy cover by Transect Zone as well as methods to achieve these goals. Tree canopy cover cools the urban environment, traps air pollutants, absorbs carbon dioxide, and intercepts rainwater to reduce stormwater runoff. The minimum tree canopy coverage goals for each zone in this table have been developed as a benchmark for the local community. The amounts should be calibrated to the community, based on the climate. The methods are standards to achieve these goals and promote tree health and survival.

Methods:

Canopy cover is a measurement of total mature tree canopy within a Transect Zone from trees located on all private lots, parking lots, open space, and street rights-of-way. Existing trees may be utilized to meet the canopy requirements, and when existing trees do not fulfill the requirements, new trees should be planted. Tree canopy is measured at mature size, established by regional growth patterns. See

Public Canopy Cover Standards - Community Scale (Article 2, Article 3 & Article 4)

Civic Space Minimum Canopy Cover

Public canopy requirements apply to civic open spaces and thoroughfares. Civic space often provides a large amount of tree canopy towards meeting the goal. The standards for these spaces are balanced to allow for sunny areas as well. See Table 13 of the model SmartCode for types of Civic Spaces.

Street Tree Requirements

Continuous street trees are an important component of the urban canopy. However, in the base SmartCode, very narrow urban thoroughfares in T-5 and T-6 are exempted from tree requirements, so conflicts should be avoided in calibration of the code with this Module. Visibility into shopfronts and "eyes on the street" should be considered when selecting tree species. See Section 3.7.3 and Section 5.11 of the base code for Public Frontages and Landscape Standards, and Table 5 Public Planting.

Private Canopy Cover Standards - Building Scale (Article 5)

Private Lot Minimum Canopy Cover

Each private lot shall also meet a minimum canopy cover requirement towards achieving the overall goal. The requirements are set to allow a balance between sun and shade on each parcel. The canopy requirements are for the lot as a whole and should be calibrated for each municipality. Tree canopy cover on green roofs may be utilized to meet this requirement, if mature canopy can be achieved by the planting method.

Street Tree Requirement

Parking lot canopy requirements are set to minimize the heat island effect of parking lots and shade a large portion of the paved area. On lots with buildings, yards, and parking lots, the parking lot should be calculated separately, per this section of the table.

Healthy Trees Standards

Canopy cover requirements are measured at mature growth, relying on a healthy planting method to achieve that maximum canopy size. While planting mix and pit size should be established based on local methods, two planting requirements are typically underutilized, especially in urban locations: permeable surface requirements and use of structural soil. See the Natural Drainage and Light Imprint Modules at www.smartcodecentral.org.

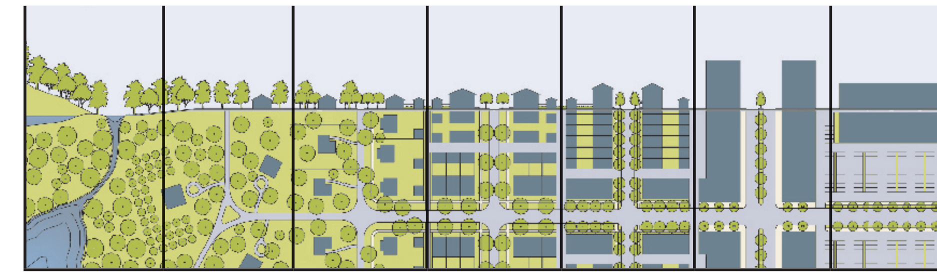
Minimum Permeable Surface per Tree

Permeable surfaces allow air and rainwater to permeate soils within the root zone of the tree. Permeable surface requirements have been set in the higher Transect Zones to accommodate trees in treewells with or without tree grates, though these levels are below the minimums to foster healthy urban tree growth. In T-4, the minimum of 270 square feet is the equivalent of a 9' wide planting strip with medium or large trees planted 30' on center. Highly permeable pavement adjacent to the tree well in walkways or on-street parking areas should be utilized in addition to both these areas, though not required in the table. In lower Transect Zones, where more space is available, the permeable surface required is equivalent to approximately 50% of the canopy area, or "drip zone," the minimum for healthy large tree growth.

Structural Soil Requirement per Tree

With reduced permeable surfaces, structural soil adjacent to the tree well can improve the health of the tree by providing areas for tree roots to penetrate, especially below pavement. Recommended surface areas for structural soils are minimal and should be calibrated to the community. These amounts are in addition to the permeable surface area required. At a minimum, structural soil should be provided adjacent to trees in tree wells in T-5 and T-6, though the municipality may elect to increase the structural soil area to a percentage of the mature canopy area, between 50% and 100%. Structural soil can be utilized below any pavement surface.

Table SU6: Tree Canopy Cover. This table establishes a goal for minimum tree canopy cover per Transect Zone and established methods for providing adequate coverage, via minimum canopy requirements and healthy tree requirements.



GOAL	T1	T2	T3	T4	T5	T6	SD
Tree Canopy Cover Goal by Zone	0	0	45%	30%	25%	15%	40%
PUBLIC CANOPY COVER STANDARDS - COMMUNITY SCALE (ARTICLE 2, ARTICLE 3 & ARTICLE 4)							
Civic Space Minimum Canopy Cover	none	none	50%	50%	50%	30%	50%
Street Tree Requirements	naturalistic	naturalistic	clustered	30' o.c.	30' o.c.	30' o.c.	30' o.c.
PRIVATE CANOPY COVER STANDARDS - BUILDING SCALE (ARTICLE 5)							
Private Lot Minimum Canopy Cover	none	1 per15,000 sf of Lot or 6%	1 per 10,000 sf of Lot or 10%	1 per 7500 sf of Lot or 12%	none	none	by Warrant
Parking Lot Minimum Canopy Cover	30%	30%	30%	30%	30%	30%	30%
HEALTHY TREES STANDARDS							
Minimum Permeable Surface per Tree	450 sf	450 sf	450 sf	270 sf	25 sf	25 sf	by Warrant
Structural Soil Requirement per Tree	none	none	none	180 sf	250 sf	250 sf	by Warrant

For Healthy Urban Trees, refer to the Urban Horticulture Institute, Cornell University.

STORMWATER MANAGEMENT

This table establishes standards for managing rainwater as close to where it falls as is reasonable. Limiting the change in stormwater runoff volume, in addition to runoff release rates, is a fundamental practice to avoid overtaxing community and regional stormwater infrastructure and to preserve the health of waterways. Incorporating stormwater management features into the design of the city and its open spaces maximizes land use without the need for retention basins that are only utilized for holding water during a storm event.

Standards

The term "retain" refers to the permanent retention of water onsite, through reuse or infiltration. A certain amount of retention is necessary to avoid overtaxing both the municipal system and the watershed. The requirements are more lenient for the higher T-zones, with the understanding that these areas tend to have higher levels of imperviousness and less space for handling stormwater. This is compensated for in the stricter requirements for the lower T-zones. A development can always follow the standards of a lower Transect Zone, but can never follow the standards of a higher Transect Zone. For example, a T-6 zone may meet the standards of a T-4 zone, but not vice-versa.

Using "percentage of the change" as a standard takes into account the soil quality in any given locale. If the development occurred on soils with poor infiltration to begin with, the development would not be penalized for that. For example, if runoff volume measures 100 units before development and 120 units after, the percentage is taken from the 20-unit change.

For this submodule, the term "district" refers to the area served by the District Stormwater System. This district could be a series of lots and buildings in just one Transect Zone, or a Community Plan area or SmartCode District development containing two or more Transect Zones. If the District Stormwater System serves more than one Transect Zone, the standards for the Transect Zone that contains the most area shall be utilized.

District Stormwater System

When an entire district or neighborhood is planned at once, one stormwater management system may be developed to manage the whole development. Increased runoff in one area can be balanced by greater infiltration in another, through incorporation into a collective District Stormwater System. The standard on this portion of the table assumes that both the Lot Level standards and the District Stormwater System are being implemented. Release rates and runoff volumes apply to the entire district.

Lot Level with District Stormwater System

A lot development within an existing or simultaneously developed district development has standards for the lot that will assist in meeting the standards of the district as a whole. However, the Lot Level controls may be waived so that it is not necessary to measure release rates from the lots, as long as it is demonstrated that the District Development standard will be met without them.

Lot Level without District Stormwater System

When no District Stormwater System is present, each lot development is responsible for its own stormwater runoff volume and release rate. Standards for the Transect Zone apply to each lot separately. This is not the ideal scenario, especially for the release rates, but it accommodates the reality of existing urbanism where lots in the higher Transect Zones often don't have room for retention or detention. Nor does the existing older hardscape on such lots have the ability to allow infiltration.

General Infiltration Methods

The methods included in this table are more generalized than the Light Imprint methods, intending only to introduce the types of methods that will be necessary to meet the standards. Light Imprint *infiltration* methods may be substituted for this list; however, Light Imprint *conveyance* methods should be utilized only for the Lot Level, with a District Stormwater System to convey the water to the district system management feature, such as a community-wide bioretention area.

Hard Surface Treatments

While applicable everywhere, hard surface treatments are very effective in higher T-zones where open space is limited. Permeable paving allows water to infiltrate even in frequently trafficked areas. Green roofs can reduce runoff by 20-90% depending on construction and season, while slowing peak discharge in storm events. Green roofs are especially relevant in higher T-zones and Special Districts (SD) where large flat roofs comprise a high percentage of the impervious surface area. See www.greenroofs.org.

Reuse of Rainwater

Rainwater for irrigation and use within a building is another management technique that is applicable even in higher Transect Zones, though currently it is most effective in the lower T-zones. Irrigation is a simple way to redirect collected rainwater to vegetated areas, eliminating the use of drinking water for irrigation. Methods can be as simple

(continued)

Table SU7: Stormwater Management. This table provides methods for on-site stormwater management to minimize post-development increases in stormwater runoff.

	T1	T2	T3	T4	T5	T6	SD
STANDARDS - REGIONAL SCALE (ARTICLE 2), COMMUNITY SCALE (ARTICLE 3 , ARTICLE 4) OR MULTIPLE BUILDINGS (ARTICLE 5)							
District Stormwater System Development of a community or portion of a community with a centralized system.							
Runoff Volume: retain this percentage of the change in runoff volume between post-development impervious surface and pre-development land surface for the 2 year event	100%	100%	70%	50%	20%	10%	by Warrant
2 Year Allowable Runoff Release Rate: as a percentage of the pre-development 2 year discharge rate	100%	100%	60%	60%	50%	50%	by Warrant
100 Year Allowable Runoff Release Rate: as a percentage of the pre-development 100 year discharge rate	100%	100%	60%	60%	50%	50%	by Warrant
STANDARDS - BUILDING SCALE (ARTICLE 5)							
Lot Level with District Stormwater System							
Runoff Volume: retain this percentage of the change in runoff volume between post-development impervious surface and pre-development land surface for the 2 year event	100%	100%	70%	40%	30%	30%	n/a
Lot Level without District Stormwater System							
Runoff Volume: retain this percentage of the change in runoff volume between post-development impervious surface and pre-development land surface for the 2 year event	100%	100%	70%	40%	30%	30%	n/a
2 Year Allowable Runoff Release Rate: as a percentage of the pre-development 2 year discharge rate	100%	100%	150%	200%	n/a	n/a	n/a
100 Year Allowable Runoff Release Rate: as a percentage of the pre-development 2 year discharge rate	100%	100%	150%	200%	n/a	n/a	n/a
GENERAL INFILTRATION METHODS							
Hard Surface Treatment							
Permeable Pavement			■	■	■	■	■
Green Roof				■	■	■	■
Reuse of Rainwater							
Reuse, Irrigation	■	■	■	■	■	■	■
Reuse, Greywater	■	■	■	■	■	■	■
Linear Infiltration							
Vegetated Swale (Bioswale)	■	■	■	■			■
Vegetated Stormwater Planters				■	■	■	■
Area Infiltration							
Rain Garden		■	■	■	in parking lots		■
Retention Basin		■	■	■	■		■
District Methods							
Retention Areas		■	■	■			■
Underground Gravel Storage			■	■	■	■	■

Chart information from Tom Price, Conservation Design Forum

(cont. Table SU7 - Stormwater Management)

as a rain barrel, or as complicated as an entire irrigation system. A Greywater system uses collected water for non-potable uses, such as flushing toilets. Some level of purification may be required by local building codes.

Linear Infiltration

These strategies allow water to infiltrate into the ground while moving overflow water to a final destination, which may be an infiltration area as part of a larger management plan or the municipal storm drain. These are most applicable along roads, lot lines, and in parking lot islands, to absorb runoff from the pavement and filter out pollutants. An open, vegetated swale (bioswale) is most appropriate in lower T-1 to T-4 zones. Hard-edged, vegetated planters are appropriate in the T-4 to T-6 zones. See also the basic Natural Drainage Module by PlanGreen, available in text form at www.smartcodecentral.org.

Area Infiltration

A rain garden is a small scale feature that collects and infiltrates rainwater on a lot by lot basis or as a culmination of a linear infiltration system. It may be an open, sloped area or a hard-edged planter. Rain gardens are extremely effective and easy to install in T-2 to T-4 zones and are also useful in parking lots in T-5. Retention basins are larger scale rain gardens that are typically large open grass areas, but may be planted similarly to a rain garden. For a Lot Level system, these are most appropriate in the lower Transect Zones because of the large land area required.

District Stormwater System Methods

Retention areas that are designed as part of a larger stormwater management plan are appropriate in lower T-zones (T-1 to T-4) when they are incorporated into public spaces and parks. Retention areas should always be functional as a recreational or environmental area, along with their stormwater management role. Retention areas should be shallow with shallow side slopes, covering a large area that may fill with water during a storm event. As the water infiltrates, the area becomes dry and is utilized as any other large landscape area.

Underground gravel storage areas can be utilized in all Transect Zones. In lower T-zones, they can be used under large pavement, such as a parking lot, or lawn areas in civic spaces for storage and infiltration of rainwater. In higher T-zones, underground gravel storage areas can be utilized under plazas or streets to store stormwater until it infiltrates or is reused.

ARTICLE 7. DEFINITIONS OF TERMS - SUSTAINABLE URBANISM

Albedo: the amount of solar radiation reflected by a surface.

Biomass: fuel derived from living or recently dead organic material.

Building Envelope: collectively, all components of a building that enclose conditioned or unconditioned above-ground space, including foundation, roof, walls, doors and windows.

Carshare: a type of short term vehicle rental which can substitute for car ownership by providing cars parked within neighborhoods.

Combined Heat and Power: characterizing a District Energy plant that manages on-site energy generation to recover heat from electrical generation for use in industrial processes, or in heating and cooling systems.

Daylight Factor: a measurement for daylight in a building, calculated as a ratio of the unshaded exterior illuminance on a horizontal plane, under a fully overcast sky, over interior illuminance on a horizontal plane. The higher the daylight factor, the more natural light is available in the room.

District Energy: technology for energy production and distribution in which a central plant provides energy for multiple users.

District Stormwater System: a stormwater system that manages runoff from multiple Lots.

Double Skin: an additional external building Facade that allows air to circulate in the space between the two Facades, providing an extra layer of insulation and air flow.

Full Cutoff: a Luminaire type that does not allow any light to be emitted or reflected above a horizontal plane.

Green Roof: a building roof partially or completely covered with vegetation and soil, or a growing medium, over a waterproofing membrane. Green roofs may be categorized as Extensive, Semi-Intensive, or Intensive, depending on the depth of the planting medium and the amount of maintenance required. *See Natural Drainage Standards Module.* (Syn: eco-roof, living roof, greenroof)

Ground Source Heat Exchange: a process by which the relatively constant temperature below ground is used in building climate control systems as a heat source for heating, or a heat sink for cooling.

Initial Lumens: a measure of how much light a lamp is emitting near the beginning of its life.

Lamp: The source of illumination in a lighting fixture.

Light Shelf: a horizontal overhang placed in a window above eye level, which reflects daylight onto the ceiling and deeper into a room. The overhang of the shelf also provides shade near the window to reduce window glare.

Linear Infiltration: a method to allow water to infiltrate into the ground while moving overflow to a final destination.

Lumen: a measure of brightness.

Luminaire: a light unit or fixture including any bulb(s), tube(s), housing, reflective shield, lens and/or ballast.

One-hundred Year Storm Event: a 24-hour rainstorm having a one percent chance of occurrence in any given year.

Photovoltaic (PV): capable of producing voltage when exposed to radiant energy, especially light.

Rideshare: a transportation mode in which vehicles carry additional passengers. (Syn: carpooling.)

Runoff Release Rate: the quantity per unit of time at which stormwater runoff is released from upstream to downstream land.

Solar Reflective Index (SRI): a measure of the constructed surface's ability to reflect solar heat, as shown by a small temperature rise. Numerically, standard black is 0 and a standard white is 100.

Stormwater Runoff Volume: the volume of water that results from precipitation that is not absorbed by the soil, evaporated into the atmosphere, or entrapped by ground surface depressions and vegetation, and that flows over the ground surface.

Structural Soil: a load-bearing soil that resists compaction to allow for healthier tree root growth. Angular gravel within the soil mix allows air and water to permeate while supporting pavement loads.

Surface to Volume Ratio (S/V Ratio): the amount of surface exposed to the outside per volume of building unit.

Transportation Demand Management (TDM): policies and strategies that are the basis for decisions made related to transportation demand and choice of mode.

Two Year Storm Event: a 24-hour rainstorm having a fifty percent chance of occurrence in any given year.

Zero Net Energy: energy production of a building that is equal to or greater than what the building consumes.