city of chandler
green building program

Green Site Design Strategies

The intent of these Green Site Design Strategies is to provide green building suggestions to new non-residential, multi-family residential and mixed-use developments. These suggested green development practices are entirely optional[1], but encouraged because incorporating these strategies can enhance the sustainability of a new development and result in cost savings from reduced water and energy consumption.

These Green Site Design Strategies are organized around five main objectives:

1. Improve opportunities to utilize public transit, bicycle, and pedestrian modes of transportation.
2. Reduce the urban heat island impact resulting from new buildings and paved surfaces.
3. Provide increased shade for parking lots, pedestrian paths, and building entrances and windows.
4. Incorporate energy-efficient design into site layout and building design so as to reduce nonrenewable energy requirements to meet buildings' cooling needs.
5. Promote water conservation efforts.

[1] Although these "Green Site Design Strategies" are optional, Zoning Code requirements are mandatory. Meeting strategies suggested within this document will not exempt a project from meeting Zoning Code requirements. For questions regarding the Zoning Code, view the code at www.municode.com, or contact a planner at 480-782-3000.

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Suggested Green Strategies List

1. Alternative Transportation

a.	Provide direct pedestrian connections to transit stops.
b.	Provide direct pedestrian connections to neighboring properties.
c.	Orient buildings toward transit stops and pedestrian/ bicycle routes.
d.	Provide shade and seating at transit stops.
e.	Provide shade along pedestrian corridors.
f.	Provide pedestrian amenities such as benches, tables and shade structures.
g.	Provide abundant bicycle storage.
h.	Cover bicycle storage.
i.	Provide changing and/or showering facilities for bicyclists/ pedestrians.
j.	Provide enhanced bicycle storage (Bicycle lockers, restricted access storage rooms, etc.).
k.	Provide preferred parking spaces for carpool.
l.	Provide preferred parking for low-emissions/ alternative fuel vehicles.
m.	Provide charging stations for electric vehicles.

2. Urban Heat Island Reduction

a.	Refrain from exceeding minimum parking requirements.
b.	Utilize permeable and/or light-colored parking surfaces[1].
c.	Provide covered parking. To meet the intent of this strategy, parking covers should be comprised of low-emissivity/ high-reflectivity materials so as to minimize the amount of solar heat gain.
d.	Utilize light-colored, low-emissivity building materials.
f.	Install a "cool roof" or a green, vegetated roof.
g.	Provide extra landscaping/ unpaved open space areas.

3. Shade

a.	Provide shade through low-water native landscaping or shade structures.
b.	To be most effective, concentrate shade on pedestrian walkways, building exteriors and parking surfaces.

4. Energy Efficient Design

a.	Orient building to minimize solar heat gain (minimize east-west exposure).
b.	Shade building with trees, overhangs, awnings, etc.
c.	Utilize exterior roof materials/ roof colors that minimize solar heat absorption.
d.	Recess windows and building entrances to provide shade. Additional shade from trees, overhangs, awnings, etc. is also recommended.
e.	Refrain from using dark, heat-absorbing building materials.
f.	Avoid locating buildings immediately adjacent to dark, heat-absorbing paving materials.
g.	Design building to accommodate solar panels (structurally and aesthetically).
h.	Install on-site renewable energy.
i.	Limit the amount of east- and west-facing windows. Shade east-, west- and south-facing windows.
j.	Allocate an area on site for the collection and pickup of recyclables.

5. Water Conservation

a.	Landscape with desert species and minimize turf areas where possible.
b.	Install high efficiency irrigation equipment (i.e. smart, weather-based sensors).
c.	Install a rainwater harvesting system and use collected rainwater to irrigate landscaping.
d.	Use treated greywater or municipal reclaimed water to irrigate landscaping.
e.	Refrain from using waterfalls, fountains, and other water features when reclaimed water is not available.

1. Any alternative paving material must be approved by the City Engineer.

OBJECTIVE 1

"Improve opportunities to utilize public transit, bicycle, and pedestrian modes of transportation."

Suggested Green Strategies

Figure 1
Pedestrian Connection

- Provide direct pedestrian connections to transit stops.
- Provide direct pedestrian connections to neighboring properties.
- Orient buildings toward transit stops and pedestrian/ bicycle routes – place buildings, not parking lots, near the street.
- Provide shade and seating at transit stops.
- Provide shade along pedestrian corridors.
- Provide pedestrian amenities such as benches, tables and shade structures.
- Provide abundant bicycle storage.
- Cover bicycle storage.
- Provide changing and showering facilities for bicyclists/ pedestrians.
- Provide enhanced bicycle storage (Bicycle lockers, restricted access storage rooms, etc.).
- Provide preferred parking spaces for carpool.
- Provide preferred parking for low-emission/ alternative fuel vehicles.
- Provide charging stations for electric vehicles.

Figure 2
Pedestrian-Oriented Buildings

Rationale

Private automobile travel has been the dominant mode of transportation in the United States for several decades. Although the private automobile offers increased flexibility and shorter travel times, the dominance of the automobile also leads to many social and environmental problems. For example, transportation is responsible for approximately 33% of the nation's greenhouse gas emissions[2].

By promoting alternative modes of transportation, such as public transit, greenhouse gas emissions and other environmental and social problems can be significantly reduced. Some benefits that result from increased public transit use include:

[2] Davis, T. and Hale, M. "Public Transportation's Contribution to Greenhouse Gas Reduction" *SAIC: From Energy to Solutions, September 2007.* http://www.publictransportation.org/reports/asp/climate_change.asp

Reduced Greenhouse Gas Emissions - In 2005, national public transportation use resulted in a reduction of 6.9 million metric tonnes of CO_2 emissions. The emissions reductions represent an approximate 25% reduction compared to the emissions that would have been generated by transit users if they had driven private vehicles[3].

Smog Reduction – On a per-capita basis, public transit generates far less smog-producing pollutants than private vehicles. Public transit results in significant reductions of Volatile Organic Compounds (VOCs), a key component in the creation of ground-level ozone, Nitrogen Oxides (No_x) and Carbon Monoxide (CO)[4].

Financial Benefits – The average household spends about $0.18 of every dollar on transportation costs[5]. Transit, and to a greater degree, bicycle and pedestrian modes of transportation, typically leads to a reduction in household transportation expenditures.

Energy Conservation – In terms of the number of miles traveled per person, public transportation is on average twice as fuel efficient as private vehicles[6].

Reduced Congestion – Increased transit use results in fewer cars on the transportation network. In 2005, this reduction in congestion resulted in a nationwide reduction of 3 million metric tonnes of CO_2 emissions[7]. Congestion reduction also reduces the need for additional highway expansions, saving considerable amounts of tax revenue.

Public Health – Increased exercise from additional walking and biking, combined with smog and pollution reduction, yields public health benefits.

Figure 3
Cool Roof

OBJECTIVE 2

"Reduce the urban heat island impact resulting from new buildings and paved surfaces."

Suggested Green Strategies

- Minimize impermeable surfaces
  - Refrain from exceeding minimum parking requirements.

[3] Davis, T. and Hale, M. "Public Transportation's Contribution to Greenhouse Gas Reduction" *SAIC: From Energy to Solutions, September 2007.* http://www.publictransportation.org/reports/asp/climate_change.asp
[4] American Public Transportation Association. http://www.apta.com/research/info/online/ben_overview.cfm
[5] American Public Transportation Association. http://www.apta.com/research/info/online/ben_overview.cfm
[6] American Public Transportation Association. http://www.apta.com/research/info/online/ben_overview.cfm
[7] Davis, T. and Hale, M. "Public Transportation's Contribution to Greenhouse Gas Reduction" *SAIC: From Energy to Solutions, September 2007.* http://www.publictransportation.org/reports/asp/climate_change.asp

  - Utilize permeable parking surfaces[8].
- Utilize light-colored parking surfaces.
- Provide underground or covered parking. Parking covers should be built with low-emissivity/ high-reflectivity materials.
- Utilize light-colored, low-emissivity building materials.
- Install open-grid parking surfaces.
- Install a "cool roof" or a green, vegetated roof. Green roofs can provide the opportunity for a community garden.
- Provide extra landscaping/ unpaved open space areas.

Figure 4
Pervious Concrete

Rationale

The Urban Heat Island is caused by heat absorbing building and paving materials. An abundance of non-natural materials that are able to store heat at greater rates than natural materials results in higher urban temperatures when compared to surrounding areas. These heat-absorbing materials slowly release stored heat during the night, contributing to higher urban nighttime temperatures.

The Phoenix metropolitan area's urban heat island results in significantly higher temperatures. Summer daytime high temperatures are an average of 1.1° F higher due to the heat island[9]. Nighttime temperatures are even more dramatically impacted. In 1948, Phoenix's average nighttime low temperature in summer was 75° F. As Phoenix urbanized, nighttime temperatures climbed. By 2003, the average nighttime low temperature was 86.7° F[10]. If the heat island is not addressed, future urban development could further drive up this nighttime temperature.

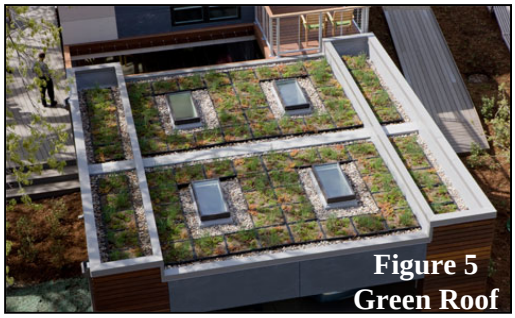

Figure 5
Green Roof

In addition to making summer temperatures increasingly uncomfortable, the urban heat island has negative energy and water implications as well. Salt River Project (SRP) estimates that each one-degree increase in temperature results in an additional $5 to $7 of monthly household cooling costs[11]. As temperatures rise, more water is needed for landscaping, swimming pools and other outdoor

[8] Any alternative parking surface must be approved by the City Engineer.
[9] ASU Global Institute of Sustainability, 2007. Guhathakurta, S. "The Impact of Urban Heat Islands on Water Use: The Case of Phoenix Metropolitan Area." http://dcdc.asu.edu/research/impactofUHI.pdf
[10] Gelt, J. "Urban Heat Island – Higher Temperatures and Increased Water Use". *Arizona Water Resource*, 15 (1). September-August 2006. http://ag.arizona.edu/AZWATER/awr/septoct06/feature1.html
[11] Yozwiak, S. "Island Sizzle; Growth may Make Valley an Increasingly Hot Spot". *The Arizona Republic*, September 25, 1998. http://www.sepp.org/Archive/reality/arizrepub.html.

water uses. The Arizona State University (ASU) Global Institute of Sustainability attributes a 2% increase in water use for each 1% increase in nighttime temperature[12].

OBJECTIVE 3:

"Provide increased shade for parking lots, pedestrian paths, and building entrances and windows."

Suggested Green Strategies

- Provide shade through low-water native landscaping such as mesquite or palo verde trees.
- Shade can also be provided through structures such as trellises, overhangs, awnings, canopies and parking covers.
- To be most effective, shaded areas can concentrate on pedestrian walkways, parking lots and building exteriors (particularly building entrances and windows).

Figure 6
Pedestrian Shade Area

Figure 7
Shaded Walkway

Rationale

With summertime temperatures exceeding 115° F, and few cloudy or rainy days in the months of May and June, the summer sun can be somewhat unbearable. Creating shade in urban developments creates a much more pleasant environment for Chandler residents, employees and visitors. These more appealing environments can serve to attract additional retail customers, further invigorating the City's economy. Shaded environments also reduce the extent of the urban heat island caused by urban development.

Figure 8
Shaded Building

[12] ASU Global Institute of Sustainability, 2007. Guhathakurta, S. "The Impact of Urban Heat Islands on Water Use: The Case of Phoenix Metropolitan Area." http://dcdc.asu.edu/research/impactofUHI.pdf

OBJECTIVE 4:

"Incorporate energy-efficient design into the site layout and building design so as to reduce nonrenewable energy use to meet buildings' cooling needs."

Figure 9
Limited South-facing Windows

Suggested Green Strategies

- Orient building to minimize solar heat gain
  - Design buildings in a manner that minimizes east and west-facing building surface areas.
- Shade building with trees, overhangs, awnings, etc.
- Utilize exterior roof materials/ roof colors that minimize solar heat absorption (cool roof/ green roof).
- Shade windows and building entrances through the use of trees, overhangs, awnings, etc. Recessing windows and doors can also be an effective shading strategy.
- Refrain from using dark, heat absorbing exterior building materials.
- Avoid locating buildings immediately adjacent to dark, heat-absorbing paving materials.
- Design building to accommodate solar panels (structurally and aesthetically).
- Install on-site renewable energy.
- Limit the amount of east- and west-facing windows. Only provide an abundance of south-facing windows if they are adequately shaded.
- Allocate an area on site for the collection and pickup of recyclables.

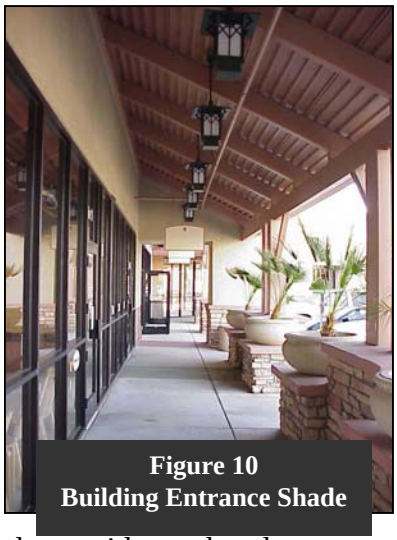

Figure 10
Building Entrance Shade

Rationale

Buildings are responsible for the consumption of 36% of the nation's total energy and 65% of the nation's electricity consumption. This energy use constitutes a large portion of the nation's greenhouse gas production. Buildings are responsible for the generation of 36%, 46% and 19% of the nation's carbon dioxide, sulfur dioxide, and nitrogen oxides emissions, respectively[13].

Many initial site and building design strategies can help to reduce the amount of energy needed to operate buildings. Passive solar design can lead to reductions in heating and cooling costs. Shading buildings, reducing the amount of heat absorbed by the building

[13] United States Green Building Council. http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1718

and it surroundings, can further reduce cooling costs. Natural daylighting approaches can reduce the amount of energy required for lighting buildings.

OBJECTIVE 5:

"Promote water conservation efforts."

Figure 11
Low Water Use Landscaping

Suggested Green Strategies

- Install high efficiency irrigation equipment (i.e. smart, weather-based sensors)
- Landscape with desert species.
  - Provide shade through low-water use species.
  - Minimize turf areas.
- Install a rainwater harvesting system and use collected rainwater to irrigate landscaping.
- Use treated greywater or municipal reclaimed water to irrigate landscaping.
- Refrain from using waterfalls, fountains, and other water features when reclaimed water is not available.

Rationale

Figure 12
Desert Landscaping

With just over nine inches of rainfall per year, Chandler's local water supply is limited[14]. As Chandler's population continues to grow, more and more water is being used. According to the United States Geological Survey (USGS), the Lower Colorado River Region (Arizona and a small portion of Nevada and New Mexico) is the only region in the nation that uses more water than is being replenished. In fact, this region uses 300 million gallons per day more than is being replenished[15].

The City has done a great job assuring access to water resources from around the state, but as the population continues to grow, water conservation is becoming more critical. Increased water conservation can preserve the city's potable water supply while reducing costs for water infrastructure, pumping and treating water. Because treating and pumping water uses large amounts of energy, conserving water also conserves energy.

[14] www.weather.com

[15] USGS, 1995. http://pick18.pick.uga.edu/mp/20q?go=http://water.usgs.gov/watuse/misc/consuse-renewable.html