



5.4 Impacts of Urbanization and Methods to Reduce Urban Runoff

College Board Topics 5.10 and 5.13

RSK pg. 335 - 354

Learning Objectives and Essential Knowledge

ENDURING UNDERSTANDING

EIN-2

When humans use natural resources, they alter natural systems.

LEARNING OBJECTIVE

EIN-2.M

Describe the effects of urbanization on the environment.

ESSENTIAL KNOWLEDGE

EIN-2.M.1

Urbanization can lead to depletion of resources and saltwater intrusion in the hydrologic cycle.

EIN-2.M.2

Urbanization, through the burning of fossil fuels and landfills, affects the carbon cycle by increasing the amount of carbon dioxide in the atmosphere.

EIN-2.M.3

Impervious surfaces are human-made structures—such as roads, buildings, sidewalks, and parking lots—that do not allow water to reach the soil, leading to flooding.

EIN-2.M.4

Urban sprawl is the change in population distribution from high population density areas to low density suburbs that spread into rural lands, leading to potential environmental problems.

ENDURING UNDERSTANDING

STB-1

Humans can mitigate their impact on land and water resources through sustainable use.

LEARNING OBJECTIVE

STB-1.B


Describe methods for mitigating problems related to urban runoff.

ESSENTIAL KNOWLEDGE

STB-1.B.1

Methods to increase water infiltration include replacing traditional pavement with permeable pavement, planting trees, increased use of public transportation, and building up, not out.


SUGGESTED SKILL

 *Environmental Solutions*

7.C

Describe disadvantages, advantages, or unintended consequences for potential solutions.

SUGGESTED SKILL

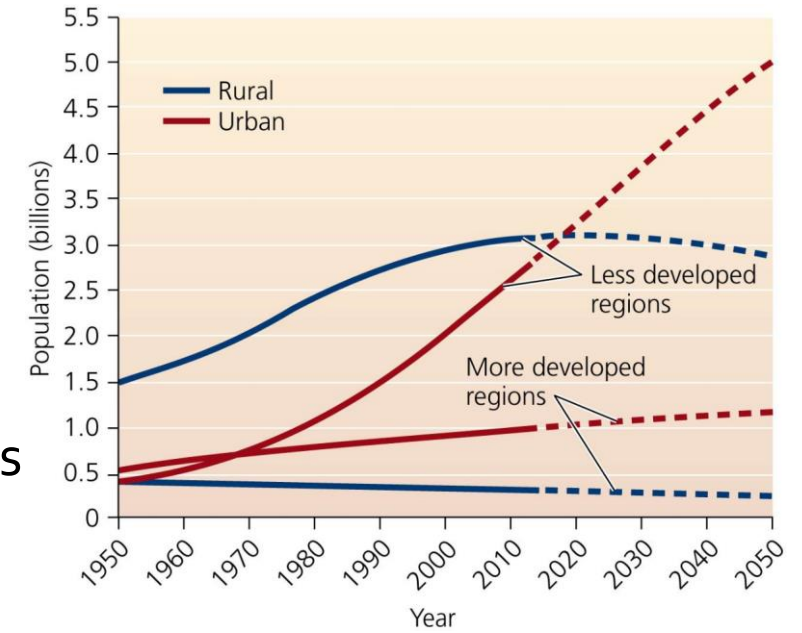
 *Scientific Experiments*

4.B

Identify a research method, design, and/or measure used.

Our Urbanizing World

- **Not only is the human population growing overall, it is growing fastest in urban areas**
 - Since 2009, more people worldwide have been living in urban areas than rural ones
 - *Urbanization*: People are moving from rural to urban areas (cities and suburbs)
- **Urbanization began when agricultural surpluses allowed people to leave their farms**
 - Mechanization made farming more efficient, requiring less farmers
 - *The industrial revolution* created jobs and opportunities in cities, and increased production efficiencies
 - Created specialized manufacturing professions, class structure, and urban centers
- **There are 23 “megacities” of over 10 million people**
 - New York and Los Angeles in the U.S.



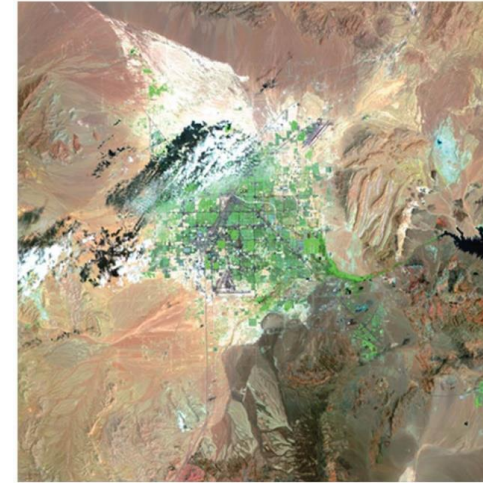
Source: US Environmental Protection Agency

The Growth of Suburbs

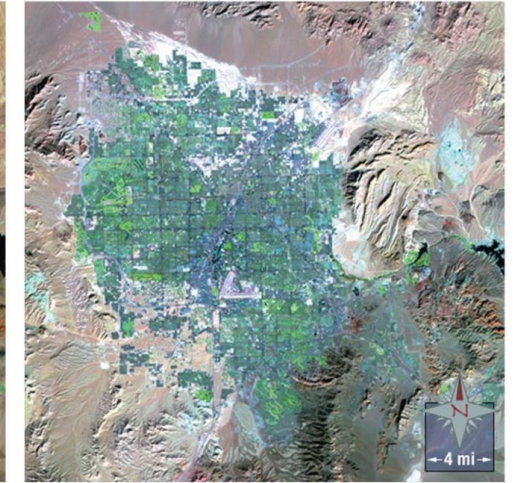
- **By the mid-1900s, industrialization, immigration and trade had increased urbanization**
 - Urban population growth often exceeds economic growth and opportunity, resulting in overcrowding, pollution, and poverty
- **Affluent people left the city and moved to suburbs**
 - Suburbs had more space
 - Cheaper real estate and economic opportunities
 - Less crime and better schools
- **Inner cities declined**
 - Chicago's urban population dropped to 80% of its peak, Philadelphia to 76%, Detroit to 55%. Portland's growth stalled but was restarted due to new policies to revitalize the city center
- **Millions now commute to downtown jobs from suburban communities**
 - Automobiles, fueled by abundant, cheap oil and an expanding road network made suburbia possible
 - Jet travel, cell phones, the Internet, and video conferencing allow easier communication from any area
 - No longer vital to live close to a central office
 - Makes suburban living easier

Urban Sprawl

- ***Sprawl*** is defined as the physical spread of development at a faster rate than the population growth rate
 - The spread of suburban development outward from an urban center
 - Environmentally harmful, and inefficient
 - Sprawl makes urban/suburban areas less densely populated even as population size increases
 - From 1950 to 2000, the population of Phoenix grew 12 times larger, but its land area grew 27 times larger
 - Increasing population densities would help reduce sprawl
- **Two major factors contribute to sprawl: population growth and per capita land consumption**
 - People desire space and privacy resulting in greater per capita land consumption

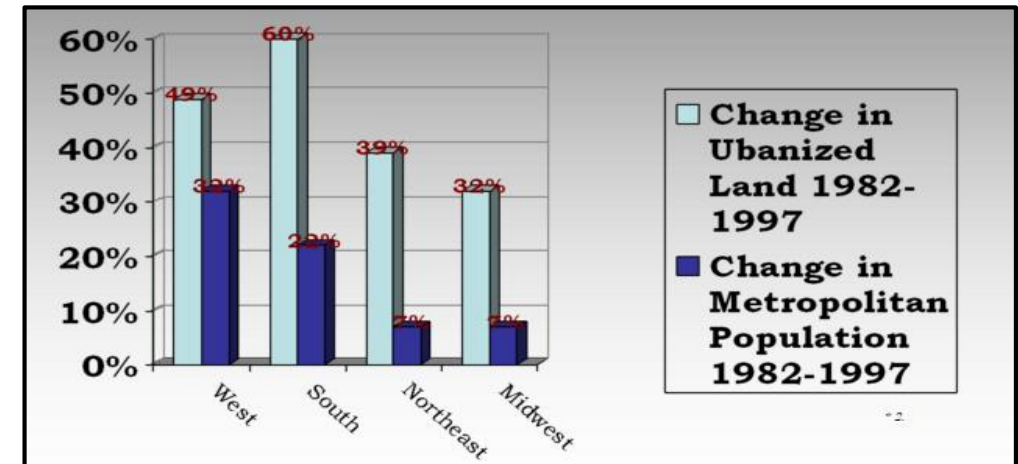


(a) Las Vegas, Nevada, 1984



(b) Las Vegas, Nevada, 2009

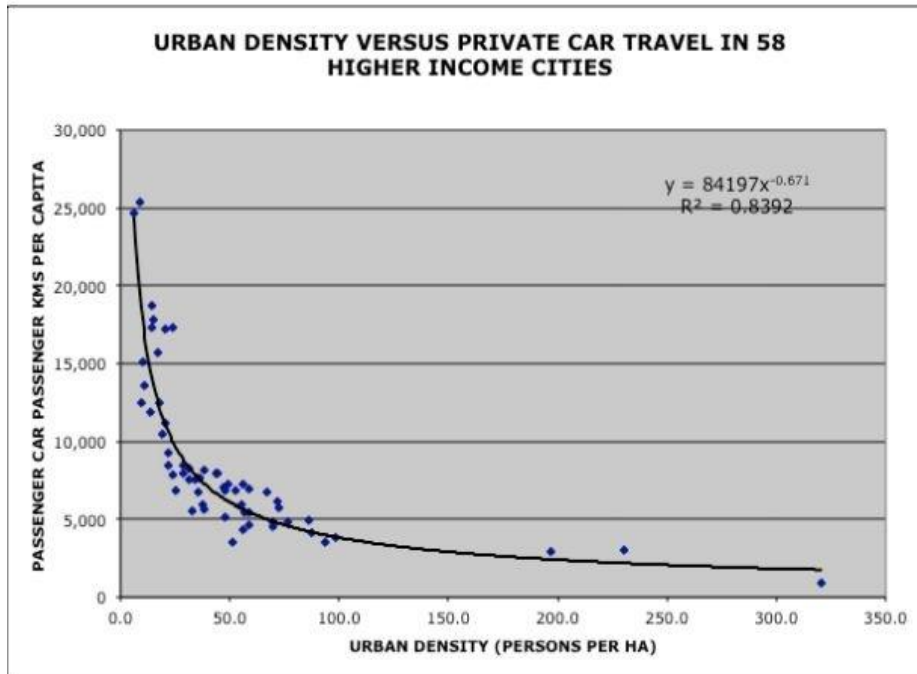
Houses and roads replace 2700 ha (6700 acres) of natural environment in the U.S. every day!



What's Wrong with Sprawl?

- **Transportation**

- Need to own cars and drive more
- Lack of mass transit options
- Increased dependence on petroleum



- **Health**

- sprawl promotes physical inactivity because driving cars replaces walking
- Increases obesity and high blood pressure
- More traffic accidents
- Higher incidence of asthma / respiratory disease

- **Economics: sprawl drains tax dollars from communities**

- Large, low-density urban areas require more money to maintain
 - For roads, water and sewer systems, electricity, police and fire services, schools, etc.
- Money for maintenance comes from taxes
- As urban areas sprawl, area to be maintained increases faster than the tax base of the population

- **Land use: less forests, fields, farmland, or ranchland**

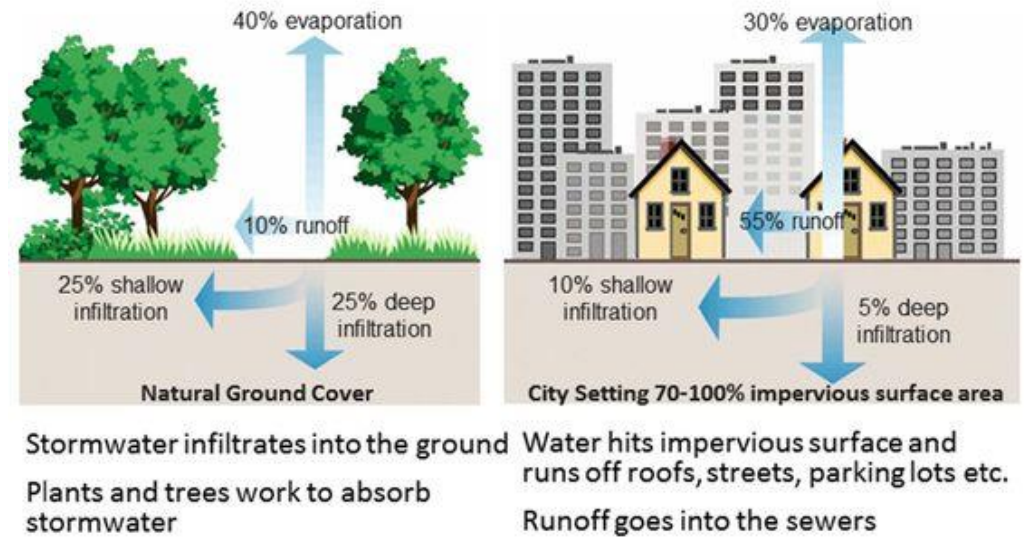
- Loss of resources, recreation, beauty, wildlife habitat, ecosystem services
- People lose access to experiences with nature, especially important for children

What's Wrong with Sprawl?

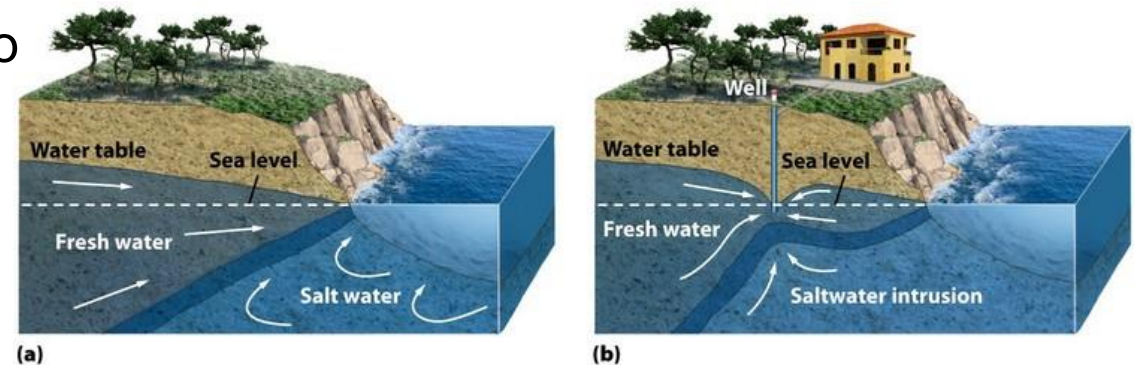
Cities Alter Climate

- **Impervious surfaces** (asphalt, concrete) reduce infiltration of water into soils
 - Increases rates of run off and volume of runoff, which increases erosion of soils and flooding downstream.
 - Reduces the **recharge rate** of aquifers that many cities depend on for water and can result in **salt water intrusion** to coastal freshwater aquifers
 - Run off contains litter, oils, gasoline, grease, animal feces, fertilizers and sediment and usually runs directly into natural waterways without treatment.
- City air is drier and less humid
 - Less water can evaporate from city surfaces due to rapid rates of run off.
 - Less vegetation means less transpiration
 - However, particulates in the air speed water condensation and increase the frequency of precipitation over cities

NATURAL vs. URBAN STORMWATER DRAINAGE

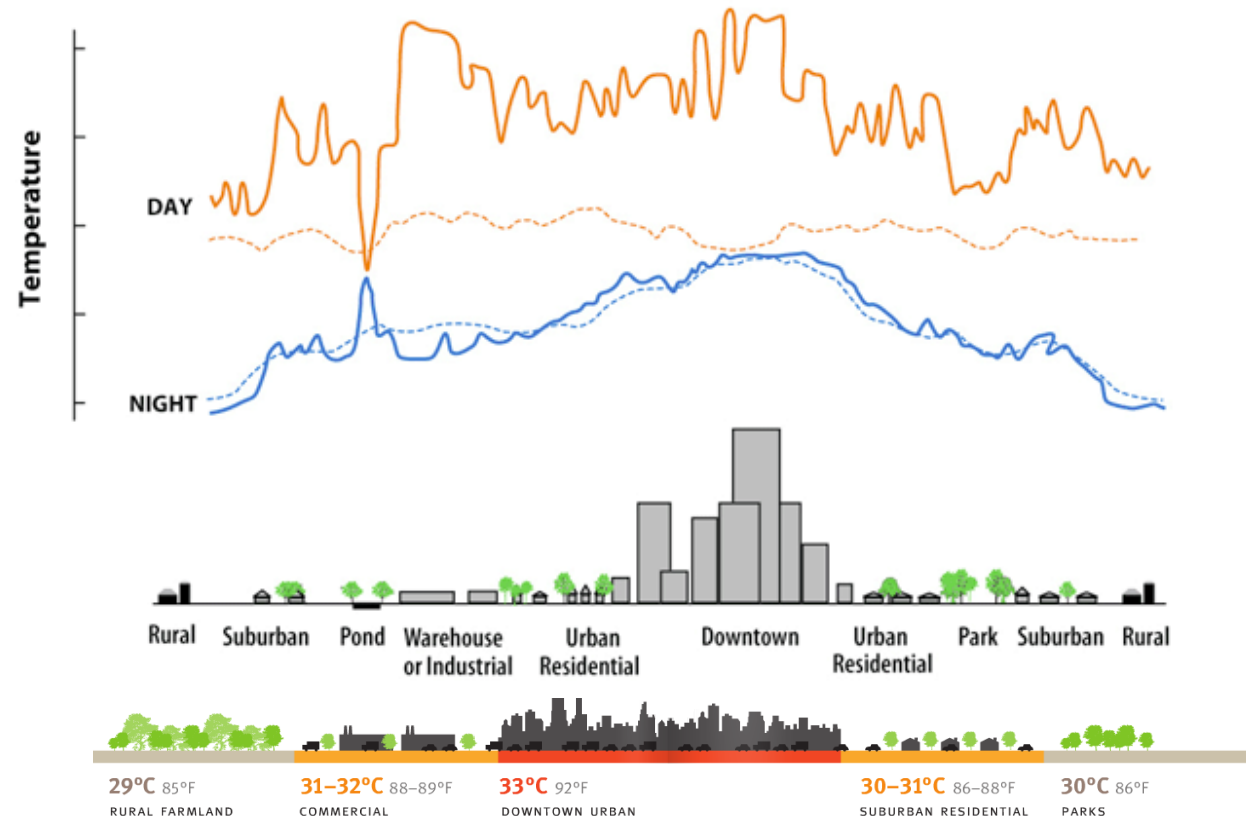
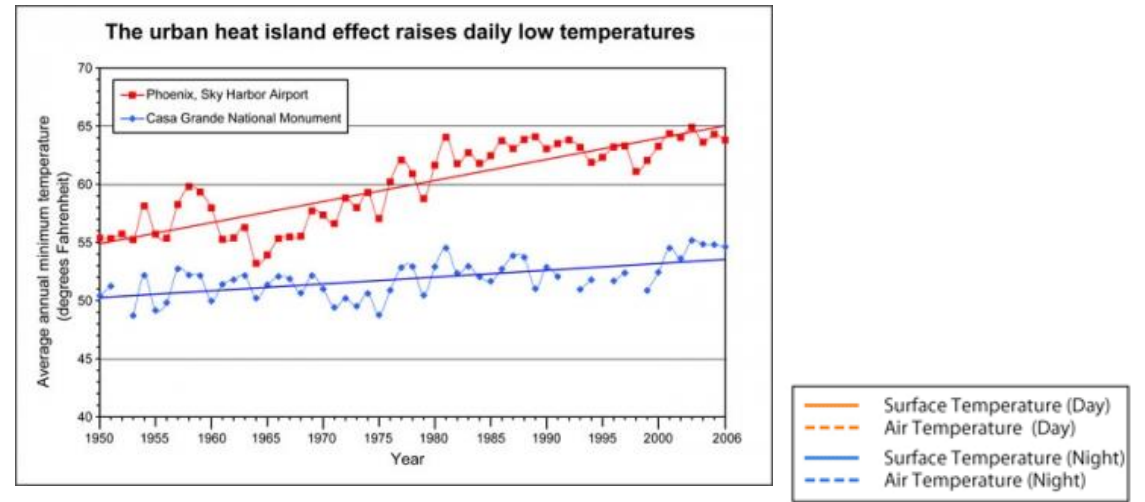


http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/alphabetical/water/restoration/?cid=nrcs143_026903



What's Wrong with Sprawl?

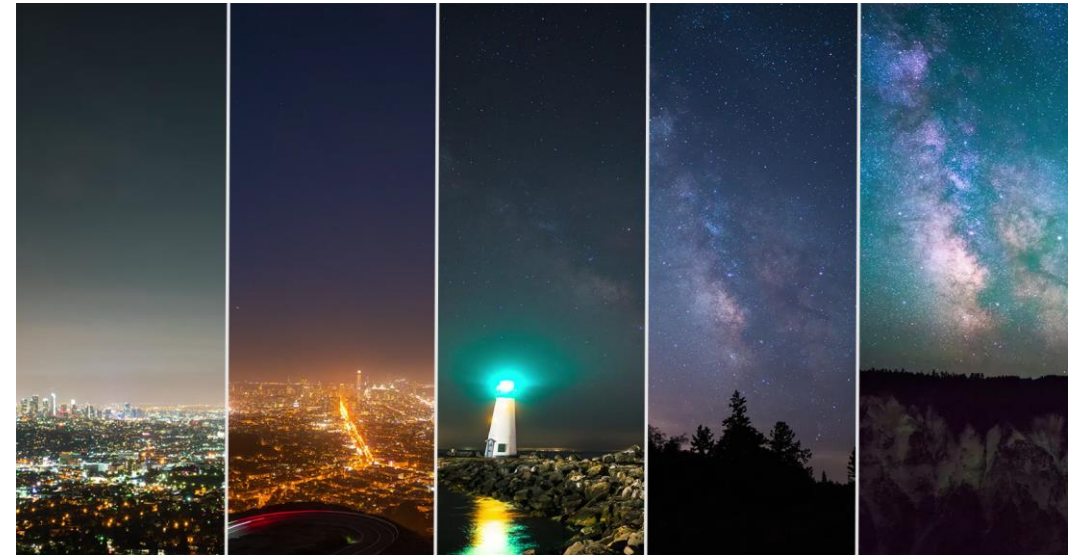
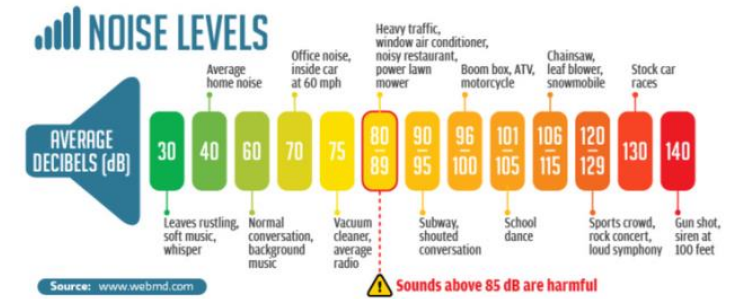
- “Urban Heat Island Effect”
 - Buildings, vehicles, factories, and people generate waste heat
 - Cities have lower *albedo* (lower reflectivity, greater absorption) than natural surfaces (Dark colored buildings and pavement absorb energy and radiate heat.)
 - Less vegetation and rapid runoff makes city air drier (less humid) and more readily heated
 - Lower average wind speeds reduce convective cooling of surfaces
- Results in temperatures that are higher than natural areas surrounding the city, especially overnight



What's Wrong with Sprawl?

Urban Areas suffer and export pollution

- **Increased Air Pollution**
 - Air pollutants from concentrated combustion of fossil fuels for transportation and manufacturing: carbon dioxide, ozone, smog, acid precipitation
- **Increased Water Pollution**
 - More pavement leads to more runoff carrying other pollutants into natural waterways through storm drains
 - Motor oil and road salt from roads and parking lots
- **Noise pollution**
 - Undesired ambient sound
 - Degrades surroundings, stressful, hurts hearing
- **Light pollution**
 - light that obscures the night sky, impairing the visibility of stars
- **Thermal Pollution**
 - Cities are hotter than surrounding rural and natural areas



Los Angeles

Great Basin National Park (Eastern Nevada)

Creating Livable Cities

- **Zoning:** the practice of classifying areas for different types of development and land use
 - Involves government restriction on the use of private lands
 - Opponents say that its restrictions violate individual freedoms
 - Proponents say government can set limits for the good of the community
 - People have generally supported the use of zoning
- **Urban growth boundaries (UGB)**
 - a line on a map intended to separate areas desired to be urban from areas desired to remain rural
 - Try to concentrate development, prevent sprawl, and preserve farmland and habitat
 - Portland, OR was one of the first large-scale attempts to limit sprawl with urban growth boundaries



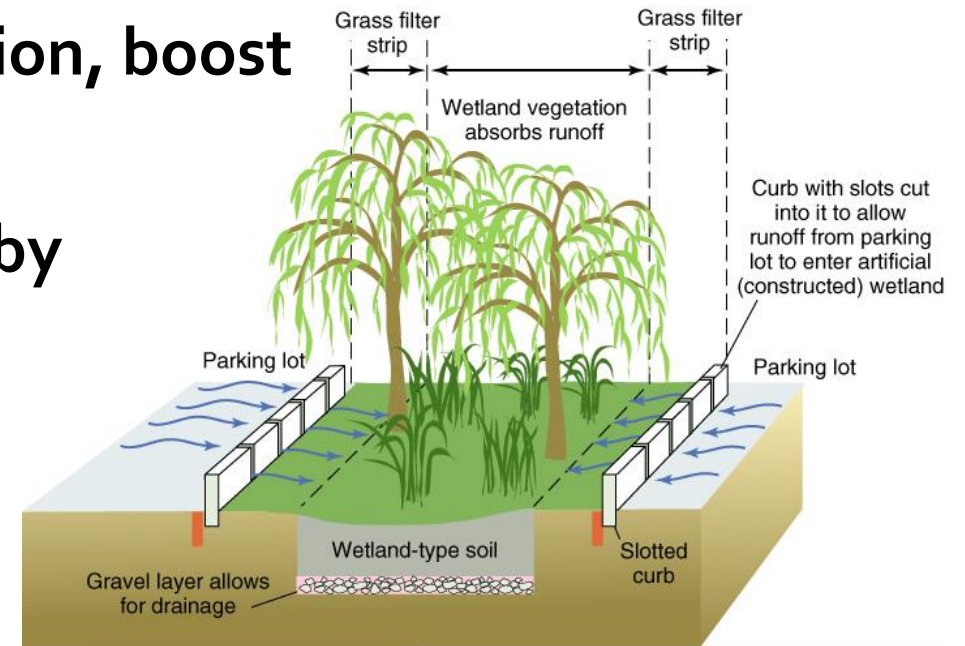
“Smart growth” aims to counter sprawl

- ***Smart growth*; “Building up, not out” (Gaslamp Redevelopment)**
 - Focusing development on rejuvenating existing areas
 - Increasing density of urban areas, not area of urban areas
 - Favoring multistory shop-houses and high-rises
- **“*New urbanism*” neighborhoods are designed on a walkable scale and a families needs can mostly be met without a car**
 - Homes, businesses, and schools are close together
 - Green spaces, mixed architecture, creative street layouts
- ***Transit-oriented development* (San Diego Trolley expansion)**
 - compact communities arrayed around stops on a major rail transit line
 - People can travel by train between neighborhoods and by foot within neighborhoods



Urban residents benefit from parklands

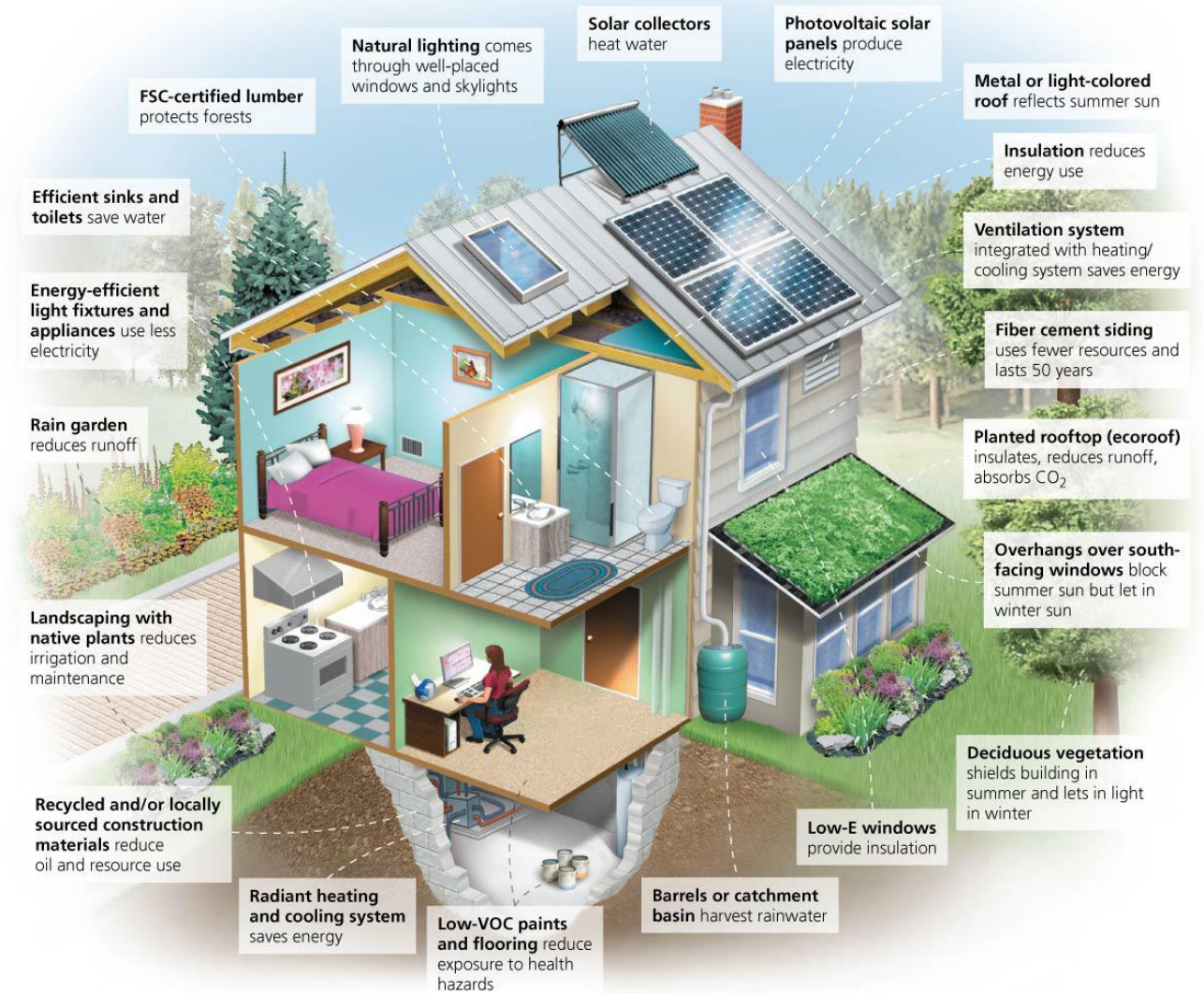
- City dwellers want to escape noise, commotion, and stress
- Natural lands, public parks, and open space provide greenery, scenic beauty, freedom, and recreation, boost property values
- They also keep ecological process functioning by
 - Helping to regulate climate
 - Purifying air and water
 - Providing wildlife habitat
- Parklands come in various types
 - Even small spaces can be important (Playgrounds, community gardens)
 - Strips of land connecting parks or neighborhoods (Greenways)
 - long, wide corridors of parklands (Greenbelts)



• Green buildings

- structures that use technologies and approaches to minimize the ecological footprints of construction and operation
 - Built from sustainable materials
 - Minimize energy and water use
 - Control pollution (permeable pavement)
 - Recycle wastes
-
- **Constructing or renovating buildings using efficient technologies is probably the best way to reduce energy use and greenhouse gas emissions**
 - Buildings consume 40% of energy and 70% of electricity
 - Leadership in Energy and Environmental Design (LEED): a certification program run by the U.S. Green Building Council
 - New or renovated buildings apply for certification (silver, gold, or platinum status)

Green buildings make cities more livable



Review

Which of the following best describes an environmental advantage of urbanization?

- A** Individuals living in cities have more varied employment opportunities than individuals living in rural areas.
- B** Individuals living in cities have greater access to health care than individuals living in rural areas.
- C** Individuals living in cities usually have greater access to fresh, local agricultural products than individuals living in rural areas.
- D** Individuals living in cities usually have a lower transportation carbon footprint than individuals living in rural areas.

Review

Which of the following solutions would help decrease flood frequencies and flood sizes that are caused by urbanization?

- A** Using new, more permeable materials for roads and sidewalks
- B** Filling nearby wetlands to reduce the amount of water in an area
- C** Encouraging construction of housing developments outward into nearby suburban and rural areas
- D** Installing new, more energy-efficient appliances in existing apartment buildings

Review

Which of the following describes an aspect of urbanization that would most increase the amount of carbon dioxide released into the atmosphere compared to rural and suburban areas?

- A** A greater amount of impermeable surfaces in urban areas that prevents organic material from entering soils
- B** Reliance on mass transportation systems in urban areas, such as buses and trains rather than individual cars and trucks, which increases carbon dioxide release
- C** Decreased square footage of living space, per person, in most housing units in urban areas that leads to an increased carbon footprint
- D** Increased amounts of waste per unit area in urban areas that leads to higher rates of decay and decomposition