Reduce Impacts

Once a site development strategy has been selected, sensitive resource areas have been identified and preserved, and other site constraints have been avoided, the next objective of the LID site planning and design process is to reduce the impacts of land alteration. This includes minimizing the creation of new impervious surfaces, preserving the timing of site runoff to approximate pre-development conditions (i.e., slowing the flow), and the use of low maintenance LID landscaping.

Similar to avoidance of impacts, the extent to which impacts can be reduced on a site is also often dictated by local land use regulations, which have the potential to facilitate or hinder the implementation of LID site planning and design strategies. Communities should review and update their local land use regulations to reduce unnecessary creation of new impervious surfaces, remove barriers to the use of LID practices, and promote the use of low maintenance landscaping. The following sections provide strategies for communities to modify local land use regulations to reduce development impacts. Additional information on these topics can be found in the information sources listed at the end of this chapter

Reducing Impervious Surfaces

Reducing impervious surfaces includes minimizing areas associated with roads, sidewalks, driveways, buildings, and parking lots. By reducing the amount of impervious cover on a site, increases in post-development stormwater runoff are reduced while infiltration and evapotranspiration are increased. Reducing the area covered by impervious surfaces also provides greater opportunity for conservation of natural features and more space for vegetated swales, bioretention systems, and other structural stormwater BMPs.

Local Roads. Many local roads are wider than necessary. Reducing the length and width of roads can reduce the creation of new impervious surfaces. Other benefits of narrower roads

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[55] Nonpoint Education for Municipal Officials (NEMO). 1999. "Conservation Subdivisions: A Better Way to Protect Water Quality, Retain Wildlife, and Preserve Rural Character". NEMO Fact Sheet #9.

include reduced clearing and grading impacts, reduced vehicle speeds (i.e., "traffic calming"), lower maintenance costs, and enhanced neighborhood character.

- Design local roads for the minimum required pavement width needed to support travel lanes; on-street parking; and emergency, maintenance, and service vehicle access. These widths should be based on future traffic volumes without compromising safety. Table 5- 2 provides recommended minimum road width standards for local roads.

Table 5- 2 Recommended Minimum Road Widths for Local Roads

Rural Local Roads (1)			
Annual Average Daily Traffic (AADT)	Type of Roadside Development		
	Open (Rural)	Moderate Density	High Density
<400	22	N/A	N/A
400 – 1,500	24	24	N/A
1,500 – 2,000	26	26	26
>2,000	28	28	28
Urban Local Roads			
On-Street Parking	Type of Area		
	Suburban	Intermediate	Built-Up
None (2)	24	24	24
One Side (3)	29	29	29
Both Sides (4)	34	34	34

Source: Adapted from CTDOT Highway Design Manual (2003 Edition including Revisions to February 2013)

Notes:

(1) Includes two travel lanes (9 to 12 feet in width) and two 2-foot shoulders.
(2) Includes two 10-foot travel lanes and two 2-foot shoulders.
(3) Includes two 10-foot travel lanes, one 2-foot shoulder, and one 7-foot parking lane.
(4) Includes two 10-foot travel lanes and two 7-foot parking lanes.
(5) Table excludes bicycle facilities, which are typically 5 feet wide.

- Consider site and road layouts that reduce overall street length. Reduce total length of residential streets by examining alternative street layouts to determine the best option for increasing the number of homes per unit length. Conservation (open space) development and other compact forms of development can reduce overall street length.

- Consider elimination of curbs and the use of roadside vegetated open channels or swales as an alternative to traditional curb and gutter drainage (i.e., curbing, catch basins, and pipes), especially in low or medium density developments and slopes where roadside erosion is not a concern (typically slopes of less than 8 percent). Open vegetated channels provide the potential for infiltration and filtering runoff from impervious surfaces, as well as groundwater recharge and reduced runoff volume. In addition to the water quality benefits that open vegetated channels provide, these systems are also significantly less expensive to construct than conventional storm drain systems. The use of vegetated drainage swales in lieu of conventional storm sewers may be limited by soils, slope, and development density.

- Use curb extensions or "bumpouts" at roadway intersections or mid-block locations to reduce impervious area, manage stormwater through bioretention or other structural stormwater BMPs, provide traffic calming, and improve pedestrian safety. These practices are most applicable in medium or high-density developments.

- Use permeable pavement for on-street parking stalls, sidewalks, and crosswalks.

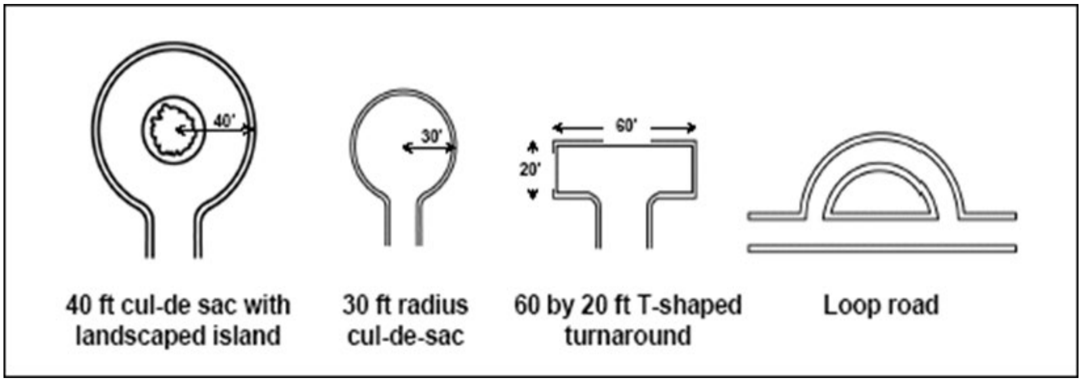
Cul-de-sacs. Cul-de-sacs are residential streets that are open at one end and have a dead-end at the other. Cul-de-sacs have a large "bulb" located at the closed end of the street to enable emergency and service vehicles to turn around without having to back up. Traditional cul-de-sacs utilize a large radius (50 to 60 feet or more), paved turnaround that can dramatically increase the imperviousness of a residential subdivision. Alternatives to this traditional design include turnaround bulbs with smaller radii and the use of a landscaped island (i.e., rain garden or bioretention area) in the center of the cul-de-sac to collect rainwater from the end of the roadway (Figure 5-1). The amount of pavement at cul-de-sac turnarounds can be reduced through the following techniques:

- Reduce the radius (and size) of the turnaround to the minimum required to accommodate emergency and maintenance vehicles, which is typically 30 to 40 feet. Consider the types of vehicles that may need to access a street. Fire trucks, service vehicles, and school buses are often cited as needing large turning radii. However, some fire trucks are designed for smaller turning radii. In addition, many newer large service vehicles are designed with a tri-axle (requiring a smaller turning radius) and school buses usually do not enter individual cul-de-sacs.

- Use a pervious center island (i.e., native vegetation or structural stormwater BMP such as an infiltration basin or bioretention system). If a cul-de-sac island is used, the cul-de-sac radius should allow for a minimum 20-foot-wide road.

- Minimize the number of cul-de-sacs and consider alternative turnaround designs such as hammerheads (T-shaped turnaround) and loop roads (jug handles).

Figure 5-1. Reduced Cul-de-Sac Radius and Alternative Turnaround Designs



Source: Adapted from Atlanta Regional Commission, 2001.[56]

Sidewalks. Subdivision codes often require sidewalks on both sides of the street, as well as a minimum sidewalk width and distance from the street, which can create excess impervious cover and stormwater runoff.

- Adopt flexible design standards that are based on safe pedestrian movement and limiting impervious cover.
- Limit sidewalks to one side of the street. A sidewalk on one side of the street may suffice in low traffic areas where safety and pedestrian access would not be significantly affected.
- Reduce sidewalk widths (3 to 4 feet), separate them from the street with a vegetated area, and grade sidewalks to drain into front lawns and away from rather than towards the street.
- Consider alternative surfaces such as permeable pavement or gravel where appropriate. Consider removing sidewalks from the roadway right-of-way and provide access to natural features or connect other destinations, such as a playground, park, or adjacent development.

Driveways. Driveways account for significant amounts of impervious cover in suburban residential development. Generally, local subdivision regulations do not contain explicit driveway design standards regarding dimensions and surface materials. Subdivision regulations also indirectly influence the length of the driveway when excessive front yard setbacks, which dictate how far houses must be from the street, are required. Overall lot imperviousness can be reduced by minimizing driveway lengths, encouraging alternative pervious surfaces, and allowing shared driveways wherever possible.

- Consider the use of shared driveways that connect two or more homes together.
- Consider minimum driveway widths of 9 feet or less (one lane) and 18 feet or less (two lanes).

[56] https://atlantaregional.org/natural-resources/water/georgia-stormwater-management-manual/

- Reduce front yard setbacks (20 to 30 feet), resulting in shorter driveways and reduced driveway imperviousness. A 20- to 30-foot-long driveway is generally adequate to meet parking needs.
- Use alternative permeable driveway surfaces (e.g., grass, gravel, permeable pavement) or the use of "two track" design for residential driveways (i.e., hard surface for vehicle tires to drive on, with grass or other permeable surface in-between and outside the tracks).

Buildings. Reducing the footprints of buildings can reduce the impervious cover in certain residential and commercial settings. Residential and commercial building footprint area can be reduced by using alternate or taller buildings while maintaining the same floor-to-area ratio.

- Minimize building footprint area and building setbacks.
- Consider the use of green roofs and the use of rain barrels and cisterns for stormwater harvesting and reuse.
- Direct roof runoff to vegetated pervious areas and structural stormwater BMPs such as rain gardens/bioretention systems, dry wells, and other infiltration or filtering systems.

Parking Lots. Parking lots account for a large percentage of impervious cover in commercial, industrial, and institutional settings. The amount of parking and associated impervious area is dictated by local land use regulations. Reducing parking ratio requirements, allowing the use of shared parking and off-site parking allowances, providing compact car spaces, minimizing stall dimensions, incorporating efficient parking aisles, use of structured parking, and using pervious materials in spillover parking areas can serve to minimize the total impervious areas associated with parking lots.

- **Parking Ratios.** The number of parking spaces at a site is determined by local parking ratios which dictate the minimum number of spaces per square foot of building space, number of dwelling units, persons, or building occupancy. Parking ratios are typically set as minimums, not maximums, thereby allowing for excess parking. Parking ratios also typically represent the minimum number of spaces needed to accommodate the highest hourly parking at the site.

    - Establish both minimum and maximum parking ratios to provide adequate parking while reducing excess impervious cover. Parking demand ratios should be based upon project-specific parking studies, where feasible. Allow additional spaces above the maximum ratio only if project-specific parking studies indicate a need for additional capacity.

    - Incorporate mechanisms into local zoning regulations that tailor parking requirements to specific development projects. Allow flexibility within the regulations and require the developer to demonstrate the appropriate amount of parking needed.[57]

- Strategies for eliminating or reducing excess parking through parking demand ratios include but are not limited to: 1) setting minimum and maximum parking ratios (providing a range of values) based on a local parking study, 2) starting with industry standard values such as those developed by the Institute of Transportation Engineers (ITE) and the Urban Land Institute (ULI) and adjusting those values to reflect local characteristics, 3) consider using current minimum parking ratios as the new maximum requirements, and 4) eliminating minimum parking requirements for non-residential properties.

- **Shared Parking.** Shared parking is a strategy that reduces the number of parking spaces needed by allowing a parking facility to serve multiple users or destinations. This approach is most successful when the participating facilities are in close proximity to each other and have peak parking demands that occur at different times during the day or week or if they share patrons that can park at one facility and walk to multiple destinations. Parking ratios can be reduced if shared parking arrangements are in place, when multi-modal transit (e.g., mass transit, bike share, or car share programs) is provided, or when nearby on-street parking is available. Shared parking generally requires contractual agreements between two adjacent users or the use of parking management districts with multiple property owners.[58]

  A related strategy is to reserve sufficient land on the project site for projected future parking requirements (e.g., future buildout or redevelopment), but only construct a portion of the parking area at the outset of the project, maintaining the additional parking as green space and converting to parking on an as-needed basis.

- **Off-Site Parking Allowances.** Current land use regulations in many communities require new development and redevelopment projects to provide all parking on-site and do not allow off-site parking availability to be counted. Communities should increase the flexibility of parking requirements and include off-site parking allowances for certain types of development such as redevelopment sites and compact mixed-use centers given the difficulty of complying with conventional on-site parking demands in such settings. Design standards should specify a maximum distance (typical walking distance of 400-800 feet)

[57] Rhode Island Department of Environmental Management (RIDEM) and Coastal Resources Management Council (CRMC). 2011. Rhode Island Low Impact Development Site Planning and Design Guidance Manual.

[58] Capitol Region Council of Governments (CRCOG). 2002. Livable Communities Toolkit: A Best Practices Manual for Metropolitan Regions, Shared Parking Fact Sheet.

and requirements for well-marked safe pedestrian travel between the site and off-site parking lot.[59]

- **Structured Parking.** Vertical parking structures can reduce impervious cover by reducing the parking footprint. In urban areas or areas where land availability is limited or land costs are high, parking garages are generally more economical to build than purchasing additional land. In such areas, communities should consider using incentives (e.g., tax credits; stormwater waivers; or density, floor area, or height bonuses) to encourage the use of multi-level, underground, and under the building parking garages.[60]

- **Parking Stall and Aisle Geometry.** Local parking codes often require standard parking stall dimensions to accommodate larger vehicles. Reducing parking stall size and incorporating alternative internal geometry or traffic patterns through the use of one-way aisles and angled parking stalls can reduce parking lot size and impervious cover.

    - Reduce parking stall dimensions to 9 feet wide and 18 feet long.
    - Encourage one-way aisles used in conjunction with angled parking to reduce the amount of aisle space needed to access each stall, depending on the geometry of the parking lot.
    - Allow for a portion of parking lots to be comprised of compact car spaces (e.g., 8-foot by 16-foot stalls or smaller) including signage clearly designating compact car spaces.

- **Alternative Paving Materials.** Impervious cover can also be reduced through the use of alternative paving materials (e.g., permeable pavement) for parking stalls, parking aisles, and overflow parking. Local land use regulations should allow for the use of permeable pavement and promote the use of such materials in low traffic areas such as overflow parking areas. Chapter 13 - Permeable Pavement contains design guidance for permeable pavement systems including porous asphalt, pervious concrete, permeable interlocking concrete pavers, and other open course paver systems (plastic turf reinforcing grids, concrete grass pavers, etc.).

- **Parking Lot Landscaping.** Landscaped areas within and around parking lots can reduce the amount of impervious cover, allow for retention and treatment of parking lot runoff, provide tree canopy and shading, and enhance the appearance of a parking lot and associated development. Small-scale infiltration and treatment stormwater BMPs (e.g., bioretention, tree filters, vegetated filter strips, water quality swales, etc.) can be incorporated into parking islands and around the perimeter of parking lots.

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[59] Rhode Island Department of Environmental Management (RIDEM) and Coastal Resources Management Council (CRMC). 2011. Rhode Island Low Impact Development Site Planning and Design Guidance Manual.

[60] Center for Watershed Protection (CWP). 2017. Better Site Design Code and Ordinance Worksheet. December 2017.

- Require a minimum percentage of a parking lot to be landscaped.
- Allow the use of structural stormwater BMPs and open section drainage (via sheet flow and flush curbs or curb cuts) within landscaped areas, setbacks, or parking areas.
- Require landscaping within parking areas that "breaks up" pavement at fixed intervals and allow vegetated stormwater management areas to count toward required landscape minimums.
- Consider requiring a minimum amount of tree canopy coverage over on-site parking lots. A minimum landscape area width of 6 feet is recommended to support large, mature trees.

Preserving Pre-development Time of Concentration

The peak discharge rate and volume of stormwater runoff from a site are influenced by the runoff travel time and hydrologic characteristics of the site. Runoff travel time can be expressed in terms of "time of concentration" which is the time it takes for runoff to travel from the most distant point of the site or watershed to the downstream outlet or design point. Runoff flow paths, ground surface slope and roughness, and channel characteristics affect the time of concentration. Increasing the post-development time of concentration to match the time of concentration for pre-development conditions can substantially reduce development impacts in terms of peak rates of runoff and runoff volumes. Site design techniques that can modify or increase the runoff travel time and time of concentration include:

- Maximizing overland sheet flow.
- Maintaining pre-development flow paths on vegetated surfaces.
- Increasing the number of and lengthening flow paths on vegetated surfaces.
- Minimizing the number and length of flow paths on impervious surfaces.
- Maintaining overland flow across vegetated surfaces and areas with permeable soils.
- Maintaining pre-development infiltration rates by preserving those areas of the site. with high-permeability soils.
- Maximizing use of vegetated swales for the conveyance of stormwater instead of traditional curb/gutter and piped drainage systems.
- Maintaining or augmenting existing vegetation on the site.

Use of Low Maintenance Landscaping

As described in Chapter 6 - Source Control Practices and Pollution Prevention, lawns and other landscaped areas can contribute stormwater runoff pollution, resulting in adverse impacts to surface waters and groundwater, due to overfertilization, overwatering, overapplication of pesticides, and direct disposal of lawn clippings, leaves, and trimmings.

To reduce these potential impacts, low-maintenance, native vegetation should be used along with other LID landscaping techniques to minimize lawn area, irrigation needs, fertilizers, and pesticides. This approach can also help conserve water by reducing irrigation water demand and increase resilience of surface and groundwater resources during periods of drought. Chapter 6 -

Source Control Practices and Pollution Prevention contains links to additional sources of information on low maintenance and LID landscaping practices.

Communities should also develop or update their local land use regulations to reflect low maintenance or LID landscaping approaches that specifically address the link between a functional landscape and protection of water quality, water conservation, and resilience. LID landscape regulations should also be tailored to different land uses, densities, and locations.[61]