Site Design Strategies




The goal of **LID site design** is to minimize the hydrologic impacts of land cover changes and storm sewer systems through non-structural, innovative strategies that preserve or mimic natural drainage features and functions, minimize runoff, and manage it as close to the source as possible. Site designers should exhaust all opportunities for non-structural methods to minimize impervious cover and runoff before determining how to mitigate impacts through structural stormwater management practices. Four key categories of site design strategies include: ***preserving important hydrologic features and functions, siting and layout of development, reducing impervious area,*** and ***using natural drainage systems.***

PRESERVING IMPORTANT HYDROLOGIC FEATURES AND FUNCTIONS

There are many features in the natural landscape that provide the important hydrologic functions of retention, detention, infiltration, and filtering of stormwater. These features include highly permeable soils, pocket wetlands, headwater drainage features, riparian buffers, floodplains, undisturbed vegetation, and trees. All features of hydrologic importance should be delineated at the earliest stage in the development planning process.

STRATEGIES

Buffers provide filtration, infiltration, flood management, and bank stability benefits | Unlike stormwater ponds and other structural infrastructure, buffers are essentially a "no capital cost" and low maintenance form of green infrastructure. The benefits of buffers diminish when slopes are greater than 25%, therefore steep slopes should not be counted as buffer.

Preserve areas of undisturbed soil and vegetation cover | Typical construction practices, such as topsoil stripping and stockpiling, site grading and compaction by construction equipment, can considerably reduce the infiltration and treatment capacity of soils. During construction, natural heritage features and locations where stormwater infiltration practices will be constructed should be delineated and not subject to construction equipment or other vehicular traffic, nor stockpiling of materials.

Avoid development on permeable soils | Highly permeable soils (i.e. hydrologic soil groups A and B) function as important groundwater recharge areas. To the greatest extent possible, these areas should be preserved in an undisturbed condition or set aside for stormwater infiltration practices. Where avoiding development on highly permeable soils is not possible, stormwater management should focus on mitigation of reduced groundwater recharge through application of stormwater infiltration practices.

Preserve existing trees and make space for new ones | Trees should be preserved or incorporated into parking lot interiors or perimeters, private lawns, open space areas, road allowances, and medians to the greatest extent possible. An uncompacted soil volume of 20 to 30 m^3 is recommended to achieve a healthy mature tree with a large crown and long lifespan. Mature stands of deciduous trees will intercept 10 to 20% of annual precipitation falling on them, and a stand of evergreens will intercept 15 to 40%. Preserving mature trees will provide immediate benefits in new developments, whereas newly planted trees will take 10 years or more to provide equivalent benefits.

	Square grid (Miletus, Houston, Portland, etc.)	Oblong grid (most cities with a grid)	Oblong grid 2 (some cities or in certain areas)	Loops (Subdivisions – 1950 to now)	Culs-de-sac (Radburn – 1932 to now)
Percentage of area for streets	36.0%	35.0%	31.4%	27.4%	23.7%
Percentage of buildable area	64.0%	65.0%	68.6%	72.6%	76.3%

Source: Canada Mortgage and Housing Corporation

Source: Schollen and Company

SITING AND LAYOUT OF DEVELOPMENT

The location and configuration of elements, such as streets, sidewalks, driveways, and buildings, within the framework of the natural heritage system provides many opportunities to reduce stormwater runoff.

STRATEGIES

Fit the design to the terrain | Using the terrain and natural drainage as a design element will reduce the amount of clearing and grading required and the extent of necessary underground drainage infrastructure. This helps to preserve pre-development drainage boundaries and water budgets. Integrate stormwater practices and facilities with road allowances, parking lots, parks, and open space systems, to the greatest extent possible.

Use open space or clustered development | Clustering development increases the development density in less sensitive areas of the site while leaving the rest of the site as protected community open space. Some features of open space or clustered development are smaller lots and shared driveways and parking. Clustered development also reduces the amount of impervious surfaces and runoff to be managed, reduces pressure on buffer areas, reduces the construction footprint, and provides more area and options for stormwater controls.

Use innovative street network designs | Loop, cul-de-sac and fused grid street networks create less impervious area than conventional grid patterns. Integrating such elements into the design of street networks can reduce the total area occupied by roads, thereby reducing the amount of impervious surfaces and stormwater runoff to be managed.

Reduce road setbacks and lot frontages | The lengths of setbacks and frontages are a determinant for the area of pavement, street, driveways, and walkways needed to service a development. Municipal zoning regulations for setbacks and frontages have been found to be a significant influence on the production of stormwater runoff.

Select LID practice options based on site conditions, context and constraints | Understand how site conditions like groundwater or top of bedrock elevation, slope and land uses constrain what types of LID practices are feasible and the space available, both surface area and subsurface depth, for stormwater infrastructure. For example, where water table or bedrock occurs at shallow depth, infiltration practices may not be feasible or require design modifications to fit into available space. See the STEP LID Planning and Design Guide wiki page, "Screening LID options" for links to detailed guidance on practices that are best suited to different site contexts and constraints.

REDUCING IMPERVIOUS AREA

Many of the strategies described previously reduce impervious area on a macro scale. The following strategies provide examples of how to reduce impervious area on a micro or lot level scale.

STRATEGIES

Reduce street width | Streets make up the largest percentage of impervious area and contribute proportionally to runoff. Street widths are sized for the free flow of traffic and movements of large emergency vehicles. With some land uses, such as low density residential, streets are wider than needed for the typical function of the street. Amending urban design standards to allow alternative, narrower street widths might be appropriate in some situations. There are various ways to accommodate emergency vehicles and traffic flow on narrower streets, including alternative street parking configurations, vehicle pullout space, connected street networks, prohibited parking near intersections, and reinforced turf or gravel edges.

Reduce building footprints | Footprint can be reduced by designing taller multi-story buildings and seeking opportunities to consolidate utilities into the same space.

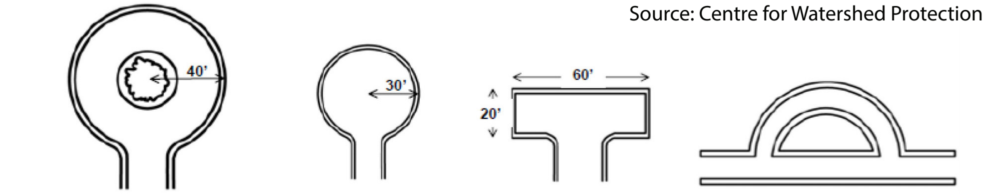
Reduce parking footprints | Excess parking results in greater stormwater impacts and management costs, as well as unnecessary construction and maintenance costs, consuming space that could be used for a revenue generating purposes.

- Keep the number of parking spaces to the minimum required. Parking ratio requirements are often set to meet the highest hourly parking demand during the peak season. The parking space requirement should instead consider an average parking demand and other factors influencing demand like access to mass transit.
- Take advantage of opportunities for shared parking. For example, businesses with daytime parking peaks can be paired with evening parking peaks, such as offices and a theatre, or land uses with weekday peak demand can be paired with weekend peak demand land uses, such as a school and church.
- Reductions in impervious surface can also be found in the geometry of the parking lot. One-way aisles when paired with angled parking will require less space than a two way aisle. Other reductions can be found in using unpaved end-of-stall overhangs, setting aside smaller stalls for compact vehicles, and configuring or overlapping common areas like fire lanes, collectors, loading, and drop off areas.
- More costly approaches to reducing the parking footprint include parking structures or underground parking and using permeable pavement.

Consider alternative cul-de-sac designs | Using alternatives to the standard 15 m radius cul-de-sac can further reduce impervious area required to service each dwelling. The amount of impervious area in cul-de-sacs can be reduced by including a landscaped or bioretention cell centre island, T-shaped turnaround, or by using a loop road instead.

Eliminate unnecessary sidewalks and driveways | A flexible design standard for sidewalks is recommended to allow for unnecessary sidewalks to be eliminated. Sidewalks that are not needed for pedestrian circulation or connectivity should be removed. Often sidewalks are only necessary on one side of the street. Driveway impervious area can be reduced through the use of shared driveways or alley accessed garages and permeable pavement.

Source: Centre for Watershed Protection



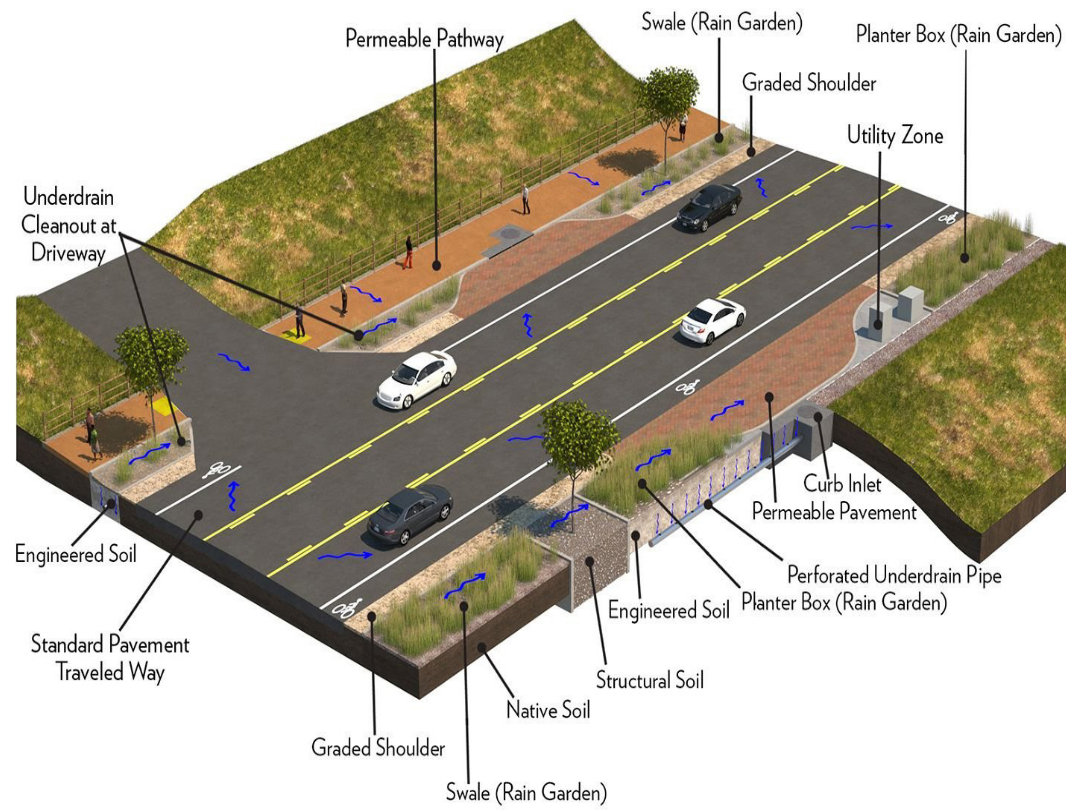
USING NATURAL DRAINAGE SYSTEMS

Rather than collecting and moving stormwater rapidly to a centralized location for detention and treatment, the goal of these strategies is to take advantage of undisturbed vegetated areas and natural drainage patterns (e.g., small headwater drainage features). These strategies extend runoff flow paths and slow down and spread out flow to allow soils and vegetation to filter and absorb it. Using natural systems or green infrastructure is often more cost effective than traditional drainage systems, and they provide more ancillary benefits.

STRATEGIES

"Disconnect" impervious areas | Drainage from roof drains or downspouts, parking lots, driveways, sidewalks, and patios should be directed to stabilized landscaped areas as sheet flow where feasible to provide passive irrigation. Where it is concentrated in gutters or pipes, the flow can be spread out with splash pads, level spreaders or stone cover. Keep the ratio of impervious drainage area to pervious landscape area receiving the runoff (i.e., I:P ratio) to 4:1 or less. Prior to installation of planting soil, scarifying, fracturing or tilling is recommended for subgrade soil that has become overly compacted. These practices are best combined with organic amendment to encourage runoff absorption. Use deep rooting vegetation in landscaped areas to maintain and possibly improve soil infiltration rate over time. See the Absorbent Landscapes fact sheet for more details.

Make space for trees and plants | Directing runoff from impervious surfaces to stormwater tree trenches and bioretention cells provides passive irrigation for the plantings and further reduces site runoff (see Stormwater Tree Trenches and Bioretention fact sheets). Continuous stormwater tree trenches increase the plantable surface area and provide more space for tree roots. Where surface space is constrained, consider employing soil cells or structural soils and suspended or permeable pavements to improve growing conditions and overall health of street trees. Use hardy, deeply rooting native species in planting plans because they are well adapted to the local climate, provide habitat for pollinators and incorporate regional character into the built environment.



Open Space Site Design. Source: WSP

Preserve or create micro-topography | Undisturbed lands have a micro-topography of dips, hummocks and mounds which slow and retain runoff. Site grading smooths out these topographic features. Micro-topography can be restored in both landscaped and naturalized areas.

Extend drainage flow paths | Slowing down flow and lengthening the flow path allows more opportunities for stormwater to be filtered and infiltrated. Extending the travel time can also delay and lower peak flows. Where suitable, flows should be conveyed using vegetated open channels (e.g., swales, filter strips).

Design with ease of inspection and maintenance in mind | Consider the routine inspection and maintenance needs of stormwater facilities during planning and design to ensure they can be operated with efficiency and ease over their full life cycle using available resources.

Source: T.E. Scott and Associates

For more information:

Visit the online Low Impact Development Stormwater Management Planning and Design Guide for more information including links to all sources cited: wiki.sustainabletechnologies.ca.

LID Stormwater Inspection and Maintenance Guide (TRCA, 2016): sustainabletechnologies.ca.

LID Construction Guide (CVC, 2012): sustainabletechnologies.ca.

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