2–Designing with the Landform
Better Site Planning & Design

In This Chapter

- ***Better Site Selection Techniques***
- ***Site Planning & Design Practices***
- ***Regulatory Permitting Information & Contacts Information***
- ***Model Site Design Comparison—The Tupelo Tract***
- ***Green Building Certification Programs***
- ***Local Green Building Case Studies***

Introduction

Now that you have a better understanding of land conservation (i.e. where development should not occur), this chapter provides better site selection, planning and design guidelines (i.e. where and how development should take place).

Although this process requires coastal Georgians to reconsider many of the conventional site development practices in use today, it does so in the interest of protecting and restoring the region's valuable natural resources and the critical ecosystem services they provide.

Site Selection

While the primary subject of this chapter focuses on how development should occur, it also very important to consider where to build. Doing so helps balance land development and economic growth with the protection of coastal Georgia's important resources – before the site planning and design process even begins. Local land use planning efforts should be used to direct development away from important natural and man-made resources—such as wetlands, high priority habitats and areas of cultural/historical significance—and toward areas that are more appropriate for development. Developers can help support local land use planning efforts by using the site selection criteria provided below to select a development site. These guidelines stress the importance of locating growth – and the corresponding demand for new infrastructure (e.g. water, sewer, roadways) and municipal services (e.g. schools, police, fire) – in close proximity to existing previously developed areas (i.e. urban centers).

When selecting a site for potential development, the design team should utilize the following criteria:
Locate in close proximity to existing development to reduce land consumption and habitat fragmentation and to make use of existing infrastructure and municipal services
Provide pedestrian access to a variety of different services (e.g., commercial areas, transit routes) and to adjacent development sites
Locate near existing or planned transit, bicycle, and pedestrian routes; if possible, perform a survey of potential future site users (e.g., residents, business owners) to identify their transportation needs and preferences
Select a site that has previously been developed or that is considered to be a brownfield site; coordinate the site planning and design process with site cleanup, remediation and restoration activities, as appropriate
Select a site that has been previously developed and build on underutilized or vacant space within an existing urban center which promotes the Smart Growth infill redevelopment strategy
Select a site that is located in a priority development growth area, as designated by a local or regional land use plans
Select a site that will not require the disturbance of rivers and streams, wetlands, marsh hammocks, floodplains, groundwater recharge areas, or other important natural and man-made resources
Select a site that will avoid disturbing high priority habitat areas, as defined in the *Comprehensive Wildlife Conservation Strategy for Georgia, GDNR-WRD 2005*, or other areas providing habitat for the plant and animal species identified on federal and state threatened and endangered species lists

During the site selection process, some basic information should be used to evaluate the feasibility of conducting a development project on the prospective site. The process should consider site characteristics and constraints, applicable local, state and federal regulations, adjacent land uses, and the availability of existing infrastructure (e.g., water, sanitary sewer). Much of this information can be gathered through a joint consultation meeting and a review of the stormwater management and site planning and design requirements applicable to the site.

Early in the planning process, it is essential to have all involved parties meet, preferably on-site, to discuss the proposed development. The joint consultation meeting should involve the entire development team and representatives from applicable federal, state, and local regulatory agencies. The main objective of the pre-development meeting is to discuss the project in concept with governing authorities and identify any potential issues that may need to be considered before moving forward with the site development plan. This approach gives the design team an opportunity to analyze various alternatives and select the option that avoids or minimizes environmental impacts to the greatest extent possible.

Addressing environmental issues during the conceptual planning phase saves the developer time and money. Regulatory compliance is achieved up front which reduces the need for major design changes and plan revisions which can ultimately reduce engineering and environmental permitting costs.

Site Selection Checklist

Site Selection Checklist		
Green Growth Guidelines	√	**Comments/Notes**
Located in close proximity to existing urban core		
Will provide pedestrian access to a variety of different services (e.g., commercial areas, transit routes) and to adjacent development sites		
Located near existing or planned transit, bicycle and pedestrian routes		
Perform a survey of potential future site users (e.g., residents, business owners) to identify their transportation needs and preferences		
Select a site that has previously been developed (i.e., greyfield site) or that is considered to be a brownfield site		
Located in a priority development or priority growth area, as designated by a local or regional land use plan		
Will not require the disturbance of rivers and streams, wetlands, marsh hammocks, floodplains, groundwater recharge areas or other important natural and man-made resources		

Site Selection Checklist		
Will not require disturbance of high priority habitat areas, as defined in the Comprehensive Wildlife Conservation Strategy for Georgia, or other areas providing habitat for the plant and animal species identified on federal and state threatened and endangered species lists		
Review the local, state and federal stormwater management and site planning and design requirements that will likely apply to the development site		
Host a meeting with the local development review authority meet during the site selection process, after one or more prospective development sites have been identified		
Evaluate the feasibility of conducting a development project on the prospective development site		
Investigate opportunities and incentives for land conservation and opportunities and incentives for sustainable development projects		

Site Fingerprinting

Site fingerprinting is a planning tool used to design communities where protection of natural resources is the primary focus. This process enables the user to view, identify, and analyze the natural, built, economic, and social aspects of a prospective site. The basic components of this process are as follows:

Identify general site features

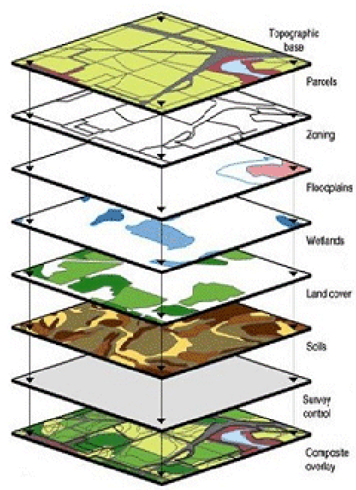
- Determine and locate primary and secondary conservation areas
- Consider the impact of other important factors such as adjacent land uses, accessibility, transportation and infrastructure availability
- Use collected information to derive the **the actual** buildable area
- Synthesize this information into various development scenarios which incorporate the natural features of the site

Land planners, community officials, environmental scientists, engineers, and developers can protect natural resources using this ecology-based planning approach. Built on traditional principles, site fingerprinting uses mapping and survey technology (Geographic Information Systems "GIS" and Global Positioning Systems "GPS") to avoid and/or minimize impacts by integrating the natural features of the site into the development concept.

The site fingerprinting process is far more efficient and accurate through the use of Geographic Information Systems (GIS) and Global Positioning Systems (GPS). These remarkably versatile mapping tools have great utility in land planning and development. GIS is a digital, geographic coordinate-based toolset used to overlay, query, and analyze information from a number of sources and inputs. GPS is a field tool used to capture geographic locations, in the form of coordinates, and record the characteristics of that location. GPS can also used to navigate to a specific location in order to verify previously gathered information or the results of GIS analysis.

The virtual desktop application of GIS and real-time, in-field application of GPS make site fingerprinting faster, cost-effective and more efficient, especially when considering the time saved in the field identifying and marking natural features already noted through GIS and GPS. While not a complete replacement for conventional methods or a legal survey, GIS and GPS improve the conventional process by delivering all site characteristics to the designer in a single picture. Furthermore, potential impacts of development scenarios can be quickly and easily measured through the use of these technologies.

A modern Geographic Information System (GIS) is a dynamic and valuable resource. To appreciate this fact, one must consider that until GIS technology was developed, maps of everything from soil types and rivers to streets and property boundaries were created by hand. The only resources for creation of these products were traditional surveys and the cartographers and field observers own interpretation of reality. To overlay any two or more of these traditional maps for any type of visual analysis posed problems. Scaling, coordinate systems, publication dates and the cartographers' own styles were all obstacles to the efficient interpretation of combined maps or data. Furthermore, the expense of photographic overlays made the overlay of multiple traditional maps even more unlikely for everyday use.



By simply adding the desired maps or layers of information to a GIS, such as parcels, residences, streets, utilities, floodplain, soils, and streams, a single digital map is produced that simultaneously displays a wealth of information. This efficient combination may produce new information such as the total acreage of wetlands on a given parcel, or the number of residences within a floodplain. What previously took weeks to research now takes a matter of hours or even minutes to complete.

GPS or Global Positioning Systems are often used in combination with GIS to field verify existing site conditions and locate physical features not yet mapped. GPS is a universal utility comprised of a radio-navigation system formed from a constellation of satellites and their ground stations. This technology uses these man-made stars as reference points to calculate one's relative position on the ground, to a level of sub-meter and sometimes centimeter accuracy. Using hand-held GPS units, real-time coordinates of certain physical features of a site can be recorded and then imported into GIS to form new layers of information from which maps and models can be produced. Like other sources of information in a GIS, the relationship between GPS and GIS is based on a common way of defining location – through real-world coordinates.

Site data can either be gathered by conventional or GPS survey methods or can be accessed by on-line databases and clearinghouses. There are many digital data sets available from national, state, and local sources that are free and/or available for purchase and can be downloaded or obtained on CD. A list of commonly used data resources are provided in Appendix B.

Natural and Man-Made Resource Inventory

Prior to the start of any land-disturbing activities, including any clearing and grading activities, acceptable site reconnaissance and surveying techniques should be used to complete a thorough assessment of the natural resources—both terrestrial and aquatic—found on a development site.

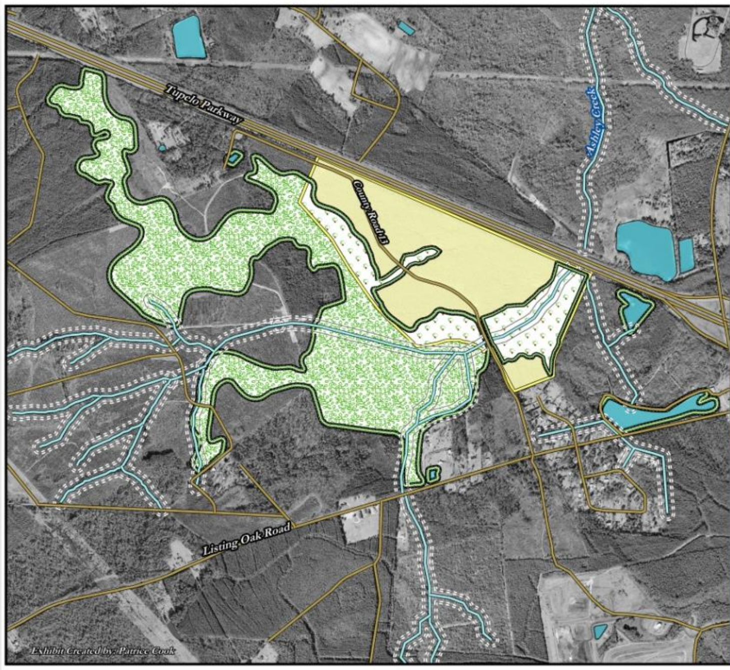
The identification, and subsequent preservation and/or restoration of these natural resources, through the use of green infrastructure practices, helps reduce the negative impacts of the land development process "by design."

The site inventory, listed in the Site Selection Checklist (contained in this chapter), should be used to identify and map the natural and man-made resources as they exist prior to the start of any land-disturbing activities.

The map that is created to illustrate the results of the natural resources inventory, (i.e. the site fingerprint) should be used to prepare a preliminary concept plan for the proposed development project.

Primary and Secondary Conservation Areas

Once a thorough analysis of existing site conditions and surrounding features is performed using GIS and GPS, the site's physical opportunities and constraints become apparent. These individual geographic, built, economical, and environmental attributes are then overlaid to form a composite map, which is used to synthesize the overall context of the site. This map shows all primary and secondary conservation areas combined, essentially defining the actual buildable area on the site.



Tupelo Tract Composite Map showing Actual Buildable Area and Primary and Secondary Conservations Areas

The overall composite becomes the base map which is used by the site designer to create a sketch level plan of the proposed development. The process of refining the land plan has historically been done using traditional survey methods. Today, we can refine the land plan using GIS and GPS technology. Instead of developing the land plan to a detailed level before site stakeout, a sketch plan can be taken into the field for adjustment (located by GPS), compared to the actual conditions on the site (mapped by GIS), and adjusted to avoid impacts before significant resources are dedicated to detailed planning, surveying, and engineering services. This process repeats until a concept plan that fits the actual character of the site is produced.

At the end of the chapter, the Site Fingerprinting process is demonstrated on a model development site—known as the **Tupelo Tract**. The demonstration includes a natural and man-made resource inventory using GIS and the preparation of a composite map showing conservation and buildable areas.

Natural & Man-Made Resource Inventory Checklist

Site Planning & Design Checklist Inventory Natural & Man-Made Resources		
Green Growth Guidelines	√	**Comments/Notes**
Identify and map existing contours, steep slopes (i.e., areas with slopes greater than 15%), natural drainage divides, depressional areas		
Identify and map natural drainage divides		
Identify and map natural drainage patterns and flow paths		
Identify and map natural drainage features (e.g., swales, basins, depressional areas)		
Identify and map historic, current and future (e.g., 25 to 50 years from now) mean high water (tide) lines		
Identify and map areas with perched or elevated groundwater tables		
Identify and map areas with seasonally or permanently high groundwater elevations (i.e., within 2 feet or less of the surface of the ground)		
Identify and map hydrologic soil groups and detailed soil map units, including approximate boundaries		
Identify and map unstable or unsuitable soils, such as hydric, extremely poorly drained and erodible soils		
Identify and map soils identified by the state of Georgia or the NRCS as prime farmland, unique farmland or farmland of statewide importance		

Site Planning & Design Checklist Inventory Natural & Man-Made Resources		
Identify and map soils disturbed by previous land development activities		
Identify and map land covers and vegetation types, indicating whether or not each zone contains the following: Note whether each zone contains the following:		
Native plants		
Invasive plants, as identified on federal, state and regional lists		
Native vegetative communities		
Managed vegetative communities (e.g., agricultural areas, silvicultural areas)		
Identify/map individual trees found on the site, particularly specimen, old growth, champion and monumental trees		
Identify and map the following aquatic resources, which have been identified as high priority habitat areas by the Comprehensive Wildlife Conservation Strategy for Georgia:		
Rivers and Streams		
Freshwater Wetlands, which include both jurisdictional and isolated, non-jurisdictional wetlands		
Tidal Rivers and Streams		
Sounds		
Tidal Creeks		

Site Planning & Design Checklist Inventory Natural & Man-Made Resources		
Coastal Marshlands, which include all of the salt marshes, intertidal areas, tidal mud flats, and tidal water bottoms found within the state's legally defined estuarine area		
Tidal Flats		
Scrub-Shrub Wetlands		
Near Coastal Waters		
Beaches		
Identify aquatic resources supporting commercial and recreational fishing and shellfishing activities including tidal marshlands, tidal creeks, estuaries, beaches, and hammocks		
Identify and map aquatic resources included on the state of Georgia's 305(b)/303(d) List		
Identify and map wetlands of international, national and state importance, including Outstanding National Resources Waters		
Identify and map aquatic resources that have been modified (e.g., buried, piped, drained, channelized, bulkheaded, armored)		
Identify and map the following terrestrial resources, which have been identified as high priority habitat areas by the Comprehensive Wildlife Conservation Strategy for Georgia:		
Dunes		
Maritime Forests		

Site Planning & Design Checklist Inventory Natural & Man-Made Resources		
Marsh Hammocks		
Evergreen Hammocks		
Canebrakes		
Bottomland Hardwood Forests		
Beech-Magnolia Forests		
Pine Flatwoods		
Longleaf Pine-Wiregrass Savannas		
Longleaf Pine-Scrub Oak Woodlands		
Identify and map high priority aquatic habitat areas, as defined in the Comprehensive Wildlife Conservation Strategy for Georgia (NOTE: there will be some overlap between this list and the aquatic resource list provided above):		
Alluvial (Brownwater) Rivers and Swamps		
Barrier Island Freshwater Wetlands and Ponds		
Bayheads and Titi Swamps		
Brackish Marsh and Salt Marsh		
Coastal Scrub-Shrub Wetlands		
Estuarine and Inshore Marine Waters		
Forested Depressional Wetlands		
Freshwater “Prairies”		

Site Planning & Design Checklist Inventory Natural & Man-Made Resources		
Intertidal/Subtidal Mud and Sand Flats		
Nonalluvial (Blackwater) Rivers and Swamps		
Offshore Marine Waters		
Natural Open-Water Ponds and Lakes		
Tidal Rivers and Freshwater Tidal Marsh		
Wet Pine Savannahs, Herb and Shrub Bogs		
Identify and map high priority terrestrial habitat areas, as defined in the Comprehensive Wildlife Conservation Strategy for Georgia (NOTE: there will be some overlap between this list and the terrestrial resource list provided above):		
Beech-Magnolia Forests		
Bottomland Hardwood Forests		
Canebrakes		
Coastal Beaches and Sand Bars		
Coastal Dunes and Bluffs		
Evergreen Hammocks and Mesic Hardwood Forests		
Hillside Seeps		
Longleaf Pine-Scrub Oak Woodlands		
Longleaf Pine-Wiregrass Savannas		
Maritime Forests and Coastal Hammocks		

Site Planning & Design Checklist Inventory Natural & Man-Made Resources		
Pine Flatwoods		
Identify and map other areas providing habitat, both recent and historic, for protected plant and animal species, such as those included on the federal and state threatened and endangered species lists and those protected by the Marine Mammal Protection Act, including:		
Bald eagle nesting sites and habitat protection areas; these areas are protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act		
Colonial bird (e.g., wading birds, shorebirds, etc.) nesting and roosting sites; these areas are protected by the Migratory Bird Treaty Act		
Gopher tortoise burrows; if gopher tortoise burrows are present, consult with the USFWS Ecological Services Office regarding the potential presence of the federally listed Eastern Indigo snake		
Downstream aquatic resources providing essential fish habitat including tidal marshlands, tidal creeks, estuaries, beaches, and hammocks		
Diadromous fish runs and anadromous fish spawning areas		
Wildlife corridors, including connectivity to the surrounding area		
Aquatic corridors, including connectivity to the surrounding area		

Site Planning & Design Checklist Inventory Natural & Man-Made Resources		
Floodplains and floodways, as determined by FEMA or GEMA or by completing a site-specific floodplain study		
Groundwater recharge areas		
Wellhead protection areas		
Other natural resources protected by setbacks, buffers, conservation easements or legal instruments (e.g., private protected lands, conservation areas)		
Identify and map existing and proposed infrastructure (e.g., utilities, roadways, railroads)		
Identify and map potential potable and non-potable water sources		
Identify nearby dams and public water supply reservoirs		
Identify and map existing and future stormwater hotspot areas and potential pollution sources		
Identify and map nearby historic landmarks and archaeological sites		
Identify and map nearby recreational areas (e.g., golf courses, state parks, amusement parks, campgrounds, forest preserves, marinas, public access sites, swimming and picnicking areas)		
Identify and map nearby trails and multi-use paths (e.g., riding trails, bicycle paths, hiking trails)		
Identify and map nearby open space (e.g., parks, playgrounds, school sites)		

Site Planning & Design Checklist Inventory Natural & Man-Made Resources		
Identify and map other interesting or unique features that help create a distinct sense of place (e.g., scenic vistas, geologic formations, specimen trees, landmarks, plazas)		

Better Site Design—Principles & Objectives

Land planning which integrates natural features (i.e. *"designing with the landform"*) into the site design is a major component of the green infrastructure approach. Site plans that accomplish this integration create livable places where natural resource conservation and wildlife management are the cornerstones for success. On a regional scale, green infrastructure strategies include the formation of compact nodes of developments connected by transportation routes and large, contiguous, green space corridors. On an individual site level, vital ecological areas are linked to the community for an improved connection to nature and to create a unique and distinctive sense of place. By understanding the context of an individual site, a site plan can be designed within the constraints of the landform, while utilizing the natural features for environmental and economic benefits. Thus, the two guiding principles which direct "*designing with the landform"* are (1) to sustain the integrity of the surrounding natural resources, and (2) to preserve and maintain cultural and natural features.

Better Site Design—Guiding Principles & Objectives
Minimize land disturbance and erosion by working with the natural topography and hydrology of the site
Locate development away from critical environmental areas such as wetlands, cultural resources, and wildlife corridors
Maintain continuous buffers and conservation areas, especially along streams and water bodies. Avoid fragmentation of buffers by roads, utilities, and trails, to the greatest extent possible
Retain a large area of green space that is preserved in a natural state and if possible, available for community recreation
Decrease the size of residential lots, streets, driveways, parking areas, and rights of way so as to increase green space acreage
Design compact development footprints that minimize impervious surface area and reduce stormwater runoff
Preserve the natural hydrology of the site and design stormwater facilities that retain runoff on-site

Better Site Design—Guiding Principles & Objectives
Preserve existing trees and vegetation and incorporate into the development, especially old growth and monumental specimens. Preserve multi-trophic layers (mixture of trees, shrubs, and herbaceous plants) that support a diverse range of wildlife species
Use native or locally adapted drought or salt-tolerant species (See marex.uga.edu/ecoscapes for local native plant lists)
Locate roads, buildings, and septic systems in areas of suitable soil, avoiding poorly drained or "hydric" soils

The Benefits of BSD

While these principles are already in use in many parts of the United States, the focus of this chapter is to adapt these principles in the coastal Georgia area. Benefits from this approach include (US EPA 2010, 2008, CWP 1988):

- Reduced and delayed stormwater runoff volumes and pollutant loads,
- Reduced sanitary and combined sewer overflow events,
- Protection of wetlands, sensitive forests, and habitats,
- Enhanced groundwater recharge,
- Reduced soil erosion during construction,
- Urban heat island mitigation,
- Reduced energy demand,
- Improved air quality,
- Increased carbon sequestration,
- Improved human health,
- Increased property values and tax revenue,
- Conservation tax incentives
- Sustainable development funding
- Reduced construction costs,
- Easier regulatory compliance,
- Creation of a sense of community within the development, and

- Improved aesthetics.

When Better Site Design (BSD) principles and Low Impact Development (LID) practices are applied in the four primary planning and design phases (namely Conservation, Streets and Parking, Lot Development, and Stormwater Management) the benefits noted above can be realized. These principles form the basis for a better site design where impervious cover is reduced, natural areas are conserved, and stormwater runoff is reduced and/or managed using Green Infrastructure and Low Impact Development practices.

The next section provides recommended practices for implementing BSD principles in each of the four primary site planning areas. The four main steps in the design process are:

1) Identification of buildable and conservation areas (Conservation Design),
2) Layout of the proposed streets and parking systems (Streets and Parking Practices),
3) Layout and configuration of the building lots (Lot Development), and
4) Layout of stormwater facilities (Stormwater Management).

A comparison of the environmental and economic benefits of these Better Site Planning and Design principles in practice on a model development site (e.g the Tupelo Tract) concludes the chapter.

Conservation Site Design

Conservation Site Design strategies seek to preserve the natural features of a site. This design type is generally achieved by compacting or condensing the actual development footprint on one portion of a site (the buildable area) while preserving significant greenspace (preferably held in its natural state) on another portion of the site (the primary and secondary conservation areas). The preservation of greenspace can result in significant economic, environmental, and social benefits, as shown throughout these Guidelines.

The first step in the design process is to identify areas within the site that should be permanently protected (i.e., non-buildable areas). This usually begins with the analysis of a composite resource map, compiled using GIS or by other conventional means.

Better site planning techniques should be used to protect the following primary conservation areas, which provide habitat for high priority plant and animal species (Appendix B and C) and are considered to be high priority habitat areas (WRD, 2005), from the direct impacts of the land development process.

Primary Conservation Areas	
Resource Group	**Resource Type**
Aquatic Resources	Rivers
	Perennial and Intermittent Streams
	Freshwater Wetlands
	Tidal Rivers and Streams
	Tidal Creeks
	Coastal Marshlands
	Tidal Flats
	Scrub-Shrub Wetlands
	Near Coastal Waters
	Beaches
Terrestrial Resources	Dunes
	Maritime Forests
	Marsh Hammocks
	Evergreen Hammocks
	Canebrakes
	Bottomland Hardwood Forests
	Beech-Magnolia Forests
	Pine Flatwoods
	Longleaf Pine-Wiregrass Savannas
	Longleaf Pine-Scrub Oak Woodlands
Other Resources	Shellfish Harvesting Areas
	Aquatic Buffers
	Other High Priority Habitat Areas

Consideration should be given to using better site planning techniques to protect the following secondary conservation areas, from the direct impacts of the land development process.

Secondary Conservation Areas	
Resource Group	**Resource Type**
General Resources	Natural Drainage Features (e.g., Swales, Basins, Depressional Areas) Erodible Soils Steep Slopes (i.e., Areas with Slopes Greater Than 15%) Trees and Other Existing Vegetation
Aquatic Resources	Groundwater Recharge Areas Wellhead Protection Areas
Other Resources	Floodplains

The following practices used during this first step in the design process are applicable to ensuring preservation of the natural features of the site with the added benefit of improved water quality.

Reduce Impervious Cover and Land Disturbance

There are strong arguments for designing more compact communities that minimize land disturbance and conserve natural areas. The first being, that the environmental benefit of a watershed is diminished when development results in land disturbance and impervious cover. Construction activities expose sediments and construction materials to rainfall events, which washes material into storm drains or directly into nearby waterways. After construction, meadows, forested areas, and other natural landscape features are replaced with compacted and fertilized lawns, impervious pavement, and rooftops. These largely impervious surfaces generate substantial quantities of surface runoff. According to U.S. Environmental Protection Agency, water quality degradation consistently occurs at relatively low levels of imperviousness, generally between 10 to 20 percent. When a watershed's topography changed and the amount of impervious cover increased, stormwater runoff was more episodic, and a larger amount of polluted water was released to receiving waterbodies. For instance, a one-acre parking lot produces 16 times the runoff as a one-acre meadow. (The Tidal Creeks Project, 1997).

The effects of urbanization on stream ecosystems are largely driven by impervious cover. There are two general ways to quantify impervious cover:

- **Total impervious area (TIA)** = all impervious area in catchment
- **Effective impervious area (EIA)** = impervious area in catchment that is directly connected to stream channels (i.e., precipitation falling on that area is effectively transported to the stream)

Many studies have found that EIA (also known as drainage connection or directly connected impervious area) is a better predictor of ecosystem alteration in urban streams. The strength of EIA relationships suggests that compact developments that retain more green space and use stormwater management practices aimed at disconnecting impervious areas from coastal waterways can improve water quality (Walsh et al. 2005).

G3 recommends the effective impervious cover be 10% or less of the total site area.

Engineers traditionally design drainage systems to move rainwater as quickly as possible by directing it towards curbs, gutters, streets, and sewers. These conventional drainage systems prevent water from flowing into the ground and filtering through soil before being released into surface and ground waters. To compound problems, traditional construction practices seek to connect all of the impervious surfaces in a development to direct water to a minimal number of drainage outlets. Even when landscaping is built into the project, the grading typically directs water away from the landscaping, thus losing any opportunity to disconnect the imperviousness for infiltration. This approach can result in increased flooding, erosion, pollution, and degraded streams.

It is important to note that some pervious surfaces, including lawns and other maintained areas, act like impervious surfaces from a water quality standpoint. However, disturbed and impervious areas vary widely in the amount, speed, and type of runoff per square foot. At one time, lawns were thought to provide open space for infiltration of water. However, development can involve wholesale grading of the site, removal of topsoil, severe erosion during construction, compaction by heavy equipment, and filling of depressions. Research now shows that even a compacted crushed rock or grassed lawn growing on severely compacted soil can act as an impervious surface.

Conservation design reduces stormwater runoff by creating compact communities that minimize land disturbance and impervious surfaces, and conserves natural areas by using smaller lots that are spaced closer together. This design practice accomplishes three major water quality goals:

1) Reduced impervious cover,
2) Reduced land disturbance due to smaller development footprint, and
3) More green space available to serve critical ecological functions (generally 20-50% of the total site area conserved).

Preserve Native Vegetation and Soils

A key principle of designing with the landform is retaining or adding significant areas of native vegetation to provide a forested canopy. Native, shrubs, and groundcover uptake excess rain water and need little or no irrigation because they are acclimated to this region's climate and rainfall. Trees also increase the value of individual lots by providing aesthetics and moderating temperatures, but they can also act as wind buffers and are one of the most effective filters for stormwater. A list of native trees, shrubs, plants, and grasses can be assessed at the University of Georgia's Marine Extension website, www.coastscapes.org.

The forest canopy can significantly reduce the volume of stormwater runoff. A healthy 100-foot-tall tree has the ability to take up 11,000 gallons of water from the soil and release it into the air again, as oxygen and water vapor, in a single growing season (Georgia Pacific, 1999). This effectiveness is achieved by a greater surface area on the leaves, branches, trunks, leaf litter and soil with which the water can interact. The whole system acts as a sponge, absorbing, treating and retaining stormwater in vast quantities.

The presence of larger trees in yards and as street trees can add from 3% to 15% to home values throughout neighborhoods. (Univ. of Washington: Green Cities: Good Health, 2010)

Measures to protect native trees and vegetation:
Locate trees before detailed planning and engineering begins
Establish tree save areas early in the planning process and protect them during construction
Keep large contiguous swathes of forested areas to maintain wildlife corridors (links) and preserve native species
Give special attention to vegetation along tidal and freshwater wetlands and streams to aid in filtering stormwater runoff before entry

In addition to native vegetation, existing soils should be considered during the planning and design phases of development. The actual performance of soils is based in great part on local conditions including:

- Severity and duration of local rainfall,
- Soil compaction,
- Velocity of runoff,
- Site contours and its neighboring grade relationship,
- Type and density of vegetation,
- Substrate type and properties,
- Distance to the water table, and
- Percolation and permeability parameters.

An analysis of all soil-related information, including percolation and stability, is essential in determining the placement of streets, lots, buildings, septic drain fields, wells and other site amenities. By knowing the location of certain soil series, planners can design the development to avoid unsuitable areas, such as hydric soils found in wetlands and poorly drained areas.

Green Infrastructure Practices for Soils
Avoid soil compaction that increases runoff. Soil compaction restricts infiltration, deep rooting, and the amount of available water, thus, inhibiting plant growth
Measures that prevent compaction include diverting traffic from areas of moist or wet soils and increasing the content of organic matter
Avoid hydric (wetland) soils for roads and building foundations
Avoid placement of septic systems in areas of poor soil – this can cause system failure and the release of contaminated effluent to groundwater aquifers
Avoid locating buildings in low areas that require the addition of fill material, especially in floodplains and wetlands, which can result in structural flooding and resource degradation
Avoid building development along unstable slopes susceptible to erosion
Retain native trees and vegetation which naturally confine soil in place

Green Infrastructure Practices for Soils

Implement proper sediment and erosion control measures during construction. Sediment barriers (silt fences, hay or straw bales) and sediment traps (forebays) are inexpensive and effective solutions. These practices are detailed in the most recent addition of the Georgia Soil & Water Conservation Commission *Field Manual for Erosion and Sediment Control*.

Protect Wetlands and Streams

When impervious cover in upstream watersheds exceeds 10%, the quality of local streams, lakes, and wetlands declines sharply, causing the following impacts often result (CWP, 1998):

- Higher peak discharge rates and greater flooding,
- Lower stream flow during dry weather (clearly evident during coastal drought periods),
- Greater stream bank erosion,
- Alteration of natural stream channels,
- Degradation of stream habitat structure,
- Increase of sediment deposition in nearby streams,
- Fragmentation of riparian forest corridor,
- Warmer stream temperatures,
- Greater loads of stormwater pollutants,
- Decline in wetland plant and animal diversity; lower diversity of aquatic insects and native fish species,
- Sewage derived bacterial levels that exceed recreational contact standards, and
- Increased number of stream crossings with greater potential to affect fish passage.

Not only is it critical for these resources to remain intact and functional for environmental reasons, it is also economically sensible to preserve these areas. Economists have calculated coastal wetlands provide valuable ecosystem services such as flood protection and recreation. For example, the Congaree Bottomland Hardwood Swamp in South Carolina removes a quantity of pollutants from the watershed equivalent to that which would be removed by a $5 million water treatment plant (USEPA 1995). In another case, scientists estimate that a 2,500 acre wetland in Georgia saves $1 million in water pollution control costs annually (OTA 1993). In 2006, hunters, anglers, bird watchers, boaters, and others who enjoy outdoor recreation spent more than $120 billion on their activities nationwide.

Coastal wetland systems are some of the most productive ecosystems in the world. Georgia's tidal wetlands account for one-third of all remaining saltwater wetlands on the east coast. Of equal importance, freshwater wetlands and streams provide essential habitat for a range of species, including some that depend on aquatic environments part or most of their life cycle. In addition, wetlands, both tidal and freshwater, provide surface and groundwater filtration and storage, flood protection, and erosion control. The water quality of these systems is essential to the overall quality of the watershed and its inhabitants. Wetlands are crucial to overall water quality as they are labyrinths of vegetation, root structures, soils, surface and submerged landforms, chemical processes, and biological activities that filter sediments and toxic substances from stormwater before discharging it into rivers and oceans. For this reason, keeping these wetland systems intact and functional is a key element of the *Designing with the Landform* process.

The following wetland protection practices are encouraged:
Avoid construction in wetlands or their buffers by building compact developments
Plan roads and utilities to cross at the narrowest point in the system
Design crossing perpendicular to the resource, diagonal crossings generally increase the area disturbed
Use permeable paving for roadways, sidewalks, driveways, parking areas, and trails
Enhance water quality by using natural wetlands for stormwater control, which puts stormwater where nature intended it
Avoid construction in contiguous and isolated wetland systems (these areas can provide natural stormwater detention for a development)
Preserve riparian buffers along wetlands and wildlife habitat
Create or construct wetlands that mimic natural hydrological processes to control nonpoint source pollutants from stormwater (see Chapter 3 - Stormwater Wetlands for a detailed description of this practice)

The quality of a receiving waterbody can be classified by the amount of impervious cover in the watershed. The amount of impervious cover is critical because it governs the amount of stormwater runoff and pollutants that flow into the stream in large quantities over short time periods. Without impervious cover, water soaks into the soil replenishing groundwater and reducing stream bank erosion among other benefits.

The primary goal of conservation design is to maintain pre-development stream quality. Healthy streams are expected to have stable channels, relatively good water quality and a diverse population of aquatic insects and fish.

Stream protection strategies include:
Reduction in the width and length of crossings to a minimum
Use existing crossings when possible
Design bridges to span the farthest distance across streams
Use bottomless culverts beneath road crossings allowing for fish passage
Preserve naturally vegetated or restored riparian buffers (a minimum of 100’ in width) to improve water quality and provide sufficient habitat, (See the following sections—Riparian Buffers/Increase Buffer Effectiveness)
Implement low impact stormwater practices that control pollutants at their source before reaching the stream (Chapter 3)
Use of natural, non-invasive bank stabilization practices (Chapter 4)
Avoid alteration or obstruction to natural stream flow

Protect Wildlife Habitat and Riparian Buffers

Vegetated riparian buffers and forested areas have the capacity to reduce stormwater volumes, remove pollutants, and slow erosive flows. Taking into account their varied and considerable impact on water quality, wildlife and more, forested buffer zones are investments yielding some of the highest returns to landowners and the public in the improvement of the quality of water and life. Riparian buffers are also critical to the protection of private property from flooding and upland erosion caused by typical wet weather events as well as extreme events (e.g. hurricane-induced tidal surge).

If a wetland is nature's water filter, the riparian buffer is the pre-filter. The vegetation and soils in the buffer area perform a number of important tasks in pre-treatment of stormwater runoff before it reaches the stream. It is important that runoff flow enter the buffer zone as a sheet of water rather than concentrated flow. Techniques such as bioretention areas and grassed filter strips disperse the flow as much as possible prior to entry into a buffer zone. This process slows the water and allows the vegetation to remove harmful nonpoint source pollutants. Some of the important effects buffer zones have on protection of water quality include:

- Infiltration of water into the buffer zone slows runoff velocity (Simple friction with the surface and vegetation slows surface flows, and results in the accumulation of organic litter),
- Groundwater, a major component of stream flow, filters itself before it enters the stream via a path that passes through the soil and roots of the buffers zone, greatly expanding the effectiveness of the zone's impact on water quality,
- Nitrogen and phosphorus can be effectively removed from water flow by biochemical processes in the buffer zone (Vegetation facilitates these processes),
- Buffer zone vegetation traps sediments (The same process that slows flow velocity through the buffer also breaks up sediments into particulates that settle to the buffer floor and become part of the soil. Thus, the sediment never reaches the stream and any phosphorus becomes a nutrient for buffer zone vegetation),
- Soil in the buffer zone makes water entering the stream less acidic (The pH of water in the zone is raised by side effects of denitrification and other beneficial processes. The acidity of flow into the stream is important because highly acidic waters can have toxic effects on marine life),
- Herbicides and pesticides can be removed by biochemical activity in the buffer zones, and
- The area surrounding a stream is cooled not only by shading but by a micro-cooling process called evapotranspiration. Forested buffers are most effective in both types of cooling.

Size is an important factor in the effectiveness of buffer zones. The larger the space available for pre-treatment processes such as filtration and chemical activity, the more such activity can take place. In addition, wildlife can utilize the area as habitat. The following chart shows pollutant removal effectiveness and wildlife habitat value as a function of increased buffer width; generally the wider the buffer, the more effective.

Buffer Width (ft)	%Pollutant Removal Effectiveness	Wildlife Habitat Value
30	70	Minimal general wildlife habitat value
50	75	Wildlife travel corridor; general avian habitat
75	80	Fair to good general wildlife habitat value
100	80	Good general wildlife habitat value; may protect significant habitat
200	90	Excellent general wildlife habitat value; likely to support a diverse community
300-600	99	Excellent general wildlife habitat value; supports a diverse community; protection of significant species

Georgia has a number of laws and regulations that apply to buffer zones, so the required minimum buffer widths can vary. The Georgia Erosion and Sedimentation Control Act restricts land disturbance and trimming of vegetation within a 25' buffer adjacent to creeks, streams, rivers, saltwater marshes, and most lakes and ponds, and within a 50' buffer on trout streams. The Mountain and River Corridors Protection Act and the Georgia Planning Act require some local governments to adopt a 100' buffer and restrict certain land uses along various large river corridors in the state. Water supply reservoirs, streams that flow into reservoirs, and streams above drinking water intakes may also require wider buffer zones, depending on their distance from the reservoir or intake. In 2009, the rules of the Coastal Marshlands Protection Act were amended to increase the buffer width to 50' for the upland component of new commercial/community docks and marinas. Many local governments have adopted ordinances that specify wider buffers than the state minimum requirements (e.g. Chatham County requires a 35’ buffer in its islands overlay district). For specific information on buffer zone requirements in your area, contact your local zoning and planning department.

Being tidal waters and marshlands have been deemed an irreplaceable resource, G3 recommends a buffer of at least 100’ in width for all fresh and tidal wetlands and waterways.

Riparian buffers are of particular importance to the protection of water quality and habitat. The University of Georgia performed a literature review of over 140 articles and books in an effort to recommend scientifically sound and legally-defensible buffer width which can be found on the web at www.ecology.uga.edu/outreach. The research cites many reasons for riparian buffers, including: a) to reduce the volume and velocity of stormwater runoff in order to protect hydrological profiles; b) to reduce the sediment and pollutants going into open waters; and c) to provide upland wildlife corridors. The first two of these can be achieved with buffers ranging from 30 to 100 feet, whereas the third typically requires buffers of 300-600 feet.

Contiguous buffers are more suitable as a wildlife habitat than smaller, isolated vegetated areas scattered across the development site. When the width of the buffer as related to the size and shape of the parcel results in a situation in which it is unworkable for the physical constraints of the property, buffer averaging may be alternative solution. Buffer averaging is a method that allows for a reduction of the buffer’s width at a certain point or points just so as the average buffer width across the entire site is the required minimum width. Since runoff is often non-uniform and flow patterns are either diverging or converging due to existing topography, effective impervious cover, and other factors; buffer width should be variable by widening and narrowing the buffer as runoff loads and site conditions vary (Bentrup, 2008).

A continuous buffer provides a wildlife corridor that is of particular value in protecting amphibians and waterfowl populations, as well as coastal fish spawning and nursery areas. Such protection has an economic payoff as well, as research shows that nearly 60% of suburban residents actively engage in wildlife observation near their homes, and a majority is willing to pay a premium for homes located in a setting that attracts wildlife.

Landscaped buffer zones planted with native trees and shrubs also filter stormwater and benefit avian, terrestrial, and aquatic species dependent upon riparian habitat for survival. Rapid maturity of these buffer zones to their natural state is part of the process of increasing the effectiveness of the entire system.

Selective pruning and thinning of the existing vegetation in the buffer is permitted for the purpose of creating and maintaining a keyhole view corridor. “Keyhole” views provide sightlines extending to the marsh or open water beyond the buffer. Vegetation frames the view and can enhance privacy, aesthetics, and a sense of place while providing necessary buffer functions (Coastal Riparian Buffer Guidance, UGA River Basin Center).

Streams, wetlands, and areas where water is stored or treated even intermittently should be protected by a buffer of mixed (both woody and herbaceous) plants native to the region and suitable for local climatic conditions (Visit www.coastscapes.org for an extensive list of recommended native plantings). In some cases, the riparian buffer may need to be restored. See Ch. 4 Streambank Stabilization, Natural Vegetation Establishment (Practice 1) for further details.

Increase Buffer Effectiveness

Buffers are created by designating a vegetated corridor along a stream or wetland as an undeveloped area. Careful site design and smart planning can increase the width of these areas by using a technique known as “stacking” the buffer. Essentially, an area adjacent to the standard “required” (usually 25’) buffer area is used for a mixture of stormwater treatment practices. As an example, placing a bioretention area or filter strip outside of the state-mandated 25’ buffer could essentially increase the area preserved along streams or wetlands. Since the bioretention area itself is vegetated, a buffer zone that could well exceed 100’ in width may be created along the stream. This is substantially more effective than a more random location of these treatment practices. Since these areas are heavily wooded, buffers may be selectively pruned so that a resident’s view corridor to streams or wetland areas is not restricted.

Recommended design practices that increase buffer effectiveness include:
Combining GI & LID stormwater practices with natural undisturbed buffer areas (also known as buffer stacking) provides a stormwater treatment train to remove potential nonpoint source pollutants from overland runoff
Avoid siting roads and supporting Infrastructure within buffer zones to the greatest extent possible (If unavoidable, utilities should be bundled and run through the buffer in the least invasive manner possible)
When buffer zones and their associated streams or wetlands are crossed, they should be done so at the narrowest possible point to limit disturbance

If buffer is absent natural vegetation, reestablish native trees, shrubs and plants that require little or no irrigation and/or fertilizers

Sea Level Rise

Compact or clustered development strategies can help communities adapt to sea level rise, storm surge, and flooding of properties located along coastal wetlands and waterway. By building on a condensed footprint and determining what land to preserve and what to develop, communities can build resilience to the weather-related effects of climate change. Besides helping communities prepare for an uncertain future, these strategies can also help them deal with natural disasters, economic changes like rising fuel prices, and other challenges that could arise regardless of climate change.

Recommended design considerations for sea level rise include:
Discourage building in existing or projected flood plains or in areas that could be affected by rising sea levels and higher tides
Upgrade stormwater systems to better manage heavier storm flows and considering methods like green infrastructure to reduce the amount of runoff from paved surfaces
Coordinating land use and transportation infrastructure decisions and incorporating climate change projections into these decisions
Preserving large, contiguous areas of open space to better protect ecosystems that may be under pressure from the changing climate
Encouraging water- and energy-efficient buildings and land-use patterns so that they can continue to thrive if energy prices rise

Georgia, in particular, is vulnerable to SLR impacts due to its more than 2,300 miles of tidally influenced shoreline and growing population which now exceeds 500,000 people in the six coastal counties (Concannon et al 2010; U.S. Census 2010).

To help developers, designers, natural resource managers, and landowners, the Skidaway Institute of Oceanography developed a web-based interactive map that displays information about sea level rise, shoreline change, storm surge, FEMA flood zones, historical hurricane tracks, land use and cover, and armored shorelines. The Georgia Coastal Hazard Portal (www.gchp.skio.usg.edu) is a user-friendly decision-support aid that can be used to evaluate how sea level rise and erosion are predicted to affect properties along coastal marshlands and waterways. Other community maps and visuals are available at NOAA Coastal Services Center's website www.csc.noaa.gov/slr.

Preserve Greenspace

Community green space offers a number of benefits including:

- Reduced cost from using undevelopable land for runoff control and treatment,
- Reduced cost by eliminating the necessity for landscape maintenance for a fairly large portion of the property. Land owners can save between $270 to $640 per acre in annual mowing and maintenance costs when open lands are managed as a natural buffer area rather than turf (Wildlife Habitat Enhancement Council, 1992),
- When carefully designed, green space can promote better pedestrian movement, a stronger sense of community space and a park-like setting. Numerous studies have confirmed that developments situated near trails or parks sell for a higher price than more distant homes (North Inlet-Winyah Bay NERR Coastal Training Program, 2002).
- Enhancing development by creating a centralized and often even educational natural area for the community,
- Providing wildlife habitat for native species and nature-watching opportunities

As consumer demand for green space amenities continues to grow, the quality of streams and wetlands can be linked to improved marketability of these areas. Communities have repeatedly found that property adjacent to protected wetlands, floodplains, shorelines, and forests constitutes an excellent location for development. (U.S. EPA, 1995). A sense of place is instilled by the presence of water, forest, and natural areas and this preference is expressed in a greater willingness to pay to live near these habitats.

When managed as a "greenway," riparian buffers can expand recreational opportunities and increase the value of adjacent properties. Several studies have shown that greenway parks increase the value of homes adjacent to them. A park in Philadelphia is credited with a 33% increase to the value of nearby property – a net increase of more than $3.3 million in real estate value is attributed to the park. A greenway in Boulder, Colorado, was found to have increased aggregate property values by $5.4 million, resulting in $500,000 of additional tax revenue per year. (Chesapeake Bay Foundation, 1996.).

Street & Parking Design

The second step is the better site design process is the layout of an appropriate transportation network. *Green Growth Guidelines* encourages designs that reduce impervious surfaces and increase usable open spaces or conservation areas. Among the many practices that can achieve this goal are better road design and green parking techniques.

Given recognition of natural features and planning to accentuate and preserve these features, the appropriate street pattern will accommodate the natural contours of the site while improving interconnectivity and safety. Since streets and parking areas are impervious collectors of grease, antifreeze, oil, heavy metals, pathogens, and general debris, it is imperative to reduce impervious surfaces and nonpoint source pollutants running off of these areas.

There are several street and parking design patterns that lend themselves to reducing impervious area and increasing common open and/or preserved green space. Use of the best features of these patterns can result in numerous environmental, social, and economic benefits when compared to conventional development. Street and parking design patterns that facilitate the green infrastructure approach include (CWP, 1998):

- The grid or traditional urban pattern features short block lengths, straight streets and a systematic layout. This pattern generates greater dispersal of traffic, increased number of routes to a given destination, greater safety for pedestrians, ease of use of public transportation, and an increase in the number of homes fronting a street by using narrower lots,
- The curvilinear "modified grid" pattern is similar to a grid pattern which features longer block lengths (The curvilinear pattern allows a site designer to better follow the topography of the site to avoid sensitive environmental areas, thereby, reducing clearing, excavation, and filling activities associated with road construction),
- Hybrid street networks combine both grid and curvilinear to better accommodate the natural features of a site.

Street Width and Length

Significant reduction to impervious cover can be accomplished by minimizing street width and length. Accordingly, streets should be designed as narrow and short as possible for intended use. Careful design of streets can satisfy concerns regarding parking, safety, and traffic congestion. Conventional standards include a 32' wide roadway composed of two 7' parking lanes on either side of two 9' wide moving traffic lanes. With only one 8' wide parking lane, two 10' wide travel lanes are standard.

Recommended design practices for roads include:
Base design on average daily traffic volume calculated by the number of actual trips per day
Provision for safe and efficient access for emergency vehicles
Design for the minimum required pavement to support traffic and parking
On-street parking lanes should serve as traffic lanes (also known as a "queuing lane")
For urban streets with parking on both sides actual width is recommended at 32' (The recommended actual width of a neighborhood street with parking on one side is 24', while local street width is recommended at 18' and a gravel alley has recommended width of 14')

Benefits from these practices include:

- Reduction in impervious cover,
- Reduction in the speed of traffic provides greater safety for pedestrians,
- Significant savings in cost of paving, clearing and grading, infrastructure, long-term pavement maintenance and stormwater management. A savings of approximately $150 per linear foot can be achieved by shortening roads (CBP, 1993). This includes savings achieved through reduced pavement and stormwater control.

Right-of-Way Width

A street right-of-way is an area where streets, sidewalks, utilities, and sometimes stormwater features are located. Often, the entire right-of-way is cleared in preparation for grading and road construction, potentially resulting in unnecessary loss of trees and vegetation. Limiting the cleared land width reduces the amount of land disturbed. Reducing the right-of-way makes more land available for housing lots and facilitates designing a compact land plan. Conventionally, a right-of-way width of 50 to 60 feet is applicable to all residential streets.

Recommended design practices for street rights-of-way include:
Reduce cleared width to minimum required to facilitate roadway, sidewalk, and vegetated open channels
Utilities should be bundled together and located within the pavement section of the right-of-way when possible
Reduce rights-of-way by 10 to 25 feet by decreasing pavement and sidewalk width and bundling utilities within the pavement section Encourage the use of natural stormwater practices within rights-of-way such as bioretention swales and grassed filter strips that reduce the use the cleared area to treat stormwater runoff

Recommended design options for a narrower right-of-way on residential streets (CWP 1998) include:

- 36’ Road Scenario

  16’ Pavement Width – Two 8’ Wide Travel Lanes

  One 8’ Grassed Utility Easement

  One 12’ to 18’ Grass Shoulder with Parking

- 38’ Road Scenario

  20’ to 22’ Pavement Width – Two 10’ to 11’ Wide Travel Lanes

  One 8’ Grassed Utility Easement

  One 8’ to 15’ Swale

- 42’ Road Scenario

  22’ to 26’ Pavement Width – Two 8’ to 9’ Travel Lanes with One 6’ to 8’ Emergency or Parking Lane

  One 8’ Grassed Utility Easement

  One 8’ Sidewalk

Primary benefits include:

- Opportunity for on-site stormwater control and treatment,
- Reduces area to be cleared, resulting in a cost benefit, and
- More land available for development or green space.

Cul-De-Sacs & Alternative Turnarounds

A cul-de-sac is a dead-end residential street often used in conventional subdivisions. Typically, the terminal end is a large “bulb” that carries a radius of 50’ to 60’, entirely impervious and almost never fully utilized for turning purposes. There are alternative turnaround designs that serve the intended purpose while significantly reducing the area of impervious cover.

Turnaround Option	Impervious Cover (SF)
40’ Radius Cul-De-Sac	5,024
40’ Radius Cul-De-Sac with Landscaped Island	4,397
30’ Radius Cul-De-Sac	2,826
30’ Radius Cul-De-Sac with Landscaped Island	2,512
60’ by 20’ T-Shaped Turnaround	1,200

Recommended design practices for cul-de-sacs and turnarounds include:
Reduce the radius of the turnaround bulb to 40’ or less
Use interconnected streets to minimize the number of cul-de-sacs
Place a pervious island in the center of the turnaround and landscape with water-absorbing plants to facilitate storage and treatment of stormwater
Consider alternatives to circular cul-de-sacs like the T-Shaped turnaround, which can generate 75% less impervious cover than a 40’ radius circular turnaround, and the loop road, which provides multiple accesses and can carry twice the traffic volume of a cul-de-sac

Benefits include (CWP, 1998):

- Reduced impervious surface area,
- Attractive to homebuyers due to lower traffic and sense of privacy, and
- Landscaped islands can be designed as rain gardens for stormwater control.

Sidewalks and Driveways

Excessive sidewalk and driveway requirements can increase the amount of impervious area within a site, further preventing infiltration of stormwater runoff into the soil. As much as 20% of the impervious cover in a residential subdivision consists of driveways and sidewalks (CWP, 1998).

Recommended design practices for sidewalks and driveways include:
Locate sidewalks on only one side of the street
Use sidewalk widths of 6 feet in areas of high foot traffic and reduce the width to 3 or 4 feet in areas that will see less traffic
Specify narrower driveway widths
Reduce the length of driveways by relaxing street and side yard setbacks
Encourage shared driveways
Use permeable surfacing materials for sidewalk and driveway construction
Create driveways as two parallel strips with vegetation between them instead of one large expanse of concrete
Sidewalks should be graded so that they drain to the adjacent bioretention swales or rain gardens, as opposed to the street

Benefits from these practices include (CWP, 1998):

- Reduces impervious area,
- Allows for greater on-site infiltration of stormwater if bio-swales and rain gardens are used, and
- Cost savings in construction and maintenance due to reduction in amount of paving.

Parking and Parking Lots

Since parking lots, like streets and on-street parking, can be the largest impervious collectors of pollutants and debris, it is imperative to reduce these impervious surfaces and non-point source pollutants running off of these areas with common, practical, strategies referred to as "green parking".

Parking ratios are the number of parking spaces that must be provided based on land use as established by local governing bodies. They are typically based on the minimum number of spaces needed to support peak parking hour(s). Studies summarized below have shown that typically, far more spaces are built than are actually needed:

Conventional Minimum Parking Ratios

Land Use	Parking Requirement	Typical Range	Actual Average Parking Demand
Single Family Homes	2 spaces per dwelling unit	1.5 – 2.5	1.11 spaces per dwelling unit
Shopping Center	5 spaces for 1000 ft	4.0 – 6.5	3.97 per 1000 ft GFA
Convenience Store	3 spaces for 1000 ft	2.0 – 10.0	-
Industrial	3.3 spaces for 1000 ft	0.5 – 2.0	1.48 per 1000 ft GFA
Medical Office	1 space for 1000 ft	4.5 – 10.0	4.11 per 1.48 per 1000 ft GFA

*GFA = gross floor area of a building without storage or utility spaces.

Recommended design practices for parking include:
Limit the number of required parking spaces to meet actual average parking demand
Reduce the dimensions of parking stalls by 6” to 1’ off their current length and width
Create more spaces for compact cars
Pervious materials are recommended for use to pave a variety of lower usage areas including overflow parking, emergency and service lanes. A wide variety of alternative materials are available including modular pavers, gravel, crushed shell, grass pave, turf blocks, and porous concrete
Reduce the volume of stormwater runoff by requiring landscaped areas be used for stormwater management. Landscaped areas can include parking islands which can be used as bioretention areas, dry swales, or filter strips
Encourage shared parking and promote structured parking (multi-level lots). In urban areas, especially commercial areas, high parking ratios make green parking techniques, especially shared parking and structured parking, a practical approach to reducing overall impervious coverage

Primary benefits from reduction of excess parking spaces, minimization of parking stall dimension, and encouragement of shared parking and multi-level garages include:

- Decreases impervious cover and related stormwater runoff,
- Reduces construction and maintenance cost. Cost per conventional space can range from $2,000, an indication that a reduction in the required number of spaces would result in a cost savings in construction or maintenance (EPA, 2006), and
- Building a parking structure is costly but takes up no more impervious area than a single level parking lot. Therefore, in an urban setting, multi-level structures may be a financial incentive for developers.

Lot Development – The Building Footprint

The third step in the Better Site Design process involves locating individual homes sites within the buildable area of the tract. Primary consideration is given to the natural contours of the land, especially when siting building lots to minimize land-disturbing activities such as clearing and grading. In addition, the dimensions of a lot can be modified to reduce overall impervious areas and then used to accommodate stormwater management features.

Conventional subdivisions require certain distance setbacks along all sides of the lot that often restrict a site designer's ability to design compact developments and reduce impervious surfaces and related runoff problems. Relaxed building setbacks and frontages can be used to reduce roadway, driveway, and sidewalk lengths and help minimize the creation of new impervious cover on development sites. This allows the design team to use flexible lot shapes which limit site imperviousness, sometimes by as much as 40 to 60 percent. (Coastal Stormwater Supplement, CWP, MPC 2009)

Site planning and design teams are encouraged to reduce impervious cover by compacting the building footprint. This can be achieved by developing vertical versus horizontal (i.e. taller buildings with same amount of livable space). According to the Atlanta Regional Commission, a single story building can generate up to 75% more impervious cover than a four-story building with the same occupancy capacity.

Benefits of these practices include:

- Reduction in total impervious area by 40% or more when compared to conventional subdivision lot layouts, particularly if narrower streets can be utilized,
- Lower construction cost by reduced clearing, grading, and paving,
- Conserves trees and natural areas,
- Protects watershed by reducing annual stormwater runoff volume by as much as 60% and, accordingly, stormwater pollution by a corresponding amount, and
- Highly desirable green space amenity creates higher market value for lots and faster value appreciation.

Stormwater Management

Human impact can disrupt or destroy many of the processes that allow the natural landscape to perform its hydrological function of releasing cleansed water to the ocean, streams and creeks and to the local groundwater. Stormwater runoff generated from impervious cover can be a significant threat to the quality of wetlands, surface water, and groundwater. Research has shown:

- Wetlands can be adversely affected by the quality and quantity of stormwater it receives from upstream areas.
- Sole source aquifers can be contaminated if stormwater pollutants are discharged underground.
- Stormwater pollutants can be directly attributed to the closure of beaches and shellfish beds.
- Fish and wildlife habitat can be degraded by erosion and sedimentation.

Stormwater management should seek to control both the quality and quantity of stormwater runoff created from new development activity. Quantity control is achieved by use of "constructed" wetlands and ponds, which help minimize flooding and protect downstream channels from accelerated erosion. Quality control is achieved through implementation of stormwater best management practices (BMP's) like enlarged vegetated buffers, bio-retention areas, and infiltration basins that use natural processes to remove harmful nonpoint source pollutants. (CWP, 1998)

To become more effective, stormwater management must incorporate low impact development practices in its process for solving stormwater problems "*at the source*". With its focus on the reduction of impervious cover and the utilization of greenspace for stormwater treatment, LID site design practices can greatly reduce the volume of stormwater runoff leaving the site.

The following LID practices can be implemented at the site design stage:
Where feasible, parking areas, paths, sidewalks, driveways, and roadways should be surfaced using permeable paving
Parking and roadways should have grass filter strips, swales or bioretention areas to provide stormwater treatment and storage
Preserve areas with native vegetation for runoff control and buffering of environmentally-sensitive areas

While these are basic examples of how LID practices can improve stormwater management, BMPs are the primary method of stormwater control. These practices, their physical description, application, and resulting benefits, are discussed further in Chapter 3. The *Coastal Stormwater Supplement* (CSS) to the *Georgia Stormwater Management Manual* provides detailed design specifications and stormwater management credit criteria for each of these practices.

Site Planning and Design Checklist

Site Planning and Design Checklist		
Analyze Site Characteristics and Constraints—Conduct a detailed analysis of the results of the natural and man-made resources inventory to gain a thorough understanding of the site's characteristics, constraints and development opportunities		
Green Growth Guidelines	√	**Comments/Notes**
Topography		
Analyze the site's natural topography, including its existing contours and topographical features		
Avoid creating the need for excessive clearing, grading and cut and fill activities on the development site		
Preserve topography during layout of the site's transportation network		
Avoid locating buildings, roadways and other impervious surfaces in low-lying areas that require the addition of significant amounts of fill material		
Avoid locating buildings, roadways and other impervious surfaces on steep slopes (i.e., slopes of 15% or greater)		
Orient buildings so that their major axes are parallel to existing contour lines		
Natural Drainage Divides, Patterns and Features		
Analyze the site's natural drainage divides, patterns and features (e.g., swales, basins, depressional areas)		
Where feasible, ensure that natural drainage features (e.g., swales, basins, depressional areas) are preserved		

Site Planning and Design Checklist		
Avoid creating the need for the filling and grading of natural drainage features, depressional areas and flow paths		
Avoid locating buildings, roadways and other impervious surfaces in natural drainage features and flow paths		
Soils		
Analyze the properties of the soils found on the development site, including soil plasticity, drainage capacity, stability, permeability and shrink-swell potential		
Evaluate proper use and management of the soils, using guidance provided by the NRCS soil surveys		
Define the site's reference soil condition by evaluating the site's undisturbed soils for the following: organic matter content and depth, texture and bulk densities, infiltration rates, soil biological function, and soil chemical characteristics		
Evaluate the site's previously disturbed soils for the following: organic matter content and depth, texture and bulk densities, infiltration rates, soil biological function, and soil chemical characteristics		
Avoid creating the need for excessive soil compaction on the development site		
Avoid locating buildings, roadways and other impervious surfaces on hydric (i.e., wetland) and extremely poorly drained soils		
Avoid locating septic systems in areas with soils that have low permeabilities and poor percolation rates		

Site Planning and Design Checklist		
Avoid locating buildings, roadways and other impervious surfaces in areas that have soils with extremely high permeabilities		
Avoid locating septic systems in areas with soils that have extremely high permeabilities		
Avoid locating buildings, roadways and other impervious surfaces in areas with unstable or unsuitable soils		
<u>Trees and Other Existing Vegetation</u>		
Analyze the site's trees and other existing vegetation		
Where feasible, ensure that trees and other existing vegetation, especially old growth and specimen trees, are preserved		
Avoid creating the need to disturb trees and other existing vegetation in areas that have soils that are particularly unstable or susceptible to erosion		
Avoid creating the need to disturb trees and other existing vegetation on steep slopes (i.e., slopes of 15 percent or greater)		
Where feasible, maintain continuous areas of trees and other existing vegetation, especially along aquatic corridors and around streams, wetlands and other aquatic resources (i.e., aquatic buffers)		
Avoid fragmenting large, continuous areas of trees and other existing vegetation with roadways, utility crossings and trails		
Delineate tree protection areas early in the site planning and design process		

Site Planning and Design Checklist		
Other Site Characteristics and Constraints		
Analyze land use changes over time by reviewing historic aerial photos		
Analyze average annual and monthly precipitation patterns and temperature conditions		
Analyze site specific conditions, such as microclimate, wind direction, sun angles, slope and microtopography, that may affect site design decisions, such as building orientation and design		

Site Planning and Design Checklist		
Apply Better Site Planning Techniques—Use better site planning techniques to protect the important natural and man-made resources found on the development site		
Green Growth Guidelines	**√**	**Comments/Notes**
Preserve and protect the following primary conservation areas, which provide a number of valuable ecosystem services, including habitat for high priority and protected plant and animal species, from the land development process:		
Aquatic Resources		
Rivers and Streams		
Freshwater Wetlands		
Tidal Rivers and Streams		
Sounds		
Tidal Creeks		
Coastal Marshlands		
Tidal Flats		
Scrub-Shrub Wetlands		
Near Coastal Waters		
Beaches		
Terrestrial Resources		
Dunes		
Maritime Forests		

Site Planning and Design Checklist		
Marsh Hammocks		
Evergreen Hammocks		
Canebrakes		
Bottomland Hardwood Forests		
Beech-Magnolia Forests		
Pine Flatwoods		
Longleaf Pine-Wiregrass Savannas		
Longleaf Pine-Scrub Oak Woodlands		
High Priority Habitat Areas and Areas Providing Habitat for Protected Plant and Animal Species		
High Priority Habitat Areas		
Areas Providing Habitat for Protected Plant and Animal Species		
Other Natural Resources		
Shellfish Harvesting Areas		
Aquatic Corridors		
Man-Made Resources		
Historic Landmarks/Archeological Sites		
Preserve and protect the following secondary conservation areas, which may be considered "buildable," but have significant value if left undisturbed, from the land development process:		
Site Characteristics and Constraints		

Site Planning and Design Checklist		
Natural Drainage Divides		
Natural Drainage Patterns		
Natural Drainage Features (e.g., Swales, Basins, Depressional Areas)		
Erodible Soils		
Steep Slopes (i.e., Areas with Slopes Greater Than 15%)		
Trees and Other Existing Vegetation		
Other Natural Resources		
Floodplains		
Groundwater Recharge Areas		
Wellhead Protection Areas		
Man-Made Resources		
Recreational Areas		
Trails		
Open Space (e.g., Parks, Playgrounds)		
Scenic Vistas		
Preserve important natural and man-made resources, such as wetlands, pine flatwoods and groundwater recharge areas as large, intact tracts of land		
Preserve high priority habitat areas, as defined in the Comprehensive Wildlife Conservation Strategy for Georgia and other areas that provide habitat for protected plant and animal species as large, intact tracts of land		

Site Planning and Design Checklist		
Preserve areas that provide habitat for diverse groups of plant and animal species		
Preserve areas containing native trees and other existing vegetation, especially old growth and specimen trees		
Preserve existing aquatic and wildlife corridors and maintain connectivity with adjacent natural and man-made resources		
Establish a buffer along aquatic corridors around all streams, wetlands and other aquatic resources		
Unless they are being reforested or revegetated, maintain primary and secondary conservation areas in an undisturbed, natural state before, during and after construction and protect them in perpetuity through a legally enforceable conservation instrument (e.g., conservation easement, deed restriction)		

Site Planning and Design Checklist		
Establish Aquatic Buffers		
Green Growth Guidelines	**√**	**Comments/Notes**
Maintain continuous areas of trees and other existing vegetation along aquatic corridors and around streams, wetlands and other aquatic resources		
Consider the intended function of the buffer when deciding how wide an aquatic buffer should be; generally speaking, the wider an aquatic buffer, the more effective it will be		
Although state law requires the creation of 25-foot wide aquatic buffers, 50- to 75-foot wide aquatic buffers are preferred		
Do not interrupt aquatic buffers with impervious surfaces or bypass them with stormwater outfalls that discharge stormwater runoff directly into the streams, wetlands or other aquatic resources being protected by the buffers		
Reforest or revegetate aquatic corridors and buffer areas that have been significantly altered by clearing, grading and other land disturbing activities or that consist exclusively of managed turf		
Instead of clearing them completely, selectively prune aquatic buffers to create "view corridors" to nearby streams and wetlands		
Limit the length of the flow path within the contributing drainage area and use level spreaders at the upstream end of aquatic buffers used to "receive" stormwater runoff		

Site Planning and Design Checklist		
Unless they are being reforested or revegetated, maintain aquatic buffers in an undisturbed, natural state before, during and after construction and protect them in perpetuity through a legally enforceable conservation instrument (e.g., conservation easement, deed restriction)		

Site Planning and Design Checklist		
Apply Better Site Design Techniques—Use better site design techniques to minimize land disturbance and limit the creation of new impervious and disturbed pervious cover on the development site		
Green Growth Guidelines	**√**	**Comments/Notes**
<u>Transportation Network Design</u>		
Use the results of the natural and man-made resource inventory to design a transportation network that compliments the development site's characteristics and constraints		
Minimize the creation of ne w impervious cover during the design of the transportation network using the following better site design techniques:		
Reducing Roadway Lengths and Widths		
Reducing Right-of-Way Widths		
Using Fewer or Alternative Cul-de-Sacs		
Reducing Driveway Lengths and Widths		
Reducing Sidewalk Lengths and Widths		
Reducing Parking Lot Footprints		
Creating Parking Lot Landscaping Islands		
<u>Lot Design</u>		
Use the results of the natural and man-made resource inventory to create a lot layout that is consistent with the development site's characteristics and constraints		

Site Planning and Design Checklist		
Use the following better site design techniques to reduce the need for roadways, driveways, sidewalks and other impervious surfaces on the development site:		
Reducing Building Footprints		
Reducing Setbacks and Frontages		

Site Planning and Design Checklist		
Apply Stormwater Management Practices—Use stormwater management practices to manage and reduce stormwaterrunoff rates, volumes and pollutant loads on the development ****See CH. 3 For Details on SW Practices Listed Below****		
Green Growth Guidelines	√	**Comments/Notes**
Stormwater Management System Design		
Review the stormwater management requirements that apply to the development site		
Distribute the following runoff-reducing low impact development practices across the development site:		
Soil Restoration		
Site Reforestation/ Revegetation		
Green Roofs		
Permeable Pavement		
Undisturbed Pervious Areas		
Vegetated Filter Strips		
Grass Channels		
Simple Downspout Disconnection		
Rain Gardens		
Stormwater Planters		
Dry Wells		
Rainwater Harvesting		

Site Planning and Design Checklist		
Bioretention Areas		
Infiltration Practices		
Dry Swales		
Where feasible, use permeable pavement to construct alleys, parking stalls, walking paths and trails, driveways, sidewalks and light-duty service roads		
Provide vegetated filter strips and depressed landscaped islands in and around parking lots		
Use dry swales and grass channels along roadways and in roadway medians to reduce stormwater runoff rates, volumes and pollutant loads near their source		
Use primary and secondary conservation areas and aquatic buffers to “receive” stormwater runoff and buffer environmentally sensitive areas		
Check to see if the stormwater management requirements that apply to the development site have been satisfied		
If the stormwater management requirements that apply to the development site cannot be satisfied exclusively through the use of better site planning and design techniques and low impact development practices, use the following general application stormwater management practices to further manage stormwater runoff rates, volumes and pollutant loads on the development site:		
Stormwater Ponds		
Stormwater Wetlands		
Bioretention Areas		

Site Planning and Design Checklist		
Filtration Practices		
Infiltration Practices		
Swales		
Use the following limited application stormwater management practices only when better site planning and design techniques, low impact development and general application stormwater management practices cannot be used to satisfy the the stormwater management requirements that apply to the development site:		
Dry Detention Basins		
Dry Extended Detention Basins		
Multi-Purpose Detention Areas		
Underground Detention Systems		
Organic Filters		
Underground Filters		
Submerged Gravel Wetlands		
Gravity (Oil-Grit) Separators		
Alum Treatment Systems		
Proprietary Systems		
Check to see if the stormwater management requirements that apply to the development site have been satisfied		
If the stormwater management requirements have not been completely satisfied, go back to the site layout to apply additional low impact development and stormwater		

Site Planning and Design Checklist		
management practices to further reduce and manage stormwater runoff rates, volumes and pollutant loads on the development site		

Site Planning and Design Checklist		
Prepare Preliminary Plan—Use the results of the site planning and design process to prepare a preliminary plan illustrating the layout of the proposed development project and showing, in general, how stormwater runoff will be managed on the development site; Host pre-submittal meeting with local development review authority		
Green Growth Guidelines	√	**Comments/Notes**
Prepare a preliminary plan that includes the following:		
Project Narrative		
Common address of site		
Legal description of site		
Vicinity map		
Site Fingerprint		
Existing Conditions Map		
Existing roads, buildings, parking areas and other impervious surfaces		
Existing utilities and utility easements		
Existing primary and secondary conservation areas		
Existing aquatic buffers		
Existing low impact development and stormwater management practices		
Existing storm drain infrastructure		
Existing channel modifications		
Proposed Conditions Map		

Site Planning and Design Checklist		
Proposed topography		
Proposed drainage divides and patterns		
Proposed roads, buildings, parking areas and other impervious surfaces		
Proposed utilities and utility easements		
Proposed limits of clearing and grading		
Proposed primary and secondary conservation areas		
Proposed aquatic buffers		
Proposed low impact development and stormwater management practices		
Proposed storm drain infrastructure		
Proposed channel modifications		
Stormwater Management System Narrative		
List of low impact development and stormwater management practices that will be used		
Calculations showing how initial estimates of the stormwater management requirements that apply to the development project were obtained		
List of Expected Waiver Requests		
Once the preliminary plan has been created, host a pre-submittal meeting with the local development review authority to discuss the proposed development project		