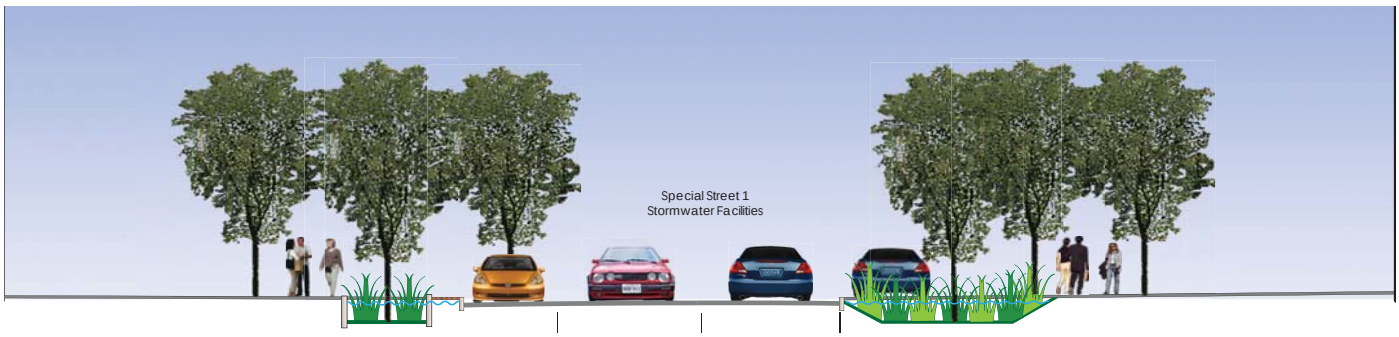
STORMWATER MANAGEMENT PLAN



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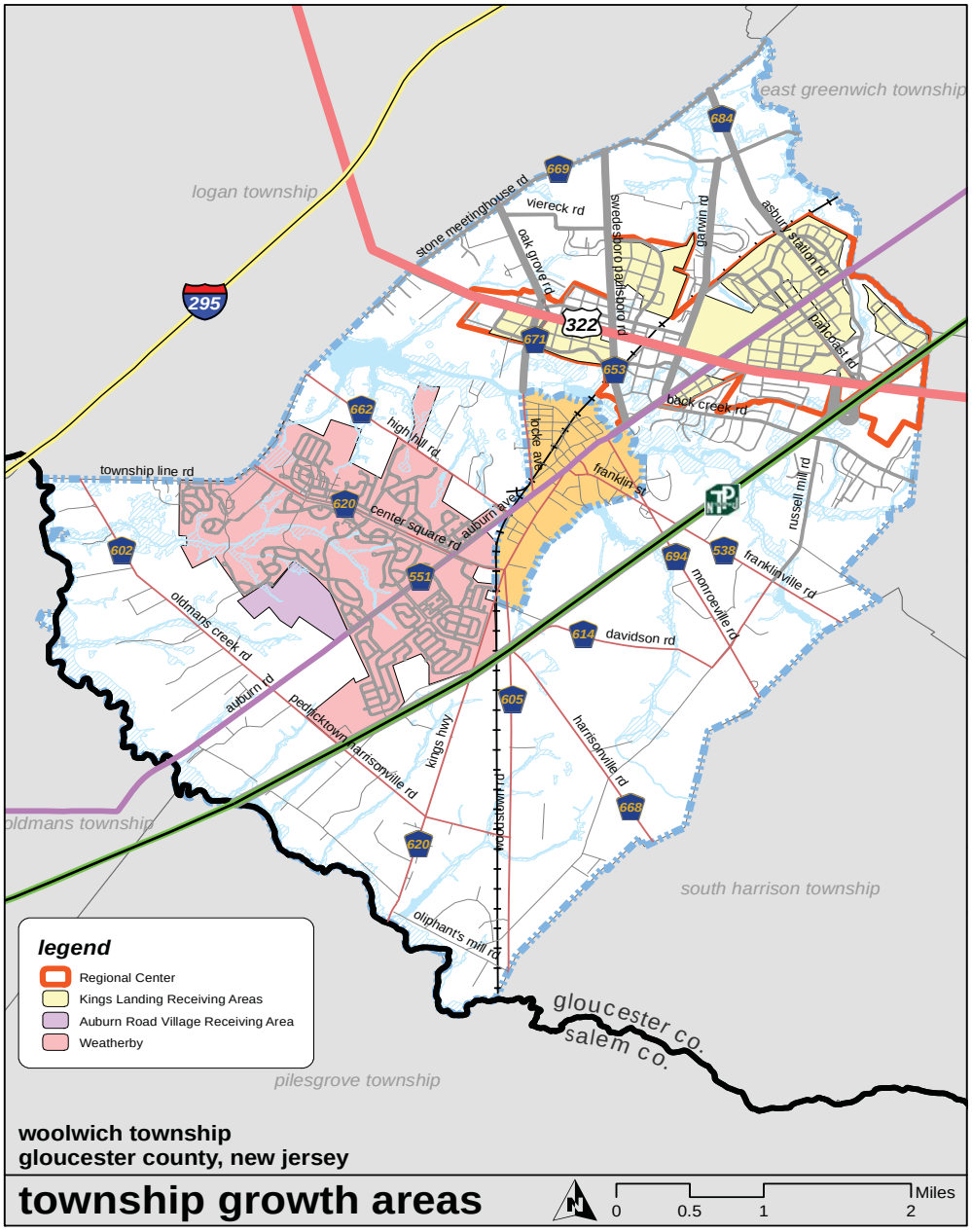
May 2016 Update

MASER CONSULTING P. A.

INTRODUCTION

OVERVIEW

To accommodate projected growth and preserve prime agricultural land, Woolwich Township is proposing the Transfer of Development Rights (TDR) from agriculturally based sending zones to receiving zones in the Township. The receiving zones are part of a larger planned regional center that Woolwich Township has proposed as part of it's Plan Endorsement Package known as Kings Landing at Woolwich Regional Center.



Woolwich Regional Center is a 2.7 square mile area along the US 322 corridor. It includes a 750 acre property owned by Woolwich Adult. Here, 925 active adult housing units, 104 affordable housing units and 2.7 million square feet of commercial space are planned. The Regional Center also encompasses the US 322 Corridor TDR Receiving Zone. This 880 acre receiving zone is divided into several noncontiguous areas. It will contain several compact residential neighborhoods with a mix of housing types, ranging in size and price, including affordable housing modeled on densities and design configurations that have become known as Traditional Neighborhood Design (TND). It will offer space for civic uses. It will also include a mixed use main street, with offices, small shops and residential units above. Parks, plazas and pedestrian paths will weave through the receiving zone. An integrated network of streets, sidewalks, and bicycle paths will connect neighborhoods within Kings Landing at Woolwich and connect the Kings Landing regional center to the surrounding area.

PURPOSE

The stormwater plan's primary purpose is to manage post development runoff generated within Kings Landing as an effective environmentally friendly component of the proposed TDR's multi-functional framework for development, resource protection, conservation, restoration and recreation. The plan's proposed stormwater strategies reflect Woolwich Township's vision of a sustainable future and draws upon state of the art solutions, including low impact development techniques and incentives for implementation of green growth guidelines.

HISTORY

Historically, conventional stormwater management has approached stormwater runoff as a problem to be solved rather than a valuable resource to be embraced. Conventional engineering methodology seeks to capture and move water as a waste product, focusing on efficient piped conveyance and detention storage. In many cases, created detention basins displace one of nature's most effective stormwater management devises – woodlands. Conventional strategies do the opposite of what nature does to manage stormwater. Nature dispenses rather than concentrate flows, managing rainfall close to where it falls.

WHY A NATURAL "ENVIRONMENTALLY FRIENDLY" APPROACH

Stormwater runoff significantly impacts the quality of our waterways, depositing sediment and pollutants. These residuals have harmful affects on drinking water supplies, recreation, fisheries and wildlife. Conventional stormwater management through storage and peak flow attenuation is not adequate to ensure the health and functionality of our natural systems. Conventional methodology does not address water quality or replenishment of ground water and allows larger volumes of runoff to enter our streams. With this methodology, even the best engineered plans over time contribute to flooding, erosion, poor water quality and degradation of ecological and hydrological systems.

Nature manages stormwater close to where it falls, reducing water volumes and release rates, while cleaning the water through natural filtration practices. A "natural" approach to stormwater management mimics a site's predevelopment hydrology by using design technologies that infiltrate, filter, store, evaporate and detain runoff close to its source. This innovative alternative approach modeled after nature is referred to as "Low Impact Development" or "Natural Drainage."

State and federal stormwater regulations have implemented new standards and best management practices based on this approach. This stormwater management plan combines conservation of natural watershed hydrology, pollution prevention and site specific approaches to maintain the viability of the associated watershed ecosystems in support of these regulations and a healthy environment.

In addition to benefiting the environment, a recent study completed by Tom Low of Duany Plater – Zyberk and Company showed that utilizing "more natural methods can sharply reduce engineering costs for traditional neighborhood design" (TND), as reported in the January/February 2007 issue of *New Urban News.* Low's team looked at the financial effect of using natural drainage techniques in Griffin Park, a TND proposed in Greenville County, South Carolina, concluding "engineering costs would drop 31 percent."

APPLICABILITY

This report provides detailed Stormwater Master Planning for Kings Landing receiving areas. That is because Kings Landing consists of a multitude of property owners and a single plan is the best way to assure that goals are achieved. That not withstanding, the goals, principles and stormwater design standards expressed in this document are to apply to all development in Woolwich Regional Center and Auburn Road Village.

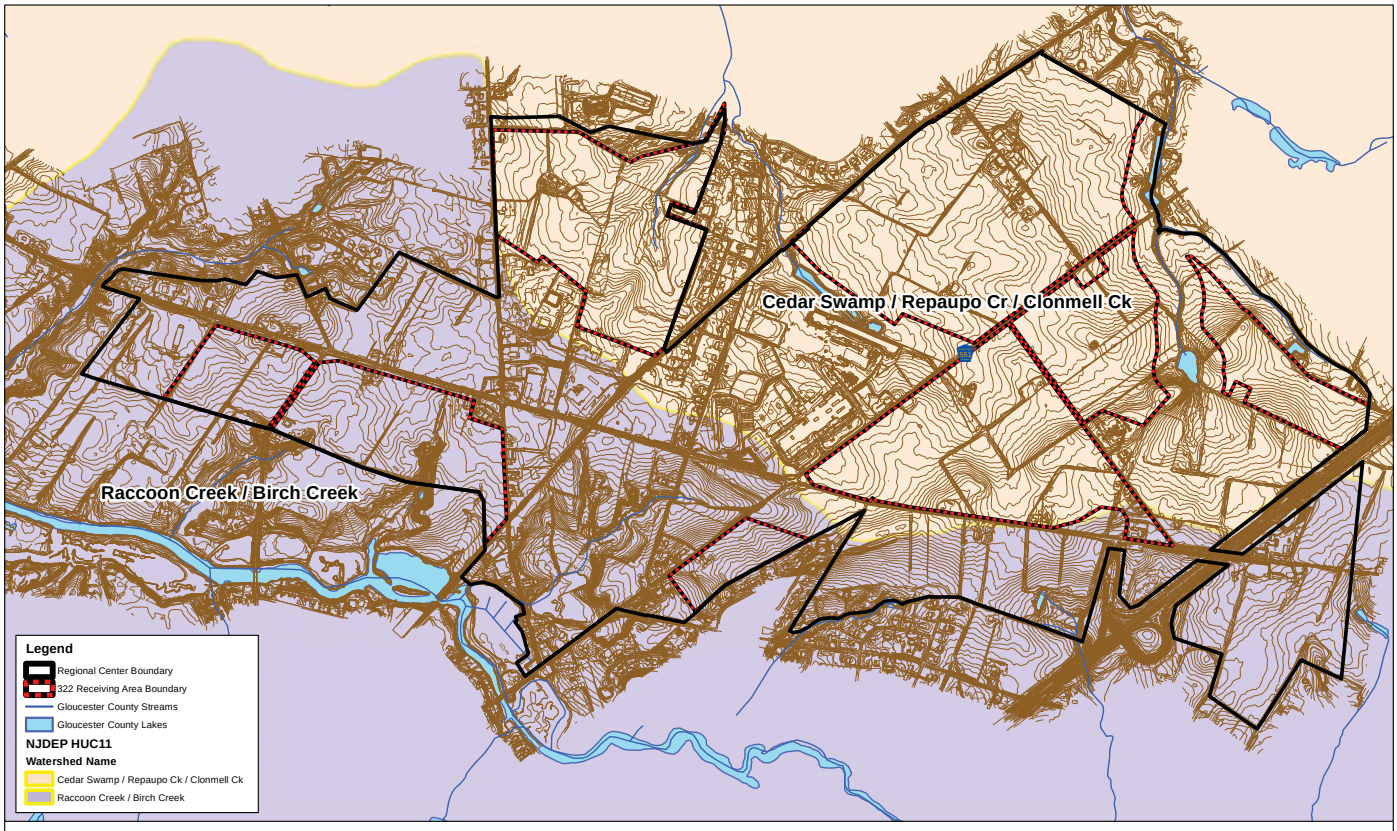
EXISTING HYDROLOGY AND PHYSICAL OVERVIEW

For the purpose of this report and stormwater conceptual design the following data has been analyzed.

- Topography from aerial flown in 2005 at 2 foot contours
- NJDEP Geographic Information Systems (GIS)landscape maps including soils
- Site Visits
- Aerial Photographs (2002)

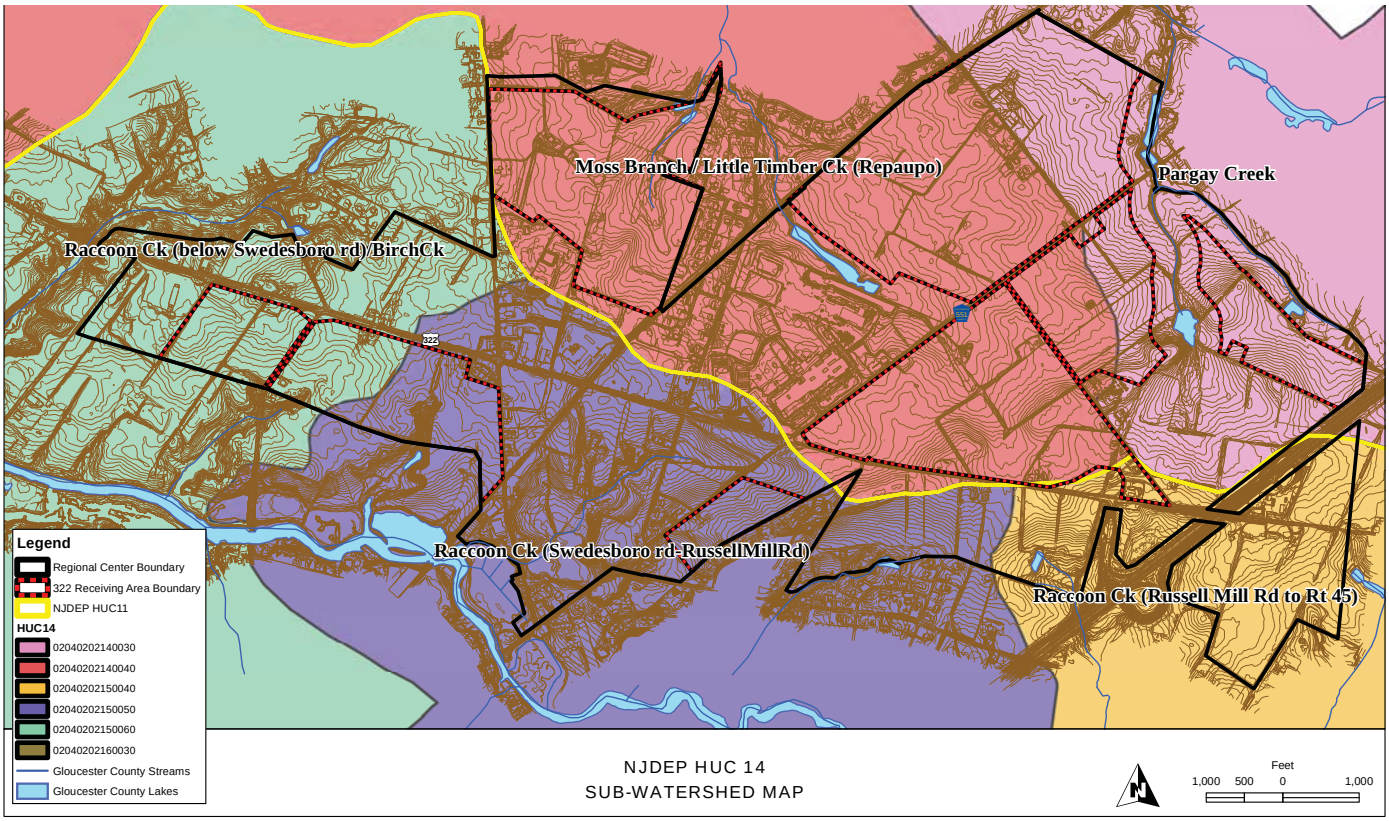
KINGS LANDING AT WOOLWICH

The Township of Woolwich rests completely within the Lower Delaware Water Management Area (known as WMA No.18), which ultimately drains to the Lower Delaware River. The proposed Woolwich New Town receiving area encompasses portions of two watersheds (known as HUC 11s) within this water management area being; the 1) Cedar Swamp/Repaupo Creek/Clonmell Creek and 2) Raccoon Creek/Birch Creek.

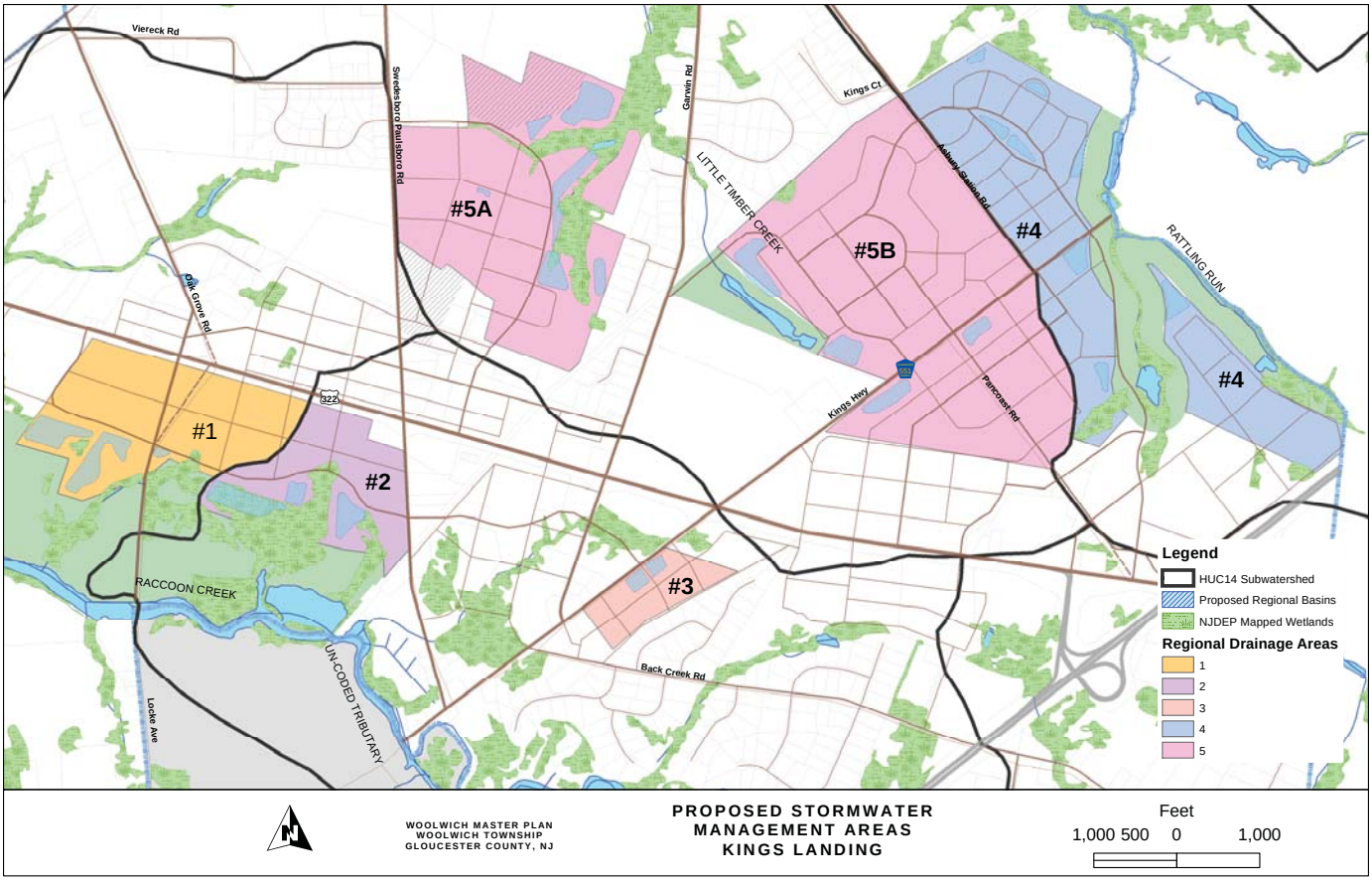


NJDEP HUC 11
WATERSHEDS MAP

These watersheds are further reduced to sub-watersheds (known as Huc 14s) which focus on the tributaries of each watershed.



NJDEP HUC 14
SUB-WATERSHED MAP



WOOLWICH MASTER PLAN
WOOLWICH TOWNSHIP
GLOUCESTER COUNTY, NJ

PROPOSED STORMWATER
MANAGEMENT AREAS
KINGS LANDING

The goal of the proposed stormwater management plan is to maintain the natural features and hydrologic conditions and characteristics of the relative portions of each following subwatershed, as outlined below.

- Raccoon Creek (below Swedesboro Road/Birch Creek) (Huc 14 No.02040202150060).

  The western end of Kings Landing to be developed lies within this sub-watershed. For the purpose of analysis, this sub-watershed has one stormwater management area labeled No. 1. The boundaries of these management areas were established based on receiving area limits, topographic ridge lines and manmade barriers such as US 322.

  Stormwater management area No.1 lies between US 322 and the Raccoon Creek and consists primarily of agricultural lands.

  The existing topography drains towards Raccoon Creek and its associated tributary. Existing woodland features along the creek naturally filter and slow stormwater runoff and are proposed to remain.

- Raccoon Creek (Swedesboro Road/Russell Mill Road) (Huc 14 No.02040202150050)

  The south central portion of Kings Landing to be developed lies within this subwatershed area. For the purpose of analysis, this sub-watershed has been separated into 2 stormwater management areas labeled as No.2 and No.3. The boundaries of these management areas were established based on receiving area limits, topographic ridge lines.

  Stormwater management area No.2 encompasses the area west of The Pennsylvania Reading Seashore Lines (Salem Branch) Railroad line from an average of 750 feet north of US 322 thence south to Raccoon Creek and is comprised of agricultural and commercial lands. The existing topography drains towards a tributary to Raccoon Creek. Existing woodland features along Raccoon Creek and its tributary serve to naturally filter and slow stormwater runoff and are a key preservation feature to remain.

  The woodland features along the tributaries to Raccoon Creek within SWMA 2 and 3 are dominant and a primary preservation feature within these areas due to their proximity to Bald Eagle foraging habitat and the pending Category I Status of Raccoon Creek.

- Pargay Creek (Repaupo). (Huc 14 No.02040202140030)

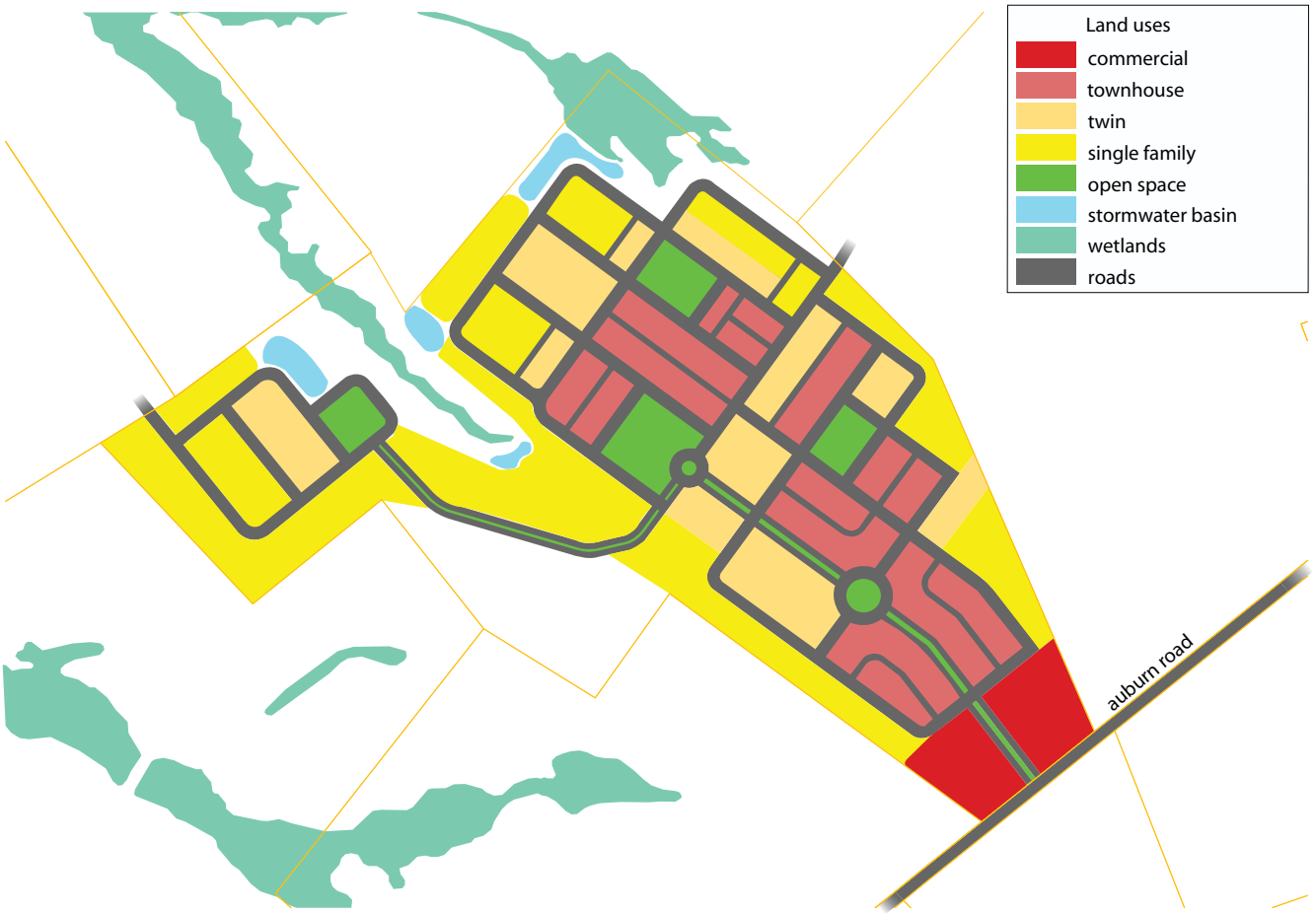
  The north eastern portion of Kings Landing to be developed lies within this sub-watershed. For the purpose of analysis, this sub-watershed has one stormwater management area labeled No. 4. The boundaries of the stormwater management area have been established based on the limits of the receiving area, topographic ridge lines and manmade barriers.

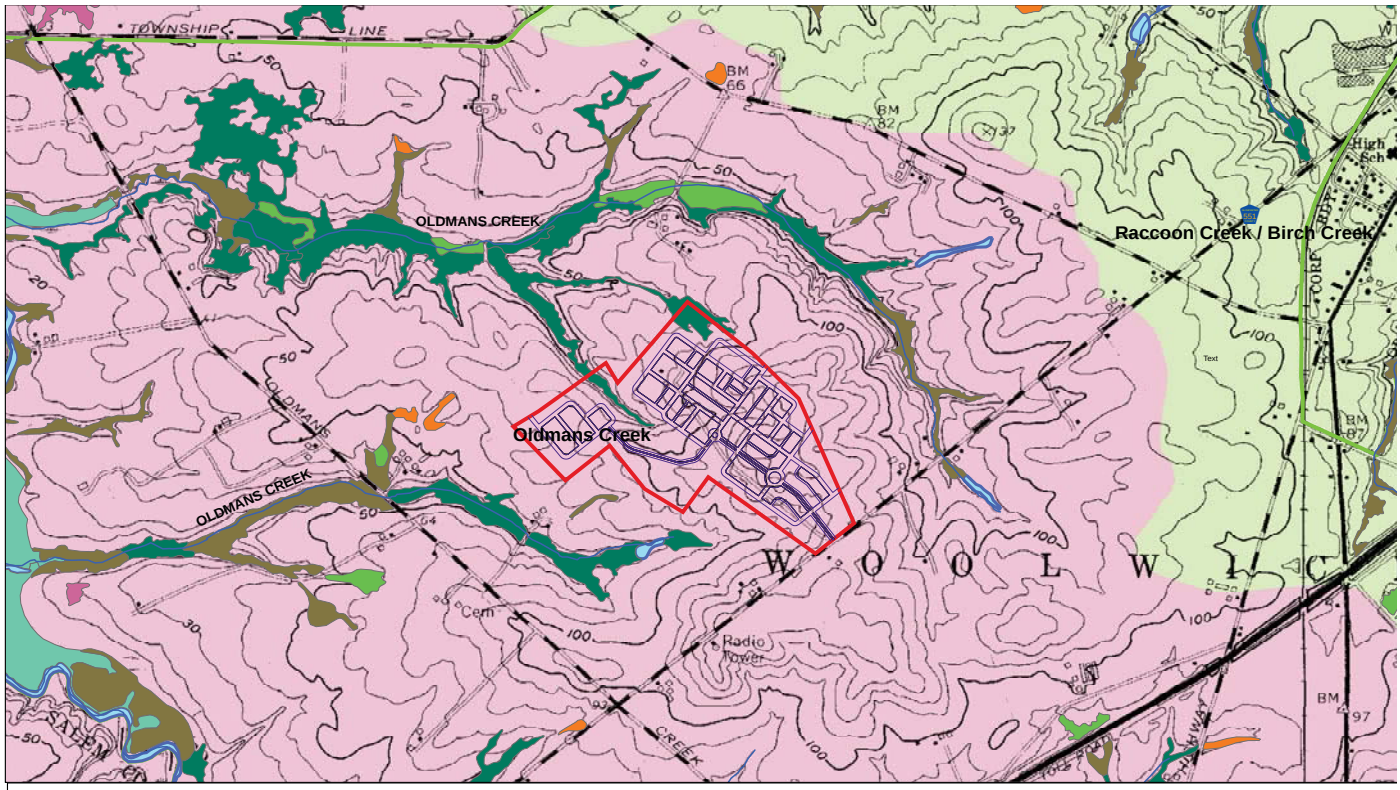
- Moss Branch Creek/Little Timber Creek (Repaupo). (Huc 14 No.02040202140040)

  The north central portion of Kings Landing to be developed lies within this sub-watershed. For the purpose of analysis, this sub-watershed has one stormwater management area labeled No.5. The boundaries of the stormwater management area have been established based on the limits of the receiving area, topographic ridge lines and manmade barriers.

AUBURN ROAD VILLAGE

The proposed Auburn Road Village receiving area, comprised of approximately 127.9 acres, is located southwest of Woolwich New Town. It falls completely within the Oldman's Creek watershed and the Oldman's Creek (Center Square Road to Kings Highway) sub-watershed area. Stormwater Management Area No. 6 encompasses the entire Auburn Road Village receiving area. The existing topography drains towards tributaries to Oldman's Creek and consists primarily of agricultural lands, with woodland features adjacent to the wetlands and stream corridors. Due to the nature of the site and the fact that it is in single ownership and will be developed by a single entity, proposed stormwater management is to be provided by the entity that develops the parcel.

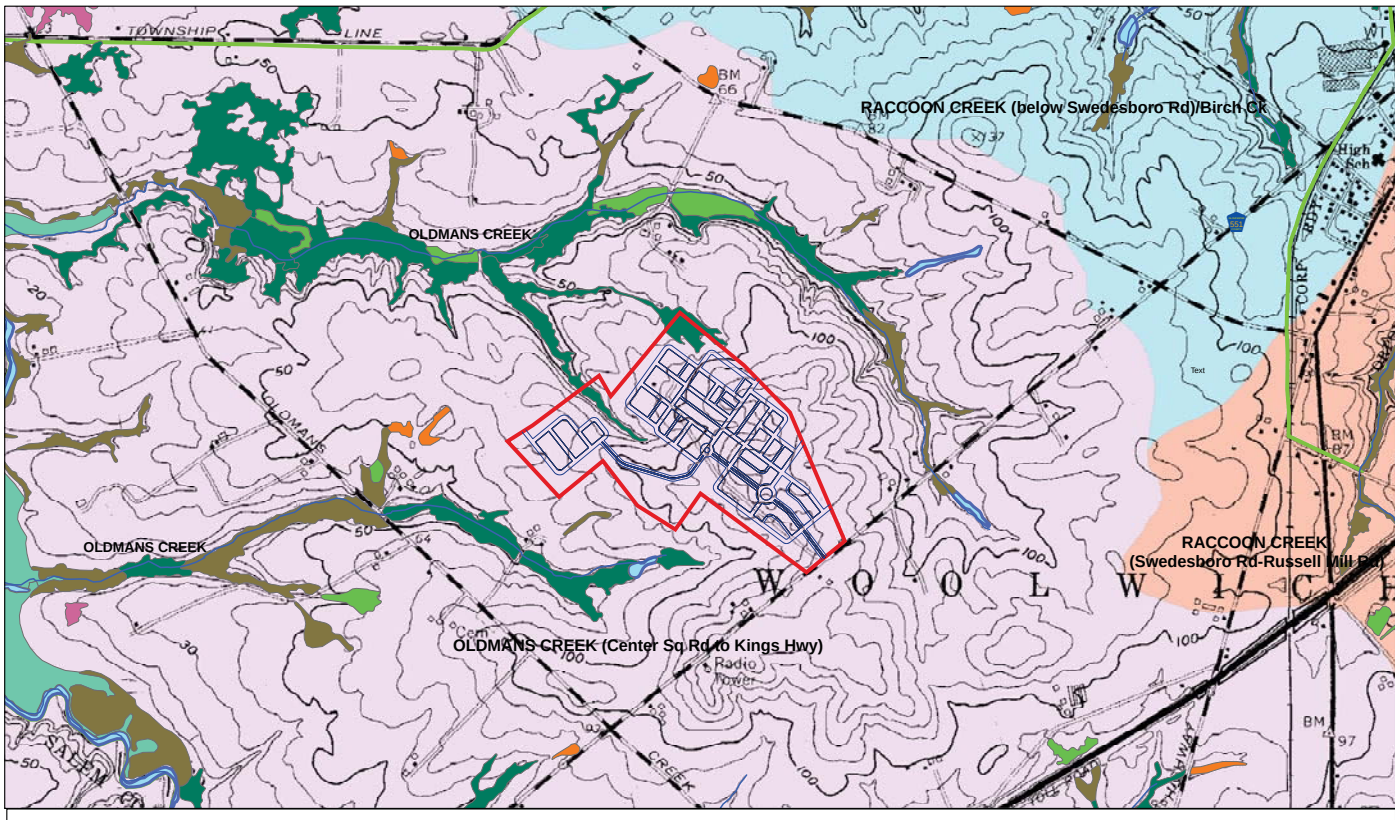




WOOLWICH MASTER PLAN
WOOLWICH TOWNSHIP
GLOUCESTER COUNTY, NJ

AUBURN ROAD VILLAGE
RECEIVING AREA
HUC 11# 02040202160

Feet
1,000 500 0 1,000



AUBURN ROAD VILLAGE
RECEIVING AREA
HUC 14# 02040202160050

Feet
1,000 500 0 1,000

STORMWATER MANAGEMENT PLAN

The stormwater management plan strives to integrate a natural low-impact concept for the protection of open space and critical creek habitat. Incorporating a natural low-impact development approach into this new community offers an unprecedented opportunity to reduce runoff, while dramatically protecting water quality, stream flows and habitat. Development projects shall utilize low impact development techniques and best management practices to mimic natural hydrology lost to urbanization. The heart of any natural drainage approach is the plants, trees and soils that support it. These components form a living infrastructure that increases in functional value over time, unlike traditional stormwater systems.

One of the stormwater plan commitments is to guide development in such a way as to impose a net positive impact on the environment. A significant step in meeting this commitment is to reduce the effective impervious cover of the proposed development. Reducing impervious cover directly reduces runoff volume and increases water quality without structural stormwater intervention. When considering post-development impervious cover, nearly 65% can be classified as "car habitats." Simply reevaluating the standard approach to these impervious habitats significantly reduces post-development stormwater runoff and the need for water quality enhancements. One of the goals of Kings Landing is to be a traditional and live/work environment that is pedestrian friendly and less dependent on cars, thereby in itself reducing car habitats.

The desired reduction can also be achieved by decentralizing and micro managing stormwater runoff at its source using Low Impact Development (LID) techniques. LID techniques simulate natural hydrology and processes by incorporating small scale decentralized practices that infiltrate, evaporate, and transpire rainwater. Specifically, LID techniques focus on minimizing impervious surfaces, disconnecting hydrologic elements (i.e. roofs, downspouts, parking areas), maintaining and/or increasing flow paths, time of concentration and decentralizing treatment. Implementing the desired techniques on a **site** and **block** level significantly reduces the impact of development runoff; however, conveyance and major storm discharge requirements still need to be accommodated, necessitating conveyance pipe networks and stormwater ponds on a **regional** level.

PLAN GOALS

The TDR receiving area is sectioned into 6 stormwater management areas (SWMA). Stormwater runoff shall be managed within each stormwater management area to achieve the following goals:

- Maintain existing hydrology.

  By making this Function like this.

- Slow rate of runoff/ increase time of concentration.

  By allowing runoff to slowly move through vegetated swales and landscaped areas rather than traditional pipes.

- Reduce volume of runoff.

  By lowering the post development runoff curve number (CN). The runoff potential for a site is characterized by the runoff curve number (CN). Limiting the percentage of impervious with green roofs and pervious alternatives along with increasing the time of concentration, works together to achieve this.

- Provide recharge throughout development.

  By integrating infiltration techniques and opportunities to allow runoff to be captured and recharged to groundwater within the development footprint, minimizing the loss of pre-development recharge capacity.

- Provide stormwater treatment close to source.

  By providing small scale treatment opportunities within, i.e. landscaped islands, parking lots, medians, curblines, parking lanes, right-of-ways, creating a treatment train.

- Integrate stormwater management within open space features.

  By utilizing open space features such as parks, right-of-ways, open fields, market places and landscaped areas for the dual purpose of stormwater storage, treatment and conveyance.

- Incorporate LID techniques for aesthetics as well as function.

  By utilizing such options as decorative permeable pavers, stormwater planters, rain gardens and ponds.

- Reduce impervious surfaces.

  By utilizing alternative treatments such as porous paving/concrete, permeable pavers, green roofs or reductions, such as islands or Hollywood drives.

- Integrate natural conveyance with traditional pipe conveyance.

  By utilizing techniques such as bioswales, stormwater planters, vegetated swales to convey storm flows with large storm overflow to traditional piped systems.

- Disconnect impervious surface flow.

  By redirecting roof runoff to grass swales, infiltration systems, bioretention systems, landscaped areas or rain barrels and directing paved surfaces to these pervious options as well.

- Increase vegetation within dense urban environment.

  By providing dual purpose landscaping features within medians, traffic calming bumpouts, pedestrian walkways, parking lots, roof tops and lots.

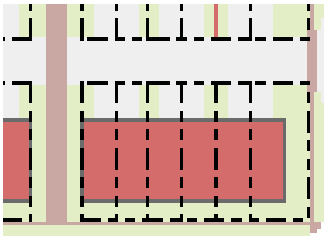
- Balance urban design with ecological function.

  By managing stormwater runoff as a resource utilizing low impact development techniques within the urban environment that mimic a site's pre-development hydrology and ecology.

PLAN MANAGEMENT LEVELS

The stormwater plan consists of three basic levels of stormwater runoff management; SITE, BLOCK and REGIONAL. Opportunities exist within each level of management to incorporate low impact development design techniques that must work in concert with each other to achieve the goals of the overall stormwater plan. Especially important is the disconnection of impervious surfaces from one level to another.

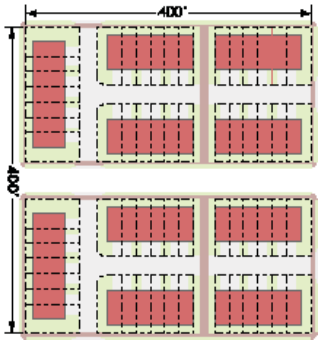
SITE



Parking Lots
Building/Rooftops
Walkways
Driveways
Patios

THE SITE LEVEL manages stormwater from onsite private spaces. Stormwater management at this level requires the utilization of low impact development techniques within these spaces to minimize stormwater runoff, provide treatment and facilitate recharge to groundwater.

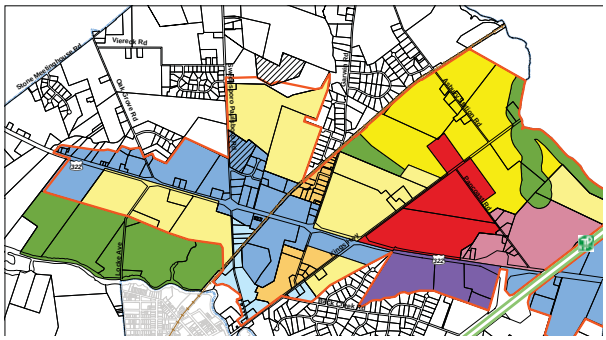
BLOCK



Streets that touch block
Alleys within block
Parks within block

THE BLOCK LEVEL manages stormwater within the public spaces that connect private spaces. This level of management serves two primary functions; 1) to connect site level stormwater overflow to block level conveyance, and; 2) manage block level stormwater runoff, utilizing low impact development techniques to minimize stormwater runoff, provide treatment and facilitate recharge to groundwater.

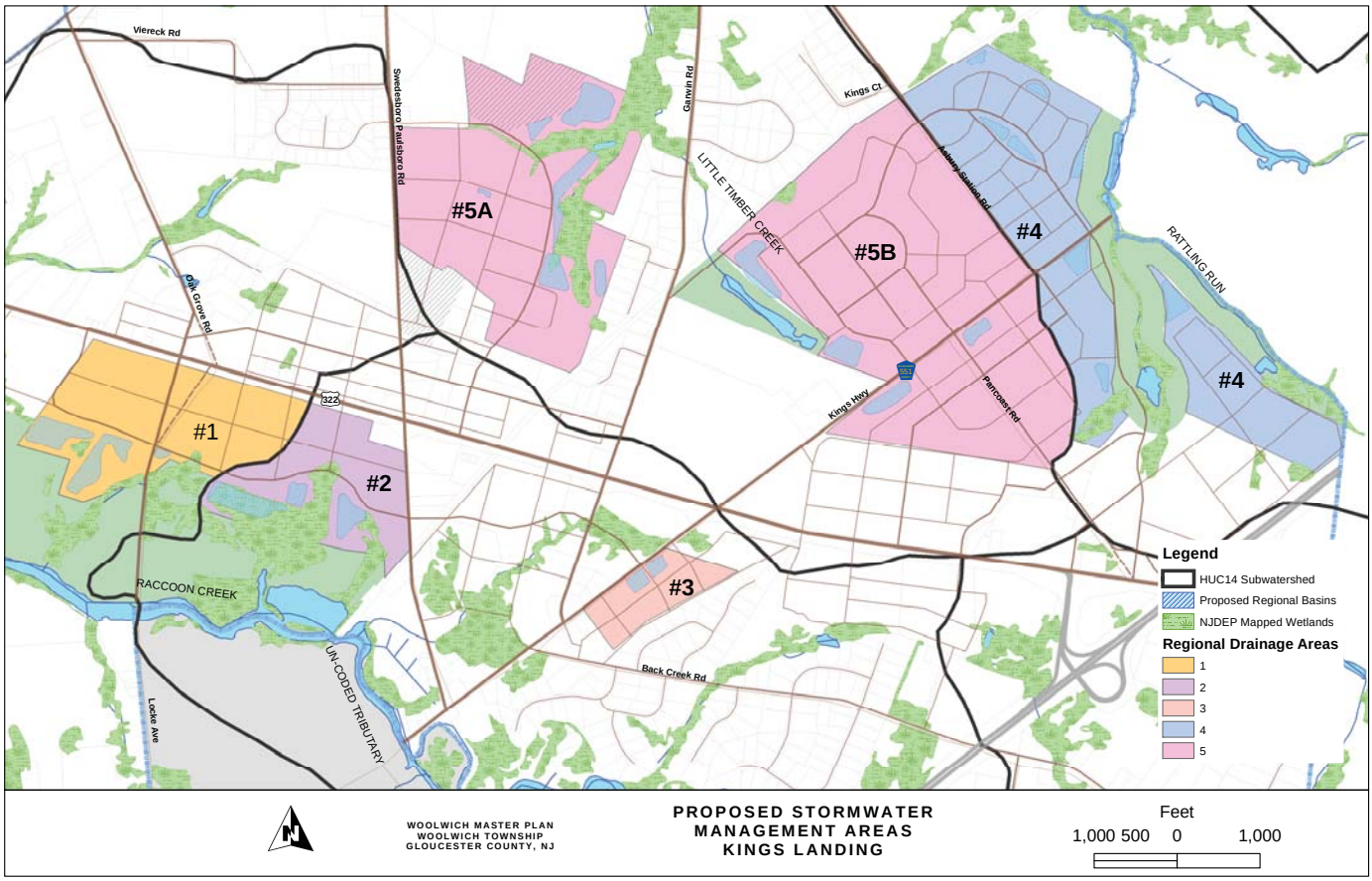
REGIONAL



Streets
Open Space/Parks
Basins

THE REGIONAL LEVEL manages stormwater within public spaces that connect block spaces for regional management. This level of management serves four primary functions: 1) To connect block level conveyance; 2) To provide stormwater conveyance utilizing low impact development techniques to minimize stormwater runoff rate, provide treatment and facilitate recharge to groundwater; 3) To provide storage for peak flow attenuation; and 4) Provide end component of the treatment train for water quality and recharge to ground water.

The Stormwater Masterplan is divided into six stormwater management areas. All three levels of management are present within each SWM area.



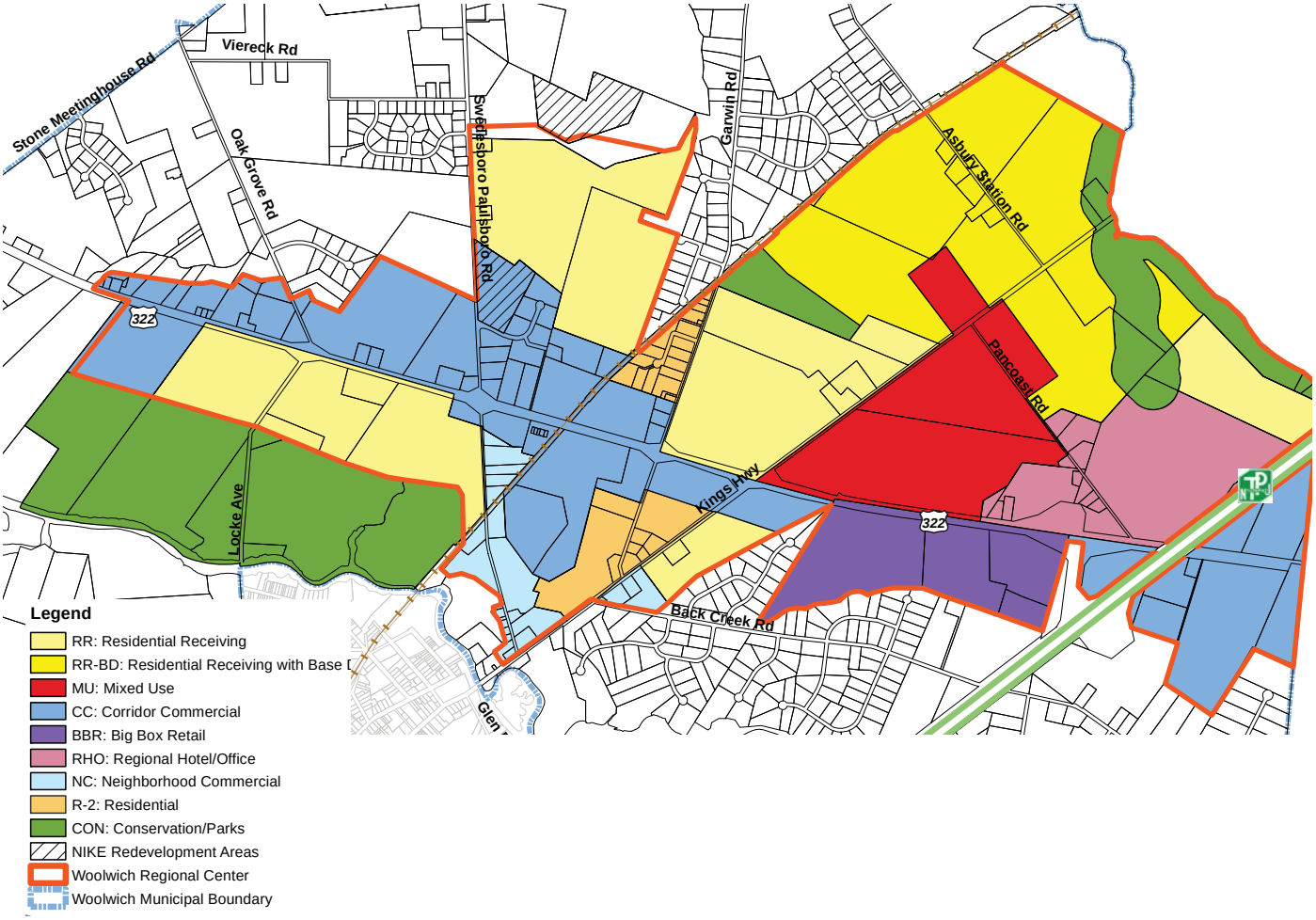
Note - SWMA No. 6 encompasses the entire Auburn Road Village Receiving Area

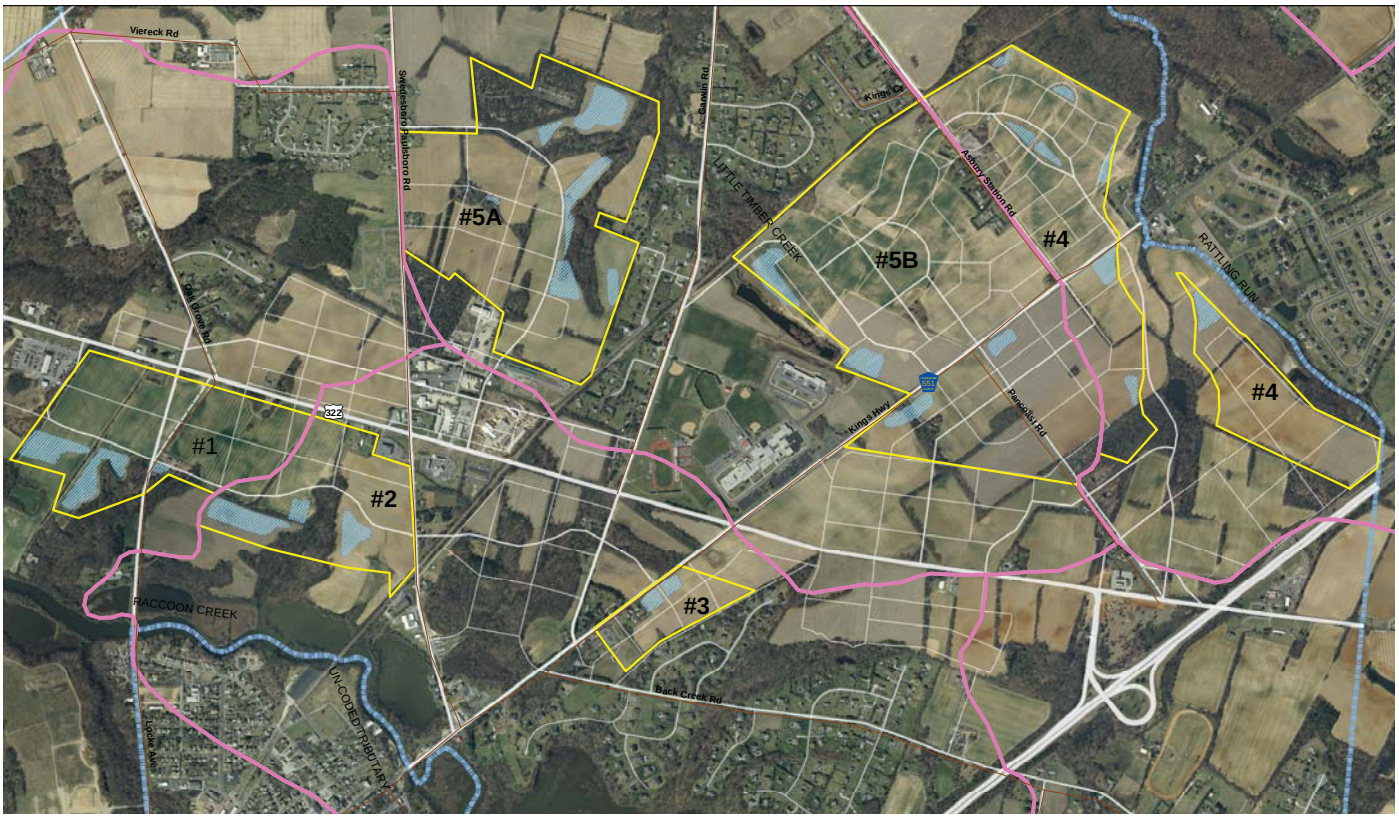
DESIGN CONCEPT

The proposed stormwater plan is a complex interconnection of the varying levels of management driven by development. The three levels referred to here are REGIONAL, BLOCK AND SITE levels. The system is designed in such a way that each development within the Center must participate in each level in order to achieve the intended stormwater management result. The proposed development footprint precludes the obligation of stormwater runoff management to be met within individual site boundaries. The regional level is designed to compliment site and block level stormwater management which is constrained by the proposed development density. To determine the size of regional stormwater facilities required to meet anticipated peak flow attenuation, maximum potential land cover was assessed for each SWMA.

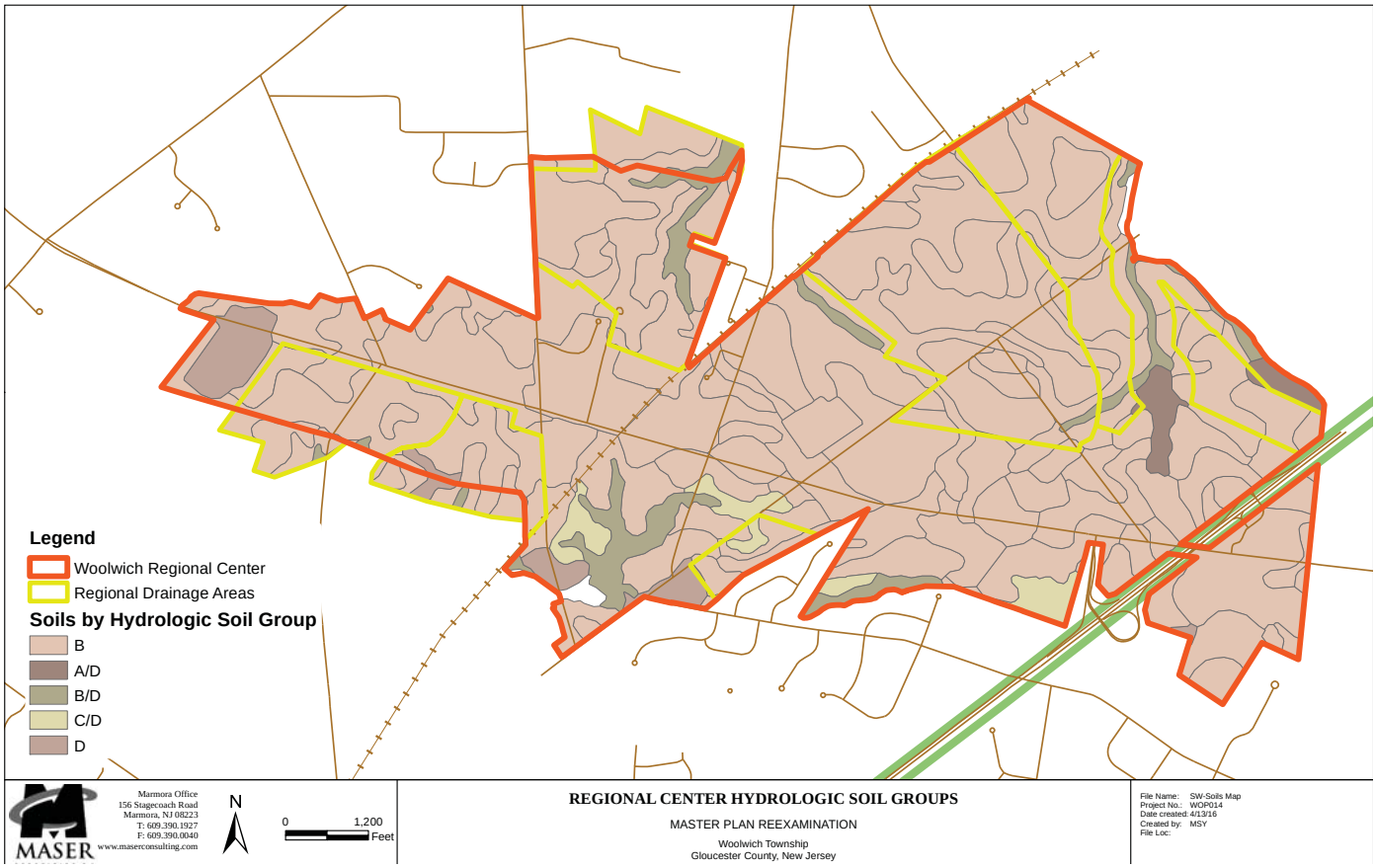
Basin areas are conventionally sized using an estimated ¼ acre-feet for each receiving area acre to be developed. Assumptions include an average of 70 percent impervious coverage, with some mitigation of post-development time of concentration and an average basin water depth of 3 – 5 feet. However, it is our expectation that with the implementation of natural, low impact development techniques across the development footprint these basin areas can be reduced in size and depth for better integration and appeal.

Regional basins are sited based on topography and best available soils, outside of the development footprint. Design engineer shall ensure location of proposed basins is in accordance with local, County, and State regulations and laws. Any environmental constraints shall be taken into consideration and any permits required shall be obtained. The location of the regional basins shown below are to be confirmed by the design engineer. Alternative locations may be proposed as required while keeping with the theme of regional stormwater management.





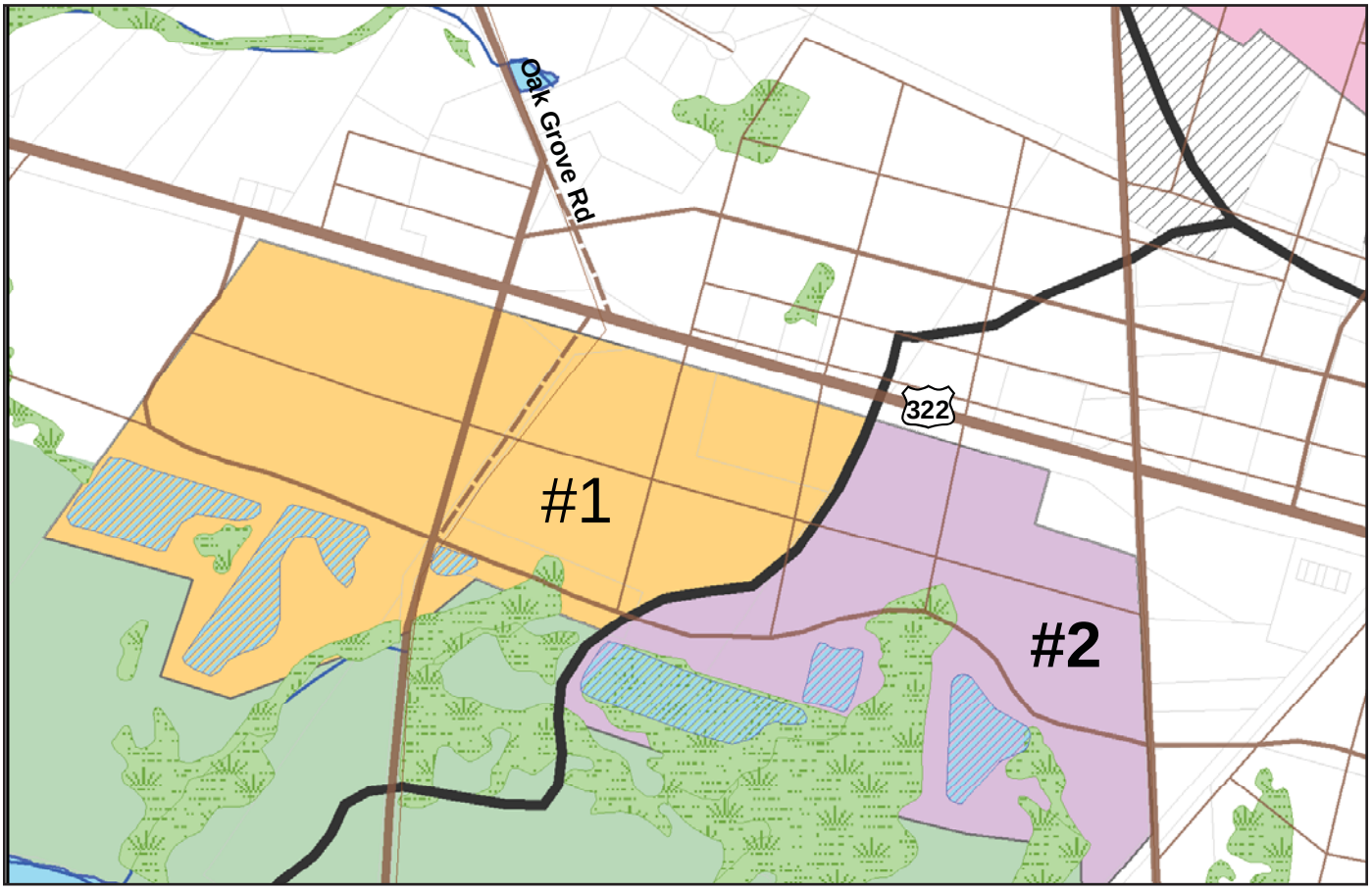
Aerial with Potential Stormwater Locations



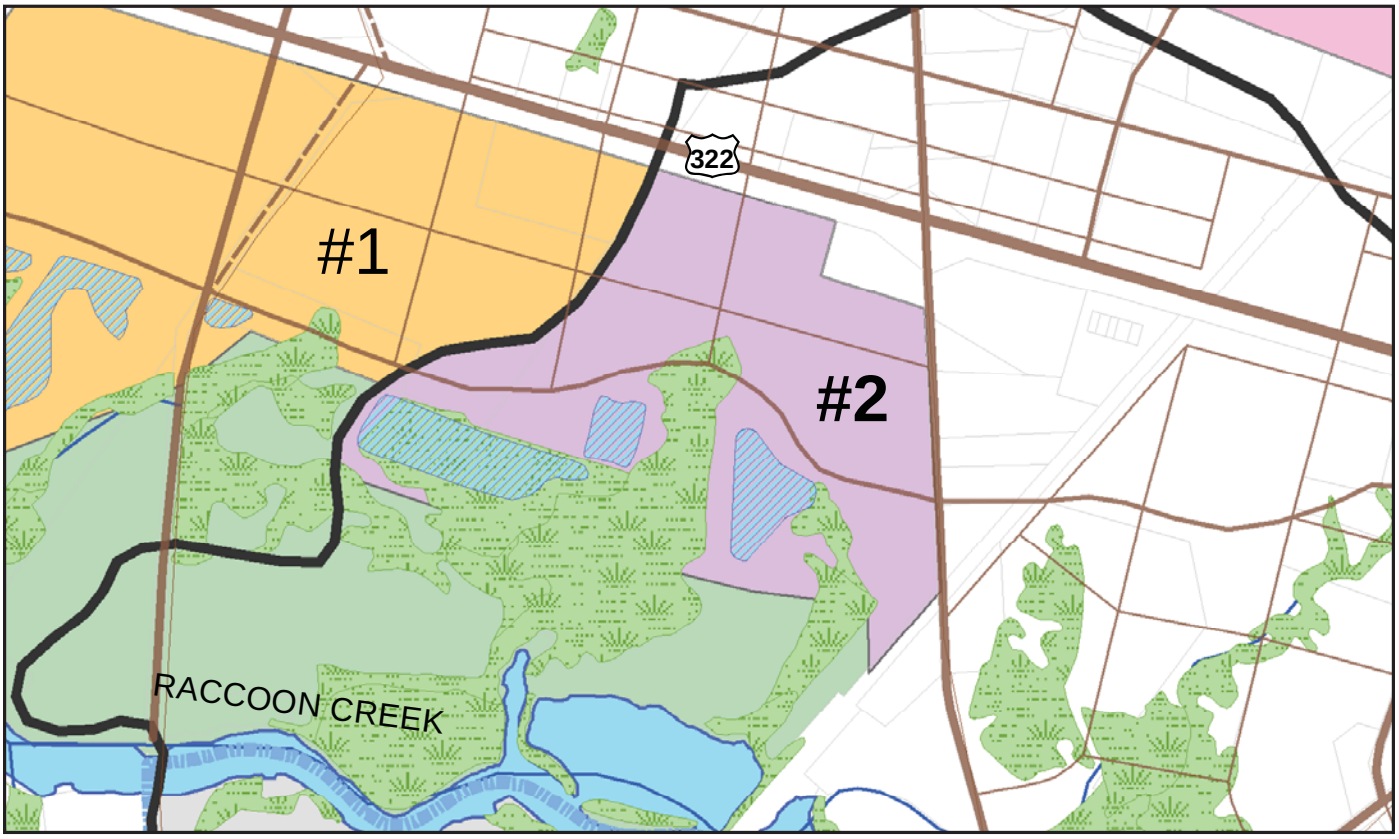
These facilities are also located outside of woodland features, steep slopes and regulated wetland buffers. Stormwater features such as wet ponds and enhanced vegetative buffers are located as such to support open space, recreation and adjacent threatened and endangered species, specifically the Bald Eagle and grassland habitat species.

Regional stormwater components are also planned within proposed public right-of-ways. Regional level management mandates that projects strive to creatively meet multiple goals within the street right-of-ways. The Regional Stormwater Masterplan includes bioswale conveyance as well as piped conveyance. Increasing stormwater recharge, providing treatment opportunities and slowing down the rate of street section runoff is representative in typical street sections.

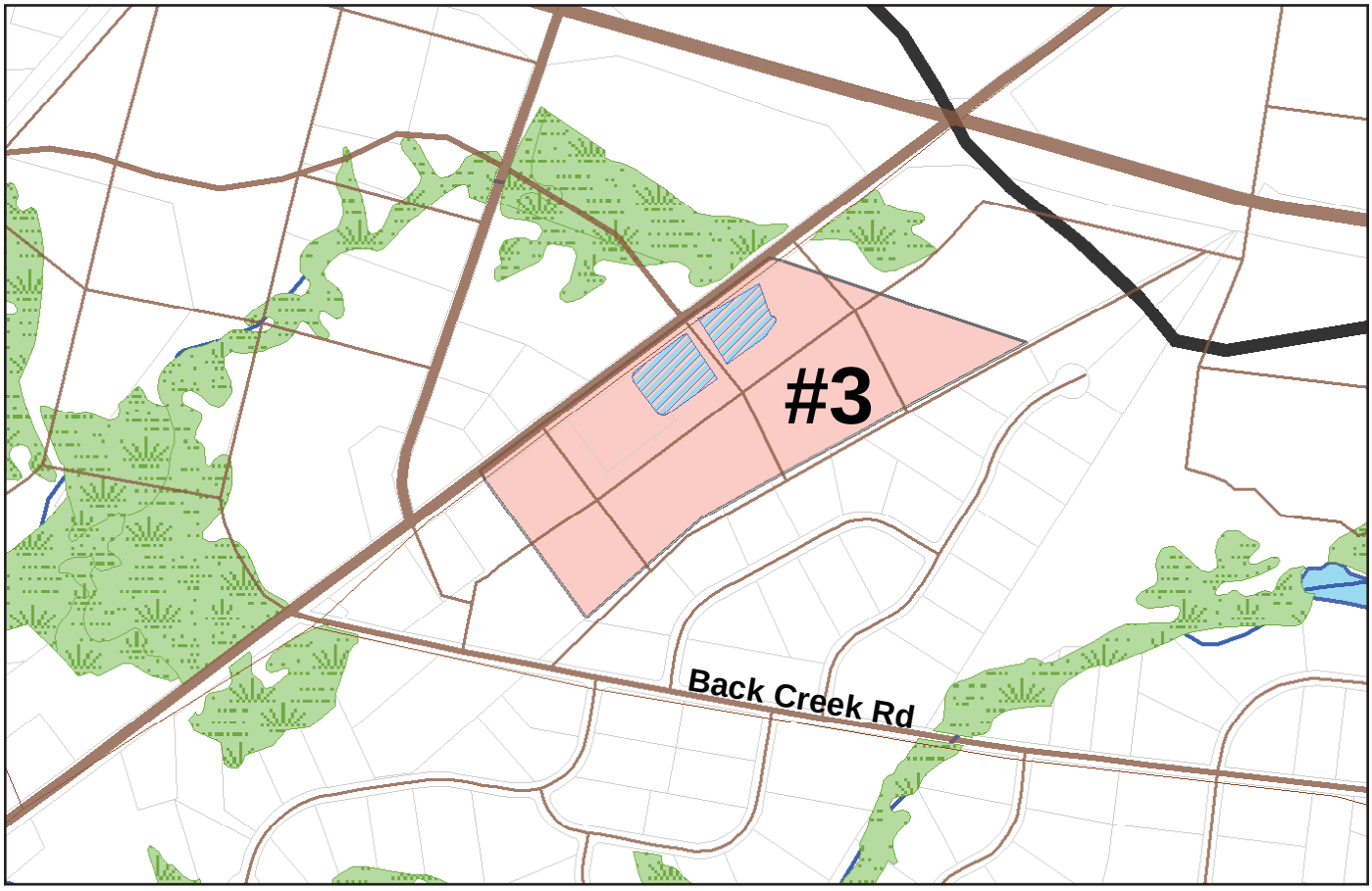
The regional stormwater master plan is illustrated for each of the SWM areas.



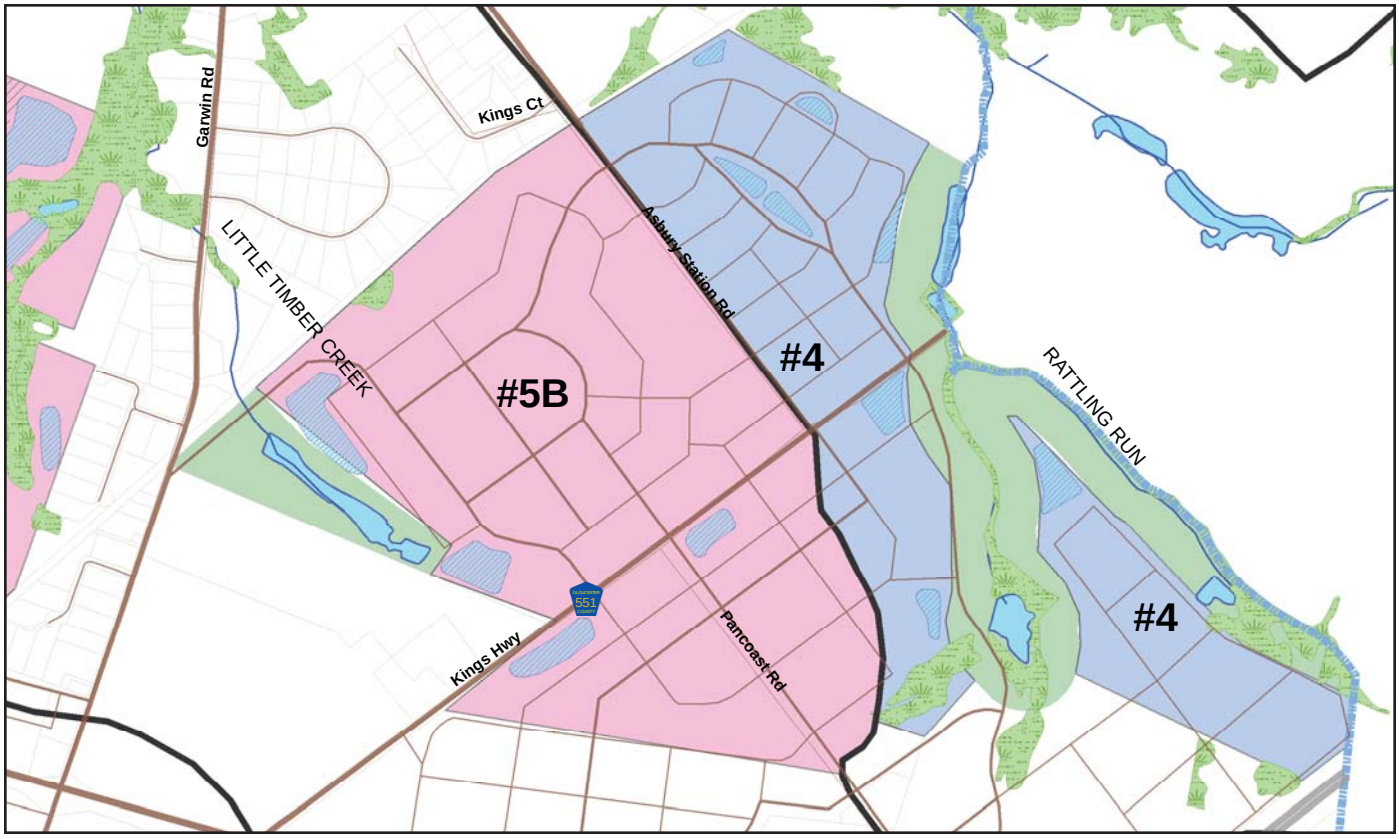
SWMA No.1 consists of approximately 89 acres to be developed. Regional stormwater facilities required are estimated to be 22.3 acre-ft. (7.4 acres at an average of 3 feet deep is proposed with one basin pontentially a wet pond).



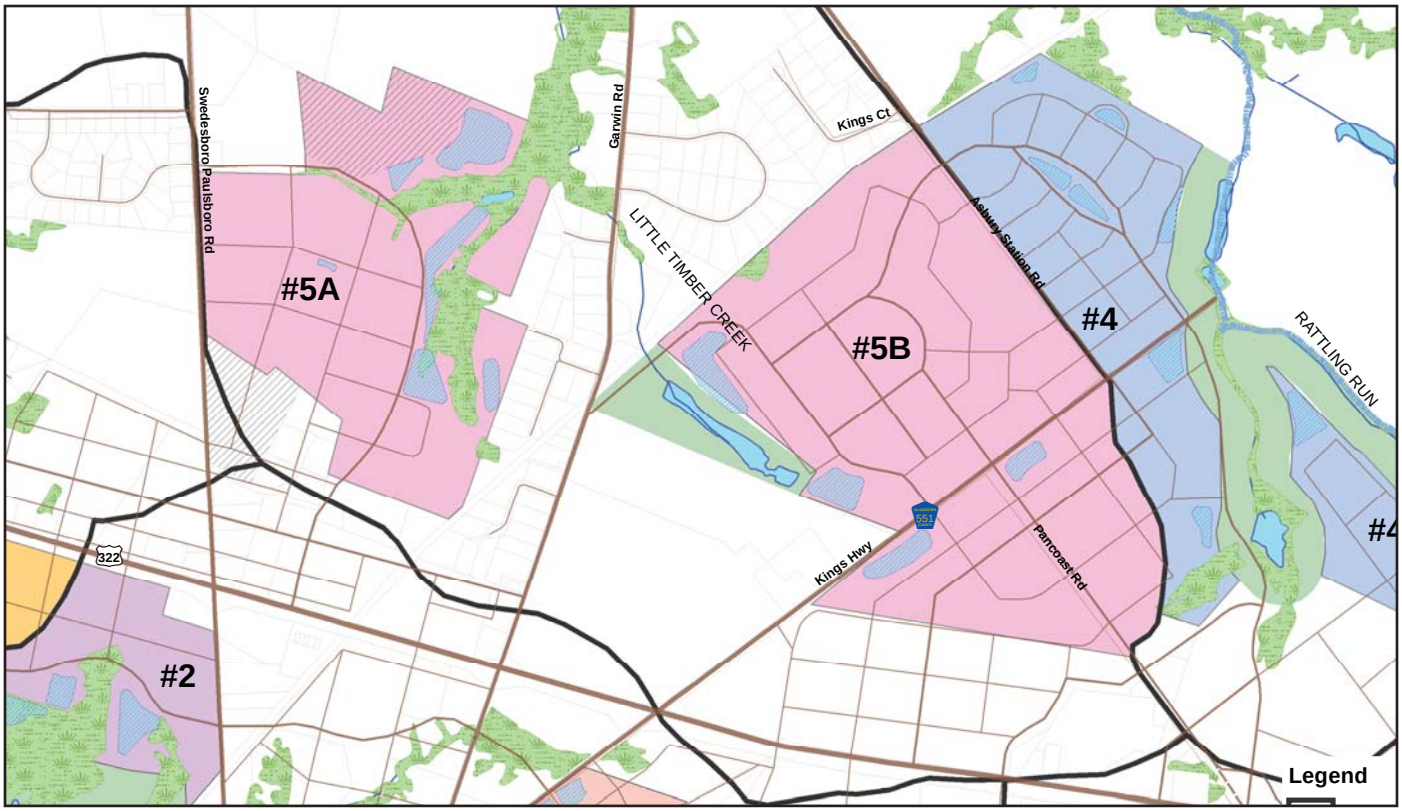
SWMA No.2 consists of approximately 66.3 acres to be developed. Regional stormwater facilities required are estimated to be 16.6 acre-ft. (6 acres at an average of 3 feet deep is proposed with one basin a wet pond).



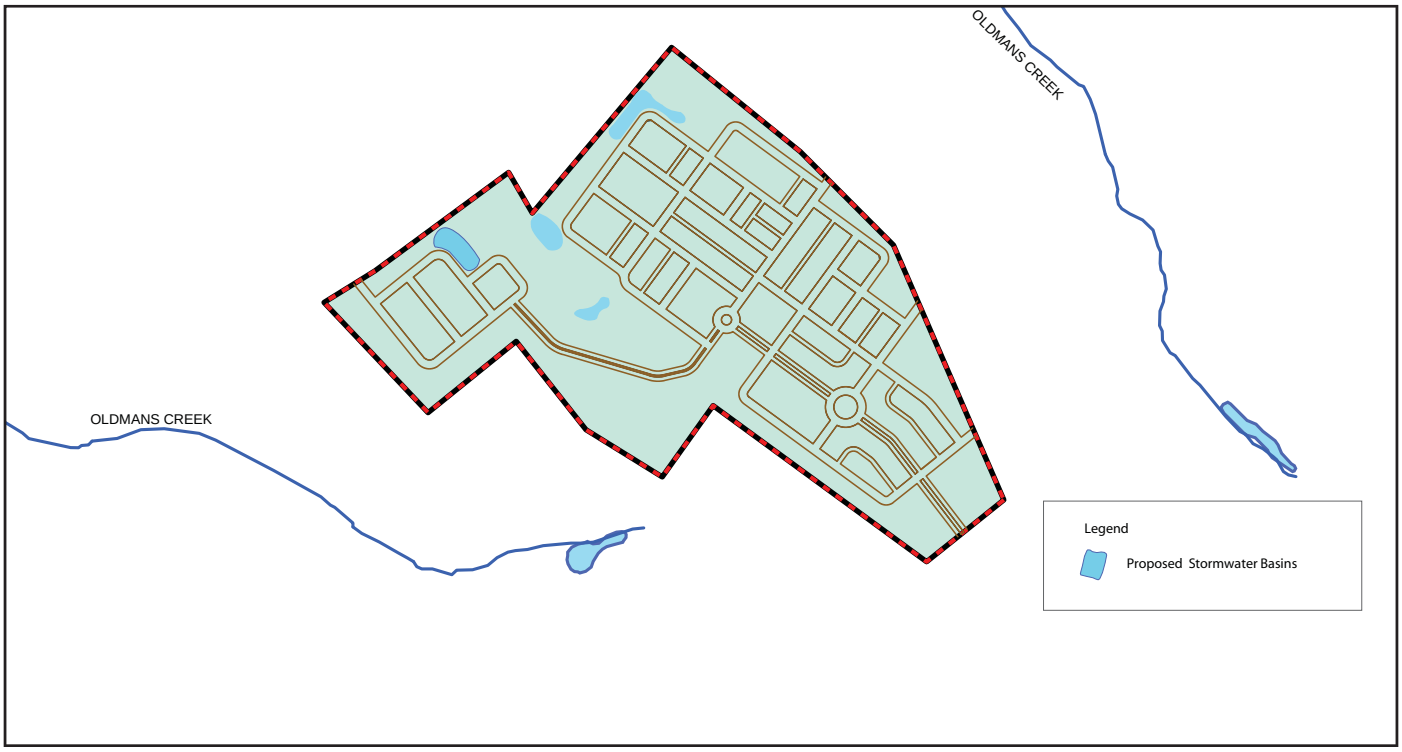
SWMA No.3 consists of approximately 22 acres to be developed. Regional stormwater facilities required area estimated to be 5.5 acre-ft. (2 acres at an average of 4 feet deep is proposed).



SWMA No.4 consists of approximately 162 acres to be developed. Regional stormwater facilities required are estimated to be 41 acre-ft. (10 acres at an average depth of 4 feet is proposed).



SWMA No.5 consists of approximately 410 acres to be developed. Regional stormwater facilities required are estimated to be 103 acres-ft. (25 acres at an average depth of 4 feet is proposed).



SWMA No.6 Auburn Road Village consists of approximately 127.9 acres under single ownership to be developed. The proposed stormwater management to be provided by others shall conform to the same goals and design concept as the Stormwater Masterplan for Woolwich New Town.

Stormwater management design at the site and block levels shall meet the following criteria:

- Site development and adjacent block development must provide a minimum of 50% net TSS removal prior to discharging to regional facilities. Regional basins are to be the end of the treatment train to meet the required 80% TSS removal.
- Recharge to ground water must be maintained across each SWMA. Proposed development must provide a minimum of 40% of its required recharge of impervious surfaces onsite. The remaining 60% may be provided by regional facilities.

Low Impact Development Techniques or Best Management Practices must be incorporated with development at the **site, block** and **regional** levels to achieve water quality and recharge requirements. Incorporation of these techniques will also minimize the volume of runoff and reduce peak flow rates requiring less pipe and regional storage.

DESIGNING TO MODEL NATURE

Conventional stormwater management, as past experience has shown, is flawed. Storage and attenuation of peak flows through a detention basin are not adequate to ensure the health and functionality of our waterways. Conventional methodology allows larger volumes of runoff to enter out streams resulting in flooding, erosion and degradation of its ecological function. Low impact development allows for greater development potential with less environmental impacts through the use of smarter designs and advanced technologies that achieve a better balance between conservation, growth, ecosystem protection, public health and quality of life.

Low impact development is an innovative stormwater management approach whose basic principle is modeled after nature. Rainfall is managed at the source using uniformly distributed, decentralized micro-swale control. The primary purpose of a natural drainage system approach is to maintain a site's pre-development watershed and ecological functions by incorporating design techniques that infiltrate, filter, store, evaporate and detain runoff close to its source. Techniques are based on the premise that stormwater is a resource to be beneficially used rather than a waste product to be disposed of. Almost all components of an urban environment have the potential to serve as a best management practice (BMP) to achieve the desired effect of low impact development. In fact, as reported in the December 2006 issue of *New Urban News*, new urbanist developers are increasingly turning to natural drainage systems. These include open space, rooftops, streetscapes, parking lots, sidewalks and medians.

Many of the techniques frequently used in natural low impact development design, referred to as Best Management Practices (BMP's), are defined on the following pages:

DEFINITIONS

Bio-retention Basin: An engineered natural treatment system designed to remove silt and pollution from surface water runoff. It consists of a recessed landscaped area constructed with a special soil planting bed, sand layer underdrain and site appropriate plant materials tolerant of both moist and dry conditions. The adopted TSS removal rate is 90%. A bioretention basin may also be designed for infiltration in lieu of an underdrain.

bio-swale planter

Bio-retention Swale: An engineered natural treatment system designed to remove silt and pollutants from surface water runoff. It consists of a swaled drainage course construction with a special soil planting bed, sand layer, underdrain and site appropriate plant materials tolerant of both moist and dry conditions. The adopted TSS removal rate is 90%. It is designed to maximize the time water spends in the swale, which aids the trapping of pollutants and silt to enhance quality. A bio-retention swale may also be designed for infiltration in lieu of an underdrain. Overflow is conveyed to a downstream drainage system.

Drywell: A specialized subsurface infiltration facility intended only for roof runoff. It receives and temporarily stores stormwater runoff. Discharge of this stored runoff is through infiltration into surrounding soils. A drywell may be used to reduce runoff volume for the water quality design storm and meet groundwater recharge requirements.

green roof

Extended Detention Basin: A stormwater facility constructed through filling and/or excavation that provides temporary storage of stormwater runoff. It has an outlet structure that detains and attenuates runoff flows and promotes the settlement of pollutants. It is normally designed as a multi stage facility that provides storage and attenuation for both water quality and quantity management. The adopted TSS removal rate is 40 – 60%, depending on detention time provided by the facility.

Green Roof: A low maintenance vegetated roof system that uses a plant – soil complex to store and filter runoff. It reduces runoff volume and increases runoff time of concentration. Rainwater is stored in the light weight soil medium, where the water is taken up by plants and transpired into the air. It also provides energy conservation benefits and aesthetic improvements to buildings.

Hollywood Drive: A driveway option in which the center portion of the driveway pavement is removed. Tracks are a minimum 24 inches wide, spaced 48 inches apart with a porous center strip. The center is a porous surface such as groundcover, grass or river rock.

porous paver parking

Infiltration Basin: A stormwater facility constructed within highly permeable soils that provide temporary storage of stormwater runoff. Outflow from an infiltration basin is normally through the surrounding soil. An infiltration basin may be combined with an extended detention basin to provide additional runoff storage beyond the water quality storm for quantity management. Infiltration basins remove pollutants and infiltrate stormwater back into the ground. The adopted TSS removal rate is 80%. They may also be designed to meet groundwater recharge requirements.

porous asphalt

Permeable Paving/Concrete: Permeable alternatives to conventional asphalt or concrete. They produce less stormwater runoff than conventional paving by allowing stormwater to penetrate and soak directly into the ground. Through this infiltration process pervious paving systems also achieve water quality treatment. The adopted TSS removal rate is 89% If combined with a storage bed of sand and stone, recharge to groundwater is provided.

Permeable Pavers: Permeable alternative to conventional asphalt or concrete. They provide reduction in runoff rates and volumes by generating less surface runoff than conventional paving. If combined with a storage bed of sand and stone, this type of system will also provide water quality treatment and groundwater recharge with an adopted TSS removal rate of 80%.

Rain Barrel/Cistern: A storage container of varying sizes placed outside of a building at roof downspouts to collect and hold rooftop runoff for later reuse. Collected rainwater may be reused for lawn and landscape watering. They can be used to change runoff timing and reduce runoff volume. Rain barrels have many advantages in urban settings. They take up very little space, are inexpensive and easy to install.

rain garden

Rain Garden: An attractive and cost effective method of containing and infiltrating stormwater. A rain garden is a shallow depression in the landscape that is planted with perennials, shrubs, small trees or herbaceous plants that can withstand periodic inundations of water. Rain gardens are a type of bioretention system but typically do not have the full spectrum of engineered features, i.e. underdrain and entire soil mix. Rain gardens can be planted and shaped to fit the character of individual residences down slope of roof drains or adjacent impervious surfaces.

Stormwater Planter: A structure that can detain and convey runoff from impervious surfaces. They receive the first flush of runoff along the curb and the stormwater is infiltrated and treated through layers of vegetation and soil consistent with bioretention. The applicable TSS removal rate is 90%. Stormwater planters can fit into any landscape scheme increasing the quality of life in urban areas by adding beauty, habitat value and reducing urban heat island effects. Overflow is conveyed to a downstream drainage system.

cistern

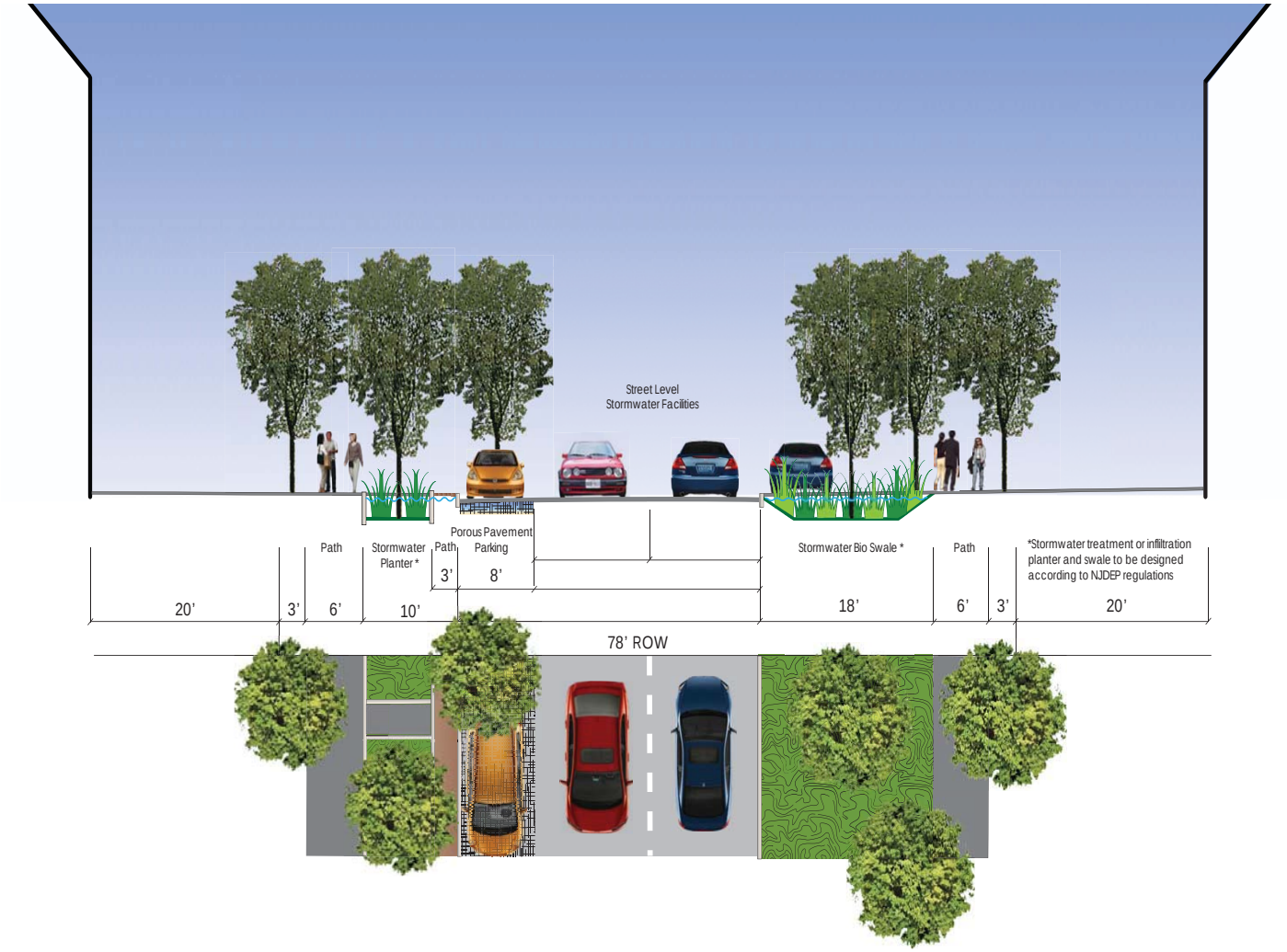
Tree-Box Filter: A boxed bio-retention basin that is installed beneath trees that can be very effective in controlling runoff, especially when distributed throughout the site. They receive the first flush of runoff along the curb and the stormwater is filtered through layers of vegetation and soil before entering a catch basin. The TSS removal rate is 90%. They can fit into any landscape scheme increasing the quality of life in urban areas by adding beauty, habitat value and reducing urban heat island effects.

Vegetative Filters Strips: An area designed to remove suspended solids and other pollutants from stormwater runoff flowing through a length of vegetation. Vegetated Filter Strips can consist of turf and native grasses to herbaceous and woody vegetation, all of which can be either planted or indigenous. All runoff to a filter strip must enter and flow through as sheet flow. The adopted TSS removal rate is 60 – 80%.

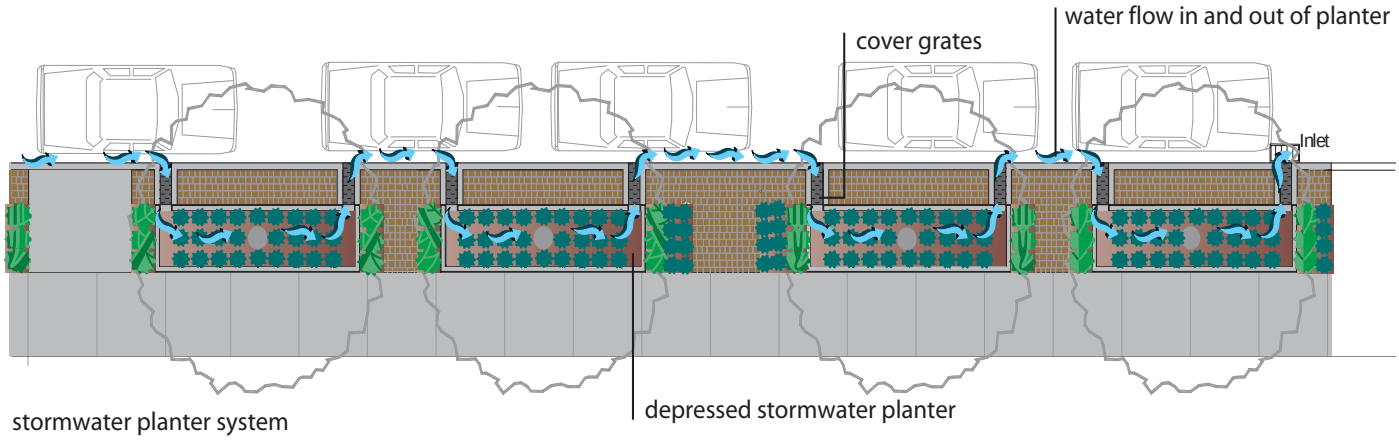
Wet Pond: A stormwater facility constructed through filling and/or excavation that provides both permanent and temporary storage of stormwater runoff. An outlet structure is utilized to create a permanent pool, detain and attenuate runoff inflows and promote settlement of pollutants. If designed as a multi stage facility, it can also provide extended detention for enhanced water quality treatment. The adopted TSS removal rate is 50 – 90%, based on pool volume and detention time.

INCORPORATING LOW IMPACT DEVELOPMENT TECHNIQUES

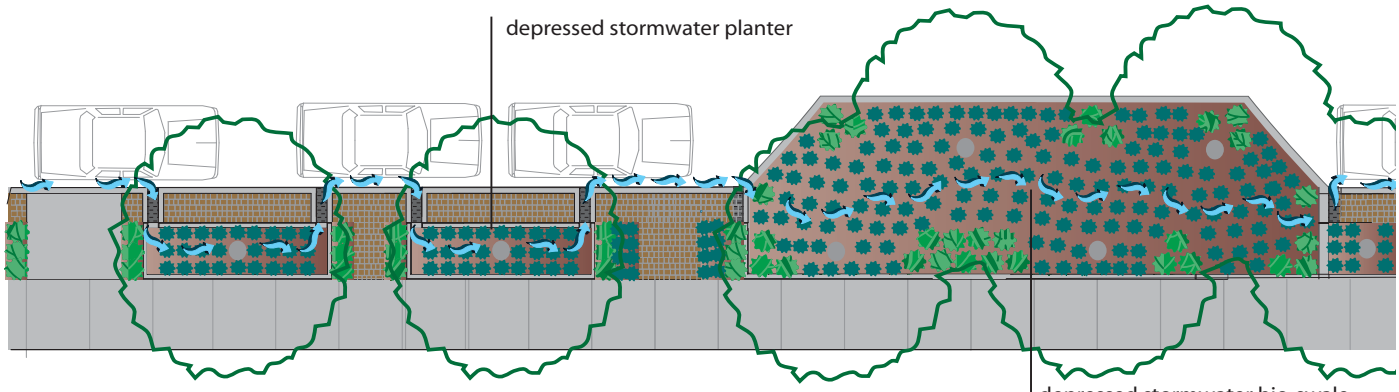
STREETS/ALLEYS



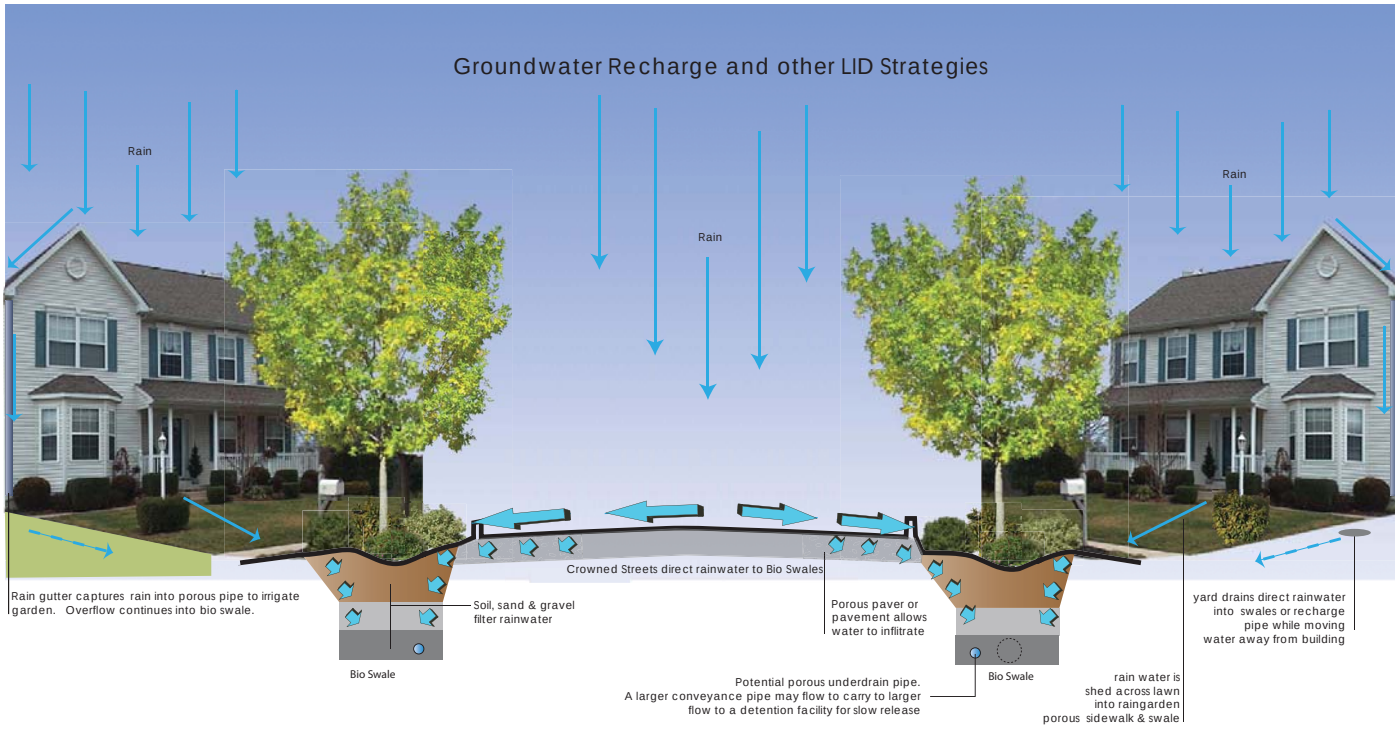
- Stormwater planters can be implemented intermittently as shown to provide conveyance, recharge and water quality benefits.
- Bioretention swales/basins can be implemented within bump outs, medians and along public street edge where width permits to provide conveyance, recharge and water quality benefits.
- Permeable pavers can be utilized within parking lanes, alleys and pedestrian walkways effectively to reduce impervious runoff and provide recharge and water quality benefits.
- The stormwater management plan proposes the use of these features in varying degrees at the regional level within the following street sections:
  - Boulevard;
  - Highway;
  - Main Street;
  - Parkway; and
  - Local Street.

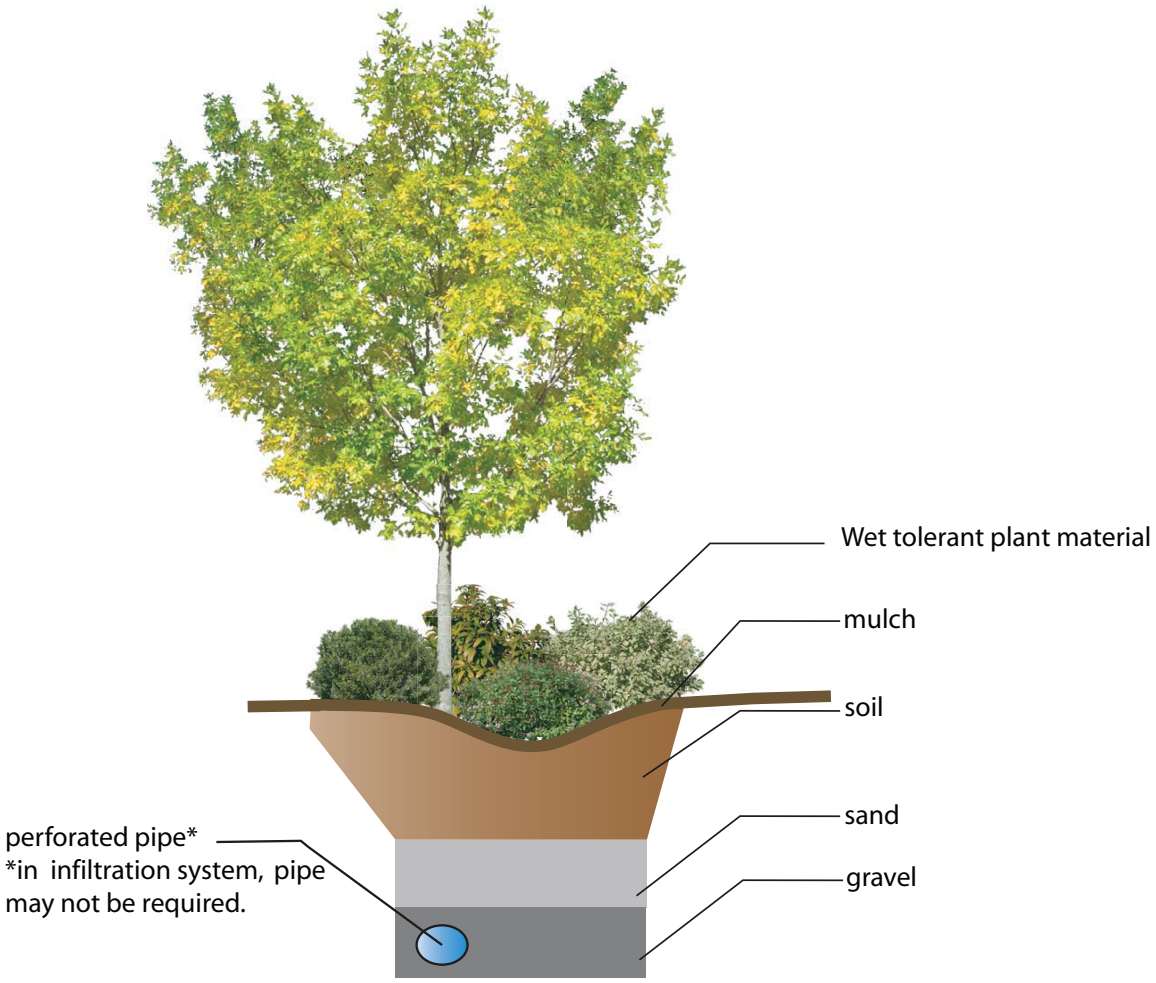


stormwater planter system



stormwater bio-planter and bio-swale system


Groundwater Recharge and other LID Strategies
Rain
Rain
Rain
Crowned Streets direct rainwater to Bio Swales
Rain gutter captures rain into porous pipe to irrigate garden. Overflow continues into bio swale.
Soil, sand & gravel filter rainwater
Bio Swale
Porous paver or pavement allows water to infiltrate
Bio Swale
Potential porous underdrain pipe. A larger conveyance pipe may flow to carry to larger flow to a detention facility for slow release
rain water is shed across lawn into raingarden porous sidewalk & swale
yard drains direct rainwater into swales or recharge pipe while moving water away from building


Wet tolerant plant material
mulch
soil
sand
gravel
perforated pipe*
*in infiltration system, pipe may not be required.



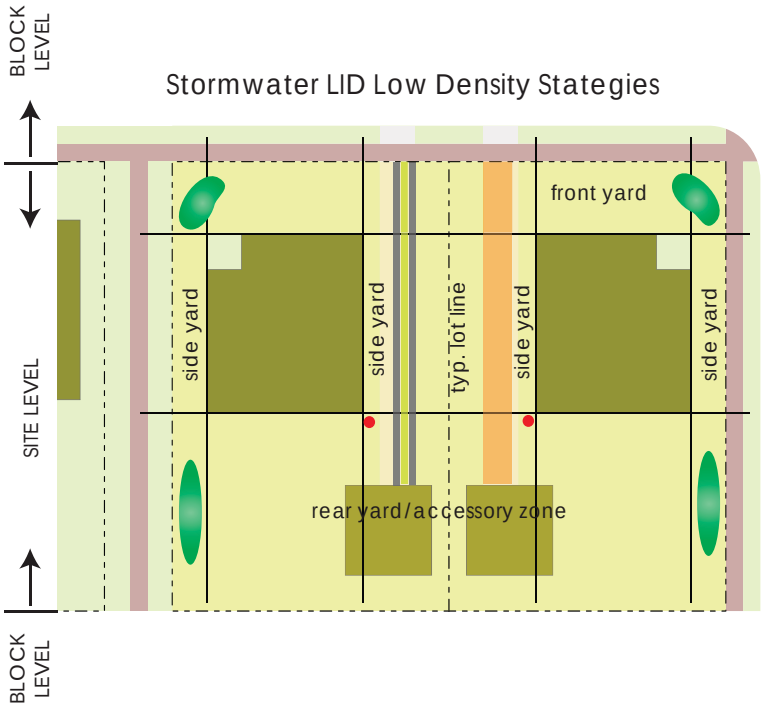
PARKS

- Utilize green space for low impact and natural approaches to stormwater management such as vegetative filters, wetponds, infiltration and bioretention basins.
- Integrate water features into park settings for runoff storage and conveyance.
- Use alternatives to paving such as porous paving or permeable pavers for marketplaces, courtyards and pedestrian pathways; also recreational spaces such as tennis and basketball courts.

PRIVATE SPACES

- Utilize alternative to paving such as; porous paving, porous concrete, permeable pavers for drives, patios, sidewalks and parking lots.
- Use Hollywood style drives to reduce width of paving.
- Incorporate rain gardens to enhance both landscaping and provide stormwater benefits such as storage, infiltration and treament.
- Utilize alternative roof treatments to create a “Green Roof” for multiple goals such as; reducing urban heat island effect, creating habitat for birds and butterflies, improving views from neighboring buildings and reducing stormwater runoff.
- Collect stormwater runoff with rain barrels for later reuse in lawn and garden irrigation, resulting in reduced runoff.
- Collect stormwater runoff in cisterns for non-potable reuse applications such as fountains, irrigation and flushing toilets, resulting in reduced runoff.
- Utilize vegetated conveyance in lieu of direct piping to slow and filter stormwater runoff.
- Provide underground parking beneath buildings to reduce impervious coverage.
- Direct roof runoff to subsurface infiltration systems to reduce runoff and facilitate recharge.
- Utilize stormwater planters or tree box filters to collect, store, infiltrate runoff reducing volume, slowing flows and improving water quality.

LOW IMPACT DEVELOPMENT STORMWATER TECHNIQUES



1 Hollywood Drive

2 Rain Garden

3 Rain Barrel

4 Permeable Pavers
Porous Pavement

5 Green Roof

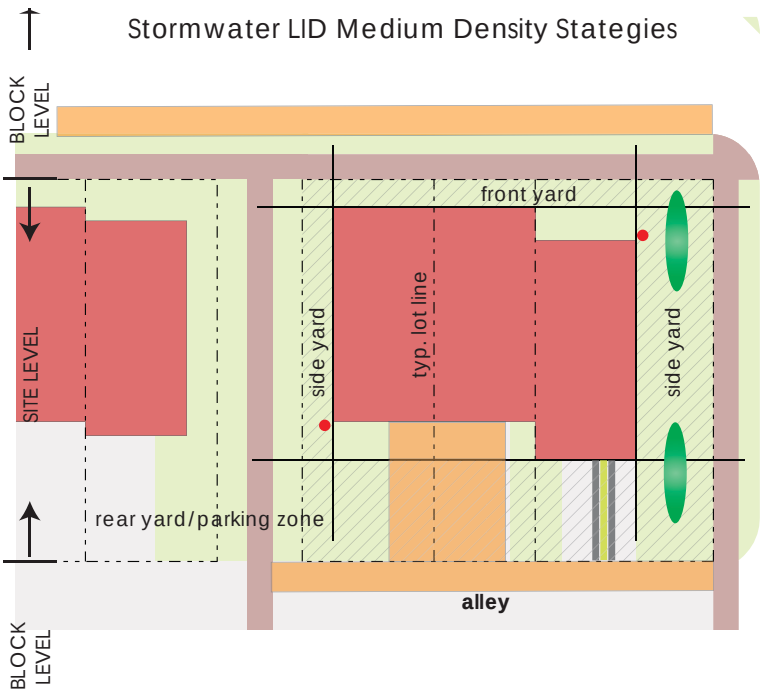
6 Underbuilding Parking

7 Rain Garden with
Porous Pavement

*All strategies are not applicable in all densities

Example of a rain barrel.

Example of on lot rain garden (biorention system).



1 Hollywood Drive

2 Rain Garden

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Porous Pavement

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7 Rain Garden with
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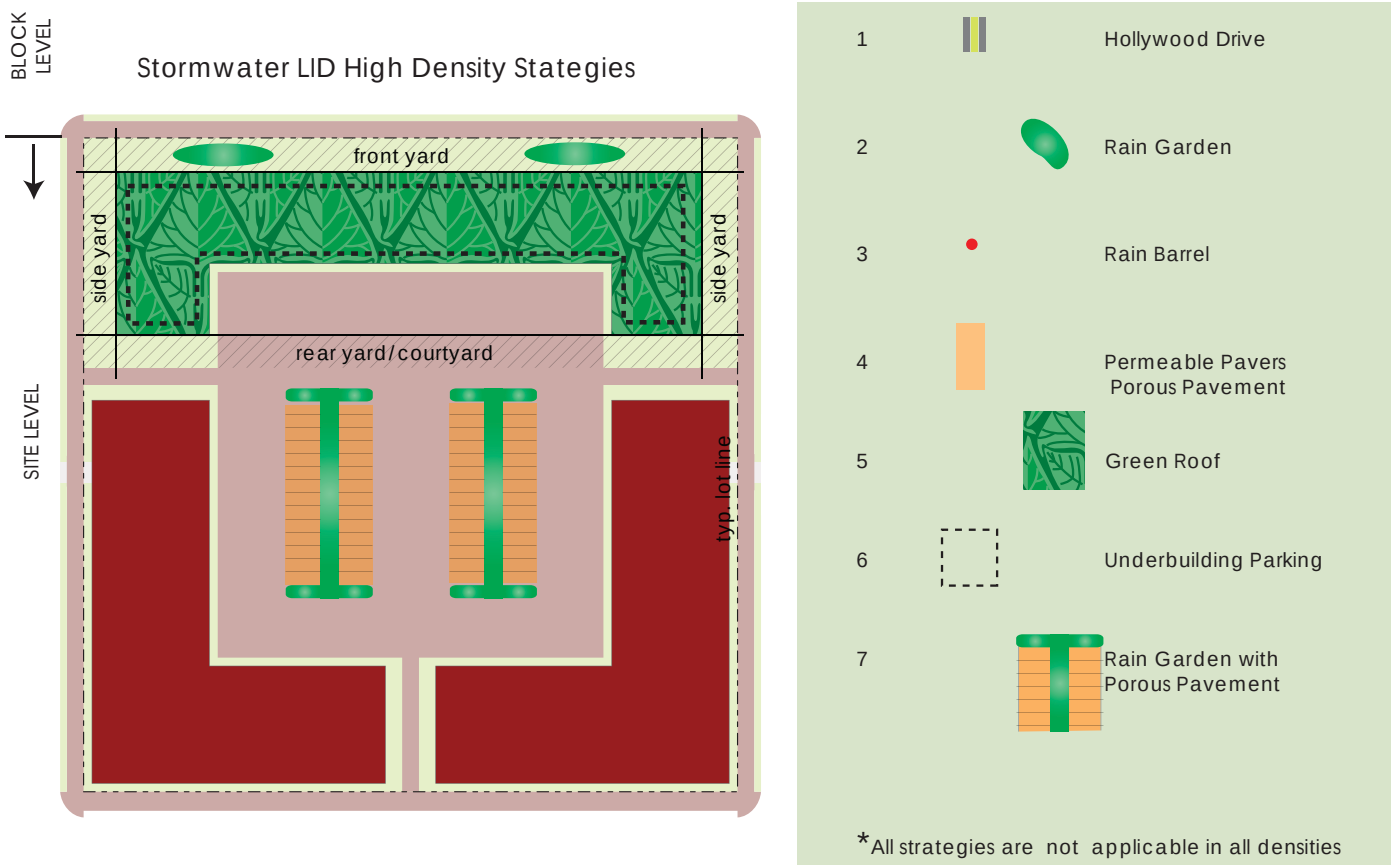
*All strategies are not applicable in all densities

Example of a rain barrel.

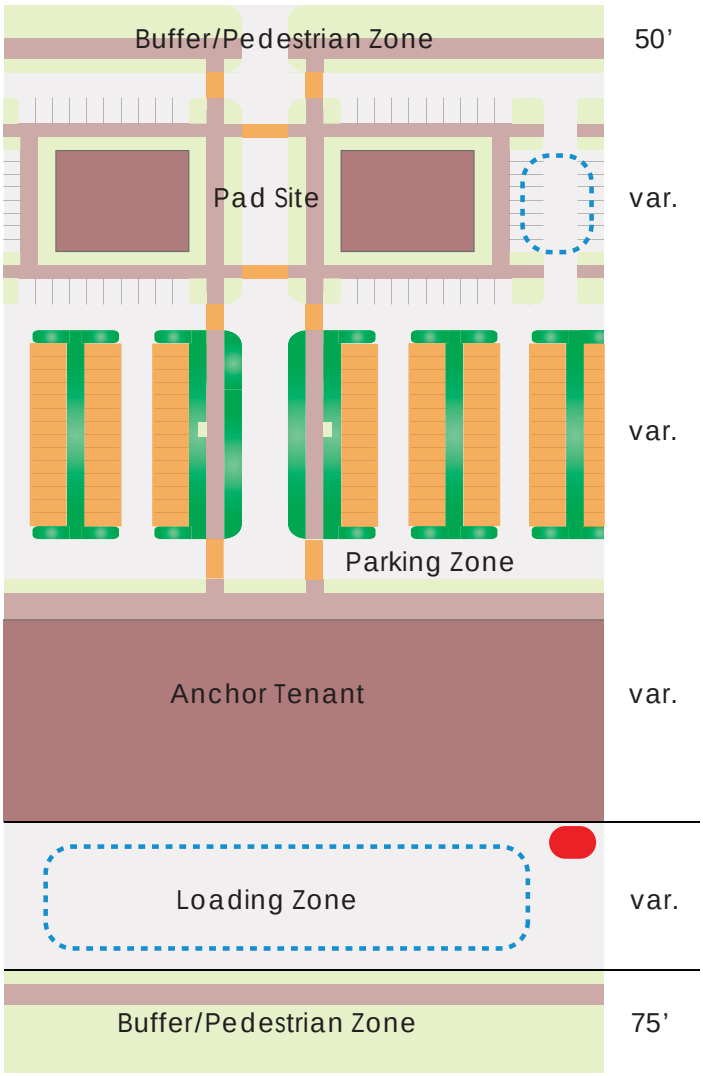
Example of permeable pavers used in driveway/parking area.

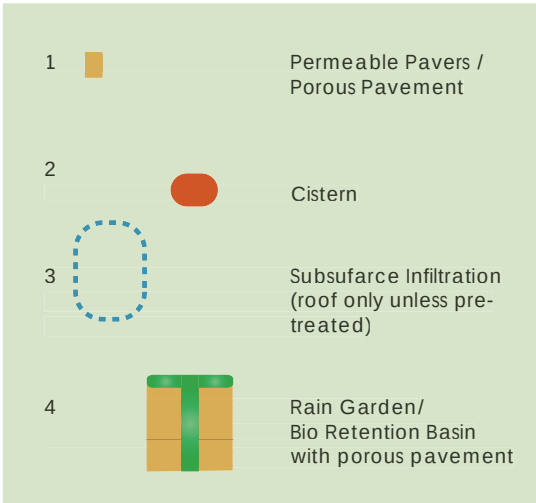


Example of permeable pavers for walkways with adjacent rain gardens.

Example of rain garden within a common parking lot area.

Highway Commercial LID Stategies



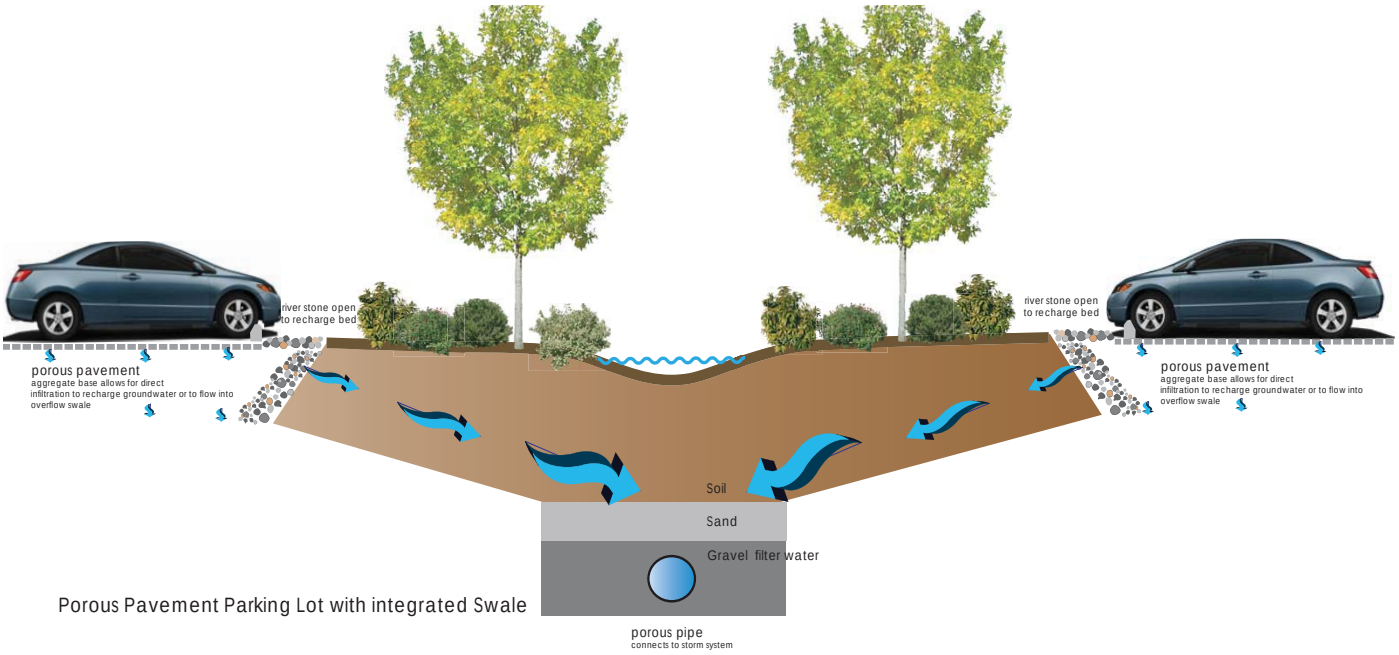


Example of a green roof on a commercial building.

Example of biorentention basins/rain gardens within a commercial parking lot.

Example of a commercial parking lot utilizing porous pavement.

IMPLEMENTATION



Porous Pavement Parking Lot with integrated Swale

PART IV - IMPLEMENTATION

The Stormwater Plan requires the implementation of stormwater management facilities to meet not only the needs of the individual developer but also the needs of multiple developers for a regionally comprehensive system. The individual development will not have enough space to manage all of its stormwater obligation without relying on shared infrastructure to achieve desired development densities. Each developer must provide SITE, BLOCK and REGIONAL obligations and or solutions.

Implementation of regional facilities will be driven by development demands on an as needed basis. In light of this reality, developers within the TDR program have the following options:

- Acquire the land associated with the regional facilities and construct same with their prospective development. With this option, the developer may bear more than his share of the regional infrastructure cost. In this case, a recapture agreement would allow the developer to charge a connection fee to subsequent developers who connect to this improvement.
- Construct temporary facilities to accommodate their proposed stormwater obligation. In addition, their regional obligation would need to be met through payment of a pro-rata share as determined by ordinance or an in-lieu contribution. Once regional facilities are available, the developer must connect and reclaim the temporary stormwater management area for development.
- Connect to regional facilities already in place and meet their regional obligation through payment of a pro-rata share as determined by ordinance or an in-lieu contribution.

The cost of implementing Site, Block and Regional facilities is born by the development as outlined above. In addition, continued maintenance will be required. Maintenance and long term management of private spaces will be the responsibility of the individual property owner or association (ie. Homeowner's, Condo). There is also a one time fee paid to the Township by each developer to cover maintenance costs over a 30-year time frame for facilities dedicated to the Township.

For public spaces it is recommended that a Special Improvement District (SID) fund be considered. The stomwater features located within streets, alleys, park and open space areas are critical to the function and purpose of the stormwater plan. On-going maintenance of plant and hardscape materials is not only required but essential to ensure an attractive, safe community. A SID functions similarly to a condo assciation, wherein money is dedicated for the maintenance of a Specific District. A Special Improvement District should be established prior to the construction of the first phase of development, adding funds as future phases of Kings Landing at Woolwich are completed, ensuring full benefits to all residents.