Scientific Overview of Coastal Buffer Water Quality Functions

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Coastal Vegetative Buffer Policy: Innovative Approaches in Urban/Suburban Environments

Key Concept:
Buffers should *slow* water movement

- Slow water velocity will:
  - Enhance sediment filtration
  - Increase infiltration of surface water into the soil and groundwater
  - Expose contaminants (pathogens, phosphorus and nitrogen) to extended periods of biological, physical and chemical removal mechanisms

Fast Water Movement: Concentrated Overland Flow

- Velocity can exceed 1 foot per second
- Water can cross 50 foot buffer in less than 1 minute
- Buffers can’t treat concentrated flow
- Examples:
  - Gutters, pipes, channels

Slow Water Movement: Ground water flow and sheet flow

- Groundwater:
  - Velocities usually less than 1 foot per day
  - Takes *weeks* to cross a 50 foot buffer
- Sheet Flow: Dispersed surface flow
  - Velocities over dense grass or woodlands: 1 – 5 feet per minute
  - Takes 5 to 20 *minutes* to cross a 50 foot buffer

A Dense Cover of Vegetation Promotes Water Quality within a Buffer

- Grass, shrubs and trees all promote slow water flow
- Developed root systems filter sediment
- Developed root systems increase infiltration rates—Maintain groundwater flow paths
- Developed root systems process nutrients: Deep rooted species can enhance groundwater nitrate removal
- Vegetation stabilizes coastal soils

Research shows the value of vegetation for groundwater nitrate removal in buffers

- Many studies find strong similarities between dense forest and a mix of forest and mowed vegetation:
  - Addy et al., 1999 (Rhode Island)
    - No difference in deep root biomass and groundwater denitrification between forest and "suburban" backyard
  - Vogt et al., 1995 (Yale)
    - Tree roots extend many meters and fully exploit subsurface below mowed areas.

Research shows the value of vegetation for groundwater nitrate removal in buffers

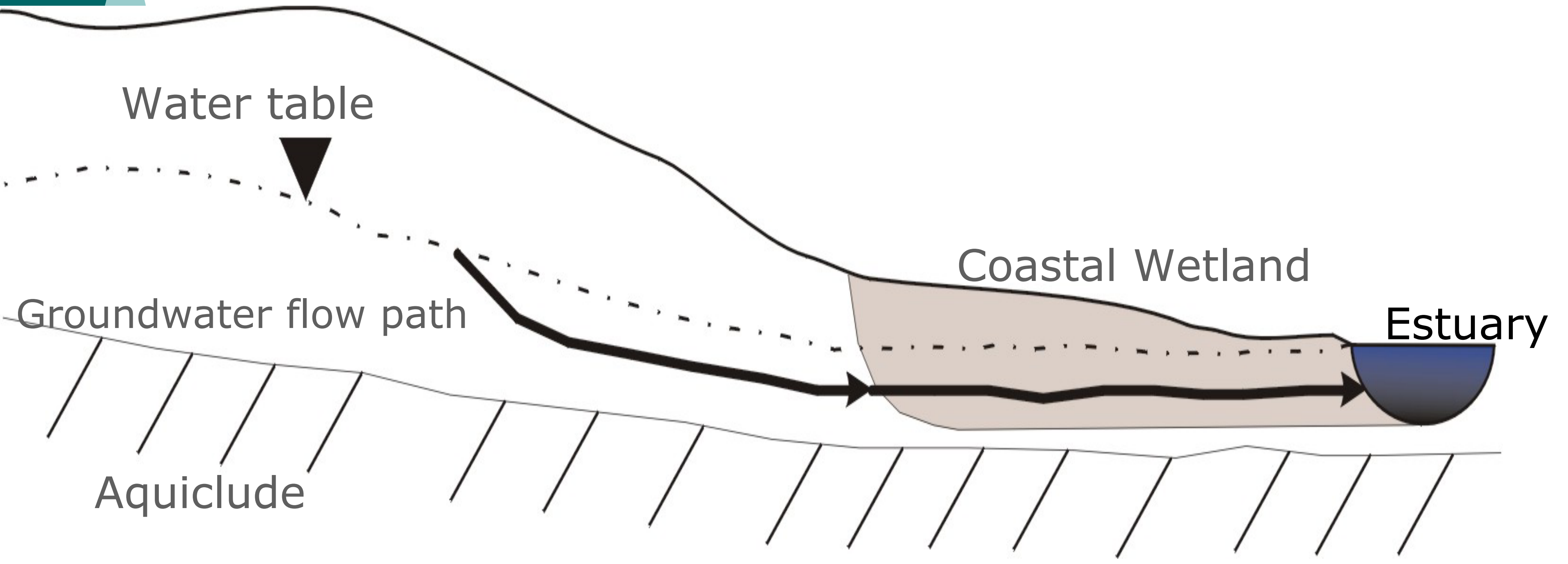
- Several studies suggest forests promote deeper roots and nitrate removal in subsoil:
  - Osborne and Kovacic, 1993 (Illinois)
    - Forested buffers added more organic carbon to subsoil and removed more nitrate than grass buffers
  - Hubbard and Lowrance, 1997 (Georgia)
    - Recommended 3 zone, multi-species buffer

Factors that Reduce Natural Buffer Effectiveness

- Increased Slopes
- High Sediment Loading (Dillaha et al., 1989)
- Dense Soils (dense till or shallow bedrock) (Lowrance et al., 1997)
- Altered Hydrology
  - Concentrated Flow (Dillaha et al., 1989)
  - Subsurface Drains (Gold et al., 2001)
  - Artificially Lowered Water Tables (Groffman et al., 2002)

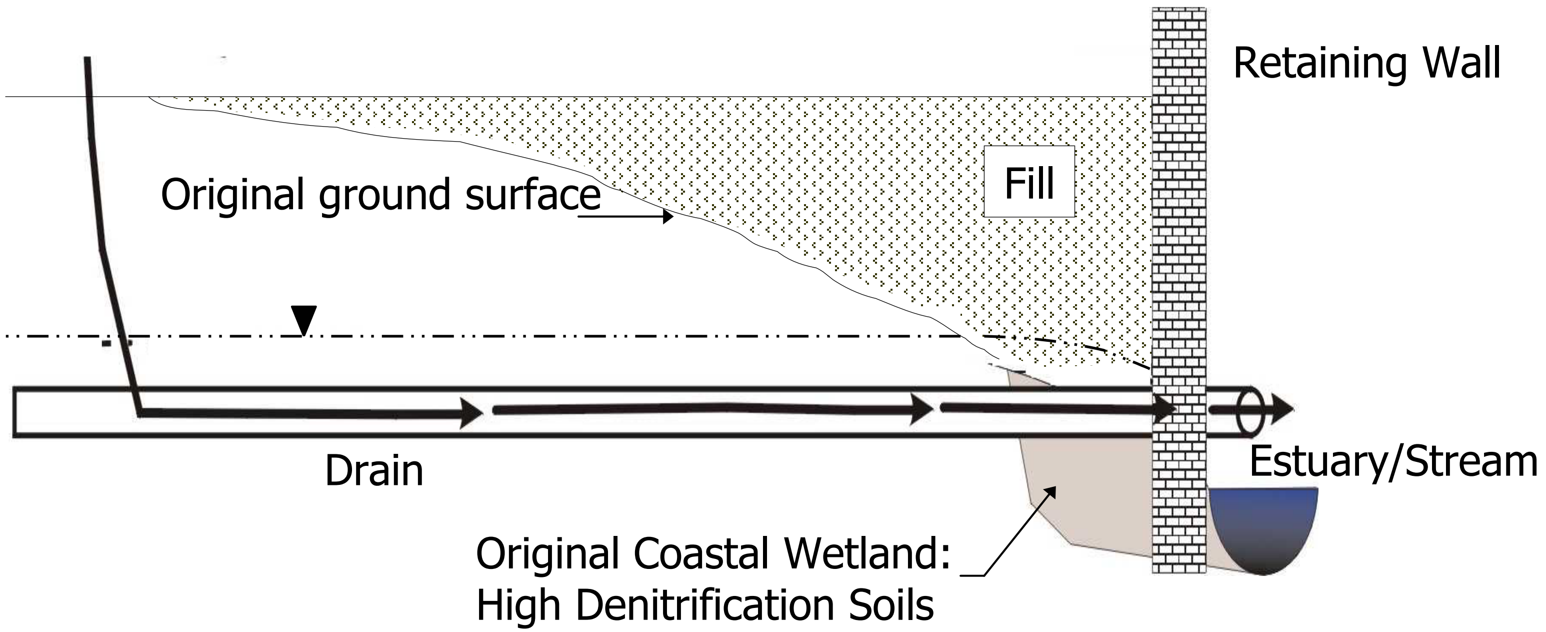
These Site Factors Argue for Greater Buffer Width and Improved Upgradient Management

Groundwater Hydrology (Groundwater Flow Path) is Important to Nitrate Removal



- Shallow groundwater moves through wetland ecosystem with elevated organic soils
- High groundwater N removal

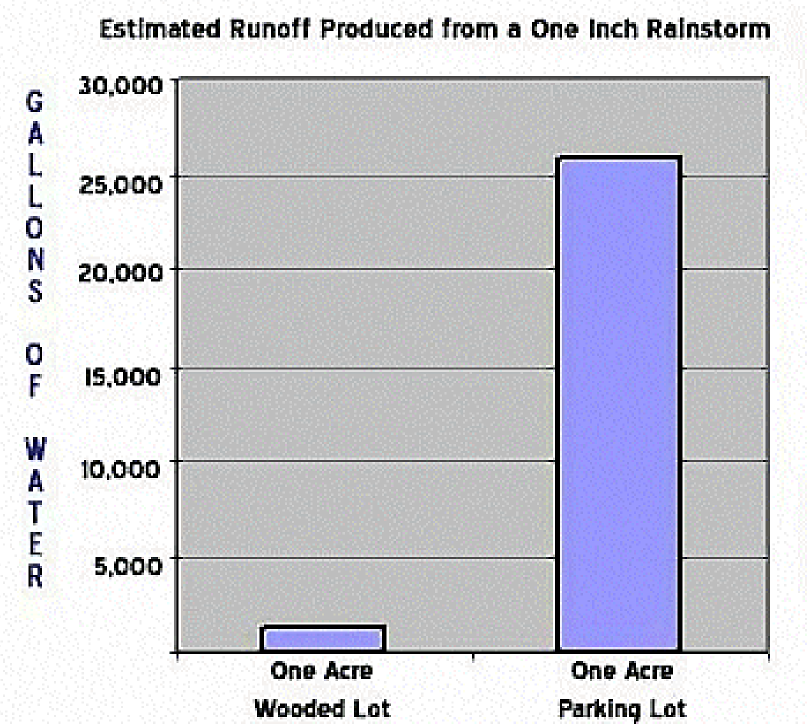
Human disturbance in coastal areas can minimize the N removal function of vegetated buffers at the land-water margin



- Bulkheads, drainage and fill lower the water table and <u>*short-circuit*</u> flowpaths that may have intercepted denitrification zones

Upland Development Can Overwhelm a Natural Buffer: Consider *LID*

- Vegetated buffers fail if upland generates concentrated flows
- Minor ground reshaping often needed to promote buffer functions



Estimate that 5% of rain runs off a wooded area & 95% of rain runs off a parking lot.

A one inch rainstorm will prodouce:

* 1 acre wooded area = 182 cubic feet (1,361 gallons) of runoff

* 1 acre parking lot = 3,449 cubic feet (25,800 gallons) of runoff

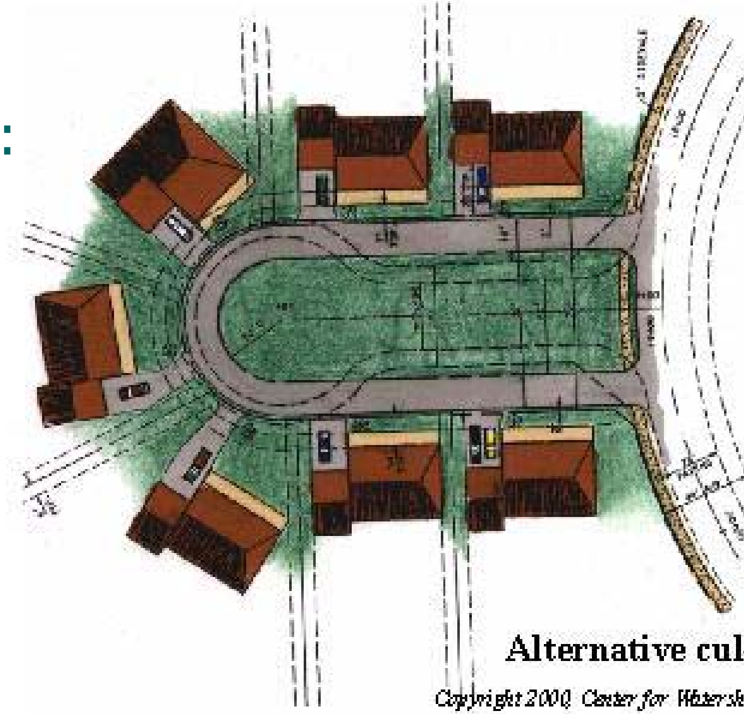
Source: Thomas Jefferson Soil & Water Conservation District

Low Impact Development in Uplands Can Protect Buffers and Coastal Features

- Reduce and disconnect impervious surface
- Minimize lot disturbance
- Infiltrate runoff near its source– Create rain gardens, rooftop storage, rain water use, parking lot storage
- Reduce concentrated overland flow

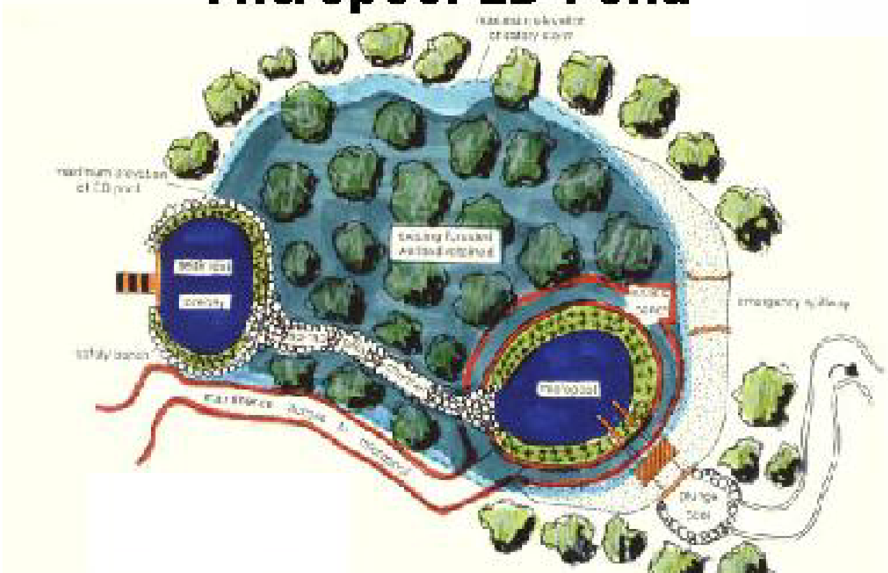
Best Management Practices:

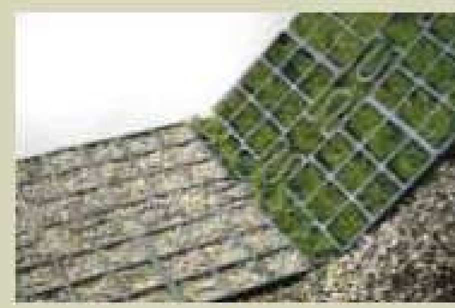
Reduce % Impervious



Alternative cul-de-sac

Micropool ED Pond





Key Considerations for Grid Pavers

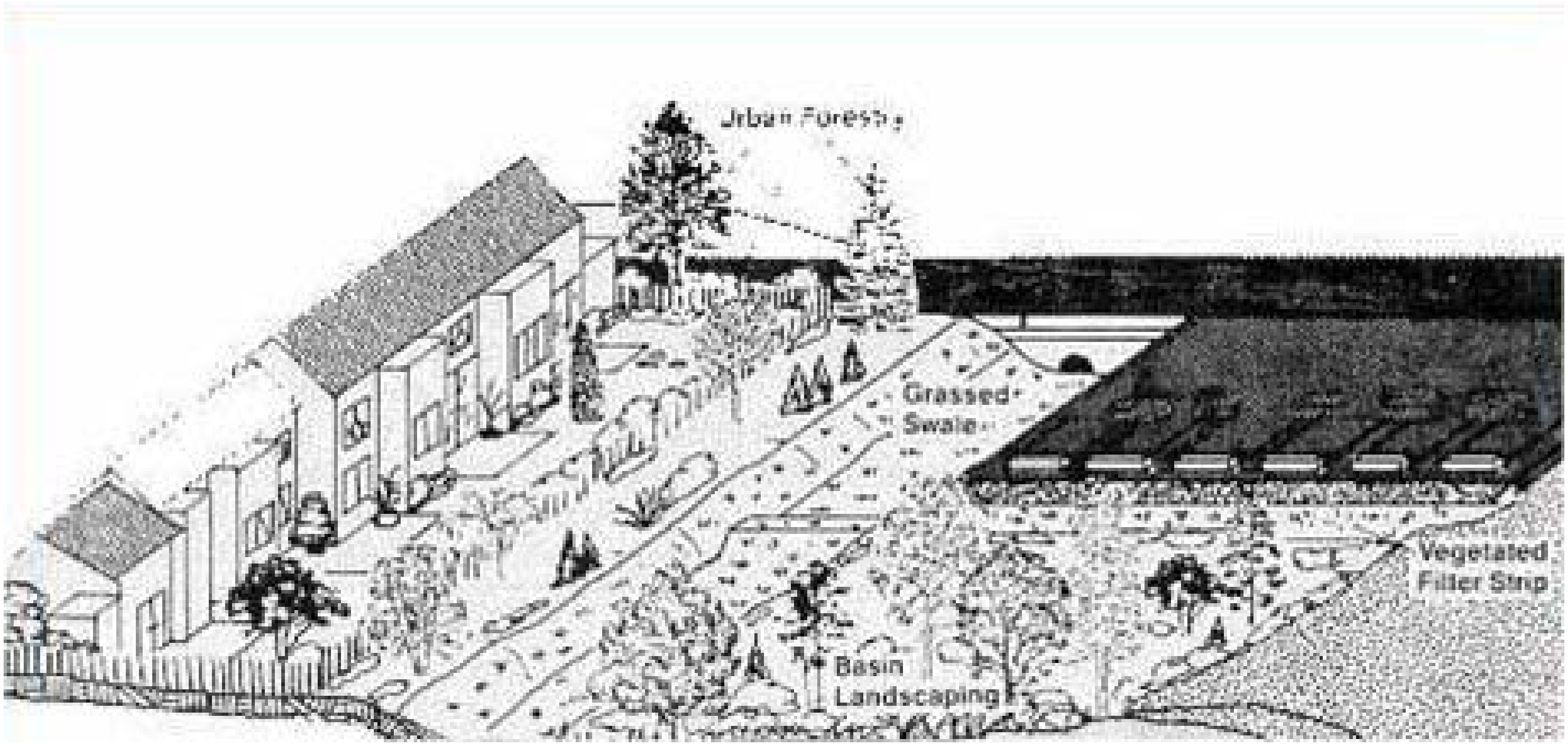
The type of sub-base used will determine the amount of infiltration the pavers provide.

Minimizing Upgradient Impacts on Buffers: Designed Bioretention Basins and Rain Gardens

Bioretention Basins
Promote Infiltration

Center For Watershed Protection:

Vision of Buffers Includes Designed, Reshaped Landscape



Recommendations

- Buffers must be viewed as one component of coastal protection
- Where upland development is intense, land reshaping, rain gardens and bioretention basins should be considered as buffer options
- Buffers with a mix of mowed and forest vegetation can provide water quality protection
- Optimal buffer width for water quality protection will vary with upland practices and site features

Coastal Buffer Design Principles

- Incorporate native, coastal, non-invasive plants
- Buffer width and vegetation must reflect safety – storm surge protection and urban crime.
- Buffers must reflect aesthetic and cultural values.
- Urban and rural locations warrant different buffer designs

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