Low-Impact Development: Principles, Manual, and Case Study

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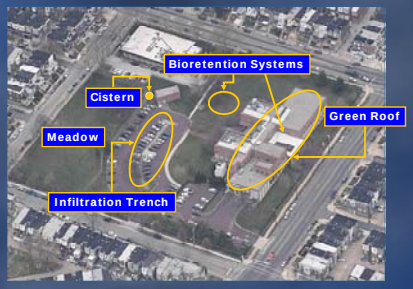
CDM

Jacksonville Where Florida Begins.

JONES EDMUNDS

Overview

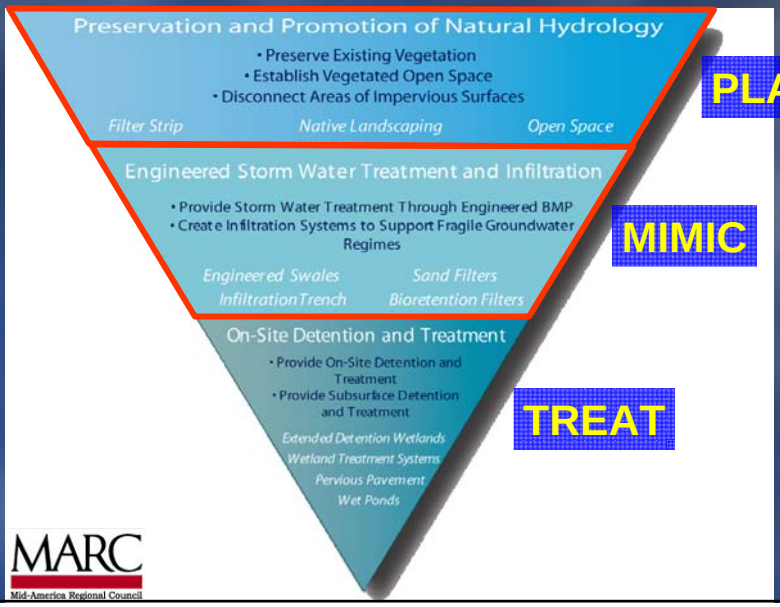
- Low Impact Development
  - Approach to land development that manages stormwater close to its source
  - Overall objective is to maintain or restore hydrologic and ecological functions
- Low Impact Development can include:
  - New development
  - Redevelopment
  - Existing development



Potential Impacts of Development

- Flooding
- Erosion
- Loss of baseflow, soils, and natural resources
- Non-attainment of water quality standards
- Poor fish, habitat, and benthic scores

Basic BMP Principles – MARC (Kansas City area)



PLAN

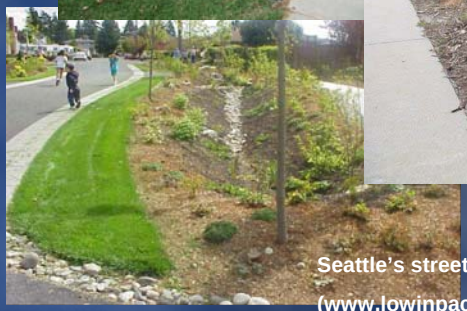
Preserving Natural Hydrology, Infiltration Capacity

Low Impact Development Center

MIMIC

Engineered Stormwater Treatment & Infiltration

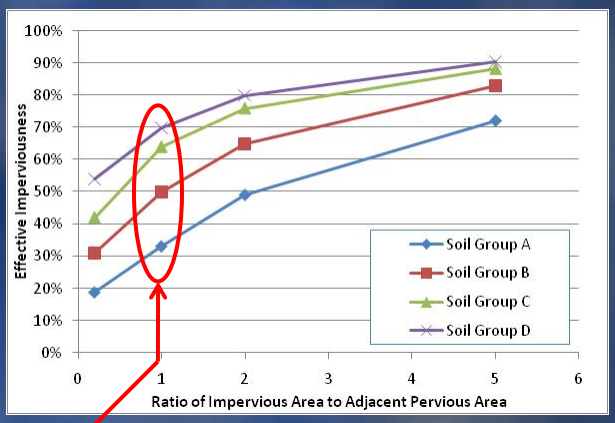
University of Missouri at Kansas City / CDM



Seattle's street edge alternatives program

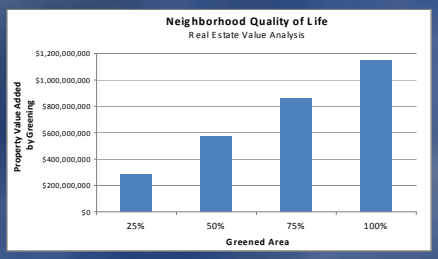
(www.lowinpactdevelopment.org)

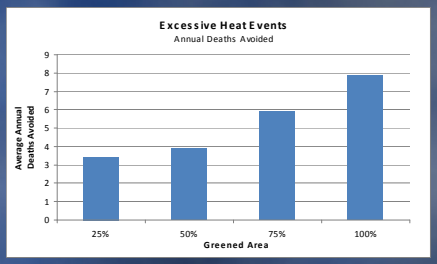
LID effectiveness for runoff reduction

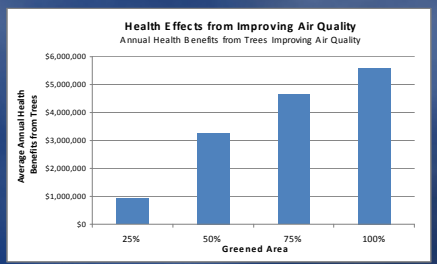


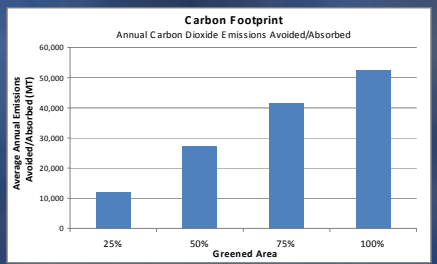
Impervious area discharging to equally-sized pervious area exhibits an "effective" or "equivalent" imperviousness of 30 – 70%.

Other potential benefits to the environment and public









Why Do We Need Low Impact Development?

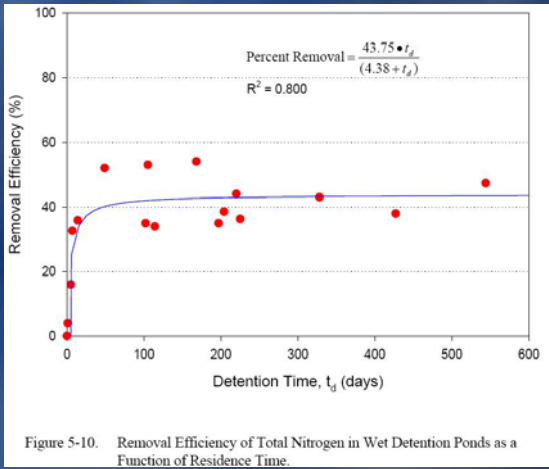
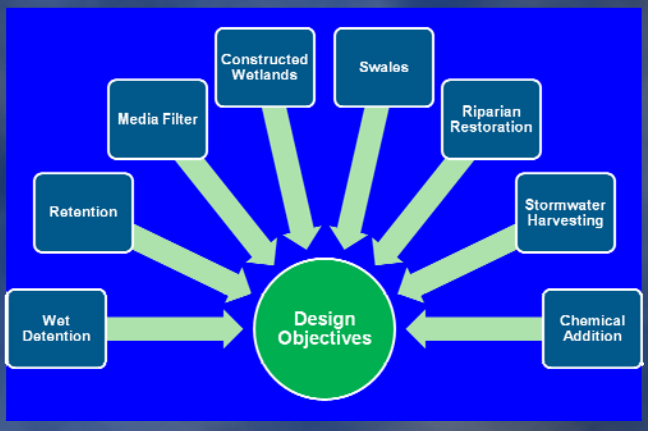


Figure 5-10. Removal Efficiency of Total Nitrogen in Wet Detention Ponds as a Function of Residence Time.

Conventional BMPs do not always achieve our desired goals

Why Do We Need Low Impact Development?



Increases options to achieve objectives

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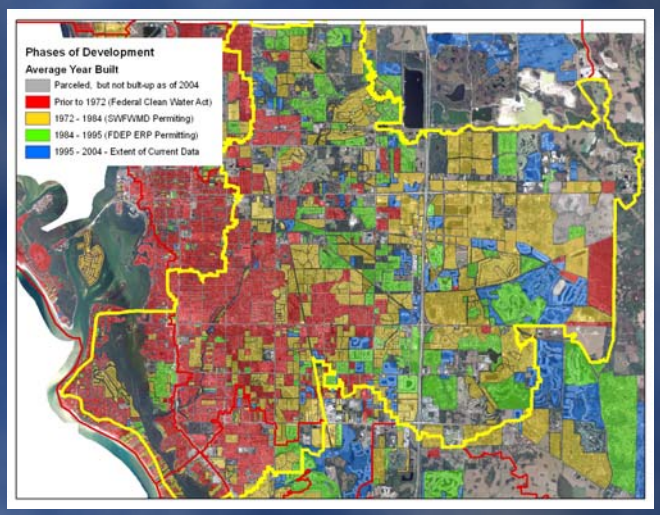
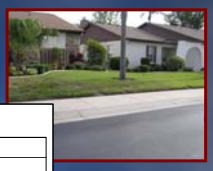
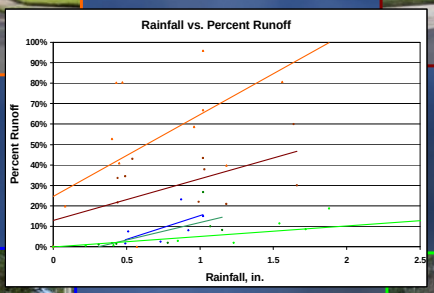


Often better suited for retrofit

Why Do We Need Low Impact Development?



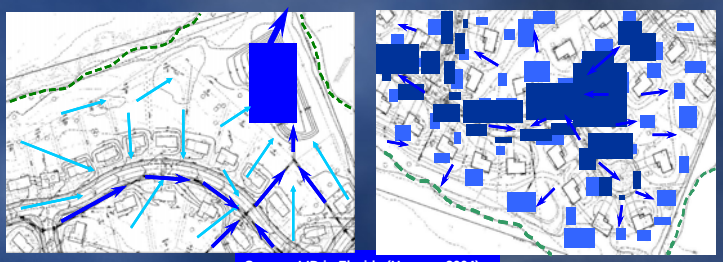


It really works!

Why Do We Need a LID Manual?

Historical Hurdles for LID Practices

- **Reasonable assurance**
  - Difficulty in determining if functioning as designed
  - Magnitude changes inspection/enforcement
- Lack of local design criteria
- Lack of monitoring/performance data



Source: LID in Florida (Heaney, 2004)

Key Attributes of LID Manual

Hurdles addressed

- Reasonable assurance
- Recognition in ERP permitting
- Detailed design criteria
- Performance evaluation

Flexibility in treatment train

LID Manual Development Process

- Establish stakeholder group and target audience
- Use existing Manuals and data
- Determine best LID practices for Duval County
- Coordinate with regional and state agencies
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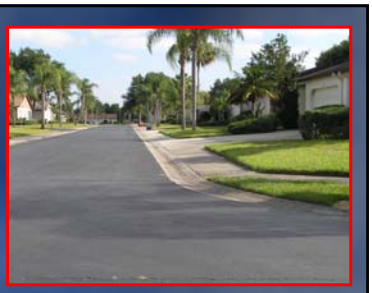
Study Concept

- Gain resolution on differences within land use types
- Are there internal differences big enough to consider?
- Swale vs Curb and Gutter appeared as a practical option
- Grassed conveyance swales are a common drainage feature in Sarasota County and are a LID practice



Versus

Sarasota County ATKINS JONES EDMUNDS Southwest Florida Water Management District

Planning

- Site Characteristics:
  - other than drainage type, ***all else equal*** to extent possible, focus on land use
  - no standing water in drainage pipes
  - all sites within the Phillippi Creek basin
- Study period of 6 months or 40 total samples (even site distribution) whichever is first

Swale 1 - Nassau

Swale 2 – Mirror Lake

Swale 3 - Admiral

Curb and Gutter 1 - Dawson

Curb and Gutter 2 - Darwin

Field Methods

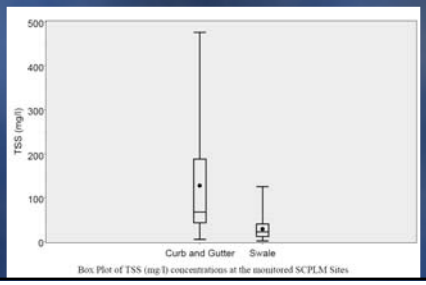
- Use ISCO Avalanche autosamplers to collect flow-weighted samples, monitor rainfall and discharge
- 0.2 inches of rain or more in less than 1 hour
- Adjust sample collection rates to match site specific conditions
- Followed all pertinent FDEP SOPs

Results

- Physical removal of particulates drives concentration reductions
- Infiltration in swales drive volume reductions
- Pollutant loads are reduced by both mechanisms

Results: TSS concentration

- Average TSS concentration was 78% lower at sites with grassed swales
- This difference is statistically significant (p=0.0002)
- Literature reports TSS removal efficiencies by grass filters of 61-86% (Deletic and Fletcher 2006, Han et al 2005)

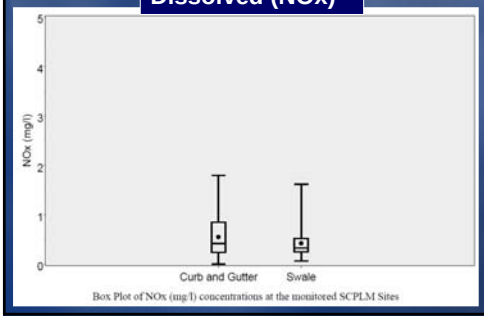


Box Plot of TSS (mg/l) concentrations at the monitored SCPLM Sites

Results: Nitrogen Concentration

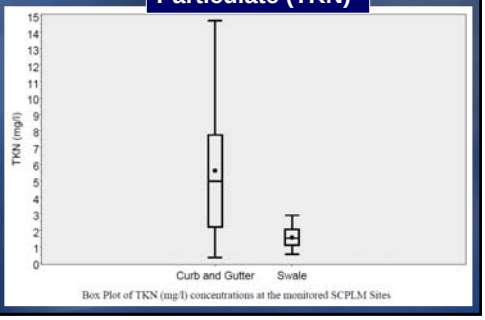
- Average TN was 68% lower, TKN was 72% lower and NOx was 22% lower at swaled sites
- In this study, most nitrogen was in particulate form

Dissolved (NOx)



Box Plot of NOx (mg/l) concentrations at the monitored SCPLM Sites

Particulate (TKN)

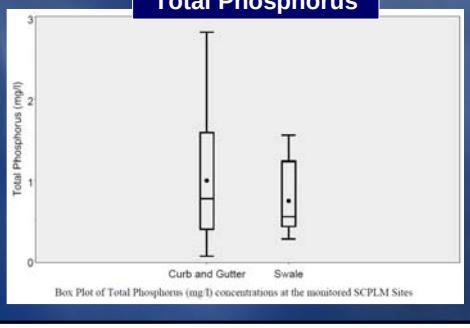


Box Plot of TKN (mg/l) concentrations at the monitored SCPLM Sites

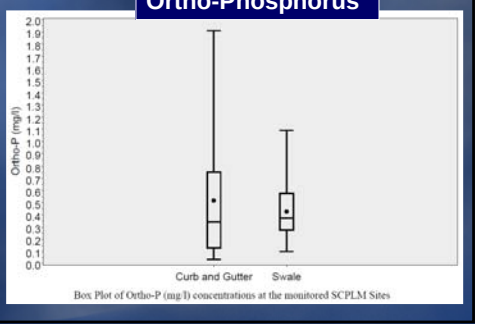
Results: Phosphorus Concentration

- Average TP was 25% lower, Ortho-Phosphorus was 17% lower at swale sites
- Differences were not statistically significant

Total Phosphorus

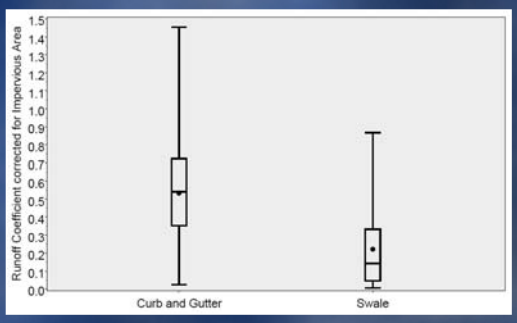


Ortho-Phosphorus



Results: Runoff

- Average runoff coefficients were 58% lower at swale sites
- Three times as much rain without runoff at swale sites
- Annual runoff difference in total flow volume is approximately 5 times lower at swale sites



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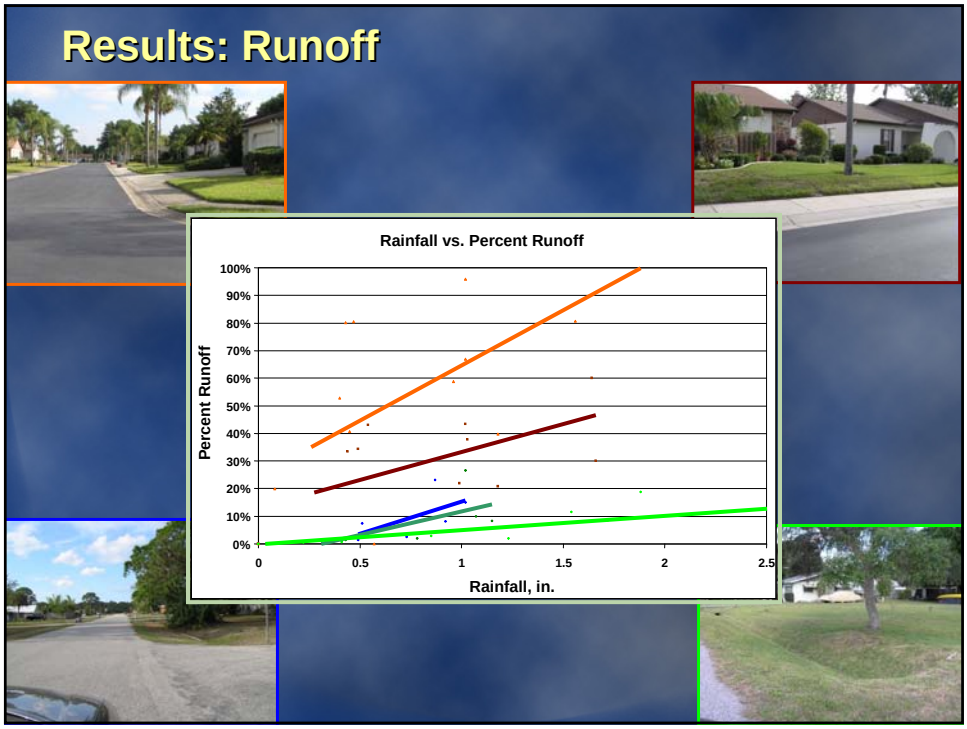


Results: Pollutant Loads

- Observed 93% lower load of TN
  - 94% TKN and 81% NOx
- Observed 82% lower load of TP
  - 81% Ortho-Phosphorus
- Observed 95% lower load of TSS
- Observed 93% lower load of BOD

Conclusions - Comparison to Conventional Treatment

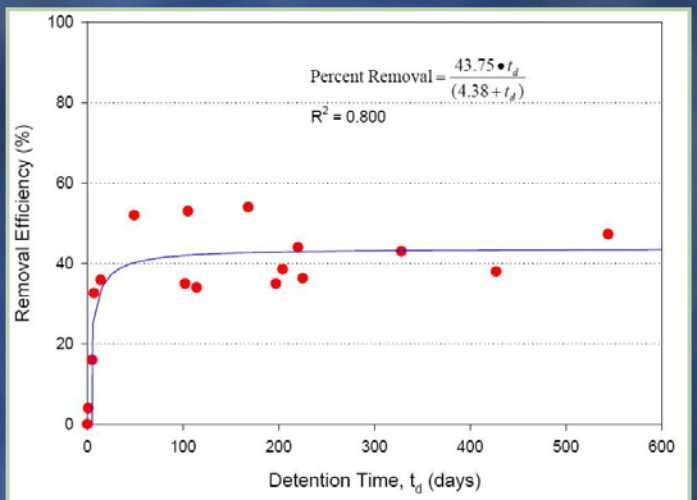
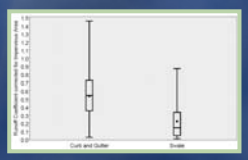
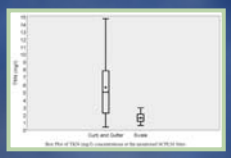


Figure 5-10. Removal Efficiency of Total Nitrogen in Wet Detention Ponds as a Function of Residence Time.

Source: Evaluation of Current Stormwater Design Criteria within the State of Florida (Harper and Baker, 2007)

Conclusions – Effectiveness of LID

Conclusions - Magnitude


= 10 lb-N/ac/yr X 50,000 ac

= 500,000 lb/yr @ $1,500-$9,000/lb/yr

= $750,000,000 - $4,500,000,000