Escambia County Low Impact Design Workshop

An Overview of Stormwater Management and the Role of Low Impact Design BMPs

www.stormwater.ucf.edu

ACKNOWLEDGEMENTS

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- **The Escambia County LID BMP Manual and the LID BMP Workshops were funded in part by a Section 319 Nonpoint Source Management Program Implementation grant from the U.S. Environmental Protection Agency through an agreement/contract with the Nonpoint Source Management Section of the Florida Department of Environmental Protection.**

Facilitators/instructors

- **Marty Wanielista, University of Central Florida, Orlando. Marty has completed over 100 research projects in the State of Florida. He has graduated with advanced degrees over 100 students, has over 300 publications and has been conducting stormwater management work in the State for 46 years. He was one of the designers of the greenroof on the Central Office Complex.**
- **Eric Livingston, Watershed Management Services. Eric, in his 35 years at FDEP, helped develop, administer, and evolve Florida's stormwater treatment program. He funded and managed hundreds of stormwater BMP projects, In 1999 he developed a 10 year LID research and monitoring program. The results of these projects have been used to refine conventional BMPs and create design criteria for LID BMPs.**

Presentation Outline

1. Florida's water quality program
2. The stormwater management issue
3. Evolution of Florida's stormwater treatment program and BMPs
4. Impaired waters and stormwater treatment
5. What is Low Impact Design?
6. Permitting LID BMPs for ERP
7. LID BMPs – purpose, design, construction, maintenance
8. LID BMP treatment effectiveness and computational aids

Florida's Waters – Diverse, Valuable, Vulnerable

- Sandy soils
- Karst geology
- Surface/ground water
- Rainfall/drought
- Agriculture
- Urbanization

1950	2,771,305
1960	4,951,560
1970	6,791,418
1980	9,746,961
1990	12,937,926
2000	15,982,378
2020	20,000,000+

Control Of New Pollution Sources

YEAR	LEGISLATION, PROGRAM, OR RULE ENACTED FOR NEW SOURCES
1973	DRI/ACSC legislation; Environmentally Endangered Lands Act
1973	Chapters 373 and 403 enacted
1975	Local Government Comprehensive Planning Act
1979	State stormwater rule; CARL program
1981	Final state stormwater rule passed; Save Our Coasts/Rivers program
1984	Wetlands Protection Act; State and Regional Planning Act
1985	State Comprehensive Plan
1986	Local Government Comprehensive Planning and Land Development Regulation Act
1989	Preservation 2000 program

YEAR	LEGISLATION, PROGRAM, OR RULE ENACTED FOR EXISTING POLLUTION SOURCES
1986	Stormwater utility enabling legislation
1987	SWIM legislation and funding
1989	Stormwater legislation creates 403.0891 and leads to State Water Implementation rule (62-40, FAC) Section 319 Nonpoint Source grant funds begin
1994	Nitrate bill and fertilizer tax for agricultural BMPs
1997	State Revolving Fund opened to urban and ag stormwater projects
1999	Florida Forever Act and Florida Watershed Restoration Acts passed
2000	Lake Okeechobee Protection Program Act
2005	FWRA Amendments (BMAPS) and doc stamp funding
2007 2016	Northern Everglades and Estuaries Protection Act Florida Springs and Aquifer Protection Act

Florida's Water Quality Management Program

Legal Framework

- Water body classification
- Water quality standards
- Point source management
- Nonpoint source management
- Land use management
- Watershed management

The Foundation – Water Quality Standards

Water Body Classifications (62-302, FAC)

- **Class 1** — **Potable water supply**
- **Class 2** — **Shellfish harvesting**
- **Class 3** — **Fishable/swimmable**
- **Class 4** — **Agricultural canals**
- **Class 5** — **Industrial**

Water Quality Standards (62-302, FAC)

- **Water chemistry**
- **Biology**
- **New numeric nutrient criteria**
- **Revised dissolved oxygen criteria**

Impaired Waters Rule (62-303, FAC)

- **For IWR assessments only**

Water Pollution

POINT SOURCES

- Municipal ww ~ 2,100 facilities
- Industrial ww ~ 1,300 facilities
- Agricultural ww - CAFOs
- Stormwater - SIC codes

NONPOINT SOURCES

- Diffuse
- Rainfall, runoff, leaching
- Related to land uses

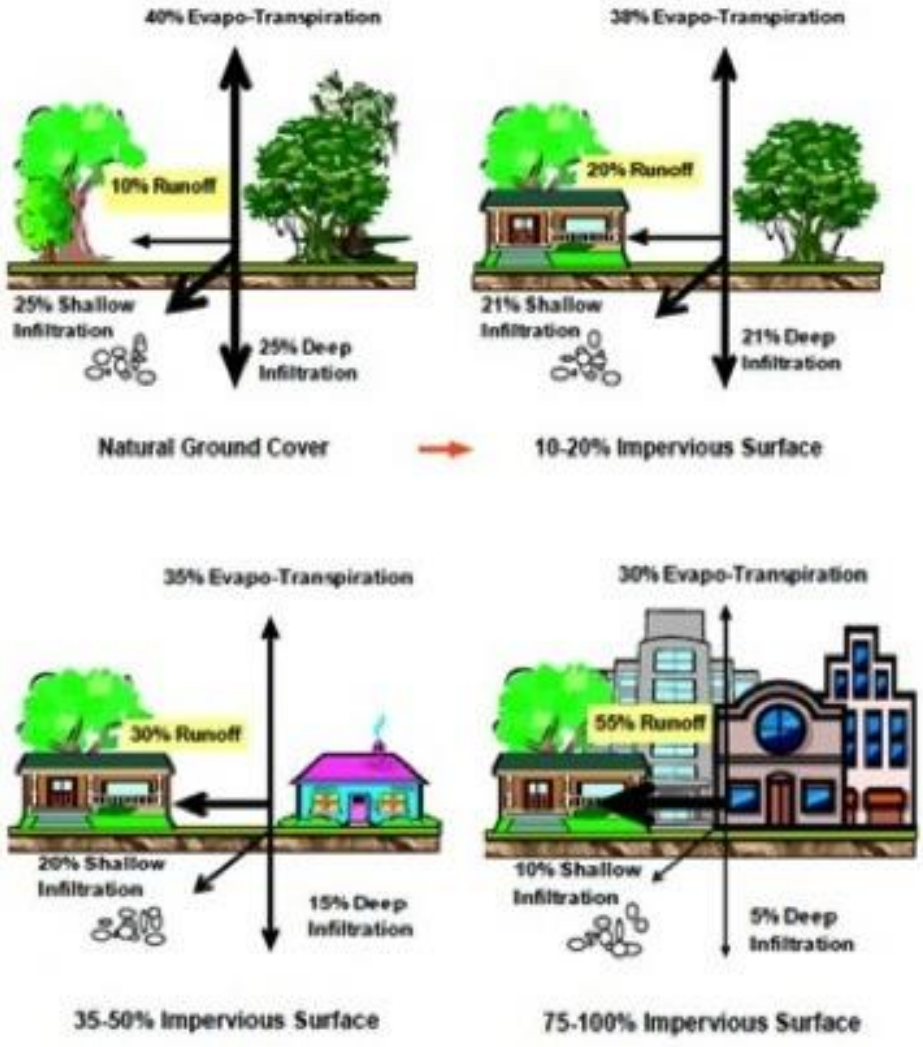
THE STORMWATER PROBLEM

Humans cause:

- Changes in land use, clearing of land
- Compaction of soil, imperviousness
- Development in floodplains, wetlands
- Alteration of natural stormwater systems
- Addition of “drainage” systems
- Addition of pollutants

Resulting in:

- Decreased recharge
- Increased speed of runoff
- Increased volume of runoff
- Increased pollutants



Hydrologic Changes Associated With Urbanization

Big Messy Problem

Common Pollutants

- Sediments
- Oxygen demanding substances
- Nutrients
- Pathogenic bacteria
- Heavy metals
- Oil & grease, hydrocarbons
- Fresh water

Florida's Stormwater Rules

1979 Chapter 17- 4.248, F.A.C.

1982 Chapter 17- 25, F.A.C.

1994 Chapter 62- 25, F.A.C.

ERP implemented

2007 NW ERP implemented

2013 Chapter 62-330, F.A.C

TECHNOLOGY BASED

- **Performance Standard**
- **BMP Design Criteria**
- **Presumption of compliance**
- **Dynamic BMP design criteria**

Performance Standard For New Stormwater Discharges (62-40.432, FAC)

Stormwater quality – Original Rule

- 80% average annual load reduction
- 95% average annual load reduction

"Of Total Suspended Solids"

Stormwater quality – 1990 – 62-40 revised

- 80% average annual load reduction
- 95% average annual load reduction

"Of pollutants that cause or contribute to violations of water quality standards"

BUT BMP DESIGN CRITERIA WERE NEVER UPDATED

Design Criteria Presumption Rebutted!

"This section provides an analysis of potential modifications to existing stormwater design criteria within the State of Florida to meet the performances objectives outlines in the Water Resource Implementation Rule (Chapter 62-40, FAC). This rule requires that stormwater management systems achieve at least an 80% reduction of the average annual load of pollutants that would cause or contribute to violations of State water quality standards. If the stormwater management system discharges to a designated OFW or other protected water body, the performance criteria increase to a 95% reduction. Based on the analyses presented in Section 5.2, with the exception of the SJRWMD design criteria for on-line dry retention, existing stormwater design criteria fail to consistently meet either the 80% or 95% target goals outlined in Chapter 62-40."

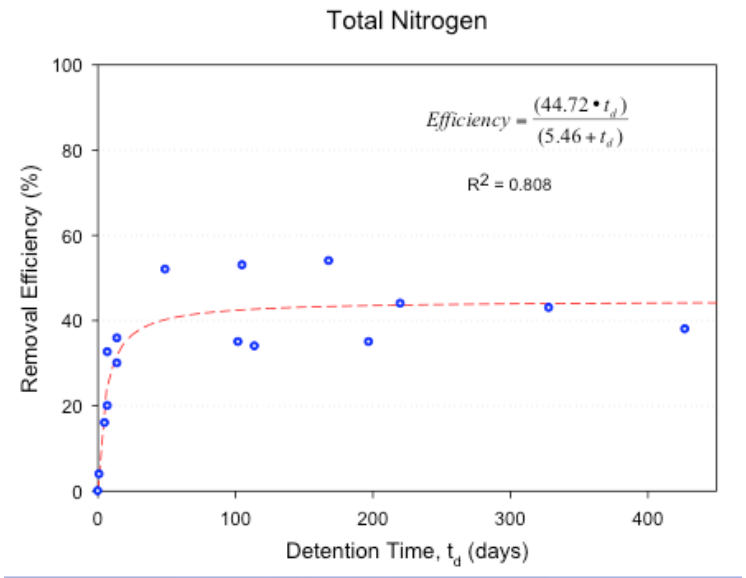
BMP Load Reduction Effectiveness

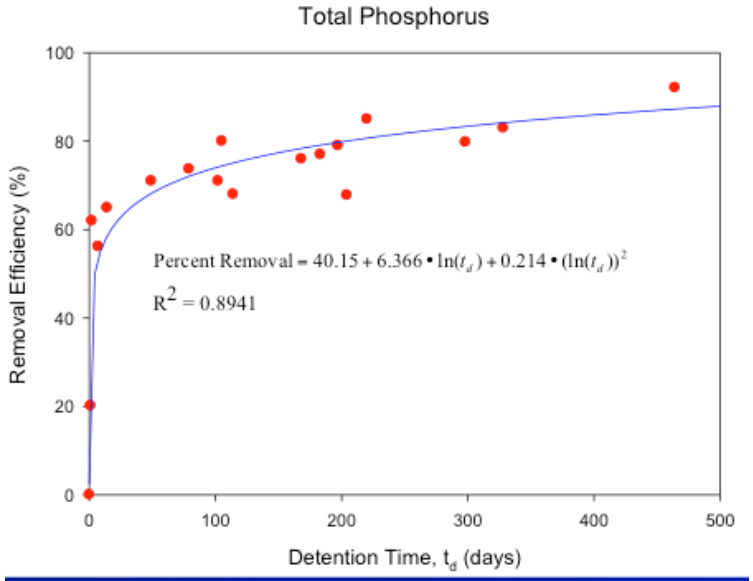
Retention BMPs

- **0.5” treatment volume provides from 38.1% to 91.8% load reduction depending on % DCIA and non-DCIA CN**

Wet detention systems

- **Treatment related to residence time**





When Are Higher Levels Of Stormwater Treatment Required?

Discharges to OFWs

- **Must meet "antidegradation" standard**
- **Presumptive = 95% load reduction**
- **Net improvement = antidegradation**

Discharges to Impaired Waters

- **Must meet "net improvement" standard**
- **Must demonstrate load reduction achieved**

What Is “Net Improvement”?

Verified impaired water body

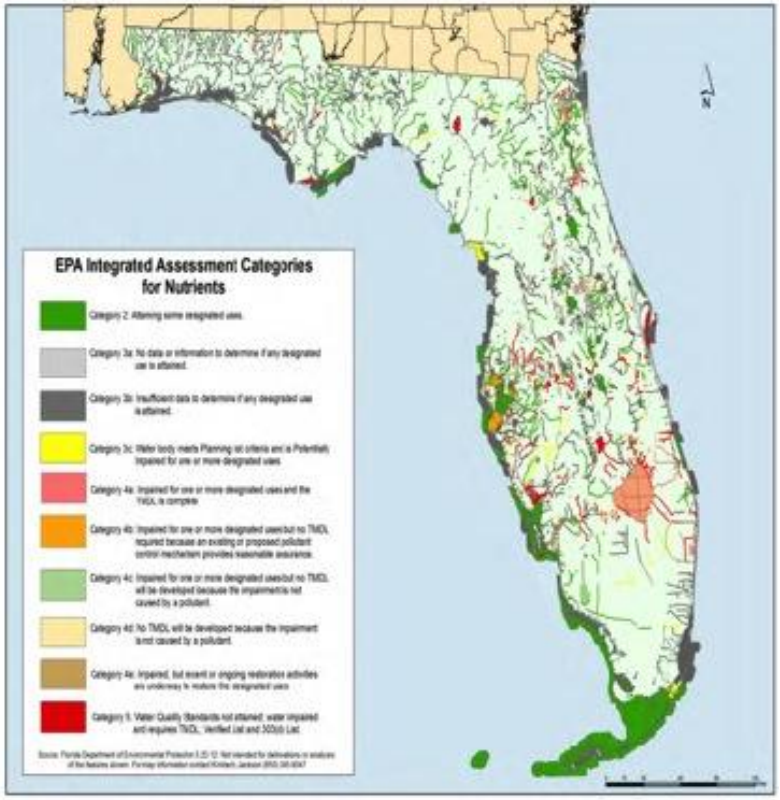
- **DEP/WMDs require one pound less loading of the pollutant(s) causing impairment after development**
- **Recommend at least 10% reduction in post-development loading to meet statutory intent.**

Impaired water body with adopted TMDL

- **Post-Development Load < Pre-Development Load – WLA % reduction**

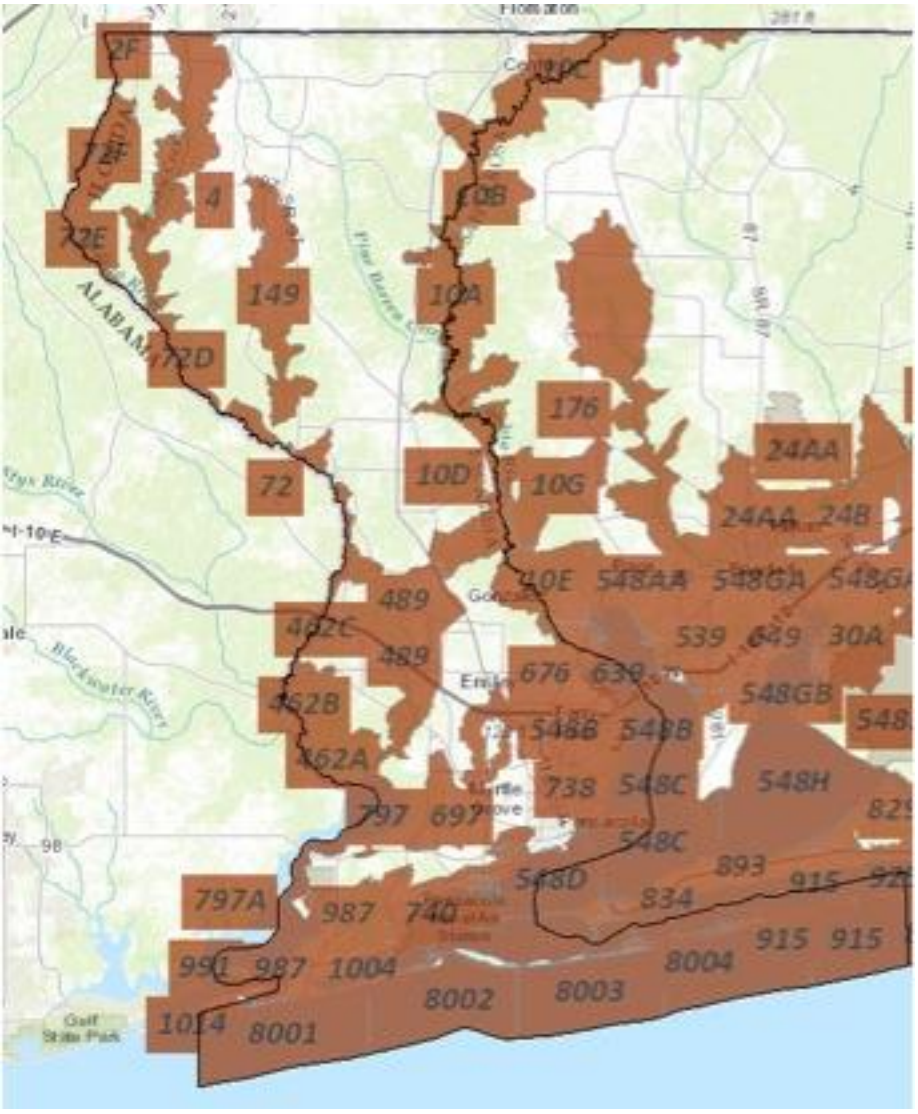
Impaired Waters In Florida

- **2,776 spreadsheet lines of water bodies in cumulative FDEP 303(d) list!**
- **Most common impairments are nutrients, DO and fecal coliforms**



Parameter Assessed	Number Impaired	Miles Impaired
DO	699	5,975
Fecal Coliform	338	2,685
Mercury (in fish tissue)	249	2,903
Nutrients (chlorophyll *a*)	153	1,014
Biology	36	320
Nutrients (other than chlorophyll *a*)	28	18
Iron	17	314
Lead	14	123
Specific Conductance	10	111
Bacteria (shellfish harvesting classification)	10	82
Turbidity	10	83
Un-ionized Ammonia	7	69
TP	6	76
Biochemical Oxygen Demand	2	21
Copper	2	3
TDS	2	6
Silver	1	6
Chloride	1	0
Dioxin	1	2
TSS	1	3

Escambia County Impaired Waters and Waters with Adopted TMDLs



How To Determine If Water Body Is An OFW, Is Impaired, Or Has An Adopted TMDL

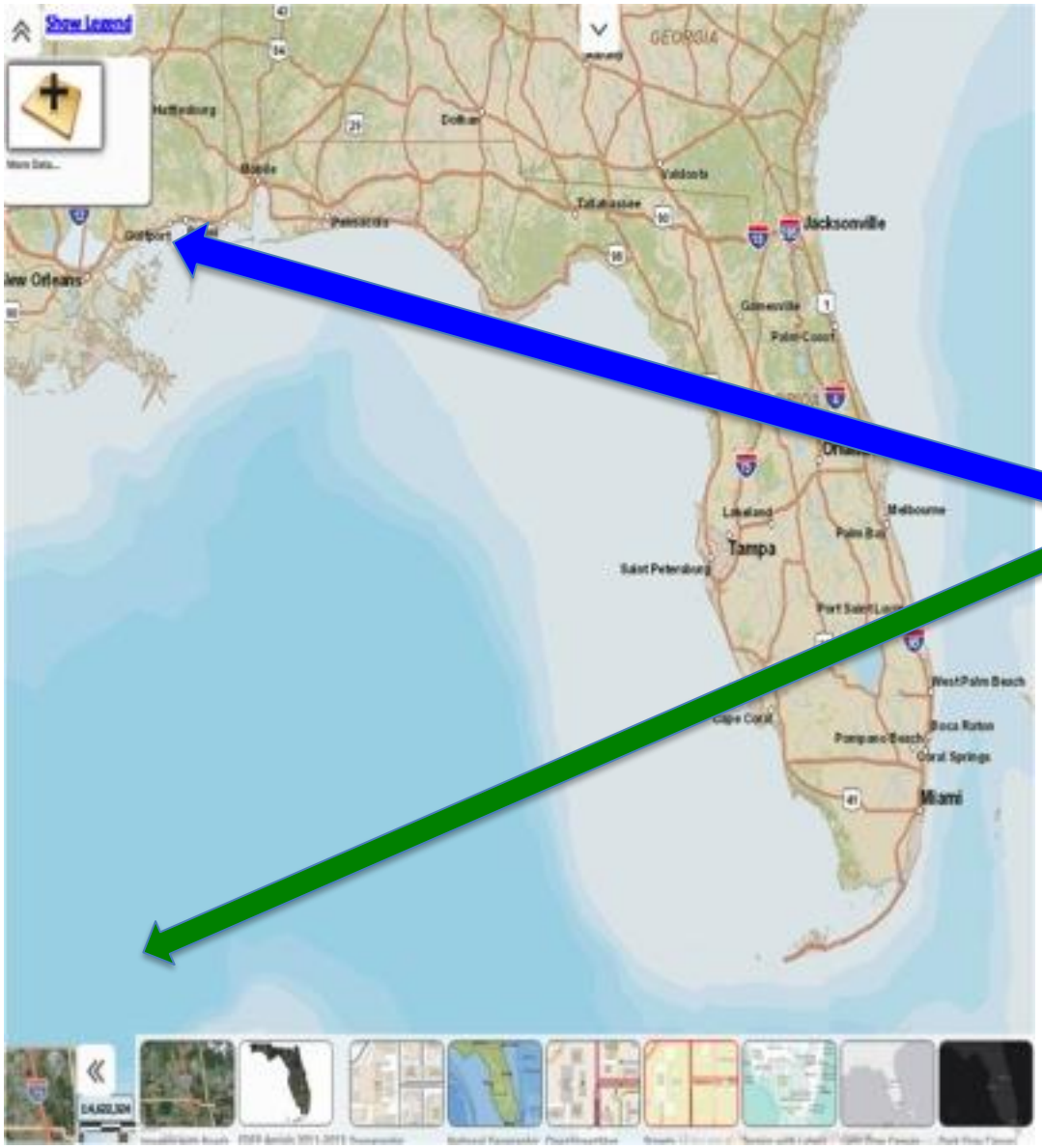
- **Use DEP's Map Direct to determine if water body or WBID is an OFW or it's impairment and TMDL status**
- **Use DEP's Map Direct to see if project site is within the 12 unit HUC (subwatershed) of an impaired water body**
- **Use DEP's TMDL Tracker system to see if a TMDL is adopted, or check 62-304, F.A.C.**
- **Use EPA's Ask Waters system**

Dep Map Direct System

http://ca.dep.state.fl.us/mapdirect

Click This Map

Select Basemap and Data Layers

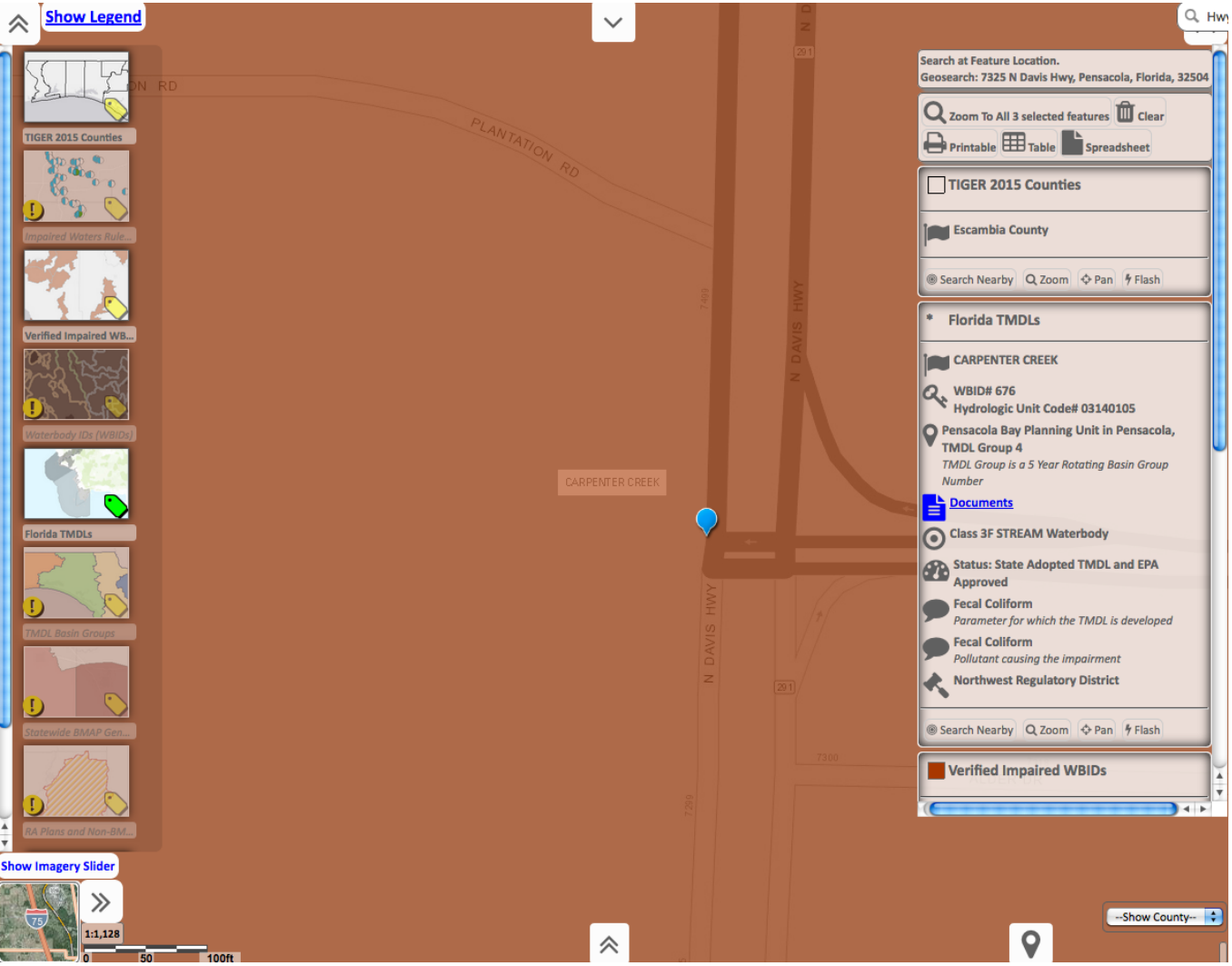


1. Select Basemap from options at arrow in left bottom of map
2. Open Data Layers by clicking on arrow at upper left of map, and then on + More Data

Map Direct - Select Data Layers

1. From NHD Data Layer
   Select HUC 12 sub-watershed
2. From Watershed Assessment
   a. Select Verified Impaired WBIDs
   b. Select Florida TMDLs
   c. Select WBIDs

Map Direct – Enter Address, WQ Results



1. Be sure desired data layers are turned “on”
2. Enter address into search box in upper right hand corner
3. Results for each data layer will be shown

Why Are Higher Levels Of Stormwater Treatment Required?

Section 402(p) of Federal Clean Water Act

- **Establishes NPDES stormwater permits**
- **Construction permit requires treatment to meet WQS**
- **MS4 permit requires local governments to reduce pollutant loadings**
- **MS4 permit requires reducing pollutant loads to achieve TMDLs and BMAPs**
- **MS4 permit requires load tracking/reporting**

Why Are Higher Levels Of Stormwater Treatment Required?

Section 373.414(1)(b)3., Florida Statutes

3. If the applicant is unable to meet water quality standards because existing ambient water quality does not meet standards, the governing board or the department shall consider mitigation measures proposed by or acceptable to the applicant that cause net improvement of the water quality in the receiving body of water for those parameters which do not meet standards.

Net Improvement = Very High Level Of Stormwater Treatment

- **Net Improvement can require as much as 90% removal to meet TMDL (26% WLA)**
- **Need to use combination of structural and nonstructural pollution prevention BMPs including Low Impact Development BMPs**

Pollutant Load = (Concentration) * (Volume)

Stormwater volume factors:

- **Rainfall variables** include when, where, how long, how intense, time between storms
- **Natural stormwater variables** include soils, geology, SHWT, topography, vegetation
- **Human stormwater variables** include land use, site design, soil compaction, percent imperviousness, % DCIA

Table 2-2a Runoff curve numbers for urban areas 1/

Cover description: Cover type and hydrologic condition	Average percent impervious area 2/	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.)3/:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) 4/		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation)5/		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

Stormwater Event Mean Concentrations

Florida EMC data base – June 2016

AWT wastewater

TN = 3mg/l

TP = 1 mg/l

Stormwater Event Mean Concentrations (mg/l)						
Land Use Category	**Total N**	**Total P**	**BOD**	**TSS**	**Copper**	**Zinc**
Low Density Residential[1]	1.64	0.270	5.25	25,75	0.010	0.036
Single Family	2.07	0.327	7.90	37.50	0.016	0.062
Multi-Family	2.32	0.520	11.30	77.90	0.009	0.086
Low Intensity Commercial	1.13	0.188	7.60	59.90	0.017	0.083
High Intensity Commercial	2.40	0.345	11.30	69.70	0.015	0.160
Light Industrial	1.20	0.260	7.60	60.00	0.003	0.057
Highway	1.52	0.200	5.20	46.00	0.025	0.116
Natural Vegetated Community	1.22	0.213	2.60	15.50	0.003	0.011
Range land/park land	1.15	0.055	1.40	8.40		
General Agricultural	2.80	0.487	3.80	34.20	0.012	0.021
Pasture	3.51	0.686	5.10	67.10		
Citrus	2.24	0.183	2.60	15.50	0.003	0.012
Row Crops	2.65	0.593		19.80	0.022	0.030
Conventional rooftops	1.05	0.12				
1. Average of single-family and undeveloped values						

How Do We Reduce Stormwater Loading?

- **Reduce stormwater pollutant concentrations**
- **Reduce stormwater volume**

- **Better site design – integrate stormwater into site**
- **Use BMP Treatment Train with nonstructural and structural stormwater BMPs**
- **Minimize imperviousness, especially DCIA**
- **Reduce pollutants using source controls including public education**

Why Low Impact Design?
Added BMPs In Tool Box

- **Promote development and redevelopment through greater flexibility**
- **Build local economy and promote "urban regeneration"**
- **Get higher levels of stormwater treatment**
- **Keep loads out of MS4**
- **Protect local taxpayers and water bodies**

- Pervious Pavement
  - Concrete
  - Pavers
- Rain Gardens / Bio Swales
- Street Infiltration Basins
- Bio Filtration Planter Boxes
- Green Gutters

City of Palmetto
Urban regeneration project

What Is Low Impact Development?

- **Comprehensive watershed approach**
- **Hydrology is integrating framework**
- **Maintain predevelopment volume and hydrology**
- **Control stormwater at the source**
- **Combine nonstructural pollution prevention BMPs with structural BMPs**
- **Create multifunctional landscape and infrastructure**

Pollution and Hydrologic Prevention

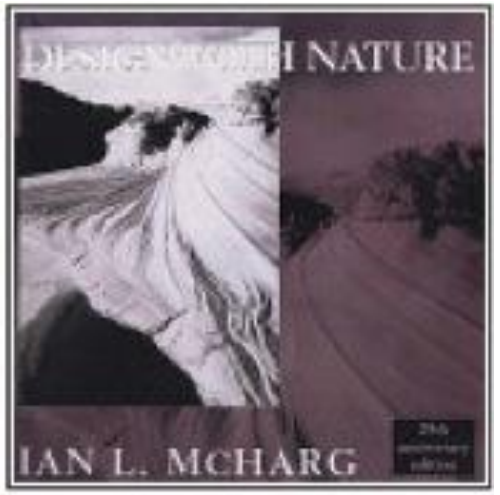
What Low Impact Development is Not

LID is NOT a silver bullet solution to all stormwater problems

- Additional nonstructural and structural tools in the BMP tool box
- Infiltration BMPs do not work everywhere

LID is NOT a new idea

- "Designing with Nature" 1969 book by Ian McHarg
- FL stormwater program has always promoted retention BMPs



The Problem: Conventional Site Design

Efficiency

- Collect
- Concentrate
- Convey

Good Drainage Approach

Low Impact Development Principles To Reduce Stormwater Volume/Loads

- Consider stormwater as a resource
- Protect/avoid sensitive areas
- Minimize disturbed areas / soil compaction
- Minimize loss of vegetation and trees
- Plant more trees – intercept rainfall
- Cluster development, have open space
- Maximize infiltration
- Minimize imperviousness, especially DCIA
- Integrate stormwater BMPs into site & landscaping
- Use Florida-friendly landscaping and fertilizers

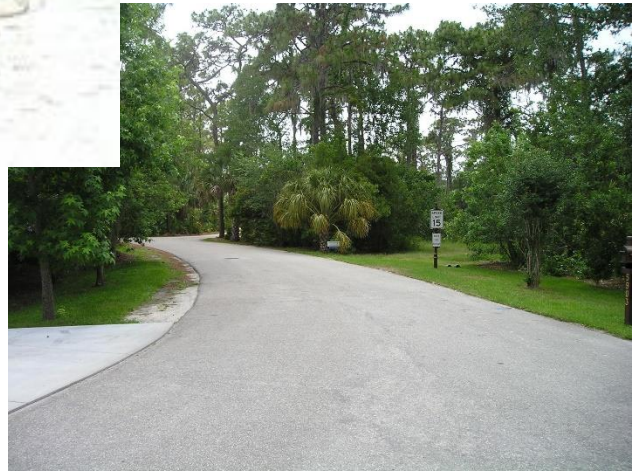
Low Impact Design Projects in Florida

Madera, Gainesville

Baldwin Park, Orlando

Town of Harmony

River Forest, Bradenton



Impediments To Advanced Stormwater Treatment/LID BMPs

- Review existing Comprehensive Plan, Code of Ordinances, Land Development Code
- Identify impediments to achieving advanced stormwater treatment or use of LID BMPs
- Identify out dated terminology, legal refs
- Ensure redevelopment activities are fully addressed
- Comprehensive Plan elements
  - Land Use, Housing
  - Transportation, Utilities
  - Conservation, Coastal Zone Mgmt

Impediments To Advanced Stormwater Treatment/LID BMPs

- Code of Ordinances
  - Fertilizer Ordinance
  - Parks and Recreation
  - Solid and hazardous waste
  - Building codes
- Land Development Code
  - General provisions – redevelopment
  - Definitions – update, consistency
  - Zoning Districts – Impervious surface ratio
  - Development Standards
    - Update references to other manuals, rules, laws
    - Update terminology

Impediments To Advanced Stormwater Treatment/LID BMPs

- **Land Development Code (continued)**
  - **Streets and parking – promote narrow, pervious**
  - **Sidewalks and trails – promote pervious**
  - **Landscaping – Consistent with FFL program**
  - **Fertilizers – Require Florida-friendly, training**
  - **Recreation – Promote pervious parking, FFL and fertilizers, Golf course BMP manual**
  - **Stormwater – promote LID BMPs, regional systems, permit reviews, inspections, OM**

Incentives For Advanced Stormwater Treatment/LID BMPs

- **Establish within Land Development Code**
  - **Open Space Requirements**
  - **Landscaping Requirements**
  - **Coordination with regional systems**
- **Financial incentives**
  - **Reduction in stormwater utility fee**
  - **Energy related rebates, such as for green roofs**
  - **For stormwater harvesting sales income offsets construction costs**
  - **Higher building density allowed**
  - **Lower impact fees**
  - **Reduced pipe sizes with lower runoff rates**
  - **Dual use of landscape areas thus reducing other land purchases.**
  - **Faster plan review time when Stormwater Manual is used.**

LID BMPs in Escambia County Manual

Site Planning BMPs	Conceptual Site Planning
SP1	Inventory Site Assets: Hydrology
SP2	Inventory Site Assets: Topography
SP3	Inventory Site Assets: Soils
SP4	Inventory Site Assets: Vegetation
SP5	Protect Surface Waters and Wetlands
SP6	Preserve Open Space
SP7	Natural Area Conservation - Retain Tree Canopy and Native Landscapes
SP8	Cluster Design and Maximize Gross Density
SP9	Minimize Building Footprint
SP10	Minimize Total Impervious Area
SP11	Minimize Directly-Connected Impervious Area
SP12	Curb Elimination and Curb Cuts
Source Control BMPs	**Source Control Techniques**
SC1	Retain Natural Landscape Depressions
SC2	Minimize Clearing and Grading
SC3	Minimize Soil Disturbance and Compaction
SC4	Build with Landscape Slope
SC5	Retain Native Landscapes at the Lot Level
SC6	Florida-friendly Landscapes and Fertilizers
SC7	Rainfall Interceptor Trees
SC8	Install Efficient Irrigation Systems
SC9	Use Non-potable Water Supply for Irrigation
SC10	Community and Home Owner Education

Structural BMPs	Structural Stormwater BMPs
SW1 – Section 5.3	Retention Basin
SW2 – Section 5.4	Exfiltration Trench
SW3 – Section 5.5	Underground Storage and Retention
SW4 – Section 5.6	Rain Gardens (Bioretention)
SW5 – Section 5.7	Treatment Swales
SW6 – Section 5.8	Vegetated Natural Buffers
SW7 – Section 5.9	Pervious Pavements
SW8 – Section 5.10	Green Roofs with Cisterns
SW9 – Section 5.11	Rainwater Harvesting/Cisterns
SW10 - Section 5.12	Stormwater Harvesting/ Horizontal Wells
SW11 - Section 5.13	Up-Flow Filter Systems
SW12 - Section 5.14	Managed Aquatic Plant Systems
SW13 - Section 5.15	Biofiltration Systems with Biosorption Activated Media

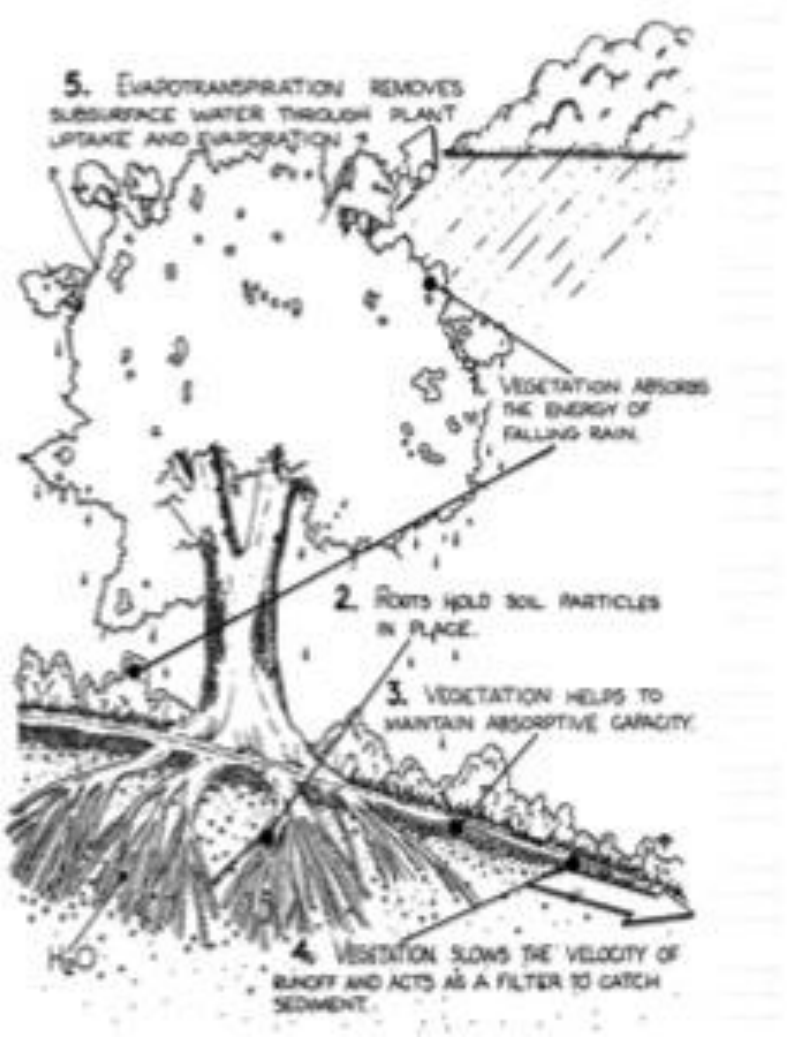
Improved Site Planning BMPs

SP5 - Protect waters, wetlands
SP6 – Preserve Open Space
SP7 – Natural Area Conservation, retain tree canopy
SP8 - Cluster development
SP9 - Minimize building footprint

SP10 - Minimize imperviousness
SP11 - Minimize DCIA
SP12 - Curb elimination & curb cuts

NATURAL AREA CONSERVATION

- **Credit for preserving natural areas**



The Stormwater Benefits Of Trees

Planting trees in urban areas intercepts and evaporates rain and reduces stormwater volume and loads

Biological Pollutant Removal

Plant / Soil Flora / Soil Chemistry

- **Phytoremediation**
  - **Translocate**
  - **Accumulate**
  - **Metabolize**
  - **Volatilize**
  - **Detoxify**
  - **Degrade**
- **Bioremediation**

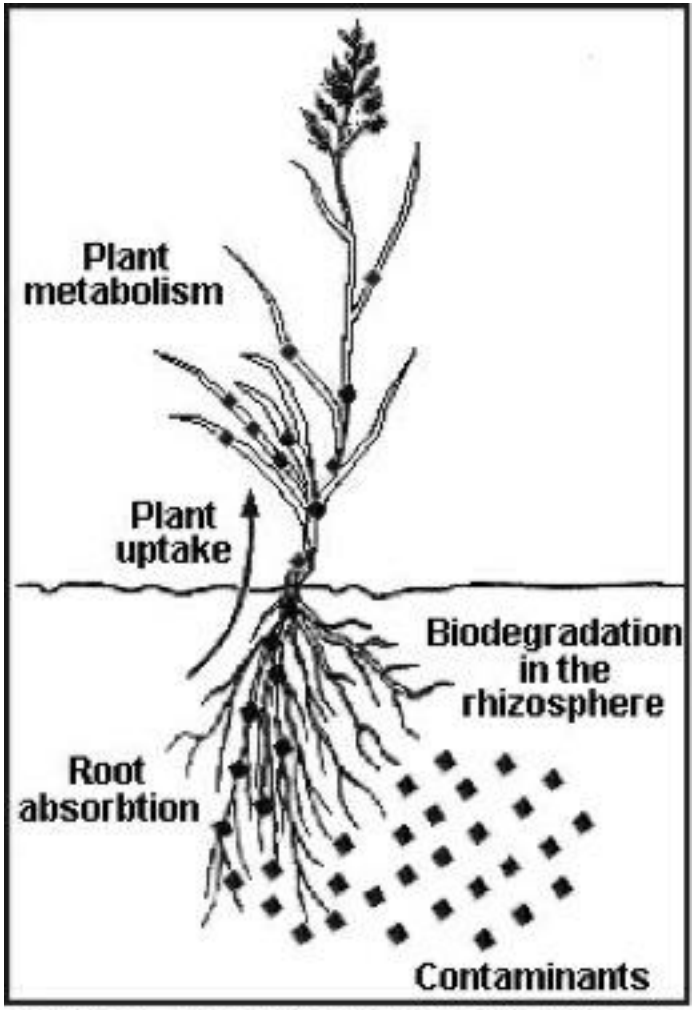


Figure 1. The fate of soil contaminants in the root-zone

Trees Are Stormwater BMPs!

Urban Ecosystem Analysis, Jacskonville

- **American Forests (www.americanforests.org)**

City of Jacksonville Land Cover***	1992 Acres	2002 Acres	% Change of landcover type
Forest/woody wetlands	234,262.4	205,320.0	-12.4%
Open Space	48,692.9	59,825.0	22.9%
Developed Area	150,869.8	175,685.3	16.4%
Open Wetlands	49,745.5	45,816.7	-7.9%
Water	56,772.9	55,787.0	-1.7%

	Forest/ Woody Wetlands (acres)	Stormwater Management Value (cu.ft.)	Stormwater Management Value** ($)	Air Pollution Annual Removal Value (lbs.)	Air Pollution Annual Removal Value ($)
City of Jacksonville 1992	234,262	984 million	$1.97 billion	22.3 million	$55.4 million
City of Jacksonville 2002	205,320	928 million	$1.86 billion	19.6 million	$48.5 million
Change	-12.4%	-56 million	-113 million	-2.76 million	-6.84 million

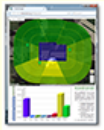
I-TREE TOOLS

http://www.itreetools.org/

i-Tree Tools | News | Resources | Support

Landscape
(web app)
Regional analyses of tree benefits in minutes for cities, counties, and more.

Design
(web app)
Parcel level analysis for current and future tree benefits.



Eco
(desktop app)
Our flagship i-Tree tool. Structure, Environmental Effects, & Value.

Hydro
(desktop app)
Explore the effects of tree canopy on water quantity and quality.

Canopy
(web app)
Quickly estimate tree canopy and beneifts using aerial maps.

What is i-Tree?

- **Quantify structure, risk & environmental services of trees**
- **Advocacy and management tools for community trees**
- **Built upon peer-reviewed USFS science**
- **Free and easy to use**

i-Tree is a state-of-the-art, peer-reviewed software suite from the USDA Forest Service that provides urban and rural forestry analysis and benefits assessment tools. The i-Tree Tools help communities of all sizes to strengthen their forest management and advocacy efforts by quantifying the structure of trees and forests, and the environmental services that trees provide.

Since the initial release of the i-Tree Tools in August 2006, thousands of communities, non-profit organizations, consultants, volunteers and students have used i-Tree to report on individual trees, parcels, neighborhoods, cities, and even entire states. By understanding the local, tangible ecosystem services that trees provide, i-Tree users can link forest management activities with environmental quality and community livability. Whether your interest is a single tree or an entire forest, i-Tree provides baseline data that you can use to demonstrate value and set priorities for more effective decision-making.

i-Tree Tools are in the public domain and are freely accessible. We invite you to explore this site to learn more about how i-Tree can make a difference in your community or forest.

i-Tree Eco v6 beta is now available for download in the i-Tree 2016 Suite update
Learn more >>

i-Tree developers targeting stress
HorticultureWeek article by Gavin McEwan >>

Dr. Dave Nowak featured in "What are Trees Worth to Cities?"
A City Lab article >>

New i-Tree Reports applying i-Tree Eco, Design, Canopy & Hydro
See the Reports Page >>

Trees make our lives better in unquantifiable ways
Article appearing in The Guardian >>

Monthly UNRI online i-Tree workshops
See topics and dates >>

< >

Using Low Impact Development To Reduce Imperviousness

- Tailor and decrease road width
- Minimize road length
- Use pervious pavements for parking
- Reduce required parking spaces
- Reduce parking space size
- Use one way angled parking
- Minimize paved driveways/size
- Side walks on one side only

Requires Land Development Code revisions

Reducing Imperviousness In Parking Lots

Nonstructural tools

- Reduce required parking spaces
- Reduce parking space size
- Use one way angled parking

Structural tools

- Use pervious pavements for parking
  - Pervious concrete
  - Turf block/pavers
  - Geoweb and sod

BUT, THIS MAY REQUIRE CODE OR CULTURAL CHANGE

THE INFLUENCE OF DCIA ON STORMWATER VOLUME

Zone 1
Mean Annual Runoff Coefficients (C Values) as a Function Of DCIA Percentage and Non-DCIA Curve Number (CN)

NDCIA CN	Percent DCIA																				
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
30	0.006	0.048	0.090	0.132	0.175	0.217	0.259	0.301	0.343	0.386	0.428	0.470	0.512	0.554	0.596	0.639	0.681	0.723	0.765	0.807	0.849
35	0.009	0.051	0.093	0.135	0.177	0.219	0.261	0.303	0.345	0.387	0.429	0.471	0.513	0.555	0.597	0.639	0.681	0.723	0.765	0.807	0.849
40	0.014	0.056	0.098	0.139	0.181	0.223	0.265	0.307	0.348	0.390	0.432	0.474	0.515	0.557	0.599	0.641	0.682	0.724	0.766	0.808	0.849
45	0.020	0.062	0.103	0.145	0.186	0.228	0.269	0.311	0.352	0.394	0.435	0.476	0.518	0.559	0.601	0.642	0.684	0.725	0.767	0.808	0.849
50	0.029	0.070	0.111	0.152	0.193	0.264	0.275	0.316	0.357	0.398	0.439	0.480	0.521	0.562	0.603	0.644	0.685	0.726	0.767	0.808	0.849
55	0.039	0.079	0.120	0.161	0.201	0.242	0.282	0.323	0.363	0.404	0.444	0.485	0.525	0.566	0.606	0.647	0.687	0.728	0.768	0.809	0.849
60	0.052	0.092	0.132	0.172	0.212	0.252	0.291	0.331	0.371	0.411	0.451	0.491	0.531	0.570	0.610	0.650	0.690	0.730	0.770	0.810	0.849
65	0.069	0.108	0.147	0.186	0.225	0.264	0.303	0.342	0.381	0.420	0.459	0.498	0.537	0.576	0.645	0.654	0.693	0.732	0.771	0.810	0.849
70	0.092	0.130	0.167	0.205	0.243	0.281	0.319	0.357	0.395	0.433	0.471	0.508	0.546	0.584	0.622	0.660	0.698	0.736	0.774	0.812	0.849
75	0.121	0.158	0.194	0.230	0.267	0.303	0.340	0.376	0.412	0.449	0.485	0.522	0.558	0.595	0.631	0.667	0.704	0.740	0.777	0.813	0.849
80	0.162	0.196	0.230	0.265	0.299	0.334	0.368	0.402	0.437	0.471	0.506	0.540	0.574	0.609	0.643	0.678	0.712	0.746	0.781	0.815	0.849
85	0.220	0.252	0.283	0.315	0.346	0.378	0.409	0.441	0.472	0.503	0.535	0.566	0.598	0.629	0.661	0.692	0.724	0.755	0.787	0.818	0.849
90	0.312	0.339	0.366	0.393	0.419	0.446	0.473	0.500	0.527	0.554	0.581	0.608	0.634	0.661	0.688	0.715	0.742	0.769	0.796	0.823	0.849
95	0.478	0.496	0.515	0.533	0.552	0.571	0.589	0.608	0.626	0.645	0.664	0.682	0.701	0.719	0.738	0.757	0.775	0.794	0.812	0.831	0.849
98	0.656	0.666	0.676	0.685	0.695	0.705	0.714	0.724	0.734	0.743	0.753	0.763	0.772	0.782	0.792	0.801	0.811	0.821	0.830	0.840	0.849

Agriculture land use (pasture)
No DCIA, CN for D soils = 90 **C = .312**
SF residential land use
¼ acre lots - DCIA = 40%, CN for lawns, D soils = 90 C =.527

Reducing Parking Lot Imperviousness And DCIA

Disconnecting Directly Connected Impervious Areas (DCIA)

RECESSED ROAD MEDIANS AS BMPs

Source Control BMPs

SC1 – Retain depression storage
SC2 – Selective clearing/grading
SC3 - Minimize compaction
SC4 - Build with slope
SC5 - Cluster development
SC6 - Florida-friendly landscape

SC7 - Rainfall interception trees
SC8 - Install efficient irrigation
SC9 - Harvest and use stormwater

Source Controls For Pollution Prevention

- Minimize clearing, removal of trees, vegetation
- Include urban reforestation
- Minimize imperviousness, esp. DCIA
  - Minimize soil compaction
  - Narrow streets, pervious parking, recessed tree islands
  - Greenroof/cistern systems for large roofs
  - Roof runoff to cisterns, pervious areas
- Minimize pollutants
  - Florida-friendly landscaping design
  - Florida-friendly fertilizers
  - Proper use of reclaimed water
  - Pet waste pick up and disposal

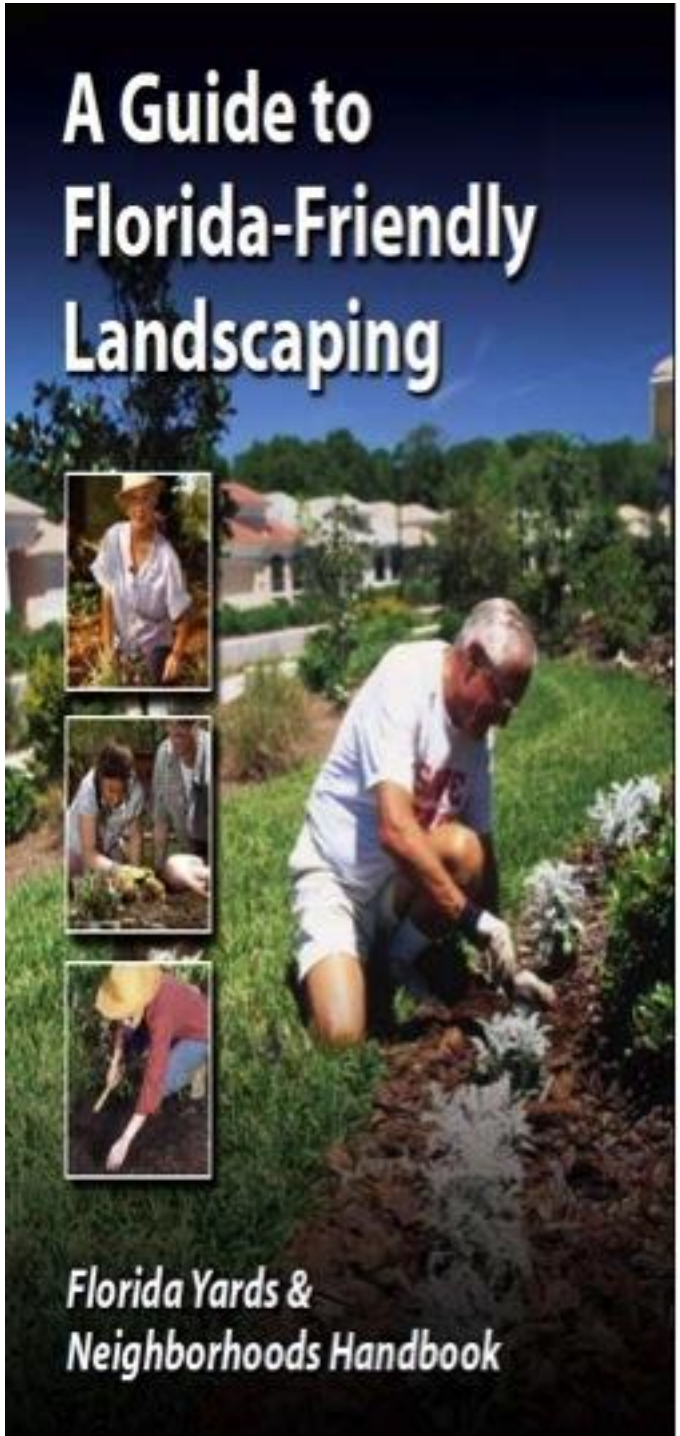
LAND CLEARING, VEGETATION REMOVAL AND SOIL COMPACTION

80% compaction on first pass of equipment

Soil Compaction And Infiltration Rates

SOIL TYPE	INFILTRATION RATE (in/hr)	
	Pitt et. al.	Gregory
Sandy soils	13.0	14.8 – 25
Compacted sandy soils	1.4	0.3 - 6.9
Clay soils	9.8	NA
Compacted or wet clay soils	0.2	NA

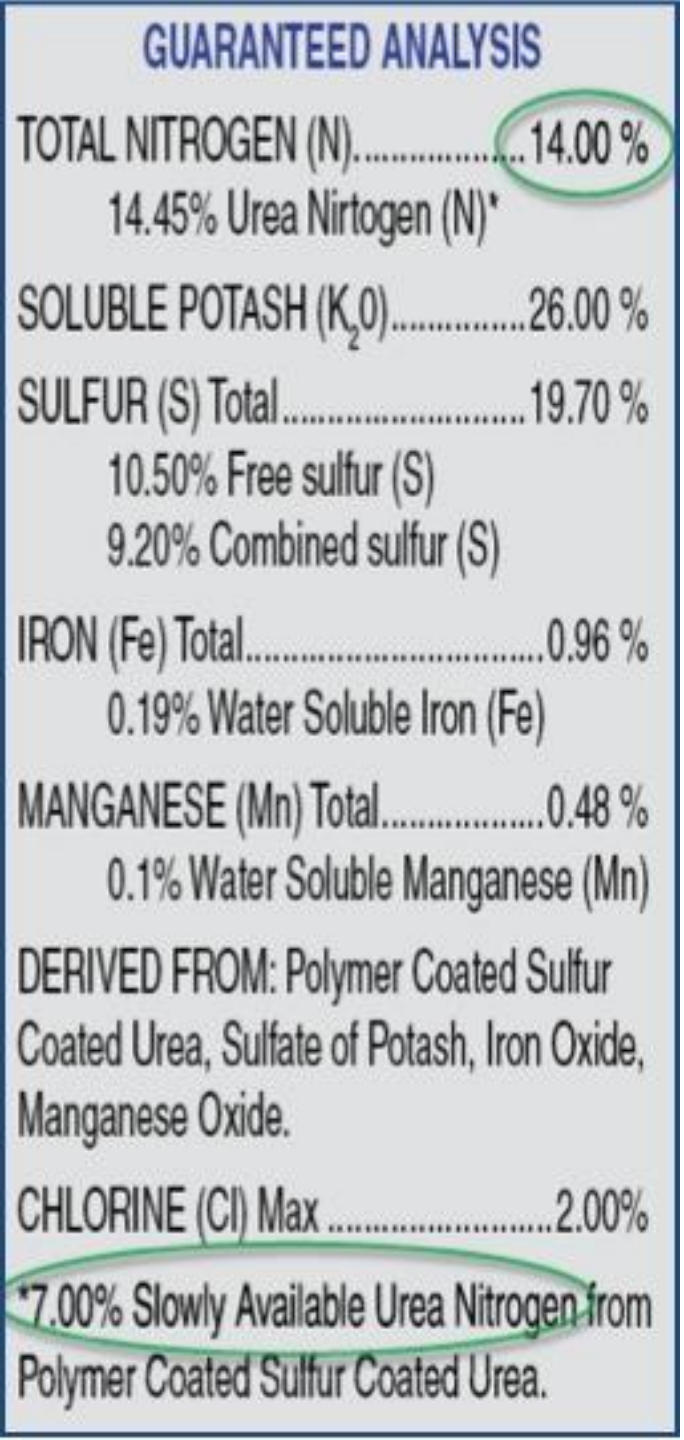
Source: Pitt, Chen, and Clark, 2001; Gregory, 2006



Florida-friendly Landscaping Principles

1. Right plant, right place
2. Water efficiently, use stormwater
3. Fertilize properly
4. Mulch
5. Attract wildlife
6. Manage yard pests properly
7. Recycle clippings and leaves
8. Reduce runoff
9. Protect the waterfront

http://www.floridayards.org



Use Florida-friendly Fertilizers

15 - 0 - 15

(N) Total Nitrogen | (P_2O_5) Phosphorus | (K_2O) Potassium

DACS Urban Turf Fertilizer Label Rule

- **Effective July 1, 2009**
- **Only specified fertilizers on turf**
  - **No or low phosphorus (< 0.5%)**
  - **Partial slow release nitrogen**
- **Maximum application rates**
  - **0.25 lbs P/1000 sf per apply**
  - **0.50 lbs P/1000 sf per year**
  - **0.7 lbs available N/1000 sf**

PET WASTE: A Major Source Of Nutrients And Bacteria Pollutants

- Pets deposit up to 0.5 lbs/day of pet waste
- Contributes to bacterial and nutrient pollution

Animal	Average fecal coliform per gram of feces	Fecal coliform load per day
Human	13,000,000	1,921,920,000
Dog	23,000,000	7,728,000,000
Cow	230,000	5,358,080,000
Horse	12,600	293,529,600

RAINFALL INTERCEPTOR TREES

Interceptor Tree BMP
Up to 18% reduction in stormwater volume

Interim BMP
Need more data!

Structural BMPs in LID Manual

Retention BMPs

- Basins
- Exfiltration trenches
- Underground storage
- Bioretention (rain garden)
- Swales
- Vegetated natural buffers
- Pervious pavements

Harvest & Reuse BMPs

- Greenroof/cistern
- Rainwater harvesting
- Stormwater harvesting

Filtration BMPs

- Managed aquatic plants
- Upflow filters
- Biofiltration with BAM

LID BMPs And Getting An Environmental Resource Permit

LID BMP	NWFWMD ACCEPTABILITY
Rain garden (bioretention)	Retention BMP
Swales	Retention BMP
Vegetated Natural Buffers	AH Section 11.0
Pervious pavements	Retention BMP
Green roof with cistern	Retention and reuse BMP
Rainwater harvesting	Retention BMP, not rain barrel
Stormwater harvesting	AH Section 8.6
Biofiltration with BAM	Approvable

5.3 Retention (Infiltration) Practices

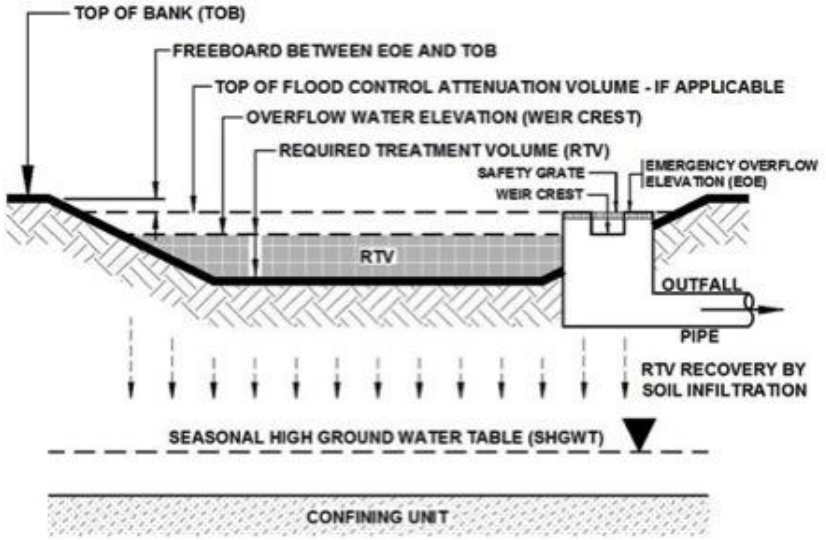
DESCRIPTION: **Family of practices where the stormwater is infiltrated or evaporated rather than discharged.**

PURPOSE:

- **Reduce total volume**
- **Reduce pollutants**

POLLUTANT REMOVAL:

- **Percolation, evaporation**
- **Filtering and adsorption**
- **Effectiveness = % annual runoff retained**



TYPICAL CROSS SECTION OF A "DRY" RETENTION SYSTEM

NOT TO SCALE

Retention BMP Generally Applicable Design Criteria

1. Treatment Volume – varies with performance standard – Use Tables A1-1 and A2-1
2. HSG A or B soils, less than 30% clay
3. 72 hour recovery time (24 - 36 hr if grassed)
4. Good percolation test data
5. Geological data if in Karst area
6. More than 2 feet to seasonal high ground water or bedrock, do a mounding analysis
7. Do not use for erosion/sediment control
8. Proper construction is essential – avoid soil compaction and sedimentation
9. Ensure hazardous materials can't enter BMP
10. Set back at least 50' from potable wells

Retention BMP Treatment Volume and Load Reduction Effectiveness

NWFWMD – off-line - 0.5” runoff

-- on-line – runoff from 1” rain

-- OFW - 50% more volume

Mean Annual Mass Removal Efficiencies for 0.50-inches of Retention for Zone 1

NDCIA	Percent DCIA																			
CN	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
30	91.8	91.5	88.3	84.0	79.5	75.0	70.7	66.6	62.9	59.6	56.5	53.6	51.1	48.7	46.6	44.6	42.8	41.1	39.6	38.1
35	88.2	89.1	86.6	82.8	78.6	74.3	70.1	66.2	62.6	59.3	56.3	53.5	51.0	48.7	46.5	44.6	42.8	41.1	39.6	38.1
40	84.0	86.3	84.4	81.2	77.4	73.4	69.4	65.7	62.2	59.0	56.0	53.3	50.8	48.5	46.4	44.5	42.7	41.1	39.6	38.1
45	79.6	82.9	81.9	79.3	75.9	72.2	68.5	65.0	61.7	58.6	55.7	53.0	50.6	48.4	46.3	44.4	42.7	41.0	39.5	38.1
50	74.8	79.1	79.0	77.0	74.1	70.8	67.4	64.1	61.0	58.0	55.3	52.7	50.4	48.2	46.2	44.3	42.6	41.0	39.5	38.1
55	70.1	74.9	75.6	74.2	71.9	69.1	66.1	63.0	60.1	57.3	54.7	52.3	50.0	47.9	46.0	44.2	42.5	40.9	39.5	38.1
60	65.5	70.4	71.7	71.1	69.4	67.0	64.4	61.7	59.1	56.5	54.1	51.8	49.6	47.6	45.8	44.0	42.4	40.9	39.5	38.1
65	61.0	65.8	67.5	67.6	66.4	64.7	62.5	60.2	57.8	55.5	53.3	51.1	49.1	47.2	45.5	43.8	42.3	40.8	39.4	38.1
70	56.7	61.1	63.1	63.6	63.1	61.9	60.2	58.3	56.3	54.3	52.3	50.3	48.5	46.8	45.1	43.5	42.1	40.7	39.4	38.1
75	52.7	56.6	58.6	59.3	59.3	58.6	57.5	56.0	54.4	52.7	51.0	49.3	47.7	46.1	44.6	43.2	41.8	40.5	39.3	38.1
80	49.1	52.2	54.1	55.0	55.2	54.9	54.2	53.2	52.1	50.8	49.4	48.0	46.6	45.3	44.0	42.7	41.5	40.3	39.2	38.1
85	46.1	48.3	49.7	50.5	50.8	50.8	50.5	49.9	49.2	48.3	47.3	46.3	45.2	44.2	43.1	42.1	41.0	40.0	39.1	38.1
90	43.5	44.8	45.6	46.1	46.4	46.5	46.4	46.1	45.7	45.2	44.6	44.0	43.3	42.6	41.9	41.1	40.4	39.6	38.9	38.1
95	41.1	41.5	41.8	41.9	42.0	42.1	42.0	41.9	41.8	41.6	41.3	41.1	40.8	40.4	40.1	39.7	39.3	38.9	38.5	38.1
98	39.8	39.8	39.8	39.8	39.8	39.7	39.7	39.6	39.5	39.4	39.3	39.2	39.1	39.0	38.9	38.7	38.6	38.4	38.3	38.1

Treatment effectiveness varies from 38% to 92%

Retention BMP Treatment Volume and Load Reduction Effectiveness

Mean Annual Mass Removal Efficiencies for 0.75-inches of Retention for Zone 1

NDCIA	Percent DCIA																		
CN	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
30	94.0	94.9	93.4	91.0	88.1	85.0	81.8	78.7	75.5	72.6	69.7	67.0	64.5	62.1	59.8	57.7	55.7	53.8	52.1	50.5
35	91.2	93.0	91.9	89.8	87.2	84.2	81.2	78.2	75.2	72.3	69.5	66.8	64.3	62.0	59.7	57.6	55.7	53.8	52.1	50.5
40	88.1	90.5	90.1	88.3	86.0	83.3	80.5	77.6	74.7	71.9	69.2	66.6	64.1	61.8	59.6	57.6	55.6	53.8	52.1	50.5
45	84.5	87.7	87.9	86.5	84.5	82.1	79.5	76.8	74.0	71.4	68.8	66.3	63.9	61.6	59.5	57.5	55.5	53.7	52.0	50.5
50	80.8	84.6	85.2	84.4	82.8	80.7	78.3	75.8	73.3	70.7	68.3	65.9	63.6	61.4	59.3	57.3	55.5	53.7	52.0	50.5
55	77.1	81.1	82.2	81.9	80.7	79.0	76.9	74.6	72.3	70.0	67.6	65.4	63.2	61.1	59.1	57.2	55.3	53.6	52.0	50.5
60	73.2	77.5	79.0	79.1	78.3	76.9	75.2	73.2	71.1	69.0	66.9	64.7	62.7	60.7	58.8	56.9	55.2	53.5	51.9	50.5
65	69.6	73.8	75.4	75.8	75.5	74.5	73.2	71.5	69.7	67.8	65.9	63.9	62.0	60.2	58.4	56.7	55.0	53.4	51.9	50.5
70	66.1	69.9	71.7	72.3	72.3	71.7	70.8	69.5	68.0	66.4	64.7	63.0	61.3	59.6	57.9	56.3	54.8	53.3	51.8	50.5
75	62.7	66.0	67.8	68.6	68.8	68.5	67.9	67.1	65.9	64.7	63.3	61.8	60.3	58.8	57.3	55.9	54.5	53.1	51.7	50.5
80	59.6	62.2	63.8	64.7	65.1	65.1	64.8	64.2	63.4	62.5	61.4	60.3	59.1	57.8	56.6	55.3	54.0	52.8	51.6	50.5
85	56.8	58.7	60.0	60.8	61.2	61.4	61.3	61.0	60.5	59.9	59.1	58.3	57.4	56.5	55.5	54.5	53.5	52.5	51.4	50.5
90	54.5	55.6	56.4	57.0	57.3	57.5	57.5	57.4	57.2	56.8	56.4	55.9	55.4	54.7	54.1	53.4	52.7	51.9	51.2	50.5
95	52.5	52.9	53.2	53.3	53.5	53.6	53.6	53.6	53.5	53.4	53.2	53.0	52.8	52.5	52.2	51.9	51.6	51.2	50.8	50.5
98	51.7	51.7	51.7	51.7	51.7	51.7	51.7	51.6	51.6	51.5	51.4	51.3	51.3	51.2	51.1	51.0	50.8	50.7	50.6	50.5

Mean Annual Mass Removal Efficiencies for 1.00-inches of Retention for Zone 1

NDCIA	Percent DCIA																		
CN	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
30	95.3	96.5	95.9	94.4	92.5	90.3	87.9	85.5	83.1	80.6	78.2	75.8	73.6	71.4	69.2	67.2	65.3	63.4	61.6	60.0
35	93.1	94.9	94.6	93.3	91.6	89.5	87.3	85.0	82.7	80.3	77.9	75.6	73.4	71.2	69.1	67.1	65.2	63.4	61.6	60.0
40	90.7	93.0	93.0	92.0	90.5	88.6	86.6	84.4	82.1	79.9	77.6	75.4	73.2	71.1	69.0	67.0	65.2	63.3	61.6	60.0
45	88.0	90.7	91.0	90.5	89.2	87.5	85.6	83.6	81.5	79.3	77.2	75.0	72.9	70.9	68.8	66.9	65.1	63.3	61.6	60.0
50	85.0	88.0	88.8	88.6	87.6	86.2	84.5	82.7	80.7	78.7	76.6	74.6	72.6	70.6	68.6	66.8	65.0	63.2	61.6	60.0
55	81.8	85.3	86.4	86.3	85.7	84.6	83.2	81.5	79.8	77.9	75.9	74.0	72.1	70.2	68.4	66.6	64.8	63.1	61.5	60.0
60	78.7	82.3	83.6	83.9	83.5	82.7	81.5	80.1	78.6	76.9	75.1	73.4	71.6	69.8	68.0	66.3	64.7	63.0	61.5	60.0
65	75.6	79.1	80.6	81.2	81.0	80.5	79.6	78.5	77.2	75.7	74.1	72.5	70.9	69.3	67.6	66.0	64.4	62.9	61.4	60.0
70	72.7	75.9	77.5	78.2	78.3	78.0	77.4	76.5	75.5	74.2	72.9	71.5	70.1	68.6	67.1	65.6	64.2	62.7	61.3	60.0
75	69.9	72.7	74.2	75.0	75.3	75.2	74.8	74.2	73.4	72.5	71.4	70.3	69.1	67.8	66.5	65.1	63.8	62.5	61.2	60.0
80	67.2	69.5	70.8	71.7	72.1	72.1	72.0	71.6	71.1	70.4	69.6	68.7	67.8	66.7	65.6	64.5	63.4	62.2	61.1	60.0
85	64.8	66.5	67.6	68.3	68.7	68.9	68.9	68.7	68.4	68.0	67.5	66.8	66.1	65.4	64.5	63.7	62.8	61.8	60.9	60.0
90	62.7	63.7	64.4	65.0	65.3	65.5	65.6	65.6	65.5	65.2	65.0	64.6	64.2	63.7	63.1	62.6	61.9	61.3	60.6	60.0
95	61.1	61.5	61.8	62.0	62.1	62.2	62.3	62.3	62.3	62.2	62.1	62.0	61.8	61.6	61.4	61.2	60.9	60.6	60.3	60.0
98	60.7	60.7	60.7	60.8	60.8	60.8	60.8	60.8	60.7	60.7	60.7	60.6	60.6	60.5	60.4	60.3	60.3	60.2	60.1	60.0

Retention BMP Treatment Volume to get 80% Load Reduction Effectiveness

Panhandle (Zone 1)

NDCIA CN	Percent DCIA																		
	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
30	0.25	0.36	0.45	0.52	0.63	0.71	0.80	0.90	0.99	1.08	1.17	1.27	1.36	1.45	1.55	1.64	1.73	1.83	1.92
35	0.29	0.39	0.46	0.54	0.64	0.72	0.82	0.91	1.00	1.09	1.18	1.27	1.37	1.46	1.55	1.64	1.74	1.83	1.92
40	0.35	0.43	0.49	0.58	0.67	0.75	0.84	0.93	1.02	1.11	1.20	1.29	1.38	1.47	1.56	1.65	1.74	1.83	1.92
45	0.44	0.47	0.54	0.62	0.70	0.78	0.87	0.95	1.04	1.13	1.21	1.30	1.39	1.48	1.57	1.66	1.74	1.83	1.92
50	0.56	0.55	0.60	0.67	0.74	0.82	0.90	0.98	1.06	1.15	1.23	1.32	1.41	1.49	1.58	1.66	1.75	1.83	1.92
55	0.71	0.67	0.69	0.74	0.80	0.87	0.95	1.02	1.10	1.18	1.26	1.34	1.43	1.51	1.59	1.67	1.75	1.84	1.92
60	0.89	0.81	0.81	0.83	0.88	0.94	1.01	1.07	1.15	1.22	1.30	1.37	1.45	1.53	1.60	1.68	1.76	1.84	1.92
65	1.07	0.98	0.95	0.96	0.99	1.03	1.08	1.14	1.21	1.27	1.34	1.41	1.48	1.55	1.62	1.70	1.77	1.85	1.92
70	1.24	1.15	1.11	1.10	1.11	1.14	1.18	1.23	1.28	1.34	1.40	1.46	1.52	1.58	1.65	1.72	1.78	1.85	1.92
75	1.42	1.33	1.29	1.27	1.27	1.28	1.30	1.33	1.37	1.42	1.47	1.52	1.57	1.62	1.68	1.74	1.80	1.86	1.92
80	1.58	1.50	1.46	1.43	1.42	1.43	1.44	1.46	1.49	1.52	1.55	1.59	1.63	1.68	1.72	1.77	1.82	1.87	1.92
85	1.73	1.67	1.63	1.60	1.59	1.58	1.59	1.59	1.61	1.63	1.65	1.68	1.71	1.74	1.77	1.80	1.84	1.88	1.92
90	1.85	1.82	1.79	1.77	1.75	1.74	1.74	1.74	1.74	1.75	1.76	1.77	1.79	1.81	1.83	1.85	1.87	1.90	1.92
95	1.94	1.92	1.91	1.90	1.89	1.88	1.88	1.87	1.87	1.87	1.87	1.88	1.88	1.88	1.89	1.90	1.90	1.91	1.92
98	1.94	1.93	1.93	1.93	1.92	1.92	1.92	1.92	1.92	1.92	1.92	1.91	1.92	1.92	1.92	1.92	1.92	1.92	1.92

Treatment volume varies from 0.25” to 1.92”

Getting Good Infiltration Data for Retention BMP Design

- See Appendix B of Manual
- Measure at proposed bottom elevation
- Allowable data
  - Mass balance field data
  - Double ring infiltrometer *
  - Lab permeability tests *
  - NRCS soil survey - planning only

    * Use half of the value

Retention BMP Construction Recommendations

- Schedule construction in dry season
- Knowledgeable construction supervisor
- Verify soil conditions, water table, rock
- Mark infiltration areas to keep equipment out
- Excavate with light, wide track equipment
- Place excavated material away, downslope
- During site construction, divert sediment runoff; don’t excavate to final grade
- Final grade excavation after site is stabilized
- Deeply till after final grade established
- Establish vegetation quickly
- Final inspection, “As-Builts” – measure final infiltration rate

Retention BMP Maintenance Inspection

- Standing water or soggy soils, cattails
- Erosion and sedimentation
- Vegetation - coverage, growth, type
- Soil compaction or smearing
- Pretreatment BMPs
- Contributing area stabilization
- Inlets, discharge – sediment, litter, debris, vegetation

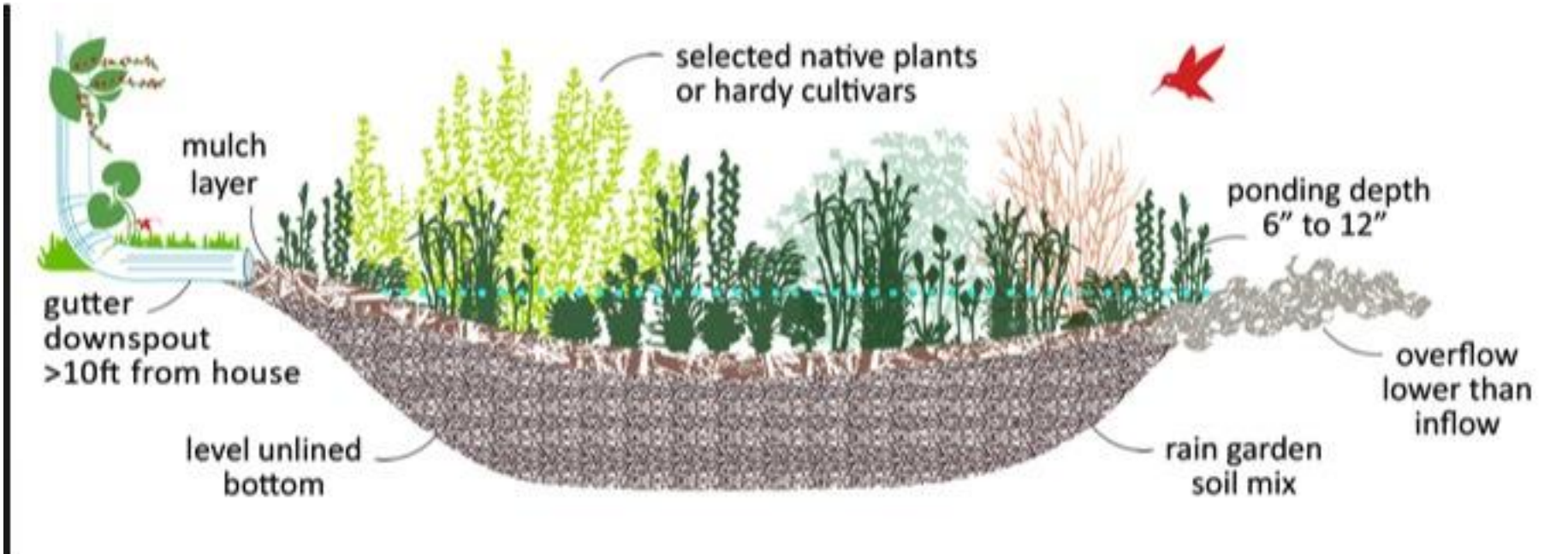
Retention BMP Maintenance Activities

Objective – maintain or restore percolation rate

- **Remove accumulated solids**
- **Mowing and removal of vegetation**
- **Repair erosion, vegetative stabilization**
- **Tilling, disking, aerating the bottom**
- **Check structures**
- **Clear debris from structures**
- **Clean pretreatment BMPs**

5.6 LID BMP – Bioretention Area or Rain Garden

- **Small retention depressions integrated into the landscaping with deep rooted Florida-friendly vegetation.**
- **http://lowimpactdevelopment.org/raingarden_design/whatisaraingarden.htm**



Rain Garden Design Criteria

- **Contributing DA <3 acres**
- **Ponding depth – 4 to 10 inches**
- **Location – sunny, on slopes <10%, at least 10’ from buildings**
- **Vegetation – depends on planting zones, dry to wet zones, need a good plan**
- **Mulch – use materials that won’t float**

Rain Garden Construction

- Determine final shape and location after locating utilities, mark on ground
- Excavate the garden, use soil for berm
- Prepare and add soil/media mixture (BAM)
- Install plants per the design, 1’ On Center
- Apply mulch (if used)
- Water plants regularly
- Check conveyance inflow, water storage, and infiltration rate

Rain Garden Maintenance

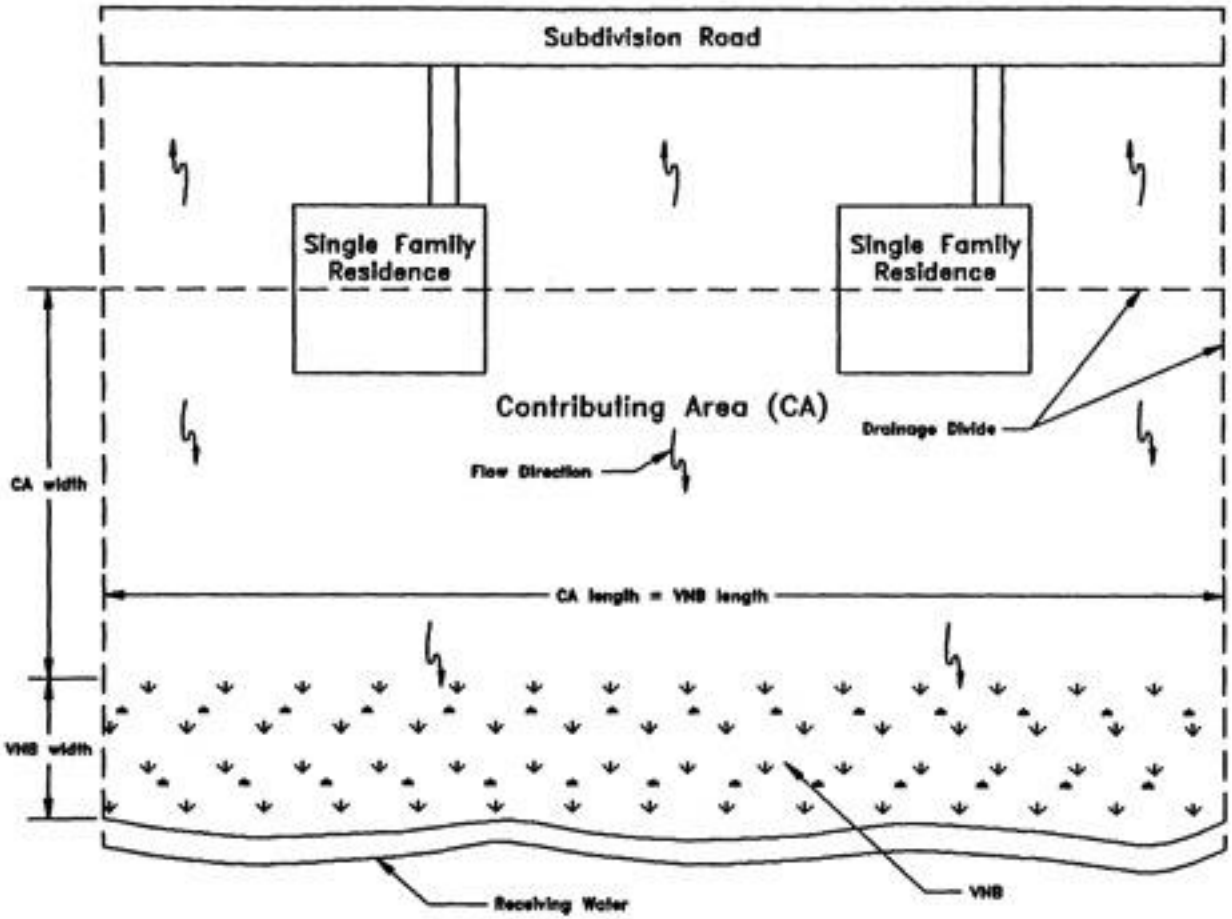
- In first year, water and weed regularly
- Inspect at start and end of rainy season
- Check infiltration rate after rainy season
- Each spring, remove dead vegetation and replenish mulch
- Weed and maintain plants as needed
- Remove sediment, trash, debris
- Repair erosion, as needed

Inlet with basin full of sediment

5.8 LID BMP – Vegetated Natural Buffers

- **A vegetated area with soil and water table conditions that allow filtering and infiltration of overland flows.**
- **Used to treat rear roof and yard runoff when impractical to route to main stormwater system.**
- **Treatment based on retention volume that is infiltrated**

5.8 LID BMP – Vegetated Natural Buffers



Vegetated Natural Buffers Design Criteria

- Infiltrate required treatment volume
- SHGWT > two feet below bottom
- 1” minimum infiltration rate
- Contributing area less than 300’ (flow length)
- Buffer length equal to the length of CA
- Buffer width (flow length) from 25’ to 100’
- 6:1 maximum slope
- Legal easement for VNB

Vegetated Natural Buffers Construction

- **Verify location and dimensions of VNB**
- **Install erosion and sediment controls and divert flows until contributing area construction is complete/stabilized**
- **Mark VNB boundaries to prevent compaction from equipment**
- **Install upstream level spreader**
- **Ensure vegetation is healthy, add Florida-friendly plants as needed**

Vegetated Natural Buffers
Inspection and Maintenance

- **Inspect during or soon after a storm to visually check sheet flow and flow paths**
- **Eliminate channelized flow areas and restore vegetation, if needed**
- **Eliminate erosion, remove sediment, restore vegetation, as needed**
- **Identify damage from vehicles, foot traffic, or encroachment**
- **Ensure infiltration within 24 – 36 hrs**