Nutrient Based Stormwater Design

June 12, 2012

Outline of Topics

- Regulatory Requirements
- Design Nutrient Loading Approach
- Design Examples
- Ongoing Efforts by DOT

Regulatory Requirements

Basins Listed for Nutrient Impairment:

- **Net Improvement Required per Rule 62-346.050**
- **Annual Loadings per Harper 2007**
- **Pre-development Load ≤ Post-development Load**

Caloosahatchee River
October 15, 2005

Design Approach

- Estimate Pre-development Loading
- Estimate Post-development Loadings
- Determine Required Treatment Efficiencies
  - TN and TP
- Achieve Efficiencies via Treatment BMPs

Harper (2007)

- 50-year continuous rainfall/runoff simulations
- 5 rainfall zones based on rainfall characteristics
- EMCs for different land uses
  - TN and TP
- Methodology for estimating annual loading
- Removal performance of BMPs

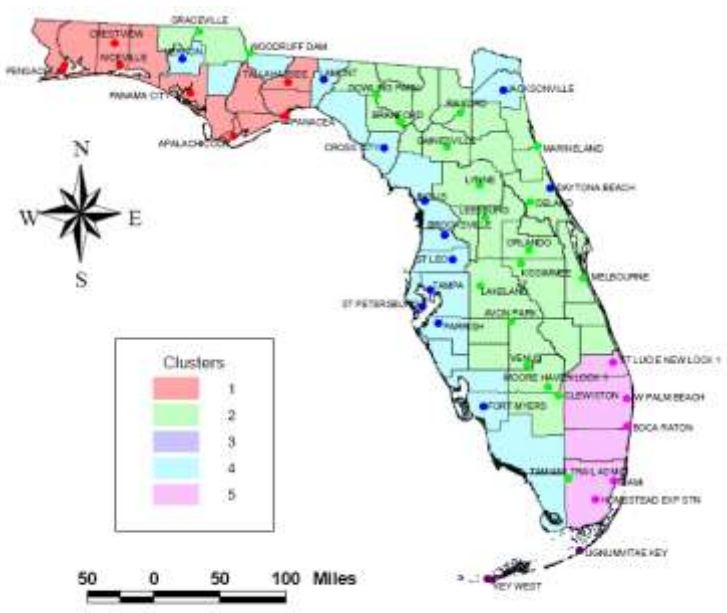


Figure 2-1. Designated Meteorological Regions (Zones) in Florida

EMCs

Land Use Category	Event Mean Concentration (mg/l)	
	Total Nitrogen	Total Phosphorus
Low-Density Residential[1]	1.50	0.18
Single-Family	1.85	0.31
Multi-Family	1.91	0.48
Low-Intensity Commercial	0.93	0.16
High-Intensity Commercial	2.48	0.23
Light Industrial	1.14	0.23
Highway	1.37	0.17
Agricultural		
Pasture	2.48	0.70
Citrus	2.31	0.16
Row Crops	2.47	0.51
General Agriculture[2]	2.42	0.46
Mining/Extractive	1.18	0.15

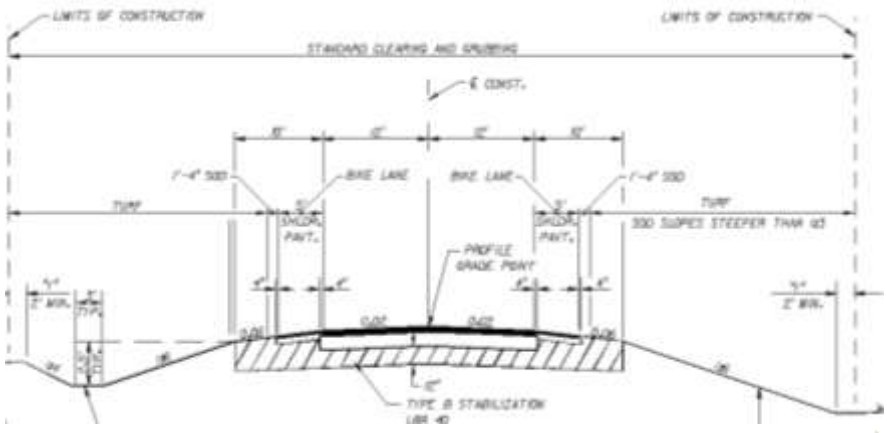
1. Average of single-family and undeveloped loading rates
2. Mean of pasture, citrus, and row crop land uses

Design Examples

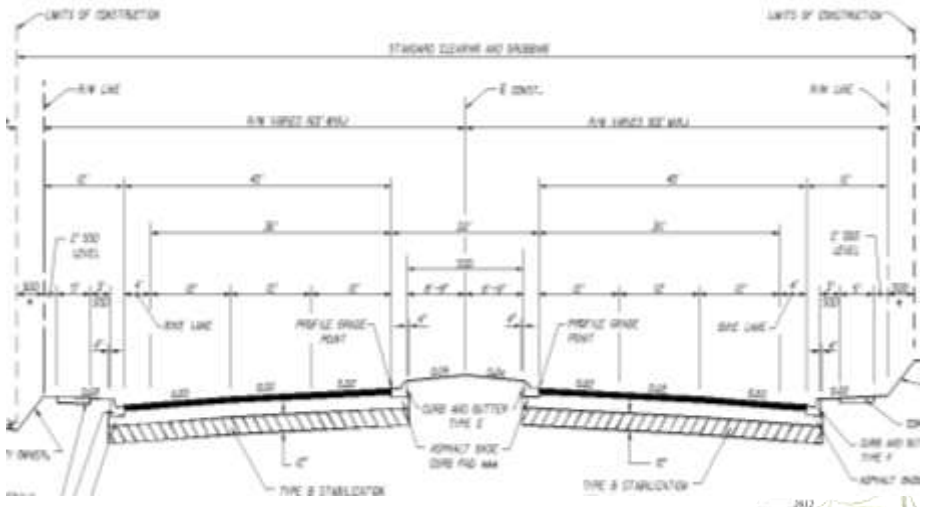
Assumptions:

- **FDOT Typical Sections – 1000 ft. length**
- **West Palm Beach Area – Zone 5**
- **Type C Soils**

Existing Typical Section



Proposed Typical Section



Estimate Pre-development Loading

- **Zone 5, CN = 84, DCIA = 0%, Type C Soils,**
  - **Annual C = 0.20 (per table)**
- **Annual Rainfall = 60”, Basin = 1000’ x 126’**
  - **Annual Runoff = 2.89 ac-ft**
- **EMCs: TN = 1.37 mg/l TP = 0.17 mg/l**
  - **Annual Loadings: TN = 4.89 kg TP = 0.17 kg**

Mean Annual Runoff Coefficients

NDCIA CN	0
30	0.008
35	0.012
40	0.018
45	0.025
50	0.034
55	0.044
60	0.057
65	0.073
70	0.093
75	0.120
80	0.157
85	0.209
90	0.292
95	0.445
98	0.614

Values) as a Function
Curve Number (CN)

NDCIA CN	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
30	0.008	0.048	0.088	0.128	0.168	0.2						0.448	0.488	0.528	0.568	0.608	0.648	0.688	0.728	0.768	0.808
35	0.012	0.052	0.092	0.132	0.171	0.2						0.450	0.490	0.529	0.569	0.609	0.649	0.689	0.728	0.768	0.808
40	0.018	0.057	0.097	0.136	0.176	0.2						0.452	0.492	0.531	0.571	0.611	0.650	0.690	0.729	0.769	0.808
45	0.025	0.064	0.103	0.142	0.182	0.2						0.456	0.495	0.534	0.573	0.612	0.651	0.691	0.730	0.769	0.808
50	0.034	0.072	0.111	0.150	0.189	0.2						0.460	0.498	0.537	0.576	0.614	0.653	0.692	0.731	0.769	0.808
55	0.044	0.082	0.121	0.159	0.197	0.2						0.464	0.502	0.541	0.579	0.617	0.655	0.693	0.732	0.770	0.808
60	0.057	0.095	0.132	0.170	0.207	0.2						0.470	0.508	0.545	0.583	0.620	0.658	0.695	0.733	0.770	0.808
65	0.073	0.112	0.147	0.181	0.220	0.2						0.477	0.514	0.551	0.588	0.624	0.661	0.698	0.735	0.771	0.808
70	0.093	0.129	0.165	0.200	0.236	0.2						0.486	0.522	0.559	0.594	0.629	0.665	0.701	0.737	0.772	0.808
75	0.120	0.155	0.189	0.223	0.258	0.2						0.496	0.533	0.567	0.602	0.636	0.670	0.705	0.739	0.774	0.808
80	0.157	0.192	0.222	0.254	0.287	0.3						0.515	0.547	0.580	0.613	0.645	0.678	0.710	0.743	0.775	0.808
85	0.209	0.239	0.269	0.299	0.329	0.3						0.538	0.568	0.598	0.628	0.658	0.688	0.718	0.748	0.778	0.808
90	0.292	0.318	0.343	0.369	0.395	0.4						0.576	0.602	0.627	0.653	0.679	0.705	0.731	0.756	0.782	0.808
95	0.445	0.464	0.482	0.500	0.518	0.5						0.645	0.663	0.681	0.699	0.717	0.736	0.754	0.772	0.790	0.808
98	0.614	0.624	0.633	0.643	0.653	0.6						0.721	0.730	0.740	0.750	0.760	0.769	0.779	0.789	0.798	0.808

Estimate Post-development Loading

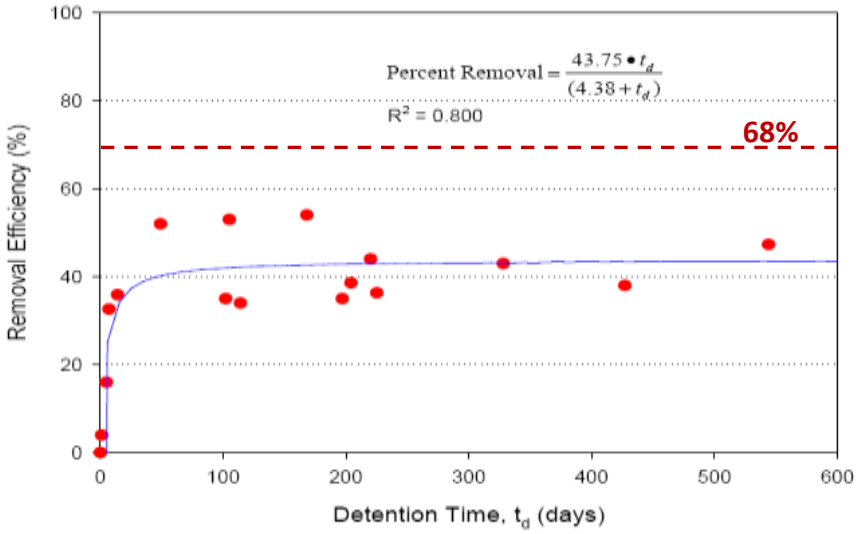
- **DCIA = 71%, N-DCIA = 8%, CN = 84**
  - **Annual C = 0.63 (per table)**
- **Annual Rainfall = 60”, Basin = 1000’ x 126’**
  - **Annual Runoff = 9.11 ac-ft**
- **EMCs: TN = 1.37 mg/l TP = 0.17 mg/l**
  - **Annual Loadings: TN = 15.39 kg TP = 1.91 kg**

Required Removal Efficiencies: 2-lane Rural to 6-lane Urban

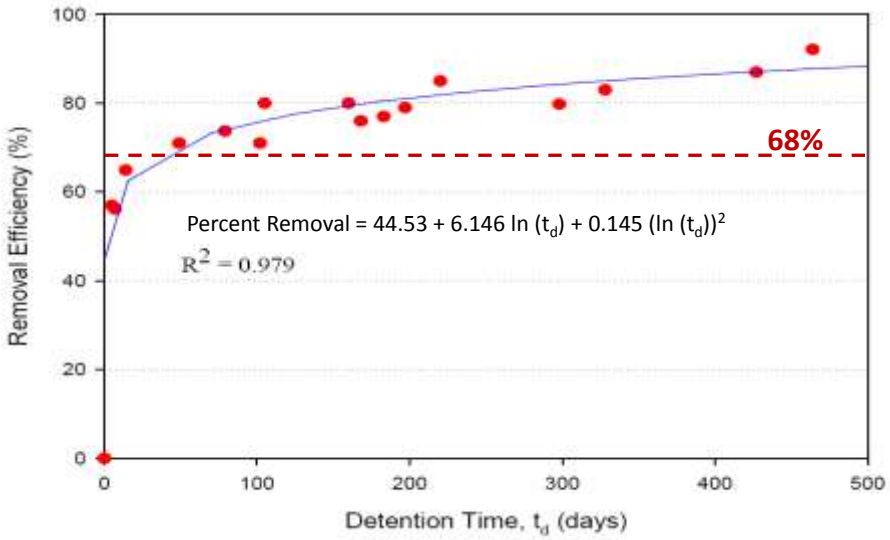
		Pre-development	Post-development	Increase
Annual Runoff (ac-ft)		2.89	9.11	215%
Loading for TN (kg)		4.89	15.39	215%
Loading for TP (kg)		0.61	1.91	215%
Required Removal Efficiency	TN		68%	
	TP		68%	

Wet Pond?

Wet Detention Ponds Removal Efficiency: Total Nitrogen vs. Residence Time



Wet Detention Ponds Removal Efficiency: Total Phosphorus vs. Residence Time



Required Removal Efficiencies: 2-lane Rural to 6-lane Urban

		Pre-development	Post-development	Increase
Annual Runoff (ac-ft)		2.89	9.11	215%
Loading for TN (kg)		4.89	15.39	215%
Loading for TP (kg)		0.61	1.91	215%
Required Removal Efficiency	TN	**68%**		
	TP	**68%**		

TN Removal via Treatment Train!

Required Removal Efficiencies: 2-lane Rural to 4-lane rural

		Pre-development	Post-development	Increase
Annual Runoff (ac-ft)		3.97	4.63	17%
Loading for TN (kg)		6.70	7.82	
Loading for TP (kg)		0.83	0.97	
Required Removal Efficiency	TN	**14%**		
	TP	**14%**		

Achieve Efficiencies via Normal Pond

Required Removal Efficiencies: 4-lane Suburban to 6-lane Urban

		Pre-development	Post-development	Increase
Annual Runoff (ac-ft)		7.52	9.11	21%
Loading for TN (kg)		12.71	15.39	
Loading for TP (kg)		1.58	1.91	
Required Removal Efficiency	TN	**17%**		
	TP	**17%**		

Achieve Efficiencies via Normal Pond

4-lane *Treated* Suburban to 6-lane Urban

		Pre-development	Post-development	Increase
Annual Runoff (ac-ft)		7.52	9.11	21%
Loading for TN (kg)		7.77	15.39	98%
Loading for TP (kg)		0.50	1.91	280%
Required Removal Efficiency	TN	**50%**		
	TP	**74%**		

Achieve TN Efficiency via BMP Treatment Train

Ongoing DOT Efforts

- Monitoring of Highway Nutrient EMCs
- Looking at Pond Nitrogen Efficiency
- Eliminate Bypass Systems
- Exploring Re-use and Regional Ponds

- Program for Nutrient Design
- Training Course for Nutrient Design
- Update to Stormwater Management HB
- In-pipe Nutrient Removal Cartridge
- Model for Re-use Adjacent to Ponds
- Efficiency of MAPS

Floating Wetland Mats

Questions?