PERFORMANCE TREATMENT STANDARDS & HOW TO MEET THEM

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METHODS TO MEET HIGHER STANDARD

Overview:

- Briefly cover new rule treatment standards.
- Example of applying minimum treatment standard vs. post=pre, and example calculation for dry retention.
- Methods of reducing site runoff:
  - Increasing “hidden” retention volumes.
  - Impact of reducing directly connected impervious surface (DCIA).
- Methods for supercharging wet detention systems.
- Examples of how to meet new minimum treatment standards with wet detention ponds.

TREATMENT STANDARDS

SUMMARY OF SECTION 8.3, APPLICANT'S HANDBOOK VOLUME I

Project Scenario	TP	TN	Additional Criteria
All Sites	80	55	or post=pre
OFW	90	80	or post=pre
Impaired Water	80	80	and post=pre plus net improvement
Impaired + OFW	95	95	and post=pre plus net improvement
Redevelopment	80	45	n/a
Redevelopment + OFW	95	60	n/a

TP = Total phosphorus.
TN = Total nitrogen.
OFW = Outstanding Florida Waters.

TREATMENT STANDARDS EXAMPLE

- Assume Class III watershed, using dry retention for treatment.
- Standards for “All Sites” category.
- Rule requires <u>greater</u> of the following two options.
  - 80% TP removal and 55% TP removal, or
  - Post-development load = pre-development load for TN and TP.
- 80% & 55% removal efficiency is self-explanatory.
- Check post=pre required efficiency to find the applicable standard.
- For this example, focus on TN as often limiting design nutrient.

EXAMPLE PROBLEM

ALL SITES: POST = PRE FOR TN

METHOD

- Calculate post-development TN load.
- Calculate pre-development TN load.
- Calculate required treatment efficiency to meet post=pre.

Load = Area x (Annual Runoff “C”) x Annual Rainfall x (EMC*).

(need to find this) *(and this)*

**EMC = event mean concentration (mg/L).*

EXAMPLE PROBLEM: POST-LOAD

ALL SITES: POST=PRE FOR TN

FOR POST-DEVELOPMENT LOAD

- Assume 10-acre parcel.
- Proposed development: low-density residential.
- Layout is 30% DCIA.
- Assume soils Curve Number (CN) of 80.
- Location is Tallahassee (Zone 1*) and annual rainfall is 62 inches.

**Source: Appendix M, Applicant's Handbook I.*

MEAN ANNUAL RUNOFF C

POST-DEVELOPMENT

Zone 1

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

NDCIA	Percent DCIA																				
CN	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	0.234	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	0.615	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

Percent DCIA = 30%   Non-DCIA CN = 80

Annual runoff C value = 0.368

Source: Appendix N, Applicant's Handbook I.

EXAMPLE PROBLEM: SELECT EMC

POST-DEVELOPMENT

LAND USE CATEGORY	TN	TP
Undeveloped – Scrubby Flatwoods	1.155	0.027
Undeveloped – Xeric Scrub	1.596	0.156
Undeveloped – Upland Hardwood	1.042	0.346
Highway	1.52	0.2
Low-Density Residential	1.645	0.346
Multi-Family Residential	1.84	0.52
High-Intensity Commercial	2.4	0.345

Units for EMCs: (mg/L)

EMC for TN = 1.645 mg/L

Source: Table 9.2, Applicant's Handbook I.

CALCULATE POST-DEVELOPMENT LOAD

ALL SITES: POST=PRE FOR TN

Post-development TN load = 10 acres x **annual runoff C** x 62 x **EMC**

Load (kg/yr) = 10 acres x 0.368 x 62 inches/year x 1.645 mg/L x 1.23 =

(Runoff C) *(EMC)*

Conversion Factor

Post-development TN load = 461 kg per year

CALCULATE PRE-DEVELOPMENT LOAD

ALL SITES: POST=PRE FOR TN

- Undeveloped condition = scrubby flatwoods.
- DCIA = 0.
- CN = 80.
- Rainfall = the same.
- Acreage = the same.

MEAN ANNUAL RUNOFF C

PRE-DEVELOPMENT

Zone 1

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

NDCIA	Percent DCIA																				
CN	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
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Percent DCIA = 0%   Non-DCIA CN = 80

Annual runoff C value = 0.162

Source: Appendix N, Applicant's Handbook I.

EXAMPLE PROBLEM: SELECT EMC

PRE-DEVELOPMENT

LAND USE CATEGORY	TN	TP
Undeveloped – Scrubby Flatwoods	1.155	0.027
Undeveloped – Xeric Scrub	1.596	0.156
Undeveloped – Upland Hardwood	1.042	0.346
Highway	1.25	0.173
Low-Density Residential	1.645	0.27
Multi-Family Residential	1.84	0.52
High-Intensity Commercial	2.4	0.345

Units for EMCs: (mg/L)

EMC for TN = 1.155 mg/L

Source: Table 9.2, Applicant's Handbook I.

CALCULATE PRE-DEVELOPMENT LOAD

ALL SITES: POST=PRE FOR TN

Pre-development TN load = 10 acres x **annual runoff C** x 62 x **EMC**

Load (kg/yr) = 10 acres x 0.162 x 62 inches/year x 1.155 mg/L x 1.23 =

(Runoff C) *(EMC)*

Conversion Factor

Pre-development TN load = 142 kg per year

EXAMPLE PROBLEM

REQUIRED TN TREATMENT EFFICIENCY

- Pre-development TN loading = 142 kg/yr.
- Establish target removal efficiency if post TN = 461 kg/yr.

$$\left(1 - \left(\frac{Predevelopment\ Loading\ [kg/yr]}{Postdevelopment\ Loading\ [kg/yr]}\right)\right) \times 100$$

Target TN removal efficiency = (1- (142/461)) x 100 = 69%.

CONTROLLING OPTION PER RULE

- TN standard for “All Sites” is 55% ***or*** post=pre, whichever is greater.
- The minimum TN treatment standard for all sites is 55%.
- In this case, post=pre yields 69% removal efficiency for TN.

EXAMPLE PROBLEM

MEETING 69% REMOVAL WITH DRY RETENTION

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

Dry retention not limited to "ponds" or single basins.

STRUCTURAL LOW IMPACT DESIGN (LID)

INNOVATIVE RETENTION SYSTEMS

- Primarily for small catchments (micro-scale).
- Landscape-oriented retention basins and swales.
- Rain gardens.
- Curb cuts.
- Biofiltration systems.
- Pervious walkways.
- Pervious pavement.

Cumulative storage may be credited to overall retention volume.

RAIN GARDENS AND CURB CUTS

ALTERNATE RETENTION SYSTEM

Microscale depressions in the landscape provide retention volume.

BIOFILTRATION OR TREE BOXES

MICROSCALE INFILTRATION BASINS THROUGHOUT ROADWAY

- Can be used without trees and/or provide “open bottom” inlets; act as small retention basins.
- Cumulative volume may be significant (100 to 200 c.f. per box, etc.).

PERVIOUS PAVEMENT

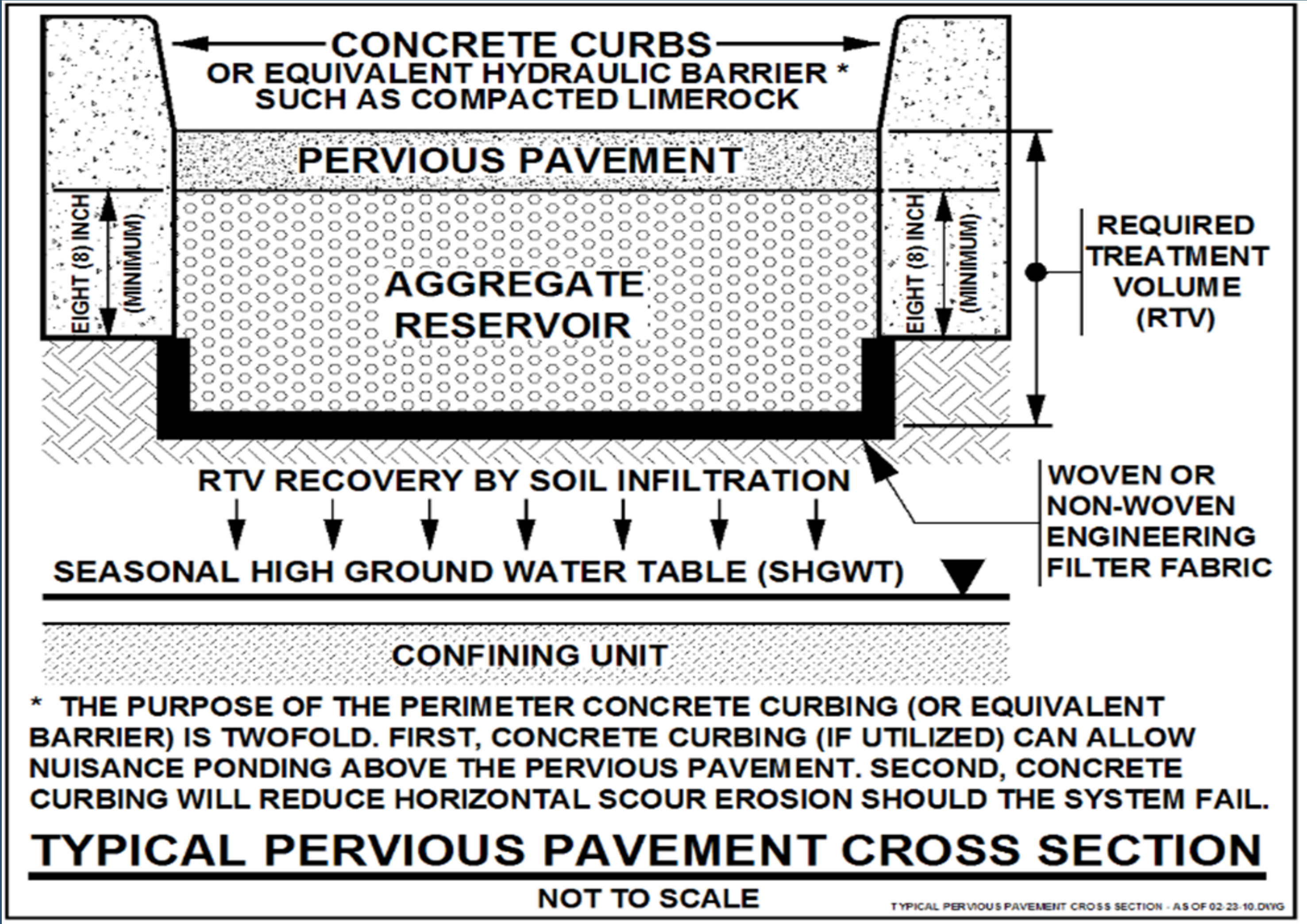
- Can be designed to reduce DCIA.

“From an ERP perspective, pervious pavement is just a retention pond with cars on top.”

-Hank Higginbotham, P.E.
formerly of the Southwest Florida Water Management District

PERVIOUS PAVEMENT AND CONCRETE

- May provide credit as retention volume.
- Critical factor is condition of the underlying media/soil.
- Can be used with, **or without** storage.



PERVIOUS PAVERS

- Recent products have excellent strength and permeabilities.
- Modular so can easily be maintained and/or replaced.

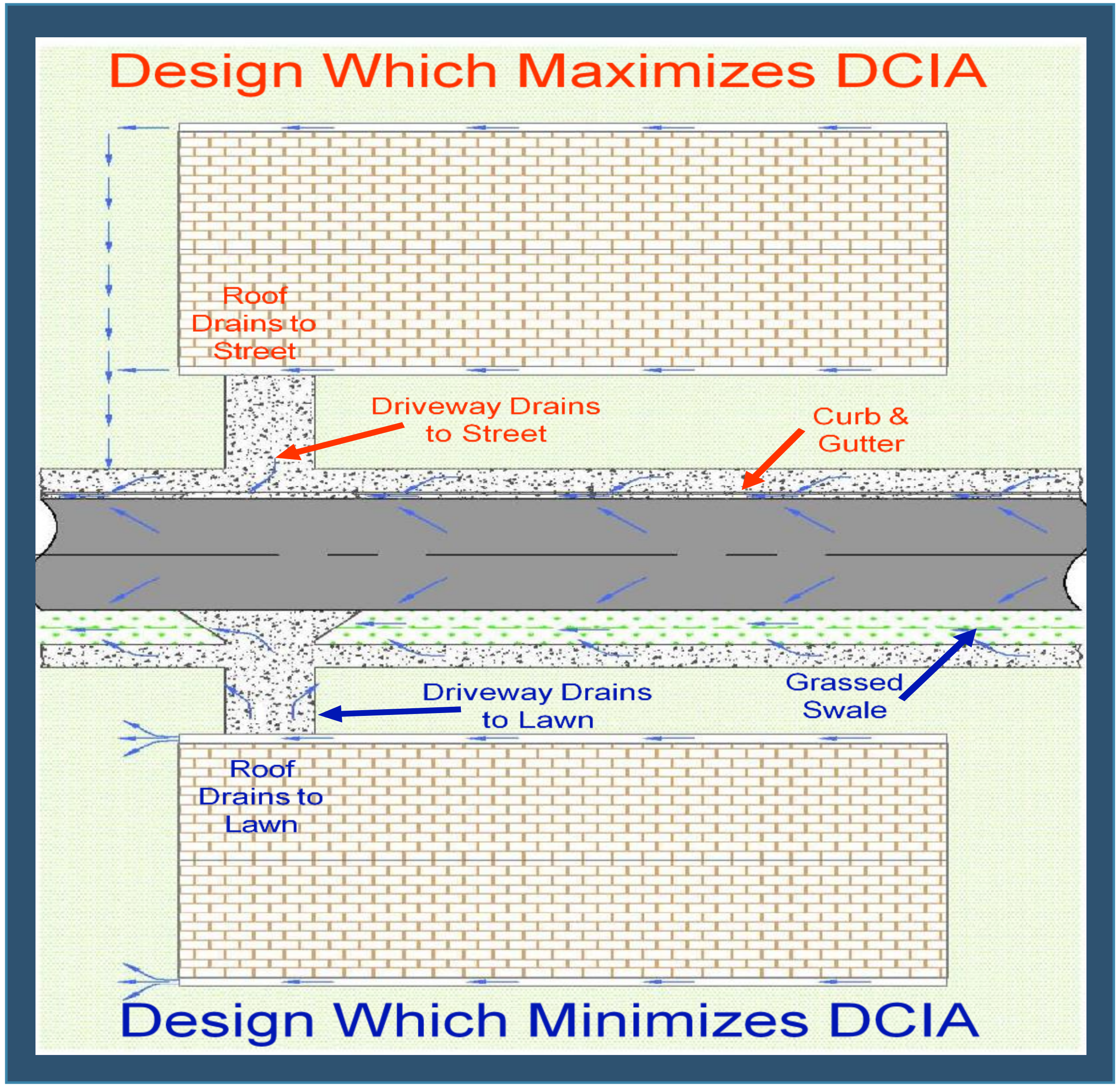
PERVIOUS PAVEMENT AND PAVERS

- Potentially significant approach to reducing onsite treatment needs by reducing annual discharge volume and potentially providing retention volume.
- Strategic locations of pervious pavement/pavers may provide a disconnect from other impervious surfaces, reducing the site's DCIA.

REDUCING DCIA

- DCIA has direct effect on the annual runoff generated from a site, directly affecting the post-development annual pollutant load.
- Reduce DCIA by shunting runoff to natural areas or turf before entering storm sewer, or other DCIA.
- Reducing DCIA requires less treatment capacity to meet goals.

DESIGN CHANGES TO REDUCE DCIA



- Potential to significantly reduce annual runoff.
- Reductions of up to 30% volumetric and nutrient load.
- Lower construction cost (infrastructure, smaller pond).

EFFECT OF DCIA ON ANNUAL RUNOFF “C” VALUES

- Sample data from Meteorologic Zone 1.
- Appendix N, Applicant’s Handbook 1.

	Mean Annual Runoff C			
Non-DCIA	**Percent DCIA**			
CN	35	45	55	65
40	0.31	0.39	0.47	0.56
60	0.33	0.41	0.49	0.57
80	0.41	0.47	0.54	0.61

EFFECT OF REDUCING DCIA

EXAMPLES OF CHANGING DCIA

Non-DCIA CN	Reduction of DCIA from 55% to 45% Reduction in Annual Runoff C Value
40	0.09
60	0.08
80	0.07

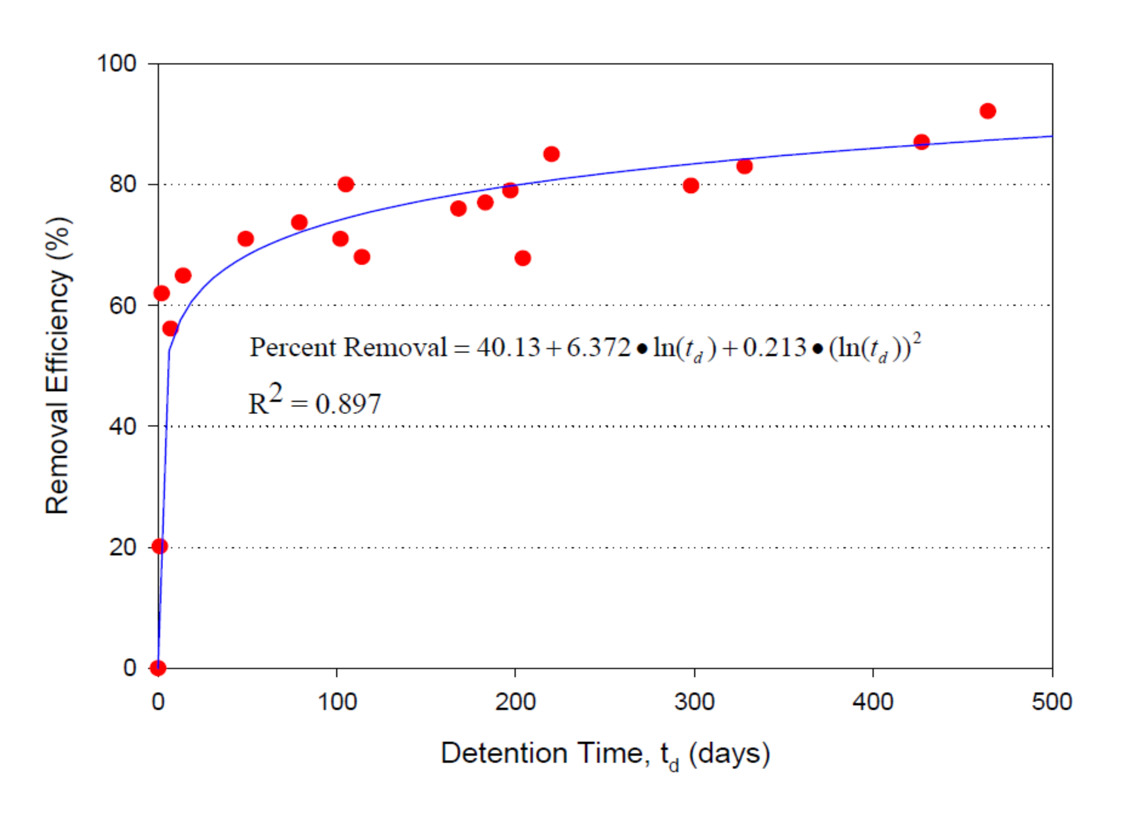
Non-DCIA CN	Reduction of DCIA from 65% to 45% Reduction in Annual Runoff C Value
40	0.17
60	0.16
80	0.14

EFFECT OF REDUCING DCIA

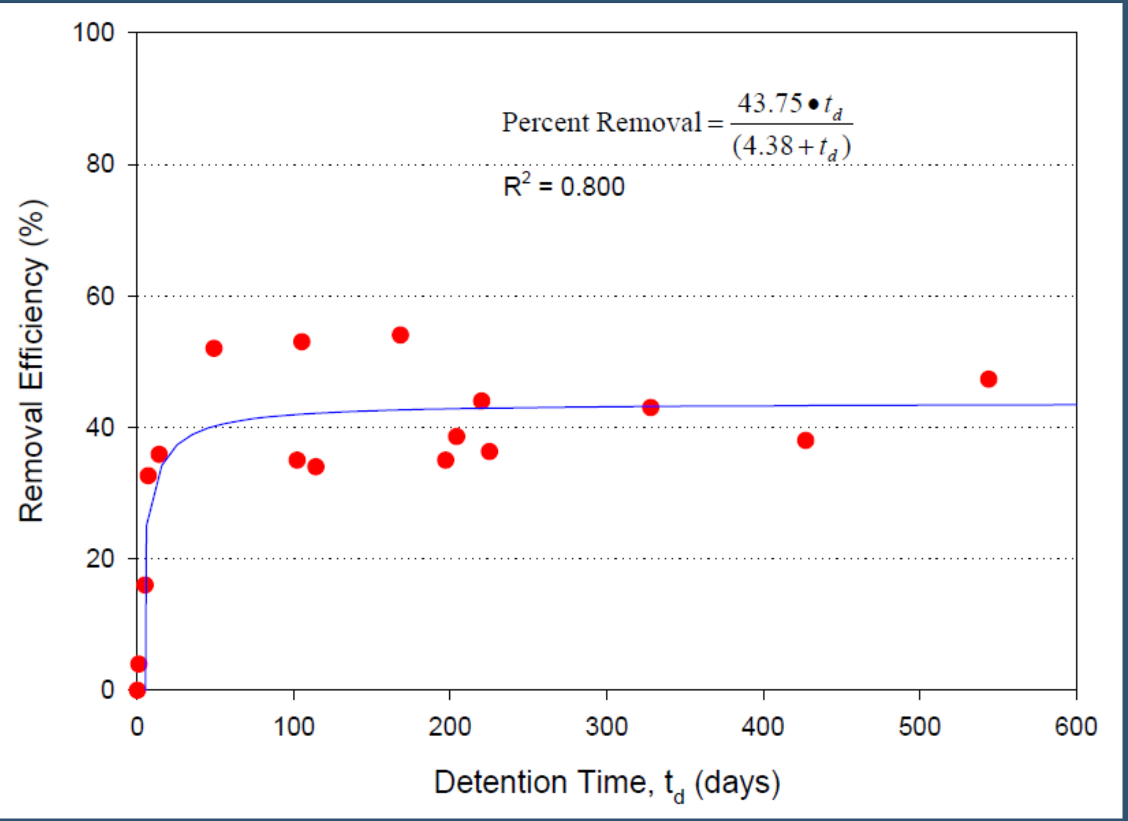
- Since the annual runoff "C" value directly results in the volume of water, and hence the nutrient load to be treated, any reduction in "C" value reduces the amount of needed treatment.
- For the above examples, reduction of DCIA results in 10% to 17% reduction of post-development volume.

WET DETENTION REVISITED

METHODS FOR ENHANCING REMOVAL EFFICIENCIES



Total Nitrogen



Total Phosphorus

WET DETENTION REVISITED

PRACTICE OPTIONS FOR INCREASED TN EFFICIENCIES

- Several best management practices (BMPs) can be used in conjunction with wet ponds to “super-charge” treatment efficiencies.
- Focus on TN as limiting factor for most wet detention systems.
- Some specific BMPs act independently on the permanent pool and not in series.

WET POND ENHANCEMENT

CREATIVE WAYS TO SUPER-CHARGE EFFICIENCY

EFFICIENCY "CREDIT" FROM APPENDIX O, APPLICANT'S HANDBOOK I

- Littoral zones (10% TN & TP for minimum coverage per Volume IIs).
- Floating treatment wetlands (FTWs) provide 12% TN & TP for 5% coverage.
- Stormwater harvesting based on annual volume removed (credit based on site specific water balance).

Wet pond enhancements do not require *any* changes to final grading or pond geometry.

LITTORAL ZONES AND FTWS

Littoral Zone

10% TN removal credit

Floating Treatment Wetland

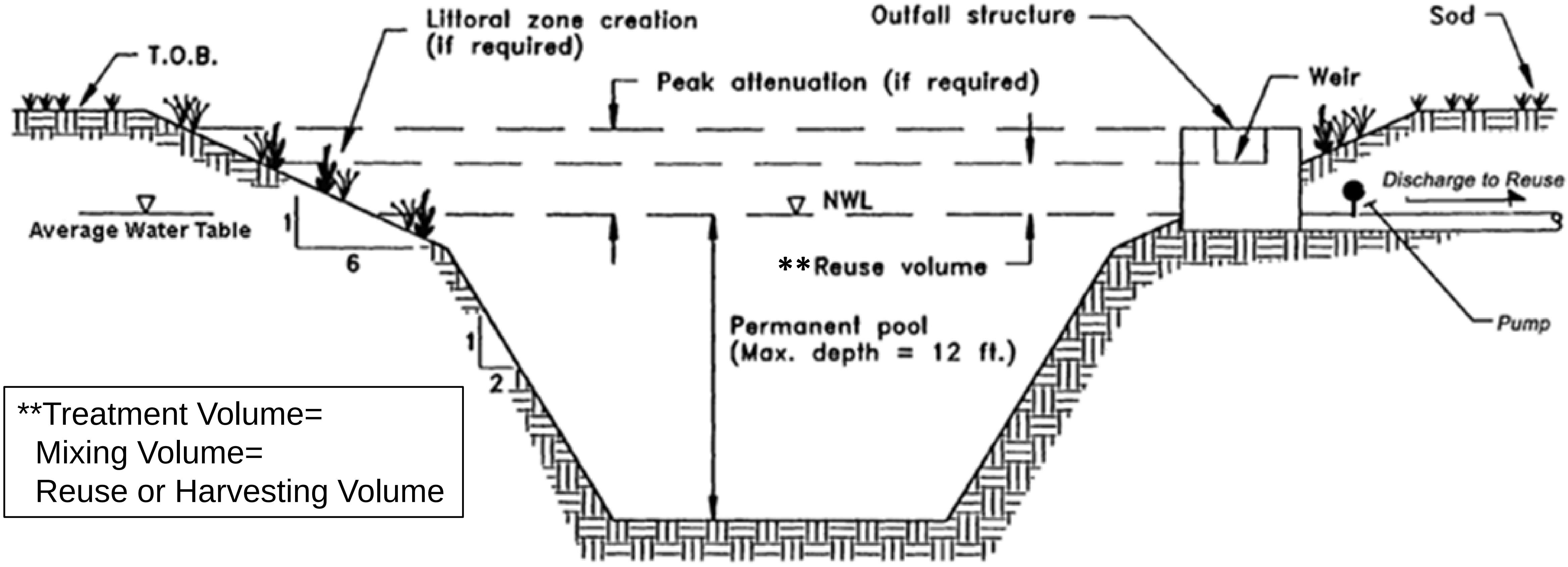
12% TN removal credit

STORMWATER HARVESTING

- Reduces annual runoff.
- Increases groundwater recharge.

STORMWATER HARVESTING (REUSE)

USED IN CONJUNCTION WITH WET DETENTION



**Treatment Volume=
Mixing Volume=
Reuse or Harvesting Volume

STORMWATER HARVESTING

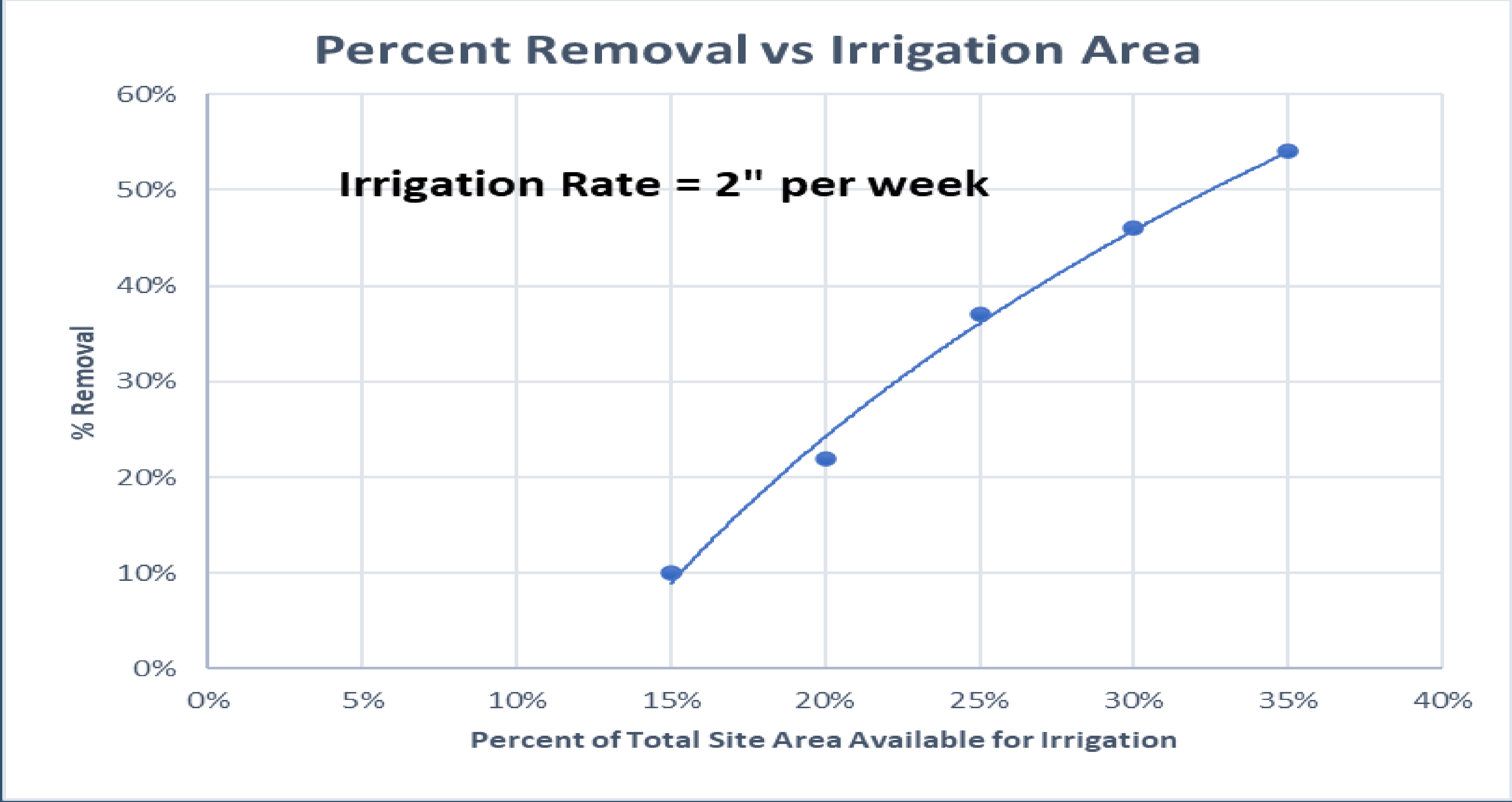
REMOVAL EFFICIENCY

- Efficiency (mass removal of water), is based on annual site runoff, storage, irrigable area and allowable irrigation rate.
- The University of Central Florida performed a series of mass balance calculations resulting in plotted-curve solutions (R-E-V curves) relating the following.
  - Irrigation rate (R).
  - Efficiency (percentage of runoff pumped for other uses) (E).
  - Harvestable volume (V).
- R-E-V curves allow use for any site since data is based on **percentages** and is **fully scalable**.

See Section 5.5, NWFWMD Applicant's Handbook II, Design Aids, for detailed design methodology.

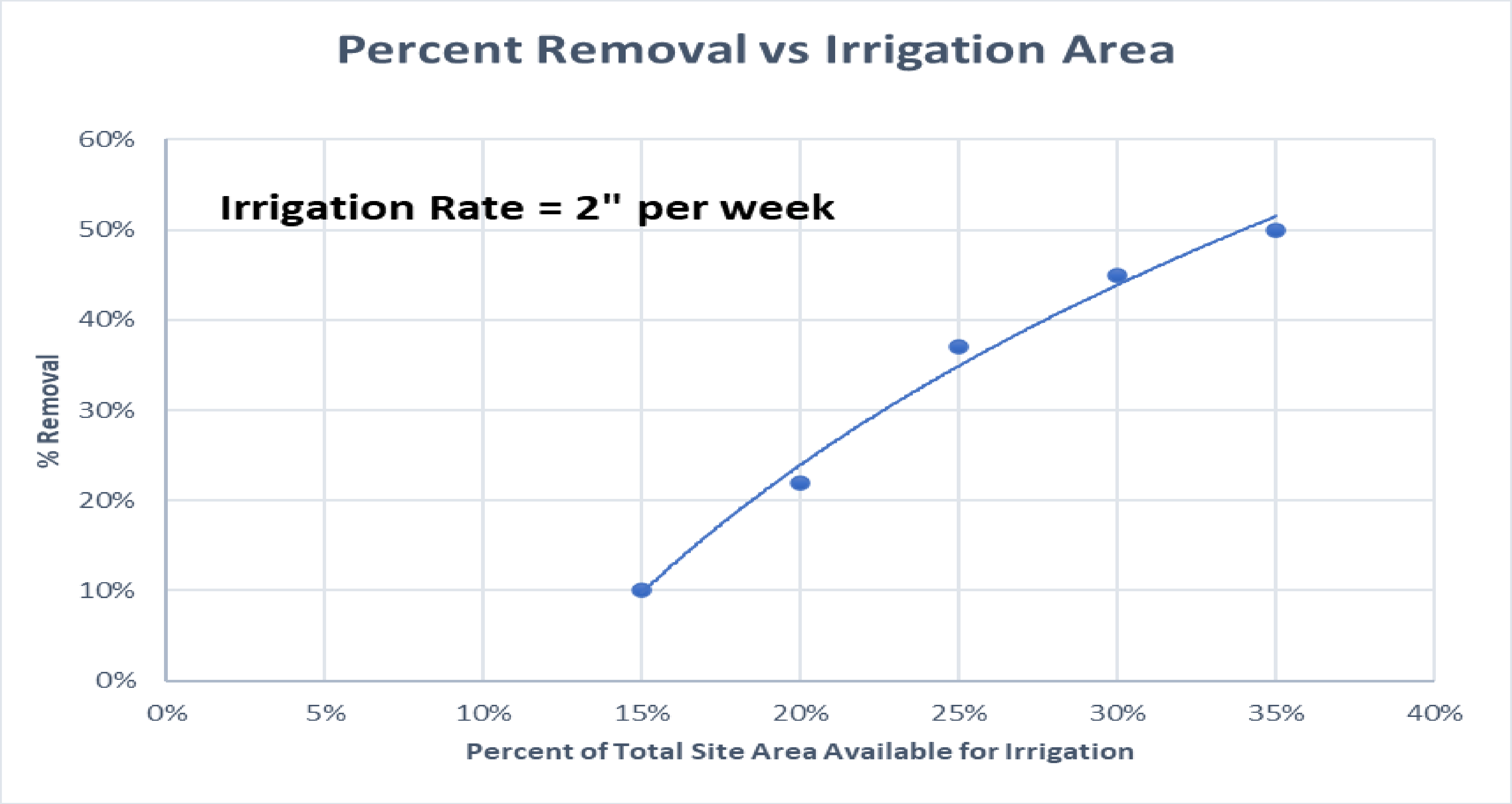
STORMWATER HARVESTING EFFICIENCY

80% IMPERVIOUS SITE



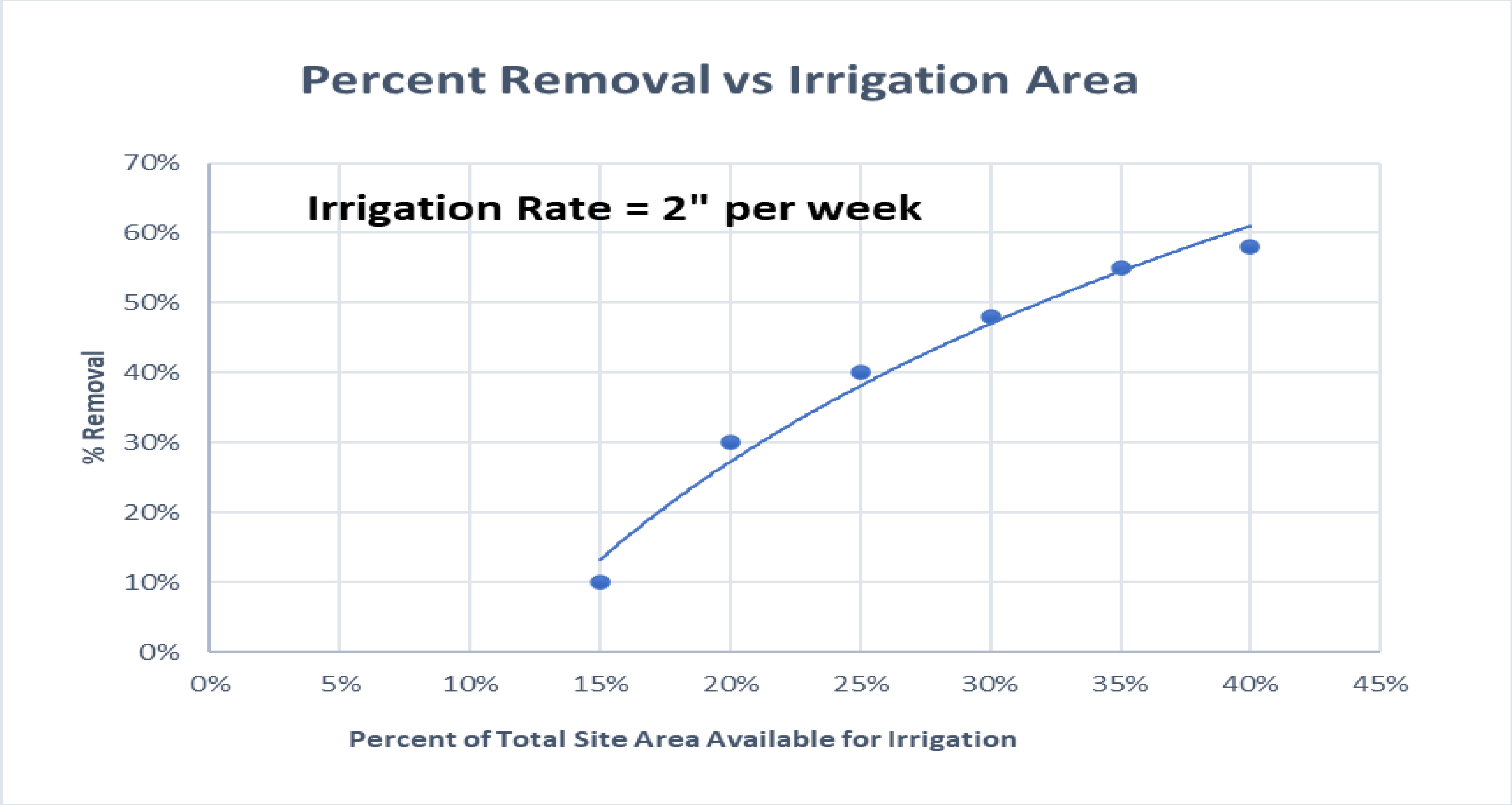
STORMWATER HARVESTING EFFICIENCY

70% IMPERVIOUS SITE



STORMWATER HARVESTING EFFICIENCY

60% IMPERVIOUS SITE



MEETING NUTRIENT REMOVAL TARGETS

WET DETENTION EXAMPLES

- The following examples include meeting minimum nutrient targets for all sites, impaired waters, OFWs and impaired and OFW.
- The example site is a generic development.
  - 60% impervious.
  - Non-DCIA CN of 60.
  - Wet detention primary driver with a complementary suite of practices.
  - Uses current rule for permanent pool detention time (14 days/21 days).
  - Irrigable area 25% of site; Maximum irrigation rate = 2.0” per week.

EXAMPLE FOR “ALL SITES”

Rule Target for "All Sites"					
TN=55 TP=80					
	Wet Pond				
Wet Detention	**Removal**	**Littoral**		**Stormwater**	**Total**
Detention = 14 days	**Efficiency**	**Zone**	**FTWs**	**Harvesting**	**Reduction**
Percent TN Removal	0.33	0	0	0	**0.33**
Percent TP Removal	0.58	0	0	0	**0.58**

EXAMPLE FOR "ALL SITES"

Rule Target for "All Sites"					
TN=55 TP=80					
	Wet Pond				
Wet Detention	**Removal**	**Littoral**		**Stormwater**	**Total**
Detention = 14 days	**Efficiency**	**Zone**	**FTWs**	**Harvesting**	**Reduction**
Percent TN Removal	0.33	0.1	0	0	**0.40**
Percent TP Removal	0.58	0.1	0	0	**0.62**

Overall Treatment Efficiency =

E1 + (1-((1-E1)*(1-E2)*(1-E3))) + Harvesting Value

EXAMPLE FOR “ALL SITES”

Rule Target for "All Sites"					
TN=55 TP=80					
	Wet Pond				
Wet Detention	**Removal**	**Littoral**		**Stormwater**	**Total**
Detention = 14 days	**Efficiency**	**Zone**	**FTWs**	**Harvesting**	**Reduction**
Percent TN Removal	0.33	0.1	0.12	0	**0.47**
Percent TP Removal	0.58	0.1	0.12	0	**0.67**

EXAMPLE FOR "ALL SITES"

Rule Target for "All Sites"					
TN=55 TP=80					
	Wet Pond			**0.75" per week**	
Wet Detention	**Removal**	**Littoral**		**Stormwater**	**Total**
Detention = 14 days	**Efficiency**	**Zone**	**FTWs**	**Harvesting**	**Reduction**
Percent TN Removal	0.33	0.1	0.12	0.15	**0.62**
Percent TP Removal	0.58	0.1	0.12	0.15	**0.82**

EXAMPLE FOR IMPAIRED WATERS

MINIMUM CRITERIA

Rule Target for Impaired Waters					
TN=80 TP=80					
Wet Detention Detention = 14 days	**Wet Pond Removal Efficiency**	**Littoral Zone**	**FTWs**	**2" per week Stormwater Harvesting**	**Total Reduction**
Percent TN Removal	0.33	0.1	0	0.4	**0.80**
Percent TP Removal	0.58	0.1	0	0.4	**0.95+**

EXAMPLE FOR OFWS

Rule Target for OFWs					
TN=80 TP=90					
	Wet Pond			**1.7" per week**	
Wet Detention	**Removal**	**Littoral**		**Stormwater**	**Total**
Detention = 21 days	**Efficiency**	**Zone**	**FTWs**	**Harvesting**	**Reduction**
Percent TN Removal	0.36	0.1	0.12	0.32	**0.81**
Percent TP Removal	0.62	0.1	0.12	0.32	**0.95+**

EXAMPLE IMPAIRED AND OFWS

MINIMUM CRITERIA

Rule Target for Impaired & OFW					
TN=95 TP=95					
	Wet Pond			**2" per week**	
Wet Detention	**Removal**	**Littoral**		**Stormwater**	**Total**
Detention = 21 days	**Efficiency**	**Zone**	**FTWs**	**Harvesting**	**Reduction**
Percent TN Removal	0.36	0.1	0.12	0.4	**0.89**
Percent TP Removal	0.62	0.1	0.12	0.4	**0.95+**

EXAMPLE IMPAIRED AND OFWS

MINIMUM CRITERIA

Rule Target for Impaired & OFW					
TN=95 TP=95					
	Wet Pond			**2" per week**	
Wet Detention	**Removal**	**Littoral**		**Stormwater**	**Total**
Detention = 60 days	**Efficiency**	**Zone**	**FTWs**	**Harvesting**	**Reduction**
Percent TN Removal	0.41	0.1	0.12	0.4	**0.93**
Percent TP Removal	0.7	0.1	0.12	0.4	**0.95+**

NOTES ON PREVIOUS CALCULATIONS

- Note that the bulk of removals result from pond detention time and mass removals by harvesting.
- Littoral zone and FTW removals act as final polishing.
- Harvesting rate is somewhat adjustable to meet need.
- Did not account for potential retention opportunities for LID-type microscale storage or pervious pavement/pavers.
- These practices do not require any change to the overall site plan footprint.

SUMMARY

- Numerous options are available for the design professional.
- Combining wet detention with other practices provides a reasonable means for meeting nutrient removal goals.
- LID concepts form a similar suite of options for dry retention.
- These practices used together will likely form the next-generation "toolbox."

QUESTIONS?

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