BMPFast Analysis for a Wet Detention Pond
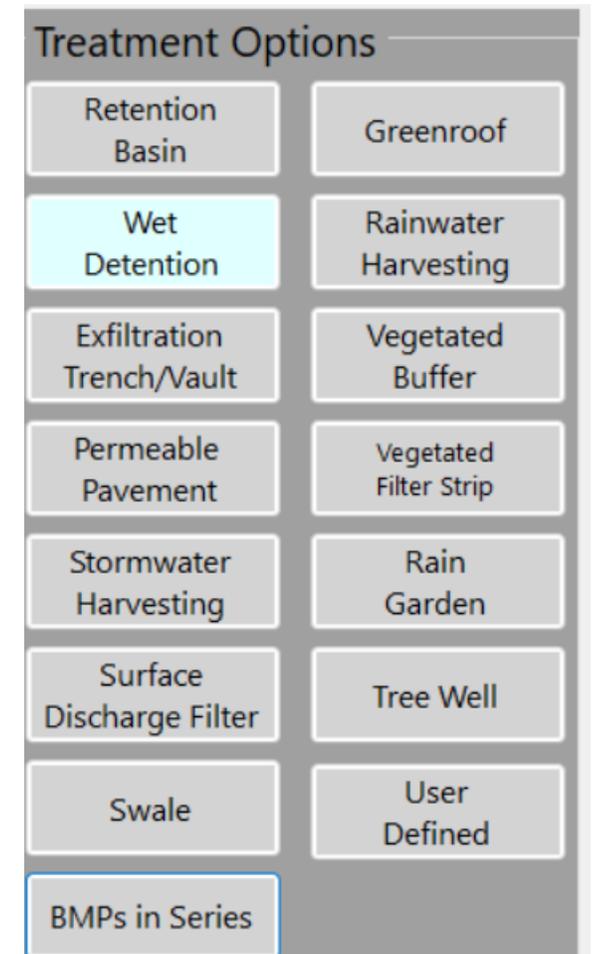
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January 2026

BMPFAST
Stormwater Toolbox

Treatment Standards, Location
Catchment Characteristics
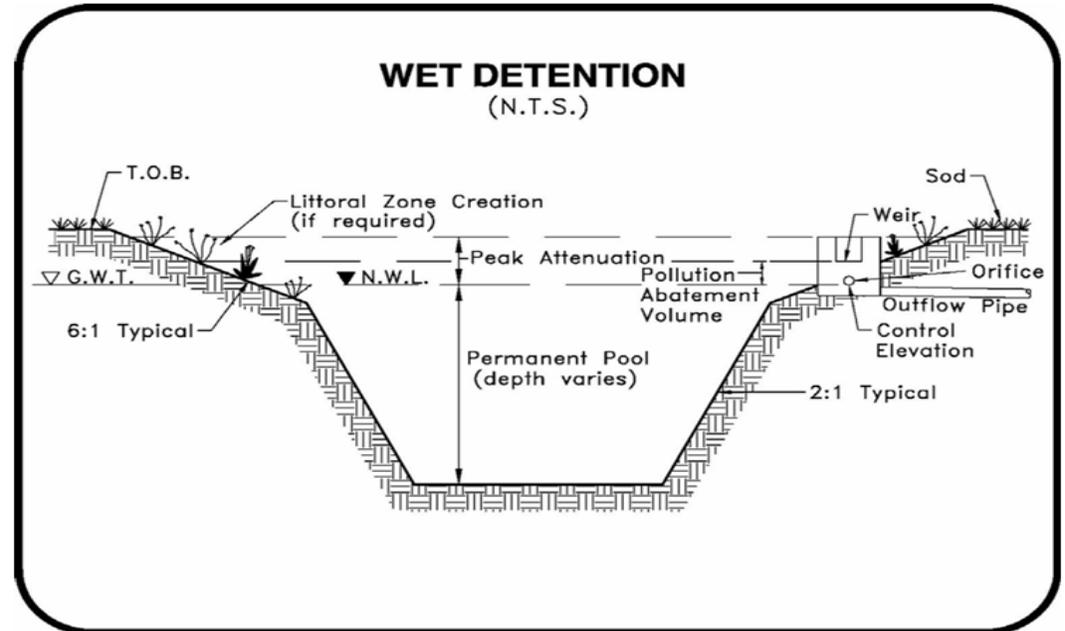Treatment Water Quality and Volume
Reference Publications

BMPFast

Learning Objectives

1. What is a wet detention pond?
2. Navigation of the software related to wet ponds.
3. Demonstrate the use of worksheets.
4. Options for evaluation of detention performance.
5. Example Problems.

Treatment Options

Retention Basin	Greenroof
Wet Detention	Rainwater Harvesting
Exfiltration Trench/Vault	Vegetated Buffer
Permeable Pavement	Vegetated Filter Strip
Stormwater Harvesting	Rain Garden
Surface Discharge Filter	Tree Well
Swale	User Defined
BMPs in Series	

What is a wet detention pond?
(one that holds water year around – a pond)

"Wet detention" means the collection and temporary storage of stormwater in a permanently wet impoundment in such a manner as to provide for treatment through physical, chemical, and biological processes with subsequent gradual release of the stormwater.

WET DETENTION
(N.T.S.)

T.O.B.
Littoral Zone Creation (if required)
G.W.T.
6:1 Typical
N.W.L.
Peak Attenuation
Pollution Abatement Volume
Permanent Pool (depth varies)
Sod
Weir
Orifice
Outflow Pipe
Control Elevation
2:1 Typical

Sources: Harper and Baker, "Evaluation of Current Stormwater Design Criteria within the State of Florida", FDEP report # SO108, June 2007.
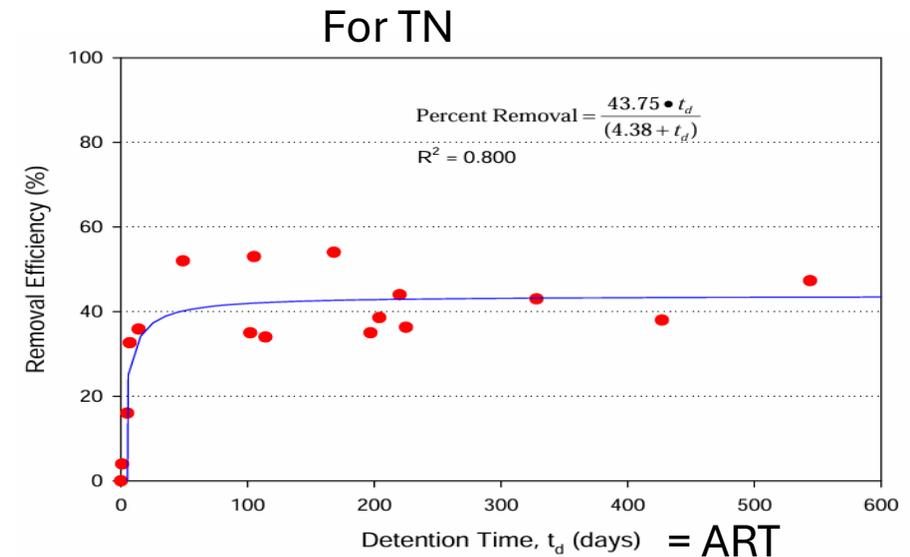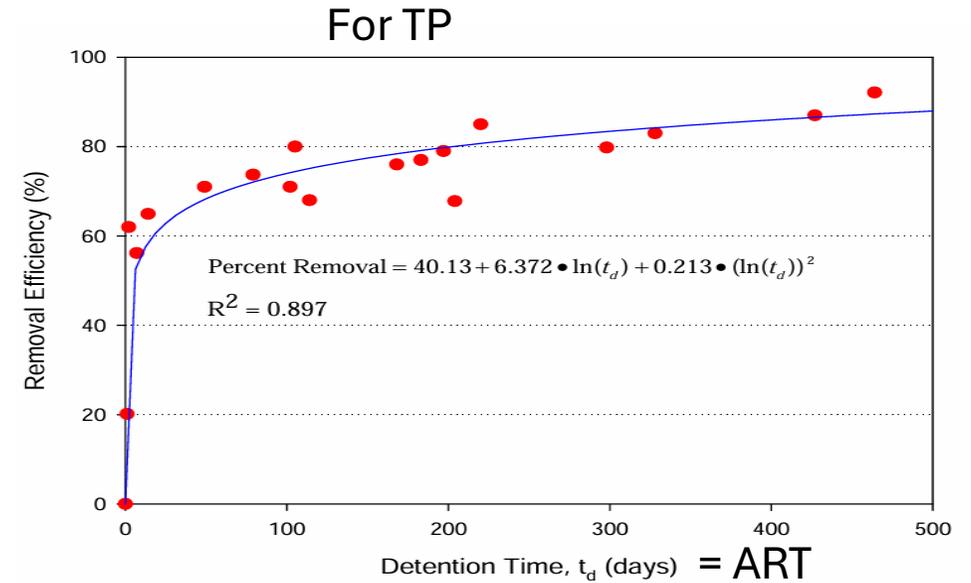Applicant's Handbook, Volume 1, Chapter 2, Appendix O, and others, June 28, 2024.

Effectiveness is a function of average Annual Residence Time (ART)

Annual Residence Time (days) [X axis] = Volume of Permanent Pool (ac-ft) x 365 (Days/year) / Annual Runoff (ac-ft/year)

Note: these effectiveness curves reflect the existence of a littoral zone, if none then the effectiveness is reduced.
Rem (no lit) = Rem (lit)/1.1   "by 10%".

Source: Harper and Baker, "Evaluation of Current Stormwater Design Criteria within the State of Florida", FDEP report # SO108, June 2007.

For TP

$$\text{Percent Removal} = 40.13 + 6.372 \bullet \ln(t_d) + 0.213 \bullet (\ln(t_d))^2$$
$$R^2 = 0.897$$

Detention Time, t_d (days)   = ART

For TN

$$\text{Percent Removal} = \frac{43.75 \bullet t_d}{(4.38 + t_d)}$$
$$R^2 = 0.800$$

Detention Time, t_d (days)   = ART

Example for Detention BMPs in Series
Double the Permanent Pool does not double the removal.

BMP Efficiency Determination

- Assume two detention BMPs in series – each have a 50-day residence time N=40%; P=70%
  - N – 40% + 40% = 80% ❌
  - P – 70% + 70% = 140% ❌
  - N – 50d + 50d = 100d ~ 43% ✅
  - P – 50d + 50d = 100d ~ 74% ✅

- CANNOT USE Equ. 9.5 A.H. Vol 1, Appendix O (upstream BMP does impact downstream effectiveness)

Detention Efficiency Plot
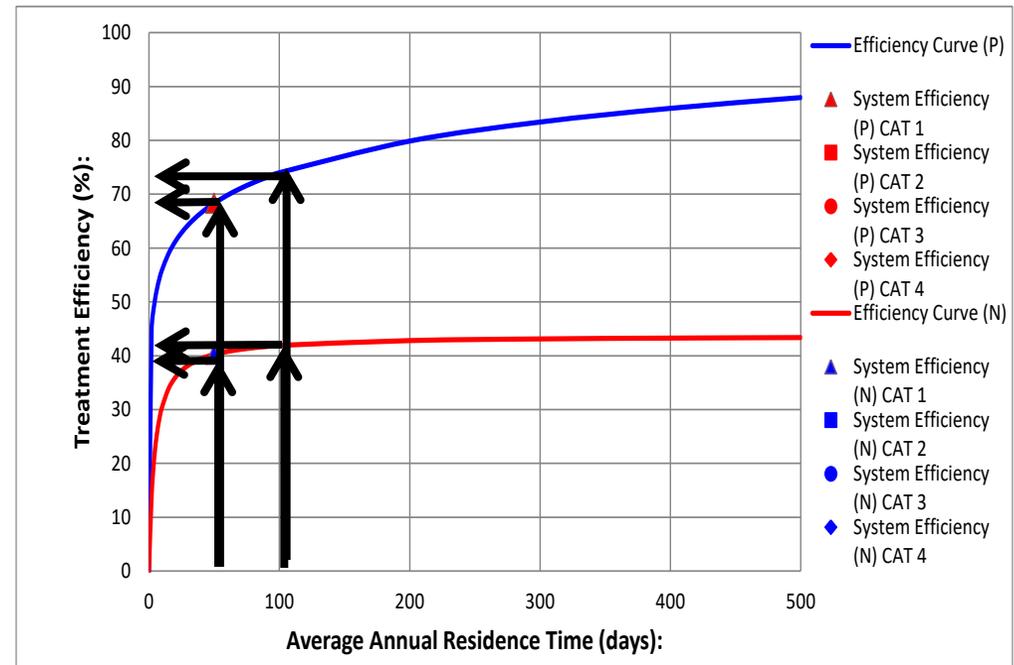
Note: A general principle, cannot remove the same pollutants more than one time

Wet Detention Pond Options

Source: AH vol 1, Appendix O and AHs vol 2

Note: For credit, in some applications, annual residence times cannot exceed an upper limit.
Pond must include a littoral zone. If no littoral zone, the credit is reduced by 10%

200 days
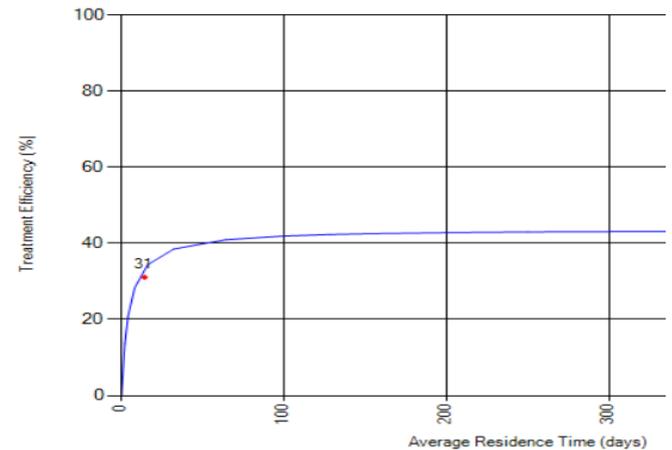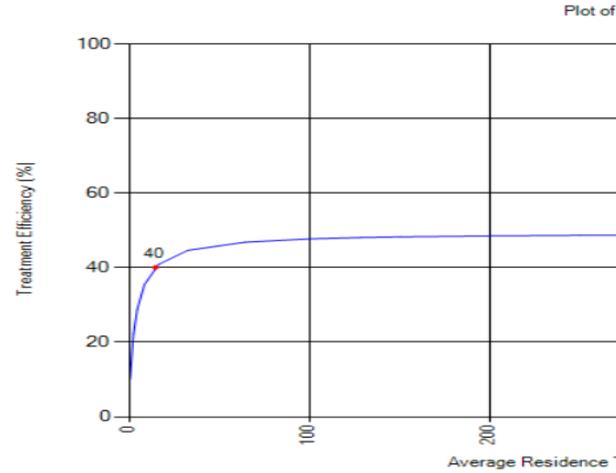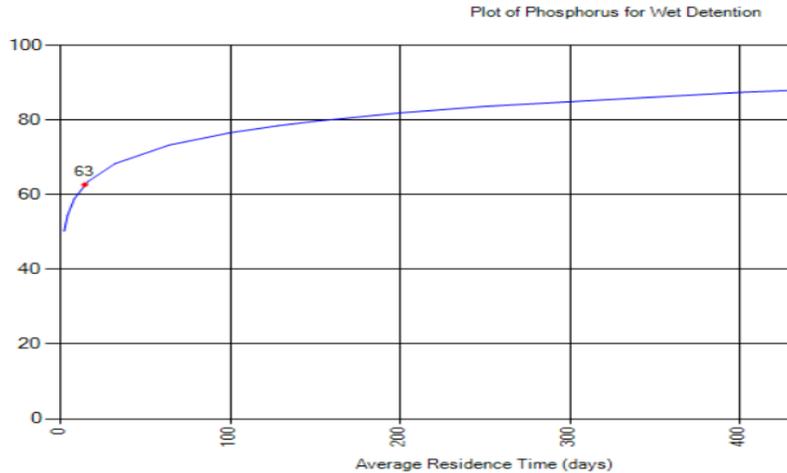As the ART

Check if there is a littoral zone

Permanent Pool Volume (acre-feet): 0.7

Floating Wetland or Mats Improvement Credit (%):

12 in AH 1, app O
Note 5% coverage

Input Pond TP (ug/l) if data available   0

Plot of Phosphorus for Wet Detention

Plot of Nitrogen for Wet Detention

# Floating Wetlands add 12% with 5% area coverage

Note, with a maintenance plan and 10% cover, 20% credit has been granted by some reviewers provided an alternative BMP is available if 20% not achieved.

Sources: Wanielista, et.el, Floating Wetland Systems for Nutrient Removal in Stormwater Ponds, FDOT Project BDK78 985-01, 2012. Applicant's Handbook, Vol. 1. Appendix O, FDEP, June 28, 2024.

12% of the residual after wet pond treatment

- Example: Wet detention followed by filtration, TN removal

BMP 1

BMP 2

100 mg → 43% → 57 mg → 12% → 50.16 mg remaining

43 mg

6.84 mg
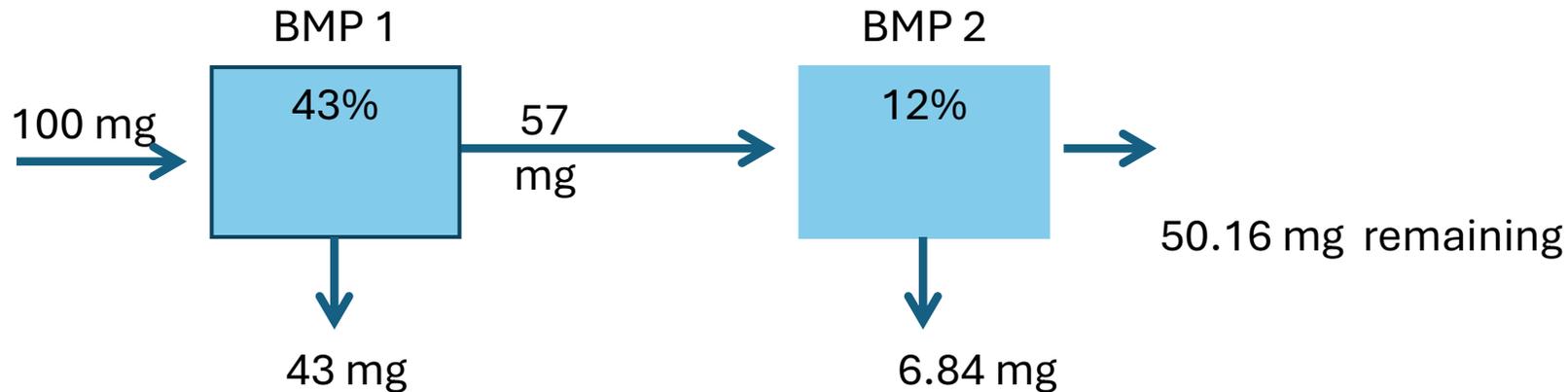
- From AH Vol 1, Appendix O: For series effectiveness use Equation 9-5 because "this equation assumes each downstream BMP acts independently of upstream BMPs" or "upstream BMP does not affect the effectiveness of the downstream BMP".

- Note this results in a 49.84% removal efficiency
  - Not 55% (43+12), and never can have over 100% removal

Example Detention Efficiency Curves
## Function of Annual Residence Time (ART) with Managed Aquatic Plants (MAP)

15 % credit for MAP (greater area coverage and a more frequent replacement plan)
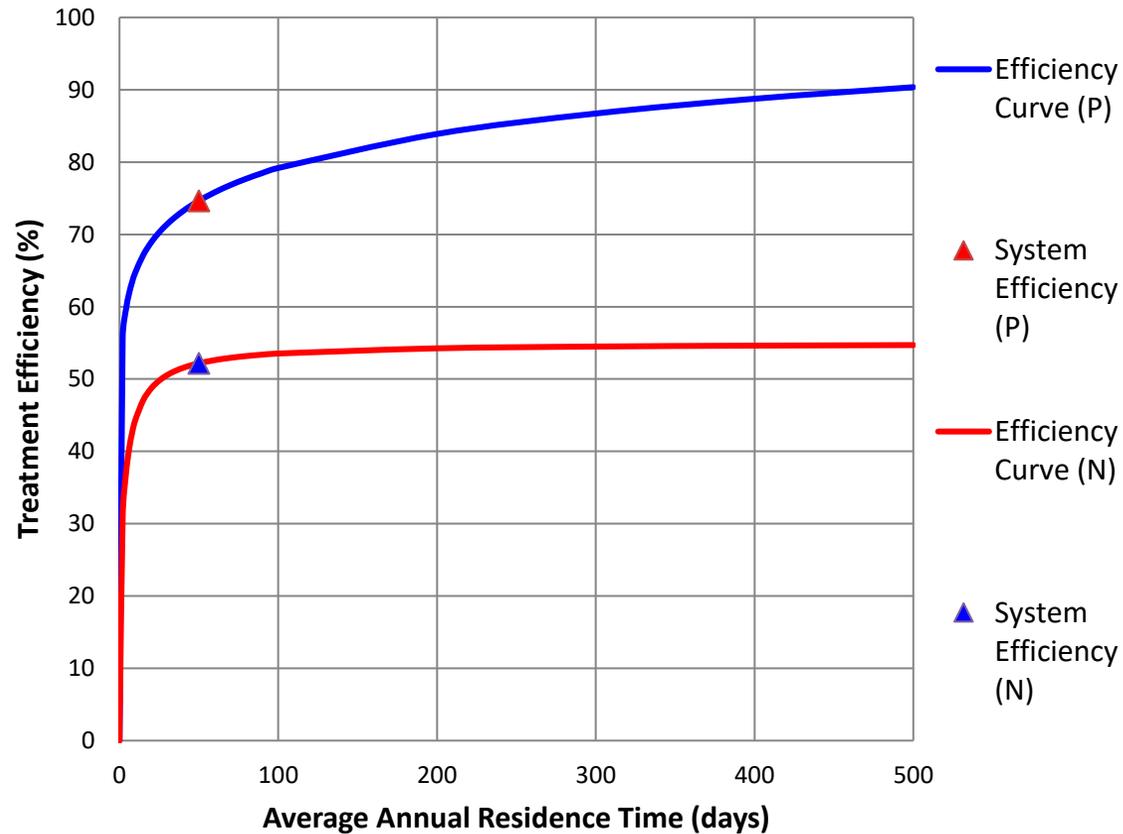
The plot is another discovery tool.

Wet Detention Effectiveness and Retention

When there are BMPs in series and the upstream one is retention, particulates are removed. When followed by a wet pond, the wet pond % removal is reduced by the fraction of particulate nutrients removed in upstream retention at a maximum of 20% for phosphorus and 10% for nitrogen. The fraction removed upstream is a function of the treatment depth and thus the maximum is adjusted proportional to the upstream annual removal.
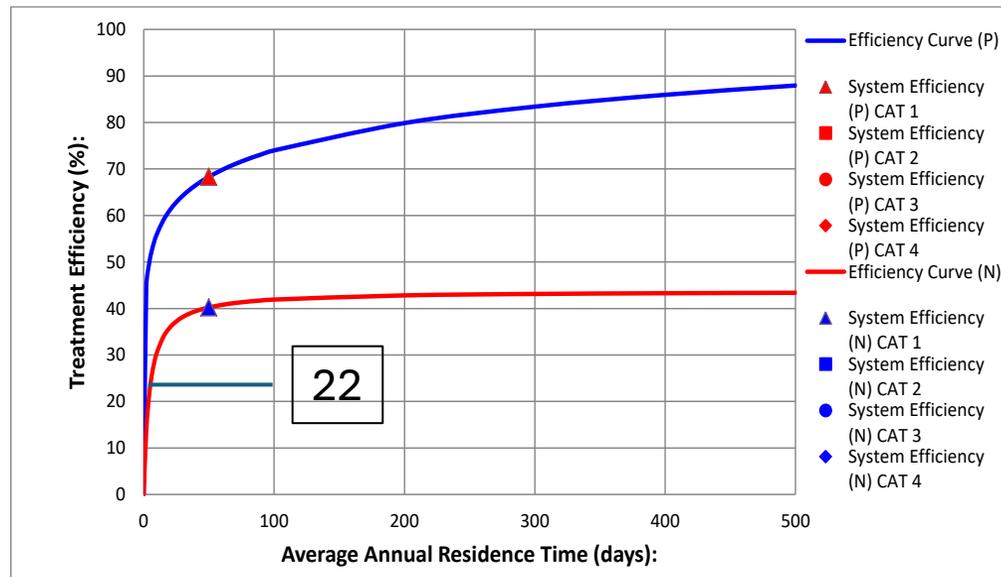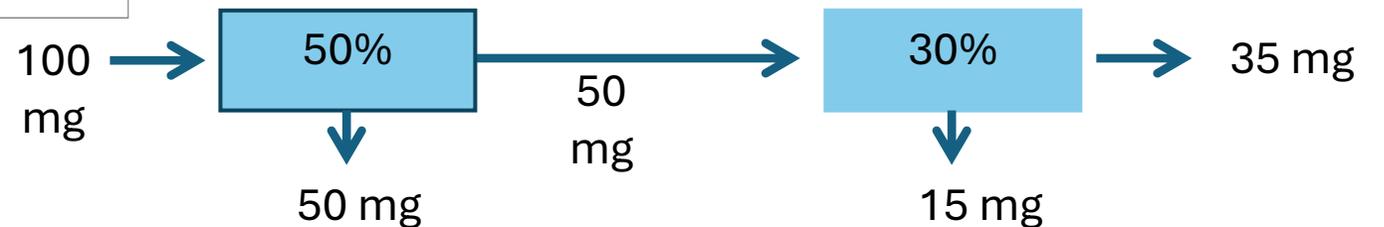

Equation: 9.5 A.H. Vol 1
Overall Treatment Train Efficiency
$$= 1 - [(1 - E1) \times (1 - E2) \times (1 - E3) \times \ . \ . \ \times (1 - EA)]$$
Example: For stand alone, there is 50% TN retention upstream and 38% wet detention downstream. First we can use Equation 9.5 because the removal mechanisms are different. Now adjust the downstream wet pond removal to 30% (38-8) removal.
Overall: Eff = 1- [(1-0.5)x(1-0.3)] = 1-0.35 = 0.65

Results of Adjusting Downstream Removal Rates

Annaul Average Residence Time (days)	200	31
EDTN Stand-alone wet pond TN removal %=	43	38
MTN Max reduction in TN removal %	10	10
EDTP Stand-alone wet pond TP removal %=	80	65
MTP Max reduction in TPremoval %	20	20

Example calculation for TN adjustment at ART =31 days

		and MTN	
for ER = 80	EDTN= 38	=	10
E of detention after retention =	(100-ER) x ((EDTN/100)-(MTN/100)x(ER/100))		
E of detention after retention =	6		

ER			Proposed		
ART = 200 d:	TN Performance		TP Performance		
Retention +	Detention	Total	Retention +	Detention	Total
90	3.40	93.40	90	6.20	96.20
80	7.00	87.00	80	12.80	92.80
70	10.80	80.80	70	19.80	89.80
60	14.80	74.80	60	27.20	87.20
50	19.00	69.00	50	35.00	85.00
40	23.40	63.40	40	43.20	83.20
30	28.00	58.00	30	51.80	81.80
20	32.80	52.80	20	60.80	80.80
0	43.00	43.00	0	80.00	80.00

ER			Proposed		
ART = 31 d:	TN Performance		TP Performance		
Retention +	Detention	Total	Retention +	Detention	Total
90	2.90	92.90	90	4.70	94.70
80	6.00	86.00	80	9.80	89.80
70	9.30	79.30	70	15.30	85.30
60	12.80	72.80	60	21.20	81.20
50	16.50	66.50	50	27.50	77.50
40	20.40	60.40	40	34.20	74.20
30	24.50	54.50	30	41.30	71.30
20	28.80	48.80	20	48.80	68.80
0	38.00	38.00	0	65.00	65.00

Project Description

This is an example for calculating the average annual removal of a wet detention pond. This is a performance example to demonstrate wet detention pond mass removal analysis and also for a BMP treatment train in the same catchment. The treatment train is typically used because wet detention frequently does not provide sufficient removal by itself. The project is located in the southwest coastal area of Florida, with an average annual rainfall of 52 inches. The pre-condition 2-acre watershed is defined as general agriculture and the post-condition as high intensity commercial with a DCIA of 30.5% and wet pond area of 0.2 acres with a permanent pool volume of 0.30 acre-feet and no littoral zone. The CN of the pre development pervious area is 70 and for post development the non-DCIA CN is 77.8 and includes the disconnected impervious areas. The site does not discharge to an OFW or an impaired water body. The wet pond has a littoral zone and sufficient space for a littoral zone of 0.30 ac-ft.

OPEN BMPFast and show screen captures of the inputs and outputs

Help and Documentation Project Name: detention examples

Select Meteorological Zone for Project: Florida Zone 4 ?

Enter the Mean Annual Rainfall: 52 inches ?

Performance Standard of Surface Discharge Analysis: All sites non-exempted

Conduct Groundwater Discharge Analysis: No

Nitrogen Removal Efficiency (%): 55 | 1. Enter Catchment

Phosphorus Removal Efficiency (%): 80 | 2. Enter Treatment

Watershed Characteristics Worksheet

Add Catchment | Catchment 1 southwest catchment

Current Catchment Number : 1 southwest catchment

and Use Catchment Name: southwest catchment ?

Pre: Agricultural - General: (TN=2.290 TP=0.381) ?

Post: High-Intensity Commercial: (TN=2.400 TP=0.345) ?

Concentrations used in Analysis

	Pre:	Post:
EMC(N) mg/l	2.290	2.400
EMC(P) mg/l	0.381	0.345
Annual ROC	0.071	0.331	?
Runoff (ac-ft/yr)	0.615	2.581
N Loading (kg/yr)	1.737	7.638	?
P Loading (kg/yr)	0.289	1.098

Total Pre-Development Catchment Area (ac): 2.00

Total Post-Development Catchment Area (ac): 2.00

Pre-Development Non DCIA Curve Number: 70.00 +

Pre-Development DCIA Percentage (0 - 100%): 0.00
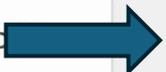
Post-Development Non DCIA Curve Number: 77.80 +

Post-Development DCIA Percentage (0 - 100%): 30.50

Wet Pond Area (No loading from this area, ac): 0.20

Repo | Calculate

Wet Detention Analysis: All sites non-exempted

Note: For credit, in some applications, annual residence times cannot exceed an upper limit.
Pond must include a littoral zone. If no littoral zone, the credit is reduced by 10%.

Check if there is a littoral zone ☑

Permanent Pool Volume (acre-feet): 0.3

Floating Wetland or and other MAPs Credit (%): 0

Input Pond TP (ug/l) if data available 0
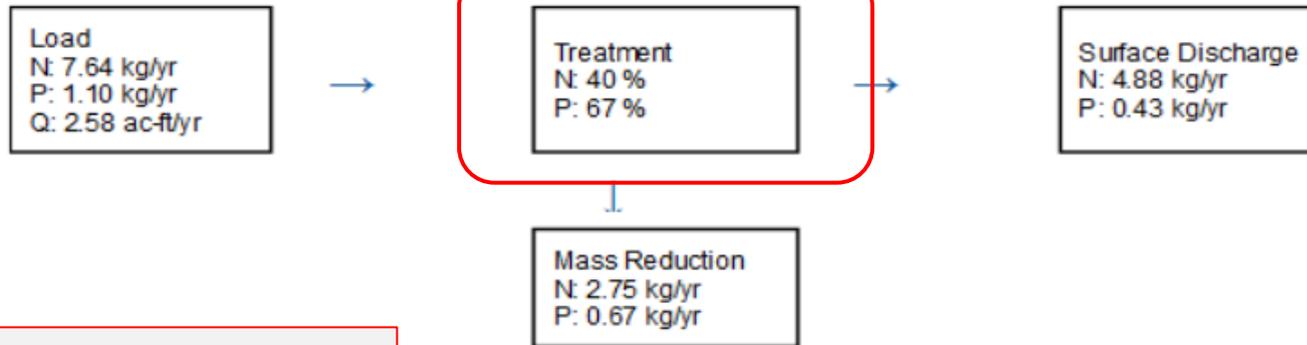
| Calculate |
| Anoxic Depth |
| Cost |
| Print |
| Plot |

Load Diagram for Wet Detention (stand-alone)

Load
N: 7.64 kg/yr
P: 1.10 kg/yr
Q: 2.58 ac-ft/yr

→

Treatment
N: 40 %
P: 67 %

→

Surface Discharge
N: 4.88 kg/yr
P: 0.43 kg/yr

Mass Reduction
N: 2.75 kg/yr
P: 0.67 kg/yr

Removal does
Not meet required
performance
standard

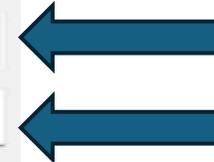| Back |

Nitrogen Removal Efficiency (%): 55

Phosphorus Removal Efficiency (%): 80

Add a surface sorption media discharge filter

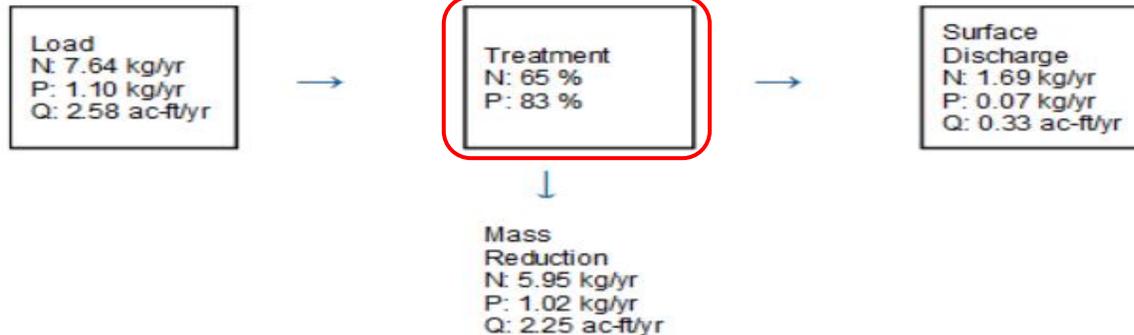Filtration System Worksheet Analysis: All sites non-exempted

Click Button to Select Media: Media   B&G CTS24

Treatment Depth (0.0-4.0 inches):   1.5

TP Mass Load (kg/yr)   0.074
TP Concentration (mg/L) 0.026

Load Diagram for Surface Discharge Filtration (stand-alone)

Load
N: 7.64 kg/yr
P: 1.10 kg/yr
Q: 2.58 ac-ft/yr

→

Treatment
N: 65 %
P: 83 %

→

Surface
Discharge
N: 1.69 kg/yr
P: 0.07 kg/yr
Q: 0.33 ac-ft/yr

↓

Mass
Reduction
N: 5.95 kg/yr
P: 1.02 kg/yr
Q: 2.25 ac-ft/yr

Cost

Calculate

Print

Plot

Copy

Back
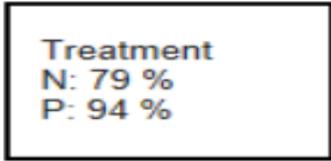
Wet pond + Filter meets the Performance Standard

Summary Treatment Report

Catchments and Associated BMP Types

ID	Catchment Name	Catchment BMP
1	southwest catchment	Multiple BMP 1: Wet Detention 2: Filtration

Volume of Runoff Summary

Scenario	Effective Area (acres)	Runoff
Pre-Condition	2	
System Post-Condition (with BMPs)	1.8	
Post-Condition (no BMP)	1.8	

Effective Area is the watershed area used to normalize runoff (acres). Runoff volumes are shown in acre-feet per ye[...]

Summary Loading Analysis

% Target Removals

Is system total nitrogen target removal met? **Yes** (Required: 55% Provided: 79.14%)
Is system total phosphorus target removal met? **Yes** (Required: 80% Provided: 94.35%)

Pre vs. Post Removals

Is % less than predevelopment system loading for TN met? **Yes** (Required: 77.25% Provided: 79.14%)
Is % less than predevelopment system loading for TP met? **Yes** (Required: 73.67% Provided: 94.35%)

Nitrogen Removal Efficiency (%): 55

Phosphorus Removal Efficiency (%): 80

What did we learn?

1. Defined a wet detention pond.
2. Navigation and enter data for average annual mass removal analysis using a wet detention pond.
3. Discovery for changes based on annual effectiveness.
4. Options using the detention worksheet.
5. Adjustment to wet pond removal based on upstream retention.
6. Understood an example problem.
7. Noted that the wet pond stand alone may not meet performance specs.

BMPFast Analysis
for a Wet Detention Pond

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