Worksheet B: Simple Design Capture Volume Sizing Method

Project:

Date:

		DMA =		
Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter design capture storm depth from Figure III.1, *d* (inches)	d=		inches
2	Enter the effect of provided HSCs, d_{HSC} (inches) (Worksheet A)	d_{HSC}=		inches
3	Calculate the remainder of the design capture storm depth, $d_{remainder}$ (inches) (Line 1 – Line 2)	$d_{remainder}$=		inches
Step 2: Calculate the DCV				
1	Enter Project area tributary to BMP(s), *A* (acres)	A=		acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=		%
3	Calculate runoff coefficient, $C = (0.75 \times imp) + 0.15$	C=		
4	Calculate runoff volume, $V_{design} = (C \times d_{remainder} \times A \times 43560 \times (1/12))$	V_{design}=		cu-ft
Step 3: Design BMPs to ensure full retention of the DCV				
Step 3a: Determine design infiltration rate				
1	Enter measured infiltration rate, $K_{measured}$[1] (in/hr) (Appendix VII)	$K_{measured}$=		in/hr
2	Enter combined safety factor from Worksheet H, S_{final} (unitless)	S_{final}=		
3	Calculate design infiltration rate, $K_{design} = K_{measured} / S_{final}$	K_{design}=		in/hr
Step 3b: Determine minimum BMP footprint				
4	Enter drawdown time, *T* (max 48 hours)	T=		hours
5	Calculate max retention depth that can be drawn down within the drawdown time (feet), $D_{max} = K_{design} \times T \times (1/12)$	D_{max}=		feet
6	Calculate minimum area required for BMP (sq-ft), $A_{min} = V_{design} / d_{max}$	A_{min}=		sq-ft
Step 4: Design and Calculate BMP Design Effective Depth and Footprint				
7	Calculate effective depth ($d_{effective}$)[2] based on applicable BMP Fact Sheet	$d_{effective}$=		ft
8	Calculate BMP design drawdown time[3]	T=		hours
9a	Calculate minimum area required based on effective depth BMP (sq-ft), $A_{min} = V_{design} / d_{effective}$	A_{min}=		sq-ft
9b	Enter actual BMP area provided	A_{BMP}=		sq-ft

[1]$K_{measured}$ is the vertical infiltration measured in the field, before applying a factor of safety. If field testing measures a rate that is different than the observed vertical infiltration rate (for example, three-dimensional borehole percolation rate) then this rate must be adjusted by an acceptable method (for example, Porchet method) to yield the field estimate of vertical infiltration, $K_{measured}$. See Appendix VII.

[2]Effective depth ≤ Maximum depth in row 5. See further guidance for effective depth on pgs 3-4 of this document.

[3]If greater than 48 hours, adjust BMP design to meet 48 hours drawdown time. If BMP design is based on drawdown greater than 48 hours, Worksheet C must be utilized to design for 80% capture efficiency.

[4]Provided BMP area should be based on the footprint at the bottom of ponding for all BMPs with dedicated surface-level ponding and/or side slopes. See following pages for additional guidance.

Worksheet C: Capture Efficiency Method for Volume-Based, Constant Drawdown BMPs

Project:

Date:

		DMA=		
Step 1: Determine the design capture storm depth used for calculating volume				
1	Enter design capture storm depth from Figure III.1, *d* (inches)	d=		inches
2	Enter calculated drawdown time of the proposed BMP based on equation provided in applicable BMP Fact Sheet, *T* [1] (hours)	T=		hours
3	Using Figure III.2, determine the "fraction of design capture storm depth" at which the BMP drawdown time (T) line achieves 80% capture efficiency, X_1	X_1=		
4	Enter the effect depth of provided HSCs upstream, d_{HSC} (inches) (Worksheet A)	d_{HSC}=		inches
5	Enter capture efficiency corresponding to d_{HSC}, Y_2 (Worksheet A)	Y_2=		%
6	Using Figure III.2, determine the fraction of "design capture storm depth" at which the drawdown time (T) achieves the equivalent of the upstream capture efficiency (Y_2), X_2	X_2=		
7	Calculate the fraction of design volume that must be provided by BMP, $fraction = X_1 - X_2$	fraction=		
8	Calculate the resultant design capture storm depth (inches), $d_{fraction} = fraction \times d$	$d_{fraction}$=		inches
Step 2: Calculate the DCV				
1	Enter Project area tributary to BMP(s), *A* (acres)	A=		acres
2	Enter Project Imperviousness, *imp* (unitless)	imp=		%
3	Calculate runoff coefficient, $C= (0.75 \times imp) + 0.15$	C=		
4	Calculate runoff volume, $V_{design} = (C \times d_{fraction} \times A \times 43560 \times (1/12))$	V_{design}=		cu-ft
Step 3: Calculate BMP footprint required				
1	Enter BMP ponding depth (d_p) or effective depth ($d_{effective}$) depending on proposed BMP type[2]	$d_{effective}$= or d_p=		acres
2	Calculate minimum area required based on effective or ponded depth BMP (sq-ft), $A_{min} = [V_{design} / d_{effective}], [V_{design} / d_p]$	A_{min}=		sq-ft
3	Enter actual BMP area provided[3]	A_{BMP}=		sq-ft

[1]Drawdown time (T/DD) is based on ponding or effective depth of the BMP depending on BMP type for 80% capture sizing. See pgs 3-4 of this document for guidance on determining these criteria.

[2]BMP depth to calculate minimum area of BMP varies depending on BMP type. See pgs 3-4 of this document for guidance on determining these criteria.

[3]Provided BMP area should be based on the footprint at the bottom of ponding for all BMPs with dedicated surface-level ponding and/or side slopes. See following pages for additional guidance.

Infiltration BMPs

Calculating effective depth for the various types of infiltration BMPs varies depending on BMP geometry. For infiltration BMP sizing, credit can be taken for each layer of the infiltration BMP including ponding, media and gravel, as appropriate. The equation below can be utilized to determine effective depth when employing both the Simple Method and the 80% Capture Efficiency Method for sizing the BMPs:

$$\textit{Effective depth: } d_{effective} = d_p + (d_{media} * n_{media}) + (d_{gravel} * n_{gravel})$$

Where,

Ponding Depth = d_p (ft)
Media Depth = d_{media} (ft)
Media Porosity (n_{media}) = 0.2 unless otherwise verified
Gravel Depth = d_{gravel} (ft)
Gravel Porosity (n_{gravel}) = 0.35 unless otherwise verified

To calculate drawdown time (DD or T), the effective depth is divided by the design infiltration rate (K_{Design}) as shown below:

$$\textit{Drawdown (DD or T)} = (d_{effective}) / (K_{Design}) \times 12$$

See some additional details below when utilizing the Simple Method versus the 80% Capture Efficiency method for final infiltration BMP sizing:

- **Simple Method:** Drawdown must be within 48 hours. If greater than 48 hours based on BMP geometry, 80% Capture Efficiency Method must be employed.
- **80% Capture Efficiency Method:** Can be employed with any drawdown time, with the following BMP specific considerations:
  - Drawdown cannot exceed 96 hours even when 80% Capture Efficiency Method is utilized due to vector control concerns.

Infiltration BMP Footprints

For all BMPs that feature dedicated surface-level ponding areas or side slopes (e.g. bioretention without underdrain, infiltration trenches), the calculated minimum area and designed BMP footprint should both correspond the *bottom footprint only* of the BMP and cannot use area under side slopes for storage credit unless additional justification is provided.

Biotreatment BMPs

Calculating effective depth for the various types of biotreatment BMPs also varies depending on BMP geometry. For biotreatment BMP sizing, however, the effective depth that can be counted for treating the water quality volume is typically limited to the ponding depth and/or the “filtered” depth depending on BMP sizing method. Gravel, as it does not provide treatment, cannot be counted towards the treatment volume. See details below for the differences in calculating effective depth for the Simple Method versus the 80% Capture Efficiency Method and additional specifications for certain BMP types:

Simple Method Biotreatment BMP Sizing Details

For Bioretention with Underdrain BMPs (BIO-1), an additional step must be taken to determine the filtered depth through the media as it compares to the ponding depth. The filtered depth is estimated as the amount of water routed through the media during the design storm, or the ponding depth, whichever is smaller.

$$\text{Filtered depth: } d_{filtered} = MIN\,[((K_{Media} * T_{routing})/12),\ d_p]$$

$$\textit{Effective depth: } d_{effective} = d_p + d_{filtered}$$

Where,

K_{media} = 2.5 in/hr unless otherwise verified
$T_{routing}$ ≤ 3 hrs per BMP Fact sheet
Ponding Depth = d_p (ft)

For Simple Method BMP sizing, the drawdown time (DD or T) of the ponding depth through the media must be within 48 hours, which is calculated using the media filtration rate (K_{media}) as shown below:

$$\textit{Drawdown (DD or T)} = (d_p / K_{Media}) \times 12$$

Where,

Ponding Depth = d_p (ft)
Media Filtration Rate (K_{media}) = 2.5 in/hr unless otherwise verified

80% Capture Efficiency Biotreatment BMP Sizing Details

When applying the 80% Capture Efficiency method for biotreatment BMP sizing, only the ponding depth can be counted towards the effective depth.

$$\textit{Effective depth: } d_{effective} = d_p$$

Drawdown is calculated the same way for 80% Capture Efficiency as compared to the Simple Method shown above.

$$\textit{Drawdown } (DD_p) = (d_p) / (K_{Media}) \times 12$$

Where,

K_{media} = 2.5 in/hr unless otherwise verified
DD_p ≥ 3 hours per BMP Fact sheet for 80% Capture Efficiency Method
Ponding Depth = d_p (ft)

See Figure III.2 *Capture Efficiency Nomograph for Constant Drawdown Systems in Orange County* below, that is utilized when sizing BMPs following the 80% Capture Efficiency Method.

Biotreatment BMP Footprints

For all BMPs that feature dedicated surface-level ponding areas or side slopes (e.g. bioretention with underdrain), the calculated minimum area and designed BMP footprint should both correspond the *bottom footprint only* of the BMP and cannot use area under side slopes for storage credit unless additional justification is provided.

Figure III.2. Capture Efficiency Nomograph for Constant Drawdown Systems in Orange County