

SIZING

MWS – Linear

Hybrid Stormwater Filtration System



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Many municipal stormwater discharge permits in California (for example) contain provisions such as Standard Urban Stormwater Mitigation Plans, Stormwater Quality Urban Impact Mitigation Plans, or Provision C.3 New and Redevelopment Performance Standards, commonly referred to as SUSMPs, SQUIMPs, or C.3 Provisions, respectively. These provisions include minimum standards for sizing of these treatment control BMPs, including the MWS – Linear Hybrid Stormwater Treatment System. Sizing standards are prescribed for both volume-based and flow-based. Depending on the most appropriate method for your project, The MWS – Linear can be designed as both a flow-based or volume based BMP. To determine which of the two is most appropriate, an analysis of project characteristics and specific treatment and flow control requirements should be properly analyzed.

In this section procedures and resources are provided to determine you projects treatment flow and/or volume. Currently, many of these design volumes and flows are based upon the 85th percentile storm event. Stormwater treatment BMPs are required to treat this 85th percentile, which simply means the large majority of storm events. It has been proven infeasible to design BMPs to treat the larger infrequent storm events. When BMPs are designed for increasingly larger storms (for example, storms up to 1 in. versus storms of up to 0.5 in.), the BMP size and cost increase dramatically, while the number of additional treated storm events are small (CASQA Handbook).

Following are the procedures for determining your projects treatment volumes and flows. With this information you will be able to easily determine the number of MWS – Linear Systems needed for you project. On average you will need one unit per acre of development, assuming 80% impervious cover. This number can vary based upon local historical rainfall data, which determines the intensity of the 85th percentile storm event.

Flow Based Design –

Typically, the water quality flow is defined as the flow of runoff produced by a rain event equal to at least two times the 85th to 90th percentile hourly rainfall intensity for the

applicable area. The percentile and safety factor can vary by region and regulator. The following sizing example describes the application of the California Stormwater BMP Handbook approach (for other regions use local sizing standards). **This example method used in combination with Cal State Sacramento's Basin Sizer Program. This program will automatically calculate the hourly rainfall intensity for the 85th percentile for a selected area of California. It is always recommended that the local method is used to calculate the treatment flow. If this method is unknown please contact a Modular Wetland System, Inc. representative for assistance in determining the appropriate method and flow rate.**

1. Identify the "BMP Drainage Area" that drains to the proposed BMP. This includes all areas that will contribute runoff to the proposed BMP, including pervious areas, impervious areas, and off-site areas, whether or not they are directly or indirectly connected to the BMP.

2. Calculate the composite runoff coefficient "C" for the area identified in Step 1. To determine the C value, first determine the projects percent of total impervious area in the "BMP Drainage Area". You will also need to determine the soil type at the projects location. Use this information and reference the table at the end of this section. The tables are directly from the San Diego and Riverside County Hydrology manual; your local region should have their own table. Each county will have this information available in their hydrology manual.

3. Select the hourly rainfall intensity percentile. This is usually 85%. This intensity is automatically calculated by the Basin Sizer Program. **Open the program select the CASQA methods tab, use the arrow cursor to select the area you project is located in. The program will automatically reference the closest rain station. Click on the rain station, and 85th percentile intensity will automatically be calculated. It should be noted that many regions of California have regional water boards that have set default intensities for stormwater treatment. For example, Region 4 has set an intensity of .2 inches/hour. Other states have various methods for calculating the treatment intensities. It is always recommended t use local standards and methods.**

4. Choose a safety factor for the rainfall intensity. This multiplier is usually 2, but it may vary by region.

5. The modified intensity for the selected percentile will be calculated automatically. The modified intensity is the one you will use as for in the Rational Formula.

6. Apply the Rational Formula to calculate the water quality flow. Multiply the "BMP Drainage Area" from Step 1, the "C" from Step 2, and the "modified intensity" from Step 5 together. The result is the water quality flow.

Calculation Example: We will use a project with a BMP drainage area of 1 acre. The projects has water shed imperviousness ratio of .8 (80%). The project in located in Oceanside, CA. and is located in an area with A type soil.

Where:

Since the project is in Oceanside, CA, which is located in San Diego County, table 2, in appendix A was referenced. The "C" value was determined to be .76.

Therefore:

C = .76 (impervious coefficient)

A = 1 (project area in acres)

I = .275 (in inches) (modified intensity)

Q = water quality flow (in CFS)

Since the project is located in Oceanside, CA the Oceanside Plumbing Plant Rain Station is referenced is chosen in the Basin Sizer Program. Once this station is selected the intensity (I) will be determined. Remember to use 85% as your percentile and 2 as your safety factor.

$$Q = C \times I \times A$$

$$Q = .76 \times 1 \times .275$$

$Q = .209$ cubic feet a second (CFS) or 93.8 gallons per minute (GPM).

This number will be used to appropriately determine the number of MWS – Linear Systems needed. The number of units will also depend on the level of treatment required, which is dependent on the pollutants of concern and existing TMDLs.

The Curb and Grate Type configurations of the MWS – Linear Hybrid Stormwater Treatment System have a primary peak treatment flow rates of 120 GPM or .27 CFS. This usually equates to “approximately” one system per acre.

Volume Based Design –

The following is an example of a volume-based BMP design standard from current municipal stormwater permits. The permits require that volume-based BMPs be designed to capture and then treat stormwater runoff equal the Water Quality Volume (WQv). The WQv can be determined by the following method. Volume based BMP design can be described as a capture, detain, and treat, discharge over an extended period (usually 48 to 72 hours).

There are two main advantages of volume based design. First, by detaining and then slowly treating and discharging over a period of 48 hours, you are creating a system that controls and attenuates flows. By doing so, this treatment system will not only satisfy treatment requirements, but also contributes to meeting all or part of the possible hydromodification requirements. The second advantage of volume based design is the 48 hour time period given to treat the WQv. The longer you have to treat the runoff the smaller the filtration BMP needs to be. The only disadvantage is the cost and land required to detain the runoff in an above ground detention basin. Underground detention systems allow you to detain water without losing valuable space, though there are infrastructure costs associated with these systems. The value of the land will determine which of the two detention (above or underground) options are most feasible.

The Urban Runoff Quality Management approach is based on volume-based BMP sizing methodology described in Urban Runoff Quality Management (WEF Manual of Practice

No. 23/ASCE Manual of Practice No. 87, 1998). It is based on two regression equations. The first equation determines the runoff coefficient. The second regression equation relates mean annual runoff-producing rainfall depths to water quality volumes determined by the "Maximized Volume Method". The following steps describe the use of the Urban Runoff Quality Management Approach utilizing CSU Sacramento's basin sizer program. Most local agencies have a method to calculate the areas Water Quality Volume depth or intensity. Use this locally specified storm depth for the following method. Step one describes the use of Cal State Sacramento's Basin Sizer Program to determine the Water Quality Volume storm depth.

- 1. Use the magnifying glass and hand tools to zoom and pan around the map. Once the BMP site has been located on the map, click on it with the arrow tool. This will cause a list of nearby rainfall stations to appear on the upper right side of the screen. This list has four columns. The first column shows the distance from the site to the station in kilometers. The second shows the elevation of the station in meters. The third column contains the length of recorded data for the station. The fourth column lists the name of the station. These stations are sorted by distance from the project site. Scroll down this list to find the rainfall station that best represents the proposed BMP site and click on it. As a general rule, look for stations with the same elevations and the longest periods of record data ("years"). Identify the "BMP Drainage Area" that drains to the proposed BMP. This includes all areas that will contribute runoff to the proposed BMP, including pervious areas, impervious areas, and off-site areas, whether or not they are directly or indirectly connected to the BMP.**
- 2. Calculate the "Watershed Imperviousness Ratio", which is equal to the percent of total impervious area in the "BMP Drainage Area" divided by 100. Enter this number into the Basin Sizer Program under the Urban Runoff Water Quality Approach Section. The resulting value of the runoff coefficient "C" will be shown to the right.**
- 3. Select the drawn down time of the basin (24 or 48 hours). This is the time it takes for the basin to drain from completely full to empty. Most areas allow a 48-hour drain down time. Longer periods could have vector control issues, which are associated with unwanted mosquito breeding.**

4. **The unit basin storage volume will be automatically calculated.**

5. Calculate the required capture volume of the BMP by multiplying the "BMP Drainage Area" from Step 1 by the "Unit Basin Storage Volume" from Step 5 to give the BMP volume. Due to the mixed units that result (e.g., ac-in., ac-ft) it is recommended that the resulting volume be converted to cubic feet or meters for use during design.

Calculation Example: We will use a project with a BMP drainage area of 1 acre. The projects has water shed imperviousness ratio of .8 (80%). The project is located in Oceanside, CA.

Where:

$$C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$$

$$i = .8$$

Therefore:

$$C = 0.858(.8)^3 - 0.78(.8)^2 + 0.774(.8) + 0.04 \quad (\text{this calculation is automatically performed by entering "i" into the Basin Sizer Program}).$$

$$C = .6$$

Since the project is located in Oceanside, CA the Oceanside Plumbing Plant Rain Station is referenced is chosen in the Basin Sizer Program. Once this station is selected the "i" value is entered.

The Program will determine the unit basin storage volume (in inches). In this example the unit basin storage volume is .5 inches. At this point, .5 inches can be converted in feet.

$$.5/12 = .04167 \text{ feet.}$$

Multiply the unit basin storage volume (in feet) by the projects BMP drainage area. In this example this area is 1 acre or 43,560 square feet.

$.04167 \times 43560 = 1,815$ cubic feet, this is equal to the projects water quality volume (WQv).

WQv = 18,151.5 cubic feet. This number will be used to appropriately size the detention facility and to determine the number of MWS – Linear Systems needed. The number of units will also depend on the level of treatment required, which is dependent on the pollutants of concern and existing TMDLs.

The Vault Type configuration of the MWS – Linear Hybrid Stormwater Treatment System can treat a maximum volume of 4000 cubic feet with a high level of treatment. This is assuming a system discharge rate of 10 gpm (recommended maximum for high level treatment) and a required drain down time of equal to 48-hours. Volume based design always requires pre-detention to store most of the water quality volume prior to treatment through the system. This usually equates to “approximately” one system for every 2 acres, and a specific amount of pre-storage/detention.

A Modular Wetland System, Inc. compliance and design specialist is always available to provide assistance. Call 760-433-7640 or email info@modularwetlands.com.

SECTION TOOLS:

Basin Sizer Program – California State University Sacramento has available an invaluable program to assist in determining water quality flows and volumes. Following is the link for a free download. <http://www.stormwater.water-programs.com/BasinSizer/Basinsizer.htm> This program will work for California. Other states should use state standards.

Coefficient Tables – The following pages (Table 2 and 3) are example of runoff coefficient tables from Riverside and San Diego Counties. These are used to determine “C” values for flow based design calculations.

MWS – Linear Flow and Volume Based Sizing Template – Following is link to email a request for the sizing templates. These interactive templates can be used to determine the number of MWS – Linear Systems required for your project.

info@modularwetlands.com.

Table 2 - RUNOFF COEFFICIENTS FOR URBAN AREAS - SAN DIEGO

NRCS Elements	Land Use	County Elements	% Impervious	Runoff Coefficients "C"			
				Soil Type			
				A	B	C	D
Undisturbed Natural Terrain (Natural)		Permanent Open Space	0*	0.2	0.25	0.3	0.35
Low Density Residential (LDR)		Residential, 1.0 DU/A or less	10	0.27	0.32	0.27	0.41
Low Density Residential (LDR)		Residential, 2.0 DU/A or less	20	0.34	0.38	0.42	0.46
Low Density Residential (LDR)		Residential, 2.9 DU/A or less	25	0.38	0.51	0.45	0.49
Medium Density Residential (MDR)		Residential, 4.3 DU/A or less	30	0.41	0.45	0.48	0.52
Medium Density Residential (MDR)		Residential, 7.3 DU/A or less	40	0.48	0.51	0.54	0.57
Medium Density Residential (MDR)		Residential, 10.9 DU/A or less	45	0.52	0.54	0.57	0.6
Medium Density Residential (MDR)		Residential, 14.5 DU/A or less	50	0.55	0.58	0.6	0.63
High Density Residential (HDR)		Residential, 24.0 DU/A or less	65	0.66	0.67	0.69	0.71
High Density Residential (HDR)		Residential, 43.0 DU/A or less	80	0.76	0.77	0.78	0.79
Commercial/Industrial (N. Com)		Neighborhood Commercial	80	0.76	0.77	0.78	0.79
Commercial/Industrial (G. Com)		General Commercial	85	0.8	0.8	0.81	0.82
Commercial/Industrial (O.P. Com)		Office Professional/Commercial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (Limited I.)		Limited Industrial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (General I.)		General Industrial	95	0.87	0.87	0.87	0.87

Table 3

RUNOFF COEFFICIENTS FOR URBAN AREAS - RIVERSIDE					
Land Use		Runoff Coefficients "C"			
County Elements	% Impervious	Soil Type			
		A	B	C	D
Natural	0*	0.06	0.14	0.23	0.28
	5	0.1	0.18	0.26	0.31
	10	0.14	0.22	0.29	0.34
	15	0.19	0.26	0.33	0.37
	(1-Acre)	20	0.23	0.3	0.36
(1/2-Acre)	25	0.27	0.33	0.39	0.43
	30	0.31	0.37	0.43	0.47
	35	0.35	0.41	0.46	0.5
(1/4-Acre)	40	0.4	0.45	0.5	0.53
	45	0.44	0.48	0.53	0.56
(Condominiums)	50	0.48	0.52	0.56	0.59
	55	0.52	0.56	0.6	0.62
	60	0.56	0.6	0.63	0.65
(Mobilehomes)	65	0.61	0.64	0.66	0.68
	70	0.65	0.67	0.7	0.71
(Apartments)	75	0.69	0.71	0.73	0.74
	80	0.73	0.75	0.77	0.78
(Commercial)	85	0.77	0.79	0.8	0.81
	90	0.82	0.82	0.83	0.84
	95	0.86	0.86	0.87	0.87
	100	0.9	0.9	0.9	0.9