

Title MA DEP Standard Calculations
Project School Street, Manchester-by-the-Sea, MA
Date July 16, 2021
Revised May 25, 2022

By SJL
 Chk'd CMQ
 Apprv'd CMQ

RECHARGE & WATER QUALITY VOLUME CALCULATIONS

$R_v = F * \text{Impervious Area}$

R_v = Required Recharge Volume, expressed in ft^3 , cubic yards or acre-feet

F = Target Depth Factor associated with each Hydraulic Soil Group

Impervious Area = pavement & rooftop area on site

V_{wq} = Required Water Quality Treatment Volume (ft^3)

D_{wq} = Water Quality Depth (in)

A_{IMP} = Impervious Area (excluding non-metal roofs)

Wshed	Area (Sq. Ft)	Landscaped	IMPERVIOUS AREA (S.F.) BY HSG		Recharge Required			Water Quality Volume Required	
			HSG B (F=.35)	HSG D (F=.1)	F Avg. (Inches)	Impervious Area (Sq. Ft)	R_v (ft^3)	D_{wq} (Inch)	V_{wq}
P-1	47,951	47,951	0	0	0.000	0	0	1.0	0
P-2	27,475	27,475	0	0	0.000	0	0	1.0	0
P-3	13,369	13,369	0	0	0.000	0	0	1.0	0
P-4A	118,254	117,844	0	410	0.100	410	3	1.0	34
P-4B	222,364	221,996	0	368	0.100	368	3	1.0	31
P-5	18,638	8,625	0	10,013	0.100	10,013	83	1.0	834
P-6	13,824	13,319	0	505	0.100	505	4	1.0	42
P-7	24,883	23,261	0	1,622	0.100	1,622	14	1.0	135
P-8	22,308	5,702	0	16,606	0.100	16,606	138	1.0	1,384
P-9	15,328	10,270	0	5,058	0.100	5,058	42	1.0	422
P-10	30,352	0	0	30,352	0.100	30,352	253	1.0	2,529
P-11	20,180	0	0	20,180	0.100	20,180	168	1.0	1,682
P-12	27,254	0	0	27,254	0.100	27,254	227	1.0	2,271
P-13	19,004	5,400	0	13,604	0.100	13,604	113	1.0	1,134
P-14	23,938	13,606	0	10,332	0.100	10,332	86	1.0	861
P-15	43,953	34,410	0	9,543	0.100	9,543	80	1.0	795
P-16	10,714	2,661	2,672	5,381	0.183	8,053	123	1.0	671
P-17	23,264	23,264	0	0	0.000	0	0	1.0	0
P-18	20,245	19,561	0	684	0.000	684	0	1.0	57
Total	743,298	588,714	2,672	151,912		154,584	1,338		12,882

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STORMWATER RECHARGE SUMMARY CALCULATIONS

$R_v = F * \text{Impervious Area}$

R_v = Required Recharge Volume, expressed in ft^3 , cubic yards or acre-feet

F = Target Depth Factor associated with each Hydraulic Soil Group

	Required (cf)	Provided (cf)	
$R_v =$	688	39,886	BMP 1 - 96" CMP Underground Infiltration System (P-8, P-9, P-10, P-11, & P-14)
$R_v =$	340	13,139	BMP 2 - MC-3500 Underground Infiltration System (P-12 & P-13)
$R_v =$	216	9,520	BMP 3 - Bioretention Area/Rain Garden #1 (P-7, P-15, P-16 & P-17)
$R_v =$	88	0	BMP 4 - Bioretention Area/Rain Garden #2 (P-5, P-6) (NO RECHARGE CREDIT)
$R_v =$	6	0	Deminimus Unmitigated Area (P-1, P-2, P-3, P-4A, P-4B, P-18)
$R_v =$	1,338	62,545	

STORMWATER QUALITY VOLUME CALCULATIONS

V_{wQ} = Required Water Quality Treatment Volume, expressed in ft^3

D_{wQ} = Water Quality Depth

A_{IMP} = Impervious Area (pavement & rooftop area excluding non-metal roofs)

	Required (cf)	Provided (cf)	
$V_{wQ} =$	6,877	39,886	BMP 1 - 96" CMP Underground Infiltration System (P-8, P-9, P-10, P-11, & P-14)
$V_{wQ} =$	3,405	13,139	BMP 2 - MC-3500 Underground Infiltration System (P-12 & P-13)
$V_{wQ} =$	1,602	9,520	BMP 3 - Bioretention Area/Rain Garden #1 (P-7, P-15, P-16 & P-17)
$V_{wQ} =$	877	1,474	BMP 4 - Bioretention Area/Rain Garden #2 (P-5, P-6) (NO RECHARGE CREDIT)
$V_{wQ} =$	122	0	Deminimus Unmitigated Area (P-1, P-2, P-3, P-4A, P-4B, P-18)
$V_{wQ} =$	12,882	64,019	

DRAWDOWN CALCULATIONS (72 HOURS MAX)

$\text{Time}_{\text{drawdown}} = (R_v) / (\text{Design Infiltration Rate in inches per hour})$ (Conversion for inches to feet) (1/bottom area in feet)

BMP 1 - Underground Infiltration System (Sandy Loam)	
Infiltration Rate (in/Hr)=	1.02
Bottom Area (ft^2) (178' x 54') =	8,946
Infiltration Volume (ft^3) (100-year) =	39,886
$\text{Time}_{\text{drawdown}}$ (Hours)=	52.5

BMP 3 - Bioretention Area/Rain Garden #1 (Sandy Loam)	
Infiltration Rate (in/Hr)=	1.02
Bottom Area (ft^2) (Elev. 60, see Hydro CAD) =	9,520
Infiltration Volume (ft^3) =	9,078
$\text{Time}_{\text{drawdown}}$ (Hours)=	11.2

BMP 2 - Underground Infiltration System-2 (Loamy Sand)	
Infiltration Rate (in/Hr)=	2.41
Bottom Area (ft^2) (170' x 54') =	4,060
Infiltration Volume (ft^3) (100-year) =	13,139
$\text{Time}_{\text{drawdown}}$ (Hours)=	16.1

****BMP-4 will not discharge to groundwater; treatment only.**

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TSS REMOVAL CALCULATIONS WORKSHEET

B BMP ¹	C TSS Removal Rate ¹	D Starting TSS Load*	E Amount Removed (C*D)	Remaining Load (D-E)	B BMP ¹	C TSS Removal Rate ¹	D Starting TSS Load*	E Amount Removed (C*D)	Remaining Load (D-E)	
Deep Sump Catch Basins	0.25	1.00	0.25	0.75	Deep Sump Catch Basins	0.25	1.00	0.25	0.75	
Proprietary Hydro-dynamic Device	0.50	0.75	0.38	0.38	Sediment Removal Proprietary Device	0.50	0.75	0.38	0.38	
Surface Infiltration System w/ Outlet Control	0.80	0.38	0.30	0.08	Rain Garden 1	0.80	0.75	0.60	0.15	
Bio-retention/Rain Garden-1	0.80	0.08	0.06	0.02	N/A					
Total TSS Removal =				99%	Total TSS Removal =				85%	

A BMP ¹	B TSS Removal Rate ¹	C Starting TSS Load*	D Amount Removed (C*D)	E Remaining Load (D-E)
Deep Sump Catch Basins	0.25	1.00	0.25	0.75
Proprietary Hydro-dynamic Device	0.50	0.75	0.38	0.38
Bio-retention/Rain Garden-2	0.80	0.38	0.30	0.08
Total TSS Removal =			93%	

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STORMWATER QUALITY FLOW RATE CALCULATIONS FOR WATER QUALITY UNITS

Structure Name	Total Area (Acres)	Imp. Area (Acres)	A ^{IMP} (Sq. Miles)	Tc (min.)	Tc (hrs.)	WQV (inches)	qu (csm/in)
WQU-1	0.42	0.20	0.00031	6.0	0.10	1	774
WQU-2	0.28	0.18	0.00029	6.0	0.10	1	774
WQU-3	0.85	0.18	0.00028	6.0	0.10	1	774
WQU-4	0.72	0.16	0.00025	6.0	0.22	1	774
WQU-5	0.42	0.31	0.00048	6.0	0.10	1	774
WQU-6	0.51	0.38	0.00060	6.0	0.10	1	774

Water Quality Flow Rate = Q1 = (qu) (A) (WQV)

Structure Name	Q1 (cfs)	
DMH-1 (WQU-1)	0.24	Use Contech CDS Model 1515-3 (design flow = 1.0 cfs)(or approved equal)
DMH-2 (WQU-2)	0.22	Use Contech CDS Model 1515-3 (design flow = 1.0 cfs)(or approved equal)
DMH-5 (WQU-3)	0.22	Use Contech CDS Model 1515-3 (design flow = 1.0 cfs)(or approved equal)
DMH-8 (WQU-4)	0.19	Use Contech CDS Model 1515-3 (design flow = 1.0 cfs)(or approved equal)
DMH-12 (WQU-5)	0.37	Use Contech CDS Model 1515-3 (design flow = 1.0 cfs)(or approved equal)
DMH-15 (WQU-6)	0.46	Use Contech CDS Model 1515-3 (design flow = 1.0 cfs)(or approved equal)