SUBSURFACE INFILTRATION CONCEPT DESIGNS
BIRCH MEADOW PARK – PARKING LOT
VERSION 1
8/7/20

Prepared for:

Town of Reading, MA

Prepared by:

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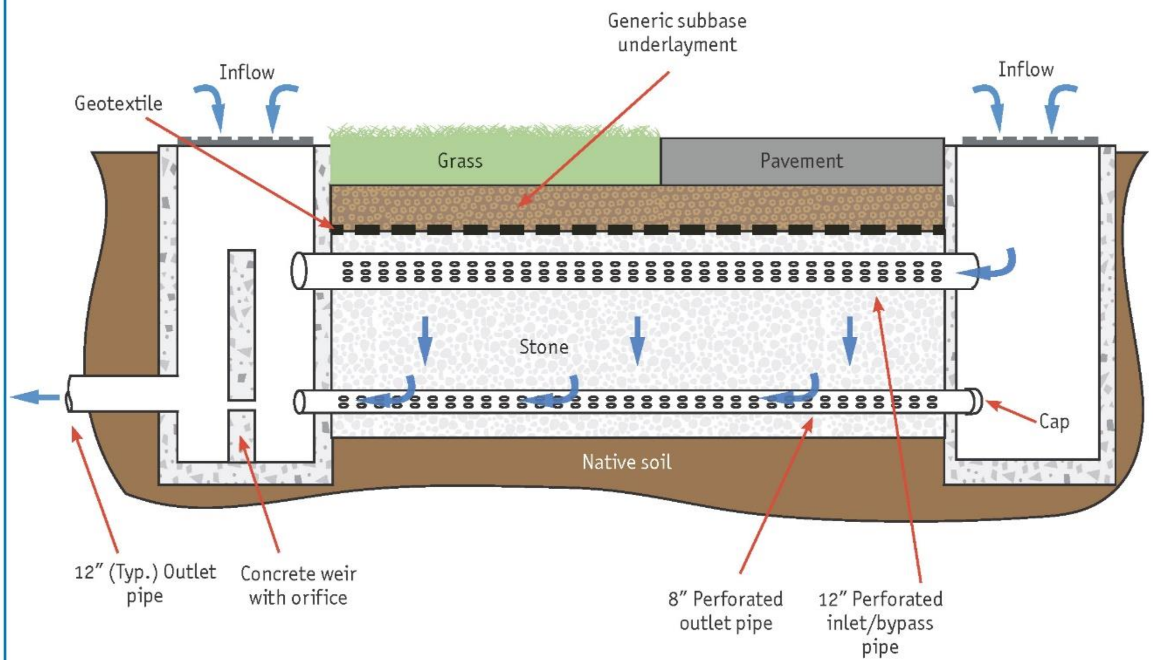
Generic Subsurface Gravel Filter Design Detail

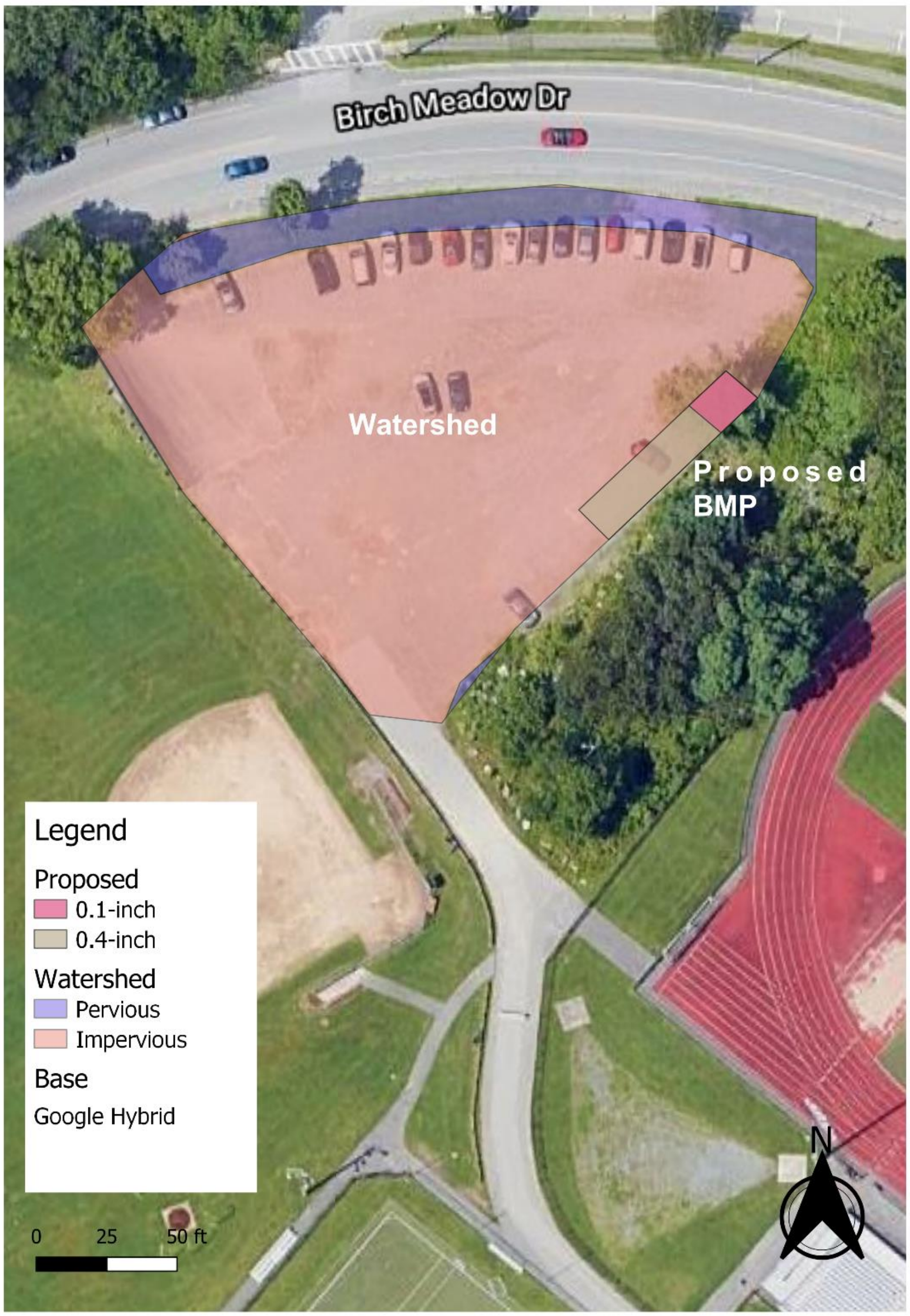


Notes

1. Similar to infiltration trenches, subsurface gravel filters are appropriate for sites that can accommodate larger system footprints and widths.
2. The storage layer (stone shown here) can be comprised of natural or manufactured materials to hold the design storage volume (DSV).
3. Locate the bypass to drain through the outlet pipe to existing drainage. The elevation may vary to meet existing infrastructure inverts, and flow is controlled through orifices and weirs.
4. Hydraulic inlets should drain by gravity where possible.
5. Surface cover may vary—pavement, grass, soil, or any combination of these can be used to meet end user needs and site requirements.
6. Add cleanouts and/or inlet protection, such as a snout or The Eliminator, as needed.

1 PROJECT AND SITE OVERVIEW

After discussions with the Town of Reading, the town expressed the need for small-scale BMP systems that could be built and maintained by the town in the parking lots, roads, and right-of-way to improve stormwater management while keeping costs and maintenance low. The main area of interest is along Birch Meadow Dr. The location indicated for improvement is in the parking lot shown below. The site is currently a gravel parking lot, however, there are plans to improve the site. The approximate watersheds for surface runoff is indicated, and the impervious cover is shown as in blue (pervious) and red (impervious).

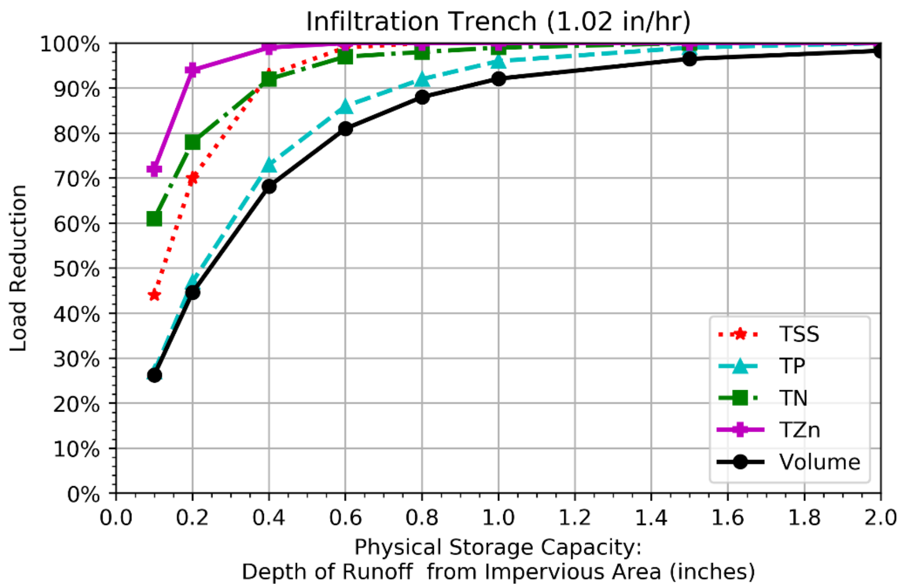


The following table shows the summary of the surface watershed:

Watershed	Pervious (ac)	Impervious (ac)	Total (ac)	% IC
1	0.077	0.628	0.705	89%

2 BMP SIZING

The proposed subsurface infiltration designs are shown with the optimized performance sized for 0.4 inches of precipitation on the impervious cover. The sizing of 0.4-inch provides the cost-optimized sizing. This size optimizes the removal efficiency vs cost of the system and would be the cost-optimized solution if applied wide-spread. An infiltration rate of 1.02 in/hr was assumed for this site without having performed any in-situ soil tests. The graph below shows the performance curve for an infiltration trench with an infiltration rate of 1.02 in/hr (BMP Performance Fact Sheets, UNH Stormwater Center, 2019).



The cost-optimized size would occur at the shoulder of the line when there are diminishing returns of performance for an increase in Physical Storage Capacity (PSC) size. This can be estimated quickly to be about between 0.4-0.6 for all parameters. It may also be calculated by finding the root of the second derivative of the line (as done here). The following table shows the cost optimization size in precipitation depth for all the parameters. Note that most parameters are about 0.4 inches, but to optimize for volume requires a larger system at 0.6 inches; TP requires the largest system at 0.8 inches.

	Optimized PSC (in)
Volume	0.6
TP	0.8
TN	0.4
TSS	0.4
TZn	0.3
E. coli	0.4

The PSC is simply a ratio of the volume of voids in the system to the Water Quality Volume (WQV), or the depth of runoff from the impervious area only. So, a system sized to hold the WQV has a PSC of 1-

inch. If the system has half the voids of the WQV, it has a PSC of 0.5-inch, etc. The optimized sizing of 0.4-inch means the system is sized to have voids capable of holding 0.4-inches of precipitation on the impervious cover. The treatment performance is not linearly correlated to the system capacity (PSC). As the system is built larger (and costs increase), the increase in performance decreases and there are diminishing returns in performance. A system sized for the 1-inch WQV may have performance between 91%-100% for all parameters, however a system sized at 40% of the capacity to treat 0.4-inch has load reductions ranging from 70% to 100% so there is little penalty in performance for building a smaller system. Construction of the much larger 1-inch system has significantly increased construction and real-estate costs.

3 PROPOSED DESIGNS

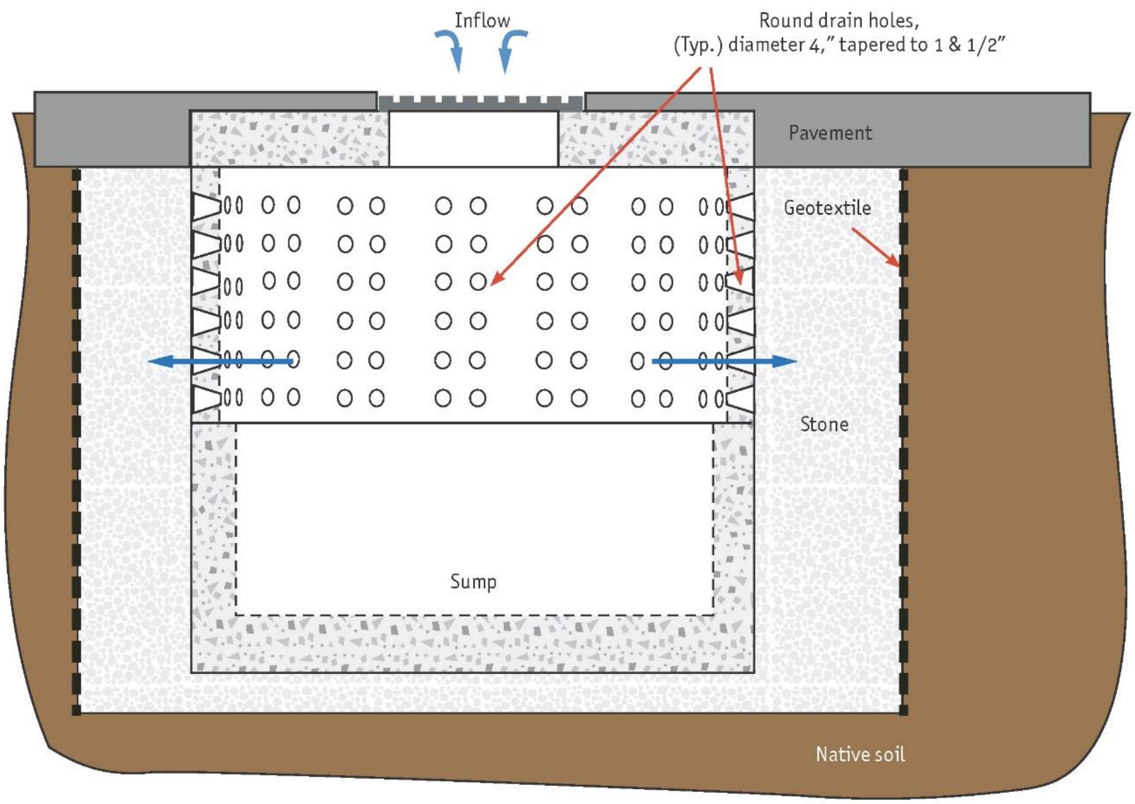
The proposed designs shown here are the approximate watersheds and subsurface infiltration BMP sizing. These concepts did not investigate site constraints in detail such as native soils infiltration rates and elevation constraints.

The proposed designs used a subsurface infiltration BMP with a stone reservoir depth of 2-feet to allow adequate cover and elevation to daylight into the Aberjona River adjacent the parking lot. This allows for sufficient cover material, including pavement.

The following generic design detail shows the subsurface infiltration profile. This sketch shows two catch basins in the BMP as an inlet and outlet; however, it can easily be modified to only have an inlet catch basin. In this case, the lower perforated outlet pipe would be drilled with an orifice; or it could be removed altogether if constraints do not allow it and sufficient infiltration in the trench is expected.

Where applicable, typical solid catch basins may be replaced with leaching catch basins with a perforated upper section to facilitate infiltration. The bottom of the basin remains solid to facilitate typical maintenance and removal of solids. The excavation would be backfilled with stone instead of the native material to provide additional void space for infiltration.

Generic Leaching Catch Basin Design Detail



Notes

1. Leaching catch basins are appropriate for sites with higher conductivity soils or where infiltration is suitable.
2. These systems can replace conventional deep sump catch basins where infiltration is appropriate.
3. The bottom should remain solid (as shown here) to function as a deep sump catch basin and to facilitate long term maintenance.
4. The excavation may be oversized and backfilled with stone to accommodate larger design storage volumes (DSV).
5. As with other infiltration systems, to limit clogging a geotextile may be used to curtain the excavation sidewalls but not on the bottom of the excavation.

3.1 BMP Design and Performance

The nutrient loading, system DSV, PSC, and removal efficiency performance were calculated using the BMP Performance Calculator (UNHSC 2019) based on calculations and performance data from the BMP Performance Fact Sheets (UNSCH 2019) and the NH Small MS4 General Permit, Appendix F (EPA Region I, 2017). The following summary table shows the two optional sizing designs: the minimum 0.1-inch and cost-optimized 0.4-inch PSC's.

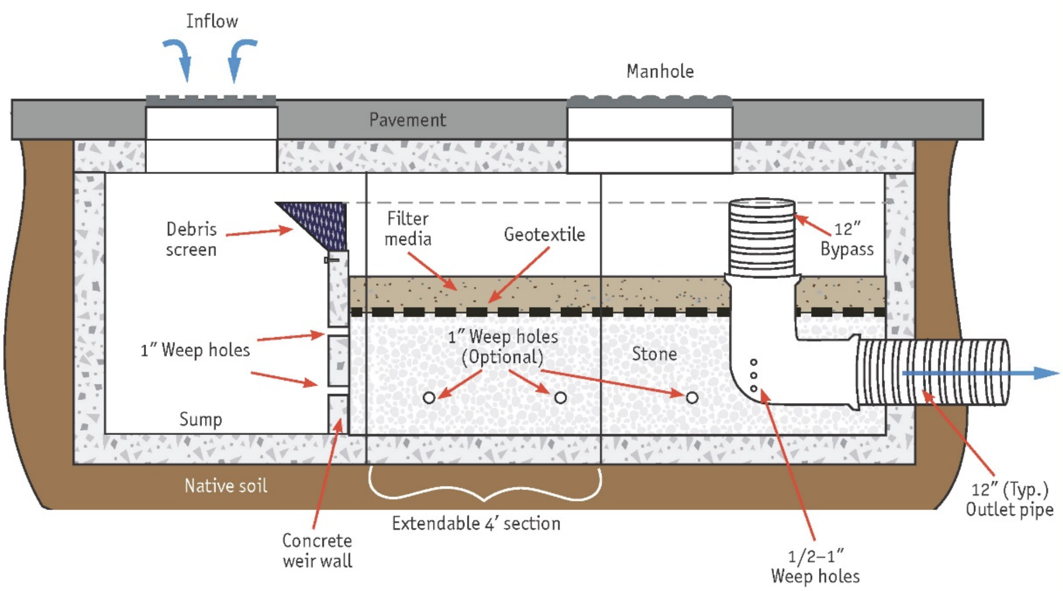
	Parameter	0.1-inch sizing	0.4-inch sizing	Units
	BMP ID	1		
Site	Location	Birch Meadow Park		
	Watershed Area	0.705		ac
	Impervious	89%		
	Inf. Rate	1.02	1.02	in/hr
Design	Width (W)	15	15	ft
	Length (L)	18	73	ft
	Area (A_{bed})	272	1090	ft^2
	Depth of Stone (D_{gravel})	2	2	ft
	Stone Porosity (η)	0.4	0.4	cm^3/cm^3
Performance	PSC	0.10	0.40	in
	Vol_{RE}	26%	68%	
	TP_{RE}	27%	73%	
	TN_{RE}	61%	92%	
	TSS_{RE}	44%	93%	
	TZn_{RE}	72%	99%	
Nutrient Loading	P - Pre-BMP export	1.12	1.12	lb/yr
	N - Pre-BMP export	9.42	9.42	lb/yr
	TSS - Pre-BMP export	236.97	236.97	lb/yr
Removal	**P Reduction**	**0.30**	**0.82**	**lb/yr**
	N Reduction	**5.75**	**8.66**	**lb/yr**
	TSS Reduction	**104.27**	**220.38**	**lb/yr**
	Volume Reduction (By infiltration)	**25,086**	**65,053**	**cf/yr**
	Volume Reduction (depth on IA)	**11.0**	**28.5**	**in/yr**

3.2 Questions and Next Steps

- Considering site specific constraints and town-wide goals, proceed with 0.1-inch or 0.4-inch sizing?
- Is the ditch adjacent the parking lot part of the Aberjona River? If so, shoreland permit?
- What is the elevation difference from parking lot surface to Aberjona River ditch bottom?
- What is the normal depth of flow in the Aberjona River ditch?

Appendix C: Watertown Media Box Filter Concept Design

Generic Sectional Media Box Filter Design Detail



Notes

1. Media box filters may replace deep sump catch basins to enhance water quality treatment.
2. Generally sized to treat 0.25 acre of impervious cover, the system may be expanded to treat larger areas with the addition of 4-foot sections in the middle to increase the filter media area.
3. The system may be lined if infiltration is not suitable, or weep holes may be added to facilitate infiltration if appropriate.
4. Filter media mixes may vary but should be comprised of sandy soils with high conductivity. Amendments may be added to enhance water quality treatment.
5. Depth of soil may vary between 6 and 12 inches as most filtration occurs at the surface.
6. To facilitate annual maintenance and/or filter media replacement, a woven textile may be added between filter media and stone reservoir.

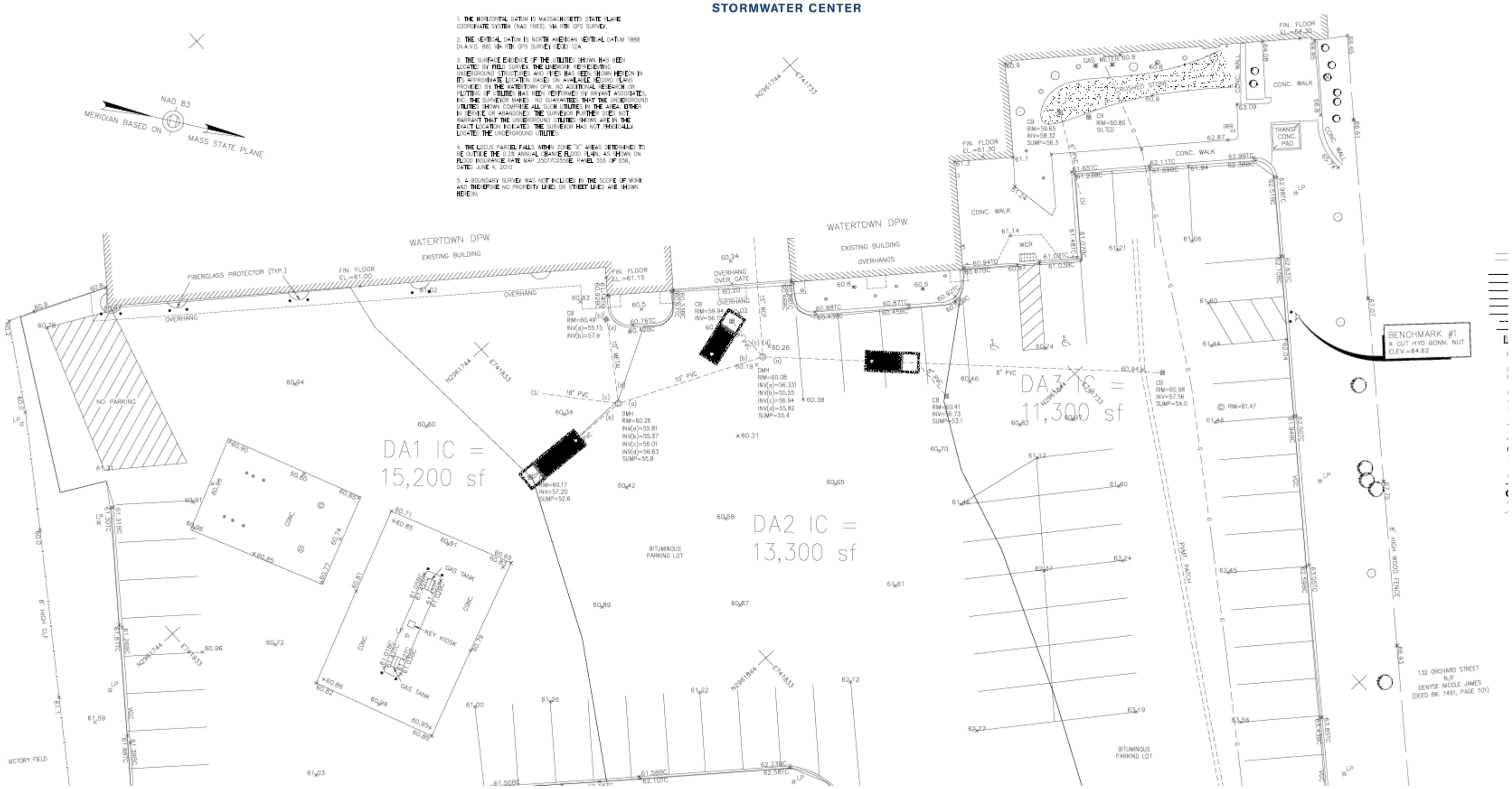


Figure 1: Plan view for installation of three innovative media box filters at the Watertown DPW

Watertown Results:

Parameter	Abbrev.	Units	BMP 1	BMP 2	BMP 3
BMP ID/Name			Left	Middle	Right
Description/Notes			pump island	yard entrance	right parking lot
Watershed	DA	ac	0.35	0.31	0.26
Percent Impervious Cover	%IA	-	100%	100%	100%
Impervious Cover	IA	ac	0.35	0.31	0.26
Land Use	LU	-	Commercial and Industrial	Commercial and Industrial	Commercial and Industrial
P - Pre-BMP export	PPre	lb/yr	0.62	0.54	0.46
N - Pre-BMP export	NPre	lb/yr	5.23	4.58	3.89
TSS - Pre-BMP export	TSSPre	lb/yr	131.69	115.23	97.90

RE not yet modeling for design flow systems.