

APPENDIX A

StormGarden Vault Configurations

StormGarden Vault Filter

Technology Description

The StormGarden Vault Filter (SGVF) is an underground vault version of the StormGarden tree-box filter with the addition of a pre-treatment chamber upstream of the filter chamber. The filter consists of three chambers, an inlet chamber, a treatment chamber with a filter bed, and an outlet chamber with a bypass weir, housed in an underground concrete vault. While the StormGarden tree-box filter is typically located along the curb of a roadway or parking lot accepting runoff through a throat inlet, the concrete vault can either be installed flush with finish grade to allow water to enter through a grated inlet or can be buried underground to accept runoff from a pipe fed by curb inlets located upstream of the filter. Stormwater runoff enters the pre-treatment chamber through an inlet pipe or a grated inlet allowing gross solids to settle out and trapping floating trash and debris preventing them from reaching the filter chamber. Pre-treated flow is then directed to the treatment chamber through a submerged opening in the baffle wall between the inlet chamber and the filter chamber.

The treatment chamber contains a filter media bed that is identical to the standard StormGarden filter media used in the TAPE test unit. The standard StormGarden media consists of a 3" top layer of shredded wooden mulch, a 21" middle layer of the standard StormGarden engineered media, and a bottom 6" layer of clean underdrain stone housing a 4" or 6" perforated underdrain pipe that discharges directly to the outlet chamber.

The outlet chamber is opened at the top providing an overflow weir that allows flows exceeding the treatment flow to bypass the system internally, thus allowing the filter to be installed on-line or off-line.

Pre-Treatment Chamber (Inlet Chamber)

Although the StormGarden Vault Filter (SGVF) is basically identical to the StormGarden tree-box filter, one big difference is the addition of the pre-treatment chamber. Because the runoff is entering the filter via a pipe, in order to prevent scour of the filter media, a pre-treatment chamber with a permanent pool of water was added. The chamber has a dual function, first the permanent pool of water in the chamber provides energy dissipation of the influent flow thus eliminating the possibility of scouring of the media. Second, the chamber pre-treats the influent prior to entering the filter chamber by allowing gross solids to settle to the bottom of the chamber and trapping floating trash and debris inside the chamber. By pre-treating the influent, we are extending the life of the media and reducing the annual maintenance costs. The chamber also allows the filter media to maintain its design hydraulic flow rate over a longer period of time by preventing sediment from building up on top of the media and clogging it.

The addition of the pre-treatment chamber will improve the performance of the StormGarden filter above and beyond what was demonstrated in the TAPE test as shown in this report.

StormGarden Filter Media

The SGVF filter chamber contains the same StormGarden standard filter media used in the TAPE test unit as detailed in the attached report. The overall media consists of a 3" top layer of shredded hardwood mulch, a 21" middle layer of the StormGarden engineered media, and a 6" thick bottom layer of clean underdrain stone. Within the stone layer is a 4" or 6" diameter perforated underdrain pipe that collects the water after filtering down through the media allowing the treated water to drain directly to the outlet chamber.

Bypass Weir/Outlet Chamber

The outlet chamber is a separate chamber inside the filter structure that is opened on top with the top perimeter acting as a bypass weir. The top of the wall, which acts as the weir, is set at an elevation 6 inches above the top of the filter media. This provides 6 inches of ponding over the top of the media allowing storage of the treatment flow as it filters down through the media. As the flow rate exceeds the design treatment flow rate, the water begins to rise above the weir bypassing the filtering process.

Concrete Structure

The SGVF container structure consists of a reinforced precast concrete shell that is designed to support AASHTO HS-20 wheel loading as well as varying depths of earth fill over the top of it. Access to the inside of the filter structure is through manhole covers above each chamber.

Site Installation Requirements

The following subsections describe the site installation requirements including necessary soil characteristics, hydraulic grade requirements, depth to groundwater limitations, utility requirements, and other limitations.

Necessary Soil Characteristics

The SGVF requires a level stone bed with a minimum thickness of 6 inches.

Hydraulic Grade Requirements

The elevation between the invert of the influent pipe and the invert of the outlet pipe is 2'-10". The SGVF allows for 6 inches of freeboard within the system for head accumulation. If the drop across the system, as measured from the invert of the influent pipe to the invert of the outlet pipe, is greater than or equal to 2'-10", the SGVF will not induce significant backwater in the collection system upstream. If the drop across the system is less than 2'-10", backwater may occur. Given the physical constraints of the system, the drop across the system cannot be less than 2'-4".

Depth to Groundwater Limitations

The SGVF does not have depth-to-groundwater limitations since it is a fully enclosed watertight system. With regards to buoyancy, if the groundwater elevation is such that the structure becomes buoyant, an exterior concrete anti-flotation collar can be added to the base of the structure to increase the structure weight to prevent it from floating.

Utility Requirements

The SGVF is designed to be a passive system requiring no power and has a free-draining outfall to an appropriate water conveyance or storage system (i.e. wet pond, storm sewer, underground filtration).

Treatment Process

Because the StormGarden Vault Filter uses the same filter media as the StormGarden tree-box filter, the treatment process is as described in the StormGarden report.

Sizing Methodology

Because the SGVF has the same basic function and media as the StormGarden tree-box filter, and comes in similar sizes, the sizing methodology is the same as the standard StormGarden tree-box filter as detailed in the attached report.

Below is a chart showing the available sizes of the StormGarden Vault Filter (SGVF). The smaller filter sizes are housed in a singular reinforced concrete vault ranging in size from 4' x 6' up to 8' x 18'. The larger filters, "StormGarden/Magna-Pod Vault Filter" (SGMPVF), consists of modular concrete components adjoined together to create larger filters.

Filter	Vault Width	Vault Length	Media Length	Filter Area (sf)
SGVF-46	4'-0"	6'-0"	3'-9"	15
SGVF-48	4'-0"	8'-0"	5'-9"	23
SGVF-410	4'-0"	10'-0"	7'-9"	31
SGVF-412	4'-0"	12'-0"	9'-9"	39
SGVF-66	6'-0"	6'-0"	3'-9"	22.5
SGVF-68	6'-0"	8'-0"	5'-9"	34.5
SGVF-610	6'-0"	10'-0"	7'-9"	46.5
SGVF-612	6'-0"	12'-0"	9'-9"	58.5
SGVF-614	6'-0"	14'-0"	11'-9"	70.5
SGVF-616	6'-0"	16'-0"	6'-6"	78
SGVF-618	6'-0"	18'-0"	7'-6"	90
SGVF-88	8'-0"	8'-0"	5'-9"	46
SGVF-810	8'-0"	10'-0"	7'-9"	62
SGVF-812	8'-0"	12'-0"	9'-9"	78
SGVF-814	8'-0"	14'-0"	11'-9"	94
SGVF-816	8'-0"	16'-0"	6'-6"	104
SGVF-818	8'-0"	18'-0"	7'-6"	120
SGMPVF-2	14'-0"	16'-0"	8'-0"	147
SGMPVF-3	22'-0"	16'-0"	8'-0"	253
SGMPVF-6	22'-0"	32'-0"	8'-0"	464

Operation & Maintenance Requirements

Inspection

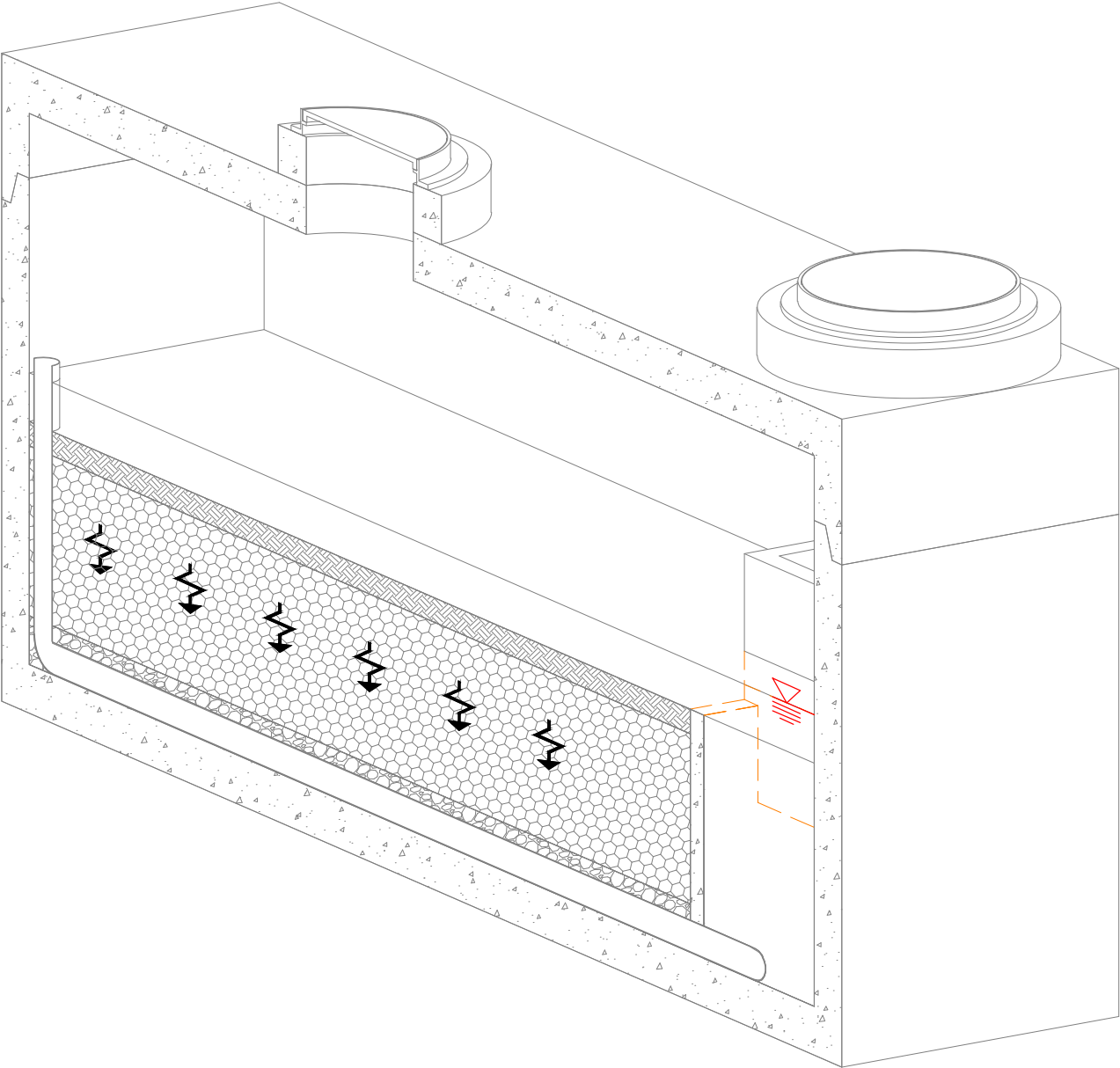
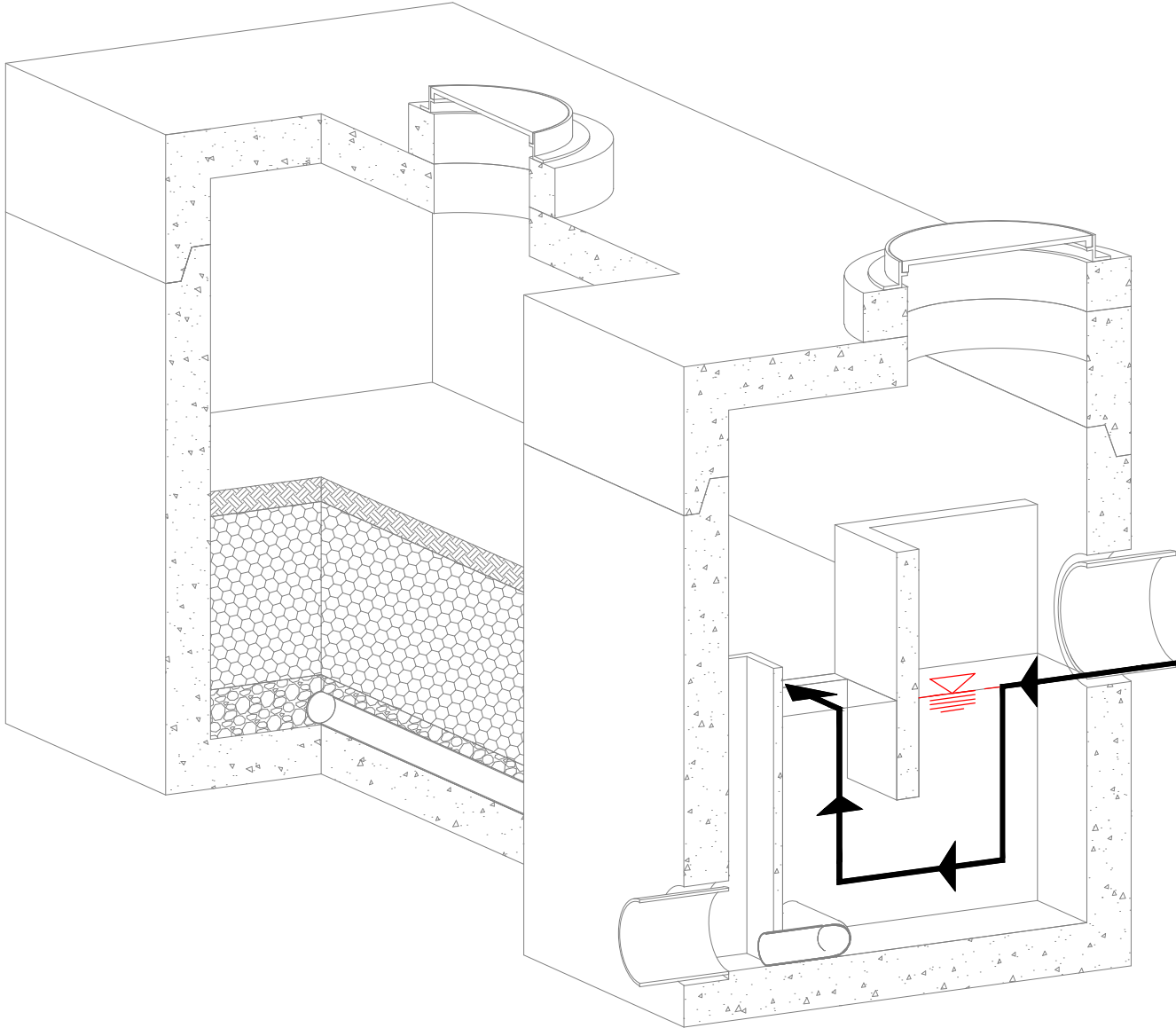
The SGVF inspections are visual and may be conducted from the ground surface without entering the unit. To complete an inspection, safety measures including traffic control should be deployed before the access covers are removed. Once the covers have been removed, the following items should be checked and recorded to determine whether maintenance is required.


- Observe whether the inlet pipe or bypass weir is blocked or obstructed. The outlet pipe is covered by the outlet chamber wall and cannot be observed without entering the unit.
- Observe and record the amount of floating trash and debris in the inlet chamber. The significance of accumulated floating trash and debris is a matter of judgement. A long-handled net may be used to retrieve the bulk of trash and debris at the time of inspection if full maintenance due to the accumulation of floating oils or settled sediment is not yet warranted.
- Observe and record the amount of accumulated oils in the inlet chamber. The significance of accumulated floating oils is a matter of judgement. However, if there is evidence of an oil or fuel spill, immediate maintenance by appropriate certified personnel is warranted.
- Observe and record the average accumulation of sediment in the inlet chamber. A calibrated dip-stick or tape measure may be used to determine the amount of accumulated sediment. The depth of sediment may be determined by calculating the difference between the measurement from the surface of the permanent pool to the top of the accumulated sediment and the measurement from the surface of the permanently pool to the bottom of the inlet chamber.
- Observe and record the amount of sediment, trash and debris resting on top of the filter bed.

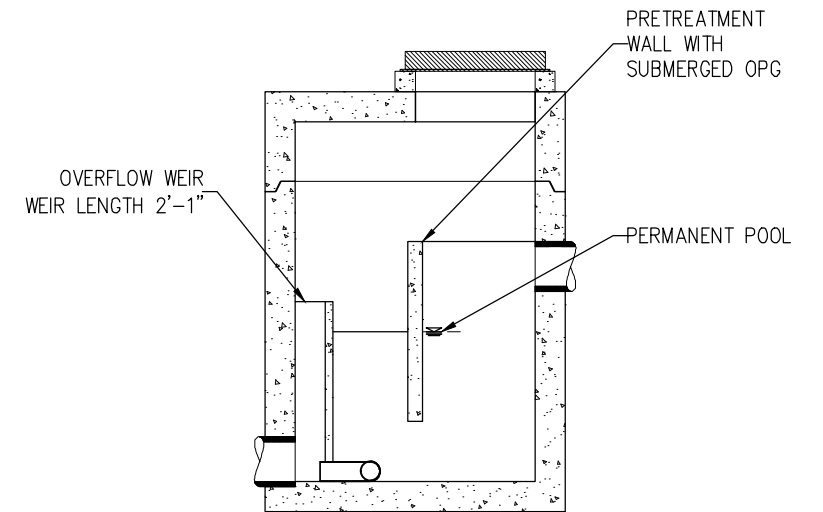
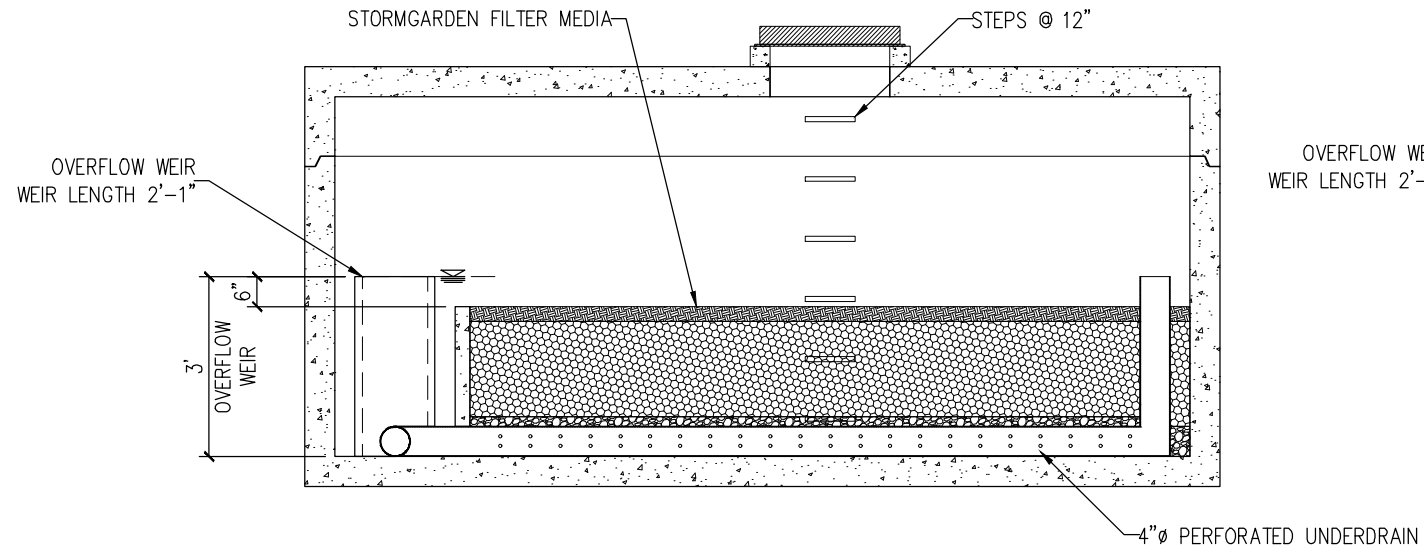
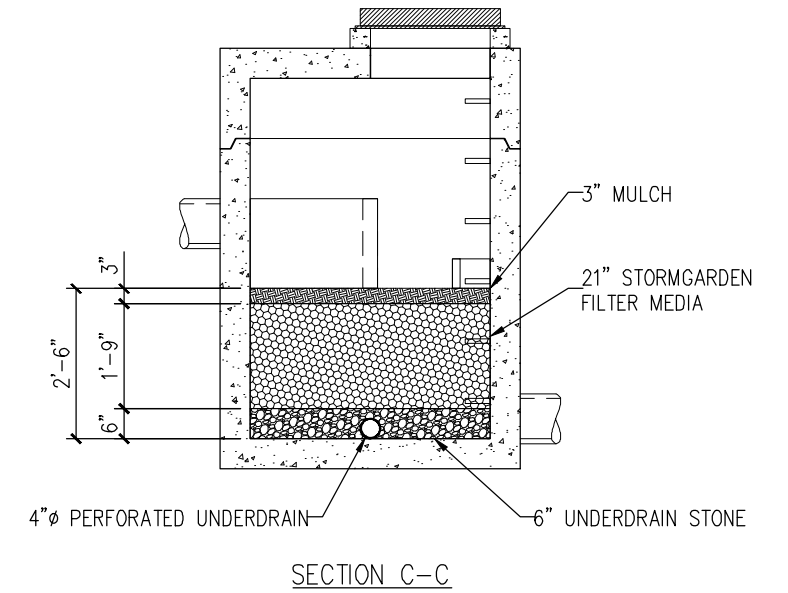
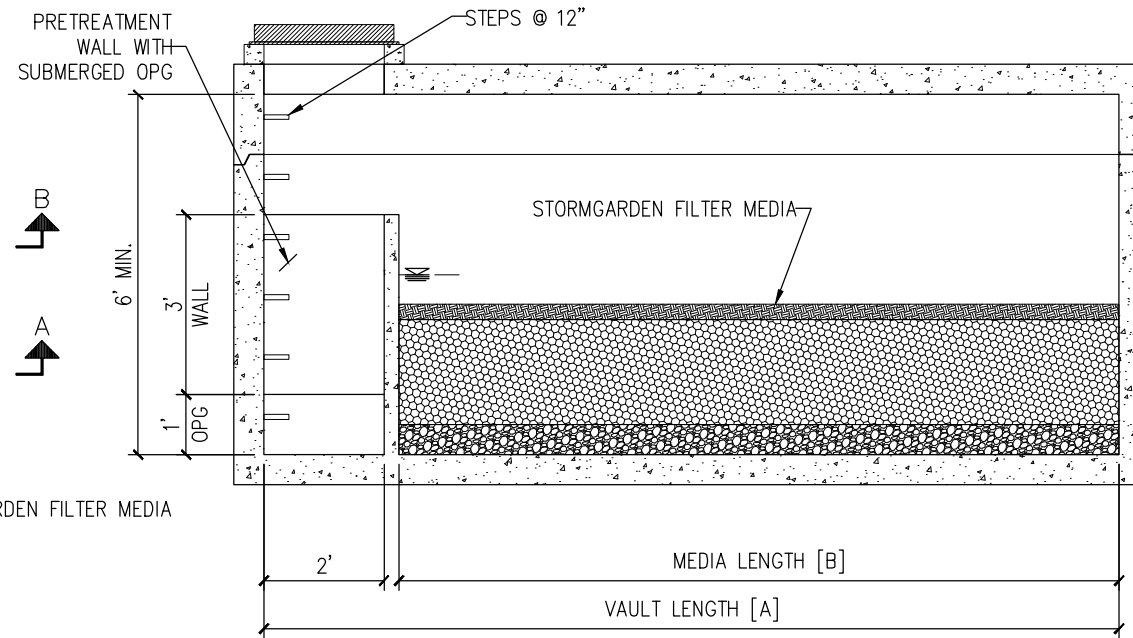
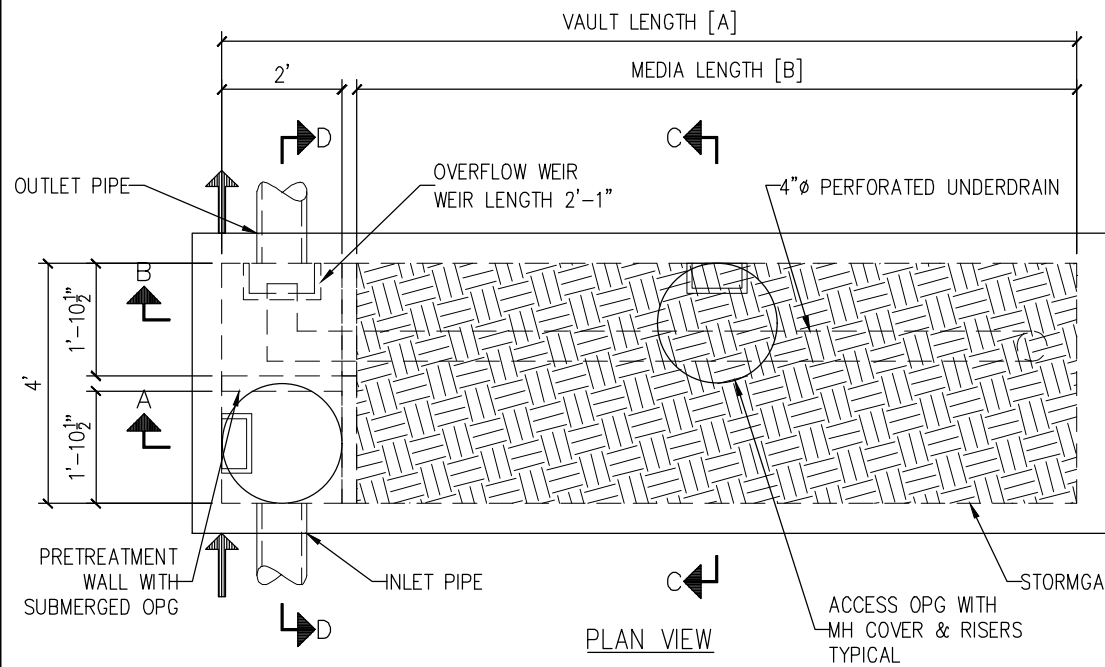
Maintenance Procedures

Maintenance should be conducted during dry weather when no flow is entering the system. Confined space entry is necessary to maintain the StormGarden Vault Filter. Only personnel that are OSHA Confined Space Entry trained and certified may enter underground structures. Once safety measures such as traffic control are deployed, the access covers may be removed, and the following activities may be conducted to complete maintenance.

- Remove floating trash, debris and oils from the water surface in the inlet chamber using the extension nozzle on the end of the boom hose of the vacuum truck. Continue using the vacuum truck to completely dewater the inlet chamber and evacuate all accumulated sediment from the inlet chamber. Some jetting may be required to fully remove sediment. The inlet chamber does not need to be refilled with water after maintenance is complete. The system will fill with water when the next storm event occurs.
- Remove built-up sediment, trash and debris on top of the filter media by removing the top 3-inch layer of mulch. After removing the mulch, inspect the filter media to determine if sediment build-up has occurred. If sediment is detected, scrape off the top few inches of media until clean media is reached and replace with clean media. Replace the top layer of mulch with new mulch.
- Securely replace access covers, as appropriate.
- The handling and disposal of sediment and waste must comply with all local, county, state and federal regulations.



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△			SCALE: NTS		
△			JOB NO.:		
△			CUSTOMER:		DWG. NO.
△					SHT.



SGVF-4X STORMGARDEN FILTERS				
DESIGNATION:	[A] VAULT LENGTH:	[B] MEDIA LENGTH:	WEIR LENGTH:	**BYPASS FLOW (CFS):
SGVF-46	6'-0"	3'-9"	2'-1"	2.48
SGVF-48	8'-0"	5'-9"	2'-1"	2.48
SGVF-410	10'-0"	7'-9"	2'-1"	2.48
SGVF-412	12'-0"	9'-9"	2'-1"	2.48

** BYPASS FLOW RATE IS BASED ON A HEAD OF 0.50' ABOVE THE WEIR.

- DESIGN NOTES:
- CONCRETE MINIMUM (28-DAY) COMPRESSIVE STRENGTH: 5,000 PSI
 - REINFORCING BARS CONFORMING TO ASTM A615 (FY = 60 KSI)
 - DESIGN LIVE LOAD: HS-20

SGVF-4X STORMGARDEN FILTERS

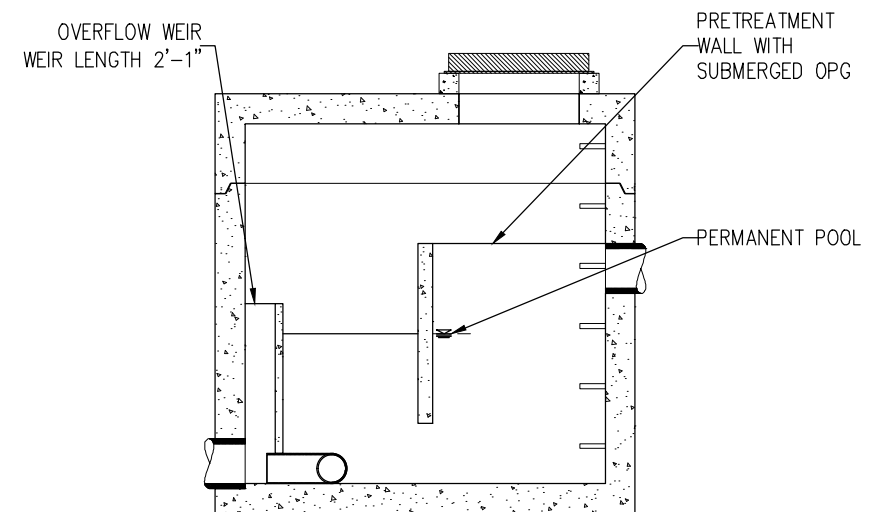
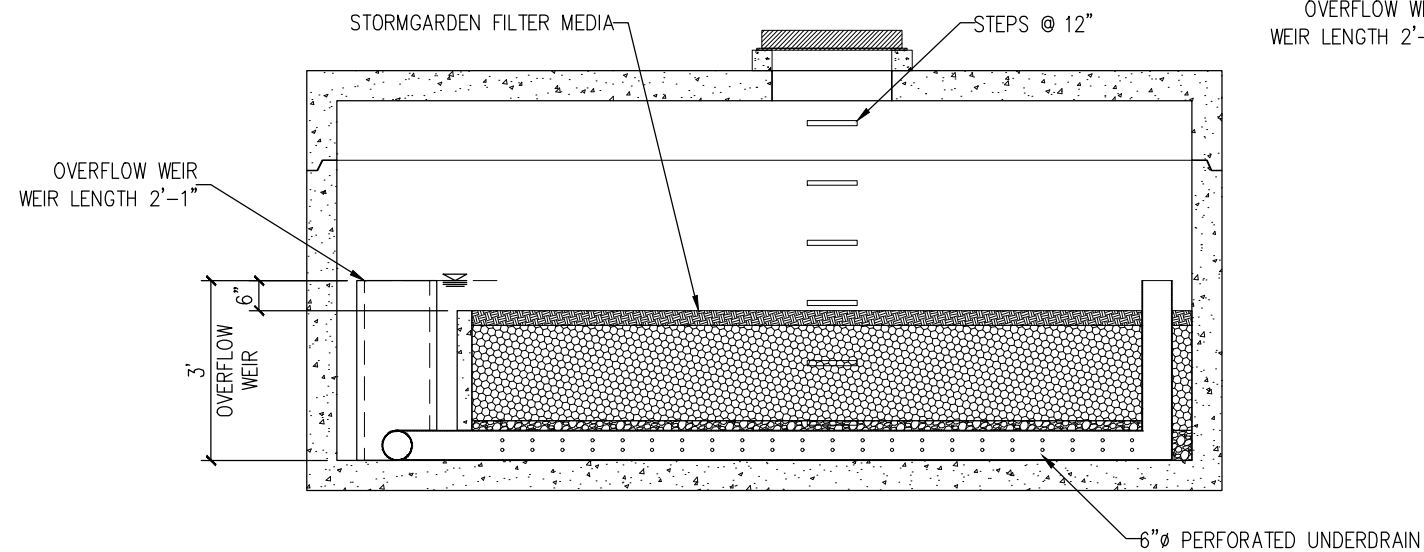
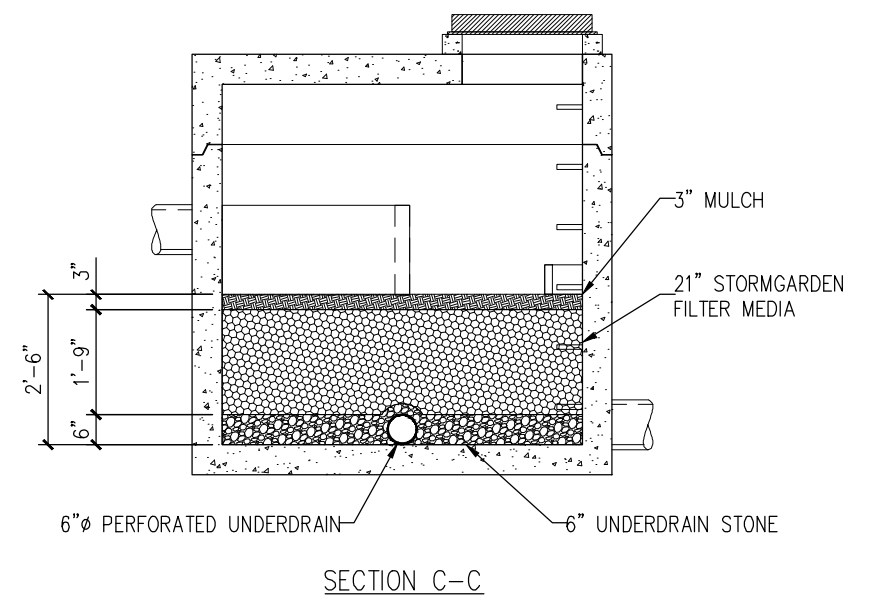
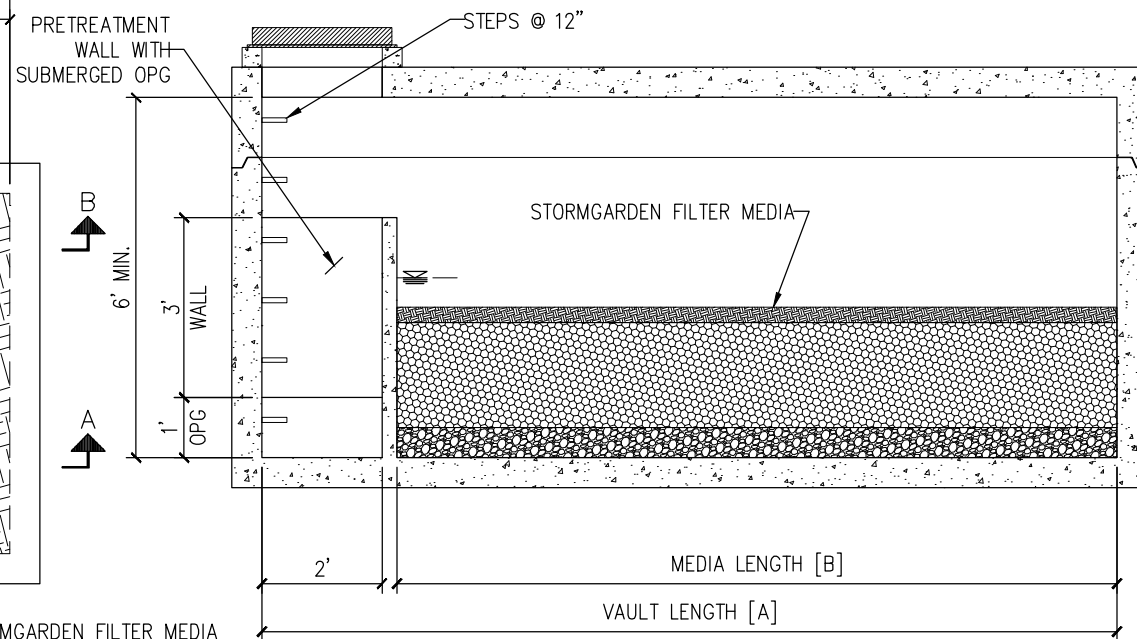
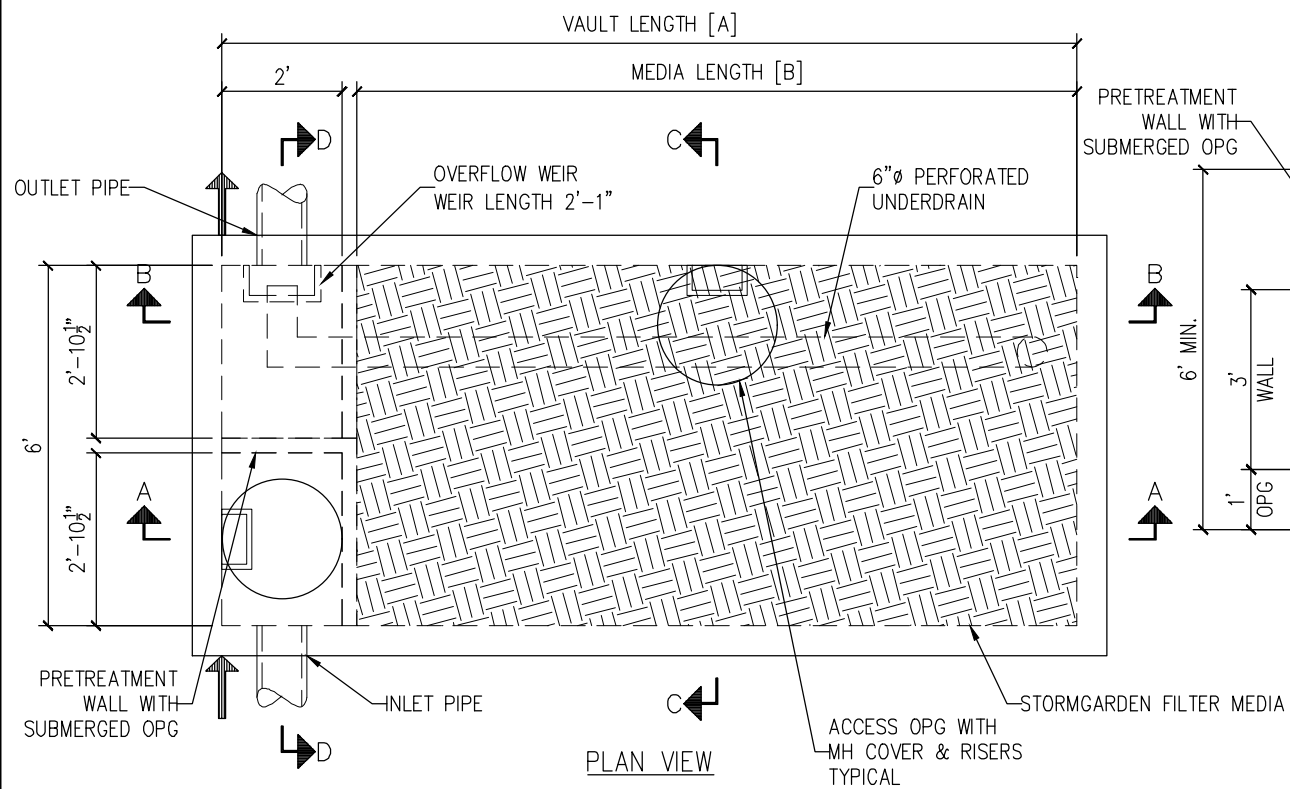
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SGVF-6X STORMGARDEN FILTERS				
DESIGNATION:	[A] VAULT LENGTH:	[B] MEDIA LENGTH:	WEIR LENGTH:	**BYPASS FLOW (CFS):
SGVF-66	6'-0"	3'-9"	2'-1"	2.48
SGVF-68	8'-0"	5'-9"	2'-1"	2.48
SGVF-610	10'-0"	7'-9"	2'-1"	2.48
SGVF-612	12'-0"	9'-9"	2'-1"	2.48
SGVF-614	14'-0"	11'-9"	2'-1"	2.48
** BYPASS FLOW RATE IS BASED ON A HEAD OF 0.50' ABOVE THE WEIR.				

DESIGN NOTES:

- CONCRETE MINIMUM (28-DAY) COMPRESSIVE STRENGTH: 5,000 PSI
- REINFORCING BARS CONFORMING TO ASTM A615 (FY = 60 KSI)
- DESIGN LIVE LOAD: HS-20

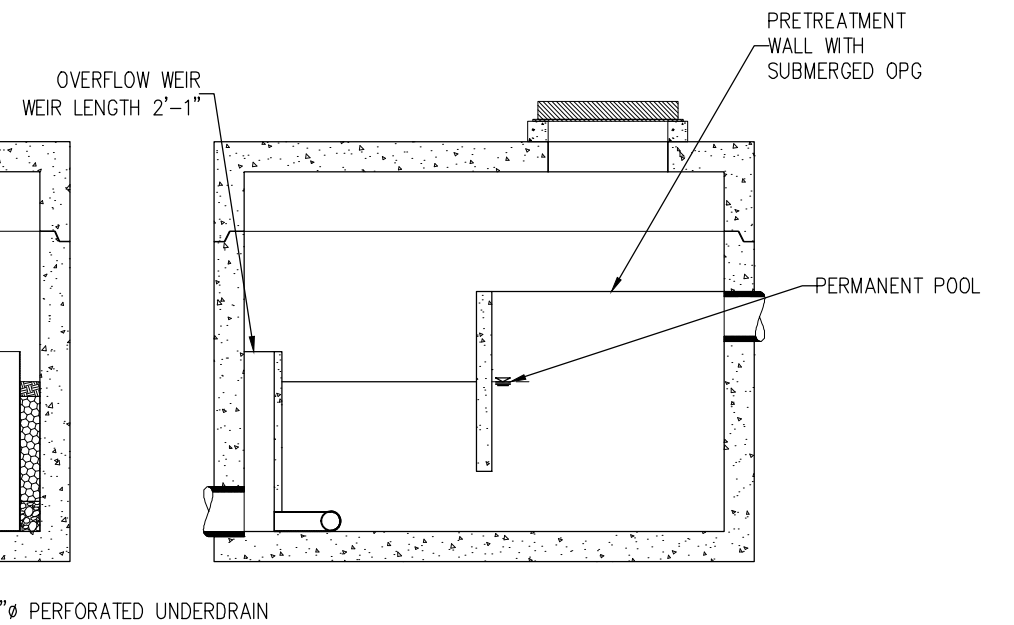
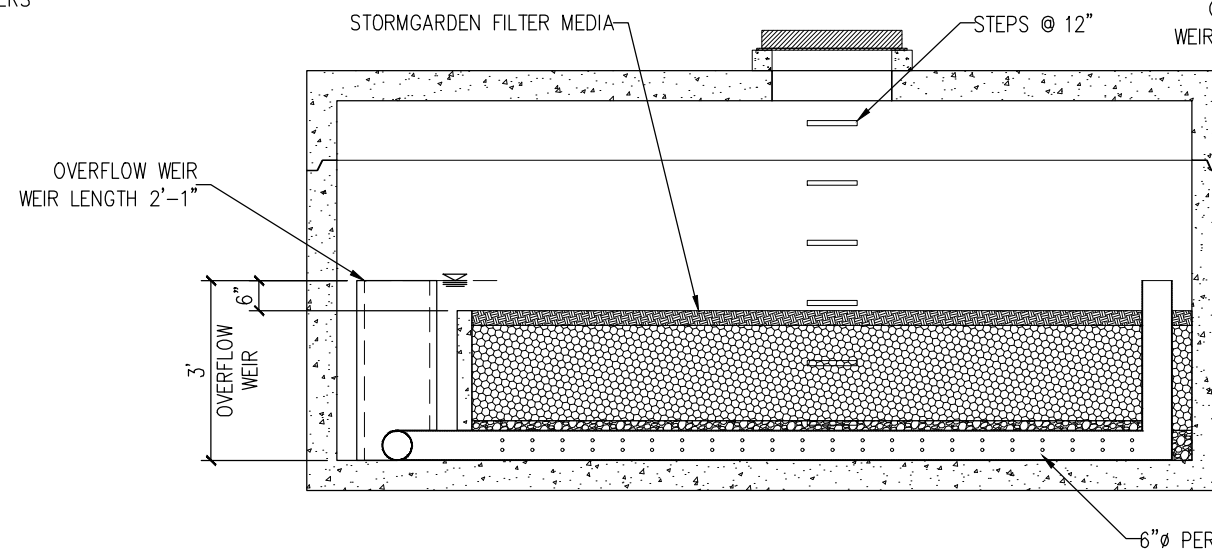
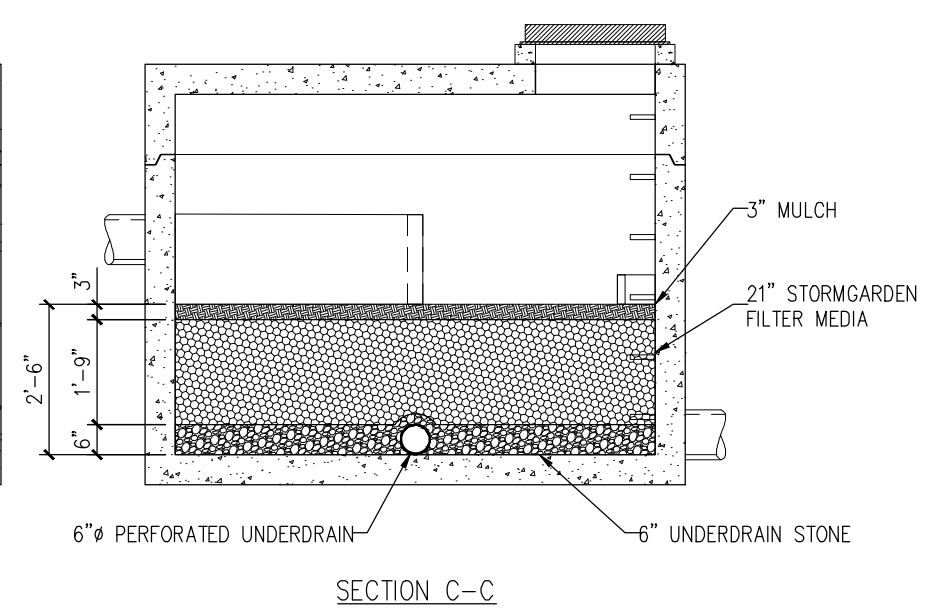
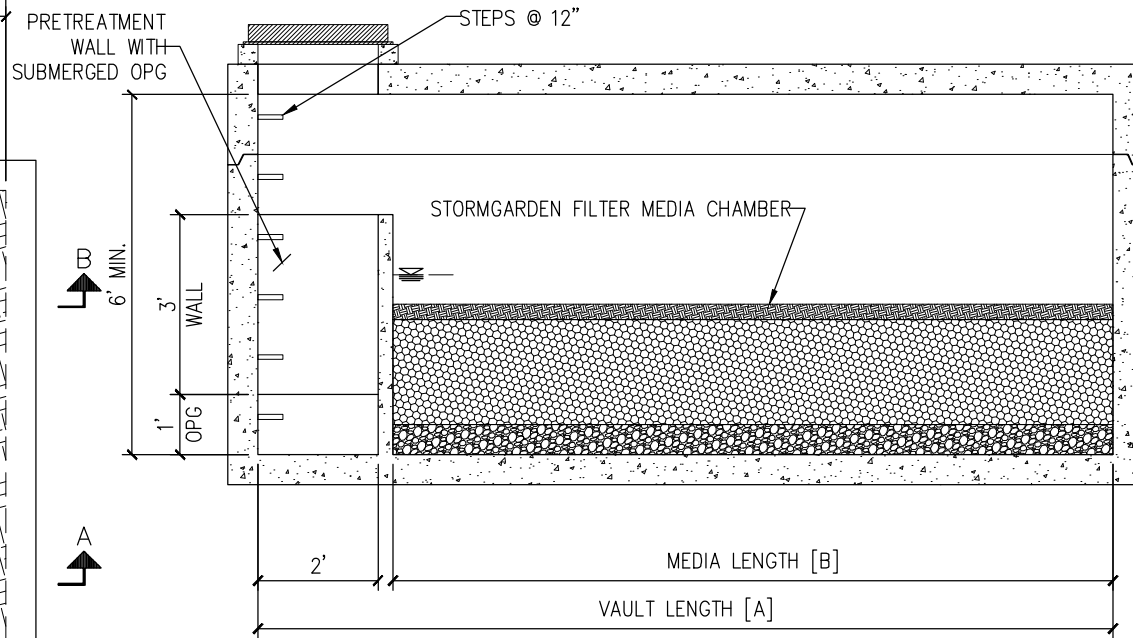
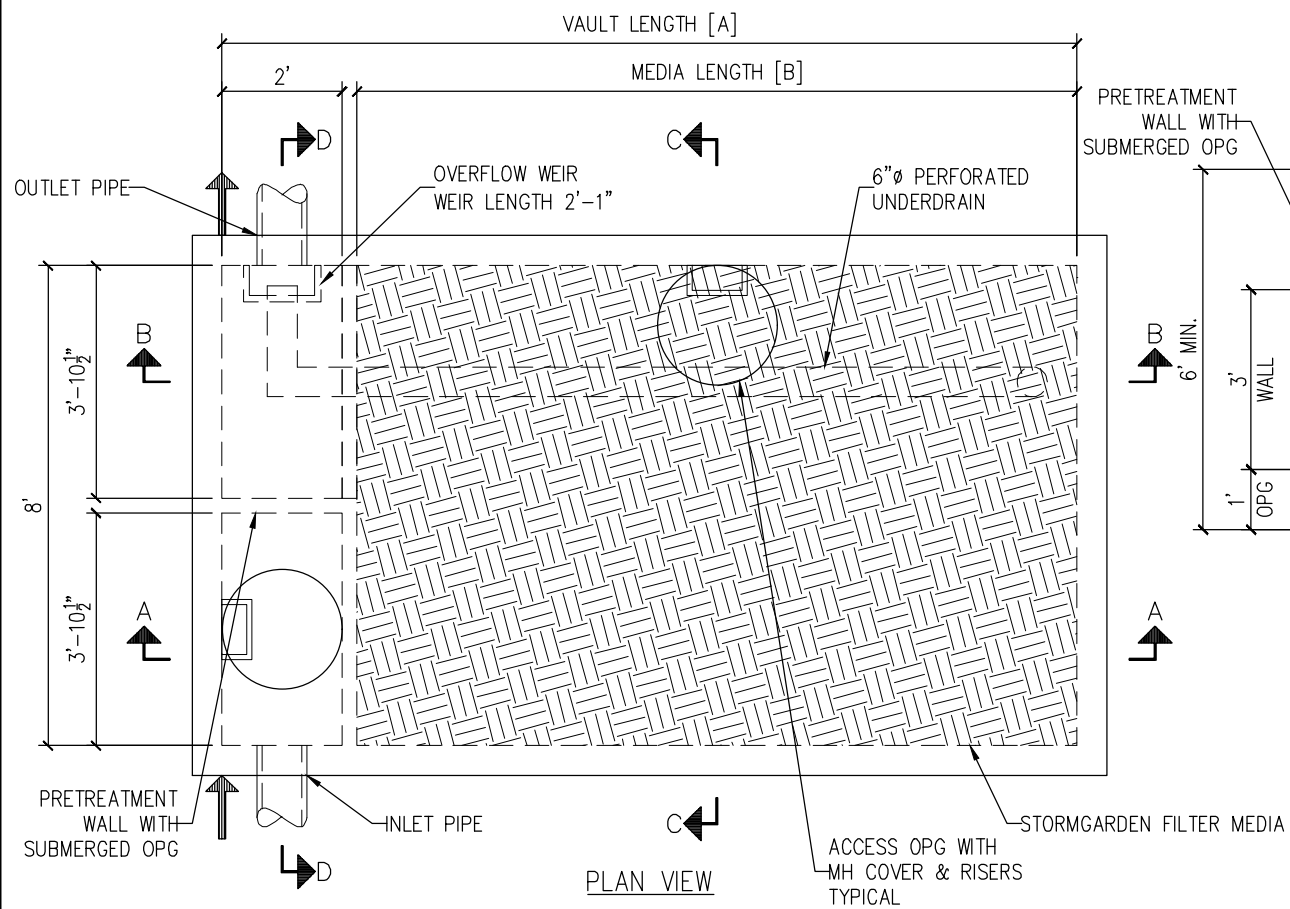
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SGVF-8X STORMGARDEN FILTERS				
DESIGNATION:	[A] VAULT LENGTH:	[B] MEDIA LENGTH:	WEIR LENGTH:	**BYPASS FLOW (CFS):
SGVF-88	8'-0"	5'-9"	2'-1"	2.48
SGVF-810	10'-0"	7'-9"	2'-1"	2.48
SGVF-812	12'-0"	9'-9"	2'-1"	2.48
SGVF-814	14'-0"	11'-9"	2'-1"	2.48

** BYPASS FLOW RATE IS BASED ON A HEAD OF 0.50' ABOVE THE WEIR.

DESIGN NOTES:

- CONCRETE MINIMUM (28-DAY) COMPRESSIVE STRENGTH: 5,000 PSI
- REINFORCING BARS CONFORMING TO ASTM A615 (FY = 60 KSI)
- DESIGN LIVE LOAD: HS-20

SGVF-8X STORMGARDEN FILTERS

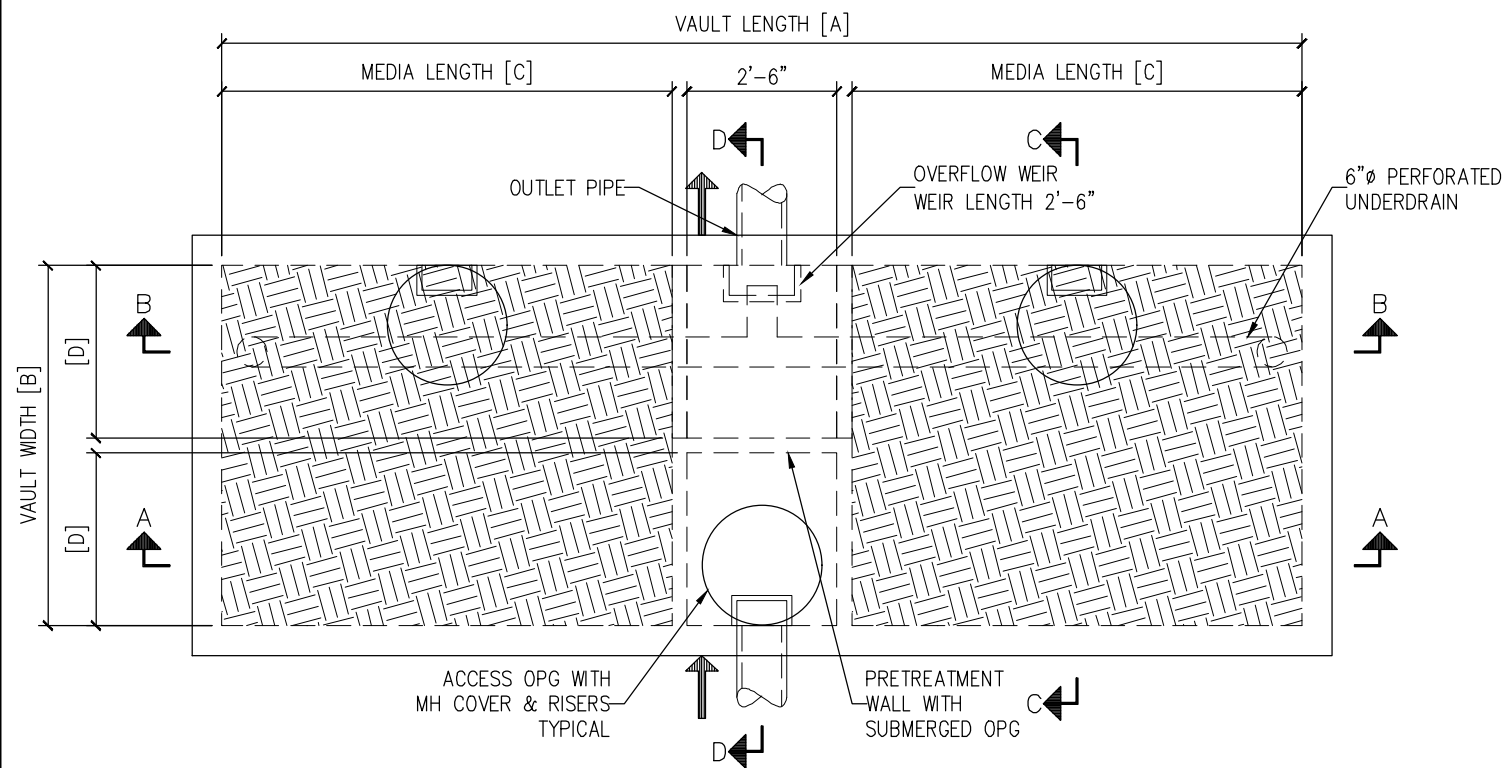
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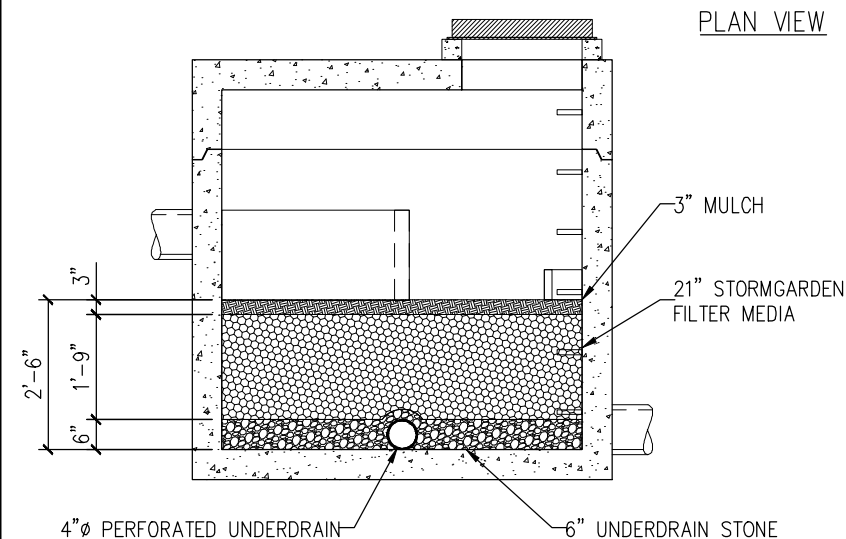
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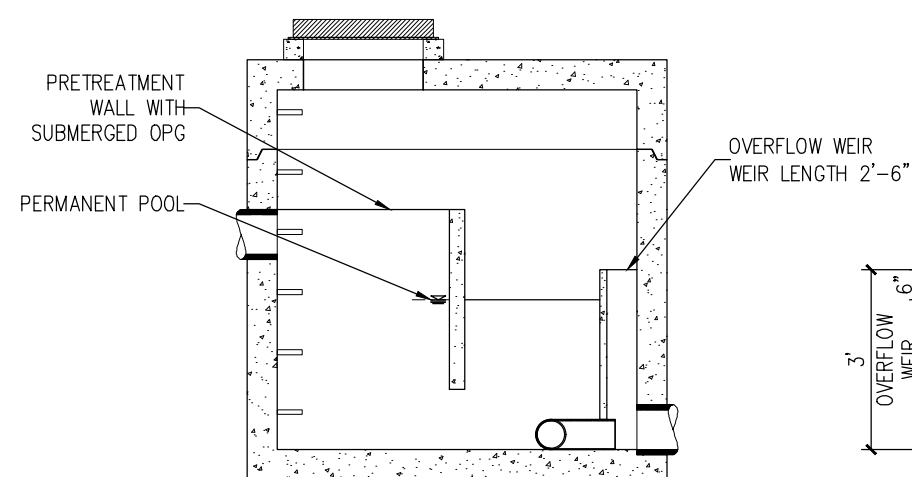
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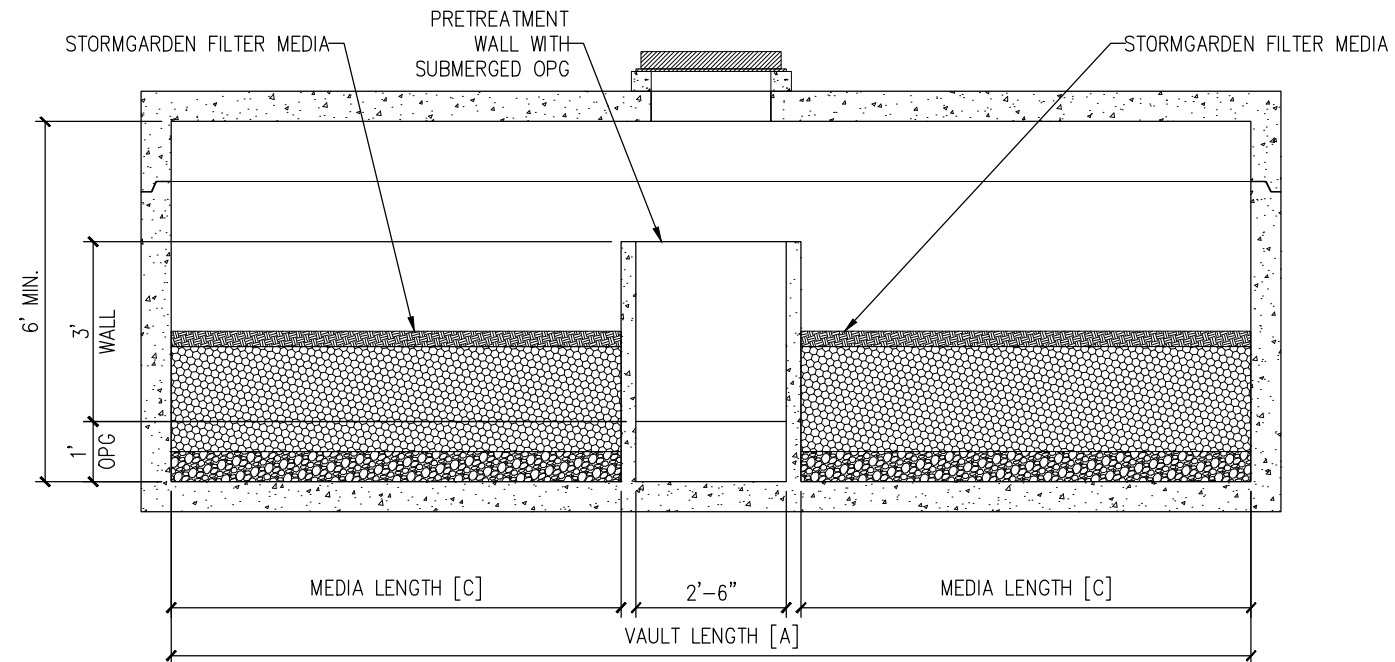
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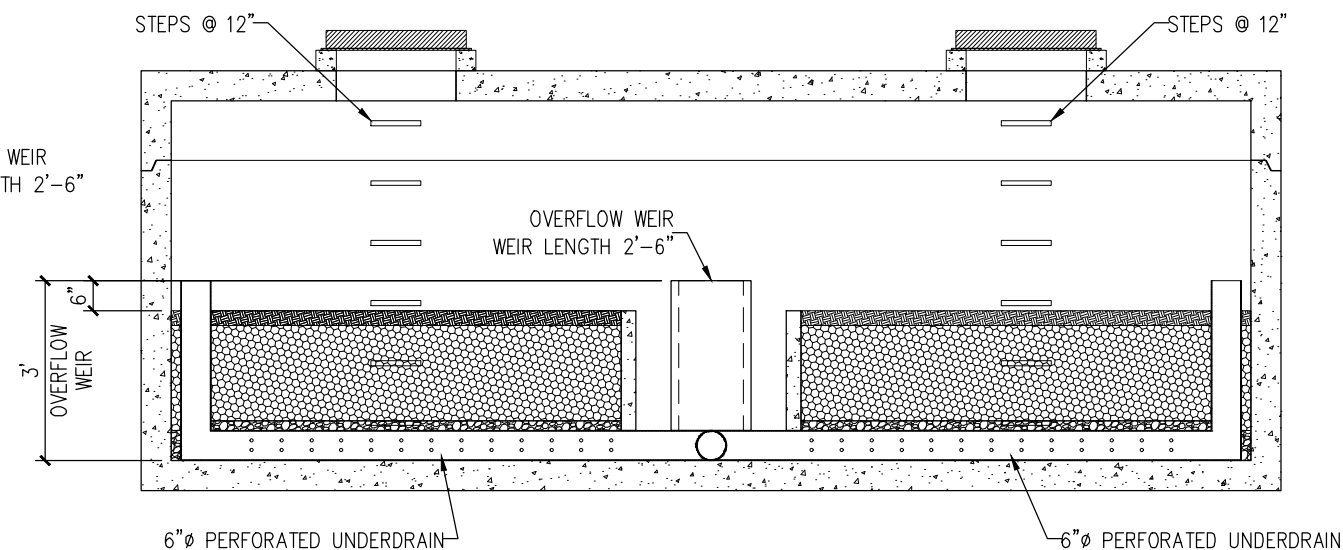
SECTION C-C



SECTION D-D



SECTION A-A



SECTION B-B

SGVF STORMGARDEN FILTERS						
DESIGNATION:	[A] VAULT LENGTH:	[B] VAULT WIDTH:	[C] MEDIA LENGTH:	[D] CHAMBER WIDTH:	WEIR LENGTH:	**BYPASS FLOW (CFS):
SGVF-616	16'-0"	6'-0"	6'-6"	2'-10½"	2'-6"	2.98
SGVF-618	18'-0"	6'-0"	7'-6"	2'-10½"	2'-6"	2.98
SGVF-816	16'-0"	8'-0"	6'-6"	3'-10½"	2'-6"	2.98
SGVF-818	18'-0"	8'-0"	7'-6"	3'-10½"	2'-6"	2.98

** BYPASS FLOW RATE IS BASED ON A HEAD OF 0.50' ABOVE THE WEIR.

DESIGN NOTES:

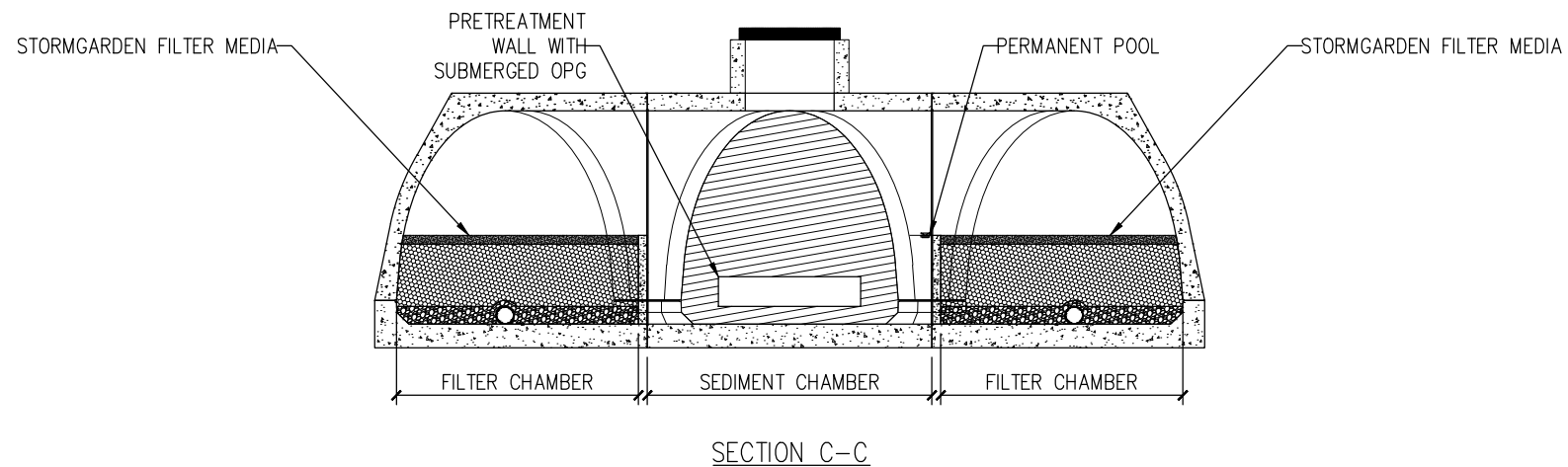
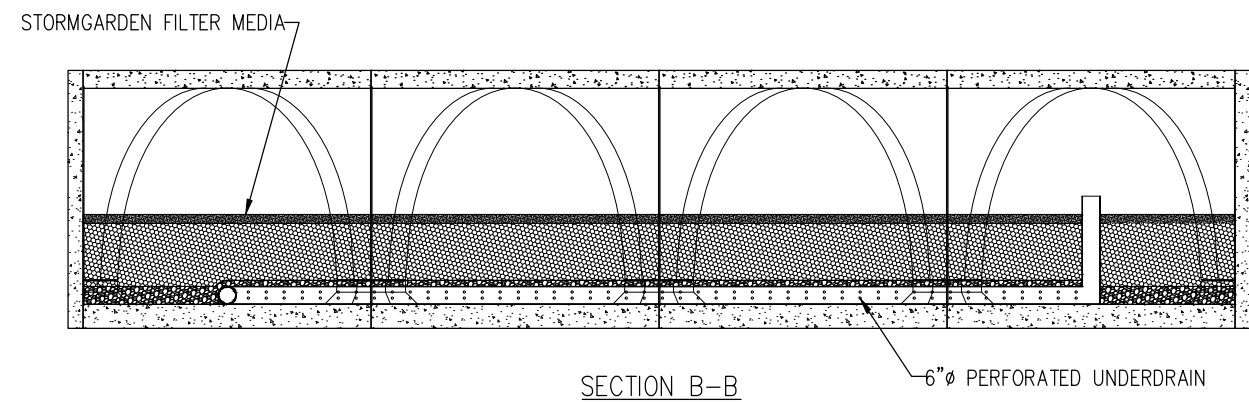
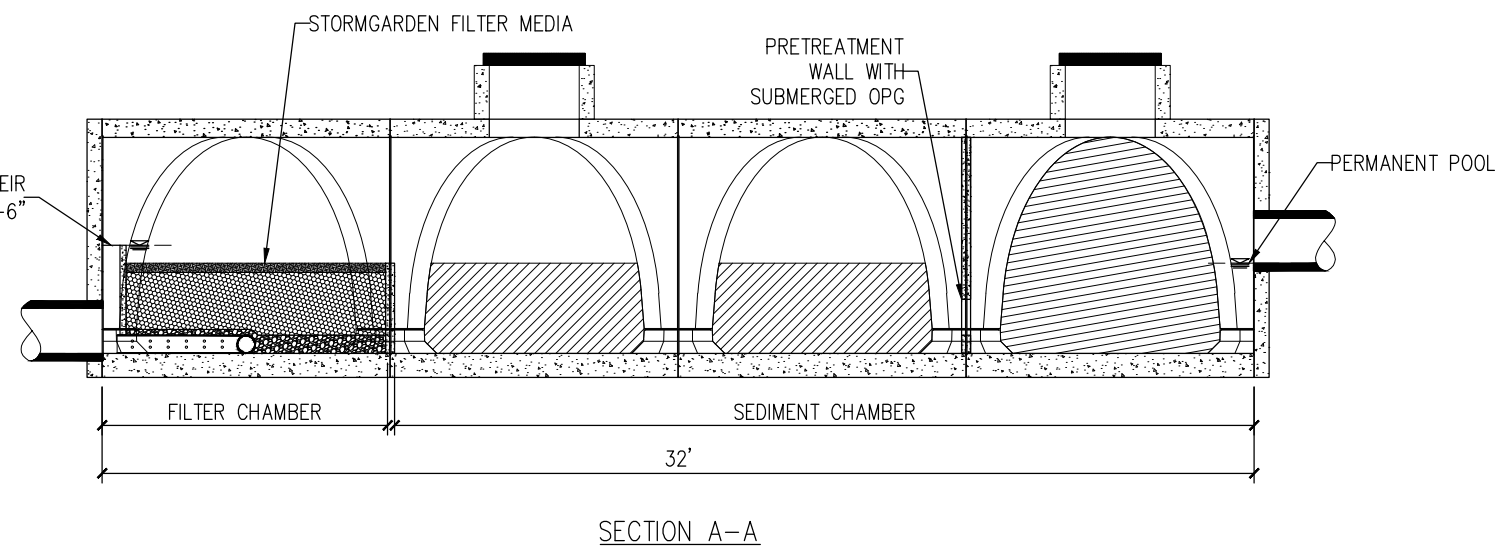
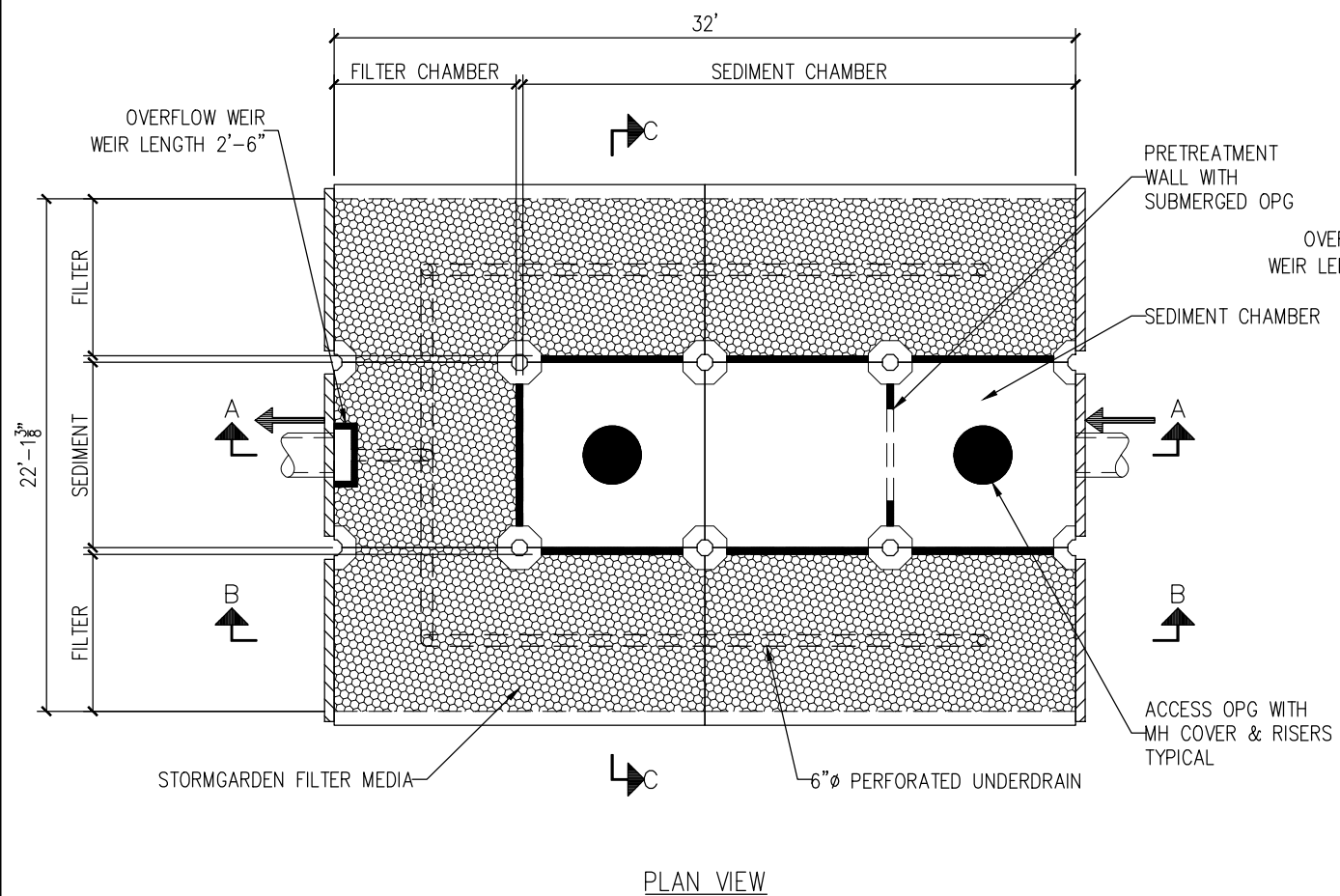
- CONCRETE MINIMUM (28-DAY) COMPRESSIVE STRENGTH: 5,000 PSI
- REINFORCING BARS CONFORMING TO ASTM A615 (FY = 60 KSI)
- DESIGN LIVE LOAD: HS-20

SGVF STORMGARDEN FILTERS

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SGMPVF STORMGARDEN/MAGNA-POD FILTERS					
DESIGNATION:	VAULT LENGTH:	VAULT WIDTH:	MEDIA AREA (SF):	WEIR LENGTH:	**BYPASS FLOW (CFS):
SGMPVF-2	16'-0"	14'-1 3/8"	147	2'-6"	2.98
SGMPVF-3	16'-0"	22'-1 3/8"	253	2'-6"	2.98
SGMPVF-6	32'-0"	22'-1 3/8"	464	2'-6"	2.98

** BYPASS FLOW RATE IS BASED ON A HEAD OF 0.50' ABOVE THE WEIR.

- DESIGN NOTES:
- CONCRETE MINIMUM (28-DAY) COMPRESSIVE STRENGTH: 6,000 PSI
 - REINFORCING BARS CONFORMING TO ASTM A615 (FY=60 KSI)
 - STRUCTURAL REINFORCING FIBERS CONFORMING TO ASTM C1116
 - DESIGN LIVE LOAD: AASHTO HL 93

STORMGARDEN/MAGNA-POD
VAULT FILTERS

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