PARAMETRIX

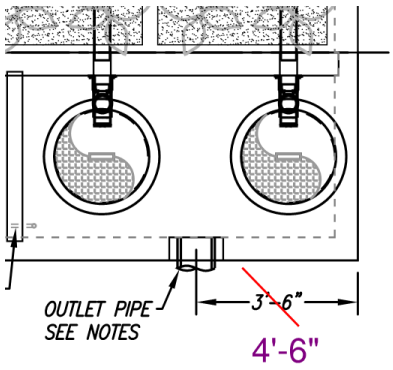
SUBMITTAL REVIEW COMMENTS

Date:	4/17/18
Owner:	Northwest Seaport Alliance
Project:	West Sitcum Stormwater Treatment
Contractor:	BioClean
Submittal Title:	Modular Wetlands
Submittal Number:	Quote 1918026WQ1
Reviewer:	C. Simmons
Review:	Make Corrections Noted

Previous Comments:
1-10. Comments Resolved

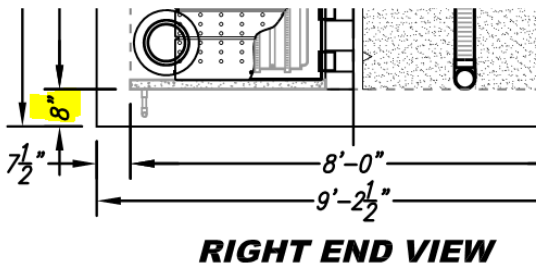
Additional Comments:

1. Sheet A2.4, Plan View, dimension 3'-6" from centerline of pipe out to exterior edge of pre-cast is incorrect. The value should be 4'-6", see Basin A penetration spreadsheet already provided.

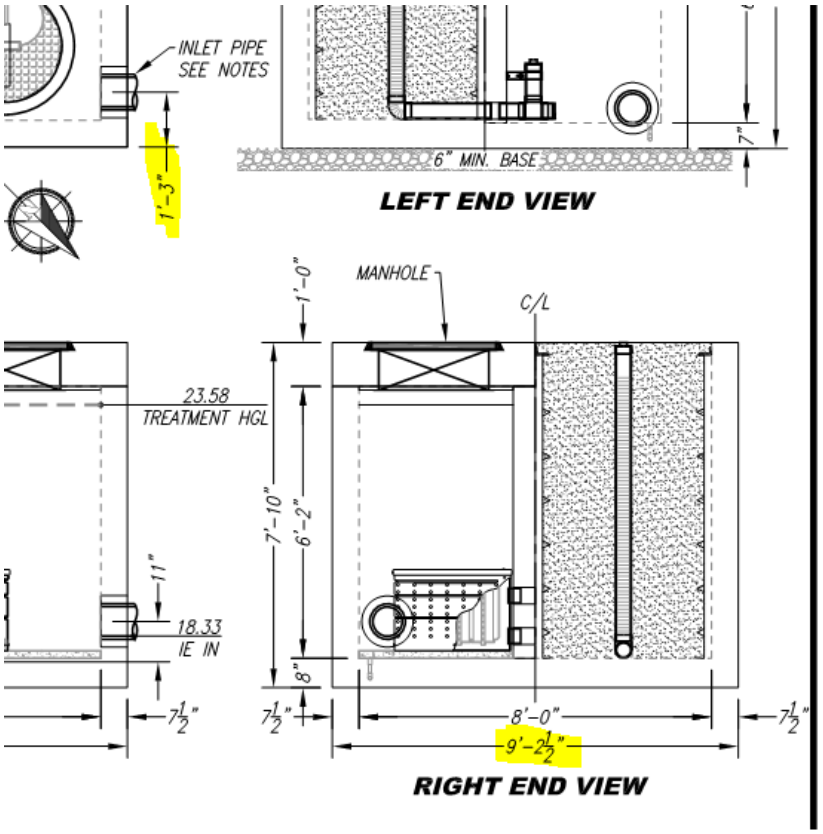


2. Sheet B1.3, Elevation View, dimension 4" from centerline of pipe out to IE out is correct. Please note that this dimension may not have been indicated in the information previously provided.

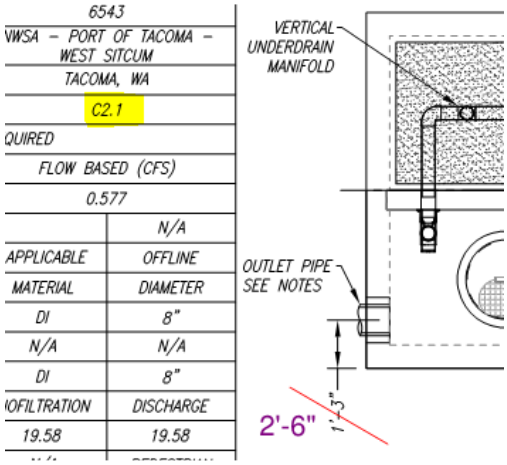
3. Sheet C1.1, Right End View, dimension 8" from pre-filter cartridge bottom to exterior bottom of pre-cast indicates 8". Spreadsheet says 7". Please confirm why this has changed.



4. Sheet C1.1, Right End View, dimension 9’-2.5” has changed from 9’-3”. This change carries over to the Plan View dimension of centerline of inlet pipe to exterior wall of pre-cast. The provided spreadsheet indicates the dimension of 8’-0” from centerline of inlet pipe to the other exterior wall. 8’-0” + 1’-3” = 9’-3” not 9’-2.5”. Please advise.



5. Sheet C2.1 – See comment 14, same comments. Also, please note that as provided in Basin C penetration spreadsheet, the dimension from the centerline of outlet pipe to other pre-cast exterior wall was given as 6’-8”, which would make the dimension provided in the submittal 2’-6” not 1’-3” as shown. See snip.



End of comments

SUBMITTAL DRAWINGS

Parametrix
ENGINEERING . PLANNING . ENVIRONMENTAL SCIENCES
60 Washington Ave., Suite 390, Bremerton, WA 98337
Main Phone: (360) 377-0014

SUBMITTAL REVIEW

Checking is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Any action shown is subject to the requirements of the plans and specifications. Contractor is responsible for dimensions which shall be confirmed and correlated at the job site, fabrication processes and techniques of construction, coordination of his work with that of all other trades, and the satisfactory performance of his work.

- ☐ No Exceptions Taken
- ☒ Make Corrections Noted
- ☐ Submit Specified Item
- ☐ Revise and Resubmit
- ☐ Rejected—See Comments

Date: 4/17/18 By: C. Simmons

Project #: 553-8001-001 Submittal #:

Bio Clean
A Forterra Company

Proven Stormwater Treatment Technology

PROJECT #:

6543

PROJECT NAME:

NWSA-Port of Tacoma-West Sitcum Stormwater Treatment

PREPARED FOR:

Port of Tacoma

DATE SUBMITTED:

04-12-2018

DISCLOSURE: It is the sole responsibility of purchaser to verify these submittals are accurate based upon the final set of construction plans. Bio Clean is not responsible for any variations to design after these submittals are approved. If information in these submittals do not match the final set of construction plans it is the responsibility of the purchaser to request revision(s) from Bio Clean prior to approving the submittals. If the purchaser approves this submittal without final construction plans and/or without approval from the project engineer they do so at own risk. Bio Clean highly recommends that the purchaser get official stamped approval from Project Engineer(s) and/or all other Project Design Professions in accordance with project submittal specifications and manufactures recommendations.

Bio Clean
398 Via El Centro
Oceanside, CA 92058

www.BioCleanEnvironmental.com
P 855-566-3938
F 760-433-3179

SITE SPECIFIC DATA

BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		A1.4	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		0.23	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	18.83	DI	6"
INLET PIPE 2	N/A	N/A	N/A
OUTLET PIPE	18.25	DI	6"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	25.50	25.50	25.50
SURFACE LOAD	PEDESTRIAN	N/A	PEDESTRIAN
FRAME & COVER	ø30"	N/A	ø24"
INDUSTRIAL MEDIA VOLUME (CY)			8.50
INDUSTRIAL MEDIA DELIVERY METHOD			PER CONTRACT
ORIFICE SIZE (DIA. INCHES)			ø1.90"
NOTES: INDUSTRIAL MEDIA MIX REQUIRED. THE TREATMENT SYSTEM COMPONENTS SHALL BE MADE IN THE USA.			

INSTALLATION NOTES

1. CONTRACTOR TO PROVIDE ALL LABOR, EQUIPMENT, MATERIALS AND INCIDENTALS REQUIRED TO OFFLOAD AND INSTALL THE SYSTEM AND APPURTENANCES IN ACCORDANCE WITH THIS DRAWING AND THE MANUFACTURERS SPECIFICATIONS, UNLESS OTHERWISE STATED IN MANUFACTURERS CONTRACT.
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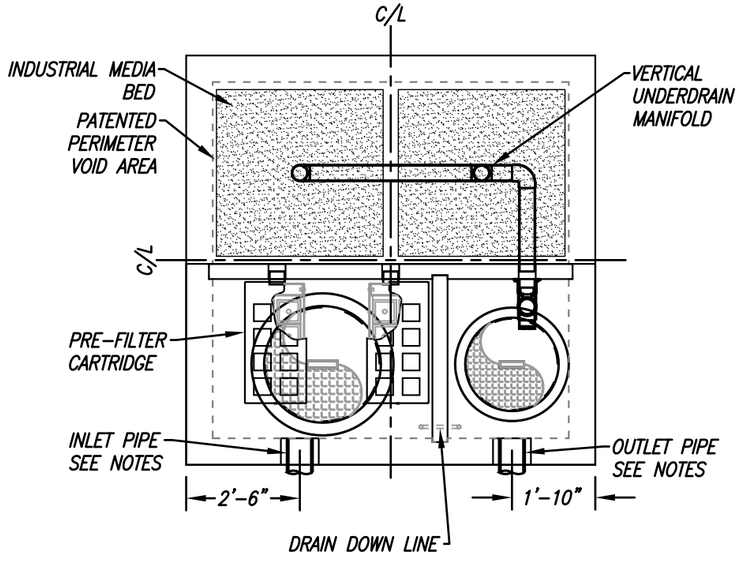
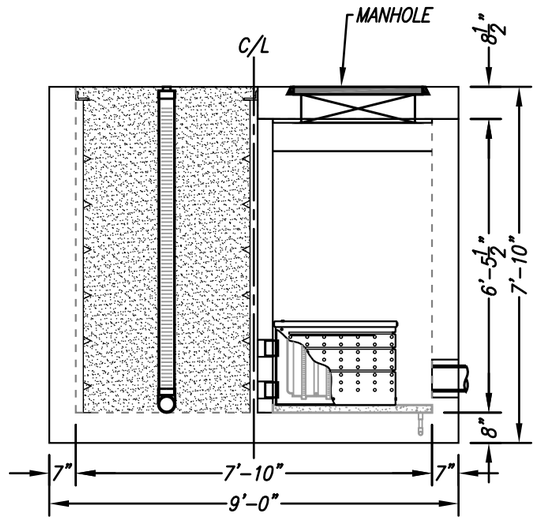
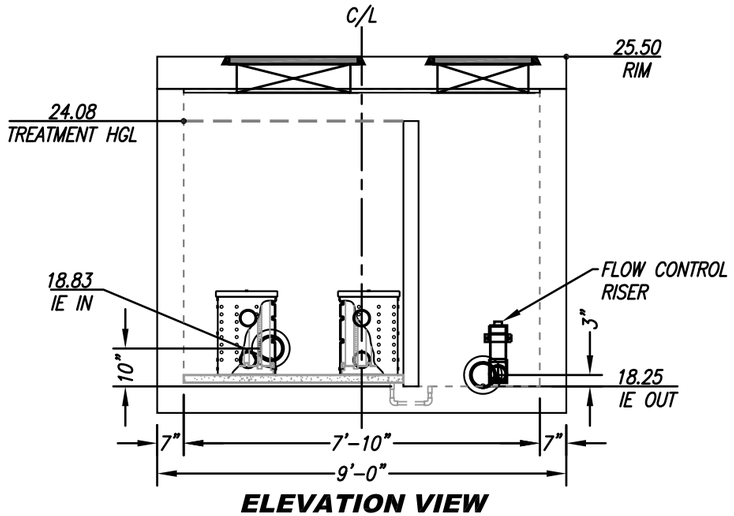


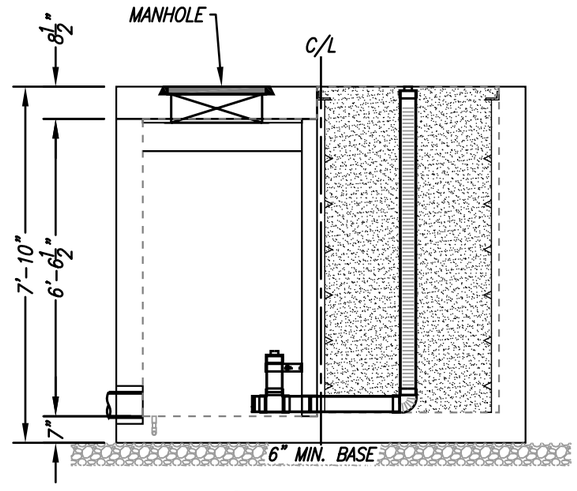
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



RIGHT END VIEW

STRUCTURAL NOTE:

"STRUCTURAL DESIGN CALCULATIONS SEALED BY A PROFESSIONAL ENGINEER LICENSED TO PRACTICE IN THE STATE OF WASHINGTON. CALCULATIONS SHALL DEMONSTRATE THAT THE TREATMENT SYSTEM ARE DESIGNED TO MEET ABOVE GROUND STRUCTURAL DESIGN REQUIREMENTS FOR CONCRETE STRUCTURES AND APPLICABLE BUILDING CODES." (PROJECT SPECS, ATTACHMENT C, DIVISION 01 GENERAL REQUIREMENTS, SECTION 01 33 00 – SUBMITTAL PROCEDURES, 1.03 SUBMITTALS) BIOCLEAN WILL PROVIDE THE STRUCTURAL CALCS WITHIN A SEPARATE STRUCTURAL SUBMITTAL.

TREATMENT FLOW (CFS)	0.23
OPERATING HEAD (FT)	5.7
PRETREATMENT LOADING RATE (GPM/SF)	2.0
INDUSTRIAL MEDIA LOADING RATE (GPM/SF)	0.6

Bio Clean
A Forterra Company

MWS-L-8-8-V
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/18ASPOLAR

SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		A2.1	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		0.23	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	14.08	DI	6"
INLET PIPE 2	N/A	N/A	N/A
OUTLET PIPE	12.00	DI	6"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	19.25	19.25	19.25
SURFACE LOAD	PEDESTRIAN	N/A	PEDESTRIAN
FRAME & COVER	ø30"	N/A	ø24"
INDUSTRIAL MEDIA VOLUME (CY)			8.50
INDUSTRIAL MEDIA DELIVERY METHOD			PER CONTRACT
ORIFICE SIZE (DIA. INCHES)			ø1.90"
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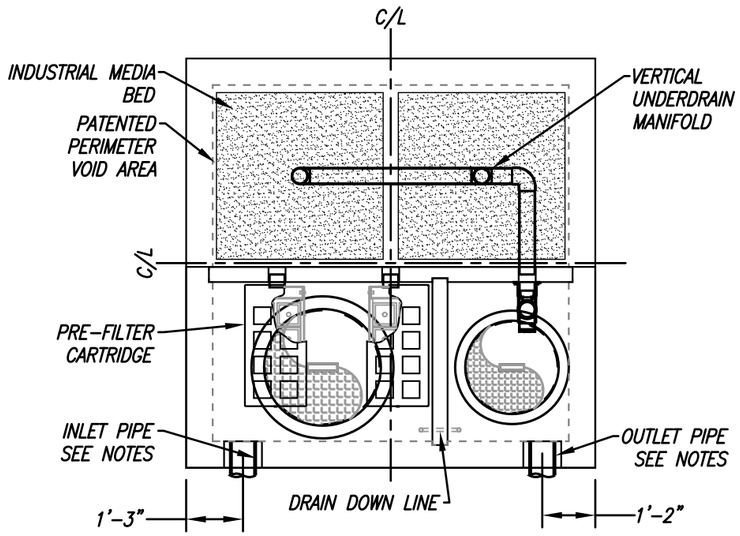
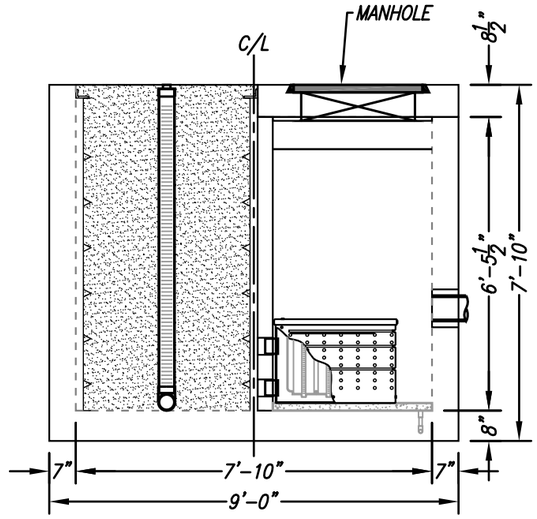
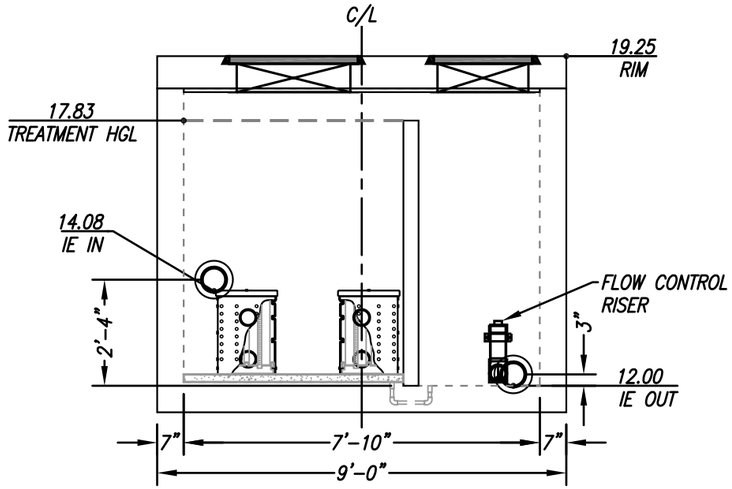


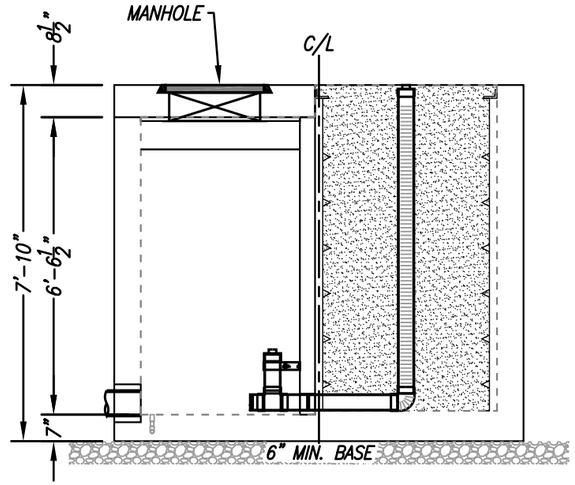
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



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OPERATING HEAD (FT)	5.7
PRETREATMENT LOADING RATE (GPM/SF)	2.0
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Bio Clean
A Forterra Company

MWS-L-8-8-V
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4.12.21BASPOLAR

SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		A1.1	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		*2.9	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	18.83	DI	8"
INLET PIPE 2			
OUTLET PIPE	18.25	DI	8"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	25.50	25.50	25.50
SURFACE LOAD	PEDESTRIAN	OPEN PLANTER	PEDESTRIAN
FRAME & COVER	2 EA 36" X 72"	N/A	2 EA ø24"
INDUSTRIAL MEDIA VOLUME (CY)			25.49
INDUSTRIAL MEDIA DELIVERY METHOD			PER CONTRACT
ORIFICE SIZE (DIA. INCHES)			2 EA ø2.81"

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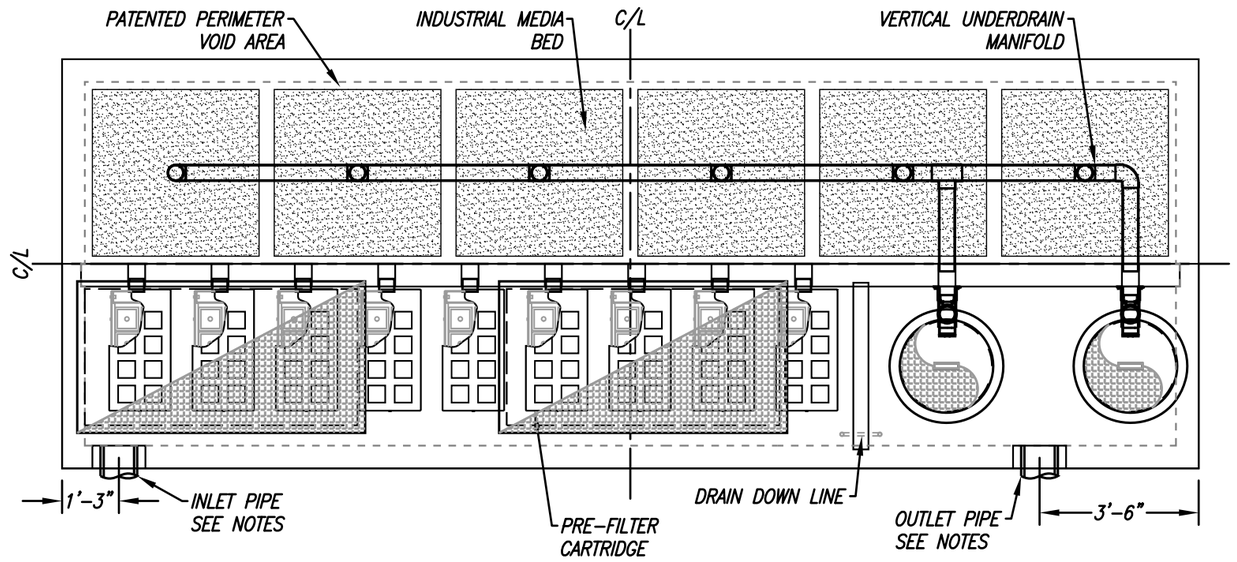
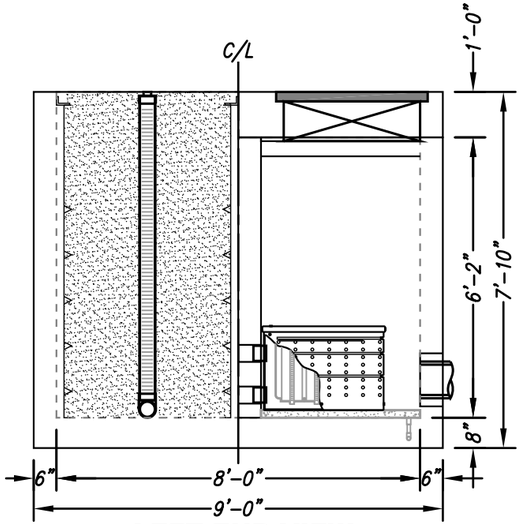
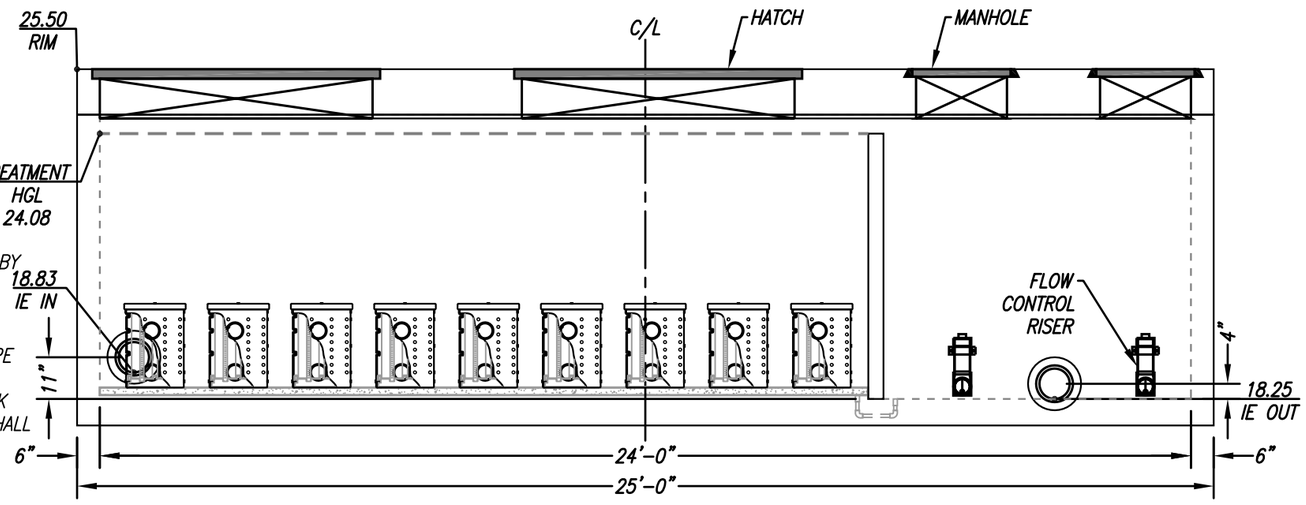


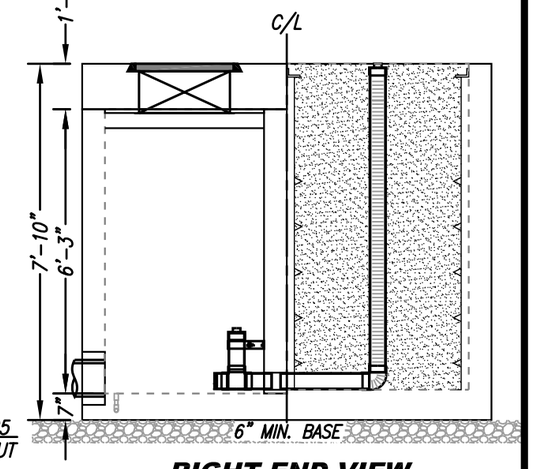
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



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PRETREATMENT LOADING RATE (GPM/SF)	1.9
INDUSTRIAL MEDIA LOADING RATE (GPM/SF)	0.9

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A Forterra Company

MWS-L-8-24-V-HC
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/18ASPOLAR

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BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		A1.2	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		*2.9	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
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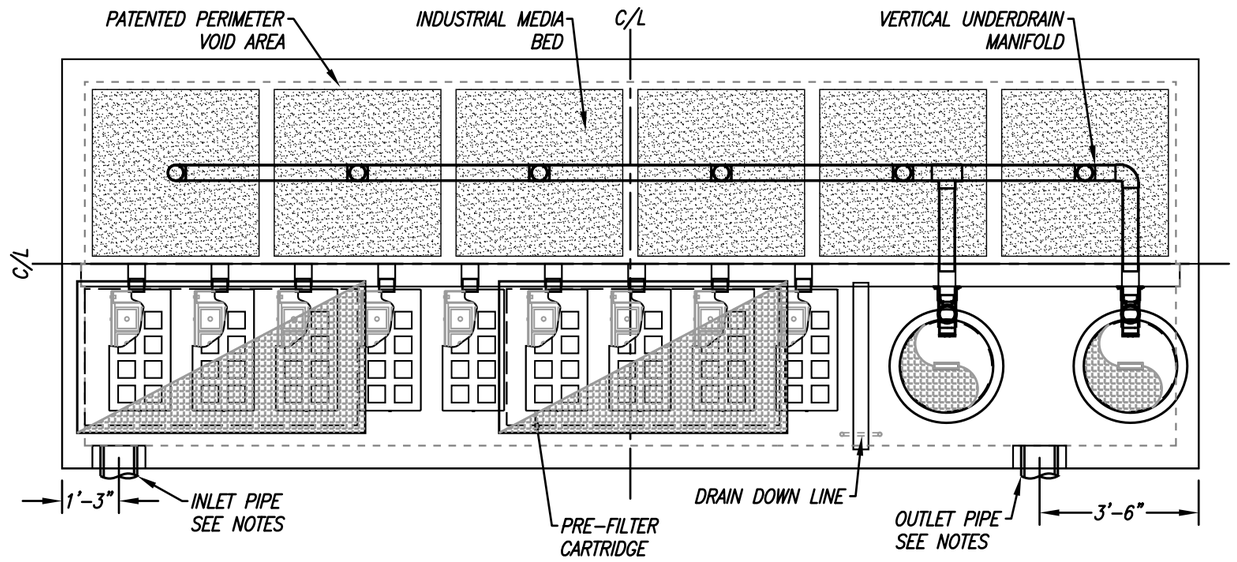
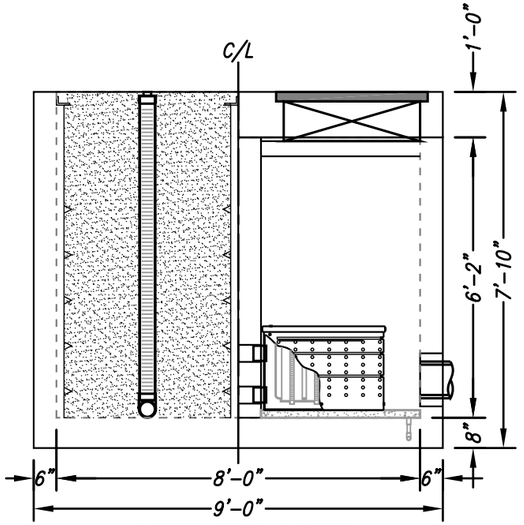
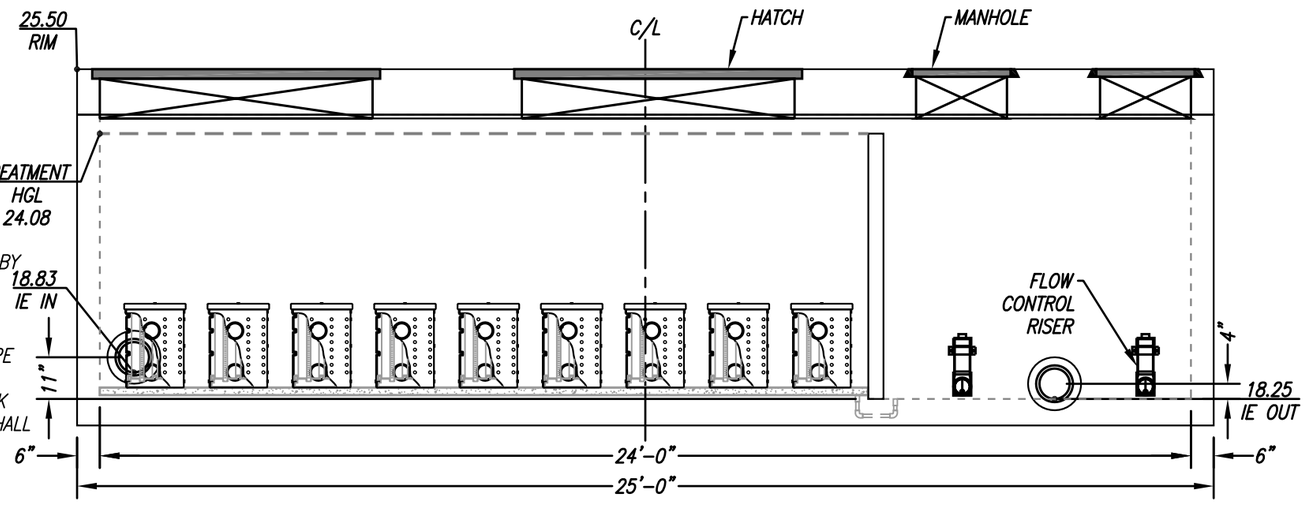


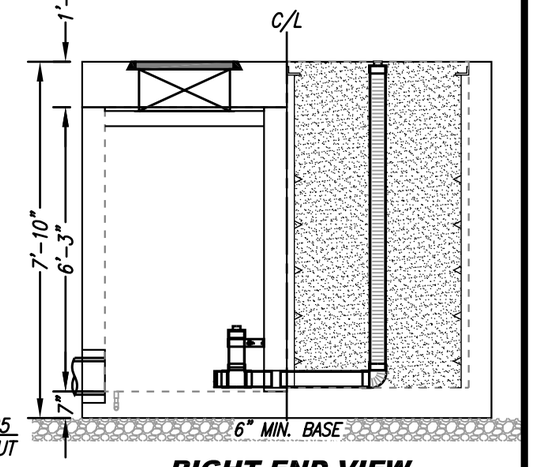
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



RIGHT END VIEW

STRUCTURAL NOTE:

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TREATMENT FLOW (CFS)	1.0
OPERATING HEAD (FT)	5.7
PRETREATMENT LOADING RATE (GPM/SF)	1.9
INDUSTRIAL MEDIA LOADING RATE (GPM/SF)	0.9

Bio Clean
A Forterra Company

MWS-L-8-24-V-HC
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/18ASPOLAR

SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		A1.3	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		*2.9	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	18.83	DI	8"
INLET PIPE 2			
OUTLET PIPE	18.25	DI	8"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	25.50	25.50	25.50
SURFACE LOAD	PEDESTRIAN	OPEN PLANTER	PEDESTRIAN
FRAME & COVER	2 EA 36" X 72"	N/A	2 EA ø24"
INDUSTRIAL MEDIA VOLUME (CY)			25.49
INDUSTRIAL MEDIA DELIVERY METHOD			PER CONTRACT
ORIFICE SIZE (DIA. INCHES)			2 EA ø2.81"

NOTES: *A TOTAL OF THREE MWS VAULTS WILL PROVIDE THE REQUIRED TREATMENT. INDUSTRIAL MEDIA MIX REQUIRED. THE TREATMENT SYSTEM COMPONENTS SHALL BE MADE IN THE USA.

INSTALLATION NOTES

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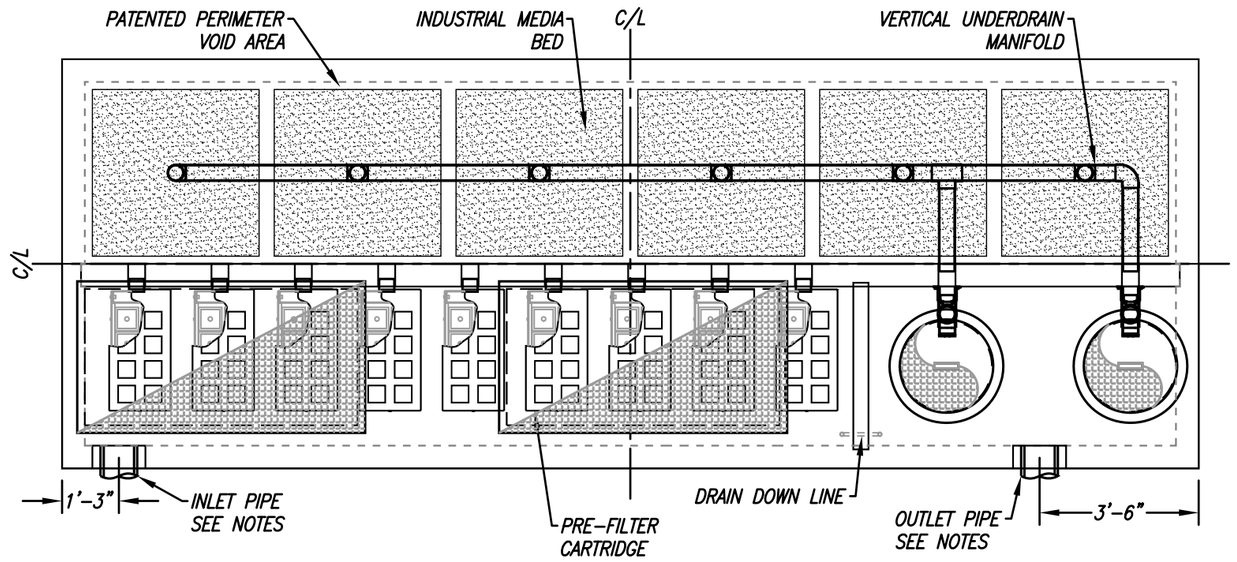
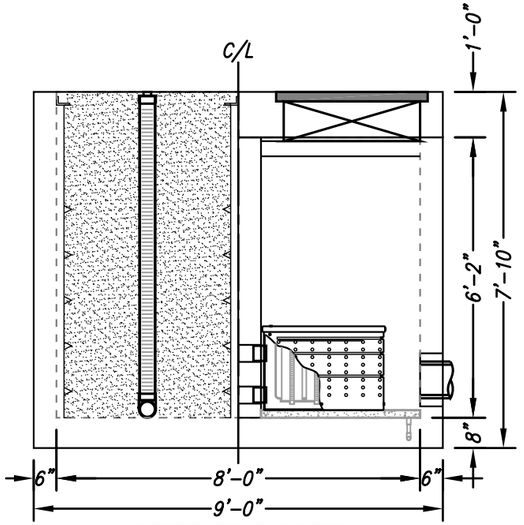


PLAN VIEW



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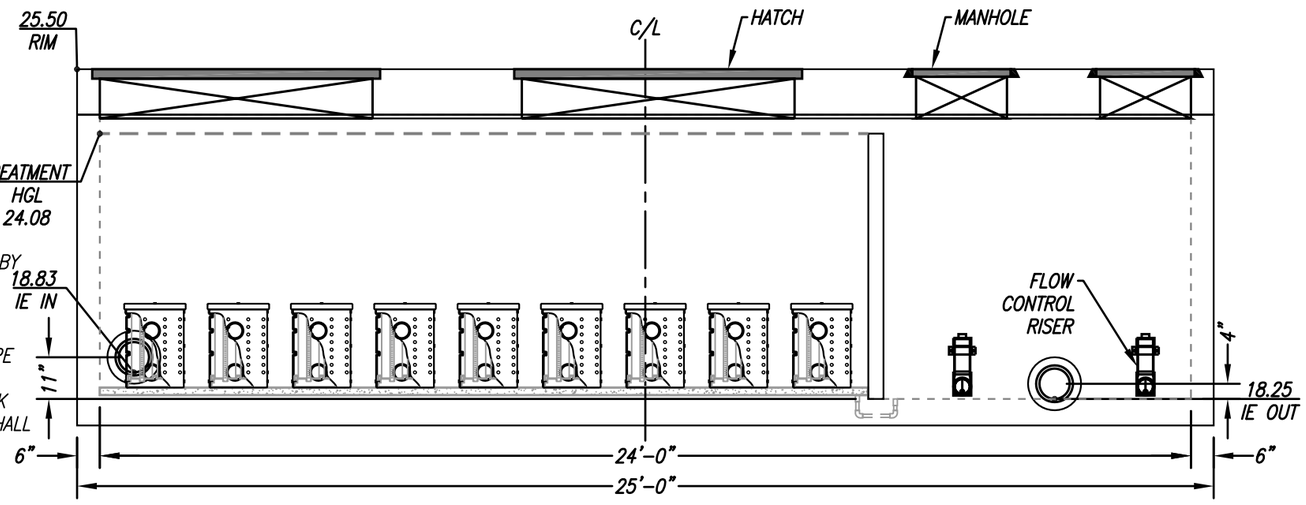
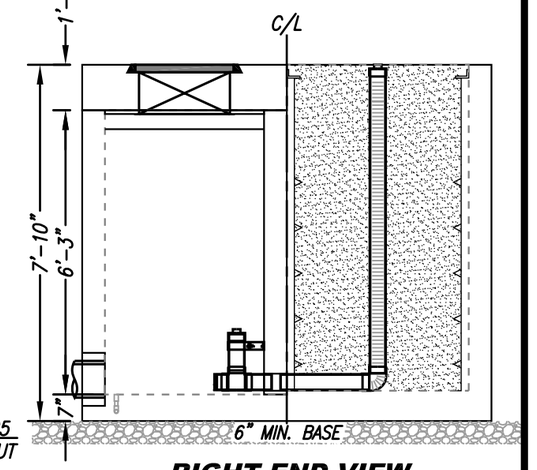


ELEVATION VIEW



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OPERATING HEAD (FT)	5.7
PRETREATMENT LOADING RATE (GPM/SF)	1.9
INDUSTRIAL MEDIA LOADING RATE (GPM/SF)	0.9

Bio Clean
A Forterra Company

MWS-L-8-24-V-HC
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/18ASPOLAR

SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		A2.2	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		*2.9	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	14.00	DI	8"
INLET PIPE 2			
OUTLET PIPE	12.00	DI	8"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	19.25	19.25	19.25
SURFACE LOAD	PEDESTRIAN	OPEN PLANTER	PEDESTRIAN
FRAME & COVER	2 EA 36" X 72"	N/A	2 EA ø24"
INDUSTRIAL MEDIA VOLUME (CY)			25.49
INDUSTRIAL MEDIA DELIVERY METHOD			PER CONTRACT
ORIFICE SIZE (DIA. INCHES)			2 EA ø2.81"
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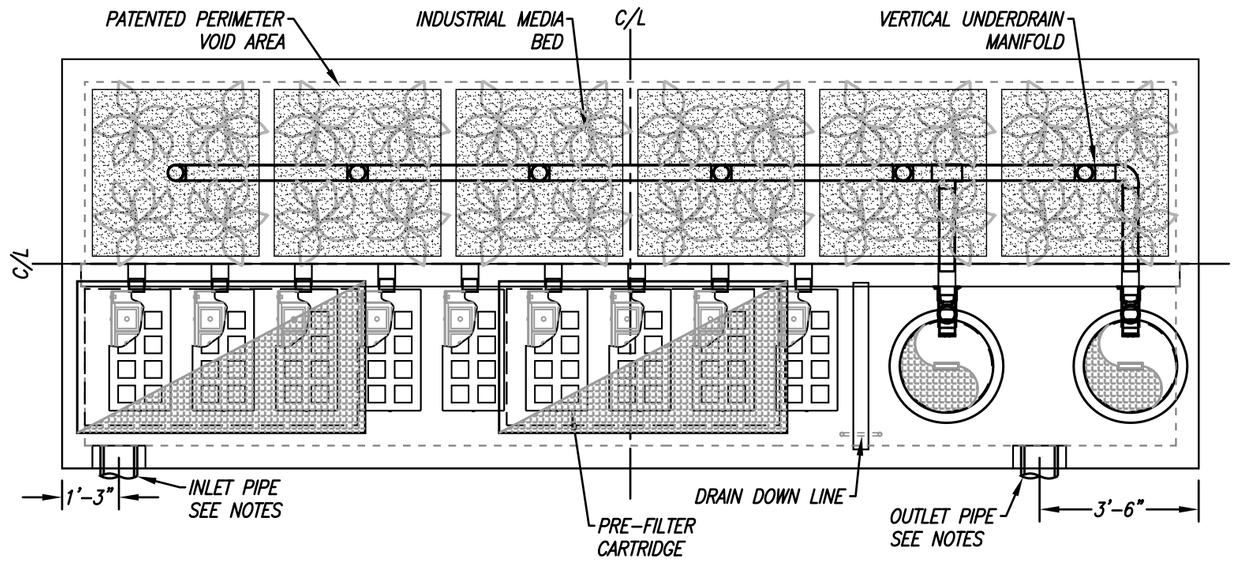

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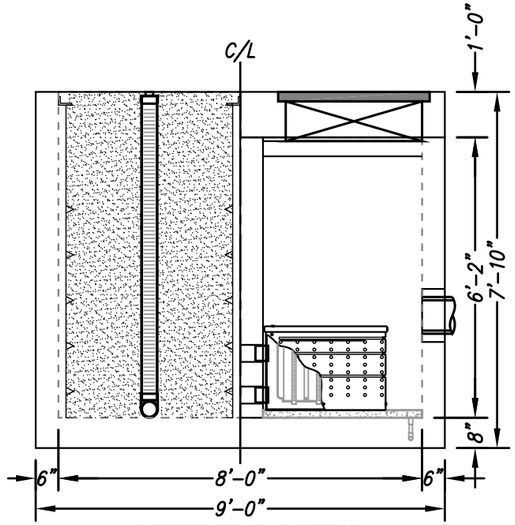
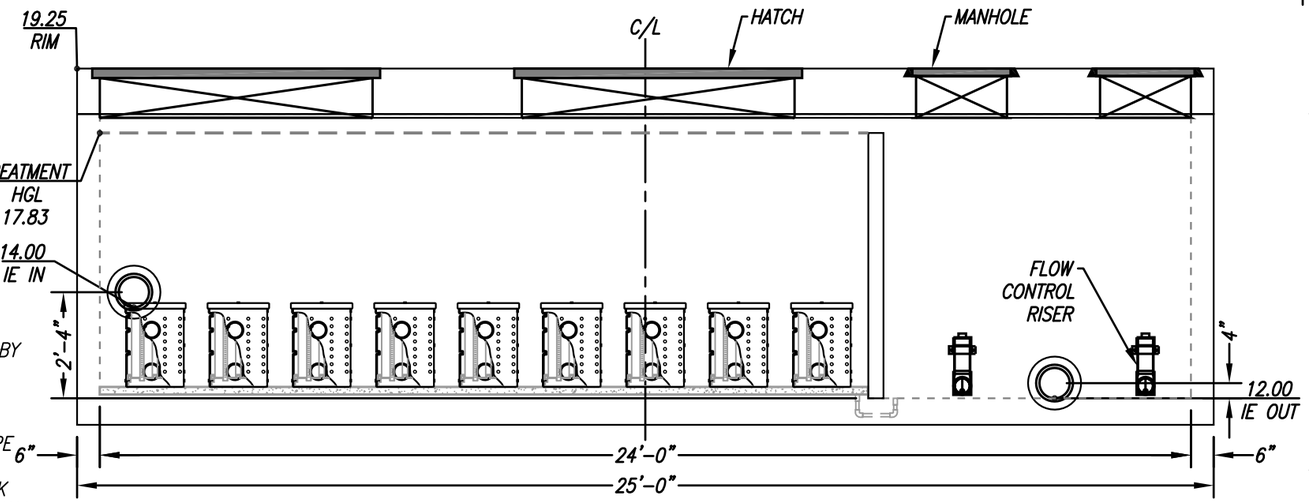
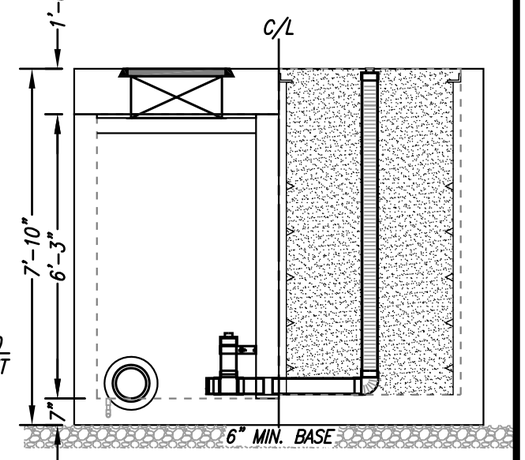


LEFT END VIEW



ELEVATION VIEW



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TREATMENT FLOW (CFS)	1.0
OPERATING HEAD (FT)	5.7
PRETREATMENT LOADING RATE (GPM/SF)	1.9
INDUSTRIAL MEDIA LOADING RATE (GPM/SF)	0.9

Bio Clean
A Forterra Company

MWS-L-8-24-V-HC
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/21BASPOLAR

SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		A2.3	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		*2.9	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	14.00	DI	8"
INLET PIPE 2			
OUTLET PIPE	12.00	DI	8"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	19.25	19.25	19.25
SURFACE LOAD	PEDESTRIAN	OPEN PLANTER	PEDESTRIAN
FRAME & COVER	2 EA 36" X 72"	N/A	2 EA ø24"
INDUSTRIAL MEDIA VOLUME (CY)			25.49
INDUSTRIAL MEDIA DELIVERY METHOD			PER CONTRACT
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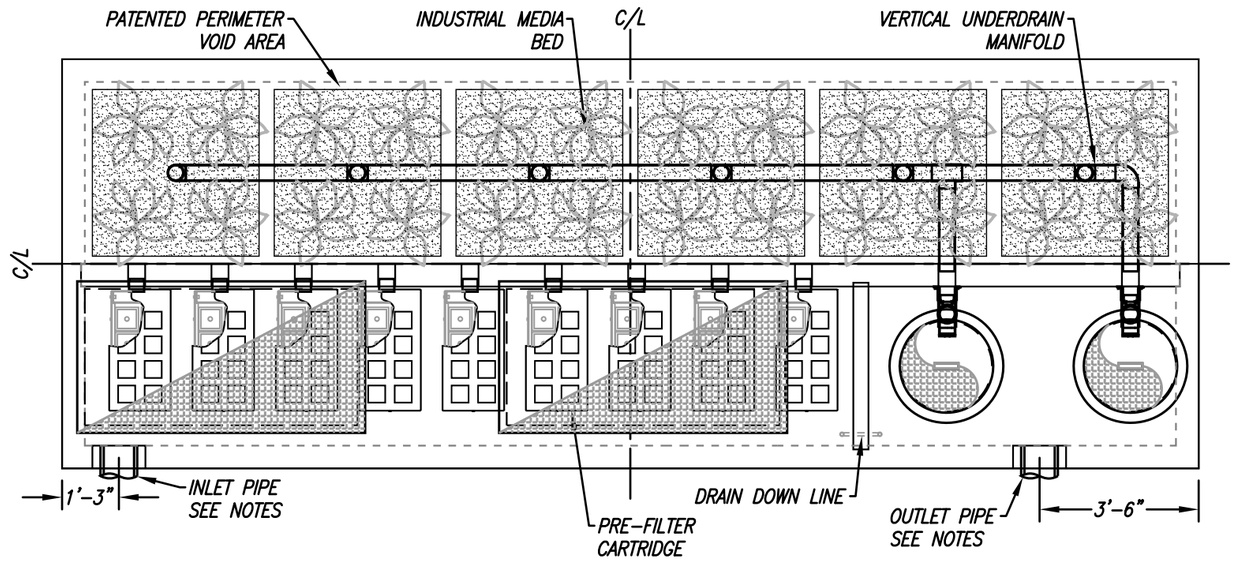
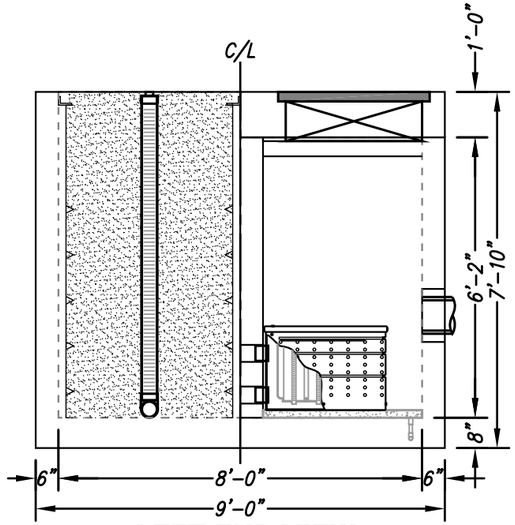
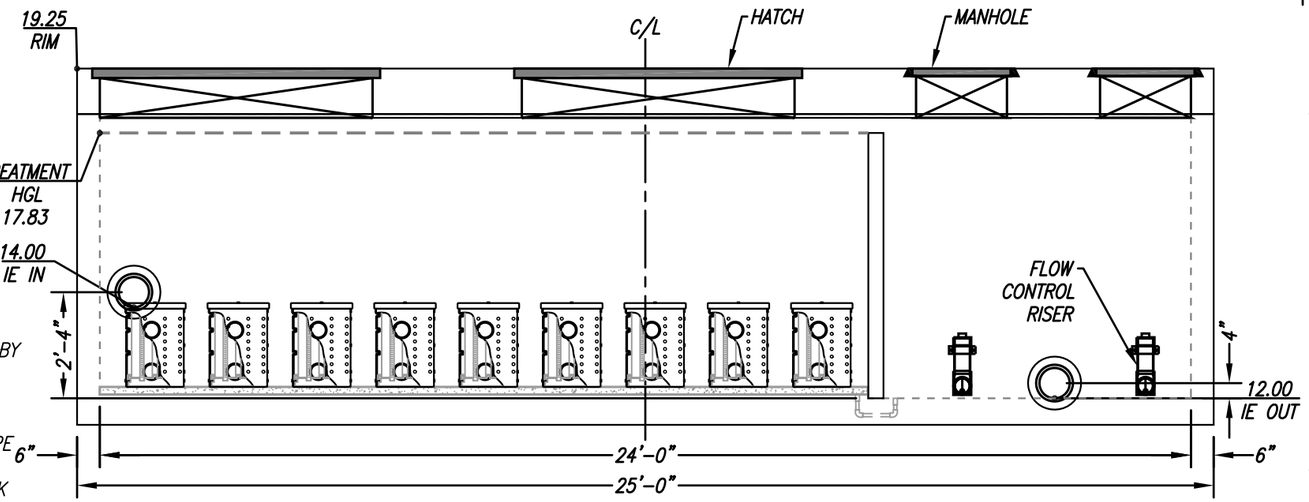


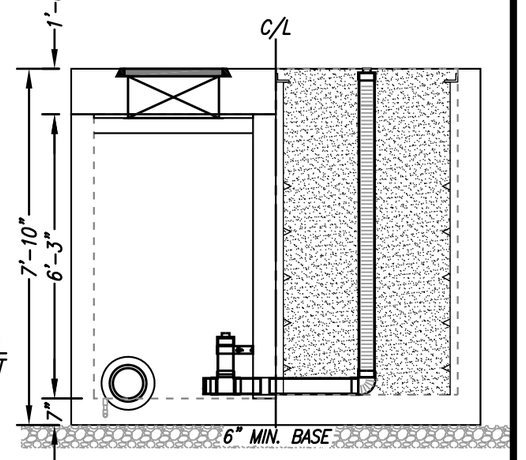
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



RIGHT END VIEW

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Bio Clean
A Forterra Company

MWS-L-8-24-V-HC
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/21BASPOLAR

SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		A2.4	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		*2.9	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	14.00	DI	8"
INLET PIPE 2			
OUTLET PIPE	12.00	DI	8"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	19.25	19.25	19.25
SURFACE LOAD	PEDESTRIAN	OPEN PLANTER	PEDESTRIAN
FRAME & COVER	2 EA 36" X 72"	N/A	2 EA ø24"
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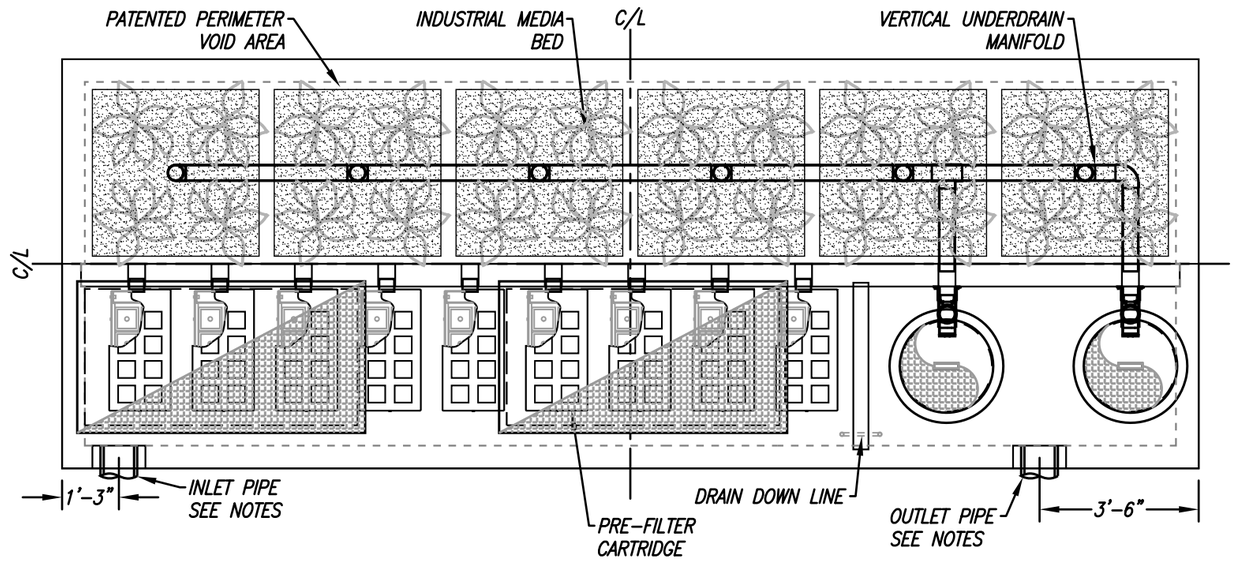
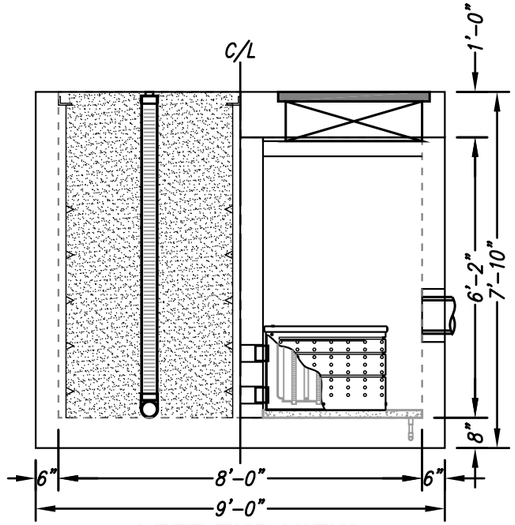
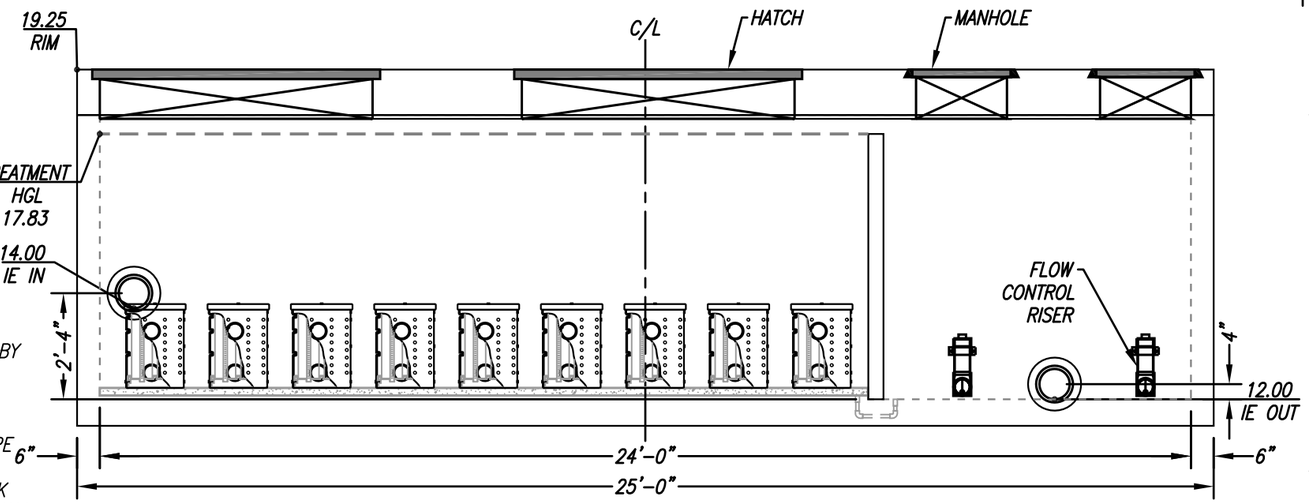


PLAN VIEW



LEFT END VIEW



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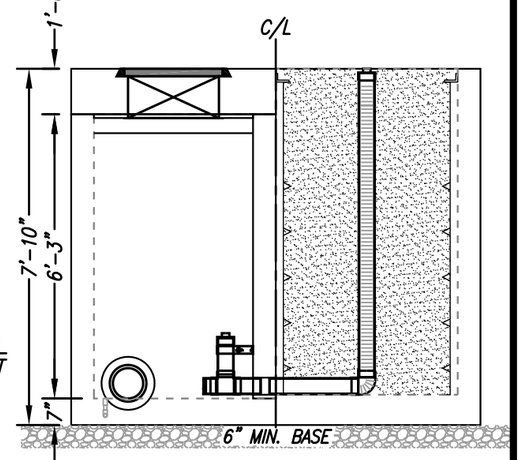

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TREATMENT FLOW (CFS)	1.0
OPERATING HEAD (FT)	5.7
PRETREATMENT LOADING RATE (GPM/SF)	1.9
INDUSTRIAL MEDIA LOADING RATE (GPM/SF)	0.9

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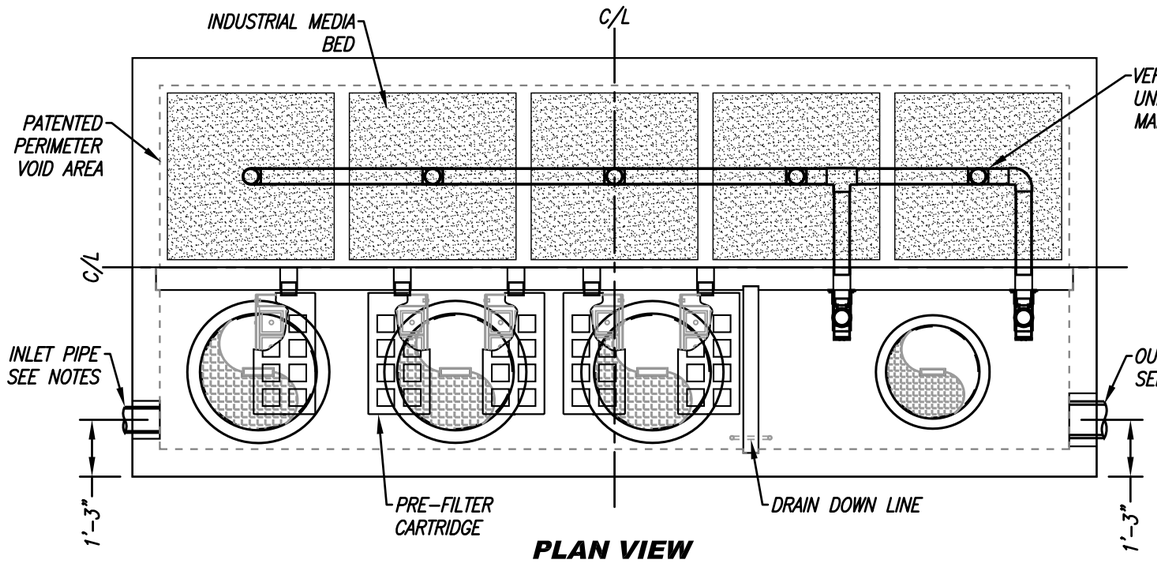
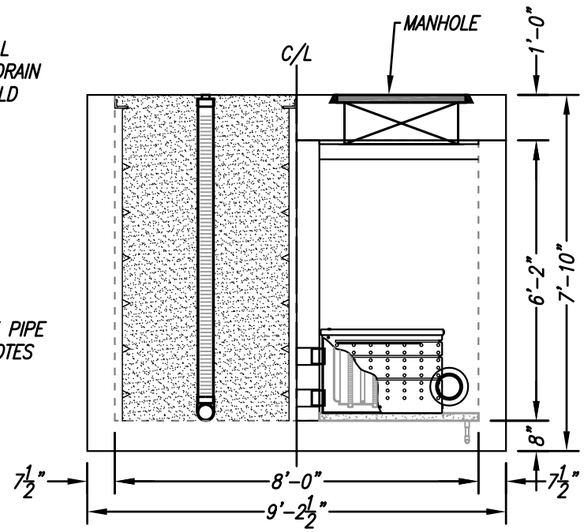
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/21BASPOLAR

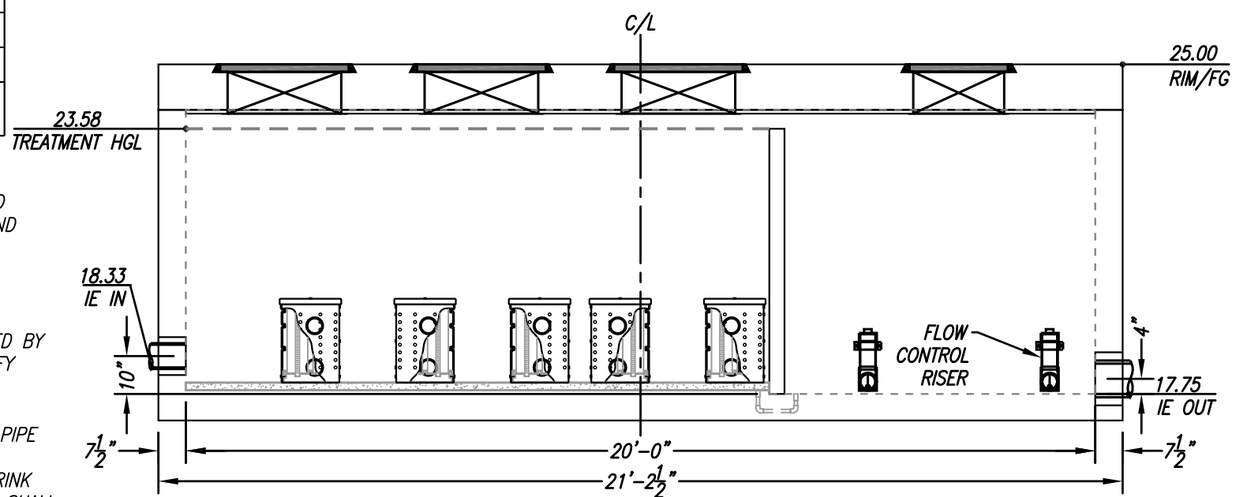
SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER			6543
PROJECT NAME			NWSA – PORT OF TACOMA – WEST SITCUM
PROJECT LOCATION			TACOMA, WA
STRUCTURE ID			B1.3
TREATMENT REQUIRED			
VOLUME BASED (CF)			FLOW BASED (CFS)
			0.577
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	18.33	DI	6"
INLET PIPE 2	N/A	N/A	N/A
OUTLET PIPE	17.75	DI	8"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	25.00	25.00	25.00
SURFACE LOAD	PEDESTRIAN	N/A	PEDESTRIAN
FRAME & COVER	3 EA ø30"	N/A	ø24"
INDUSTRIAL MEDIA VOLUME (CY)			21.24
INDUSTRIAL MEDIA DELIVERY METHOD			PER CONTRACT
ORIFICE SIZE (DIA. INCHES)			2 EA ø2.13"
NOTES: INDUSTRIAL MEDIA MIX REQUIRED. THE TREATMENT SYSTEM COMPONENTS SHALL BE MADE IN THE USA.			



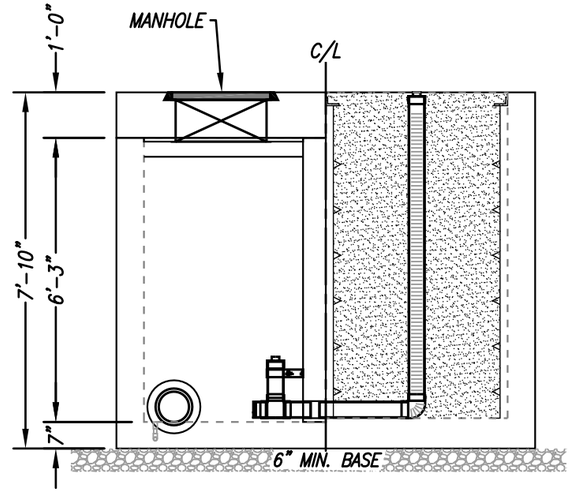
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



RIGHT END VIEW

INSTALLATION NOTES

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GENERAL NOTES

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STRUCTURAL NOTE:

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TREATMENT FLOW (CFS)	0.577
OPERATING HEAD (FT)	5.7
PRETREATMENT LOADING RATE (GPM/SF)	2.0
INDUSTRIAL MEDIA LOADING RATE (GPM/SF)	0.6

Bio Clean
A Forterra Company

MWS-L-8-20-V
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/18ASPOLAR

SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		B2.3	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		0.577	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	12.83	PVC	8"
INLET PIPE 2	N/A	N/A	N/A
OUTLET PIPE	12.33	PVC	6"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	19.58	19.58	19.58
SURFACE LOAD	PEDESTRIAN	N/A	PEDESTRIAN
FRAME & COVER	3 EA ø30"	N/A	ø24"
INDUSTRIAL MEDIA VOLUME (CY)			21.24
INDUSTRIAL MEDIA DELIVERY METHOD			PER CONTRACT
ORIFICE SIZE (DIA. INCHES)			2 EA ø2.13"
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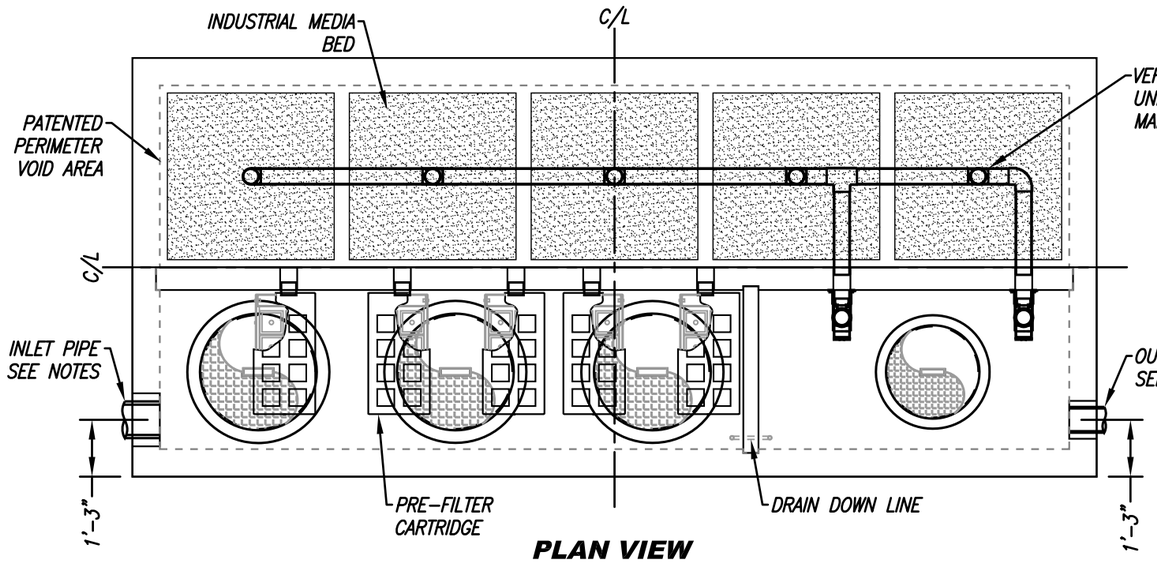
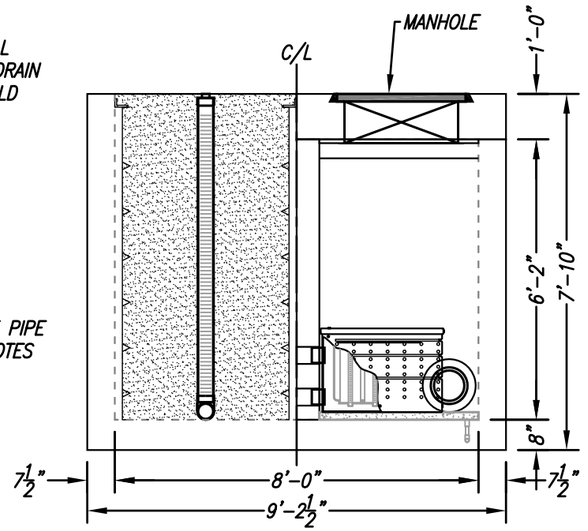
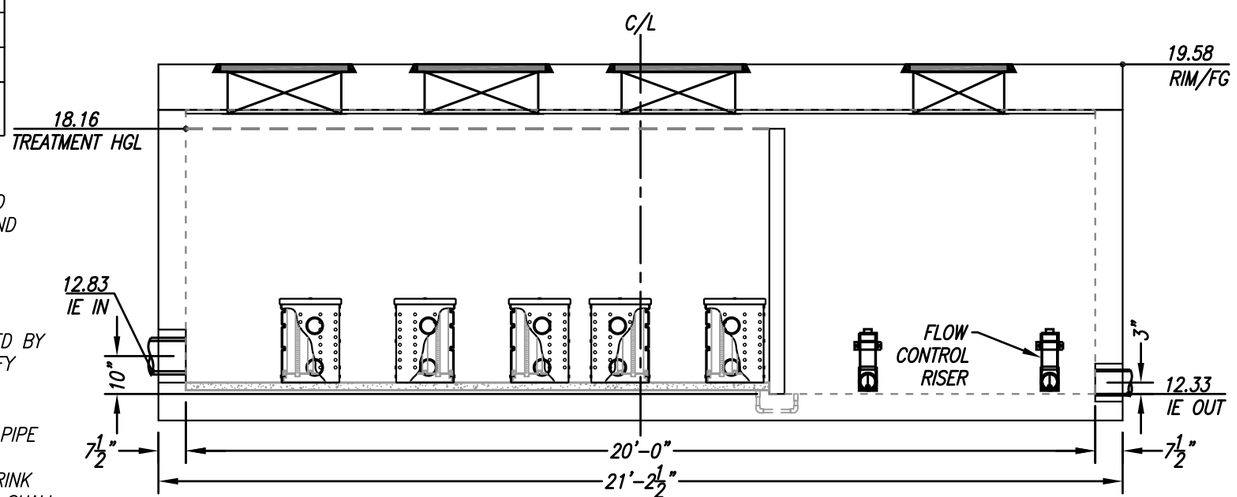


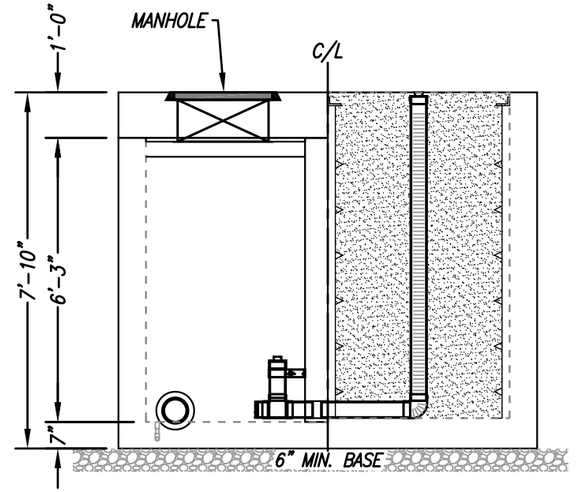
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



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TREATMENT FLOW (CFS)	0.577
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Bio Clean
A Forterra Company

MWS-L-8-20-V
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/18ASPOLAR

SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		B1.1	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		*2.2	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	18.33	DI	8"
INLET PIPE 2			
OUTLET PIPE	17.75	DI	10"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	25.00	25.00	25.00
SURFACE LOAD	PEDESTRIAN	OPEN PLANTER	PEDESTRIAN
FRAME & COVER	2 EA 36" X 72"	N/A	2 EA ø24"
INDUSTRIAL MEDIA VOLUME (CY)			25.49
INDUSTRIAL MEDIA DELIVERY METHOD			PER CONTRACT
ORIFICE SIZE (DIA. INCHES)			2 EA ø2.81"

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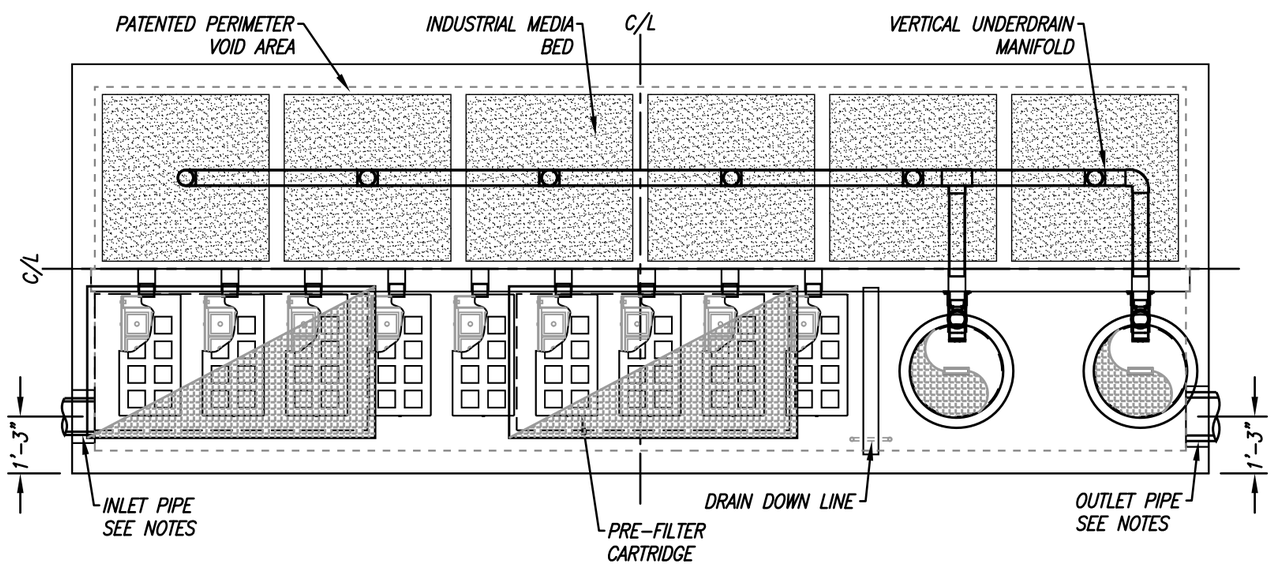
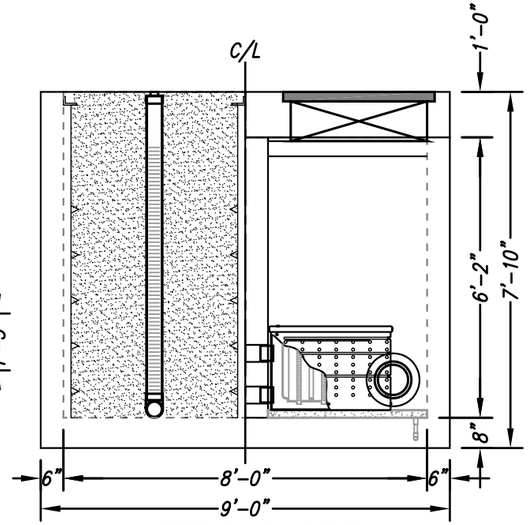
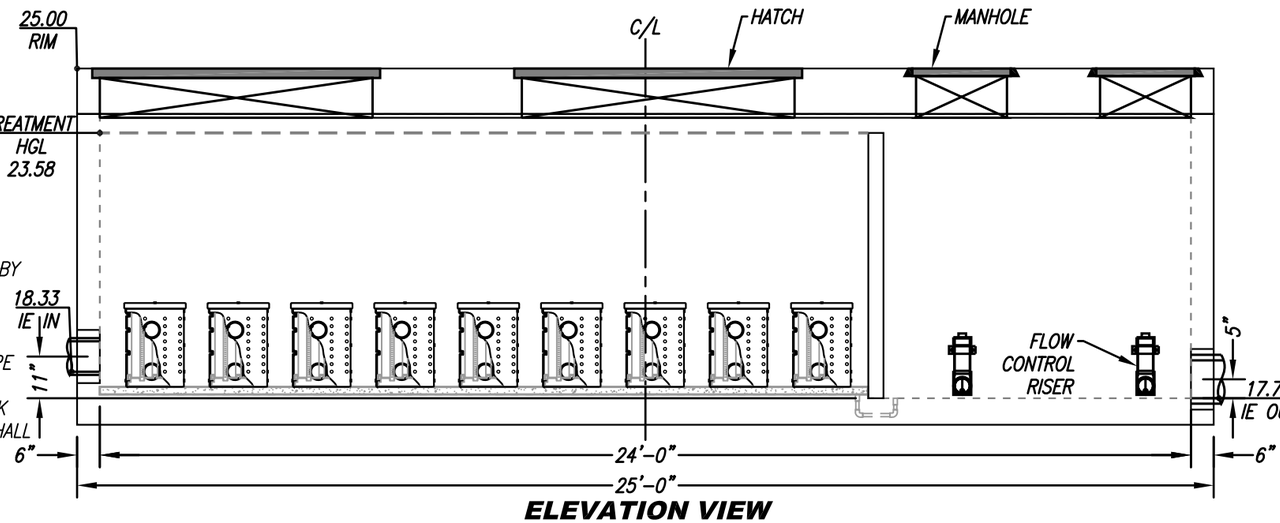


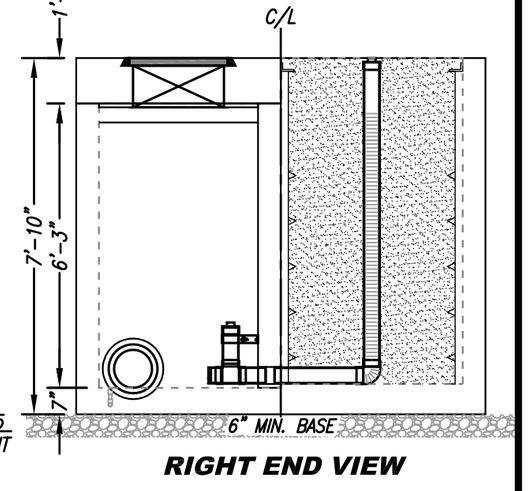
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



RIGHT END VIEW

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TREATMENT FLOW (CFS)	1.0
OPERATING HEAD (FT)	5.7
PRETREATMENT LOADING RATE (GPM/SF)	1.9
INDUSTRIAL MEDIA LOADING RATE (GPM/SF)	0.9

Bio Clean
A Forterra Company

MWS-L-8-24-V-HC
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/18ASPOLAR

SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		B1.2	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		*2.2	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	18.33	DI	8"
INLET PIPE 2			
OUTLET PIPE	17.75	DI	10"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	25.00	25.00	25.00
SURFACE LOAD	PEDESTRIAN	OPEN PLANTER	PEDESTRIAN
FRAME & COVER	2 EA 36" X 72"	N/A	2 EA ø24"
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INDUSTRIAL MEDIA DELIVERY METHOD			PER CONTRACT
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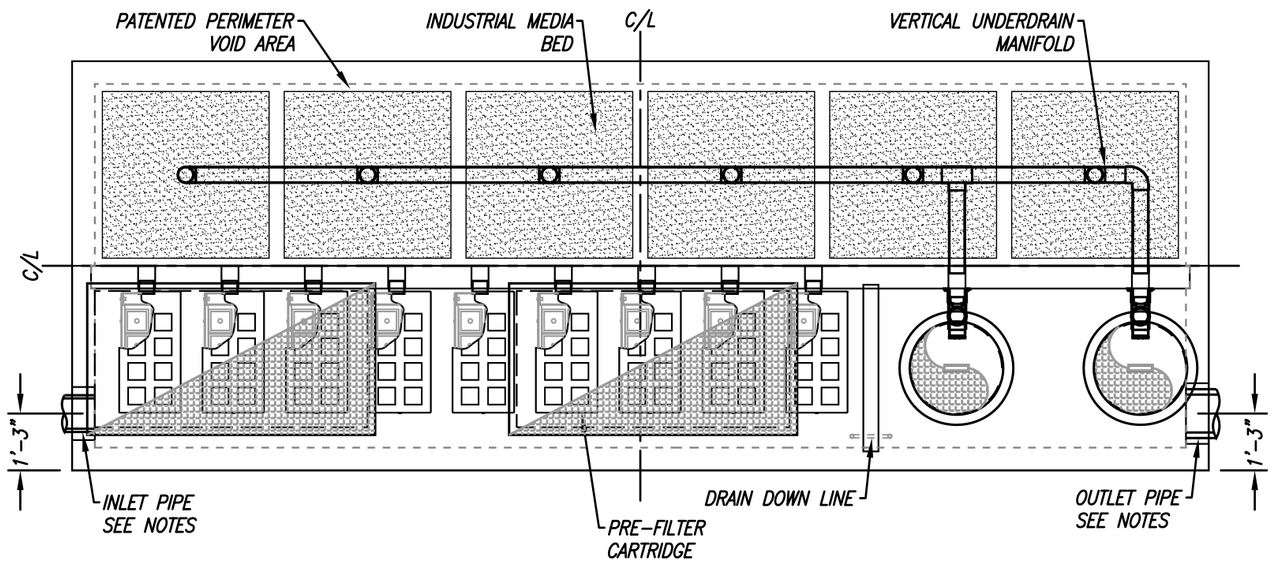
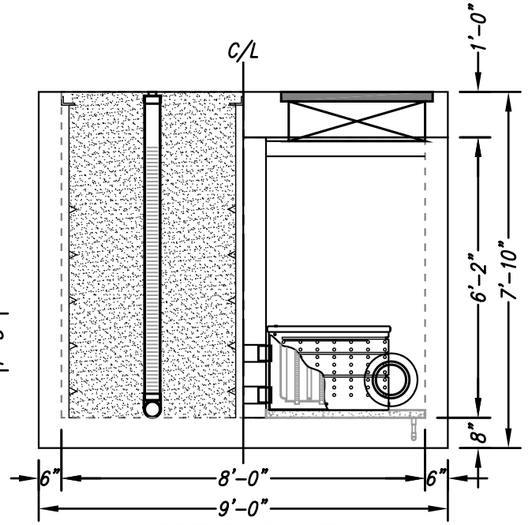
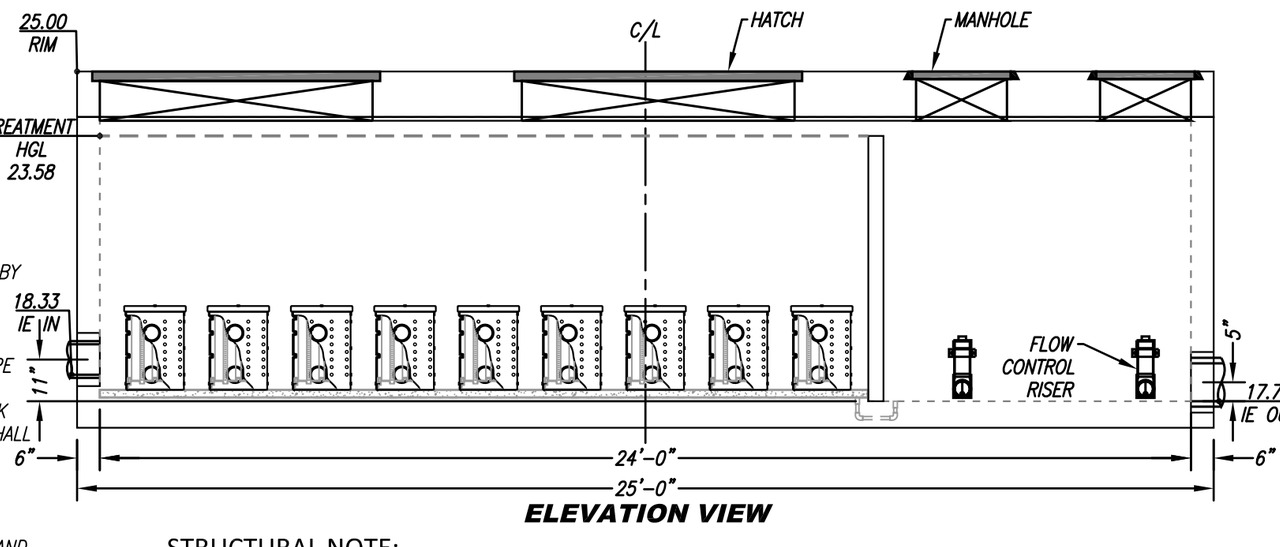


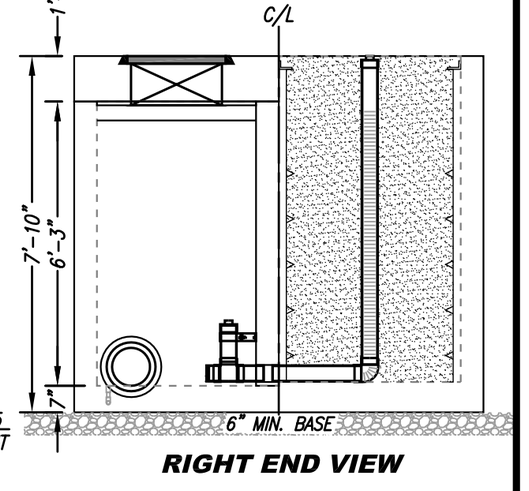
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



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Bio Clean
A Forterra Company

MWS-L-8-24-V-HC
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/18ASPOLAR

SITE SPECIFIC DATA

BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		B2.1	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		*2.2	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
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INLET PIPE 1	12.91	DI	10"
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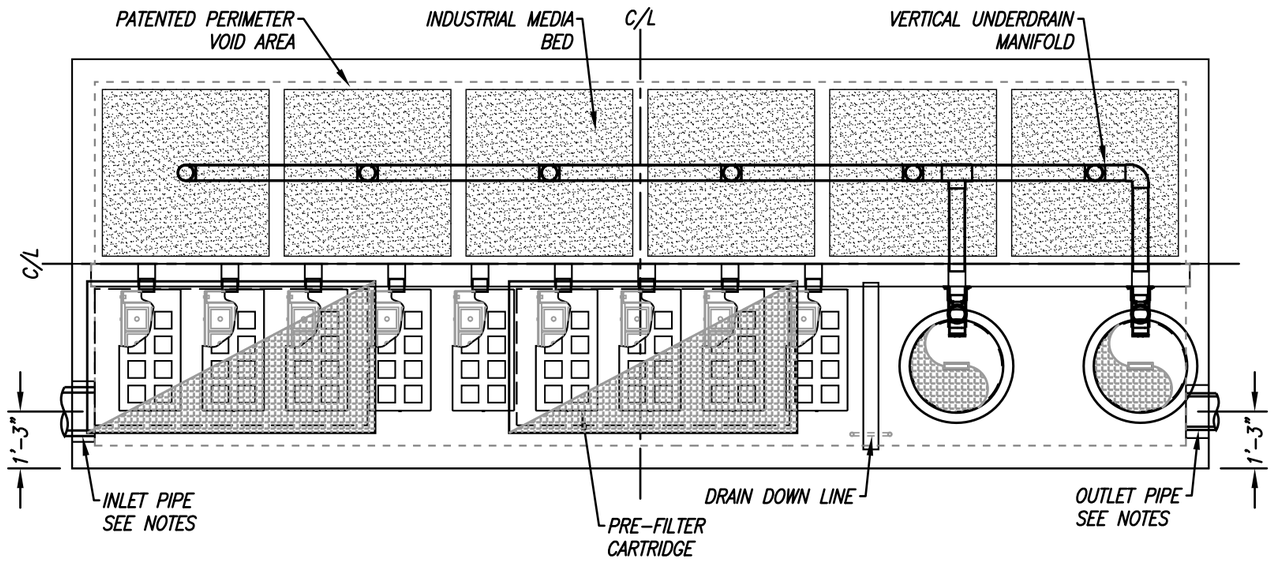
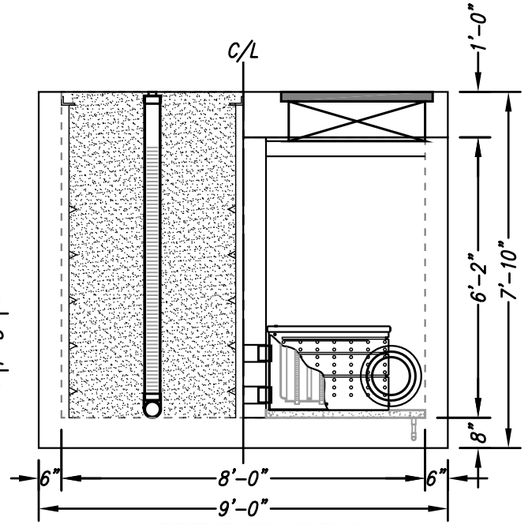
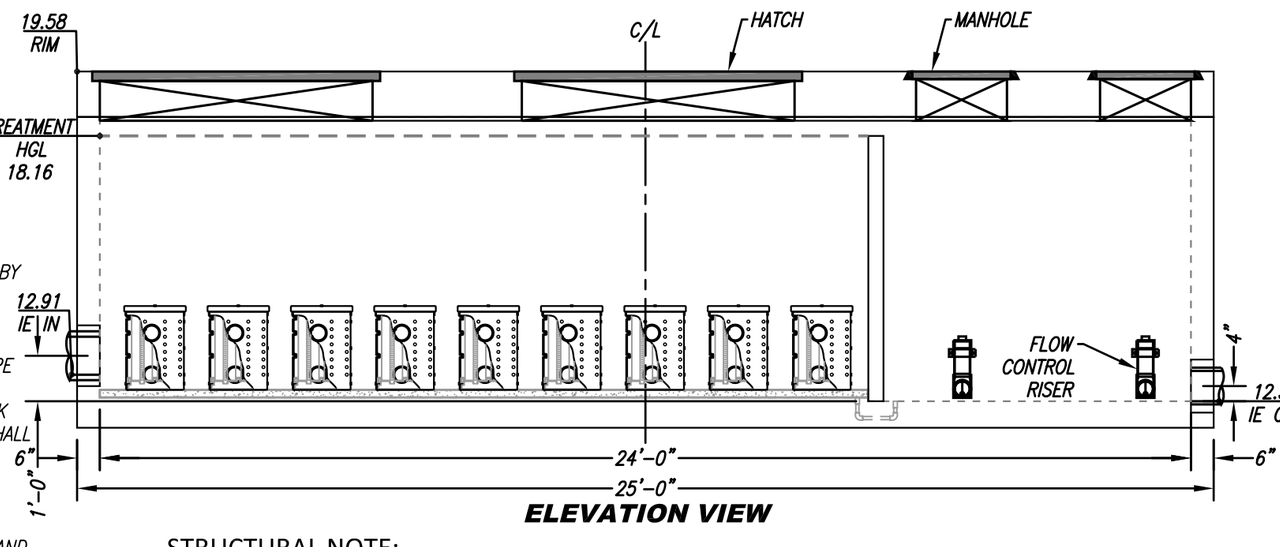


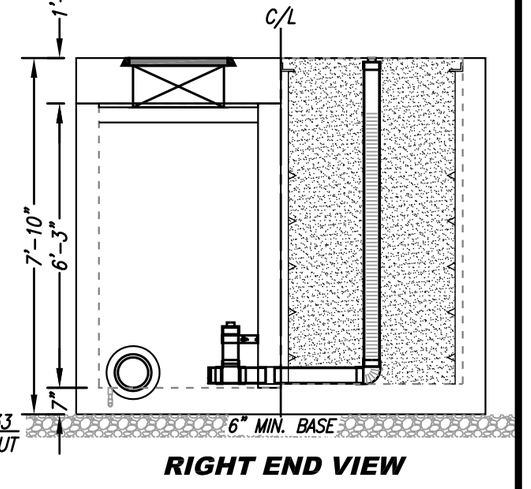
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



RIGHT END VIEW

STRUCTURAL NOTE:

"STRUCTURAL DESIGN CALCULATIONS SEALED BY A PROFESSIONAL ENGINEER LICENSED TO PRACTICE IN THE STATE OF WASHINGTON. CALCULATIONS SHALL DEMONSTRATE THAT THE TREATMENT SYSTEM ARE DESIGNED TO MEET ABOVE GROUND STRUCTURAL DESIGN REQUIREMENTS FOR CONCRETE STRUCTURES AND APPLICABLE BUILDING CODES." (PROJECT SPECS, ATTACHMENT C, DIVISION 01 GENERAL REQUIREMENTS, SECTION 01 33 00 – SUBMITTAL PROCEDURES, 1.03 SUBMITTALS) BIOCLEAN WILL PROVIDE THE STRUCTURAL CALCS WITHIN A SEPARATE STRUCTURAL SUBMITTAL.

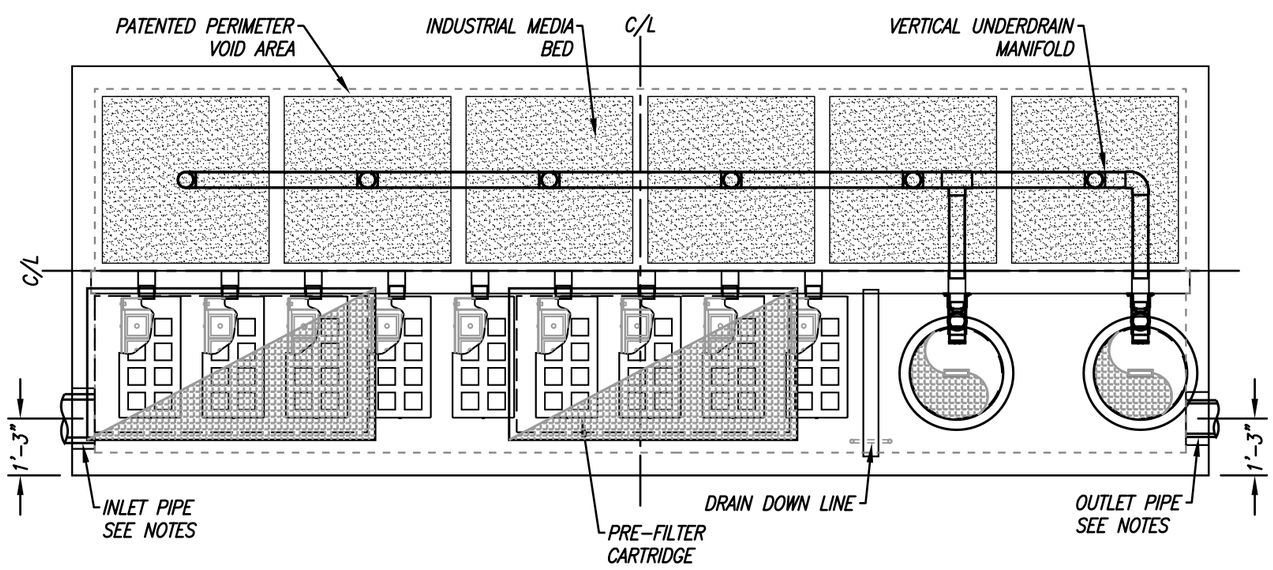
TREATMENT FLOW (CFS)	1.0
OPERATING HEAD (FT)	5.7
PRETREATMENT LOADING RATE (GPM/SF)	1.9
INDUSTRIAL MEDIA LOADING RATE (GPM/SF)	0.9

Bio Clean
A Forterra Company

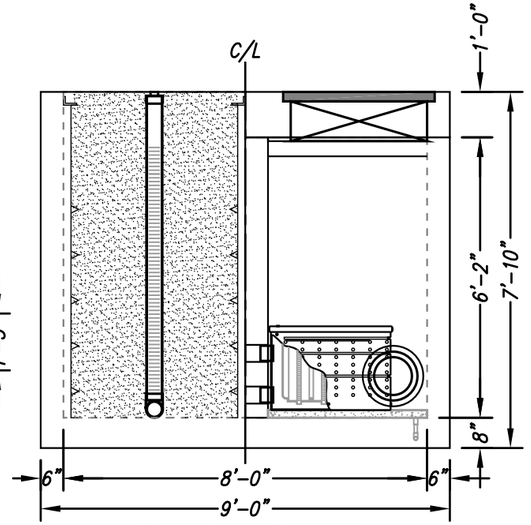
MWS-L-8-24-V-HC
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/18ASPOLAR

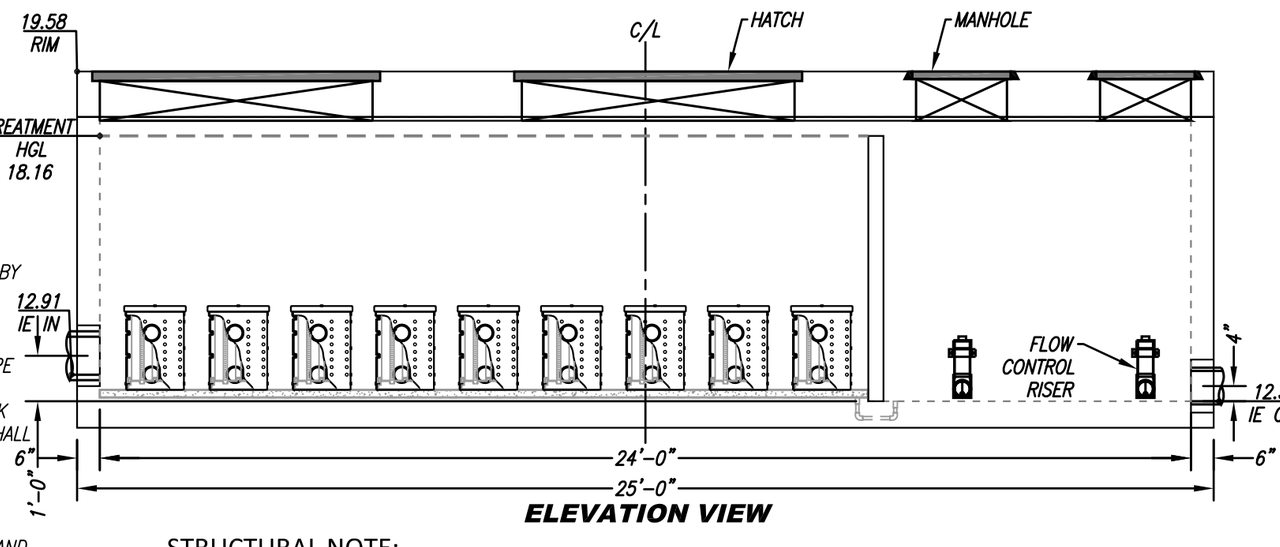
SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		B2.2	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		*2.2	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	12.91	DI	10"
INLET PIPE 2			
OUTLET PIPE	12.33	DI	8"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	19.58	19.58	19.58
SURFACE LOAD	PEDESTRIAN	OPEN PLANTER	PEDESTRIAN
FRAME & COVER	2 EA 36" X 72"	N/A	2 EA ø24"
INDUSTRIAL MEDIA VOLUME (CY)			25.49
INDUSTRIAL MEDIA DELIVERY METHOD			PER CONTRACT
ORIFICE SIZE (DIA. INCHES)			2 EA ø2.81"
NOTES: *A TOTAL OF THREE MWS VAULTS WILL PROVIDE THE REQUIRED TREATMENT. INDUSTRIAL MEDIA MIX REQUIRED. THE TREATMENT SYSTEM COMPONENTS SHALL BE MADE IN THE USA.			



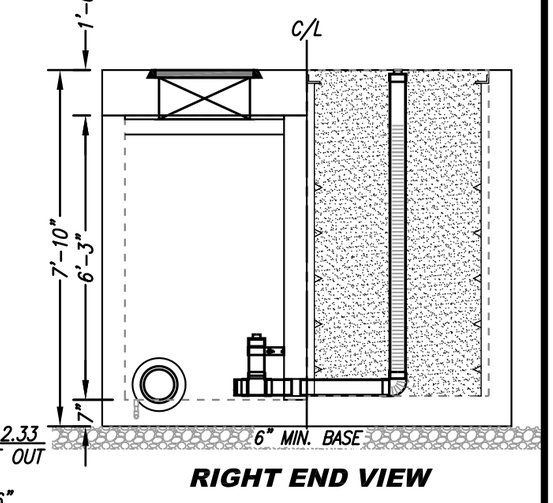
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



RIGHT END VIEW

INSTALLATION NOTES

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2. UNIT MUST BE INSTALLED ON LEVEL BASE. MANUFACTURER RECOMMENDS A MINIMUM 6" LEVEL ROCK BASE UNLESS SPECIFIED BY THE PROJECT ENGINEER. CONTRACTOR IS RESPONSIBLE TO VERIFY PROJECT ENGINEERS RECOMMENDED BASE SPECIFICATIONS.
3. ALL PIPES MUST BE FLUSH WITH INSIDE SURFACE OF CONCRETE. (PIPES CANNOT INTRUDE BEYOND FLUSH). INVERT OF OUTFLOW PIPE MUST BE FLUSH WITH DISCHARGE CHAMBER FLOOR. ALL GAPS AROUND PIPES SHALL BE SEALED WATER TIGHT WITH A NON-SHRINK GROUT PER MANUFACTURERS STANDARD CONNECTION DETAIL AND SHALL MEET OR EXCEED REGIONAL PIPE CONNECTION STANDARDS.
4. CONTRACTOR TO SUPPLY AND INSTALL ALL EXTERNAL CONNECTING PIPES.
5. CONTRACTOR RESPONSIBLE FOR INSTALLATION OF ALL RISERS, MANHOLES, AND HATCHES. CONTRACTOR TO GROUT ALL MANHOLES AND HATCHES TO MATCH FINISHED SURFACE UNLESS SPECIFIED OTHERWISE.
6. DRIP OR SPRAY IRRIGATION REQUIRED ON ALL UNITS WITH VEGETATION.
7. CONTRACTOR RESPONSIBLE FOR CONTACTING MODULAR WETLANDS FOR ACTIVATION OF UNIT. MANUFACTURES WARRANTY IS VOID WITH OUT PROPER ACTIVATION BY A MODULAR WETLANDS REPRESENTATIVE.

GENERAL NOTES

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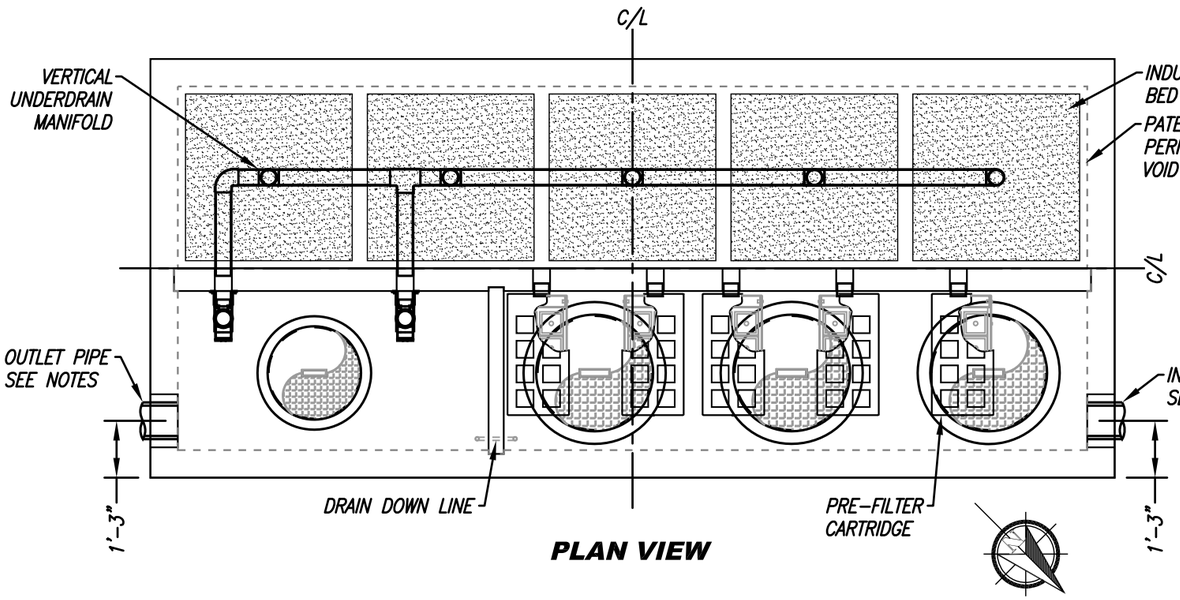
OPERATING HEAD (FT)	5.7
PRETREATMENT LOADING RATE (GPM/SF)	1.9
INDUSTRIAL MEDIA LOADING RATE (GPM/SF)	0.9

Bio Clean
A Forterra Company

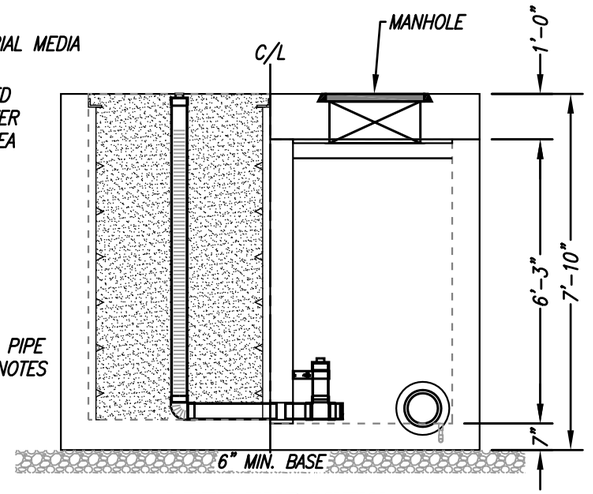
MWS-L-8-24-V-HC
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/18ASPOLAR

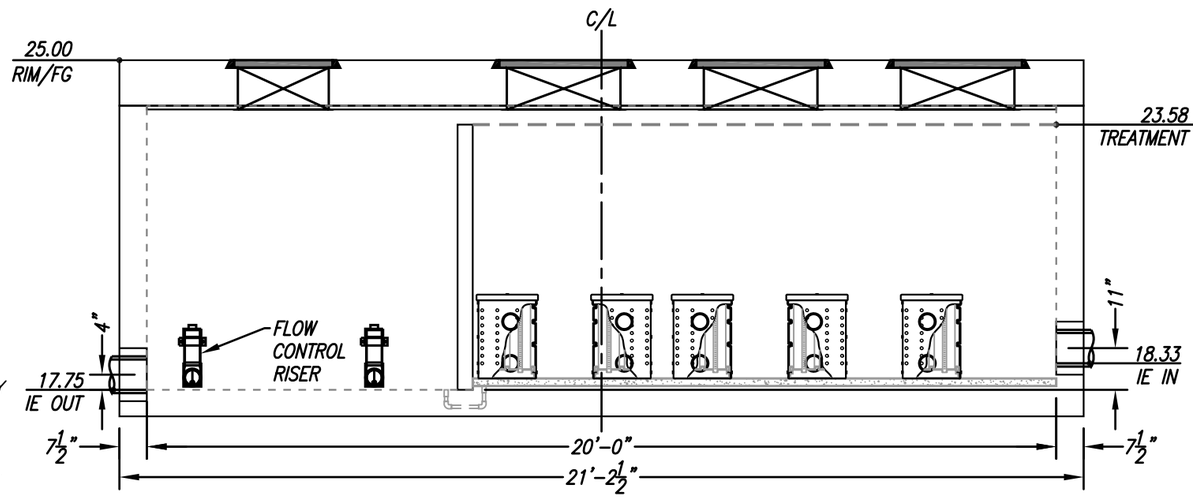
SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		C1.1	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		0.577	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	18.33	DI	8"
INLET PIPE 2	N/A	N/A	N/A
OUTLET PIPE	17.75	DI	8"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	25.00	25.00	25.00
SURFACE LOAD	PEDESTRIAN	N/A	PEDESTRIAN
FRAME & COVER	3 EA ø30"	N/A	ø24"
INDUSTRIAL MEDIA VOLUME (CY)			21.24
INDUSTRIAL MEDIA DELIVERY METHOD			PER CONTRACT
ORIFICE SIZE (DIA. INCHES)			2 EA ø2.13"
NOTES: INDUSTRIAL MEDIA MIX REQUIRED. THE TREATMENT SYSTEM COMPONENTS SHALL BE MADE IN THE USA.			



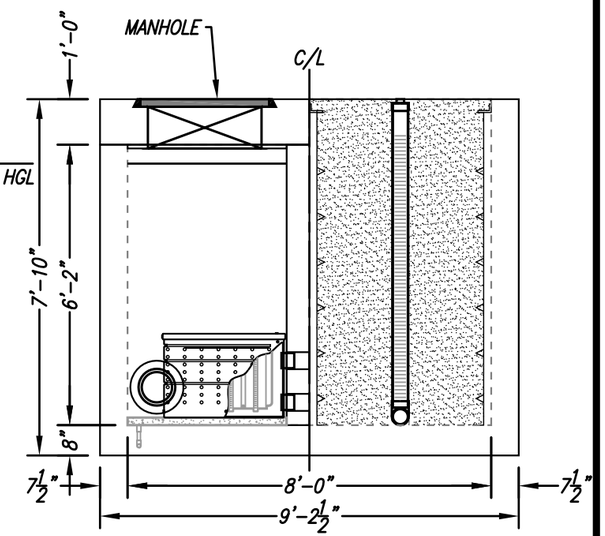
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



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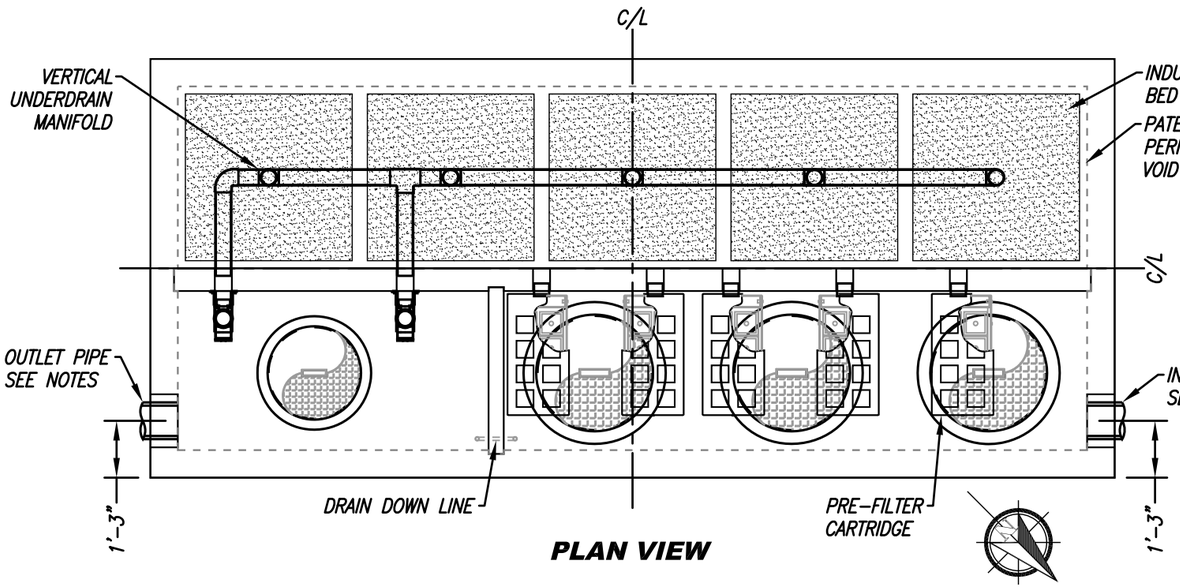
TREATMENT FLOW (CFS)	0.577
OPERATING HEAD (FT)	5.7
PRETREATMENT LOADING RATE (GPM/SF)	2.0
INDUSTRIAL MEDIA LOADING RATE (GPM/SF)	0.6

Bio Clean
A Forterra Company

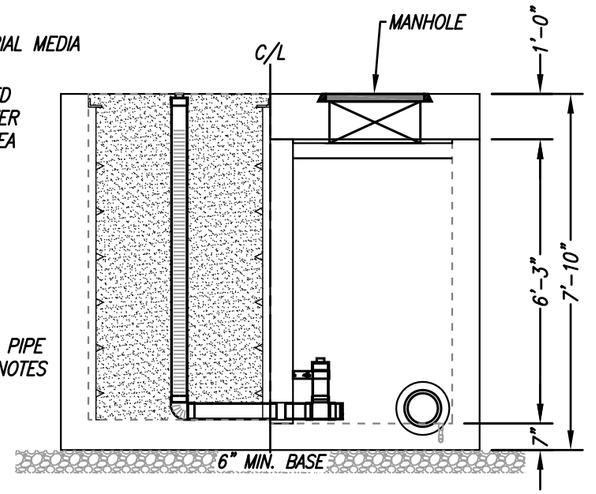
MWS-L-8-20-V
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/18ASPOLAR

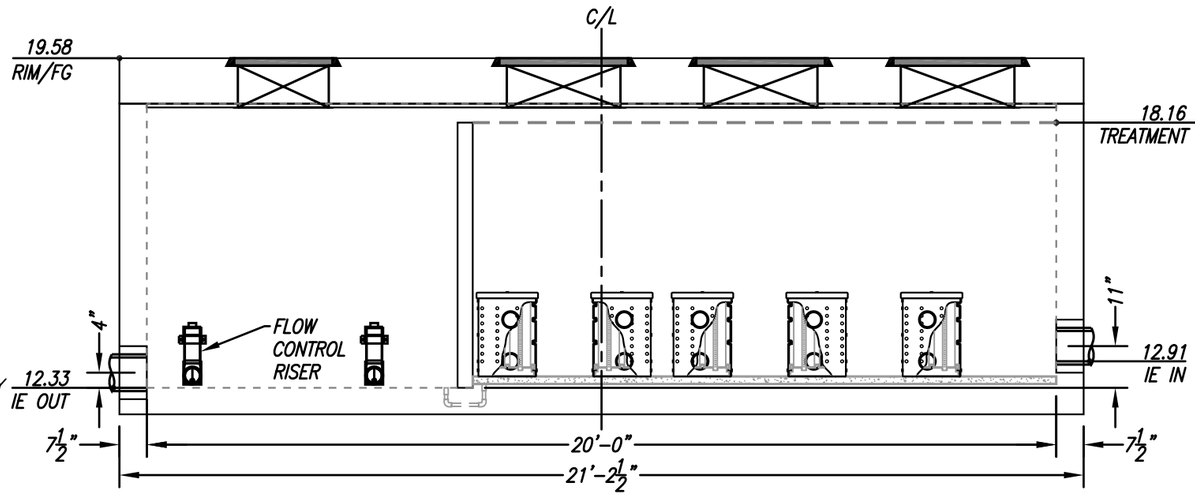
SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		C2.1	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		0.577	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	12.91	DI	8"
INLET PIPE 2	N/A	N/A	N/A
OUTLET PIPE	12.33	DI	8"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	19.58	19.58	19.58
SURFACE LOAD	PEDESTRIAN	N/A	PEDESTRIAN
FRAME & COVER	3 EA ø30"	N/A	ø24"
INDUSTRIAL MEDIA VOLUME (CY)			21.24
INDUSTRIAL MEDIA DELIVERY METHOD			PER CONTRACT
ORIFICE SIZE (DIA. INCHES)			2 EA ø2.13"
NOTES: INDUSTRIAL MEDIA MIX REQUIRED. THE TREATMENT SYSTEM COMPONENTS SHALL BE MADE IN THE USA.			



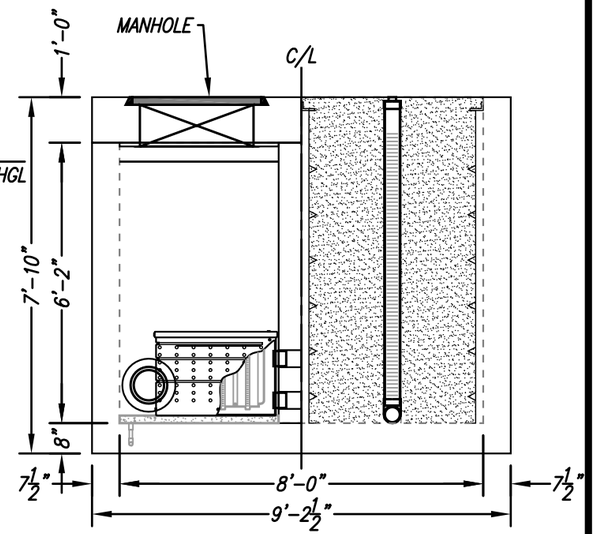
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



RIGHT END VIEW

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TREATMENT FLOW (CFS)	0.577
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PRETREATMENT LOADING RATE (GPM/SF)	2.0
INDUSTRIAL MEDIA LOADING RATE (GPM/SF)	0.6

Bio Clean
A Forterra Company

MWS-L-8-20-V
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/18ASPOLAR

SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		C1.2	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		*4.9	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	18.33	DI	8"
INLET PIPE 2			
OUTLET PIPE	17.75	DI	10"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	25.00	25.00	25.00
SURFACE LOAD	PEDESTRIAN	OPEN PLANTER	PEDESTRIAN
FRAME & COVER	2 EA 36" X 72"	N/A	2 EA ø24"
INDUSTRIAL MEDIA VOLUME (CY)			25.49
INDUSTRIAL MEDIA DELIVERY METHOD			PER CONTRACT
ORIFICE SIZE (DIA. INCHES)			2 EA ø2.81"
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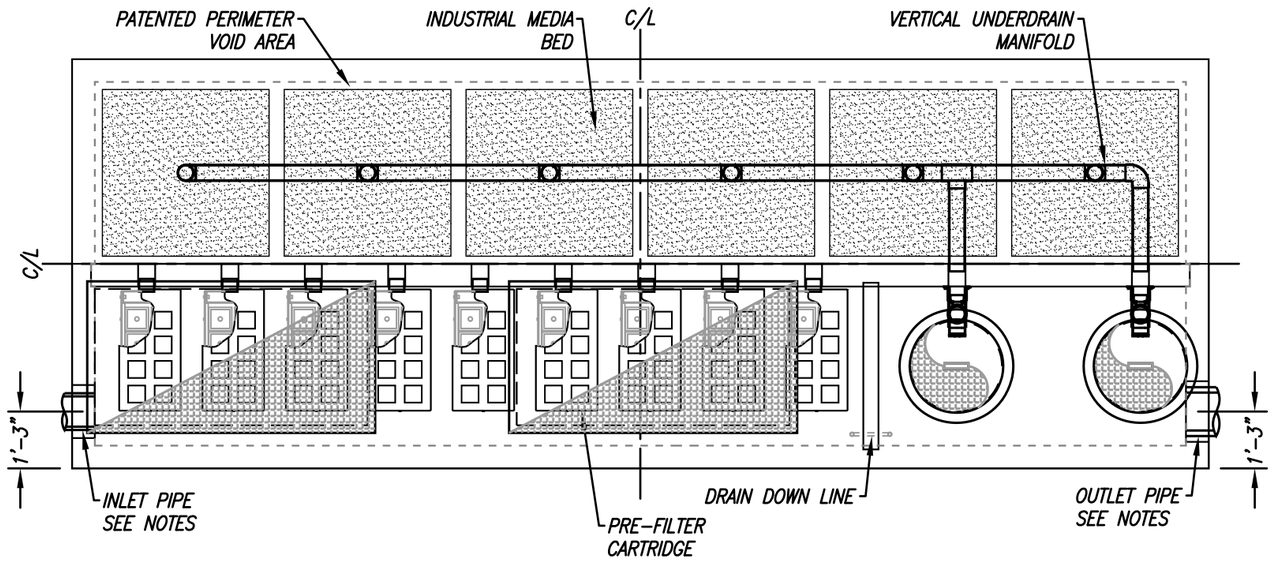
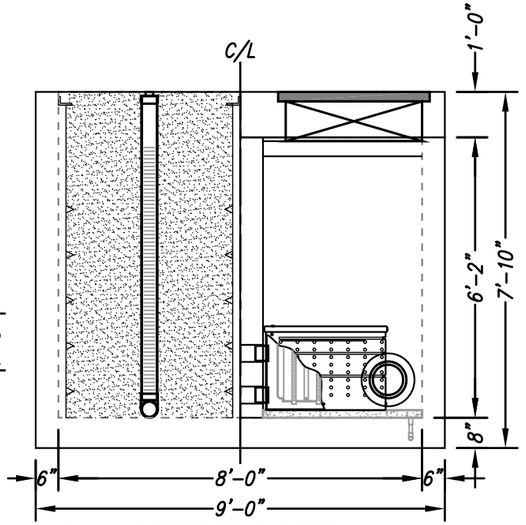
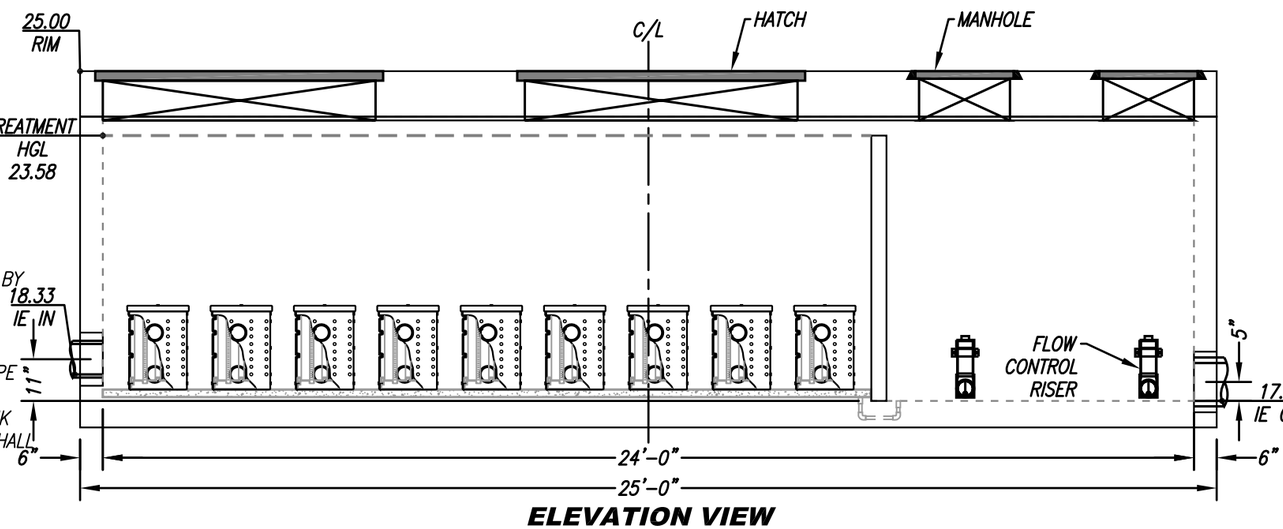


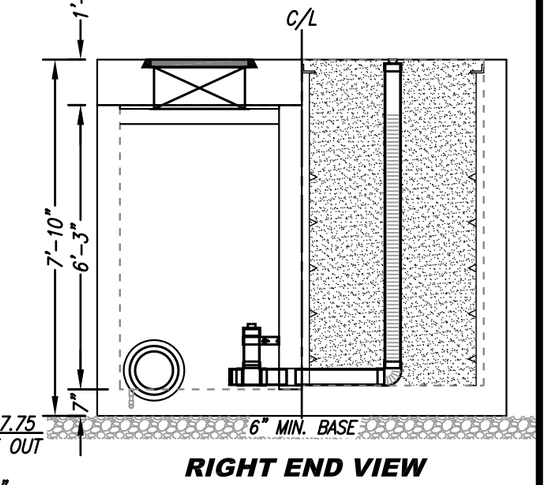
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



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INSTALLATION NOTES

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TREATMENT FLOW (CFS)	1.0
OPERATING HEAD (FT)	5.7
PRETREATMENT LOADING RATE (GPM/SF)	1.9
INDUSTRIAL MEDIA LOADING RATE (GPM/SF)	0.9

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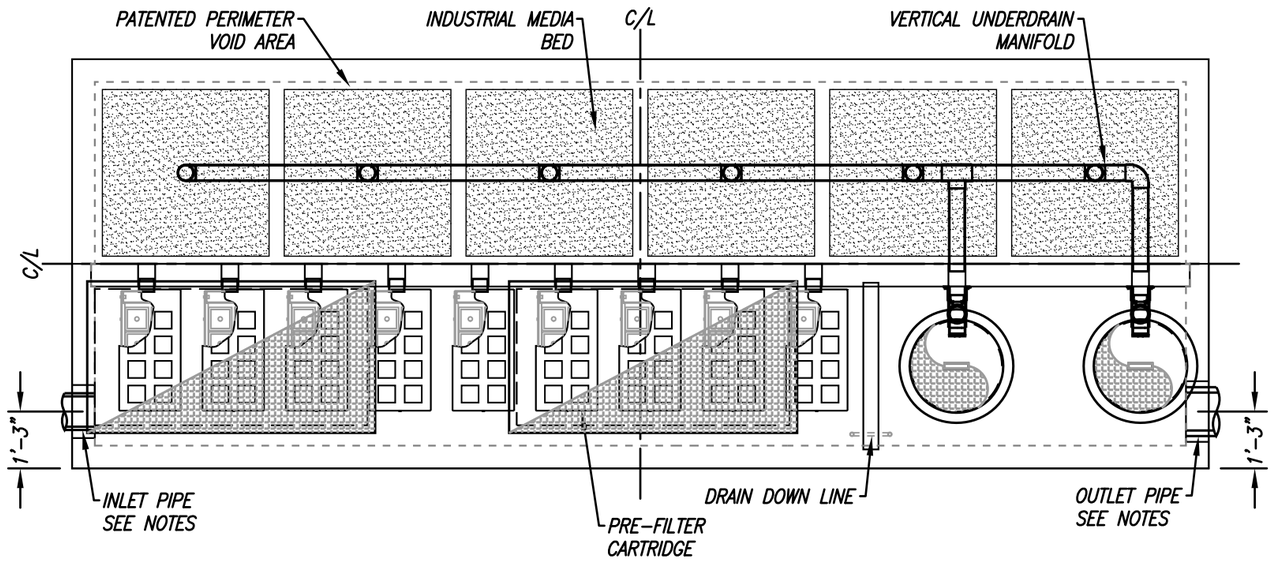
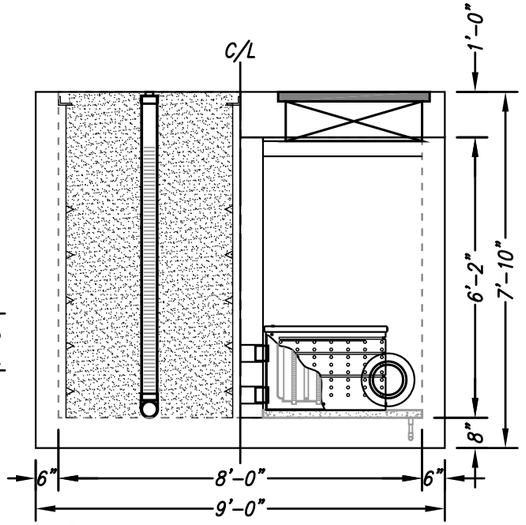
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/18ASPOLAR

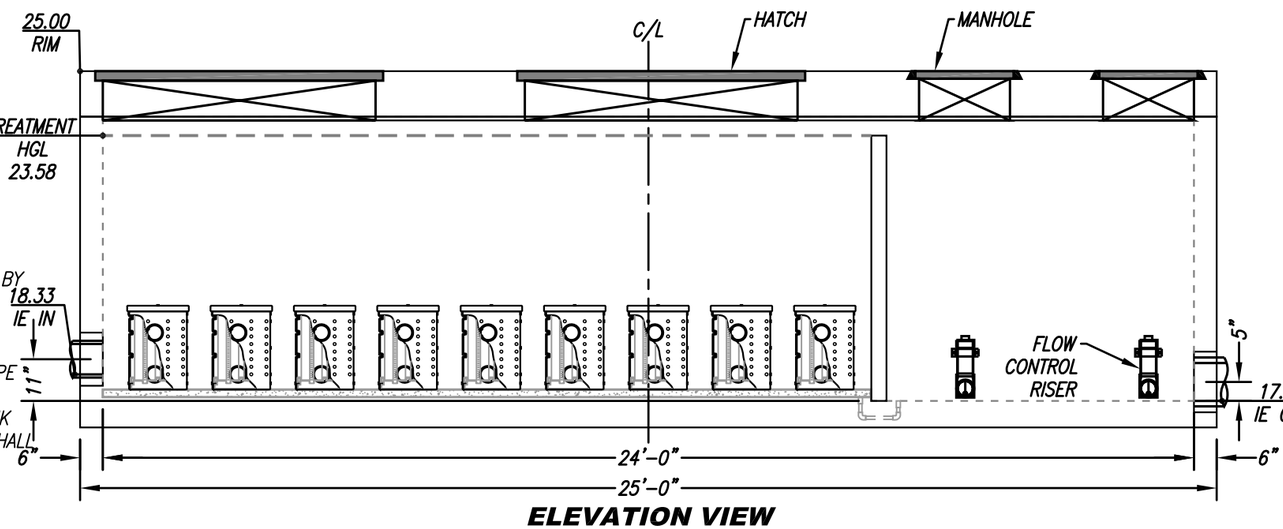
SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		C1.3	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		*4.9	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	18.33	DI	8"
INLET PIPE 2			
OUTLET PIPE	17.75	DI	10"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	25.00	25.00	25.00
SURFACE LOAD	PEDESTRIAN	OPEN PLANTER	PEDESTRIAN
FRAME & COVER	2 EA 36" X 72"	N/A	2 EA ø24"
INDUSTRIAL MEDIA VOLUME (CY)			25.49
INDUSTRIAL MEDIA DELIVERY METHOD			PER CONTRACT
ORIFICE SIZE (DIA. INCHES)			2 EA ø2.81"
NOTES: *A TOTAL OF SIX MWS VAULTS WILL PROVIDE THE REQUIRED TREATMENT. INDUSTRIAL MEDIA MIX REQUIRED. THE TREATMENT SYSTEM COMPONENTS SHALL BE MADE IN THE USA.			



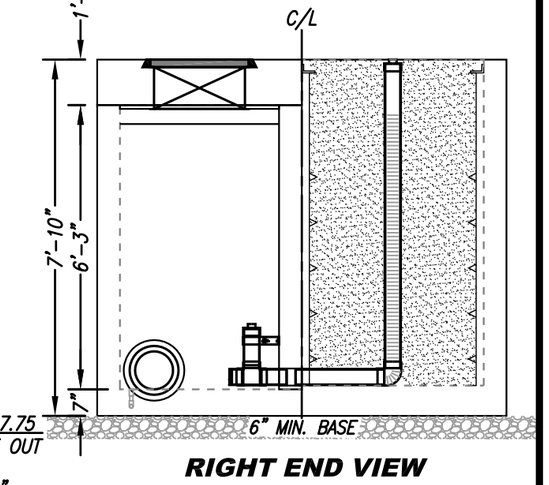
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



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INSTALLATION NOTES

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STRUCTURAL NOTE:

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TREATMENT FLOW (CFS)	1.0
OPERATING HEAD (FT)	5.7
PRETREATMENT LOADING RATE (GPM/SF)	1.9
INDUSTRIAL MEDIA LOADING RATE (GPM/SF)	0.9

Bio Clean
A Forterra Company

MWS-L-8-24-V-HC
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/18ASPOLAR

SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		C1.4	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		*4.9	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	18.33	DI	8"
INLET PIPE 2			
OUTLET PIPE	17.75	DI	10"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	25.00	25.00	25.00
SURFACE LOAD	PEDESTRIAN	OPEN PLANTER	PEDESTRIAN
FRAME & COVER	2 EA 36" X 72"	N/A	2 EA ø24"
INDUSTRIAL MEDIA VOLUME (CY)			25.49
INDUSTRIAL MEDIA DELIVERY METHOD			PER CONTRACT
ORIFICE SIZE (DIA. INCHES)			2 EA ø2.81"
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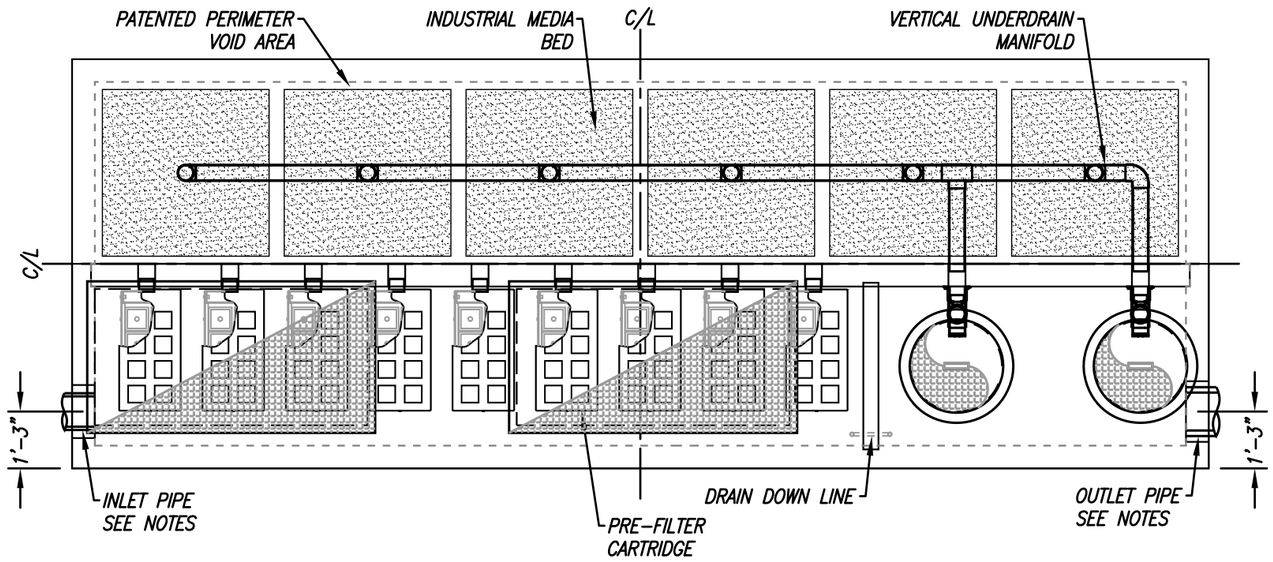
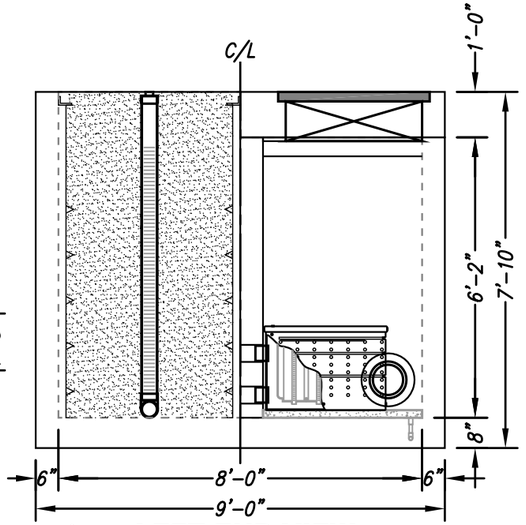


PLAN VIEW



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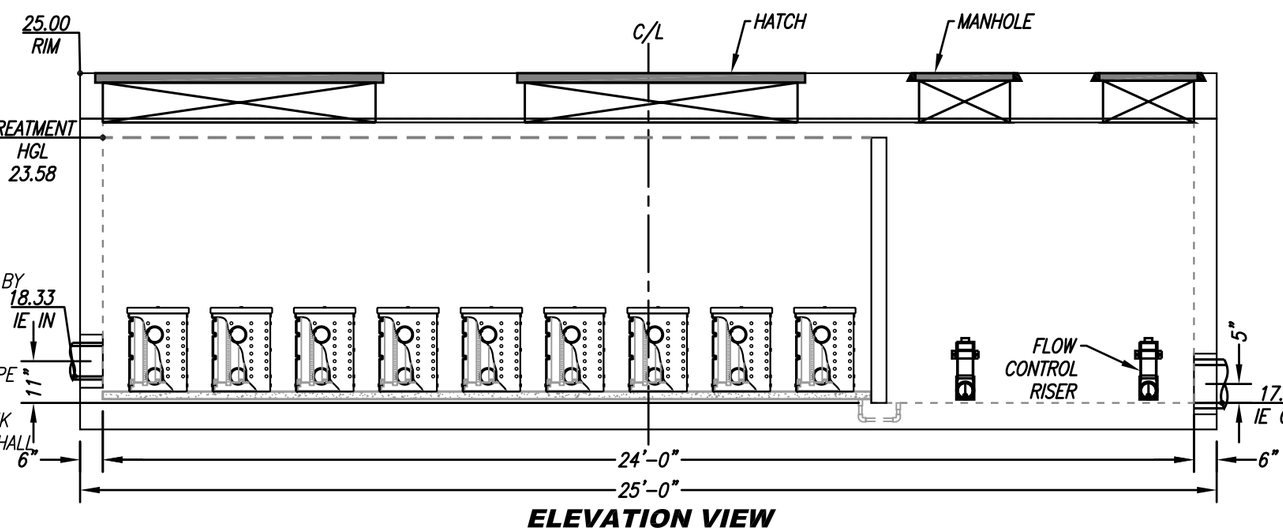
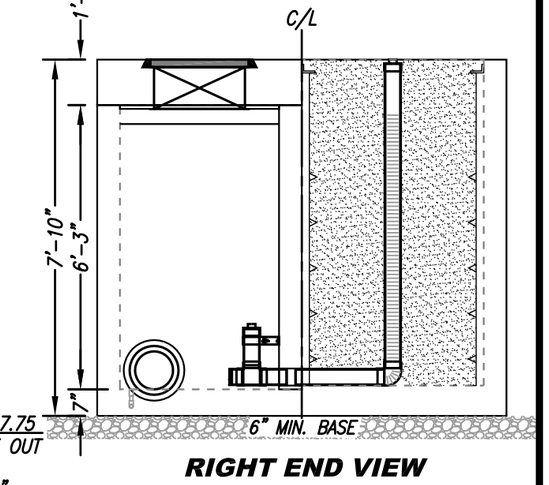


ELEVATION VIEW



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TREATMENT FLOW (CFS)	1.0
OPERATING HEAD (FT)	5.7
PRETREATMENT LOADING RATE (GPM/SF)	1.9
INDUSTRIAL MEDIA LOADING RATE (GPM/SF)	0.9

Bio Clean
A Forterra Company

MWS-L-8-24-V-HC
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/18ASPOLAR

SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		C1.5	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		*4.9	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	18.33	DI	8"
INLET PIPE 2			
OUTLET PIPE	17.75	DI	10"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	25.00	25.00	25.00
SURFACE LOAD	PEDESTRIAN	OPEN PLANTER	PEDESTRIAN
FRAME & COVER	2 EA 36" X 72"	N/A	2 EA ø24"
INDUSTRIAL MEDIA VOLUME (CY)			25.49
INDUSTRIAL MEDIA DELIVERY METHOD			PER CONTRACT
ORIFICE SIZE (DIA. INCHES)			2 EA ø2.81"

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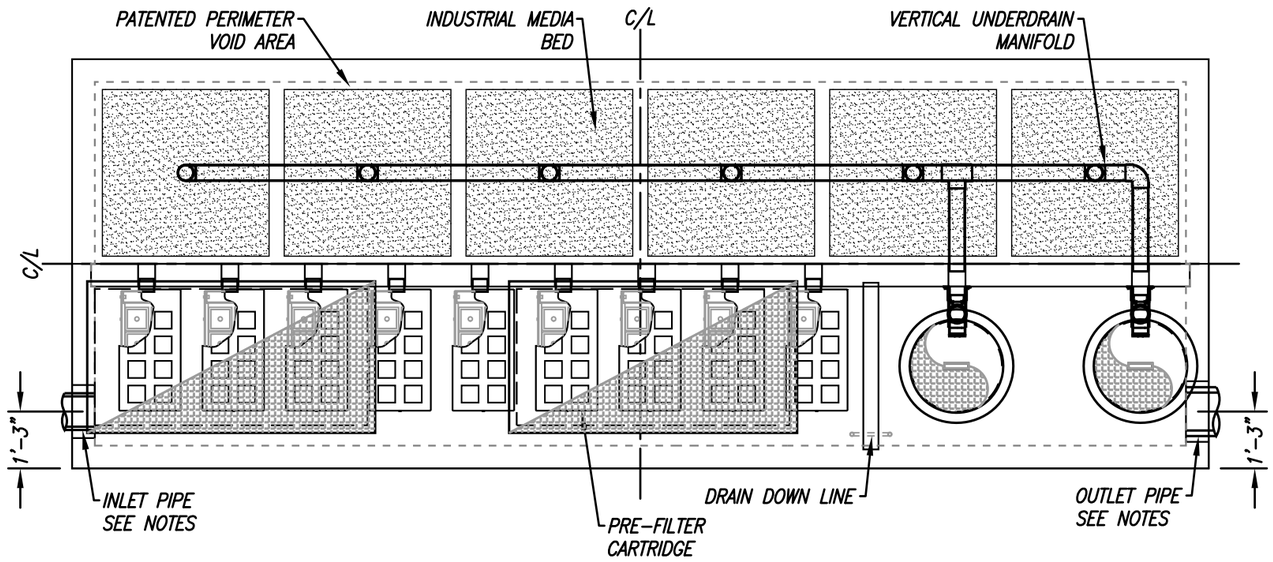
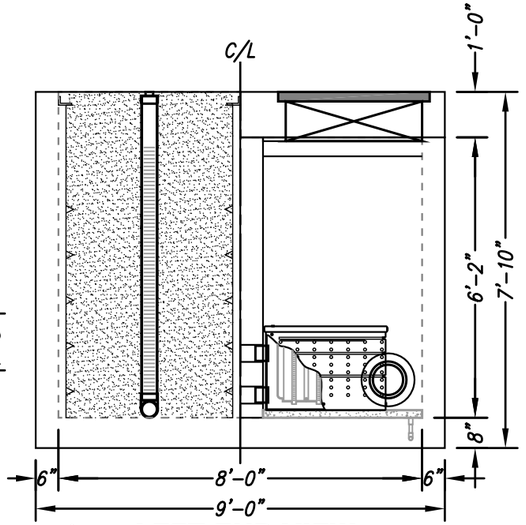
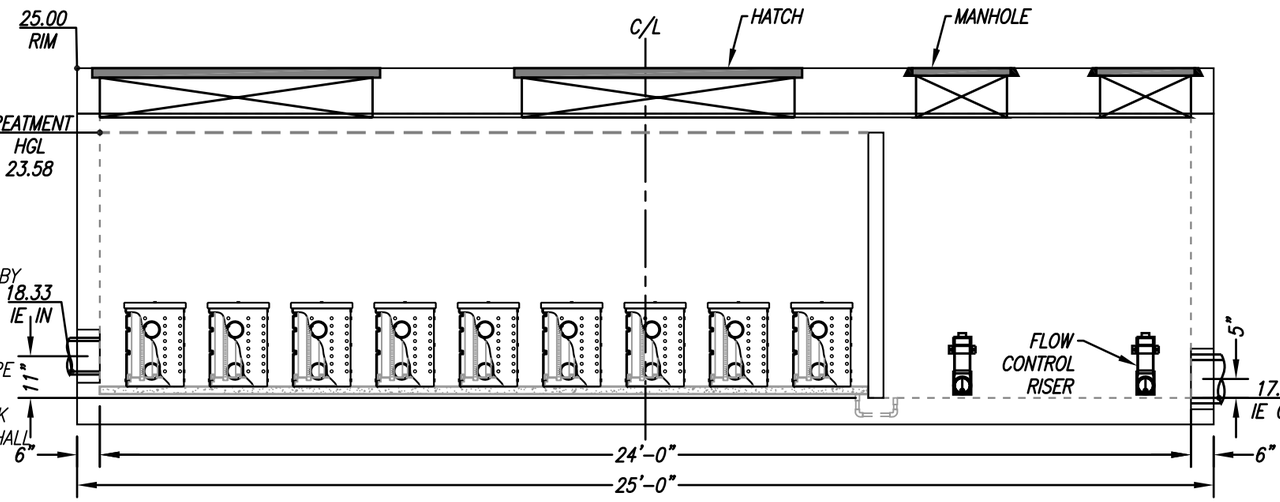


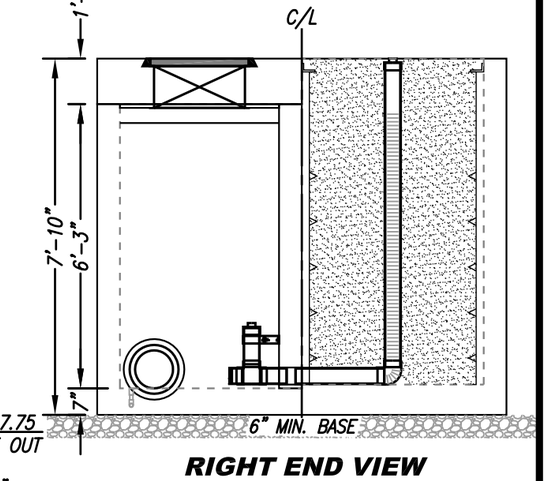
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



RIGHT END VIEW

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OPERATING HEAD (FT)	5.7
PRETREATMENT LOADING RATE (GPM/SF)	1.9
INDUSTRIAL MEDIA LOADING RATE (GPM/SF)	0.9

Bio Clean
A Forterra Company

MWS-L-8-24-V-HC
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/18ASPOLAR

SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		C1.6	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		*4.9	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	18.33	DI	8"
INLET PIPE 2			
OUTLET PIPE	17.75	DI	10"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	25.00	25.00	25.00
SURFACE LOAD	PEDESTRIAN	OPEN PLANTER	PEDESTRIAN
FRAME & COVER	2 EA 36" X 72"	N/A	2 EA ø24"
INDUSTRIAL MEDIA VOLUME (CY)			25.49
INDUSTRIAL MEDIA DELIVERY METHOD			PER CONTRACT
ORIFICE SIZE (DIA. INCHES)			2 EA ø2.81"
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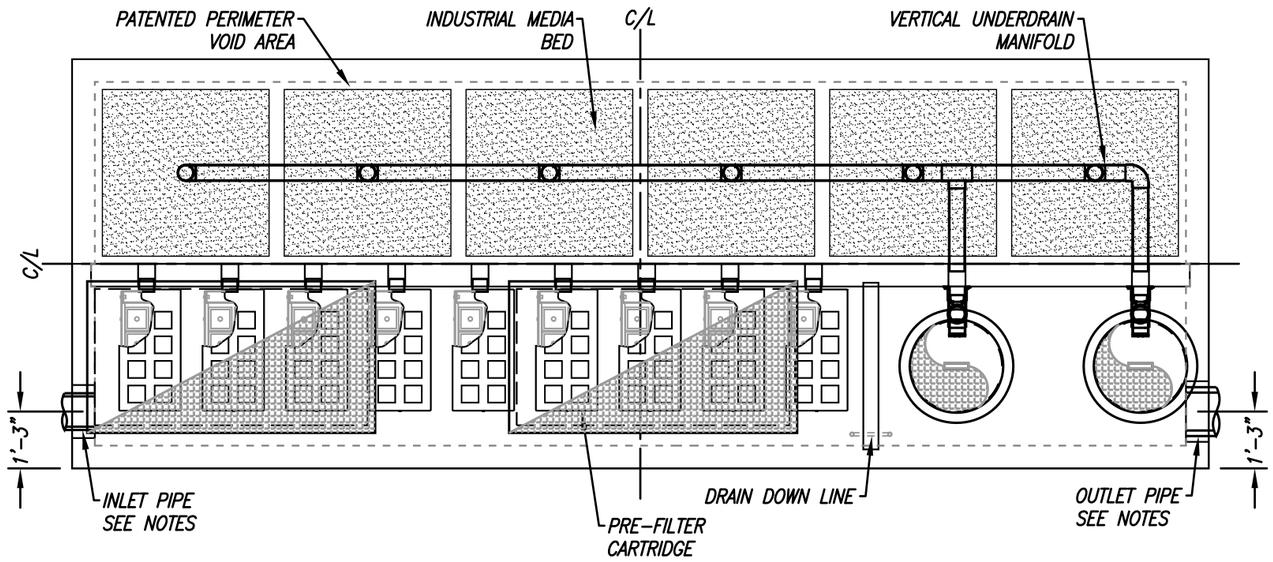

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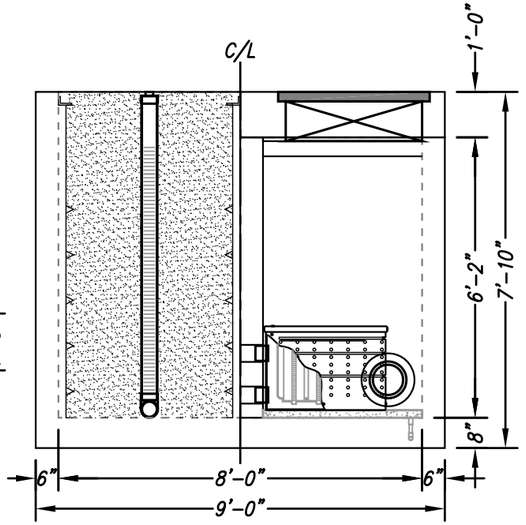

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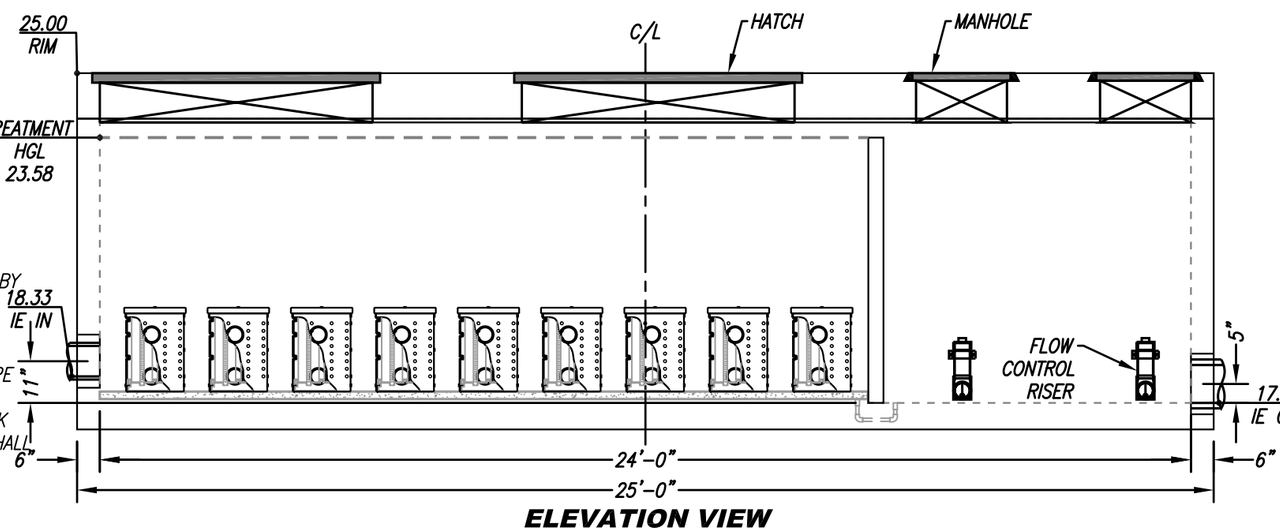
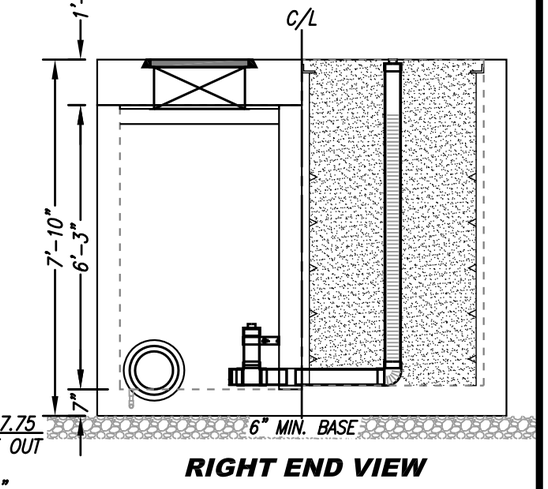


ELEVATION VIEW



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Bio Clean
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MWS-L-8-24-V-HC
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/18ASPOLAR

SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		C2.2	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		*4.9	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	12.91	DI	10"
INLET PIPE 2			
OUTLET PIPE	12.33	DI	8"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	19.58	19.58	19.58
SURFACE LOAD	PEDESTRIAN	OPEN PLANTER	PEDESTRIAN
FRAME & COVER	2 EA 36" X 72"	N/A	2 EA ø24"
INDUSTRIAL MEDIA VOLUME (CY)			25.49
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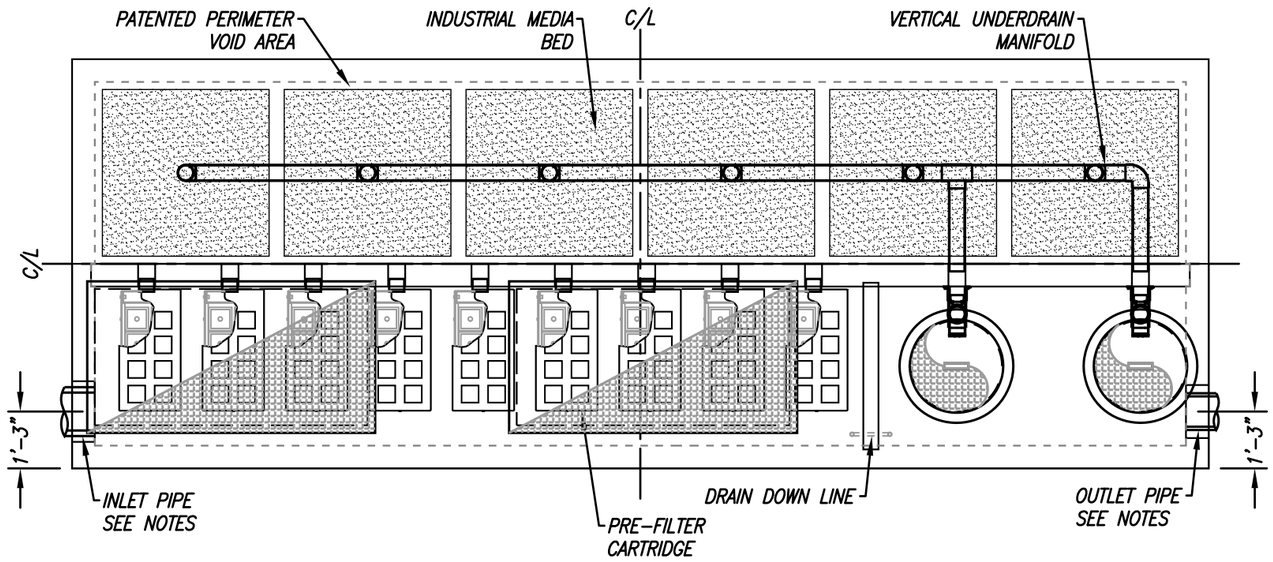
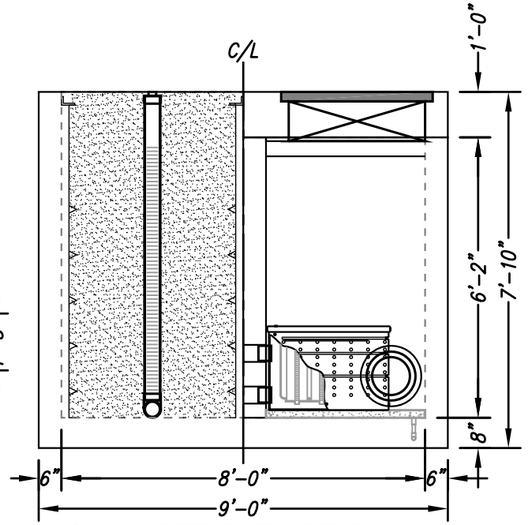
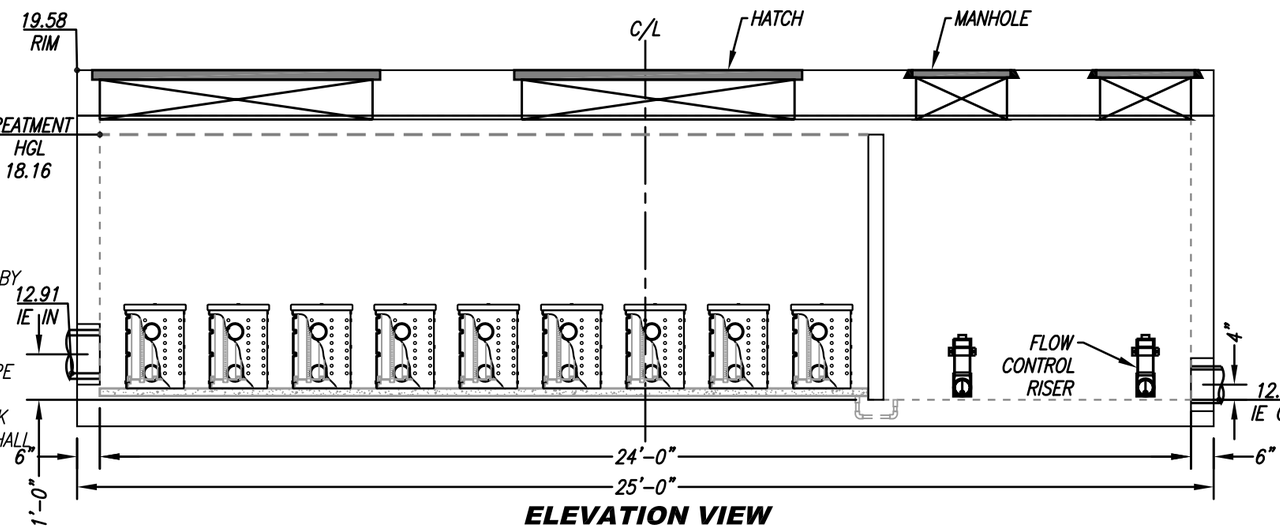


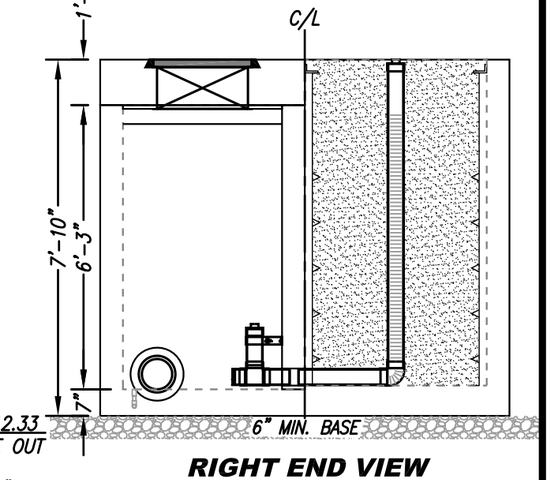
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



RIGHT END VIEW

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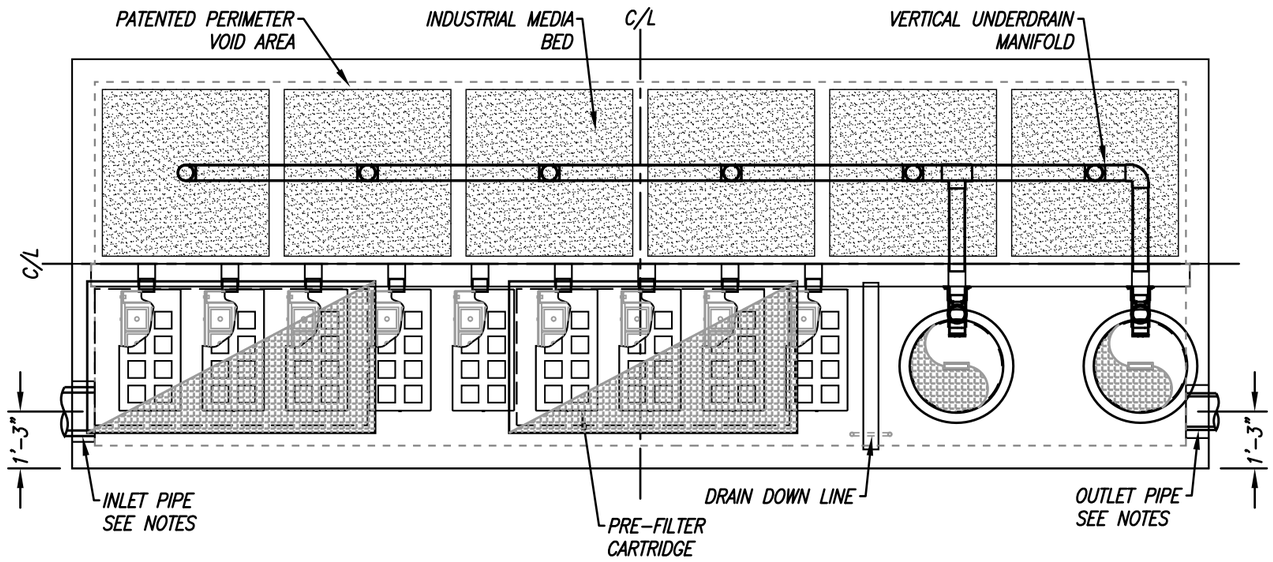
TREATMENT FLOW (CFS)	1.0
OPERATING HEAD (FT)	5.7
PRETREATMENT LOADING RATE (GPM/SF)	1.9
INDUSTRIAL MEDIA LOADING RATE (GPM/SF)	0.9

Bio Clean
A Forterra Company

MWS-L-8-24-V-HC
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/18ASPOLAR

SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		C2.3	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		*4.9	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	12.91	DI	10"
INLET PIPE 2			
OUTLET PIPE	12.33	DI	8"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	19.58	19.58	19.58
SURFACE LOAD	PEDESTRIAN	OPEN PLANTER	PEDESTRIAN
FRAME & COVER	2 EA 36" X 72"	N/A	2 EA ø24"
INDUSTRIAL MEDIA VOLUME (CY)			25.49
INDUSTRIAL MEDIA DELIVERY METHOD			PER CONTRACT
ORIFICE SIZE (DIA. INCHES)			2 EA ø2.81"
NOTES: *A TOTAL OF SIX MWS VAULTS WILL PROVIDE THE REQUIRED TREATMENT. INDUSTRIAL MEDIA MIX REQUIRED. THE TREATMENT SYSTEM COMPONENTS SHALL BE MADE IN THE USA.			



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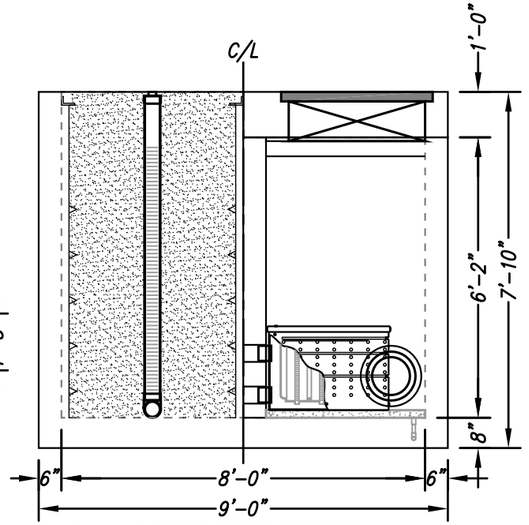

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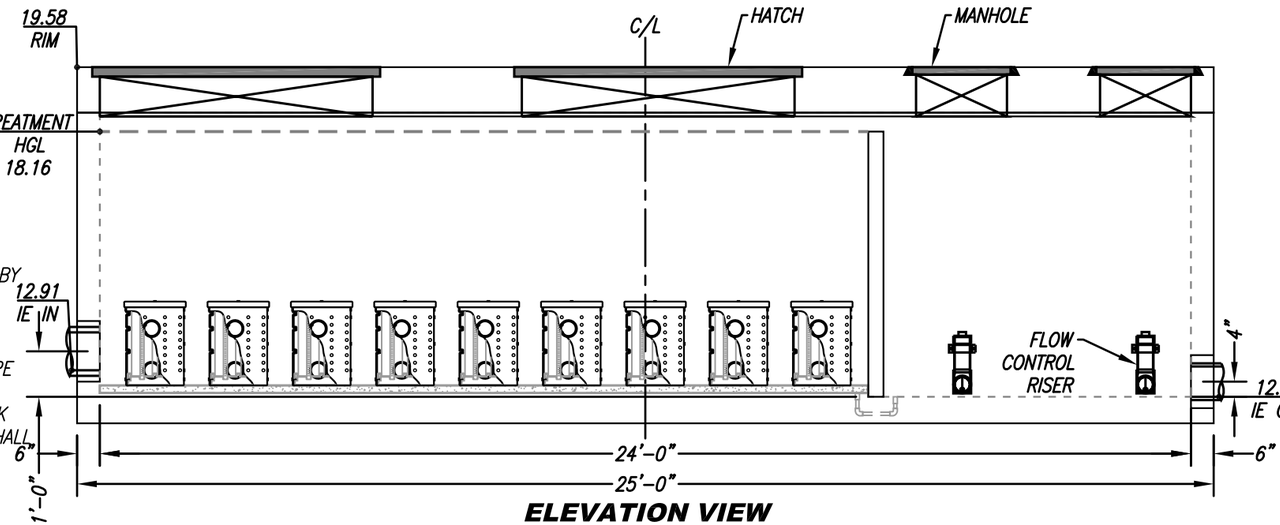

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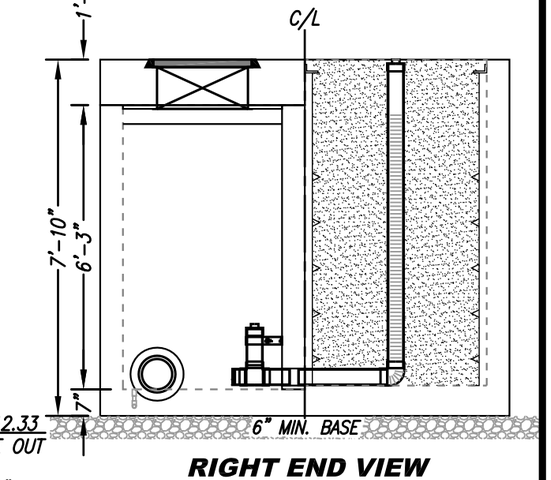

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Bio Clean
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MWS-L-8-24-V-HC
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/18ASPOLAR

SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		C2.4	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		*4.9	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	12.91	DI	10"
INLET PIPE 2			
OUTLET PIPE	12.33	DI	8"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	19.58	19.58	19.58
SURFACE LOAD	PEDESTRIAN	OPEN PLANTER	PEDESTRIAN
FRAME & COVER	2 EA 36" X 72"	N/A	2 EA ø24"
INDUSTRIAL MEDIA VOLUME (CY)			25.49
INDUSTRIAL MEDIA DELIVERY METHOD			PER CONTRACT
ORIFICE SIZE (DIA. INCHES)			2 EA ø2.81"

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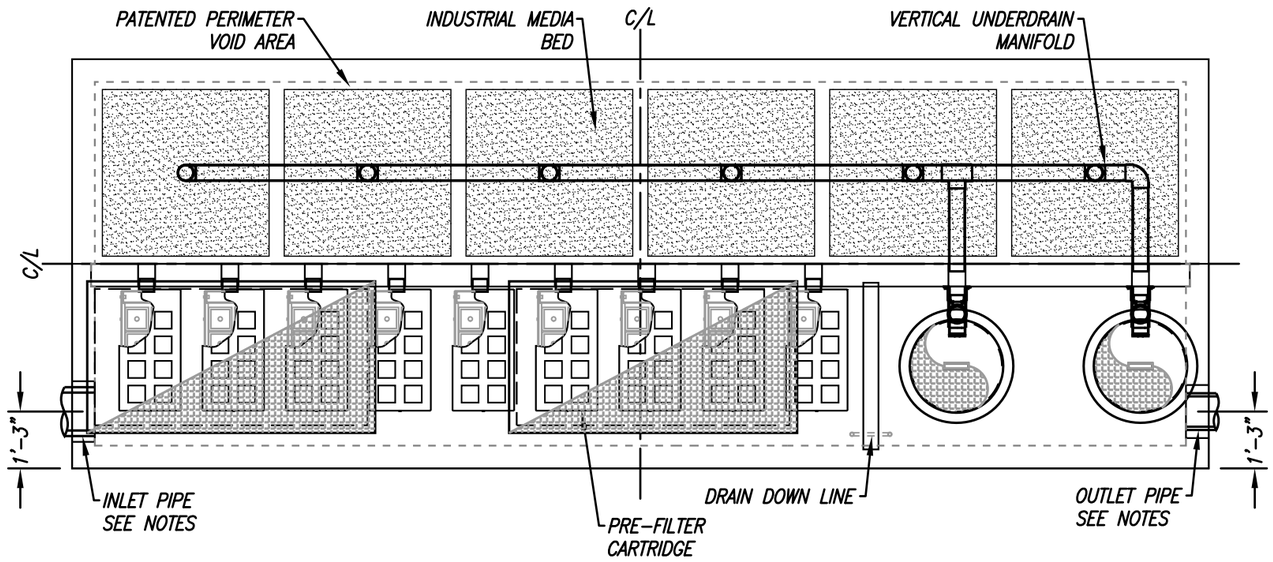
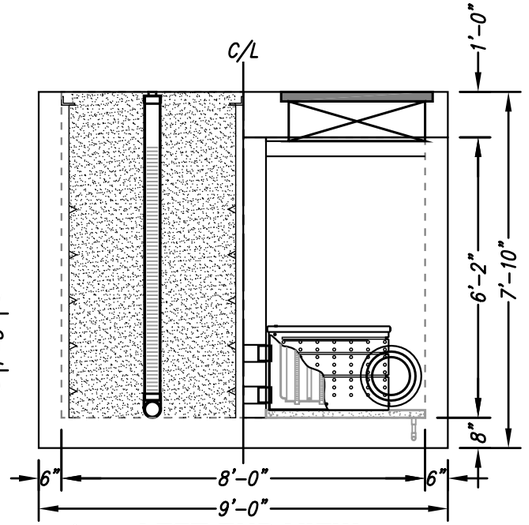
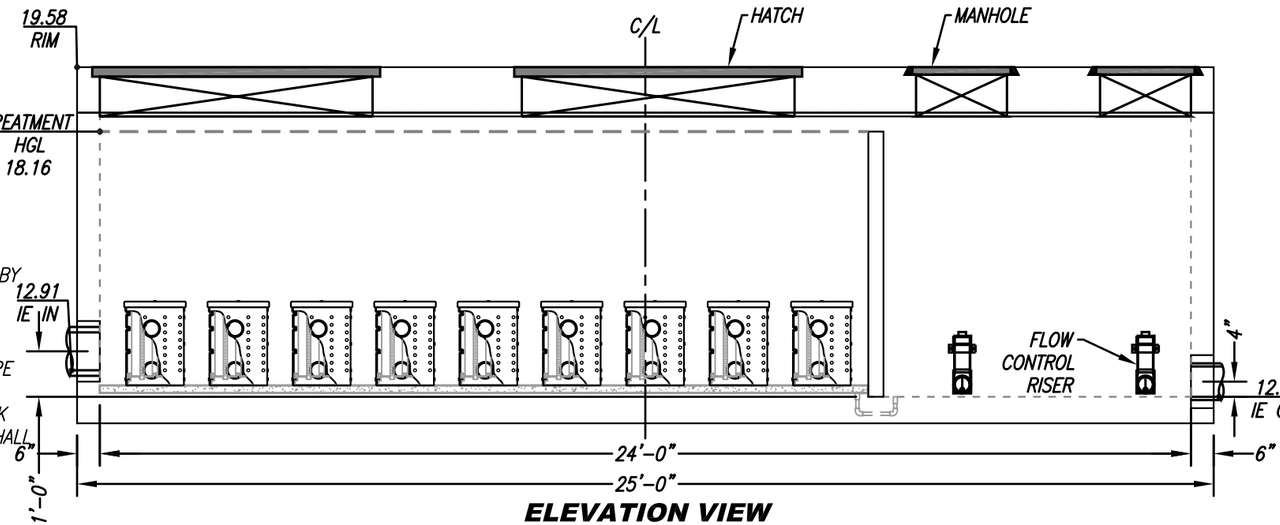


PLAN VIEW



LEFT END VIEW



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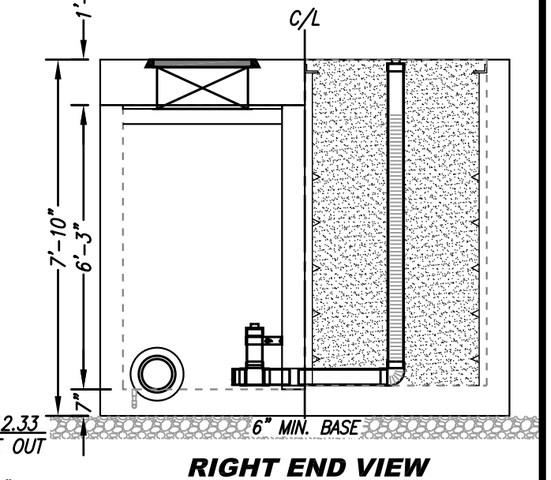

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Bio Clean
A Forterra Company

MWS-L-8-24-V-HC
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/18ASPOLAR

SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER			6543
PROJECT NAME			NWSA – PORT OF TACOMA – WEST SITCUM
PROJECT LOCATION			TACOMA, WA
STRUCTURE ID			C2.5
TREATMENT REQUIRED			
VOLUME BASED (CF)			FLOW BASED (CFS)
			*4.9
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	12.91	DI	10"
INLET PIPE 2			
OUTLET PIPE	12.33	DI	8"
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION	19.58	19.58	19.58
SURFACE LOAD	PEDESTRIAN	OPEN PLANTER	PEDESTRIAN
FRAME & COVER	2 EA 36" X 72"	N/A	2 EA ø24"
INDUSTRIAL MEDIA VOLUME (CY)			25.49
INDUSTRIAL MEDIA DELIVERY METHOD			PER CONTRACT
ORIFICE SIZE (DIA. INCHES)			2 EA ø2.81"

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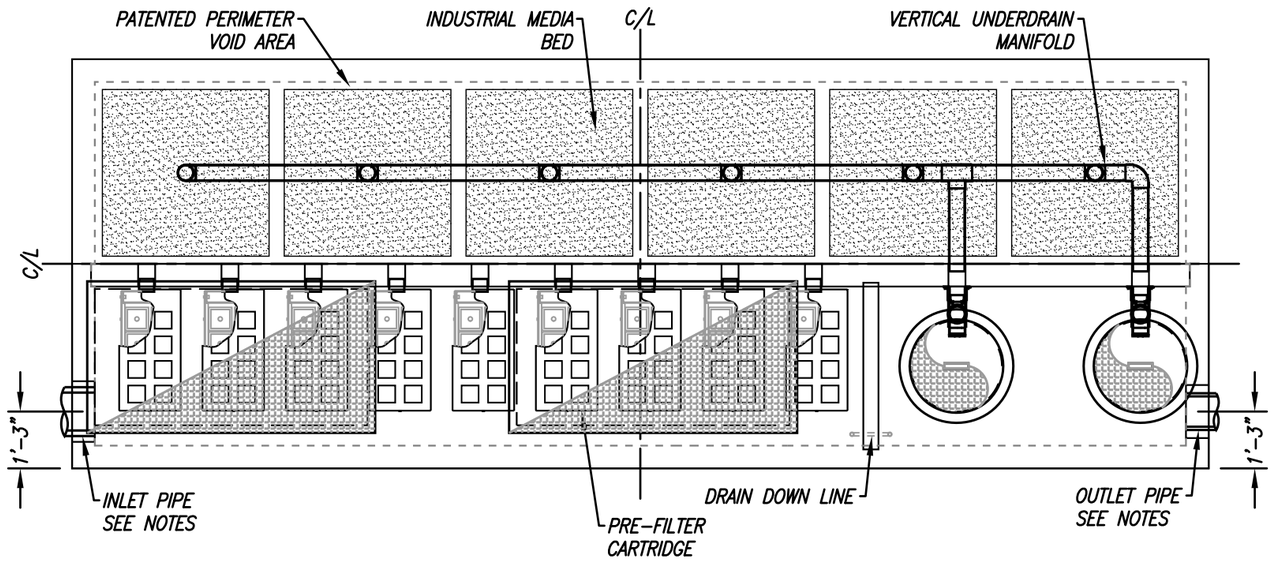
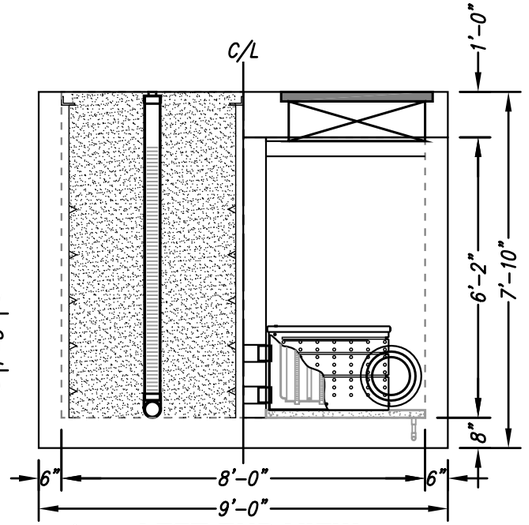
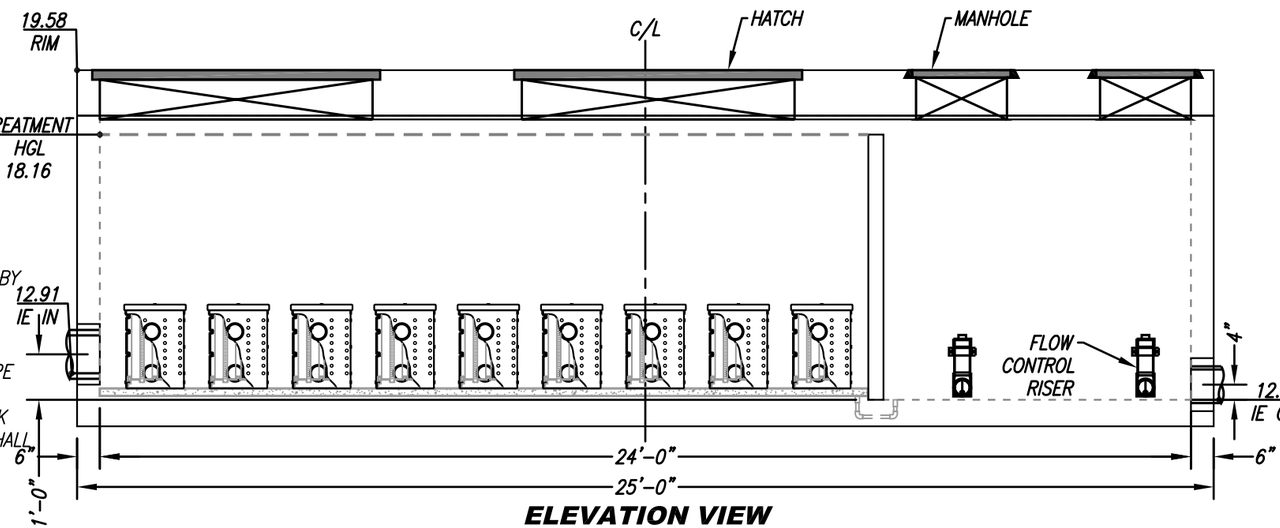


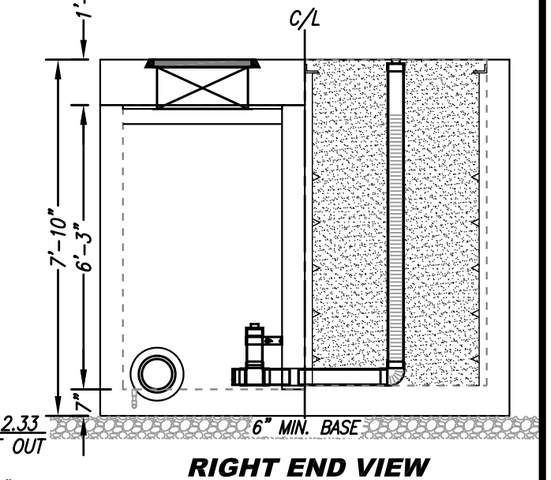
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



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Bio Clean
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MWS-L-8-24-V-HC
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/18ASPOLAR

SITE SPECIFIC DATA			
BIOCLEAN PROJECT NUMBER		6543	
PROJECT NAME		NWSA – PORT OF TACOMA – WEST SITCUM	
PROJECT LOCATION		TACOMA, WA	
STRUCTURE ID		C2.6	
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
		*4.9	
TREATMENT HGL AVAILABLE (FT)			N/A
PEAK BYPASS REQUIRED (CFS) – IF APPLICABLE			OFFLINE
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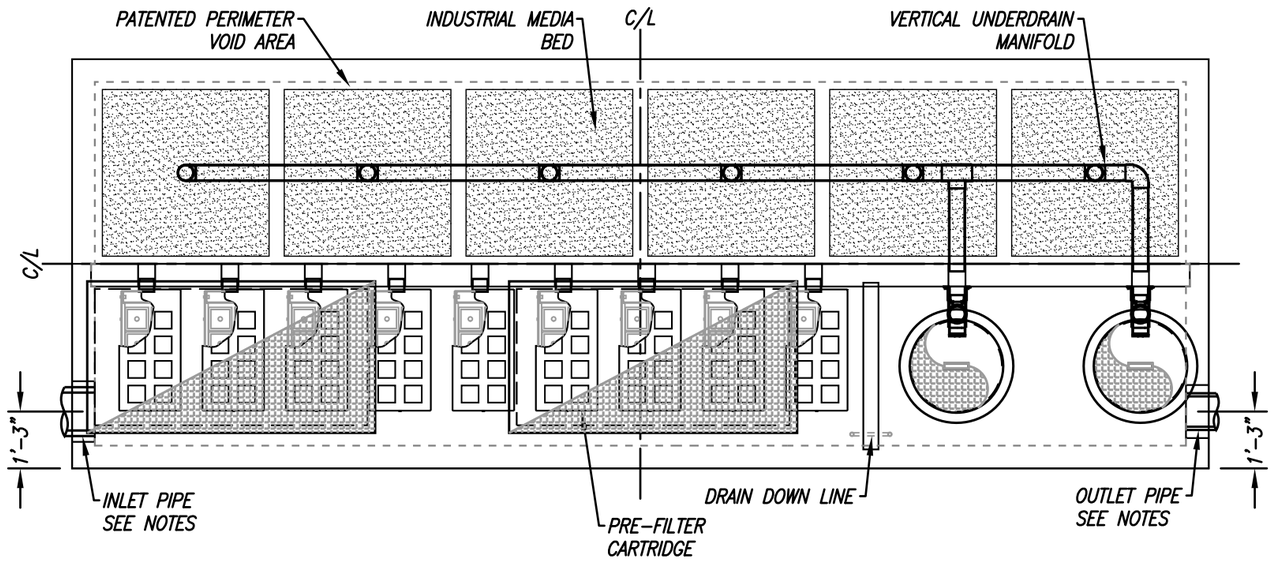

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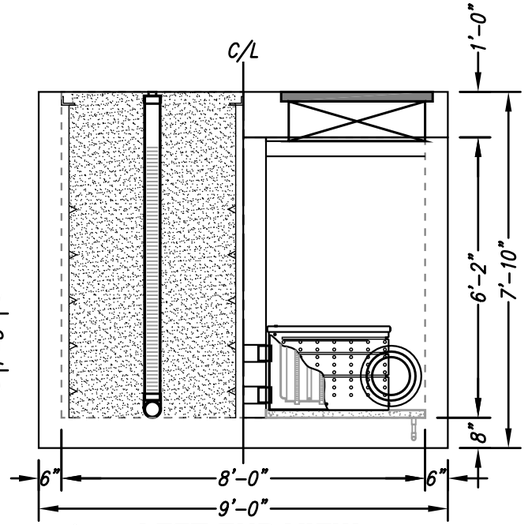

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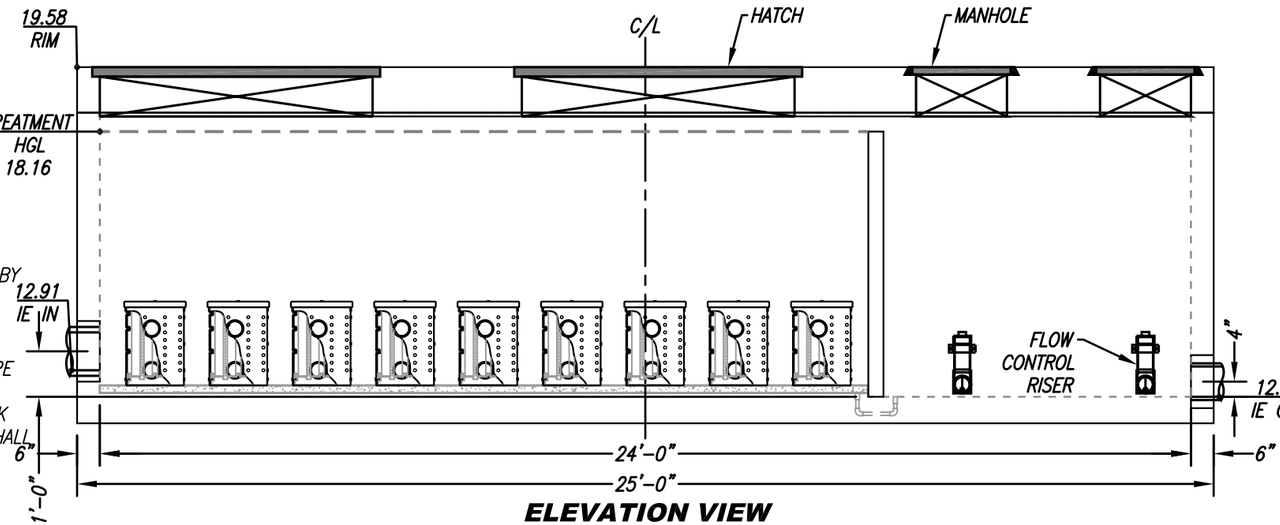

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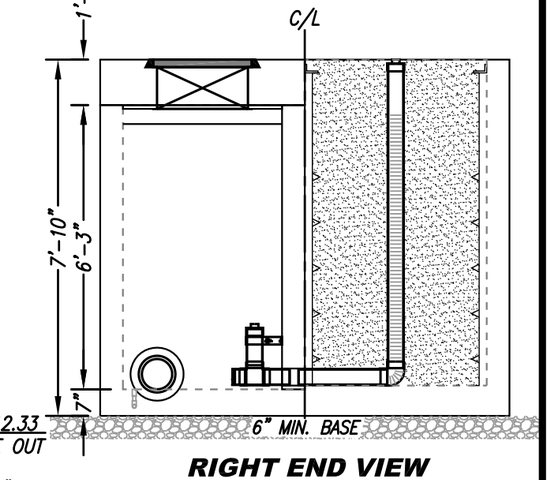

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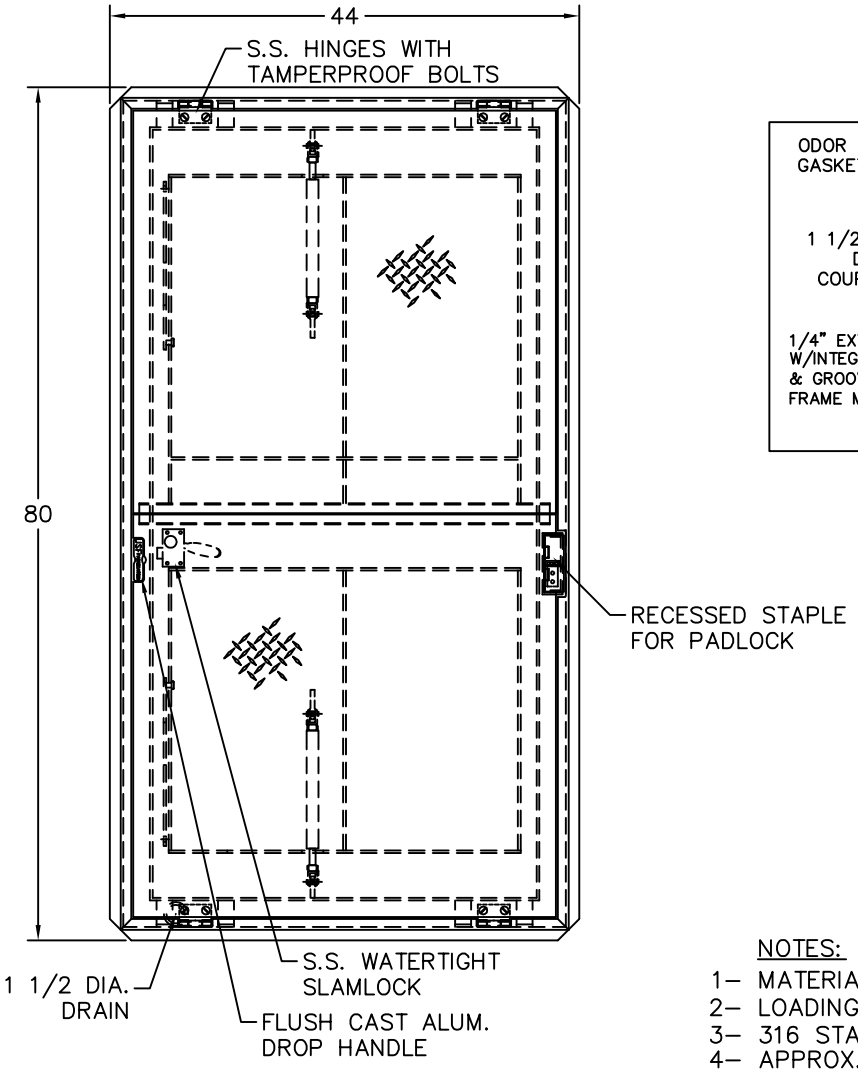
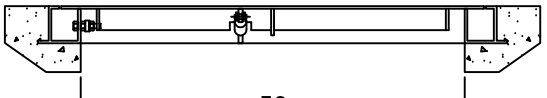
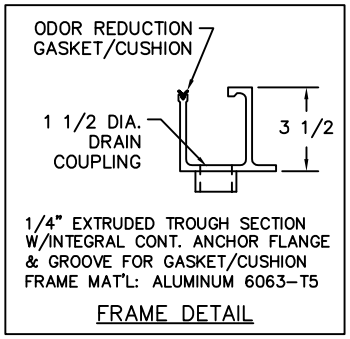
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

4/12/18ASPOLAR

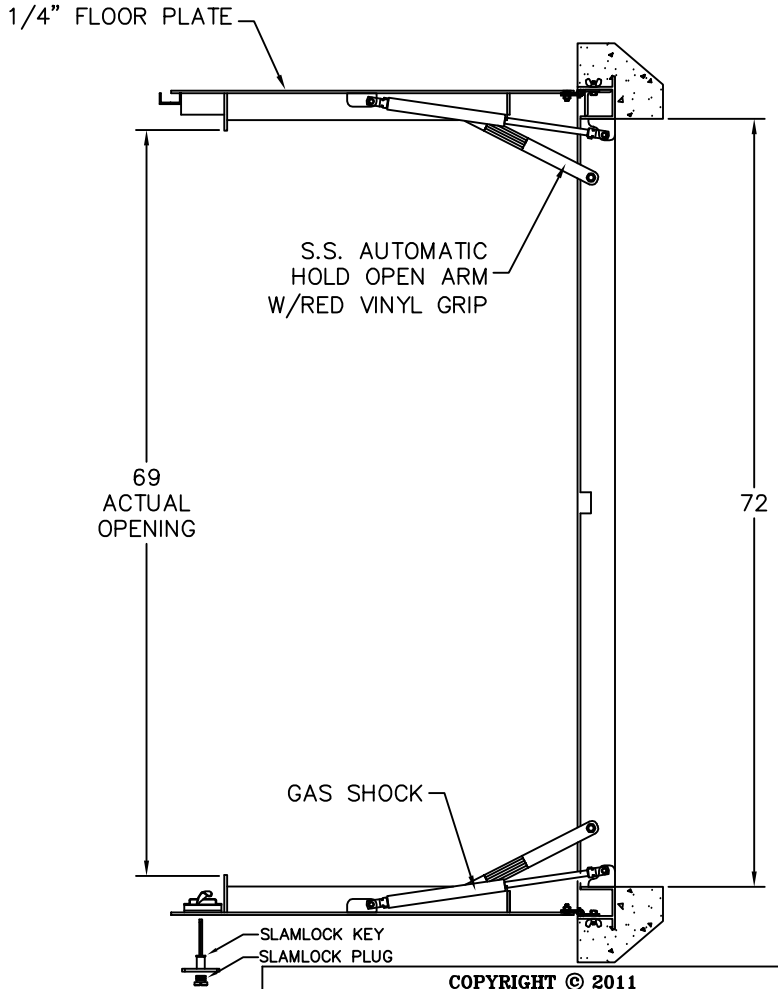






NOTES:

1- MATERIAL: ALUMINUM
2- LOADING: 300 LBS. PER SQ. FT.
3- 316 STAINLESS STEEL NUTS & BOLTS
4- APPROX. HATCH WEIGHT: 185 LBS.
5- SAFETY GRATE TO BE PAINTED WITH SAFETY ORANGE POWDER COAT.
6- AREA OF FRAME IN CONTACT WITH CONCRETE TO BE PAINTED WITH BITUMINOUS COATING



U.S.F. FABRICATION INC.
HIALEAH, FLORIDA

HATCH TPD 36 X 72 ALUMINUM
W/GAS SHOCK, SLAMLOCK, REC'D PADLOCK & BIT. PAINT

DWN. BY: C.S.	SCALE: 1"=1'	QUOTE# 104722	DATE: 11/11/11
CHK. BY:	DWG.# 70287	SHEET SIZE: B	SHEET NO: 1 OF 1	REV:

U.S.F Fabrication, Inc. Product Specifications

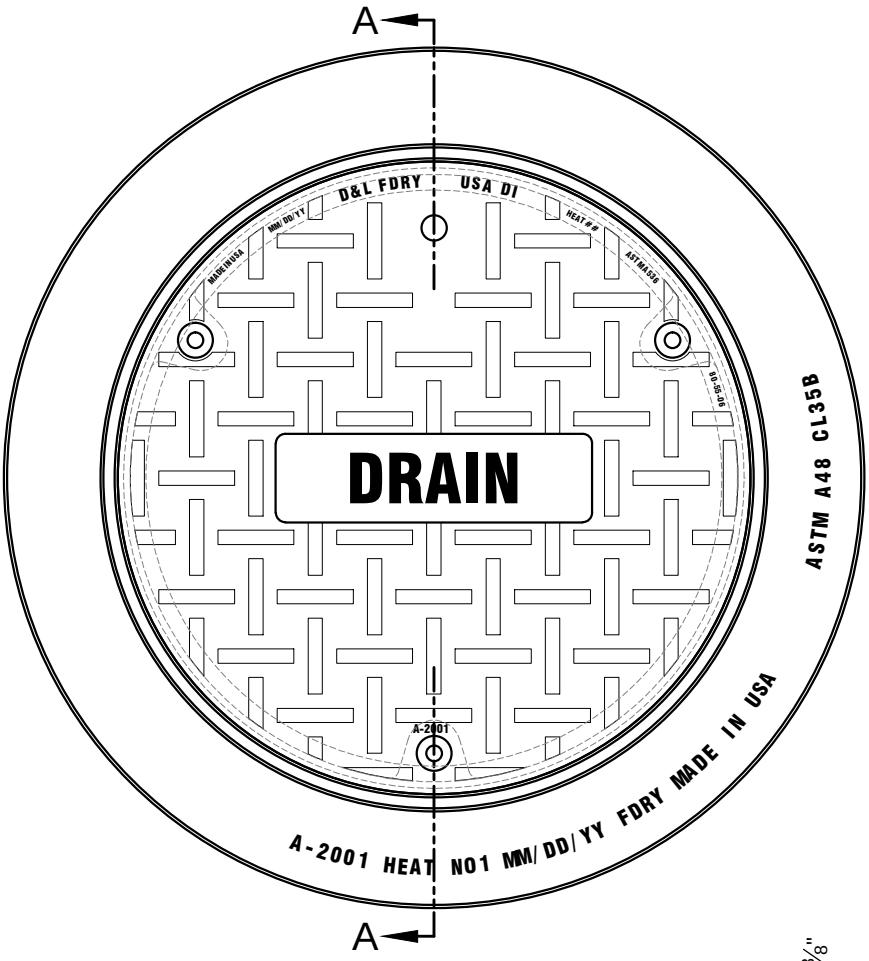
Type TPD Aluminum Hatch:
Trough Frame, 300 PSF Pedestrian Loading, Double-Leaf

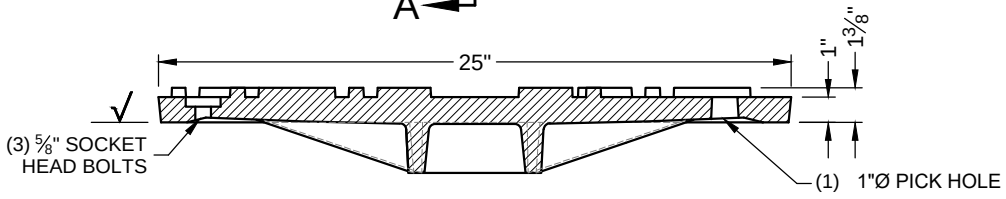
The floor access door shall be Model TPD as manufactured by U.S.F. Fabrication, Inc., Hialeah, Florida and or Ogden UT, with the size being specified on the plans. Door leaves shall be 1/4-inch thick aluminum diamond plate reinforced for a 300 PSF Pedestrian loading. The frame shall be extruded aluminum trough section with an integral anchor flange on all four (4) sides. The frame shall include an EPDM odor reduction gasket that reduces the amount of odor that escapes from below the door and a 1 1/2-inch threaded drain coupling. The floor access door shall be equipped with a flush drop handle that does not protrude above the cover, and 316 stainless steel hold open arms with red vinyl grips that automatically lock the covers in the 90 degree open position. The door shall have 316 stainless steel hinges and 316 stainless steel tamper resistant bolts/locknuts. The door shall be equipped with a watertight 316 stainless steel slamlock with threaded plug, removable outside key, and fixed inside handle. The slamlock must latch onto a 316 stainless steel catch that is bolted to the frame. The access door leaf shall include lift assist to control accent and decent of door leaf. Lift assist operators shall be engineered and installed to insure one person can easily open and operate the access door and shall be 316L stainless steel. The force required to open any one-leaf shall not exceed 15 pounds maximum. The lift assist operators shall be mounted on the hinged side of door leaf. A 2 mills bituminous coating shall be applied to all areas of the aluminum frame that may come in contact with concrete. The hatch shall include an oversized hinged recessed padlock box sized 4 ½ x6” for customer supplied padlock. Padlock box shall remain flush with cover leaf when in the closed position. Access door frame shall include 1 ½” drain coupling located in bottom corner of hatch frame for draining water away from frame itself. An adhesive backed vinyl material that protects the product during shipping and installation shall cover the entire top of the frame and covers. Installation shall be in accordance with the manufacturer's attached instructions. The entire frame including the seat on which the reinforcing rests shall be supported by concrete or other material designed to support the cover loading. The door shall be manufactured and assembled in the United States. Manufacturer shall guarantee the door against defects in materials and workmanship for a period of ten (10) years.

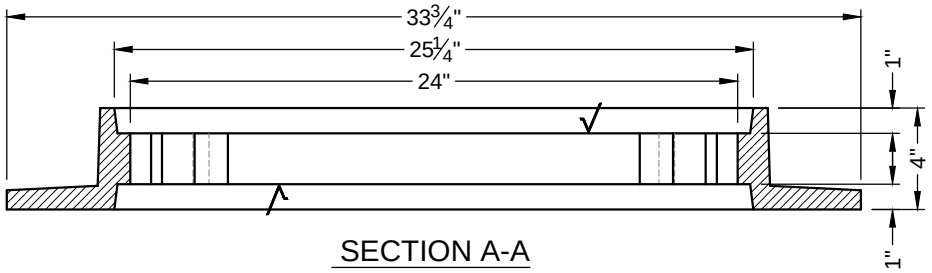
Optional Features

Frame Skirt: The hatch shall have an aluminum skirt welded to the frame's perimeter to accommodate the thickness of the concrete top slab.

A-2001



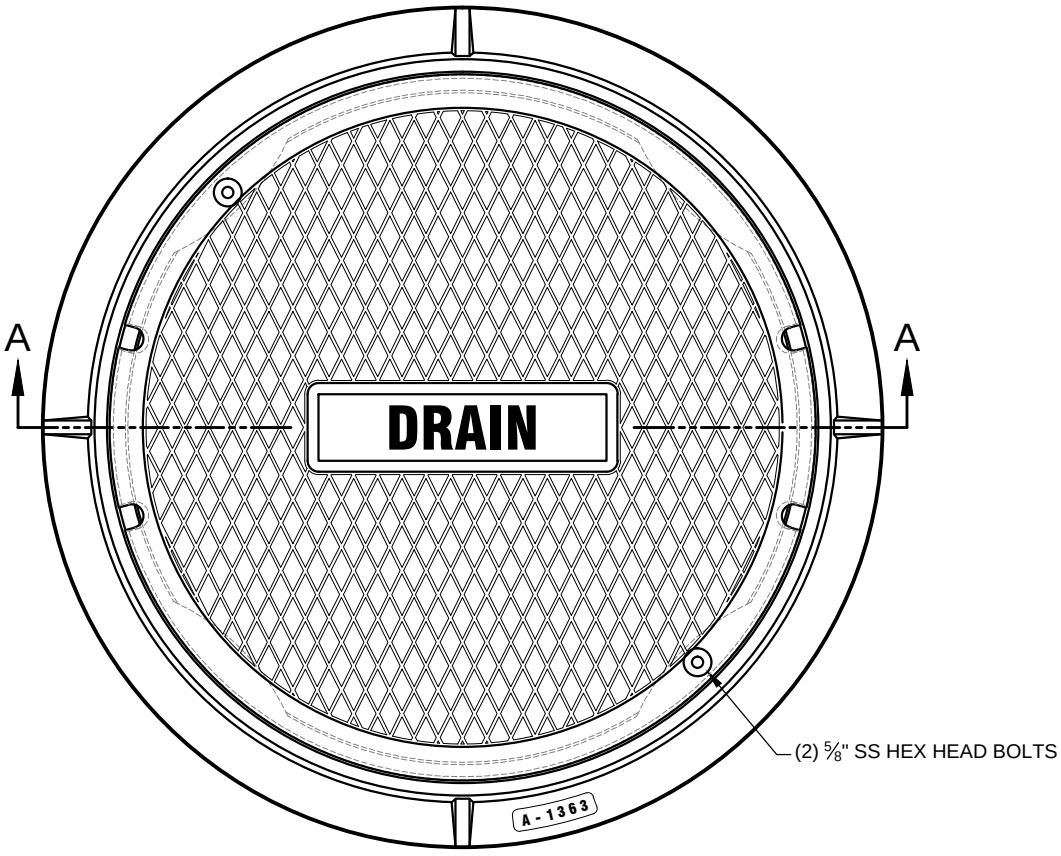


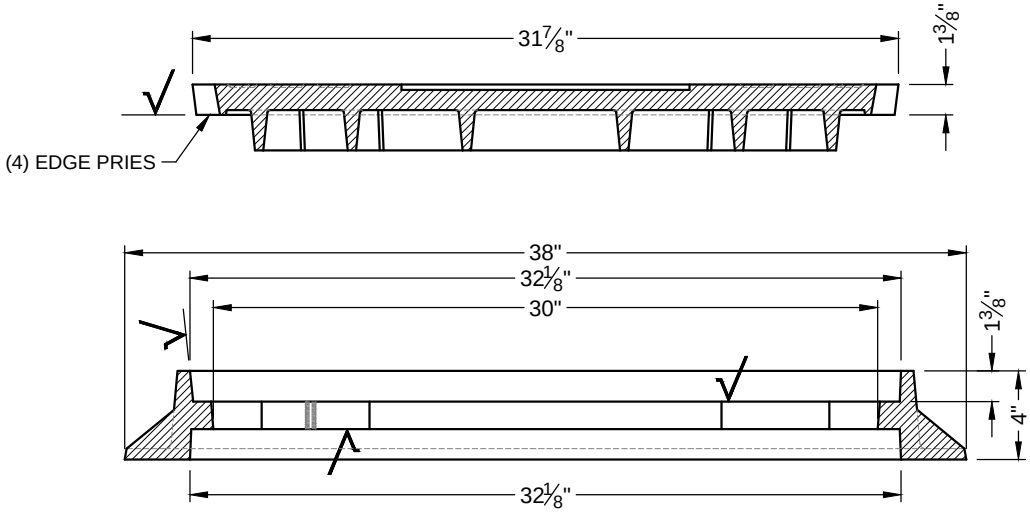


SECTION A-A
VIEW IS ROTATED

CONFIDENTIALITY STATEMENT D&L Supply Co.(DLS) claims proprietary rights to the information disclosed in this document. The document is issued for information only and may not, in part or in whole, be reproduced or disclosed to anyone without the direct written consent of DLS. Dimensions are for reference ONLY. DLS reserves the right to change dimensions and or weights at its own discretion.	Washington Sales: (509) 766-3131 Fax: (509) 765-8124 California Sales: (707) 557-4525 Fax: (707) 557-4655 Utah Sales: (801) 785-5015 Fax: (801) 785-0835 √= INDICATES MACHINED SURFACE	D&L SUPPLY COMPANY EST. 1977	DRAWN BY: CDILLEY	DATE: 1/30/2017
			PRODUCT NUMBER:	MATERIAL TYPE:
			COVER: A-2001-S8	DUCTILE IRON: ASTM A-536 CL 80-55-06
			RING: A-2001-R5	GRAY IRON: ASTM A-48 CL 35B
			MEETS: H20 WHEEL LOADING	
			B:__DLS DRAWINGS\A\A-2001\A-2001-R5_A-2001-S8.DWG	

A-1363 / A-1380





SECTION A-A

Washington Sales:
(509) 766-3131 Fax: (509) 765-8124
California Sales:
(707) 557-4525 Fax: (707) 557-4655
Utah Sales:
(801) 785-5015 Fax: (801) 785-0835

√ = INDICATESMACHINED SURFACE

D&L SUPPLY COMPANY EST. 1977

DRAWN BY: CDILLEY	DATE: 2/1/2017
PRODUCT NUMBER:	MATERIAL TYPE:
COVER: A-1380-237	GRAY IRON: ASTM A-48 CL 35B
RING: A-1363-R3a	GRAY IRON: ASTM A-48 CL 35B
MEETS: H20 WHEEL LOADING	
B:__DLS DRAWINGS\A\A-1363\A-1363-R3A_A-1380-237.DWG	

BUOYANCY COMPUTATIONS PREPARED FOR:

GP GRANITE PRECAST
4116 BAKERVIEW SPUR, BELLINGHAM, WA 98226
(360) 671-2251 1-800-808-2251 FAX: (360) 671-0780

PROJECT:

NWSA – Port of Tacoma

PRODUCT:

Precast Bio Clean Vault
8'-0" x 8'-0" x 6'-6 ½" I.D.
(Includes Rebar & Welded Wire Options for Base Unit)

SPECIALTY ENGINEERING SERVICES PROVIDED BY:

Concrete Engineering Solutions, LLC
101 Pine View Estates
Mountain Top, PA 18707
Phone: 570-868-2081
Fax: 570-868-2082

4/12/18

CONCRETE ENGINEERING SOLUTIONS, LLC
101 PINEVIEW ESTATES
MOUNTAIN TOP, PA 18707
PHONE:570-868-2081
FAX: 570-868-2082

Customer: Granite Precasting
Project: NWSA Port of Tacoma
Job Number: 18-01.39
Structure Name: 8x8 Bio Clean Vault

Structure Size:	Length	Width	Inside Ht.
	8.00'	8.00'	6.54'
Top Slab Thickness:			9.0''
Bottom Slab Thickness:			8.0''
Wall Thickness (Min):			6.00''
Base Extension:			0''

*Sidewalls 8"

Vault Design:

Design Assumptions (To Be Verified By E.O.R.):

Design Load:		
	300 PSF	Uniform Load
Min. Earth Fill :	0.00'	
Max. Earth Fill:	0.00'	
Unit Wt. of Soil:	120 PCF	
Unit Wt. of Concrete:	150 PCF	
Watertable Depth:	3.0'	(Below Grade-Min.)
Lateral Earth Pressure:	64.2 PCF	(See Following Sheets)
LL Surcharge:	80.0 PSF	(Ref. ASTM C857/C890: 0.005*Wheel Load)
Depth to Apply Surcharge:	8.0'	(Ref. ASTM C857/C890)
Unit Wt. of Water:	62.4 PCF	
Min. Buoyancy Safety Factor Req'd:	1.0	(See Buoyancy Analysis for Actual Safety Factor)
Concrete Strength, f'c:	5,000 PSI	
Reinforcing Yield Strength, fy:	60,000 PSI	

Load Factors:	1.6	(Live Load)	
	1.2	(Dead Load)	(Note, If no Live Load, set DL Factor to 1.4)
	1.6	(Earth Pressure)	
Capacity Reduction:	0.9	(Flexure)	
	0.75	(Shear)	

References:

1.)ACI318 "Building Code Requirements for Structural Concrete", latest edition.
2.)ASTM C478 "Specification for Precast Reinforced Concrete Manhole Sections", latest edition.
3.) ASTM C890 "Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures", latest edition.
4.) ASTM C857 "Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures", latest edition.
5.) HS-20 or HS-25 wheel loads per AASHTO "Standard Specificationfor Highway Bridges", 17th Edition.
6.) PCA "Rectangular Concrete Tanks", 5th Edition.

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Project Name: NWSA Port of Tacoma
Job Number: 18-01.39
Structure Name: 8x8 Bio Clean Vault

Top Slab Design: (Uniform Live Load)

1-Way Slab Design (Span 1-way or 2-way depending on top opening size and orientation.)

Live Load:	
(Uniform Load)	300 PSF
Earth Fill :	0.00'
Average Design Span:	4.50'
Bar Cover:	2.00''
Dead Load:	
Top Slab:	0.113 KSF
Soil:	0.000 KSF
Other:	
Total:	0.113 KSF

Live Load: (Ref. ASTM C890)
Uniform Live Load: 0.300 KSF

Calculate Flexural Moments:

Dead Load Moment:	0.28 K-FT	(wl^2/8	, w=dead load, l=design span)
Live Load Moment:	0.76 K-FT	(wl^2/8	, w=live load, l=design span)
Total Service Moment,Ms:	1.04 K-FT		
Factored Moment, Mu:	**1.56 K-FT**		

Calculate Flexural Capacity:

Trial Bar Size/Spacing: #4 @ 8'' o.c. (As Provided =0.29 sq.in./ft.)

$\phi Mn=\phi A_s fy(d-a/2)$: **8.72 K-FT** **OK**

$c=As*Fy/.85*f'c*\beta1*b=$ 0.43''
Where, $\beta1=[0.85-.05*(f'c-4ksi)]=$ 0.80
$a=c*\beta1=$ 0.35''
d=Slab-cover-1/2Bar Dia.= 6.75''

Check Min A_s Provided: (Ref. ACI318, 10.5.1)

As, min=3√f'c/fy*b*d: 0.29 sq.in./ft. **OR** 200*b*d (Controls)

As Provided>As,min: **OK**

Check Shear:

V_{DL}:	0.19 KIPS	(wdl*(Span-2*d)/2)
V_{LL}:	0.51 KIPS	(wll*(Span-2*d)/2)
Vu:	**1.04 KIPS**	[LF*Vdl + LF*Vll]
Shear Capacity, ϕVn:	**8.59 KIPS**	**OK**

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Project Name: NWSA Port of Tacoma
Job Number: 18-01.39
Structure Name: 8x8 Bio Clean Vault

Top Slab Min Fill (Cont.):

Check Max Bar Spacing & Serviceability: (Ref. ACI318, 10.6.4)

ρ = As / b * d =	0.00364	ρ_{max} = (.75 ρb) =	0.02515	**OK**
Es=	29000000			
Ec=57000*√f'c=	4030509			
n=Es/Ec=	7.20			
ρ * n =	0.02616			
k = √(2ρn +(ρn)^2) - ρn =	0.2041			
j = 1 - (k/3) =	0.932			
fs=Ms/(As*j*d)=	6,763 PSI	<	2/3fy=40,000 PSI	**OK**

Max Spacing, s=15(40000/fs)-2.5Cc= 83.7'' **OR** 12(40000/fs)= 71.0'' (Controls)

Actual Spacing=8'' **OK**

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MOUNTAIN TOP, PA 18707
PHONE:570-868-2081
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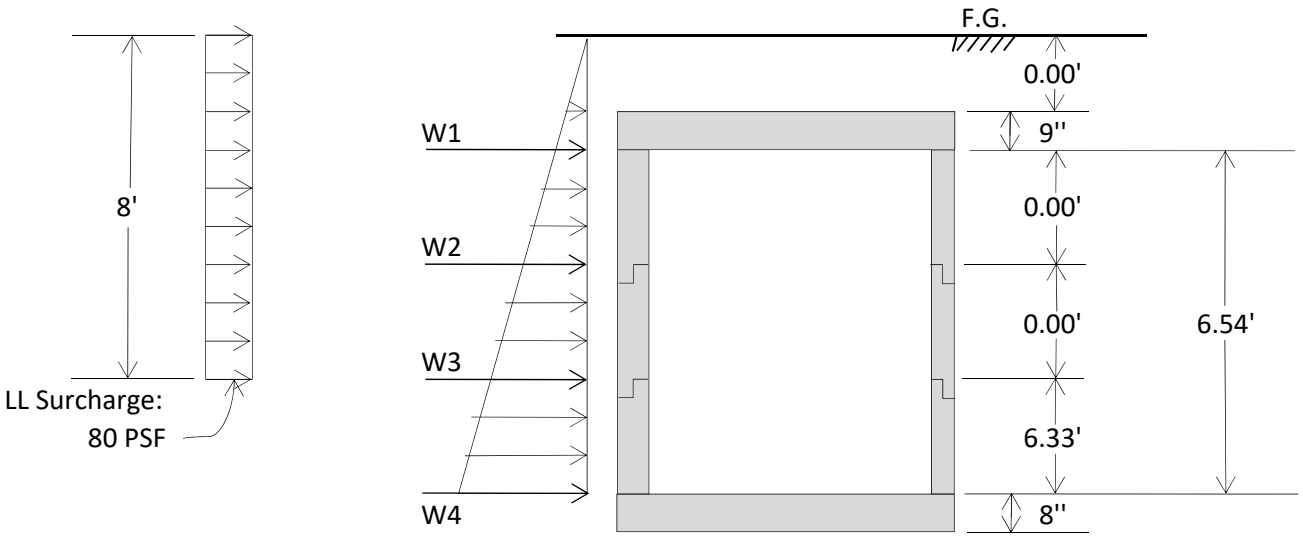
Customer: Granite Precasting
Project Name: NWSA Port of Tacoma
Job Number: l8-01.39
Structure Name: 8x8 Bio Clean Vault

Soil Pressure On Walls:

(Not all components may be used for all vault designs - configurations may vary)



Unit Weight of Soil:	120 PCF	
Earth Pressure Coefficient, Ka:	0.33	
Unit Weight of Water:	62.4 PCF	
Max. Earth Fill:	0.00'	
Water Table Depth:	3.00'	
Dry Soil Pressure:	39.6 PCF	[Ka*Ws]
Saturated Soil Pressure:	81.4 PCF	[(Ws-Ww)*Ka+Ww]
Design Earth Pressure: (Weighted Avg.)	**64.2 PCF**	

Pressures Used for Wall Component Design:

(Note: LL Surcharge Applied On Actual Component Design Sheet When Required)

	Design Depth:	Design Pressure:
W1:	0.75'	48 PSF
W2:	0.96'	62 PSF
W3:	0.96'	62 PSF
W4:	7.29'	468 PSF

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Customer: Granite Precasting
Project Name: NWSA Port of Tacoma
Job Number: 18-01.39
Structure Name: 8x8 Bio Clean Vault

Monolithic or Integral Wall Design: (Bottom Unit)

Outside Face of Wall (Negative Moment)

(Ref. PCA Tables, Chapter 2, Cases 3 & 8)

Wall Length, b:	8.00'
Wall Height, a:	6.54'
b/a:	1.2
Thickness:	6.00''
Bar Cover:	2.00''

Lateral Earth Pressure:

Top of Wall, W3:	0.062 KSF
Bottom of Wall, W4:	0.468 KSF
Live Load Surcharge:	0.080 KSF

Calculate Flexural Moments: (Negative Moments, M=PCA Coeff*Pressure*a^2)

Horizontal Design: Bars to Outside: Yes

Case 8	Case 3	Ms	Mu
0.124	0.036	1.37 K-FT	**2.19 K-FT**

Try: D5.5 @ 4'' o.c. (As Prov.=0.17 sq.in./ft.)

$\phi Mn=\phi A_s fy(d-a/2)$: 3.50 K-FT OK

c=As*Fy/.85*f'c*β1*b= 0.24''
Where, β1=[0.85-.05*(f'c-4ksi)]= 0.80
a=c*β1= 0.19''
d= 3.87''

Check Min A_s Provided: (Ref. ACI318, 10.5.1)

$As_{min}=3\sqrt{f'c}/fy*b*d$: 0.16 sq.in./ft. (Controls)
OR 200*b*d/fy: 0.15 sq.in./ft.
As Provided>As,min: **OK**

Check Serviceability: (Ref. ACI318, 10.6.4)

ρ = As / b * d =	0.00356	
ρ_{max} = (.75 ρb) =	0.02515	**OK**
Es=	29000000	
Ec=57000*√f'c=	4030509	
n=Es/Ec=	7.20	
ρ * n =	0.02558	
k = √(2ρn +(ρn)^2) - ρn =	0.2020	
j = 1 - (k/3) =	0.933	
fs=Ms/(As*j*d)=	27,597 PSI	
<	2/3fy=50,000 PSI	**OK**
Max Spacing, s=15(40000/fs)-2.5Cc=		16.7''
OR 12(40000/fs)=		17.4''
OR 3*Tw=		18.0''
Actual Spacing=4''	< 16.7''	**OK**

Check Shear: (V=PCA Coeff*Pressure*a)

Case 8	Case 3	Vs	Vu
0.62	0.25	1.23 KIPS	**1.96 KIPS**

Horiz. Shear Capacity, ϕVn: 4.92 KIPS
ϕVn>Vu: OK

Vertical Design: Bars to Outside: No

Case 8	Case 3	Ms	Mu
0.081	0.045	1.28 K-FT	**2.05 K-FT**

Try: D5.5 @ 4'' o.c. (As Prov.=0.17 sq.in./ft.)

$\phi Mn=\phi A_s fy(d-a/2)$: 3.25 K-FT OK

c=As*Fy/.85*f'c*β1*b= 0.24''
Where, β1=[0.85-.05*(f'c-4ksi)]= 0.80
a=c*β1= 0.19''
d= 3.60''

$As_{min}=3\sqrt{f'c}/fy*b*d$: 0.15 sq.in./ft. (Controls)
OR 200*b*d/fy: 0.14 sq.in./ft.
As Provided>As,min: **OK**

ρ = As / b * d =	0.00382	
ρ_{max} = (.75 ρb) =	0.02515	**OK**
Es=	29000000	
Ec=57000*√f'c=	4030509	
n=Es/Ec=	7.20	
ρ * n =	0.02746	
k = √(2ρn +(ρn)^2) - ρn =	0.2085	
j = 1 - (k/3) =	0.931	
fs=Ms/(As*j*d)=	27,737 PSI	
<	2/3fy=50,000 PSI	**OK**
Max Spacing, s=15(40000/fs)-2.5Cc=		14.9''
OR 12(40000/fs)=		17.3''
OR 3*Tw=		18.0''
Actual Spacing=4''	< 14.9''	**OK**

Case 8	Case 3	Vs	Vu
0.54	0.35	1.43 KIPS	**2.29 KIPS**

Vertical Shear Capacity, ϕVn: 4.59 KIPS
ϕVn>Vu: OK

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Project Name: NWSA Port of Tacoma
Job Number: 18-01.39
Structure Name: 8x8 Bio Clean Vault

Monolithic or Integral Wall Design (Cont.):

Inside Face of Wall (Positive Moment)

Bar Cover: 3.50''

Calculate Flexural Moments: (Positive Moments, M=PCA Coeff*Pressure*a^2)

Horizontal Design: Bars to Inside: No

Case 8	Case 3	Ms	Mu
0.059	0.015	0.63 K-FT	**1.00 K-FT**

Try: D5.5 @ 4'' o.c. (As Prov.=0.17 sq.in./ft.)

$\phi Mn=\phi A_s fy(d-a/2)$: 2.97 K-FT OK

c=As*Fy/.85*f'c*β1*b= 0.24''
Where, β1=[0.85-.05*(f'c-4ksi)]= 0.80
a=c*β1= 0.19''
d= 4.10''

Check Min A_s Provided: (Ref. ACI318, 10.5.1)

(-)M: $As_{min}=3\sqrt{f'c}/fy*b*d$: 0.17 sq.in./ft. (Controls)
OR 200*b*d/fy: 0.16 sq.in./ft.
As Provided>As,min: **NG**
4/3 As Provided, OK

Check Serviceability: (Ref. ACI318, 10.6.4)

ρ = As / b * d = 0.00335
ρ_{max} = (.75 ρb) = 0.02515 **OK**
Es= 29000000
Ec=57000*√f'c= 4030509
n=Es/Ec= 7.20
ρ * n = 0.02411
k = √(2ρn +(ρn)^2) - ρn = 0.1968
j = 1 - (k/3) = 0.934
fs=Ms/(As*j*d)= 11,858 PSI
< 2/3fy=50,000 PSI **OK**
Max Spacing, s=15(40000/fs)-2.5Cc= 40.1''
OR 12(40000/fs)= 40.5''
OR 3*Tw= 18.0''
Actual Spacing=4'' < 18.0'' **OK**

Vertical Design: Bars to Inside: Yes

Case 8	Case 3	Ms	Mu
0.019	0.012	0.33 K-FT	**0.53 K-FT**

Try: D5.5 @ 4'' o.c. (As Prov.=0.17 sq.in./ft.)

$\phi Mn=\phi A_s fy(d-a/2)$: 3.17 K-FT OK

c=As*Fy/.85*f'c*β1*b= 0.24''
Where, β1=[0.85-.05*(f'c-4ksi)]= 0.80
a=c*β1= 0.19''
d= 4.37''

(+)M: $As_{min}=3\sqrt{f'c}/fy*b*d$: 0.19 sq.in./ft. (Controls)
OR 200*b*d/fy: 0.17 sq.in./ft.
As Provided>As,min: **NG**
4/3 As Provided, OK

ρ = As / b * d = 0.00315
ρ_{max} = (.75 ρb) = 0.02515 **OK**
Es= 29000000
Ec=57000*√f'c= 4030509
n=Es/Ec= 7.20
ρ * n = 0.02265
k = √(2ρn +(ρn)^2) - ρn = 0.1914
j = 1 - (k/3) = 0.936
fs=Ms/(As*j*d)= 5,859 PSI
< 2/3fy=50,000 PSI **OK**
Max Spacing, s=15(40000/fs)-2.5Cc= 93.7''
OR 12(40000/fs)= 81.9''
OR 3*Tw= 18.0''
Actual Spacing=4'' < 18.0'' **OK**

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Customer: Granite Precasting
Project Name: NWSA Port of Tacoma
Job Number: 18-01.39
Structure Name: 8x8 Bio Clean Vault

Monolithic or Integral Wall Design: (Bottom Unit)

Outside Face of Wall (Negative Moment)

(Ref. PCA Tables, Chapter 2, Cases 3 & 8)

Wall Length, b:	8.00'
Wall Height, a:	6.33'
b/a:	1.3
Thickness:	6.00''
Bar Cover:	2.00''

Lateral Earth Pressure:

Top of Wall, W3:	0.062 KSF
Bottom of Wall, W4:	0.468 KSF
Live Load Surcharge:	0.080 KSF

Calculate Flexural Moments: (Negative Moments, M=PCA Coeff*Pressure*a^2)

Horizontal Design: Bars to Outside: Yes

Case 8	Case 3	Ms	Mu
0.143	0.038	1.43 K-FT	**2.30 K-FT**

Try: #4 @ 12'' o.c. (As Prov.=0.20 sq.in./ft.)

ϕMn=ϕ$A_s$fy(d-a/2): 3.21 K-FT OK

c=As*Fy/.85*f'c*β1*b= 0.29''
Where, β1=[0.85-.05*(f'c-4ksi)]= 0.80
a=c*β1= 0.23''
d= 3.75''

Check Min A_s Provided: (Ref. ACI318, 10.5.1)

As_{min}=3√f'c/fy*b*d: 0.16 sq.in./ft. (Controls)
OR 200*b*d/fy: 0.15 sq.in./ft.
As Provided>As,min: **OK**

Check Serviceability: (Ref. ACI318, 10.6.4)

ρ = As / b * d =	0.00436	
ρ_{max} = (.75 ρb) =	0.02515	**OK**
Es=	29000000	
Ec=57000*√f'c=	4030509	
n=Es/Ec=	7.20	
ρ * n =	0.03139	
k = √(2ρn +(ρn)^2) - ρn =	0.2211	
j = 1 - (k/3) =	0.926	
fs=Ms/(As*j*d)=	25,241 PSI	
<	2/3fy=40,000 PSI	**OK**
Max Spacing, s=15(40000/fs)-2.5Cc=	18.8''	
OR 12(40000/fs)=	19.0''	
OR 3*Tw=	18.0''	
Actual Spacing=12''	< 18.0''	**OK**

Check Shear: (V=PCA Coeff*Pressure*a)

Case 8	Case 3	Vs	Vu
0.66	0.25	1.24 KIPS	**1.99 KIPS**

Horiz. Shear Capacity, ϕVn: 4.77 KIPS
ϕVn>Vu: OK

Vertical Design: Bars to Outside: No

Case 8	Case 3	Ms	Mu
0.094	0.051	1.36 K-FT	**2.18 K-FT**

Try: #4 @ 12'' o.c. (As Prov.=0.20 sq.in./ft.)

ϕMn=ϕ$A_s$fy(d-a/2): 2.77 K-FT OK

c=As*Fy/.85*f'c*β1*b= 0.29''
Where, β1=[0.85-.05*(f'c-4ksi)]= 0.80
a=c*β1= 0.23''
d= 3.25''

As_{min}=3√f'c/fy*b*d: 0.14 sq.in./ft. (Controls)
OR 200*b*d/fy: 0.13 sq.in./ft.
As Provided>As,min: **OK**

ρ = As / b * d =	0.00503	
ρ_{max} = (.75 ρb) =	0.02515	**OK**
Es=	29000000	
Ec=57000*√f'c=	4030509	
n=Es/Ec=	7.20	
ρ * n =	0.03622	
k = √(2ρn +(ρn)^2) - ρn =	0.2354	
j = 1 - (k/3) =	0.922	
fs=Ms/(As*j*d)=	27,746 PSI	
<	2/3fy=40,000 PSI	**OK**
Max Spacing, s=15(40000/fs)-2.5Cc=	15.4''	
OR 12(40000/fs)=	17.3''	
OR 3*Tw=	18.0''	
Actual Spacing=12''	< 15.4''	**OK**

Case 8	Case 3	Vs	Vu
0.58	0.37	1.47 KIPS	**2.35 KIPS**

Vertical Shear Capacity, ϕVn: 4.14 KIPS
ϕVn>Vu: OK

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Project Name: NWSA Port of Tacoma
Job Number: 18-01.39
Structure Name: 8x8 Bio Clean Vault

Monolithic or Integral Wall Design (Cont.):

Inside Face of Wall (Positive Moment)

Bar Cover: 3.00''

Calculate Flexural Moments: (Positive Moments, M=PCA Coeff*Pressure*a^2)

Horizontal Design: Bars to Inside: No

Case 8	Case 3	Ms	Mu
0.067	0.017	0.65 K-FT	**1.05 K-FT**

Try: #4 @ 12'' o.c. (As Prov.=0.20 sq.in./ft.)

$\phi Mn=\phi A_s fy(d-a/2)$: 1.89 K-FT OK

$c=As*Fy/.85*f'c*\beta1*b=$ 0.29''
Where, $\beta1=[0.85-.05*(f'c-4ksi)]=$ 0.80
$a=c*\beta1=$ 0.23''
$d=$ 2.25''

Check Min A_s Provided: (Ref. ACI318, 10.5.1)

(-)M: $As_{min}=3\sqrt{f'c}/fy*b*d$: 0.10 sq.in./ft. (Controls)
OR $200*b*d/fy$: 0.09 sq.in./ft.
As Provided>As,min: **OK**

Check Serviceability: (Ref. ACI318, 10.6.4)

$\rho = As / b * d =$ 0.00727
$\rho_{max} = (.75\ \rho b) =$ 0.02515 **OK**
$Es=$ 29000000
$Ec=57000*\sqrt{f'c}=$ 4030509
$n=Es/Ec=$ 7.20
$\rho * n =$ 0.05232
$k = \sqrt{(2\rho n + (\rho n)^2)} - \rho n =$ 0.2754
$j = 1 - (k/3) =$ 0.908
$fs=Ms/(As*j*d)=$ 19,583 PSI
< 2/3fy=40,000 PSI **OK**
Max Spacing, $s=15(40000/fs)-2.5Cc=$ 21.9''
OR $12(40000/fs)=$ 24.5''
OR $3*Tw=$ 18.0''
Actual Spacing=12'' < 18.0'' **OK**

Vertical Design: Bars to Inside: Yes

Case 8	Case 3	Ms	Mu
0.021	0.013	0.34 K-FT	**0.54 K-FT**

Try: #4 @ 12'' o.c. (As Prov.=0.20 sq.in./ft.)

$\phi Mn=\phi A_s fy(d-a/2)$: 2.33 K-FT OK

$c=As*Fy/.85*f'c*\beta1*b=$ 0.29''
Where, $\beta1=[0.85-.05*(f'c-4ksi)]=$ 0.80
$a=c*\beta1=$ 0.23''
$d=$ 2.75''

(+)M: $As_{min}=3\sqrt{f'c}/fy*b*d$: 0.12 sq.in./ft. (Controls)
OR $200*b*d/fy$: 0.11 sq.in./ft.
As Provided>As,min: **OK**

$\rho = As / b * d =$ 0.00595
$\rho_{max} = (.75\ \rho b) =$ 0.02515 **OK**
$Es=$ 29000000
$Ec=57000*\sqrt{f'c}=$ 4030509
$n=Es/Ec=$ 7.20
$\rho * n =$ 0.04281
$k = \sqrt{(2\rho n + (\rho n)^2)} - \rho n =$ 0.2529
$j = 1 - (k/3) =$ 0.916
$fs=Ms/(As*j*d)=$ 8,188 PSI
< 2/3fy=40,000 PSI **OK**
Max Spacing, $s=15(40000/fs)-2.5Cc=$ 65.8''
OR $12(40000/fs)=$ 58.6''
OR $3*Tw=$ 18.0''
Actual Spacing=12'' < 18.0'' **OK**

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Project Name: NWSA Port of Tacoma
Job Number: 18-01.39
Structure Name: 8x8 Bio Clean Vault

Base Slab Design:

(Design for Uniform Upward Bearing Pressure)
(Ref. PCA Rectangular Tanks, Chapter 2, Case 10: Pinned 4-Sides)

Design Length, b: 8.50'
Design Width, a: 8.50' b/a: 1.00
Base Slab Thickness: 8.0''

Dead Load:		OR	**Hydrostatic Load:**	
Top Slab:	0.113 KSF		Watertable Depth:	3.00'
Soil (Max. Fill-Conservative):	0.000 KSF		Depth (WT. to Base):	4.96'
Walls:	0.206 KSF		Water Pressure:	0.309 KSF
Other:				
Total:	0.318 KSF	(Controls)		

(Note: Design based on higher value of Dead Load and Hydrostatic Load.)

Live Load:
Wheel Load: 0 KIPS
Uniform Load: 0.300KSF

Check Shear:
Max PCA Shear Coeff: 0.34
Design Shear, Vu: **2.49 KIPS** (V=PCA Coeff*Bearing*a)
Shear Capacity, ϕVn: **6.83 KIPS** **OK**

Calculate Flexural Moments:

	PCA Case 10	Ms	**Mu**
Transverse:	0.044	1.97 K-FT	**2.74 K-FT**
Longitudinal:	0.044	1.97 K-FT	**2.74 K-FT**

(M=PCA Coeff*Bearing*a^2)

Calculate Flexural Capacity:

Transverse Bar Size/Spacing: D5.5 @ 4'' o.c. (As Provided =0.17 sq.in./ft.)
Longitudinal Bar Size/Spacing: D5.5 @ 4'' o.c. (As Provided =0.17 sq.in./ft.)

Transverse Design:

ϕMn=ϕ$A_s$fy(d-a/2): **4.89 K-FT** **OK**
c=As*Fy/.85*f'c*β1*b= 0.24''
Where, β1=[0.85-.05*(f'c-4ksi)]= 0.80
a=c*β1= 0.19''
Bar Cover: 2.50''
d=Slab-cover-1/2Bar Dia.= 5.37''

Check Min A_s Provided: (Ref. ACI318, 10.5.1)

(-)M: As_{min}=3√f'c/fy*b*d: 0.23 sq.in./ft. (Controls)
OR 200*b*d/fy: 0.21 sq.in./ft.
As Provided>As,min: **NG**
4/3 As Provided, OK

Longitudinal Design:

ϕMn=ϕ$A_s$fy(d-a/2): **4.65 K-FT** **OK**
c=As*Fy/.85*f'c*β1*b= 0.24''
Where, β1=[0.85-.05*(f'c-4ksi)]= 0.80
a=c*β1= 0.19''
Bar Cover: 2.76''
d=Slab-cover-Trans Bar-1/2Bar Dia.= 5.10''

(+)M: As_{min}=3√f'c/fy*b*d: 0.22 sq.in./ft. (Controls)
OR 200*b*d/fy: 0.20 sq.in./ft.
As Provided>As,min: **NG**
4/3 As Provided, OK

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Transverse Design (Cont.):

Check Serviceability (-) Moment:

(Ref. ACI318, 10.6.4)

ρ = As / b * d =	0.00256	
ρ_{max} = (.75 ρb) =	0.02515	**OK**
Es=	29000000	
Ec=57000*√f'c=	4030509	
n=Es/Ec=	7.20	
ρ * n =	0.01843	
k = √(2ρn +(ρn)^2) - ρn =	0.1744	
j = 1 - (k/3) =	0.942	
fs=Ms/(As*j*d)=	28,280 PSI	
<	2/3fy=50,000 PSI	**OK**
Max Spacing, s=15(40000/fs)-2.5Cc=		15.0''
OR	12(40000/fs)=	17.0''
Actual Spacing=4''	< 15.0''	**OK**

Longitudinal Design (Cont.):

Check Serviceability (+)Moment:

(Ref. ACI318, 10.6.4)

ρ = As / b * d =	0.00269	
ρ_{max} = (.75 ρb) =	0.02515	**OK**
Es=	29000000	
Ec=57000*√f'c=	4030509	
n=Es/Ec=	7.20	
ρ * n =	0.01939	
k = √(2ρn +(ρn)^2) - ρn =	0.1785	
j = 1 - (k/3) =	0.941	
fs=Ms/(As*j*d)=	29,789 PSI	
<	2/3fy=50,000 PSI	**OK**
Max Spacing, s=15(40000/fs)-2.5Cc=		13.2''
OR	12(40000/fs)=	16.1''
Actual Spacing=4''	< 13.2''	**OK**

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Base Slab Design:

(Design for Uniform Upward Bearing Pressure)
(Ref. PCA Rectangular Tanks, Chapter 2, Case 10: Pinned 4-Sides)

Design Length, b: 8.50'
Design Width, a: 8.50' b/a: 1.00
Base Slab Thickness: 8.0''

Dead Load:		OR	**Hydrostatic Load:**	
Top Slab:	0.113 KSF		Watertable Depth:	3.00'
Soil (Max. Fill-Conservative):	0.000 KSF		Depth (WT. to Base):	4.96'
Walls:	0.206 KSF		Water Pressure:	0.309 KSF
Other:				
Total:	0.318 KSF	(Controls)		

(Note: Design based on higher value of Dead Load and Hydrostatic Load.)

Live Load:
Wheel Load: 0 KIPS
Uniform Load: 0.300KSF

Check Shear:
Max PCA Shear Coeff: 0.34
Design Shear, Vu: **2.49 KIPS** (V=PCA Coeff*Bearing*a)
Shear Capacity, ϕVn: **6.68 KIPS** **OK**

Calculate Flexural Moments:

	PCA Case 10	Ms	**Mu**
Transverse:	0.044	1.97 K-FT	**2.74 K-FT**
Longitudinal:	0.044	1.97 K-FT	**2.74 K-FT**

(M=PCA Coeff*Bearing*a^2)

Calculate Flexural Capacity:

Transverse Bar Size/Spacing: #4 @ 12'' o.c. (As Provided =0.20 sq.in./ft.)
Longitudinal Bar Size/Spacing: #4 @ 12'' o.c. (As Provided =0.20 sq.in./ft.)

Transverse Design:

ϕMn=ϕ$A_s$fy(d-a/2): **4.54 K-FT** **OK**
c=As*Fy/.85*f'c*β1*b= 0.29''
Where, β1=[0.85-.05*(f'c-4ksi)]= 0.80
a=c*β1= 0.23''
Bar Cover: 2.50''
d=Slab-cover-1/2Bar Dia.= 5.25''

Check Min A_s Provided: (Ref. ACI318, 10.5.1)

(-)M: As_{min}=3√f'c/fy*b*d: 0.22 sq.in./ft. (Controls)
OR 200*b*d/fy: 0.21 sq.in./ft.
As Provided>As,min: **NG**
4/3 As Provided, OK

Longitudinal Design:

ϕMn=ϕ$A_s$fy(d-a/2): **4.09 K-FT** **OK**
c=As*Fy/.85*f'c*β1*b= 0.29''
Where, β1=[0.85-.05*(f'c-4ksi)]= 0.80
a=c*β1= 0.23''
Bar Cover: 3.00''
d=Slab-cover-Trans Bar-1/2Bar Dia.= 4.75''

(+)M: As_{min}=3√f'c/fy*b*d: 0.20 sq.in./ft. (Controls)
OR 200*b*d/fy: 0.19 sq.in./ft.
As Provided>As,min: **NG**
4/3 As Provided, OK

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Project Name: NWSA Port of Tacoma
Job Number: 18-01.39
Structure Name: 8x8 Bio Clean Vault

Transverse Design (Cont.):

Check Serviceability (-) Moment:

(Ref. ACI318, 10.6.4)

ρ = As / b * d =	0.00312	
ρ_{max} = (.75 ρb) =	0.02515	**OK**
Es=	29000000	
Ec=57000*√f'c=	4030509	
n=Es/Ec=	7.20	
ρ * n =	0.02242	
k = √(2ρn +(ρn)^2) - ρn =	0.1905	
j = 1 - (k/3) =	0.936	
fs=Ms/(As*j*d)=	24,437 PSI	
<	2/3fy=40,000 PSI	**OK**
Max Spacing, s=15(40000/fs)-2.5Cc=		18.3''
OR 12(40000/fs)=		19.6''
Actual Spacing=12''	< 18.3''	**OK**

Longitudinal Design (Cont.):

Check Serviceability (+)Moment:

(Ref. ACI318, 10.6.4)

ρ = As / b * d =	0.00344	
ρ_{max} = (.75 ρb) =	0.02515	**OK**
Es=	29000000	
Ec=57000*√f'c=	4030509	
n=Es/Ec=	7.20	
ρ * n =	0.02479	
k = √(2ρn +(ρn)^2) - ρn =	0.1992	
j = 1 - (k/3) =	0.934	
fs=Ms/(As*j*d)=	27,093 PSI	
<	2/3fy=40,000 PSI	**OK**
Max Spacing, s=15(40000/fs)-2.5Cc=		14.6''
OR 12(40000/fs)=		17.7''
Actual Spacing=12''	< 14.6''	**OK**

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Project Name: NWSA Port of Tacoma
Job Number: 18-01.39
Structure Name: 8x8 Bio Clean Vault

Member: Baffle

Member Thickness:	6''	
Bar Cover:	2.6''	
Concrete Strength, f'c:	5000 PSI	
Beam Width, b:	12.0''	
Factored Moment, Mu:	**0.94 K-FT**	=Ms*1.6LF
Service Moment, Ms:	**0.59 K-FT**	=(0.08-0.0624kcf)*6.25'*2/3*8'^2/8

Calculate Flexural Capacity:

Bar Size/Spacing: #5 @ 8'' o.c. (As Provided =0.46 sq.in./ft.)

$\phi Mn=\phi A_s fy(d-a/2)$: **5.77 k-ft** **OK**

$c=As*Fy/.85*f'c*\beta1*b=$ 0.68''
Where, $\beta1=[0.85-.05*(f'c-4ksi)]=$ 0.80
$a=c*\beta1=$ 0.54''
d=Thickness-Cover-1/2Bar Dia.= 3.06''

Check Min A_s Provided: (Ref. ACI318, 10.5.1)

As, min=3√f'c/fy*b*d: 0.13 sq.in./ft. (Controls) **OR** 200*b*d/fy: 0.12 sq.in./ft.

As Provided>As,min: **OK**

Check Max Bar Spacing & Serviceability: (Ref. ACI318, 10.6.4)

ρ = As / b * d =	0.01254	ρ_{max} = (.75 ρb) =	0.02515 **OK**
Es=	29000000		
Ec=57000*√f'c=	4030509		
n=Es/Ec=	7.20		
ρ * n =	0.0902		
k = √(2ρn +(ρn)^2) - ρn =	0.3441		
j = 1 - (k/3) =	0.885		
fs=Ms/(As*j*d)=	5,652 PSI	< 2/3fy=40,000 PSI	**OK**

Max Spacing, s=15(40000/fs)-2.5Cc= 99.6'' **OR** 12(40000/fs)= 84.9'' (Controls)

Actual Spacing=8'' **OK**

Check Shear:

Factored Shear, Vu: **0.47 KIPS** =(0.08-0.0624kcf)*6.25'*2/3*8'^2/8*1.6LF

Shear Capacity, ϕVn: **3.89 KIPS** **OK**

(ϕVn=2*√f'c*b*d/1000)

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Customer: Granite Precasting
Project Name: NWSA Port of Tacoma
Job Number: 18-01.39
Structure Name: 8x8 Bio Clean Vault

Buoyancy Analysis:

Design Methodology: Uplift computed based on volume of water displaced from outside dimensions of structure, including base extension (if provided), from bottom of base slab to water table height. Resisting force based on dry unit weights of concrete and soil above the bottom of base slab. Analysis neglects skin friction of soil against structure - conservative.

Analysis Assumptions (To Be Verified By E.O.R.):

Min. Earth Fill :	0.00'	
Unit Wt. of Soil:	120 PCF	
Unit Wt. of Concrete:	150 PCF	
Watertable Depth:	3.0'	(Below Grade)
Unit Wt. of Water:	62.4 PCF	
Minimum Safety Factor:	1.0	

Compute Upward Forces:

Volume of Water Displaced= Water Depth*O.D. Length & Width = **401.49 CF**
(Water Depth = Fill+Top+Inside Ht+Bottom-W.T. Depth=4.96')
O.D. Width=9.00' O.D. Length=9.00'

Upward Force = Vol. of Water Displaced * Water Unit Weight= **25,053 LBS**

Compute Downward Forces:

Earth Fill(w/opng deduct)=	0 LBS	Opening Size:	0.0'' Dia.	(Round)
Top Slab(w/opng deduct)=	4,289 LBS	**OR**	0.0''L x 0.0''W	(Rectangular)
Walls=	16,677 LBS		(Equivalent area removed)	
Base Slab=	8,100 LBS			
Soil Over Extension=	0 LBS	Base Extension=	0.0''	
Soil Wedge=	0 LBS			
Other=	3,552 LBS	Baffles		
Total Downward Force=	**32,618 LBS**			

Net Buoyancy Reaction= **7,565 LBS**

Buoyancy Safety Factor= **1.3** **OK**

BUOYANCY COMPUTATIONS PREPARED FOR:

GP GRANITE PRECAST
4116 BAKERVIEW SPUR, BELLINGHAM, WA 98226
(360) 671-2251 1-800-808-2251 FAX: (360) 671-0780

PROJECT:

NWSA – Port of Tacoma

PRODUCT:

Precast Bio Clean Vaults
8’-0” x 24’-0” Max x 6’-3” Max I.D.
(Includes Rebar and Welded Wire Options for Base Units)

SPECIALTY ENGINEERING SERVICES PROVIDED BY:

Concrete Engineering Solutions, LLC
101 Pine View Estates
Mountain Top, PA 18707
Phone: 570-868-2081
Fax: 570-868-2082

4/12/18

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MOUNTAIN TOP, PA 18707
PHONE:570-868-2081
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Customer: Granite Precasting
Project: NWSA Port of Tacoma
Job Number: 18-01.39
Structure Name: 8x24 Bio Clean Vaults*

Structure Size:	Length	Width	Inside Ht.
	24.00'*	8.00'	6.25'
Top Slab Thickness:			12.0''
Bottom Slab Thickness:			8.0''
Wall Thickness (Min):			6.00''
Base Extension:			0''

*Note: Design Conservative for 8x20 Units

Vault Design:

Design Assumptions (To Be Verified By E.O.R.):

Design Load:		
	300 PSF	Uniform Load
Min. Earth Fill :	0.00'	
Max. Earth Fill:	0.00'	
Unit Wt. of Soil:	120 PCF	
Unit Wt. of Concrete:	150 PCF	
Watertable Depth:	3.0'	(Below Grade-Min.)
Lateral Earth Pressure:	64.1 PCF	(See Following Sheets)
LL Surcharge:	80.0 PSF	(Ref. ASTM C857/C890: 0.005*Wheel Load)
Depth to Apply Surcharge:	8.0'	(Ref. ASTM C857/C890)
Unit Wt. of Water:	62.4 PCF	
Min. Buoyancy Safety Factor Req'd:	1.0	(See Buoyancy Analysis for Actual Safety Factor)
Concrete Strength, f'c:	7,000 PSI	
Reinforcing Yield Strength, fy:	60,000 PSI	

Load Factors:	1.6	(Live Load)	
	1.2	(Dead Load)	(Note, If no Live Load, set DL Factor to 1.4)
	1.6	(Earth Pressure)	
Capacity Reduction:	0.9	(Flexure)	
	0.75	(Shear)	

References:

1.)ACI318 "Building Code Requirements for Structural Concrete", latest edition.
2.)ASTM C478 "Specification for Precast Reinforced Concrete Manhole Sections", latest edition.
3.) ASTM C890 "Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures", latest edition.
4.) ASTM C857 "Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures", latest edition.
5.) HS-20 or HS-25 wheel loads per AASHTO "Standard Specificationfor Highway Bridges", 17th Edition.
6.) PCA "Rectangular Concrete Tanks", 5th Edition.

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Customer: Granite Precasting
Project Name: NWSA Port of Tacoma
Job Number: 18-01.39
Structure Name: 8x24 Bio Clean Vaults

Top Slab Design: (Uniform Live Load)

1-Way Slab Design (Span 1-way or 2-way depending on top opening size and orientation.)

Live Load:	
(Uniform Load)	300 PSF
Earth Fill :	0.00'
Average Design Span:	4.50'
Bar Cover:	2.00''
Dead Load:	
Top Slab:	0.150 KSF
Soil:	0.000 KSF
Other:	
Total:	0.150 KSF

Live Load: (Ref. ASTM C890)
Uniform Live Load: 0.300 KSF

Calculate Flexural Moments:

Dead Load Moment:	0.38 K-FT	(wl^2/8	, w=dead load, l=design span)
Live Load Moment:	0.76 K-FT	(wl^2/8	, w=live load, l=design span)
Total Service Moment,Ms:	1.14 K-FT		
Factored Moment, Mu:	**1.67 K-FT**		

Calculate Flexural Capacity:

Trial Bar Size/Spacing: #4 @ 8'' o.c. (As Provided =0.29 sq.in./ft.)

$\phi Mn=\phi A_s fy(d-a/2)$: **12.76 K-FT** **OK**

$c=As*Fy/.85*f'c*\beta1*b=$ 0.35''
Where, $\beta1=[0.85-.05*(f'c-4ksi)]=$ 0.70
$a=c*\beta1=$ 0.25''
d=Slab-cover-1/2Bar Dia.= 9.75''

Check Min A_s Provided: (Ref. ACI318, 10.5.1)

As, min=3√f'c/fy*b*d: 0.49 sq.in./ft. (Controls) **OR** 200*b*d 0.39 sq.in./ft.

As Provided>As,min: **NG**
4/3 As Provided, OK

Check Shear:

V_{DL}:	0.22 KIPS	(wdl*(Span-2*d)/2)
V_{LL}:	0.43 KIPS	(wll*(Span-2*d)/2)
Vu:	**0.95 KIPS**	[LF*Vdl + LF*Vll]

Shear Capacity, ϕVn: **14.68 KIPS** **OK**

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Job Number: 18-01.39
Structure Name: 8x24 Bio Clean Vaults

Top Slab Min Fill (Cont.):

Check Max Bar Spacing & Serviceability: (Ref. ACI318, 10.6.4)

ρ = As / b * d =	0.00252	ρ_{max} = (.75 ρb) =	0.03081	**OK**
Es=	29000000			
Ec=57000*√f'c=	4768962			
n=Es/Ec=	6.08			
ρ * n =	0.01531			
k = √(2ρn +(ρn)^2) - ρn =	0.1603			
j = 1 - (k/3) =	0.947			
fs=Ms/(As*j*d)=	5,029 PSI	<	2/3fy=40,000 PSI	**OK**

Max Spacing, s=15(40000/fs)-2.5Cc= 114.3'' **OR** 12(40000/fs)= 95.5'' (Controls)

Actual Spacing=8'' **OK**

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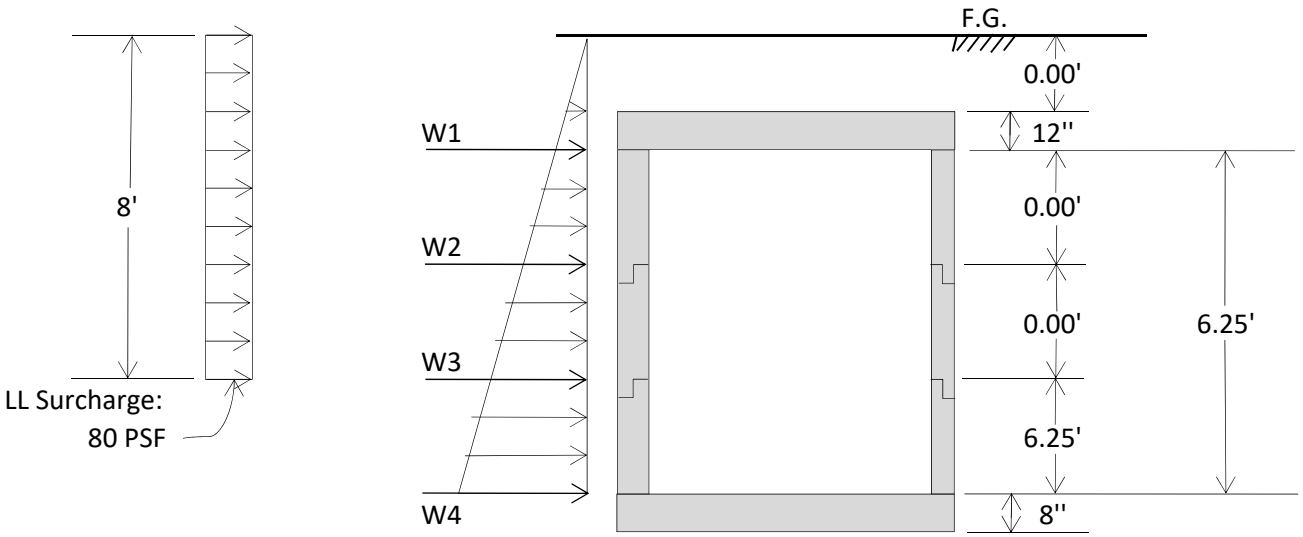
Job Number: l8-01.39
Structure Name: 8x24 Bio Clean Vaults

Soil Pressure On Walls:

(Not all components may be used for all vault designs - configurations may vary)



Unit Weight of Soil:	120 PCF	
Earth Pressure Coefficient, Ka:	0.33	
Unit Weight of Water:	62.4 PCF	
Max. Earth Fill:	0.00'	
Water Table Depth:	3.00'	
Dry Soil Pressure:	39.6 PCF	[Ka*Ws]
Saturated Soil Pressure:	81.4 PCF	[(Ws-Ww)*Ka+Ww]
Design Earth Pressure: (Weighted Avg.)	**64.1 PCF**	

Pressures Used for Wall Component Design:

(Note: LL Surcharge Applied On Actual Component Design Sheet When Required)

	Design Depth:	Design Pressure:
W1:	1.00'	64 PSF
W2:	1.00'	64 PSF
W3:	1.00'	64 PSF
W4:	7.25'	465 PSF

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Structure Name: 8x24 Bio Clean Vaults

Monolithic or Integral Wall Design: (Bottom Unit)

Outside Face of Wall (Negative Moment)

(Ref. PCA Tables, Chapter 2, Cases 3 & 8)

Wall Length, b:	24.00'
Wall Height, a:	6.33'
b/a:	3.8
Thickness:	6.00''
Bar Cover:	2.00''

Lateral Earth Pressure:

Top of Wall, W3:	0.064 KSF
Bottom of Wall, W4:	0.465 KSF
Live Load Surcharge:	0.080 KSF

Calculate Flexural Moments: (Negative Moments, M=PCA Coeff*Pressure*a^2)

Horizontal Design: Bars to Outside: Yes

Case 8	Case 3	Ms	Mu
0.399	0.097	3.87 K-FT	**6.19 K-FT**

Try: D10 @ 4'' o.c. (As Prov.=0.30 sq.in./ft.)

ϕMn=ϕ$A_s$fy(d-a/2): **6.24 K-FT** **OK**

c=As*Fy/.85*f'c*β1*b= 0.36''
Where, β1=[0.85-.05*(f'c-4ksi)]= 0.70
a=c*β1= 0.25''
d= 3.82''

Check Min A_s Provided: (Ref. ACI318, 10.5.1)

As_{min}=3√f'c/fy*b*d: 0.19 sq.in./ft. (Controls)
OR 200*b*d/fy: 0.15 sq.in./ft.
As Provided>As,min: **OK**

Check Serviceability: (Ref. ACI318, 10.6.4)

ρ = As / b * d =	0.00654	
ρ_{max} = (.75 ρb) =	0.03081	**OK**
Es=	29000000	
Ec=57000*√f'c=	4768962	
n=Es/Ec=	6.08	
ρ * n =	0.03978	
k = √(2ρn +$(\rho n)^2$) - ρn =	0.2451	
j = 1 - (k/3) =	0.918	
fs=Ms/(As*j*d)=	44,083 PSI	
<	2/3fy=50,000 PSI	**OK**
Max Spacing, s=15(40000/fs)-2.5Cc=	8.6''	
OR 12(40000/fs)=	10.9''	
OR 3*Tw=	18.0''	
Actual Spacing=4''	< 8.6''	**OK**

Check Shear: (V=PCA Coeff*Pressure*a)

Case 8	Case 3	Vs	Vu
1.06	0.31	1.74 KIPS	**2.78 KIPS**

Horiz. Shear Capacity, ϕVn: **5.76 KIPS**
ϕVn>Vu: **OK**

Vertical Design: Bars to Outside: No

Case 8	Case 3	Ms	Mu
0.417	0.145	4.73 K-FT	**7.56 K-FT**

Try: D14 @ 4'' o.c. (As Prov.=0.42 sq.in./ft.)

ϕMn=ϕ$A_s$fy(d-a/2): **7.69 K-FT** **OK**

c=As*Fy/.85*f'c*β1*b= 0.50''
Where, β1=[0.85-.05*(f'c-4ksi)]= 0.70
a=c*β1= 0.35''
d= 3.43''

As_{min}=3√f'c/fy*b*d: 0.17 sq.in./ft. (Controls)
OR 200*b*d/fy: 0.14 sq.in./ft.
As Provided>As,min: **OK**

ρ = As / b * d =	0.01020	
ρ_{max} = (.75 ρb) =	0.03081	**OK**
Es=	29000000	
Ec=57000*√f'c=	4768962	
n=Es/Ec=	6.08	
ρ * n =	0.06201	
k = √(2ρn +$(\rho n)^2$) - ρn =	0.2956	
j = 1 - (k/3) =	0.901	
fs=Ms/(As*j*d)=	43,653 PSI	
<	2/3fy=50,000 PSI	**OK**
Max Spacing, s=15(40000/fs)-2.5Cc=	5.6''	
OR 12(40000/fs)=	11.0''	
OR 3*Tw=	18.0''	
Actual Spacing=4''	< 5.6''	**OK**

Case 8	Case 3	Vs	Vu
1.03	0.50	2.20 KIPS	**3.53 KIPS**

Vertical Shear Capacity, ϕVn: **5.17 KIPS**
ϕVn>Vu: **OK**

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Monolithic or Integral Wall Design (Cont.):

Inside Face of Wall (Positive Moment)

Bar Cover: 4.25''

Calculate Flexural Moments: (Positive Moments, M=PCA Coeff*Pressure*a^2)

Horizontal Design: Bars to Inside: No

Case 8	Case 3	Ms	Mu
0.069	0.017	0.67 K-FT	**1.07 K-FT**

Try: D10 **@ 4'' o.c.** (As Prov.=0.30 sq.in./ft.)

$\phi Mn=\phi A_s fy(d-a/2)$: **4.08 K-FT** **OK**

$c=As*Fy/.85*f'c*\beta1*b=$ 0.36''

Where, $\beta1=[0.85-.05*(f'c-4ksi)]=$ 0.70

$a=c*\beta1=$ 0.25''

$d=$ 3.15''

Check Min A_s Provided: (Ref. ACI318, 10.5.1)

(-)M: $As_{min}=3\sqrt{f'c}/fy*b*d$: 0.16 sq.in./ft. (Controls)

OR $200*b*d/fy$: 0.13 sq.in./ft.

As Provided>As,min: **OK**

Check Serviceability: (Ref. ACI318, 10.6.4)

$\rho = As / b * d =$ 0.00794

$\rho_{max} = (.75\ \rho b) =$ 0.03081 **OK**

$Es=$ 29000000

$Ec=57000*\sqrt{f'c}=$ 4768962

$n=Es/Ec=$ 6.08

$\rho * n =$ 0.04827

$k = \sqrt{(2\rho n + (\rho n)^2)} - \rho n =$ 0.2662

$j = 1 - (k/3) =$ 0.911

$fs=Ms/(As*j*d)=$ 9,312 PSI

< 2/3fy=50,000 PSI **OK**

Max Spacing, $s=15(40000/fs)-2.5Cc=$ 49.4''

OR $12(40000/fs)=$ 51.5''

OR $3*Tw=$ 18.0''

Actual Spacing=4'' < 18.0'' **OK**

Vertical Design: Bars to Inside: Yes

Case 8	Case 3	Ms	Mu
0.011	0.008	0.19 K-FT	**0.30 K-FT**

Try: D14 **@ 4'' o.c.** (As Prov.=0.42 sq.in./ft.)

$\phi Mn=\phi A_s fy(d-a/2)$: **6.35 K-FT** **OK**

$c=As*Fy/.85*f'c*\beta1*b=$ 0.50''

Where, $\beta1=[0.85-.05*(f'c-4ksi)]=$ 0.70

$a=c*\beta1=$ 0.35''

$d=$ 3.54''

(+)M: $As_{min}=3\sqrt{f'c}/fy*b*d$: 0.18 sq.in./ft. (Controls)

OR $200*b*d/fy$: 0.14 sq.in./ft.

As Provided>As,min: **OK**

$\rho = As / b * d =$ 0.00989

$\rho_{max} = (.75\ \rho b) =$ 0.03081 **OK**

$Es=$ 29000000

$Ec=57000*\sqrt{f'c}=$ 4768962

$n=Es/Ec=$ 6.08

$\rho * n =$ 0.06014

$k = \sqrt{(2\rho n + (\rho n)^2)} - \rho n =$ 0.2919

$j = 1 - (k/3) =$ 0.903

$fs=Ms/(As*j*d)=$ 1,678 PSI

< 2/3fy=50,000 PSI **OK**

Max Spacing, $s=15(40000/fs)-2.5Cc=$ 347.0''

OR $12(40000/fs)=$ 286.1''

OR $3*Tw=$ 18.0''

Actual Spacing=4'' < 18.0'' **OK**

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Monolithic or Integral Wall Design: (Bottom Unit)

Outside Face of Wall (Negative Moment)

(Ref. PCA Tables, Chapter 2, Cases 3 & 8)

Wall Length, b:	24.00'
Wall Height, a:	6.25'
b/a:	3.8
Thickness:	6.00''
Bar Cover:	2.00''

Lateral Earth Pressure:

Top of Wall, W3:	0.064 KSF
Bottom of Wall, W4:	0.465 KSF
Live Load Surcharge:	0.080 KSF

Calculate Flexural Moments: (Negative Moments, M=PCA Coeff*Pressure*a^2)

Horizontal Design: Bars to Outside: Yes

Case 8	Case 3	Ms	Mu
0.399	0.097	3.77 K-FT	**6.03 K-FT**

Try: #4 @ 6'' o.c. (As Prov.=0.39 sq.in./ft.)

ϕMn=ϕ$A_s$fy(d-a/2): **6.34 K-FT** **OK**

c=As*Fy/.85*f'c*β1*b= 0.47''
Where, β1=[0.85-.05*(f'c-4ksi)]= 0.70
a=c*β1= 0.33''
d= 3.75''

Check Min A_s Provided: (Ref. ACI318, 10.5.1)

As_{min}=3√f'c/fy*b*d: 0.19 sq.in./ft. (Controls)
OR 200*b*d/fy: 0.15 sq.in./ft.
As Provided>As,min: **OK**

Check Serviceability: (Ref. ACI318, 10.6.4)

ρ = As / b * d =	0.00873	
ρ_{max} = (.75 ρb) =	0.03081	**OK**
Es=	29000000	
Ec=57000*√f'c=	4768962	
n=Es/Ec=	6.08	
ρ * n =	0.05307	
k = √(2ρn +(ρn)^2) - ρn =	0.2770	
j = 1 - (k/3) =	0.908	
fs=Ms/(As*j*d)=	33,850 PSI	
<	2/3fy=40,000 PSI	**OK**
Max Spacing, s=15(40000/fs)-2.5Cc=	12.7''	
OR 12(40000/fs)=	14.2''	
OR 3*Tw=	18.0''	
Actual Spacing=6''	< 12.7''	**OK**

Check Shear: (V=PCA Coeff*Pressure*a)

Case 8	Case 3	Vs	Vu
1.06	0.31	1.72 KIPS	**2.75 KIPS**

Horiz. Shear Capacity, ϕVn: **5.65 KIPS**
ϕVn>Vu: **OK**

Vertical Design: Bars to Outside: No

Case 8	Case 3	Ms	Mu
0.417	0.145	4.61 K-FT	**7.37 K-FT**

Try: #5 @ 6'' o.c. (As Prov.=0.61 sq.in./ft.)

ϕMn=ϕ$A_s$fy(d-a/2): **8.09 K-FT** **OK**

c=As*Fy/.85*f'c*β1*b= 0.74''
Where, β1=[0.85-.05*(f'c-4ksi)]= 0.70
a=c*β1= 0.52''
d= 3.19''

As_{min}=3√f'c/fy*b*d: 0.16 sq.in./ft. (Controls)
OR 200*b*d/fy: 0.13 sq.in./ft.
As Provided>As,min: **OK**

ρ = As / b * d =	0.01604	
ρ_{max} = (.75 ρb) =	0.03081	**OK**
Es=	29000000	
Ec=57000*√f'c=	4768962	
n=Es/Ec=	6.08	
ρ * n =	0.09755	
k = √(2ρn +(ρn)^2) - ρn =	0.3548	
j = 1 - (k/3) =	0.882	
fs=Ms/(As*j*d)=	32,067 PSI	
<	2/3fy=40,000 PSI	**OK**
Max Spacing, s=15(40000/fs)-2.5Cc=	12.5''	
OR 12(40000/fs)=	15.0''	
OR 3*Tw=	18.0''	
Actual Spacing=6''	< 12.5''	**OK**

Case 8	Case 3	Vs	Vu
1.03	0.50	2.18 KIPS	**3.48 KIPS**

Vertical Shear Capacity, ϕVn: **4.80 KIPS**
ϕVn>Vu: **OK**

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Job Number: 18-01.39
Structure Name: 8x24 Bio Clean Vaults

Monolithic or Integral Wall Design (Cont.):

Inside Face of Wall (Positive Moment)

Bar Cover: 2.88''

Calculate Flexural Moments: (Positive Moments, M=PCA Coeff*Pressure*a^2)

Horizontal Design: Bars to Inside: No

Case 8	Case 3	Ms	Mu
0.069	0.017	0.65 K-FT	**1.04 K-FT**

Try: #4 **@ 6'' o.c.** (As Prov.=0.39 sq.in./ft.)

$\phi Mn=\phi A_s fy(d-a/2)$: **3.68 K-FT** **OK**

c=As*Fy/.85*f'c*β1*b= 0.47''
Where, β1=[0.85-.05*(f'c-4ksi)]= 0.70
a=c*β1= 0.33''
d= 2.25''

Check Min A_s Provided: (Ref. ACI318, 10.5.1)

(-)M: $As_{min}=3\sqrt{f'c}/fy*b*d$: 0.11 sq.in./ft. (Controls)
OR 200*b*d/fy: 0.09 sq.in./ft.
As Provided>As,min: **OK**

Check Serviceability: (Ref. ACI318, 10.6.4)

ρ = As / b * d = 0.01458
ρ_{max} = (.75 ρb) = 0.03081 **OK**
Es= 29000000
Ec=57000*√f'c= 4768962
n=Es/Ec= 6.08
ρ * n = 0.08864
k = √(2ρn +(ρn)^2) - ρn = 0.3416
j = 1 - (k/3) = 0.886
fs=Ms/(As*j*d)= 10,005 PSI
< 2/3fy=40,000 PSI **OK**
Max Spacing, s=15(40000/fs)-2.5Cc= 51.2''
OR 12(40000/fs)= 48.0''
OR 3*Tw= 18.0''
Actual Spacing=6'' < 18.0'' **OK**

Vertical Design: Bars to Inside: Yes

Case 8	Case 3	Ms	Mu
0.011	0.008	0.18 K-FT	**0.29 K-FT**

Try: #5 **@ 6'' o.c.** (As Prov.=0.61 sq.in./ft.)

$\phi Mn=\phi A_s fy(d-a/2)$: **7.04 K-FT** **OK**

c=As*Fy/.85*f'c*β1*b= 0.74''
Where, β1=[0.85-.05*(f'c-4ksi)]= 0.70
a=c*β1= 0.52''
d= 2.81''

(+)M: $As_{min}=3\sqrt{f'c}/fy*b*d$: 0.14 sq.in./ft. (Controls)
OR 200*b*d/fy: 0.11 sq.in./ft.
As Provided>As,min: **OK**

ρ = As / b * d = 0.01821
ρ_{max} = (.75 ρb) = 0.03081 **OK**
Es= 29000000
Ec=57000*√f'c= 4768962
n=Es/Ec= 6.08
ρ * n = 0.11075
k = √(2ρn +(ρn)^2) - ρn = 0.3727
j = 1 - (k/3) = 0.876
fs=Ms/(As*j*d)= 1,455 PSI
< 2/3fy=40,000 PSI **OK**
Max Spacing, s=15(40000/fs)-2.5Cc= 405.3''
OR 12(40000/fs)= 330.0''
OR 3*Tw= 18.0''
Actual Spacing=6'' < 18.0'' **OK**

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Structure Name: 8x24 Bio Clean Vaults

Base Slab Design:

(Design for Uniform Upward Bearing Pressure)
(Ref. PCA Rectangular Tanks, Chapter 2, Case 10: Pinned 4-Sides)

Design Length, b: 24.50'
Design Width, a: 8.50' b/a: 2.90
Base Slab Thickness: 8.0''

Dead Load:

Top Slab:	0.150 KSF
Soil (Max. Fill-Conservative):	0.000 KSF
Walls:	0.138 KSF
Other:	
Total:	0.288 KSF

OR

Hydrostatic Load:

Watertable Depth:	3.00'
Depth (WT. to Base):	4.92'
Water Pressure:	0.307 KSF (Controls)

(Note: Design based on higher value of Dead Load and Hydrostatic Load.)

Live Load:

Wheel Load:	0 KIPS
Uniform Load:	0.300KSF

Check Shear:

Max PCA Shear Coeff: 0.488
Design Shear, Vu: **3.52 KIPS** (V=PCA Coeff*Bearing*a)
Shear Capacity, ϕVn: **8.03 KIPS** **OK**

Calculate Flexural Moments:

	PCA Case 10	Ms	**Mu**
Transverse:	0.117	5.12 K-FT	**7.16 K-FT**
Longitudinal:	0.036	1.59 K-FT	**2.22 K-FT**

(M=PCA Coeff*Bearing*a^2)

Calculate Flexural Capacity:

Transverse Bar Size/Spacing: D9.0 @ 4'' o.c. (As Provided =0.27 sq.in./ft.)
Longitudinal Bar Size/Spacing: D9 @ 4'' o.c. (As Provided =0.27 sq.in./ft.)

Transverse Design:

ϕMn=ϕ$A_s$fy(d-a/2): **7.92 K-FT** **OK**
c=As*Fy/.85*f'c*β1*b= 0.32''
Where, β1=[0.85-.05*(f'c-4ksi)]= 0.70
a=c*β1= 0.23''
Bar Cover: 2.50''
d=Slab-cover-1/2Bar Dia.= 5.33''

Check Min A_s Provided: (Ref. ACI318, 10.5.1)

(-)M: As_{min}=3√f'c/fy*b*d: 0.27 sq.in./ft. (Controls)
OR 200*b*d/fy: 0.21 sq.in./ft.
As Provided>As,min: **OK**

Longitudinal Design:

ϕMn=ϕ$A_s$fy(d-a/2): **7.41 K-FT** **OK**
c=As*Fy/.85*f'c*β1*b= 0.32''
Where, β1=[0.85-.05*(f'c-4ksi)]= 0.70
a=c*β1= 0.23''
Bar Cover: 2.84''
d=Slab-cover-Trans Bar-1/2Bar Dia.= 4.99''

(+)M: As_{min}=3√f'c/fy*b*d: 0.25 sq.in./ft. (Controls)
OR 200*b*d/fy: 0.20 sq.in./ft.
As Provided>As,min: **OK**

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Transverse Design (Cont.):

Check Serviceability (-) Moment:

(Ref. ACI318, 10.6.4)

ρ = As / b * d =	0.00422	
ρ_{max} = (.75 ρb) =	0.03081	**OK**
Es=	29000000	
Ec=57000*√f'c=	4768962	
n=Es/Ec=	6.08	
ρ * n =	0.02567	
k = √(2ρn +(ρn)^2) - ρn =	0.2024	
j = 1 - (k/3) =	0.933	
fs=Ms/(As*j*d)=	45,781 PSI	
<	2/3fy=50,000 PSI	**OK**
Max Spacing, s=15(40000/fs)-2.5Cc=		6.9''
OR	12(40000/fs)=	10.5''
Actual Spacing=4''	< 6.9''	**OK**

Longitudinal Design (Cont.):

Check Serviceability (+)Moment:

(Ref. ACI318, 10.6.4)

ρ = As / b * d =	0.00451	
ρ_{max} = (.75 ρb) =	0.03081	**OK**
Es=	29000000	
Ec=57000*√f'c=	4768962	
n=Es/Ec=	6.08	
ρ * n =	0.02741	
k = √(2ρn +(ρn)^2) - ρn =	0.2083	
j = 1 - (k/3) =	0.931	
fs=Ms/(As*j*d)=	15,183 PSI	
<	2/3fy=50,000 PSI	**OK**
Max Spacing, s=15(40000/fs)-2.5Cc=		32.4''
OR	12(40000/fs)=	31.6''
Actual Spacing=4''	< 31.6''	**OK**

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Structure Name: 8x24 Bio Clean Vaults

Base Slab Design:

(Design for Uniform Upward Bearing Pressure)
(Ref. PCA Rectangular Tanks, Chapter 2, Case 10: Pinned 4-Sides)

Design Length, b: 24.50'
Design Width, a: 8.50' b/a: 2.90
Base Slab Thickness: 8.0''

Dead Load:

Top Slab:	0.150 KSF
Soil (Max. Fill-Conservative):	0.000 KSF
Walls:	0.138 KSF
Other:	
Total:	0.288 KSF

OR

Hydrostatic Load:

Watertable Depth:	3.00'
Depth (WT. to Base):	4.92'
Water Pressure:	0.307 KSF (Controls)

(Note: Design based on higher value of Dead Load and Hydrostatic Load.)

Live Load:

Wheel Load:	0 KIPS
Uniform Load:	0.300KSF

Check Shear:

Max PCA Shear Coeff: 0.488
Design Shear, Vu: **3.52 KIPS** (V=PCA Coeff*Bearing*a)
Shear Capacity, ϕVn: **7.81 KIPS** **OK**

Calculate Flexural Moments:

	PCA Case 10	Ms	**Mu**
Transverse:	0.117	5.12 K-FT	**7.16 K-FT**
Longitudinal:	0.036	1.59 K-FT	**2.22 K-FT**

(M=PCA Coeff*Bearing*a^2)

Calculate Flexural Capacity:

Transverse Bar Size/Spacing: #5 @ 8'' o.c. (As Provided =0.46 sq.in./ft.)
Longitudinal Bar Size/Spacing: #5 @ 12'' o.c. (As Provided =0.31 sq.in./ft.)

Transverse Design:

ϕMn=ϕ$A_s$fy(d-a/2): **10.34 K-FT** **OK**
c=As*Fy/.85*f'c*β1*b= 0.55''
Where, β1=[0.85-.05*(f'c-4ksi)]= 0.70
a=c*β1= 0.39''
Bar Cover: 2.50''
d=Slab-cover-1/2Bar Dia.= 5.19''

Check Min A_s Provided: (Ref. ACI318, 10.5.1)

(-)M: As_{min}=3√f'c/fy*b*d: 0.26 sq.in./ft. (Controls)
OR 200*b*d/fy: 0.21 sq.in./ft.
As Provided>As,min: **OK**

Longitudinal Design:

ϕMn=ϕ$A_s$fy(d-a/2): **6.12 K-FT** **OK**
c=As*Fy/.85*f'c*β1*b= 0.37''
Where, β1=[0.85-.05*(f'c-4ksi)]= 0.70
a=c*β1= 0.26''
Bar Cover: 3.13''
d=Slab-cover-Trans Bar-1/2Bar Dia.= 4.56''

(+)M: As_{min}=3√f'c/fy*b*d: 0.23 sq.in./ft. (Controls)
OR 200*b*d/fy: 0.18 sq.in./ft.
As Provided>As,min: **OK**

CONCRETE ENGINEERING SOLUTIONS, LLC
101 PINEVIEW ESTATES
MOUNTAIN TOP, PA 18707
PHONE:570-868-2081
FAX: 570-868-2082

Customer: Granite Precasting
Project Name: NWSA Port of Tacoma
Job Number: 18-01.39
Structure Name: 8x24 Bio Clean Vaults

Transverse Design (Cont.):

Check Serviceability (-) Moment:

(Ref. ACI318, 10.6.4)

ρ = As / b * d =	0.00739	
ρ_{max} = (.75 ρb) =	0.03081	**OK**
Es=	29000000	
Ec=57000*√f'c=	4768962	
n=Es/Ec=	6.08	
ρ * n =	0.04495	
k = √(2ρn +(ρn)^2) - ρn =	0.2582	
j = 1 - (k/3) =	0.914	
fs=Ms/(As*j*d)=	28,164 PSI	
<	2/3fy=40,000 PSI	**OK**
Max Spacing, s=15(40000/fs)-2.5Cc=		15.1''
OR	12(40000/fs)=	17.0''
Actual Spacing=8''	< 15.1''	**OK**

Longitudinal Design (Cont.):

Check Serviceability (+)Moment:

(Ref. ACI318, 10.6.4)

ρ = As / b * d =	0.00560	
ρ_{max} = (.75 ρb) =	0.03081	**OK**
Es=	29000000	
Ec=57000*√f'c=	4768962	
n=Es/Ec=	6.08	
ρ * n =	0.03408	
k = √(2ρn +(ρn)^2) - ρn =	0.2292	
j = 1 - (k/3) =	0.924	
fs=Ms/(As*j*d)=	14,731 PSI	
<	2/3fy=40,000 PSI	**OK**
Max Spacing, s=15(40000/fs)-2.5Cc=		32.9''
OR	12(40000/fs)=	32.6''
Actual Spacing=12''	< 32.6''	**OK**

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MOUNTAIN TOP, PA 18707
PHONE:570-868-2081
FAX: 570-868-2082

Customer: Granite Precasting
Project Name: NWSA Port of Tacoma
Job Number: l8-01.39
Structure Name: 8x24 Bio Clean Vaults

Member: (Full-Length Baffle)

Member Thickness:	6''	
Bar Cover:	2.6''	
Concrete Strength, f'c:	7000 PSI	
Beam Width, b:	12.0''	
Factored Moment, Mu:	**8.45 K-FT**	=Ms*1.6
Service Moment, Ms:	**5.28 K-FT**	=(0.08kcf-0.0624kcf)*6.25'*2/3*24'^2/8

Calculate Flexural Capacity:

Bar Size/Spacing: #6 @ 6'' o.c. (As Provided =0.88 sq.in./ft.)

$\phi Mn=\phi A_s fy(d-a/2)$: **10.43 k-ft** **OK**

$c=As*Fy/.85*f'c*\beta1*b=$ 1.06''
Where, $\beta1=[0.85-.05*(f'c-4ksi)]=$ 0.70
$a=c*\beta1=$ 0.74''
d=Thickness-Cover-1/2Bar Dia.= 3.00''

Check Min A_s Provided: (Ref. ACI318, 10.5.1)

As, min=3√f'c/fy*b*d: 0.15 sq.in./ft. (Controls) **OR** 200*b*d/fy: 0.12 sq.in./ft.

As Provided>As,min: **OK**

Check Max Bar Spacing & Serviceability: (Ref. ACI318, 10.6.4)

ρ = As / b * d =	0.02458	ρ_{max} = (.75 ρb) =	0.03081 **OK**
Es=	29000000		
Ec=57000*√f'c=	4768962		
n=Es/Ec=	6.08		
ρ * n =	0.1495		
k = √(2ρn +(ρn)^2) - ρn =	0.4174		
j = 1 - (k/3) =	0.861		
fs=Ms/(As*j*d)=	27,812 PSI	< 2/3fy=40,000 PSI	**OK**

Max Spacing, s=15(40000/fs)-2.5Cc= 15.0'' (Controls) **OR** 12(40000/fs)= 17.3''

Actual Spacing=6'' **OK**

Check Shear:

Factored Shear, Vu:	**1.41 KIPS**	=(0.08kcf-0.0624kcf)*6.25'*2/3*24'/2
Shear Capacity, ϕVn:	**4.51 KIPS**	**OK**

(ϕVn=2*√f'c*b*d/1000)

CONCRETE ENGINEERING SOLUTIONS, LLC
101 PINEVIEW ESTATES
MOUNTAIN TOP, PA 18707
PHONE:570-868-2081
FAX: 570-868-2082

Customer: Granite Precasting
Project Name: NWSA Port of Tacoma
Job Number: 18-01.39
Structure Name: 8x24 Bio Clean Vaults

Buoyancy Analysis:

Design Methodology: Uplift computed based on volume of water displaced from outside dimensions of structure, including base extension (if provided), from bottom of base slab to water table height. Resisting force based on dry unit weights of concrete and soil above the bottom of base slab. Analysis neglects skin friction of soil against structure - conservative.

Analysis Assumptions (To Be Verified By E.O.R.):

Min. Earth Fill :	0.00'	
Unit Wt. of Soil:	120 PCF	
Unit Wt. of Concrete:	150 PCF	
Watertable Depth:	3.0'	(Below Grade)
Unit Wt. of Water:	62.4 PCF	
Minimum Safety Factor:	1.0	

Compute Upward Forces:

Volume of Water Displaced= Water Depth*O.D. Length & Width = **1106.25 CF**
(Water Depth = Fill+Top+Inside Ht+Bottom-W.T. Depth=4.92')
O.D. Width=9.00' O.D. Length=25.00'

Upward Force = Vol. of Water Displaced * Water Unit Weight= **69,030 LBS**

Compute Downward Forces:

Earth Fill(w/opng deduct)=	0 LBS	Opening Size:	0.0'' Dia.	(Round)
Top Slab(w/opng deduct)=	13,341 LBS	**OR**	109.0''L x 109.0''W	(Rectangular)
Walls=	30,938 LBS		(Equivalent area removed)	
Base Slab=	22,500 LBS			
Soil Over Extension=	0 LBS	Base Extension=	0.0''	
Soil Wedge=	0 LBS			
Other=	12,017 LBS	(Baffles)		
Total Downward Force=	**78,796 LBS**			

Net Buoyancy Reaction= **9,766 LBS**

Buoyancy Safety Factor= **1.1** **OK**

INSTALLATION

MWS – Linear

Hybrid Stormwater Filtration System

Bio Clean

A Forterra Company

Bio Clean
398 Via El Centro
Oceanside, CA 92058

www.BioCleanEnvironmental.com
P 855-566-3938
F 760-433-3179

Installation Guidelines for Modular Wetland System

Delivery & Unloading/Lifting

1. Bio Clean shall deliver the unit(s) to the site in coordination with the Contractor.

2. The Contractor will require spreader bars and chains/cables to safely and securely lift the main structure, risers a set of suitable lifting hooks, knuckles, shackles and eye bolts.

3. The main structure and lid can be lifted together or separately.

   Please see Modular Wetland Weights and Lifting Details. Contact Bio Clean for additional lifting details.

Inspection

1. Inspection of the Modular Wetland unit and all parts contained in or shipped outside of the unit shall be inspected at time of delivery by the site Engineer/Inspector and the Contractor. Any non-conformance to approved drawings or damage to any part of the system shall be documented on the Modular Wetland shipping ticket. Damage to the unit during and after unloading shall be corrected at the expense of the Contractor. Any necessary repairs to the Modular Wetland unit shall be made to the acceptance of the Engineer/Inspector.

Site Preparation

1. The Contractor is responsible for providing adequate and complete site/inlet protection when the Modular Wetland unit is installed prior to final site stabilization (full landscaping, grass cover, final paving, and street sweeping completed).

2. The Contractor shall adhere to all jurisdictional and/or OSHA safety rules in providing temporary shoring of the excavation.

3. The Contractor or Owner is responsible for appropriately barricading the Modular Wetland unit from traffic (in accordance with local codes).

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Installation Guidelines for Modular Wetland System

Installation

1. Each unit shall be constructed at the locations and elevations according to the sizes shown on the approved drawings. Any modifications to the elevation or location shall be at the direction of and approved by the Engineer.

2. The unit shall be placed on the compacted sub-grade with a minimum 6-inch gravel base matching the final grade of the curb line in the area of the unit. The unit is to be placed such that the unit and top slab match the grade of the curb in the area of the unit. Compact undisturbed sub-grade materials to 95% of maximum density at +1% to 2% of the optimum moisture. Unsuitable material below sub-grade shall be replaced to site engineer's approval. Please see Modular Wetlands Weights and Lifting Details. Contact Bio Clean for guidance where slope exceeds 0.5%.

3. Once the unit is set, the internal wooden forms and protective silt fabric cover must be left intact (if WetlandMedia pre-installed). The top lid(s) should be sealed onto the box section before backfilling, using a non-shrink grout, butyl rubber or similar waterproof seal. The boards on the top of the lid and boards sealed in the unit's throat must NOT be removed. The Supplier will remove these sections at the time of activation.

4. Outlet connections shall be aligned and sealed to meet the approved drawings with modifications necessary to meet site conditions and local regulations. The correct outlet will be marked on the Modular Wetland unit.

5. Backfilling should be performed in a careful manner, bringing the appropriate fill material up in 6-inch lifts on all sides. Precast sections shall be set in a manner that will result in a watertight joint. In all instances, installation of the Modular Wetland unit shall conform to ASTM specification C891 "Standard Practice for Installation of Underground Precast Utility Structures" unless specified otherwise in contract documents.

6. It is the responsibility of the Contractor to provide curb and gutter and transition to the Modular Wetland unit for proper stormwater flow into the system through the throat, pipe or grate opening. A standard drawing of the throat and gutter detail is available in the following section; however the plans and contract documents supersede all standard drawings. Several variations of the standard design are available. Effective bypass for the Modular Wetland System is essential for correct operation (i.e. bypass to an overflow at lower elevation).

Installation Procedure

The contractor **MUST** provide all rigging And lifting apparatus, such as all cables, chains or straps and a set of lifting hooks, shackles, knuckles and eye bolts.

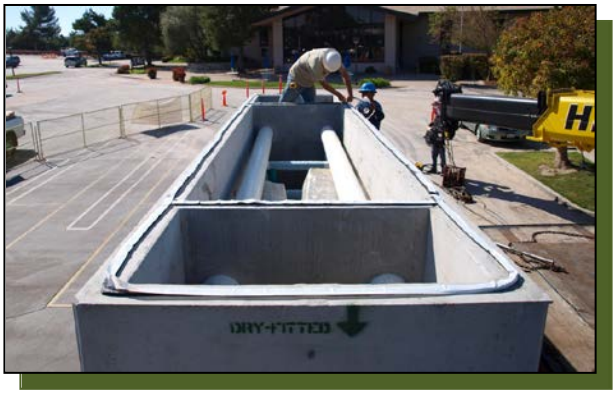
It is the contractor's responsibility to provide suitable lifting equipment to off-load the Modular Wetland unit.

Modular Wetland units are designed to be off-loaded using the contractor's spreader bar.

1. Apply Butyl Tape Seal

Apply butyl tape seal along the top of the box section. Butyl tape seal is provided with every unit.

Modular Wetland installed protective throat board and installed silt fabric must be left in place to protect the unit from construction sediment.



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2. Unload and Set Box

Unload the Modular Wetland unit
the prepared hole with appropriate sub-grade.*

* Compacted sub-grade with a minimum
of six inches of gravel base which must match
the final grade of curb line the area of the unit.

3. Set Top On Box

Set the top slab on the box.

The Contractor is responsible for providing
adequate and complete site/inlet protection
when the Modular Wetland is installed prior
to final site stabilization (full landscaping,
grass cover, final paving, and street sweeping
completed).

4. Connect Outfall Pipe

The correct outlet will be marked on the
Modular Wetland.

Invert of outlet pipe **MUST** be even
with the floor of the system.

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5. Install Curb & Gutter

It is the responsibility of the Contractor to provide curb and gutter and transition to the Modular Wetland for proper flow into the system through a 5”- 7” throat opening. A standard drawing of the throat and gutter detail in the following section. CONTRACTOR RESPONSIBLE FOR GROUTING IN ANY VISIBLE LIFTING POINTS.

6. Activation

Activation is performed **ONLY** by Bio Clean personnel.

Activation can occur once the project site is fully stabilized (full landscaping, grass cover, final paving and street sweeping completed) and there is a 5” - 7” throat opening.

Call 855-566-3938 to schedule your activation.

NOTE: WetlandMedia Installation

For Larger models (MWS-L-4-13 and above) the system will be delivered without WetlandMedia pre-installed to minimize pick weight and prevent contamination of the media during construction. For these models the WetlandMedia will be delivered in bulk or in super sacks. It will be responsibility of the contractor to fill the system with the WetlandMedia during the installation process. Installation of the WetlandMedia can be done after the unit is fully installed to avoid contamination. See following pages for details.

WetlandMedia Install (if applicable)

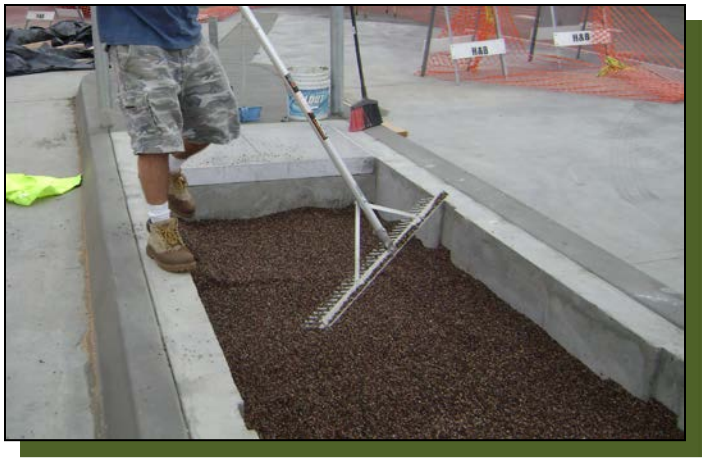
1. Fill WetlandMedia

Position super sack of WetlandMedia over wetland chamber. Bottom of sack should not be more than 2' above top of system. Open sack and fill evenly*.

* One to several hundred cubic yards of WetlandMedia will be required based upon the model number and size of the system. For large scale jobs WetlandMedia will be delivered in bulk and will require a bobcat of similar to fill the system. All equipment is the responsibility of the contractor.

2. Install Plant Propagation Layer

Fill WetlandMedia up to 9" below the top of the wetland chamber. Level out the WetlandMedia as shown. Ensure that the level does not vary more than one inch or plant growth will be affected.



3. Install Plant Propagation Layer

Utilize plant propagation blocks provided by the manufacturer. Each block is approximately 40" by 6" by 3" thick. Blocks shall be placed side by side and end to end and cover the entire length and width of the wetland chamber unless specified.

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4. Finish Filling WetlandMedia

After plant propagation blocks are installed repeat step 1 and fill the system to the top of the wetland chamber as shown. WetlandMedia must be filled within 2” of the top of the unit.

5. Planting

After system is filled with WetlandMedia planting of vegetation can begin. Utilizing 1 gallon plants dig down until The plant propagation blocks are reached. Remove plant and it’s root ball from the container. Set the bottom of the root ball on the tops of the blocks. Fill hole back in with WetlandMedia. After planting a thorough watering of the plants is necessary. The plant propagation blocks must be saturated to provide a water source for the plants during the establishment phase. It is recommended that hand watering is done three times a week for the first two months. Hand water can be supplemented with drip or spray irrigation after the second week. Please call the manufacturer for more details on plants, planting arrangement and irrigation options.

NOTE: planting is required on all units, including units delivered with WetlandMedia pre-installed.

PLANT PROPAGATION LAYER INSTALL

MWS-LINEAR 2.0

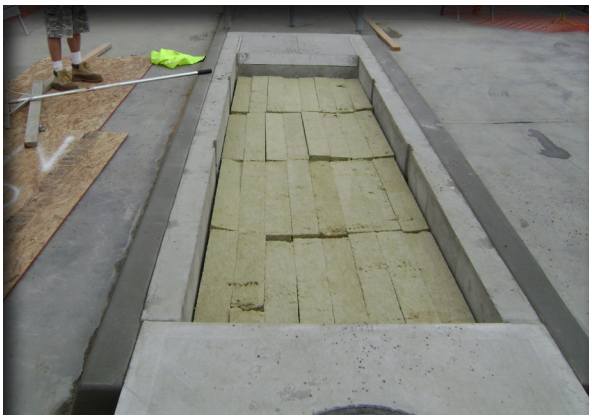
Patented Process: Ensures plant growth and establishment

Modular Wetland System Linear 2.0 (MWS-L 2.0) utilizes an advanced “organic free” biofiltration media called WetlandMedia. The nutrients needed for initial plant establishment are already present in the soil contained within the pot which the vegetation is removed from before planting. To enusre rapid and successful plant establishment a patented layer of “plant propagation” media is installed 6” below the surface. When vegetation is installed in the system the root ball of the plant is set on this layer of propagation media. This media holds large amounts of moisture and provides the optimal water/air ratio for rapid root penentration. Once the plant as established it will shoot roots through propagation media to the biofiltration media below. This media contains high amounts of silica which is necessary for root establishment and plant growth rates. The passing stormwater entering the system will provide the long term nutrient source for the plants.

Instructions for Installation:

STEP 1
Fill up biofiltration media to 9” below top of unit. Even out media so it’s flat.

STEP 2
Place 3” thick plant propagation meda over the biofiltration media.



STEP 3
Cover entire chamber with propagation media.

STEP 4
Continue filling chamber to the top with biofiltration media.

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Oceanside, CA 92058

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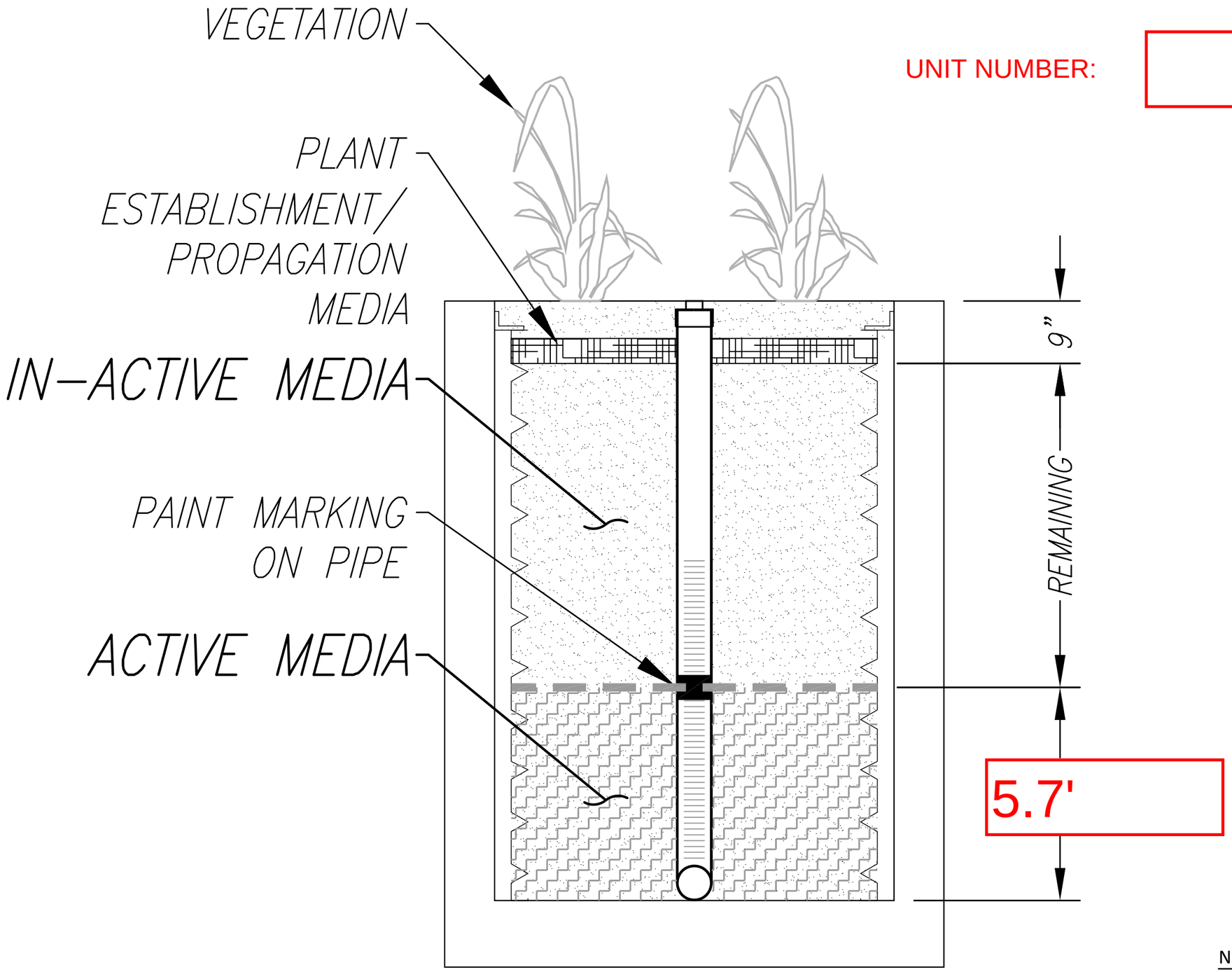
UNIT NUMBER:



NOT TO SCALE

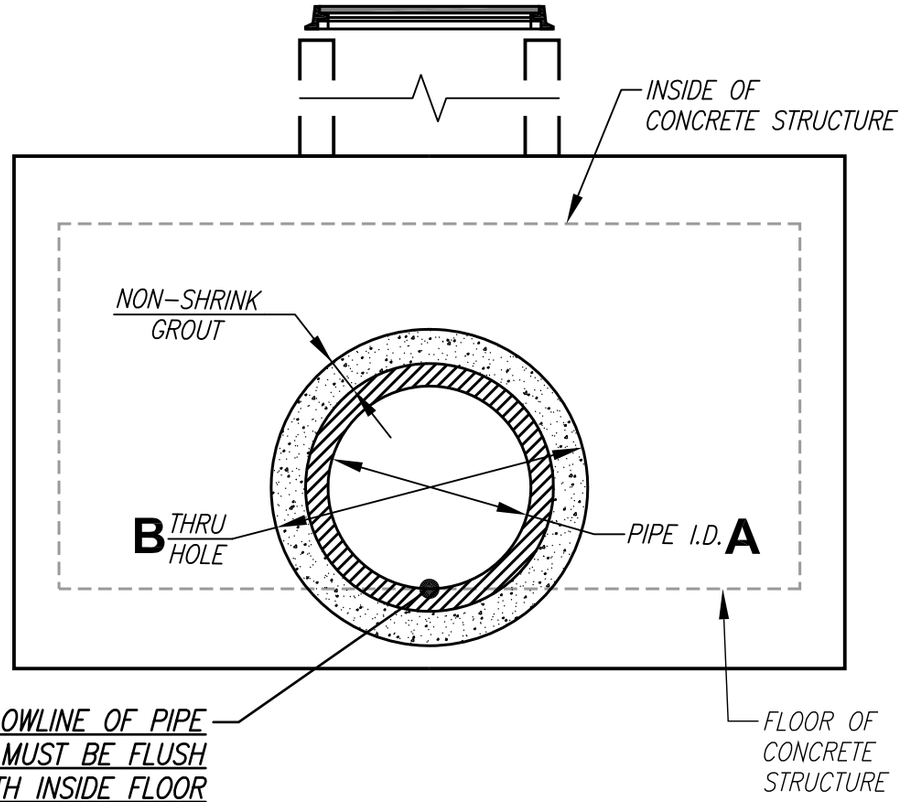
MODULAR WETLANDS
www.ModularWetlands.com | (855) 5MOD-WET

ACTIVE MEDIA FILL
STANDARD DETAIL

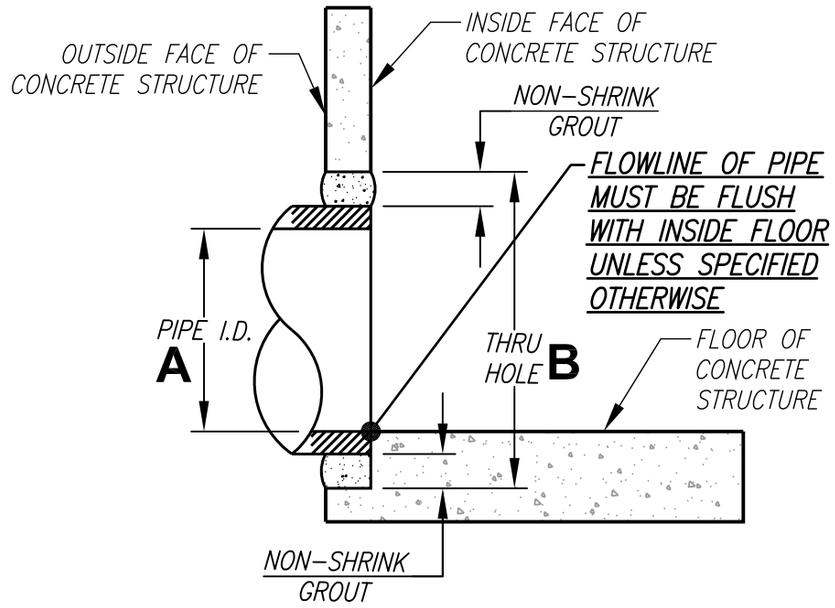
1/26/17/HAYDEN

Connection Details

Bio Clean
P. 855-566-3938
F. 760-433-3176
E. Info@BioCleanEnvironmental.com



END VIEW



ELEVATION VIEW

INSTALLATION NOTES

1. ALL CONNECTION PIPES SUPPLIED AND INSTALLED BY CONTRACTOR. MODULAR WETLAND UNIT WILL BE DELIVERED WITH A THRU HOLE AND ITS THE CONTRACTORS RESPONSIBILITY TO SUPPLY PIPE, AND ALL LABOR AND MATERIAL TO CONNECT PIPE AND SEAL UNIT WATER TIGHT INCLUDING BUT NOT LIMITED TO GROUT, CONCRETE LUG, REBAR, PLUG, ANCHORS, COUPLER, FITTINGS AND/OR ALL SUPPORT AND CONNECTING HARDWARE.
2. ALL CONNECTIONS ARE TO BE FLUSH WITH THE INSIDE SURFACE OF THE CONCRETE STRUCTURE. (CAN NOT INTRUDE BEYOND FLUSH) ALL PIPE FLOWLINES SHALL BE FLUSH WITH INSIDE FLOOR UNLESS SPECIFIED OTHERWISE.
3. ALL GROUT AND/OR CONCRETE SHALL BE NON–SHRINK AND MEET OR EXCEED LOCAL PIPE CONNECTION STANDARDS.
4. REFER TO AGENCY SPECIFICATIONS WHERE APPLICABLE.
5. IF CONNECTING TO AN EXISTING PIPE CONTRACTOR MUST POT HOLE PIPE AND VERIFY EXISTING PIPE CONNECTION ELEVATION PRIOR TO APPROVING MODULAR WETLAND SUBMITTALS.

PIPE THRU HOLE NOTE:

ALL UNITS WITH PRECAST THRU HOLES WILL HAVE THE GIVEN THRU HOLE DIAMETER PER THE PRECAST THRU HOLE CHART HERON. IF A DIFFERENT THRU HOLE SIZE IS REQUIRED IT MUST BE CLEARLY MARKED ON THE APPROVED SUBMITTALS.

PRECAST THRU HOLE CHART

A PIPE INSIDE DIAMETER (INCHES)	B THRU HOLE DIAMETER (INCHES)
4	8
6	10
8	14
10	16
12	18
15	21
18	26
24	33
30	41
36	48
42	56
48	64

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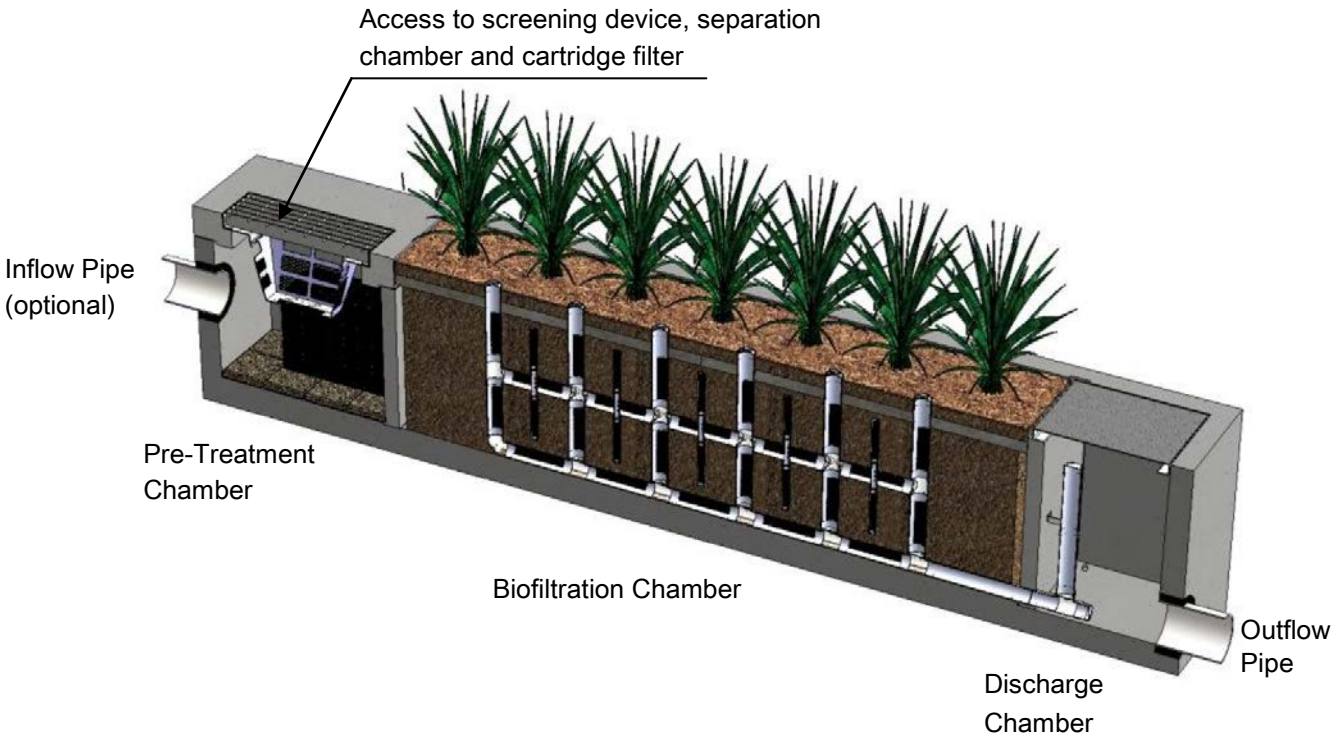
PIPE CONNECTION
STANDARD DETAIL

Maintenance Guidelines for Modular Wetland System - Linear

Maintenance Summary

- Remove Sediment from Separation Chamber – average maintenance interval is 12 to 24 months.
  - (*10 minute average service time*).
- Replace Cartridge Filter Media – average maintenance interval 12 to 24 months.
  - (*10-15 minute per cartridge average service time*).
- Trim Vegetation – average maintenance interval is 6 to 12 months.
  - (*Service time varies*).

System Diagram



Maintenance Procedures

Separation Chamber

1. Perform maintenance procedures of screening device listed above before maintaining the separation chamber.
2. With a pressure washer spray down pollutants accumulated on walls and cartridge filters.
3. Vacuum out Separation Chamber and remove all accumulated pollutants. Replace screening device, grate or manhole cover when completed.

Cartridge Filters

1. Perform maintenance procedures on screening device and separation chamber before maintaining cartridge filters.
2. Enter separation chamber.
3. Unscrew the two bolts holding the lid on each cartridge filter and remove lid.
4. Remove each of 4 to 8 media cages holding the media in place.
5. Spray down the cartridge filter to remove any accumulated pollutants.
6. Vacuum out old media and accumulated pollutants.
7. Reinstall media cages and fill with new media from manufacturer or outside supplier. Manufacturer will provide specification of media and sources to purchase.
8. Replace the lid and tighten down bolts. Replace screening device, grate or manhole cover when completed.

Maintenance Notes

1. Following maintenance and/or inspection, it is recommended the maintenance operator prepare a maintenance/inspection record. The record should include any maintenance activities performed, amount and description of debris collected, and condition of the system and its various filter mechanisms.

2. The owner should keep maintenance/inspection record(s) for a minimum of five years from the date of maintenance. These records should be made available to the governing municipality for inspection upon request at any time.

3. Transport all debris, trash, organics and sediments to approved facility for disposal in accordance with local and state requirements.

4. Entry into chambers may require confined space training based on state and local regulations.

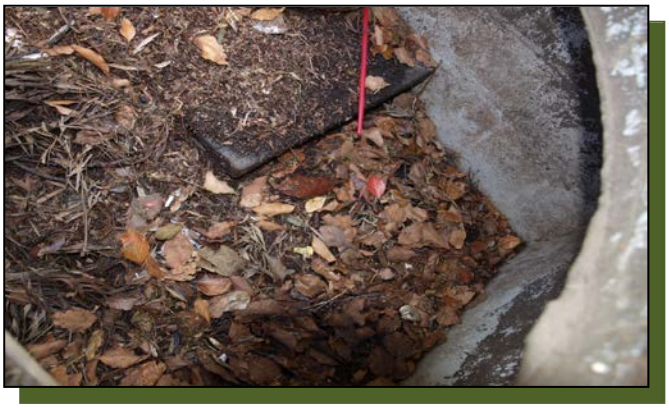
5. No fertilizer shall be used in the Biofiltration Chamber.

6. Irrigation should be provided as recommended by manufacturer and/or landscape architect. Amount of irrigation required is dependent on plant species. Some plants may require irrigation.

Maintenance Procedure Illustration

Separation Chamber

The separation chamber is located directly beneath the screening device. It can be quickly cleaned using a vacuum truck or by hand. A pressure washer is useful to assist in the cleaning process.



Cartridge Filters

The cartridge filters are located in the Pre-Treatment chamber connected to the wall adjacent to the biofiltration chamber. The cartridges have removable tops to access the individual media filters. Once the cartridge is open media can be easily removed and replaced by hand or a vacuum truck.

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Trim Vegetation

Vegetation should be maintained in the same manner as surrounding vegetation and trimmed as needed. No fertilizer shall be used on the plants. Irrigation per the recommendation of the manufacturer and or landscape architect. Different types of vegetation requires different amounts of irrigation.

Maintenance Report

Bio Clean
P. 855-566-3938
F. 760-433-3176
E. Info@BioCleanEnvironmental.com

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Cleaning and Maintenance Report
Modular Wetlands System

Project Name _____

Project Address _____
(city) (Zip Code)

Owner / Management Company _____

Contact _____ Phone ( ) –

Inspector Name _____ Date ____/____/____ Time _____ AM / PM

Type of Inspection ☐ Routine ☐ Follow Up ☐ Complaint ☐ Storm Storm Event in Last 72-hours? ☐ No ☐ Yes

Weather Condition _____ Additional Notes _____

For Office Use Only
(Reviewed By)
(Date)
Office personnel to complete section to the left.

Site Map #	GPS Coordinates of Insert	Manufacturer / Description / Sizing	Trash Accumulation	Foliage Accumulation	Sediment Accumulation	Total Debris Accumulation	Condition of Media 25/50/75/100 (will be changed @ 75%)	Operational Per Manufactures' Specifications (If not, why?)
	Lat: Long:	MWS Catch Basins						
		MWS Sedimentation Basin						
		Media Filter Condition						
		Plant Condition						
		Drain Down Media Condition						
		Discharge Chamber Condition						
		Drain Down Pipe Condition						
		Inlet and Outlet Pipe Condition						

Comments:

398 Via El Centro, Oceanside, CA 92058 P. 855-566-3938 F. 760.433.3176

Inspection Form

Bio Clean
P. 855-566-3938
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E. Info@BioCleanEnvironmental.com

Bio Clean
A Forterra Company

Inspection Report
Modular Wetlands System

Project Name _____

Project Address _____
(city) (Zip Code)

Owner / Management Company _____

Contact _____ Phone ( ) –

Inspector Name _____ Date ___/___/___ Time _____ AM / PM

Type of Inspection ☐ Routine ☐ Follow Up ☐ Complaint ☐ Storm Storm Event in Last 72-hours? ☐ No ☐ Yes

Weather Condition _____ Additional Notes _____

For Office Use Only
(Reviewed By)
(Date)
Office personnel to complete section to the left.

Inspection Checklist

Modular Wetland System Type (Curb, Grate or UG Vault): _____ Size (22', 14' or etc.): _____

Structural Integrity:	**Yes**	**No**	**Comments**
Damage to pre-treatment access cover (manhole cover/grate) or cannot be opened using normal lifting pressure?			
Damage to discharge chamber access cover (manhole cover/grate) or cannot be opened using normal lifting pressure?			
Does the MWS unit show signs of structural deterioration (cracks in the wall, damage to frame)?			
Is the inlet/outlet pipe or drain down pipe damaged or otherwise not functioning properly?			
Working Condition:			
Is there evidence of illicit discharge or excessive oil, grease, or other automobile fluids entering and clogging the unit?			
Is there standing water in inappropriate areas after a dry period?			
Is the filter insert (if applicable) at capacity and/or is there an accumulation of debris/trash on the shelf system?			
Does the depth of sediment/trash/debris suggest a blockage of the inflow pipe, bypass or cartridge filter? If yes, specify which one in the comments section. Note depth of accumulation in in pre-treatment chamber.			Depth:
Does the cartridge filter media need replacement in pre-treatment chamber and/or discharge chamber?			Chamber:
Any signs of improper functioning in the discharge chamber? Note issues in comments section.			
Other Inspection Items:			
Is there an accumulation of sediment/trash/debris in the wetland media (if applicable)?			
Is it evident that the plants are alive and healthy (if applicable)? Please note Plant Information below.			
Is there a septic or foul odor coming from inside the system?			

Waste:	**Yes**	**No**
Sediment / Silt / Clay		
Trash / Bags / Bottles		
Green Waste / Leaves / Foliage		

Recommended Maintenance	
No Cleaning Needed	
Schedule Maintenance as Planned	
Needs Immediate Maintenance	

Plant Information	
Damage to Plants	
Plant Replacement	
Plant Trimming	

Additional Notes: _____

398 Via El Centro, Oceanside, CA 92058 P. 855-566-3938 F. 760.433.3176

Section [_____]
Modular Subsurface Flow Wetland System

PART 1 – GENERAL

01.01.00 Purpose
The purpose of this specification is to establish generally acceptable criteria for Modular Subsurface Flow Wetland Systems used for biofiltration of stormwater runoff including dry weather flows and other contaminated water sources. It is intended to serve as a guide to producers, distributors, architects, engineers, contractors, plumbers, installers, inspectors, agencies and users; to promote understanding regarding materials, manufacture and installation; and to provide for identification of devices complying with this specification.

01.02.00 Description
Modular Subsurface Flow Wetland Systems (MSFWS) are used for filtration of stormwater runoff including dry weather flows. The MSFWS is a pre-engineered biofiltration system composed of a pretreatment chamber containing filtration cartridges, a horizontal flow biofiltration chamber with a peripheral void area and a centralized and vertically extending underdrain, the biofiltration chamber containing a sorptive media mix which does not contain any organic material and a layer of plant establishment media, and a discharge chamber containing an orifice control structure . Treated water flows horizontally in series through the pretreatment chamber cartridges, biofiltration chamber and orifice control structure.

01.03.00 Manufacturer
The manufacturer of the MSFWS shall be one that is regularly engaged in the engineering design and production of systems developed for the treatment of stormwater runoff for at least (10) years, and which have a history of successful production, acceptable to the engineer of work. In accordance with the drawings, the MSFWS(s) shall be a filter device Manufactured by Bio Clean or assigned distributors or licensees. Bio Clean can be reached at:

Corporate Headquarters:
Bio Clean
398 Via El Centro
Oceanside, CA 92058
Phone: (855) 566-3938
Fax: (760) 433-3176
www.biocleanenvironmental.com

01.04.00 Submittals

01.04.01 Shop drawings are to be submitted with each order to the contractor and consulting engineer.

01.04.02 Shop drawings are to detail the MSFWS and all components required and the sequence for installation, including:

- System configuration with primary dimensions
- Interior components
- Any accessory equipment called out on shop drawings

01.04.03 Inspection and maintenance documentation submitted upon request.

01.05.00 Work Included

01.05.01 Specification requirements for installation of MSFWS.

01.05.02 Manufacturer to supply components of the MSFWS(s):

- Pretreatment chamber components (pre-assembled)
- Concrete Structure(s)
- Biofiltration chamber components (pre-assembled)
- Flow control discharge structure (pre-assembled)

01.06.00 Reference Standards

ASTM C 29	Standard Test Method for Unit Weight and Voids in Aggregate
ASTM C 88	C 88 Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C131	C 131 Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregates by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	C 136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 330	C 330 Standard Specification for Lightweight Aggregate for Structural Concrete
ASTM D 698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft.-lbf/ft3 (600 kN-m/m3)
ASTM D 1621	10 Standard Test Method for Compressive Properties Of Rigid Cellular Plastics
ASTM D 1777	ASTM D1777 - 96(2007) Standard Test Method for Thickness of Textile Materials
ASTM D 4716	Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
AASHTO T 99-01	Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in) Drop
AASHTO T 104	Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
AASHTO T 260	Standard Method of Test for Sampling and Testing for Chloride Ion in Concrete and Concrete Raw Materials.
AASHTO T 288	Standard Method of Test for Determining Minimum Laboratory Soil Resistivity
AASHTO T 289	Standard Method of Test for Determining ph of Soil for Use in Corrosion Testing
AASHTO T 291	Standard Method of Test for Determining Water Soluble Chloride Ion Content in Soil
AASHTO T 290	T 290 Standard Method of Test for Determining Water Soluble Sulfate Ion Content in Soil

PART 2 – COMPONENTS

The Modular Subsurface Flow Wetland Systems (MSFWS) and all of its components shall be self-contained within a concrete structure constructed of concrete with a minimum 28 day compressive strength of 5,000 psi, with reinforcing per ASTM A 615, Grade 60, and supports and H20 loading as indicated by AASHTO. Each Chamber shall have appropriate access hatches for easy maintenance and sized to allow removal of all internal components without disassembly. All water transfer system components shall conform with the following;

- Filter netting shall be 100% Polyester with a number 16 sieve size, and strength tested per ASTM D 3787.
- Drainage cells shall be manufactured of lightweight injection-molded plastic and have a minimum compressive strength test of 6,000 psi and a void area along the surface making contact with the filter media of 75% or greater. The cells shall be at least 2" in thickness and allow water to freely flow in all four directions.

02.01.00 Pretreatment Chamber Components

02.01.01 Filter Cartridges shall operate at a loading rate not to exceed 3 gallons per minute per square foot surface area.

02.02.00 Biofiltration Chamber Components

02.02.01 Media shall consist of ceramic material produced by expanding and vitrifying select material in a rotary kiln. Media must be produced to meet the requirements of ASTM C330, ASTM C331, and AASHTO M195. Aggregates must have a minimum 24-hour water absorption of 10.5% mass. Media shall not contain any organic material. Flow through media shall be horizontal from the outer perimeter of the chamber toward the centralized and vertically extending underdrain. The retention time in the media shall be at least 3 minutes. Downward flow filters are not acceptable alternatives. The thickness of the media shall be at least 19" from influent end to effluent end. The loading rate on the media shall not exceed 1.1 gallons per minute per square foot surface area. Media must be contained within structure that spaces the surface of the media at least 2" from all vertically extending walls of the concrete structure.

02.02.02 Planting shall be native, drought tolerant species recommend by manufacturer and/or landscape architect.

02.02.03 Plant Support Media shall be made of a 3" thick moisture retention cell that is inert and contains no chemicals or fertilizers, is not made of organic material and has an internal void percentage of 80%.

02.03.00 Discharge Chamber

The discharge device shall house a flow control orifice plate that restricts flows greater than designed treatment flow rate. All piping components shall be made of a high-density polyethylene.

PART 3 – PERFORMANCE

03.01.00 General

03.01.01 Function - The MSFWS has no moving internal components and functions based on gravity flow, unless otherwise specified. The MSFWS is composed of a pretreatment chamber, a biofiltration chamber and a discharge chamber. The pretreatment device houses cartridge media filters, which consist of filter media housed in a perforated enclosure. The untreated runoff flows into the system via subsurface piping and or surface inlet. Water entering the system is forced through the filter cartridge enclosures by gravity flow. Then the flow contacts the filter media. The flow through the media is horizontal toward the center of each individual media filter. In the center of the media shall be a round slotted PVC pipe of no greater than 1.5" in diameter. The slotted PVC pipe shall extend downward into the water transfer cavity of the cartridge. The slotted PVC pipe shall be threaded on the bottom to connect to the water transfer cavity. After pollutants have been removed by the filter media the water discharges the pretreatment chamber and flows into the water transfer system and is conveyed to the biofiltration chamber. Once runoff has been filtered by the biofiltration chamber it is collected by the vertical underdrain and conveyed to a discharge chamber equipped with a flow control orifice plate. Finally the treated flow exits the system.

03.01.02 Pollutants - The MSFWS will remove and retain debris, sediments, TSS, dissolved and particulate metals and nutrients including nitrogen and phosphorus species, bacteria, BOD, oxygen demanding substances, organic compounds and hydrocarbons entering the filter during frequent storm events and continuous dry weather flows.

03.01.03 Treatment Flow Rate and Bypass - The MSFWS operates in-line. The MSFWS will treat 100% of the required water quality treatment flow based on a minimum filtration capacities listed in section 03.02.00. The size of the system must match those provided on the drawing to ensure proper performance and hydraulic residence time.

Minimum Treatment Capabilities

• System must be capable of treating flows to the specified treatment flow rate on the drawings. The flow rate shall be controlled by an orifice plate.

PART 4 - EXECUTION

04.01.00 General

The installation of the MSFWS shall conform to all applicable national, state, state highway, municipal and local specifications.

04.02.00 Installation

The Contractor shall furnish all labor, equipment, materials and incidentals required to install the (MSFWS) device(s) and appurtenances in accordance with the drawings and these specifications.

04.02.01 Grading and Excavation site shall be properly surveyed by a registered professional surveyor, and clearly marked with excavation limits and elevations. After site is marked it is the responsibility of the contractor to contact local utility

companies and/or DigAlert to check for underground utilities. All grading permits shall be approved by governing agencies before commencement of grading and excavation. Soil conditions shall be tested in accordance with the governing agencies requirements. All earth removed shall be transported, disposed, stored, and handled per governing agencies standards. It is the responsibility of the contractor to install and maintain proper erosion control measures during grading and excavation operations.

04.02.02 Compaction – All soil shall be compacted per registered professional soils engineer's recommendations prior to installation of MSFWS components.

04.02.03 Backfill shall be placed according to a registered professional soils engineer's recommendations, and with a minimum of 6" of gravel under all concrete structures.

04.02.04 Concrete Structures – After backfill has been inspected by the governing agency and approved the concrete structures shall be lifted and placed in proper position per plans.

04.02.05 Subsurface Flow Wetland Media shall be carefully loaded into area so not to damage the Wetland Liner or Water Transfer Systems. The entire wetland area shall be filled to a level 9 inches below finished surface.

04.02.06 Planting layer shall be installed per manufacturer's drawings and consist of a minimum 3" grow enhancement media that ensures greater than 95% plant survival rate, and 6" of wetland media. Planting shall consist of native plants recommended by manufacturer and/or landscape architect. Planting shall be drip irrigated for at least the first 3 months to insure long term plant growth. No chemical herbicides, pesticides, or fertilizers shall be used in the planting or care and maintenance of the planted area.

04.03.00 Shipping, Storage and Handling

04.03.01 Shipping – MSFWS shall be shipped to the contractor's address or job site, and is the responsibility of the contractor to offload the unit(s) and place in the exact site of installation.

04.03.02 Storage and Handling– The contractor shall exercise care in the storage and handling of the MSFWS and all components prior to and during installation. Any repair or replacement costs associated with events occurring after delivery is accepted and unloading has commenced shall be born by the contractor. The MSFWS(s) and all components shall always be stored indoors and transported inside the original shipping container until the unit(s) are ready to be installed. The MSFWS shall always be handled with care and lifted according to OSHA and NIOSA lifting recommendations and/or contractor's workplace safety professional recommendations.

04.04.00 Maintenance and Inspection

04.04.01 Inspection – After installation, the contractor shall demonstrate that the MSFWS has been properly installed at the correct location(s), elevations, and with appropriate components. All components associated with the MSFWS and its installation shall be subject to inspection by the engineer at the place of installation. In addition, the contractor shall demonstrate that the MSFWS has been installed per the manufacturer's specifications and recommendations. All components shall be inspected by a qualified person once a year and results of inspection shall be kept in an inspection log.

04.04.02 Maintenance – The manufacturer recommends cleaning and debris removal maintenance of once a year and replacement of the Cartridge Filters as needed. The maintenance shall be performed by someone qualified. A Maintenance Manual is available upon request from the manufacturer. The manual has detailed information regarding the maintenance of the MSFWS. A Maintenance/Inspection record shall be kept by the maintenance operator. The record shall include any maintenance activities preformed, amount and description of debris collected, and the condition of the filter.

04.04.03 Material Disposal - All debris, trash, organics, and sediments captured by the MSFWS shall be transported and disposed of at an approved facility for disposal in accordance with local and state requirements. Please refer to state and local regulations for the proper disposal of toxic and non-toxic material.

PART 5 – QUALITY ASSURANCE

05.01.00 Warranty

The Manufacturer shall guarantee the MSFWS against all manufacturing defects in materials and workmanship for a period of (5) years from the date of delivery to the _____. The manufacturer shall be notified of repair or replacement issues in writing within the warranty period. The MSFWS is limited to recommended application for which it was designed.

05.02.00 Performance Certification

The MSFWS manufacturer shall submit to the Engineer of Record a “Manufacturer’s Performance Certificate” certifying the MSFWS is capable of achieving the specified removal efficiency for suspended solids, phosphorous and dissolved metals.