

16<sup>th</sup> Oct, 2020

Mr. Jaime Favila  
California State Water Resources Control Board  
Division of Water Quality  
P.O. Box 100  
Sacramento, CA 95812-100

**Re: Application for Trash Treatment Control Device – First Defense® High Capacity Screened**

Dear Mr. Favila,

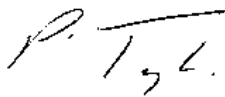
Hydro International® is pleased to submit this application for the First Defense® High Capacity Screened (HCS) for Certification as a Full Capture System - Trash Treatment Control Device.

Documentation for this application is being submitted in accordance with the California State Water Resources Control Board *Trash Treatment Control Device Application Requirements* document that includes the following minimum required sections:

1. Cover Letter
2. Table of Contents
3. Physical Description
4. Installation Guidance
5. Operation and Maintenance Information
6. Vector Control Accessibility
7. Reliability Information
8. Field/Lab Testing Information and Analysis

Please contact me with any questions or should additional information be required. Thank you for your consideration of this application.

Regards,



Phillip Taylor  
Technical Product Manager  
Hydro International®

## 1.0 COVER LETTER

### a. Product Name and General Description

**Name:** First Defense® High Capacity Full Trash Capture Device (FDHC FTC)

The FDHC FTC is designed to remove sediment, trash, and free-floating hydrocarbons from stormwater when installed as part of typical stormwater drainage network system. The Device is able to provide full trash capture as defined by treating the 1 year 1 hour, and meet vector control accessibility requirements.

The FDHC FTC has patented flow-modifying internal components that create a swirling flow path within the treatment chamber, which serves to enhanced pollution removal performance. Screens are used on the weirs and over the outlet chute to capture trash greater than 5 mm.

The FDHC FTC's internal components are installed in a precast concrete manhole with models sized of 3, 4, 5, 6, 8 & 10 ft diameters. The internal components are rotationally molded high-density polyethylene (HDPE), stainless steel screens and hardware.

The screens utilized in the FDHC FTC are made from stainless steel mesh with an opening aperture that does not exceed 4.7mm in size.

Manhole covers will provide direct access to the screens and internal clean out shaft in the center of the unity to facilitate easy inspection and cleaning from the surface.

### b. Device Owner

**Company:**

Hydro International®  
Mark Dennis  
Interim General Manager - Americas Stormwater  
Hydro International®  
94 Hutchins Drive  
Portland, ME 04102  
[mdennis@hydro-int.com](mailto:mdennis@hydro-int.com)  
P: +1 423-580-4629

**Contact:**

Phillip Taylor, CPSWQ  
Technical Product Manager  
Hydro International®  
94 Hutchins Drive  
Portland, Maine 04102  
(207) 756-6200  
[ptaylor@hydro-int.com](mailto:ptaylor@hydro-int.com)

**Authorized Representative:**

Phil O'Neill  
Regional Sales Manager – Hydro International®

109 First Street  
Solvang, California 93463  
(805) 350-8163  
[poneill@hydro-int.com](mailto:poneill@hydro-int.com)

**c. Website**

<https://www.hydro-int.com/en/products/first-defense>

**d. Manufacturing Locations**

Hydro International® utilizes a combination of contract manufacturers and component suppliers to produce stormwater treatment systems. These partner facilities are located throughout the United States and Hydro International® selects the facility used based on proximity to the project as well as other factors. The facilities utilized for any specific project are selected to provide the most cost effective and convenient solution. Hydro International® currently retains over 60 partner manufacturing facilities.

Four facilities currently provide support for the California market, located in San Diego, Santa Maria, Simi Valley, and Pleasanton.

**e. Testing**

The FDHC FTC is an adaption of the First Defense® HC system and has not been tested with the screens in place. The screens provide a trash capture ability and the hydraulic capacity of the screens have been calculated mathematically based on the flow characteristics of the screen and the area provided. These calculations include calculations for full flow, 25%, 50%, and 75% blinding of the screens and the corresponding flow rates that can be treated without bypass.

**f. Device Limitations, Operational, Sizing, and Maintenance Considerations**

The FDHC FTC is designed to operate as part of a stormwater system in design limitations include, peak stormwater flows for online and offline use, pipe sizes, expected pollutant loads, access for maintenance, etc. These are common engineering consideration for all stormwater treatment systems and no special considerations unique to the FDHC FTC are needed.

Sizing is based on 2 primary considerations, treatment flow and peak flow. In most cases the internal bypass capacity is adequate to handle the peak flow when the unit is sized based on the water quality storm flow. Should the peak flow or pipe sizes, be larger than can be accommodated by the device selected based on the water quality flow, an offline configuration can be used.

The FDHC FTC is a passive system requiring no operational input, other than the regular inspection and maintenance as typically required in a site's stormwater management plan.

Normal operation and maintenance necessitate no entry into the Device, all maintenance functions can be and should be performed from the surface. Adherence to Hydro International® design recommendations will ensure operation is within the design limits of the FDHC FTC.

All screens, inlet and outlet pipes, sump, and treatment areas can be inspected from the surface and directly accessed without removal of any internal components. Vector control inspection can be accomplished and any necessary treatment done without visual or access obstruction.


No special equipment is needed to maintain the device.

**g. Existing Installations**

There are no current installations of the FDHC FTC device.

**h. The certification below:**

*I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons that manage the system or those persons directly responsible for gathering the information, to the best of my knowledge and belief, the information submitted is, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.*



---

Mark Dennis, Managing Director – Hydro International

7-7-20

Date

THIS PAGE INTENTIONALLY LEFT BLANK

## 2.0 TABLE OF CONTENTS

### Contents

1.0	COVER LETTER.....	2
a.	Product Name and General Description .....	2
b.	Device Owner.....	2
c.	Website .....	3
d.	Manufacturing Locations .....	3
e.	Testing .....	3
f.	Device Limitations, Operational, Sizing, and Maintenance Considerations.....	3
g.	Existing Installations.....	4
h.	Certification Statement.....	5
2.0	TABLE OF CONTENTS .....	7
3.0	PHYSICAL DESCRIPTION .....	9
a.	Trash Capture .....	9
b.	Peak Flows / Trash Volumes .....	11
c.	Hydraulic Capacity .....	12
d.	Comparison Table .....	12
e.	Design Drawings .....	12
f.	Alternative Configurations.....	12
g.	Internal Bypass.....	13
h.	Previously Trapped Material .....	13
i.	Calibration Feature.....	13
j.	Photographs .....	13
k.	Materials.....	14
l.	Design Life .....	14
4.0	Installation Guide .....	15
a.	Standard Installation .....	15
b.	Installation Limitations / Non-standard Device Installation Procedures .....	16
c.	Methods for Diagnosing and Correcting Installation Errors. ....	16
5.0	Operation and Maintenance.....	16
a.	Inspection Procedures & Frequency Considerations .....	16
c.	Maintenance Procedures .....	18

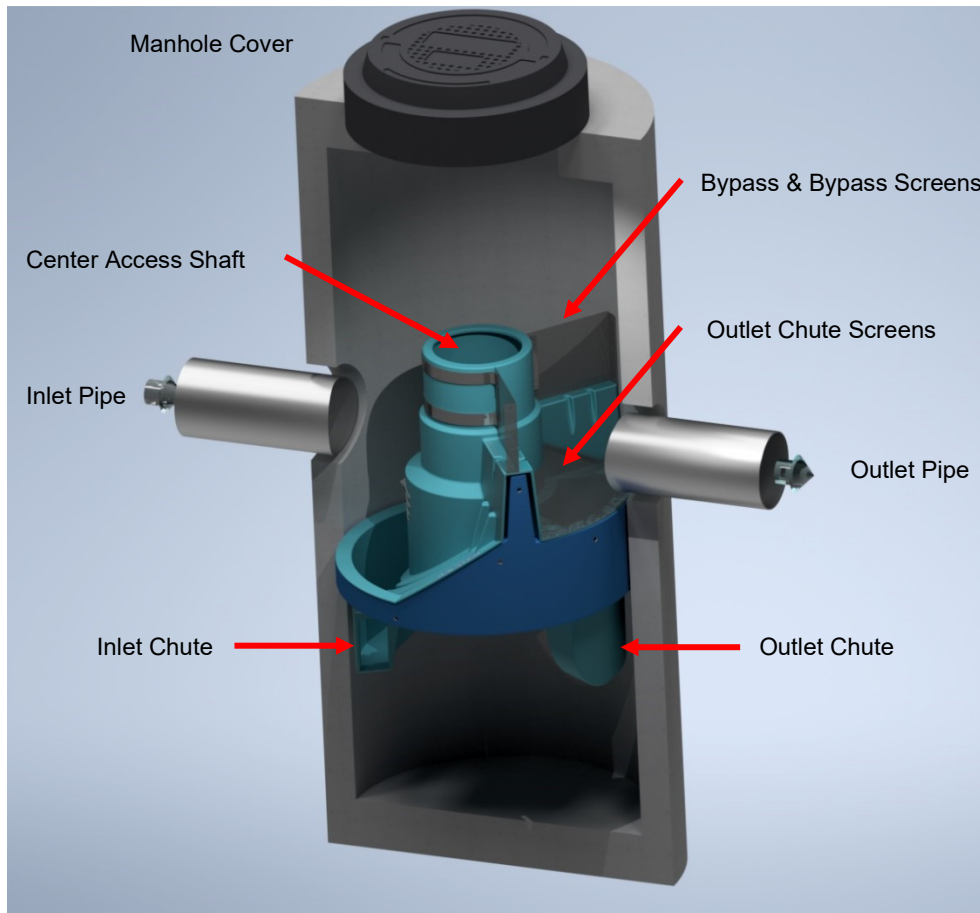
d.	Recommended Maintenance Equipment and Materials.....	18
e.	Deferred Maintenance .....	19
f.	Repair of Screens and Internal Parts .....	19
6.0	Vector Control Accessibility.....	19
a.	Vector Control Accessibility Letter Application Date .....	19
b.	Vector Control Accessibility .....	19
c.	Vector Control Accessibility Letter .....	22
7.0	RELIABILITY INFORMATION .....	23
a.	Estimate Design Life of Device Components Before Major Overhaul .....	23
b.	Warranty.....	23
c.	Customer Support Information.....	23
8.0	Field/Lab Testing Information and Analysis.....	23
	APPENDIX A – GA Drawings.....	24
	APPENDIX B - Specification.....	30
	APPENDIX C - Installation Information.....	35
	APPENDIX D – Operation and Maintenance.....	43
	APPENDIX E – MVCAC Letter .....	58
	APPENDIX F – Warranty .....	61
	APPENDIX G – Screen Hydraulics .....	63



### 3.0 PHYSICAL DESCRIPTION

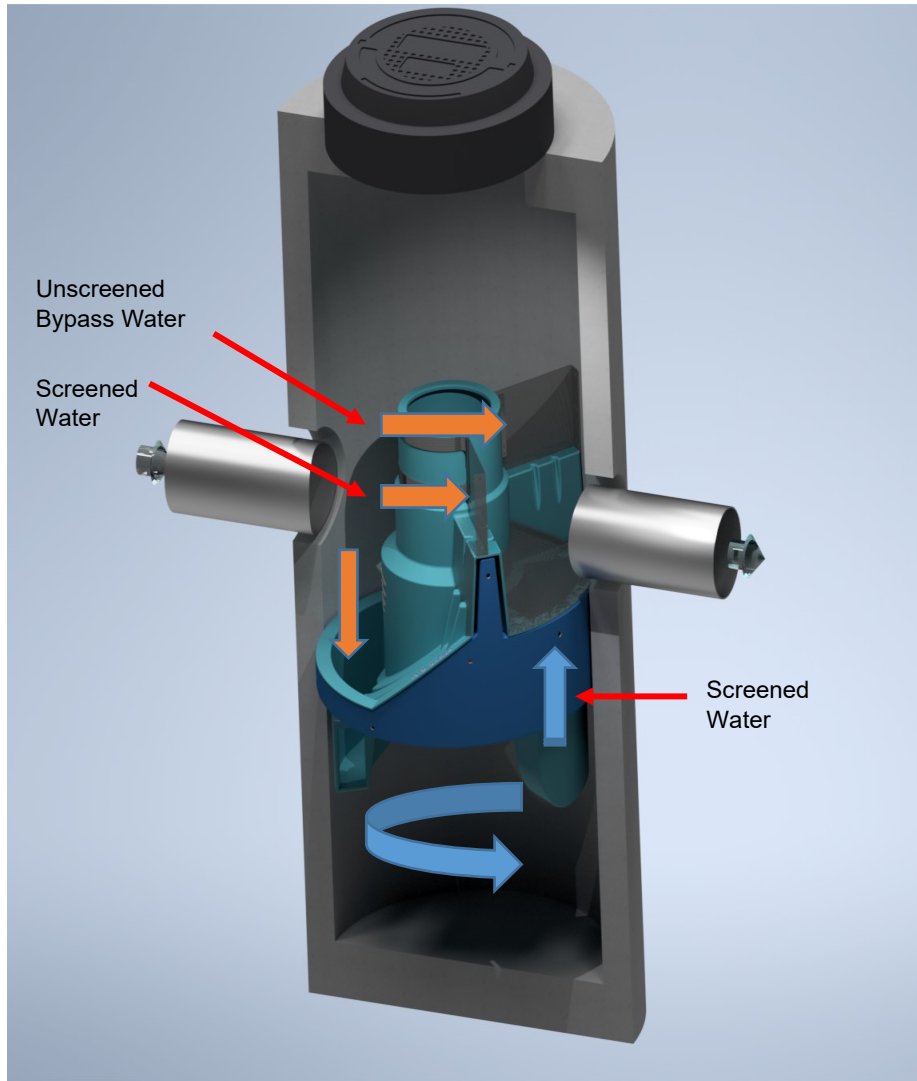
#### a. Trash Capture

The FDHC FTC configuration is as detailed in Diagram 1. The FDHC FTC is available in five precast model sizes – 3, 4, 5, 6, and 8 ft, with a 10 ft. diameter size planned for late 2020.



*Diagram 1 – Standard FDHC FTC Internal Components*

Operation of the FDHC FTC begins when water enters the Device through the Inlet Pipe. The water is directed down the Inlet Chute to create a rotational flow around the outer wall of the inside lower chamber the manhole, improving sediment removal and retention. Water exits via the Outlet Chute in the reverse direction to the flow. The water rises in the Outlet Chute before exiting through the Outlet Pipe. High flows lift the water level over the Bypass Weirs and are pass directly to the outlet, Diagram 2.



*Diagram 2 – Standard FDHC FTC Flow Path*

To comply with full trash capture requirements, 4.7 mm screens are mounted to the internal components as shown in Diagram 3.

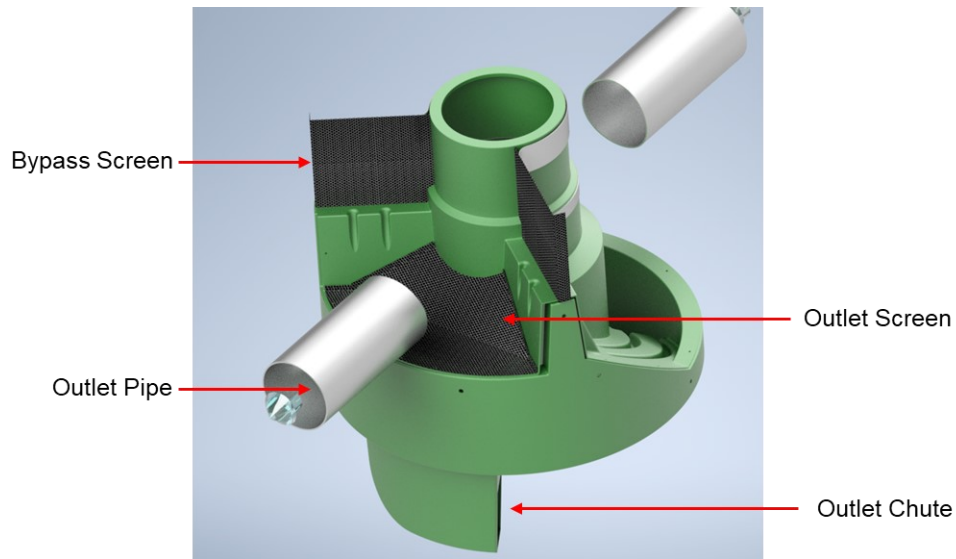


Diagram 3 – Standard First Defense® HC Screens

The Outlet Screen is a semi-circular cylindrical 4.7 mm screen installed horizontally over the top of the Outlet Chute. The Bypass Screens are installed vertically on the bypass weirs to screen water during bypass flow conditions. The screens will prevent any trash and debris 5 mm or larger from exiting the manhole.

## b. Peak Flows / Trash Volumes

In the event of a high intensity rainfall event or a blocked screen, the Bypass Screen can be overtopped to allow infrequent large flows to pass directly to outlet. At this stage, the outlet pipe will likely be submerged preventing some free-floating material from leaving the structure. As water levels return to normal some material downstream of the Bypass may be released.

In some cases, such as retrofits to large pipes, steep sites, or sites taking off-site rainfall flow, an offline configuration is employed using an external bypass manhole with weir to manage the peak flow and protect the Device from extreme flow conditions. The top elevation of the external bypass weir can be set such that bypass initiates before the water level in the FDHC FTC crests the internal bypass weir screens, ensuring no trash is lost.

Table 1 provides flow rates that can be used for design based on HydroCAD modelling of the screens for different degrees of screen blinding. The flow rates are calculated with the water level at the top of the bypass screen. Flows exceeding these will bypass without screening.

**Table 1 - FDHC FTC – Flow Rates**

Model Number and (ft)	Flow Rate (cfs) for Screen Blinding Percentage <sup>(1)</sup>				Bypass Capacity (cfs)
	0%	25%	50%	75%	
FDHC3 FTC	2.93	2.33	1.75	1.17	15
FDHC4 FTC	7.94	7.10	5.27	3.43	18
FDHC5 FTC	13.02	10.51	7.87	6.07	20
FDHC6 FTC	25.6	21.5	16.01	10.66	32
FDHC8 FTC	34.16	33.75	26.29	16.88	50
FDHC10 FTC	Not yet set – Planned for 2021				

(1) Calculated using HydroCAD modelling. Refer to Appendix G for example calculation

**c. Hydraulic Capacity**

The FDHC FTC is designed for in-line operation. While the Device may also be used in off-line applications, the hydraulics and internal bypass weirs of the Device allow for maximized treatment and internal bypass at flows that typically well exceed the design storm and placement off-line is often not usually necessary.

Appendix G contains an explanation of the calculations used to develop Table 1, which an example calculation.

The design engineer should calculate the water quality flow rate and peak storm flow and use Table 1 to select the correct sized Device.

**d. Comparison Table**

**Table 2 - FDHC FTC - Capacities Chart**

Model Number and Diameter	Maximum Pipe Diameter		Trash Storage Capacity <sup>1</sup>			
	(ft)	(m)	(in)	(mm)	(yd <sup>3</sup> )	(m <sup>3</sup> )
FDHC3 FTC	3	0.9	18	457	0.36	0.28
FDHC4 FTC	4	1.2	24	600	0.83	0.63
FDHC5 FTC	5	1.5	24	600	1.54	1.18
FDHC6 FTC	6	1.8	30	750	2.22	1.70
FDHC8 FTC	8	2.4	48	1219	5.28	4.00
FDHC10 FTC	10	3.0	Not yet set – Planned for 2021			

1. Trash storage volume estimated as ½ the chamber volume measured from the base of the Inlet Chute to top of Bypass Weirs (Not bypass screens). Actual volume of material stored will vary with size, density, and type of trash. Larger volumes of trash may be retained.

**e. Design Drawings**

Standard general arrangement drawings are included in Appendix A. Each project will have site specific drawings produced and Vector control compliant manhole access covers provided.

**f. Alternative Configurations**

No alternative configurations.

**g. Internal Bypass**

The internal bypass allows for extreme events to pass over the bypass screens preventing upstream flooding.

**h. Previously Trapped Material**

Under normal design and operating conditions, the FDHC FTC will remove and retain all trash and debris 5.0mm in size or larger. Conditions under which the Device may re-introduce previously trapped trash are as follows:

- Extreme high flow condition where the water level exceeds the top bypass screen elevation.
- Unmaintained condition allowing the screen to become fully blinded.

**i. Calibration Feature**

No calibration features.

**j. Photographs**

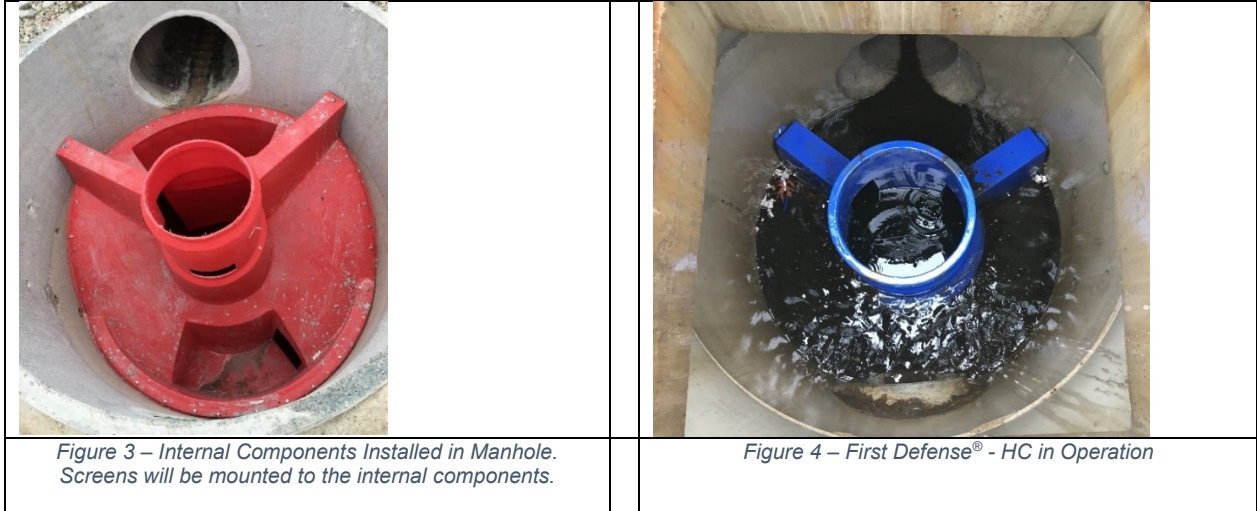
No photographs of the FDHC FTC are currently available. Figures 1 – 4 show the internal plastic parts prior to screen installation.



*Figure 1 – Mounting Ring*



*Figure 2 – Mounting Ring & Internal Components*



Screens are placed over the outlet chute and on each bypass weir, Diagram 3.

#### k. Materials

The FDHC FTC is constructed of industry standard materials that are suitable for the harsh environment experienced by a subsurface stormwater treatment system.

- **Structure** – The FDHC FTC main structure is made from a concrete manhole conforming to ASTM C478. The walls, floor, ceiling, and baffles are all made from concrete with a minimum 28-day compressive strength of 4,000psi or greater with aggregate per ASTM C33 and reinforcing steel per ASTM A615, Grade 60. The structure is designed to support traffic loads per AASHTO HS-25.
- **Metal Screens** – The main treatment screen and the bypass screen are made from perforated stainless steel conforming to ASTM A240, Grade 304 with perforations not greater than 4.7mm (0.185 in) in size.
- **Inlet, Outlet, Bypass, Center Cone, and Mounting Ledge** – The internal components are rotationally molded from High Density Polyethylene (HDPE).
- **Securing Components** – Mounting hardware and securing fasteners are made from stainless steel conforming to ASTM F593 and F594, Grade 304.
- **Access Covers** – Manhole frames and covers are cast from iron in conformance with ASTM A48, CL358 and AASHTO M105. Hatches (if used) are made from aluminum. Either access system is designed to support traffic loads per AASHTO HS-25.

#### I. Design Life

The design service life for the FDHC FTC is dependent on the materials, design, installation, and proper operation and maintenance. The FDHC FTC is constructed from materials with a design service life of between 50 and 100 years. The metal and plastic components are rated for the

shorter span of 50 years while the concrete structure is rated for 100 years. The Device does not utilize any consumable materials.

## **4.0 Installation Guide**

### **a. Standard Installation**

The FDHC FTC is supplied with internal components pre-installed into a precast manhole. In most situations the installation is the same as any precast stormwater manhole. Pipe connections are made to local standards and are grouted, or if required booted connects are provided.

The FDHC FTC Installation Manual is included in Appendix C of this submittal and contains typical installation considerations.

The device is supplied complete and partially assembled, the contractor may need to remove and reinstall the Outlet Chute Screen to completely grouting of the outlet pipe. This will not require any special tools or reinstallation material.

The FDHC FTC Installation Manual is included in Appendix C of this submittal. The Installation Manual includes methods and practices for the following:

- Site Conditions
- Delivery, Offloading, & Handling
  - Pre-Inspection
  - Component Weight
  - Lifting Devices
  - Storage
- Site Preparation
  - Excavation
  - Bedding
- Installation
  - Placement
  - Jointing and Sealing
  - Pipe Connections
  - Access, Risers, & Manholes
  - Backfilling
- Installation Log

The FDHC FTC is intended to be a near turnkey Device that arrives at the construction site complete for installation. Assembly of manhole sections and access structures as well as inlet and outlet connections are required to be performed in the field as these cannot be completed at the manufacturing facility. Guidelines are provided to the Contractor to assist with installation. In all instances, Federal, State, and Local laws and regulations should be followed.

Internal components are pre-installed at the factory. In some instances, internal components may need to be installed on site. During such instances, a Hydro International® representative and/or



contractor will be on site for the installation of these components. At no time should a Contractor be tasked with installation of the internal components unless the Contractor has received appropriate training and instruction from Hydro International®.

Inspection is a critical component of the installation. Inspection should occur before, during, and after installation to ensure proper installation and function of the Device. An installation log is provided in the Installation Manual to document the installation of the Device. This log should be provided to Hydro International® and the Owner and a copy should be retained by the Contractor for future reference.

#### **b. Installation Limitations / Non-standard Device Installation Procedures**

The FDHC FTC is installed in the stormwater drainage systems with no special requirements or non-standard procedures, tools, or practices.

#### **c. Methods for Diagnosing and Correcting Installation Errors.**

The FDHC FTC is supplied preassembled and the contractor should not be required to do anything other than complete the manhole installation and pipe connections. Visual inspection and comparison to the design drawing will confirm the correct installation.

Installation errors of the FDHC FTC are not common provided installation is completed by a qualified Contractor and the installation is overseen by a knowledgeable Owner. Hydro International® has procedures in place to prevent installation errors but in the event an error occurs, immediate diagnosis and corrective action are required.

Prior to manufacture and delivery of the FDHC FTC, the Contractor and Owner or Owners Representative are provided with design drawings and instructions. These drawings provide specific details of the design and construction of the Device. A Hydro International® representative can also be available for delivery, installation, and maintenance of the Device. The drawings should be utilized to help diagnose errors.

Should an error be encountered, Hydro International® should be consulted for any necessary corrective action.

### **5.0 Operation and Maintenance**

#### **a. Inspection Procedures & Frequency Considerations**

The FDHC FTC *Operation and Maintenance Manual* is included with this submittal in Appendix D. The manual provides detailed information for FDHC FTC Inspection procedures and frequency considerations.

The FDHC FTC design allows for quick inspection from surface level and requires no entry into the manhole.



## **Inspection Procedures**

- Set up any necessary safety equipment around the access hatches and/or manhole covers of the FDHC FTC as required by local ordinances. Safety equipment should notify pedestrians and vehicle traffic of work in the area.
- Remove the manhole covers or access hatches.
- Without entering the structure, visually inspect the annular space around top of the Device for trash, debris, and other gross pollutants.
- Using a sediment probe, measure the depth of sediment in the central sump.
- Visually inspect for signs of abnormal operation such as indications of long term elevated water levels, broken or damaged internal components, or absence of any pollutants.
- Record the date, Device location, trash and debris volumes estimates, and sediment levels measured.
- If screens are clogged full maintenance should be scheduled.
- Securely replace the access cover/hatches.
- Remove safety equipment.
- Contact the local Mosquito and Vector Control District should mosquito or vector be present in the vault.

## **Inspection Frequency**

- During the first year of operation, the FDHC FTC should be inspected every three to six months. This initial inspection schedule is needed to determine the site-specific pollutant loading and is utilized to determine ongoing maintenance frequency.
- Inspection may be conducted during any season but is typically conducted prior to the start of the rainy season.
- Typically, most sites will benefit from inspection every 6 months, however trash loads may require more frequent inspections.

### **b. Maintenance Frequency and Hydraulic Capacity**

The FDHC FTC may experience some reduction in hydraulic capacity depending on the type and amount of trash entering the systems. During the initial inspection period after installation the characteristics of the trash load coming from the source area should be noted and considered when determining the maintenance frequency for any specific site.

There are two screened flow paths in the Device, one is below inlet and outlet inverts and is the primary flow path of the more frequent smaller storms. The other is the bypass flow path above the inlet and outlet pipes inverts and is the primary flow path of the larger less frequent storms. Refer to Diagrams 2 & 3.

Spitting the operation between two hydraulically different flow paths helps maintain the operational capacity of the system. Maintenance is critical for all systems to effectively manage and reduce pollutants.

### **c. Maintenance Procedures**

The FDHC FTC Operation and Maintenance Manual is included with this submittal in Appendix D. The manual provides detailed information for FDHC FTC Maintenance procedures and frequency considerations. Visual inspection will usually be sufficient to indicate the need for trash removal.

Maintenance of the FDHC FTC should occur as determined during inspection of the Device. If no inspection records have been used to determine a maintenance frequency, then maintenance should occur annually or when inspection indicates the screen are blinded, or sediment and trash levels exceed 75% of the capacity listed in Table 1.

A summary of requirements maintenance procedures is listed below:

- Set up any necessary safety equipment around the access ports as stipulated by local ordinances. Safety equipment should notify passing pedestrian and road traffic that work is being done.
- Remove access lids and visually inspect the inside of the manhole. Document observations and take pictures. Estimate and record the screenings and sediment depths. Update the maintenance log.
- Using a vacuum removal system, vacuum pollutants trapped around the top of the Device.
- Insert the vacuum tube in the central opening and vacuum sediment and liquid from the central sump.
- Screen can be inspected and cleaned from above using a water jet. No entry is required. Once cleaned the sump should be vacuumed again.
- Document the cleaning with photographs and by completing the maintenance log included with the *FDHC FTC Operation and Maintenance Manual*.
- Replace the access covers/hatches and remove the safety equipment.

### **d. Recommended Maintenance Equipment and Materials**

The following equipment is the minimum recommended equipment for routine maintenance of the FDHC FTC. Additional equipment may be necessary based on unique site or installation conditions.

- PPE (Personal Protective Equipment)
- Safety and Traffic control equipment (cones, barricades, signage, flagging, etc.)
- Manhole hook or pry bar
- Flashlight
- Tape measure
- Measuring stick or sludge sampler
- Long-handled net and brush
- Confined space entry equipment
- Vacuum truck
- Digital Camera
- Inspection/Maintenance Report

#### **e. Deferred Maintenance**

For full trash capture deferred maintenance may result in blinded screens, early bypass, Trash loss, and upstream flooding. Organic material may decompose resulting in odors and release of secondary pollutants such as bacteria, nitrogen, etc.

Sediment in the sump may become compacted and more difficult to remove.

#### **f. Repair of Screens and Internal Parts**

Minor repairs may be required and Hydro International® should be contacted in the event of a minor repair for specific repair instructions. Major repairs are not anticipated but should be evaluated by a Hydro International® representative on a case-by-case basis.

Screens and structural components can be accessed and repaired or replaced in-situ if repair is required. It may be necessary to remove the concrete flattop for the larger Devices as the screens will not fit through a standard manhole cover. All internal parts are replaceable without removal of the concrete manhole structure.

### **6.0 Vector Control Accessibility**

#### **a. Vector Control Accessibility Letter Application Date**

July 8, 2020

#### **b. Vector Control Accessibility**

The FDHC FTC is a subsurface stormwater treatment Device that maintains an accommodating environment for Mosquito and Vector. Conscious of this, Hydro International® designed the FDHC FTC for quick and convenient access to inspect and abate for Mosquito and Vector. The orange arrows in Diagram 4 represent unobstructed visual and physical access to the wet sump areas of the Device. Mosquito and Vector personnel can use these access points to visually inspect for Mosquito and Vector activity as well as mitigate by way application of larvicide pellets, briquettes or liquid spray.

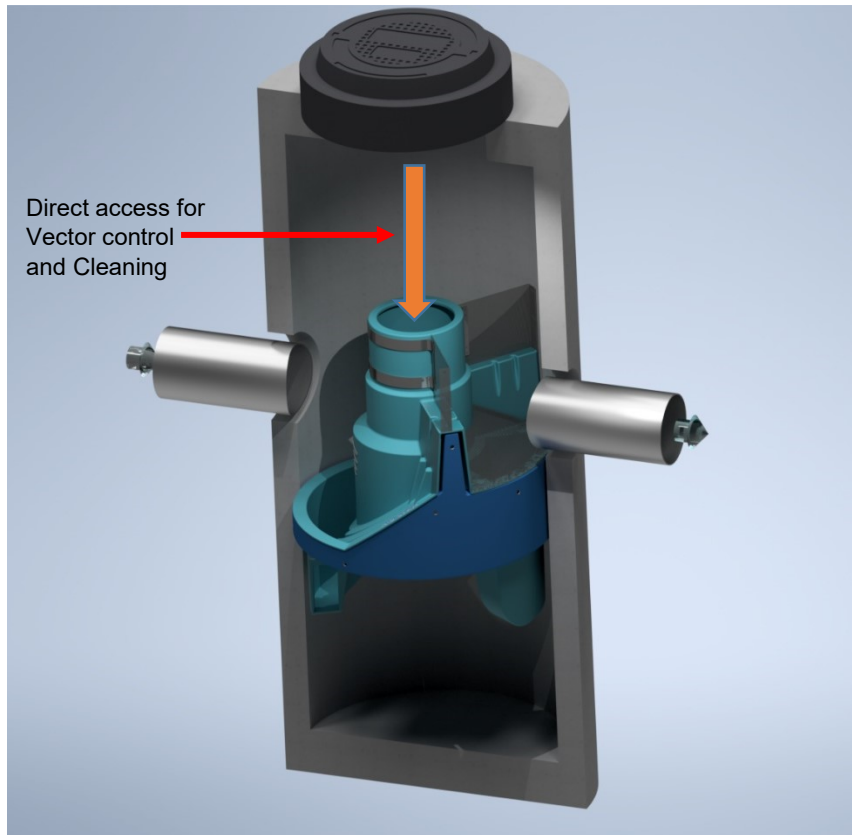


Diagram 4 – First Defense® - HCS in Sump Access

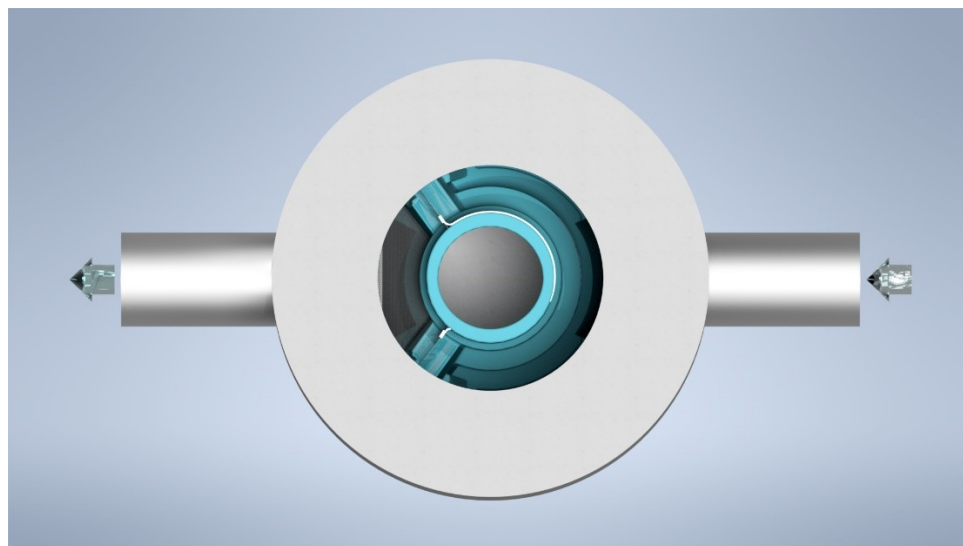


Diagram 5 - First Defense® - HCS Top Down View Illustrating Internal Access

Diagram 5 is a top down view of a typical First Defense® - HCS manhole. The access cover is shown in this Figure as semi-transparent orange circle so that the internal components can be seen relative to the access points. As illustrated in this Figure, the totality of the components can be visually and physically accessed through the provided access point. The central access point to the sump is directly accessible from the center manhole access point and the annular space

containing water and trash and debris is easily accessible from the same central access. Physical access is large enough for a vactor truck nozzle as well as manned entry. Should liquid or solid forms of larvicide need to be applied for Mosquito control, the visual and physical access is available.

Figure 5 provides the same top down view as Diagram 5 but of a field-installed operational unit. The centrally located manhole access point provides access to the central channel leading to the sump. This area will contain water, any trash and debris that is obstructing access to the water in this area can be moved with a sampling rod. The area around the center access shaft contains water and will contain trash and debris.



*Figure 5 - View from Manhole Access Point*

Hydro International supplies all FDHC FTC devices with solid covers to prevent Mosquito and



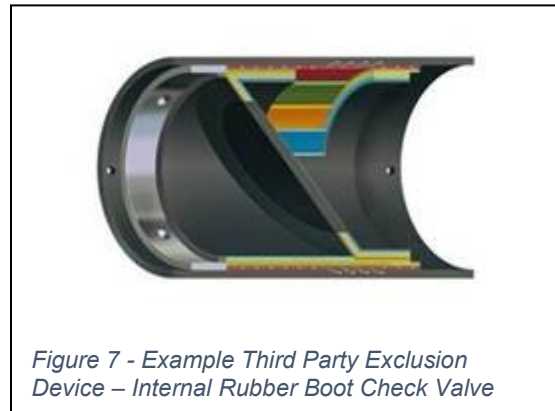
*Diagram 6 - Example Solid and Open Pick Hole Manhole Covers*

Vector entry. Diagram 6 illustrates example manhole covers with and without an open pick hole. Inlet and outlet pipes are another possible entry points to the Device for Mosquito and Vector.

Figure 6 and Figure 7 are examples of potential third party exclusion devices that may be utilized to prevent mosquito and vector from entering the manhole through the inlet and outlet pipes. Both devices are considered to be check valves and function by allowing water to pass through the device in one direction. When water is not moving the valves are closed thus preventing passage of Mosquito and vector. The devices operate with low head pressure but confirmation of function within the storm drain system should be confirmed prior to application.



*Figure 6 - Example Third Party Exclusion Device - Duckbill Valve*



*Figure 7 - Example Third Party Exclusion Device - Internal Rubber Boot Check Valve*

Hydro International® should be contacted in the design phase should any third-party exclusion device be a consideration for review and evaluation of compatibility.

**c. Vector Control Accessibility Letter**

MVCAC Letter of Verification to be attached in Appendix E

## **7.0 RELIABILITY INFORMATION**

### **a. Estimate Design Life of Device Components Before Major Overhaul**

As per Section 3.1., the design service life for the FDHC FTC is dependent on the materials, design, installation, and proper operation and maintenance. The FDHC FTC is constructed from materials with a design service life of between 50 and 100 years. The metal and plastic components are rated for the shorter span of 50 years while the concrete structure is rated for 100 years. The Device does not utilize any consumable materials. A major overhaul would not be anticipated prior to 50 years of operation.

### **b. Warranty**

The warranty for the FDHC FTC is a two (2) year limited warranty. A copy of the warranty is included in Appendix F.

### **c. Customer Support Information.**

Hydro International® Stormwater has a corporate office located in Portland, Maine and representatives throughout the country.

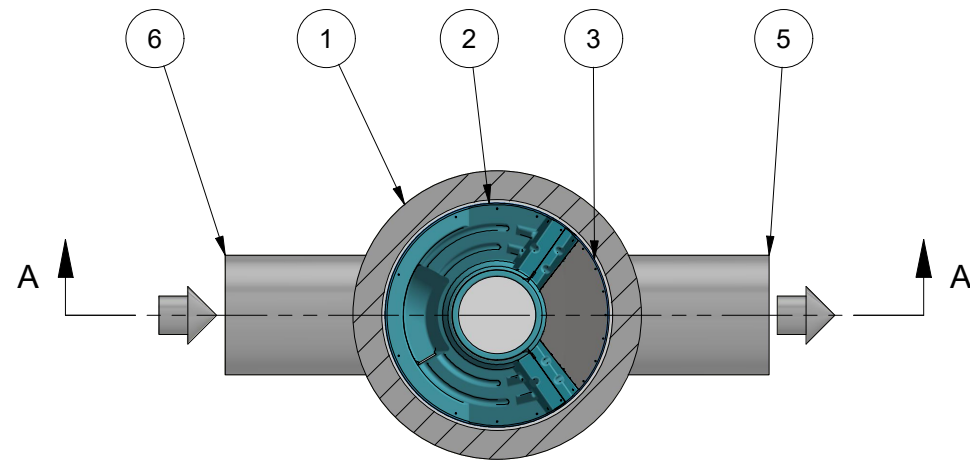
Hydro International® Americas Stormwater Headquarters  
94 Hutchins Drive  
Portland, Maine 04102  
Phone: (207) 756-6200  
Fax: (207) 756-6212  
[inquiries@hydro-int.com](mailto:inquiries@hydro-int.com)

## **8.0 Field/Lab Testing Information and Analysis**

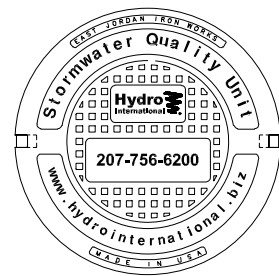
The FDHC FTC has not been lab verified specifically for trash. The Device is a screened variant of an extensively tested First Defense® HC that has undergone extensive testing for hydraulics and sediment removal. The addition of the screens to produce the FDHC FTC has had additional modelling done to produce the hydraulic capacity evaluation as detailed in Table 1.

# APPENDIX A – GA Drawings



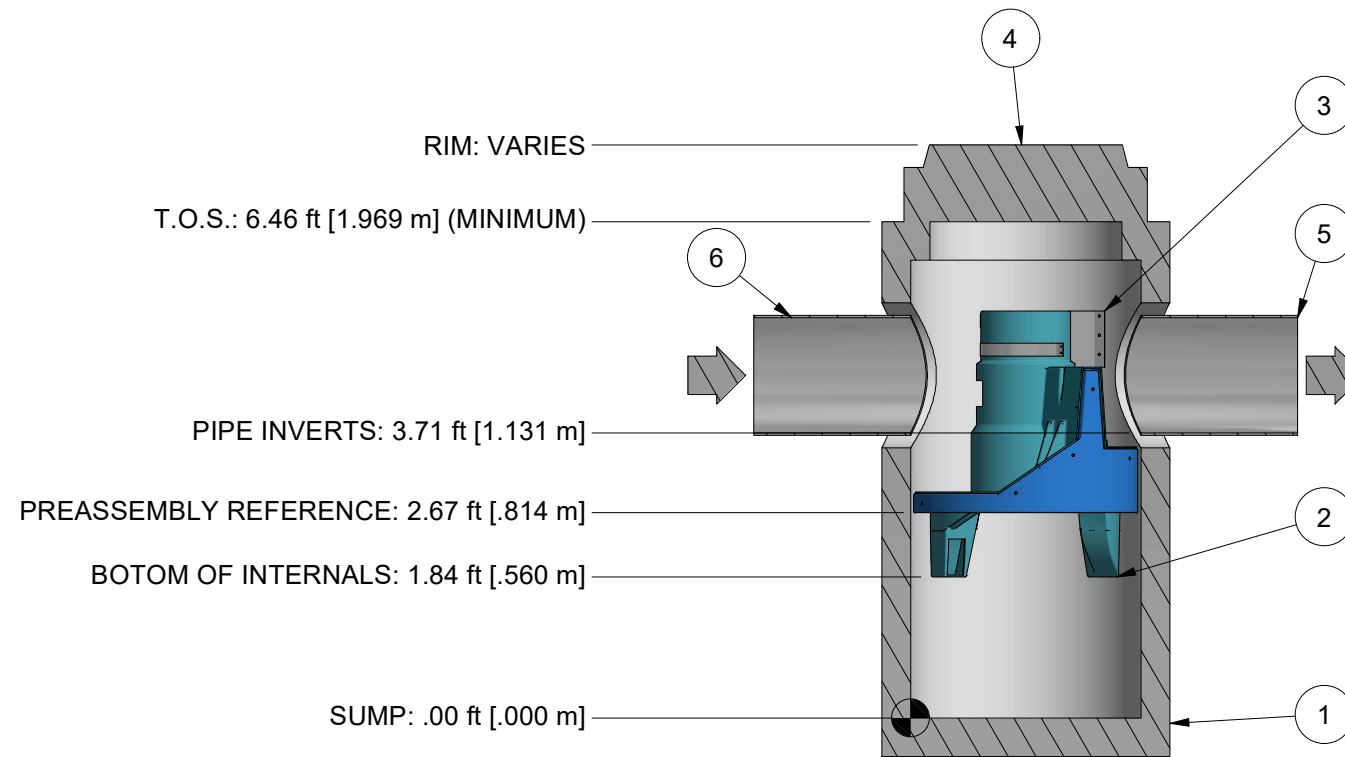


**PLAN VIEW**



**HYDRO FRAME AND COVER (INCLUDED)**

GRADE RINGS BY OTHERS AS REQUIRED



**SECTION A-A**

1. MANHOLE WALL AND SLAB THICKNESSES ARE NOT TO SCALE.
2. CONTACT HYDRO INTERNATIONAL FOR A BOTTOM OF STRUCTURE ELEVATION PRIOR TO SETTING FIRST DEFENSE MANHOLE.
3. CONTRACTOR TO CONFIRM RIM, PIPE INVERTS, PIPE DIA. AND PIPE ORIENTATION PRIOR TO RELEASE OF UNIT TO FABRICATION.



**IF IN DOUBT ASK**

DATE: 9/8/2020	SCALE: 1:40
DRAWN BY: EHR	CHECKED BY:
APPROVED BY:	

Title  
3-ft DIAMETER  
FDHC FULL TRASH CAPTURE

**GENERAL ARRANGEMENT**



hydro-int.com  
©2020 HYDRO INTERNATIONAL

WEIGHT:	MATERIAL: Stainless Steel
STOCK NUMBER:	
DRAWING NO.: FDHC-S	
SHEET SIZE: B	SHEET: 1 OF 1
Page 25 of 72	

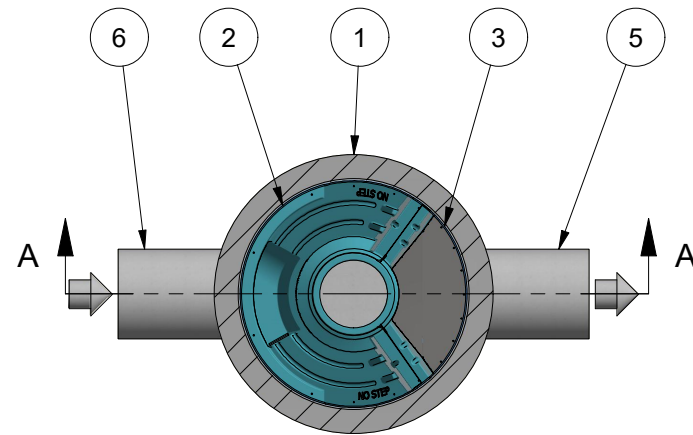
**PRODUCT SPECIFICATION:**

1. Peak Hydraulic Flow: 15.0 cfs (424 l/s)
2. Maximum Inlet/Outlet Pipe Diameters: 18 in. (450 mm)
3. For More Product Information Including Regulatory Acceptances, Please Visit <https://hydro-int.com/en/products/first-defense>

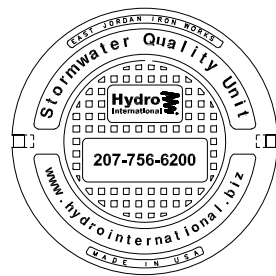
**GENERAL NOTES:**

1. General Arrangement drawings only. Contact Hydro International for site specific drawings.
2. Multiple inlet pipes possible (refer to project plan).
3. Inlet/outlet pipe angle can vary to align with drainage network (refer to project plan.s)
4. Peak flow rate and minimum height limited by available cover and pipe diameter.
5. Larger sediment storage capacity may be provided with a deeper sump depth.

PARTS LIST				
ITEM	QTY	SIZE (in)	SIZE (mm)	DESCRIPTION
1	1	36	900	I.D. PRECAST MANHOLE
2	1			INTERNAL COMPONENTS (PRE-INSTALLED)
3	1			5mm TRASH SCREEN (PRE-INSTALLED)
4	1	30	750	FRAME AND COVER (ROUND)
5	1	18 (MAX)	450 (MAX)	OUTLET PIPE (BY OTHERS)
6	1	18 (MAX)	450 (MAX)	INLET PIPE (BY OTHERS)



**SECTION A-A**  
SCALE 1:40



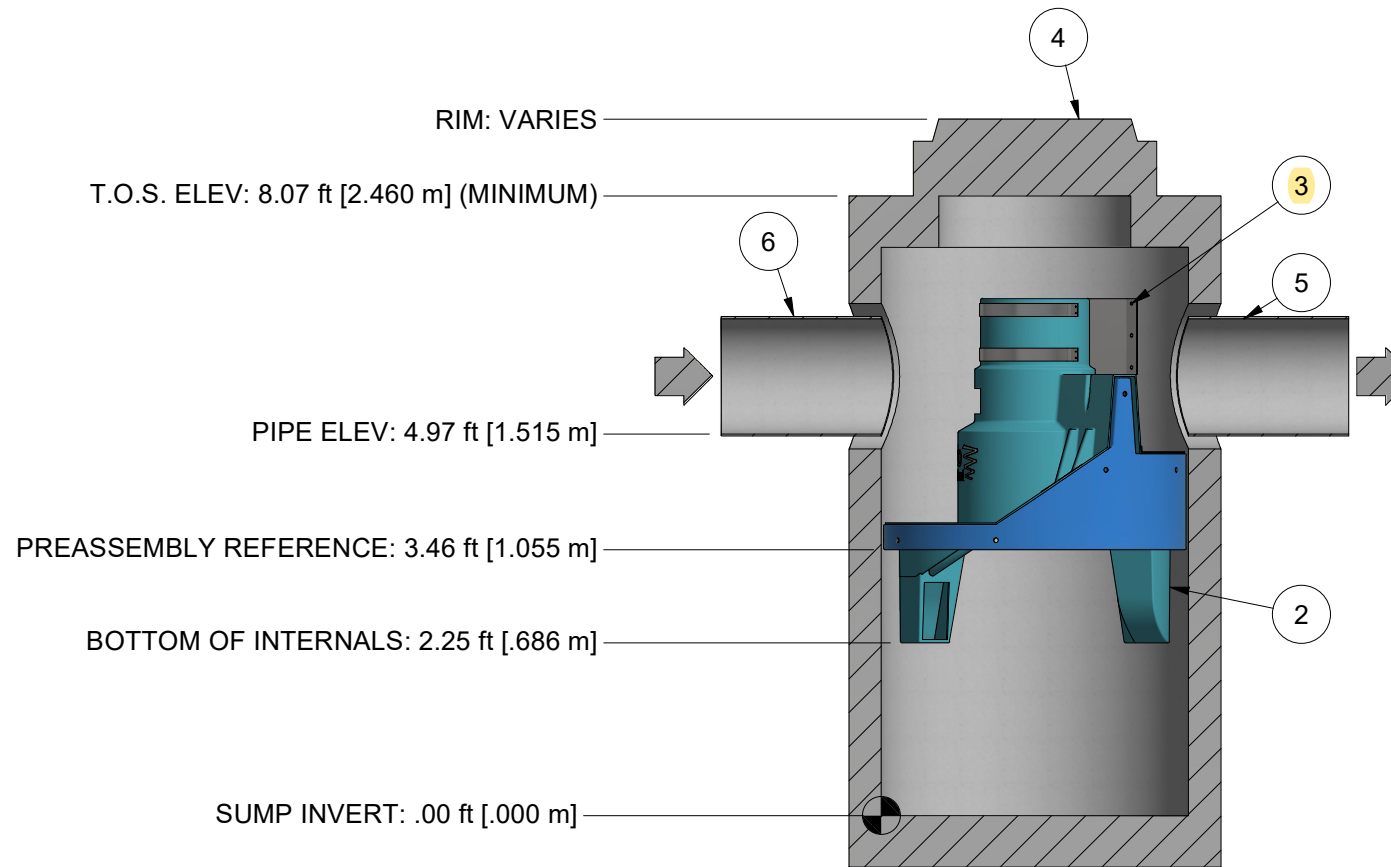
**HYDRO FRAME AND COVER (INCLUDED)**  
GRADE RINGS BY OTHERS AS REQUIRED

**PRODUCT SPECIFICATION:**

1. Peak Hydraulic Flow: 18.0 cfs (510 l/s)
2. Min Sediment Storage Capacity: 0.7 cu. yd. (0.5 cu. m.)
3. Oil Storage Capacity: 191 gal. (723 liters)
4. Maximum Inlet/Outlet Pipe Diameters: 24 in. (600 mm)
5. The Treatment System Shall Use An Induced Vortex To Separate Pollutants From Stormwater Runoff.
6. For More Product Information Including Regulatory Acceptances, Please Visit <https://hydro-int.com/en/products/first-defense>

**GENERAL NOTES:**

1. General Arrangement drawings only. Contact Hydro International for site specific drawings.
2. The diameter of the inlet and outlet pipes may be no more than 24".
3. Multiple inlet pipes possible (refer to project plan).
4. Inlet/outlet pipe angle can vary to align with drainage network (refer to project plan.s)
5. Peak flow rate and minimum height limited by available cover and pipe diameter.
6. Larger sediment storage capacity may be provided with a deeper sump depth.



**SECTION A-A**  
SCALE 1:30

1. MANHOLE WALL AND SLAB THICKNESSES ARE NOT TO SCALE.
2. CONTACT HYDRO INTERNATIONAL FOR A BOTTOM OF STRUCTURE ELEVATION PRIOR TO SETTING FIRST DEFENSE MANHOLE.
3. CONTRACTOR TO CONFIRM RIM, PIPE INVERTS, PIPE DIA. AND PIPE ORIENTATION PRIOR TO RELEASE OF UNIT TO FABRICATION.



**IF IN DOUBT ASK**

DATE: 9/8/2020	SCALE: 1:40	
DRAWN BY: EHR	CHECKED BY:	APPROVED BY:

Title  
4-ft DIAMETER  
FDHC FULL TRASH CAPTURE

GENERAL ARRANGEMENT



hydro-int.com  
©2020 HYDRO INTERNATIONAL

WEIGHT: 35633 lbmass	MATERIAL: Stainless Steel
-------------------------	------------------------------

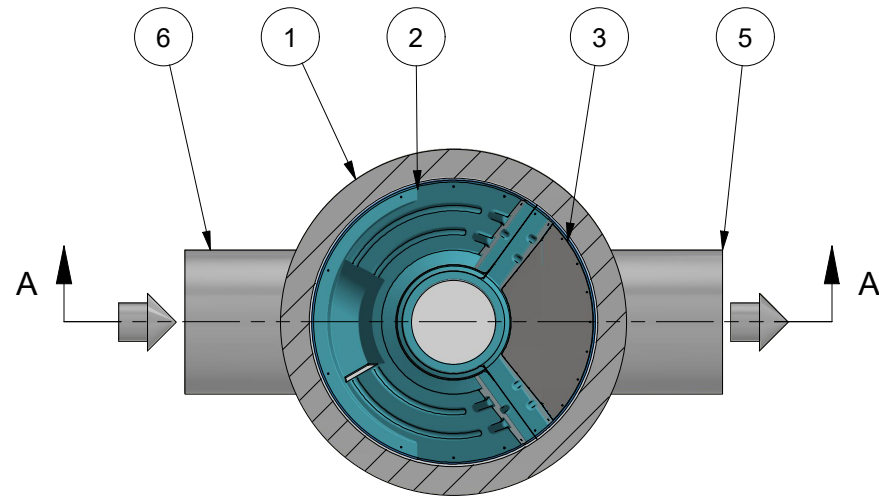
STOCK NUMBER:

DRAWING NO.:  
FDHC-S

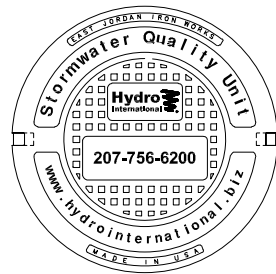
SHEET SIZE: B	SHEET: 1 OF 1	Page 26 of 72	Rev:
------------------	------------------	---------------	------

**PARTS LIST**

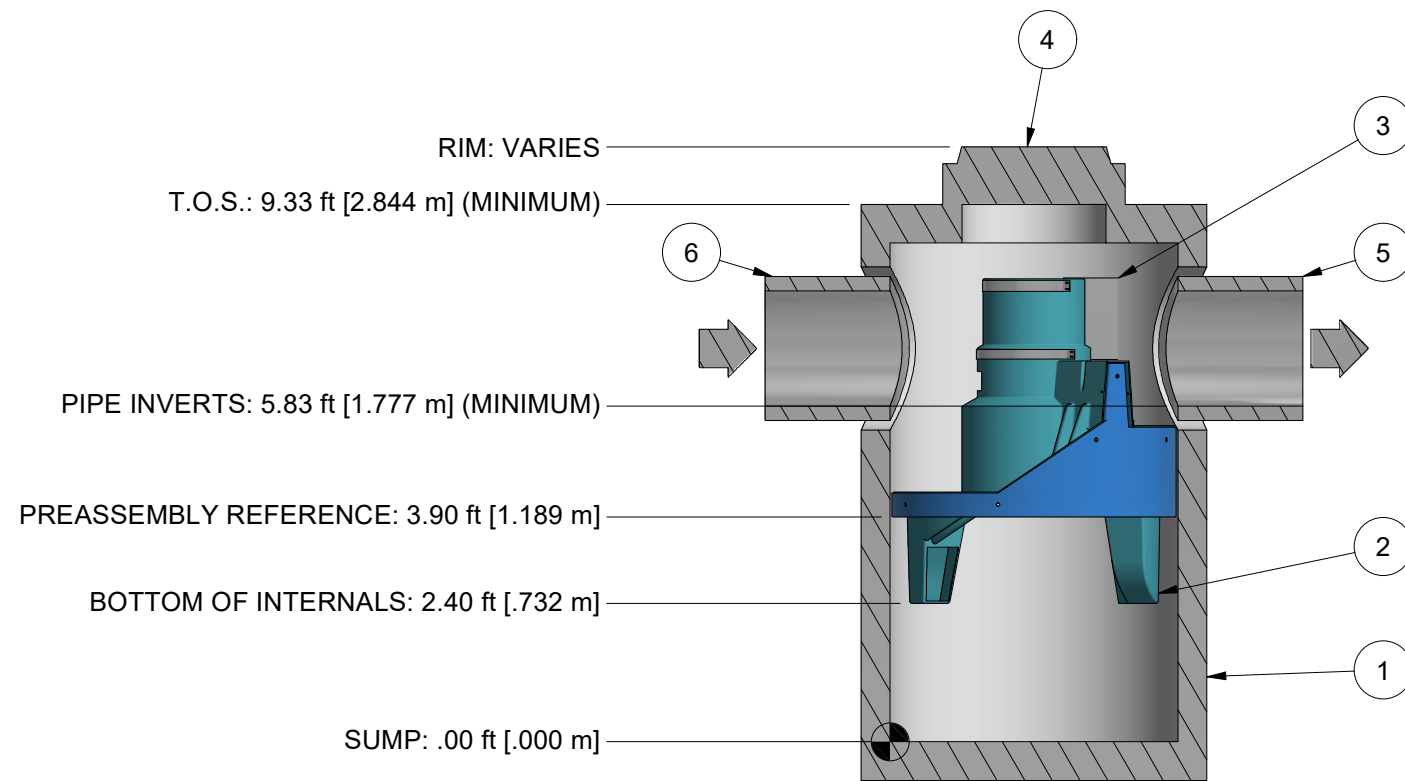
ITEM	QTY	SIZE (in)	SIZE (mm)	DESCRIPTION
1	1	48	1200	I.D. PRECAST MANHOLE
2	1			INTERNAL COMPONENTS (PRE-INSTALLED)
3	1			5mm TRASH SCREEN (PRE-INSTALLED)
4	1	30	750	FRAME AND COVER (ROUND)
5	1	24 (MAX)	600 (MAX)	OUTLET PIPE (BY OTHERS)
6	1	24 (MAX)	600 (MAX)	INLET PIPE (BY OTHERS)



**SECTION A-A**  
SCALE 1:40



**HYDRO FRAME AND COVER (INCLUDED)**  
GRADE RINGS BY OTHERS  
AS REQUIRED



**SECTION A-A**  
SCALE 1:40

1. MANHOLE WALL AND SLAB THICKNESSES ARE NOT TO SCALE.
2. CONTACT HYDRO INTERNATIONAL FOR A BOTTOM OF STRUCTURE ELEVATION PRIOR TO SETTING FIRST DEFENSE MANHOLE.
3. CONTRACTOR TO CONFIRM RIM, PIPE INVERTS, PIPE DIA. AND PIPE ORIENTATION PRIOR TO RELEASE OF UNIT TO FABRICATION.



**IF IN DOUBT ASK**

DATE: 9/8/2020	SCALE: 1:40	
DRAWN BY: EHR	CHECKED BY:	APPROVED BY:

Title  
5-ft DIAMETER  
FDHC FULL TRASH CAPTURE

GENERAL ARRANGEMENT



WEIGHT: MATERIAL:  
Stainless Steel

STOCK NUMBER:

DRAWING NO.:  
FDHC-S

SHEET SIZE: B SHEET: 1 OF 1 Page 27 of 72 Rev:

**PRODUCT SPECIFICATION:**

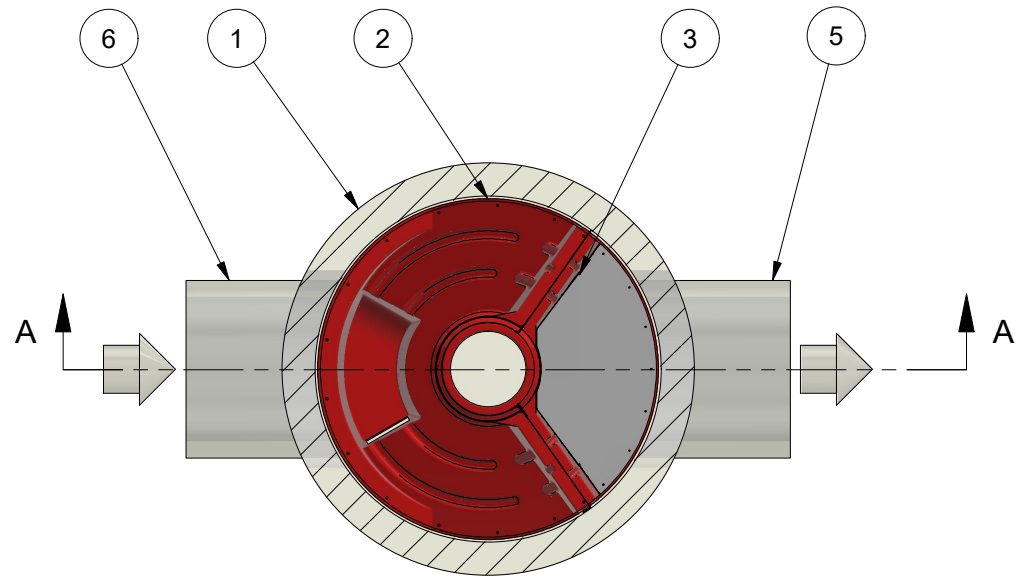
1. Peak Hydraulic Flow: 20 cfs (566 l/s)
2. Maximum Inlet/Outlet Pipe Diameters: 24 in. (600 mm)
3. For More Product Information Including Regulatory Acceptances, Please Visit <https://hydro-int.com/en/products/first-defense>

**GENERAL NOTES:**

1. General Arrangement drawings only. Contact Hydro International for site specific drawings.
2. Multiple inlet pipes possible (refer to project plan).
3. Inlet/outlet pipe angle can vary to align with drainage network (refer to project plan.s)
4. Peak flow rate and minimum height limited by available cover and pipe diameter.
5. Larger sediment storage capacity may be provided with a deeper sump depth.

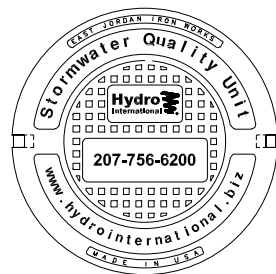
**PARTS LIST**

ITEM	QTY	SIZE (in)	SIZE (mm)	DESCRIPTION
1	1	60	1500	I.D. PRECAST MANHOLE
2	1			INTERNAL COMPONENTS (PRE-INSTALLED)
3	1			5mm TRASH SCREEN (PRE-INSTALLED)
4	1	30	750	FRAME AND COVER (ROUND)
5	1	24 (MAX)	600 (MAX)	OUTLET PIPE (BY OTHERS)
6	1	24 (MAX)	600 (MAX)	INLET PIPE (BY OTHERS)



**SECTION A-A**

SCALE 1:40



**HYDRO FRAME AND COVER (INCLUDED)**

GRADE RINGS BY OTHERS AS REQUIRED

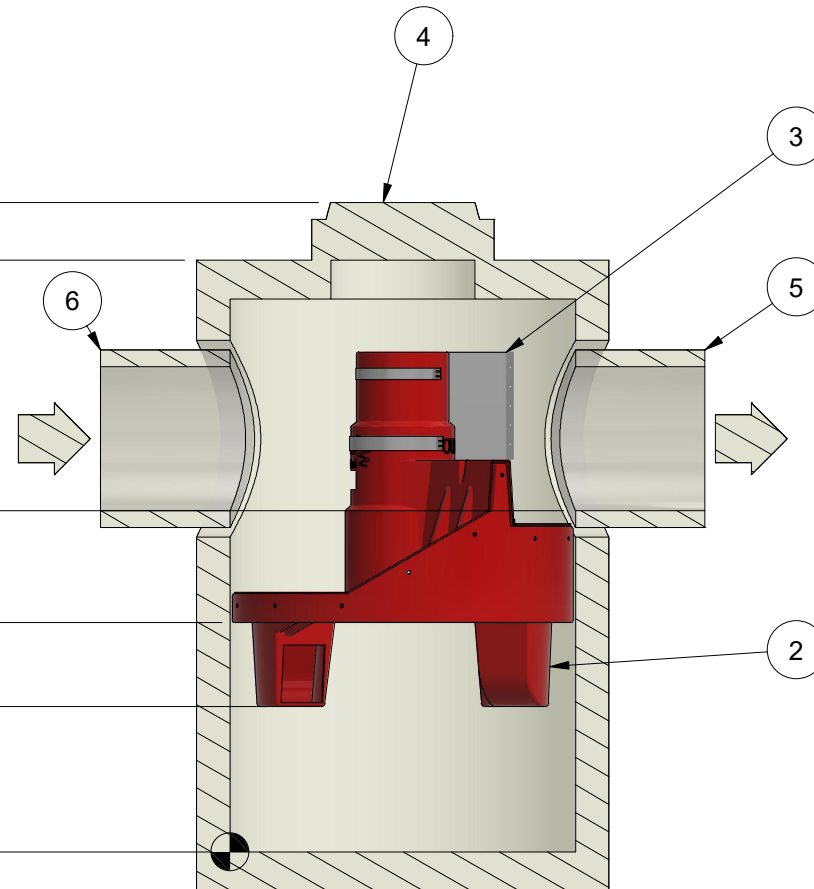
RIM: VARIES  
T.O.S.: 10.27 ft [3.130 m] (MINIMUM)

PIPE INVERTS: 5.92 ft [1.804 m] (MINIMUM)

PREASSEMBLY REFERENCE: 3.98 ft [1.214 m]

BOTTOM OF INTERNALS: 2.53 ft [.770 m]

SUMP: .00 ft [.000 m]



**SECTION A-A**

SCALE 1:40

1. MANHOLE WALL AND SLAB THICKNESSES ARE NOT TO SCALE.

2. CONTACT HYDRO INTERNATIONAL FOR A BOTTOM OF STRUCTURE ELEVATION PRIOR TO SETTING FIRST DEFENSE MANHOLE.

3. CONTRACTOR TO CONFIRM RIM, PIPE INVERTS, PIPE DIA. AND PIPE ORIENTATION PRIOR TO RELEASE OF UNIT TO FABRICATION.



**IF IN DOUBT ASK**

DATE: 9/8/2020	SCALE: 1:40	
DRAWN BY: EHR	CHECKED BY:	APPROVED BY:

Title  
6-ft DIAMETER  
FDHC FULL TRASH CAPTURE

GENERAL ARRANGEMENT



hydro-int.com

©2020 HYDRO INTERNATIONAL

WEIGHT: MATERIAL:  
Stainless Steel

STOCK NUMBER:

DRAWING NO.:  
FDHC-S

SHEET SIZE: SHEET: Rev:  
B 1 OF 1 Page 28 of 72

**PRODUCT SPECIFICATION:**

1. Peak Hydraulic Flow: 32.0 cfs (906 l/s)
2. Maximum Inlet/Outlet Pipe Diameters: 30 in. (750 mm)
3. For More Product Information Including Regulatory Acceptances, Please Visit <https://hydro-int.com/en/products/first-defense>

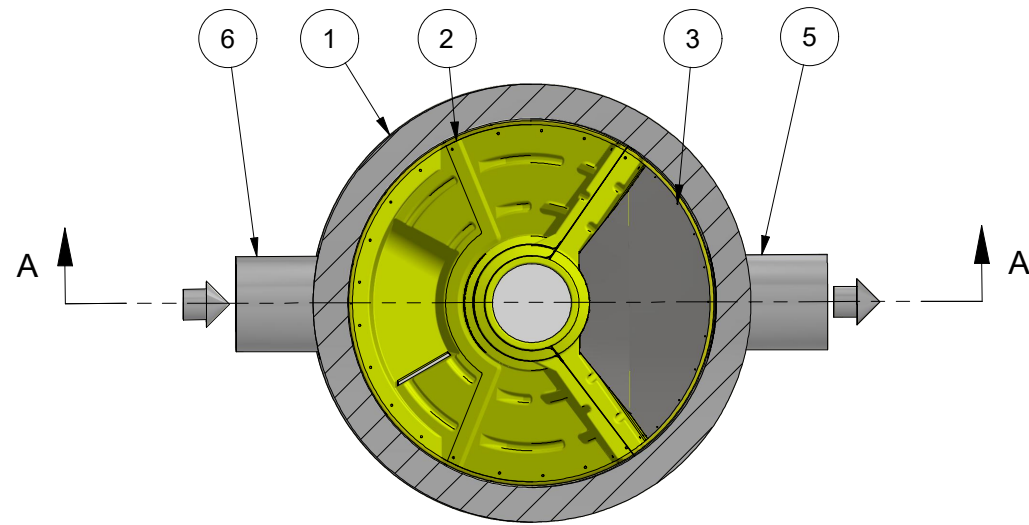
**GENERAL NOTES:**

1. General Arrangement drawings only. Contact Hydro International for site specific drawings.
2. Multiple inlet pipes possible (refer to project plan).
3. Inlet/outlet pipe angle can vary to align with drainage network (refer to project plan.s)
4. Peak flow rate and minimum height limited by available cover and pipe diameter.
5. Larger sediment storage capacity may be provided with a deeper sump depth.

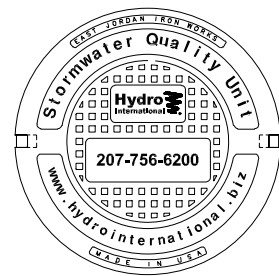
**PARTS LIST**

ITEM	QTY	SIZE (in)	SIZE (mm)	DESCRIPTION
1	1	72	1800	I.D. PRECAST MANHOLE
2	1			INTERNAL COMPONENTS (PRE-INSTALLED)
3	1			5mm TRASH SCREEN (PRE-INSTALLED)
4	1	30	750	FRAME AND COVER (ROUND)
5	1	30 (MAX)	750 (MAX)	OUTLET PIPE (BY OTHERS)
6	1	30 (MAX)	750 (MAX)	INLET PIPE (BY OTHERS)



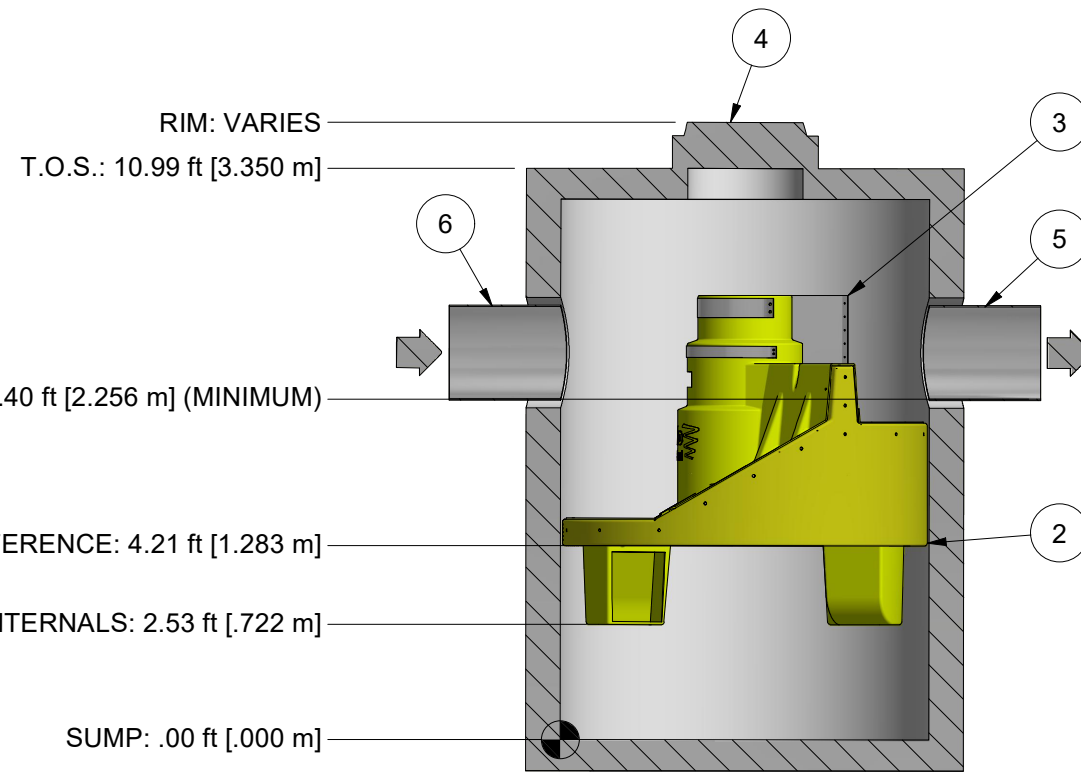


**PLAN VIEW**



**HYDRO FRAME AND COVER (INCLUDED)**

GRADE RINGS BY OTHERS AS REQUIRED



**SECTION A-A**

RIM: VARIES  
T.O.S.: 10.99 ft [3.350 m]  
PIPE INVERTS: 7.40 ft [2.256 m] (MINIMUM)  
PREASSEMBLY REFERENCE: 4.21 ft [1.283 m]  
BOTTOM OF INTERNALS: 2.53 ft [.722 m]  
SUMP: .00 ft [.000 m]

1. MANHOLE WALL AND SLAB THICKNESSES ARE NOT TO SCALE.
2. CONTACT HYDRO INTERNATIONAL FOR A BOTTOM OF STRUCTURE ELEVATION PRIOR TO SETTING FIRST DEFENSE MANHOLE.
3. CONTRACTOR TO CONFIRM RIM, PIPE INVERTS, PIPE DIA. AND PIPE ORIENTATION PRIOR TO RELEASE OF UNIT TO FABRICATION.



**IF IN DOUBT ASK**

DATE: 9/8/2020 SCALE: 1:40  
DRAWN BY: EHR CHECKED BY: APPROVED BY:

Title  
4-ft DIAMETER  
FDHC FULL TRASH CAPTURE

GENERAL ARRANGEMENT



hydro-int.com  
©2020 HYDRO INTERNATIONAL

WEIGHT: 170806 lbmass MATERIAL: Stainless Steel

STOCK NUMBER:

DRAWING NO.: FDHC-S

SHEET SIZE: B SHEET: 1 OF 1 Page 29 of 72

**PRODUCT SPECIFICATION:**

1. Peak Hydraulic Flow: 50.0 cfs (1415 l/s)
2. Maximum Inlet/Outlet Pipe Diameters: 48 in. (1200 mm)
3. For More Product Information Including Regulatory Acceptances, Please Visit <https://hydro-int.com/en/products/first-defense>

**GENERAL NOTES:**

1. General Arrangement drawings only. Contact Hydro International for site specific drawings.
2. Multiple inlet pipes possible (refer to project plan).
3. Inlet/outlet pipe angle can vary to align with drainage network (refer to project plan.s)
4. Peak flow rate and minimum height limited by available cover and pipe diameter.
5. Larger sediment storage capacity may be provided with a deeper sump depth.

PARTS LIST				
ITEM	QTY	SIZE (in)	SIZE (mm)	DESCRIPTION
1	1	96	2400	I.D. PRECAST MANHOLE
2	1			INTERNAL COMPONENTS (PRE-INSTALLED)
3	1			5mm TRASH SCREEN (PRE-INSTALLED)
4	1	30	750	FRAME AND COVER (ROUND)
5	1	48 (MAX)	1200 (MAX)	OUTLET PIPE (BY OTHERS)
6	1	48 (MAX)	1200 (MAX)	INLET PIPE (BY OTHERS)

# APPENDIX B - Specification

## **PART 1 - GENERAL**

### **1.01 SCOPE**

- A. Work described in this section includes furnishing all labor, equipment, materials, tools and incidentals required for a complete and operable installation of the First Defense® High Capacity Full Trash Capture (FDHC FTC) stormwater treatment system as shown on the drawings and specified herein.
- B. The manufacturer shall design and supply the equipment listed herein and the Contractor shall install the equipment in accordance with the manufacturer's Handling, Storage, and Installation Instructions.

### **1.02 GENERAL REQUIREMENTS**

- A. The treatment system shall use an induced vortex to separate pollutants from stormwater runoff. The system shall be self-activating with no mechanical parts or external power requirements.
- B. Upon request, independently certified performance data and references shall be made available to the Engineer of Record for use in determining that the treatment system meets the design criteria and performance requirements stated herein.

### **1.03 SUBMITTALS**

- A. Submittals shall be provided and shall include the following:
  - i. Site plan showing location and orientation of proposed pipe sizes, connections and excavation limits.
  - ii. Product installation drawings showing plan and elevation views with water elevations for the flow conditions specified herein.
  - iii. Performance data as required in Part 2.
  - iv. Inspection and maintenance procedures.

### **1.04 QUALITY ASSURANCE**

- A. The treatment system shall be manufactured under the direction of an ISO 9001 Certified Company.
- B. Inspection

The treatment system shall be subject to inspection by the Engineer of Record or the owner's representative at either the place of manufacture or the project site. Any and all observed defects shall be repaired to the satisfaction of the owner or owner's representative or replacement shall be made available.

C. Warranty

The manufacturer shall guarantee the treatment system free from defects in materials and workmanship for a period of two years following installation. If during the warranty period defects in materials or workmanship are noted, then the manufacturer shall be promptly notified. The decision to repair or replace affected units shall be made at the discretion of the manufacturer.

D. Patent Indemnity

Upon request, the manufacturer shall warrant that the treatment system does not infringe upon or violate any patent, copyright, trade secret or any other proprietary right of any third party and shall indemnify the Owner against any loss, cost, expense or liability arising out of such claim whether or not such claim is successful.

E. Certificate of Compliance

Upon request, the manufacturer shall provide a "Letter of Certification" to certify that the treatment system adheres to the specifications required herein and complies with the project's stormwater management permit.

**1.05 MANUFACTURER**

- A. The treatment system shall be supplied by a manufacturer regularly engaged in such work who has furnished similar installations that have been in successful and continuous operation for a minimum period of five years. The manufacturer shall be a Stormwater Equipment Manufacturer Association (SWEMA) member.

**PART 2 – STORMWATER TREATMENT SYSTEM**

**2.01 General**

- A. The treatment system shall use a tangential inlet chute to establish rotational flow within a cylindrical vortex chamber and be able to treat the Water Quality Flow Rate stated herein without re-suspending and releasing captured sediments.
- B. The treatment system shall be fitted with screens with no more than 5 mm aperture size to provide 100% trash capture as defined by California Water Boards, Full Trash Capture Regulations.
- C. The treatment system shall fit within the limits of excavation (area and depth) as shown in the project plans and will not exceed the dimensions for the design flow rates specified herein.
- D. Minimum 24-inch frame and cover shall provide access to the sediment storage volumes from the surface for inspection and maintenance. Removal of pollutants from the treatment system shall be possible without requiring confined space entry.



## 2.02 Performance

- A. The treatment system shall convey the Peak On-line Flow Rates listed in Table 1 without causing upstream surcharge conditions.
- B. The treatment system shall be capable of capturing and retaining fine silt and sand size particles. Analysis of captured sediment from full-scale field installations shall demonstrate particle sizes predominately in the 20-micron range.

Table 1.

Model Number (ft)	Flow Rate (cfs) for Screen Blinding Percentage			
	0%	25%	50%	75%
FDHC3 FTC	2.93	2.33	1.75	1.17
FDHC4 FTC	7.94	7.10	5.27	3.43
FDHC5 FTC	13.02	10.51	7.87	6.07
FDHC6 FTC	25.6	21.5	16.01	10.66
FDHC8 FTC	34.16	33.75	26.29	16.88
FDHC10 FTC	Not yet set – Planned for 2021			

## **PART 3 – EQUIPMENT**

- A. The treatment system shall be manufactured with materials typically used in stormwater drainage systems that have a minimum life expectancy of 30 years.
  - (i) Materials of construction shall be cross-linked polyethylene (XLPE) and/or Type 304 stainless steel or carbon steel powder coated in accordance with ASTM 775/ ASTM A775M. All components shall be designed to withstand normal loadings associated with fabrication, shipping, site installation, and normal operation of the equipment.
  - (ii) Precast shall be manufactured with concrete that has attained a compressive strength of 4,000 psi after 28 days. The structure shall be reinforced to withstand an HS20-44 loading. Shiplap joints shall be sealed with butyl rubber mastic sealant conforming to ASTM C990. Slab tops shall be suitably reinforced and provided with manhole openings and covers as required. The cast iron manhole frames and covers shall be sized as per the manufacturer’s drawings and shall be in accordance with ASTM A48, CL.35B and AASHTO M105. The masonry fixing bolts shall be Type 304 stainless steel.
  - (iii) All piping connections and ancillary items not listed herein shall be provided by the Contractor.

## **PART 4 - EQUIPMENT DELIVERY**

- A. The treatment components of the treatment system shall be delivered within six weeks of date of approved technical submittal.

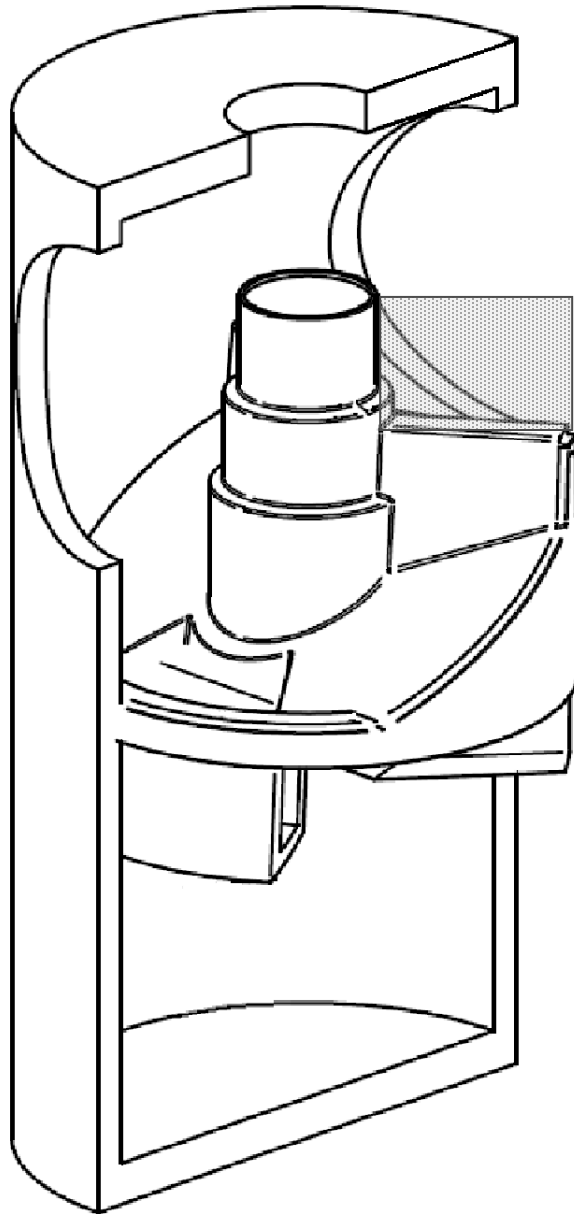
- B. The components of the treatment system shall be preassembled and delivered to the site fully fabricated and ready for the final assembly.
- C. Off-loading, storage, and installation shall be by the Contractor.
- D. The Contractor shall inspect and provide signed acceptance of equipment prior to unloading, or notify the manufacturer of any damage to equipment to effect proper remedial action. Failure to notify the manufacturer of damage to equipment prior to unloading will void all warranties pertaining to subject equipment.

#### **PART 5 - EQUIPMENT INSTALLATION**

- A. The system shall be installed in strict accordance with the site plans, and the manufacturer's general arrangement drawings and Handling, Storage and Installation Instructions. The Contractor shall be responsible for installing the equipment and all necessary site connections.
- B. The Manufacturer shall be notified immediately of any equipment which is damaged during unloading, storage, or installation. The damaged equipment shall be repaired or replaced at the discretion of the manufacturer and entirely at the Contractor's expense.
- C. The precast concrete structure shall be set on a granular or compacted sand sub-base in accordance with local requirements for standard manhole installation. In no instances shall the compacted sub-base material have a thickness of less than 12 inches.
- D. The precast concrete structure shall be set level and plumb to within 0.5%.
- E. Non-shrink grout or hydraulic cement conforming to ASTM C 595 shall be used to provide a water tight seal in the lift holes, any drain holes and around the concrete knock-outs for the inlet and outlet pipes.
- F. The Contractor shall, at the discretion of the owner or owner's representative, test the concrete structure for water tightness before backfilling.

# APPENDIX C - Installation Information

## First Defense<sup>®</sup> High Capacity Full Trash Capture Handling and Installation Instructions



## Materials Supplied By Hydro International



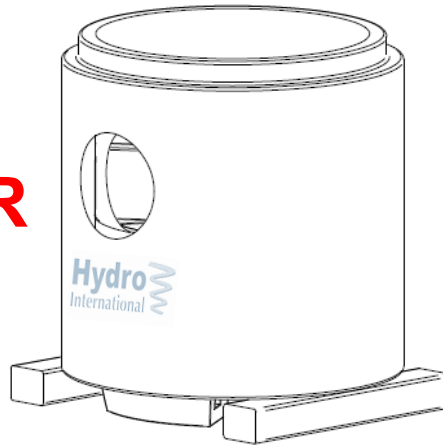
← 3 ft./ 4 ft./ 6 ft./ 8 ft. diameter top slab



← 3 ft./ 4 ft./ 5 ft./ 6 ft./ 8 ft. diameter top riser (s) as necessary per site requirements (see shop drawings)

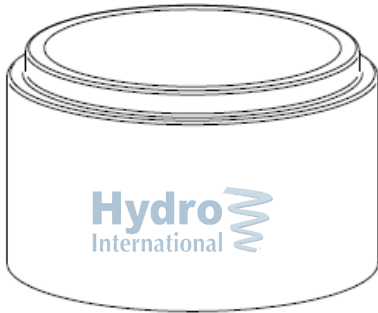


**OR**



← 3 ft./ 4 ft./ 5 ft./ 6 ft./ 8 ft. Middle riser with installed First Defense HCS® Internal components\*

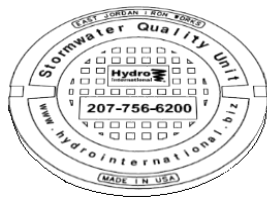
**\*Note: If installed internal components extend beneath riser be sure to set on base section or suitable blocking to prevent damage to system components**



← 3 ft./ 4 ft./ 5 ft./ 6 ft./ 8 ft. diameter base consisting of either a bottom slab and riser or a single monolithic base section

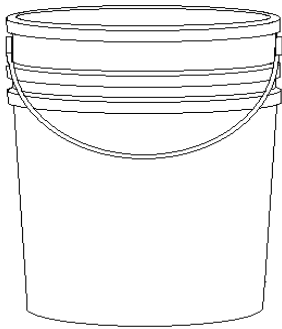


Joint Sealant

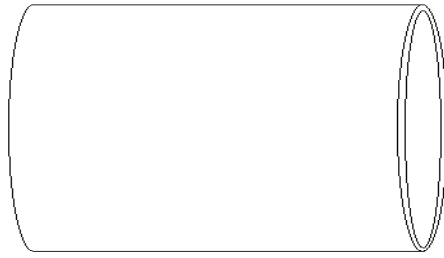


30 in. Frame/Grates/Covers

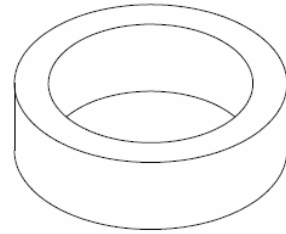
## Materials Supplied By Contractor



Non-Shrinking Grout



Inlet/Outlet Pipes



Applicable Grade  
Rings/Brick and  
Mortar

## Handling and Storage

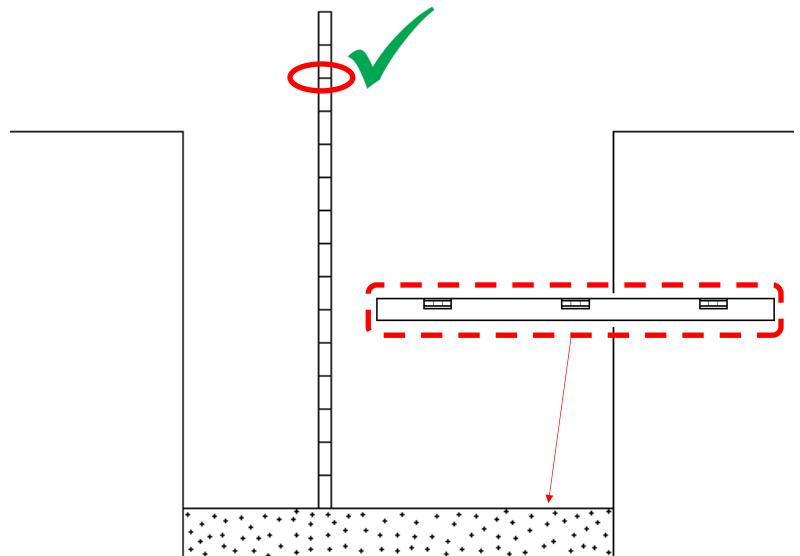
Hydro International's **First Defense**<sup>®</sup> **HC FTC** internal components are manufactured utilizing highly durable thermoplastics; however, improper handling may result in damage to components and accessories. Failure to comply with handling, and installation instructions voids all warranties.

1. Upon delivery of the **First Defense**<sup>®</sup> **HC FTC** components, inspect immediately for defects or shipping damage. If any discrepancies are found, notify Hydro International prior to unloading to initiate corrective action. Unloading of a damaged unit without notifying Hydro International voids all warranties and releases liability of costs to repair or replace from Hydro International and places onto the contractor.
2. At all times during unloading and installation, avoid unnecessary and extreme impacts to the internal components. All components shall be handled with firm and complete support. At no time shall anyone step, stand, or otherwise place an unnecessary load, on the components.
3. The **First Defense**<sup>®</sup> **HC FTC** shall be installed as soon after delivery as practical. Pending installation, all components shall be protected from ultraviolet light, vandalism, and impact.

## Installation

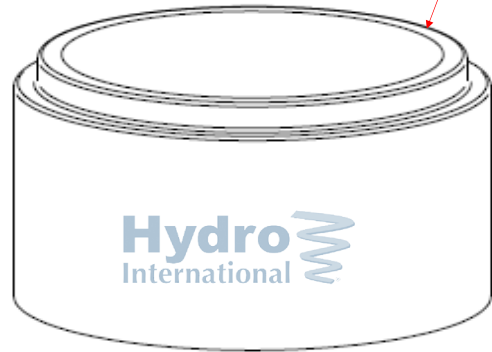
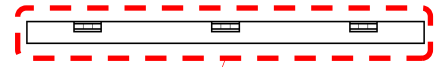
### Step 1

Excavation shall be prepared prior to installation and shall meet all applicable specifications for standards of construction. A sufficient sub-base of compacted stone, leveled and at correct elevation, is required at minimum.



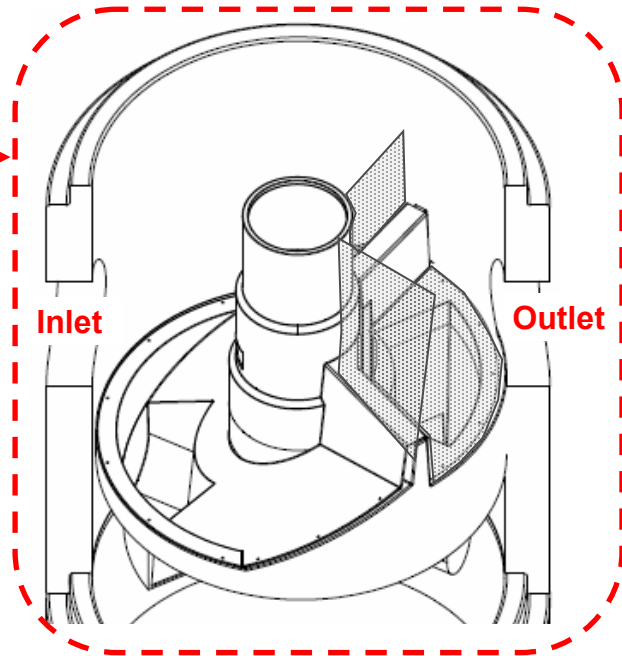
### Step 2

Install the First Defense® HC FTC pre-cast base in properly prepared excavation. Base must be level prior to installation of successive risers.



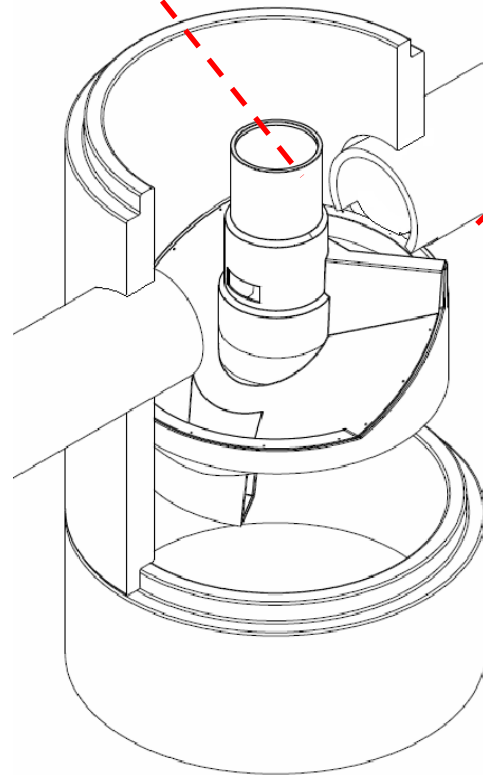
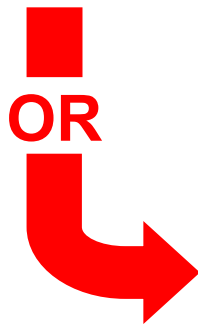
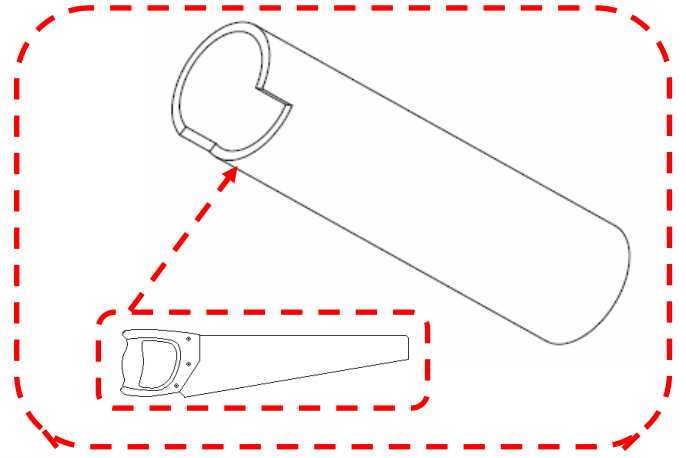
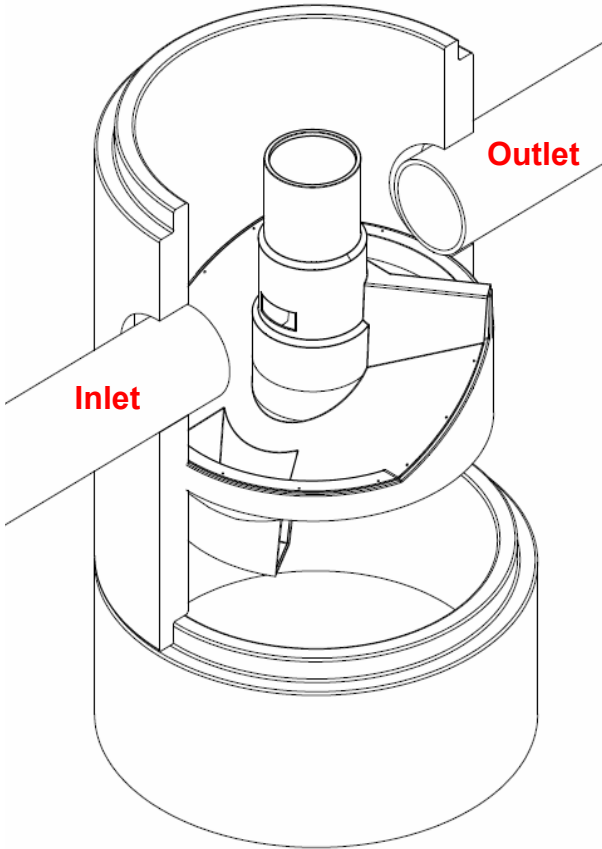
### Step 3

Install successive risers, cleaning joints and placing supplied joint sealant per specifications. Ensure the riser(s) containing the inlet and outlet pipe knockouts is orientated per alignment shown on the engineering drawings. Do not install pre-cast lid. Grout pick holes, if applicable, with watertight non-shrink grout.



### Step 4 -Screens Not Shown for Clarity

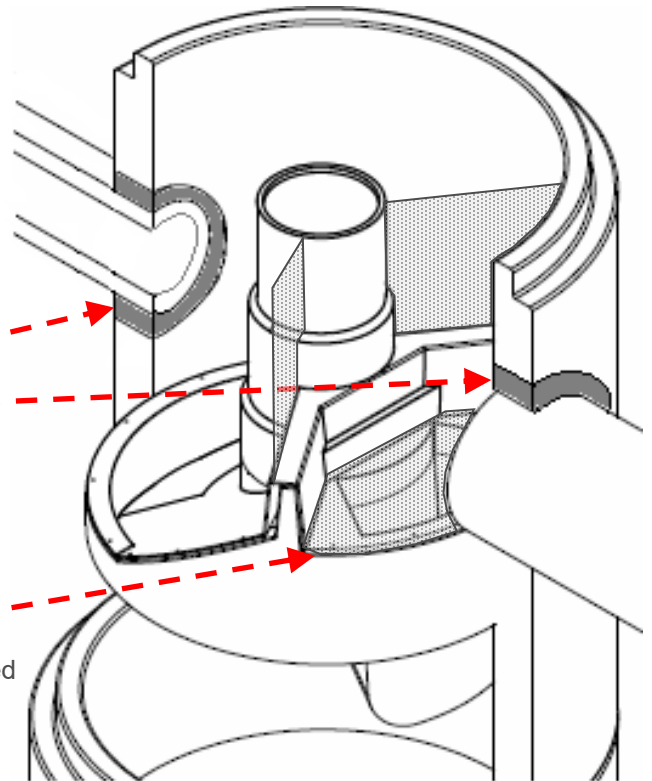
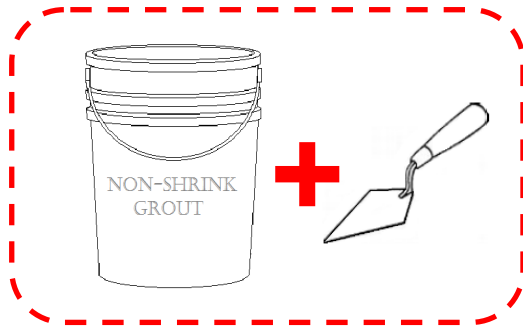
Run inlet and outlet pipes through and center in respective knock-outs. Larger diameter pipes may need to be notched on the bottom at the outlet location if they interfere with the plastic internals. **Invert of the I.D. of the outlet pipe must not fall below the ledge of the FDHCS internal components.**





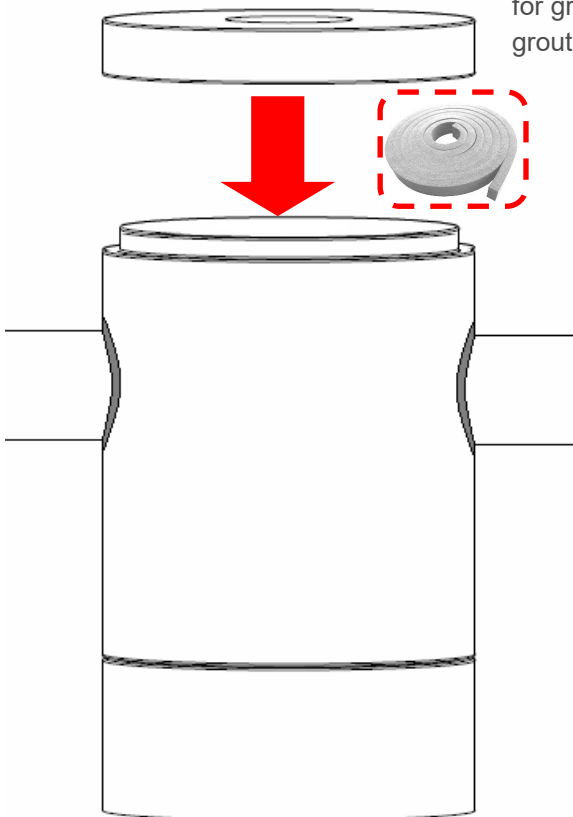
### Step 5

Seal the area between the perimeter of each pipe and the respective cutout with non-shrink grout. Cut the ends of each pipe flush with the interior pre-cast wall. Also ensure grout on the interior is finished to a uniform, smooth surface flush with pre-cast wall. **No grout shall spill inside the unit.**



#### Step 5a

Remove lower screen if required for grouting and reinstall after grouting.

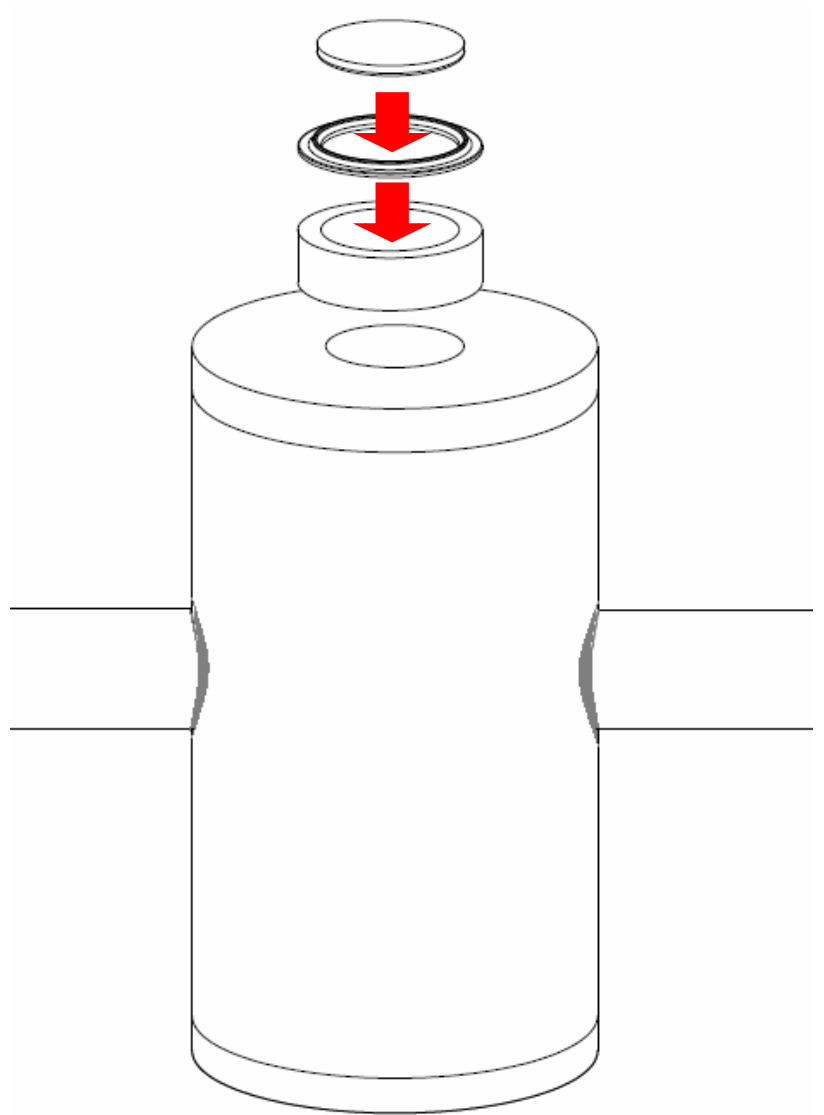


### Step 6

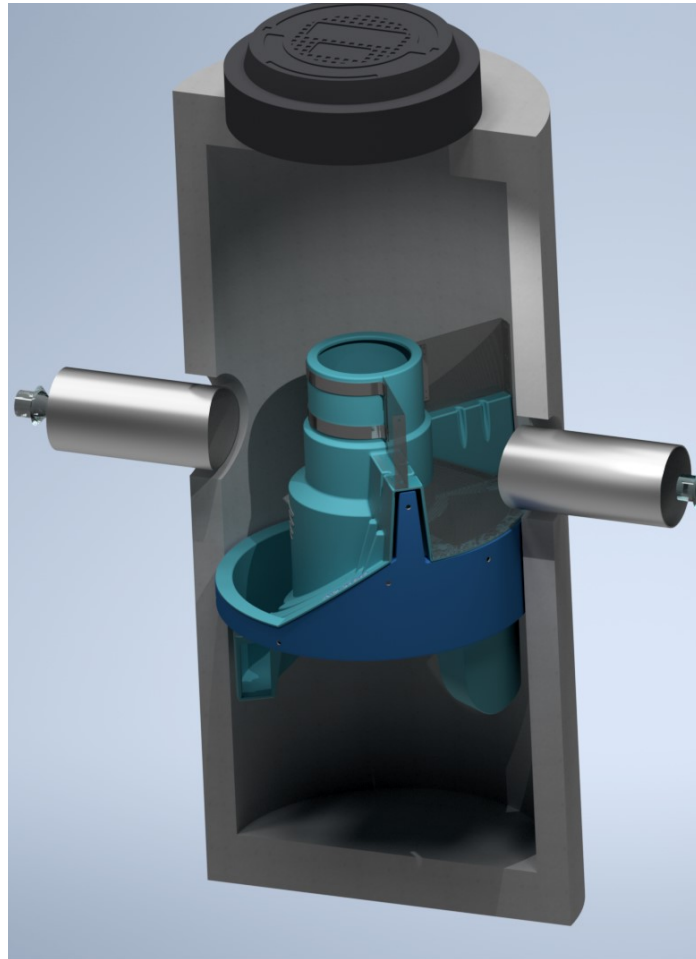
Prepare the upper most riser joint with supplied joint sealant and install pre-cast lid.

### Step 7

Install cast frame(s) and cover(s) using accepted construction standards of adjusting to grade. Carefully backfill around unit.



# APPENDIX D – Operation and Maintenance



## Operation and Maintenance Manual

### **First Defense<sup>®</sup> High Capacity Full Trash Capture**

---

Vortex Separator for Stormwater Treatment and Trash Control

## HYDRO MAINTENANCE SERVICES

Hydro International has been engineering stormwater treatment systems for over 30 years. We understand the mechanics of removing pollutants from stormwater and how to keep systems running at an optimal level.

NOBODY KNOWS OUR SYSTEMS BETTER THAN WE DO



## AVOID SERVICE NEGLIGENCE

Sanitation services providers not intimately familiar with stormwater treatment systems are at risk of the following:

- Inadvertently breaking parts or failing to clean/replace system components appropriately.
- Charging you for more frequent maintenance because they lacked the tools to service your system properly in the first place.
- Billing you for replacement parts that might have been covered under your Hydro warranty plan .
- Charging for maintenance that may not yet have been required.

## LEAVE THE DIRTY WORK TO US

Trash, sediment and polluted water is stored inside treatment systems until they are removed by our team with a vactor truck. Sometimes teams must physically enter the system chambers in order to prepare the system for maintenance and install any replacement parts. Services include but are not limited to:

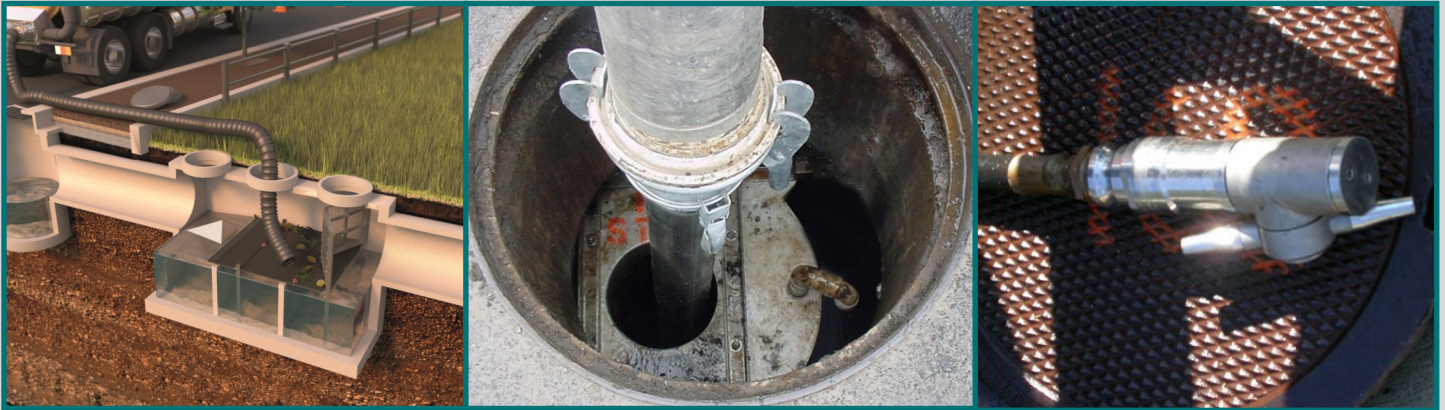
- Solids removal
- Removal of liquid pollutants
- Replacement media installation (when applicable)





## BETTER TOOLS, BETTER RESULTS

Not all vacor trucks are created equal. Appropriate tools and suction power are needed to service stormwater systems appropriately. Companies who don't specialize in stormwater treatment won't have the tools to properly clean systems or install new parts.



## SERVICE WARRANTY

Make sure you're not paying for service that is covered under your warranty plan. Only Hydro International's service teams can identify tune-ups that should be on us, not you.

## TREATMENT SYSTEMS SERVICED BY HYDRO:

- Stormwater filters
- Stormwater separators
- Baffle boxes
- Biofilters/biorention systems
- Storage structures
- Catch basins
- Stormwater ponds
- Permeable pavement



SAVE TIME & MONEY: CALLHYDRO FOR A QUOTE

**1 (800) 382-7808**

LEARN MORE AT [HYDRO-INT.COM/SERVICE](http://HYDRO-INT.COM/SERVICE)



# Table of Contents

- 1 First Defense® High Capacity Full Trash Capture (FDHC FTC) by Hydro International**
  - Introduction
  - Operation
  - Pollutant Capture and Retention
  - Applications
- 2 Model Sizes & Configurations**
  - First Defense® High Capacity Full Trash Capture Components
  - Table of Capacities
- 3 Maintenance**
  - Overview
  - Maintenance Equipment Considerations
  - Determining Your Maintenance Schedule
  - Inspection Procedures
  - Floatables and Sediment Cleanout
- 5 Cleanout Procedures**
- 8 First Defense® High Capacity Full Trash Capture Inspection and Maintenance Log**

---

**COPYRIGHT STATEMENT:** The contents of this manual, including the graphics contained herein, are intended for the use of the recipient to whom the document and all associated information are directed. Hydro International plc owns the copyright of this document, which is supplied in confidence. It must not be used for any purpose other than that for which it is supplied and must not be reproduced, in whole or in part stored in a retrieval system or transmitted in any form or by any means without prior permission in writing from Hydro International plc. First Defense® is a trademarked hydrodynamic vortex separation device of Hydro International plc. A patent covering the First Defense® has been granted.

**DISCLAIMER:** Information and data contained in this manual is exclusively for the purpose of assisting in the operation and maintenance of Hydro International plc's First Defense®. No warranty is given nor can liability be accepted for use of this information for any other purpose. Hydro International plc has a policy of continuous product development and reserves the right to amend specifications without notice.

# I. First Defense® High Capacity Full Trash Capture by Hydro International

## Introduction

The First Defense® High Capacity Full Trash Capture (FDHC FTC) is an enhanced vortex separator that combines an effective and economical stormwater treatment chamber with trash screens and an integral peak flow bypass. It efficiently removes total suspended solids (TSS), trash and hydrocarbons from stormwater runoff.

## Operation

The FDHC FTC operates on simple fluid hydraulics. It is self-activating, has no moving parts, no external power requirement and is fabricated with durable non-corrosive components. No manual procedures are required to operate the unit and maintenance is limited to monitoring accumulations of stored pollutants and periodic clean-outs. The First Defense® HCS has been designed to allow for easy and safe access for inspection, monitoring and clean-out procedures. Neither entry into the unit nor removal of the internal components is necessary for maintenance, thus safety concerns related to confined-space-entry are avoided.

## Pollutant Capture and Retention

The internal components of the FDHC FTC have been designed to optimize trash capture. Sediment is captured and retained in the base of the unit, while oil and floatables are stored on the water surface in the inner volume (Fig.1).

The pollutant storage volumes are isolated from the built-in bypass chamber to prevent washout during high-flow storm events. The sump of the FDHC FTC retains a standing water level between storm events. This ensures a quiescent flow regime at the onset of a storm, preventing resuspension and washout of pollutants captured during previous events.

Accessories such as oil absorbent pads are available for enhanced oil removal and storage. Due to the separation of the oil and floatable storage volume from the outlet, the potential for washout of stored pollutants between clean-outs is minimized.

## Applications

- Stormwater treatment at the point of entry into the drainage line
- Sites constrained by space, topography or drainage profiles with limited slope and depth of cover
- Retrofit installations where stormwater treatment is placed on or tied into an existing storm drain line
- Pretreatment for filters, infiltration and storage

## Advantages

- Inlet options include surface grate or multiple inlet pipes
- Integral high capacity bypass conveys large peak flows without the need for “offline” arrangements using separate junction manholes
- Long flow path through the device ensures a long residence time within the treatment chamber, enhancing pollutant settling
- Maintainable from the surface, no confined space entry

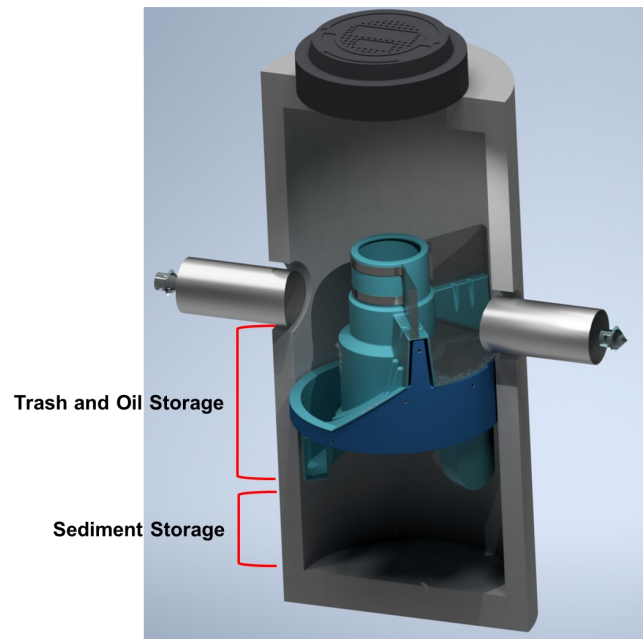


Fig.1 Pollutant storage areas in the FDHC FTC



## II. Model Sizes and Configurations

FDHC FTC models include the internal components that are designed to remove and retain total suspended solids (TSS), gross solids, floatable trash and hydrocarbons (Fig.2). FDHC FTC model parameters and design criteria are shown in Table 1.

### First Defense® HCS Components

- |                       |                     |                  |
|-----------------------|---------------------|------------------|
| 1. Bypass Screens (2) | 4. Outlet Pipe      | 7. Trash Storage |
| 2. Inlet Pipe         | 5. Outlet Chute     | 8. Manhole Cover |
| 3. Inlet Chute        | 6. Sediment Storage | 9. Outlet Screen |

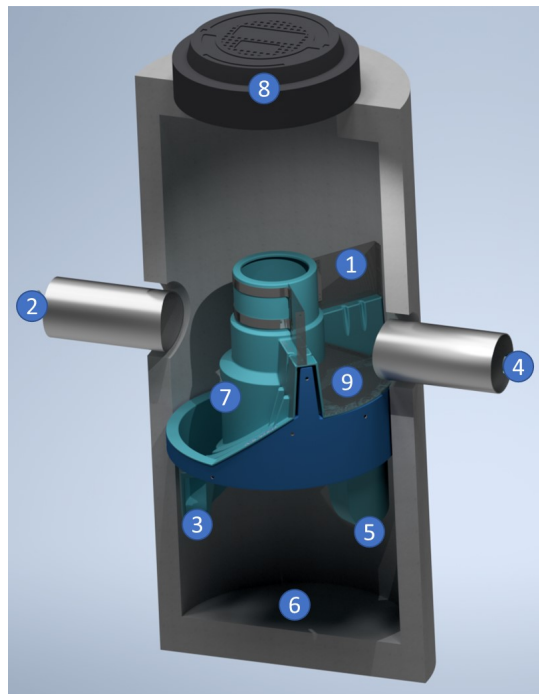


Fig 2 - First Defense® High Capacity FTC Components

Table 1. First Defense® High Capacity Full Trash Capture Capacities

First Defense® HCS Model Number	Diameter	Peak Online Flow Rate	Maximum Pipe Diameter <sup>1</sup>	Trash & Oil Storage Capacity	Typical Sediment Storage Capacity <sup>2</sup>	Minimum Distance from Outlet Invert to Top of Rim <sup>3</sup>	Standard Dis- tance from Outlet invert to Sump Floor
	(ft / m)	(cfs / L/s)	(in / mm)	(yd <sup>3</sup> / m <sup>3</sup> )	(yd <sup>3</sup> / m <sup>3</sup> )	(ft / m)	(ft / m)
FDHC3 FTC	3 / 0.9	15 / 424	18 / 450	0.36 / 0.28	0.4 / 0.3	2.0 - 3.5 / 0.6 - 1.0	3.71 / 1.13
FDHC4 FTC	4 / 1.2	18 / 510	24 / 600	0.83 / 0.63	0.7 / 0.5	2.3 - 3.9 / 0.7 - 1.2	4.97 / 1.5
FDHC5 FTC	5 / 1.5	20 / 566	24 / 600	1.54 / 1.18	1.1 / 0.84	2.5 - 4.5 / 0.7 - 1.3	5.19 / 1.5
FDHC6 FTC	6 / 1.8	32 / 902	30 / 750	2.22 / 1.70	1.6 / 1.2	3.0 - 5.1 / 0.9 - 1.6	5.97 / 1.8
FDHC8 FTC	8 / 2.4	50 / 1415	48 / 1200	5.28 / 4.0	2.8 / 2.1	3.0 - 6.0 / 0.9 - 1.8	7.4 / 2.2
FDHC10 FTC	10 / 3.0	Planned for 2021					

1 Contact Hydro International when larger pipe sizes are required.

2. Contact Hydro International when custom sediment storage capacity is required.

3 Minimum distance for models depends on pipe diameter.

## III. Maintenance

### Overview

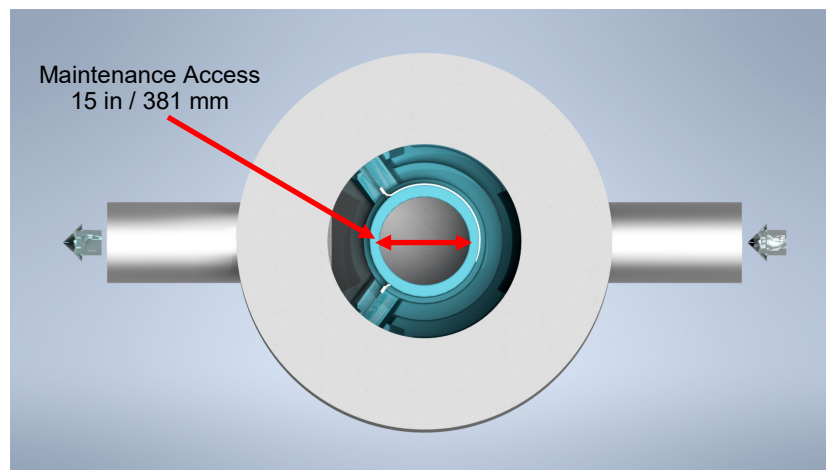
The FDHC FTC protects the environment by removing a wide range of pollutants from stormwater runoff. Periodic removal of these captured pollutants is essential to the continuous, long-term functioning of the FDHC FTC. The FDHC FTC will capture and retain sediment, trash, and oil until the sediment and oil storage volumes are full to capacity. Maximum pollutant storage capacities are provided in Table 1.

The FDHC FTC allows for easy and safe inspection, monitoring and clean-out procedures. A commercially or municipally owned sump-vac is used to remove captured sediment and floatables. Access ports are located in the top of the manhole.

Maintenance events may include Inspection, Oil & Floatables Removal, and Sediment Removal. Maintenance events do not require entry into the FDHC FTC, nor do they require the internal components of the FDHC FTC to be removed. In the case of inspection and floatables removal, a vactor truck is not required. However, a vactor truck is required if the maintenance event is to include oil removal and/or sediment removal.

### Maintenance Equipment Considerations

The internal components of the FDHC FTC have a centrally located circular shaft through which the sediment storage sump can be accessed with a sump vac hose. The open diameter of this access shaft is 15 inches (381 mm) in diameter (Fig.3). Therefore, the nozzle fitting of any vactor hose used for maintenance should be less than 15 inches (381 mm) in diameter.



*Fig.3 - The central opening to the sump of the FDHC FTC is 15 inches (381 mm) in diameter.*

### Determining Your Maintenance Schedule

The frequency of clean out is determined in the field after installation. During the first year of operation, the unit should be inspected every six months to determine the rate of sediment and floatables accumulation. A simple probe such as a Sludge-Judge<sup>®</sup> can be used to determine the level of accumulated sediment stored in the sump. This information can be recorded in the maintenance log (see page 7) to establish a routine maintenance schedule.

The vactor procedure, including both sediment and oil / floatables removal, for a FDHC FTC typically takes 30 to 45 minutes.

## Inspection Procedures

1. Set up any necessary safety equipment around the access port or grate of the FDHC FTC as stipulated by local ordinances. Safety equipment should notify passing pedestrian and road traffic that work is being done.
2. Remove the lid to the manhole.
3. Without entering the vessel, look down into the chamber to inspect the inside. Make note of any irregularities.
4. Note the amount of trash contained and estimate the volume.
5. Using a sediment probe such as a Sludge Judge<sup>®</sup>, measure the depth of sediment that has collected in the sump of the vessel.
6. On the Maintenance Log (see page 7), record the date, unit location, estimated volume of floatables and gross debris, and the depth of sediment measured. Also note any apparent irregularities such as damaged components or blockages.
7. Securely replace the grate or lid.
8. Take down safety equipment.
9. Notify Hydro International of any irregularities noted during inspection.

## Floatables and Sediment Clean Out

1. Take care not to damage the screens.
2. Floatables clean out is typically done in conjunction with sediment removal. A commercially or municipally owned sump-vac is used to remove captured sediment and floatables.
3. Floatables and loose debris can also be netted with a skimmer and pole. The access port located at the top of the manhole provides unobstructed access for a vactor hose and skimmer pole to be lowered to the base of the sump.
4. Once trash has been removed place the vacuum hose down the center shaft and draw the water volume down to the sump and jet wash the screens and interior into the sump while continuing to vacuum from the sump.
5. On the Maintenance Log provided by Hydro International record the date, unit location, estimated volumes of floatables and gross debris, and the sediment depth. Also note anything that may be irregular or obviously needing further attention.
6. Once cleaned remove vacuum hose and replace the manhole lid.

## Scheduling

- Floatables and sump clean out are typically done once or twice a year.
- The device should be cleaned following an oil or other contamination spill in the contributing area.
- Cold climates may require an early summer clean to remove winter grit loads.

## Recommended Equipment

- Safety Equipment (traffic cones, etc.)
- Crow bar or other tool to remove grate or lid
- Pole with skimmer or net (if only floatables are being removed)
- Sediment probe (such as a Sludge Judge<sup>®</sup>)
- Vactor truck (flexible hose recommended)
- FDHC FTC Maintenance Log

Action	Timing
Inspection	<ul style="list-style-type: none"> <li>• Regular (recommended 2 - 4 times a year in the first year depending on expected pollutant load)</li> <li>• Every 6 (six) months after first year of operation or more frequently if pollutant loads indicate a need</li> </ul>
Oils and Floatables Removal	<ul style="list-style-type: none"> <li>• Remove as part of regular cleaning schedule</li> </ul>
Sediment Removal	<ul style="list-style-type: none"> <li>• Once a year or more frequently if inspections indicate</li> <li>• Never more then 2 years apart to avoid sediment compaction in the sump</li> </ul>
<p>NOTE: For most clean outs the entire volume of liquid does not need to be removed from the manhole. Only remove the first few inches of oils and floatables from the water surface to reduce the total volume of liquid removed during a clean out. Some vector systems air aspirate and will require the entire water volume to be removed.</p>	

## First Defense® High Capacity FTC Installation Log

REFERENCE NUMBER:	
SITE NAME:	SITE ADDRESS:
OWNER:	CONTRACTOR:
CONTACT NAME:	CONTACT NAME:
COMPANY:	COMPANY:
ADDRESS:	ADDRESS:
PHONE:	PHONE:
EMAIL:	EMAIL:

**INSTALLATION DATE:**                    /   /

**SIZE (CIRCLE):**                    3ft    4ft    5ft    6ft    8ft

**NOTES:**









DO IT RIGHT THE FIRST TIME

LEARN MORE AT [HYDRO-INT.COM/SERVICE](http://HYDRO-INT.COM/SERVICE)



CALL 1 (888) 382-7808 TO SCHEDULE AN APPOINTMENT

## Stormwater Solutions

94 Hutchins Drive  
Portland, ME 04102

Tel: (207)756-6200

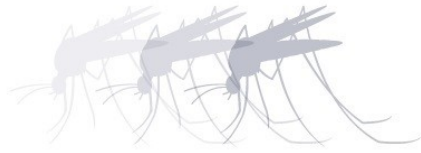
Fax: (207) 756-6212

[StormwaterInquiry@hydro-int.com](mailto:StormwaterInquiry@hydro-int.com)

[www.hydro-int.com](http://www.hydro-int.com)

Turning Water Around...®

# APPENDIX E – MVCAC Letter



**MVCAC**  
Mosquito and Vector Control Association of California

One Capitol Mall, Suite 800 • Sacramento, CA 95814 • p: (916) 440-0826 • f: (916) 444-7462 • e: [mvcac@mvcac.org](mailto:mvcac@mvcac.org)

Mr. Phillip Taylor  
Hydro International  
94 Hutchins Drive  
Portland, Maine 04102

August 20, 2020

Dear Mr. Taylor,

Thank you for the submission of the Hydro International First Defense High Capacity full capture device application for review by the Mosquito and Vector Control Association of California pursuant to the SWRCB Trash Treatment Control Device Application Requirements. The Association has reviewed the conceptual drawings for the First Defense High Capacity device and verifies that provisions have been included in the design that allow for full visual access to all areas for presence of standing water, and when necessary, allows for treatments of mosquitoes.

The mosquito minimization measures described in Section 6.b. and illustrated in Diagram 6 of the application is not required as part of this review. Mosquito exclusion measures are appreciated, but should be vetted by the local mosquito control agency prior to their inclusion into a system.

While this verification letter confirms that inspection and treatment for the purpose of minimizing mosquito production should be possible with the First Defense High Capacity device as presented, it does not affect the local mosquito control agency's rights and remedies under the State Mosquito Abatement and Vector Control District Law. For example, if the installed device or the associated stormwater system infrastructure becomes a mosquito breeding source, it may be determined by a local mosquito control agency to be a public nuisance in accordance with California Health and Safety Code sections 2060-2067.

“Public nuisance” means any of the following:

1. Any property, excluding water, that has been artificially altered from its natural condition so that it now supports the development, attraction, or harborage of

- vectors. The presence of vectors in their developmental stages on a property is prima facie evidence that the property is a public nuisance.
2. Any water that is a breeding place for vectors. The presence of vectors in their developmental stages in the water is prima facie evidence that the water is a public nuisance.
  3. Any activity that supports the development, attraction, or harborage of vectors, or that facilitates the introduction or spread of vectors. (Heal. & Saf. Code § 2002 (j).)

Declaration of a facility or property as a public nuisance may result in penalties as provided under the Health and Safety Code. Municipalities and the vendors they work with are encouraged to discuss the design, installation, and maintenance of stormwater trash capture devices with their local mosquito control agency to reduce the potential for disease transmission and public nuisance associated with mosquito production.

Sincerely,

A handwritten signature in black ink, appearing to read 'Bob Achermann', with a long horizontal flourish extending to the right.

Bob Achermann,  
MVCAC Executive Director

# APPENDIX F – Warranty

### Stormwater Equipment Limited Product Warranty

Hydro International's equipment, including the DOWNSTREAM DEFENDER®, FIRST DEFENSE®, UP-FLO® FILTER, HYDRO DRYSCREEN®, HYDRO STORMSCAPE™, HYDRO-BRAKE® or REG-U-FLO® Vortex Flow Control, is backed by the following warranty:

Hydro International warrants all of its products to be free from defects in materials and workmanship; and will replace, repair, or reimburse at its discretion any part or parts which, after Hydro's examination, Hydro shall have determined to have failed under normal use and service by the original user within two years following initial installation. Such repair or replacement shall be free of charge for all items except for (i) those items that are consumable and normally replaced during maintenance, (ii) labor costs incurred by Hydro to obtain access to the part or unit for repair or replacement, (iii) any costs to repair or replace any surface treatment / cover after repair or replacement or (iv) other charges that Hydro may incur incident to such repair or replacement. Repair or replacement of such consumable items shall be subject to assessment of a pro-rated charge based upon Hydro International's estimate of the percentage of normal service life realized by the item. Hydro International's obligation under this Warranty is conditioned upon (a) its receiving prompt notice of claimed defects which shall in no event be later than thirty (30) days following expiration of the above warranty period and (b) owner of the product properly operating, inspecting, maintaining and caring for the product and is limited to repair or replacement as aforesaid. Purchaser agrees that the foregoing warranty is Purchaser's sole remedy under any legal theory whether pleaded in contract, tort, or otherwise.

THIS WARRANTY IS EXPRESSLY MADE BY HYDRO INTERNATIONAL AND ACCEPTED BY PURCHASER IN LIEU OF ALL OTHER WARRANTIES, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE, WHETHER WRITTEN, ORAL, EXPRESS, IMPLIED, OR STATUTORY. HYDRO INTERNATIONAL NEITHER ASSUMES, NOR AUTHORIZES ANY OTHER PERSON TO ASSUME FOR IT, ANY OTHER LIABILITIES WITH RESPECT TO ITS EQUIPMENT INCLUDING NEGLIGENCE IN DESIGN OR MANUFACTURE AND PURCHASER AGREES THAT THIS WARRANTY AND THE OBLIGATIONS OF HYDRO INTERNATIONAL SET FORTH HEREIN ARE THE SOLE REMEDIES AVAILABLE TO PURCHASER FOR THE FAILURE OF ANY PRODUCT TO PERFORM AS WARRANTED. HYDRO INTERNATIONAL SHALL NEITHER BE LIABLE FOR NORMAL WEAR AND TEAR NOR FOR INCIDENTAL OR CONSEQUENTIAL DAMAGE DUE TO USE OR INOPERABILITY OF ITS EQUIPMENT FOR ANY REASON WHATSOEVER.

This Warranty shall not apply to equipment or parts thereof which have been altered or repaired outside of an authorized Hydro International facility or fabricator, or damaged by improper handling, installation, or application, or subject to misuse, abuse, neglect, accident or improper or inadequate maintenance. The Contractor shall inspect and provide signed acceptance of equipment prior to unloading, or notify Hydro International of any damage to equipment to effect proper remedial action.

Failure to notify Hydro International of damage to equipment prior to unloading will void all warranties pertaining to subject equipment.

# APPENDIX G – Screen Hydraulics

## First Defense High Capacity Full Trash Capture

### Screen Blinding Calculation Explanation

The methodology used for calculating the unit flow assumed that all flow passed through the screens and each screen was modeled assuming a 51% open area of the screen material. To simplify the simulation, the outlet screen was considered a horizontal circular orifice with a starting area of 51% of the outlet screen area. The weir screens were considered a vertical rectangular orifice, with the same 51% open starting area.

HydroCAD was used to model the units, in standard catch basins with pipe sizing adjusted so the limit of flow was the screens. Two flow paths were used, one passing through the molded internals and out the outlet screen. The second flow path passed over the molded unit weir and the vertical weir screen, both flow paths converged before being routed out the outlet pipe. The HydroCAD simulation was run by adjusting the orifice multiplication factor to simulate blinding of the screens. Units were considered full flowing when the flow began overtopping the weir screen.

%Blinding	3ft FDHC Full Trash Capture	4ft FDHC Full Trash Capture	5ft FDHC Full Trash Capture	6ft Full Trash Capture	8ft Full Trash Capture
0	2.93 cfs	7.94 cfs	13.02 cfs	25.6 cfs	34.16 cfs
25	2.33 cfs	7.1 cfs	10.51 cfs	21.5 cfs	33.75 cfs
50	1.75 cfs	5.27 cfs	7.87 cfs	16.01 cfs	26.29 cfs
75	1.17 cfs	3.43 cfs	6.07 cfs	10.66 cfs	16.88 cfs



**FD-HCS Calcs**

Constant Intensity scaled to 100.00 hrs Rainfall=10.00"

Prepared by Hydro International

Printed 10/13/2020

HydroCAD® 10.10-4a s/n 03484 © 2020 HydroCAD Software Solutions LLC

Page 1

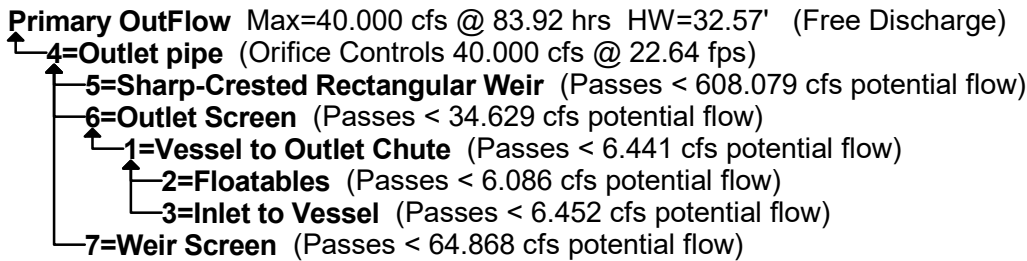
**Summary for Pond 28P: 4ft FD all in one**

[57] Hint: Peaked at 32.57' (Flood elevation advised)

Inflow = 40.000 cfs @ 83.92 hrs, Volume= 8,359,780 cf  
 Outflow = 40.000 cfs @ 83.92 hrs, Volume= 8,359,780 cf, Atten= 0%, Lag= 0.0 min  
 Primary = 40.000 cfs @ 83.92 hrs, Volume= 8,359,780 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.01 hrs / 3  
 Peak Elev= 32.57' @ 83.92 hrs

Device	Routing	Invert	Outlet Devices
#1	Device 6	-2.73'	<b>5.0" W x 9.0" H Vert. Vessel to Outlet Chute</b> C= 0.450 Limited to weir flow at low heads
#2	Device 1	0.25'	<b>8.0" W x 4.0" H Vert. Floatables</b> C= 0.600 Limited to weir flow at low heads
#3	Device 1	-2.73'	<b>5.0" W x 9.0" H Vert. Inlet to Vessel</b> C= 0.450 Limited to weir flow at low heads
#4	Primary	0.00'	<b>18.0" Vert. Outlet pipe</b> C= 0.500 Limited to weir flow at low heads
#5	Device 4	2.00'	<b>2.2' long Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)
#6	Device 4	0.00'	<b>15.2" Horiz. Outlet Screen</b> C= 0.600 Limited to weir flow at low heads
#7	Device 4	0.77'	<b>20.0" W x 17.4" H Vert. Weir Screen</b> C= 0.600 Limited to weir flow at low heads



**FD-HCS Calcs**

Constant Intensity scaled to 100.00 hrs Rainfall=10.00"

Prepared by Hydro International

Printed 10/13/2020

HydroCAD® 10.10-4a s/n 03484 © 2020 HydroCAD Software Solutions LLC

Page 2

**Stage-Discharge for Pond 28P: 4ft FD all in one**

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
-2.73	0.000	1.43	4.218	5.59	15.599	9.75	21.272
-2.65	0.000	1.51	4.792	5.67	15.728	9.83	21.366
-2.57	0.000	1.59	5.396	5.75	15.855	9.91	21.460
-2.49	0.000	1.67	6.026	5.83	15.981	9.99	21.554
-2.41	0.000	1.75	6.683	5.91	16.107	10.07	21.647
-2.33	0.000	1.83	7.365	5.99	16.231	10.15	21.739
-2.25	0.000	1.91	7.637	6.07	16.355	10.23	21.832
-2.17	0.000	1.99	7.896	6.15	16.477	10.31	21.924
-2.09	0.000	2.07	8.147	6.23	16.599	10.39	22.015
-2.01	0.000	2.15	8.390	6.31	16.719	10.47	22.106
-1.93	0.000	2.23	8.626	6.39	16.839	10.55	22.197
-1.85	0.000	2.31	8.856	6.47	16.958	10.63	22.288
-1.77	0.000	2.39	9.080	6.55	17.077	10.71	22.378
-1.69	0.000	2.47	9.299	6.63	17.194	10.79	22.467
-1.61	0.000	2.55	9.513	6.71	17.310	10.87	22.557
-1.53	0.000	2.63	9.722	6.79	17.426	10.95	22.646
-1.45	0.000	2.71	9.927	6.87	17.541	11.03	22.734
-1.37	0.000	2.79	10.127	6.95	17.656	11.11	22.823
-1.29	0.000	2.87	10.324	7.03	17.769	11.19	22.911
-1.21	0.000	2.95	10.517	7.11	17.882	11.27	22.998
-1.13	0.000	3.03	10.707	7.19	17.994	11.35	23.085
-1.05	0.000	3.11	10.893	7.27	18.105	11.43	23.172
-0.97	0.000	3.19	11.076	7.35	18.216	11.51	23.259
-0.89	0.000	3.27	11.256	7.43	18.326	11.59	23.345
-0.81	0.000	3.35	11.433	7.51	18.436	11.67	23.431
-0.73	0.000	3.43	11.608	7.59	18.544	11.75	23.517
-0.65	0.000	3.51	11.780	7.67	18.653	11.83	23.602
-0.57	0.000	3.59	11.949	7.75	18.760	11.91	23.687
-0.49	0.000	3.67	12.116	7.83	18.867	11.99	23.772
-0.41	0.000	3.75	12.281	7.91	18.973	12.07	23.857
-0.33	0.000	3.83	12.444	7.99	19.079	12.15	23.941
-0.25	0.000	3.91	12.605	8.07	19.184	12.23	24.025
-0.17	0.000	3.99	12.763	8.15	19.289	12.31	24.108
-0.09	0.000	4.07	12.920	8.23	19.393	12.39	24.191
-0.01	0.000	4.15	13.074	8.31	19.496	12.47	24.274
0.07	0.022	4.23	13.227	8.39	19.599	12.55	24.357
0.15	0.101	4.31	13.379	8.47	19.701	12.63	24.440
0.23	0.233	4.39	13.528	8.55	19.803	12.71	24.522
0.31	0.417	4.47	13.676	8.63	19.904	12.79	24.604
0.39	0.647	4.55	13.822	8.71	20.005	12.87	24.685
0.47	0.774	4.63	13.967	8.79	20.105	12.95	24.767
0.55	0.837	4.71	14.110	8.87	20.205	13.03	24.848
0.63	0.896	4.79	14.252	8.95	20.304	13.11	24.928
0.71	0.951	4.87	14.392	9.03	20.403	13.19	25.009
0.79	1.018	4.95	14.531	9.11	20.502	13.27	25.089
0.87	1.222	5.03	14.669	9.19	20.599	13.35	25.169
0.95	1.508	5.11	14.806	9.27	20.697	13.43	25.249
1.03	1.855	5.19	14.941	9.35	20.794	13.51	25.329
1.11	2.250	5.27	15.075	9.43	20.890	13.59	25.408
1.19	2.687	5.35	15.208	9.51	20.986	13.67	25.487
1.27	3.163	5.43	15.339	9.59	21.082	13.75	25.566
1.35	3.674	5.51	15.470	9.67	21.177	13.83	25.644

**Stage-Discharge for Pond 28P: 4ft FD all in one (continued)**

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
13.91	25.723	18.07	29.509	22.23	32.863	26.39	35.904
13.99	25.801	18.15	29.577	22.31	32.924	26.47	35.960
14.07	25.878	18.23	29.645	22.39	32.985	26.55	36.016
14.15	25.956	18.31	29.713	22.47	33.046	26.63	36.072
14.23	26.033	18.39	29.781	22.55	33.107	26.71	36.127
14.31	26.110	18.47	29.848	22.63	33.167	26.79	36.183
14.39	26.187	18.55	29.915	22.71	33.228	26.87	36.239
14.47	26.264	18.63	29.983	22.79	33.288	26.95	36.294
14.55	26.341	18.71	30.050	22.87	33.349	27.03	36.349
14.63	26.417	18.79	30.116	22.95	33.409	27.11	36.405
14.71	26.493	18.87	30.183	23.03	33.469	27.19	36.460
14.79	26.569	18.95	30.250	23.11	33.529	27.27	36.515
14.87	26.644	19.03	30.316	23.19	33.589	27.35	36.570
14.95	26.720	19.11	30.382	23.27	33.649	27.43	36.625
15.03	26.795	19.19	30.448	23.35	33.709	27.51	36.680
15.11	26.870	19.27	30.514	23.43	33.768	27.59	36.735
15.19	26.944	19.35	30.580	23.51	33.828	27.67	36.789
15.27	27.019	19.43	30.646	23.59	33.887	27.75	36.844
15.35	27.093	19.51	30.712	23.67	33.946	27.83	36.899
15.43	27.167	19.59	30.777	23.75	34.006	27.91	36.953
15.51	27.241	19.67	30.842	23.83	34.065	27.99	37.007
15.59	27.315	19.75	30.907	23.91	34.124	28.07	37.062
15.67	27.389	19.83	30.972	23.99	34.182	28.15	37.116
15.75	27.462	19.91	31.037	24.07	34.241	28.23	37.170
15.83	27.535	19.99	31.102	24.15	34.300	28.31	37.224
15.91	27.608	20.07	31.167	24.23	34.359	28.39	37.278
15.99	27.681	20.15	31.231	24.31	34.417	28.47	37.332
16.07	27.753	20.23	31.295	24.39	34.475	28.55	37.386
16.15	27.826	20.31	31.360	24.47	34.534	28.63	37.440
16.23	27.898	20.39	31.424	24.55	34.592	28.71	37.493
16.31	27.970	20.47	31.488	24.63	34.650	28.79	37.547
16.39	28.042	20.55	31.551	24.71	34.708	28.87	37.600
16.47	28.113	20.63	31.615	24.79	34.766	28.95	37.654
16.55	28.185	20.71	31.679	24.87	34.824	29.03	37.707
16.63	28.256	20.79	31.742	24.95	34.881	29.11	37.761
16.71	28.327	20.87	31.805	25.03	34.939	29.19	37.814
16.79	28.398	20.95	31.868	25.11	34.996	29.27	37.867
16.87	28.469	21.03	31.931	25.19	35.054	29.35	37.920
16.95	28.539	21.11	31.994	25.27	35.111	29.43	37.973
17.03	28.610	21.19	32.057	25.35	35.168	29.51	38.026
17.11	28.680	21.27	32.120	25.43	35.226	29.59	38.079
17.19	28.750	21.35	32.182	25.51	35.283	29.67	38.132
17.27	28.820	21.43	32.245	25.59	35.340	29.75	38.184
17.35	28.889	21.51	32.307	25.67	35.396	29.83	38.237
17.43	28.959	21.59	32.369	25.75	35.453	29.91	38.289
17.51	29.028	21.67	32.431	25.83	35.510	29.99	38.342
17.59	29.098	21.75	32.493	25.91	35.566	30.07	38.394
17.67	29.167	21.83	32.555	25.99	35.623	30.15	38.447
17.75	29.235	21.91	32.617	26.07	35.679	30.23	38.499
17.83	29.304	21.99	32.679	26.15	35.736	30.31	38.551
17.91	29.373	22.07	32.740	26.23	35.792	30.39	38.603
17.99	29.441	22.15	32.801	26.31	35.848	30.47	38.655

**FD-HCS Calcs***Constant Intensity scaled to 100.00 hrs Rainfall=10.00"*

Prepared by Hydro International

Printed 10/13/2020

HydroCAD® 10.10-4a s/n 03484 © 2020 HydroCAD Software Solutions LLC

Page 4

**Stage-Discharge for Pond 28P: 4ft FD all in one (continued)**

Elevation (feet)	Primary (cfs)
30.55	38.707
30.63	38.759
30.71	38.811
30.79	38.863
30.87	38.915
30.95	38.966
31.03	39.018
31.11	39.069
31.19	39.121
31.27	39.172
31.35	39.223
31.43	39.275
31.51	39.326
31.59	39.377
31.67	39.428
31.75	39.479
31.83	39.530
31.91	39.581
31.99	39.632
32.07	39.682
32.15	39.733
32.23	39.783
32.31	39.834
32.39	39.884
32.47	39.935
32.55	39.985
32.63	40.035
32.71	<b>40.086</b>

**FD-HCS Calcs**

Constant Intensity scaled to 100.00 hrs Rainfall=10.00"

Prepared by Hydro International

Printed 10/13/2020

HydroCAD® 10.10-4a s/n 03484 © 2020 HydroCAD Software Solutions LLC

Page 1

**Summary for Pond 41P: 4ft FD 50**

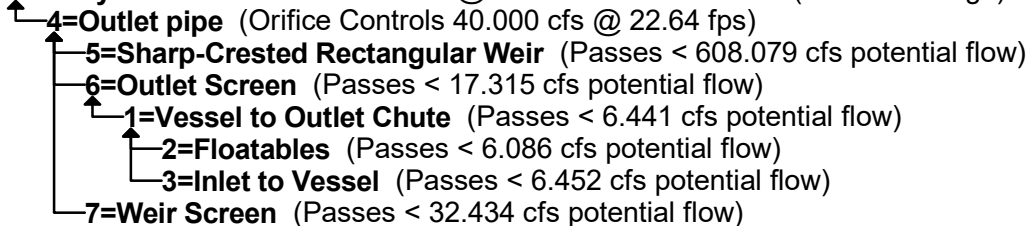
[57] Hint: Peaked at 32.57' (Flood elevation advised)

Inflow = 40.000 cfs @ 83.92 hrs, Volume= 8,359,780 cf  
 Outflow = 40.000 cfs @ 83.92 hrs, Volume= 8,359,780 cf, Atten= 0%, Lag= 0.0 min  
 Primary = 40.000 cfs @ 83.92 hrs, Volume= 8,359,780 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.01 hrs / 3  
 Peak Elev= 32.57' @ 83.92 hrs

Device	Routing	Invert	Outlet Devices
#1	Device 6	-2.73'	<b>5.0" W x 9.0" H Vert. Vessel to Outlet Chute</b> C= 0.450 Limited to weir flow at low heads
#2	Device 1	0.25'	<b>8.0" W x 4.0" H Vert. Floatables</b> C= 0.600 Limited to weir flow at low heads
#3	Device 1	-2.73'	<b>5.0" W x 9.0" H Vert. Inlet to Vessel</b> C= 0.450 Limited to weir flow at low heads
#4	Primary	0.00'	<b>18.0" Vert. Outlet pipe</b> C= 0.500 Limited to weir flow at low heads
#5	Device 4	2.00'	<b>2.2' long Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)
#6	Device 4	0.00'	<b>15.2" Horiz. Outlet Screen X 0.50</b> C= 0.600 Limited to weir flow at low heads
#7	Device 4	0.77'	<b>20.0" W x 17.4" H Vert. Weir Screen X 0.50</b> C= 0.600 Limited to weir flow at low heads

**Primary OutFlow** Max=40.000 cfs @ 83.92 hrs HW=32.57' (Free Discharge)



**FD-HCS Calcs**

Constant Intensity scaled to 100.00 hrs Rainfall=10.00"

Prepared by Hydro International

Printed 10/13/2020

HydroCAD® 10.10-4a s/n 03484 © 2020 HydroCAD Software Solutions LLC

Page 2

**Stage-Discharge for Pond 41P: 4ft FD 50**

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
-2.73	0.000	1.43	2.784	5.59	15.599	9.75	21.272
-2.65	0.000	1.51	3.090	5.67	15.728	9.83	21.366
-2.57	0.000	1.59	3.409	5.75	15.855	9.91	21.460
-2.49	0.000	1.67	3.742	5.83	15.981	9.99	21.554
-2.41	0.000	1.75	4.088	5.91	16.107	10.07	21.647
-2.33	0.000	1.83	4.446	5.99	16.231	10.15	21.739
-2.25	0.000	1.91	4.816	6.07	16.355	10.23	21.832
-2.17	0.000	1.99	5.197	6.15	16.477	10.31	21.924
-2.09	0.000	2.07	5.721	6.23	16.599	10.39	22.015
-2.01	0.000	2.15	6.403	6.31	16.719	10.47	22.106
-1.93	0.000	2.23	7.178	6.39	16.839	10.55	22.197
-1.85	0.000	2.31	7.962	6.47	16.958	10.63	22.288
-1.77	0.000	2.39	8.763	6.55	17.077	10.71	22.378
-1.69	0.000	2.47	9.299	6.63	17.194	10.79	22.467
-1.61	0.000	2.55	9.513	6.71	17.310	10.87	22.557
-1.53	0.000	2.63	9.722	6.79	17.426	10.95	22.646
-1.45	0.000	2.71	9.927	6.87	17.541	11.03	22.734
-1.37	0.000	2.79	10.127	6.95	17.656	11.11	22.823
-1.29	0.000	2.87	10.324	7.03	17.769	11.19	22.911
-1.21	0.000	2.95	10.517	7.11	17.882	11.27	22.998
-1.13	0.000	3.03	10.707	7.19	17.994	11.35	23.085
-1.05	0.000	3.11	10.893	7.27	18.105	11.43	23.172
-0.97	0.000	3.19	11.076	7.35	18.216	11.51	23.259
-0.89	0.000	3.27	11.256	7.43	18.326	11.59	23.345
-0.81	0.000	3.35	11.433	7.51	18.436	11.67	23.431
-0.73	0.000	3.43	11.608	7.59	18.544	11.75	23.517
-0.65	0.000	3.51	11.780	7.67	18.653	11.83	23.602
-0.57	0.000	3.59	11.949	7.75	18.760	11.91	23.687
-0.49	0.000	3.67	12.116	7.83	18.867	11.99	23.772
-0.41	0.000	3.75	12.281	7.91	18.973	12.07	23.857
-0.33	0.000	3.83	12.444	7.99	19.079	12.15	23.941
-0.25	0.000	3.91	12.605	8.07	19.184	12.23	24.025
-0.17	0.000	3.99	12.763	8.15	19.289	12.31	24.108
-0.09	0.000	4.07	12.920	8.23	19.393	12.39	24.191
-0.01	0.000	4.15	13.074	8.31	19.496	12.47	24.274
0.07	0.022	4.23	13.227	8.39	19.599	12.55	24.357
0.15	0.101	4.31	13.379	8.47	19.701	12.63	24.440
0.23	0.233	4.39	13.528	8.55	19.803	12.71	24.522
0.31	0.417	4.47	13.676	8.63	19.904	12.79	24.604
0.39	0.647	4.55	13.822	8.71	20.005	12.87	24.685
0.47	0.774	4.63	13.967	8.79	20.105	12.95	24.767
0.55	0.837	4.71	14.110	8.87	20.205	13.03	24.848
0.63	0.896	4.79	14.252	8.95	20.304	13.11	24.928
0.71	0.951	4.87	14.392	9.03	20.403	13.19	25.009
0.79	1.011	4.95	14.531	9.11	20.502	13.27	25.089
0.87	1.137	5.03	14.669	9.19	20.599	13.35	25.169
0.95	1.304	5.11	14.806	9.27	20.697	13.43	25.249
1.03	1.500	5.19	14.941	9.35	20.794	13.51	25.329
1.11	1.719	5.27	15.075	9.43	20.890	13.59	25.408
1.19	1.959	5.35	15.208	9.51	20.986	13.67	25.487
1.27	2.218	5.43	15.339	9.59	21.082	13.75	25.566
1.35	2.493	5.51	15.470	9.67	21.177	13.83	25.644

**Stage-Discharge for Pond 41P: 4ft FD 50 (continued)**

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
13.91	25.723	18.07	29.509	22.23	32.863	26.39	35.904
13.99	25.801	18.15	29.577	22.31	32.924	26.47	35.960
14.07	25.878	18.23	29.645	22.39	32.985	26.55	36.016
14.15	25.956	18.31	29.713	22.47	33.046	26.63	36.072
14.23	26.033	18.39	29.781	22.55	33.107	26.71	36.127
14.31	26.110	18.47	29.848	22.63	33.167	26.79	36.183
14.39	26.187	18.55	29.915	22.71	33.228	26.87	36.239
14.47	26.264	18.63	29.983	22.79	33.288	26.95	36.294
14.55	26.341	18.71	30.050	22.87	33.349	27.03	36.349
14.63	26.417	18.79	30.116	22.95	33.409	27.11	36.405
14.71	26.493	18.87	30.183	23.03	33.469	27.19	36.460
14.79	26.569	18.95	30.250	23.11	33.529	27.27	36.515
14.87	26.644	19.03	30.316	23.19	33.589	27.35	36.570
14.95	26.720	19.11	30.382	23.27	33.649	27.43	36.625
15.03	26.795	19.19	30.448	23.35	33.709	27.51	36.680
15.11	26.870	19.27	30.514	23.43	33.768	27.59	36.735
15.19	26.944	19.35	30.580	23.51	33.828	27.67	36.789
15.27	27.019	19.43	30.646	23.59	33.887	27.75	36.844
15.35	27.093	19.51	30.712	23.67	33.946	27.83	36.899
15.43	27.167	19.59	30.777	23.75	34.006	27.91	36.953
15.51	27.241	19.67	30.842	23.83	34.065	27.99	37.007
15.59	27.315	19.75	30.907	23.91	34.124	28.07	37.062
15.67	27.389	19.83	30.972	23.99	34.182	28.15	37.116
15.75	27.462	19.91	31.037	24.07	34.241	28.23	37.170
15.83	27.535	19.99	31.102	24.15	34.300	28.31	37.224
15.91	27.608	20.07	31.167	24.23	34.359	28.39	37.278
15.99	27.681	20.15	31.231	24.31	34.417	28.47	37.332
16.07	27.753	20.23	31.295	24.39	34.475	28.55	37.386
16.15	27.826	20.31	31.360	24.47	34.534	28.63	37.440
16.23	27.898	20.39	31.424	24.55	34.592	28.71	37.493
16.31	27.970	20.47	31.488	24.63	34.650	28.79	37.547
16.39	28.042	20.55	31.551	24.71	34.708	28.87	37.600
16.47	28.113	20.63	31.615	24.79	34.766	28.95	37.654
16.55	28.185	20.71	31.679	24.87	34.824	29.03	37.707
16.63	28.256	20.79	31.742	24.95	34.881	29.11	37.761
16.71	28.327	20.87	31.805	25.03	34.939	29.19	37.814
16.79	28.398	20.95	31.868	25.11	34.996	29.27	37.867
16.87	28.469	21.03	31.931	25.19	35.054	29.35	37.920
16.95	28.539	21.11	31.994	25.27	35.111	29.43	37.973
17.03	28.610	21.19	32.057	25.35	35.168	29.51	38.026
17.11	28.680	21.27	32.120	25.43	35.226	29.59	38.079
17.19	28.750	21.35	32.182	25.51	35.283	29.67	38.132
17.27	28.820	21.43	32.245	25.59	35.340	29.75	38.184
17.35	28.889	21.51	32.307	25.67	35.396	29.83	38.237
17.43	28.959	21.59	32.369	25.75	35.453	29.91	38.289
17.51	29.028	21.67	32.431	25.83	35.510	29.99	38.342
17.59	29.098	21.75	32.493	25.91	35.566	30.07	38.394
17.67	29.167	21.83	32.555	25.99	35.623	30.15	38.447
17.75	29.235	21.91	32.617	26.07	35.679	30.23	38.499
17.83	29.304	21.99	32.679	26.15	35.736	30.31	38.551
17.91	29.373	22.07	32.740	26.23	35.792	30.39	38.603
17.99	29.441	22.15	32.801	26.31	35.848	30.47	38.655

**FD-HCS Calcs***Constant Intensity scaled to 100.00 hrs Rainfall=10.00"*

Prepared by Hydro International

Printed 10/13/2020

HydroCAD® 10.10-4a s/n 03484 © 2020 HydroCAD Software Solutions LLC

Page 4

**Stage-Discharge for Pond 41P: 4ft FD 50 (continued)**

Elevation (feet)	Primary (cfs)
30.55	38.707
30.63	38.759
30.71	38.811
30.79	38.863
30.87	38.915
30.95	38.966
31.03	39.018
31.11	39.069
31.19	39.121
31.27	39.172
31.35	39.223
31.43	39.275
31.51	39.326
31.59	39.377
31.67	39.428
31.75	39.479
31.83	39.530
31.91	39.581
31.99	39.632
32.07	39.682
32.15	39.733
32.23	39.783
32.31	39.834
32.39	39.884
32.47	39.935
32.55	39.985
32.63	40.035
32.71	<b>40.086</b>