Hydroworks

July 18, 2024

Mr. Leo Cosentini
California State Water Resources Control Board
P.O. Box 100
Sacramento, CA 95812-0100

Subject: Application for Trash Treatment Control System - HydroDome® TS

Dear Mr. Cosentini,

Hydroworks, LLC is pleased to submit this application for the HydroDome® TS full capture system. The HydroDome TS is similar to the already certified HydroDome TR full capture system but is designed to capture an increased amount of sediment without reducing trash capture. We request that the HydroDome TS full capture system be included on the State Water Boards Certified Full Capture System list as a *High Flow Capacity Trash Full Capture System*. Information in support of this application is being submitted in accordance with the *Application Requirements for Trash Full Capture System Certification* (June 2024). The application consists of the following 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 and Laboratory Testing Information and Analysis

Please contact me if you have any questions or require additional information to complete your review.

Sincerely,

Graham Bryant, P.Eng. MSc
President

1. Cover Letter

a. The system name and general description

The HydroDome® Trash and Sediment (TS) separator is designed to provide full trash capture and vector control accessibility as defined by the Trash Provisions and Mosquito Vector Control Association, respectively. The HydroDome TS is optimized to remove all trash 5mm and larger from stormwater runoff, which is its primary function. What distinguishes the TS from the previously certified HydroDome TR is that the HydroDome TS is also optimized to remove sediment. However, all calculations included in this application pertain only to flow through the device's perforated 4.76mm inlet screens and are not related to TSS removal performance. Certification of this application is for trash capture only and does not confer any additional certification or approval for TSS or other pollutants. Descriptions related to TSS are included in this application only for the purpose of distinguishing between the HydroDome TR and the HydroDome TS.

The HydroDome TS utilizes a weir and siphon to control the water level inside the structure during storms to reduce flow velocities and maximize particle settling. The raised water level also creates extra separation between floatable pollutants and the submerged inlet screen (i.e., system outlet) during flow events, which significantly reduces scour and resuspension. Water enters the device through the bottom of the HydroDome TS insert and flows upwards into the siphon itself. Once the water level reaches a pre-determined height, the siphon begins to engage and water flows out of the structure and into the downstream conveyance system. The siphon flow is controlled by an orifice whose size scales with model size. A weir above the siphon provides the main flow path through the separator and prevents the system from surcharging.

The HydroDome TS, just like the HydroDome TR, is equipped with a 4.76 mm screen fully enclosing the device's inlet to ensure 100% capture and retention of all trash greater than the screen opening size.

The box-shaped screen is made of perforated plastic, with a circular opening aperture of 4.76 mm. A street level, solid manhole cover or inlet grate will provide direct access to the screens and sump for inspection, maintenance, and cleaning, which can be performed from the surface. A solid deflector baffle, as described in section 3.f. of this application, is mandatory when a grated manhole cover is installed.

b. The name and contact information of the applicant

Graham Bryant
President
Hydroworks, LLC
257 Cox Street
Roselle, NJ 07203
info@hydroworks.com

c. The applicant's webpage address

www.hydroworks.com

d. **The location of the system manufacturing sites**

The HydroDome TS consists of a high-density polyethylene (HDPE) or copolymer polypropylene (CPP) insert installed inside a precast concrete manhole or vault structure. Plastic inserts are currently manufactured at the following locations:

Plastic Design, Inc
180 Middlesex Street
North Chelmsford, MA 01863

Hydroworks, LLC
257 Cox Street
Roselle, NJ 07203

Greyco Products
812095 East Back Line
RR #3 Dundalk Ontario N0C 1B0
Canada

Hydroworks partners with local suppliers close to project sites to provide the precast structure as well as access covers. Local plastic fabricators are also sought in some markets to promote local manufacturing and reduce lead times for product delivery.

e. Brief summary of any field or laboratory testing results

The HydroDome TS has not been tested specifically for trash capture in the laboratory or field.

Hydraulics Testing

Since it is not feasible to test all model sizes, pipe configurations, and clogging scenarios, in the laboratory, we have developed a mathematical model to simulate hydraulics through the HydroDome TS. This model is intended to be used to assist in designing and sizing of the device.

To develop and validate the mathematical model, we previously performed hydraulics testing on a prototype HydroDome TR (model HDTR2-6), which we mounted inside a 2-ft diameter test tank with a 6” outlet pipe and installed in our Roselle, NJ laboratory flow loop. Water levels inside the test tank were measured at different influent flow rates and with different degrees of inlet screen blinding. Additionally, we tested a HydroDome TS prototype (model HDTS2-6) in our flow loop to provide further validation. Observed measurements were compared to predictions to validate the mathematical model. The combined results from multiple test runs demonstrate that the model accurately predicts the hydraulic impact of blinded inlet screens for a range of conditions. This confirms its suitability for sizing and designing units across a range of model sizes. The results and an explanation of the methodology are provided in Section 3.c. (Hydraulic Model Development).

Inspection and maintenance are intended to be performed from the surface. Maintenance intervals and procedures are provided in the included Operations & Maintenance Manual (Appendix C).

f. Locations where the system has been installed for capturing trash

There are currently no HydroDome TS units installed.

g. High flow capacity trash full capture systems

The HydroDome TS is designed and was tested to capture and retain trash in high flows. Accordingly, we are applying for inclusion on the list of high flow capacity trash full capture systems.

h. Certification Statement

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.

Graham Bryant 07/18/2024

Graham Bryant, President – Hydroworks, LLC Date

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3. Physical Description

The HydroDome® TS consists of a plastic insert installed in a precast concrete structure. The HydroDome TS is available in eight standard round precast manhole sizes: 3-, 4-, 5-, 6-, 7-, 8-, 10-, and 12-ft diameters. Inserts are scaled based on both manhole and outlet pipe size, and model names reference both. For example, a HydroDome TS4-12 is a 4-ft diameter HydroDome Trash and Sediment Capture unit with the insert installed in a 12-in diameter outlet pipe. The HydroDome TS can also be installed in a rectangular vault structure. Model names for rectangular structures refer to the nearest surface-area equivalent to a round structure.

The internals of the HydroDome TS consist of a siphon with orifice outlet and integrated weir wall (Figure 1). The internal components of the HydroDome TS scale with the pipe size and manhole size to ensure both acceptable hydraulic characteristics and trash capture volumes. The proper unit size must be selected to trap trash for the peak flow generated from the 1-year, 1-hour storm.

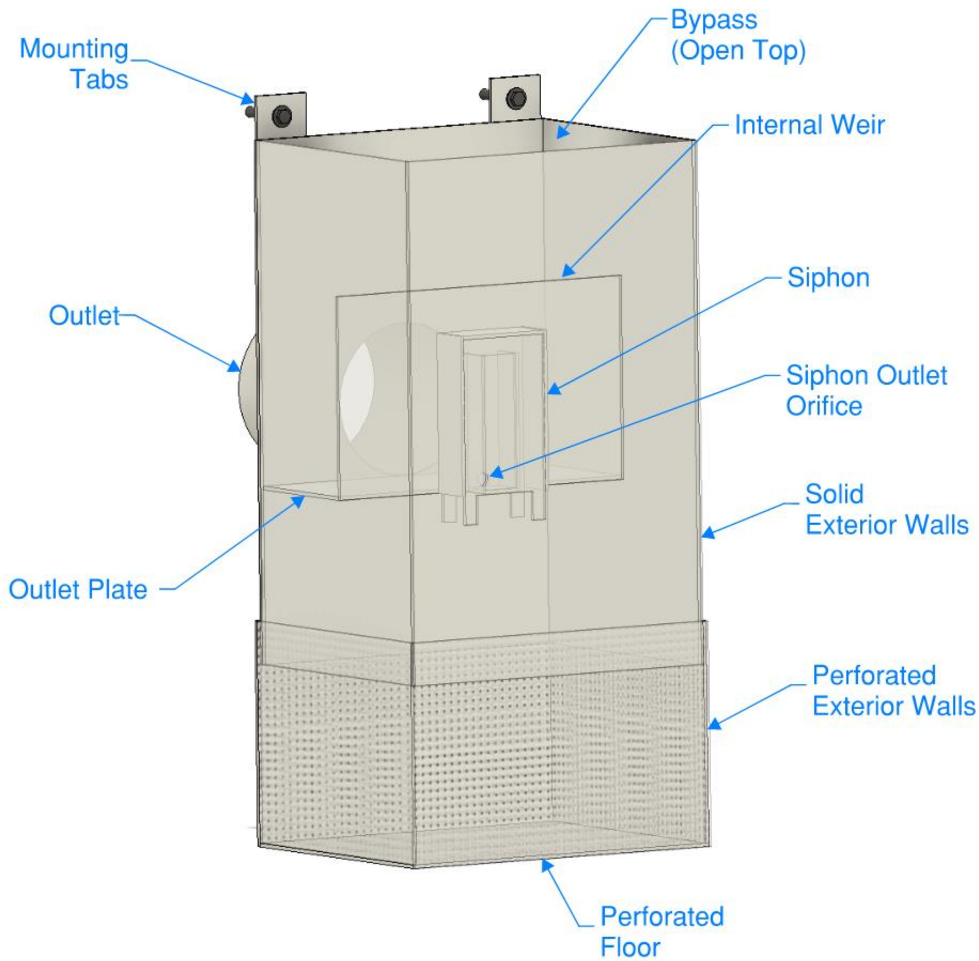
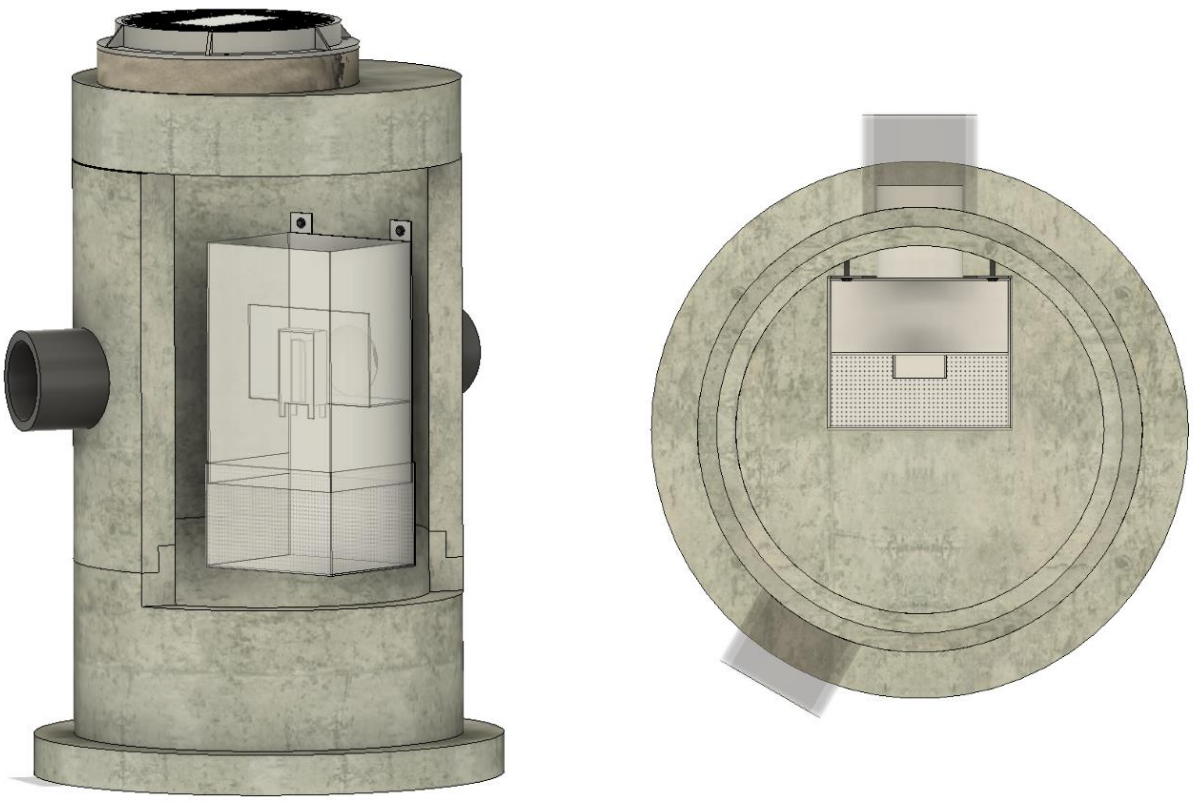


Figure 1. HydroDome® TS Insert Components with Transparent Front & Side Wall

An integrated outlet stub protruding from the insert slides into the outlet pipe and the insert is secured to the manhole wall with stainless steel anchor bolts (Figure 2).



Plan

Cutaway

Figure 2. HydroDome TS Round Manhole Installation

Water enters the device through one or more inlet pipes and/or an inlet grate. Water then passes into the insert through a perforated plastic screen, comprising four perforated exterior walls and a perforated floor. Due to the depth of the openings below the standing water level, most oil, trash, and floatable debris is trapped between the solid insert wall and the precast structure wall. The nominal size of the perforated openings (4.75 mm) prevents any trash 5mm or greater from passing into and through the unit.

If a grated inlet is installed, a sloped lid is fitted to the top of the insert to deflect any trash that enters the structure vertically from above (Figure 3). The “roof” lid is raised above the insert walls to allow an unrestricted bypass flow path. Hinges on the lid allow access for inspection, maintenance, and mosquito treatment inside the insert. The lid can be opened from the surface with a pole and hook by pulling upward on the handle.

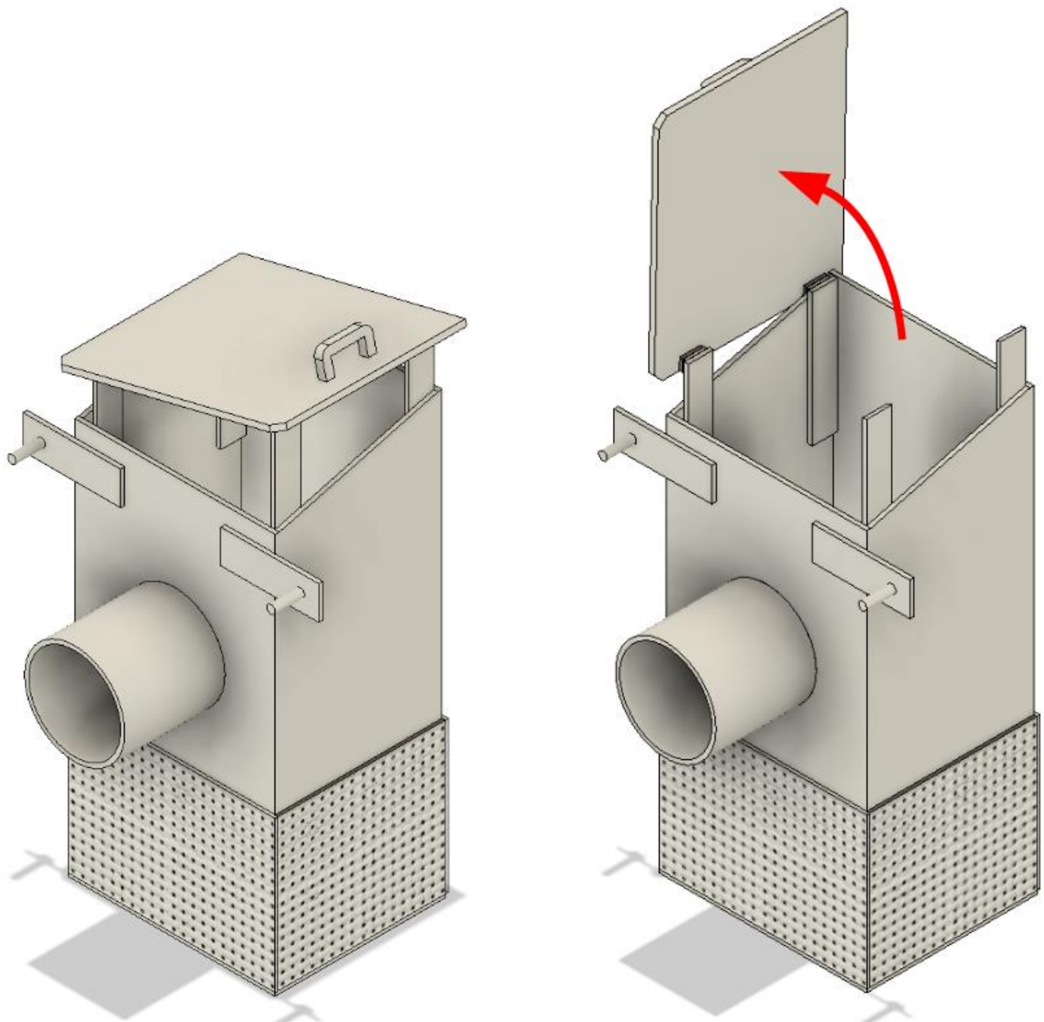


Figure 3. Alternate Configurations: Hinged Lid for Grated Inlet

CAD drawings for standard HydroDome TS model sizes are provided in Appendix A.

During storm events, the water level inside the structure must rise until it reaches the top of the siphon before any water exits the structure. Once the siphon engages, water begins discharging at a rate controlled by the siphon orifice. The raised water level and relatively low flow velocities enhance settling and provide additional vertical separation between floatable trash and the submerged inlet screens. Once water reaches the top of the weir, flow is discharged over the weir to limit the hydraulic impact upstream.

After a storm event, water flows through the engaged siphon and exits through the orifice opening to lower the water level back down to the outlet invert elevation.

a. Trash Capture

The solid outer shell of the HydroDome and submerged inlet prevent trash from moving into the insert. During high flows, the raised water level also prevents captured trash from being re-entrained and lost downstream. However, to ensure that all 5 mm trash is captured by the device, the HydroDome TS includes perforated polypropylene “screens” around all inlet openings. The round screen openings are 3/16” (4.76 mm) diameter, spaced 5/16” apart, and vertically staggered for a total open area of 32%. The screened flow path and bypass flow path are illustrated in Figure 4.

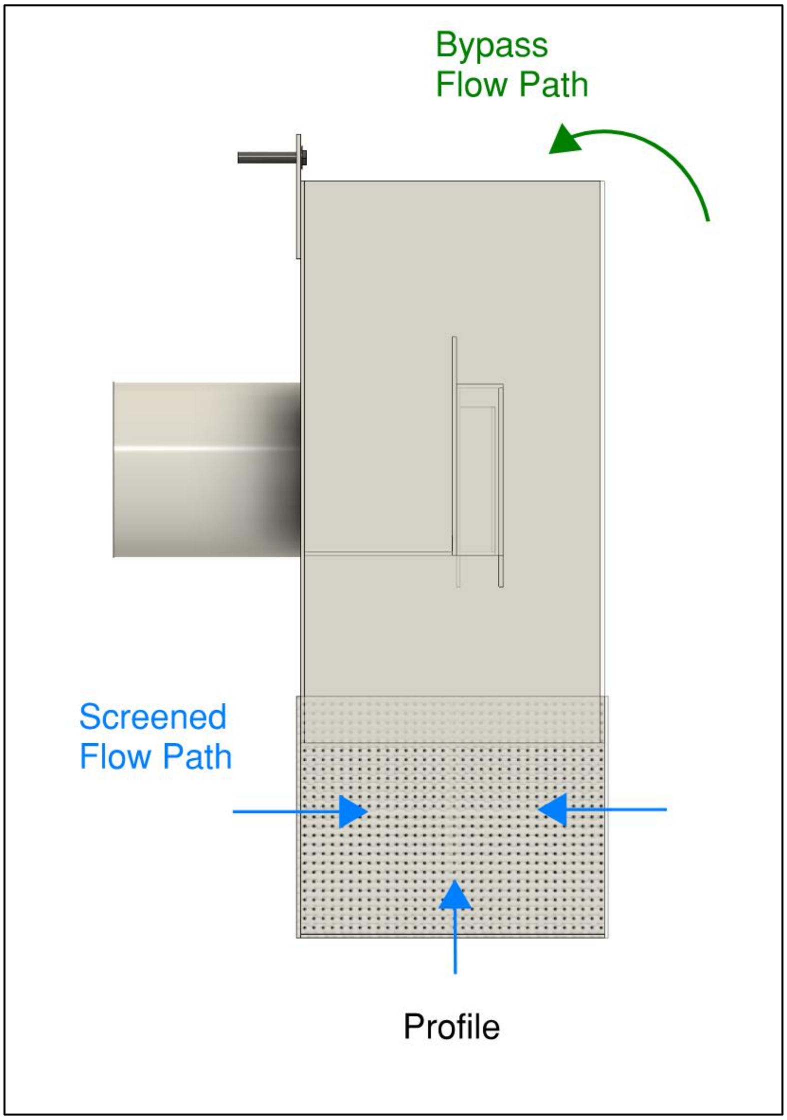


Figure 4. HydroDome TS Flow Paths

b. Peak Flows/Trash Capture Volumes

The HydroDome TS is sized based on conveying the design treatment flow without bypass. The design treatment flow is provided by the engineer of record and must be minimally calculated based on the 1-year, 1-hour storm using local hydrology and the associated sub-drainage area. Depending on site-specific requirements, larger model size HydroDome TS units may also be selected based on anticipated trash capture volumes or to additionally remove sediment or other pollutants. Maximum flow rates are provided for standard model sizes in Table 1. This table can be used to select an appropriately sized HydroDome TS model. Hydroworks can also provide custom designs and flow rates for HydroDome TS models outside the standard range, however, such custom designs would need to be first added to this application and approved.

The HydroDome TS bypass elevation and weir height are standardized based on model and pipe size. Flow rates listed in Table 1 represent the flow rate through the unit when the water level inside the manhole or vault equals the bypass elevation. Bypass elevations are customizable based on site-specific requirements (see Figure 15). However, custom bypass elevations do not affect bypass capacity, which must be equal to or greater than the peak flow rate generated by a 1-year, 1-hour storm.

Trash storage capacities for HydroDome TS models are provided in Table 2. Floatable trash storage capacity is equal to the volume between the outlet invert and the vertical midpoint of the inlet screen. Settleable trash storage capacity is equal to the volume between the bottom of the sump and the bottom of the inlet screen.

In the event that flow exceeds the peak design flow of the drainage system, the outlet pipe from the structure will act as an orifice, raising the water level inside and upstream of the structure. Maximum bypass capacity is therefore dependent on characteristics of the drainage system external to the HydroDome TS unit.

Table 1. HydroDome TS Full Trash Capture Peak Treatment Flow Rates

Max Flow Rate Prior to Bypass (cfs) [1,2]							
Model	Manhole Diameter (ft)	Pipe Diameter (in)	Screen Blinding Percentage				
			0%	25%	50%	75%	90%
HDTS3-6	3	6	1.75	1.60	1.32	0.85	0.41
HDTS3-8	3	8	1.85	1.71	1.44	0.96	0.47
HDTS3-12	3	12	1.96	1.85	1.64	1.15	0.60
HDTS3-15	3	15	2.01	1.93	1.73	1.28	0.69
HDTS4-8	4	8	3.96	3.55	2.91	1.84	0.88
HDTS4-12	4	12	4.27	3.93	3.36	2.25	1.10
HDTS4-15	4	15	4.43	4.16	3.60	2.49	1.26
HDTS4-18	4	18	4.55	4.28	3.79	2.70	1.40
HDTS5-12	5	12	6.87	6.27	5.21	3.43	1.66
HDTS5-15	5	15	7.13	6.58	5.62	3.77	1.89
HDTS5-18	5	18	7.36	6.87	5.80	4.14	2.09
HDTS5-24	5	24	7.60	7.28	6.48	4.70	2.50
HDTS6-15	6	15	10.51	9.67	8.09	5.33	2.59
HDTS6-18	6	18	10.93	10.03	8.58	5.80	2.87
HDTS6-24	6	24	11.40	10.67	9.36	6.62	3.43
HDTS6-30	6	30	11.68	11.11	10.01	7.33	3.70
HDTS7-18	7	18	16.44	15.05	12.60	8.25	4.01
HDTS7-24	7	24	17.28	16.08	13.92	9.46	4.75
HDTS7-30	7	30	17.85	16.89	14.80	10.45	5.44
HDTS7-36	7	36	18.21	17.35	15.57	11.44	6.02
HDTS8-24	8	24	23.04	21.37	18.05	12.13	6.06
HDTS8-30	8	30	23.95	22.44	19.38	13.49	6.94
HDTS8-36	8	36	24.33	23.11	20.53	14.76	7.53
HDTS8-42	8	42	24.82	23.74	21.36	15.90	7.95
HDTS10-30	10	30	40.92	37.48	31.88	21.33	10.67
HDTS10-36	10	36	42.03	39.23	33.98	23.36	11.81
HDTS10-42	10	42	43.17	40.58	35.62	25.08	13.09
HDTS10-48	10	48	43.75	41.61	36.98	26.75	14.16
HDTS12-36	12	36	62.34	57.44	48.85	32.91	16.45
HDTS12-42	12	42	64.08	59.81	51.81	35.62	17.99
HDTS12-48	12	48	64.87	61.00	53.94	37.76	19.46
HDTS12-54	12	54	66.09	62.63	55.43	40.09	20.87
HDTS12-60	12	60	67.06	63.59	57.06	41.91	22.35
1. Assumes no tailwater. Tailwater conditions may affect flow rate calculations.							
2. Conveyance capcity of inlet and outlet pipes not considered.							

Table 2. HydroDome TS Storage Capacities

Storage Capacities [3,4]				
Model	Manhole Diameter (ft)	Pipe Diameter (in)	Floatable Trash Storage Capacity[1] (ft^3)	Settleable Trash Storage Capacity[2] (incl. Sediment) (ft^3)
HDTS3-6	3	6	6	15
HDTS3-8	3	8	6	15
HDTS3-12	3	12	6	15
HDTS3-15	3	15	6	15
HDTS4-8	4	8	14	30
HDTS4-12	4	12	14	30
HDTS4-15	4	15	14	30
HDTS4-18	4	18	14	30
HDTS5-12	5	12	26	60
HDTS5-15	5	15	26	60
HDTS5-18	5	18	26	60
HDTS5-24	5	24	26	60
HDTS6-15	6	15	44	100
HDTS6-18	6	18	44	100
HDTS6-24	6	24	44	100
HDTS6-30	6	30	44	100
HDTS7-18	7	18	68	160
HDTS7-24	7	24	68	160
HDTS7-30	7	30	68	160
HDTS7-36	7	36	68	160
HDTS8-24	8	24	103	235
HDTS8-30	8	30	103	235
HDTS8-36	8	36	103	235
HDTS8-42	8	42	103	235
HDTS10-30	10	30	201	455
HDTS10-36	10	36	201	455
HDTS10-42	10	42	201	455
HDTS10-48	10	48	201	455
HDTS12-36	12	36	347	780
HDTS12-42	12	42	347	780
HDTS12-48	12	48	347	780
HDTS12-54	12	54	347	780
HDTS12-60	12	60	347	780

1. Floatable trash storage capacity equal to volume between midpoint of perforated screen and outlet invert.
2. Settleable trash storage capacity equal to volume between bottom of perforated screen and bottom of sump.
3. Listed storage capacities are standard values based on an open-top design.
4. Additional storage capacity can be provided based on customized designs to meet project-specific requirements.

c. Hydraulic Capacity

The HydroDome TS is designed to be installed on-line. In the event of blinding of the inlet screen, maximum flow capacity through the screen prior to bypass (i.e., peak treatment flow) will be reduced. Table 1 shows the peak treatment capacity of the unit at various degrees of screen blinding and for different models prior to bypass. Flows in excess of these thresholds will bypass the screen.

The perforated inlet screen is designed to be minimally restrictive when completely clear. This is demonstrated by the fact that the drop in water elevation from the upstream to downstream side of the screen (i.e., head on screen) is less than 1” at the peak treatment flow rate with a fully clear inlet. As the screen begins to blind, the total hydraulic capacity through the system begins to decrease, which in turn reduces the volume and height of flow over the internal weir. As a consequence of a lower water level inside the insert, at the moment when water begins to overtop the insert (i.e., bypass), the head on the screen will be comparatively higher. This means that as the percentage of screen blinding increases, the maximum head on the screen at bypass also increases such that each hole conveys a progressively higher flow. As a result, the reduction in hydraulic capacity through the screen is not proportional to the degree of screen blinding.

As shown in the table, the peak treatment flow at 50% screen blinding is generally 75% to 85% of the treatment flow rate when the inlet is fully clear. Higher blinding percentages result in an exponential decrease in hydraulic capacity. For this reason, maintenance is typically recommended when the screen is 50% blinded.

Although the bypass capacity of the unit in isolation remains constant, peak bypass capacity through the treatment system is a function of the drainage system, including pipe sizes, slopes, and tailwater elevation, so this value cannot be provided on a generic basis. The HydroDome TS is sized that such the hydraulic bypass capacity always exceeds the capacity of the outlet pipe. Design engineers should use Table 1 in conjunction with calculated treatment and peak design flows to select the appropriately sized HydroDome TS model. An explanation of the methodology used for the hydraulic calculations, including formulas, test data, and example calculations is provided below.

Hydraulics Model Development

The HydroDome TS comes in a wide range of model sizes. This makes it impractical to test the hydraulics of each unit in a laboratory. Therefore, a mathematical model was developed to estimate the water level upstream of the device’s perforated inlet screen based on the full range of model dimensions and screen blinding conditions. This mathematical model was previously validated as part of the application for the HydroDome TR. Since the hydraulics for the HydroDome TS and TR are the same, this mathematical model was used to calculate the peak flow rates provided in Table 1 and can also be used to calculate peak flow rates for modified or non-standard model units. An additional test run was performed in the Hydroworks Test Laboratory to provide further validation for the mathematical model and calculations.

The model is based on weir flow and orifice flow. Weir flow is based on the rectangular, broad crested weir equation:

$$Q = C_w L H^{1.5} \qquad (1)$$

where Q is the flow rate, C_w is the weir coefficient, L is the weir length, and H is the distance between water surface and weir crest.

Orifice flow is based on the standard orifice equation:

$$Q = C_d A(2gH)^{0.5} \qquad (2)$$

where Q is the flow rate, C_d is the coefficient of discharge, A is the cross-sectional area of the orifice, g is the acceleration due to gravity, and H is the head acting on the centerline of the orifice.

For these calculations, it is assumed that there is no tailwater acting on the system. If tailwater conditions are present, the design engineer should contact Hydroworks to assess the hydraulics through the HydroDome.

A sample calculation is provided on pages 21 through 25 for the HydroDome TS HDTS4-12 model with 75% screen blinding. Figures 10-13 provide a graphical illustration of the example calculation across the full range of flows, and Table 3 provides the corresponding tabulated values.

The HydroDome TS inlet screen consists of four perforated horizontal walls and a perforated floor. To simplify the calculations, it is assumed that all perforations represent horizontal orifices of a uniform 3/16” diameter. Since the perforations are fully submerged, it is assumed that the head acting on each individual hole is the same.

Figure 5 provides an illustration of the critical water elevations inside the test tank, which represent the components of the headloss through the unit. The water level in the tank, upstream of the inlet screen Z_a is the sum of the weir elevation (Z_w) plus the head on the weir (Z_b - Z_w) plus the head on the inlet screen (Z_a - Z_b).

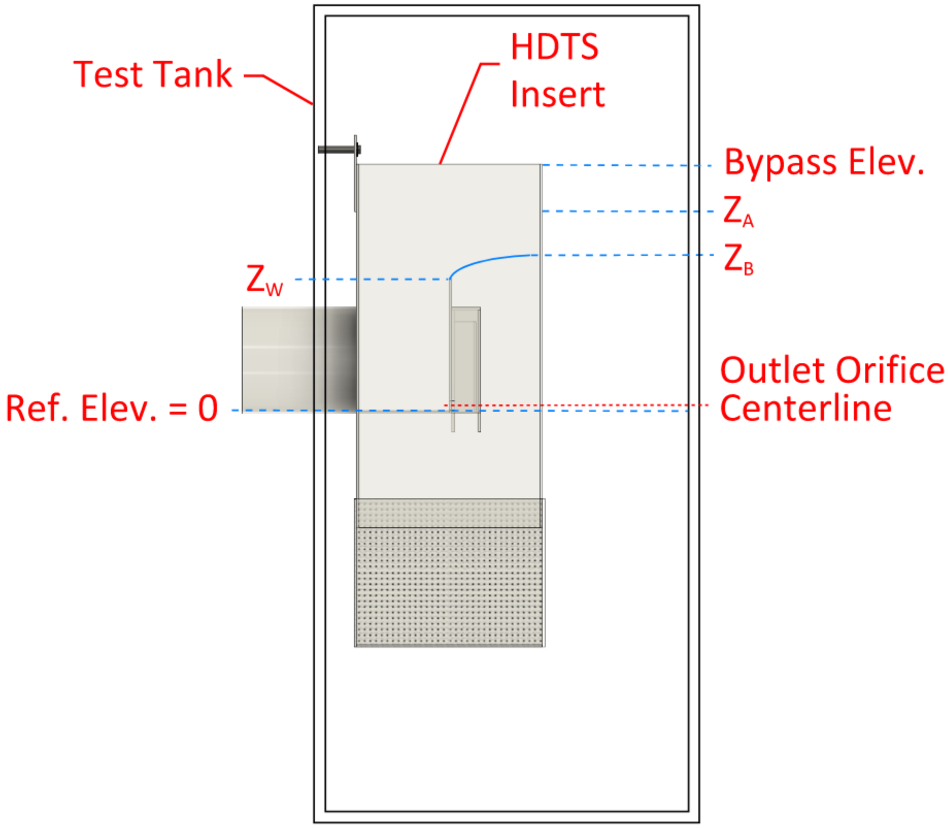


Figure 5. Reference Points for Water Level Measurements

A simple mathematical model was previously validated to support the development of the HydroDome TR. Since the design of the perforated inlet in the HydroDome TS is identical to the HydroDome TR, the model can be applied to the sizing of either variant. However, as a further check of the validity of the model calculations, we tested a HydroDome TS HDTS2-6 model in our hydraulics laboratory in Roselle, NJ. The test unit consisted of an insert scaled for a 6-inch pipe installed in a 2-ft round “manhole” (i.e., test tank). The test unit dimensions are provided in Figure 7 and pictures of the test setup are shown in Figures 8 and 9. During testing, flow rates ranging from approximately 0.02 cfs to 0.18 cfs were directed to the test unit controlled by a manually operated gate value and measured by a Seametrics iMAG 4700p flow meter, with an accuracy of ±1%. Water levels were manually recorded to the nearest 1/16” inside the test tank.

Figure 6 visually illustrates an example peak treatment flow calculation for a HydroDome TS HDTS4-12 model with 75% screen blinding. The reference 0" elevation is equal to the inlet and outlet inverts, which are level. The bypass elevation for this model is 28". The peak flow rate prior to bypass is calculated based on the intersection between the (orange) curve representing water level in the test tank (Z_a) and the bypass elevation (dashed red horizontal line). The peak flow rate prior to bypass in this case is 2.25 cfs. The water level inside the test tank upstream of the perforated inlet screen (Za = orange curve) can be estimated by adding together the head on the weir (blue), the head on the inlet screen (grey), and the weir height (dashed blue). Unlike the calculations for the HydroDome TR, the water elevation in the outlet pipe can be ignored since the weir in the HydroDome TS is above the obvert of the outlet pipe. A weir coefficient of 3.33 and a free discharge over the weir are assumed.

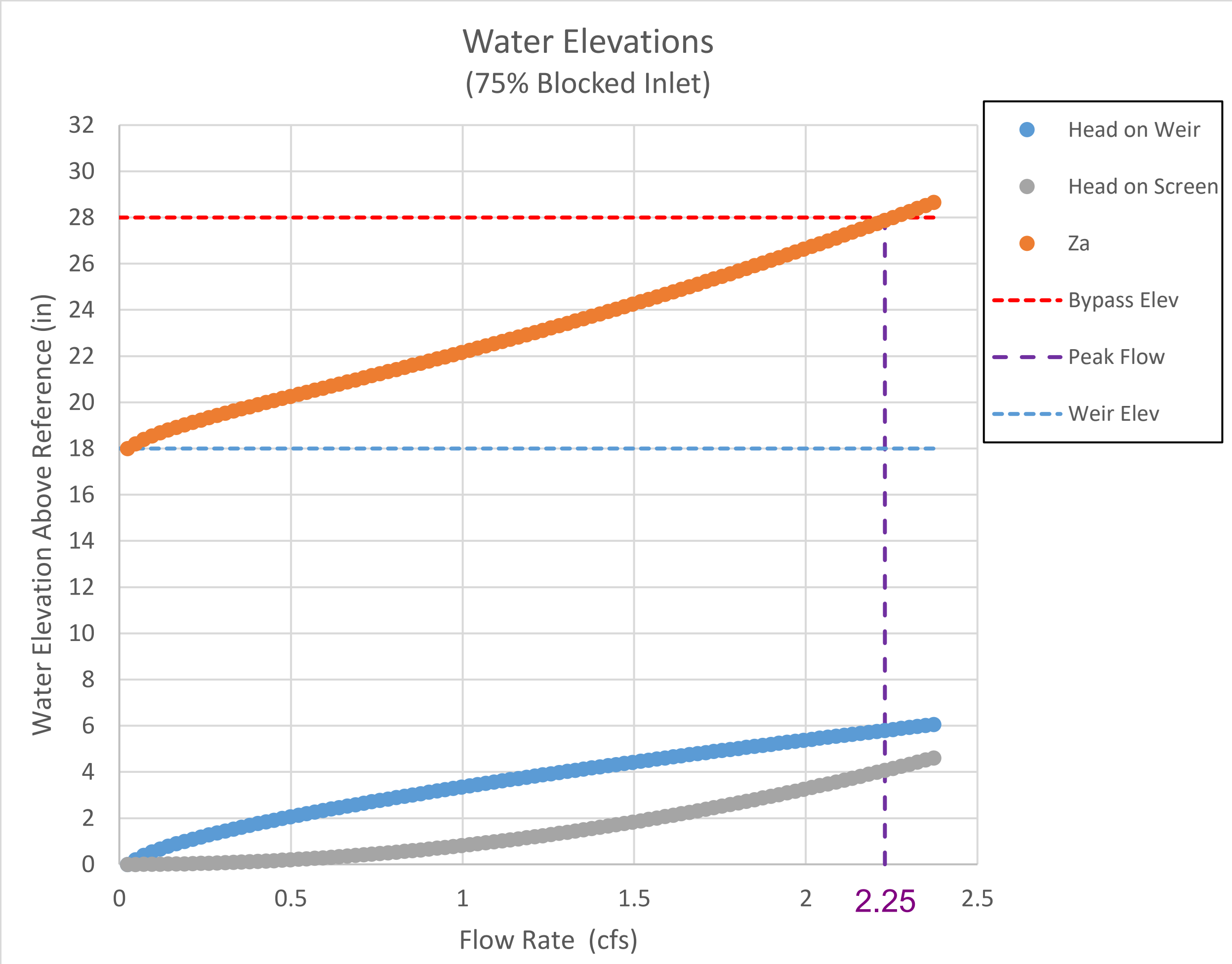


Figure 6. Grahical Illustration of Peak Treatment Flow Rate Calculation

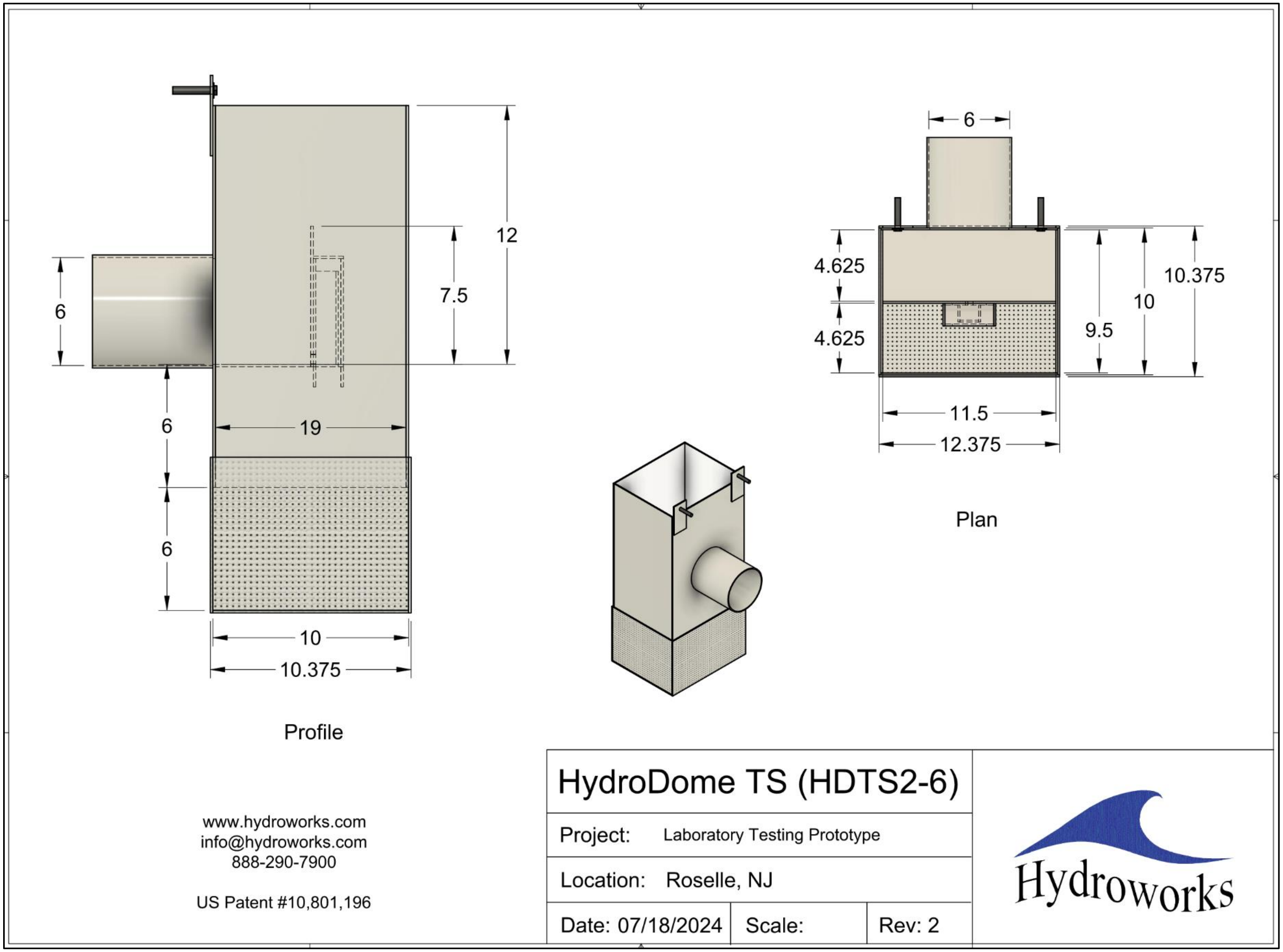


Figure 7. HydroDome TS (HDTS2-6) Test Protoype CAD Drawing

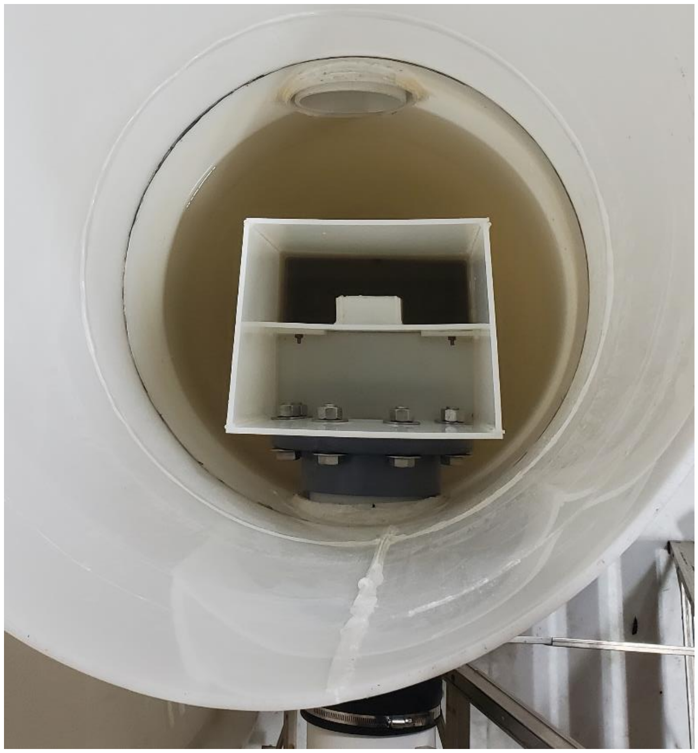


Figure 8. HydroDome TR (HDTS2-6) Installed in Hydroworks Laboratory (TOP)

Figure 9. HydroDome TR (HDTS2-6) Installed in Hydroworks Laboratory (SIDE)

Detailed steps to perform this calculation are described below and illustrated in Figures 10-13 for a HydroDome TS HDTS4-12 model under a 75% clogged screen scenario.

Step 1 – Calculate the water elevation above the weir (i.e., head on weir) for the full range of flow rates (Figure 10). The water height above the weir is dependent on the portion of flow that passes over the weir vs. through the orifice. This relationship is circular since an increase in flow over the weir increases the head on the weir, which increases the flow through the outlet orifice and therefore reduces the total volume of water available to flow over the weir. Total flow is the sum of the flow through the orifice and the flow over the weir. Since the flow calculations involve a circular dependency, they require software or a spreadsheet to iteratively solve. Values for flow and head were iteratively calculated with a spreadsheet across the full range of flows in order to determine the peak flow rate prior to bypass. However, to provide an example at a specific flow rate, the calculations below are based on the subsequently calculated peak flow rate (2.25 cfs).

The flow over the weir and through the siphon outlet orifice are calculated using equations (1) and (2) respectively.

The head (H_o) acting on the centerline of the outlet orifice (Ø=1") is given by:

$$H_o\ [in] = Z_w + H_w - \frac{Ø}{2}\ , \qquad (3)$$

where Z_w is the weir height and H_w is the head on the weir. The total flow is the sum of the flows through the orifice Q_o and over the weir Q_w:

$$Q = Q_o + Q_w\ . \qquad (4)$$

The partitioned flow rates and corresponding water elevations inside the insert are determined by iteratively solving the system of equations (1-4). Using equation (3), the head on the orifice is given by:

$$H_o\ [in] = 18.00\ [in] + 5.84\ [in] - 0.50\ [in] = 23.34\ [in].$$

Using equation (1), the flow through the outlet orifice is then given by:

$$Q_o\ [ft^3/s] = (0.61) \times (\pi(\tfrac{1}{24})^2) \times (2 \times 32.17 \times (23.34/12))^{0.5} = 0.0372\ [ft^3/s].$$

Using equation (2), the flow over the weir is given by:

$$Q_w\ [ft^3/s] = 3.33 \times 1.96 \times (5.84/12)^{1.5} = 2.21\ [ft^3/s].$$

Using equation (4), the combined flow is equal to the sum of the components flows:

$$Q\ [ft^3/s] = 2.21 + 0.037 \sim= 2.25\ [ft^3/s].$$

This iterative calculation was performed to calculate the head on the weir for the full range of flow rates.

Step 2 – Calculate the water elevation inside the HDTS insert (Z_b). This water level is calculated by adding the weir height (Z_w) to the head on the weir H_w calculated above:

$$Zb\ [in] = Z_w + H_w = 18.0\ [in] + 5.84\ [in] = 23.84''.$$

Water elevations inside the insert (Z_b) were calculated for the full range of flow rates (Figure 11).

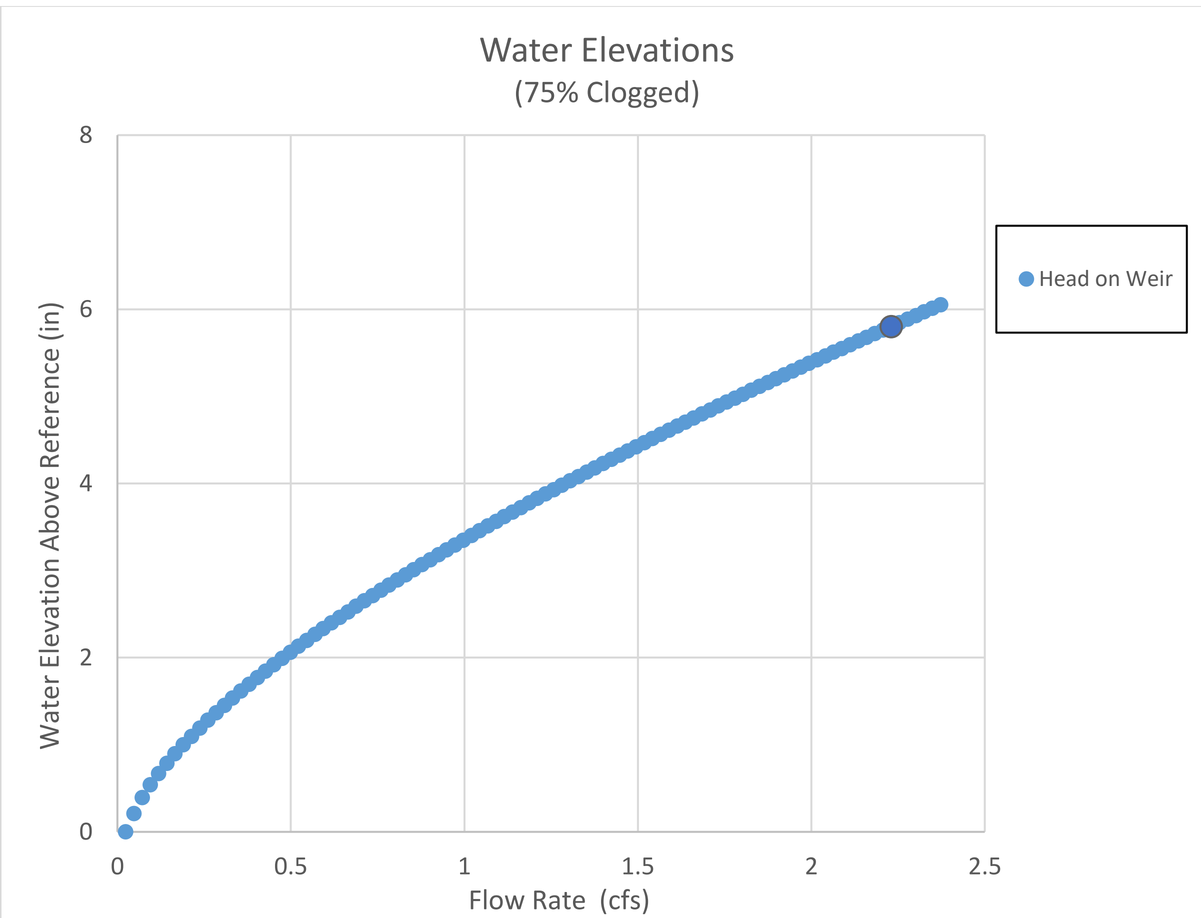


Figure 10. Calculation of the Head on the Weir

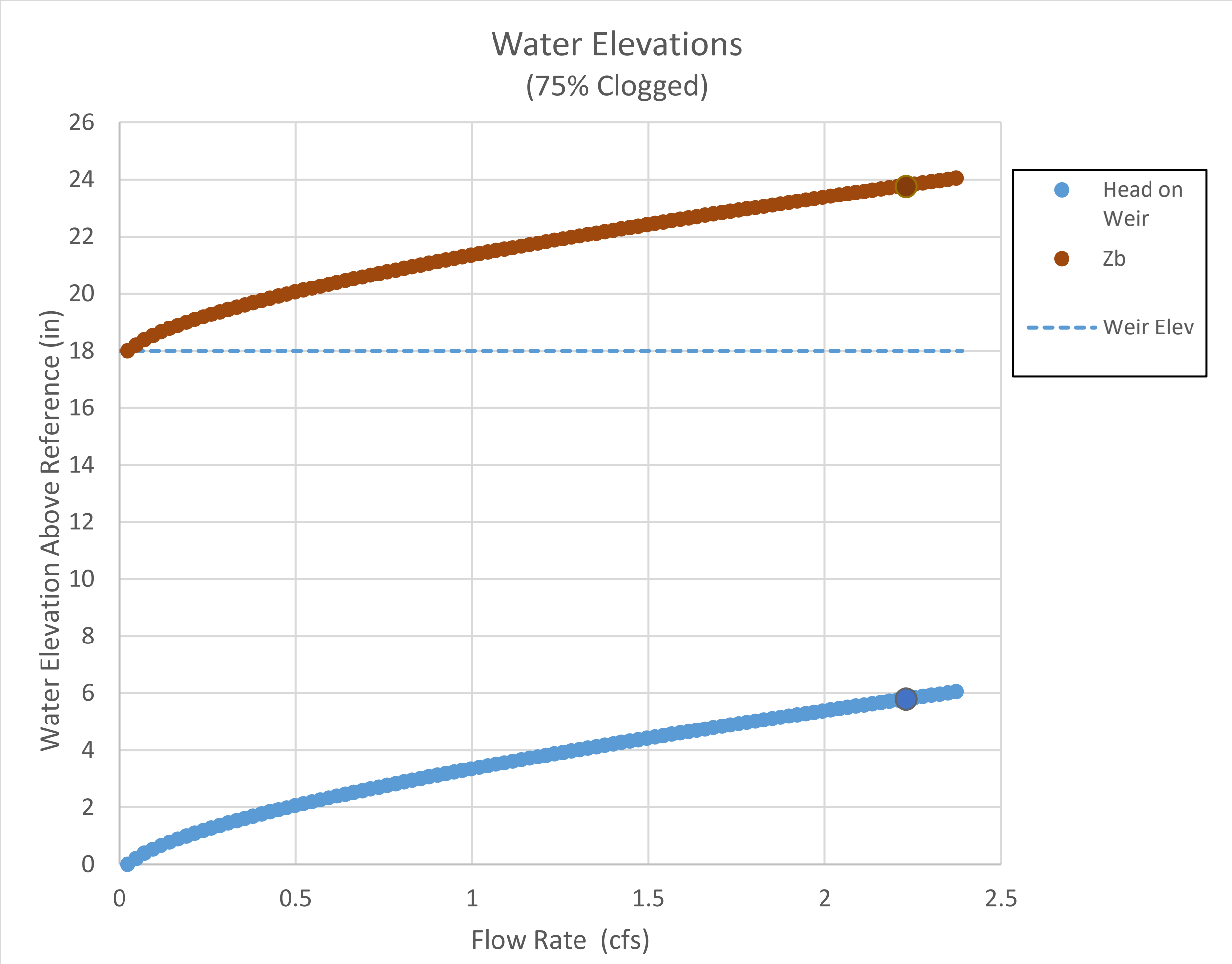


Figure 11. Calculation of Water Elevation Inside Insert

Step 3: Determine the total number of perforated (orifice) openings in the unit and then calculate the total number that are not blinded. These numbers are calculated in a spreadsheet based on the specifications of the perforated plastic walls and the dimensions of the HydroDome TS model. In this example, based on the HydroDome TS HDTS4-12 model, there are 18102 total openings, which leaves 4525 open (e.g., 25%) when 75% are blinded.

Step 4: Calculate the water elevation in the test tank (Z_a) using the orifice equation (2) and assuming the values calculated in step 2 (i.e., Z_b) represent a tailwater on the orifices. Assume the flow is proportioned equally through all 4525 openings and treat them as horizontal orifices. The resulting values are plotted in Figure 12 for the full range of flow rates. An example calculation is provided in the next step.

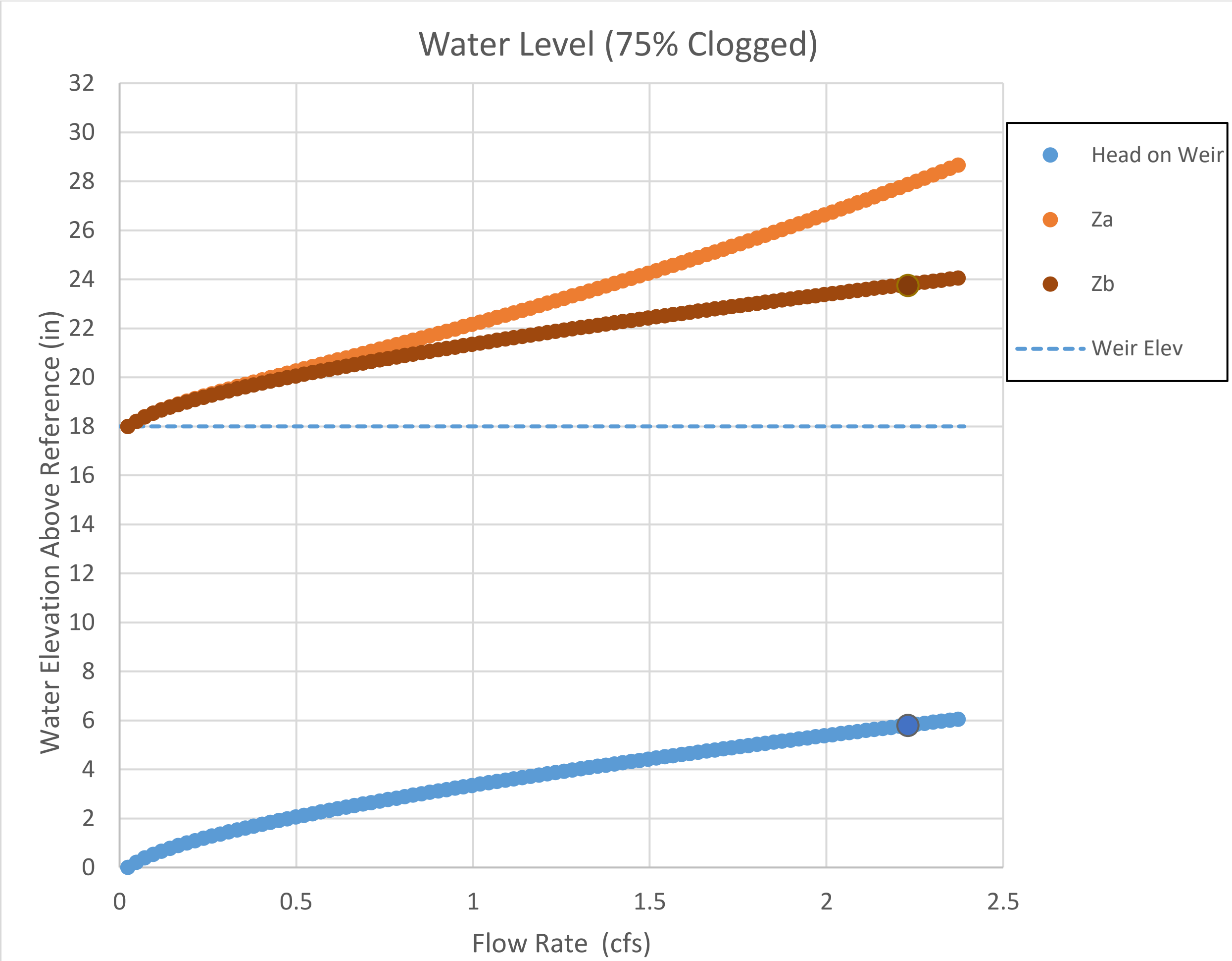


Figure 12. Calculation of the Water Elevation Inside Test Tank

Step 5: Identify the bypass elevation, which is standardized by model and pipe size. For a HydroDome HDTS4-12, the bypass elevation is 28”. Using a spreadsheet or a polynomial fit of the plotted curve, solve for the peak flow rate before the water elevation in the tank (Z_a) exceeds the bypass elevation, which is 28” in the example case (Figure 13). The peak treatment flow rate without bypass in this scenario, as demonstrated in the calculations below, is 2.25 cfs. Note the value for C_d was empirically derived during the verification testing of the HydroDome TR prototype.

At a flow rate of 2.25 cfs, the water elevation inside the tank (Z_a) is given by (2) and is equal to:

Z_a *[in] =* $[Q/(C_dA)]^2 / 2g + Z_b$ *[in],* where $Q = 2.25$ *cfs / 4525* orifices. Therefore,

Z_a *[in]* $= [[(2.25/4525)/(0.55 \times 0.000192)]^2 / (2 \times 32.17)] \times 12$ *[in]* $+ 23.84$ *[in]* $= 27.98$ *[in]*

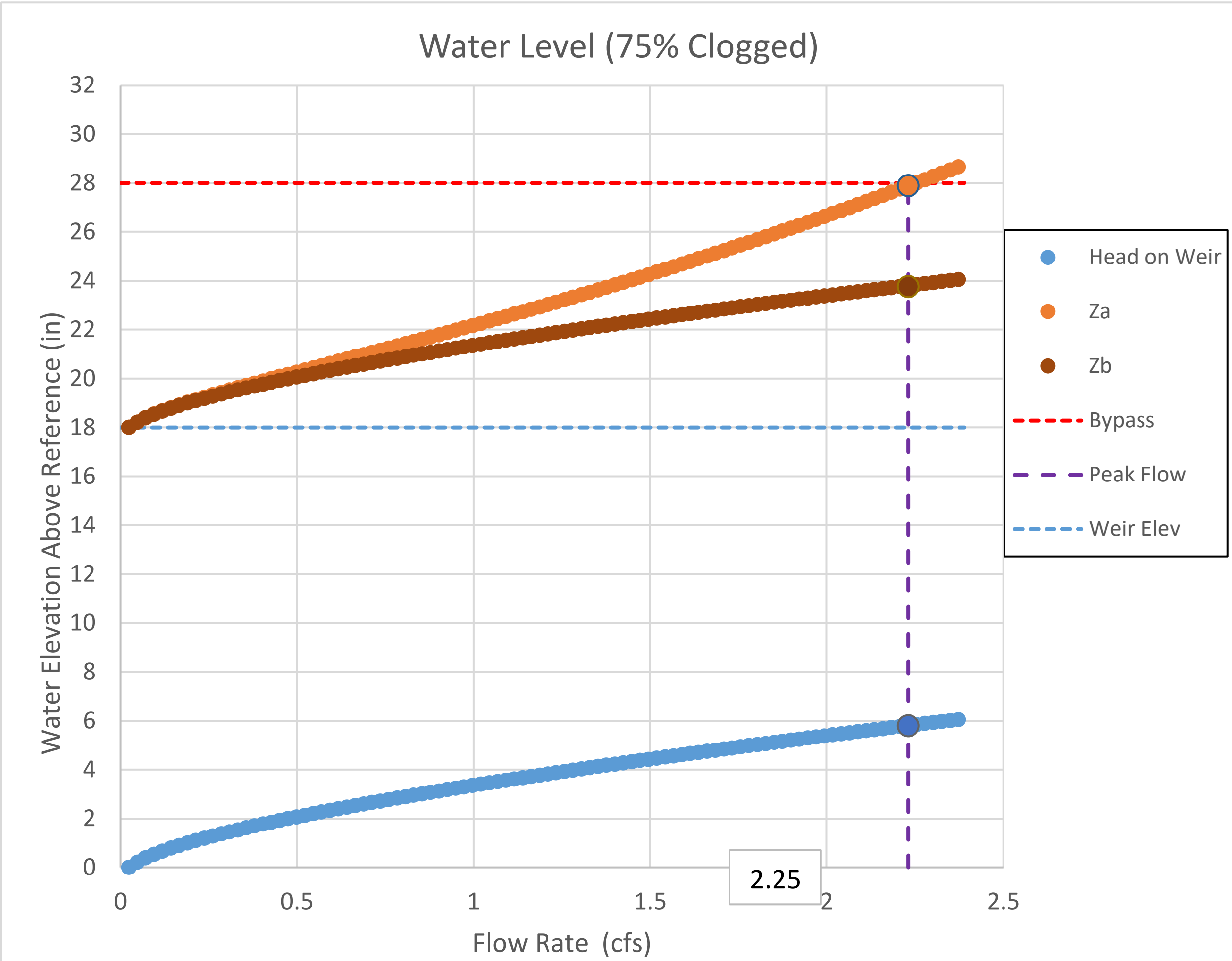


Figure 13. Calculation of the Peak Treatment Flow Rate

A subset of the tabulated values described and illustrated in the previous steps to demonstrate a calculation of peak treatment flow are provided in Table 3. The calculated maximum water elevation in the tank at 2.25 cfs is 27.98”, which is slightly less than the bypass elevation of 28”. A finer discretization of flows in the calculation would in some cases result in a slightly higher peak treatment flow, but we have chosen to select a slightly conservative peak value.

Table 3. Tabulated Values for Water Elevations from Example Peak Flow Calculation

HDTS	
Model Size	**4**
Pipe Size (in)	**12**
Blocked %	**75**

Weir length (ft)	1.958333
Weir Height (in)	18
Bypass Elev. (in)	28

Perforated Openings	
Total	18102
# Open	4525

Orifice Equation		
Q = CdA(2gh)^.5		
Cd	A	g
0.55	0.000192	32.174

Weir Equation
Q = CwLh^1.5
Cw
3.33

Peak Treatment Flow Rate	
2.25	(cfs)

Flow Rate (cfs)	Q Orifice (cfs)	Q Weir (cfs)	H on weir (in)	Zb (in)	Za (in)
2.107	0.0370	2.070	5.58	23.58	27.22
2.112	0.0370	2.075	5.59	23.59	27.24
2.116	0.0370	2.079	5.60	23.60	27.27
2.121	0.0370	2.084	5.61	23.61	27.29
2.126	0.0370	2.089	5.62	23.62	27.32
2.131	0.0370	2.094	5.63	23.63	27.34
2.135	0.0370	2.098	5.63	23.63	27.37
2.140	0.0371	2.103	5.64	23.64	27.39
2.145	0.0371	2.108	5.65	23.65	27.42
2.150	0.0371	2.113	5.66	23.66	27.44
2.154	0.0371	2.117	5.67	23.67	27.47
2.159	0.0371	2.122	5.68	23.68	27.49
2.164	0.0371	2.127	5.69	23.69	27.52
2.169	0.0371	2.132	5.69	23.69	27.55
2.173	0.0371	2.136	5.70	23.70	27.57
2.178	0.0371	2.141	5.71	23.71	27.60
2.183	0.0371	2.146	5.72	23.72	27.62
2.188	0.0371	2.150	5.73	23.73	27.65
2.192	0.0371	2.155	5.74	23.74	27.67
2.197	0.0371	2.160	5.74	23.74	27.70
2.202	0.0371	2.165	5.75	23.75	27.72
2.207	0.0372	2.169	5.76	23.76	27.75
2.211	0.0372	2.174	5.77	23.77	27.77
2.216	0.0372	2.179	5.78	23.78	27.80
2.221	0.0372	2.184	5.79	23.79	27.83
2.226	0.0372	2.188	5.79	23.79	27.85
2.230	0.0372	2.193	5.80	23.80	27.88
2.235	0.0372	2.198	5.81	23.81	27.90
2.240	0.0372	2.203	5.82	23.82	27.93
2.245	0.0372	2.207	5.83	23.83	27.95
2.249	0.0372	2.212	5.84	23.84	27.98
2.254	0.0372	2.217	5.84	23.84	28.01
2.259	0.0372	2.222	5.85	23.85	28.03
2.264	0.0372	2.226	5.86	23.86	28.06

To provide additional validation of this mathematic model, we performed hydraulics testing on a prototype HydroDome TS (model HDTS2-6) in our Roselle, NJ laboratory flow loop. Screen blinding was achieved by sealing off portions of the inlet screen with waterproof duct tape to fully prevent flow through these portions of the screen. For this test, 90.7% of the inlet screen was sealed off, which corresponded to three open rows of holes. This relatively high blinding percentage was chosen to simulate a condition where we could achieve bypass with our pumping capacity. Water levels in the tank were also calculated with the mathematical model for the same screen blinding scenario. A comparison between modeled and observed water levels is provided in Figure 14.

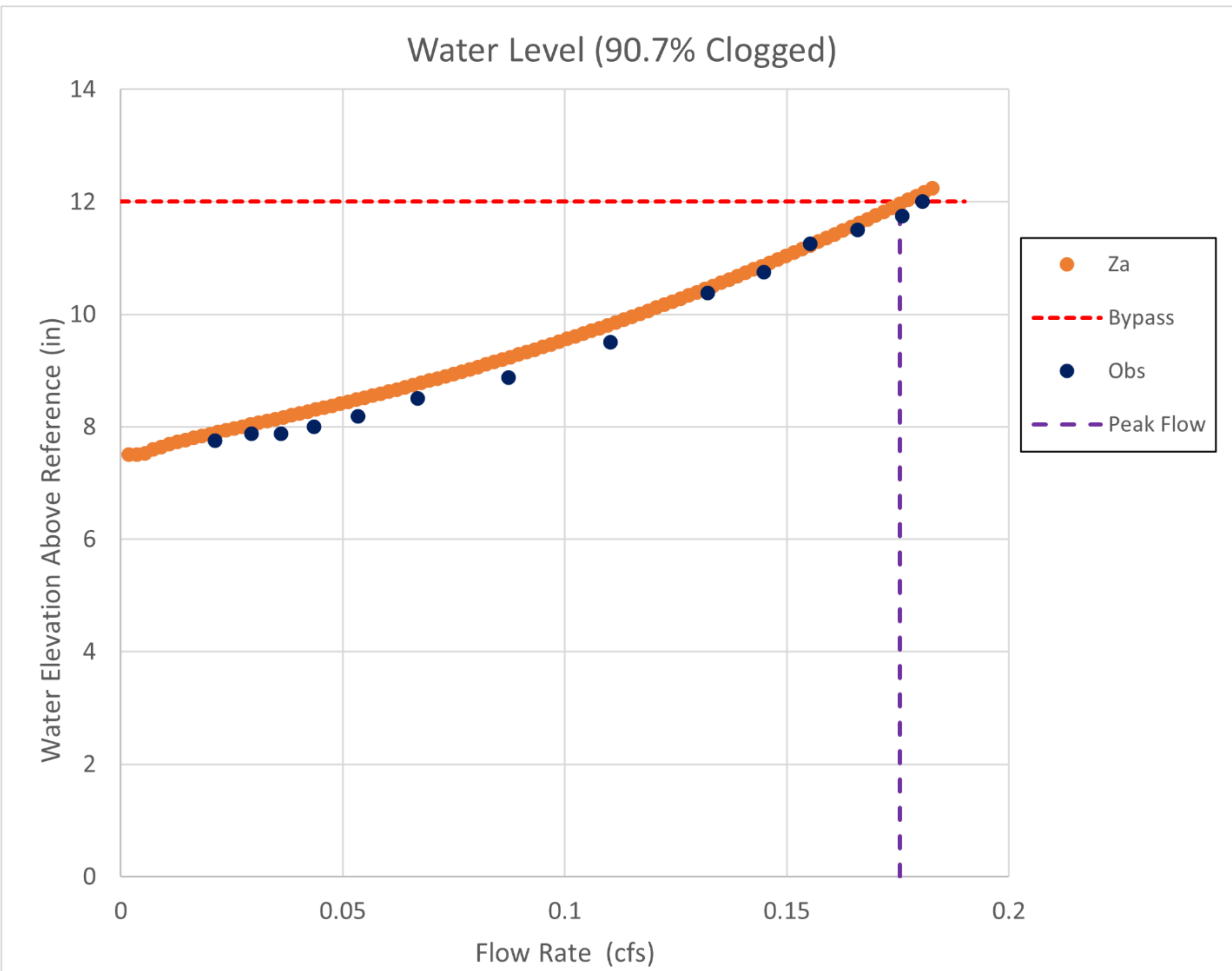


Figure 14. Observed vs Calculated Water Elevations

As demonstrated by the plotted data comparison, the model-predicted water elevations match the observed water levels to a high degree (deviation of <0.25" for nearly all measured points). It is also noted that the calculated values match the observations increasingly well at higher flow rates, up to an including bypass, which is the area of primary interest. The model-predicted bypass was 0.175 cfs, which is slightly conservative compared to the observed bypass at 0.178 cfs during laboratory testing.

The demonstrated validation of the mathematical model and tabulated treatment flow rates (Table 1) confirms its suitability for sizing and designing units across a range of model sizes.

d. Comparison Table

See Tables 1-2

e. Design Drawings

Design drawings for standard HydroDome TS model sizes are provided in Appendix A. Customized drawings will be provided for each project to reflect site-specific requirements and conditions.

f. Optional Components

Grated Manhole Cover

If a grated manhole cover is installed, a solid deflector must be installed on top of the HydroDome TS to deflect trash into the sump and prevent it from passing downstream. If the solid deflector is not installed, the installation does not satisfy the certification requirements and does not comply with the Trash Provisions. The lid requires a minimum slope of 30% and is hinged to provide visual access inside the insert (Figure 3). A handle on the lid can be hooked from the surface to pivot it open.

g. Bypass

The open top of the HydroDome TS provides a bypass for flows in excess of the peak treatment flow rate. The height of the bypass (i.e., height of insert walls) is standardized based on model and pipe size, and the peak treatment flow rates provided in Table 1 reflect this standardized design dimension. However, the wall heights and therefore bypass elevation and peak treatment flow rates can be modified (see Figure 15) in consultation with the design engineer based on site-specific requirements. For example, if the upstream drainage system cannot accommodate the HGL in the HydroDome TS unit during high flows, the bypass elevation could be lowered. Alternatively, a higher bypass elevation could be set to increase the peak treatment flow rate prior to bypass, but would also increase the upstream hydraulic impact.

Custom designs for the bypass elevation are developed in consultation with the design engineer and any regulatory authority having jurisdiction. Hydroworks can provide calculated peak treatment flows based on custom bypass elevations. In all cases, however, the bypass capacity must be equal to or greater than the peak flow rate generated by a 1-year, 1-hour storm in order to meet the certification requirements and comply with the Trash Provisions.

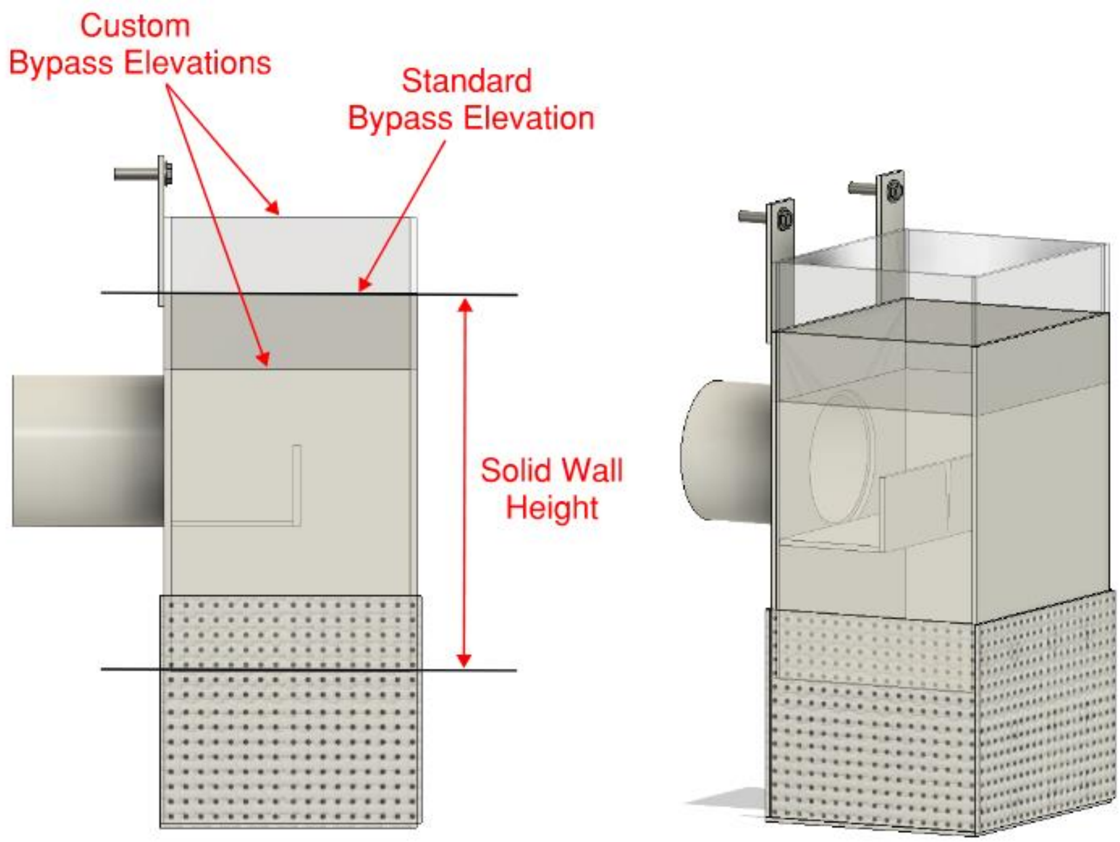


Figure 15. Illustration of Standard and Custom Bypass Elevations

h. Previously Trapped Trash

The HydroDome TS is designed to retain all captured trash. However, the unit will re-introduce previously captured trash to the system under the following conditions:

i. Extreme storm event where flows to the unit exceed the peak design flow of the drainage system
ii. Total or near total blinding of the screens (e.g., due to poor maintenance of unit)

i. Calibration Feature

N/A

j. Photos

Since there are no current installations, no photos of installed units are available. Figure 16 shows the HydroDome TS prototype (model HDTS2-6) used for laboratory testing The test prototype consists of a plastic insert housed in a 2-ft diameter tank and installed in a 6-in outlet pipe. The test prototype has a Van Stone flange bolted to the back wall to allow quick connection and disconnection to the test tank outlet pipe.

However, typical HydroDome TS units include mounting tabs for anchor bolts and an integrated outlet stub that slides into the outlet pipe of the precast structure to form a permanent connection.

Figure 16. Laboratory Test Prototype – HydroDome TS (HDTS2-6)

k. Material Type

Insert

The internal components of the HydroDome TS are made out of high-density polyethylene (HDPE) or copolymer polypropylene (CPP) plastic.

Structure

The insert is installed in a manhole typically made of precast concrete. The precast is designed to meet ASTM C478 standards and AASHTO HS-20 loading.

Hardware

All hardware used in the inserts or to secure the inserts to the housing structure are made of grade 304 stainless steel.

Screens

The perforated inlet screens are made of polypropylene plastic, with maximum opening size of 3/16” (4.76 mm).

Access Covers

Manhole frames, covers, and inlet grates are cast iron and meet ASTM A48 and AASHTO M-306 loading.

l. Design Life

The design life of all components used in the HydroDome TS is between 50 and 100 years. Actual service life depends on proper design, installation, and maintenance.

4. Installation Guidance

a. Standard System installation procedures

Installation of the precast manhole structure should be performed separately from the HydroDome TS insert. The installation steps for the insert are summarized below:

- Caulk the outlet stub (generously) with Pro-Seal34
- Lower the HydroDome TS into the structure with lifting straps
- Gently slide the outlet stub into the structure outlet pipe as far as it will go
- Secure the insert to the wall with anchor bolts through the mounting tabs

Detailed installation procedures for the standard HydroDome TS, with illustrations, are provided in Appendix B.

b. Description of System installation limitations and/or non-standard System installation procedures

The HydroDome TS cannot be installed until the manhole is set and the outlet pipe is in place (since it installs into the outlet pipe). The structure top cap should not be placed on the manhole until after HydroDome TS installation is complete.

If the HydroDome TS is installed in a round manhole, the outlet pipe should be radially centered.

Deviations from these standard requirements will require custom modifications to the insert and/or the installation procedures.

c. Methods for diagnosing and correcting installation errors

Most installation errors are caused by installing a unit in the wrong manhole or damage during transportation that goes unreported.

The HydroDome TS insert should be inspected for damage or defects such as cracked welds etc. before installation.

The project name and unit number are routed into the plastic lid of the insert or otherwise marked such that each unit can be clearly identified. Confirming that this information matches the structure identifier prevents most installation errors before they happen.

Installation of the HydroDome TS shall conform to recommended procedures (Appendix B) as well as all engineering plans. Hydroworks should be contacted to answer any questions regarding installation or to evaluate corrective actions in case of errors.

5. Operation and Maintenance Information

a. Inspection procedures

The O&M Manual for the HydroDome TS, including procedures for inspection and maintenance, is provided in Appendix C. The general inspection procedure is described below.

Visual inspection can be performed from the surface to assess accumulation of floatable and non-floatable trash. Visual inspection of the condition of the structure and insert should also be performed simultaneously to identify any possible damage or defects to the unit.

Inspection should be performed at minimum twice per year. The initial inspections will indicate the required frequency of future inspections and maintenance.

The procedure involves quantifying the captured trash inside the structure. Maintenance/cleanout is required once accumulated trash reaches the volumes indicated in the O&M manual.

The HydroDome TS is designed to convey the peak treatment flow without bypass when 50% or more of the inlet screen in blinded. However, as the percentage of screen clogging increases, the hydraulic impact upstream will also increase. As the screens progressively clog, during storm events, the upstream water level will eventually rise to the point where influent flow bypasses the screens by overtopping the HydroDome TS insert walls.

Any evidence of premature bypass, e.g., significant accumulation of trash inside the insert or distinct water stains on the structure wall above the bypass elevation may indicate the need for maintenance. These observations should be correlated with recent rainfall observations to determine if the peak treatment rate was exceeded or if the unit requires maintenance. A standing water level above the outlet invert 24 hours after rainfall also indicates that the screens are clogged and require maintenance. All observations should be recorded in the inspection log.

b. Recommended minimum maintenance frequency

The HydroDome TS is capable of conveying high flows at clogging percentages up to and exceeding 90%. However, it is recommended to maintain the HydroDome TS when the screen is 50% blinded to preserve near-optimal hydraulic capacity. Since floatables capture volumes do not correlate perfectly to screen clogging percentages, inspections are important for characterizing typical volume and type of trash as well as required maintenance frequencies. It should be noted that the applicable Municipal Stormwater Permit may include specific maintenance frequencies more stringent than that recommended by Hydroworks for HydroDome TS.

c. Maintenance procedures, including procedures to clean the trash capture screen

Floatable and settleable trash/sediment are typically removed from the HydroDome at the same time. Maintenance can typically be performed from the surface, through the access opening, without entering the structure. Sediment, trash, and water should be removed together using a vactor truck. The inlet screens should be hosed down to flush any trapped debris into the sump while continuing to vacuum the sump. The local municipality should be consulted for the allowable disposal options for both water and sediments prior to any maintenance operation. All maintenance activities should be documented, and reports archived.

Detailed maintenance procedures are provided in the O&M manual in Appendix C.

d. Essential equipment and materials for proper maintenance activities

Recommended equipment for maintenance includes a manhole hook, vactor truck, tape measure, sludge/sediment sampler, inspection log, and safety equipment.

e. Description of the effects of deferred maintenance

Deferred maintenance may result in blinded screens, which will cause bypass at progressively lower flow rates. Bypass will result in the loss of some previously captured floatable trash and oil as well as a higher upstream hydraulic grade line. Decomposition of organic material may also cause the release of bacteria, nutrients, and odors.

f. Repair procedures for the System’s structural and screening components

The screening components of the HydroDome TS are made of 3/16” thick (min) perforated plastic sheet and are therefore intended to last for at least 50 years or the product's full lifetime without repairs. This assumes proper sizing and installation as well as typical trash loading.

The device’s structural components are similarly robust and repairs are not anticipated. However, small repairs to any insert components can be performed in place provided the structure is pumped down first. Larger repairs or the replacement of the full insert may require removal of the precast top cap. Hydroworks should be contacted to evaluate potential repairs before attempting to perform any such work.

6. Vector Control Accessibility

a. The description of how mosquito vector control personnel can readily access the bottom of the storm water vault and/or System for visual observation and mosquito treatment. A video may be required for Systems with complex vector control accessibility procedures.

The open design of the HydroDome TS provides unobstructed access to all areas where standing water may exist inside the HydroDome TS for vector inspection and treatment. Both the sump and the interior of the insert are visible through the access opening.

b. System drawings that depict the vector control accessibility including sight lines.

Figure 17 shows sight lines into a 4-ft diameter round manhole structure housing a HydroDome TR unit (model HDTR4-12). These are virtually the same sight lines as in the HydroDome TS HDTS4-12 model, since they share design commonality. Since a precast manhole was not available for demonstration, Autodesk Fusion 360 was used to model a HydroDome TR unit and illustrate the sight lines for visual inspection and mosquito treatment.

The access opening is 30” in diameter for all model sizes. For units installed in round manholes 8-ft in diameter and larger, two 30”-diameter access openings are provided, which further improves visibility and access. Since insert footprint scales with manhole size, sight lines for all model sizes are similar. Sight lines into the structure improve as the depth of the insert below the access opening increases. For the modeled unit pictured in Figure 17, the top of the insert is 12” below the bottom of the manhole flat top, which is a relatively shallow depth.

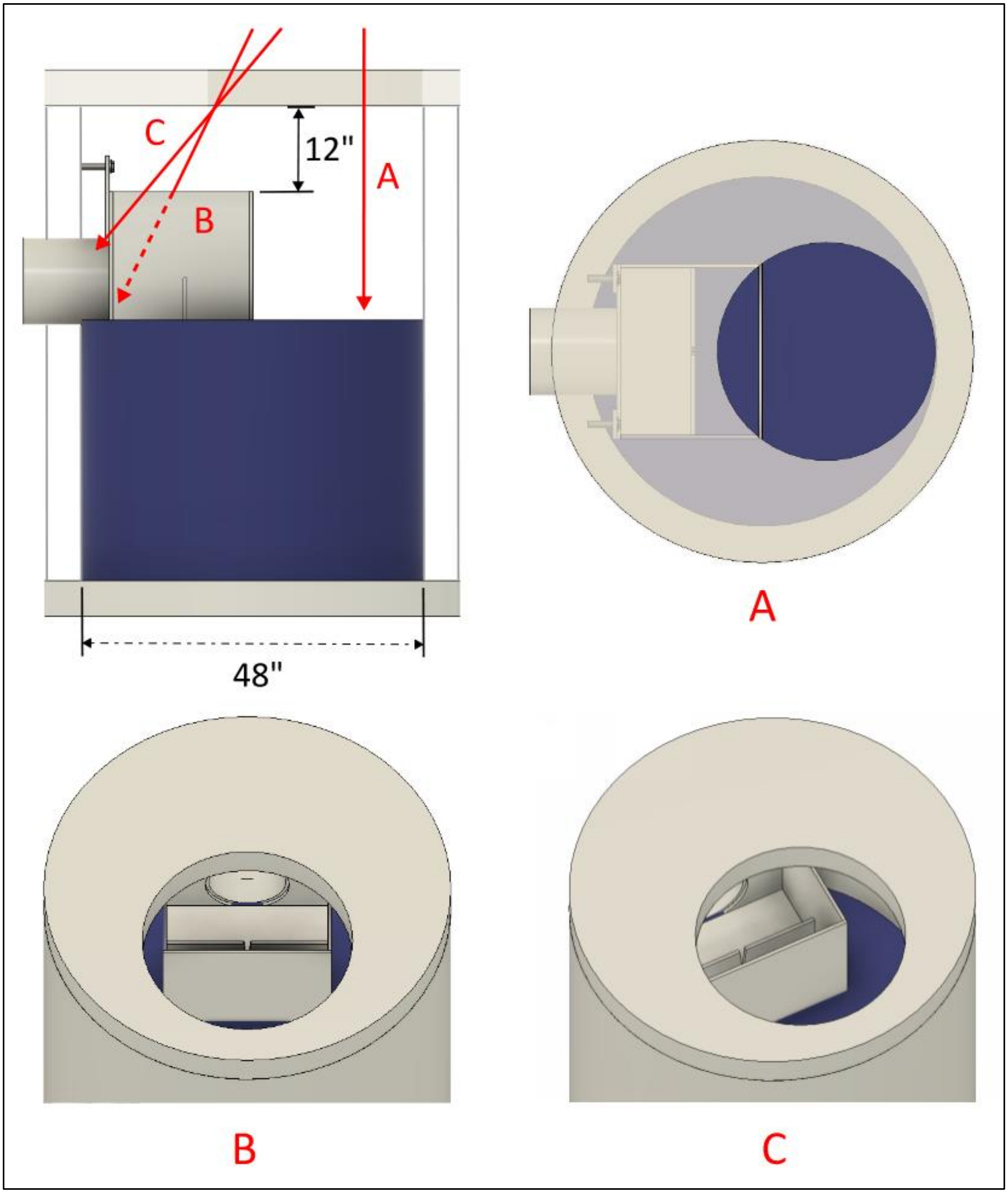


Figure 17. Sight Lines into HydroDome TR Round Manhole

c. The date the System application was submitted for vector control accessibility design verification via email to the Mosquito Vector Control Association of California at Trashtreatment@mvcac.org.

d. Once received, the date of the Mosquito Vector Control Association of California Letter of Verification. The letter shall be attached to the application.

The MVCAC Letter of Verification for the Hydroworks HydroDome TS (attached) was dated August 14, 2024.

MVCAC
Mosquito and Vector Control Association of California

One Capitol Mall, Suite 320 • Sacramento, CA 95814 • p: (916) 440-0826 • f: (916) 444-7462 • e: mvcac@mvcac.org

Hydroworks, LLC
257 Cox Street
Roselle, NJ 07203

August 14, 2024

Dear Mr. Bryant,

Thank you for the submission of the Hydroworks HydroDome TS 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 HydroDome TS 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.

While this verification letter confirms that inspection and treatment for the purpose of minimizing mosquito production should be possible with the HydroDome TS 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,

Megan MacNee
MVCAC Executive Director

7. Reliability Information

a. Estimated design life of System components before major overhaul

The estimated design life of all components is between 50 and 100 years depending on proper design, installation, and maintenance.

b. Warranty information

Hydroworks, LLC provides a one (1) year limited warranty. A copy of the warranty is included in the O&M Manual (Appendix C).

c. Customer support information

Hydroworks can be reached at:

Address:	Hydroworks, LLC 257 Cox Street Roselle, NJ 07203
Email:	support@hydroworks.com
Phone:	888-290-7900

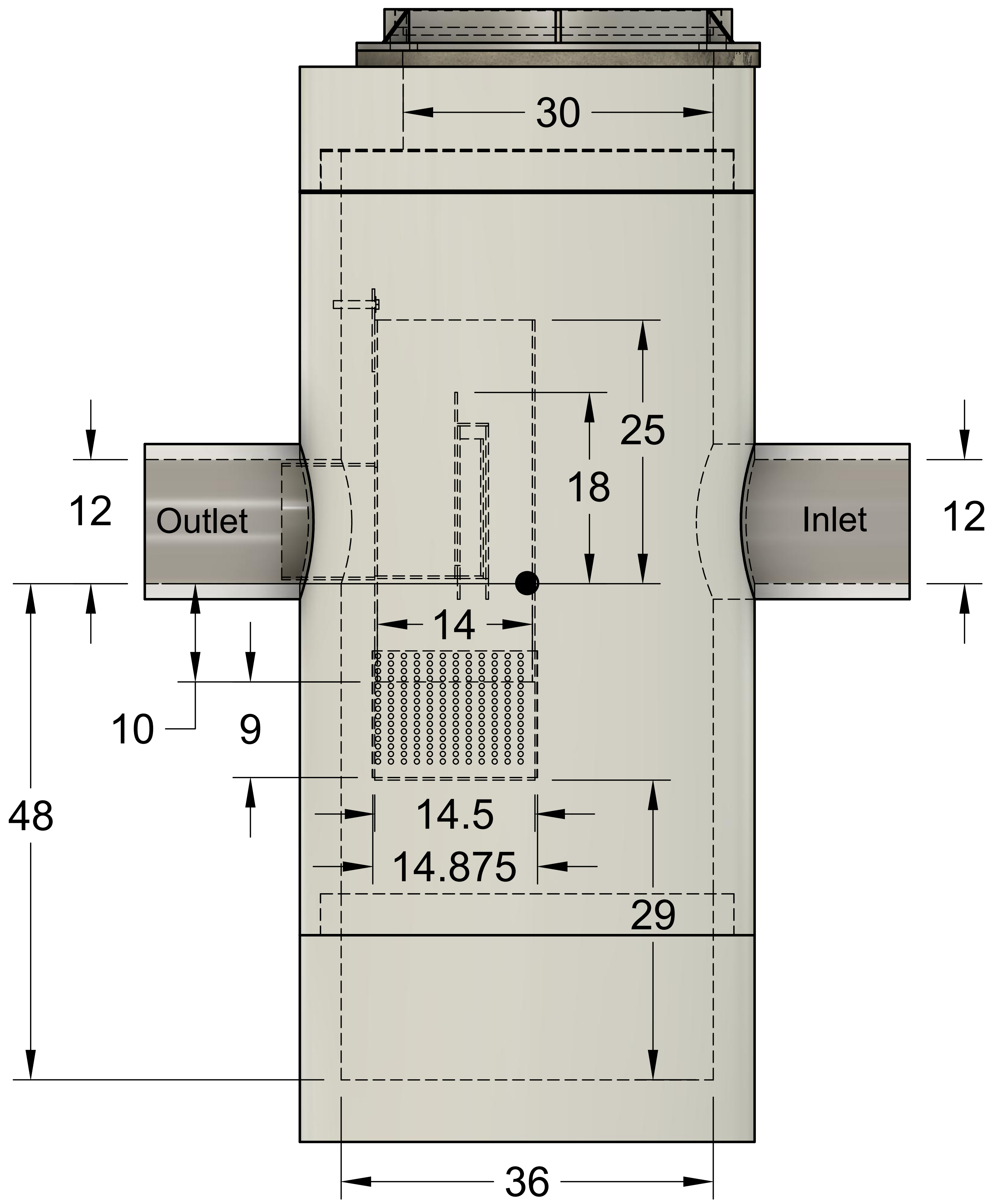
8. Field and Laboratory Testing Information

a. For Systems that include 5-millimeter screening, field or laboratory testing is optional. Applicants may provide available field or laboratory testing information; or

b. If the System does not include a 5-millimeter screen, field or laboratory testing is mandatory.

The HydroDome TS has not been laboratory tested specifically for trash capture.

Appendix A
Standard Drawings



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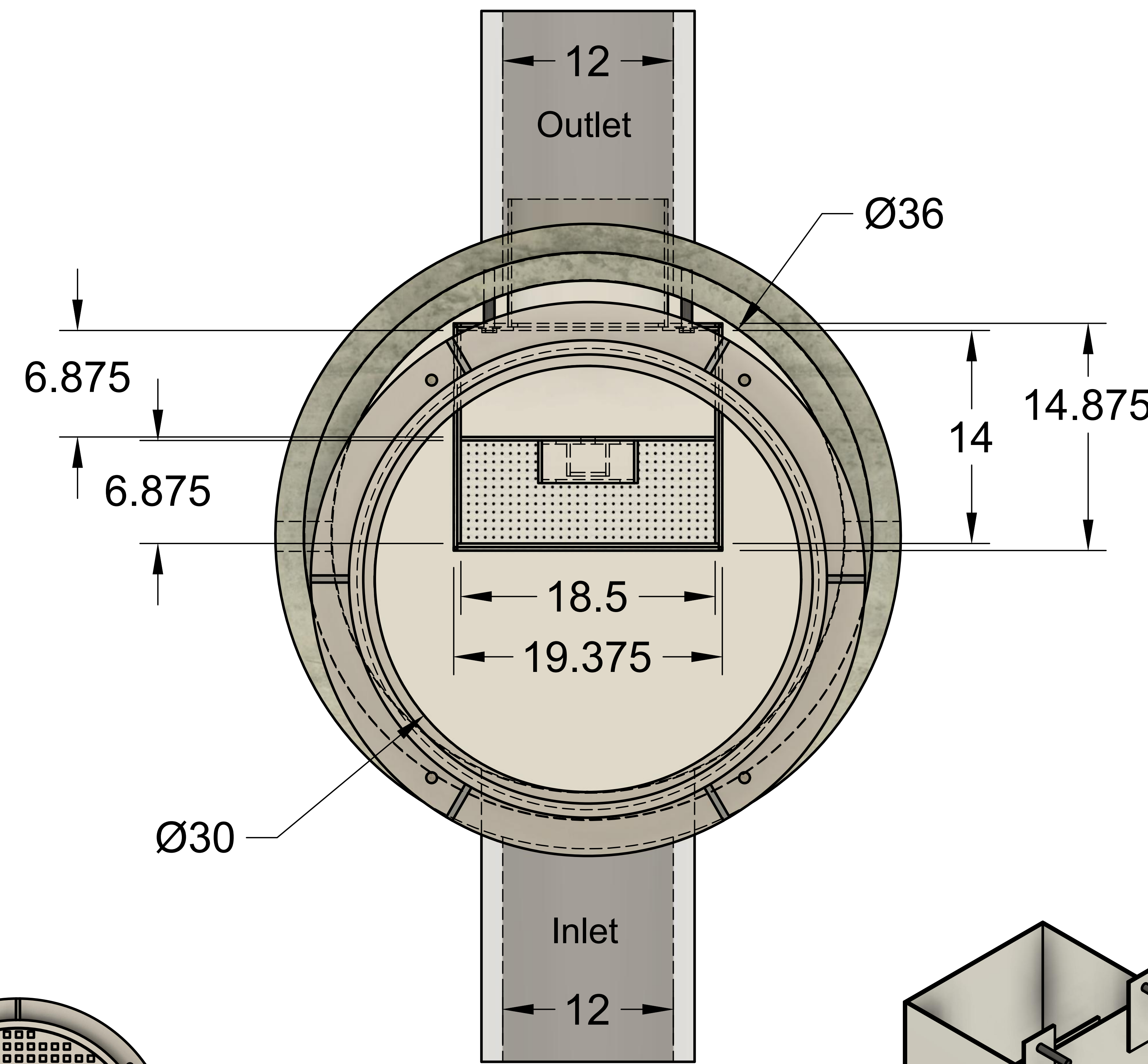
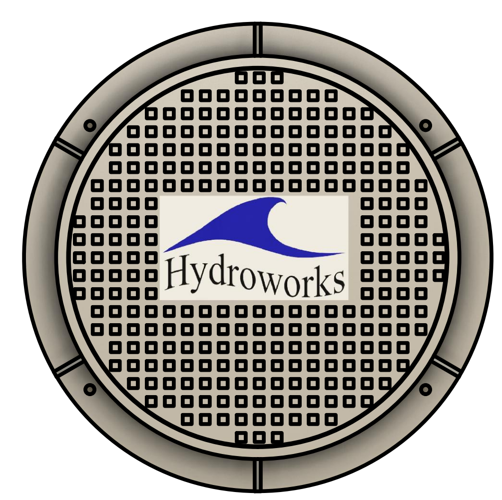
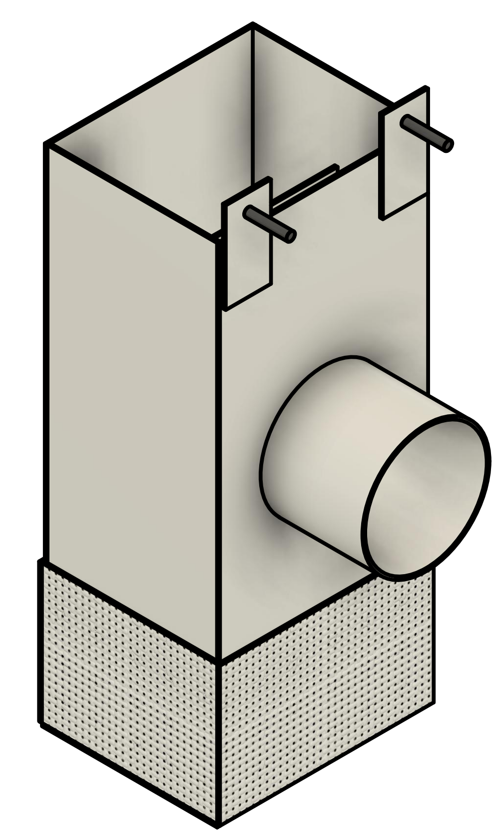




Hydroworks Frame and Cover

Plan



Notes:
1. Generic layout shown. Contact Hydroworks for site-specific drawing.
2. Dimensions not to scale. Standard dimensions indicated.
3. Multiple inlet pipes possible.
4. Drops through structure possible
5. Increased peak treatment flows and storage capcities can be provided based on custom designs
6. Contact Hydroworks· more information

HydroDome by Hydroworks, LLC
NJCAT Verified and NJDEP Certified

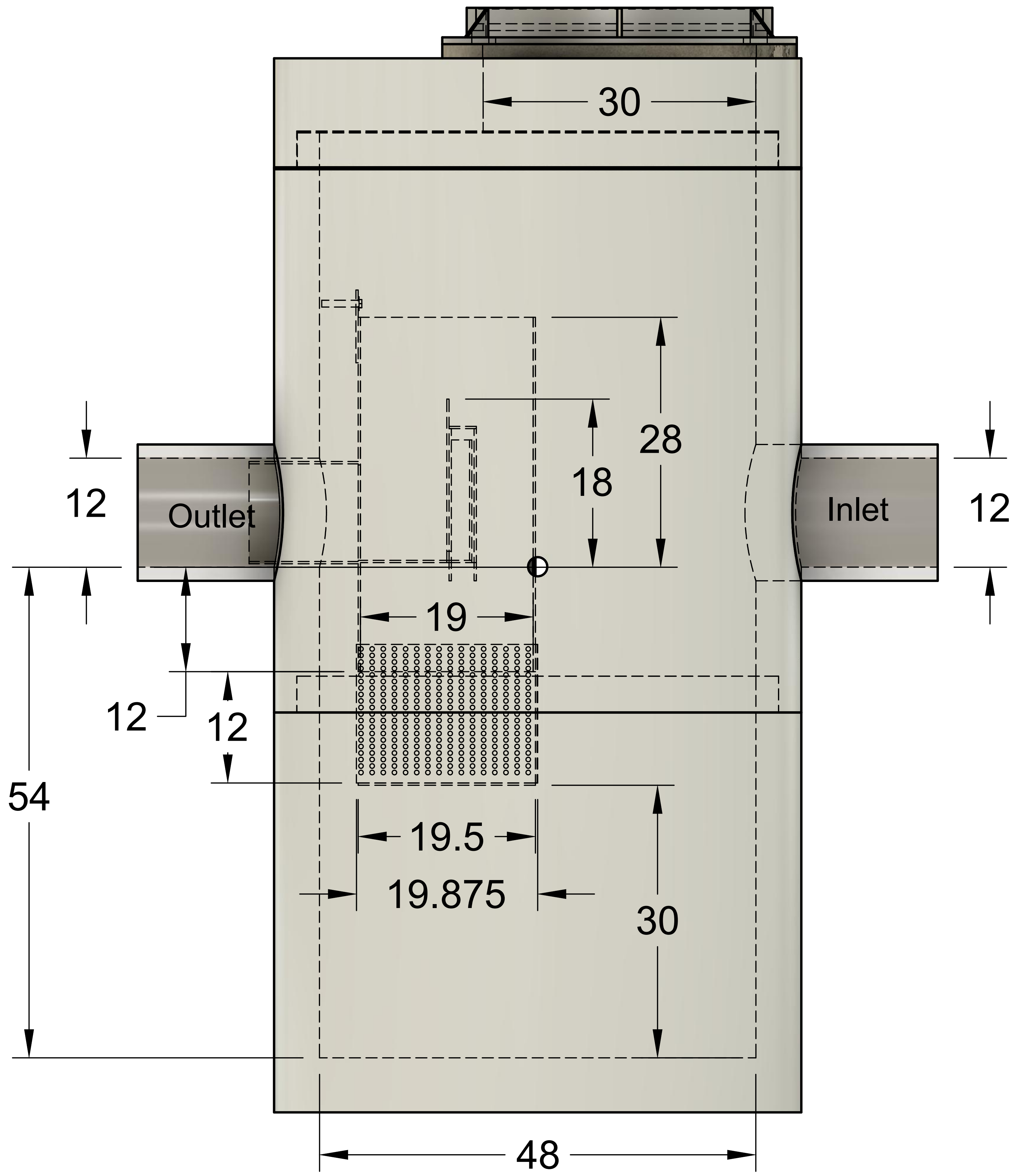
www.hydroworks.com
info@hydroworks.com
888-290-7900

US Patent #10,801,196

HydroDome HDTS3-12

Project:	Full Trash Capture - Standard Drawing
Location:	

Date: 07/10/2024	Scale:	Rev: 1



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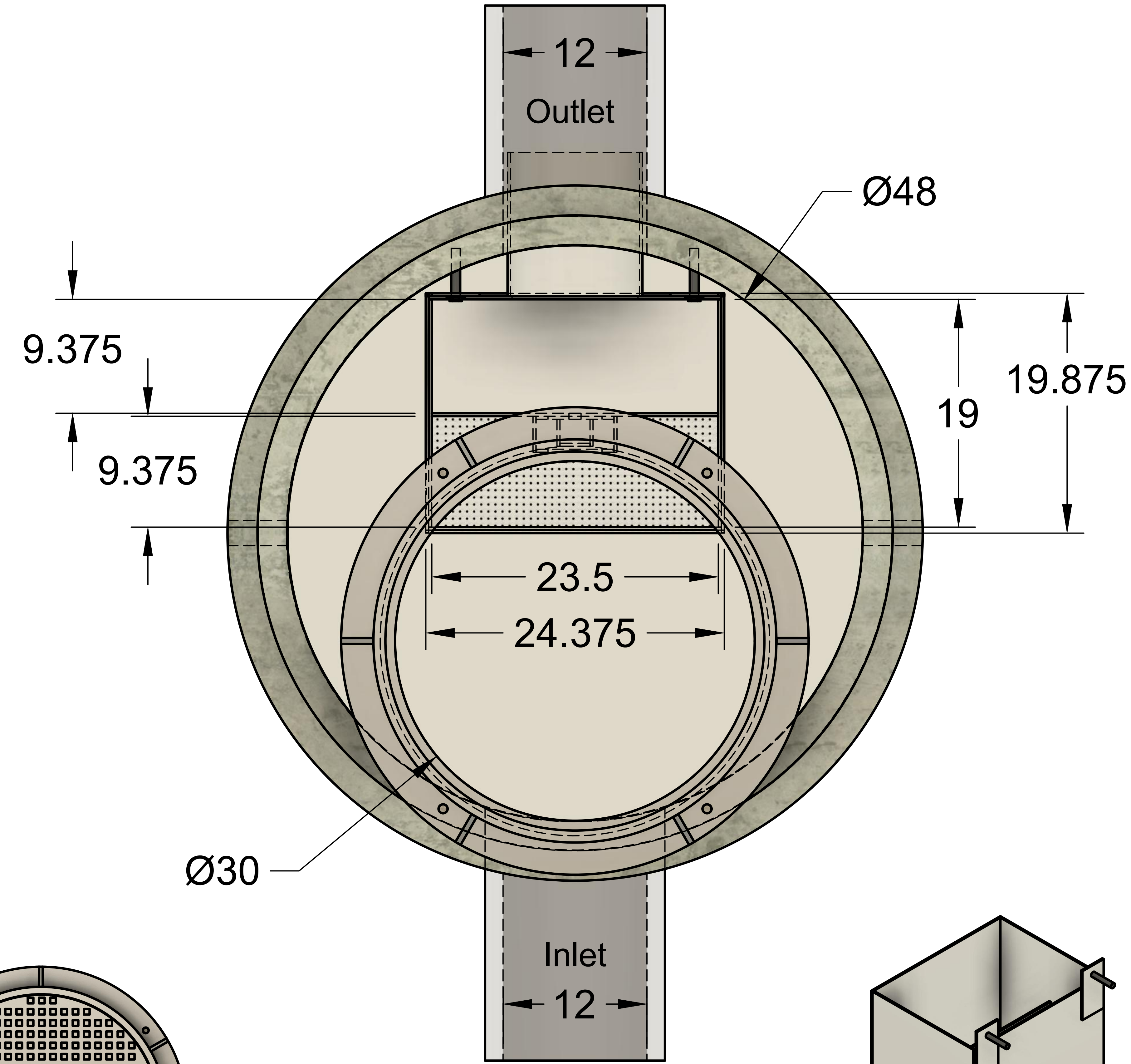
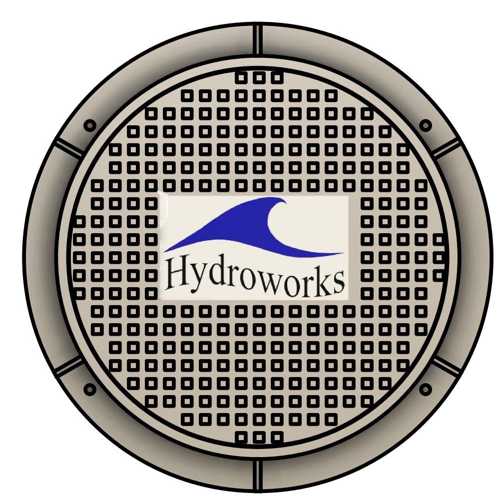
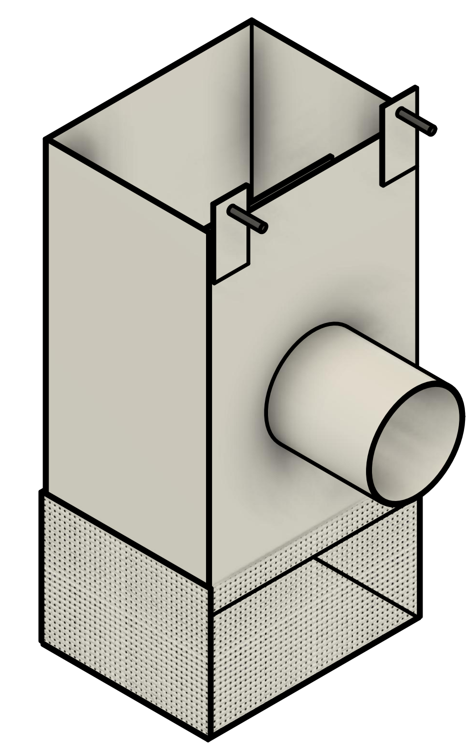


Plan



Hydroworks Frame and Cover



Notes:
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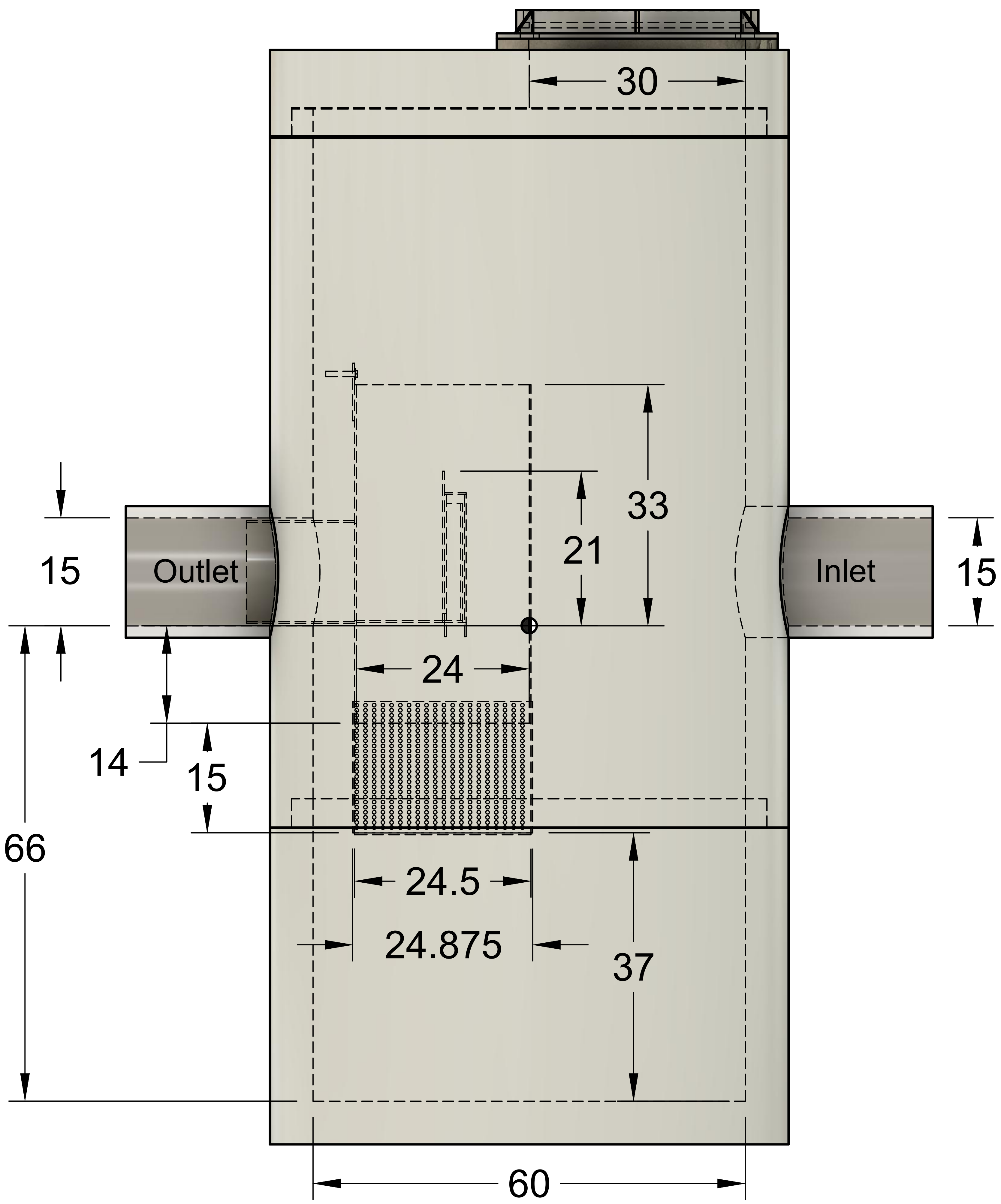
US Patent #10,801,196

HydroDome HDTS4-12

Project:	Full Trash Capture - Standard Drawing
Location:	

Date: 07/10/2024	Scale:	Rev: 1

Hydroworks



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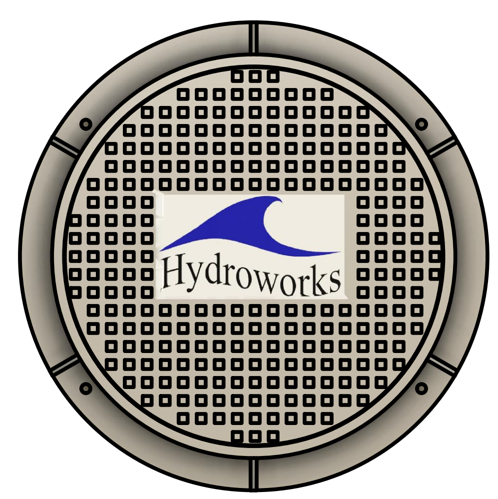
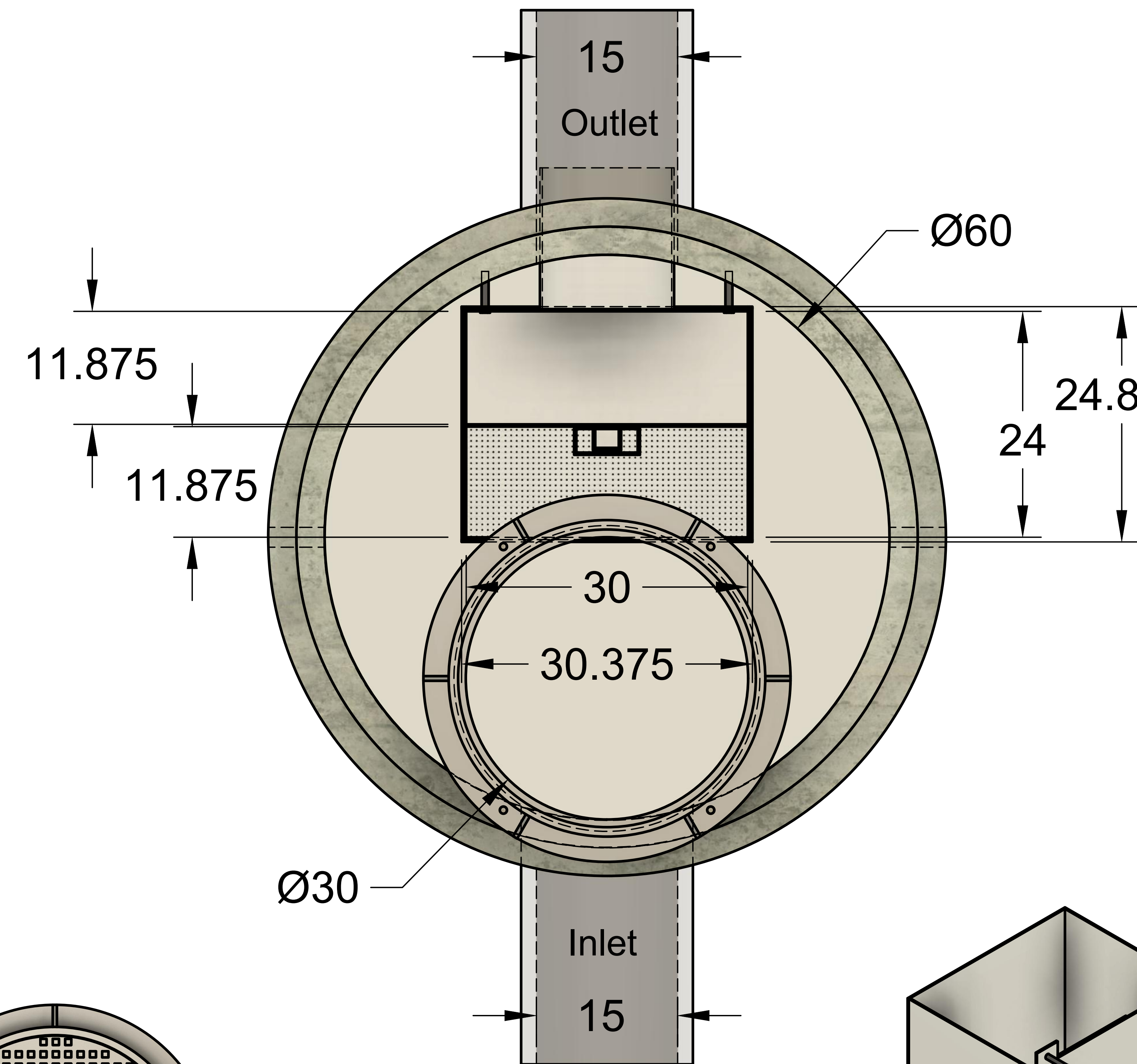
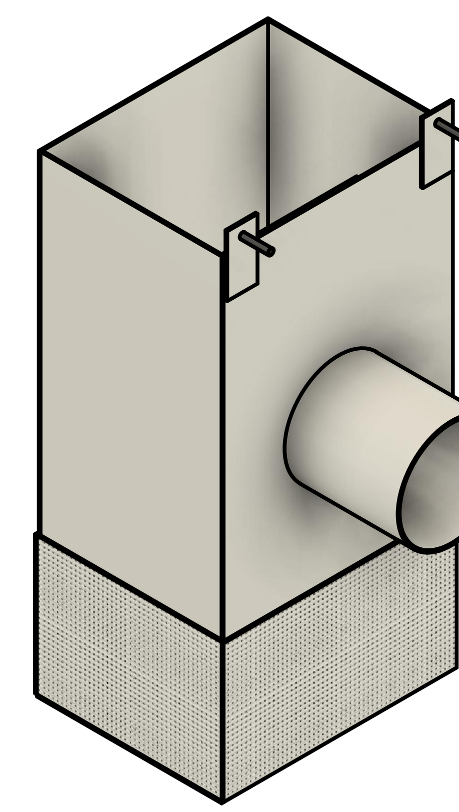


Hydroworks Frame and Cover



Plan



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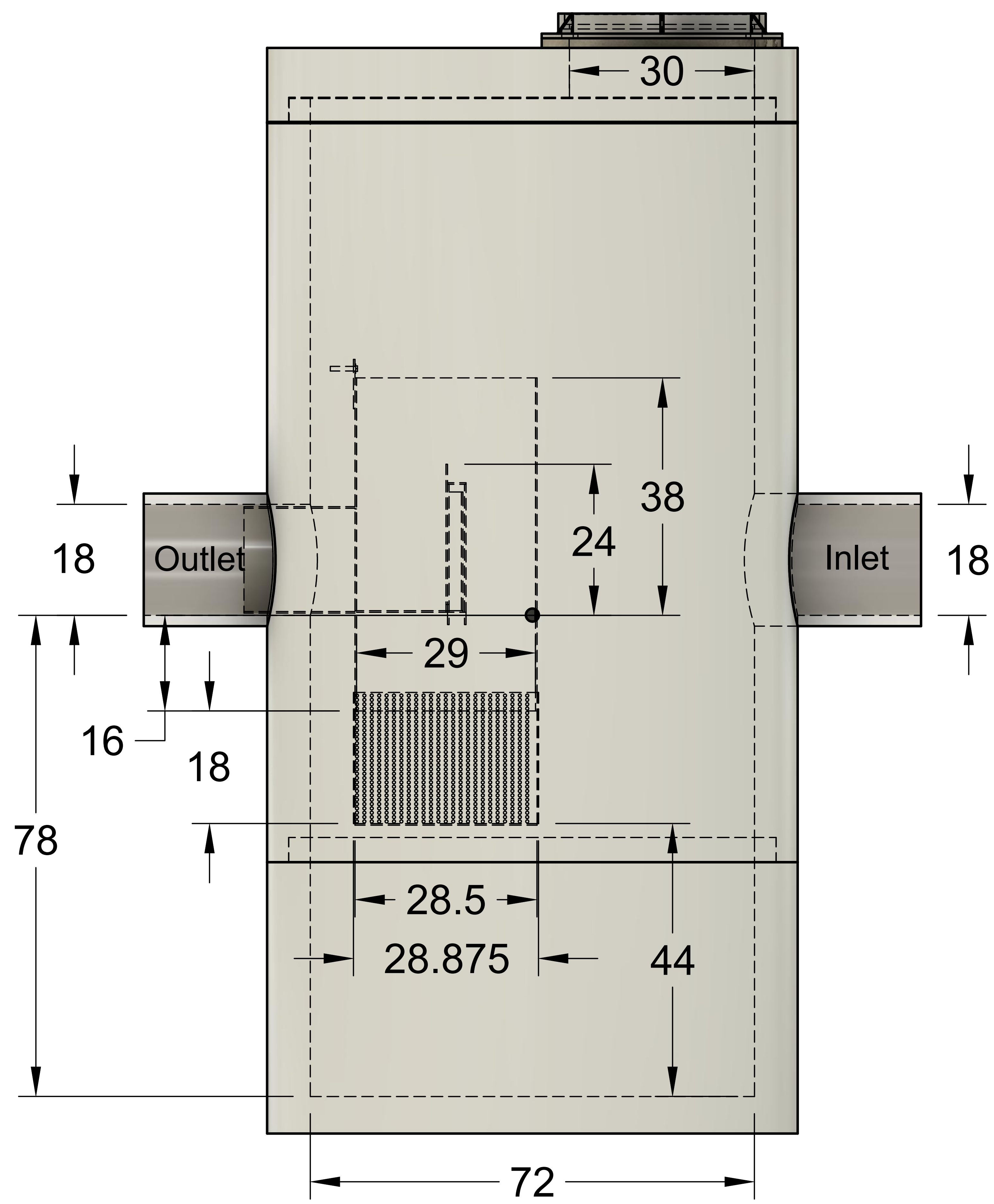
US Patent #10,801,196

HydroDome HDTS5-15

Project:	Full Trash Capture - Standard Drawing
Location:	

Date: 07/10/2024	Scale:	Rev: 1

Hydroworks



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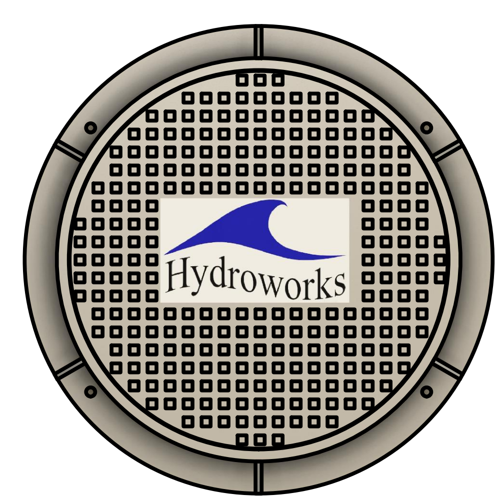
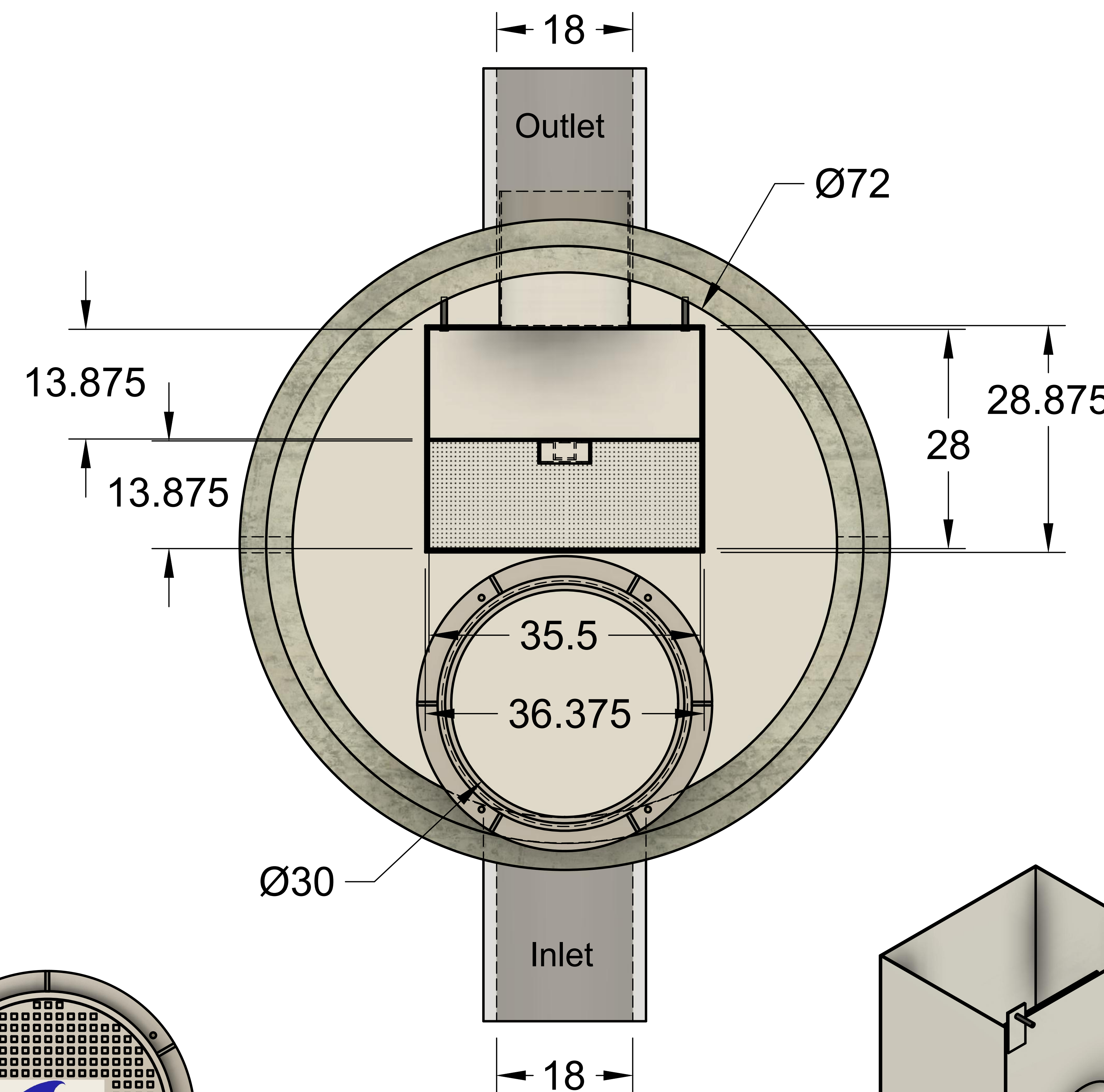


Hydroworks Frame and Cover



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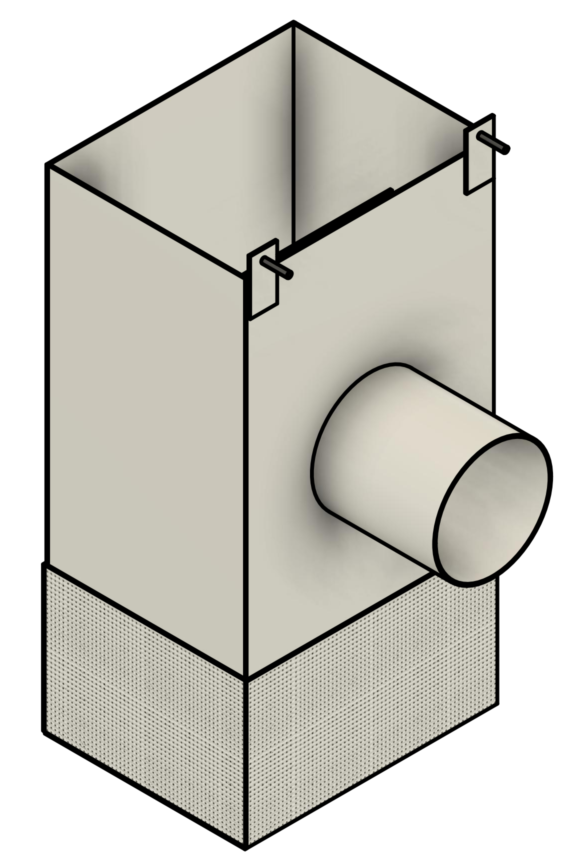


Notes:
1. Generic layout shown. Contact Hydroworks for site-specific drawing.
2. Dimensions not to scale. Standard dimensions indicated.
3. Multiple inlet pipes possible.
4. Drops through structure possible
5. Increased peak treatment flows and storage capcities can be provided based on custom designs
6. Contact Hydroworks· more information

HydroDome by Hydroworks, LLC
NJCAT Verified and NJDEP Certified

www.hydroworks.com
info@hydroworks.com
888-290-7900

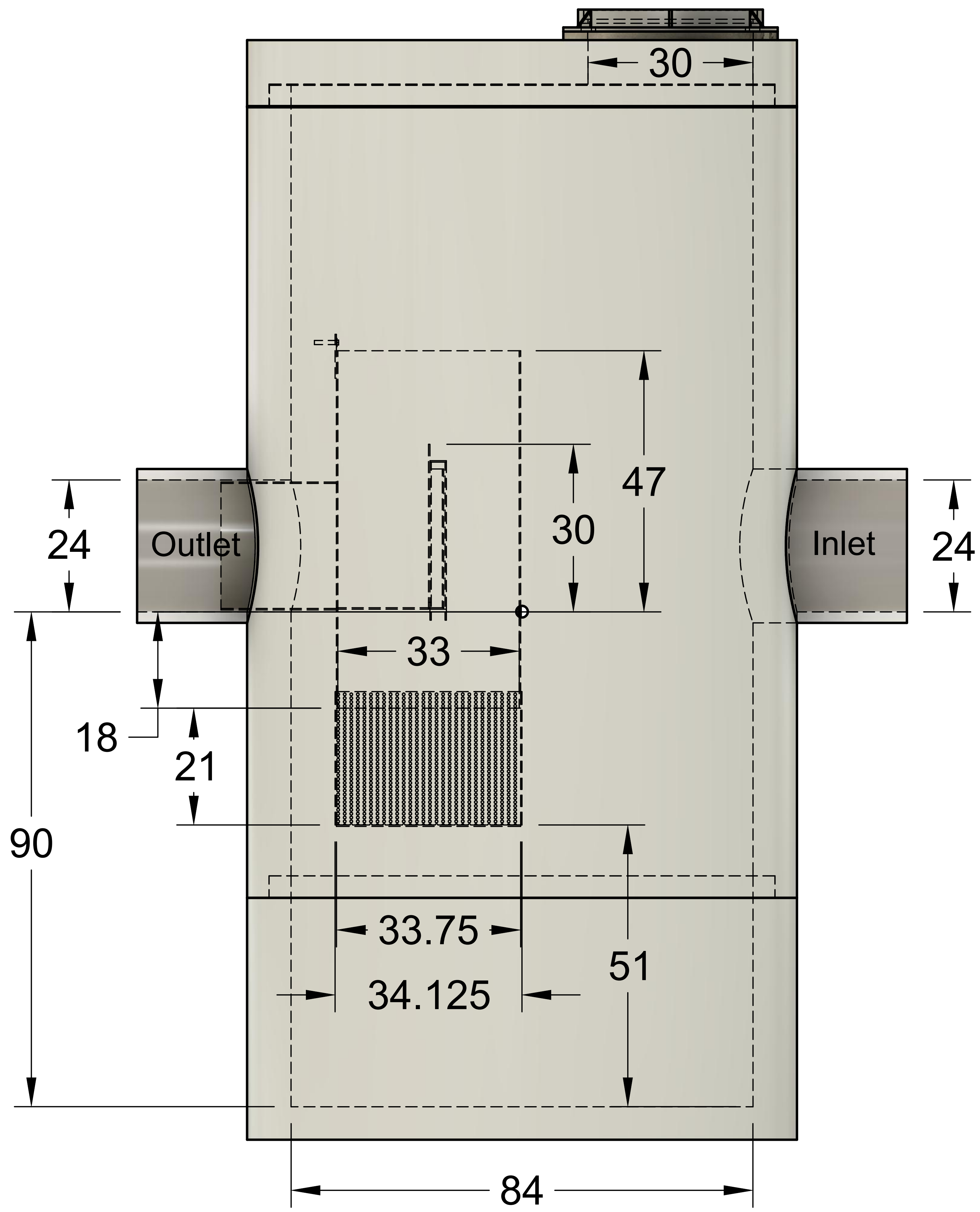
US Patent #10,801,196

HydroDome HDTS6-18

Project:	Full Trash Capture - Standard Drawing
Location:	

Date: 07/10/2024	Scale:	Rev: 1

Hydroworks



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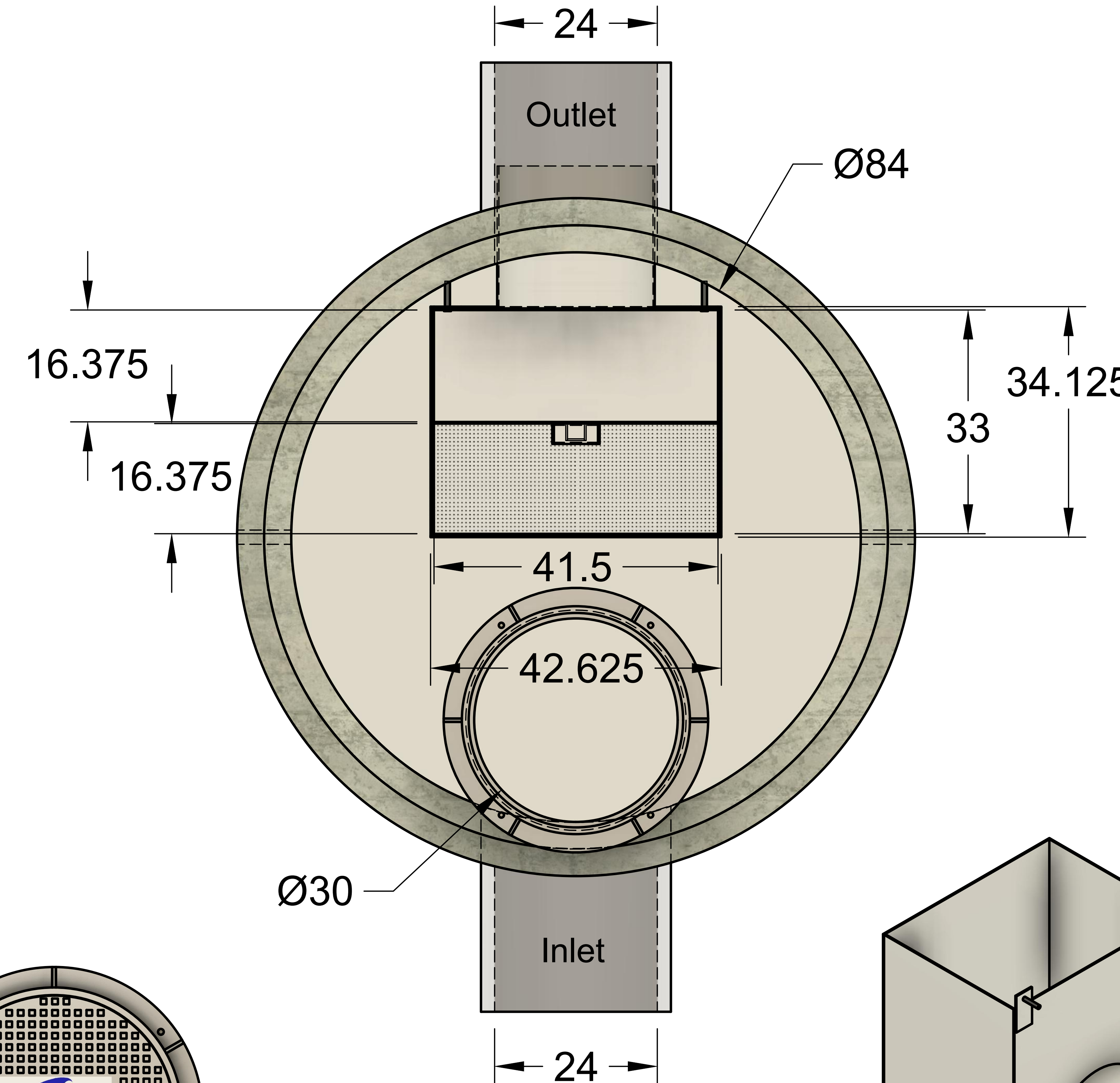

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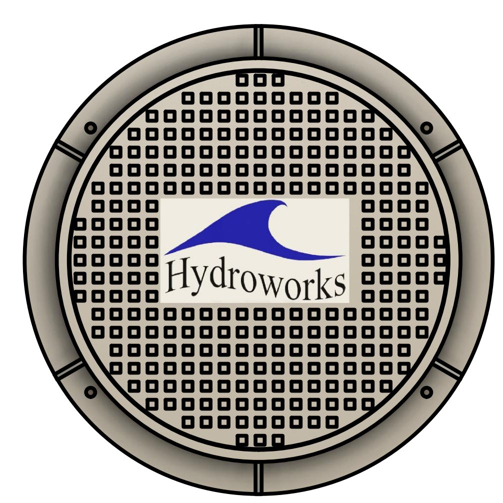
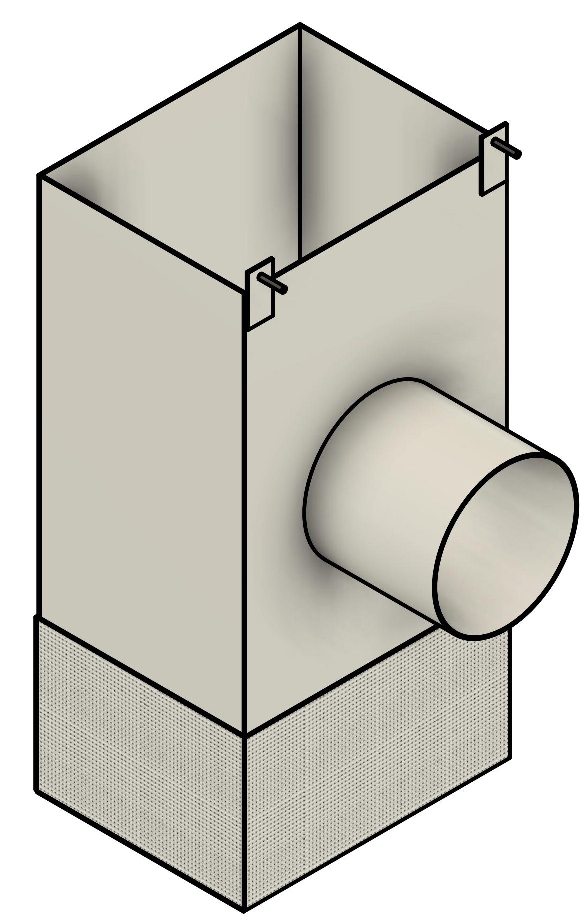


Hydroworks Frame and Cover



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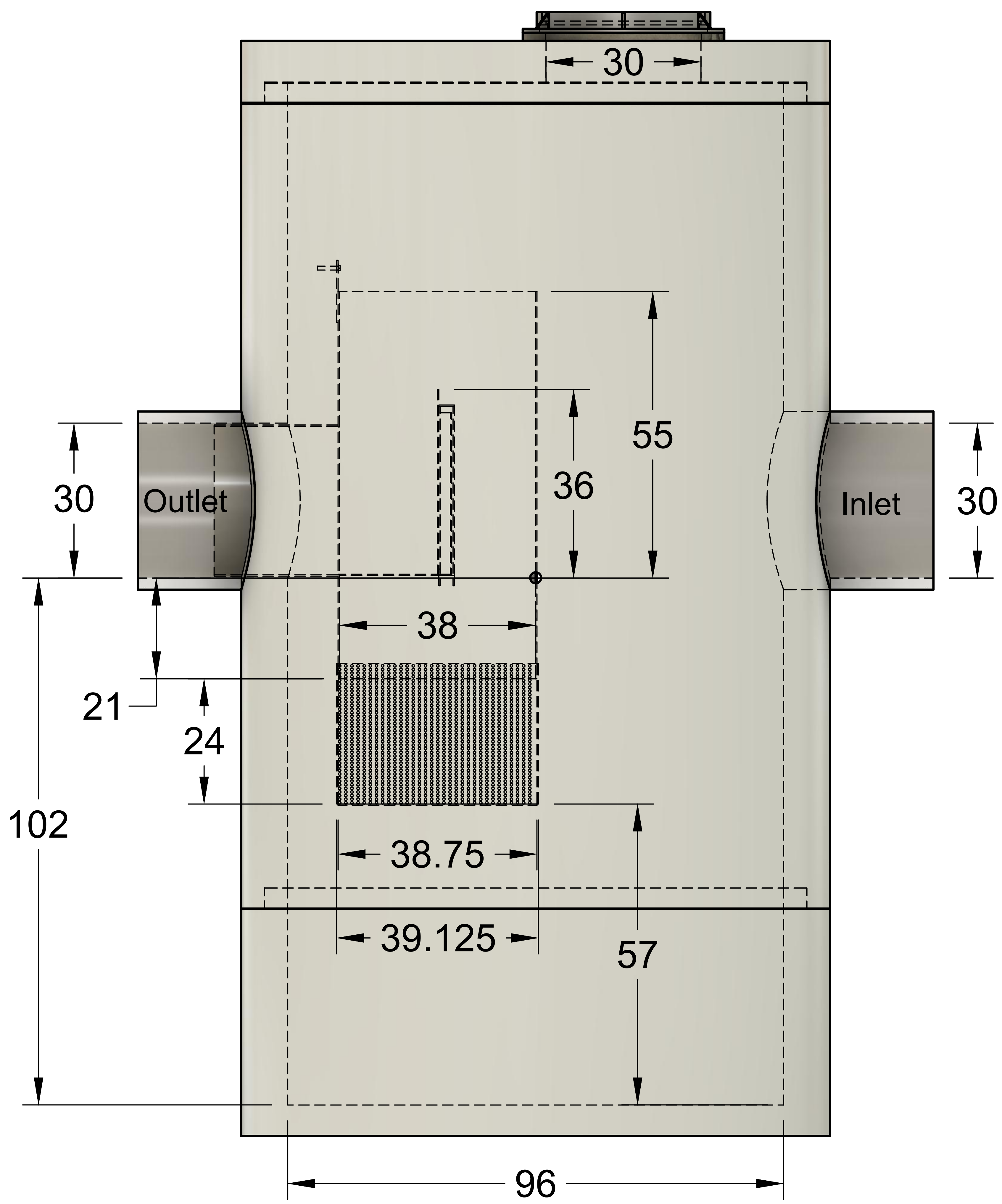
US Patent #10,801,196

HydroDome HDTS7-24

Project:	Full Trash Capture - Standard Drawing
Location:	

Date: 07/10/2024	Scale:	Rev: 1

Hydroworks



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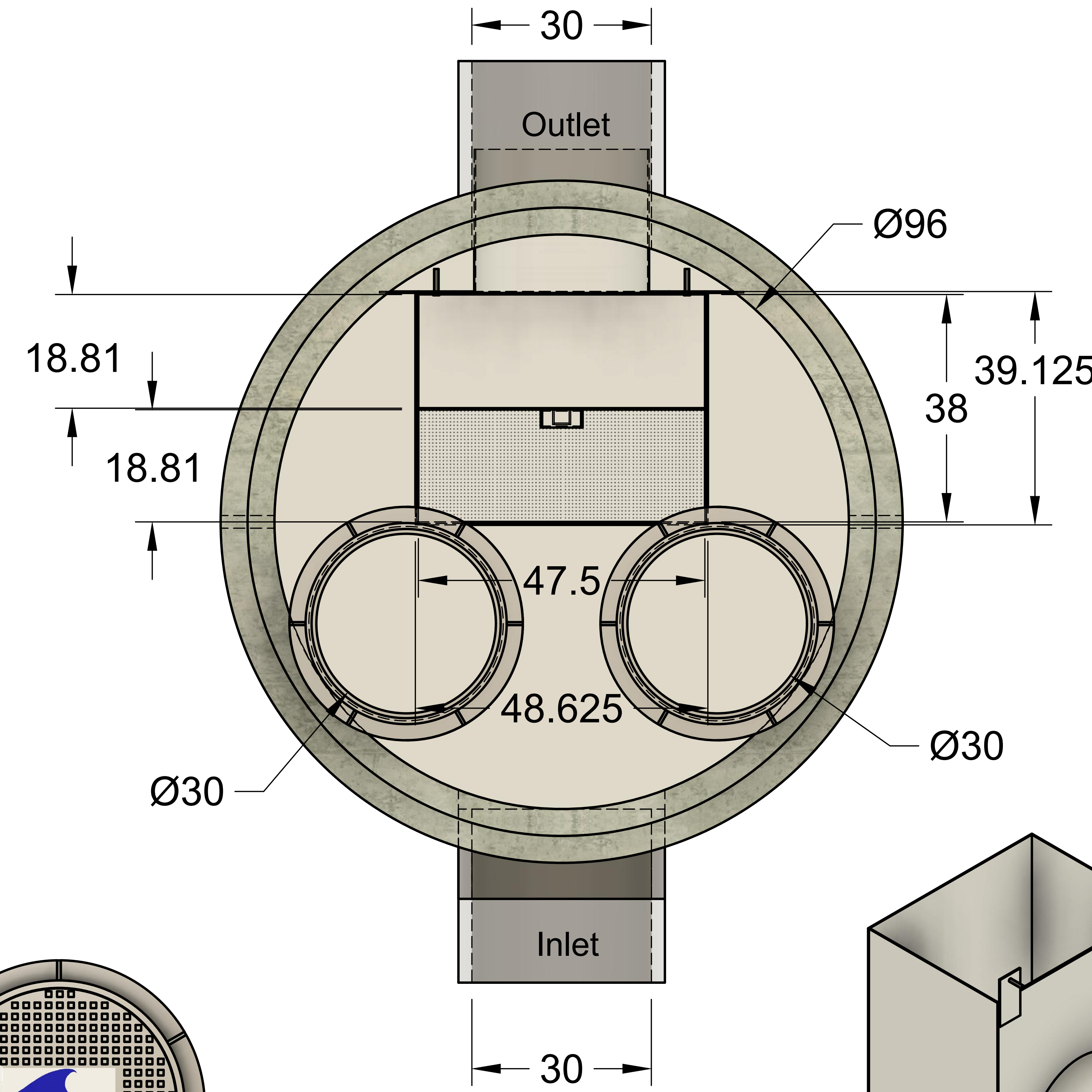

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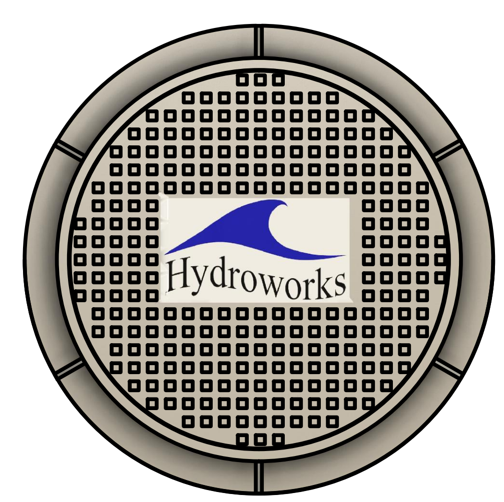
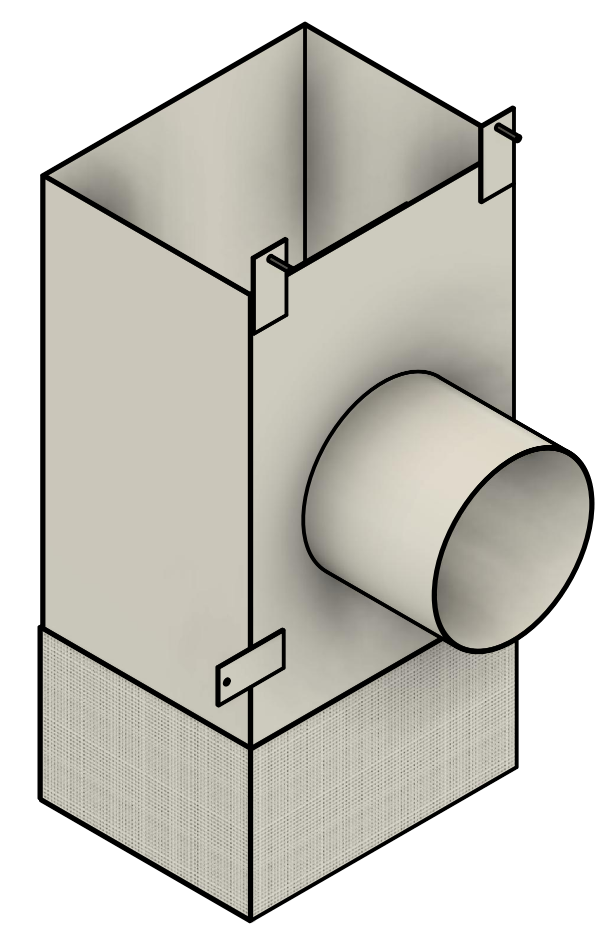


Hydroworks Frame and Cover



Notes:
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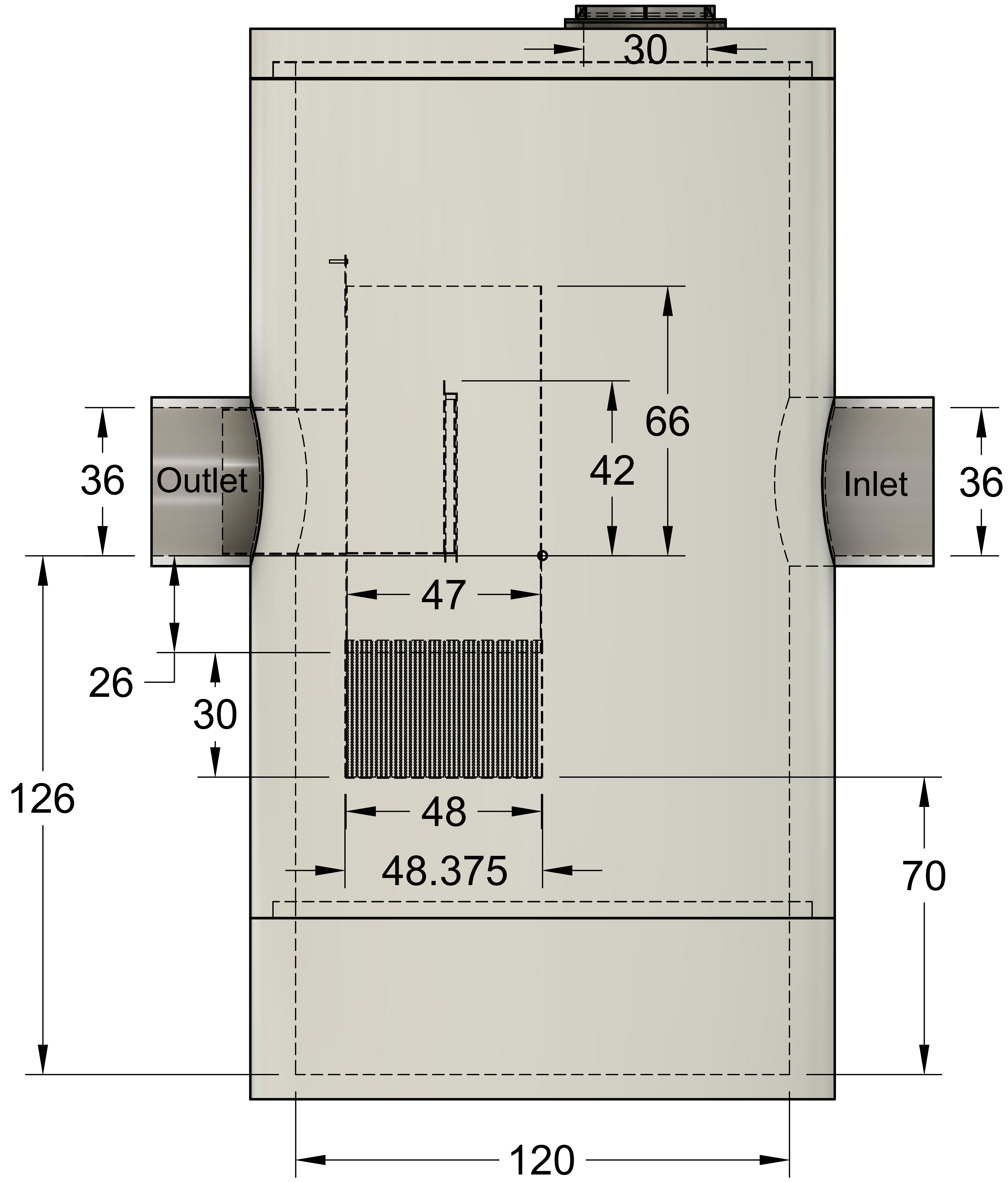
US Patent #10,801,196

HydroDome HDTS8-30

Project:	Full Trash Capture - Standard Drawing
Location:	

Date: 07/10/2024	Scale:	Rev: 1

Hydroworks



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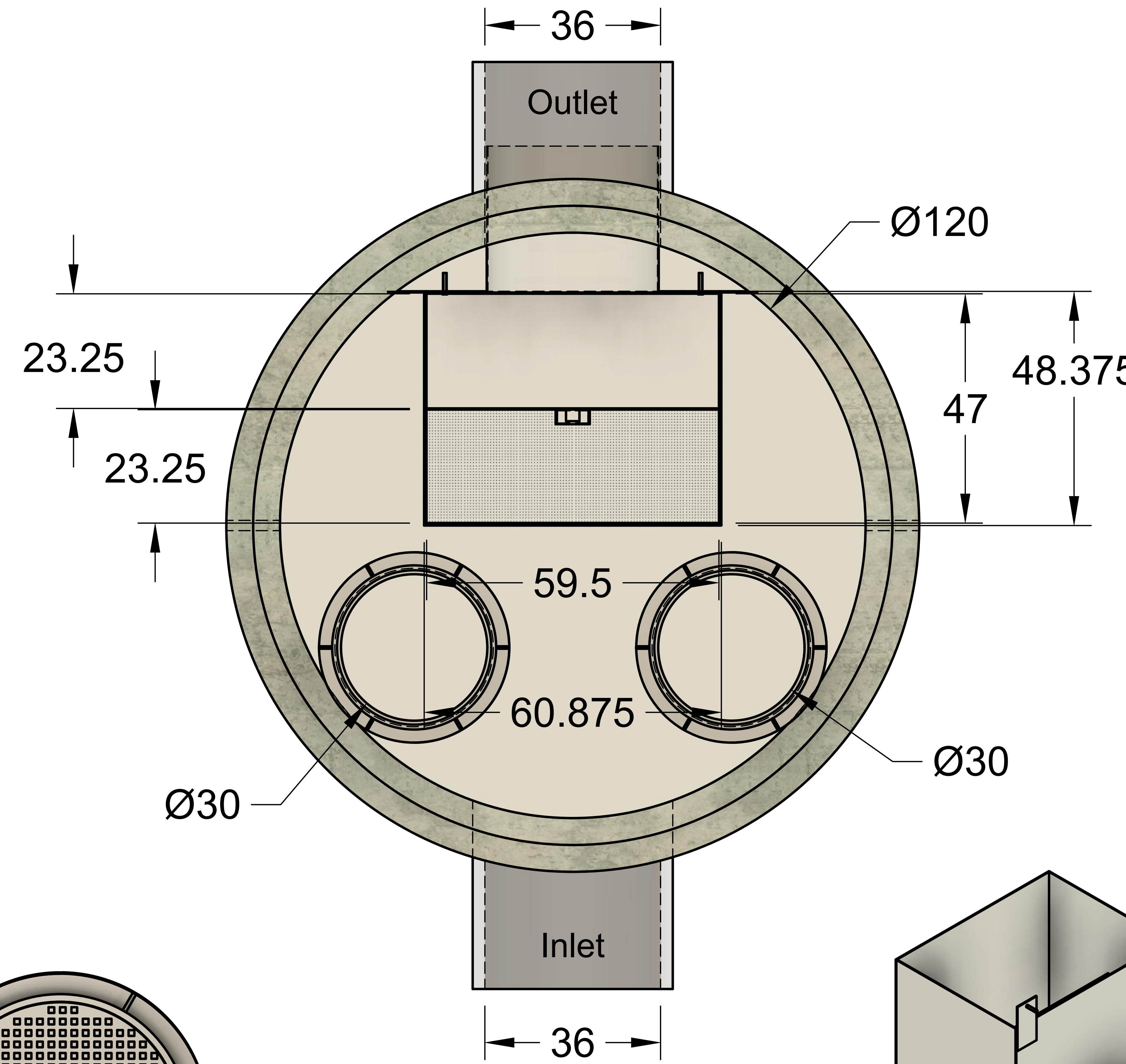
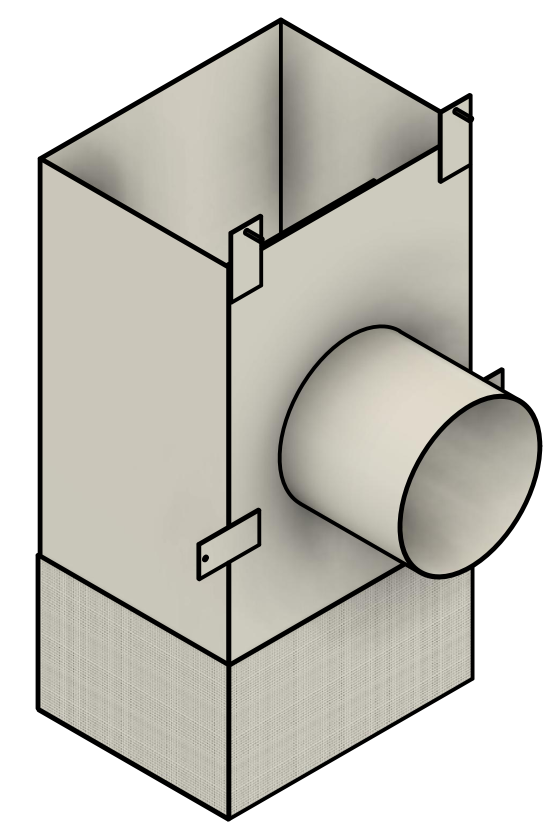
Hydroworks Frame and Cover



Plan



Notes:
1. Generic layout shown. Contact Hydroworks for site-specific drawing.
2. Dimensions not to scale. Standard dimensions indicated.
3. Multiple inlet pipes possible.
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888-290-7900

US Patent #10,801,196

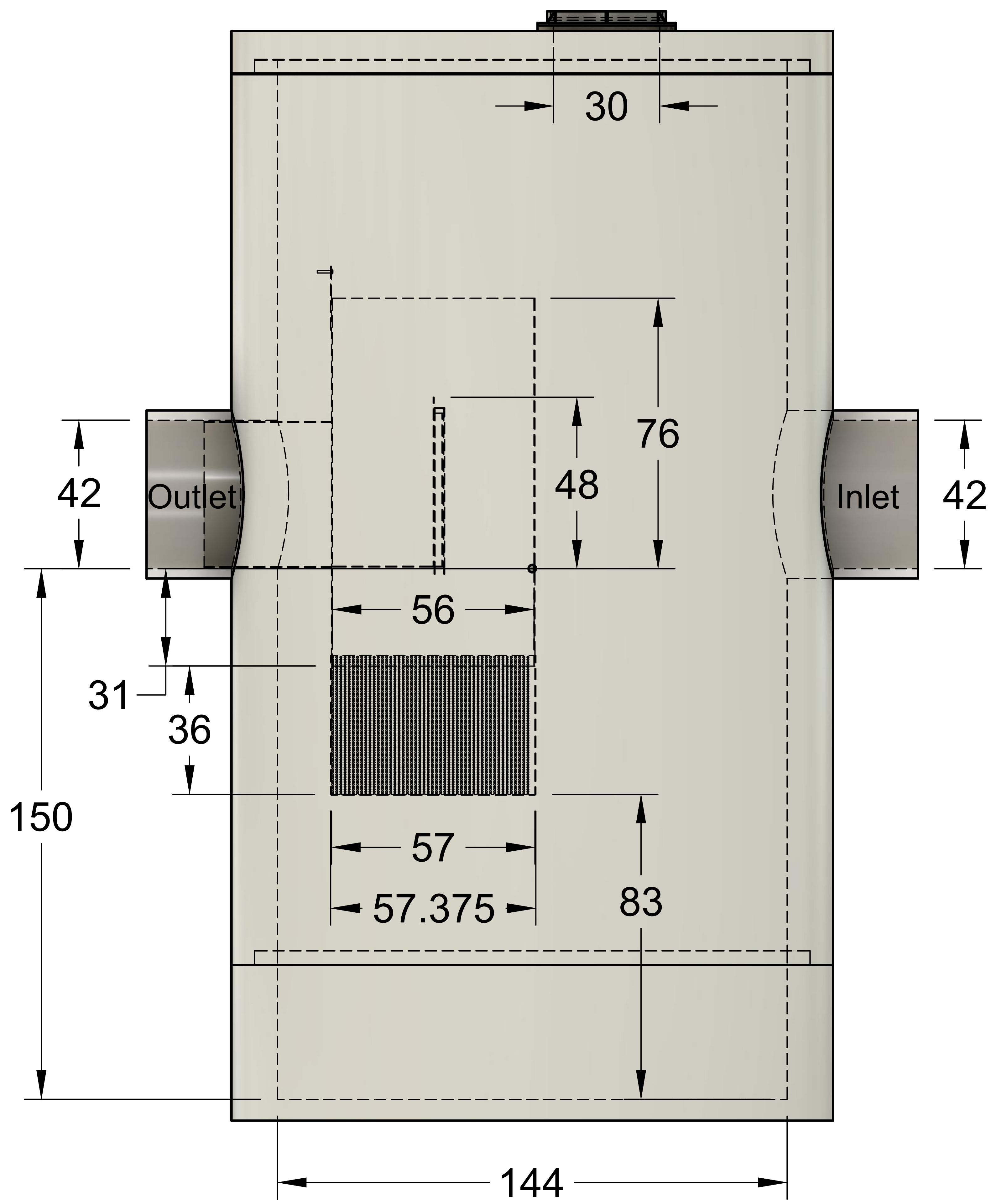
HydroDome HDTS10-36

Project: Full Trash Capture - Standard Drawing

Location:

Date: 07/10/2024 | Scale: | Rev: 1

Hydroworks



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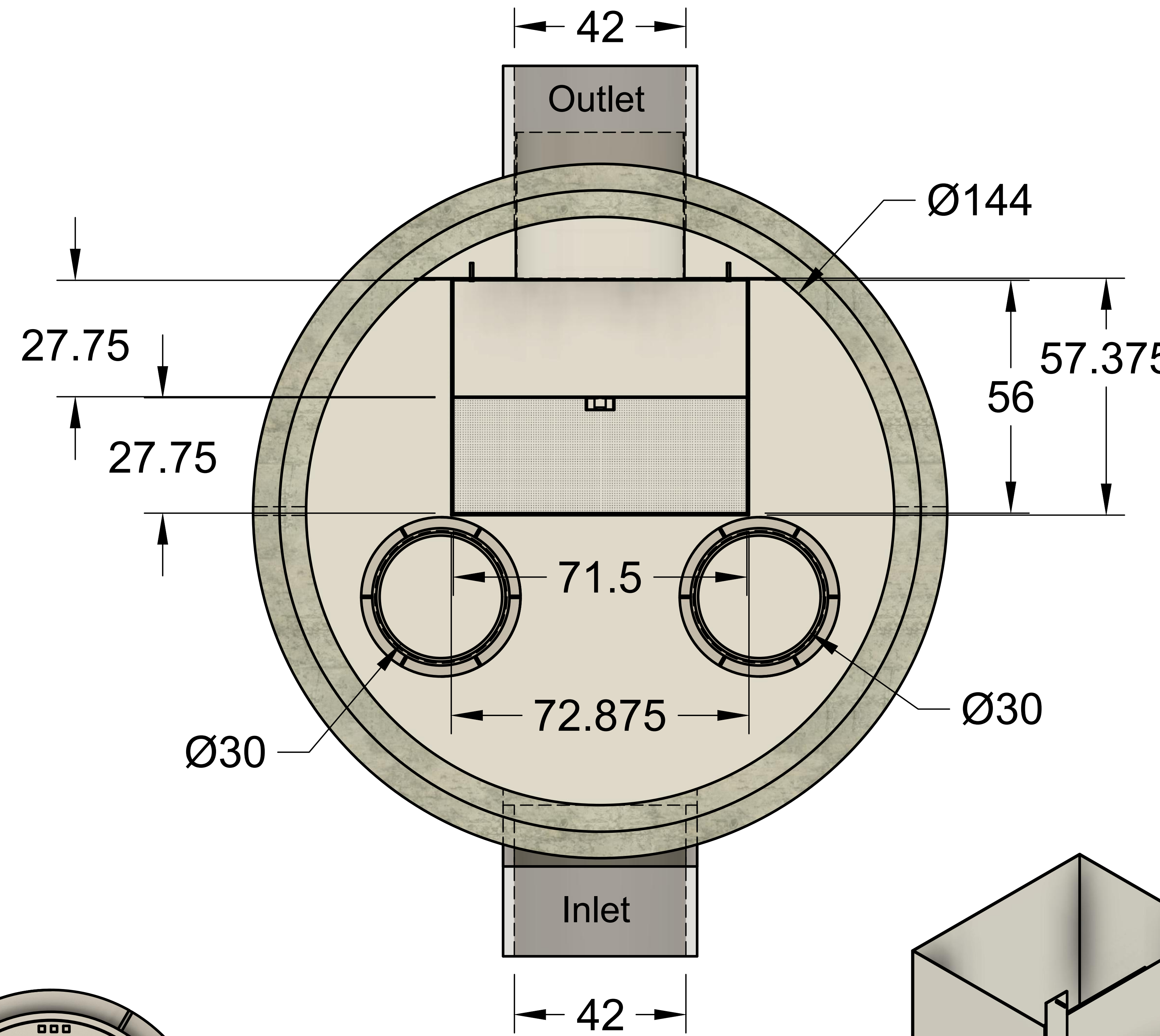
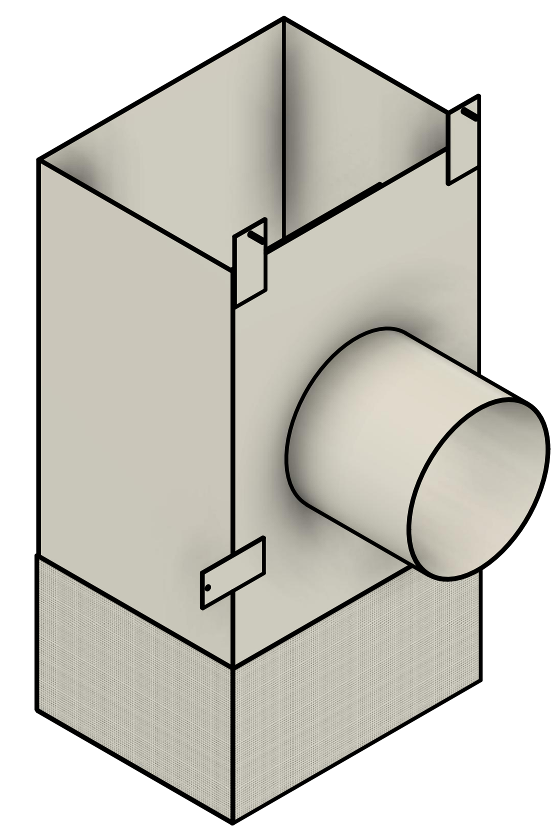


Hydroworks Frame and Cover

Plan



Notes:
1. Generic layout shown. Contact Hydroworks for site-specific drawing.
2. Dimensions not to scale. Standard dimensions indicated.
3. Multiple inlet pipes possible.
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info@hydroworks.com
888-290-7900

US Patent #10,801,196

HydroDome HDTS12-42

Project: Full Trash Capture - Standard Drawing		
Location:		
Date: 07/10/2024	Scale:	Rev: 1

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Appendix B
Installation Procedures

HYDRODOME TS/TR INSTALLATION INSTRUCTIONS

HYDRODOME CANNOT BE INSTALLED UNTIL THE MANHOLE IS SET AND THE OUTLET PIPE IS IN PLACE. THE TOP CAP SHOULD NOT BE PLACED ON THE MANHOLE UNTIL AFTER HYDRODOME INSTALLATION IS COMPLETE. HYDRODOME SHOULD ONLY BE LIFTED BY PASSING TWO LIFTING STRAPS UNDER THE UNIT.

1. 

Apply two generous beads of Pro-Seal34 caulk around the outlet stub of the HydroDome insert directly next to the weather stripping furthest from the back of the HydroDome.

2. 

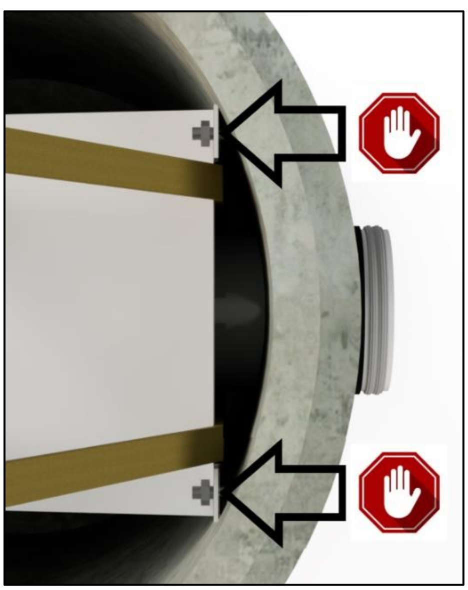
Lower the HydroDome so that the outlet pipe stub is level with the **outlet** pipe of the manhole.

3. 

Gently slide the HydroDome outlet stub into the manhole outlet as far as possible without forcing it, until the HydroDome insert is close to the wall.

4. 

Drill 0.5” holes, no more than 3” into the manhole wall, through the holes in the attachment tabs. Tabs may be on the top and/or sides of the HydroDome. Only two holes for anchor bolts are necessary. Avoid drilling into precast joints.

5. 

Use the supplied stainless steel concrete anchor bolts, washers and nuts to fasten the HydroDome flanges to the structure wall. STOP TIGHTENING AS SOON AS BOLT MEETS PLASTIC. DO NOT OVERTIGHTEN.

Appendix C
Operation & Maintenance

Hydroworks® HydroDome® TS

Operations & Maintenance Manual

Version 1.1

Please call Hydroworks at 888-290-7900 or email us at support@hydroworks.com if you have any questions regarding the Inspection Checklist. Please email a copy of the completed checklist to Hydroworks at support@hydroworks.com for our records.

Introduction

HydroDome (HD) TS ("Trash and Sediment") is one of two full trash capture variants of the HydroDome hydrodynamic separator. The HDTS (Figure 1) is optimized to capture and retain both trash and sediment. It can also be used for quantity flow control if desired.

HydroDome TS combines the functions of a full trash capture device and a hydrodynamic separator. Full trash capture devices are designed to remove trash from stormwater. Trash is typically defined as material greater than 5mm in diameter. Hydrodynamic separators remove solids, debris and lighter than water (oil, trash, floating debris) pollutants from stormwater. Trash capture devices, hydrodynamic separators, and other water quality measures are mandated by regulatory agencies (Town/City, State, Federal Government) to protect storm water quality from pollution generated by urban development.

Screens that remove trash from stormwater runoff may eventually clog with organic matter or debris. In addition, as stormwater treatment structures fill up with pollutants, they become less effective at removing additional pollution. Therefore, it is important that stormwater treatment structures be maintained on a regular basis to ensure that they are operating at optimum performance. The HydroDome TS is no different in this regard and this manual has been assembled to provide the owner/operator with the necessary information to inspect and maintain their HydroDome TS.

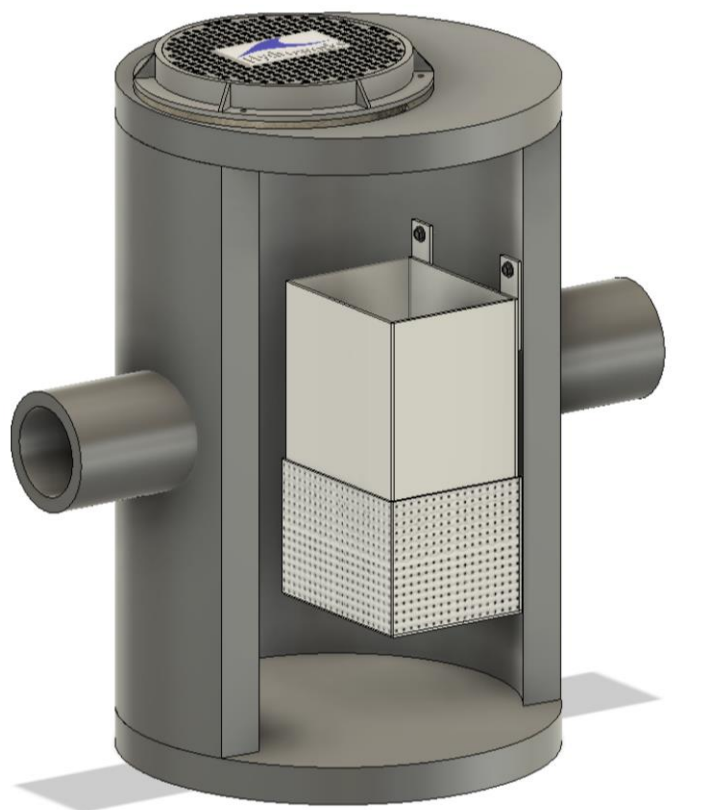
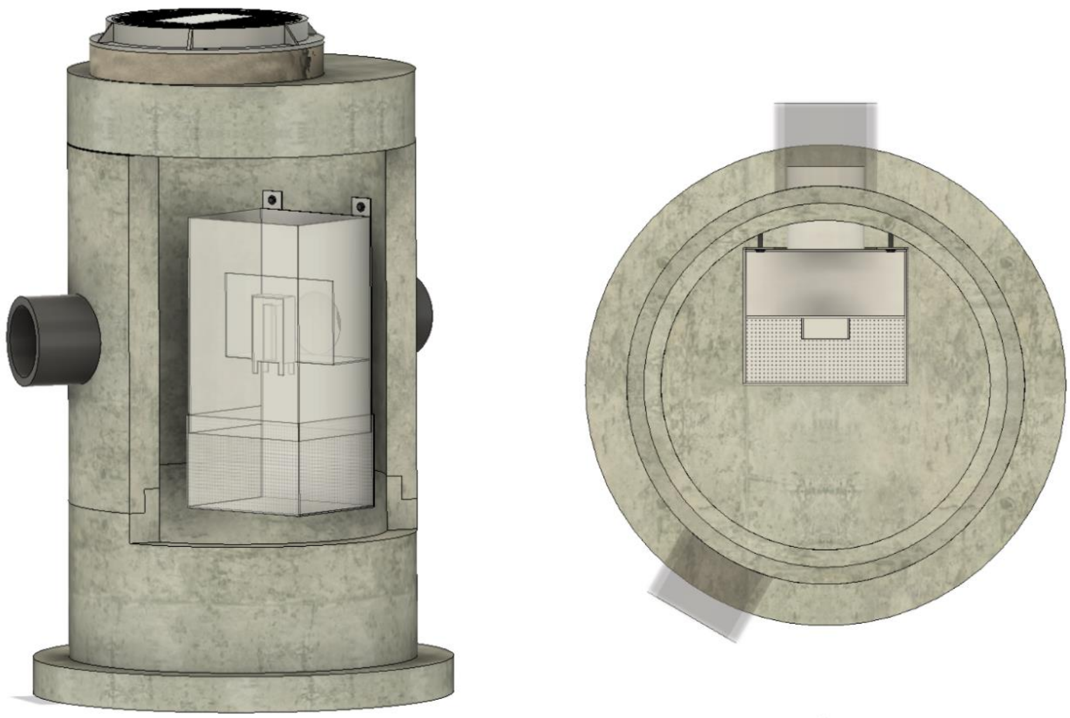


Figure 1. Hydroworks HydroDome TS

Hydroworks

The HydroDome TS consists of a plastic insert installed in a precast concrete structure. An integrated outlet stub protruding from the insert slides into the outlet pipe, and the insert is secured to the manhole wall with stainless steel anchor bolts (Figure 2). The outlet stub comes pre-gasketed, and the connection is caulked during installation to ensure watertightness.



Plan

Cutaway

Figure 2 HydroDome TS Round Manhole Installation

Water enters the device through one or more inlet pipes and/or an inlet grate. Water then passes into the insert through a box-shaped perforated plastic screen. Due to the depth of the perforated openings well below the standing water level, most oil, trash, and floatable debris is trapped between the insert and the precast structure wall. Any trash 5mm or greater that does become submerged is prevented from passing downstream by the perforated plastic screen, which has a nominal opening aperture of 4.75 mm. Settleable trash and sediment is captured and retained in the structure sump.

The internals of the HydroDome TS consist of a siphon with flow control orifice and a weir (Figure 3). During storm events, the water level inside the structure must rise to a pre-determined level before water can begin exiting the structure. This reduces flow velocities to enhance particle settling and provides additional vertical separation between floatable trash and the submerged inlet screens. This added water depth also reduces scour of previously captured solids. Once water reaches the top of the siphon, the siphon begins to engage and water flows out of the structure downstream. The siphon flow is controlled by an orifice whose size is standardized by model size but can also be customized to provide the desired flow control. A weir above the siphon provides the main flow path through the device and prevents the system from surcharging.

During peak flows, water may overtop the insert walls, thereby bypassing the inlet screens. After a storm event, water flows through the siphon and orifice to lower the water level back down to the outlet invert elevation.

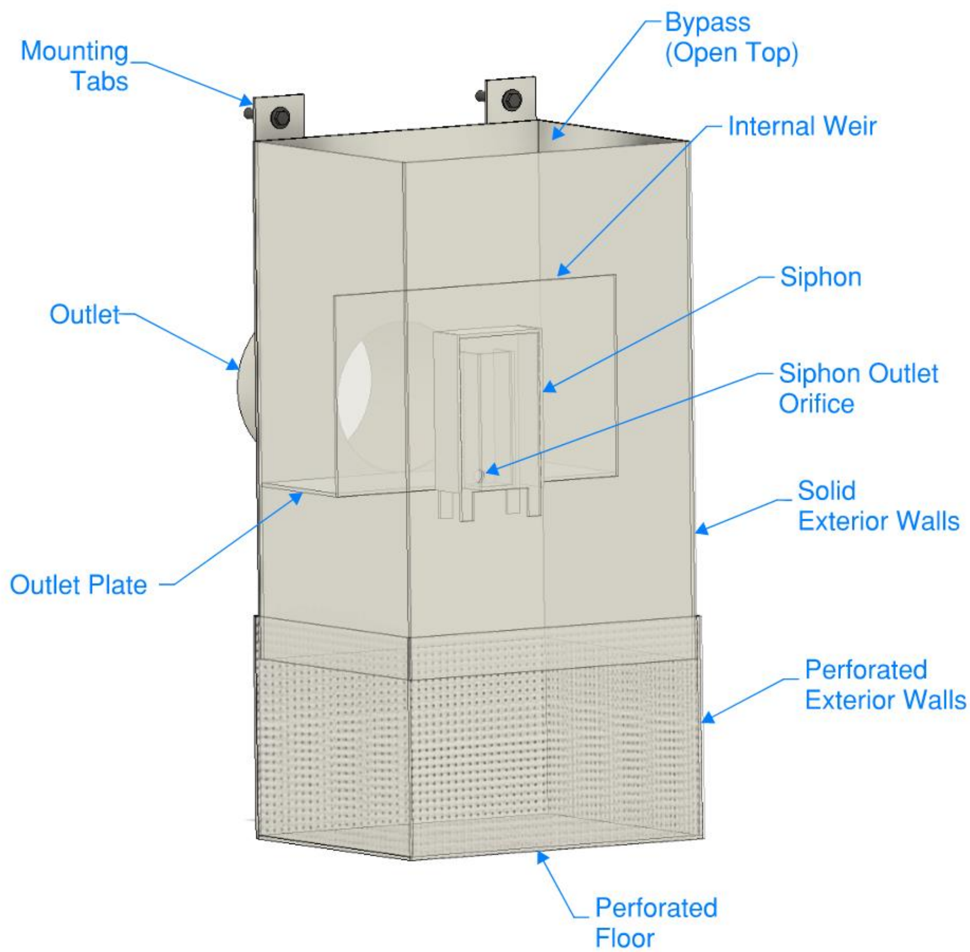


Figure 3 HydroDome TS Components (transparent front wall to show internals)

For installations with a grated inlet, the insert is equipped with a sloped lid to deflect floatables into the sump (Figure 4). Hinges attached to the lid allow for access inside the insert.

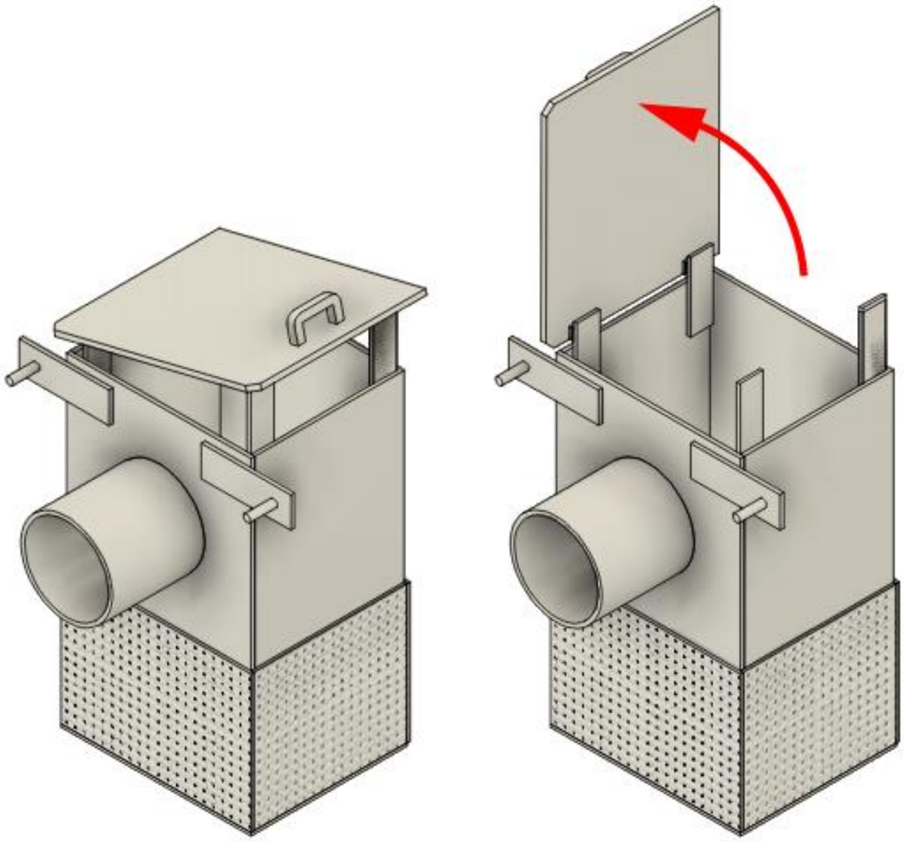


Figure 4. Hinged Lid for Grated Inlet

Inspection

Procedure

Floatables

A visual inspection can be conducted for floatables by removing the cover/grate and looking down into the structure. Entry into the structure is not required.

TSS/Sediment

Inspection for TSS build-up can be conducted using a Sludge Judge®, Core Pro®, AccuSludge® or equivalent sampling device that allows the measurement of the depth of TSS/sediment in the unit. These devices typically have a ball valve at the bottom of the tube that allows water and TSS to flow into the tube when lowering the tube into the unit. Once the unit touches the bottom of the device, it is quickly pulled upward such that the water and TSS in the tube forces the ball valve closed allowing the user to see a full core of water/TSS in the unit. Several readings (2 or 3) should be made at different locations in the structure to ensure that an accurate TSS depth measurement is recorded.

Operation

The standing water level inside the structure during periods without rain should be near the outlet invert. If the water level remains above the outlet invert 24 hours after a storm event, this may indicate that the inlet screens are occluded and require cleaning.

The HydroDome TS is designed to convey the peak treatment flow without bypass when 50% or more of the inlet screen is occluded. However, as the percentage of screen clogging increases, the upstream hydraulic impact will increase, particularly during high flows. Depending on degree of clogging and flow rate, the influent flow will eventually bypass the inlet screens by overtopping the insert walls. Any evidence of unacceptable upstream hydraulic impact or internal bypass (accumulation of trash or oil inside the insert) would indicate that maintenance is required.

Frequency

Construction Period

The HydroDome TS should be inspected every four weeks and after every large storm (over 0.5” [12.5 mm] of rain) during the construction period.

Post-Construction Period

Typically, HydroDome TS will have a maintenance frequency of twice per year. Each site is different, however, and sites with upstream construction activities, exposed materials on-site, a high potential for spills, or high average daily traffic can expect to have more frequent maintenance. Therefore, initial inspections are important to determine the proper maintenance frequency for the site in question.

The HydroDome TS should be inspected twice during the first year of operation for normal stabilized sites (grassed or paved areas). If the unit is subject to oil spills or runoff from unstabilized areas (storage piles, exposed soils), the HydroDome TS should be inspected more frequently (4 times per year). The initial annual inspection will indicate the required frequency of inspection and maintenance. All inspection reports should be kept and used as a guide to monitor changes in site conditions, unit performance, and maintenance requirements.

Reporting

Reports should be prepared as part of each inspection and include the following information:

1. Date of inspection
2. GPS coordinates of Hydroworks unit
3. Time since last rainfall
4. Date of last inspection
5. Installation deficiencies (missing parts, incorrect installation of parts)
6. Structural deficiencies (concrete cracks, broken parts)
7. Operational deficiencies (leaks, elevated water level)
8. Presence of oil sheen or depth of oil layer
9. Estimate of depth/volume of floatables (trash, leaves) captured
10. Quantitative or qualitative description of degree of inlet screen clogging if visible or during cleanout
11. Sediment depth measured
12. Recommendations for any repairs and/or maintenance for the unit

A sample inspection checklist is provided at the end of this manual.

Maintenance

Procedure

The local municipality should be consulted for the allowable disposal options for both water and sediments prior to any maintenance operation.

Floatable and settleable trash/sediment are typically removed from the HydroDome TS at the same time. Floatables can be netted with a skimmer and pole if permitted by local regulation. Sediment, settleable trash, and water should be removed together using a vactor truck. The inlet screens should be hosed down to flush any trapped debris into the sump while continuing to vacuum the sump. The plastic insert and inlet screens are robust, however, care should be taken not to damage the components with excessively high powered washing. The vacuumed water is then separated from the sediment on the truck or at the disposal facility.

The open area around the HydroDome TS insert provides clear access to the bottom of the structure (Figure 5). This is the area where a vacuum hose should be lowered to clean out the unit.

In instances where a vactor truck is not available, other maintenance methods (i.e. clamshell bucket) can be used, but they will be less effective. If a clamshell bucket is used, the water must be decanted prior to cleaning since the sediment is underwater and typically fine in nature.

Maintenance of a HydroDome TS unit will typically take 1 to 2 hours using a vactor truck, depending on size of unit. Cleaning may take longer for other cleaning methods (i.e. clamshell bucket).

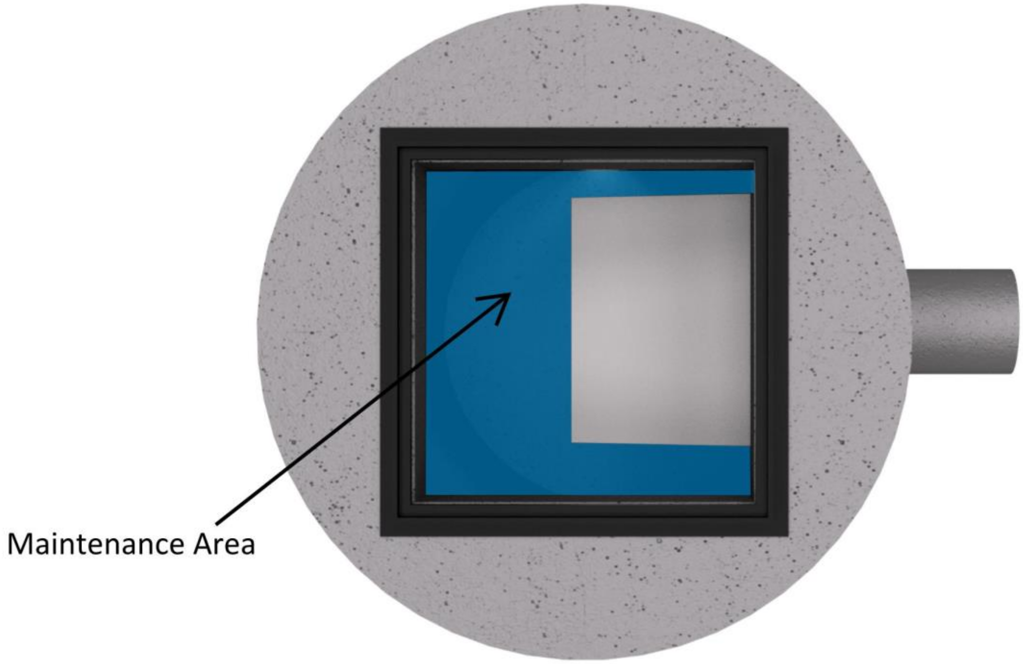


Figure 5. HydroDome TS Maintenance Access

Frequency

<u>Construction Period</u>

Trash capture devices and hydrodynamic separators can fill with construction sediment quickly during the construction period. The HydroDome TS must be maintained during the construction period when the depth of TSS/sediment reaches the indicated maintenance depth listed in Table 1. It must also be maintained during the construction period if there is an appreciable depth of oil in the unit (more than a sheen) or if the standing water level is above the outlet invert 24 hours after a storm event.

The HydroDome TS should be fully cleaned out at the end of the construction period, prior to operation for the post-construction period.

Post-Construction Period

The HydroDome TS is designed to capture a significant volume of floatable trash. Stored trash may coalesce into a layer that extends well below the water surface without impairing the functioning of the device. Recommended maintenance floatables depths are listed in Table 1. However, since estimating the depth of trash from the surface is challenging, it is recommended to use surface coverage of trash as a maintenance trigger. If floatable trash covers more than 90% of the water surface inside the structure, the water surface should be disturbed with a pole to assess the depth of the trash layer. If floating trash is easily displaced to reveal open water, the trash layer represents only minor surface coverage and maintenance is not required. Alternatively, if the bottom of the trash layer is not visible after displacing surface trash or if a significant layer depth is observed, the unit should be maintained.

The unit should also be maintained if there is an appreciable depth of oil in the unit (more than a sheen) or if the standing water level in the structure is higher than the outlet invert 24 hours after a storm event.

Table 1 provides the standard sediment maintenance depths for the HydroDome TS. Maintenance for sediment accumulation is needed if captured sediment fills the volume of the sump below the perforated inlet screens.

Some HydroDome TS units are designed with increased sediment, floatables/trash, and/or oil storage based on specifications or site-specific criteria. Please contact Hydroworks at 888-290-7900 to inquire whether your HydroDome TS was designed with extra storage capacity to extend the frequency of maintenance.

Table 1. Standard Maintenance Depths for HydroDome TS Models

Model	Diameter (ft /mm)	Maintenance Floatables Depth[1,2] (in/mm)	Maintenance Sediment Depth[1,2] (in/mm)
HDTS3	3 (900)	9 (225)	12 (300)
HDTS4	4 (1200)	12 (300)	12 (300)
HDTS5	5 (1500)	15 (375)	12 (300)
HDTS6	6 (1800)	18 (450)	12 (300)
HDTS7	7 (2100)	21 (525)	12 (300)
HDTS8	8 (2400)	24 (600)	12 (300)
HDTS10	10 (3000)	30 (750)	12 (300)
HDTS12	12 (3600)	36 (900)	12 (300)

1. Maintenance depths are recommended values and do not reflect maximum capacities
2. Custom inserts may have greater or lesser maintenance depths

HYDRODOME TS INSPECTION SHEET

Date ______________________________
Date of Last Inspection ______________________________

Site ______________________________
City, State ______________________________
Owner ______________________________

GPS Coordinates ______________________________

Date of last rainfall ______________________________

Site Characteristics	**Yes**	**No**
Soil erosion evident (upstream)	☐	☐
Exposed material storage on site	☐	☐
Large exposure to leaf litter (lots of trees)	☐	☐
High traffic (vehicle) area	☐	☐
High trash (people) area	☐	☐

HydroDome TS	**Yes**	**No**
Obstructions in the inlet pipe	☐ *	☐
Damage to HydroDome TS (cracked, broken, loose pieces)	☐ **	☐
Improperly installed outlet pipe	☐ ***	☐
Floating debris (trash) inside insert	☐ *	☐
Significant layer of floating debris (trash, leaves) outside insert	☐ *	☐
Large debris visible in the structure	☐ *	☐
Defined layer of oil inside manhole	☐ *	☐
Concrete cracks/deficiencies	☐ ***	☐
Exposed rebar	☐ **	☐
Raised water level (standing water above outlet invert)	☐ *	☐
Water seepage (standing water below outlet invert)	☐ ***	☐

* Maintenance required
** Repairs required
*** Further investigation required

Routine Measurements

Floating debris depth (in) ______________

Floating debris surface coverage (%) ______________

Sludge depth (in) ______________

Note: Inspections should not be made within 24 hours of a storm to allow water to drain from the structure in order to identify a raised standing water level or seepage.

Hydroworks

Other Comments:

Hydroworks

Hydroworks® HydroDome® TS

One Year Limited Warranty

Hydroworks, LLC warrants, to the purchaser and subsequent owner(s) during the warranty period subject to the terms and conditions hereof, the Hydroworks HydroDome TS to be free from defects in material and workmanship under normal use and service, when properly installed, used, inspected and maintained in accordance with Hydroworks written instructions, for the period of the warranty. The standard warranty period is 1 year.

The warranty period begins once the separator has been manufactured and is available for delivery. Any components determined to be defective, either by failure or by inspection, in material and workmanship will be repaired, replaced or remanufactured at Hydroworks' option provided, however, that by doing so Hydroworks, LLC will not be obligated to replace an entire insert or concrete section, or the complete unit. This warranty does not cover shipping charges, damages, labor, any costs incurred to obtain access to the unit, any costs to repair/replace any surface treatment/cover after repair/replacement, or other charges that may occur due to product failure, repair or replacement.

This warranty does not apply to any material that has been disassembled or modified without prior approval of Hydroworks, LLC, that has been subjected to misuse, misapplication, neglect, alteration, accident or act of God, or that has not been installed, inspected, operated or maintained in accordance with Hydroworks, LLC instructions and is in lieu of all other warranties expressed or implied. Hydroworks, LLC does not authorize any representative or other person to expand or otherwise modify this limited warranty.

The owner shall provide Hydroworks, LLC with written notice of any alleged defect in material or workmanship including a detailed description of the alleged defect upon discovery of the defect. Hydroworks, LLC should be contacted at 136 Central Ave., Clark, NJ 07066 or any other address as supplied by Hydroworks, LLC. (888-290-7900).

This limited warranty is exclusive. There are no other warranties, express or implied, or merchantability or fitness for a particular purpose and none shall be created whether under the uniform commercial code, custom or usage in the industry or the course of dealings between the parties. Hydroworks, LLC will replace any goods that are defective under this warranty as the sole and exclusive remedy for breach of this warranty.

Subject to the foregoing, all conditions, warranties, terms, undertakings or liabilities (including liability as to negligence), expressed or implied, and howsoever arising, as to the condition, suitability, fitness, safety, or title to the Hydroworks HydroDome TS are hereby negated and excluded and Hydroworks, LLC gives and makes no such representation, warranty or undertaking except as expressly set forth herein. Under no circumstances shall Hydroworks, LLC be liable to the Purchaser or to any third party for product liability claims; claims arising from the design, shipment, or installation of the HydroDome TS, or the cost of other goods or services related to the purchase and installation of the HydroDome TS. For this Limited Warranty to apply, the HydroDome TS must be installed in accordance with all site conditions required by state and local codes; all other applicable laws; and Hydroworks' written installation instructions.

Hydroworks, LLC expressly disclaims liability for special, consequential or incidental damages (even if it has been advised of the possibility of the same) or breach of expressed or implied warranty. Hydroworks, LLC shall not be liable for penalties or liquidated damages, including loss of production and profits; labor and materials; overhead costs; or other loss or expense incurred by the purchaser or any third party. Specifically excluded from limited warranty coverage are damages to the HydroDome TS arising from ordinary wear and tear; alteration, accident, misuse, abuse or neglect; improper maintenance, failure of the product due to improper installation of the concrete sections or improper sizing; or any other event not caused by Hydroworks, LLC. This limited warranty represents Hydroworks' sole liability to the purchaser for claims related to the HydroDome TS, whether the claim is based upon contract, tort, or other legal basis.