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Webinar will begin
At 1:00 pm EDT

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Retrofitting Basins for Water Quality

NEXT GENERATION REUSABLE SKIMMER

MARLEE FLOAT

A RYMAR INNOVATION

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Jamie McCutchen, PE

- 1992 Graduate – Clemson University
  - BS – Civil Engineering
- 1999 - Founded CCAD Engineering
- 2013 - Invented the Marlee Float skimmer
- Licensed Professional Engineer
  - SC, NC & GA

Presentation Agenda

- Permanent Use of Skimmers
- Case Studies of Retrofit for Maintenance
- Filtration Based Water Quality

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Why Consider Skimmers for Permanent Use In Basins

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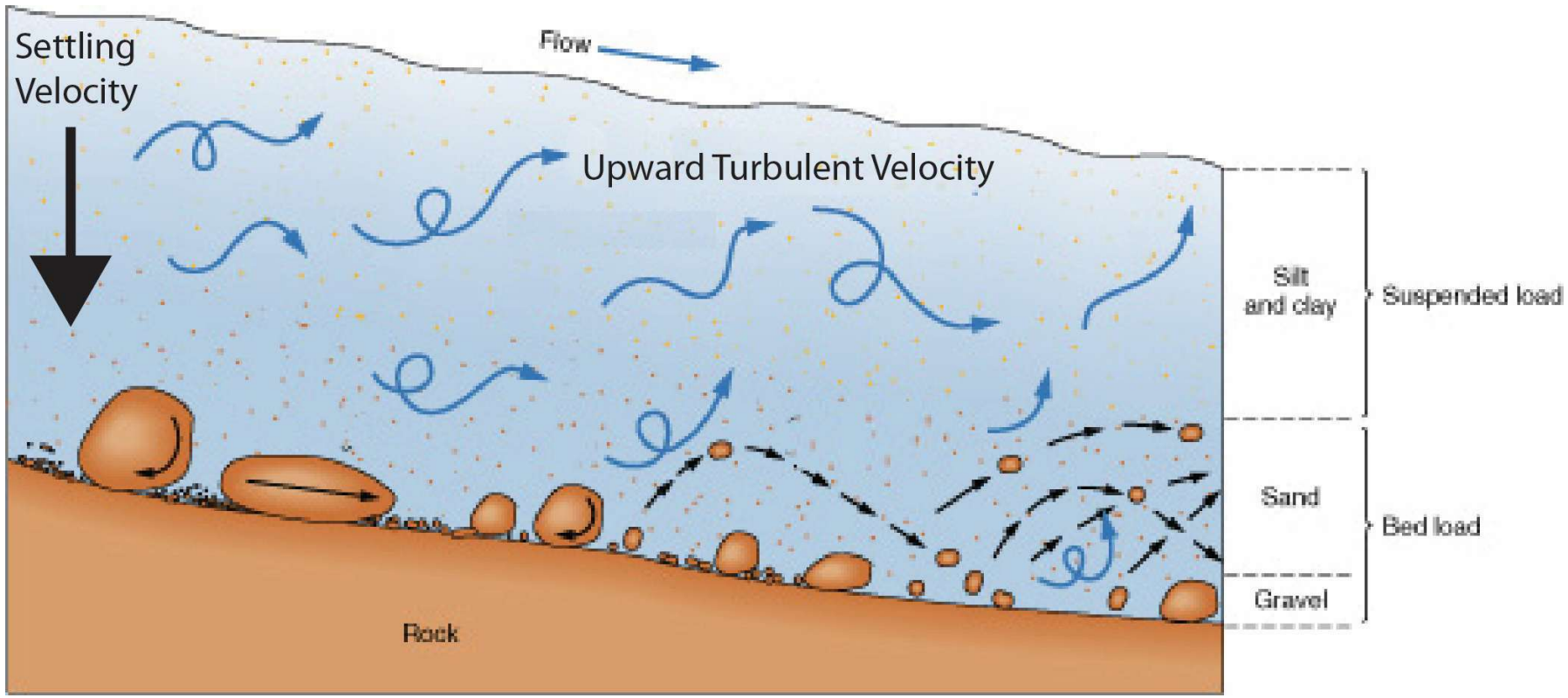
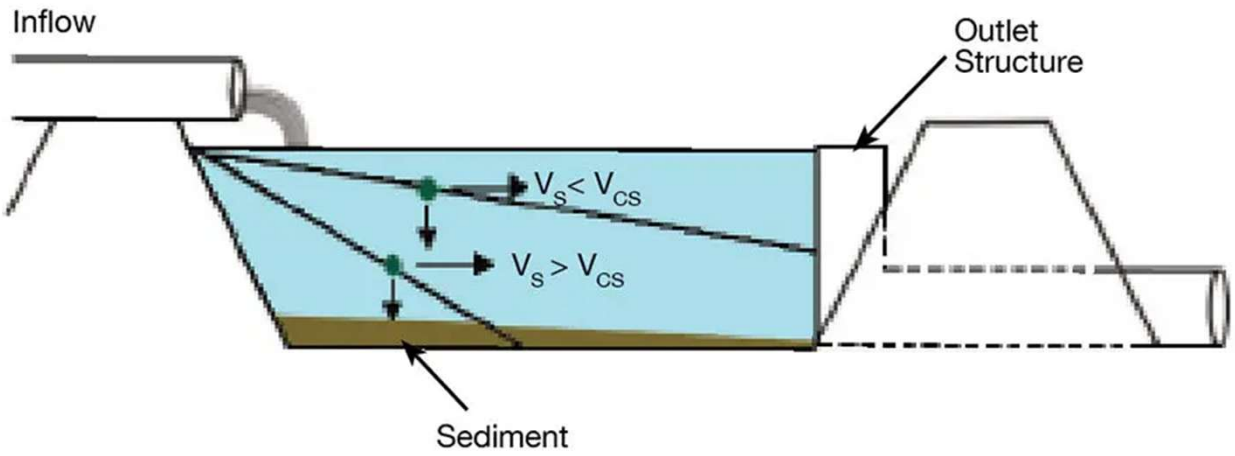
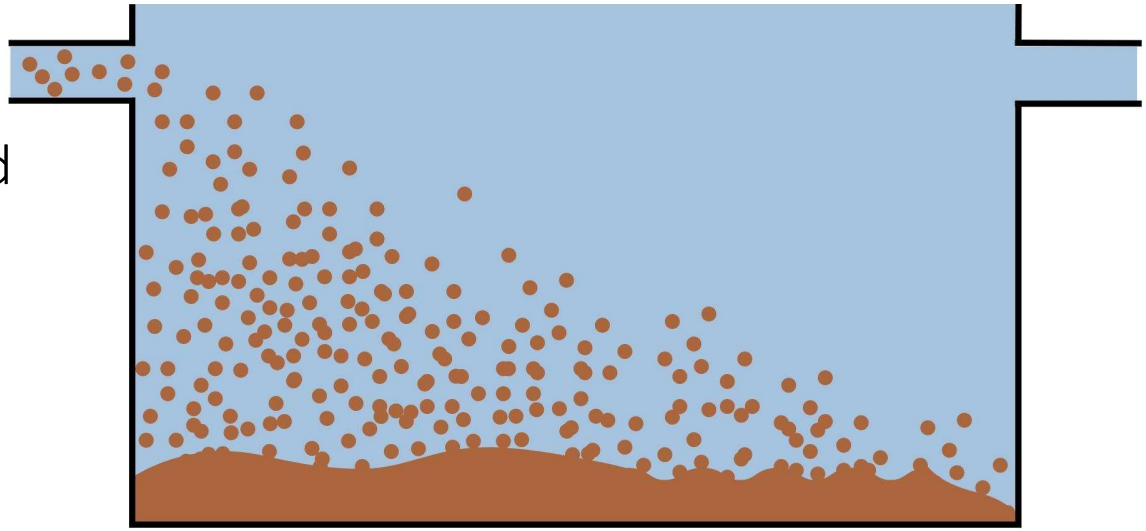


Particle settling is dependent upon particle size and velocity of flow

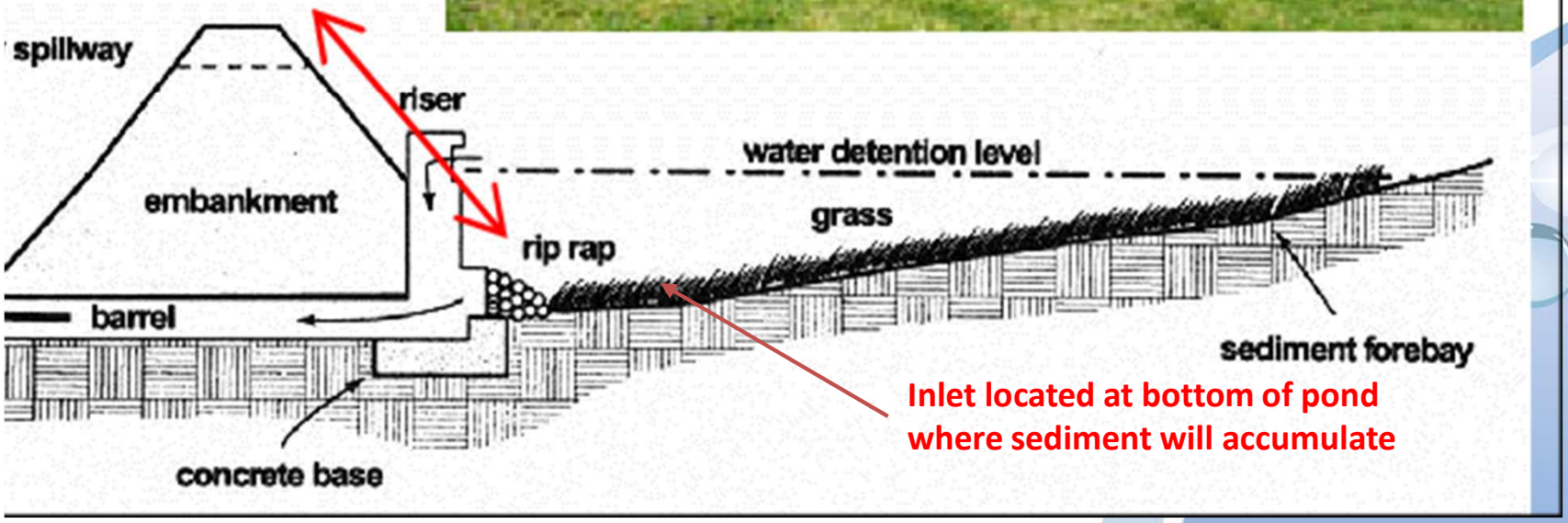




It is important to slow the flow and have sufficient travel distance for particles to settle before reaching the outlet.

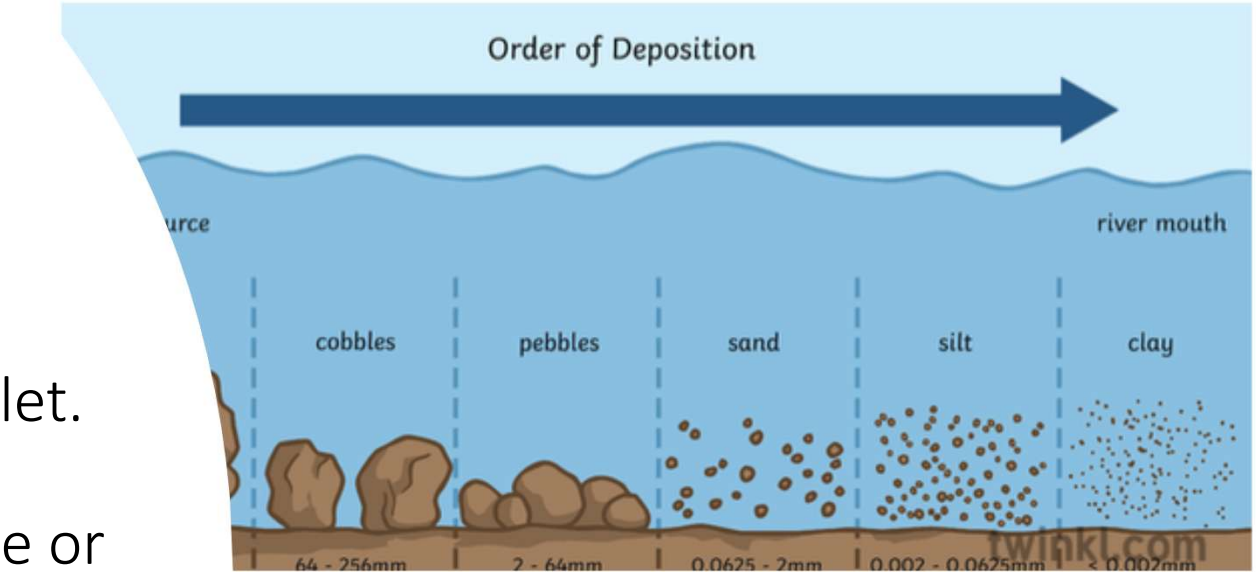
A forebay in the pond will capture lager particles and reduce velocity

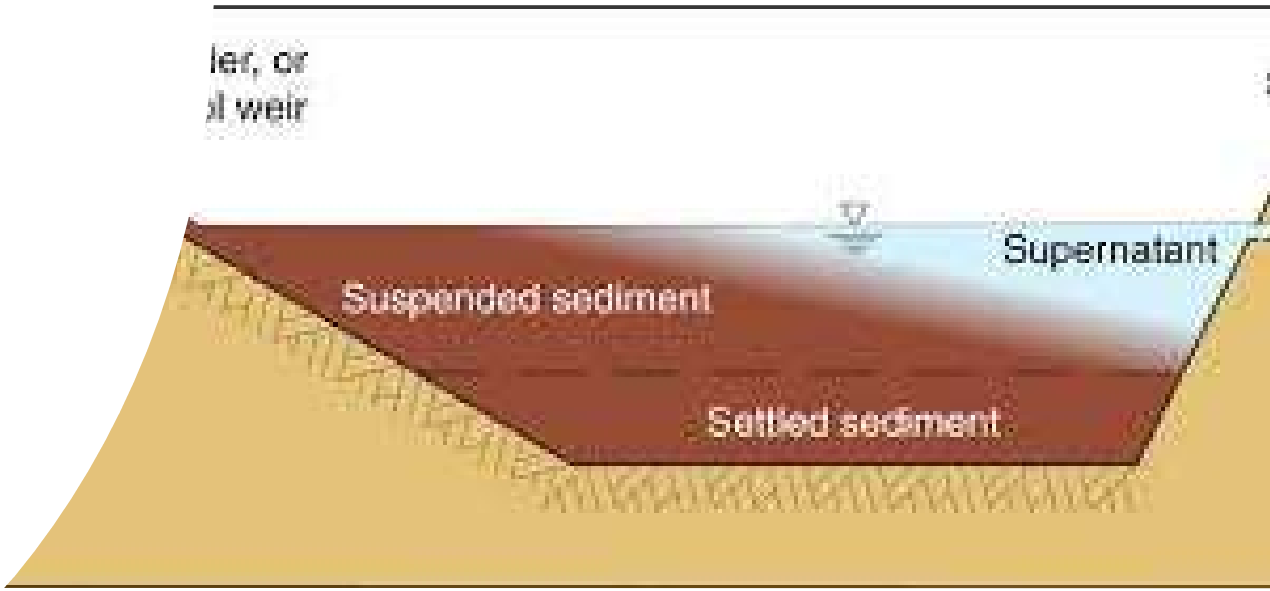
Typical Dry Detention Basin

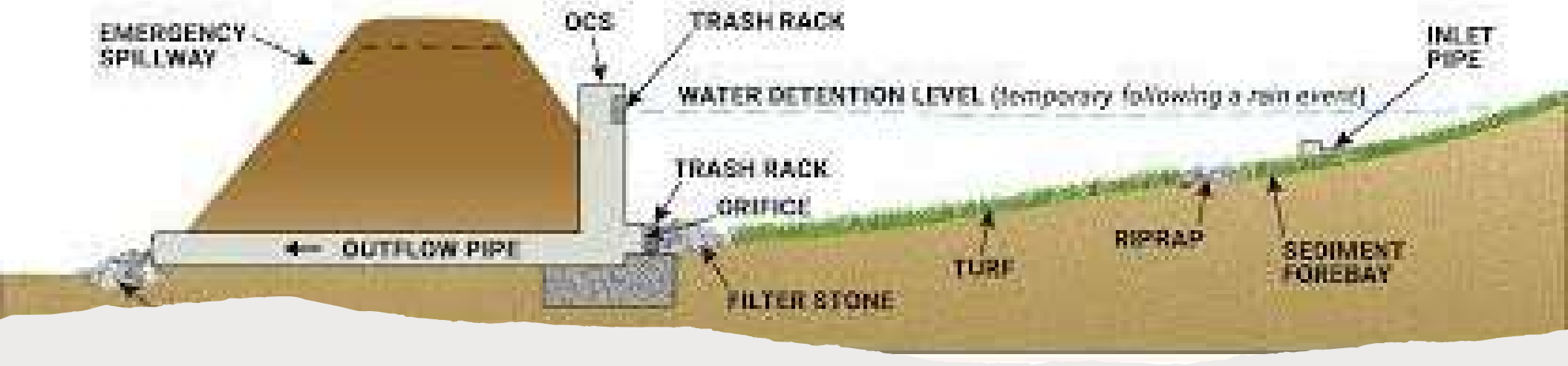


Sediment will reach the outlet.

Larger particles should settle or be captured in forebay but smaller particles likely not







Traditional Dry Detention Basin (most common BMP)

- Skimmer is removed
- Low Flow Orifice installed at bottom of riser to release “First Flush”
- Often includes some sort of guard or filter to reduce clogging

Flaws with using Extended Detention for Water Quality

Basins that rely on settling provide very little treatment for smaller storm events due to limited ponding/holding time.

Small storm events flow in and out with minimal detention time.

Traditional First Flush Design Example

Size First Flush orifice

Flow rate of 0.21 cfs is needed which equates to a 2.6” orifice.

If the WQ volume is greater then the size of the pond to accommodate it will also increase.

5 Acre Site
First Flush Calculations

Pond Type:	Dry		
Contributing Area	217,800	ft²	5.0 Acres
WQ Volume Req'd: (1/2" over Total for wet pond, 1" over Total for dry pond)	18,150	ft³	

Orifice Sizing:

WQ Volume to be held:	24	hr
~	86,400	sec
Average Flow Rate req'd:	0.21	ft³/s (where $Q_{req}=V_{req}/A$)

Using Orifice Equation:

$$Q = CA\ (2gh)^{\frac{1}{2}}$$

g = 32.2
C = 0.6

elevation for required WQ Volume (feet) =	13.00	feet
elvation at orifice invert (feet) =	10.00	feet
height difference (feet) =	3.000	feet
average head-h (feet) =	1.5	feet
required orifice area =	0.03562239	sq feet

$$A = Q/(C(2gh)^{\frac{1}{2}})$$

required orifice diameter =	0.21	ft
SELECTED ORIFICE SIZE:	2.6	in

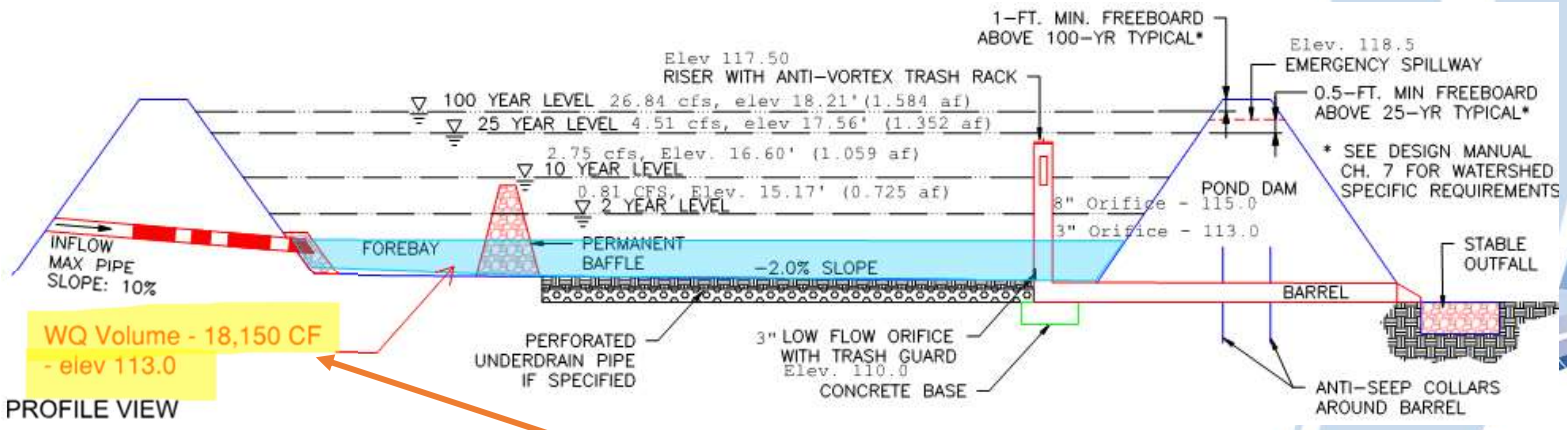
Flaws with using Extended Detention for Water Quality

The typical method to size the low-flow orifice assumes the entire water quality volume instantaneously appears in the basin.

This results in larger pond volumes than actually used for water quality storm events

Comparison of Required Water Quality Volume vs Actual Volume Used

Traditional Riser and Emergency Spillway



Storm	Peak Flow (cfs)	Peak Elev	Vol. Req (af)	Vol. Req (CF)
WQ	0.25	12.51	0.245	10,672
2-yr	0.81	15.17	0.725	31,581
10-yr	2.75	16.60	1.059	46,130
25-yr	4.51	17.56	1.352	58,893

Flaws with using Extended Detention for Water Quality

Basins designed and constructed prior to water quality requirements typically do not have sufficient volume to incorporate a first-flush design and still meet quantity control requirements.

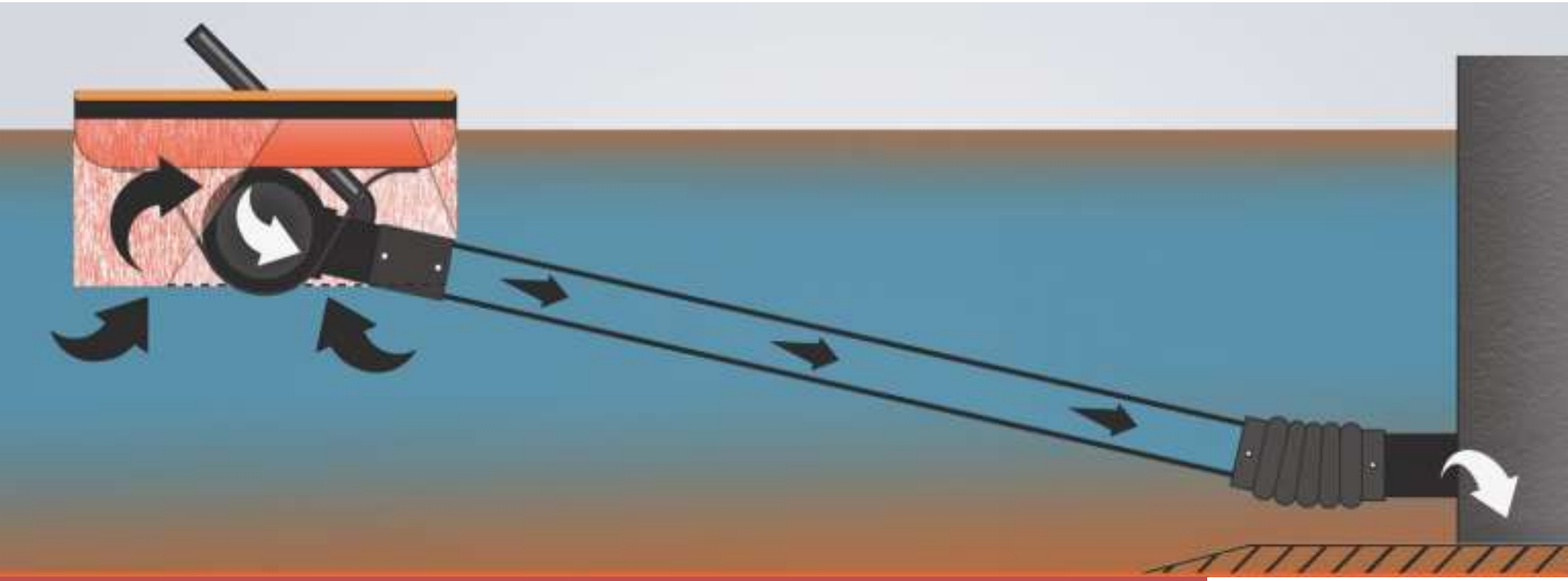
Why Consider Surface Withdrawal for Permanent Basins?

Low-flow water quality orifices often need to be 3” or less in diameter and are prone to clogging.

Basins are meant to collect sediment and will often have significant sediment build-up over time that will cover the low-flow orifice and require more maintenance

Surface withdrawal from permanent detention or retention basins releases the cleaner water from near the surface and allows more time for pollutants to settle.

Does it make sense to do this during construction but then use an orifice at the bottom of the pond for post-construction?



Skimmers float at the surface of the water and withdraw from surface, or near surface to release the cleaner water at the top of the water column.

They are required during construction and shown to achieve 80%+ Sediment Trapping Efficiency in Sediment Basins.

Makes sense to use same methods for post-construction water quality.

Skimmer releases relatively clean water from sediment basin.

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Case Studies Skimmers for Reduced Maintenance

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Two Case Studies of Skimmers used to retrofit basins for permanent use and reduced maintenance

- **Former Simpsonville Chevrolet Simpsonville, South Carolina**

- **Providence Park Apartments Charlotte, North Carolina**

Former Simpsonville Chevrolet

- In 2013 the site received an NOV for failure to maintain the pond. The pond was severely overgrown and the outlet structure was not functioning properly.

Former Simpsonville Chevrolet

- After the removal of the initial vegetation, it was determined that the pond had accumulated +/-6’ of mud and debris. There was a 2” outlet at the bottom of the basin that had been clogged for many years.

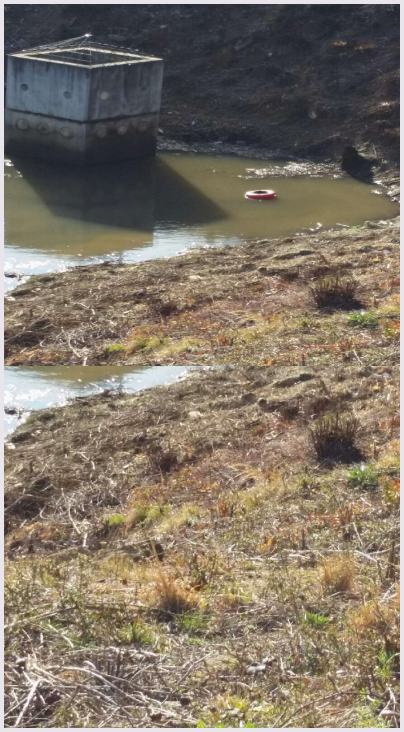
- Due to the size of the pond, the steep banks and the volume of muck to be removed, initial estimates for cleanout of the basin were $60,000 - $75,000.

Former Simpsonville Chevrolet

- The basin was redesigned to allow the muck and debris to remain and modify the outlet structure to still meet regulatory requirements.
- Greenville County required that the 2” low flow discharge rate be maintained as part of the design modification.
- Not having to remove the sediment buildup resulted in a savings of over $50,000.

Pond retrofit with a 5” Skimmer to replace a 2” low-flow orifice due to continued maintenance issues.

Former Simpsonville Chevrolet



- The basin was monitored monthly for the first 12 months of the skimmer being in place to insure it was working properly.

Former Simpsonville Chevrolet

In August 2014 the area had a major rain event that dumped nearly 5” of rain in less than 8 hours. This occurred the afternoon after the pond had been cut but before the debris could be removed.

Despite the large amount of debris in the basin, the skimmer did not clog and drained the basin.

Former Simpsonville Chevrolet

- Modification of the pond outlet structure to include a skimmer **saved over $50,000** in maintenance expense.
- The skimmer has functioned very well as the low-flow water quality outlet.
- Skimmer has been less prone to clog and easy to access for maintenance.
- Continue to use site for R&D of Filter Concept

Providence Park Apartments Charlotte, North Carolina

- In 2012 this property received notice that it would be inspected for compliance and maintenance of the detention pond. The pond was severely overgrown and the outlet structure was not functioning properly.

Providence Park Apartments Charlotte, North Carolina

- The property owner also wanted to try to obtain stormwater utility fee credits to help offset the maintenance cost and reduce their costs going forward.

- Initial work involved removing built up mud and debris from the existing 10” outlet pipe, which was reduced to a 6” outlet in order to obtain a 45% fee credit.

Providence Park Apartments Charlotte, North Carolina

- However, the natural area draining to the outlet had a large amount of debris and resulted in a clogged outlet after the initial rain.

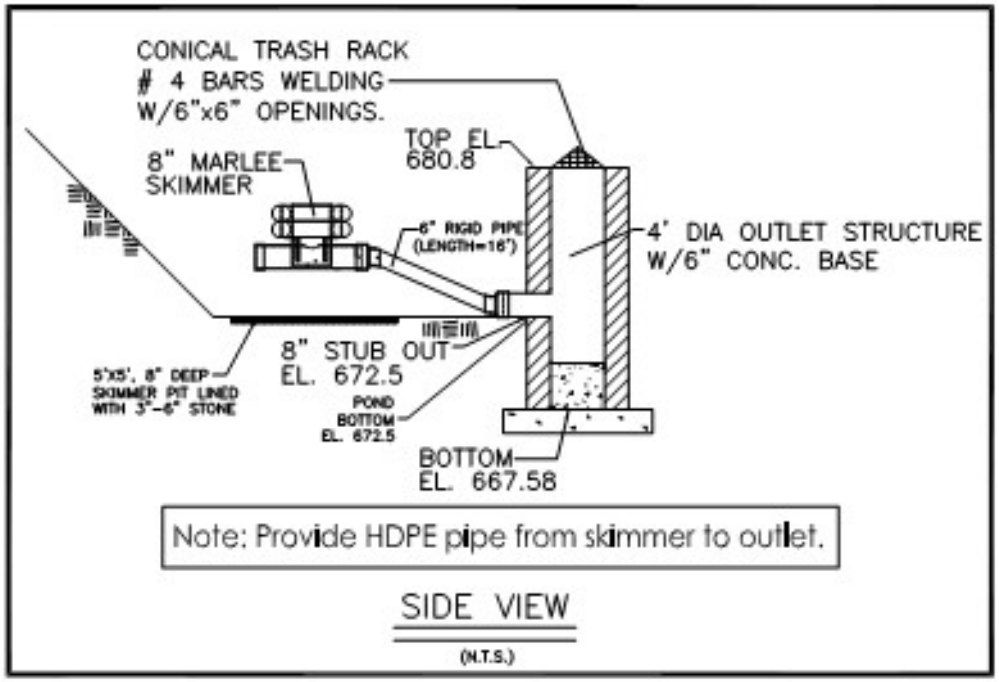
Providence Park Apartments
Charlotte, North Carolina

- We suggested that a skimmer be installed to help limit the clogging. However, the City of Charlotte Stormwater Manual did not allow skimmers for permanent use.

- We met with the City to review the use of a skimmer made of HDPE rather than PVC and they agreed to allow it for permanent use.

Providence Park Apartments
Charlotte, North Carolina

- The pond design was modified to include a riser structure and skimmer. In doing so, the stormwater fee credit was also recalculated. The new design resulted in a 95% fee credit, resulting in a total savings of over **$25,000** per year in stormwater fees.



Providence Park Apartments Charlotte, North Carolina

- Cost to cleanout the pond, design & permit the modification, construct the new outlet and prepare final certifications was approximately $50,000.

- The fee credit offset the cost within 2 years and has resulted in much less maintenance needed to keep the pond functioning properly.

Providence Park Apartments Charlotte, North Carolina

- Although there have been some minor issues with clogs, the skimmer has functioned substantially better than the prior outlet with much less maintenance required.

Providence Park Apartments Charlotte, North Carolina

- Skimmer was replaced with latest model in August 2021

Providence Park Apartments Charlotte, North Carolina

Due to volume of natural debris, a debris guard was added to the skimmer to help reduce clogging in 2023

Providence Park Apartments Charlotte, North Carolina

- April 2024 the Basin had +-/3’ of sediment build up removed, which had accumulated over 9 years

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Filtration Based Water Quality

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Benefits to Filtration instead of Settling

Ponds provide a large containment volume to reduce maintenance frequency and treat larger drainage areas

There is excellent potential to retrofit older basins that did not include water quality benefits in the design if peak flow rate can be maintained

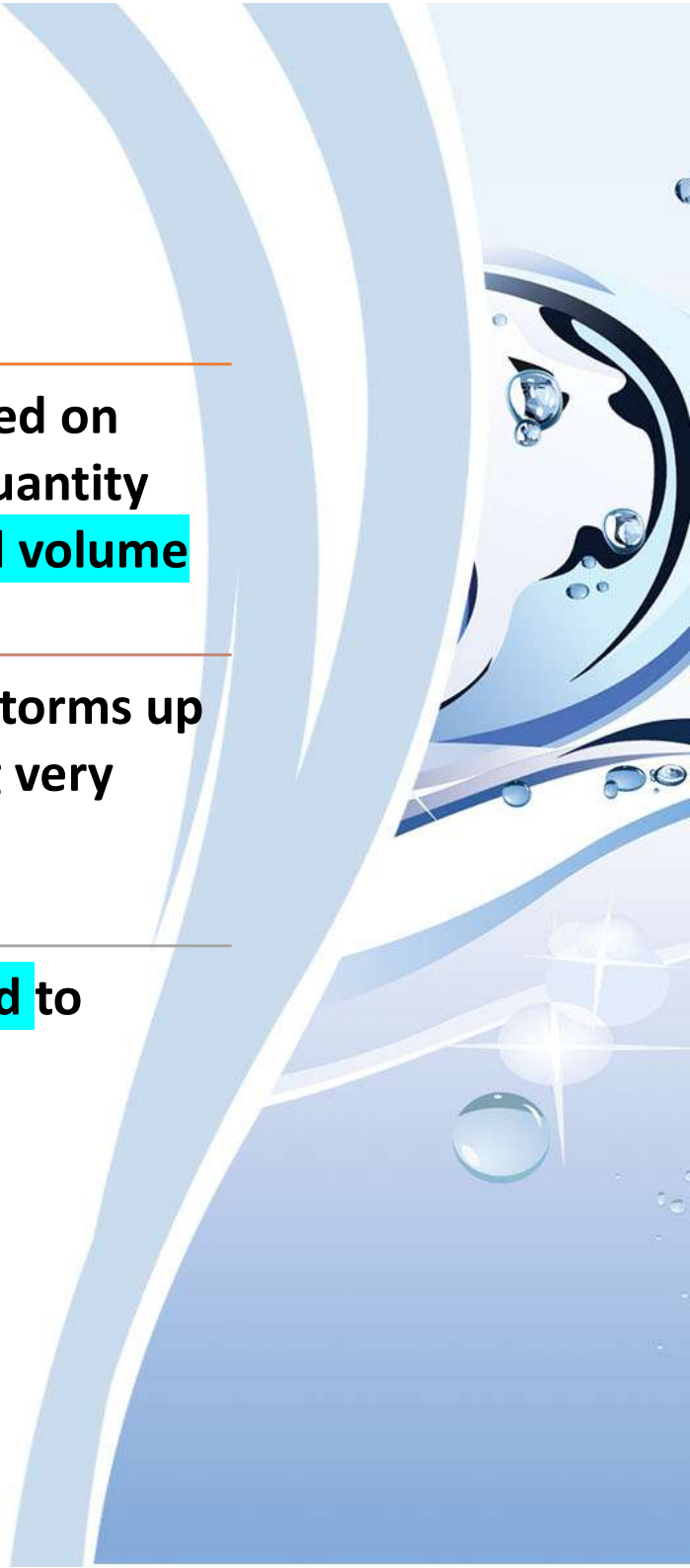
Filters in ponds can be relatively easy to access and maintain, especially when compared to systems that use underground vaults and require confined space entry.

Benefits to Filtration vs Settlement

The peak rate of discharge can be based on filter treatment flow rate up to first quantity storm event, resulting in smaller pond volume

The filter treats 100% of runoff from storms up to the peak rate of the filter, including very small storms with minimal ponding

The filtration media can be customized to target specific pollutants of concern.



Benefits to Using Skimmers with Filtration

- The skimmer can be sized to control the peak rate for lower storm events
- Skimmer increases filter efficiency by withdrawing from the surface, where water is cleaner
- Skimmer is easy to access or pull to side of pond for maintenance and changing filters.

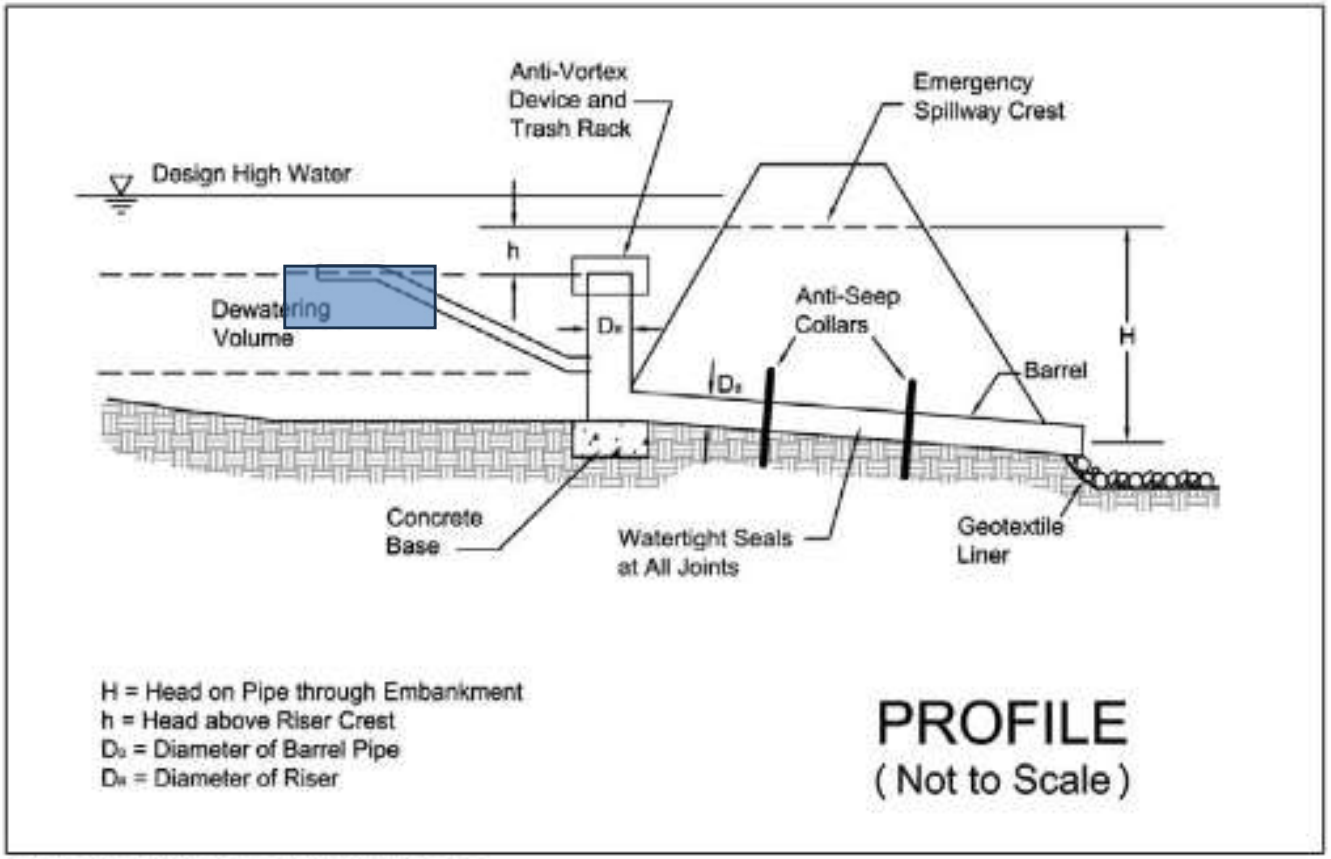
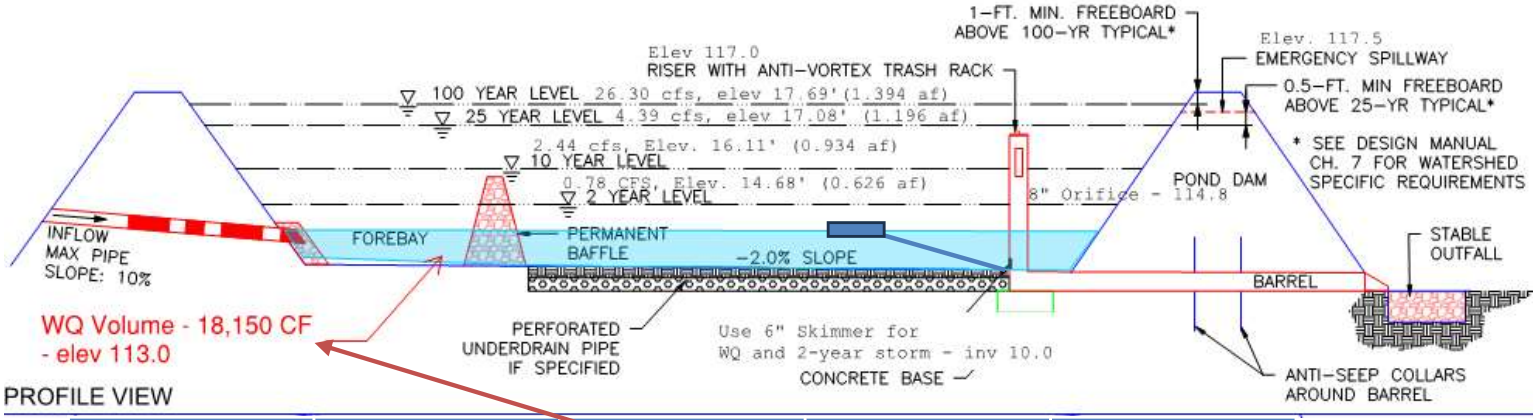


Figure 6.1.10 Principal Spillway Design

Filtration Based Water Quality Greatly Reduces Required Pond Volume to Achieve Treatment

Design pond with traditional riser with skimmer in place of low flow orifice and 2-year control orifice, additional orifices to control other storm events and emergency spillway



Storm	Peak Flow (cfs)	Peak Elev.	Vol. Req (af)	Vol. Req (CF)
WQ	0.70	12.01	0.174	7,579
2-yr	0.78	14.68	0.626	27,268
10-yr	2.44	16.11	0.934	40,685
25-yr	4.39	17.08	1.196	52,098

Traditional Pond vs Pond w/ Skimmer Comparison

	WQ	2 - yr	10-yr	25-yr	100-yr
Traditional Flow	0.25	0.81	2.75	4.51	26.84
Skimmer Pond Flow	0.70	0.78	2.44	4.39	26.30
Traditional Pond Storage	0.245	0.725	1.059	1.352	1.584`
Skimmer Pond Storage	0.174	0.626	0.934	1.196	1.394
Difference in Storage Required	-29%	-14%	-12%	-12%	-12%

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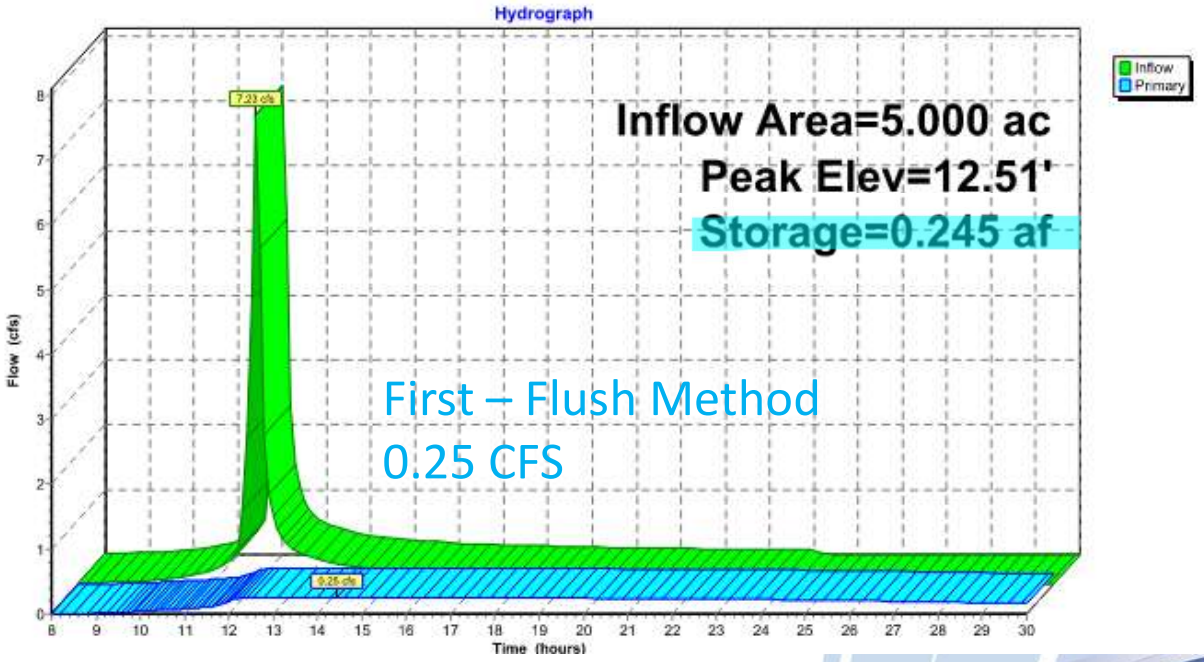
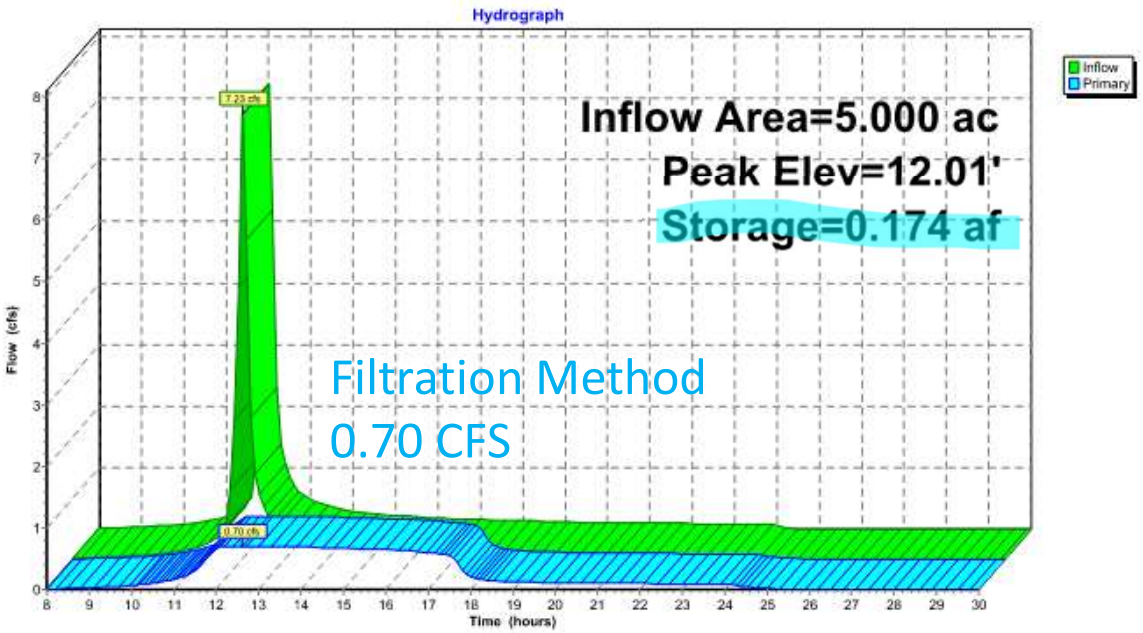
Example 5 Ac. Site
Skimmer controls
2-Yr Storm

Filter allows Water Quality volume to be released faster, resulting in +/- 30% less pond volume required compared to "First Flush" Method

Treats all runoff up to 2-Yr Storm to 90% TSS Removal





Challenges to Using Skimmers with Filtration

Filters are prone to clog over time and will require maintenance and periodic cleaning or changing

Skimmer must be durable and last more than a few years to be suitable for permanent use. May need alternate drain during frozen conditions.

There are no established standards for basis of design and permitting based upon combination of pond and filtration

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R&D has been underway to test adding filter media around the skimmer to remove TSS, metals, hydrocarbons and other pollutants

- The prototype was regularly monitored and was in the pond for over 24 months
- Area flowing to pond is highly developed with few other stormwater management facilities, therefore, large volume of sediment, trash and debris enters this pond

Filtration R&D

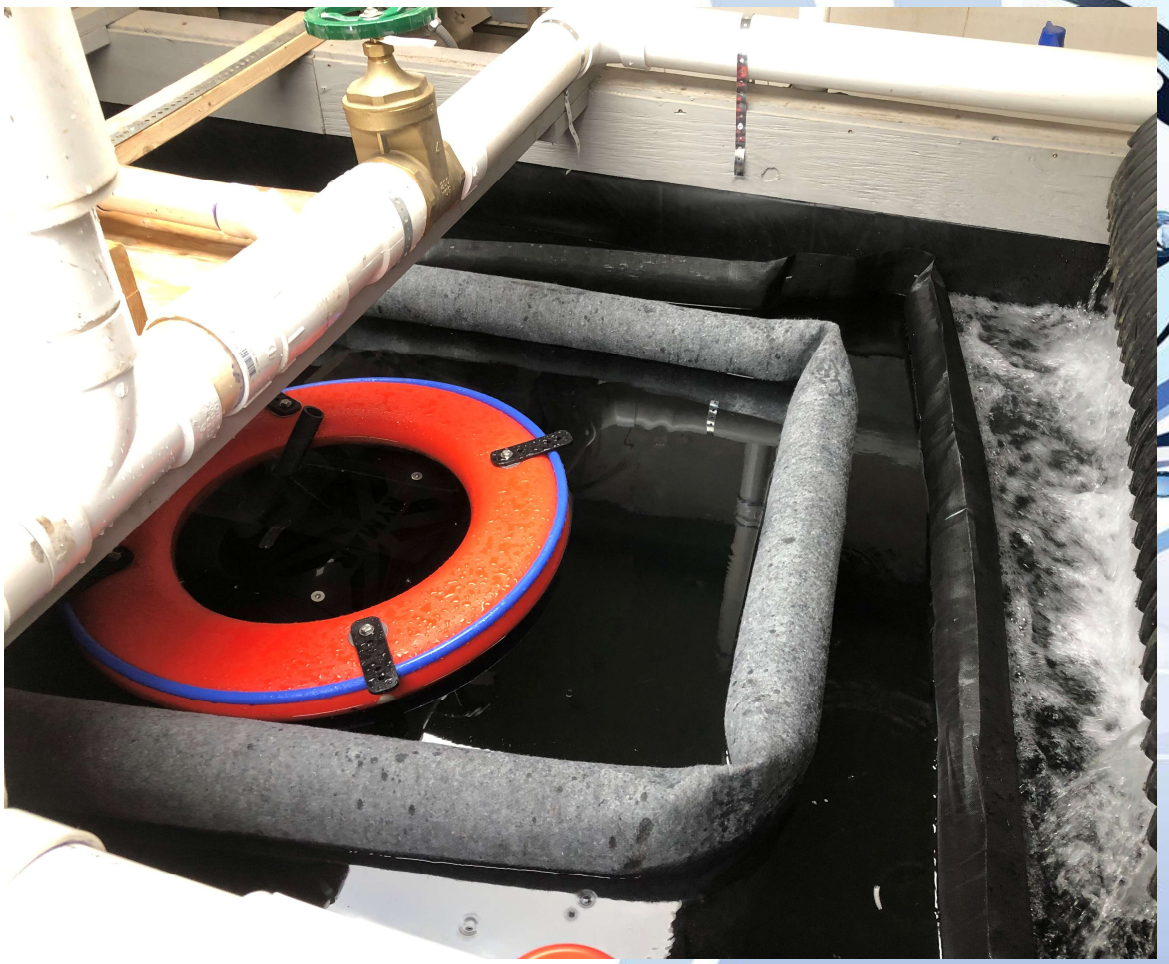
• Vegetation started to grow in inner non-woven filter. Will evaluate for nutrient removal potential.

Testing Results

- **Results**
- **Field testing of double filtration model shows discharge water has less turbidity and minimal sediment.**
- **Third Party Testing of TSS removal confirmed over 90% TSS removal**

Third Party Testing

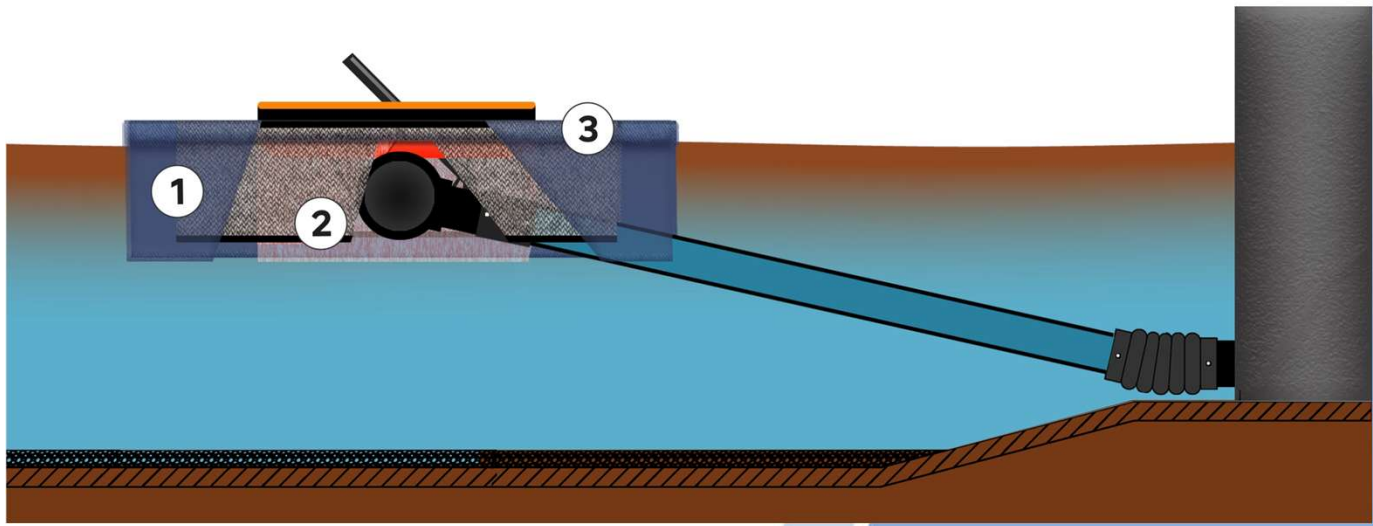
- **TRI Environmental tested two versions of the skimmer with filter in accordance with ASTM C1746.**
- **ASTM C1746 is a standard test method for sediment retention devices.**
- **Tank was setup to minimize effect of the “pond” by introducing sediment laden water within 2’ of the filter.**



1. Outer layer for debris and large particle removal is made from polyethylene fabric.

2. Inner layer for smaller particles is made from non-woven fabric by Adsorb-it.

3. The combination of the 2 fabric layers in conjunction with the Marlee Float creates over 90% TSS removal.



Updated Version has been installed to continue monitoring and has time lapse camera to document performance

Example of Pond with Filter for Water Quality

Summary

Skimmers are less prone to clogging than orifices located at the bottom of the pond and often require less maintenance to keep the pond functioning properly.

Skimmers can be a very effective way to retrofit existing basins to reduce maintenance and provide enhanced water quality

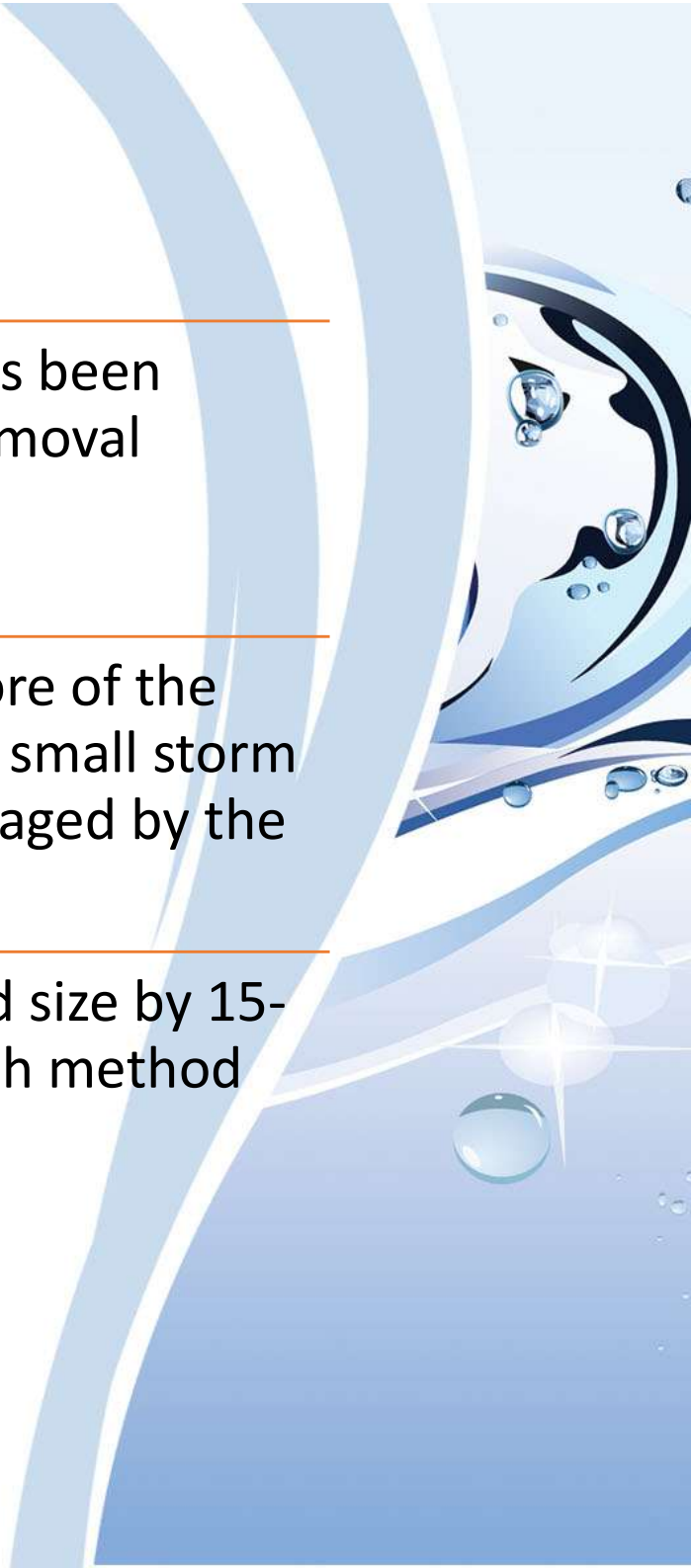
Surface withdrawal releases cleaner water from the basin for enhanced water quality

Summary

Use of Skimmer with Filter has been tested to confirm 90% TSS Removal Efficiency

Skimmer with Filter treats more of the annual rainfall, including very small storm events and larger events managed by the skimmer.

Filtration model reduces pond size by 15-20% over traditional First Flush method

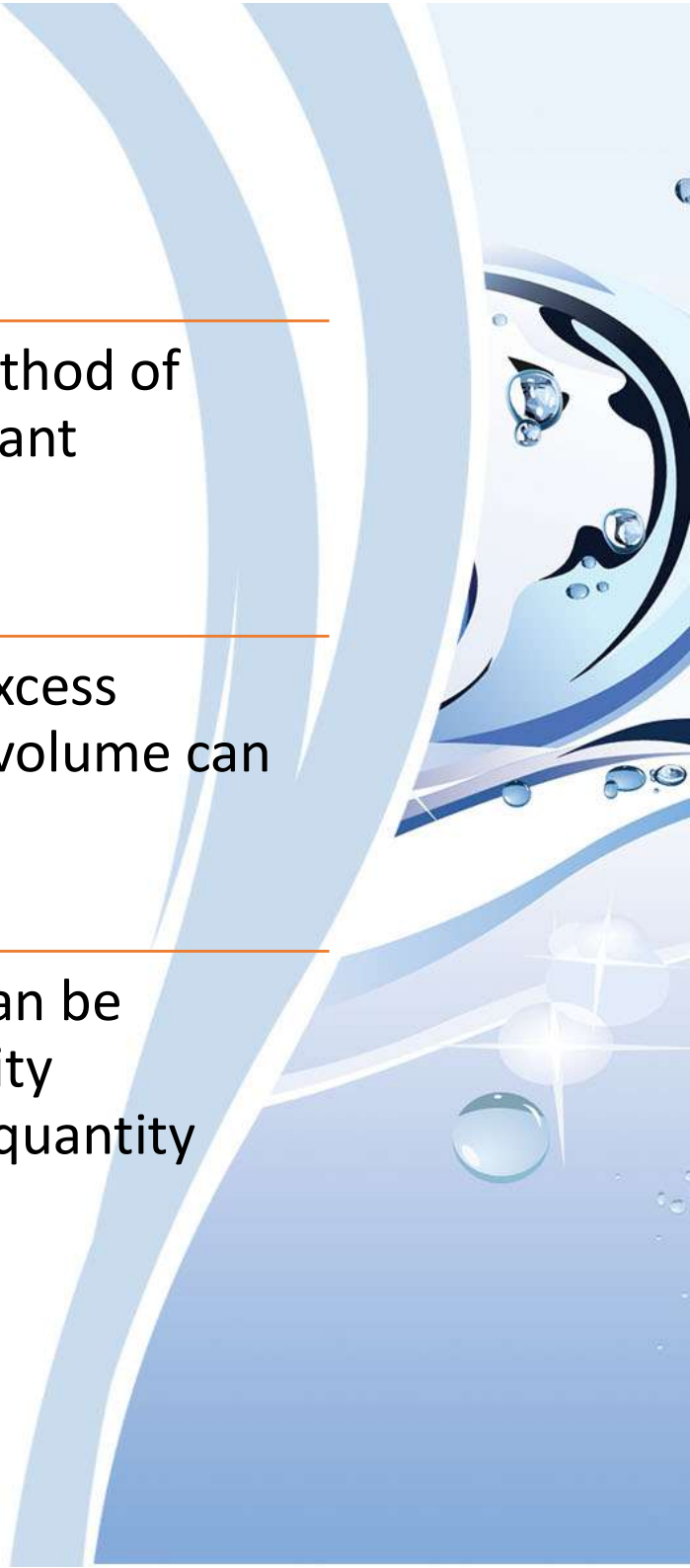


Summary

The Traditional First-Flush method of water quality requires significant additional volume in ponds.

Ponds typically do not have excess volume available and adding volume can be cost prohibitive

By utilizing filtration, ponds can be retrofit to provide water quality treatment while maintaining quantity control requirements



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