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Key Considerations for Choosing Underground Detention and Manufactured Water Quality Solutions

2018 INAFSM Conference

Angie Bidlack, PE
Samantha Brown, PE

Agenda

- Underground Detention Solutions
  - Cost-Effectiveness
  - Site considerations
  - Maintenance
- Hydrodynamic Separation (HDS)
  - Site considerations
  - Maintenance
  - Case study
- Filtration
  - Proper sizing
  - Site considerations
  - Maintenance
  - Case studies

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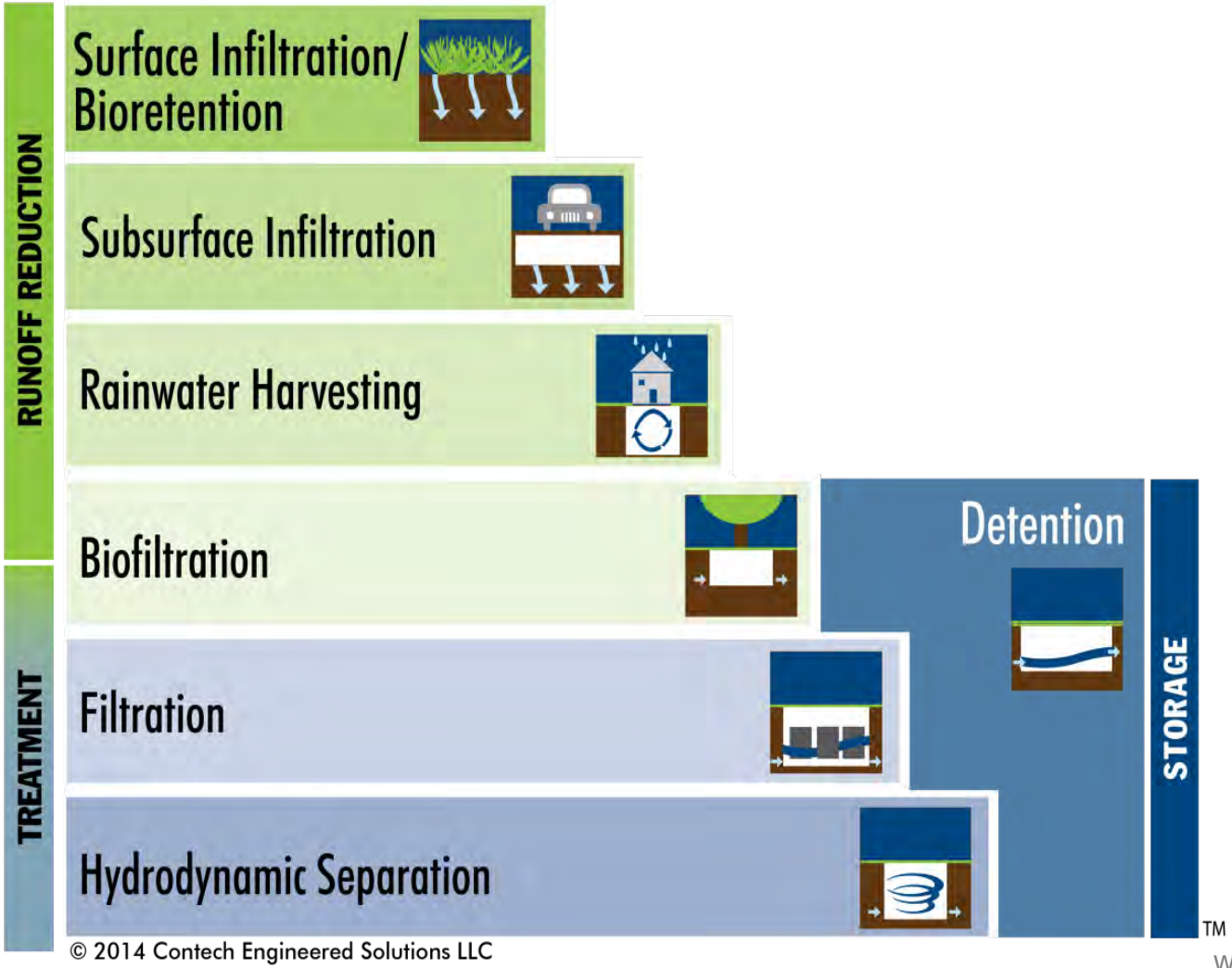
Stormwater Solutions Staircase



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Detention & Subsurface Infiltration

CMP

Plastic

Concrete

Key Considerations

- Effective depth
- Limiting widths/lengths
- Infiltration opportunities / Minimizing footprint
- Maintenance

Detention/Retention Solutions

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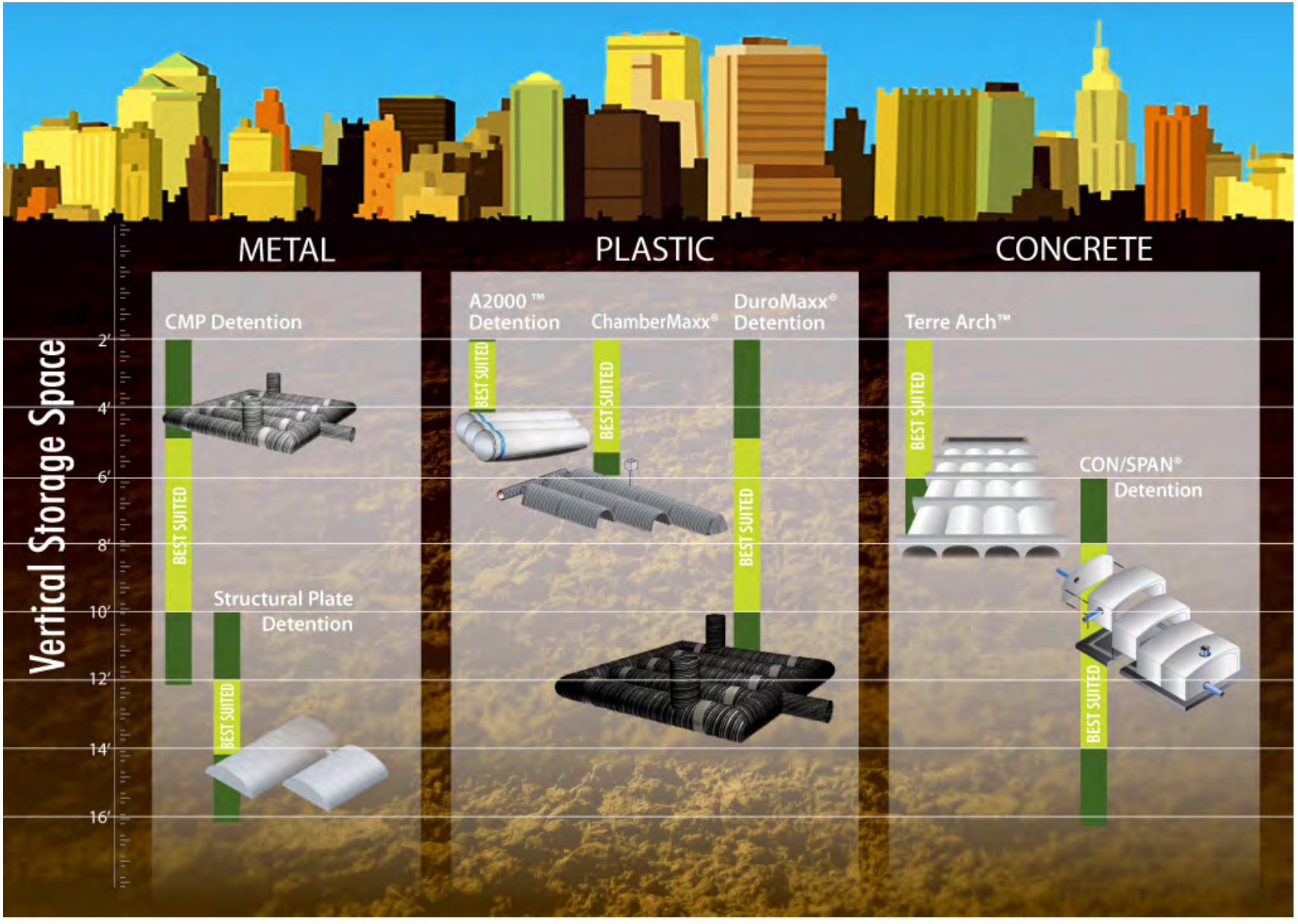
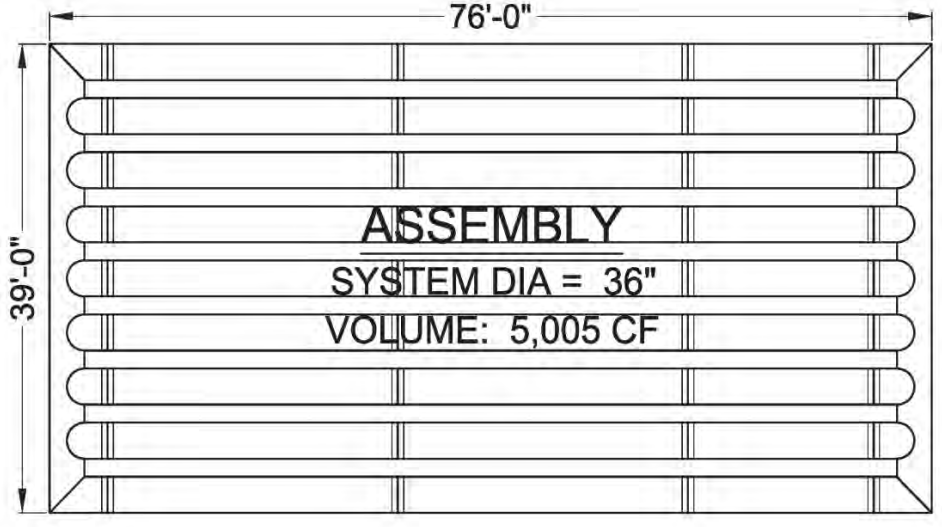
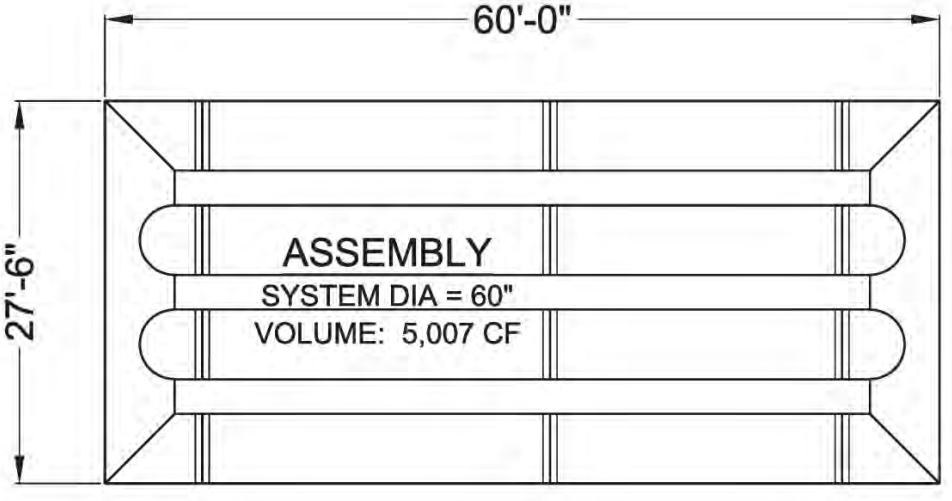


Maximizing Depth

- Factors that save cost
  - Maximizing Depth
  - Minimizing excavation / footprint of the system





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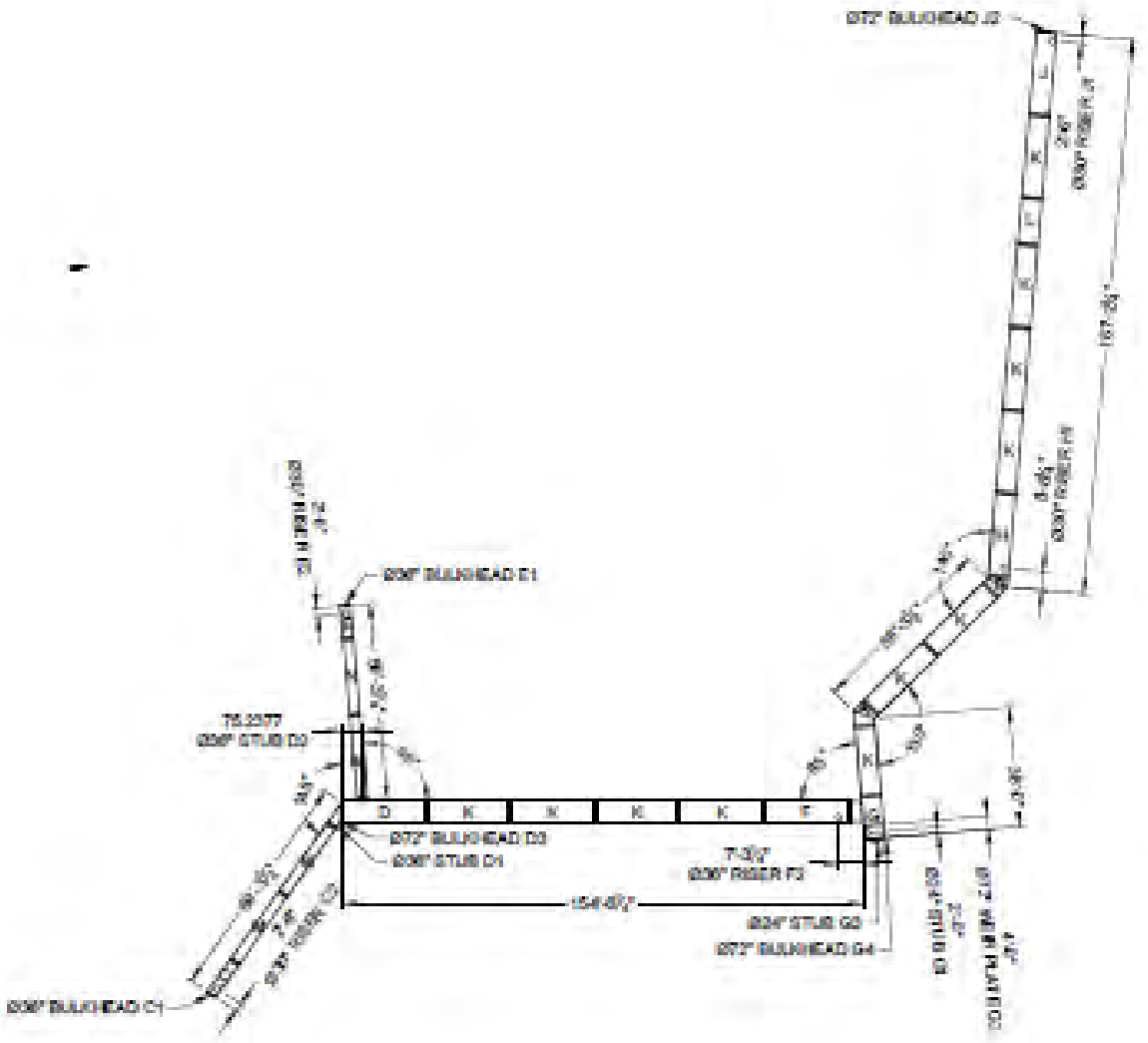
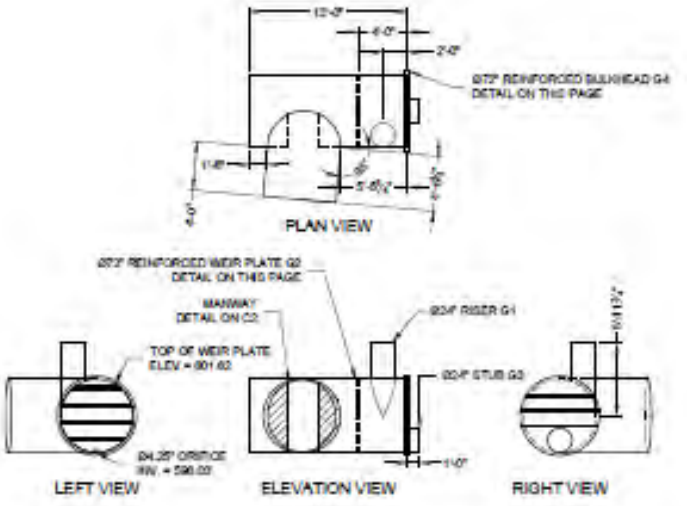
In-line Detention





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Open Systems: Using Stone for Storage

- Utilize void space of the stone backfill to store water
- Generally accepted: 40% void space
  - Some municipalities are decreasing allowable void space
  - Some requiring additional volume for sediment storage

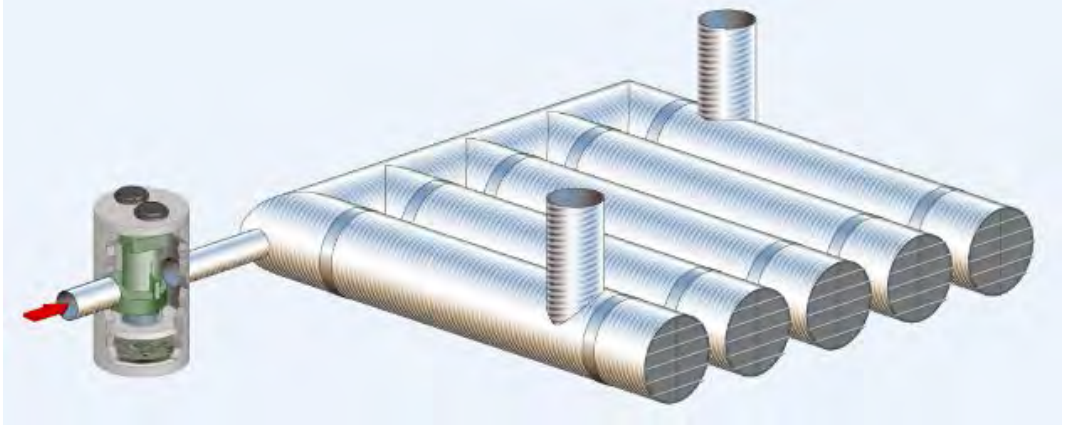
Open Systems: Using Stone for Storage

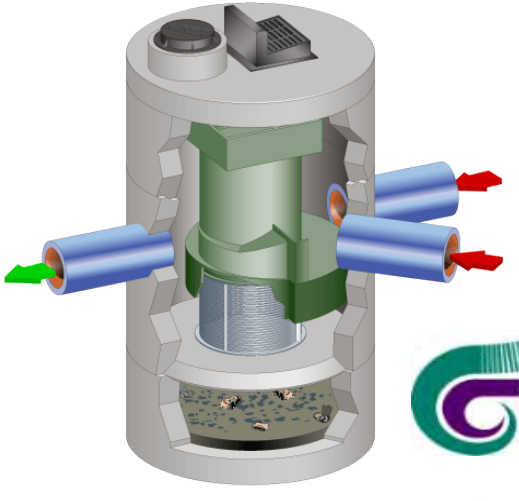
	Reading High School		Winchester Pike	
	• 19,000 cf • 42” CMP		• 34,850 cf • 48” CMP	
	Perforated	**Solid**	**Perforated**	**Solid**
Material Cost	$68,000	$81,500	$92,800	$125,000
System Footprint	170’ x 35’	195’ x 51’	437’ x 21’	553’ x 26’

Pretreatment

- Protects outlet control structures
- Remove sediment prior to entering system
- Consolidate sediment in one location
  - Water Quality Structures are easier to maintain
- Maintain stone voids in perforated system
- Increase service life of system
- Meet local regulations

Vortechs®





GDS

Inspection & Maintenance

- Address during design
- Inspection Protocol
  - How will the system be visually inspected?
  - Are ample access points provided?
  - Can someone physically access the system if needed?
  - Inspection frequency – quarterly, semi-annual, annually
- Maintenance
  - Determine appropriate maintenance frequency based on inspections
  - Determine appropriate maintenance methods

Inspection & Maintenance

Case Study: Churchill Downs, Louisville, KY

Project Features:

- 96” diameter perforated CMP retention system
- Provided water quality and quantity control
- Included additional volume for partial flood mitigation in surrounding areas
- HDS units sized to 50% TSS removal as pretreatment

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So Many Choices…

	Hydrodynamic Separation	Filtration
Pollutants of Concern	TSS	TSS, Nutrients, Metals
Targeted Particle Size Distribution	> 50 micron	< 50 micron
Recognized Testing Protocol	• Lab Testing: NJDEP • Field Testing: TARP Tier II	• Lab Testing: NJDEP • Field Testing: TAPE or TARP Tier II
Placement Relative to Detention	• Upstream for effective performance	• Upstream or downstream

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Hydrodynamic Separator Fundamentals

Organize inflow energy & turbulence into a stable flow pattern

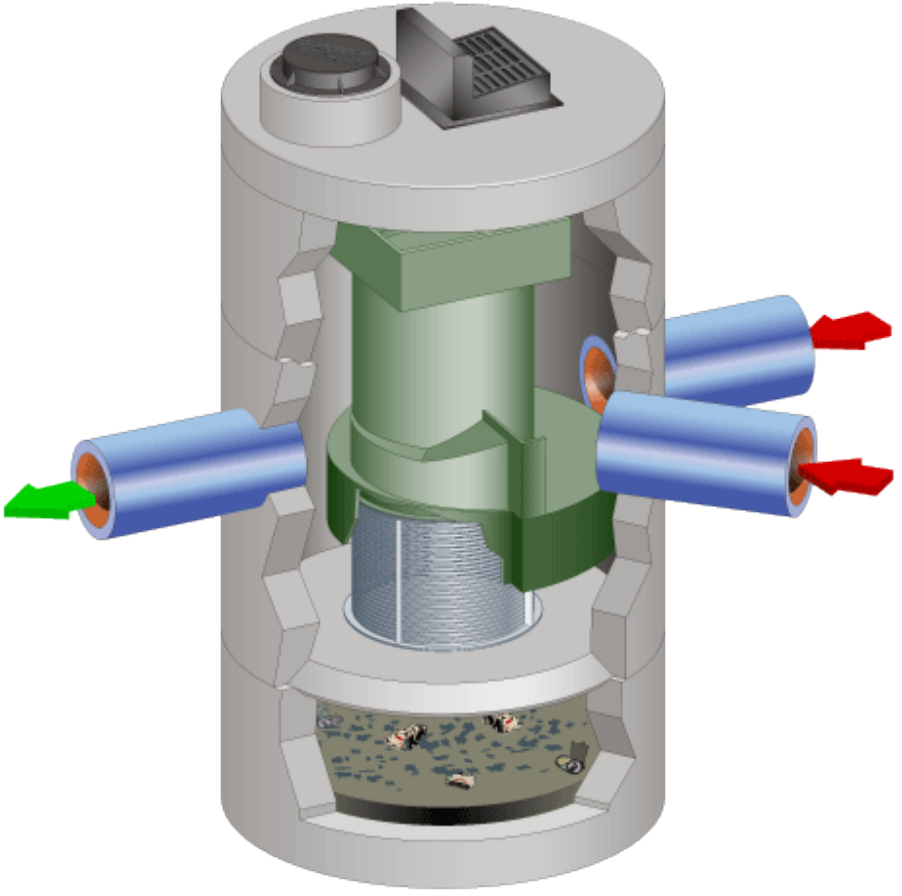
Swirl Concentration

Gravity Separation

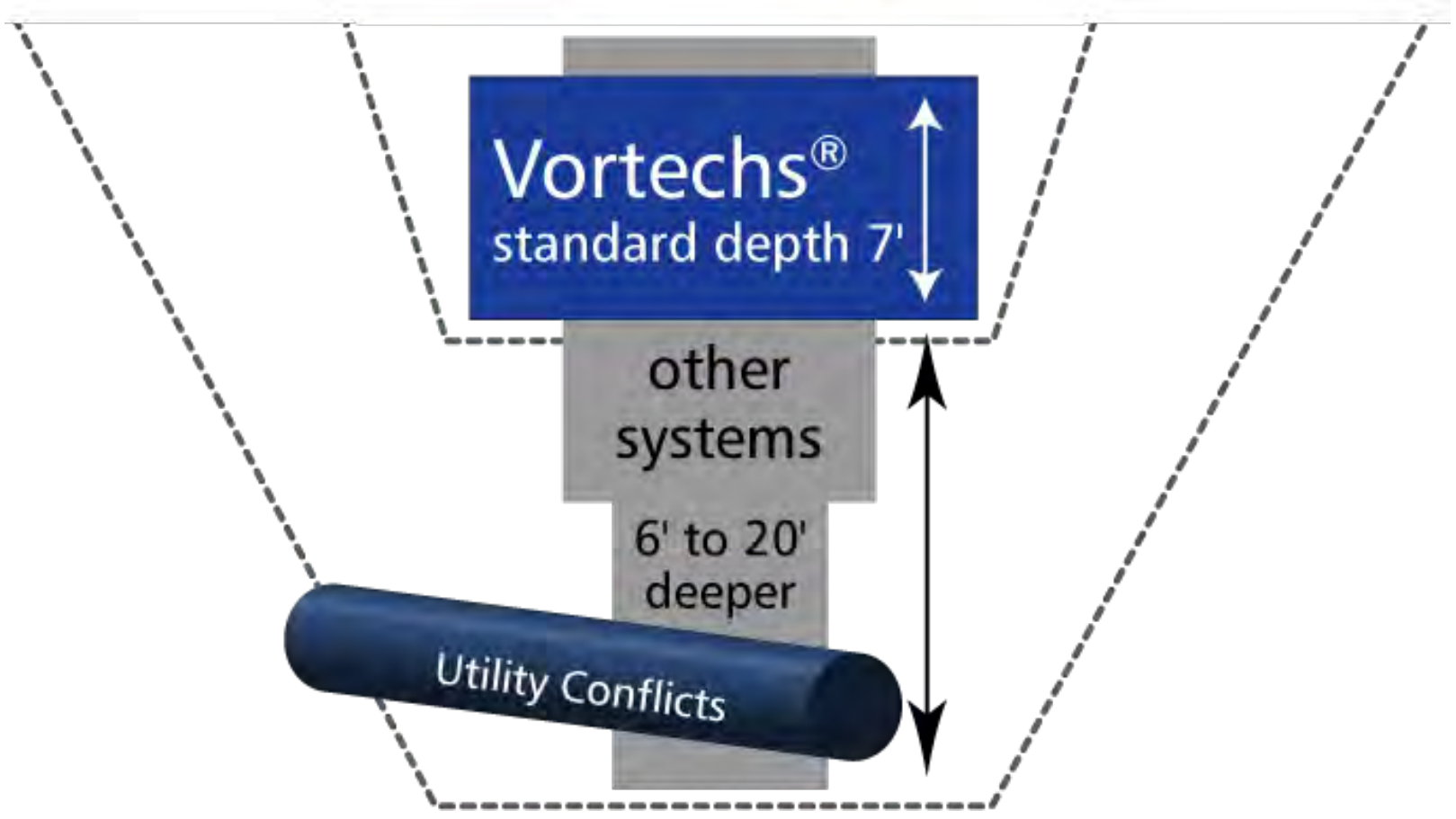
Flow Controls

Site Considerations for Selection – Footprint & Other POCs

- Additional features in some HDS devices:
  - Junction Structure
  - Catch Basin
  - Hydrocarbons, FOGs
  - Trash/Neutrally Buoyant Materials

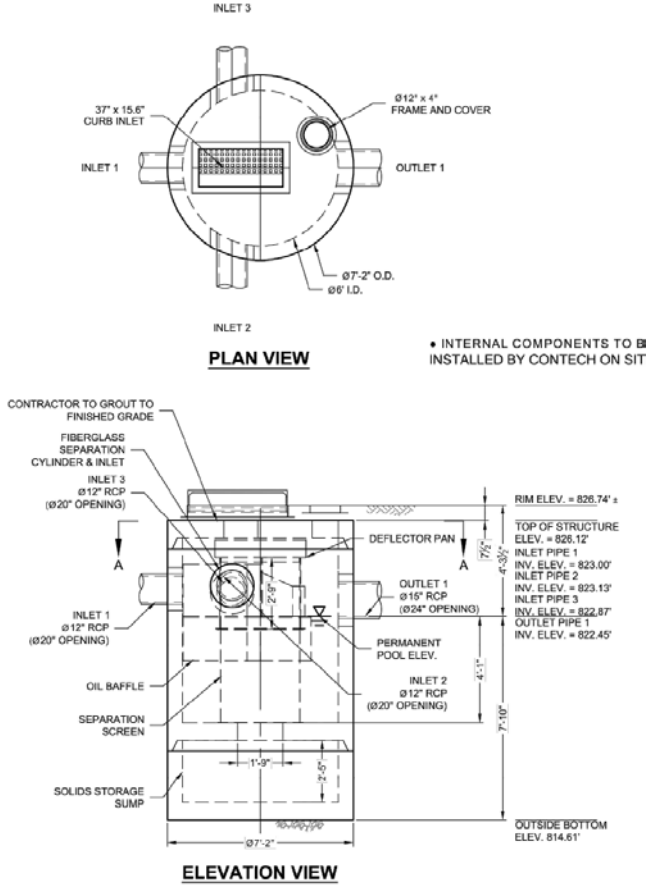


Site Considerations for Selection - Depth

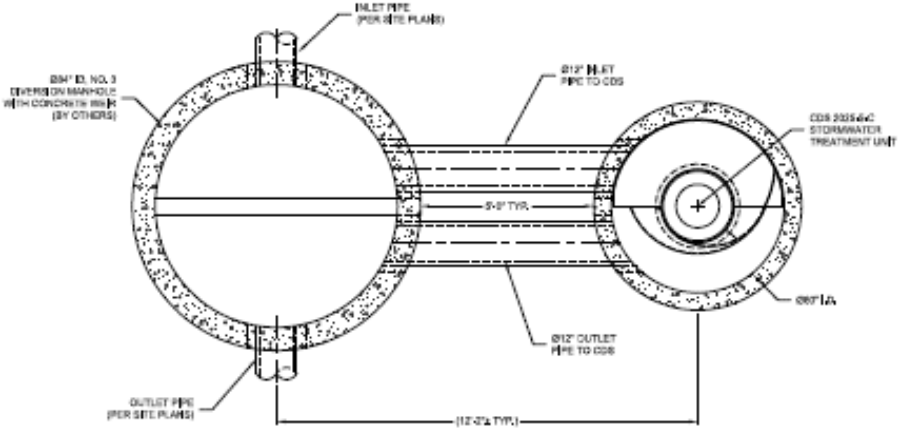


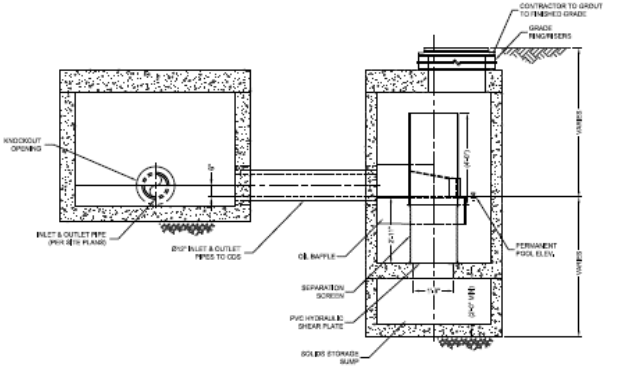
Layout: Online vs. Offline Positioning

Online configuration



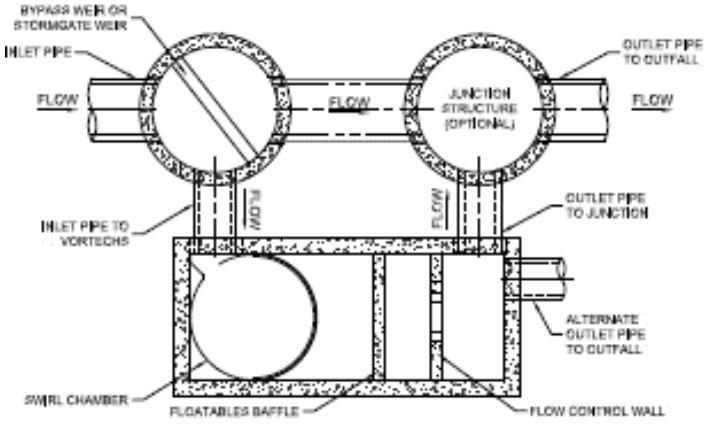
Offline configuration – Single Diversion/Junction Structure

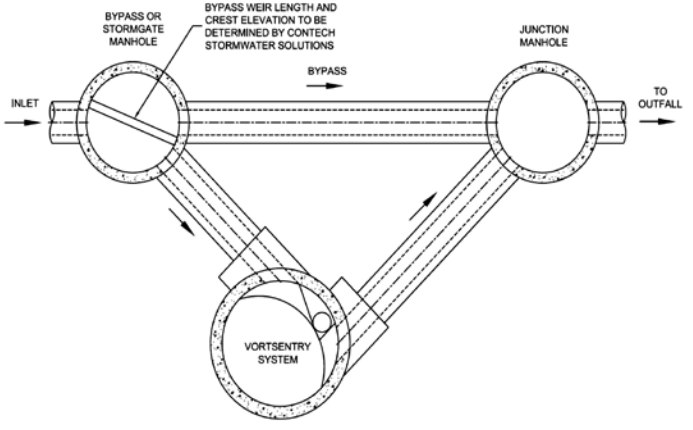


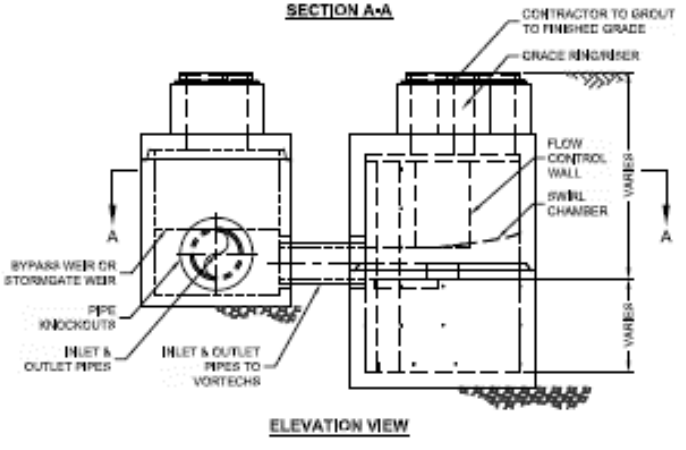


Layout: Alternate Offline Positioning

Offline configuration – Separate Diversion and Junction Structures

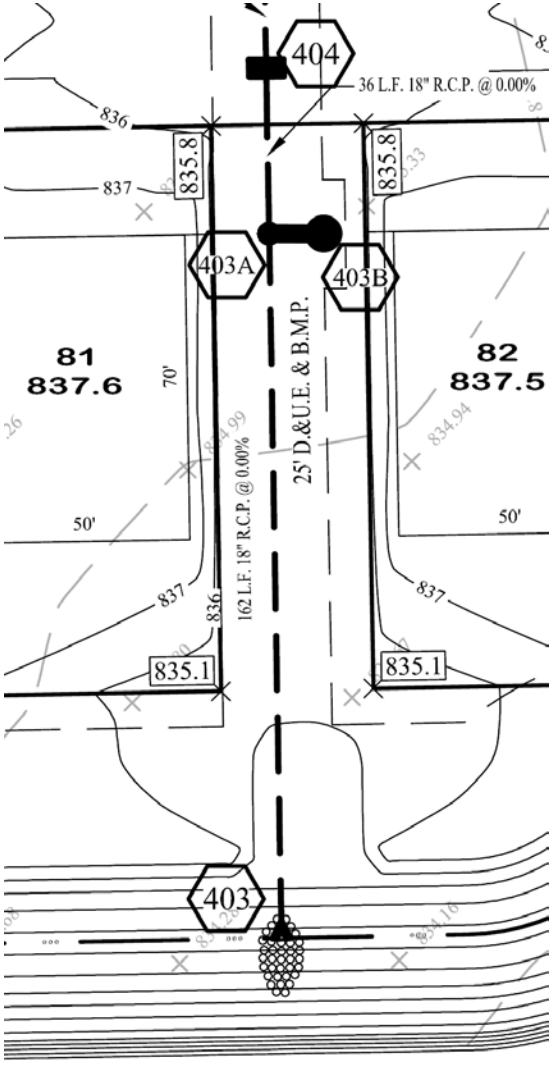






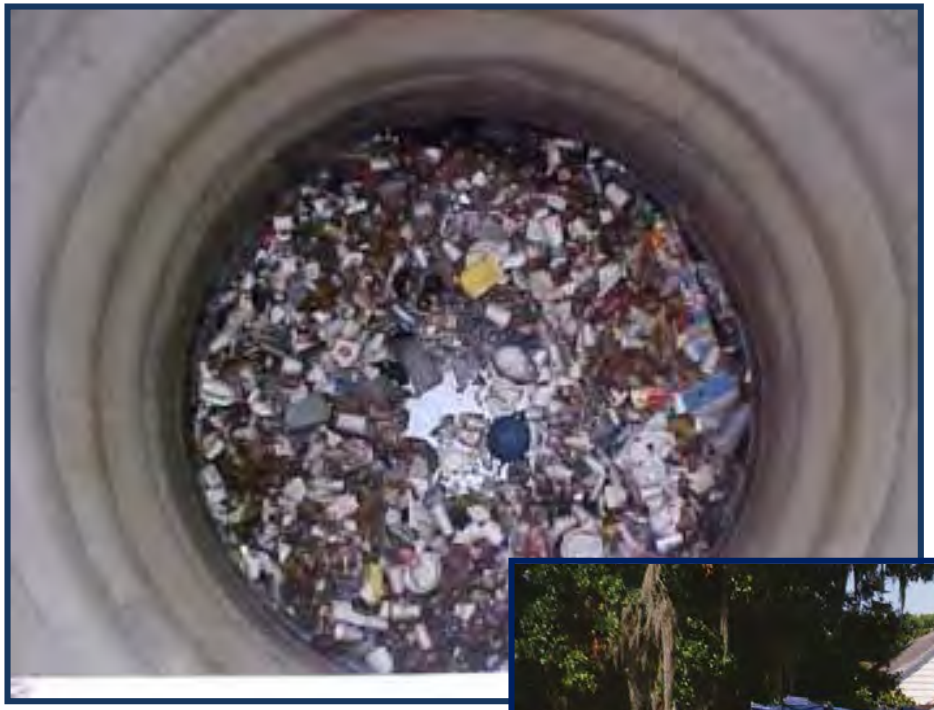
Layout – Access and Easements

- Many communities require easements
  - Dimensions vary
  - May be linear or square
  - Units may be required to be within a given distance from the edge of pavement



Inspection & Maintenance: HDS

Start

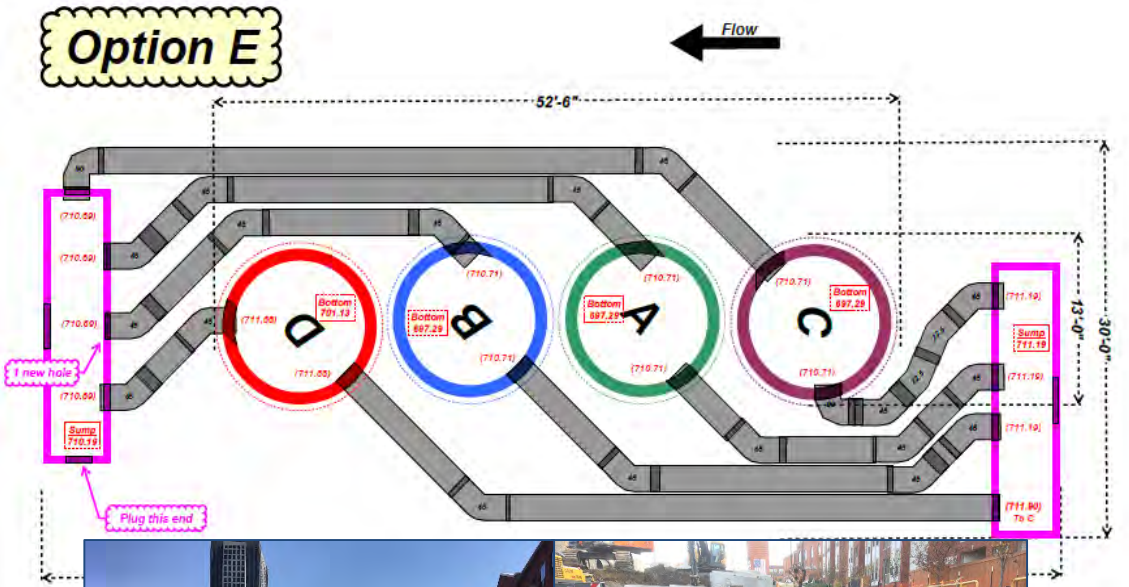


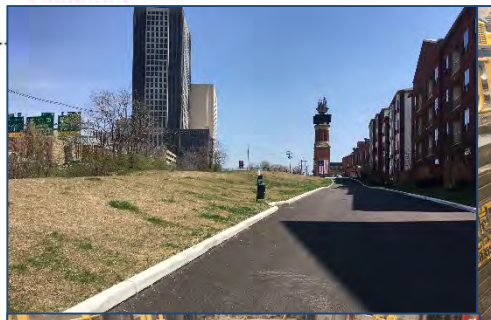
Finish

Case Study: ODOT I-71/70 Interchange

Project Features:

- 4 – 10ft diameter CDS units
- Provided water quality for 75 cfs
- HDS units sized to ODOT QPL – OK110 particle size distribution
- Footprint and site utilities were major constraints





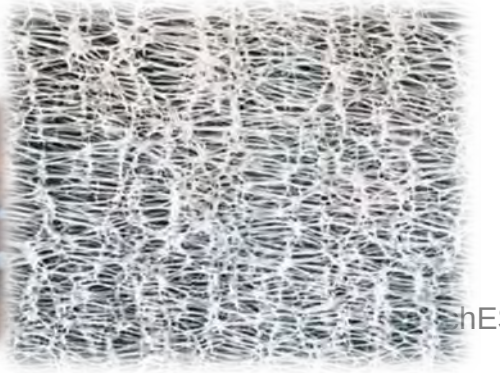
Filtration Fundamentals

Filter Capabilities

- Fine particle removal (<50 microns)
- Dissolved pollutant removal
- Customizable media to target specific pollutants

Typical Filter Applications

- Standalone Treatment
  - New Development
  - Redevelopment
- LID Pretreatment
  - Subsurface Infiltration
  - Rainwater Harvesting
- Polishing Treatment
  - Downstream of Detention



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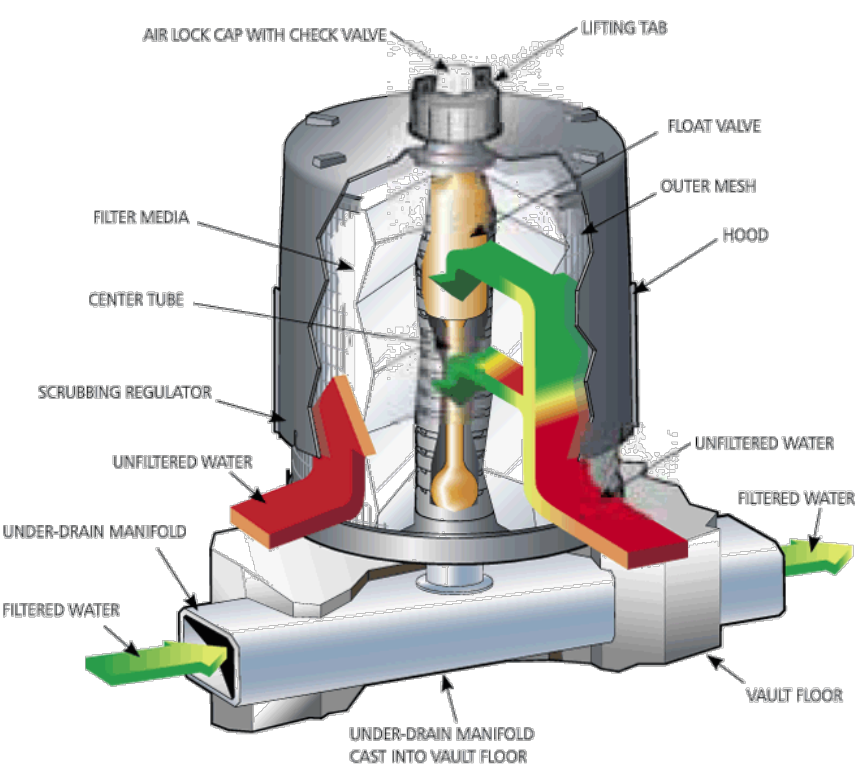
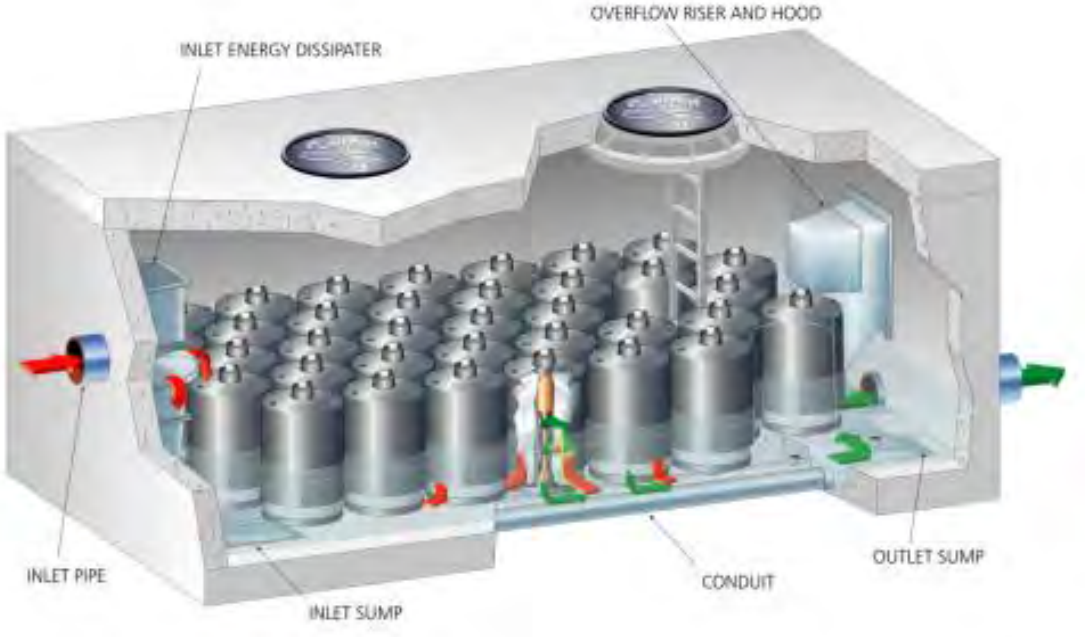
Innovative Media Filtration





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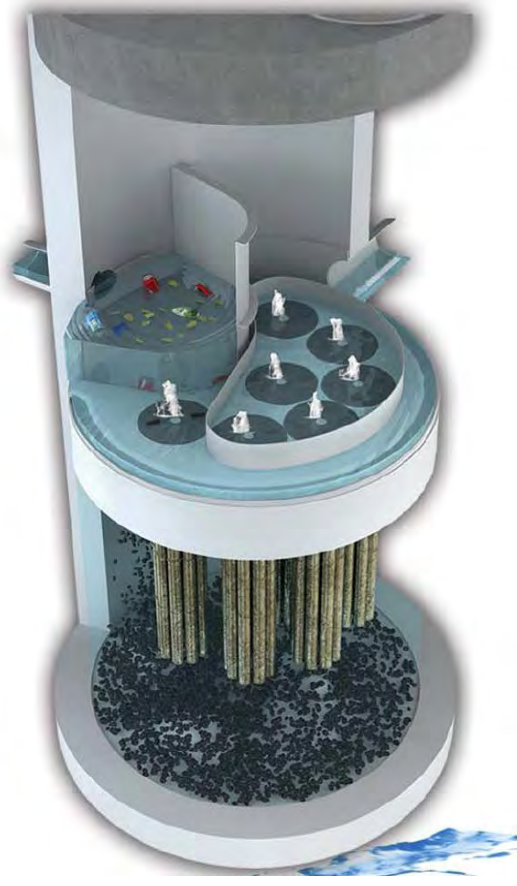
Innovative Membrane Filtration

Pleated Membrane Filter

Evolution of Filter Technology

Maximum Surface Area in
Compact System



Jellyfish Filter

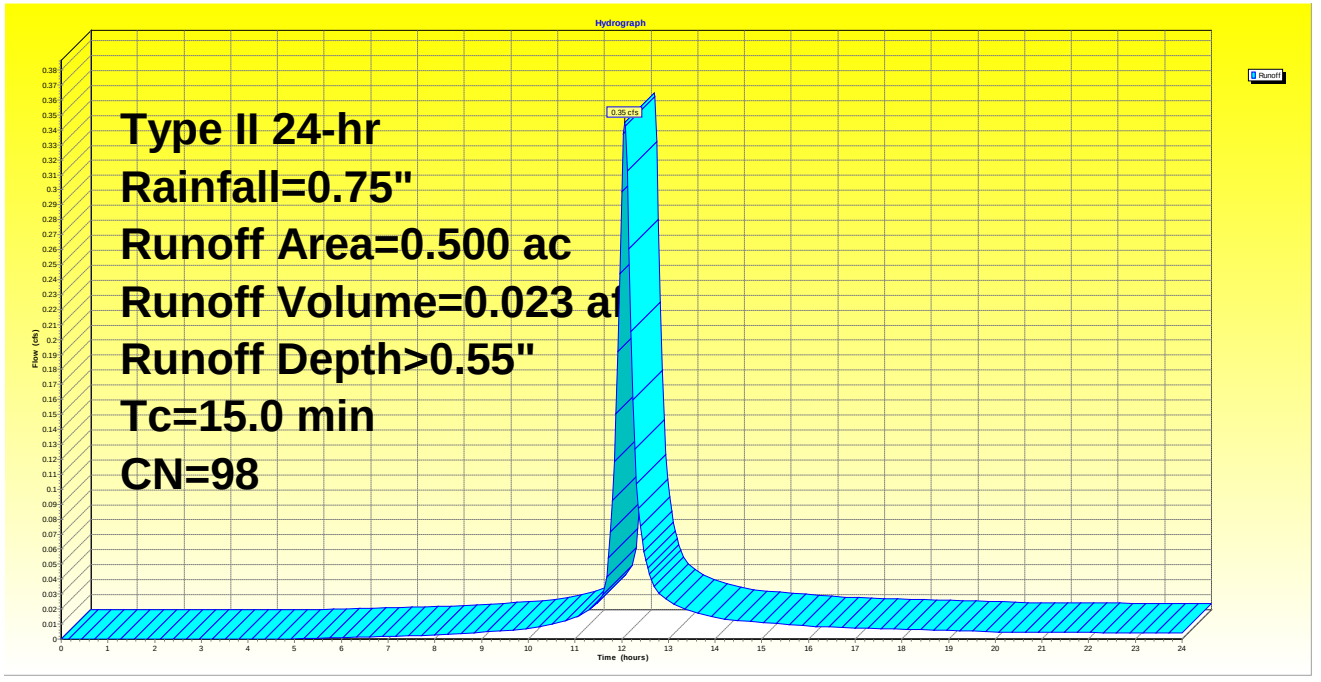
Basic Filter Properties

- Peak flow conveyance (ex: 0.05 cfs)
- Pollutant capacity prior to maintenance (ex. 54 lbs)
- Headloss and driving head required for filter to flow at published flow rate

Flow Based Filtration

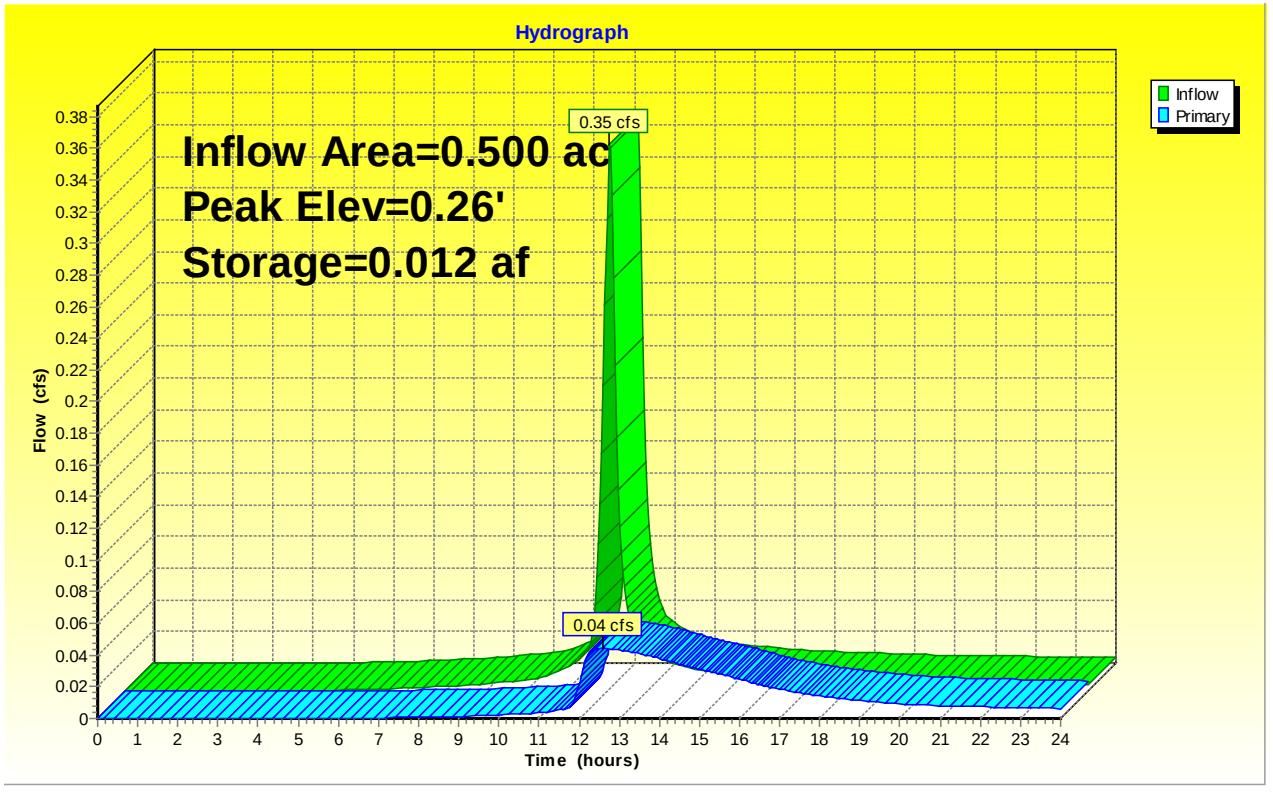
- Example:
  - Drainage Area: 0.5 acres
  - WQ Flow: 0.36 cfs

- Use: 8 StormFilter cartridges to treat 0.36 cfs



Volume Based Filter Sizing

- Post detention flow rate 0.04 cfs
  - Still treating the same runoff volume at a lower flow rate.
- Use: 1 StormFilter cartridge to treat 0.04 cfs



Mass Based Filter Sizing

- Same Site (0.5 acres)
  - 36 inches of rain annually (assumed)
  - Event mean concentration of pollutants (70 mg/l)

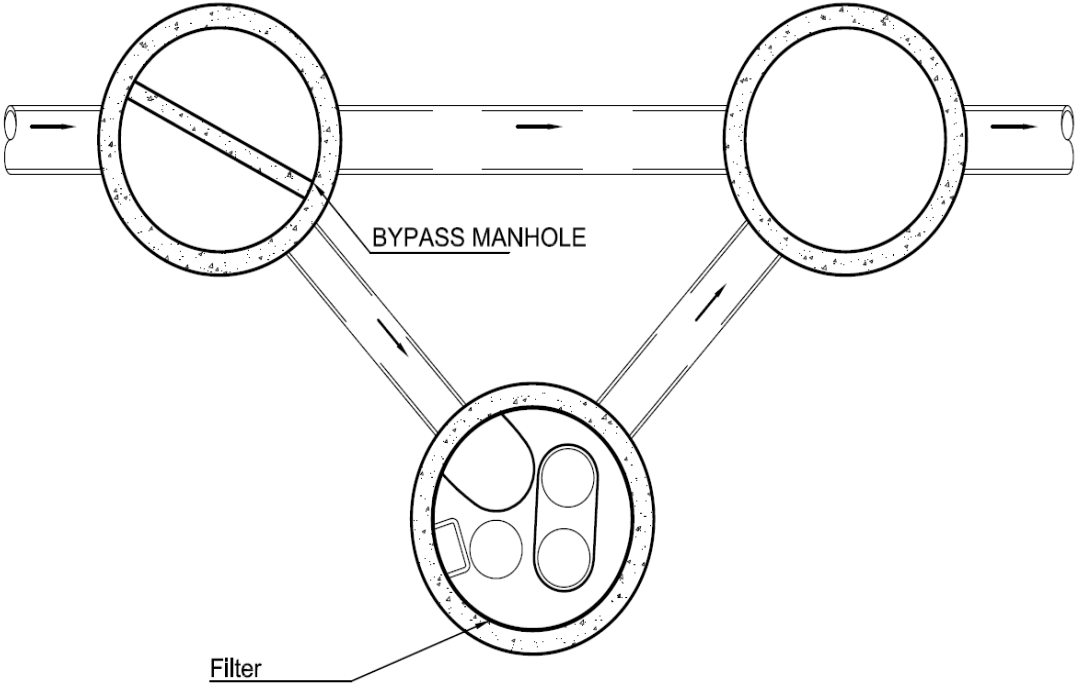
- 36” over 0.5 acres → 65,340 cf of water annually

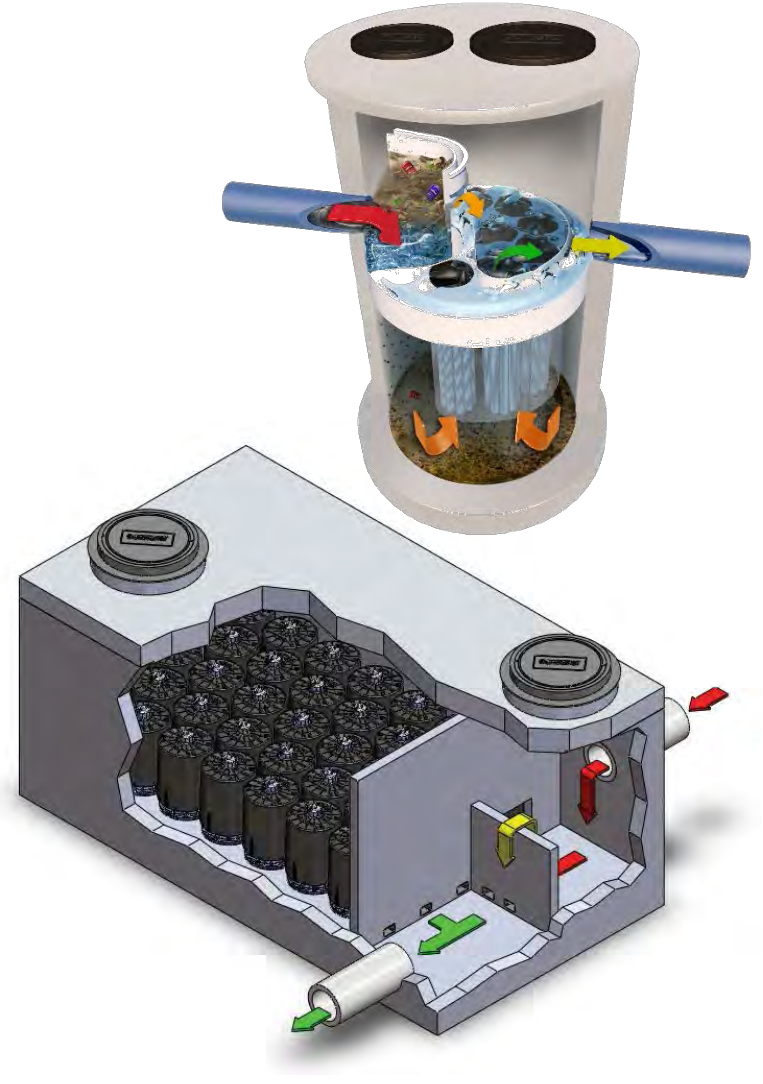
- 65,340 cf of water with a pollutant concentration of 70 mg/l → 285 lbs of pollutants annually

- $\frac{285\ lbs}{54\ lbs/cartridge}$ → 6 StormFilter cartridges

Filter Layouts

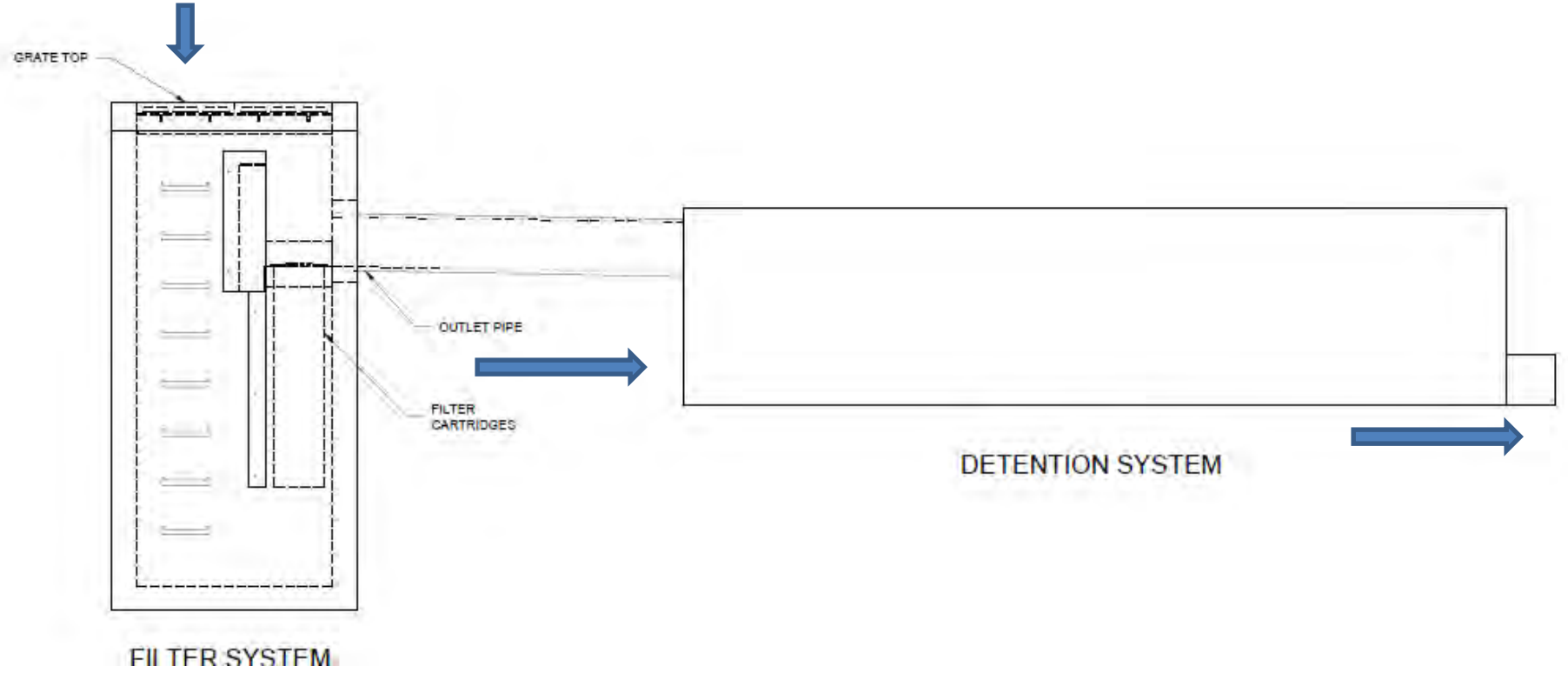
- Online/ Offline





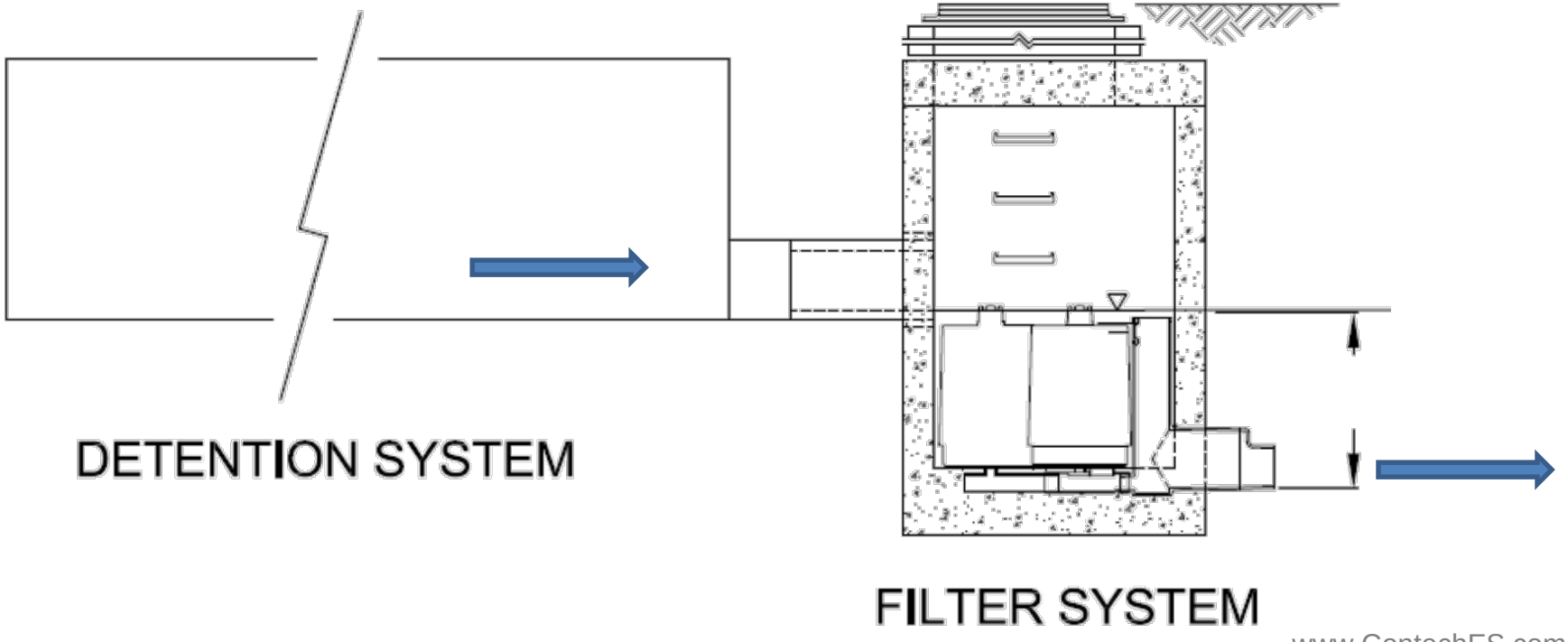
Filter Layouts

- Upstream of Detention
  - Pretreatment
  - Flow based



Filter Layouts

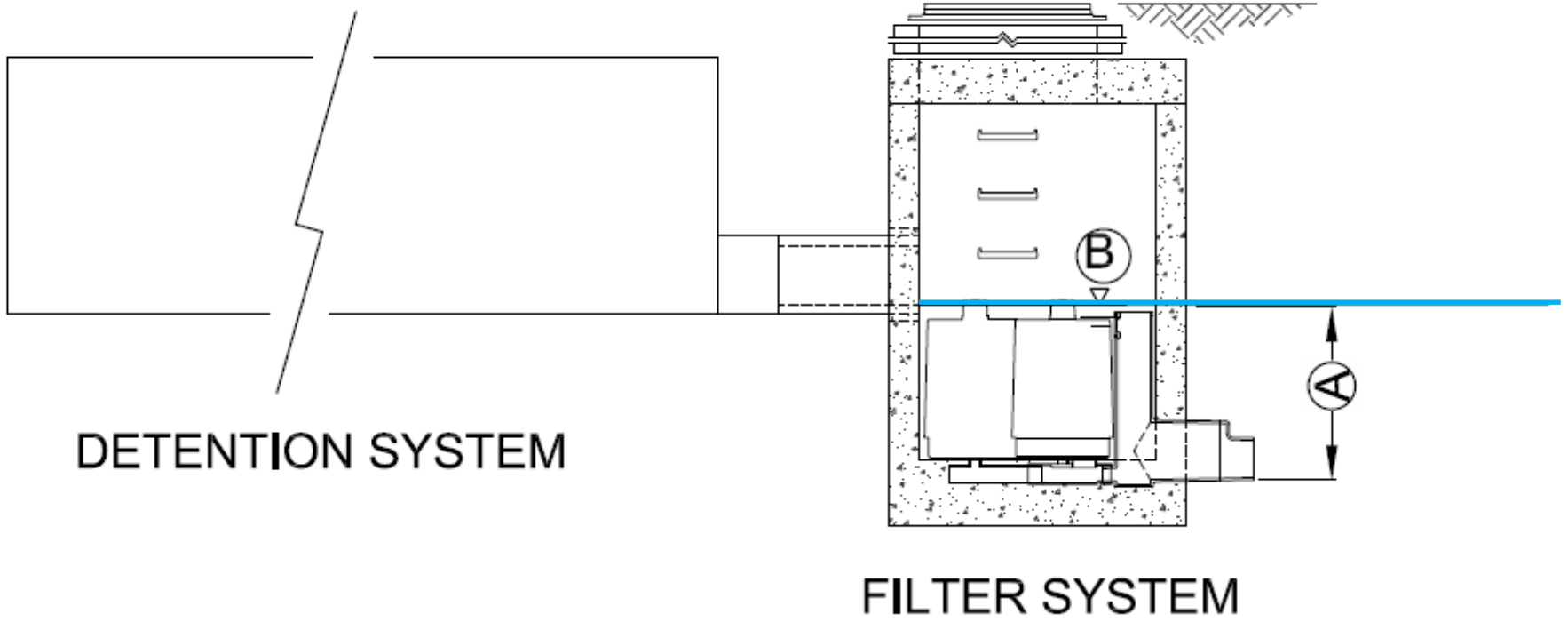
- Downstream of Detention
  - Decreased flow rate
  - Volume/Mass based sizing
- Consider headloss associated with Filter



Filter Layout Downstream of Detention

A) Head required for filter to operate at published flow rate

B) Water surface elevation during water quality storm



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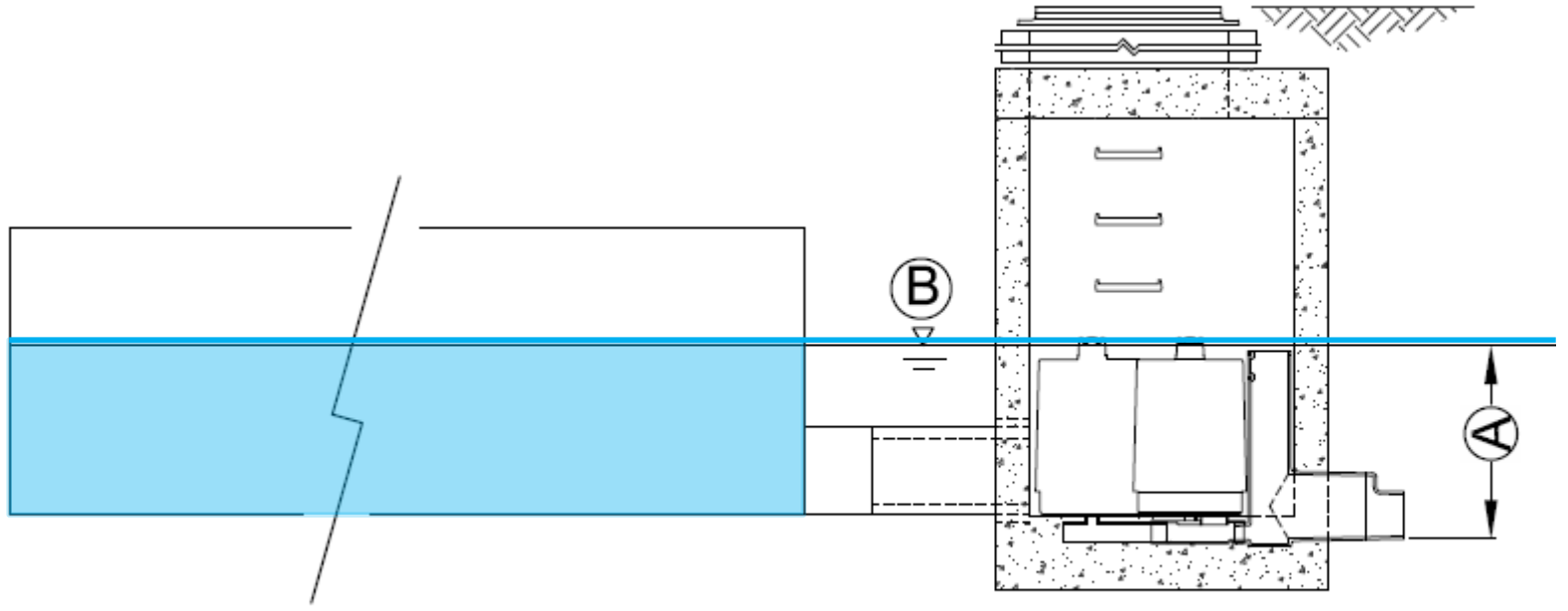

Filter Maintenance

- All filters will clog eventually!
- Things to consider:
  - Is the filter system easily accessible with a vac-truck?
  - Is there direct access to filter trough top slab openings?
  - Are the filter components easily replaceable without excavation of entire system.

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Filtration Maintenance

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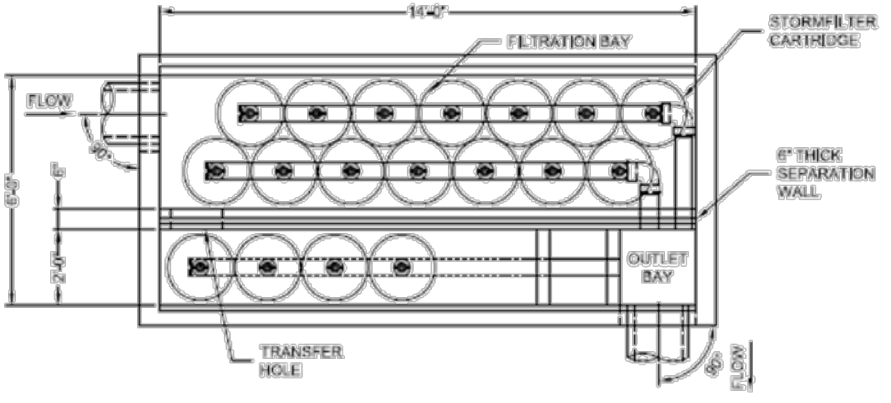
Case Study: Alliance Hospitality Cleveland, OH

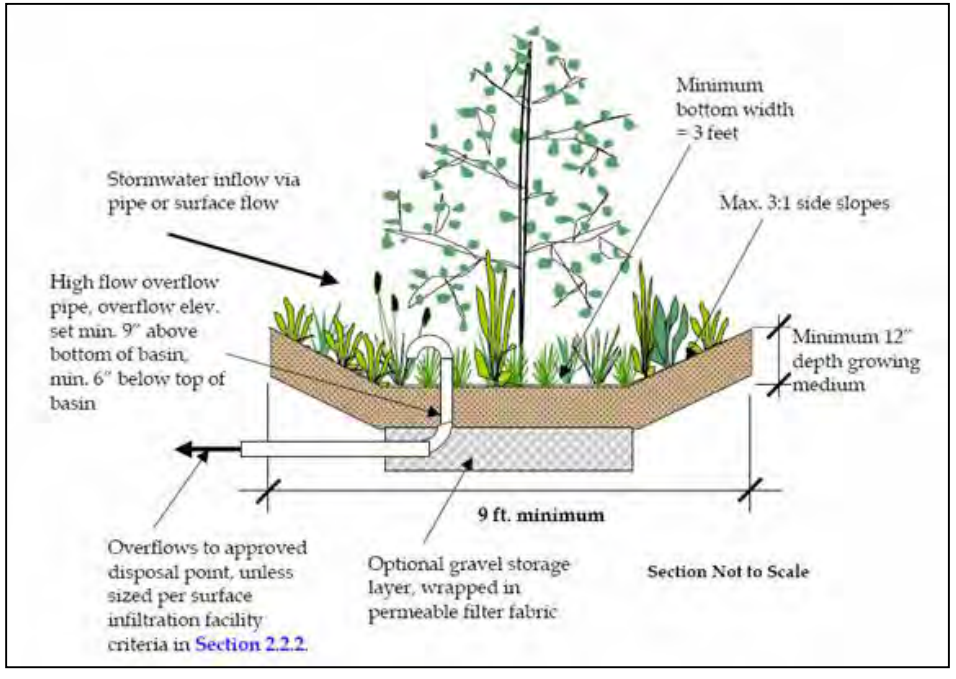
- Project Requirements
  - Treat 0.75” first flush storm
  - Meet OEPA standards
  - Work around depth and footprint constrictions

- Solution
  - Shallow StormFilter vault design with internal bypass
  - Grated top to eliminate upstream catch basin
  - (18) 18” tall cartridges



PLAN VIEW

Bioretention



Benefits

- Provides volume reduction, detention and water quality benefits
- Adaptable to nearly every site
- Provides ancillary benefits like habitat, aesthetic appeal, heat island effect mitigation

Challenges

- Opportunities for failure abound
- Media sourcing and composition critical but QC often lacking
- Can be maintenance intensive

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High Performance Biofiltration

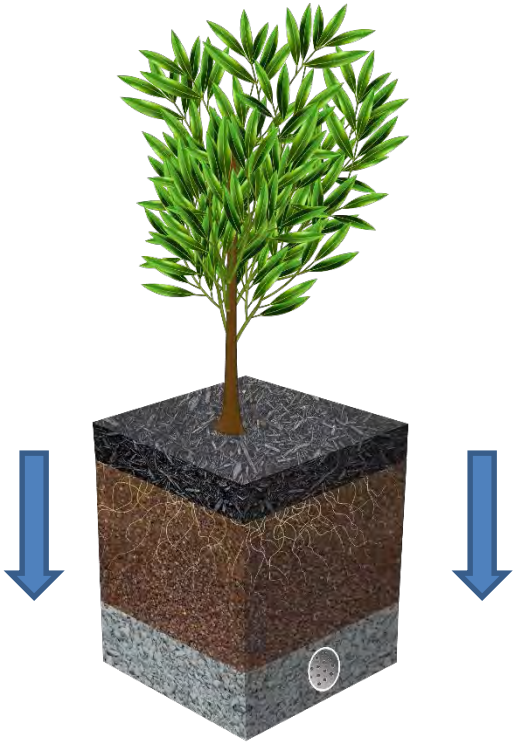
- High Flow Media
  - o Same principles as traditional biofiltration
  - o 100+ inches/hr flowrate
  - o Reduced footprint – typically 1% of tributary drainage area
  - o Quality control of media composition

filterra®
Bioretention Systems

Bioretention Sizing

- FSA: DA (Filter Surface Area : Drainage Area)
  - Volume based sizing
  - Example: 0.463%

- Flow Based
  - Example: 140 in/hr



Bioretention Configuration

- Traditional

Bioretention Configuration

- Filterra BioScape

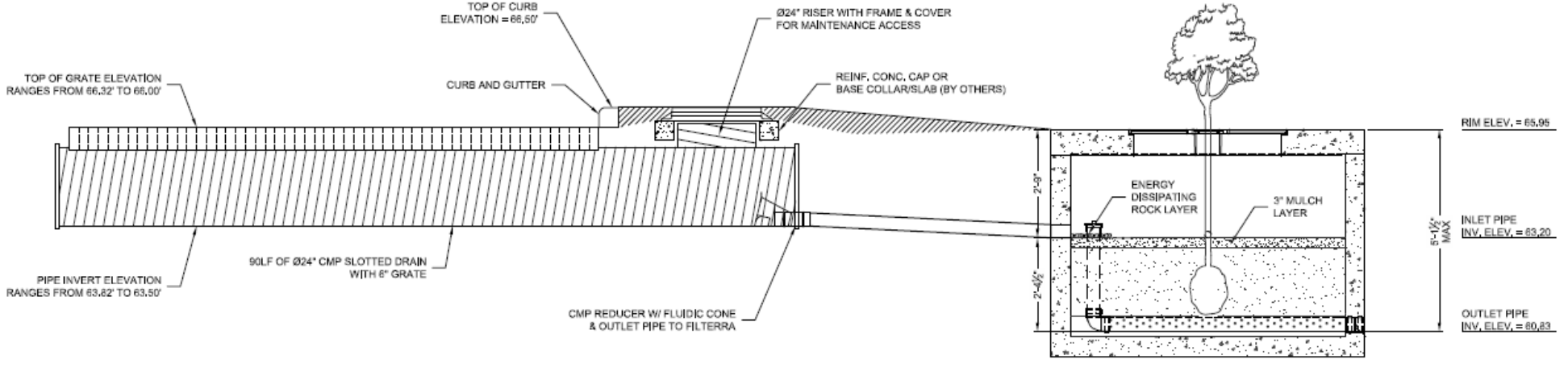
•Offline Filterra

Bioretention Configuration

- Pretreatment

Bioretention Configuration

- Downstream of slotted drain / detention pipe



Maintenance

- Remove Tree Grate
- Remove debris, trash & mulch
- Replace mulch

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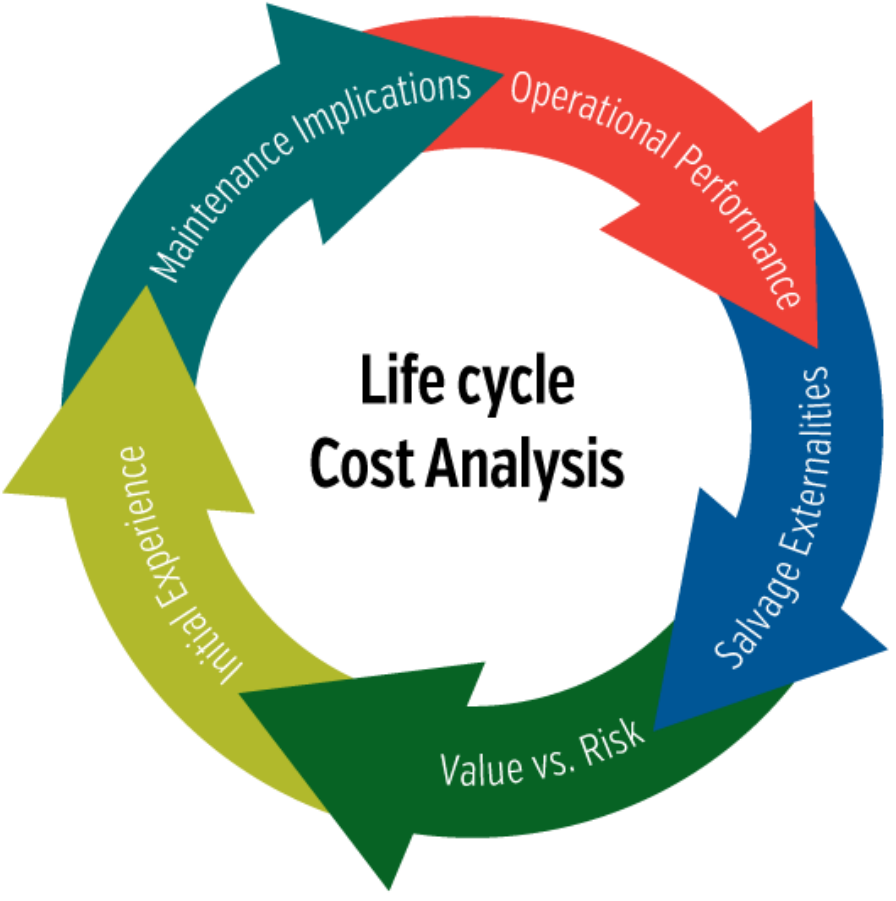
Case Study: Promedica Toledo, OH

- Project requirements
  - Treat first 0.75” water quality volume
  - Meet OEPA treatment standards
- Solution
  - 12 Offline Filterras
  - Sized using FSA:DA ratio (Volume based)

The Value of MTDs

- Business case where ponds are an amenity
  - May make sense for quality control, if not for quantity
- Costs for consideration in life cycle analysis
  - Material
  - Installation
  - Inspection
  - Maintenance
  - Maintenance intervals
  - Replacement
- Verified performance



Questions

Angie Bidlack, PE

abidlack@conteches.com

317-586-3175

Samantha Brown, PE

sbrown@conteches.com

859-321-5825