# Modeling Catchbasins and Hydrodynamic Devices

Tab 6a

PVA LLC
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1

## We will cover . . .

- **Research Results**
- **Entering Catchbasin Data into the Model**
- **Model Output**
- **Variable Sensitivity**

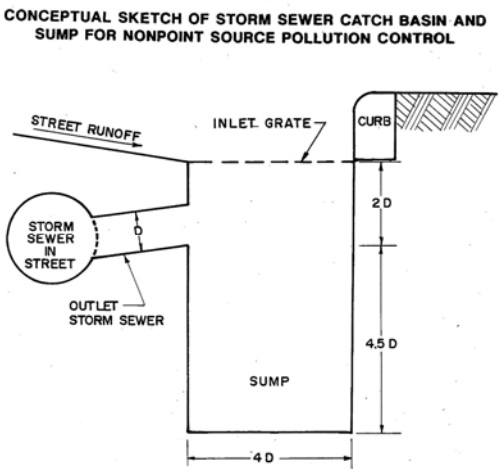
# Catchbasins

## Research Results

- **A New Jersey study (Pitt, *et al.* 1994) found average removal rates of 32% for suspended solids using catchbasins with a suitable sump.**
- **Pitt & Shawley (1982) found cleaning catchbasin twice per year reduced total residue yields between 10% and 25%.**
- **Pitt & Field (2004) found sediment in catchbasins were the largest particles washed from streets.**

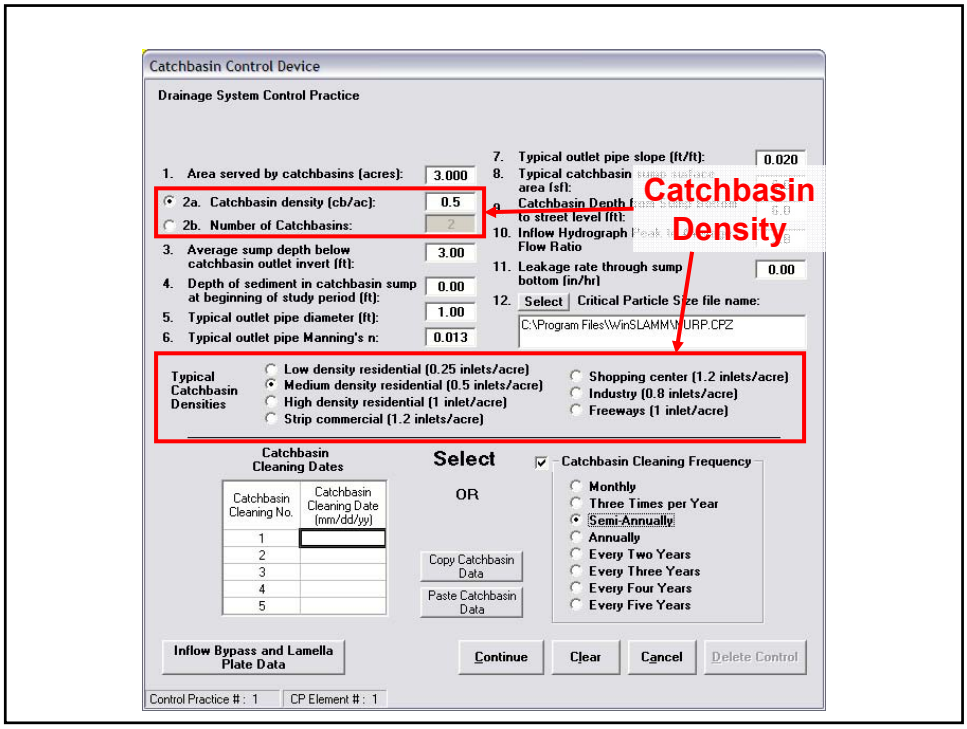
## Catchbasins . . .

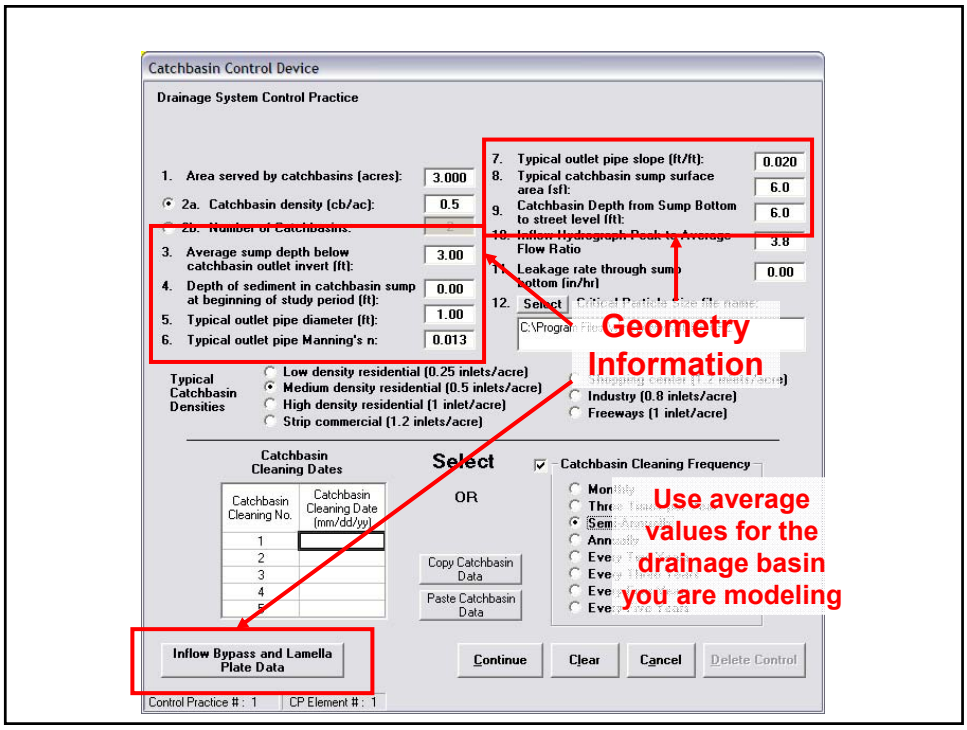
- Are Inlets or Manholes
- Must Contain a Sump
- Are not very useful if streets are also swept
- Are typically applied as drainage controls
- Must be cleaned

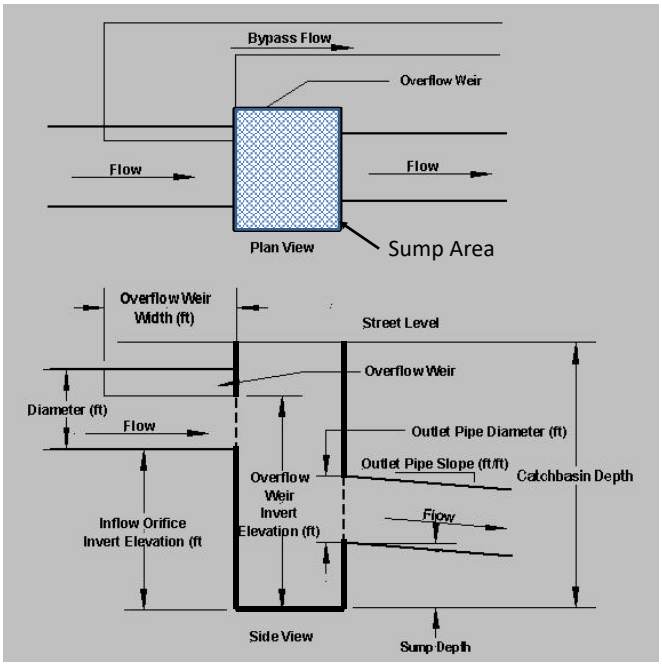



## Four Components to Modeling Catchbasins

1. Device Density
2. Device Geometry
3. Flow and Particle Size Data
4. Device Cleaning Information


Catchbasin Control Device
Drainage System Control Practice
1. Area served by catchbasins (acres): 3.000
2a. Catchbasin density (cb/ac): 0.5
2b. Number of Catchbasins: 2
3. Average sump depth below catchbasin outlet invert (ft): 3.00
4. Depth of sediment in catchbasin sump at beginning of study period (ft): 0.00
5. Typical outlet pipe diameter (ft): 1.00
6. Typical outlet pipe Manning's n: 0.013
7. Typical outlet pipe slope (ft/ft): 0.020
8. Typical catchbasin sump surface area (sf):
9. Catchbasin Depth from Sump Bottom to street level (ft):
10. Inflow Hydrograph Peak to Average Flow Ratio
11. Leakage rate through sump bottom (in/hr) 0.00
12. Select Critical Particle Size file name:
C:\Program Files\WinSLAMM\NURP.CPZ
Catchbasin Density
Typical Catchbasin Densities
Low density residential (0.25 inlets/acre)
Medium density residential (0.5 inlets/acre)
High density residential (1 inlet/acre)
Strip commercial (1.2 inlets/acre)
Shopping center (1.2 inlets/acre)
Industry (0.8 inlets/acre)
Freeways (1 inlet/acre)
Catchbasin Cleaning Dates
Catchbasin Cleaning No.
Catchbasin Cleaning Date (mm/dd/yy)
Select
OR
Copy Catchbasin Data
Paste Catchbasin Data
Catchbasin Cleaning Frequency
Monthly
Three Times per Year
Semi-Annually
Annually
Every Two Years
Every Three Years
Every Four Years
Every Five Years
Inflow Bypass and Lamella Plate Data
Continue
Clear
Cancel
Delete Control
Control Practice # : 1
CP Element # : 1

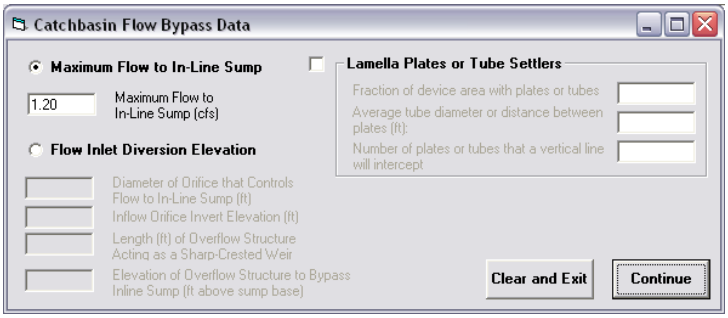

Catchbasin Control Device
Drainage System Control Practice
1. Area served by catchbasins (acres): 3.000
2a. Catchbasin density (cb/ac): 0.5
3. Average sump depth below catchbasin outlet invert (ft): 3.00
4. Depth of sediment in catchbasin sump at beginning of study period (ft): 0.00
5. Typical outlet pipe diameter (ft): 1.00
6. Typical outlet pipe Manning's n: 0.013
7. Typical outlet pipe slope (ft/ft): 0.020
8. Typical catchbasin sump surface area (sf): 6.0
9. Catchbasin Depth from Sump Bottom to street level (ft): 6.0
Flow Ratio 3.8
11. Leakage rate through sump bottom (in/hr) 0.00
Geometry Information
Use average values for the drainage basin you are modeling
Typical Catchbasin Densities
Low density residential (0.25 inlets/acre)
Medium density residential (0.5 inlets/acre)
High density residential (1 inlet/acre)
Strip commercial (1.2 inlets/acre)
Industry (0.8 inlets/acre)
Freeways (1 inlet/acre)
Catchbasin Cleaning Dates
Catchbasin Cleaning No.
Catchbasin Cleaning Date (mm/dd/yy)
Select
OR
Copy Catchbasin Data
Paste Catchbasin Data
Inflow Bypass and Lamella Plate Data
Continue
Clear
Cancel
Delete Control
Control Practice # : 1
CP Element # : 1




# Inflow Bypass Data

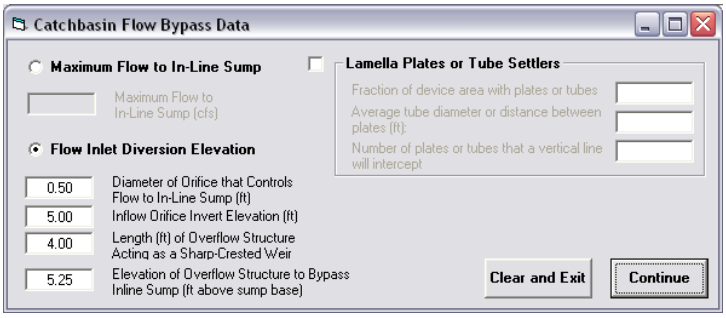
# Inflow Bypass Data

**Two Options – Either**
**User-defined**
**Maximum Flow, or . . .**



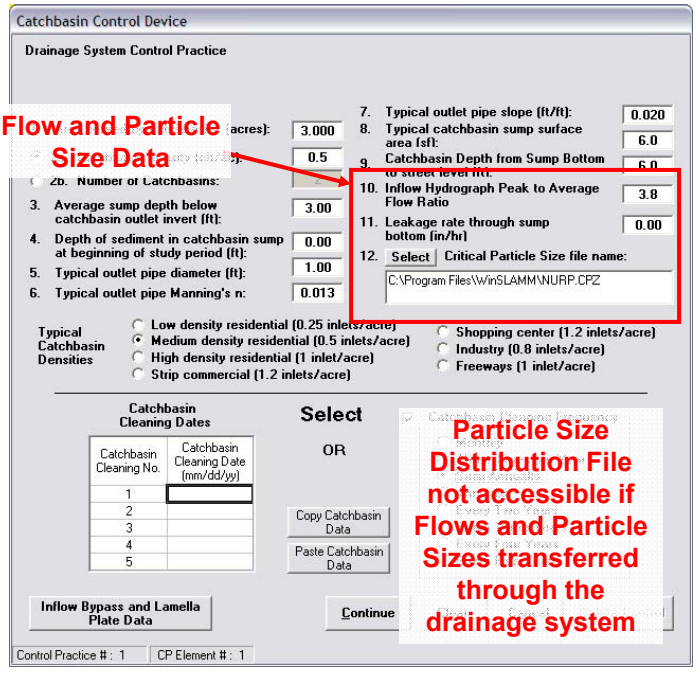
# Inflow Bypass Data

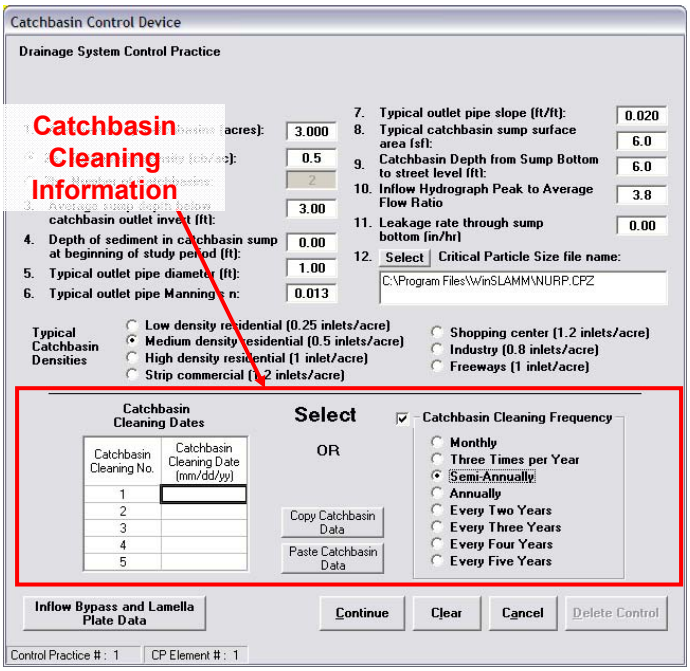
**Defined Flow Diversion Geometry**




**Lamella Plates or Tube Settlers are also an option**

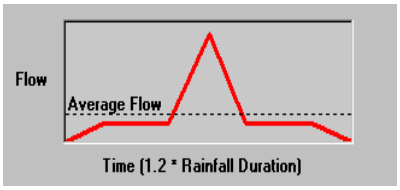
(See Hydrodynamic Device discussion)

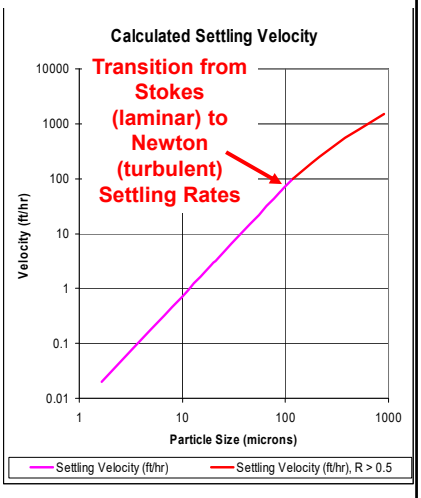





# Catchbasin Performance

- Particulate removal based upon particle size
- Settling modeled as a detention basin assuming:
  - Vertical sides
  - No storage
- Flow rate calculated using Complex Triangular Hydrograph



# Additional Output

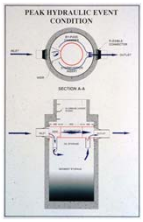
## Catchbasin Performance by Event

| Rain No. | Rain Depth (in) | Runoff Volume per CB (cf) | Maximum Inflow from Basin (cfs) | Time Increment (min) | Maximum Inflow through CB (cfs) | Volume In (cf) | Hydraulic Volume Out (cf) | Seepage Volume Out (cf) | Total Volume Out of CB (cf) | Bypass Volume (cf) | Cumulative Volume Out of CB (cf) | CB Efficiency Reduction | Maximum Inflow Stage | Maximum CB Stage | Weighted Total Solids Reduction (fraction) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.01 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 |
| 2 | 0.06 | 307.3593 | 5.41E-02 | 10 | 5.41E-02 | 312.848 | 312.848 | 0 | 312.848 | 0 | 312.848 | 0 | 0 | 3.07 | 0.1834095 |
| 3 | 0.01 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 312.848 | 0 | 0 | 3 | 1 |
| 4 | 0.02 | 25.168 | 7.38E-03 | 6 | 7.38E-03 | 25.61744 | 25.61744 | 0 | 25.61744 | 0 | 338.4654 | 0 | 0 | 3.02 | 0.353254 |
| 5 | 0.2 | 1430.123 | 0.179711 | 14 | 0.179711 | 1455.661 | 1455.661 | 0 | 1455.661 | 0 | 1794.126 | 0 | 0 | 3.12 | 0.1200792 |
| 6 | 0.01 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1794.126 | 0 | 0 | 3 | 1 |
| 7 | 0.04 | 170.4842 | 2.50E-02 | 12 | 2.50E-02 | 173.5285 | 173.5285 | 0 | 173.5285 | 0 | 1967.655 | 0 | 0 | 3.05 | 0.2404892 |
| 8 | 0.23 | 1670.089 | 0.163229 | 15 | 0.163229 | 1694.667 | 1694.667 | 0 | 1694.667 | 0 | 3662.322 | 0 | 0 | 3.12 | 0.1247973 |
| 9 | 0.19 | 1346.409 | 0.169192 | 14 | 0.169192 | 1370.453 | 1370.453 | 0 | 1370.453 | 0 | 5032.774 | 0 | 0 | 3.12 | 0.1233367 |
| | | | | | | | | | 3642.1 | 0 | 8674.874 | 0 | 0 | 3.14 | 0.103546 |
| | | | | | | | | | 1008.875 | 0 | 9683.749 | 0 | 0 | 3.08 | 0.1605299 |
| | | | | | | | | | 385.6555 | 0 | 10069.4 | 0 | 0 | 3.05 | 0.2257967 |
| | | | | | | | | | 85.35033 | 0 | 10154.75 | 0 | 0 | 3.04 | 0.2659832 |
| | | | | | | | | | 173.5285 | 0 | 10328.28 | 0 | 0 | 3.06 | 0.2102898 |
| | | | | | | | | | 85.35033 | 0 | 10413.63 | 0 | 0 | 3.03 | 0.2855439 |
| | | | | | | | | | 0 | 0 | 10413.63 | 0 | 0 | 3 | 1 |
| | | | | | | | | | 238.8086 | 0 | 10652.44 | 0 | 0 | 3.08 | 0.168602 |
| | | | | | | | | | 85.35033 | 0 | 10737.79 | 0 | 0 | 3.03 | 0.2855439 |
| | | | | | | | | | 25.61744 | 0 | 10763.41 | 0 | 0 | 3.04 | 0.2504332 |
| | | | | | | | | | 395.6464 | 0 | 11159.06 | 0 | 0 | 3.1 | 0.1407803 |
| | | | | | | | | | 25.61744 | 0 | 11184.67 | 0 | 0 | 3.03 | 0.3116934 |
| | | | | | | | | | 25.61744 | 0 | 11210.29 | 0 | 0 | 3.03 | 0.3116934 |
| | | | | | | | | | 25.61744 | 0 | 11235.91 | 0 | 0 | 3.03 | 0.3116934 |
| | | | | | | | | | 25.61744 | 0 | 11261.53 | 0 | 0 | 3.02 | 0.353254 |
| | | | | | | | | | 0 | 0 | 11261.53 | 0 | 0 | 3 | 1 |
| | | | | | | | | | 238.8086 | 0 | 11500.33 | 0 | 0 | 3.09 | 0.1460115 |
| | | | | | | | | | 4716.113 | 0 | 16216.45 | 0 | 0 | 3.22 | 7.04E-02 |
| 28 | 0.01 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 16216.45 | 0 | 0 | 3 | 1 |

Other Output Options

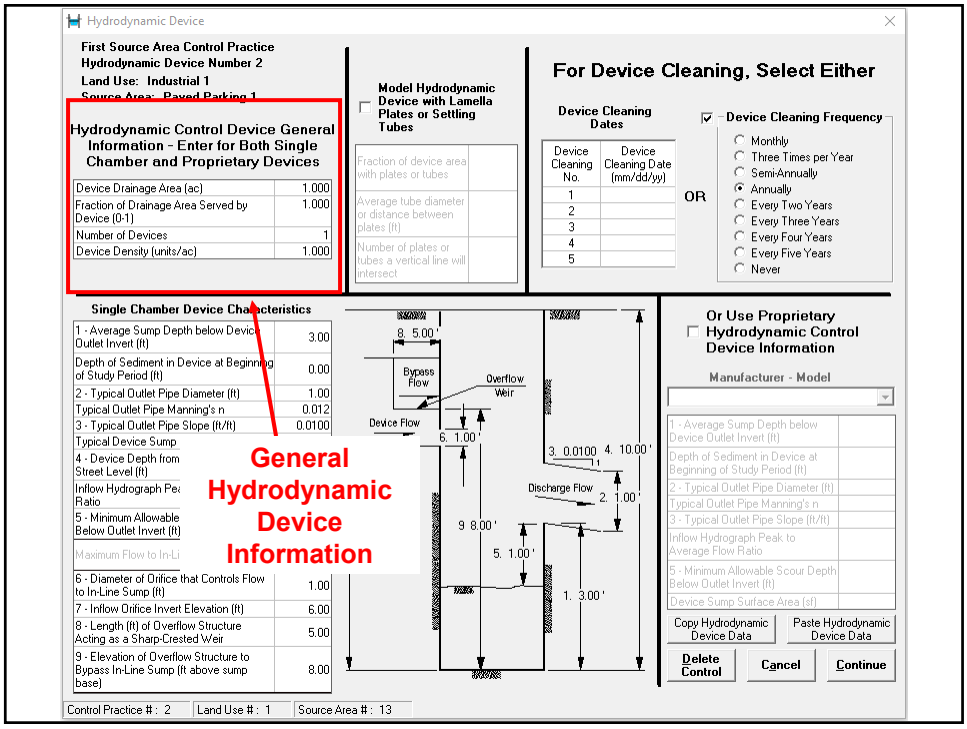
- Stage-outflow data
- Performance by time step
- Stage-inflow data

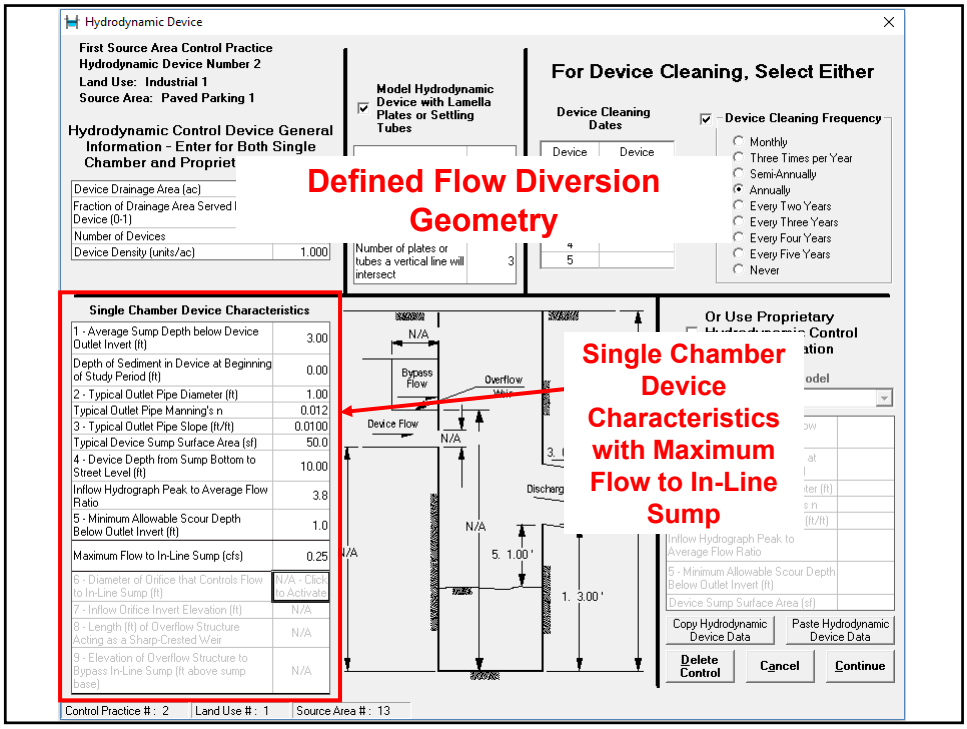
# Hydrodynamic Devices

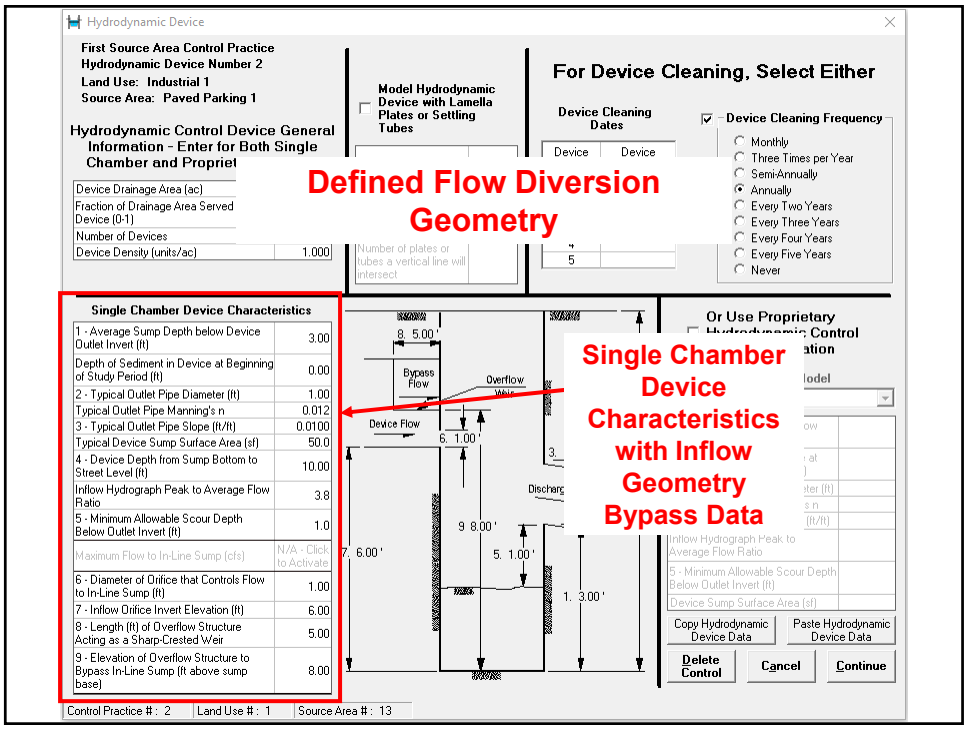


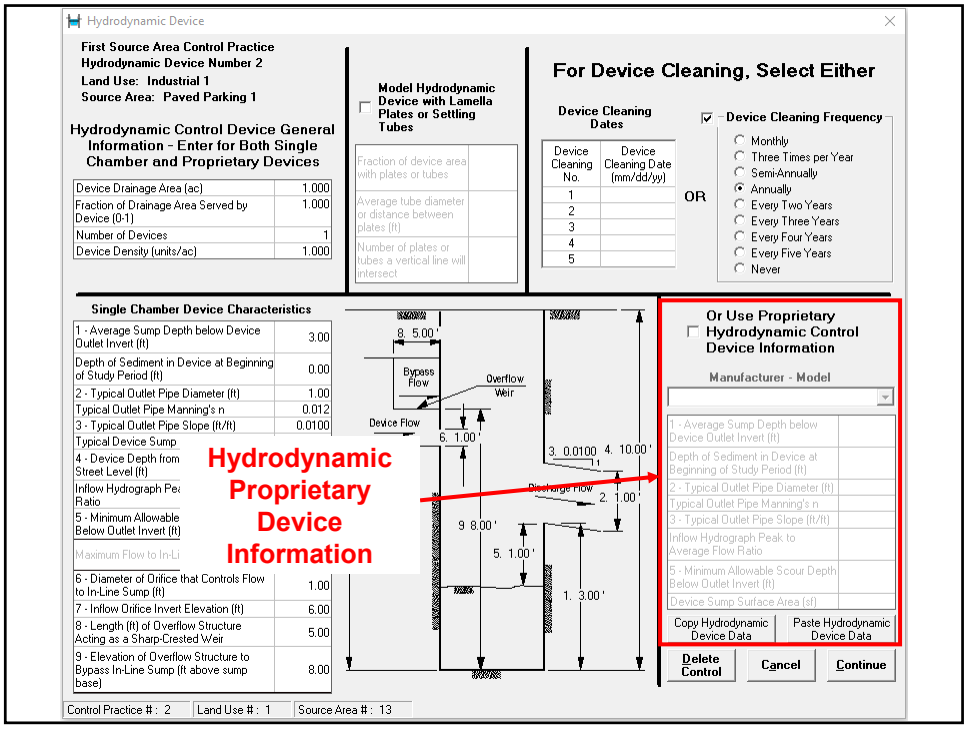

# Research Results

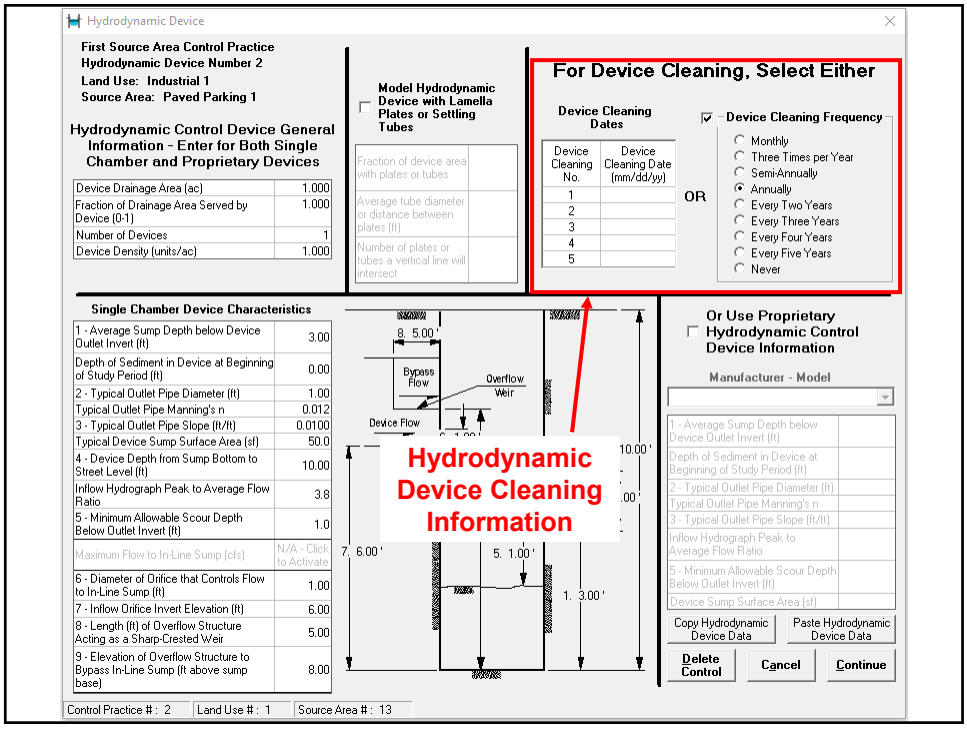
- **Clark (2006) evaluated the performance of inclined plate settlers for treating stormwater solids**
- **Greb, *et al*. (1998) evaluated the performance of a hydrodynamic device in a City of Madison maintenance yard.**

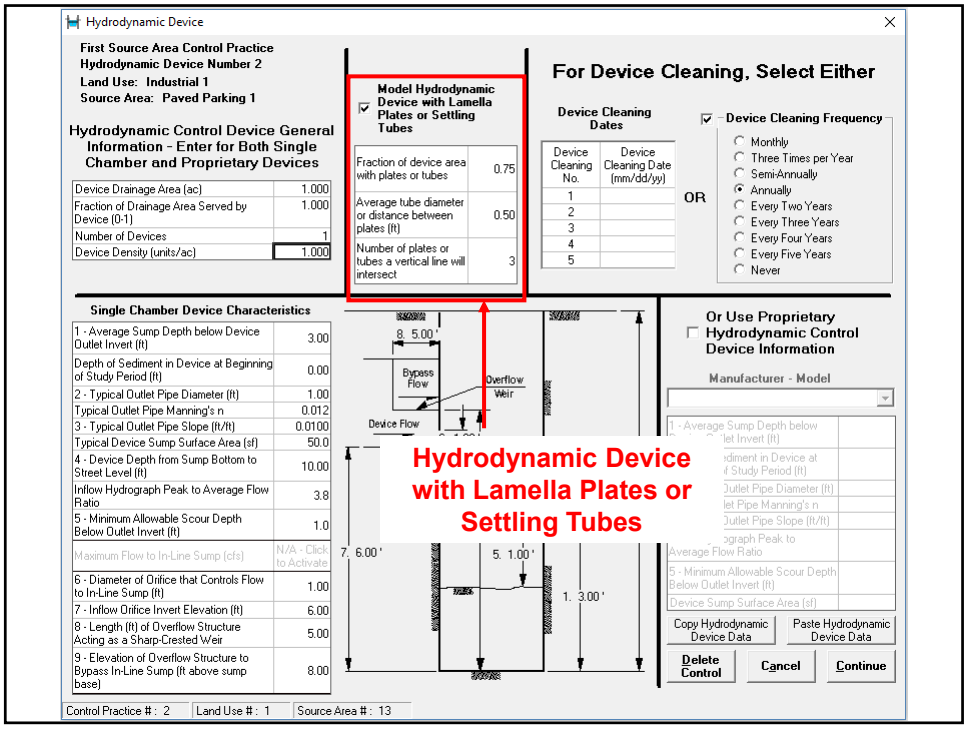



Hydrodynamic Device
First Source Area Control Practice
Hydrodynamic Device Number 2
Land Use: Industrial 1
Source Area: Paved Parking 1
Hydrodynamic Control Device General Information - Enter for Both Single Chamber and Propriet
Model Hydrodynamic Device with Lamella Plates or Settling Tubes
For Device Cleaning, Select Either
Device Cleaning Dates
Device Cleaning Frequency
Monthly
Three Times per Year
Semi-Annually
Annually
Every Two Years
Every Three Years
Every Four Years
Every Five Years
Never
Device Drainage Area (ac)
Fraction of Drainage Area Served I Device (0-1)
Number of Devices
Device Density (units/ac) 1.000
Number of plates or tubes a vertical line will intersect 3
Defined Flow Diversion Geometry
Single Chamber Device Characteristics
1 - Average Sump Depth below Device Outlet Invert (ft) 3.00
Depth of Sediment in Device at Beginning of Study Period (ft) 0.00
2 - Typical Outlet Pipe Diameter (ft) 1.00
Typical Outlet Pipe Manning's n 0.012
3 - Typical Outlet Pipe Slope (ft/ft) 0.0100
Typical Device Sump Surface Area (sf) 50.0
4 - Device Depth from Sump Bottom to Street Level (ft) 10.00
Inflow Hydrograph Peak to Average Flow Ratio 3.8
5 - Minimum Allowable Scour Depth Below Outlet Invert (ft) 1.0
Maximum Flow to In-Line Sump (cfs) 0.25
6 - Diameter of Orifice that Controls Flow to In-Line Sump (ft) N/A - Click to Activate
7 - Inflow Orifice Invert Elevation (ft) N/A
8 - Length (ft) of Overflow Structure Acting as a Sharp-Crested Weir N/A
9 - Elevation of Overflow Structure to Bypass In-Line Sump (ft above sump base) N/A
Single Chamber Device Characteristics with Maximum Flow to In-Line Sump
N/A
Bypass Flow
Overflow
Device Flow
N/A
N/A
5. 1.00 '
1. 3.00 '
Or Use Proprietary
Inflow Hydrograph Peak to Average Flow Ratio
5 - Minimum Allowable Scour Depth Below Outlet Invert (ft)
Device Sump Surface Area (sf)
Copy Hydrodynamic Device Data
Paste Hydrodynamic Device Data
Delete Control
Cancel
Continue
Control Practice # : 2
Land Use # : 1
Source Area # : 13


Hydrodynamic Device
First Source Area Control Practice
Hydrodynamic Device Number 2
Land Use: Industrial 1
Source Area: Paved Parking 1
Hydrodynamic Control Device General Information - Enter for Both Single Chamber and Propriet
Model Hydrodynamic Device with Lamella Plates or Settling Tubes
For Device Cleaning, Select Either
Device Cleaning Dates
Device Cleaning Frequency
Monthly
Three Times per Year
Semi-Annually
Annually
Every Two Years
Every Three Years
Every Four Years
Every Five Years
Never
Device Drainage Area (ac)
Fraction of Drainage Area Served Device (0-1)
Number of Devices
Device Density (units/ac) 1.000
Number of plates or tubes a vertical line will intersect 5
Defined Flow Diversion Geometry
Single Chamber Device Characteristics
1 - Average Sump Depth below Device Outlet Invert (ft) 3.00
Depth of Sediment in Device at Beginning of Study Period (ft) 0.00
2 - Typical Outlet Pipe Diameter (ft) 1.00
Typical Outlet Pipe Manning's n 0.012
3 - Typical Outlet Pipe Slope (ft/ft) 0.0100
Typical Device Sump Surface Area (sf) 50.0
4 - Device Depth from Sump Bottom to Street Level (ft) 10.00
Inflow Hydrograph Peak to Average Flow Ratio 3.8
5 - Minimum Allowable Scour Depth Below Outlet Invert (ft) 1.0
Maximum Flow to In-Line Sump (cfs) N/A - Click to Activate
6 - Diameter of Orifice that Controls Flow to In-Line Sump (ft) 1.00
7 - Inflow Orifice Invert Elevation (ft) 6.00
8 - Length (ft) of Overflow Structure Acting as a Sharp-Crested Weir 5.00
9 - Elevation of Overflow Structure to Bypass In-Line Sump (ft above sump base) 8.00
Single Chamber Device Characteristics with Inflow Geometry Bypass Data
8. 5.00 '
Bypass Flow
Overflow
Device Flow
6. 1.00 '
9 8.00 '
7. 6.00 '
5. 1.00 '
1. 3.00 '
Or Use Proprietary
Inflow Hydrograph Peak to Average Flow Ratio
5 - Minimum Allowable Scour Depth Below Outlet Invert (ft)
Device Sump Surface Area (sf)
Copy Hydrodynamic Device Data
Paste Hydrodynamic Device Data
Delete Control
Cancel
Continue
Control Practice # : 2
Land Use # : 1
Source Area # : 13


Hydrodynamic Device
First Source Area Control Practice
Hydrodynamic Device Number 2
Land Use: Industrial 1
Source Area: Paved Parking 1
Hydrodynamic Control Device General Information - Enter for Both Single Chamber and Proprietary Devices
Device Drainage Area (ac) 1.000
Fraction of Drainage Area Served by Device (0-1) 1.000
Number of Devices 1
Device Density (units/ac) 1.000
Model Hydrodynamic Device with Lamella Plates or Settling Tubes
Fraction of device area with plates or tubes
Average tube diameter or distance between plates (ft)
Number of plates or tubes a vertical line will intersect
For Device Cleaning, Select Either
Device Cleaning Dates
Device Cleaning No.
Device Cleaning Date (mm/dd/yy)
OR
Device Cleaning Frequency
Monthly
Three Times per Year
Semi-Annually
Annually
Every Two Years
Every Three Years
Every Four Years
Every Five Years
Never
Single Chamber Device Characteristics
1 - Average Sump Depth below Device Outlet Invert (ft) 3.00
Depth of Sediment in Device at Beginning of Study Period (ft) 0.00
2 - Typical Outlet Pipe Diameter (ft) 1.00
Typical Outlet Pipe Manning's n 0.012
3 - Typical Outlet Pipe Slope (ft/ft) 0.0100
Typical Device Sump
4 - Device Depth from Street Level (ft)
Inflow Hydrograph Pe Ratio
5 - Minimum Allowable Below Outlet Invert (ft)
Maximum Flow to In-Li
6 - Diameter of Orifice that Controls Flow to In-Line Sump (ft) 1.00
7 - Inflow Orifice Invert Elevation (ft) 6.00
8 - Length (ft) of Overflow Structure Acting as a Sharp-Crested Weir 5.00
9 - Elevation of Overflow Structure to Bypass In-Line Sump (ft above sump base) 8.00
Hydrodynamic Proprietary Device Information
Or Use Proprietary Hydrodynamic Control Device Information
Manufacturer - Model
1 - Average Sump Depth below Device Outlet Invert (ft)
Depth of Sediment in Device at Beginning of Study Period (ft)
2 - Typical Outlet Pipe Diameter (ft)
Typical Outlet Pipe Manning's n
3 - Typical Outlet Pipe Slope (ft/ft)
Inflow Hydrograph Peak to Average Flow Ratio
5 - Minimum Allowable Scour Depth Below Outlet Invert (ft)
Device Sump Surface Area (sf)
Copy Hydrodynamic Device Data
Paste Hydrodynamic Device Data
Delete Control
Cancel
Continue
Control Practice # : 2
Land Use # : 1
Source Area # : 13


Hydrodynamic Device
First Source Area Control Practice
Hydrodynamic Device Number 2
Land Use: Industrial 1
Source Area: Paved Parking 1
Hydrodynamic Control Device General Information - Enter for Both Single Chamber and Proprietary Devices
Device Drainage Area (ac) 1.000
Fraction of Drainage Area Served by Device (0-1) 1.000
Number of Devices 1
Device Density (units/ac) 1.000
Model Hydrodynamic Device with Lamella Plates or Settling Tubes
For Device Cleaning, Select Either
Device Cleaning Dates
Device Cleaning No.
Device Cleaning Date (mm/dd/yy)
OR
Device Cleaning Frequency
Monthly
Three Times per Year
Semi-Annually
Annually
Every Two Years
Every Three Years
Every Four Years
Every Five Years
Never
Single Chamber Device Characteristics
1 - Average Sump Depth below Device Outlet Invert (ft) 3.00
Depth of Sediment in Device at Beginning of Study Period (ft) 0.00
2 - Typical Outlet Pipe Diameter (ft) 1.00
Typical Outlet Pipe Manning's n 0.012
3 - Typical Outlet Pipe Slope (ft/ft) 0.0100
Typical Device Sump Surface Area (sf) 50.0
4 - Device Depth from Sump Bottom to Street Level (ft) 10.00
Inflow Hydrograph Peak to Average Flow Ratio 3.8
5 - Minimum Allowable Scour Depth Below Outlet Invert (ft) 1.0
Maximum Flow to In-Line Sump (cfs) N/A - Click to Activate
6 - Diameter of Orifice that Controls Flow to In-Line Sump (ft) 1.00
7 - Inflow Orifice Invert Elevation (ft) 6.00
8 - Length (ft) of Overflow Structure Acting as a Sharp-Crested Weir 5.00
9 - Elevation of Overflow Structure to Bypass In-Line Sump (ft above sump base) 8.00
Hydrodynamic Device Cleaning Information
Or Use Proprietary Hydrodynamic Control Device Information
Manufacturer - Model
Copy Hydrodynamic Device Data
Paste Hydrodynamic Device Data
Delete Control
Cancel
Continue
Control Practice # : 2
Land Use # : 1
Source Area # : 13

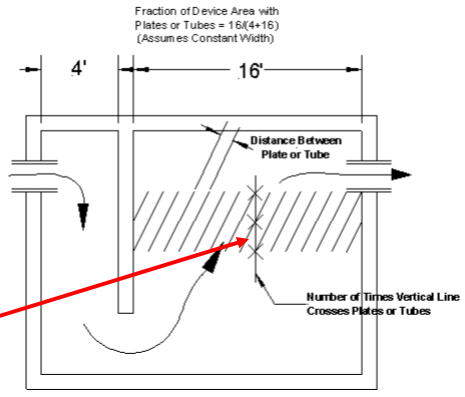



# What are Lamella Plates?

**Key Variables**

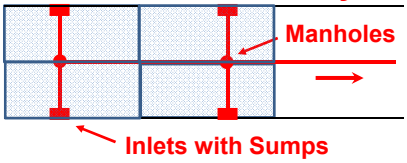
- **Fraction of device area with plates or tubes**
- **Average tube diameter or distance between plates**
- **Number of plates or tubes in a vertical line**

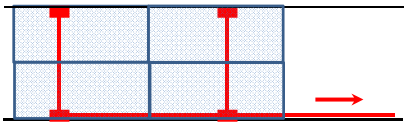
**Increase the effective surface area of the device by the number of times a vertical line crosses a plate or tube**



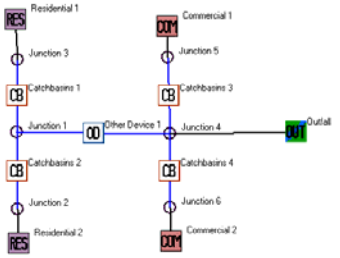
# Effect of Drainage System Configuration

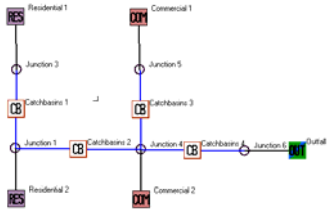
**Parallel Collection System**



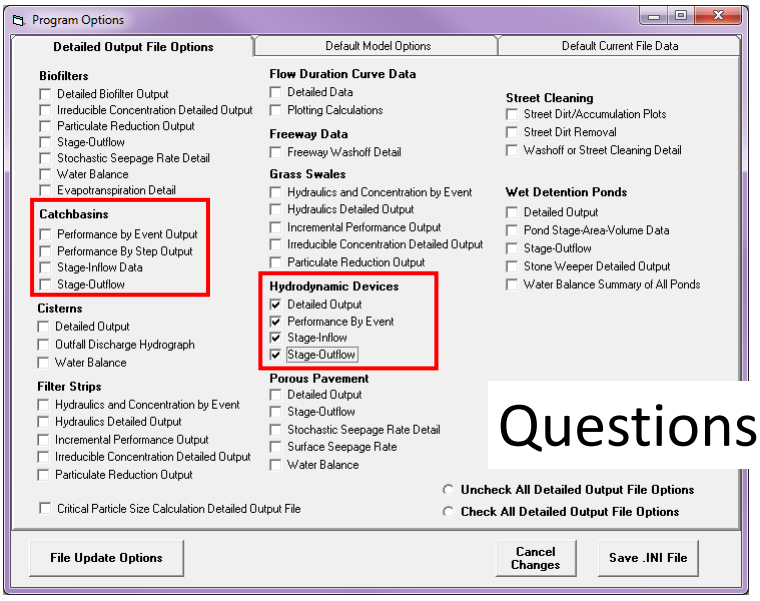
**Series Collection System**



| Collection System | # CBs | % TSS Reduction |
|---|---|---|
| Parallel | 11 | 11.16% |
| Series | 11 | 8.91% |

# Detailed Output Options




Questions?