**Comparison of Minnesota and NJCAT**
**TSS Removal Testing**

New Jersey Center for Advanced Technology (NJCAT) and Minnesota Department of Transportation (MnDOT) both have tested multiple proprietary hydrodynamic separators to determine their effectiveness to remove total suspended solids (TSS) from stormwater runoff. Each one used a different approach to test multiple proprietary hydrodynamic separators.

- NJCAT tests each device to meet a regulatory requirement of 50% TSS removal. The result is a table with the maximum flow for approved models of a given device, that will result in 50% TSS removal.

- MnDOT tests each device to plot a curve that is used to calculate TSS removal for any flow, pipe size, pipe slope, and device size (diameter of structure and depth of sump). The result is a predictive model that can be used to correctly size the device to meet the required TSS removal.

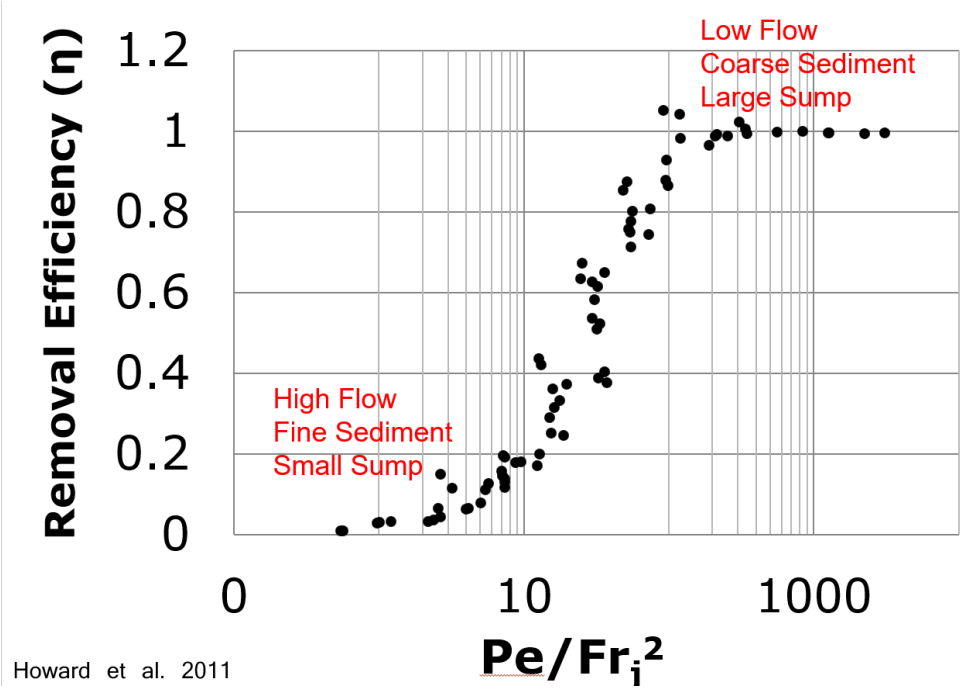
To create the TSS removal curve, MnDOT ran a minimum of 60 tests on each device. Sediment was tested one particle size at a time, with a wide range of particle sizes being tested. Other factors such as structure diameter, sump depth, pipe diameter, and flow were also varied from test to test, until enough data was collected to fit a curve to the data.

The data was plotted with $Pe/Fr_j^2$ on the x-axis and TSS removal efficiency on the y-axis.

- TSS removal efficiency is the result of each test (empirical).
- $Pe/Fr_j^2$ is calculated based on how each test is set up.

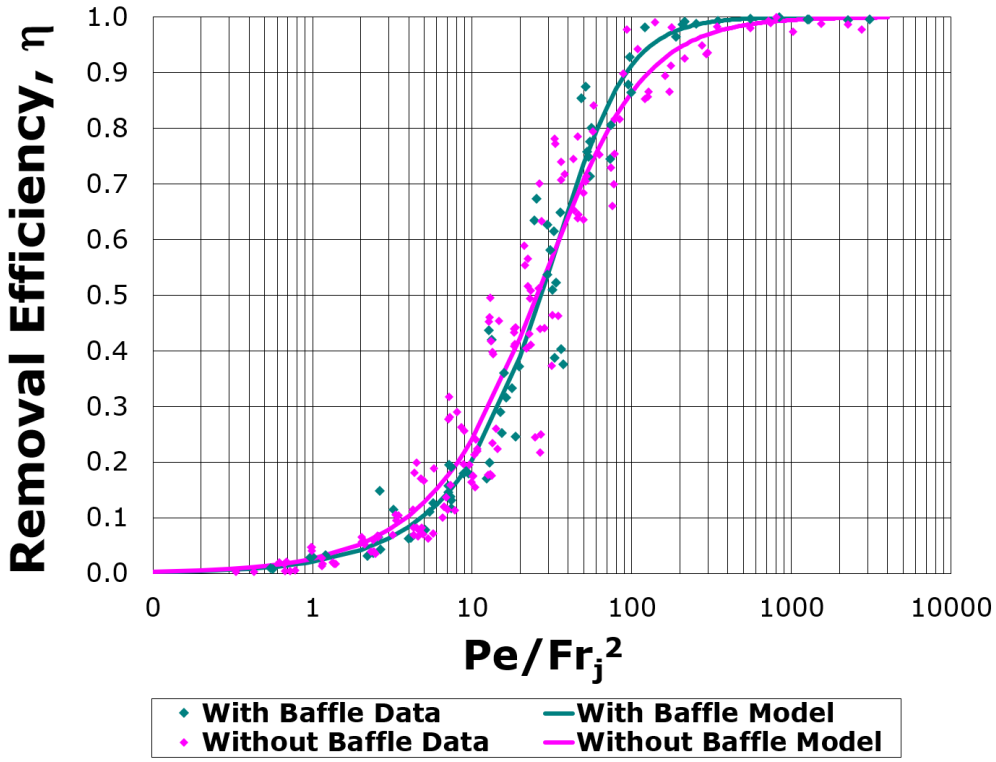
| $Pe = (V_s \times h \times d)/Q$ | $Fr_j = [v/(g \times h_m)^{1/2}]$ |
|---|---|
| Pe = Peclet number | Fr = Froude number |
| $V_s$ = particle settling velocity | v = flow velocity through structure |
| h = depth of sump below lowest pipe invert | $h_m$ = hydraulic mean depth of inlet pipe |
| d = diameter of sump structure | g = acceleration of gravity |
| Q = flow through structure | |

Here is the data plot for the SAFL Baffle:

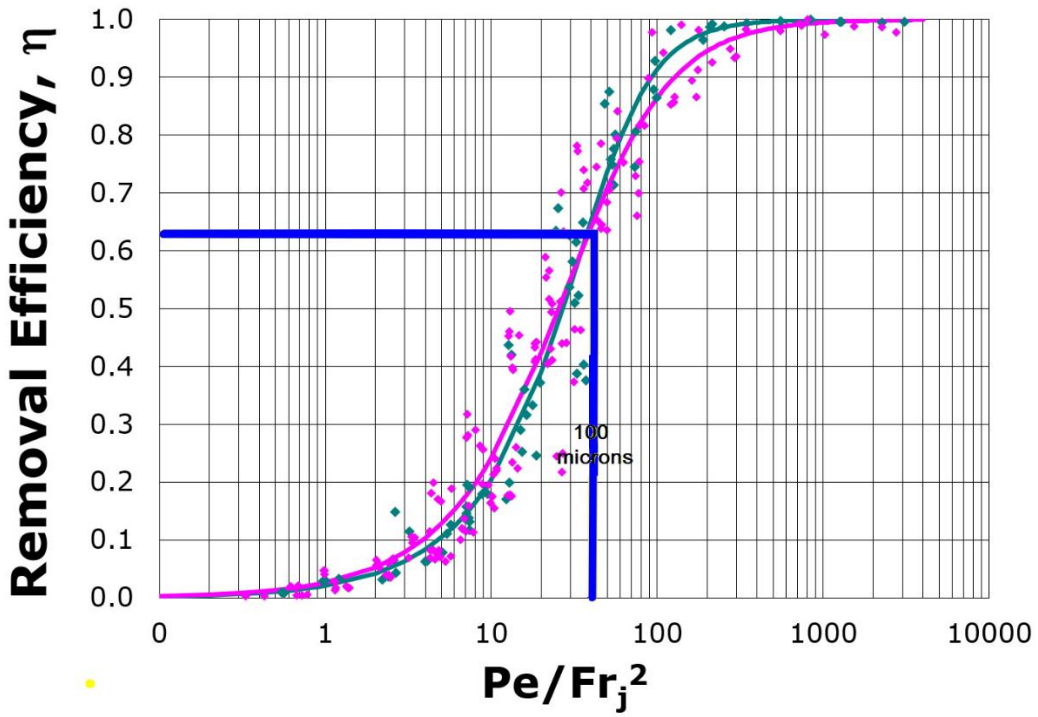



Howard et al. 2011

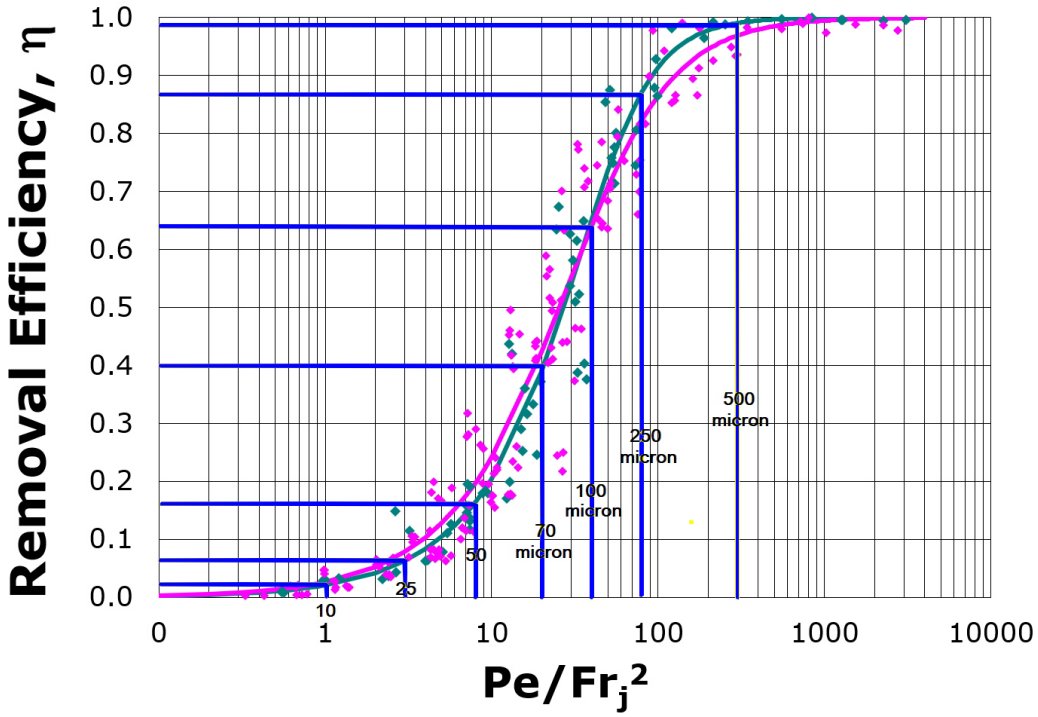
The data points all fall along an "S" shape, allowing a curve to be fit through the data. Here is the curve for the SAFL Baffle, in blue:



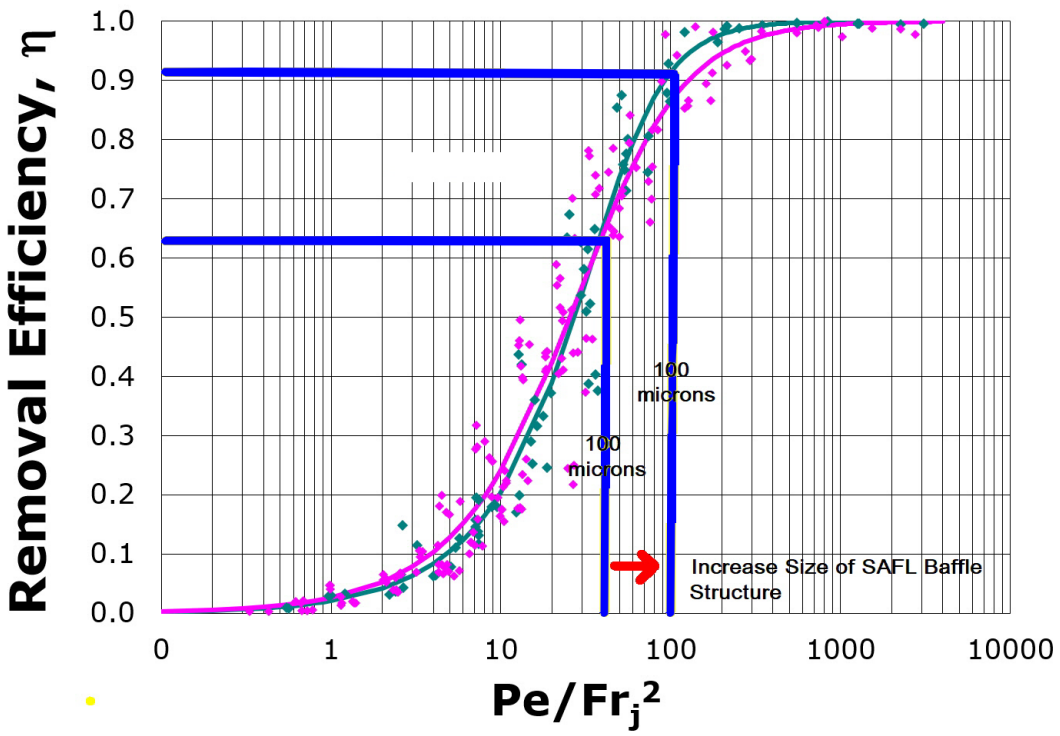

We can determine the TSS removal percentage for any particle size, for a given flow, structure diameter, sump depth, inlet pipe diameter, and inlet pipe slope.




To determine TSS removal across a distribution of particle sizes, the removal of each particle size is determined from the curve.



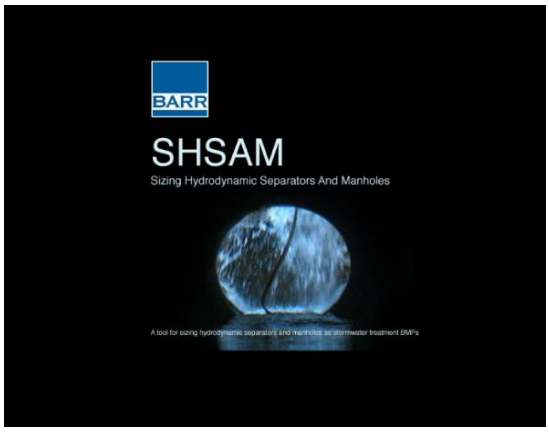

The TSS removals of the particle sizes are added together to determine an overall TSS removal percentage. If the TSS removal is too low, choose a larger structure, deeper sump, and/or larger pipe diameter to increase TSS removal. This will increase the value of $Pe/Fr_j^2$ and shift the results to the right along the curve.




Each hydrodynamic separator has an "S" curve like the SAFL Baffle, with some shifted left and some shifted right of the SAFL Baffle curve.

Barr Engineering developed software to automate the calculations for TSS removal, using this curve. The software includes the data (curve) from Baysaver, CDS, Downstream Defender, Environment 21, SciClone X, standard sumps, SAFL Baffle, Stormceptor, and Vortechs System.

https://shsam.barr.com/




**SHSAM** Software
(Sizing Hydrodynamic Separators and Manholes)