The Value of Historical Stormwater Particulate Data and Suggestions for Monitoring

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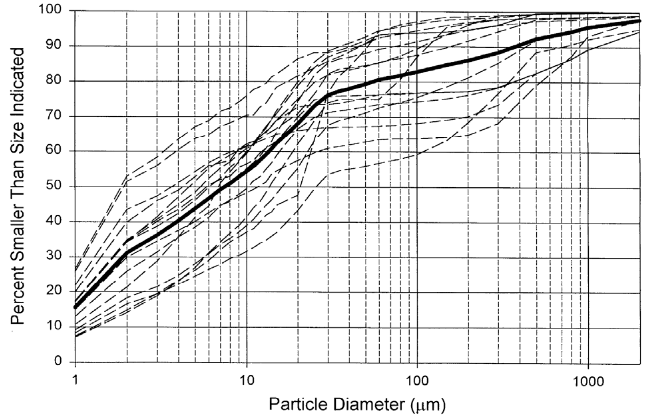
Measured Particle Sizes, Including Bed Load Component, at influent to the Monroe St. Detention Pond, Madison, WI



Very few of the large particles that enter the drainage systems are transported to the outfalls in typical urban drainage systems. Most (about 85% in this typical example) of the outfall particulates discharged are less than 100 μm in size. 2

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TSS vs. SSC and PSD Relationships

Two separate issues:

- sampling to obtain representative water samples with all particulates of interest, and
- laboratory processing to represent all particulates.

Most problems result in loss of large particles. The combination of methods used affects modeling approach, especially particle size distributions and confusion between TSS and SSC. 3

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Sampling Effects on Particulate Solids Characteristics

- Sampling issues associated with stratified flows and bedload.
  - Sampler intakes on bottom of pipe may collect more bedload than represented in well-mixed sample, and
  - sampler tube velocity may not be able to transport large particles to sample bottles

  These are two opposite problems that seldom cancel each other out nicely.

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Results of Verification Monitoring of a Hydrodynamic Device by WI DNR and USGS (Madison, WI)

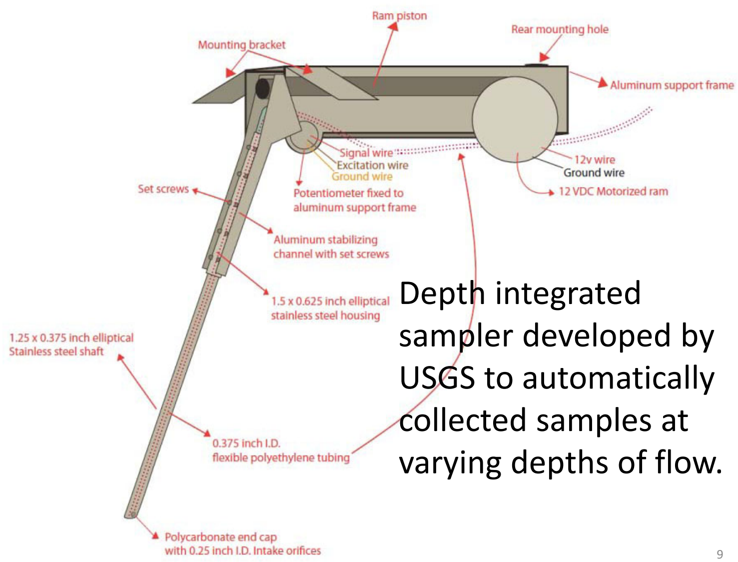
Sampled solids load in	**1623 kg**
Sampled solids load out	**1218 kg**
Trapped by difference	**405 kg (25% removal)**
Actual trapped total sediment (by direct measurement)	**536 kg (33% actual removal)**
Fraction total solids not captured by automatic samplers	**8% (131 kg missed by sampler, out of 1623 kg in sampler)**

Standard automatic water samplers with single intakes at bottom of pipes. Influent samplers are affected by large particles while effluent samplers should not be, assuming most any stormwater control is capable of removing the larger particles that stress the samplers.

Bed load in storm drainage compromised about 4% of Madison area total solids discharges (WI DNR and USGS) monitoring).

Bedload in corrugated stormdrain and mound of settleable material at discharge into wet detention pond after many years of operation at ski resort at Snowmass, CO (drain from several acre resort parking area having sand applications for traction control).

Simple methods to obtain representative sample: create cascading and well-mixed flow at sampling location (well-mixed flow with bedload and no stratification). Examples shown for gutter and pipe flow installations.



Depth integrated sampler developed by USGS to automatically collected samples at varying depths of flow.

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Comparison of Three TSS/SSC Analytical Methods

EPA TSS 160.2	Standard Methods TSS 2540D	ASTM SSC D3977-97B
Shake sample bottle vigorously then pour aliquot into graduated cylinder	Use stir plate and pipet at mid-depth in bottle and midway between wall and vortex	Use entire sample and pour from original bottle

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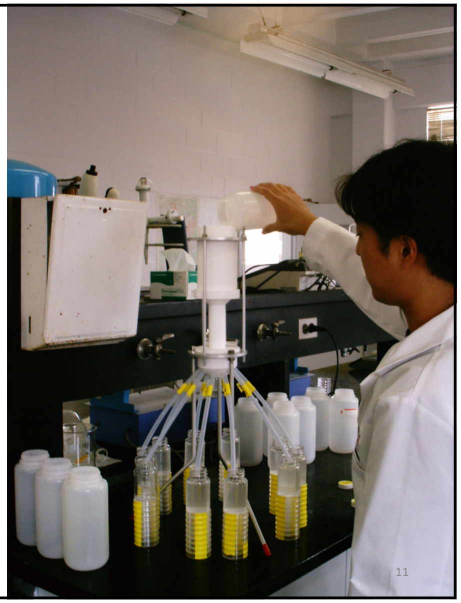
USGS/Dekaport cone splitter used to separate sample into smaller volumes for different analyses.



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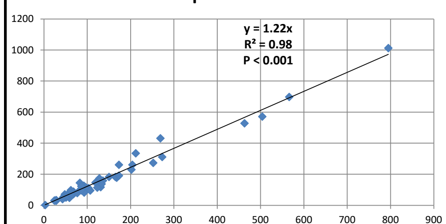
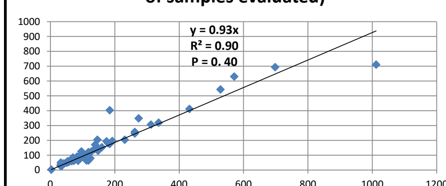
TSS (shake and pour vs. stir and pipette)
Significant difference: 22% bias, shake and pour low



stir and pipette TSS vs. SSC
no significant difference (for the number of samples evaluated)



shake and pour vs. stir and pipette
t-Test: Paired Two Sample for Means

	Shake and Pour	Stir and Pipette
Mean	133	160
Variance	19818	31015
Observations	59	59
Pearson Correlation	0.99	
Hypothesized Mean Difference	0	
df	58	
t Stat	-4.99	
P(T<=t) one-tail	2.92E-06	

Results of parallel tests using 59 stormwater samples

stir and pipette TSS vs. SSC
t-Test: Paired Two Sample for Means

	Stir and Pipette	SSC cone splitter
Mean	160	158
Variance	31015	26095
Observations	59	59
Pearson Correlation	0.95	
Hypothesized Mean Difference	0	
df	58	
t Stat	0.27	
P(T<=t) one-tail	0.40	

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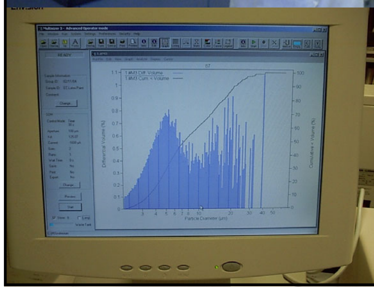

Coulter Counter Multi-Sizer 3 used to measure particle size distribution of solids up to several hundred micrometers. Larger particles (up to several mm) are quantified using sieves.

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Pre-sieving a sample with 106 micrometer sieve (before use of 140 micrometer aperture tube)

Large particles (sands) are captured in 106 micrometer sieve

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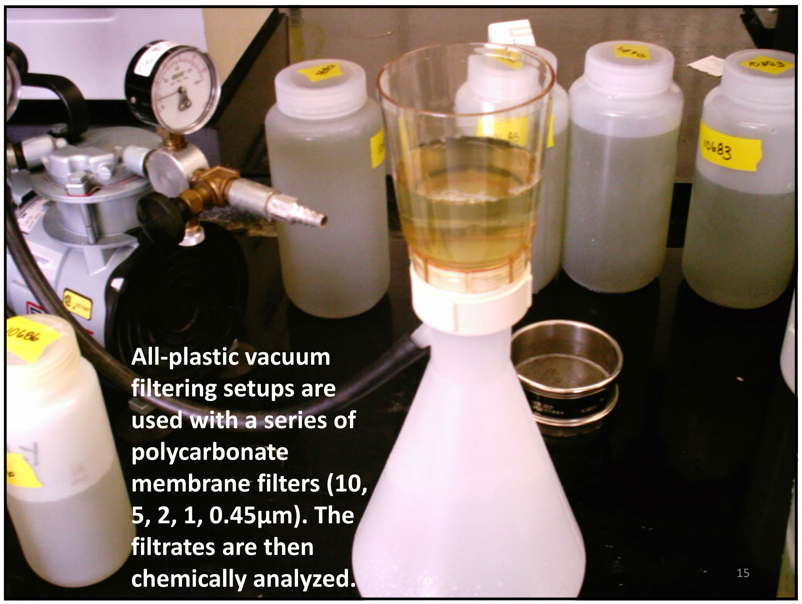

All-plastic vacuum filtering setups are used with a series of polycarbonate membrane filters (10, 5, 2, 1, 0.45µm). The filtrates are then chemically analyzed.

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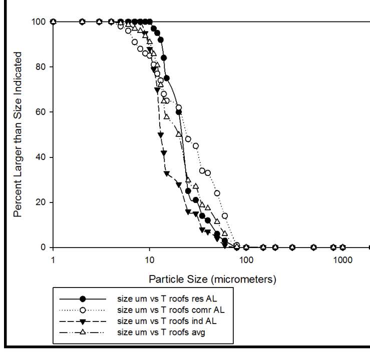
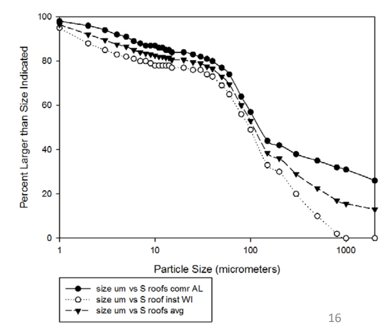
Roof runoff particle size distributions (for TSS shake and pour on left and for TSS stir and pipette and SSC on right)





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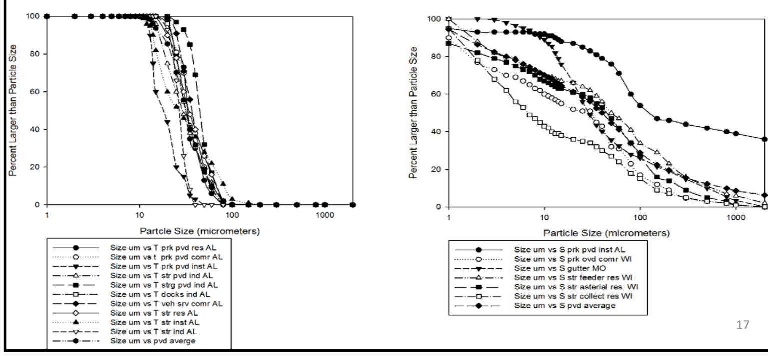
Paved parking, storage, loading dock, vehicle service area, and street runoff particle size distributions (for shake and pour TSS on left and for stir and pipette TSS and SSC on right)



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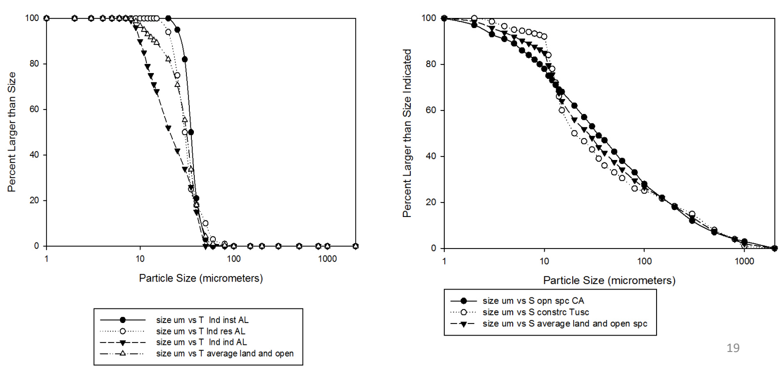
Landscaped, open space, and construction site runoff particle size distributions (for shake and pour TSS on left and for stir and pipette TSS and SSC on right)



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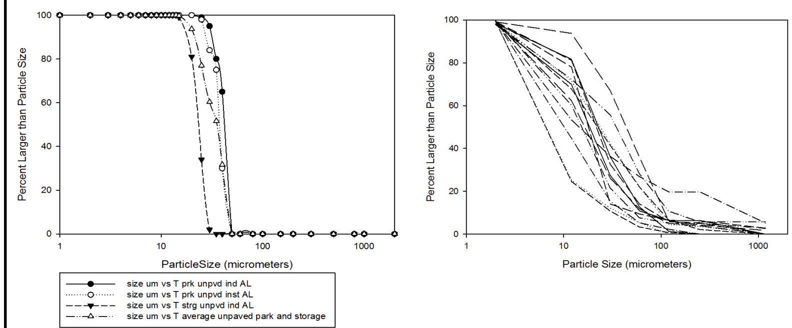
Non-paved parking and storage area runoff particle size distributions (for shake and pour TSS on left; SSC on right)



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Conclusions

- The largest particles found in sheetflows from source areas are preferentially deposited along the flow paths and drainage system.
- Shake and pour TSS methods do not measure these large particles, while stir and pipette TSS and SSC methods do include these particles.
- Most outfall particle size distributions lack these large particles, and different TSS or SSC methods do not result in significant PSD differences at the outfalls.
- "Short" drainage systems that do not retain the large particulates do result in different particle size distributions if different methods are used.
- Appropriate PSDs must be matched with the correct TSS or SSC values with modeling stormwater particulates.

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