erformance of Stormwater Practices in Cold Climate

Thomas P. Ballestero, Robert M. Roseen, Alison Watts, James J. Houle,
Pedro Avellaneda, Robert Wildey, and Joshua Briggs

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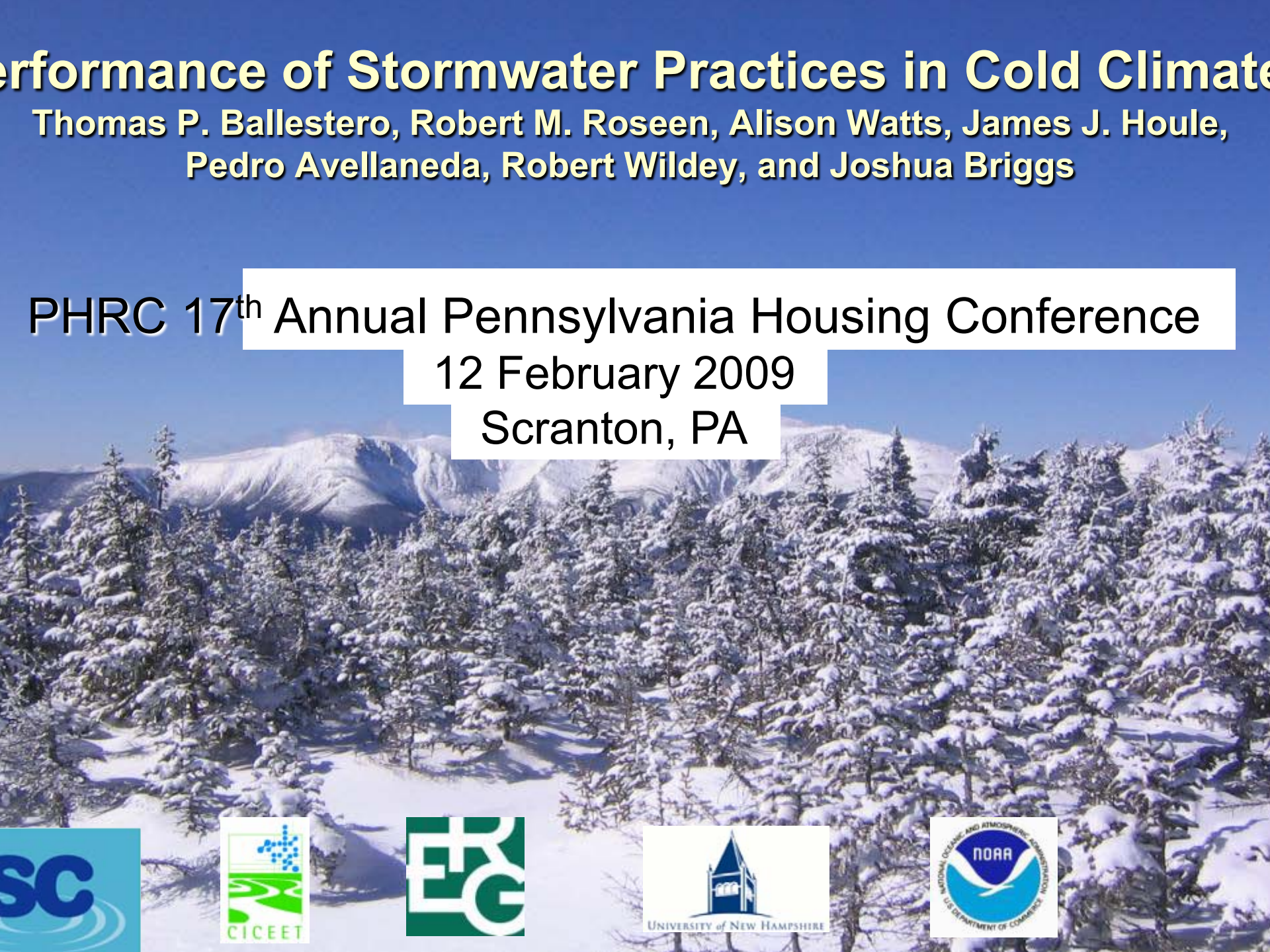

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UNIVERSITY OF NEW HAMPSHIRE STORMWATER CENTER

KEY COLD CLIMATE ISSUES

- Hydrology of melt
- Snow storage, removal, and snow melt
- Reduced or No Infiltration Capacity resulting in increased surface runoff
- Frost related damage (heaving)
- Chloride (Secondary Drinking Water Standard but toxic)

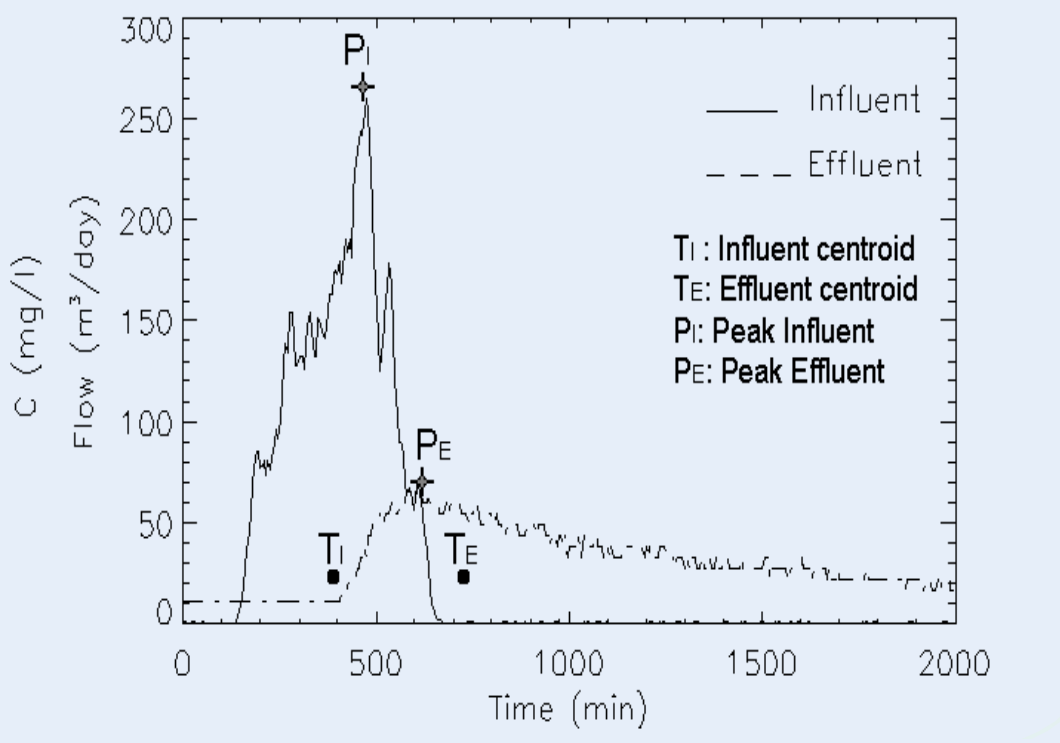
Hydraulic Efficiency

Equation 1: Peak reduction coefficient

$$= \frac{\qquad}{\qquad} \leq$$

Equation 2: Lag coefficient

$$= \frac{\qquad}{\qquad} \geq$$



Hydraulic Efficiency

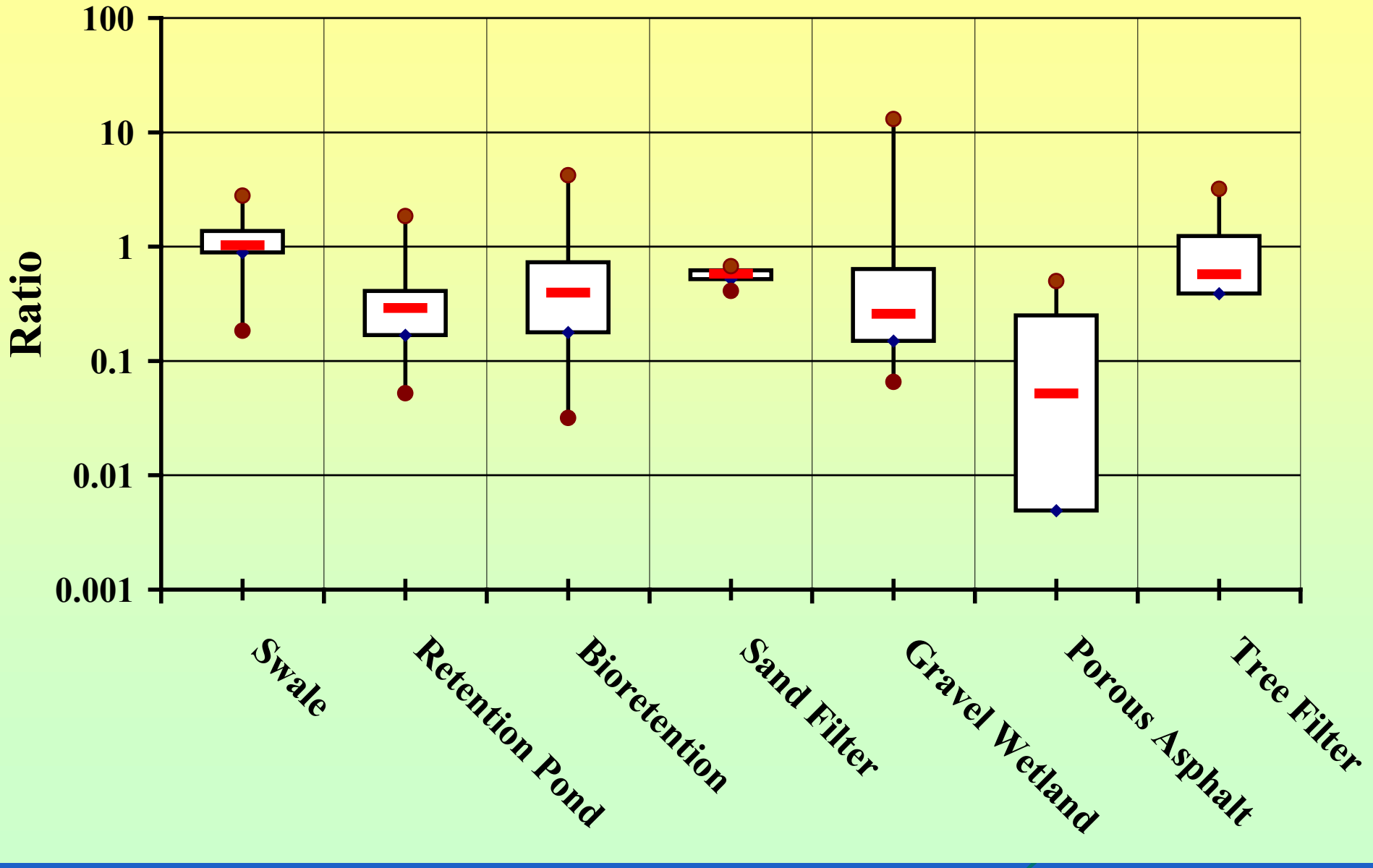
Annual and Seasonal lag (k_L) and delay (k_P) coefficients

Device		Annual	winter(6)	summer(6)
Subsurface Infiltration	Kl	1.60	1.68	1.46
	Kp	0.17	0.17	0.16
Surface Sand Filter	Kl	1.47	1.56	1.27
	Kp	0.40	0.45	0.29
Retention Pond	Kl	2.02	2.11	1.77
	Kp	0.15	0.16	0.11
Bioretention	Kl	2.16	2.27	1.81
	Kp	0.15	0.18	0.06
Gravel Wetland	Kl	1.58	1.56	1.61
	Kp	0.15	0.16	0.14
Stone-Lined Swale	Kl	1.02	1.00	1.25
	Kp	1.03	1.13	0.79

MIN IMPACT

GREATEST IMPACT

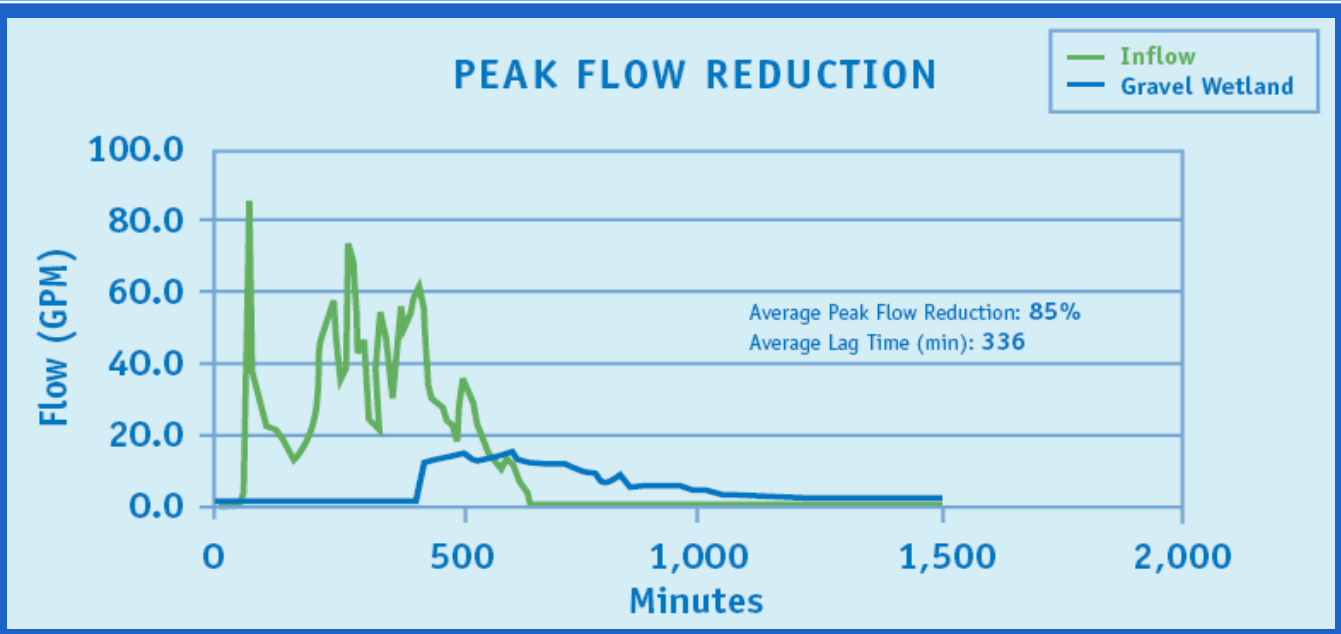
Outflow Peak to Inflow Peak Ratios

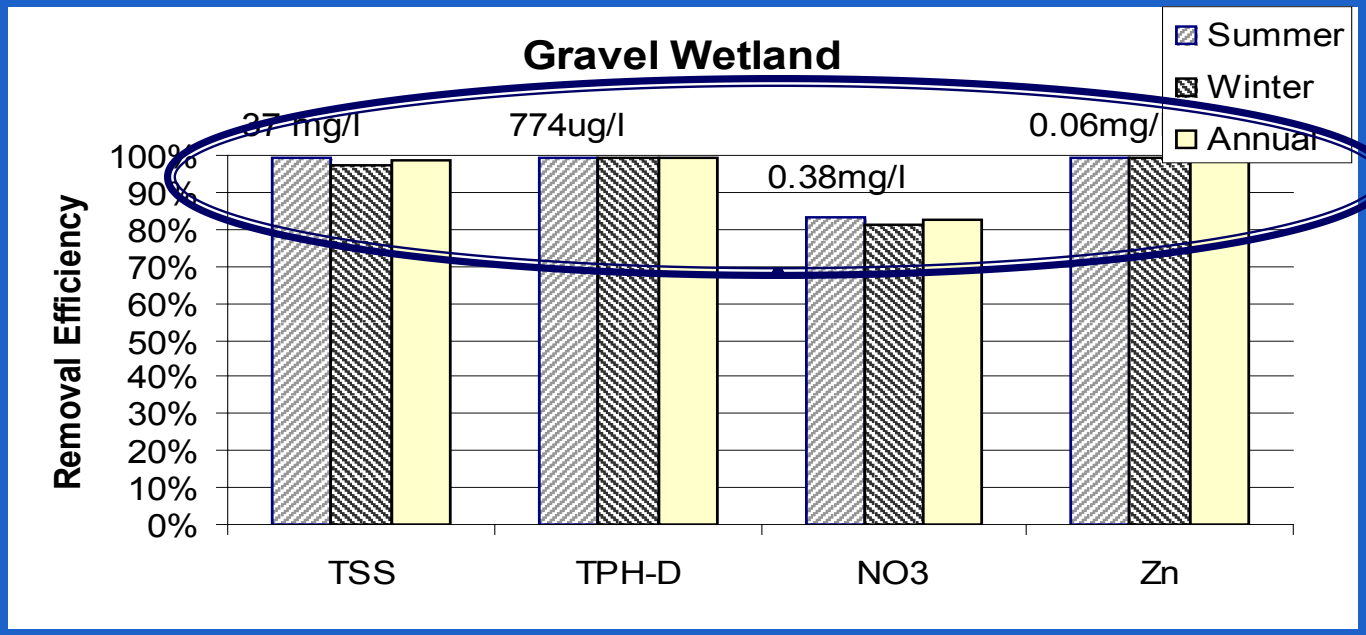


Statistical Summary - Peak Ratios

- Porous asphalt is superior
- Retention pond, bioretention, and gravel wetland have similar performances
- Sand filter and tree filter modest
- Swale virtually no peak reduction

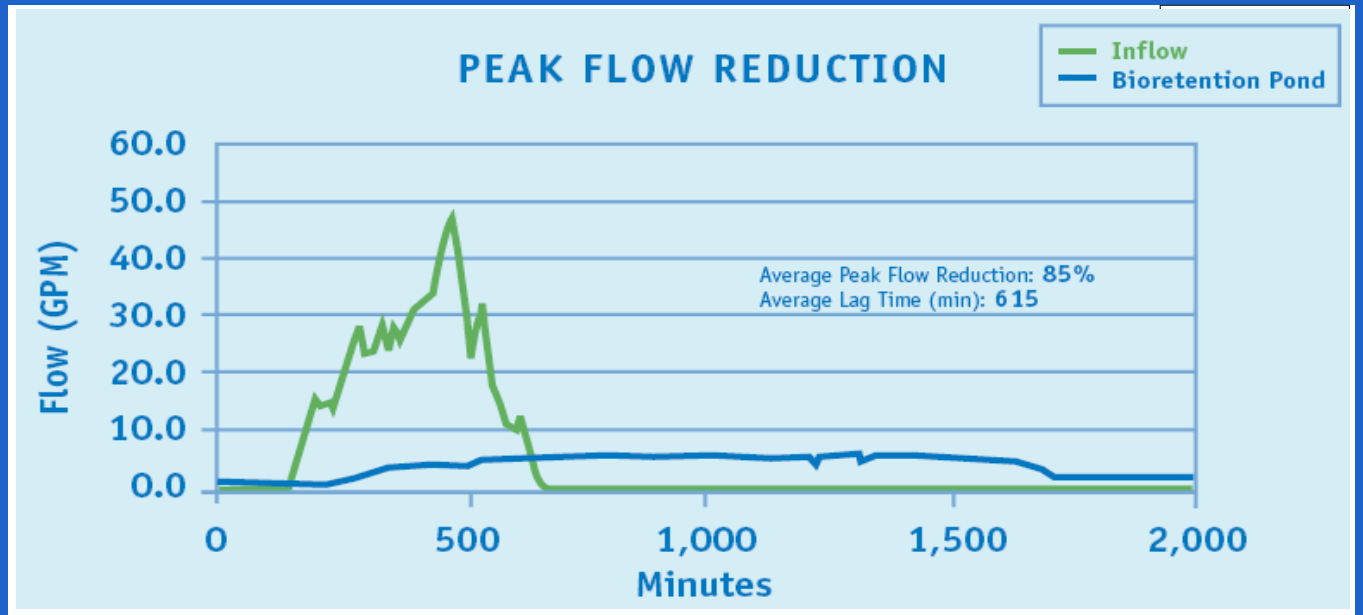
Performance

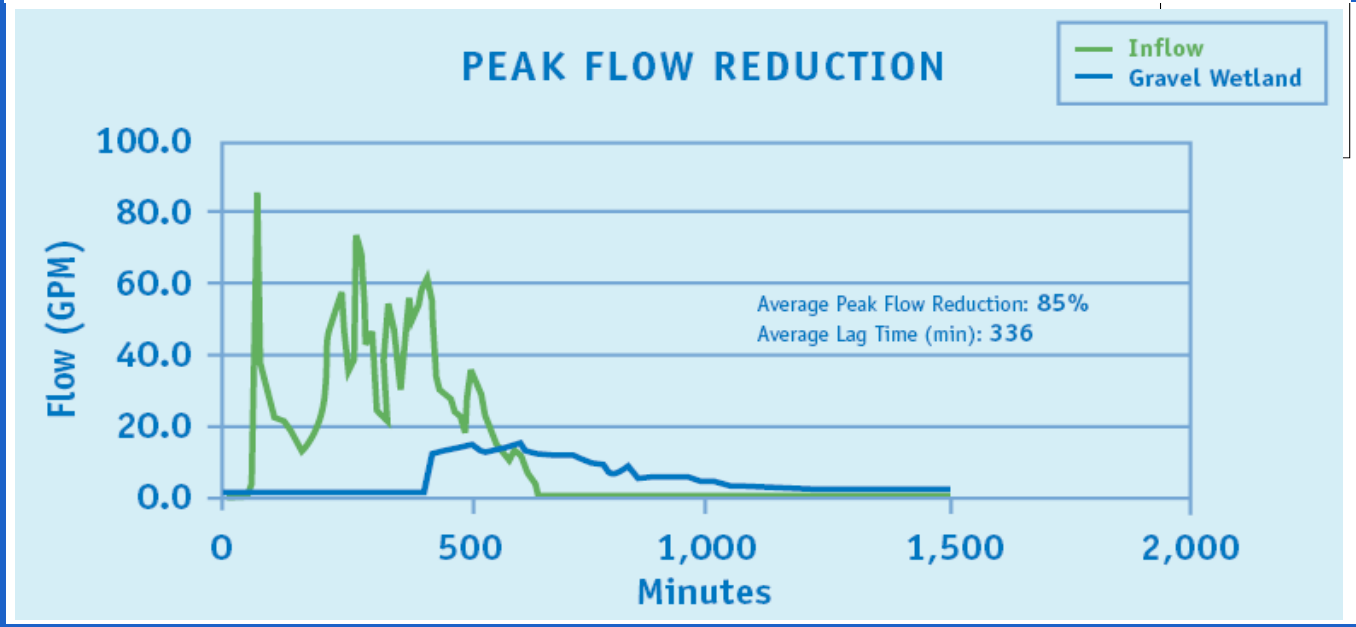




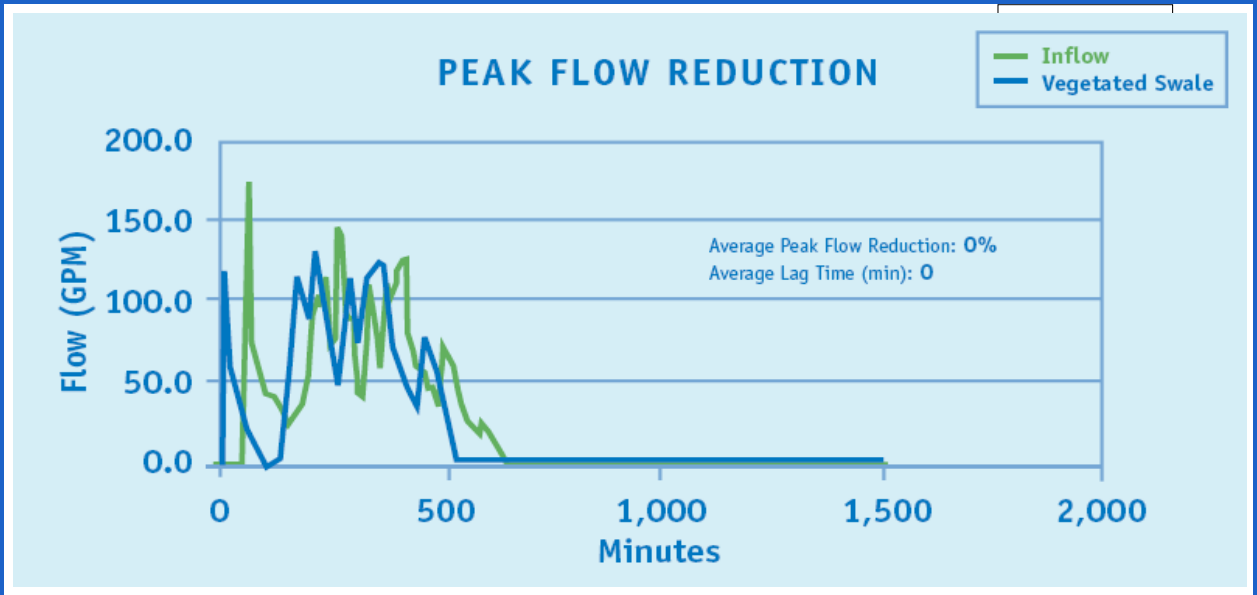
No significant seasonal performance characteristics

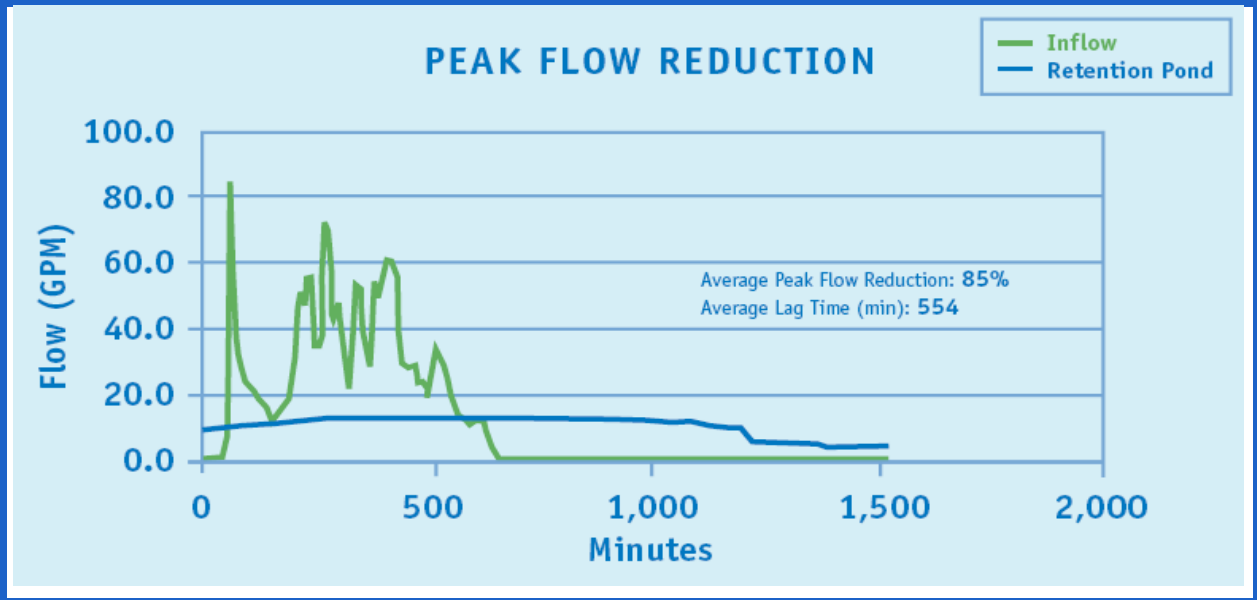
Performance Efficiencies –Filtration/Infiltration



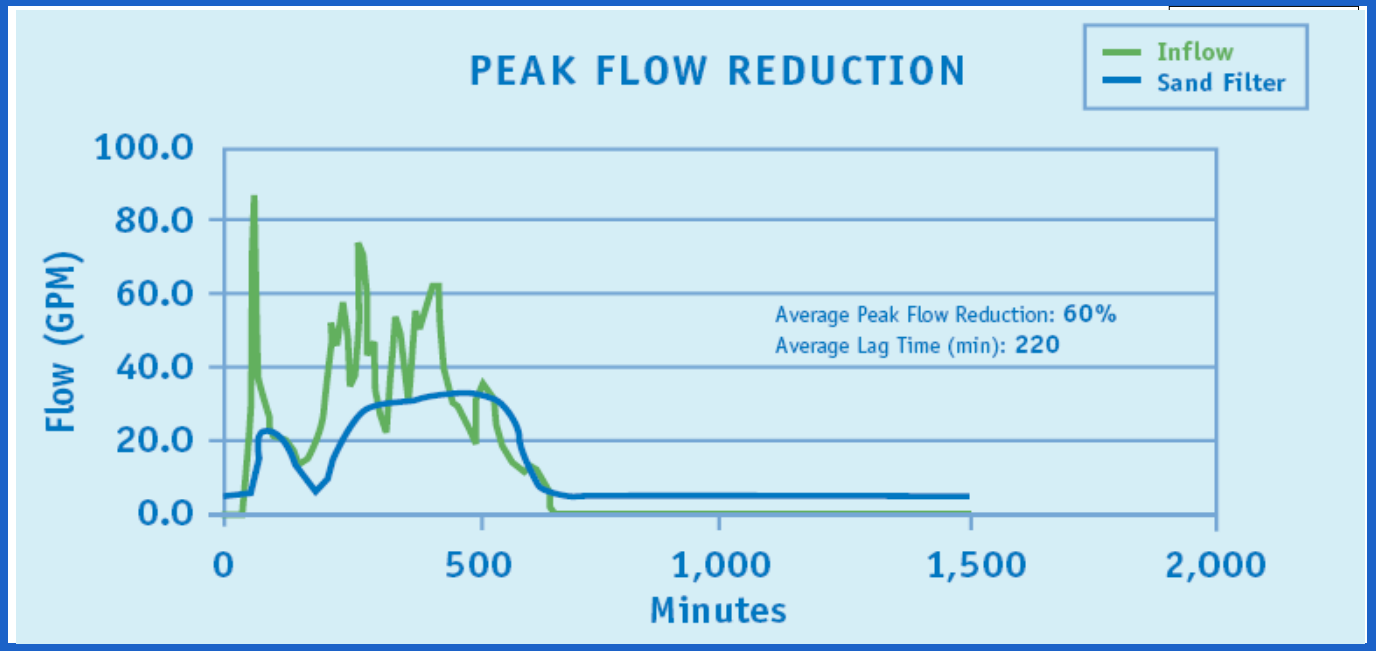


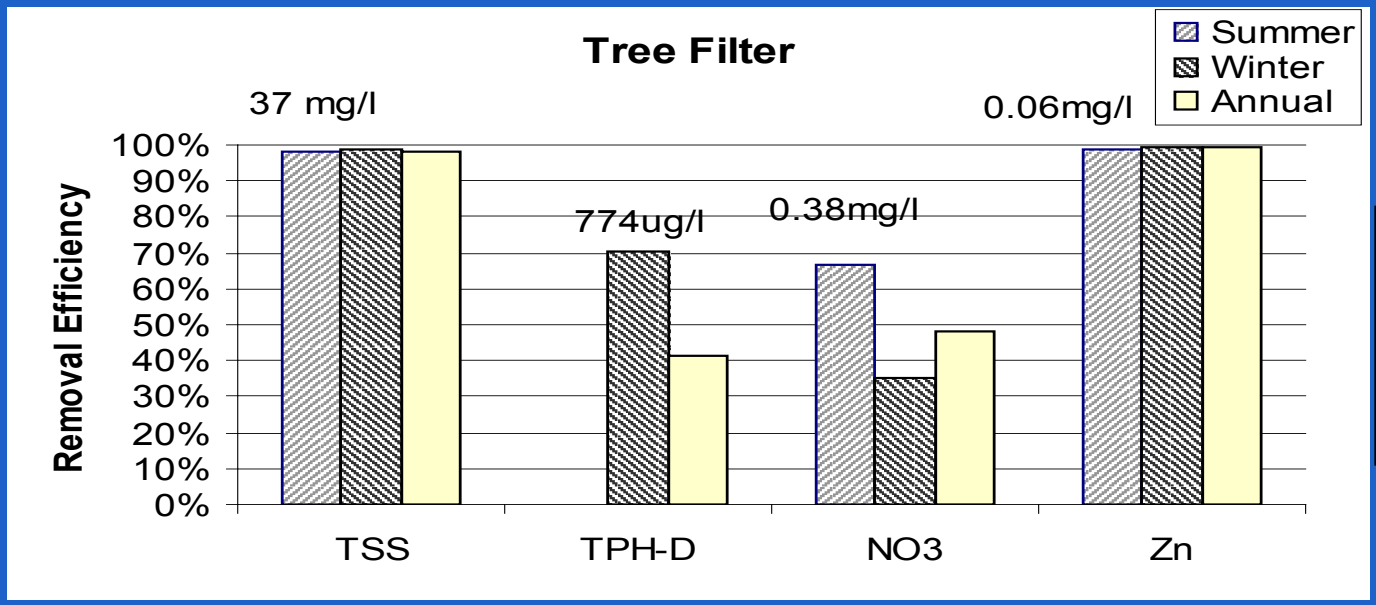
Performance Efficiencies -Conventional



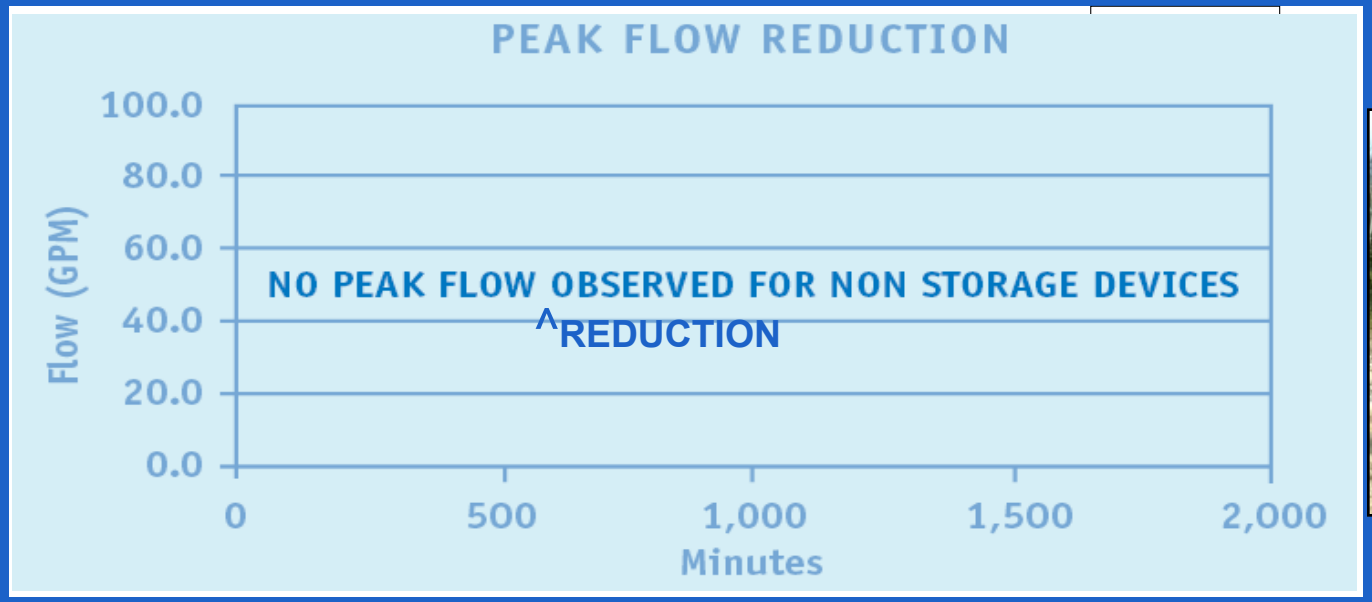


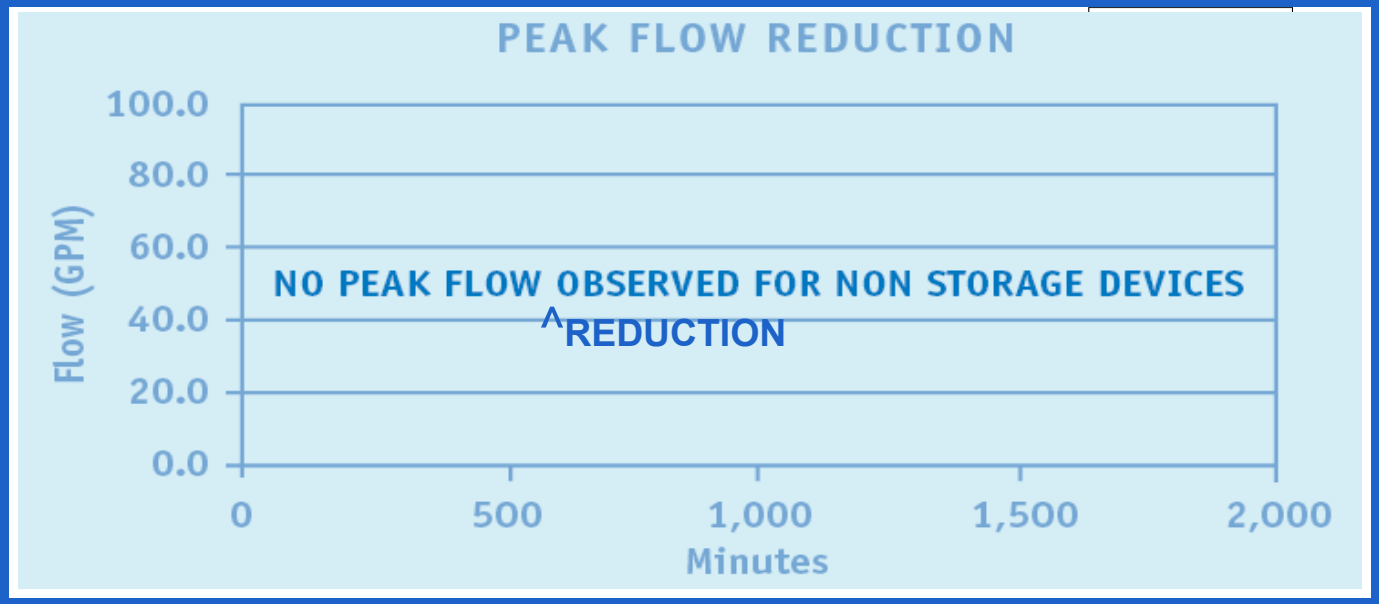
Performance Efficiencies –Filtration/Infiltration



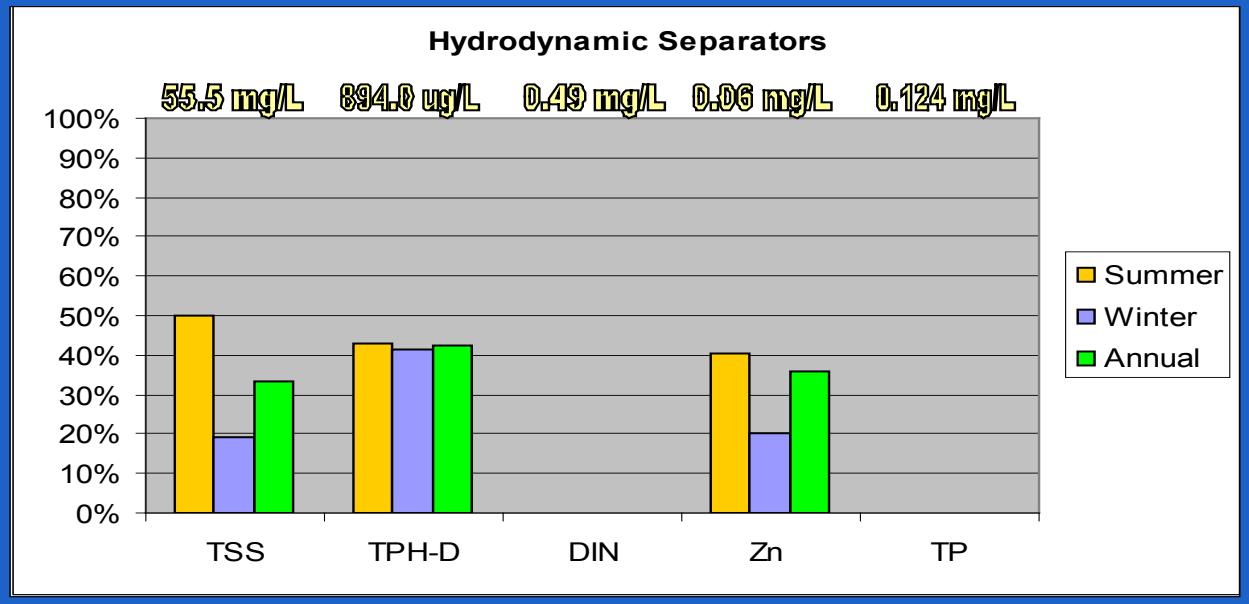


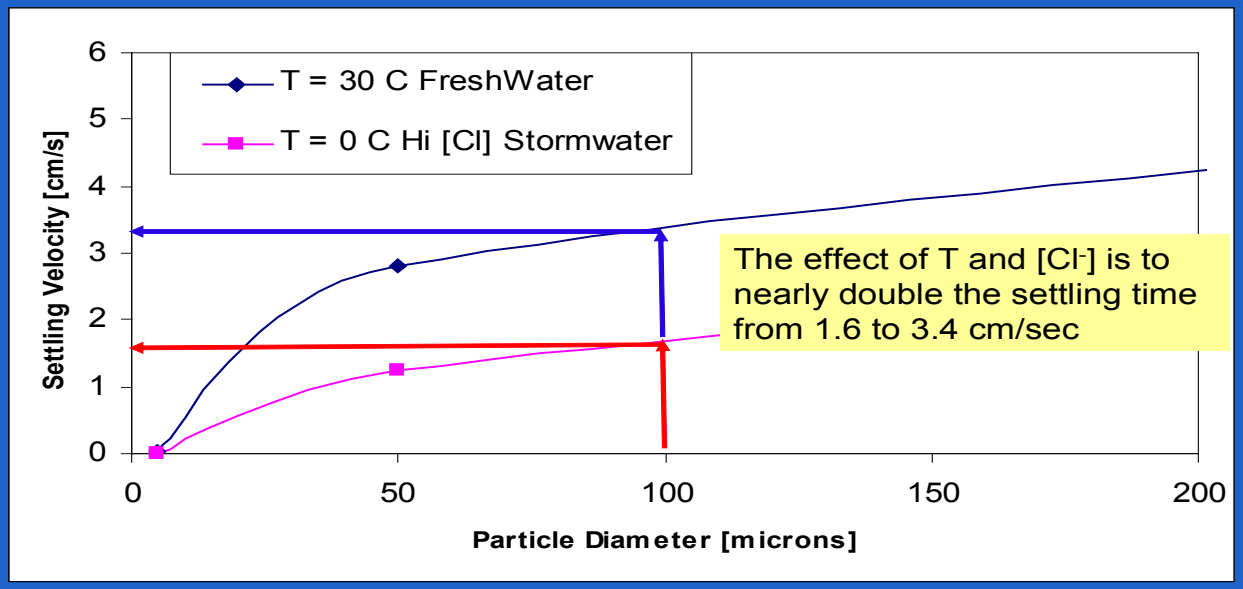
Performance Efficiencies-Manufactured System





Performance Efficiencies - Manufactured





*Oberts (2003), Jokela (1990)

Summary Conclusions

- Systems dependent on particle settling show the greatest affect by season.
- Cold climate issues (frozen filter media) are less of an issue for LID systems than conventional treatment
- Chloride treatment is minimal leaving reduction and source control strategies
- Bacterial concentrations are only reduced significantly by LID systems and subsurface infiltration (exception is sand filter)

Summary Conclusions

- LID designs have a high level of functionality during winter months and frozen filter media does not reduce performance
- Infiltration and filtration systems have the highest removal efficiency
- It is interesting to note that many of the systems used routinely, without concern for reduced winter performance, are showing otherwise.
- Future designs focusing on the use of :
  - Storm volume reduction through infiltration
  - Water quality treatment by filtration
- Will addresses the primary cause of water quality degradation