2018 OHIO STORMWATER CONFERENCE 11th Annual

Improved Performance of Green Stormwater Infrastructure through Outlet Control

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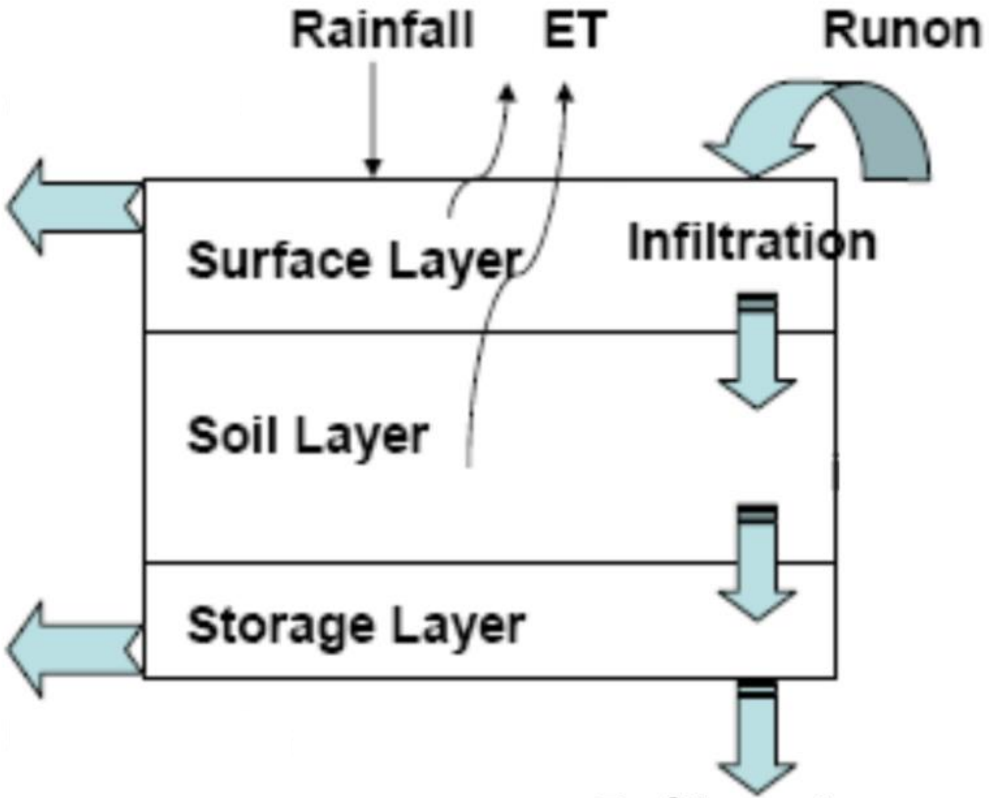
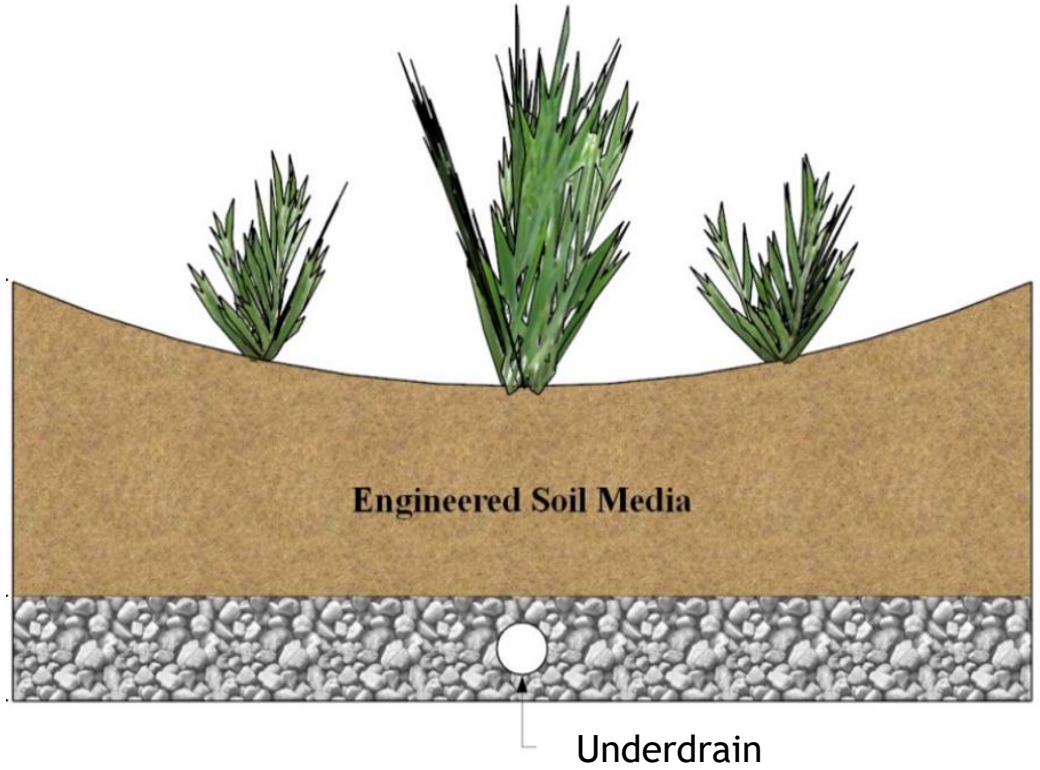
Objective

Estimate the potential benefits of providing outlet control of a rain garden (RG)

- Develop a model for a rain garden.
- Run simulations with varying conditions.
- Quantify benefits of outlet control.

What is outlet control?

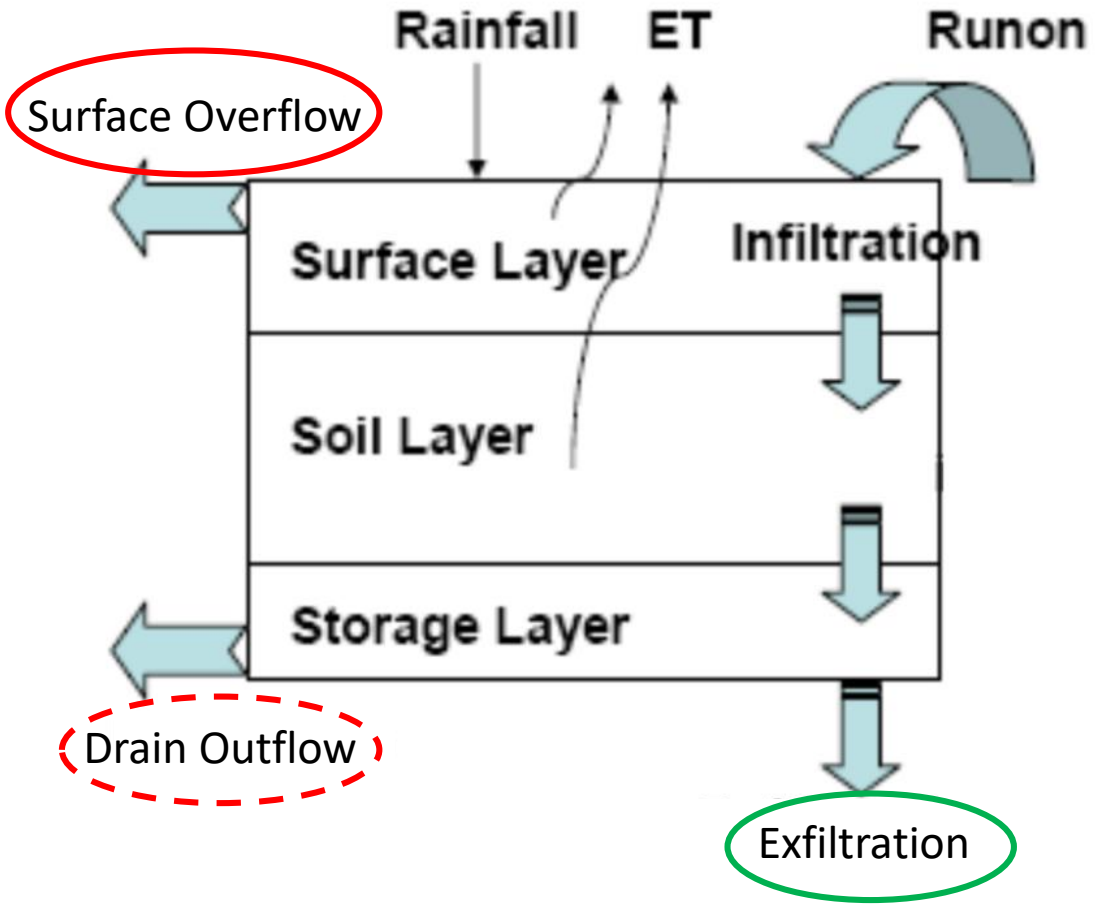




soils infiltration rate < 0.5 in/hr include an underdrain

Rain Garden Performance

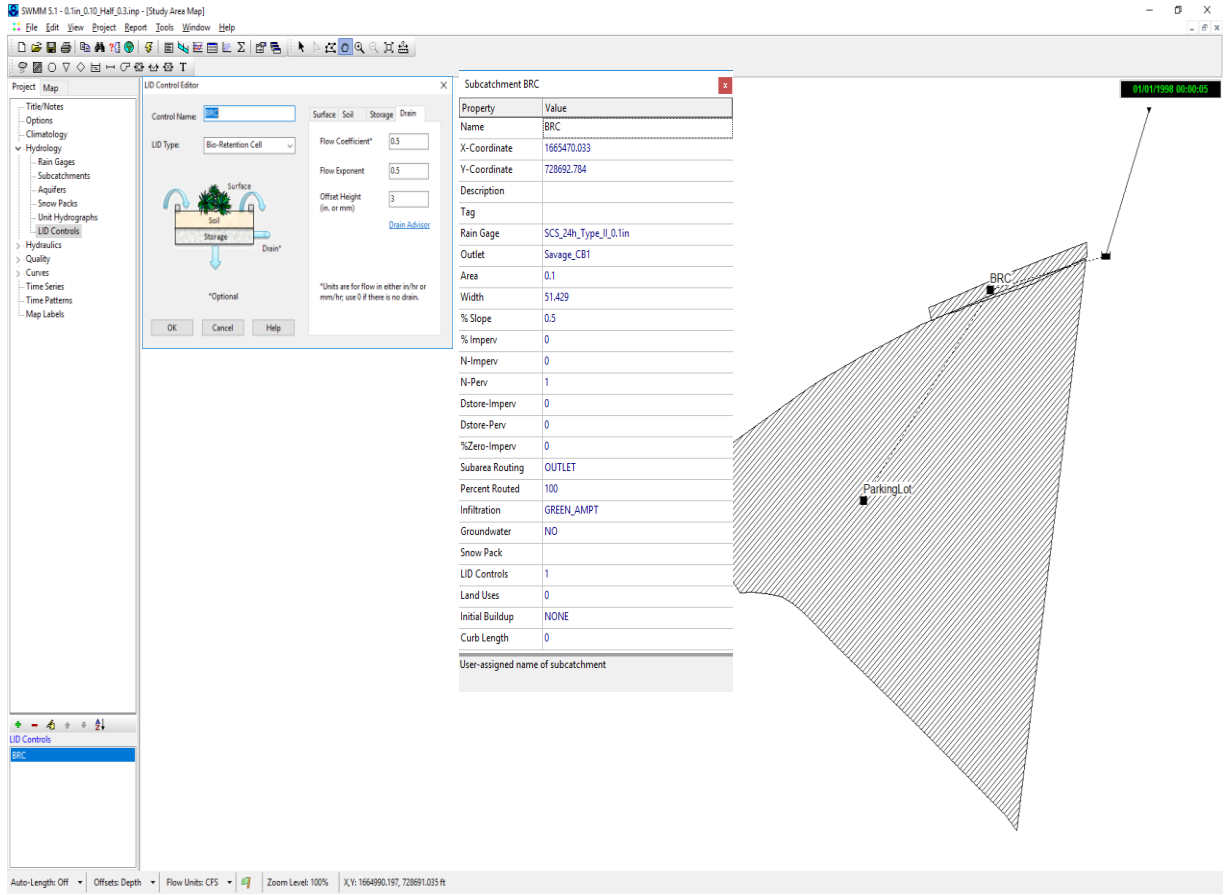
- BEST: Exfiltrated Volume - stormwater diverted from outlet (aquifer recharge)
- NEXT BEST: Treatment - flow is infiltrated and delivered through underdrain.
- Overflow – untreated



Methods - Hydrologic Modeling

EPA's Storm Water Management Model (SWMM) -dynamic hydrology-hydraulic model for single event or long-term continuous simulation.

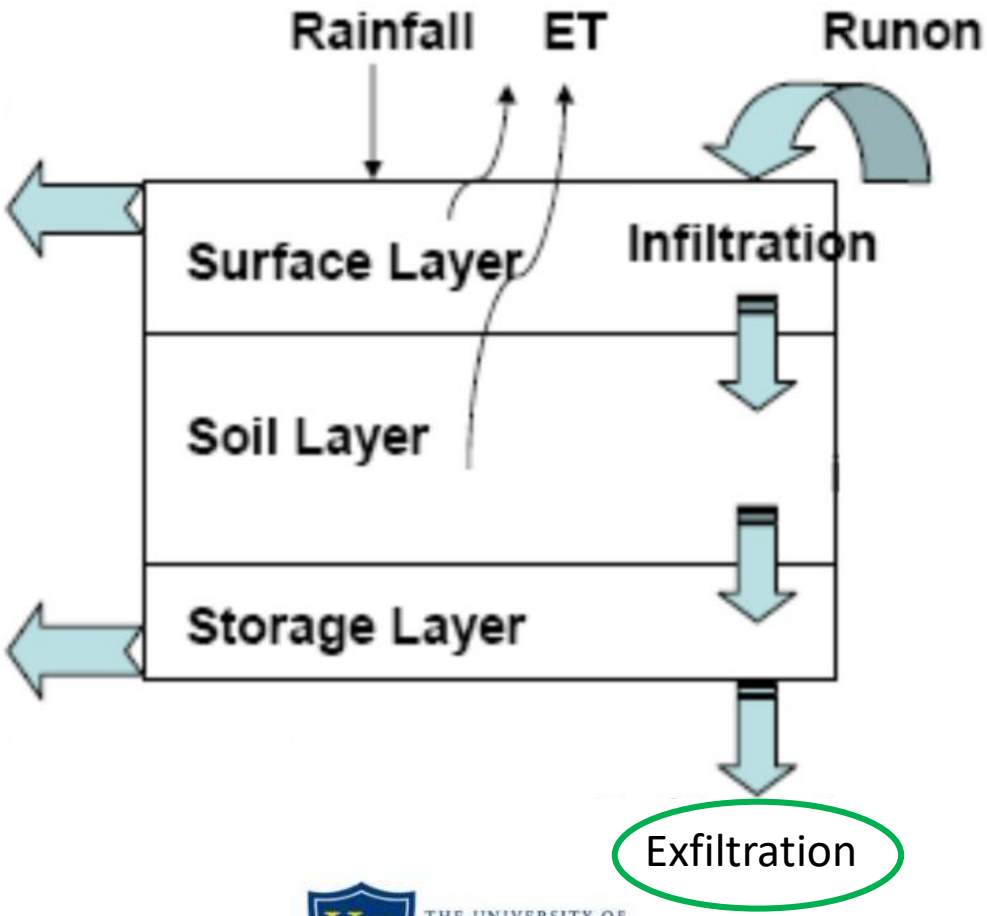
Variables: RG size, storm size, soil type



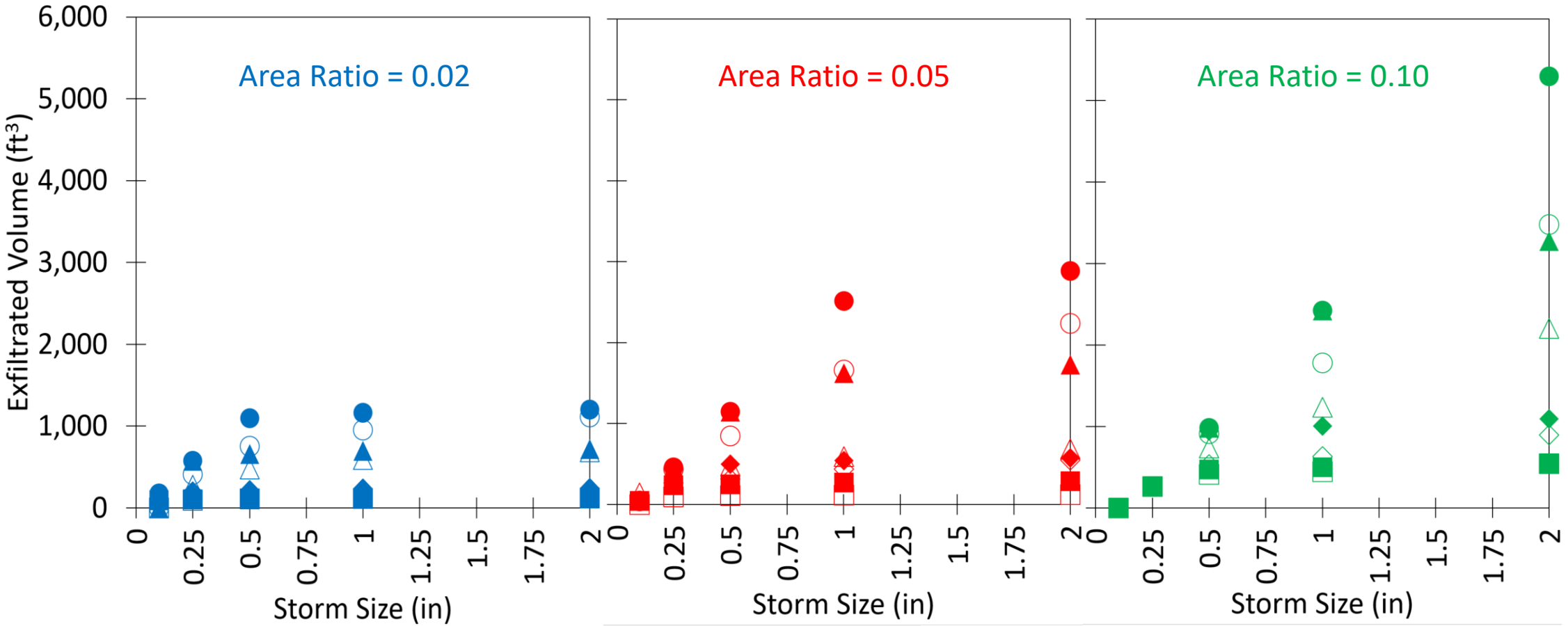
Variables Studied

- Soil Type: Ksat (sat hydr conductivity) 0.02 to 0.5 in/hr
- Area Ratios (area of RG/area of watershed): 0.2 to 2.0
- Storm Size : 0.1 to 2.0 inches in 24 hours

RG Performance-Exfiltrated Volume



Exfiltrated Volume (Opened Vs Closed)



- Better performance when valve is closed
- Better performance for better drained soils
- Better performance for bigger systems

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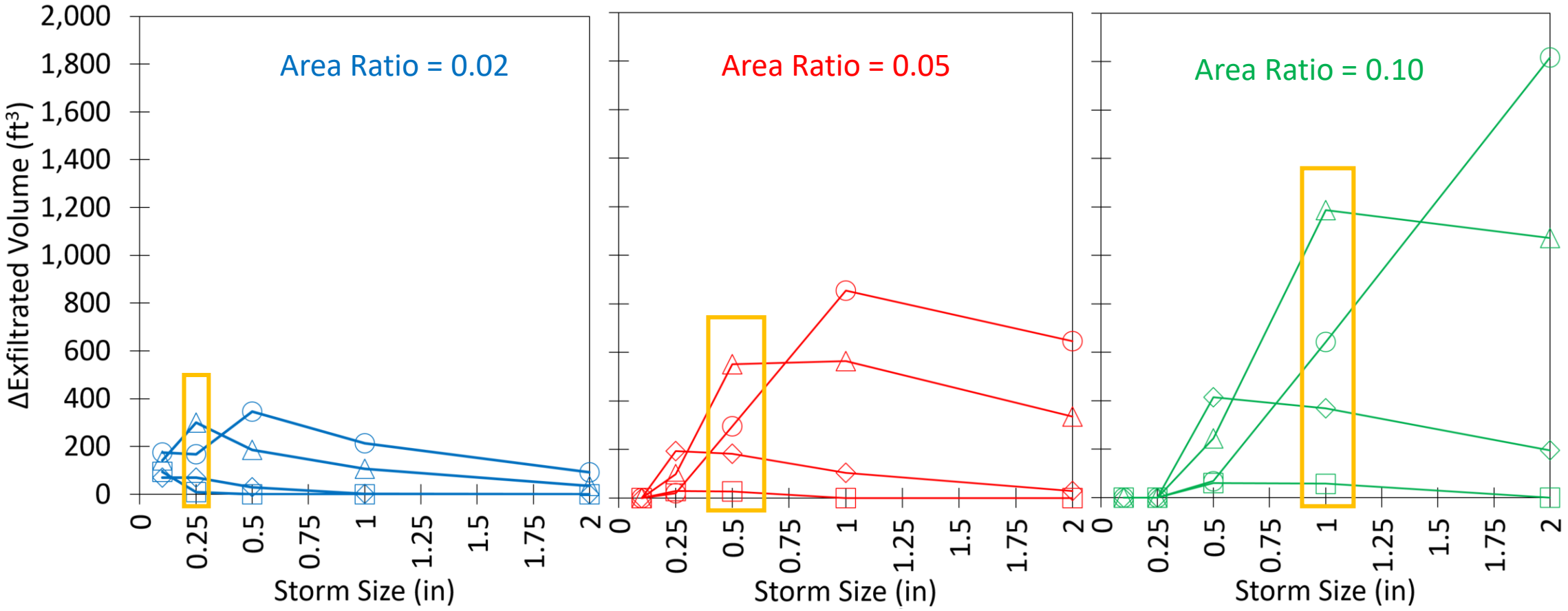
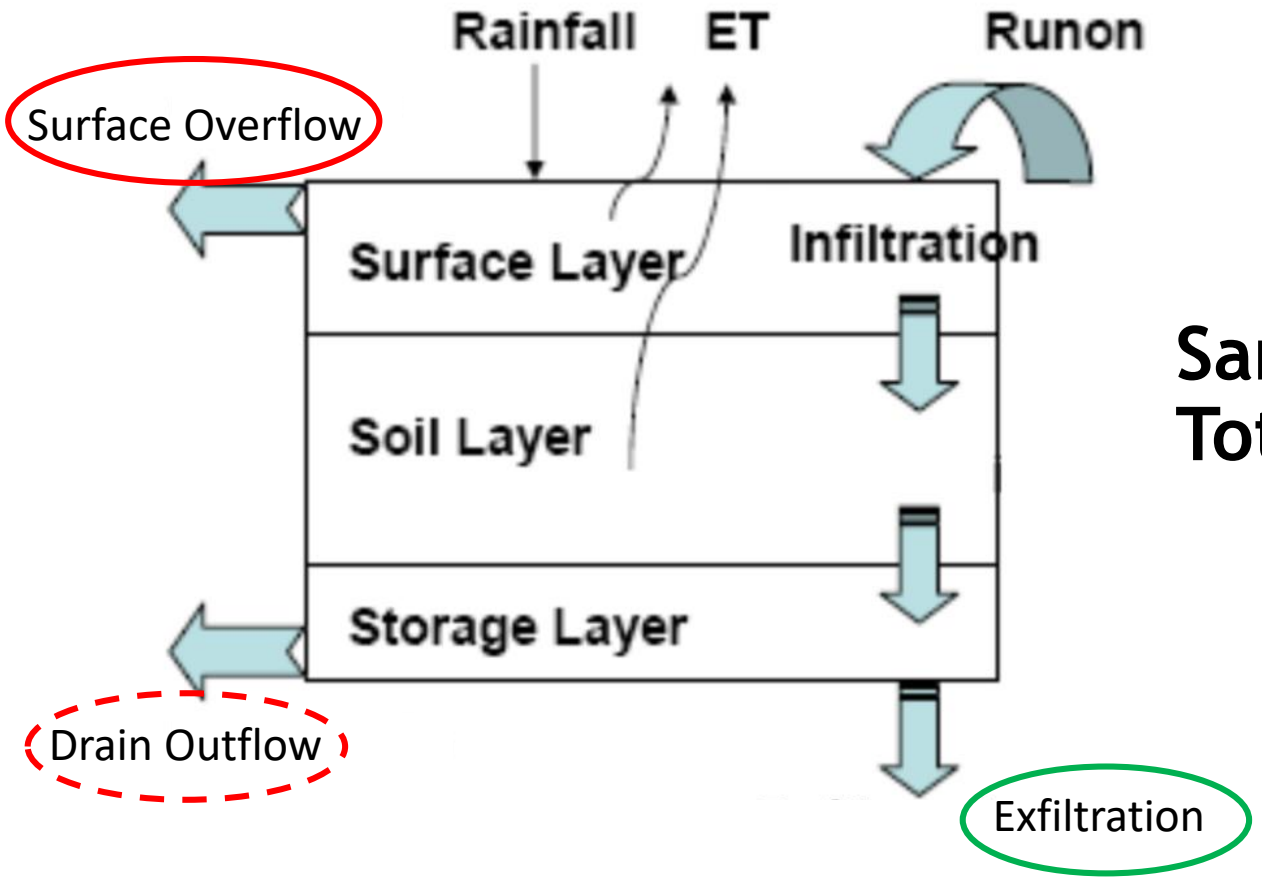
Size of the storm causes some change in rate of performance – more apparent in small systems

Importance of Control



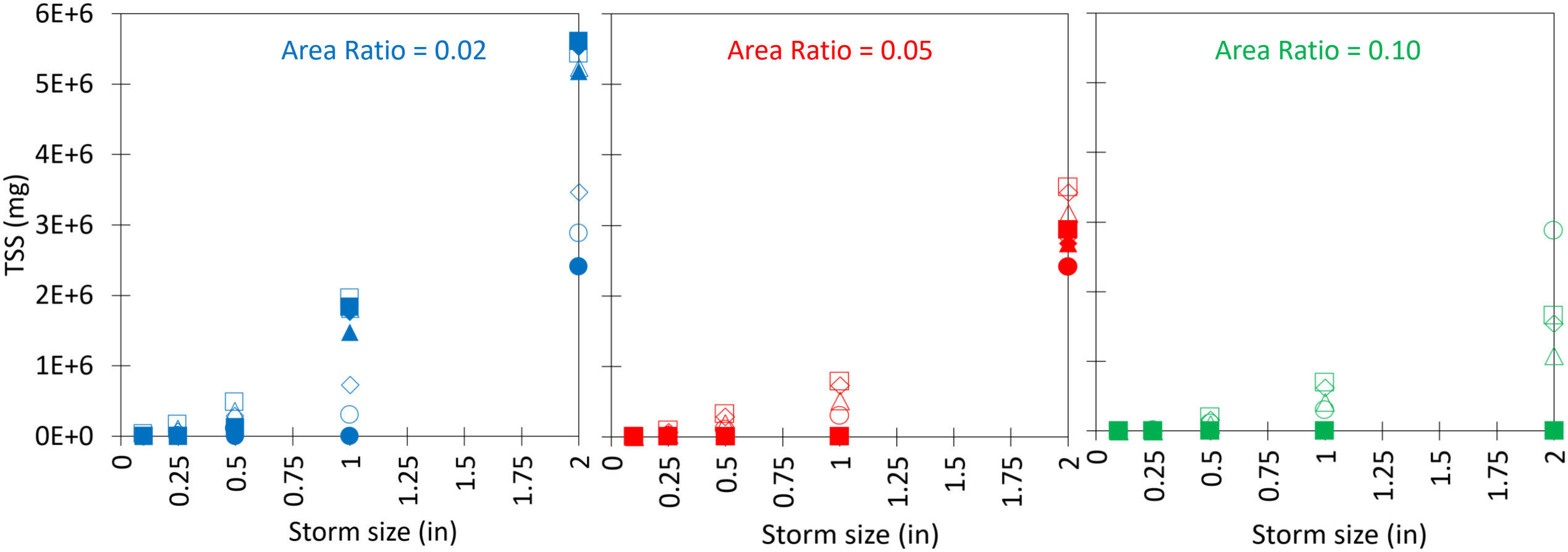
- **More important in better drained soils except the highlights**
- **More important in bigger systems**

RG Performance - Reduce Load (TSS)



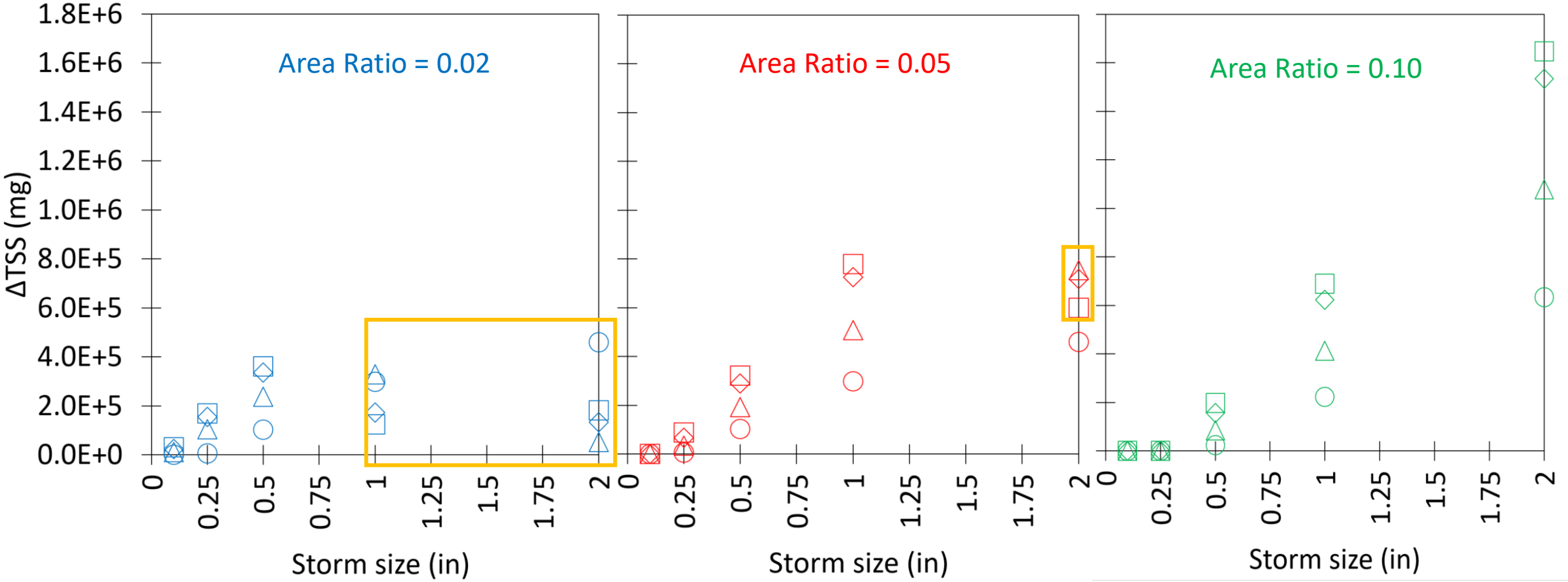
Sample Contaminant:
Total Suspended Solids (TSS)

TSS Load – Open vs. Closed Valve



- **Better performance when valve is closed except when undersized, poor soils and big storm**
- **Better performance for bigger systems**
- **Better performance for better drained soils except in bigger systems with big storms**

Importance of Control



- **More important in bigger systems**
- **More important in worse drained soils except the highlights**

Discussion

- Rain gardens typically are built with static (open) underdrain. Control (closed valve) is beneficial under certain conditions.
- Exfiltration Volume is increased when the valve is closed. Benefits increase for bigger rain gardens. Larger storms have a reduced benefit.
- TSS Load is reduced when the valve is closed. Benefits increase for bigger rain gardens and bigger storms.
- The ability to open and close the valve with consecutive days of rain (to drain the system) would be helpful.

Conclusion

- Rain gardens are typically static (no ability to control flows).
- Implementing outlet control can improve their performance outcomes.
- The reduced cost of valves and actuators will encourage their implementation and facilitate improved performance.

References

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- Morgan K (2010). Bradford Beach Parking Lot with Rain Garden. Flickr, Yahoo!, www.flickr.com/photos/menomoneerivergroup/4256919467/.
- Rossman L. A. (2010). Modeling low impact development alternatives with SWMM. Journal of Water Management Modeling.

Thank you!
Questions?

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