Stormwater Engineering

Monitoring of Retrofit Urban Stormwater BMPs

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Collaborative Project

Charlotte-Mecklenburg STORM WATER Services

PROPERTY OF
MECKLENBURG COUNTY
LAND USE & ENVIRONMENTAL SERVICES
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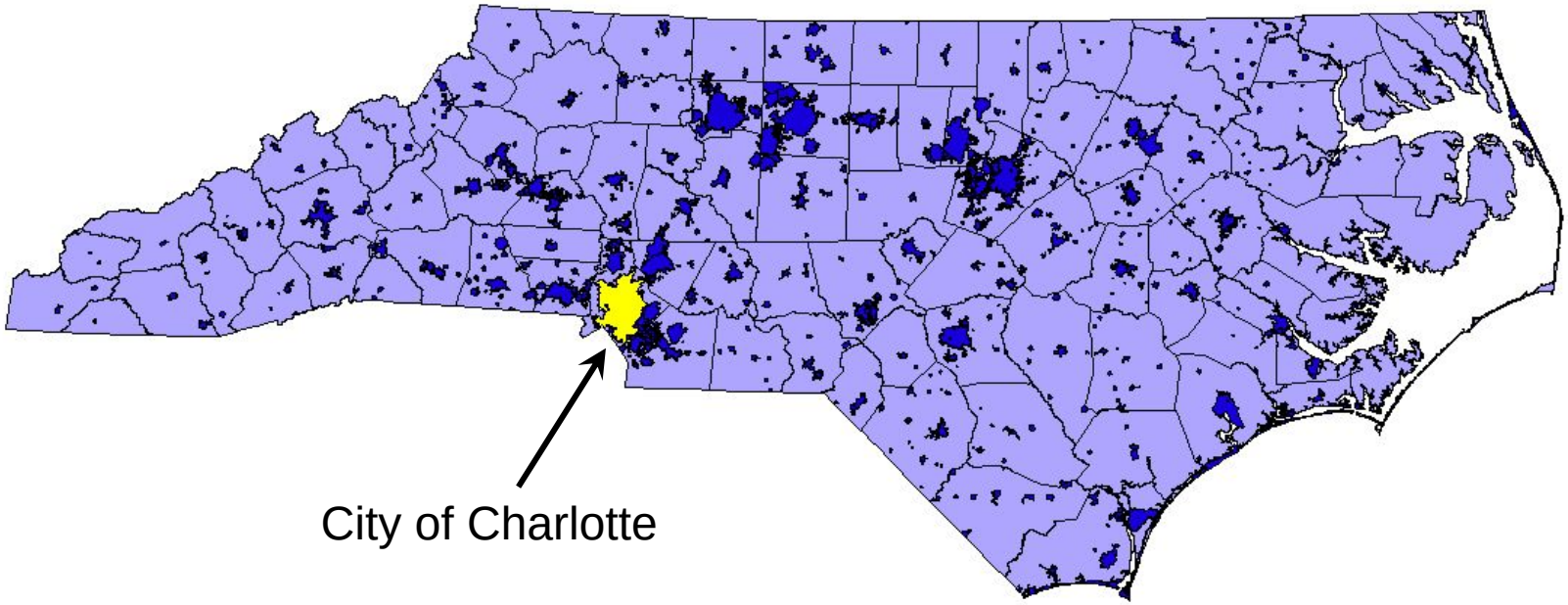
Charlotte – Mecklenburg Stormwater Services (CMSS)

NC STATE UNIVERSITY

Collaborative Project



Objective

- Aid in set-up of “pilot” monitoring sites for BMP program
  - Site selection
  - Monitoring protocols for each site
  - Develop framework / protocols that could be applied to future monitoring by CMSS
- Provide pollutant specific BMP data for CMSS to aid in program development
  - Efficient water quality management through accurate pollutant removal data
- Mutually beneficial program

Monitoring site selection criteria

- BMPs common to Charlotte
  - Bioretention, stormwater wetlands, dry detention basins, wet ponds, proprietary devices
- Access to site for monitoring
- Stable watershed
- Single inflow-single outflow
- Capable of flow monitoring
- Good Examples of BMPs
  - Maintenance and Design

Site Selection: results

- Initial review:
  - ~100 investigated
  - 31 retrofit and existing sites “pre-screened”
  - 5 sites suitable for monitoring
- Second Review
  - ~50 dry detention sites investigated
  - 21 pre-screened
  - 2 sites suitable for monitoring

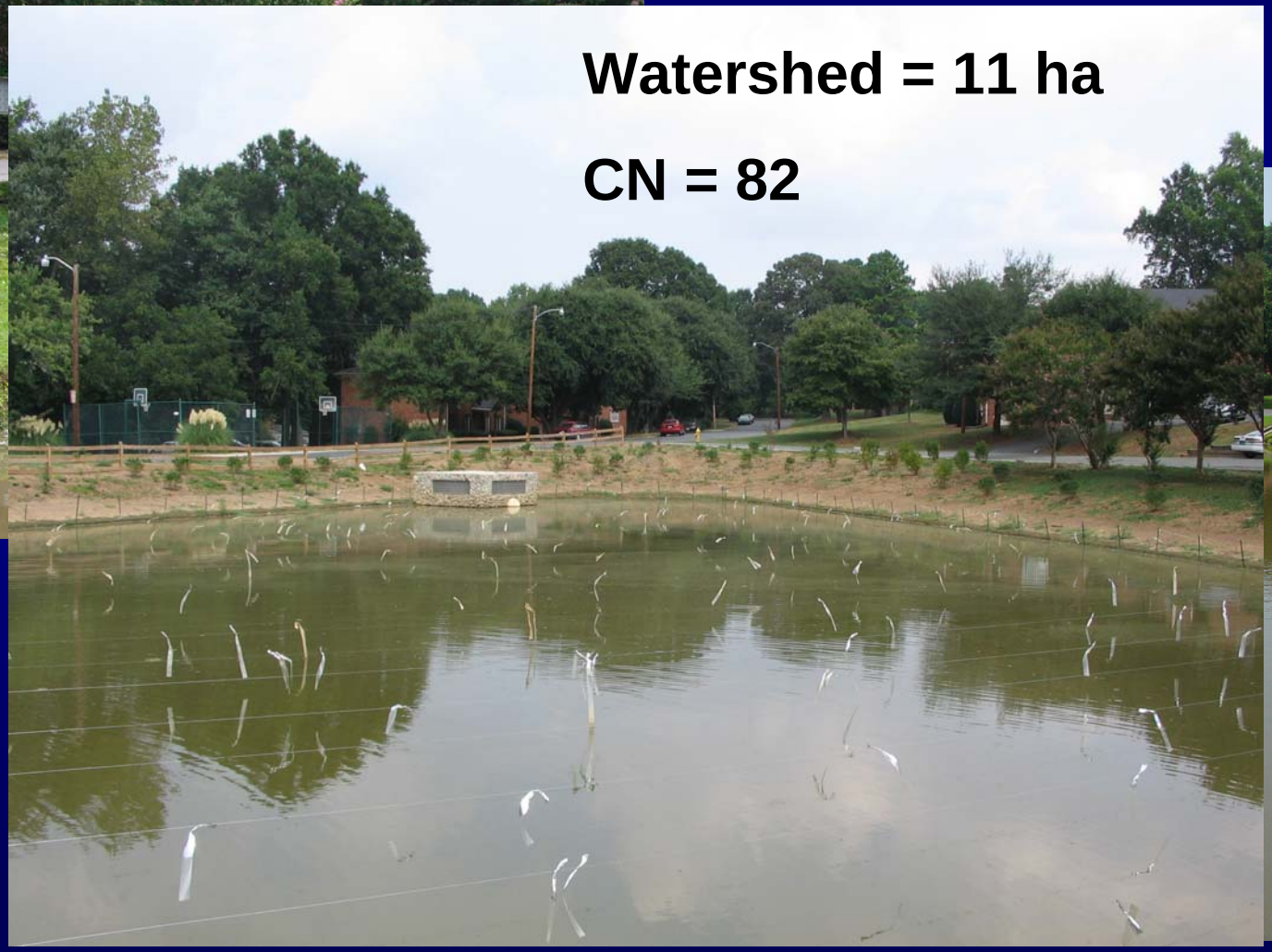
BMPs Monitored and Evaluated

Wetlands	2
Bioretention	1
Dry Detention	2
Wet pond	2
Level Spreader – Filter Strip	1
Proprietary devices	4
Total	**12**

University Dry Detention

Morehead Dry Detention

Shade Valley
Urban Pond Retrofit



Pierson Pond

Edwards Branch Wetland retrofit

Bruns Ave Elementary Retrofit Wetland

Hal Marshal Bioretention

Westfield Level Spreader

Monitoring of CATS BMOF

Monitoring setup

- Monitor at Inflow and Outflow
  - Flow and Water Quality
- Flow paced sampling where possible
  - Nutrients, Sediment, Metals, etc
- Grab samples for additional analysis
  - Bacterial Indicators, Oil and Grease
- Attempt to monitor 1 storm / month

Monitoring Equipment

- ISCO® portable samplers
  - Often Portable Refrigerated Samplers
- ISCO® tipping bucket rain gage
- Flow Monitoring Variable Depending on Site
  - Bubbler
  - Area Velocity meter

Lessons learned

- Training of monitoring personnel is critical to monitoring performance
- ~5% of BMPs lend themselves to monitoring
- Monitoring structures may impact operation and performance of BMP's
- There is no perfect site
- Don't wait to analyze data

Lessons learned: continued

- Communication between cooperators is key
- Area-velocity meters did not perform well for stormwater monitoring
  - Use weirs whenever possible
- It always rains on Friday

Bacteria Pollution

- EPA – National Water Quality Inventory (2000)
  - 13% of the streams and rivers that were surveyed were impacted by bacteria pollution
- Public health risk from pathogens
- Indicator bacteria
  - Fecal coliform
  - *E. coli*

Bacteria Pollution

- Stormwater is a transport mechanism for bacterial pollution
- Urbanization can lead to increased pathogen loads to surface waters
- Very little data regarding BMP performance with respect to bacteria removal

Data Collection

Site	Start	End	Number of Samples Fecal Coliform	Number of Samples E. Coli
Dry Detention 1	Feb-05	Jul-06	9	9
Dry Detention 2	Jan-05	Dec-05	12	12
Wet Pond	Aug-04	Apr-06	14	10
Wetland 1	Mar-04	Jun-05	9	6
Wetland 2	Sep-04	Dec-05	15	10
Bioretention	Aug-04	Mar-06	19	14
Proprietary 1	Oct-05	Oct-06	7	7
Proprietary 2	Oct-05	Oct-06	6	6
Proprietary 3	Oct-05	Oct-06	6	6

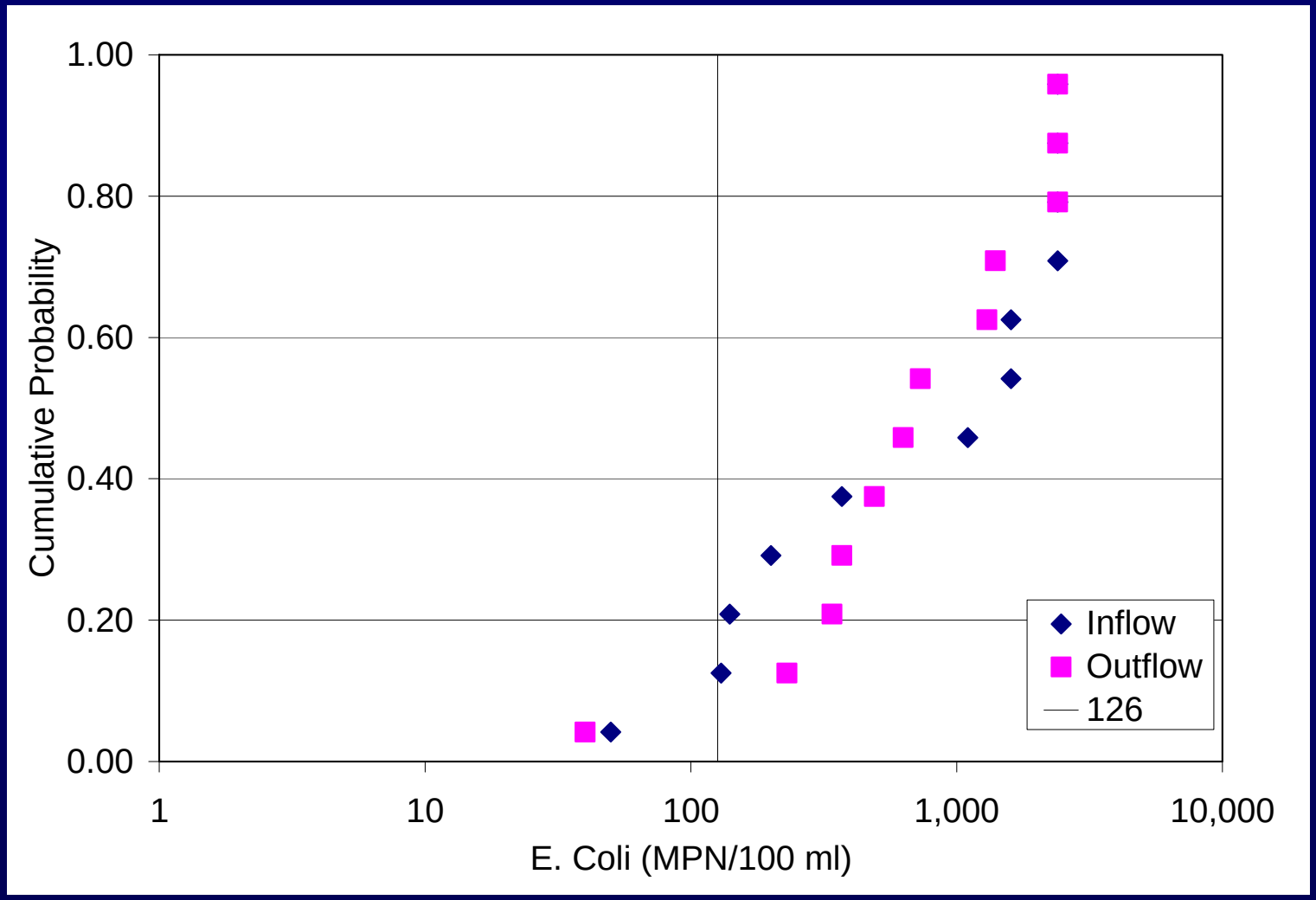
BMP Efficiency

BMP Type	Efficiency Fecal Coliform (%)	Efficiency *E. coli* (%)
Dry Detention 1	-3%	5%
Dry Detention 2	-21%	14%
Wet Pond	57%	18%
Wetland 1	99%	92%
Wetland 2	70%	22%
Bioretention	69%	71%
Proprietary 1	77%	-13%
Proprietary 2	-169%	-186%
Proprietary 3	-381%	-96%

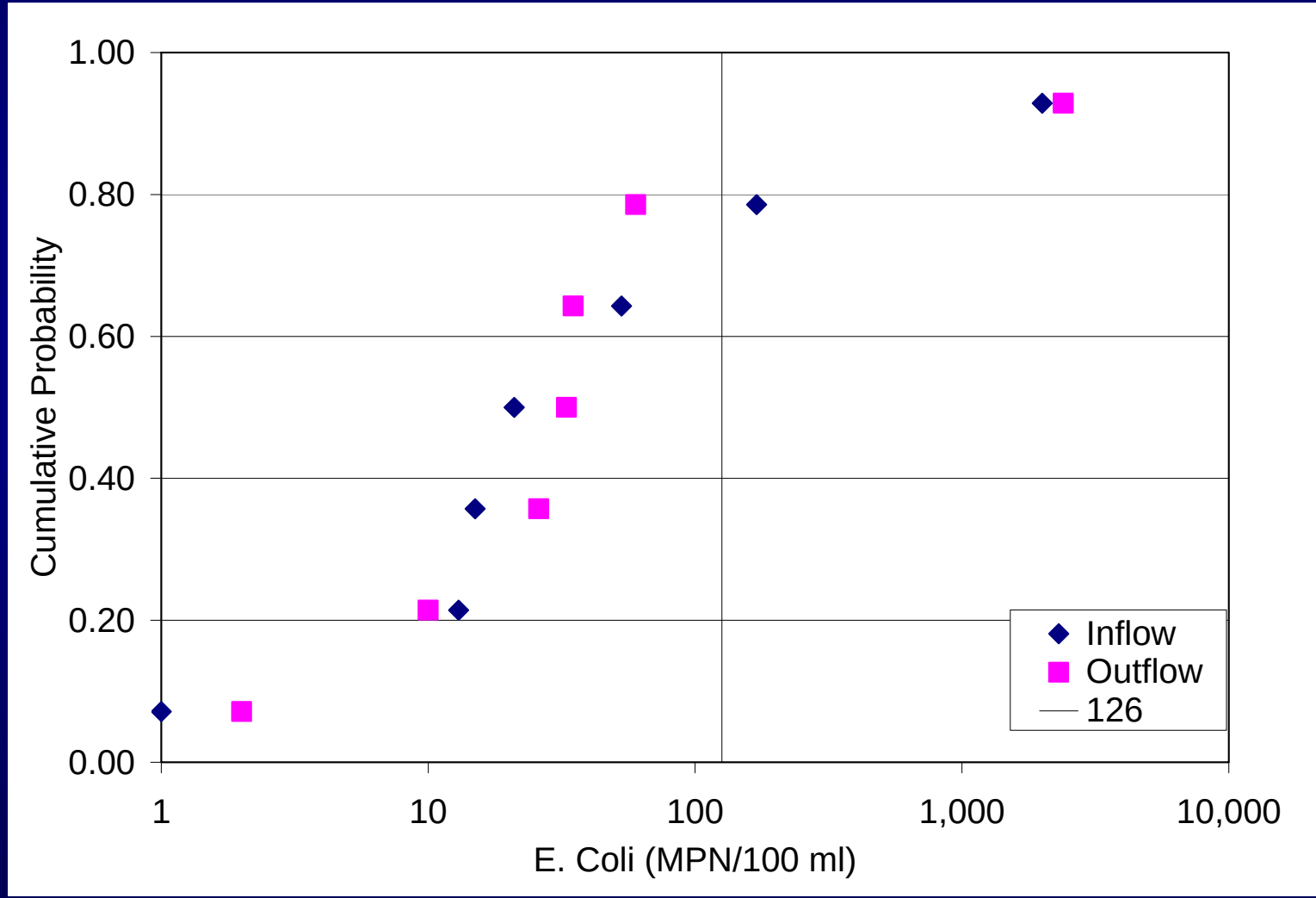
Statistical Analysis ($p<0.05$)

BMP Type	Fecal Coliform Significant?	*E. coli* Significant?
Dry Detention 1	no	no
Dry Detention 2	no	no
Wet Pond	no	no
Wetland 1	Yes	Yes
Wetland 2	Yes	no
Bioretention	Yes	Yes
Proprietary 1	no	no
Proprietary 2	no	no
Proprietary 3	no	no

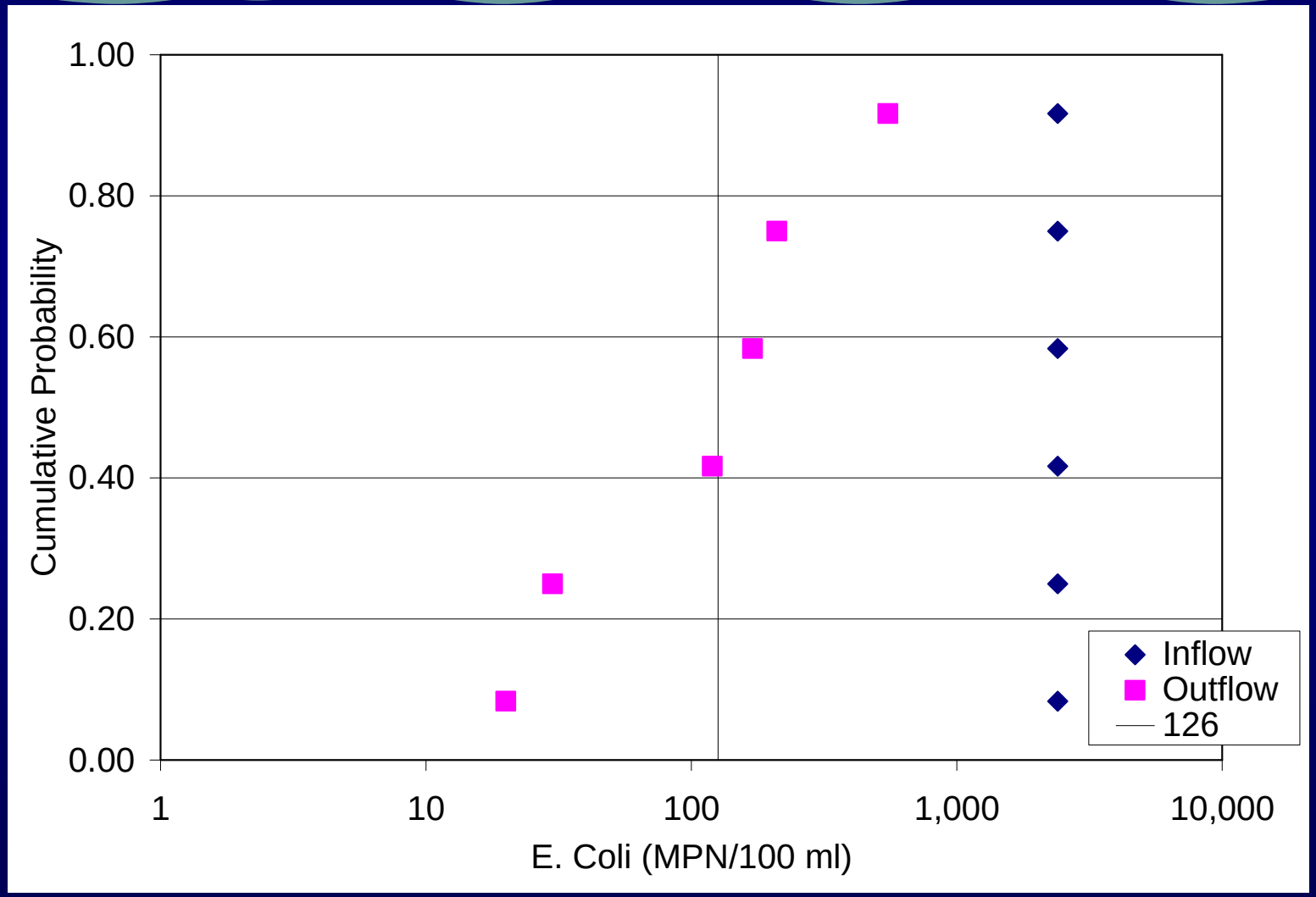
Cumulative Probability Plots – Dry Detention



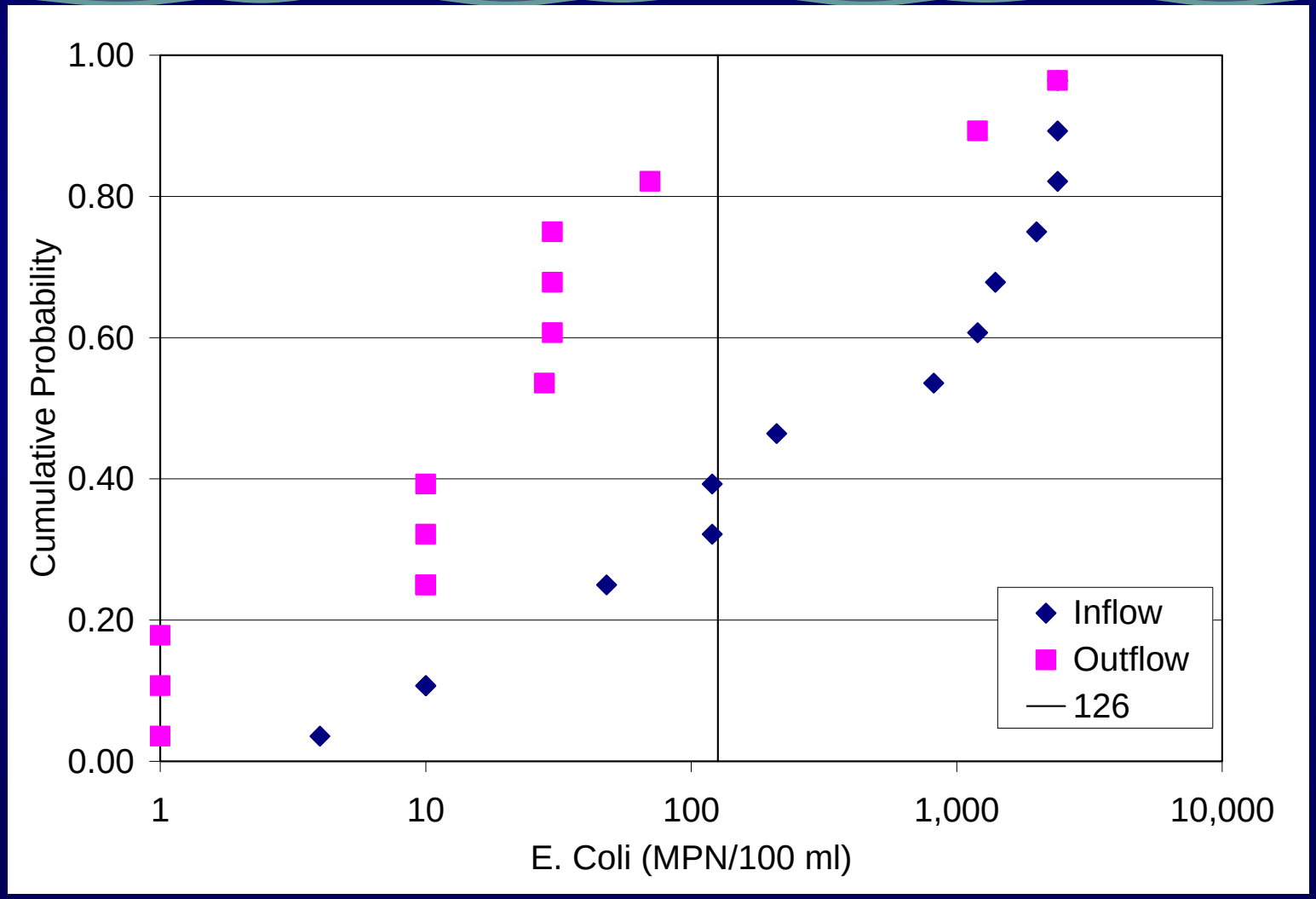
Cumulative Probability Plots – Proprietary Device



Cumulative Probability Plots – Wetland 1



Cumulative Probability Plots – Bioretention



Effluent Concentrations

BMP Type	*E. Coli* Concentrations		
	Median Influent	Median Effluent	% of samples under 126 counts/100 ml
Dry Detention 1	2400	1700.00	0
Dry Detention 2	1350.00	680.00	8
Wet Pond	2400.00	2200.00	10
Wetland 1	2400.00	145.00	33
Wetland 2	2116.95	1900.00	10
Bioretention	**515.00**	**19.00**	**86**
Proprietary 1	21.00	33.00	71
Proprietary 2	1.50	21.00	83
Proprietary 3	185.50	172.50	50

Take Home Points

- Some stormwater management practices show promise in removing bacteria
  - Sun Exposure
  - Drying
- Some stormwater BMPs may be sources of bacteria
  - Presence of animal activity
  - Wet, nutrient and organic rich environments

Take Home Points

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Take Home Points

- BMPs are often chosen to treat specific types of watersheds, making comparisons difficult
  - Different watersheds produce different influent bacteria concentrations
- More data is needed !!
- Journal article in review

Acknowledgements

- Staff of Charlotte-Mecklenburg Stormwater Services

Questions?

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(Individual Site Reports Available)