The Effectiveness of Dry and Wet Stormwater Detention Basins as Sediment and Nutrient Processors

Caroline Fortunato, American University Owen McDonough, College of William & Mary Faculty Mentor: Dr. Randy Chambers

Introduction

- Urban sprawl places watersheds and associated streams and rivers under increased stress in terms of impaired water quality from stormwater runoff.
- James City County, Virginia is a county that is presently experiencing rapid residential and commercial growth.
- Stormwater detention basins are constructed to mitigate the negative effects of increased runoff.

Objective

• To assess and compare the effectiveness of wet and dry stormwater detention basins in developing watersheds in terms of their ability to retain sediment and nutrients

Hypothesis

• Wet detention basins discharge lower concentrations of sediment and nutrients, relative to dry basins

Site Selection Process

- Selected sites based on:
 - Basin Type (wet / dry / untreated)
 - Basin Drainage Area
 - Land Use of Surrounding Area
 - Basin Condition





Sampling Locations



Wet Basin

JCC Courthouse

Site Profile: James City County Courthouse





- Basin Type: Bioretention
 and untreated
 stormwater
- Drainage Area: 5 acres
- Land Use: JCC Courthouse and new commercial area
- Watershed: Powhatan Creek
- Year Built: 2003

Site Profile: Ironbound Village





- Basin Type: Dry Basin
- Drainage Area: 6.9 acres
- Land Use: New single family moderate income homes
- Watershed: College Creek
- Year Built: 2001

Site Profile: James City Service Authority





- Basin Type: Wet Basin
- Drainage Area: 14.9 acres
- Land Use: Municipal grounds and service vehicle parking lots
- Watershed: Powhatan Creek
- Year Built: 1991

Site Profile: James City Service Authority





- Basin Type: Dry Basin
- Drainage Area: 2.45 acres
- Land Use: Service vehicle parking lot and future industrial sites
- Watershed: Powhatan Creek
- Year Built: 2001

Methods

- Placement of ISCO water samplers at basin outlets
- Programming of samplers to collect 250-500mL at 15-30 minute intervals during three storm events





Methods

- Analysis of samples for:
 - Ammonium
 - Nitrate + Nitrite
 - Dissolved Phosphate
 - Total Particulate
 Phosphorus
 - Total Suspended Sediment (TSS)
 - Total Dissolved Solids (TDS)





Storm Event: 7/12/04

- Total Rainfall: 0.02 inches
- Maximum Rain Rate: 0.07 inches per hour at 7:20pm
- **Duration:** 20-30 min. between approximately 7:10pm to 7:30pm
- Sampling Time: 6:30pm to 12:00am
- Sampling Rate: 23 samples taken at 15 min. intervals





Storm Event: 7/18/04

- Total Rainfall: 0.19 inches
- Maximum Rain Rate: 1.17 inches per hour at 5:30am
- **Duration:** 1 hour between approximately 5:10am to 6:10am
- Sampling Time: 12:00am to 11:00am
- Sampling Rate: 23 samples taken at 30 min. intervals









Storm Event: 7/22/04

- Total Rainfall: 0.24 inches
- Maximum Rain Rate: 1.89 inches per hour at 8:00pm
- **Duration:** 1 hour between approximately 8:00pm to 9:00pm
- Sampling Time: 7:45pm to 1:15am
- Sampling Rate: 23 samples taken at 15 min. intervals





















Conclusions

- Dry basins discharge higher concentrations of sediment and dissolved nutrients than the wet basin during storm events.
- Dry basins performed similar to or worse than untreated stormwater in:
 - Total Suspended Sediment
 - Dissolved Phosphate
 - Total Particulate Phosphorus

Recommendations





• It is suggested that:

- Measures be taken to decrease the amount of sediment entering Ironbound Village dry basin
 - Construction of Silt Fence
 - Removal of Loose Sediment from Site
- Stormwater bypassing the bioretention strip at JCC Courthouse be treated
 - Reengineering of Stormwater Management Plan

Significance

- There are 474 stormwater basins in James City County alone. This study showed the effectiveness of 3. The water discharged from each of these basins affects other downstream basins, streams, and watersheds.
- The failure of these basins to effectively treat stormwater leads to impairment of local streams, lakes, and ultimately the Chesapeake Bay.





Acknowledgments

We would like to thank the following people for their help and support throughout this study: Dr. Randy Chambers Tim Russell Scott Thomas, JCC Environmental Division And the ISCO Crew: **Kristen Pederson** Jeremy Wacksman Jenn Toy **Bert Harris**