Pathogen TMDL Monitoring and FC-EC Relations in the Lower Passaic River

SARATH CHANDRA JAGUPILLA,
DAVID A. VACCARI,
RICHARD I. HIRES,
TSAN-LIANG SU,
(STEVENS INSTITUTE OF TECHNOLOGY)

ROBERT MISKEWITZ,
(RUTGERS UNIVERSITY)

AND MARZOOQ ALEBUS
(NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION)
Outline

- Introduction
- Study Area
- Description of Project
- Events Overview
- Salient Field Observations
- Effect of Rain
- FC-EC Relations
- Summary of Results
- Acknowledgements
Funding

- Funding provided by The New Jersey Department of Environmental Protection through a contract with Rutgers NJ EcoComplex via a grant award to Stevens Institute of Technology.
Goal

- Compute TMDL and its allocations
  - Load allocations,
  - Waste Load allocations, and
  - Margin of Safety
Sampling Plan

- **Six Sampling Events** –
  - Three dry weather (3 samples per site)
  - Three wet weather events (14 samples per site)
  - Two dry and one wet event conducted so far

- **Fourteen Sampling Sites** –
  - Six on the main stem
  - Three tributaries
  - Three CSOs and two SWOs
Sampling Locations

Land Use Patterns
- AGRICULTURE
- BARREN LAND
- FOREST
- URBAN
- WATER
- WETLANDS

Sampling Locations:
- Tunnel
- Molly Ann
- Pennington
- Goffle
- Lincoln
- Totowa
- Market Street

Map showing sampling locations along a river system.
Description of Sampling Events

- **Dry Event** –
  - Sampling times – 6 AM, 10 AM, and 1 PM
  - No CSOs or SWOs

- **Wet Event** –
  - Sampling times – variable
  - Five to Seven consecutive days
Dry Event 1 Overview

- Conducted on July 17, 2009
- Average flow 9.05 m³/s (320 cfs)
- Pathogens concentrations at 6 AM significantly higher than those at 10 AM and 2 PM
- Upward trend in concentrations between Totowa and Lincoln indicates potential sources in between
Dry Event 1 Observations

![Graph showing FC per 100 mL across different site numbers and locations.]

Site Number

1 - Totowa
2 - Wayne
3 - Northwest
4 - Lincoln
5 - Morlot
6 - Market
Flow Data for Dry Event 1

Flow in CFS

Date

Dry Event 2 Overview

- Conducted on August 18, 2009

- Average flow 14.90 m³/s (526 cfs)

- Pathogen concentrations at 6 AM higher than those at 10 AM and 2 PM

- Upward trend in concentrations between Totowa and Lincoln indicates potential sources in between
Dry Event 2 Observations

Site Number

FC per 100 mL

1 - Totowa
2 - Wayne
3 - Northwest
4 - Lincoln
5 - Morlot
6 - Market
Flow for Dry Event 2

Date

Flow in CFS

Wet Event 1 Overview

- Conducted from October 15, 2009 to October 22, 2009
- One sample on day 1, three on day 2, two on day 3, two on day 4, two on day 5, one on day 6 and one sample on day 8
- Average flow 9.44 m³/s (334 cfs)
- 1 inch rain during the entire sampling event
- No observed CSO discharge, but circumstantial evidence for one at Market street
Wet Event 1 Sample Observations

![Graph showing FC per 100 mL and Rainfall over time from 10/14/2009 to 10/24/2009. The graph includes three lines representing Morlot, Market, and Rainfall.](image)

*STEVEN'S*
Institute of Technology
Flow Data for Wet Event 1

Date

Flow in CFS

# Pennington Brook Effect

<table>
<thead>
<tr>
<th></th>
<th>Fecal coliforms</th>
<th></th>
<th>Escherichia coli</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>GM</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td><strong>Dry Events</strong></td>
<td>4600</td>
<td>8418</td>
<td>31000</td>
<td>5600</td>
</tr>
<tr>
<td><strong>Wet Event</strong></td>
<td>980</td>
<td>3797</td>
<td>20000</td>
<td>590</td>
</tr>
</tbody>
</table>
Effect of Rainfall on Pennington

![Graph showing the effect of rainfall on Pennington's FC per 100 mL over time from 10/14/2009 to 10/24/2009. The graph compares the FC levels with rainfall in inches.]

STEVEN'S Institute of Technology
Effect of Rainfall at Molly Ann
Effect of Rainfall at Goffle
FC-EC relationship

- Strong linear relationship between log transformed FC and EC concentrations
- Regression equation based on all 3 events

\[ EC = 2.16 \text{FC}^{0.87} \]

Overall \( R^2 = 0.88 \)
Log EC vs. Log FC - All Data

$y = 0.8734x + 0.335$

$R^2 = 0.8812$
Summary of Results

- Early morning pathogen concentrations significantly higher than mid-day concentrations

- Positive evidence of dry weather sources between Totowa and Lincoln (possibly Pennington and Molly Ann brooks)

- Strong effect of CSO discharge at downstream of Morlot site

- Effect of rainfall on tributaries:
  - increased concentrations at Goffle and Westside
  - dilution effect at Pennington

- Strong relationship between FC and EC concentrations
Future Course of Action

- Two wet weather events and one dry weather event
- Added a sampling site upstream of Pennington (Garrett Mountain)
- A sampling site added at the Molly Ann diversion tunnel
- Focus on higher-intensity rainfall events
Acknowledgements

- NJDEP
- PVSC
- Jim and Rob DeBlock
- Paterson and Elmwood Park Municipalities
- Tina Singh and Fionnuala Coyle
- Numerous graduate and undergraduate students from the Stevens Institute Department of Civil, Environmental and Ocean Engineering
Questions, Suggestions, Comments?