

# Evaluating the Success of the Narragansett Bay Commission's CSO Abatement Program

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# Narragansett Bay Commission

- Narragansett Bay Commission (NBC) is a quasi-state agency which oversees the two largest WWTFs in Rhode Island:
  - Bucklin Point in East Providence
  - Field's Point in Providence
- Service area: 10 municipalities
- 360,000 people served including 8,000 commercial and industrial customers



# NBC's WWTFs

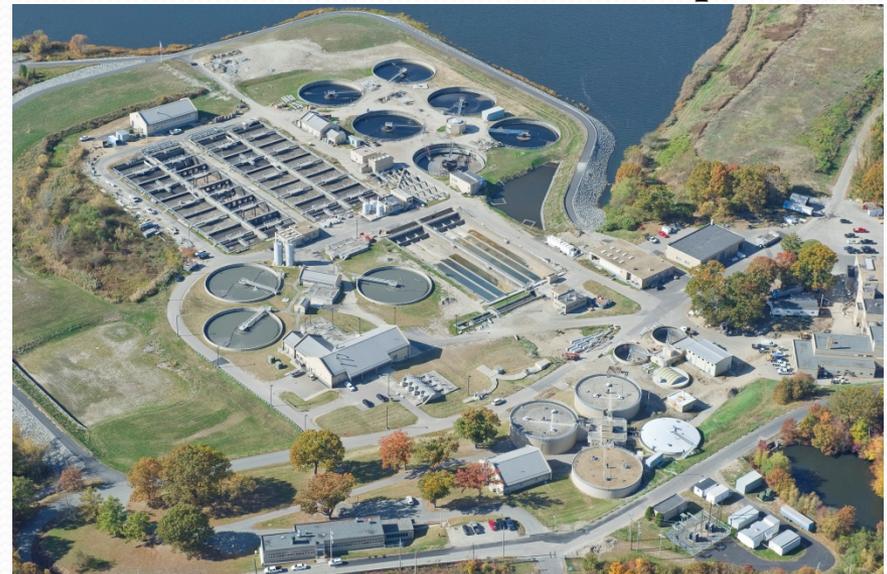
## Field's Point WWTF

- Avg dry weather flow of 45 MGD
- Hypochlorite for Disinfection
- 65 MG CSO Tunnel – 2008
- BNR upgrade – 2014 (5 mg/L TN)
- Mixed of industrial, medical, food service & residential input



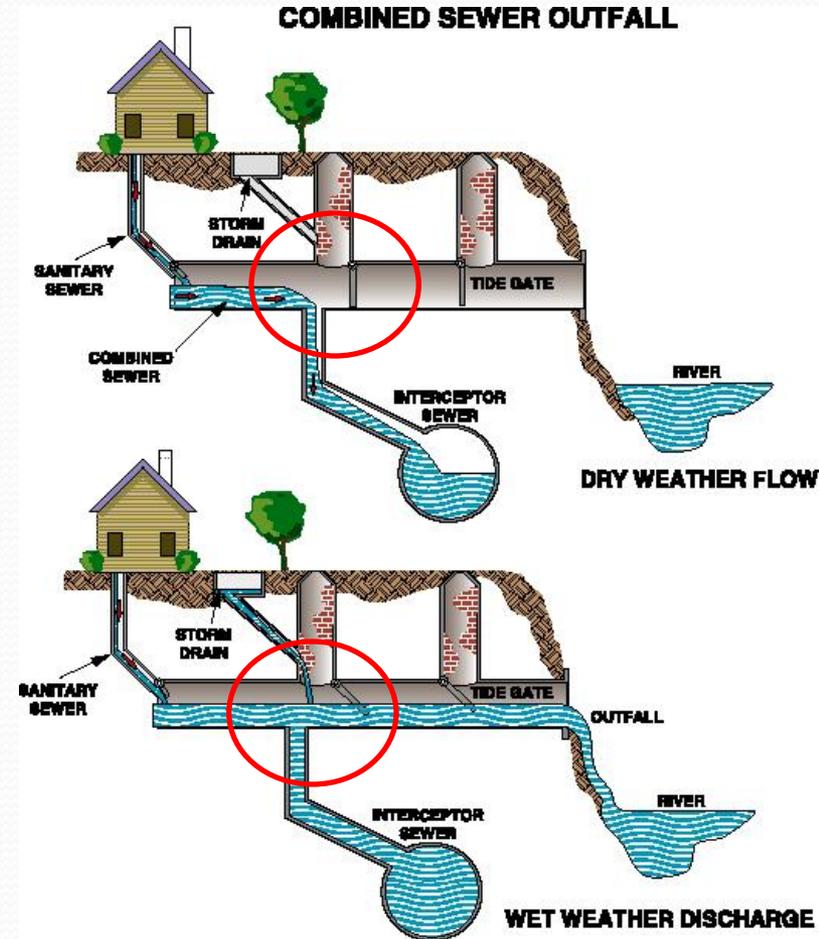
## Bucklin Point WWTF

- Avg dry weather flow of 24 MGD
- UV for Disinfection
- BNR install 2006 (8.5 mg/L TN)
- BNR upgrade 2014 (5 mg/L TN)
- Mixed of industrial, medical, food service & residential inputs



# What is a CSO?

- Legacy of 100 year old sewer systems
  - Providence, Pawtucket, Central Falls
- Overflows occur when stormwater overwhelms capacity of sewer pipes
  - excess stormwater/sanitary sewage discharges into local rivers
- Contains a mix of residential, industrial & commercial business discharges which effect public health & water quality
- Discharges violate Clean Water Act



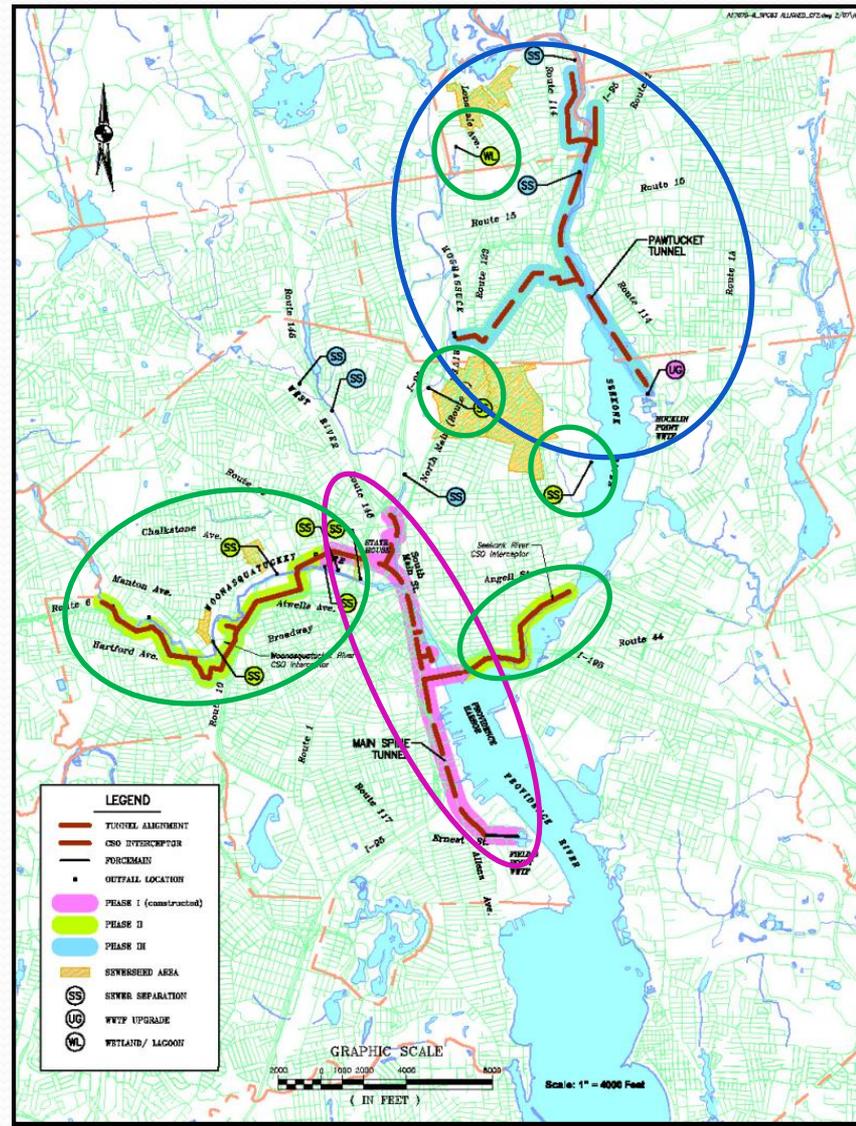
# CSO Abatement Project: 3 Phases - ~\$1.2 Billion

## Three Phases over 20 years

- Design storm: 3-month - 1.6 inches of rain in 6 hours

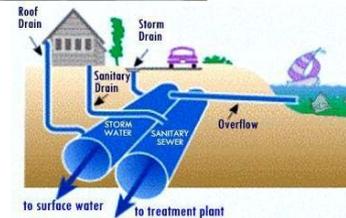
## PHASE I (2001 – Nov 2008)

- 26 ft diameter deep rock tunnel
- 3+ mile long, 300 ft. below ground
- 62 MG design capacity (actual~65 MG)
- 7 drop shafts to divert flow to tunnel
- Diversion structures at 8 CSOs
- Relief structures at 2 interceptors
- Collects sewer/stormwater from 12 CSOs in FP area
- **Actual Cost: ~\$359 million**

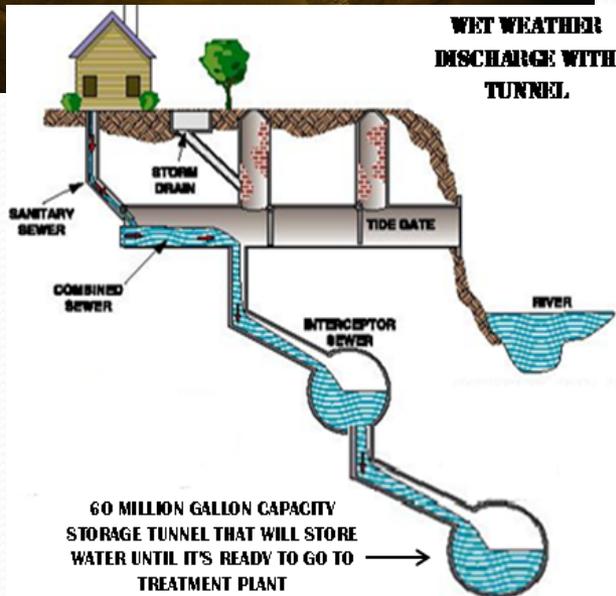


# Phase II of CSO Abatement

- Focused to improve water quality of Urban Rivers
- Woonasquatucket & Seekonk interceptors constructed to transport flow to the CSO tunnel
- Two sewer separations –
  - Construct new storm sewers via conventional open-cut trenching methods
  - Extensive utility impacts
    - \$3.6 million for gas main replacement
    - \$4.25 million for water main replacement
- Constructed wetlands facility in Central Falls
  - 0.32 MG of storage
  - Pumped to sanitary sewer after rain event
  - Overflows to wetlands when tanks are full
- Flows to interceptors end of 2014
- Whole project completed 2015
- Projected costs: **\$213 million**



# CSO Abatement Tunnel: Phase I



## Expected benefits:

- Reduce annual CSO volume by 39%
- Reduce fecal coliform bacteria load by 40%
- Reduce TSS by 30%
- Reduce BOD by 31%
- Reduce the acre-days of shellfish closure in northern half of Upper Narragansett Bay by 47% and 77% in southern half

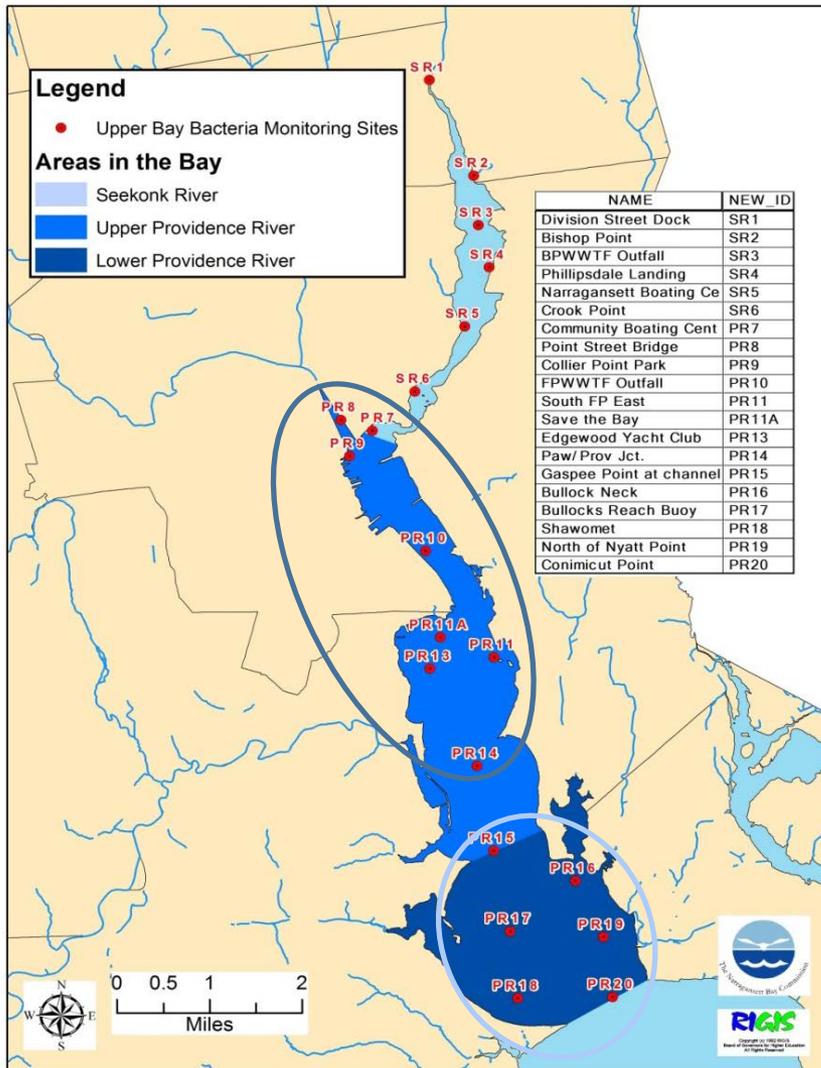
*[Combined system with the 65 million gallon CSO Tunnel, which captures & stores stormwater until it can be treated at the WWTF.](#)*

# Pollutants Removed Due To Tunnel

- Tunnel captured 6.5 billion gallons of CSO flow over past 6+ years (through 7/24/15)
- Captured Flow is pumped to FP WWTF and receives full secondary and tertiary treatment
- ~1.1 billion gallons/year captured
  - 50% of the CSO volume captured and treated annually (based on design model)
  - 50% Bacteria Load Reduction!!!
- Millions of pounds of pollutants prevented from being discharged
  - >2.5 Million Pounds TSS
  - >1.6 Million Pounds BOD
  - ~255,000 Pounds Nitrogen
  - >80,000 Pounds of Metals

Contaminant	Average Concentration CSO Tunnel Effluent		Total Pounds Removed by Capture in Tunnel & Treatment at Field's Point
Total Volume Captured in Tunnel	6,502,000,000 gallons		
Total Suspended Solids	50.54	mg/L	2,529,575
Biochemical Oxygen Demand	32.15	mg/L	1,621,114
Total Nitrogen	8.50	mg/L	255,535
Cyanide	6.29	µg/L	263
Aluminum	240	µg/L	12,316
Cadmium	1.27	µg/L	65
Chromium	5.67	µg/L	267
Copper	11.52	µg/L	525
Iron	1,432	µg/L	66,286
Lead	9.38	µg/L	462
Nickel	17.48	µg/L	292
Silver	2.02	µg/L	105
Zinc	30.98	µg/L	1,255

# Upper Bay Bacteria Monitoring

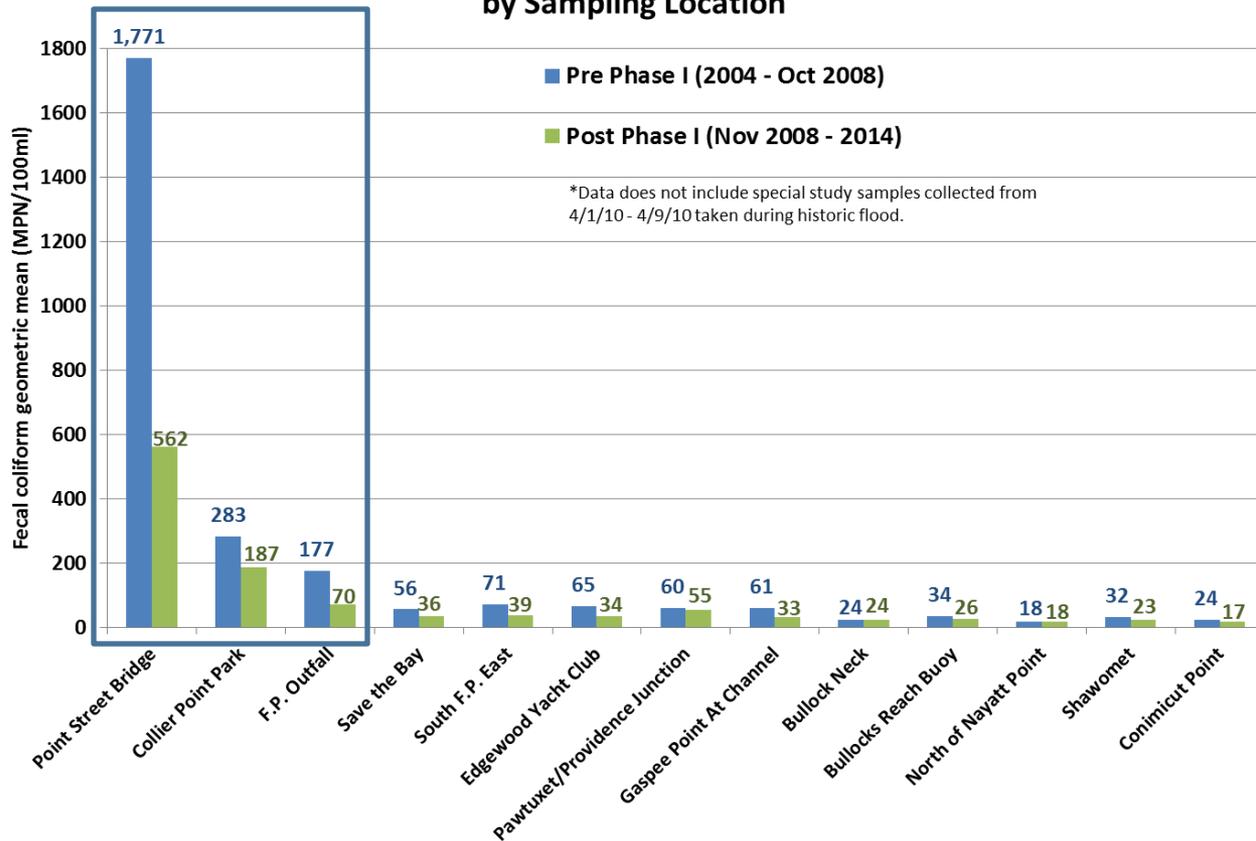


- 20 monitoring stations in Seekonk and Providence Rivers
- Biweekly throughout year for fecal coliform bacteria
- Pre-Phase I (2004 – Oct 2008)
- Post-Phase I (Nov 2008 – 2014)
- Extra sampling conducted during March 2010 storms were excluded from analysis (April 1 – 9, 2010)
- Wet day – rainfall 3 days prior >0.1 inches
- Dry day - rainfall 3 days prior <0.1 inches
- Water Quality Determination
  - May – October
  - Geomean < 50 MPN/100 mL
  - Not more than 10% samples > 400 MPN/100 mL

# Upper Bay Bacteria Data Analysis

## Providence River – All Weather

Fecal coliform Geometric Mean Pre and Post Phase I  
by Sampling Location



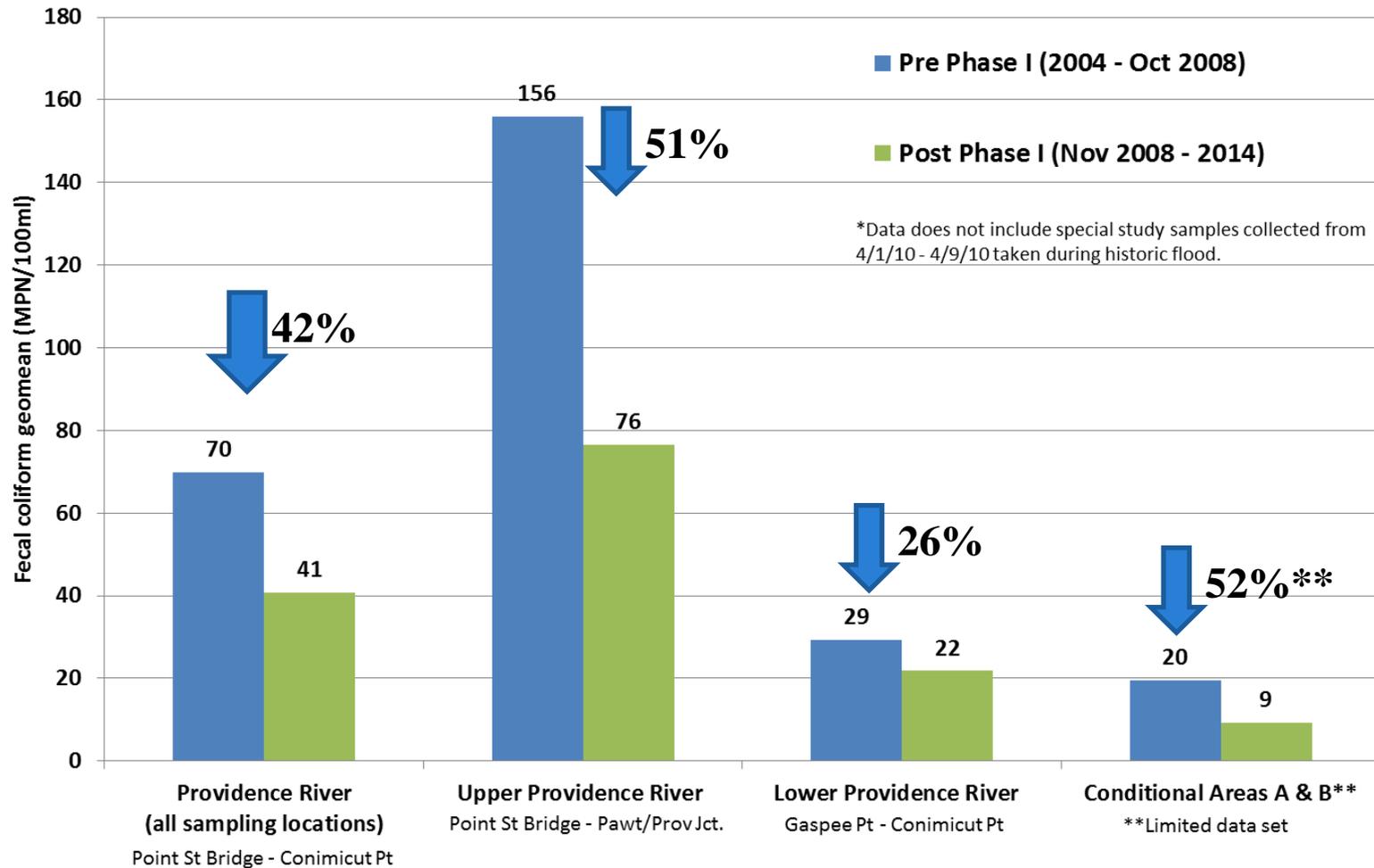
Point Street Bridge  
closest to CSOs tied  
into Tunnel

**Biggest impact on  
bacteria levels!**  
(70% decrease)

# Upper Bay Bacteria Data Analysis

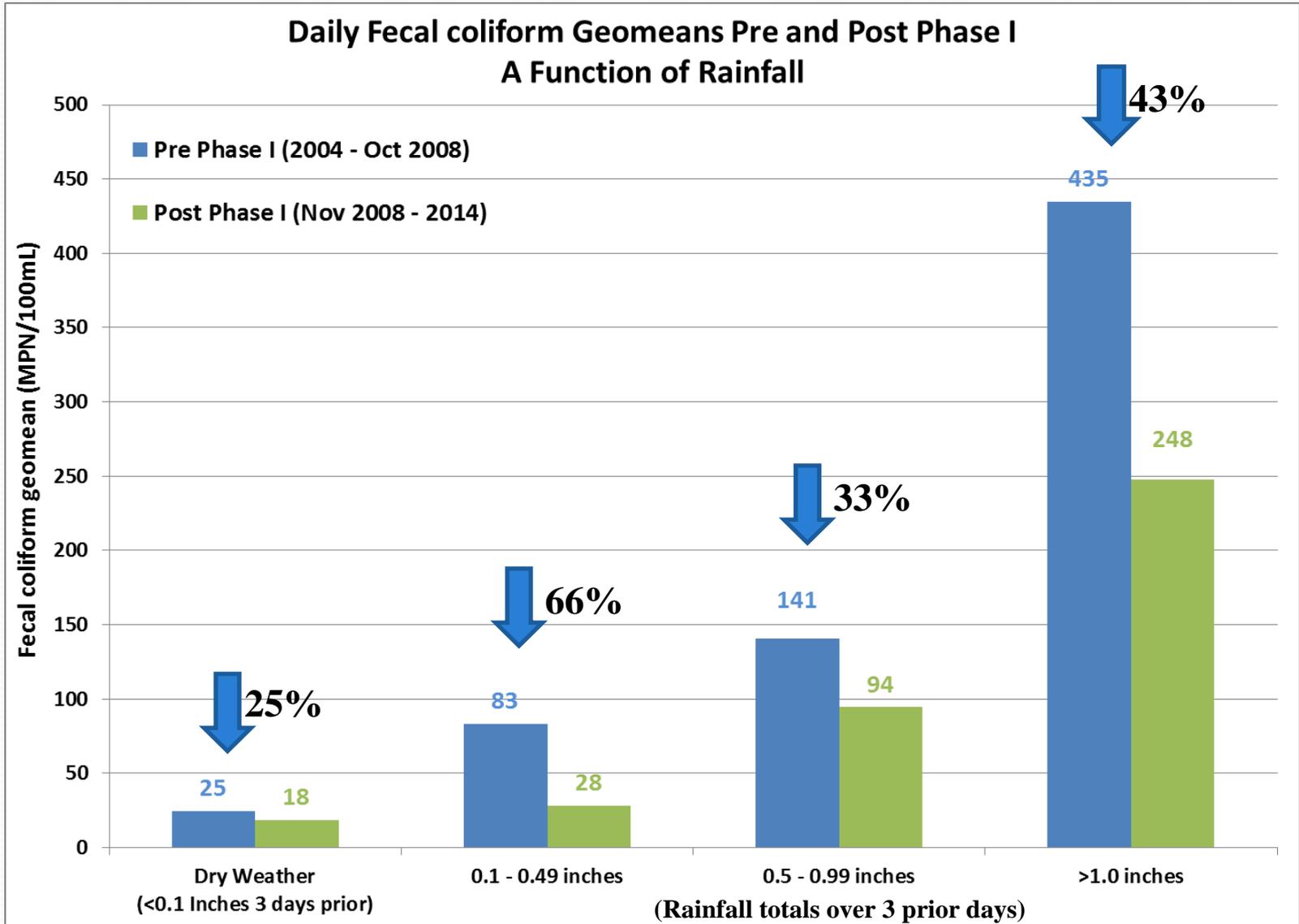
## Providence River – All Weather

Providence River/Upper Bay Fecal coliform Geomeans  
Pre and Post Tunnel Operation



# Upper Bay Bacteria Data Analysis

## Providence River – Wet Weather

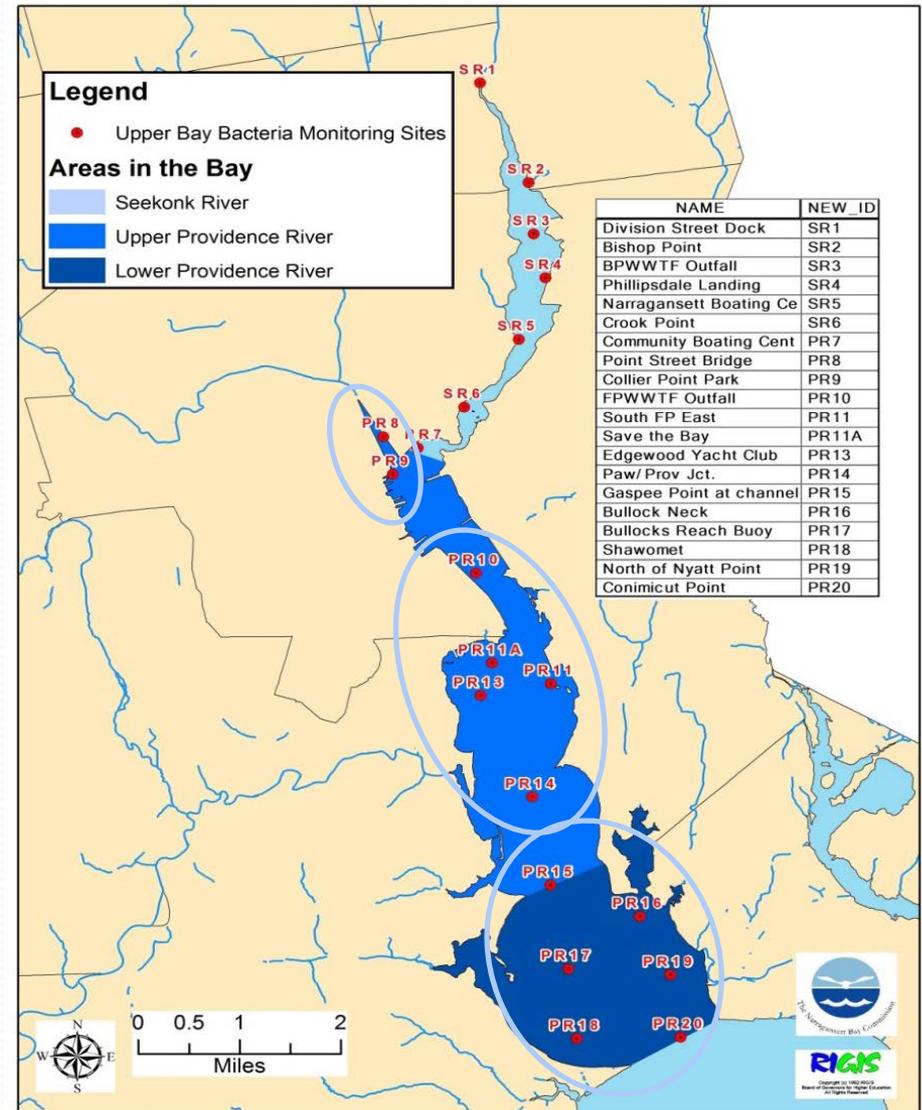


# Upper Bay Bacteria Data Analysis

## Meeting Water Quality Standards?

### Providence River Post Phase I

- Upper Providence River did not meet WQ Standards
- Mid Providence River:
  - Met more frequently after Phase I
  - 2014: ALL stations met for first time!
- Lower Providence River:
  - Met both criteria most years, improved post Phase I
  - 65% of years met pre Phase I
  - 87% of years met post Phase I



# Shellfishing Analysis

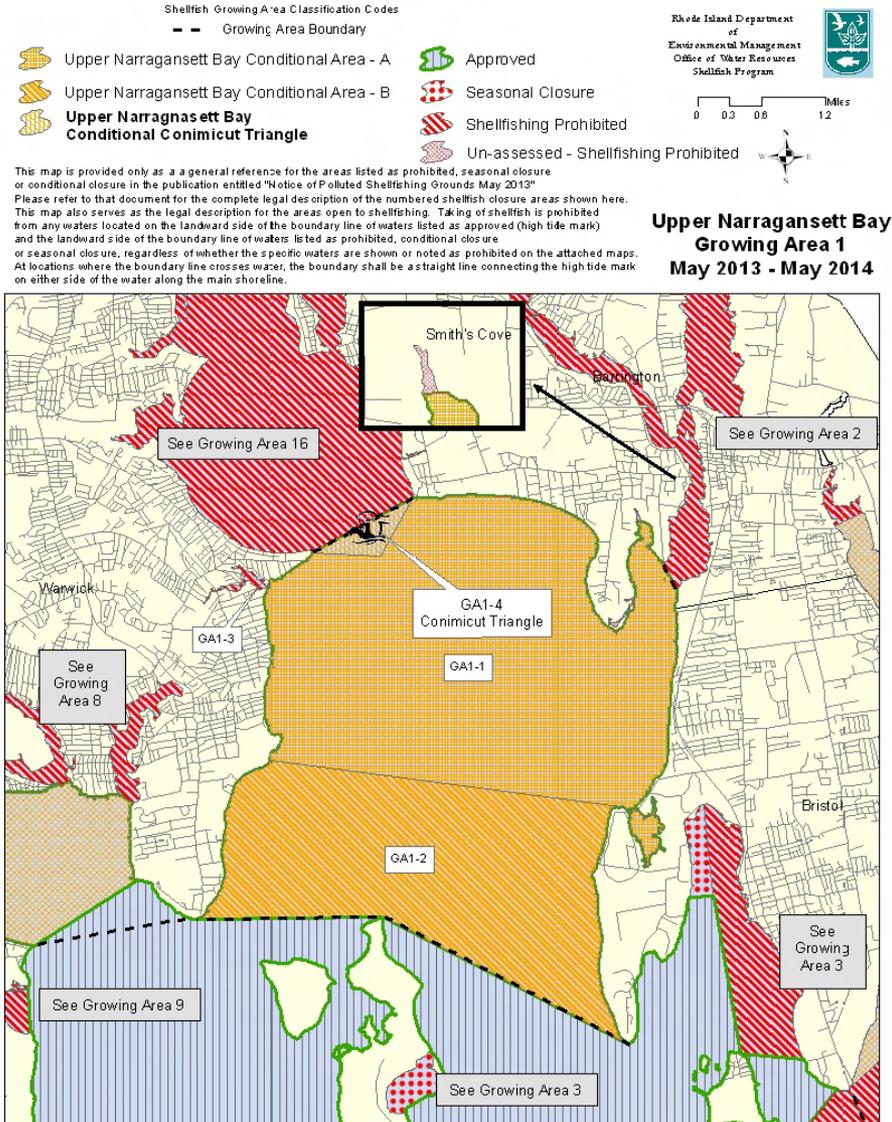
## Has Phase I Improved Upper Bay Shellfisheries?

- **Shellfishing Standard**
  - Geomean < 14 MPN/100 mL
  - Not more than 10% samples > 49 MPN/100 mL
- **Before Phase I:**
  - Cond. Area A closed for week with 0.5 inches of rainfall within a 24 hour period
  - Cond. Area B closed with 1.0 inch of rainfall
- **Regulations Relaxed in 2011:**
  - Cond. Area A closed with 0.8 inches of rainfall
  - Cond. Area B closed with 1.5 inches of rainfall
- RIDEM attributes closure changes to success of Phase I CSO Project
- DEM reevaluating the criteria now that Phase II is complete

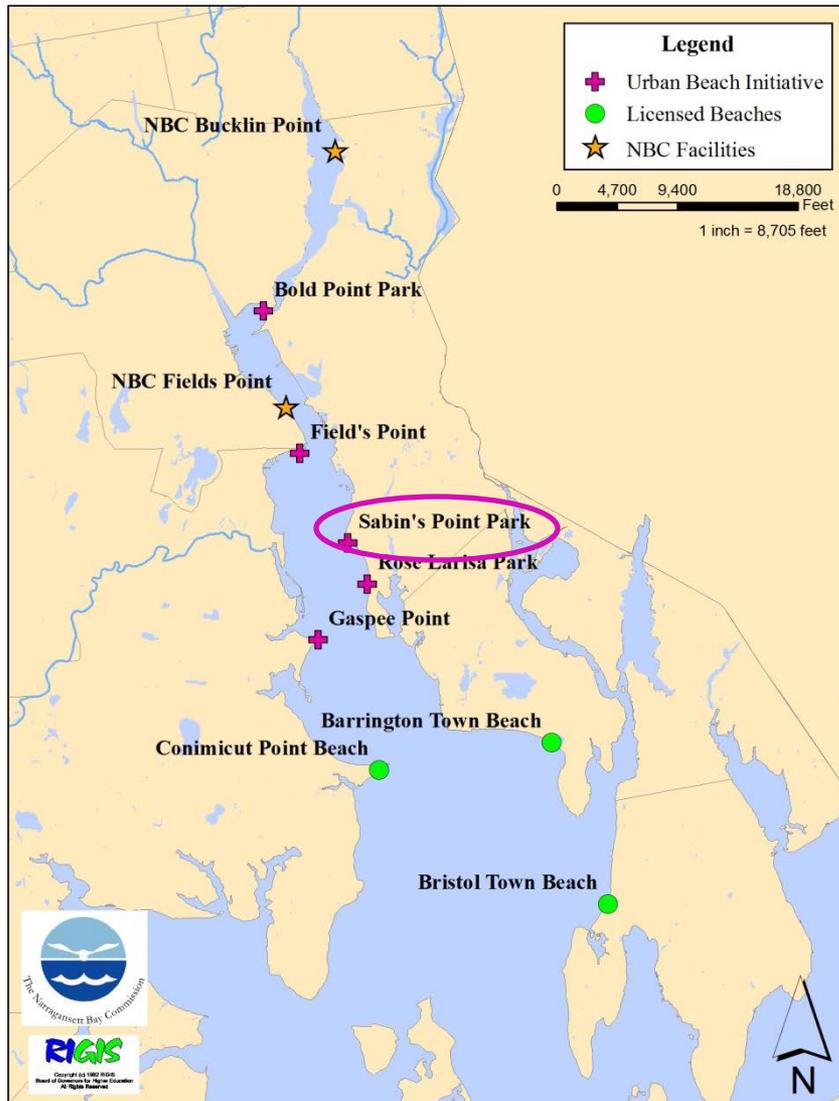


# Shellfishing Analysis

- Conditional Area A expected to be open 65 more days/year
- Conditional Area B is projected to be open 45 more days/year
- 36% increase in number of acre-days that Conditional Areas were open in 2013 compared to 2004 (years of similar rainfall)
- This is important because, in 2012....
  - 45% of the quahog harvest came from Areas A & B (54% in 2014!)
  - Totaling 17.5 million clams
  - Equaling \$2.48 million (Data from J. Mercer, RIDEM)



# DOH Upper Bay Beach Closure Analysis



## RIDOH Report

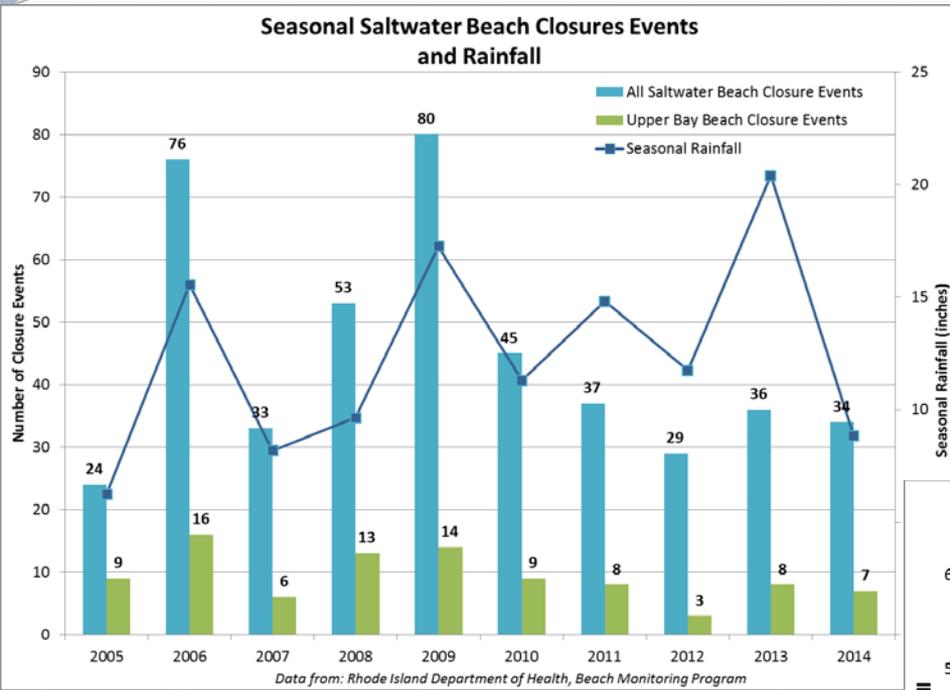
- Evaluated WQ at Bristol, Barrington & Conimicut Beaches for 2006 vs 2010
- Found closure events decreased by 44%,
- Found closure days decreased by 82%
- Attributed to Phase I Tunnel Project

## “Urban Beach Initiative” Report

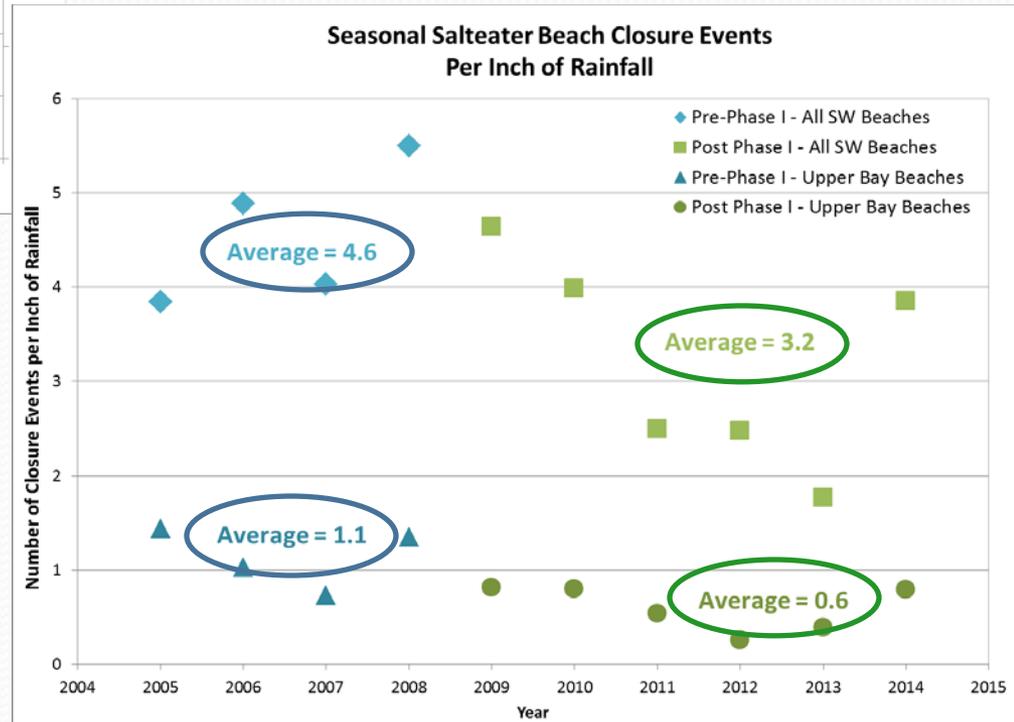
- In 2010, RIDOH sampled 3 beaches in the Providence River - Sabin Pt, Rose Larisa Park & Gaspee Pt
- Since then to include – Field’s Pt, Bold Pt & Stillhouse Cove (assisted by Save the Bay)
- Evaluated for potential use as licensed beaches
- Compliance rate varies with rainfall
- Compliance rates similar to what was found in beaches in areas not impacted by CSO’s
- In 2014, 4 urban beaches compliance: 79 – 100%
- East Providence moving forward to open Sabin Point Beach to bathing!!!

**Phase I has Improved water quality of Upper Bay Beaches**

# Beach Closures



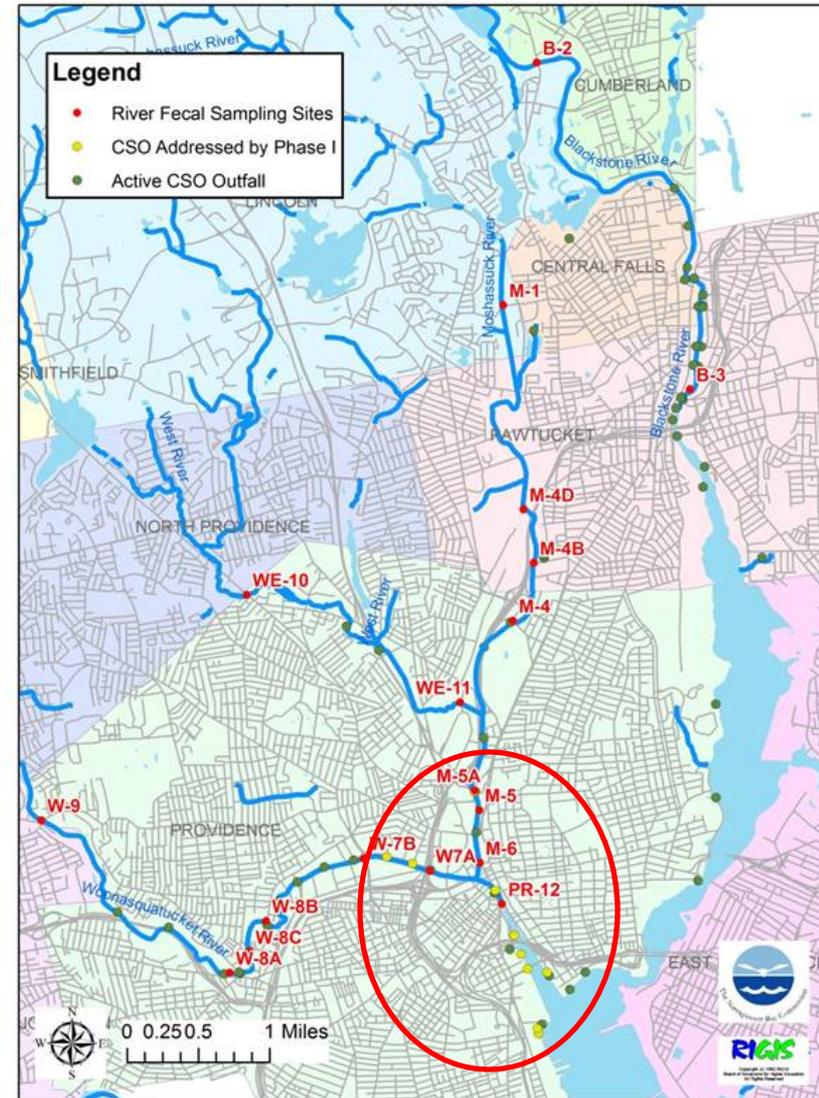
- Prior to 2009, saltwater beach closures varied with amount of rainfall



- Since 2009, beach closures have declined based on the one inch of rainfall

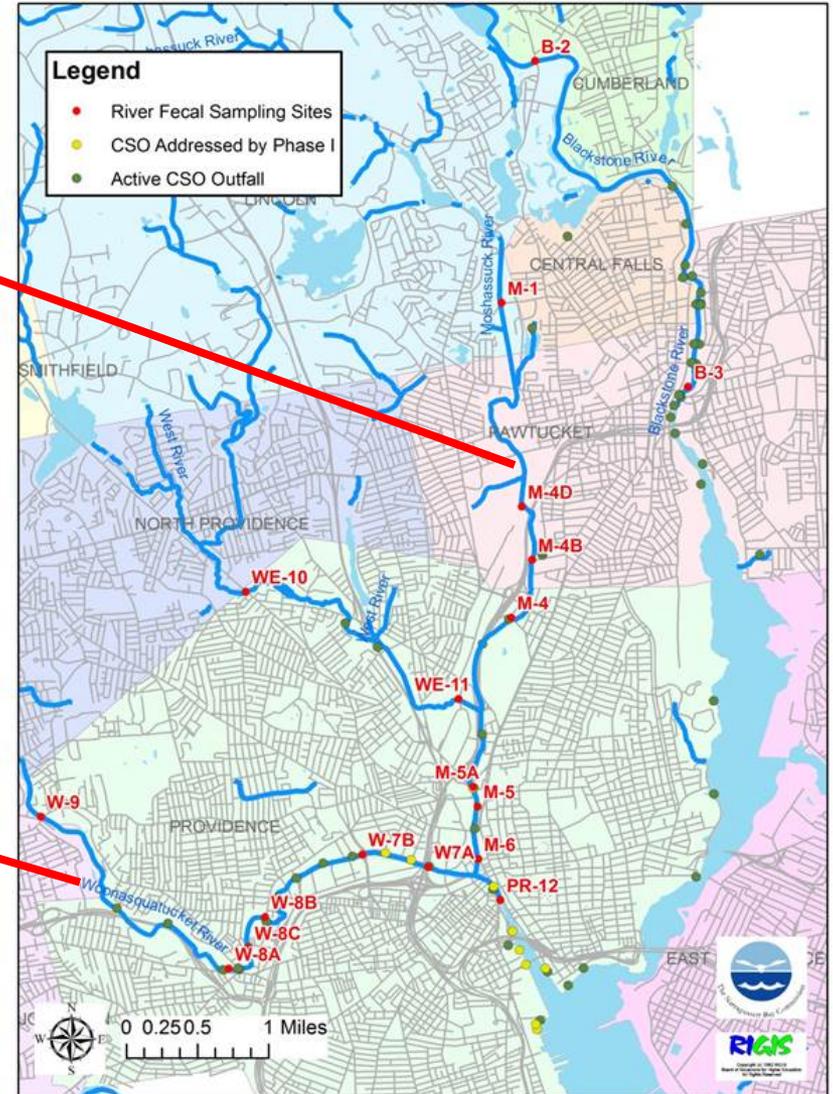
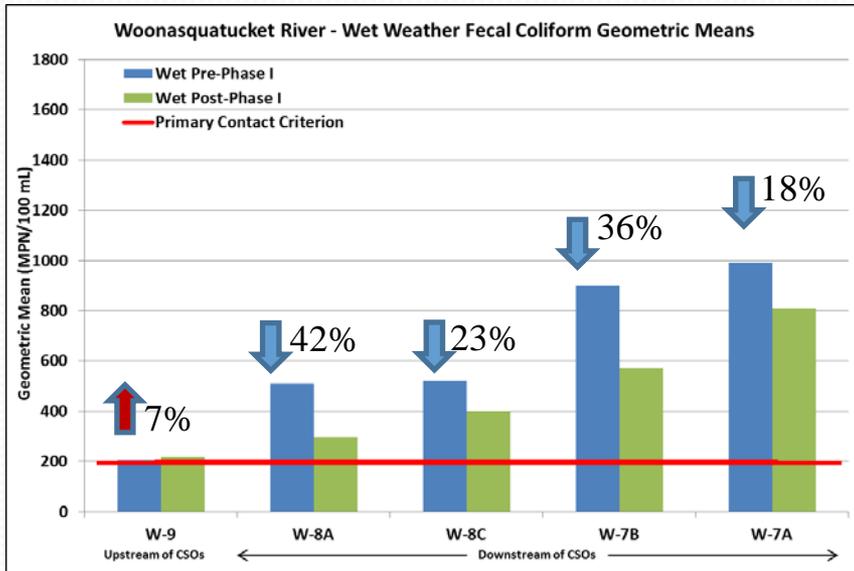
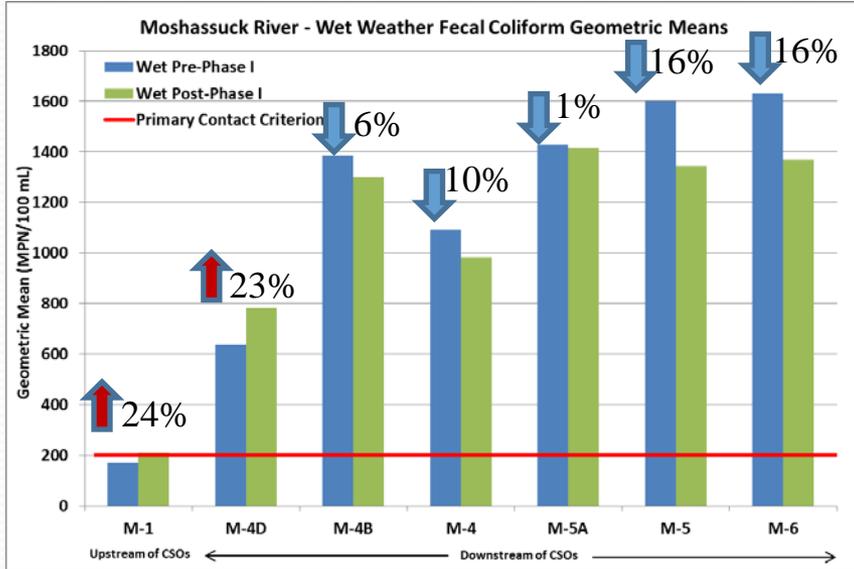
# Urban River Bacteria Sampling

- Required by DEM RIPDES Permits (CSO 9 Minimum Controls Program)
  - Data collected weekly Monday & Tuesday (Thursday if results elevated)
  - Monitor Up/Downstream of CSOs
  - 1 station on Pawtuxet River as baseline
- Includes data from 2004 – 2014
- Pre-Phase I (2004 – Oct 2008)
- Post-Phase I (Nov 2008 – 2014)
- Wet day – rainfall 3 days prior  $>0.1$  inches
- Dry day – rainfall 3 days prior  $<0.1$  inches
- Water Quality Determination
  - May – October
  - Geomean  $< 200$  MPN/100 mL
  - Not more than 10% samples  $> 400$ MPN/100 mL



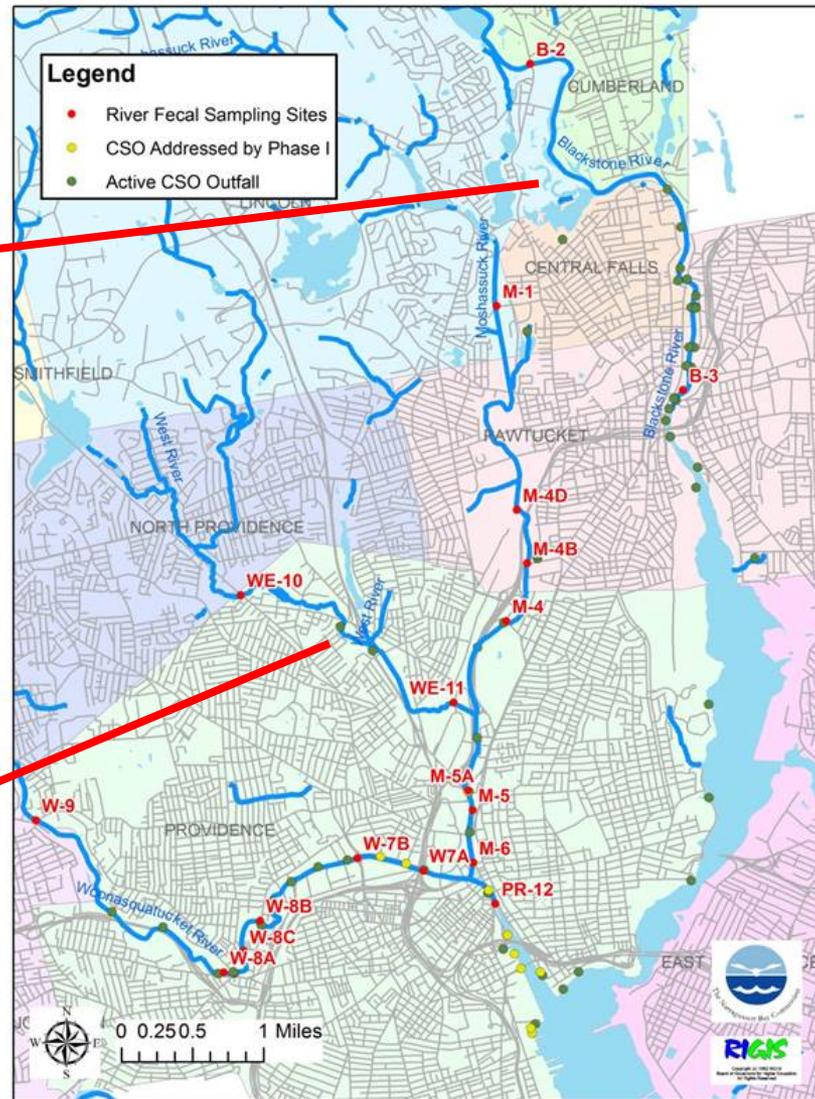
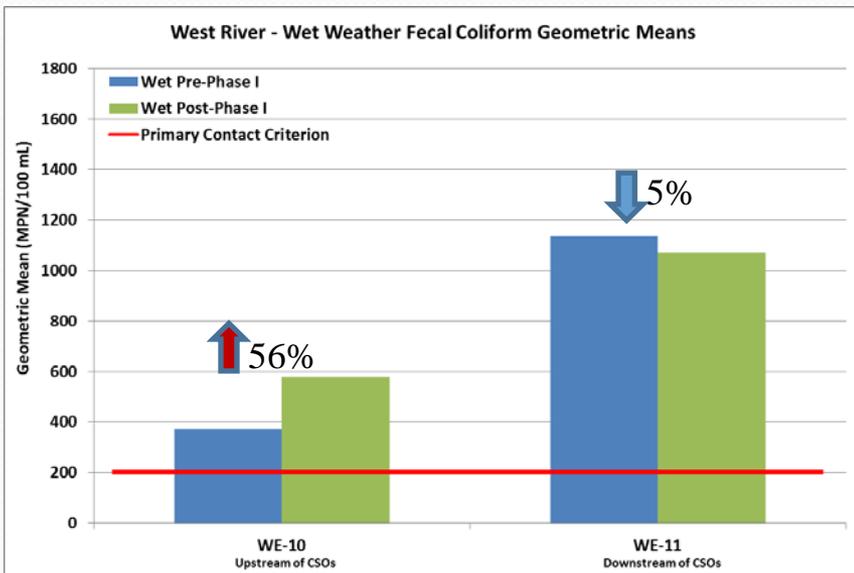
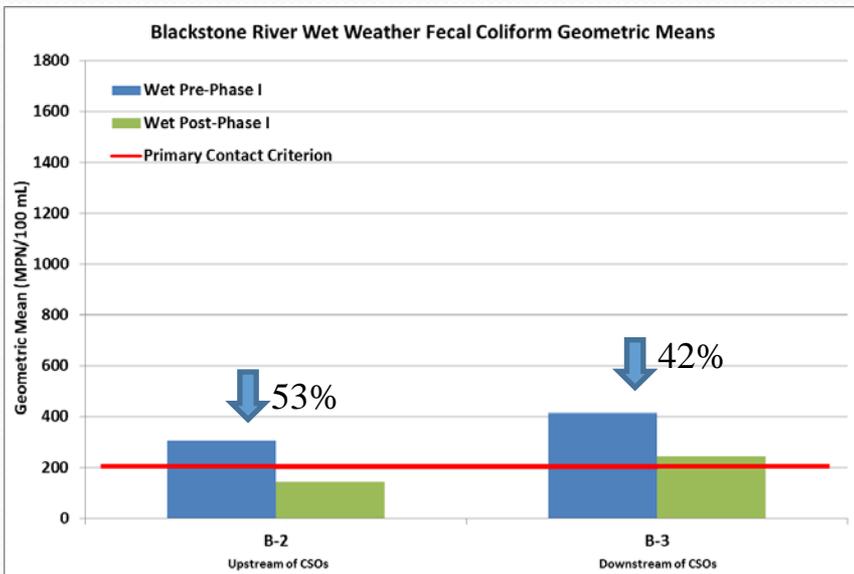
# Urban River Bacteria Data Analysis

## Wet Weather Results Pre vs Post Phase I Tunnel



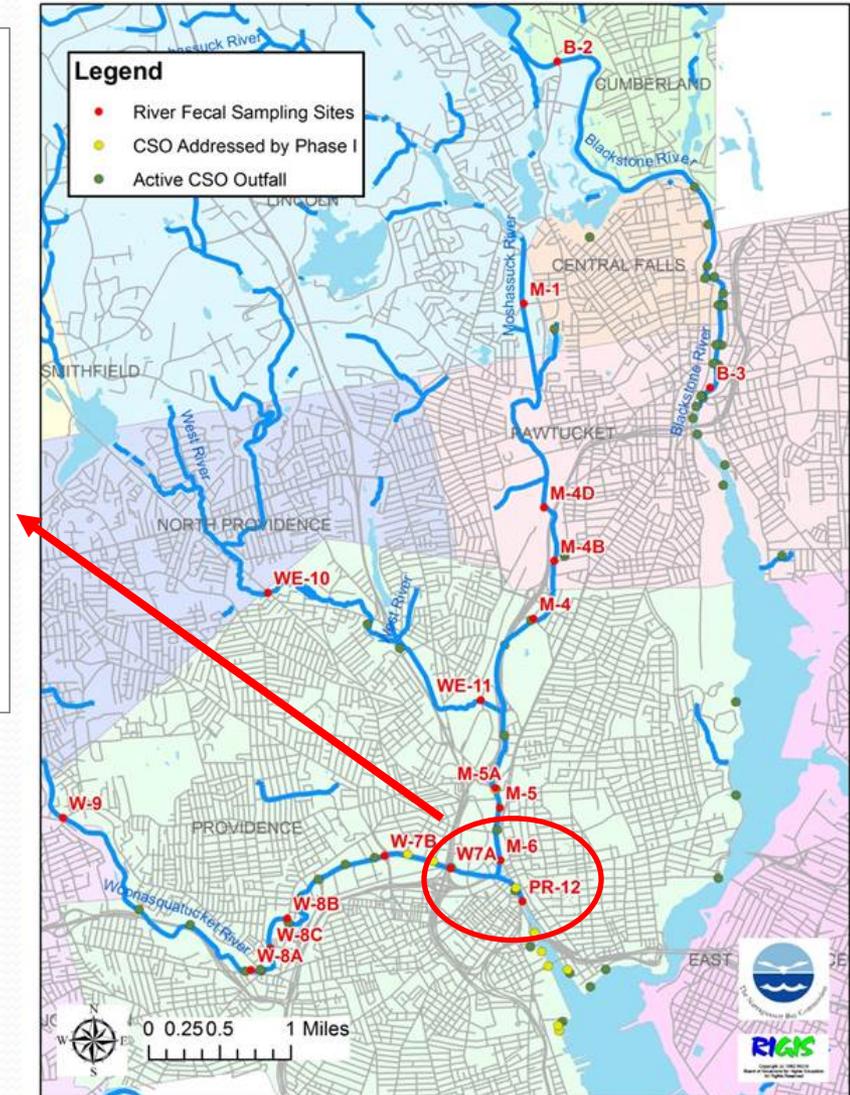
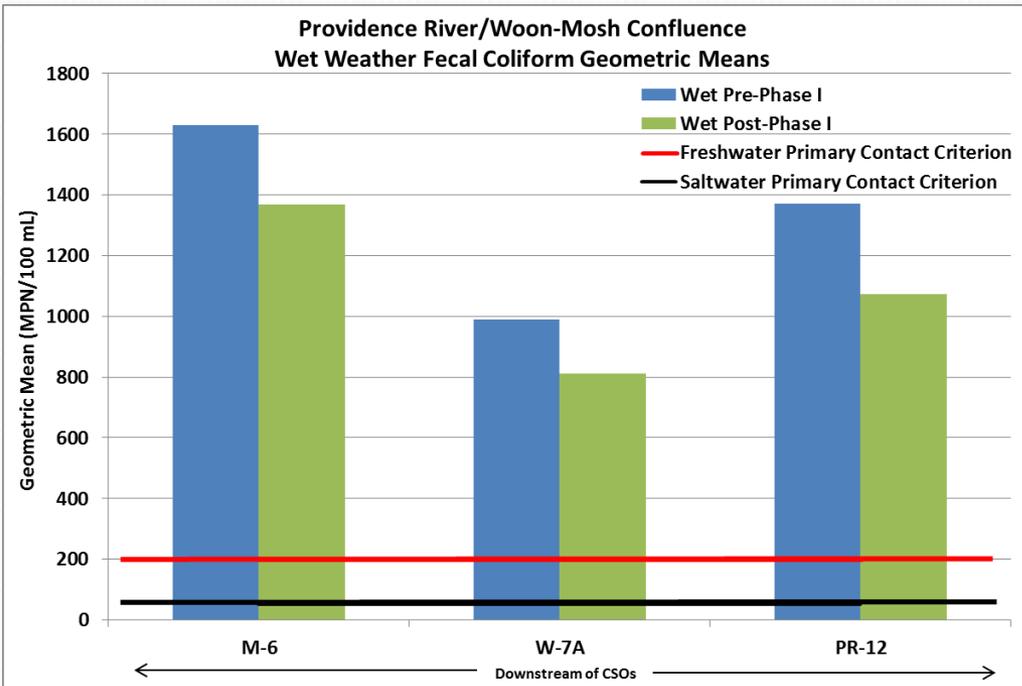
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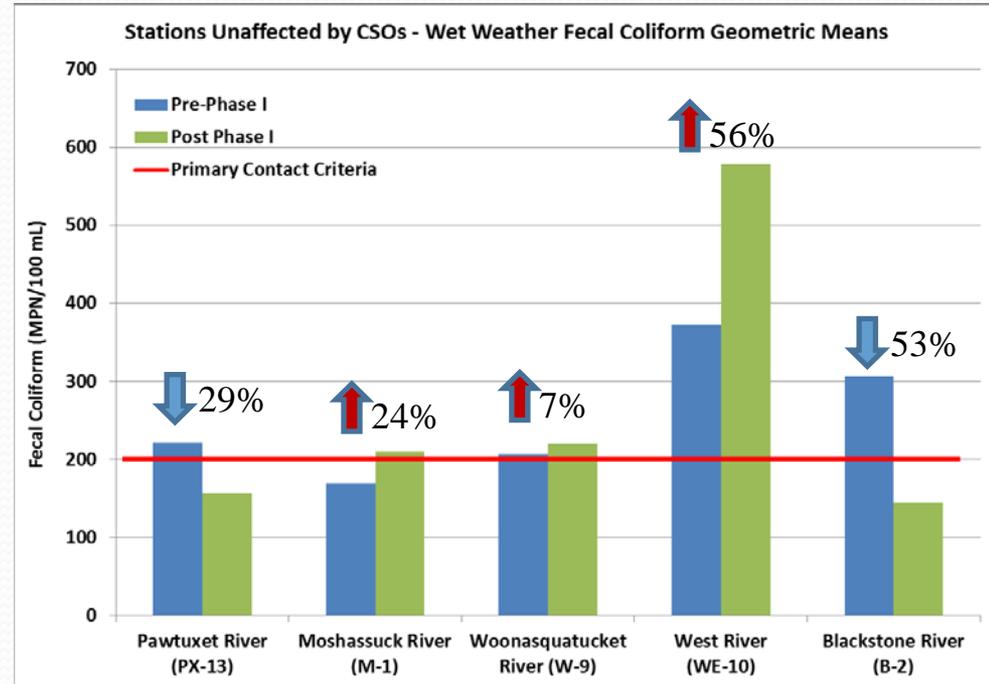
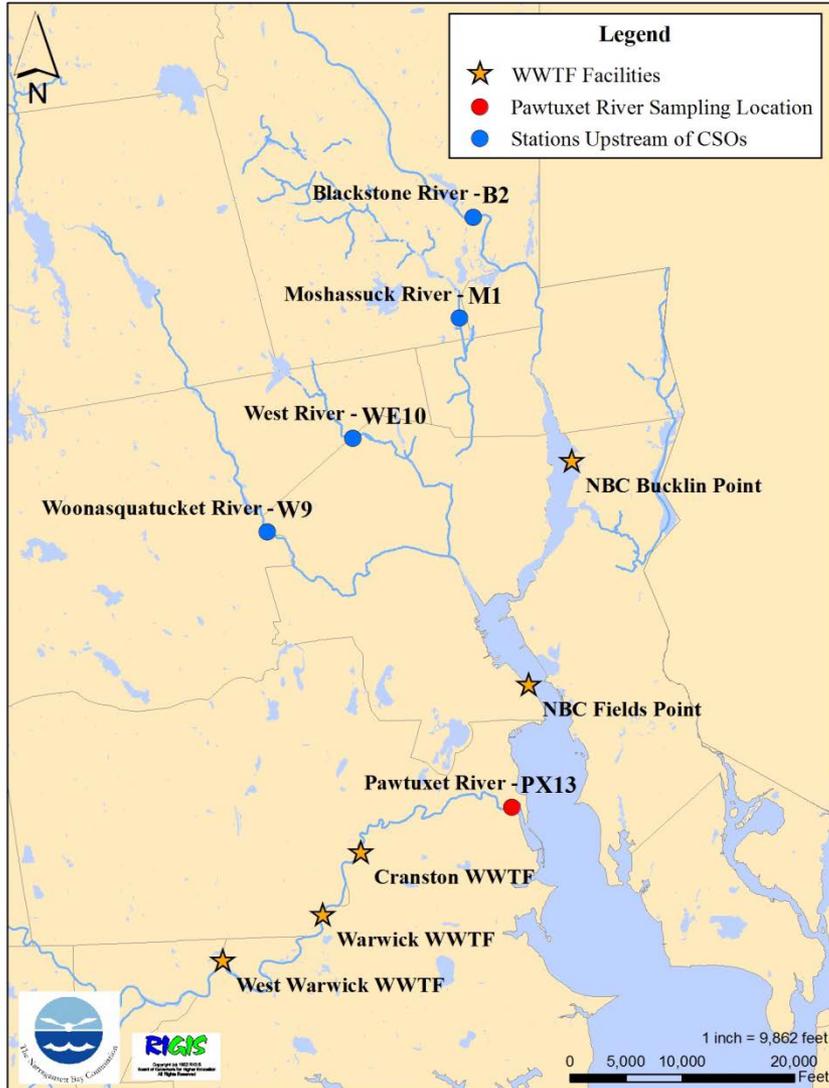
# Urban River Bacteria Data Analysis

## Wet Weather Results Pre vs Post Phase I Tunnel



- Moshassuck River mouth ↓ 16%
- Woonasquatucket River mouth ↓ 18%
- Providence River headwaters ↓ 22%

# Monitoring Stations Upstream of NBC CSOs

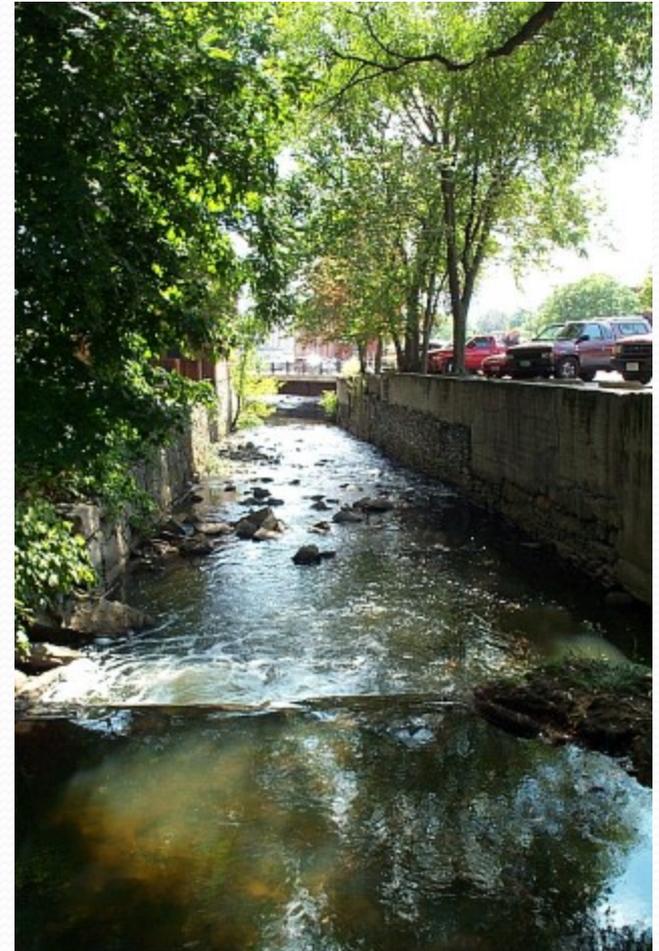


- NBC monitors stations upstream of CSOs
- Also samples Pawtuxet River (no CSOs on this river)
- **NBC Data shows frequent water quality violations at all stations**

# Urban River Bacteria Data Analysis

## Meeting Water Quality Standards?

- **No stations met water quality criteria in all weather conditions (Wet and Dry)**
- Some stations met criteria using only dry weather results, but only in some years
  - Woonasquatucket River station met standards upstream of CSOs in 2008 & 2014
  - Blackstone River station met upstream of CSOs in all years but 2004, 2011 & 2012
  - Blackstone River station met downstream of CSOs in 2012 & 2014
  - Pawtuxet River station met in 2008 & 2009
- **Stations unaffected by CSOs are not always meeting criteria...** other pollution sources upstream of CSOs need to be addressed



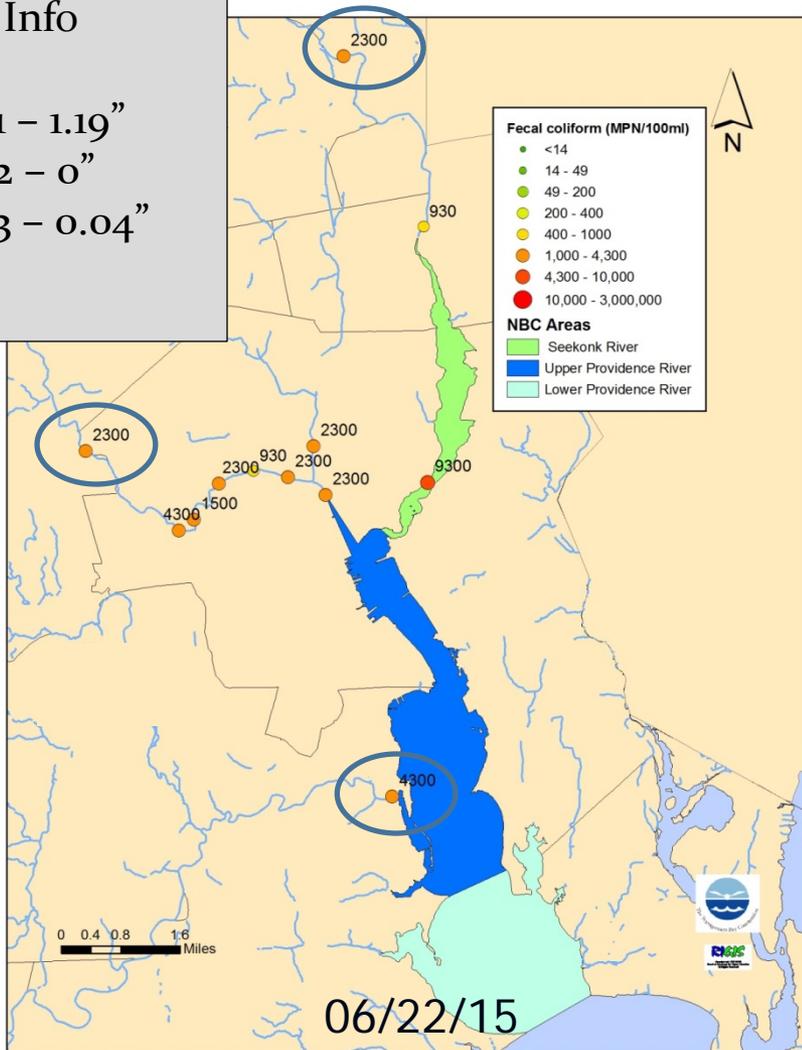
# Monitoring Stations Upstream of NBC CSOs

## Rain Info

06/21 - 1.19"

06/22 - 0"

06/23 - 0.04"



- Stations upstream of CSOs have higher bacteria concentrations than downstream of CSOs
- Pawtuxet River – 2<sup>nd</sup> highest concentration
- Other pollution sources need to be addressed

# Stormwater Impairments

Stormwater Dishcharge Data 2013

Constituent	Units	India Point - East	India Point - West	India Point - Average
Fecal Coliform	MPN/100 mL	24,000	819,756*	252,654
Enterococcus	MPN/100 mL	>2,420	>2,420	2,420
Total Suspended Solids	mg/L	130.00	118.00	124.00
Total Nitrogen	mg/L	4.65	2.74	3.70
Total Kjeldahl Nitrogen	mg/L	3.37	1.60	2.49
Nitrite + Nitrate	mg/L	1.28	1.14	1.21
Ammonia	mg/L	1.92	0.85	1.39
Dissolved Aluminum	µg/L	57.54	69.03	63.29
Dissolved Silver	µg/L	<0.02	<0.02	<0.02
Dissolved Cadmium	µg/L	0.09	0.10	0.10
Dissolved Chromium	µg/L	1.64	4.38	3.01
Dissolved Copper	µg/L	51.68	59.65	55.67
Dissolved Iron	µg/L	169.30	196.60	182.95
Dissolved Nickel	µg/L	1.75	2.42	2.08
Dissolved Lead	µg/L	36.15	27.16	31.66
Dissolved Zinc	µg/L	93.05	140.80	116.93
Total Metals Silver	µg/L	0.07	0.19	0.13
Total Metals Cadmium	µg/L	0.24	0.30	0.27
Total Metals Chromium	µg/L	2.57	9.19	5.88
Total Metals Copper	µg/L	91.95	152.78	122.36
Total Metals Iron	µg/L	1,898	1,757	1,828
Total Metals Nickel	µg/L	<10	<10	<10
Total Metals Lead	µg/L	121.86	194.38	158.12
Total Metals Zinc	µg/L	290.50	220.86	255.68
Total Metals Arsenic	µg/L	1.59	1.49	1.54
Total Metals Selenium	µg/L	1.06	0.56	0.81
Total Metals Aluminum	µg/L	1,446	921	1,184
Total Metals Molybdenum	µg/L	1.35	2.52	1.93



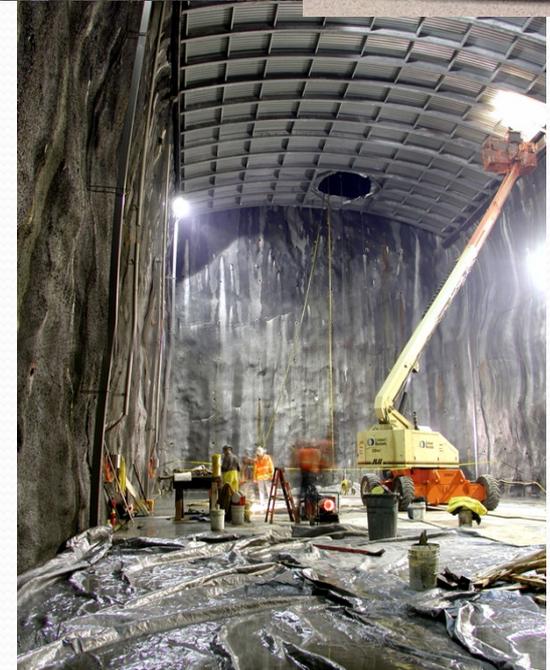
- Stormwater lines at India Point Park sampled on August 22, during a storm of 0.49 inches of rainfall
- Stormwater lines have treatment systems (Vortech systems)
- Variation in some parameters between the outfalls
- Fecal coliform:
  - Range: 24,000 to > 24,000,000 MPN/100 mL
  - Exceeded primary contact criteria
  - All Enterococci samples were > 2,420 MPN/100 mL

\* Geomean of replicate samples: >24,000,000 & 28,000 MPN/100 mL

# Phase I Summary

## Phase I CSO Tunnel Project has:

- Captured ~1.1 Billion Gallons/Year of CSO flow
  - Reduced CSO volume and bacteria loads by ~50%
  - Prevented millions of pounds of pollutants from discharging to our rivers and Narragansett Bay
  - Assisted in reducing beach closures
  - Allowed DEM to relax Shellfishing Closure standards
- 
- NBC Received Water Environment Federation's National Water Quality Improvement Award
  - But, monitoring stations unaffected by CSOs are not meeting standards
  - **NBC CSO Abatement Program WILL NOT meet water quality standards:**
    - ✓ CSO System will still overflow ~ 4 times per year
    - ✓ Other Sources of Bacterial Pollution Needs to be addressed



# Any Questions?

*Special Thanks to:*

- ▶ *Christine Comeau, Catherine Oliver, Eliza Moore, Kimberly Kirwan, Jim Kelly, John Motta & Tom Uva*
- ▶ *NBC Monitoring, Lab & ESTA Staff*



Snapshot of the Bay - Home Page Microsoft Internet Explorer provided by Narragansett Bay Commission

Snapshot of the Bay - Home Page

**SNAPSHOT** WATER QUALITY MONITORING BOATS GLOSSARY PUBLICATIONS

**Welcome**

The Narragansett Bay Commission's (NBC) Mission Statement is to maintain a leadership role in the protection of water quality in Narragansett Bay and its tributaries. The NBC keeps to this vow by continuously monitoring water quality at its two bay locations, collecting water quality casts, mapping surface water quality parameters, and taking samples of the Bay's bacterial and nutrient levels.

**Providence Conditions**

Live Conditions: 4/17/08

Wind	Temperature
Direction	59°F
Speed	11 mph
Pressure	30.07 inHg
Humidity	77%
Visibility	10.00 mi
Clouds	0%

**Bullock Reach**

Last Update: 4/17/08 10:00 AM			
Depth	Surface	Midline	Bottom
Depth (ft)	4.50	4.50	1.00
Temperature (C)	16.00	16.00	16.00
Salinity (ppt)	28.00	28.00	28.00
Chlorophyll (mg/L)	0.00	0.00	0.00
pH	7.70	7.60	7.60
Dissolved Oxygen (mg/L)	1.00	1.00	1.00
Turbidity (NTU)	1.00	1.00	1.00

**Phillipsdale**

Last Update: 4/17/08 10:00 AM			
Depth	Surface	Midline	Bottom
Depth (ft)	1.50	1.50	0.50
Temperature (C)	16.00	16.00	16.00
Salinity (ppt)	28.00	28.00	28.00
Chlorophyll (mg/L)	0.00	0.00	0.00
pH	7.70	7.60	7.60
Dissolved Oxygen (mg/L)	1.00	1.00	1.00
Turbidity (NTU)	1.00	1.00	1.00

**Summary of Water Quality in the Bay**

Fixed Site Network (Historical Blog)

Weeks of May 5<sup>th</sup> - 2008  
4<sup>th</sup>, 6<sup>th</sup>, 8<sup>th</sup> - 2008  
11<sup>th</sup>

Data and Presentations are available on  
NBC Website at  
<http://snapshot.narrabay.com>

