RUTGERS

THE STATE UNIVERSITY OF NEW JERSEY

NATIONAL WATER QUALITY MONITORING COUNCIL

Working Together for Clean Water

NWQMC

New Monitoring & Mapping Technology in Watershed Management

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Environmental Issues in Watershed Management

- Water quality & quantity
- Non-point source pollutants
- Point source pollutants
- Stormwater runoff & erosion
- Safe drinking & irrigation water
- Healthy food

TIERED APPROACH

- Tier 1 - GIS Analysis
  Sampling Sites, Landuse, Landcover, Streams, Sewers,...
- Tier 2 - Ambient Monitoring
  Map waterbodies & Storm Drains, Measure Bacterial “Hotspots”
- Tier 3 - MST Techniques
  Chemical Indicators, Coliphage Isolates, ARA, PCR

New Tools & Technologies

A. Ag Mapping – GPS/GIS
- ARCView 9 & other new software
- Land use data & video modeling

B. Portable Multiparameter Sampling
- YSI/Hydroprobe/Etc field devices
- Hach phosphorus meter

C. Microbial Source Tracking

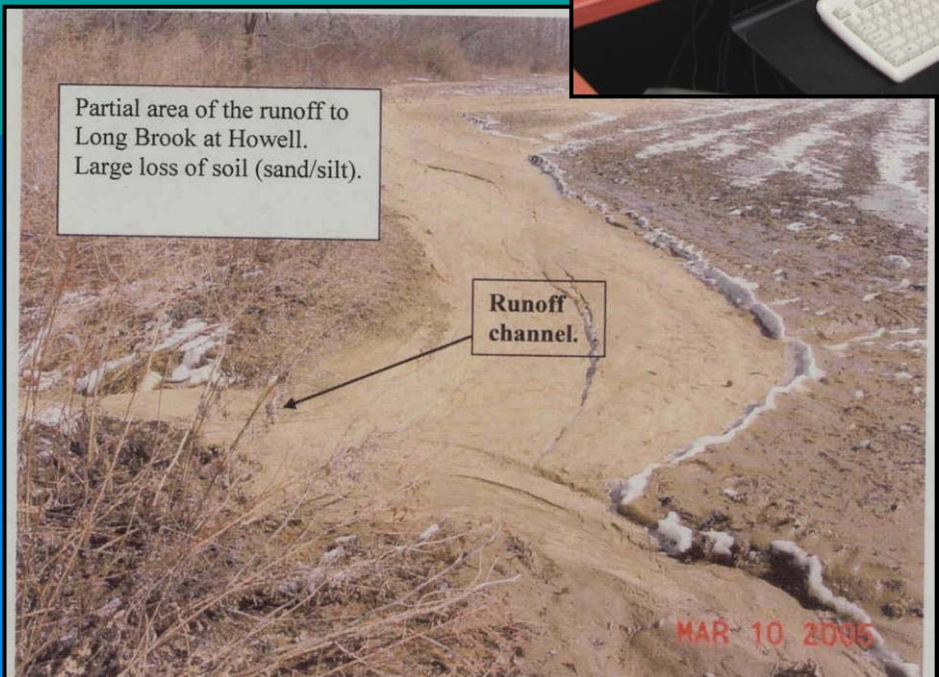
D. Manufactured Devices for Stormwater

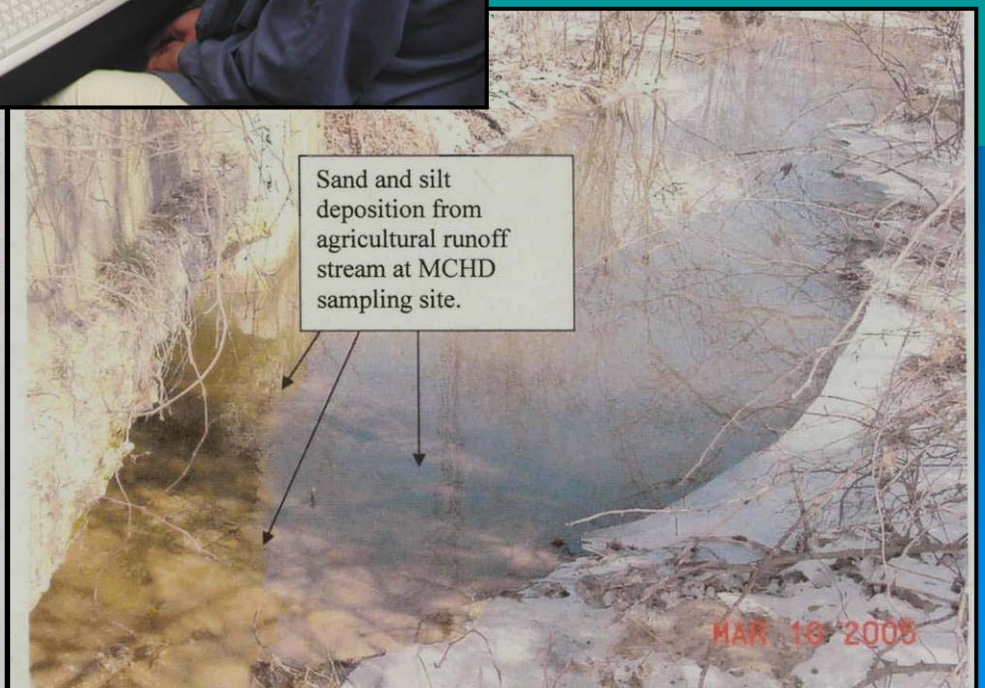
E. Economic analysis – Natural Capital $

New Tools & Technologies

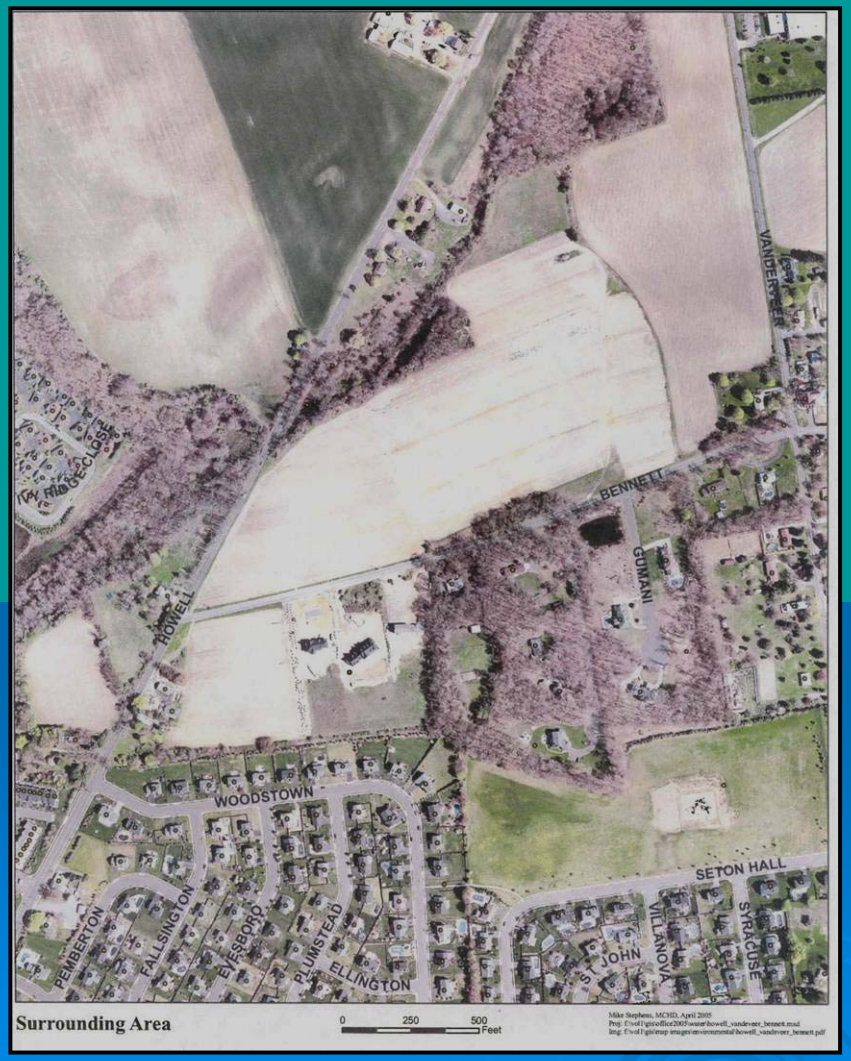
GPS-GIS

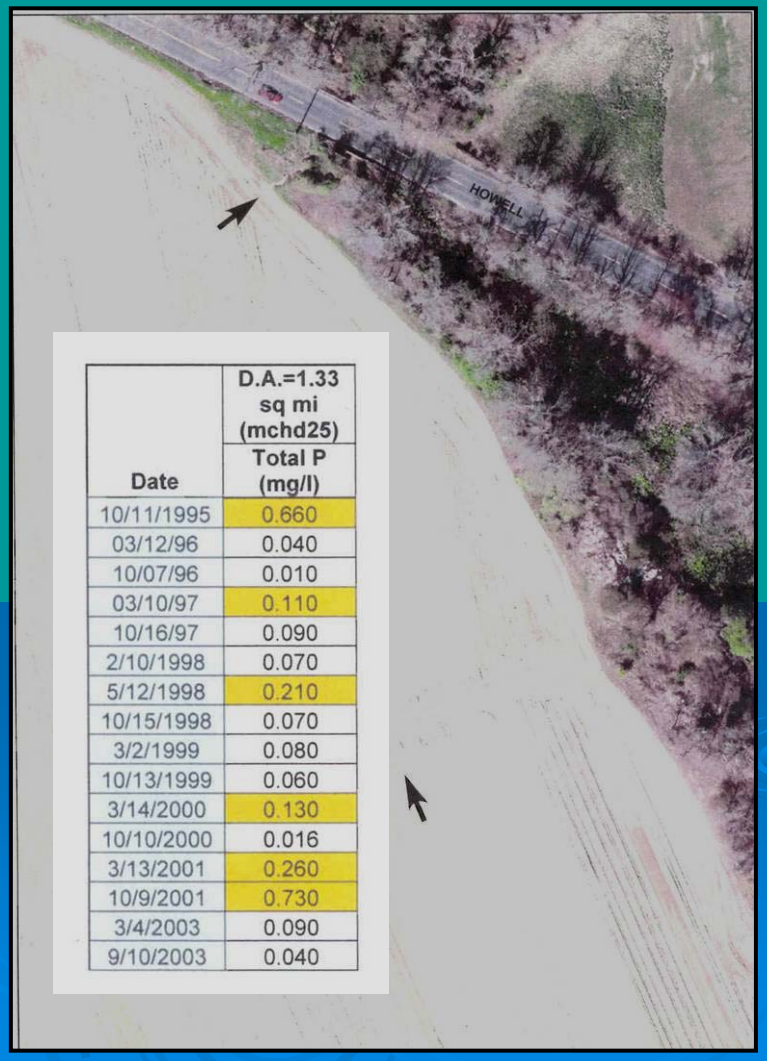
Digital Photos Embedded





Global Positioning System
Geographic Information System





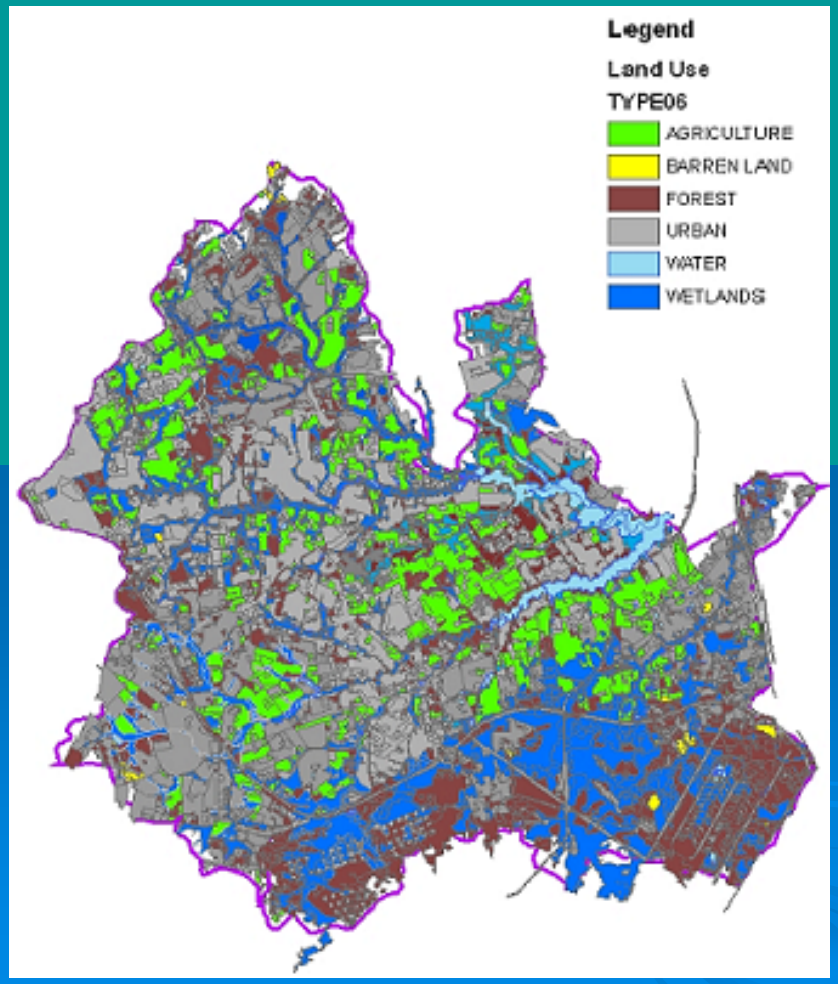
Date	D.A.=1.33 sq mi (mchd25) Total P (mg/l)
10/11/1995	0.660
03/12/96	0.040
10/07/96	0.010
03/10/97	0.110
10/16/97	0.090
2/10/1998	0.070
5/12/1998	0.210
10/15/1998	0.070
3/2/1999	0.080
10/13/1999	0.060
3/14/2000	0.130
10/10/2000	0.016
3/13/2001	0.260
10/9/2001	0.730
3/4/2003	0.090
9/10/2003	0.040

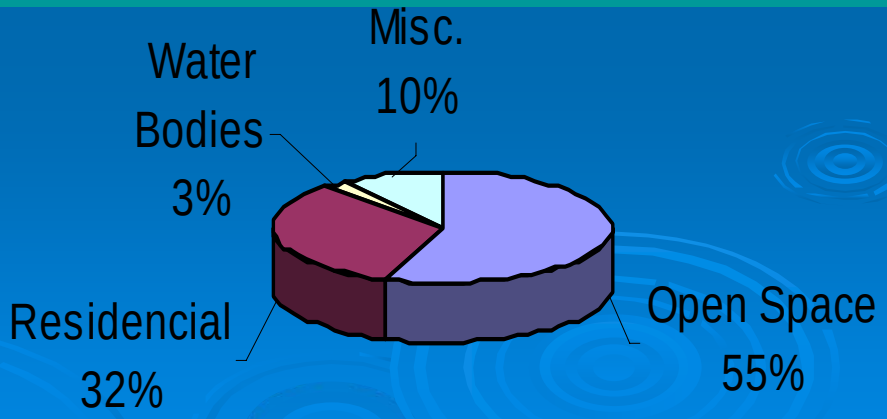
Land Use

- Open Space
  - Agricultural – 4621.90
  - Forest – 6735.45
  - Wetlands – 8361.60
  - Barren Land – 135.88
- Residential – 11530.54

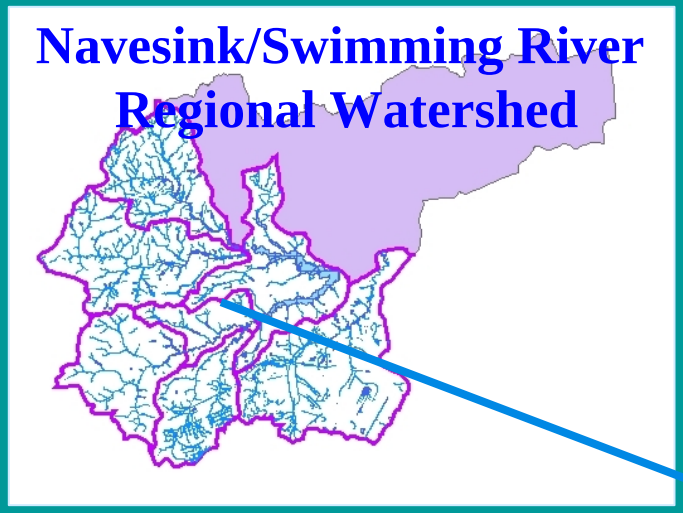
Water Bodies – 933.71

Miscellaneous – 3429.50





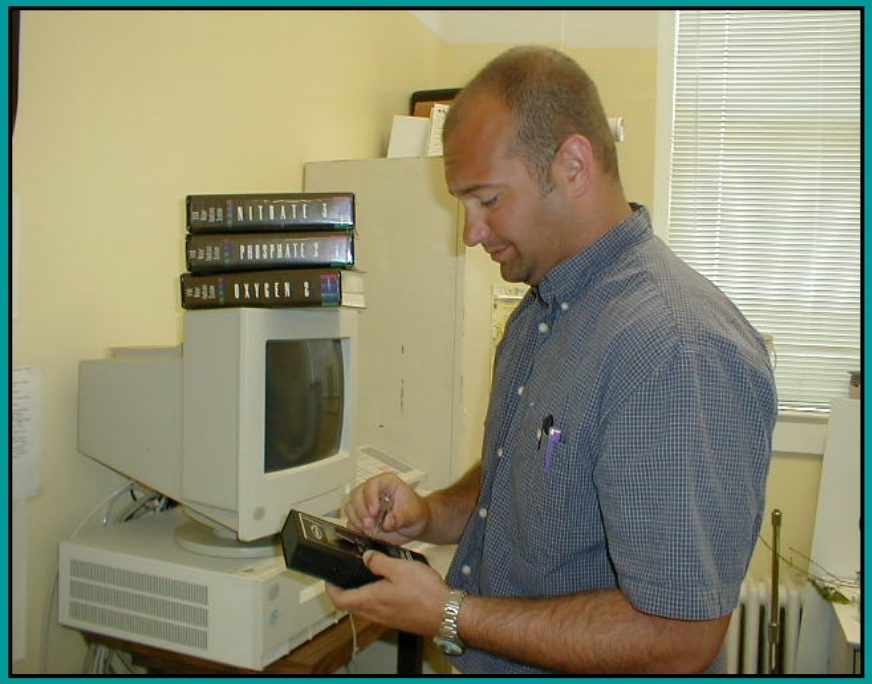
Colts Neck Watershed Overview



The area to be studied is the upstream portion of a larger HUC – 11 Region called the Navesink/Swimming River Watershed (95 sq. mi.)

The area under study is comprised of seven watersheds
and encompasses 55.86 sq. mi.

New Sampling Tools

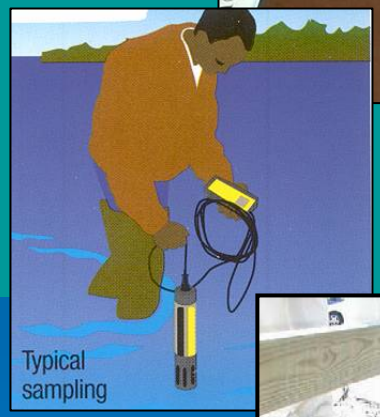


Hach for Phosphorus

Multiparameter probe

MULTIPARAMETER PROBES

Ammonium-nitrogen
non-vented depth
dissolved oxygen
nitrate-nitrogen
temperature
conductivity
vented level
ammonia
turbidity
chloride
salinity
ORP
pH



Nutrients and water quality Data

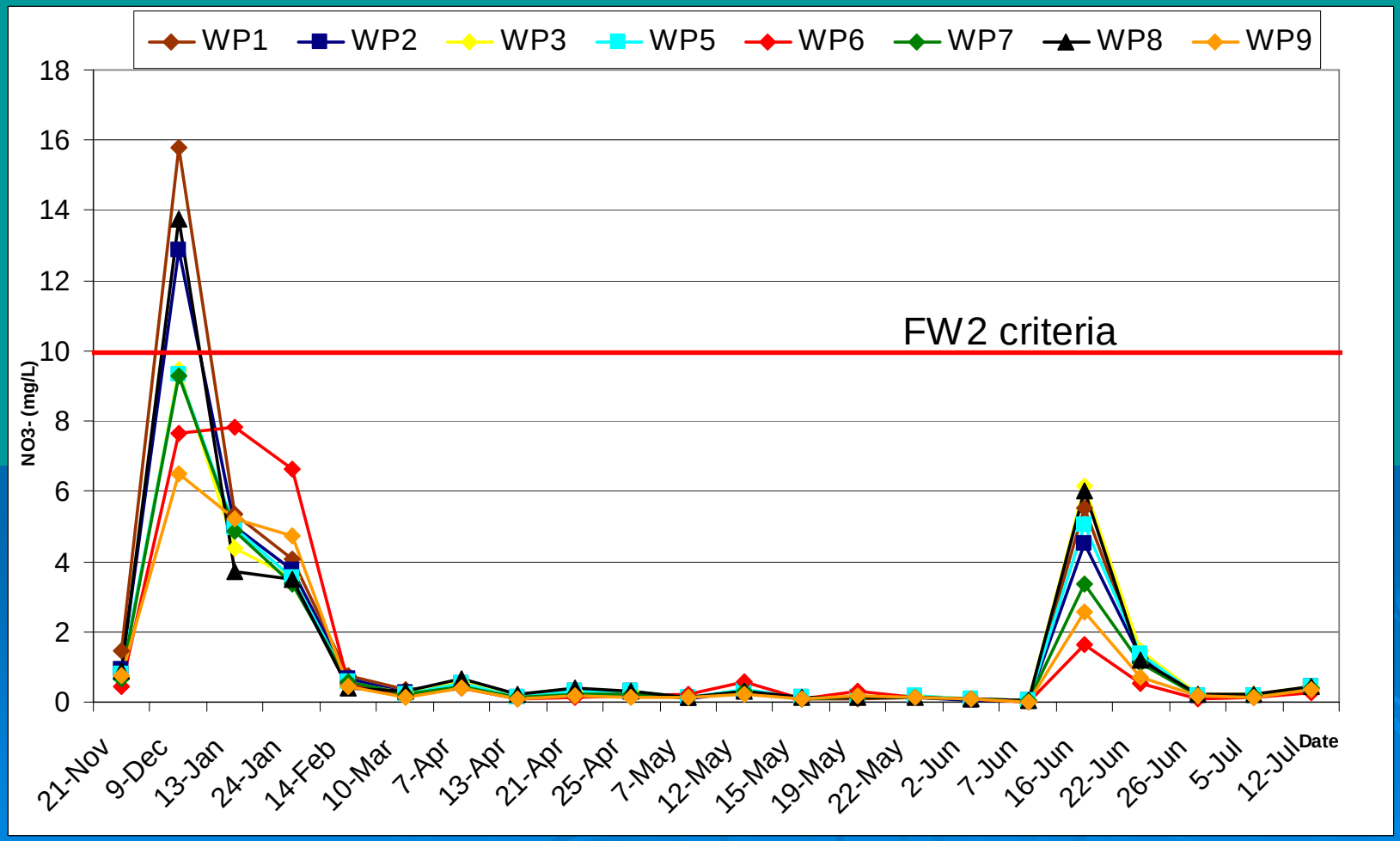
Parameter statistics	Unit	Count	Minimum	Maximum	Median	Average
Temperature	deg, F	175	37.25	78.82	59.73	58.42
Temperature	deg, C	175	2.92	26.01	15.41	14.68
Specific Conductivity	mS/cm	166	0.09	16.20	0.18	0.70
Dissolved Oxygen	mg/L	134	5.90	21.29	12.00	11.87
pH	std. Unit	175	0.13	7.36	6.39	6.10
Ammonia	mg/L	175	0.00	0.04	0.00	0.00
Nitrate	mg/L	175	0.02	15.79	0.32	1.62
Turbidity	NTU	175	0.00	202.80	2.10	8.17
Chlorophyll	ug/L	175	0.00	48.00	3.30	3.72
Orthophosphate	mg/L	144	0.08	1.20	0.26	0.32

Wreck Pond FW2 Water Quality Criteria Exceedences			
Parameter	**Criteria**	**# of Samples***	**# of Exceedences**
Nitrate	< 10 mg/L	175	3
pH	w/i 6.5-8.5	175	110
Dissolved Oxygen	> 4.0 mg/L	134	0
Turbidity (NTU)	< 50 NTU	175	6
		* - Calibrated Data Only	

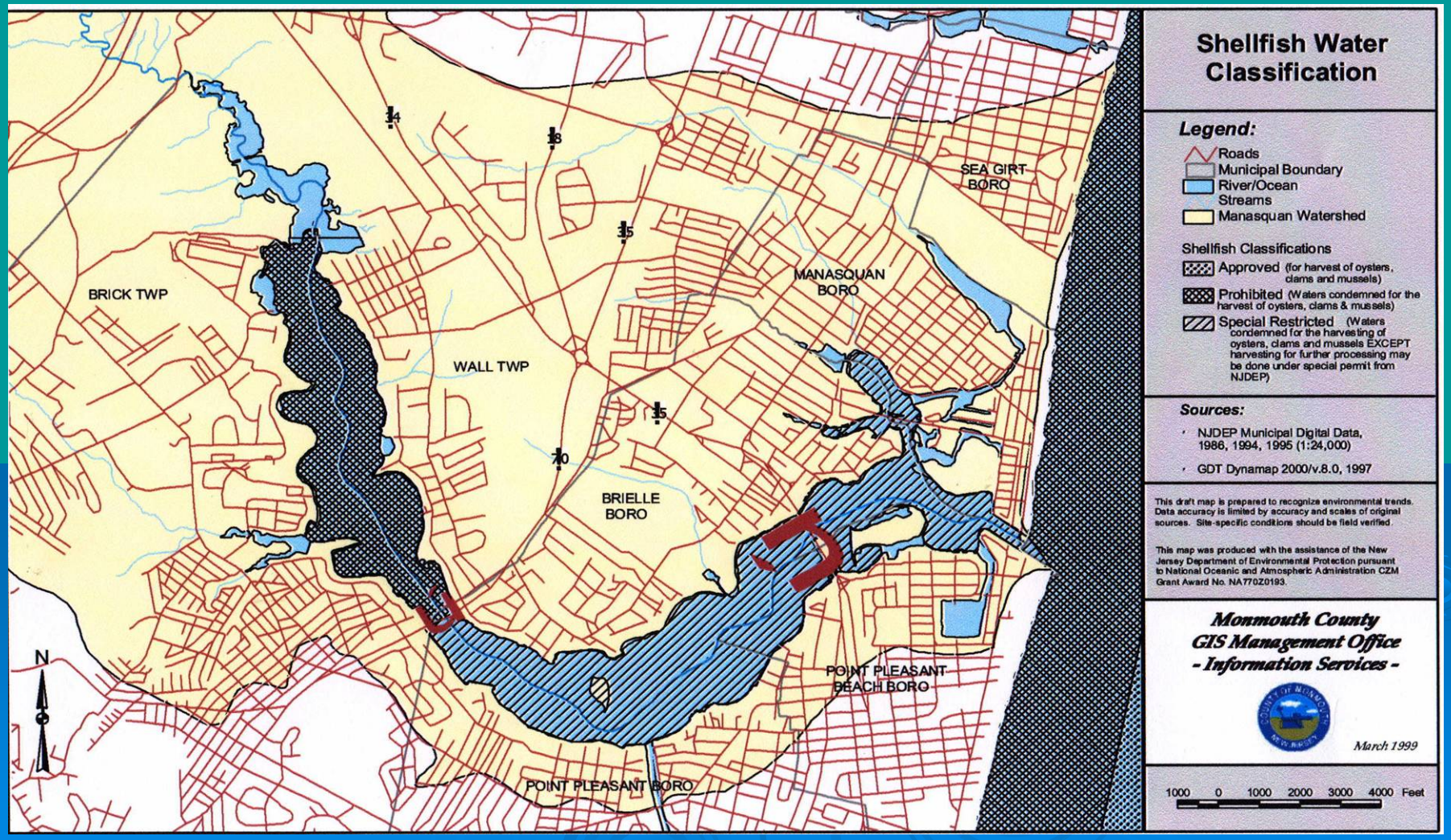
Nitrate concentrations

Precipitation:

4 inches in Nov. on waterlogged soils



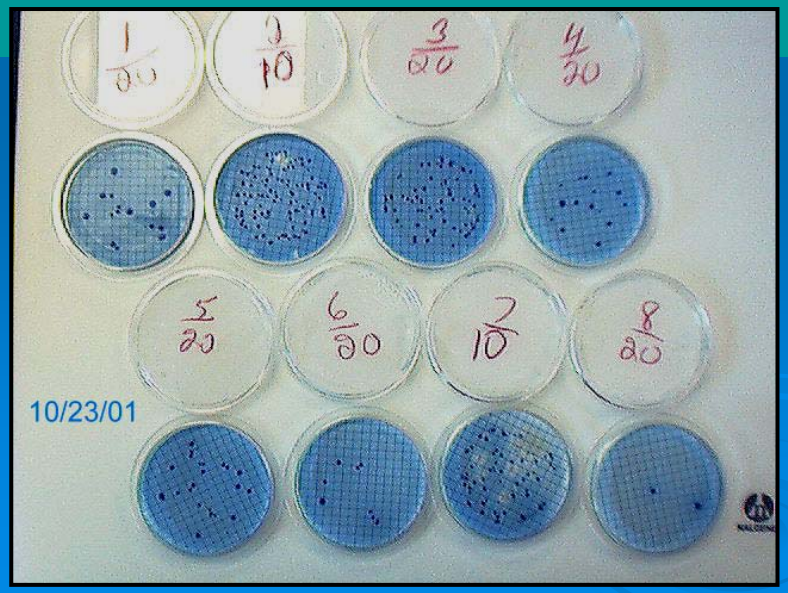
Bacterial Source Tracking of Fecal Pollution in Aquaculture

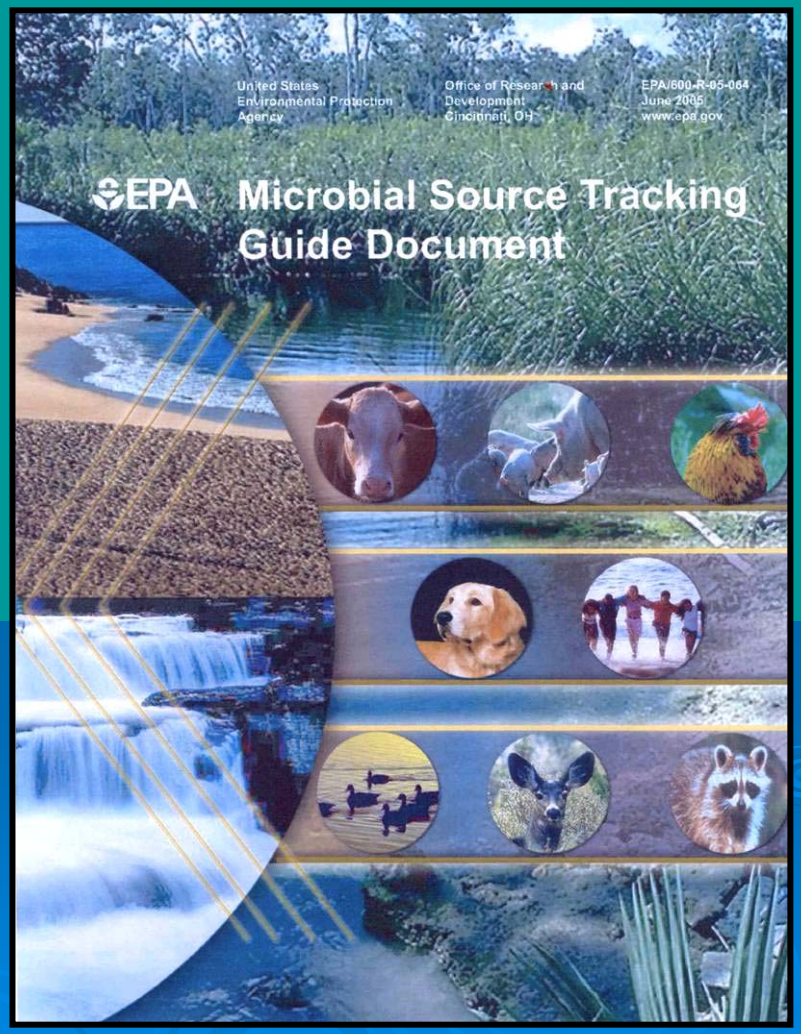


Bacterial Sources of Pollution

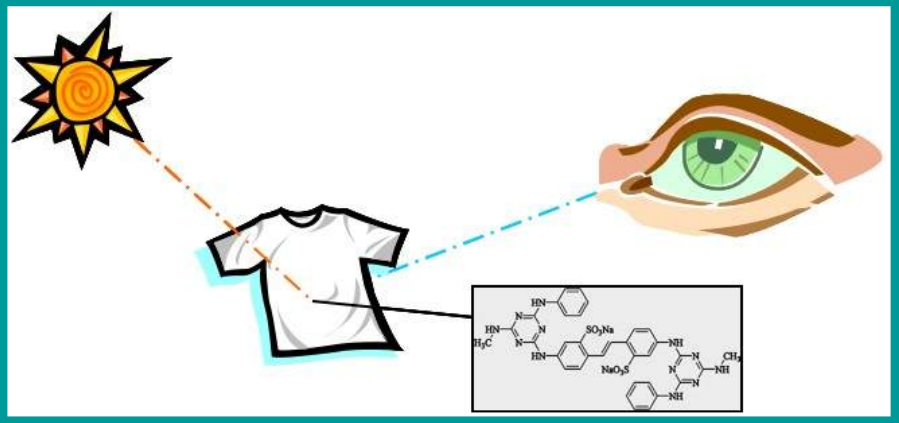
MST Indicators & Pathogens

- Fecal coliforms
- Escherichia coli
- Enterococcus species
- Animal specific bacteriophage
- Human enteric viruses
- Bacteroides-Prevotella





Optical Brighteners

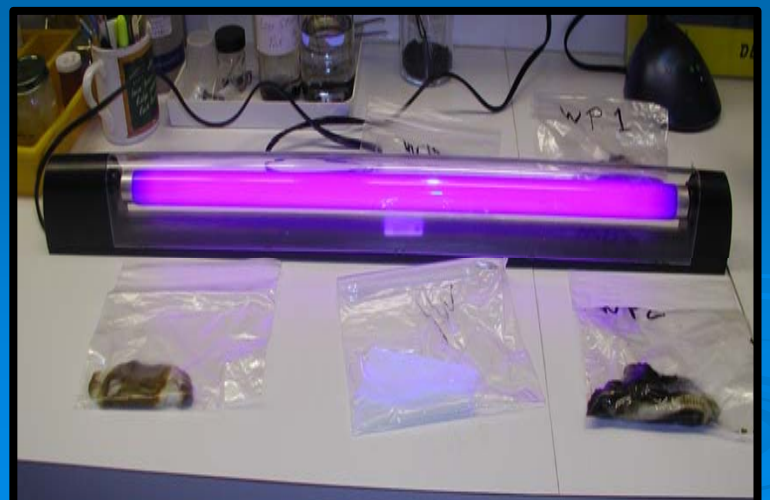


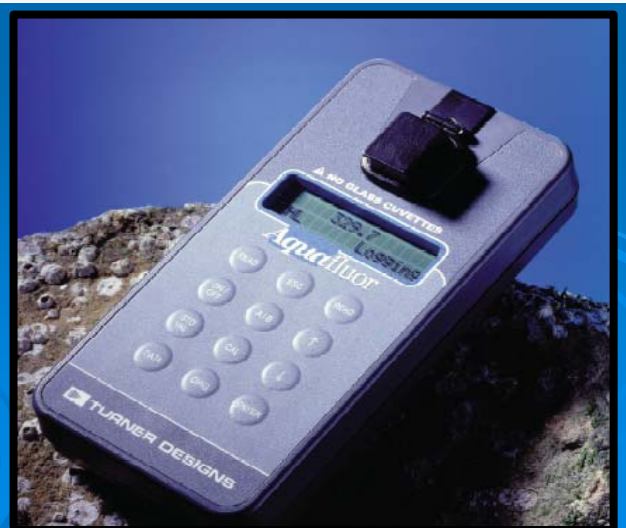
- Fluorescent white added to laundry detergents and paper to produce a “brighter white”
- Fluoresce under ultra violet light
- Are a definitive HUMAN indicator
- Persist in the environment, for a limited time
- Are present in septic and sewer wastewater
- Can indicate untreated human effluent

The Process

- Set in surface water or outfall for 5-7 days
- Rinse and remove pad into plastic bag
- Glow Test - UV/black light or Fluorometric meter

Fecal Bacterial Numbers		Optical Brightener		Likely Result
High		High		Failing onsite waste disposal system or leaking sewer pipe
High			Low	Human (e.g., outhouse) or other warm-blooded animals
	Low	High		Gray water in storm water system
	Low		Low	No evidence of fecal contamination





MST Methods

Ribotyping (LB)

Polymerase chain reaction (PCR) (LB)

Pulse Field Gel Electrophoresis (PFGE) (LB)

Antibiotic Resistance Analysis ARA) (LB)

Terminal restriction fragment length polymorphism (NLB)

Bacteriophage analysis (NLB)

Enterotoxin genes as biomarkers (NLB)

Enterovirus and Adenovirus isolation (NLB)

LB = Library Based; NLB = non Library Based

Experimental Approach: Multiple Antibiotic Resistance (MAR) Analysis

Collect Fecal Samples

↓

Suspend Sample in MAR Saline,
Filter & Incubate on MacConkey Agar

↓

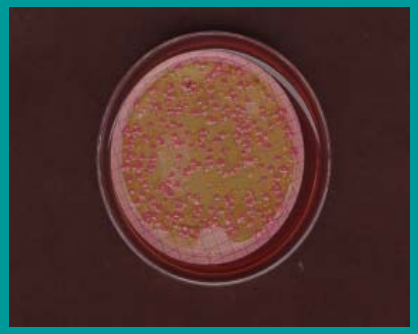
Mac-Positive Colonies Cultured in
48-Well Tissue Culture Plate

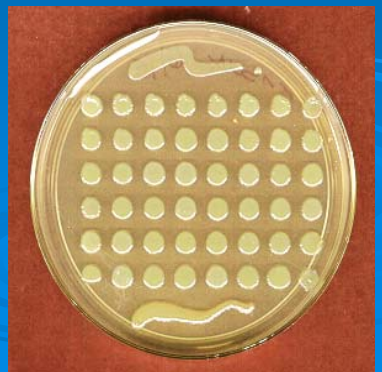
↓

Replica Plate Isolates onto Control
Plates & 12 Antibiotic Plates

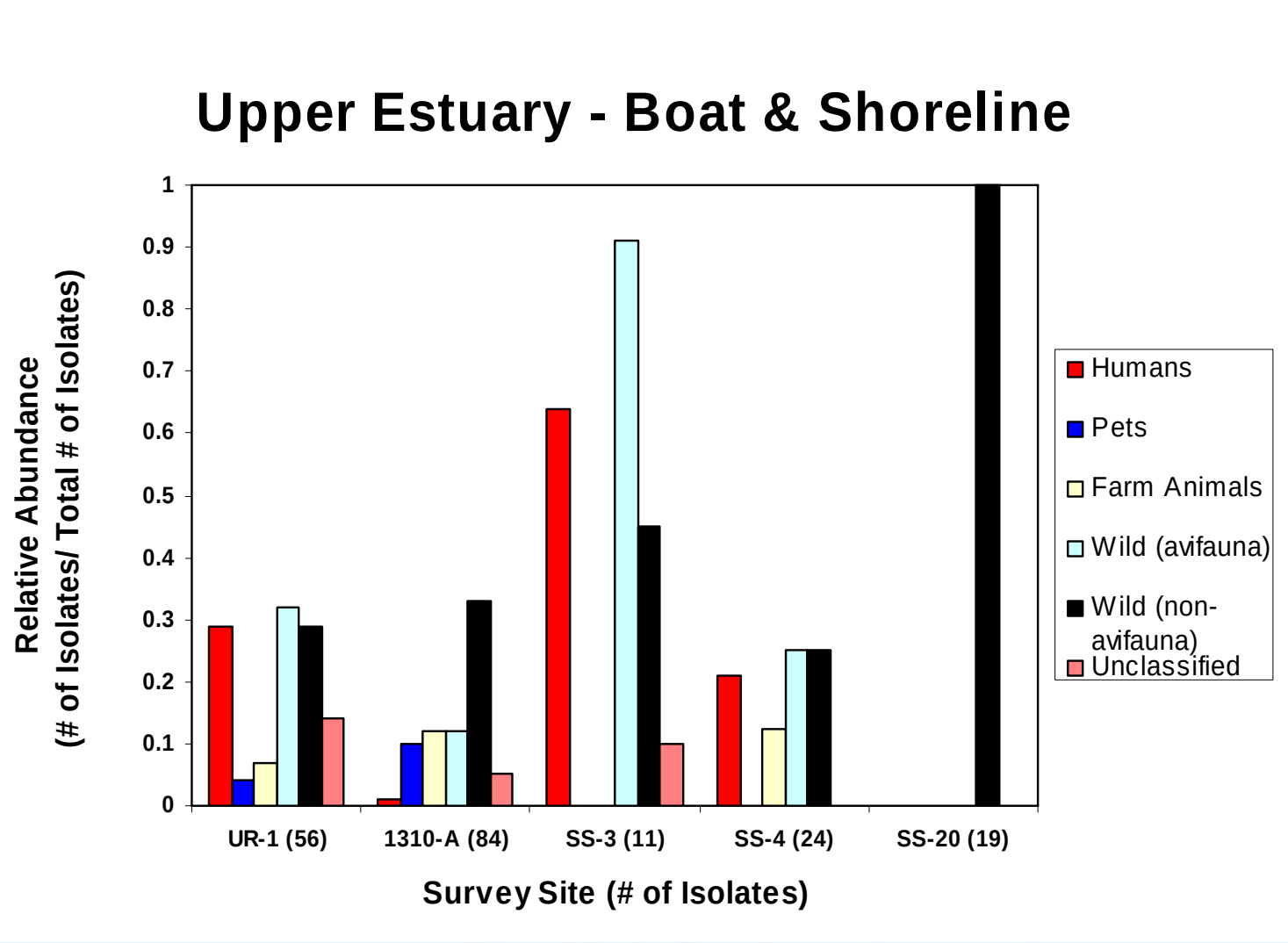
↓

Isolates Frozen for DNA Fingerprinting





Bacterial Source Tracking of Fecal Pollution in River Estuary



Experimental Approach: Ribotype DNA Fingerprinting

Isolate Genomic DNA from Fecal *E. coli*

↓

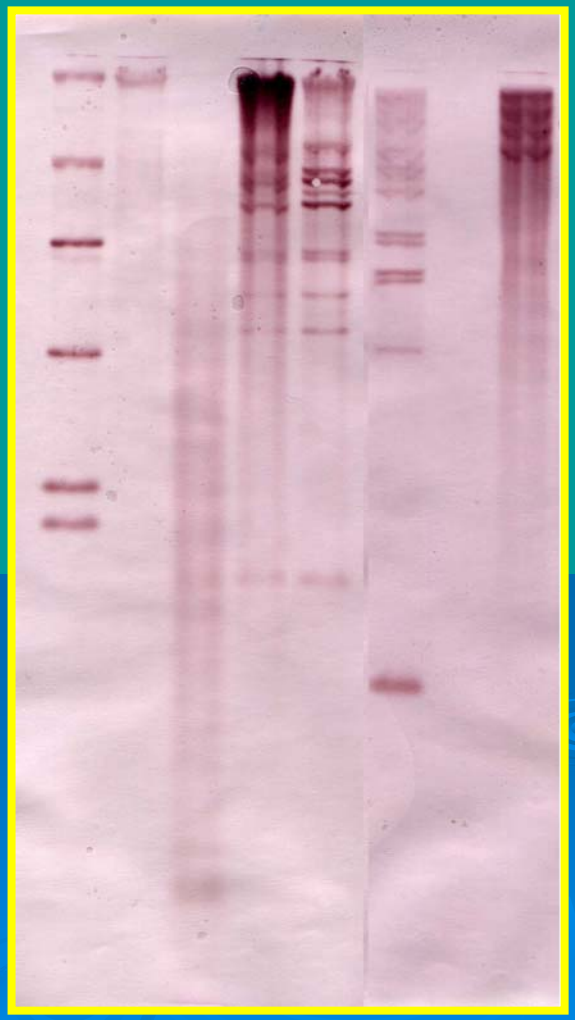
Digest DNA with *Hin*dIII

↓

Separate DNA Fragments by Gel Electrophoresis and Transfer DNA to Nylon by Southern Blotting

↓

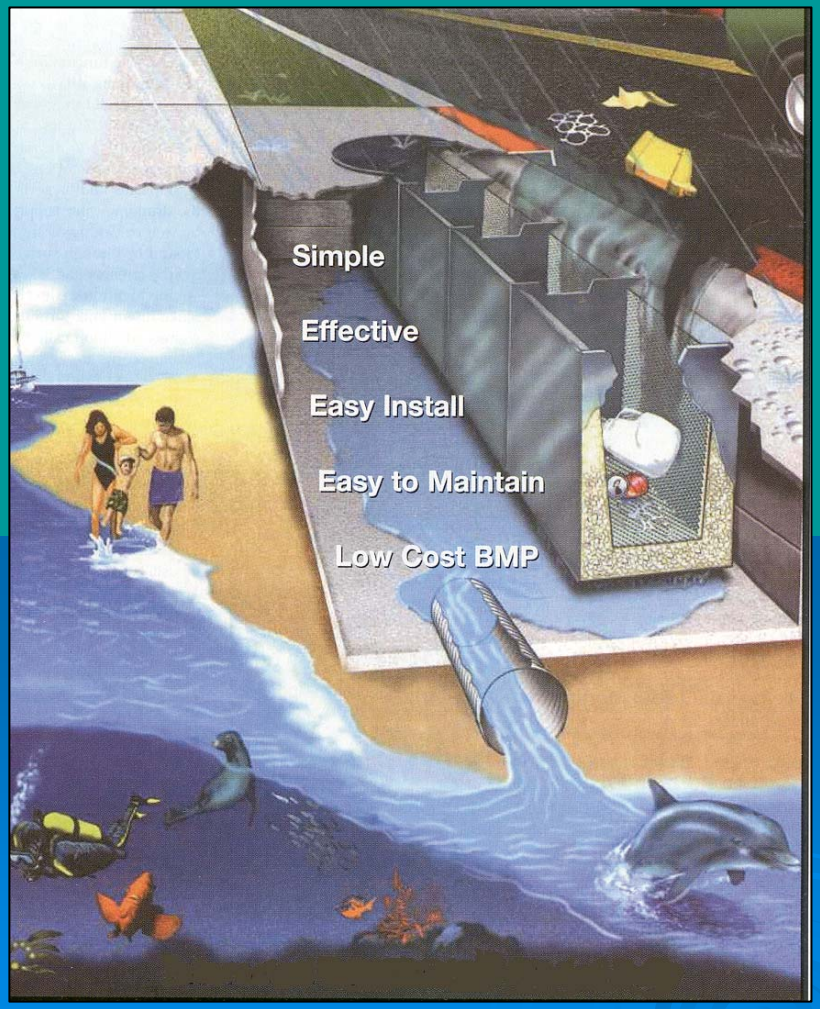
Probe Blots with Digoxigenin-labeled Probes for 16S & 23S Ribosomal RNA (rRNA) Genes



qPCR for Microbial ID

- Polymerase chain reaction
  - Highly qualitative
  - Potentially quantative
  - Decreasing in cost
  - Non-regulatory
  - Fast turnaround

NEW FILTRATION SYSTEMS FOR STORMWATER RUNOFF



= NEW SAMPLING EQUIPMENT

Second Maintenance Event (Dec. 20, 2001)	
Weight (lbs)	Notes
40	Leaves & sediment
55	Leaves & sediment
85	Leaves, sediment & trash
60	Leaves, sediment & trash
15	Leaves & sediment
15	Leaves & sediment
10	Landscaping woodchips, leaves & sediment
25	Leaves, sediment & trash
30	Leaves & sediment
25	Leaves, sediment & trash
10	Leaves & trace sediment
4	Leaves, sediment & trash
15	Leaves, trace sediment & trash
10	Leaves & sediment
10	Leaves & sediment
15	Leaves & sediment
5	Leaves, trace sediment & foam packing "peanuts"
10	Leaves, trace sediment & foam packing "peanuts"
----	Installed new full basket and collar
10	Leaves, trace sediment & trash
15	Leaves, sediment & trash
20	Leaves, trace sediment & trash
5	Leaves, trace sediment & trash
5	Sediment & trash
7	Sediment & trash
10	Sediment, trash & cigarette butts
30	Sediment & trash
---	Not cleaned. Car parked over basin.
541	

Economic Projection of Natural Resource Values Goods & Services

How Much are open space, forests, pasture and agricultural land $$$Worth$$$ to Municipalities?

Current Value of Goods – timber, food, mining
Value of Natural Service is much higher - NJDEP

+ Groundwater Recharge – Colts Neck is Situated above the Kirkwood-Cohansey Aquifer System and is also Critical Water Supply Management Area
+ Meeting Stormwater Requirements
+ Bacterial and Nutrient Absorption and Retention
+ Flood Control
+ Tourism
+ Supporting Industries
+ Overall Land Value

Exponentially Larger Economic Value Than Currently Recognized – "dumb" growth, infrastucture needs, carbon credits, water $, CO2,aquaculture…

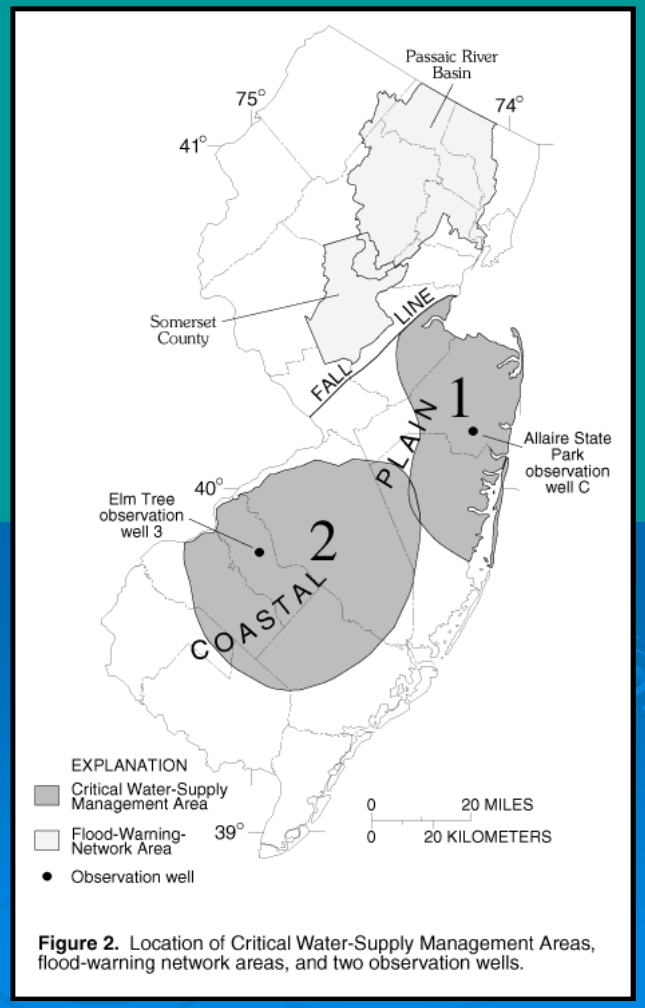


Figure 2. Location of Critical Water-Supply Management Areas, flood-warning network areas, and two observation wells.

NJ AGRICULTURAL EXPERIMENT STATION
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COOPERATIVE RESEARCH & EXTENSION

Putting Science and Research to Work for Communities

NEW JERSEY AGRICULTURAL EXPERIMENT STATION
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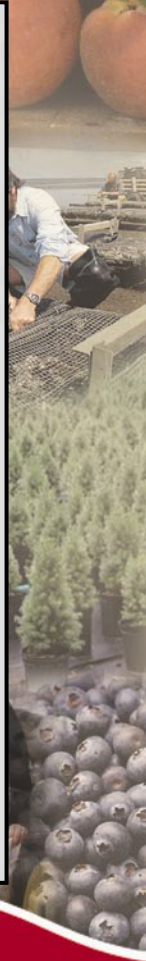
U.S. Department of Agriculture, Rutgers - The State University of New Jersey, and County Boards of Chosen Freeholders Cooperating.