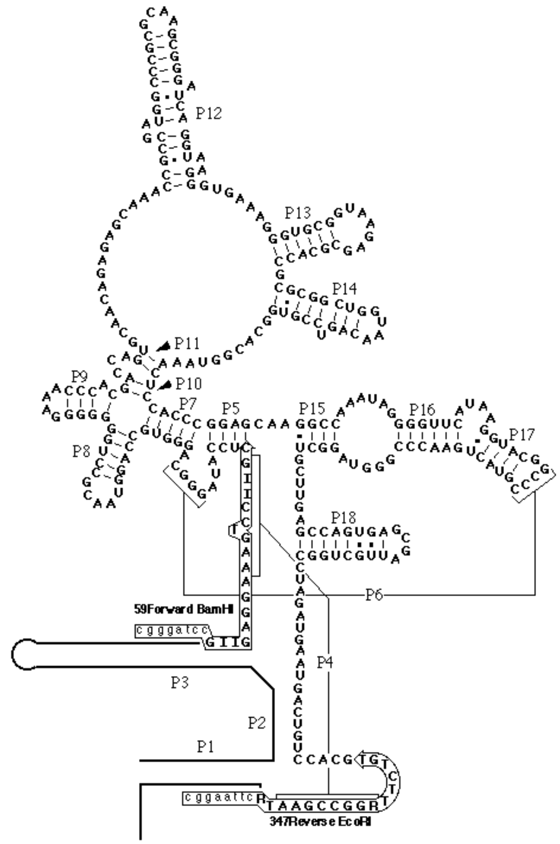
# Part 1: Shoreline
# Surveys Using Standard Tests with an Innovative CEHA Laboratory.

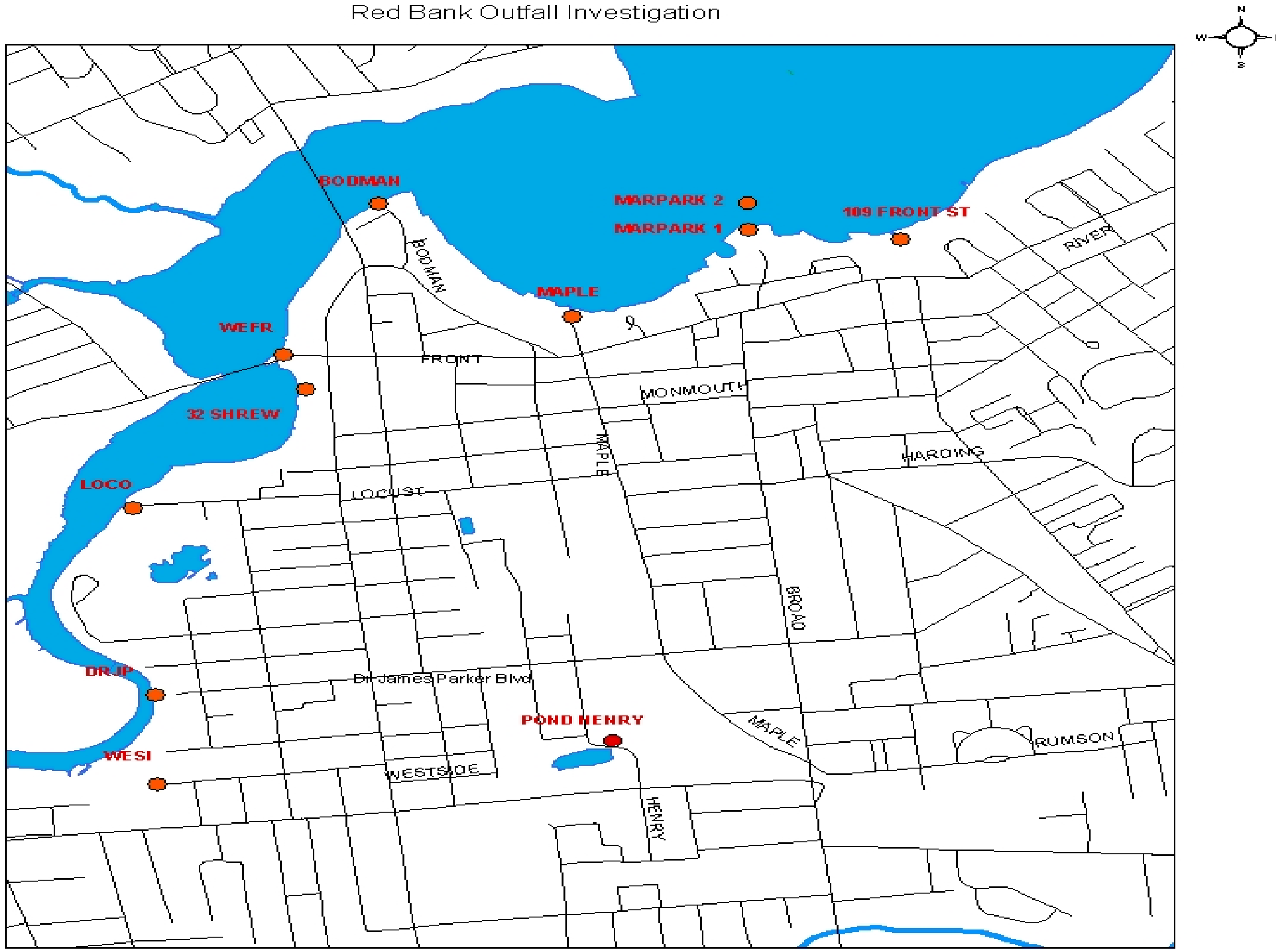
# Part 2: Microbial Source Tracking – Survival Assumptions Need Testing.




**PCR amplification scheme.** Many of the available RNase P RNA sequences are partial sequences obtained by PCR. The amplification primer sequences 59FBam and 347REco (note that the latter is the complement of the sequence present in the RNA) are boxed, with arrowheads indicating the polarity of the primers and lower-case nucleotides indicating linker sequences used for cloning. Sequences distal to the amplification primers are not available and are indicated by lines only.


- William Simmons, Environmental Health Coordinator, Monmouth County Health Department
- wsimmons@co.monmouth.nj.us 04/05/06

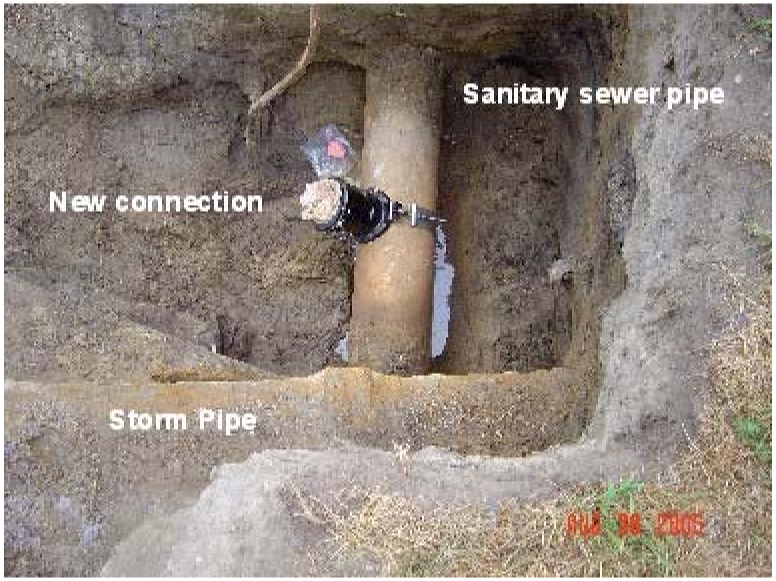
Red Bank Outfall Investigation




| Site | Outfall size | Date 1 | Fecal | Entero | Date 2 | Fecal | Entero | Date 3 | Fecal | Entero | Date 4 | Fecal | Entero |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WESI | 24" | 5/26/2004 | 22000 | 129000 | 8/16/2004 | 14700 | >6000 | 12/7/2004 | 24000 | >6000 | 3/28/2005 | 800 | 4300 |
| DRJP | | 5/26/2004 | 4000 | 23000 | 8/16/2004 | 13900 | 16500 | 12/7/2004 | >6000 | >6000 | 3/28/2005 | 3100 | 3000 |
| LOCU | 42" | 5/26/2004 | 16000 | 64000 | 8/16/2004 | 7100 | 13200 | 12/7/2004 | 21000 | >6000 | 3/28/2005 | 400 | 1800 |
| WEFR | 24" | 5/26/2004 | 2000 | 2600 | 8/16/2004 | 15900 | 10500 | | | | | | |
| MARPARK | | 10/19/2004 | 92000 | 133000 | 12/7/2004 | 1700 | 13800 | | | | 3/28/2005 | 1300 | 1770 |
| MARPARK2 | | | | | 12/7/2004 | 3000 | 9300 | | | | | | |
| 109E FRONT ST | 48" | 10/19/2004 | 3100 | 26000 | | | | | | | | | |
| MAPLE AVE | 42" | 10/19/2004 | 5900 | 23000 | 12/7/2004 | 4200 | 15000 | | | | | | |
| 32 SHREWS | | 10/19/2004 | 300 | 6300 | | | | | | | | | |
| POND HENRY | | 10/19/2004 | 3400 | 7000 | | | | | | | | | |
| BODMAN | 24" | 10/19/2004 | 1400 | 12000 | | | | | | | | | |
| CB end of Dr. James Parker Ave | | 11/4/2004 | 173000 | | | | | | | | | | |

CCondie 03/31/05
f/vol1gisoffice2005/Redbankoutfalls

# 2 Illicit Connections




# Sediment Vs. Water Column Samples

1. TMDL Site at Squankum (Rt. 195 & Rt. 524)


**Fecal Coliform** Counts
(Sampled 7/6/00)

| | Water | **Sediment** | % Total Solids |
|---|---|---|---|
| 1 | 210 | | |
| 2 | | **5,000** | 77.24% |
| 3 | | **2,300** | 80.39% |
| 4 | | **13,000** | 64.76% |

Total **Phosphorus**
(Sampled 9/21/00)

| | Water (mg/L) | Sediment (mg/kg) | % Total Solids |
|---|---|---|---|
| 1 | | | |
| 2 | 0.13 | **5318.00** | 22.4% |
| 3 | 0.30 | **928.00** | 70.0% |
| 4 | 0.18 | **2558.00** | 57.1% |

- Manasquan River at fishing access off Squankum – Yellowbrook Road
  (about 1 mile upstream of Site 1 – TMDL Site)

**Fecal Coliform** Counts
(Sampled 7/6/00)

| | Water | Sediment | % Total Solids |
|---|---|---|---|
| Central | 210 | **8,000** | 80.27% |
| East | | **23,000** | 72.30% |
| West | | **5,000** | 79.86 % |

Total **Phosphorus**
(Sampled 9/21/00)

| Water (mg/L) | **Sediment** (mg/kg) | % Total Solids |
|---|---|---|
| 0.13 | **3573.00** | 65.1% |
| 0.18 | **2438.00** | 42.0% |
| 0.15 | **6677.00** | 34.8% |

Percent total solids is the remainder of an aquatic sediment sample after the water has been evaporated. A sample that consists of silt and clay will have a lower percent total solids value than one consisting of sand and pebbles. Silt is preferentially eroded from streambanks. Fecal coliform adsorb and survive best on silt.

When stormwater runoff erodes streambanks, it also increases the numbers of fecal coliform in the sediment by providing greater amounts of silt in the streambed than would be present naturally. Coliform are resuspended into the water column during and after rainstorms.

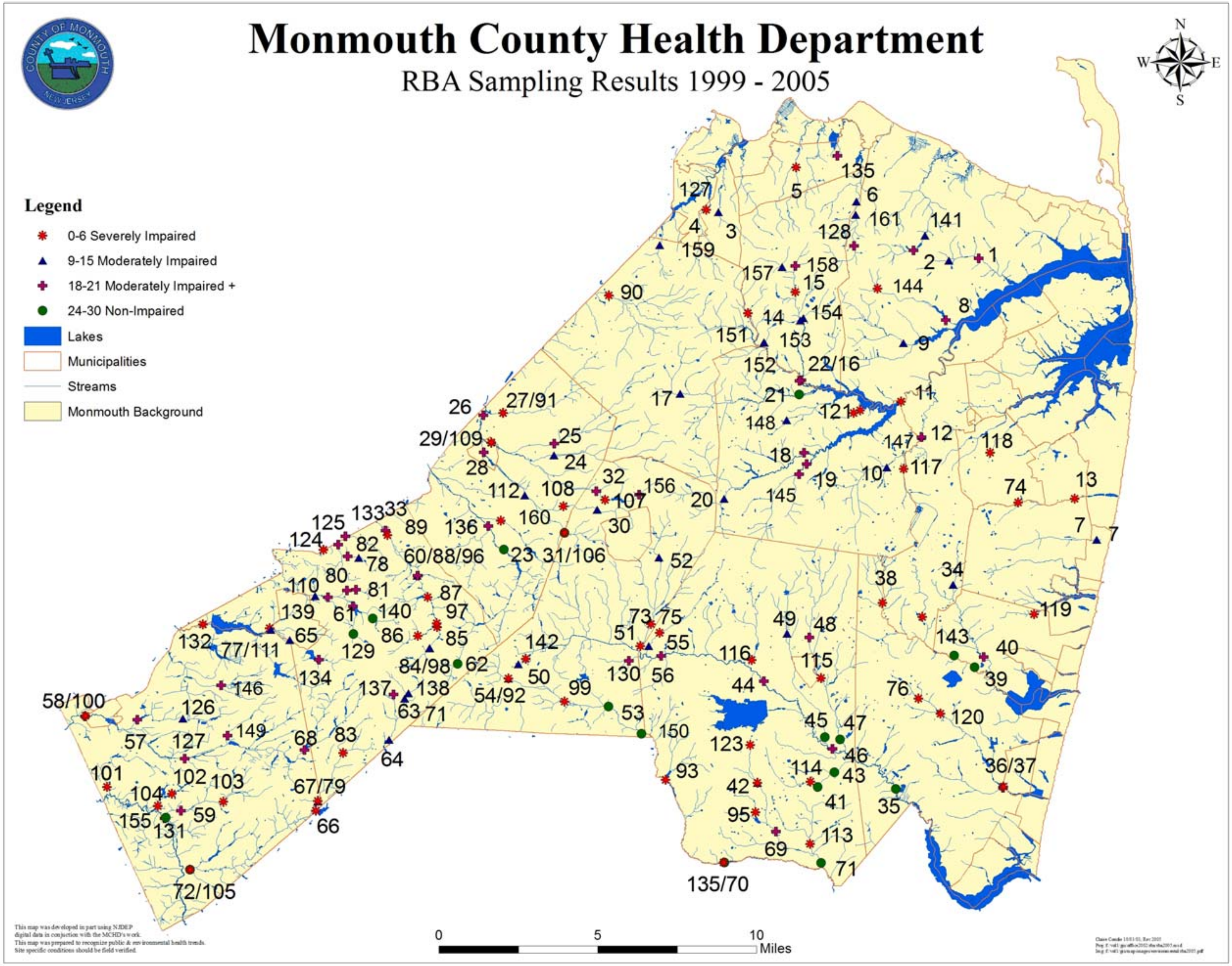
Ramanessin Brook, Crawford Corners Rd., Holmdel: Spring 2003 RBA

Downstream of PNC: NJIS 3

B
F

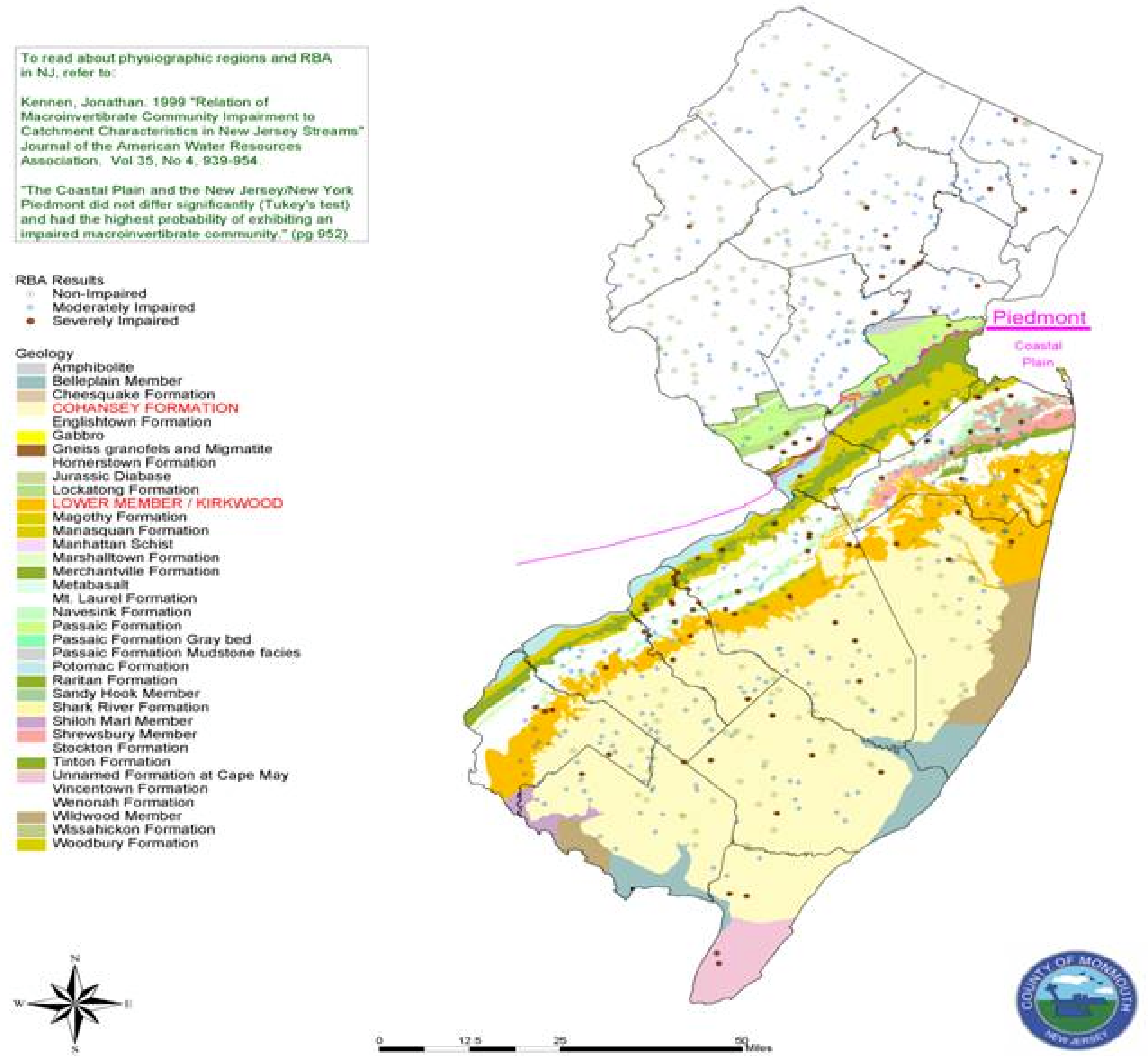
Holland Rd. Nature Trail: NJIS: 24

B
F


Monmouth County Health Department
RBA Sampling Results 1999 - 2005
Legend
0-6 Severely Impaired
9-15 Moderately Impaired
18-21 Moderately Impaired +
24-30 Non-Impaired
Lakes
Municipalities
Streams
Monmouth Background
N
S
E
W
0
5
10
Miles
This map was developed in part using NJDEP
digital data in conjuction with the MCHD's work.
This map was prepared to recognize public & environmental health trends.
Site specific conditions should be field verified.

# RBA Trends Within the Coastal Plain

Severe Impairment in the Silt and Clay Formations between the Piedmont Cobble and the Kirkwood Cohansey Sands




This map was developed in part using NJDEP digital data in conjunction with the MCHDs work, but this secondary product has not been verified by the NJDEP and is not state authorized.

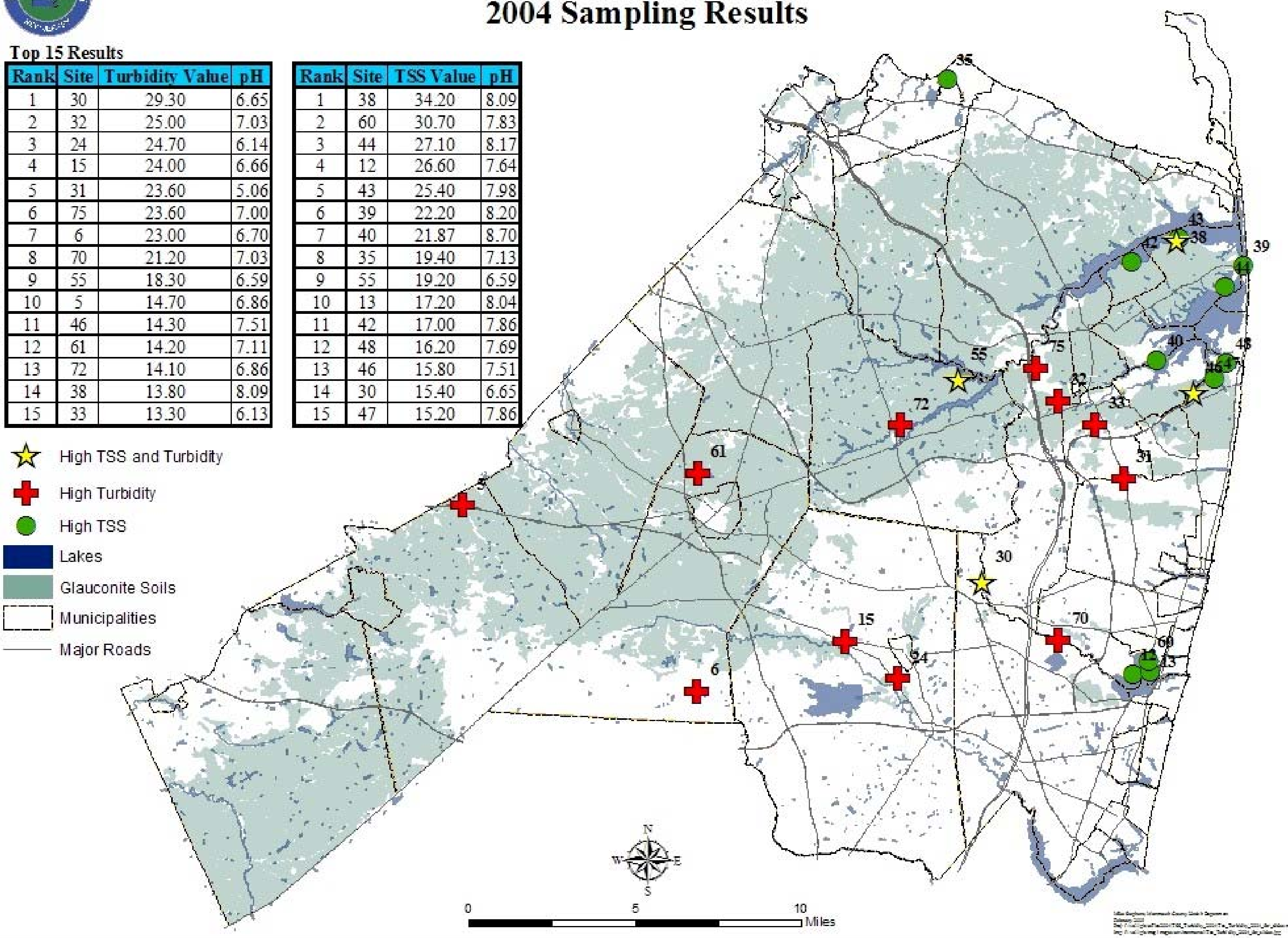
Data accuracy is limited by the accuracy of the scales of the original data sources. Site specific conditions should be field verified.

# Highest TSS and Turbidity Results at Ambient Site Monitoring Locations
# 2004 Sampling Results

**Top 15 Results**

| Rank | Site | Turbidity Value | pH |
|---|---|---|---|
| 1 | 30 | 29.30 | 6.65 |
| 2 | 32 | 25.00 | 7.03 |
| 3 | 24 | 24.70 | 6.14 |
| 4 | 15 | 24.00 | 6.66 |
| 5 | 31 | 23.60 | 5.06 |
| 6 | 75 | 23.60 | 7.00 |
| 7 | 6 | 23.00 | 6.70 |
| 8 | 70 | 21.20 | 7.03 |
| 9 | 55 | 18.30 | 6.59 |
| 10 | 5 | 14.70 | 6.86 |
| 11 | 46 | 14.30 | 7.51 |
| 12 | 61 | 14.20 | 7.11 |
| 13 | 72 | 14.10 | 6.86 |
| 14 | 38 | 13.80 | 8.09 |
| 15 | 33 | 13.30 | 6.13 |

| Rank | Site | TSS Value | pH |
|---|---|---|---|
| 1 | 38 | 34.20 | 8.09 |
| 2 | 60 | 30.70 | 7.83 |
| 3 | 44 | 27.10 | 8.17 |
| 4 | 12 | 26.60 | 7.64 |
| 5 | 43 | 25.40 | 7.98 |
| 6 | 39 | 22.20 | 8.20 |
| 7 | 40 | 21.87 | 8.70 |
| 8 | 35 | 19.40 | 7.13 |
| 9 | 55 | 19.20 | 6.59 |
| 10 | 13 | 17.20 | 8.04 |
| 11 | 42 | 17.00 | 7.86 |
| 12 | 48 | 16.20 | 7.69 |
| 13 | 46 | 15.80 | 7.51 |
| 14 | 30 | 15.40 | 6.65 |
| 15 | 47 | 15.20 | 7.86 |



# Glauconitic Streams In Monmouth County Exceed Turbidity But Not TSS Standards After Rain

2005 Ambient Sites:

| BOTTLE | SITE | STREET | Wet_TSS_1 | Wet_Tur_1 |
|---|---|---|---|---|
| 1 | DEAL LAKE | OCEAN AVE | 5.2 | 8.0 |
| 2 | CROSSWICKS CREEK | WAINFORD RD | 20.8 | [illegible] |
| 3 | DOCTORS CREEK | ROUTE 539 | 9.2 | 11.8 |
| 4 | ASSUNPINK CREEK | ROUTE 539 | 7.2 | 7.2 |
| 5 | MILLSTONE RIVER | ROUTE 33 | 8.8 | 16.1 |
| 6 | NORTH BRANCH METEDECONK | JACKSON MILLS RD | 12.0 | 9.2 |
| 7 | TOMS RIVER | ROUTE 527 | 2.8 | 5.6 |
| 9 | WEAMACONK CREEK | MAIN ST | 16.0 | [illegible] |
| 10 | HOLLOW BROOK | ROUTE 35 | 2.8 | 9.8 |
| 11 | MUSQUASH BROOK | BRIGHTON AVE | 6.8 | 9.6 |
| 14 | WRECK POND BROOK | ALLENWOOD RD | 16.0 | [illegible] |
| 15 | YELLOW BROOK | ELTON-ADELPHIA RD | 9.2 | [illegible] |
| 16 | SQUANKUM BROOK | EASY ST | 6.0 | 8.4 |
| 17 | MUDDY FORD BROOK | LAKEWOOD-ALLENWOOD RD | 9.2 | 11.7 |
| 18 | HAYSTOCK BROOK | MAXIM-SOUTHARD RD | 3.6 | 7.1 |
| 19 | TITMOUSE CREEK | FRIENDSHIP RD | 1.6 | 6.8 |
| 20 | GRAVELLY BROOK | LLOYD RD | 16.0 | 6.2 |
| 21 | BIG BROOK | ROUTE 79 | 5.6 | 9.5 |
| 22 | McGELLAIRDS BROOK | MAIN ST | 11.6 | [illegible] |
| 23 | MINGAMAHONE BROOK | BELMAR BLVD | 13.6 | [illegible] |
| 24 | MARSH BOG BROOK | PREVENTORIUM RD | 22.8 | [illegible] |
| 25 | LONG BROOK | HOWELL RD | 8.4 | [illegible] |
| 30 | SHARK RIVER BROOK | SHARK RIVER STATION RD | 8.8 | [illegible] |
| 31 | WHALE POND BROOK | ROUTE 35 | 16.6 | [illegible] |
| 32 | LAFETRA'S BROOK | HOPE RD | 7.2 | 14.8 |
| 33 | HUSKY BROOK | SOUTH ST | 2.8 | 7.6 |
| 34 | PINE BROOK | HOCKHOCKSON RD | 6.0 | 5.9 |
| 50 | LAKE TAKANASSEE | OCEAN AVE | 2.2 | 8.5 |
| 52 | WILLOW BROOK | WILLOW BROOK RD | 116.4* | [illegible] |
| 53 | RAMANESSIN BROOK | WILLOW RD | 6.8 | 11.8 |
| 54 | BORDONS BROOK | ROUTE 520 | 6.8 | 12.1 |
| 55 | TROUT BROOK | RICHDALE RD | 8.4 | [illegible] |
| 56 | BARREN NECK BROOK | LONG BRIDGE RD | 3.6 | [illegible] |
| 57 | BIG BROOK | LAURELWOOD DR | 8.0 | 11.6 |
| 58 | MINE BROOK | MERCER RD | 5.2 | 6.2 |
| 59 | POPLAR BROOK | OCEAN AVE | 12.0 | [illegible] |
| 61 | LAKE TOPANEMUS | POND RD | 2.8 | 6.2 |
| 65 | LAKE MATAWAN | MAIN ST | 2.4 | 1.7 |
| 66 | LAKE LEFFERTS | ROUTE 34 - BUTTONWOOD MANOR | 3.6 | 7.5 |
| 67 | ECHO LAKE | MAXIM-SOUTHARD RD | 0.8 | 2.0 |
| 68 | WEMROCK BROOK | RT 9 (BEFORE PIPES) | 0.0 | 0.0 |
| 69 | WEMROCK BROOK | RT 9 (AFTER 1ST PIPE) | 0.0 | 0.0 |
| 70 | SHARK RIVER | GULLY ROAD | 20.4 | [illegible] |
| 71 | JUMPING BROOK | RT 33 @ DAYS INN | 16.4 | [illegible] |
| 72 | YELLOW BROOK | CREAMERY RD | 9.2 | [illegible] |
| 73 | MANASQUAN RIVER | CASINO DR | 12.4 | [illegible] |
| 75 | HOCKHOCKSON BROOK | RIVERDALE AVE | 8.0 | [illegible] |

*Exceeds Standards

TSS - Over 15 NTU
(Standard in Non-Trout is 40 mg/l, Trout is 25 mg/l)

| Rank | BOTTLE_NO | Wet_TSS_1 |
|---|---|---|
| 1 | 52 | 116.40* † |
| 2 | 24 | 22.40 |
| 3 | 2 | 20.80 |
| 4 | 70 | 20.40 |
| 5 | 71 | 16.40 |

Turbidity - Over 15 NTU
(Standard Average is 15 mg/l)

| Rank | BOTTLE_NO | Wet_Tur_1 |
|---|---|---|
| 1 | 70 | 46.60* |
| 2 | 24 | 32.20* |
| 3 | 23 | 28.80* |
| 4 | 14 | 27.40* |
| 5 | 9 | 27.30* |
| 6 | 73 | 26.30* |
| 7 | 52 | 24.90* † |
| 8 | 71 | 24.10* |
| 9 | 30 | 21.90* |
| 10 | 31 | 20.80* |
| 11 | 59 | 20.10* |
| 12 | 2 | 19.90* |
| 13 | 15 | 19.20* |
| 14 | 22 | 17.70* |
| 15 | 55 | 17.40* |
| 16 | 25 | 16.90* |
| 17 | 56 | 16.40* |
| 18 | 72 | 16.20* |
| 19 | 75 | 15.70* |

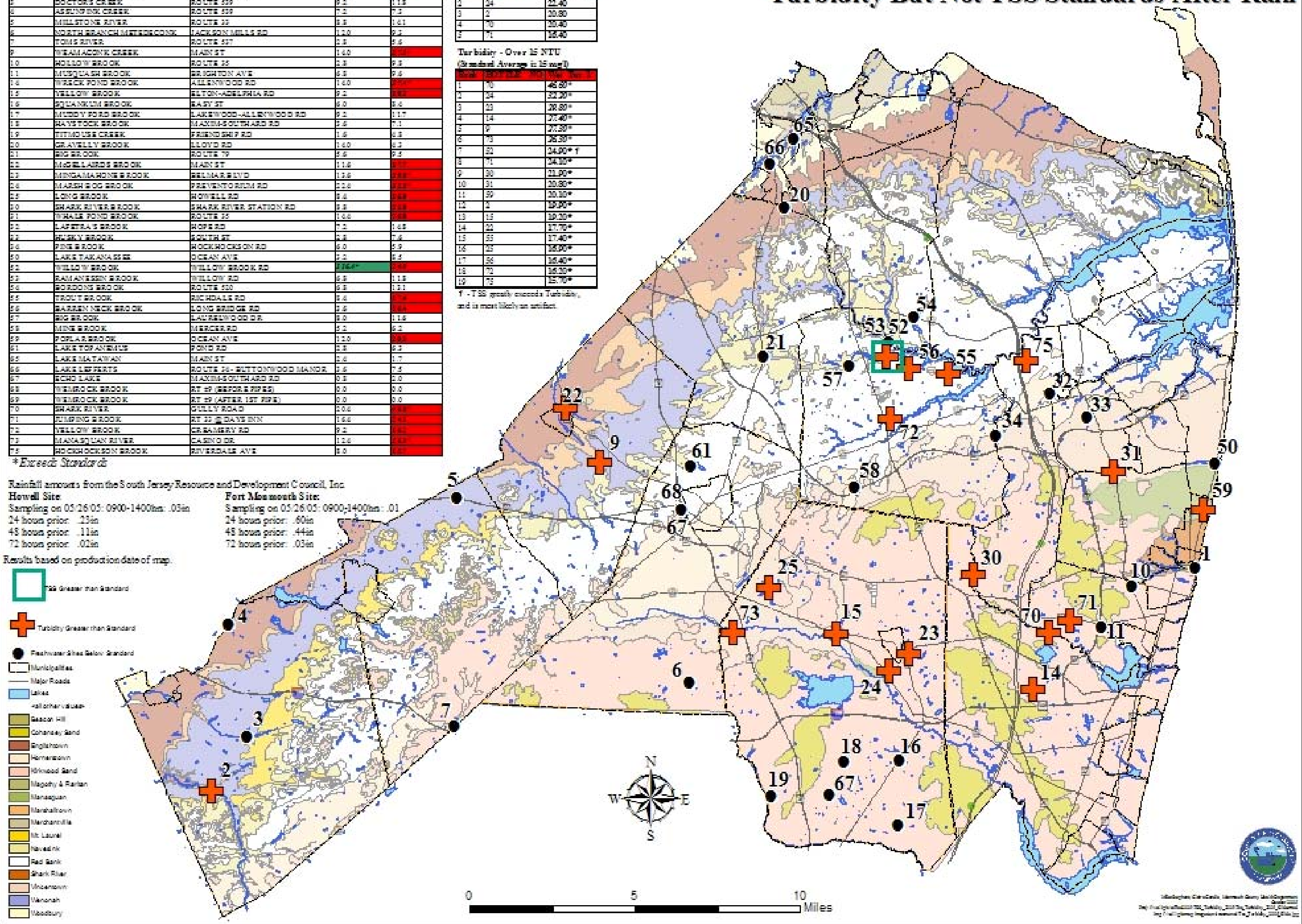
† - TSS greatly exceeds Turbidity, and is most likely an artifact.

Rainfall amounts from the South Jersey Resource and Development Council, Inc.

**Howell Site:**
Sampling on 05/26/05: 0900-1400hrs: .03in
24 hours prior: .23in
48 hours prior: .11in
72 hours prior: .02in

**Fort Monmouth Site:**
Sampling on 05/26/05: 0900-1400hrs: .01
24 hours prior: .60in
48 hours prior: .44in
72 hours prior: .03in

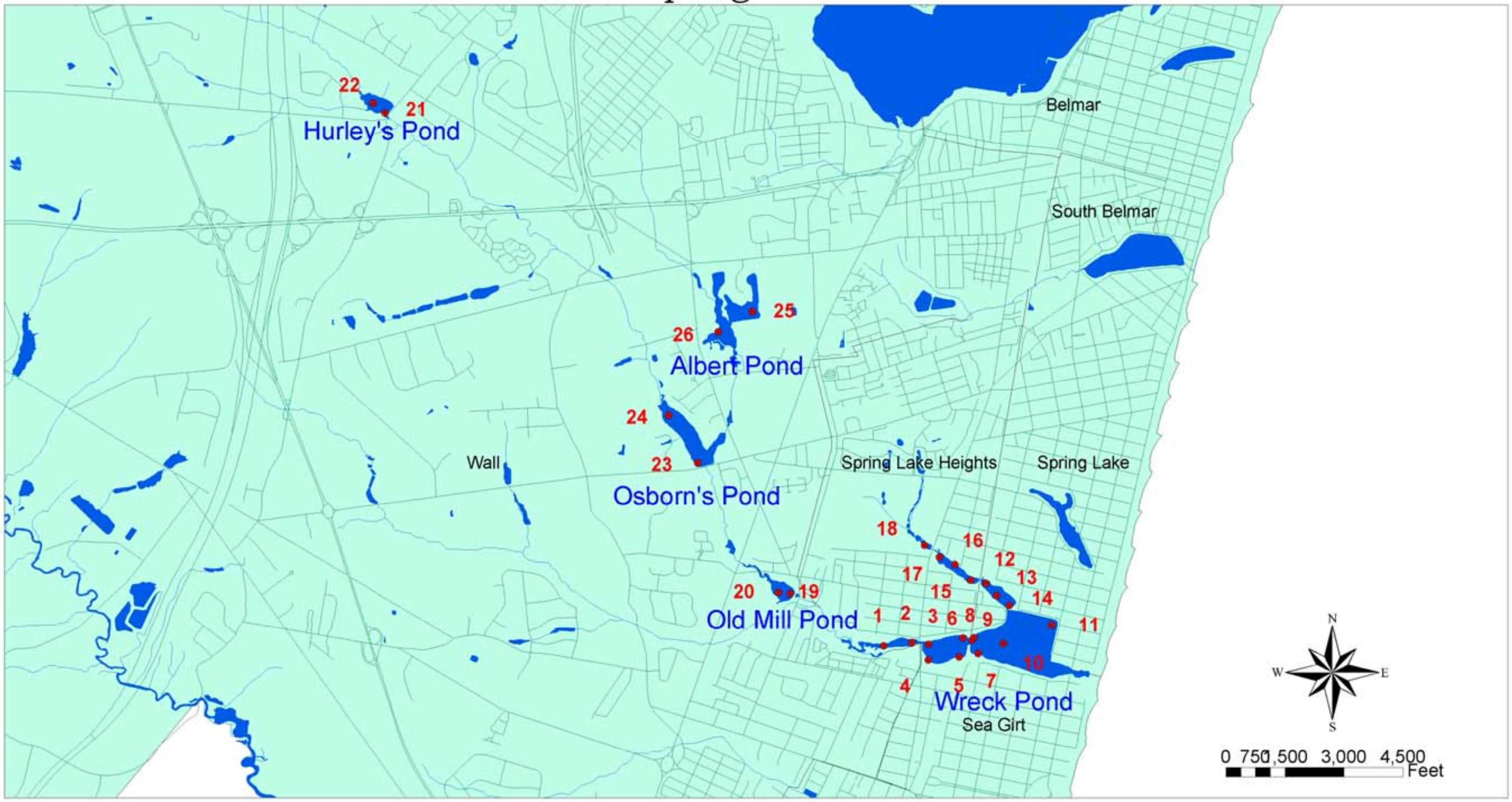
Results based on production date of map.



# Monmouth County Health Department

# Wreck Pond

## Fecal Coliform Colony Values
## Sampling Locations


**Legend**

- ● Sample Sites
- Roads
- Streams
- Lakes
- Municipalities

**Wreck Pond**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | 340 | 17000 | 7 | 450 | 30000 | 13 | 220 | 3500 |
| 2 | 280 | 30000 | 8 | 350 | 5000 | 14 | 2800 | 1300 |
| 3 | 430 | 50000 | 9 | 140 | 17000 | 15 | 1700 | 8000 |
| 4 | 1060 | 17000 | 10 | 170 | 300 | 16 | 70 | 50000 |
| 5 | 100 | 1600000 | 11 | 70 | 300 | 17 | 670 | 500000 |
| 6 | 1300 | 2200 | 12 | 170 | 300 | 18 | 1600 | 5000 |

**Old Mill Pond**

| | | |
|---|---|---|
| 19 | 670 | 5000 |
| 20 | 80 | 40 |

**Hurley's Pond**

| | | |
|---|---|---|
| 21 | 40 | 11000 |
| 22 | 80 | 17000 |

**Osborn's Pond**

| | | |
|---|---|---|
| 23 | 1880 | 1700 |
| 24 | 850 | 17000 |

(surface water colonies per 100mL / sediment colonies per 100grams wet weight)

This map was developed in part, using NJDEP digital data, in conjunction with the MCHDs work, but this secondary product, has not been verified by the NJDEP and is not state authorized.

This map was prepared to recognize public and environmental health trends. Data accuracy is limited by the accuracy and scales of the original data sources. Site specific conditions should be field verified.

EPA Method 1600 problems for Enterococcus

Aerococcus viridans growth at Ocean County beaches in 2004 (Feerst et al, 2002).

EPA: only count colonies >0.5 mm. Monmouth Park colonies less < 0.5 mm. confirmed for enterococcus during 96 hour test.

Staphylococcus growth in 2005 during dry weather with north or east winds, at 8:30 AM at sites near Sandy Hook and to a lesser extent other estuaries and lakes. The NJ Public Health Research Institute confirmed by PCR that the isolates are Staphylococcus but are not *S.* aureus. Likely S. haemolyticus or S. saprophyticus, in natural biofilms. For further discussion of Staph and marine growth see (Duan et al, 1995; Lee et al, 2003;)

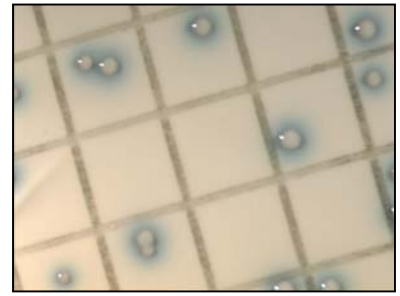


Figure 5. *E. faecalis ATCC29212*

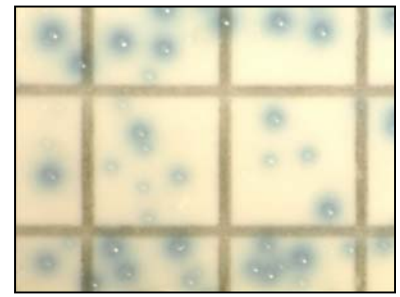


Figure 6. *A. viridans ATCC*

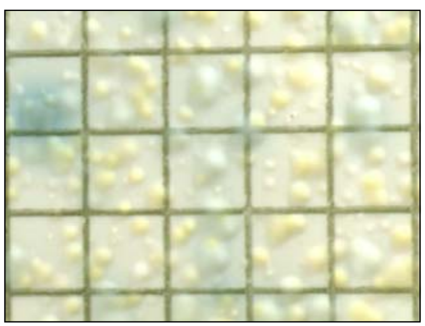


figure 12. Yellow staphylococcal growth on mEI agar, USEPA Method 1600

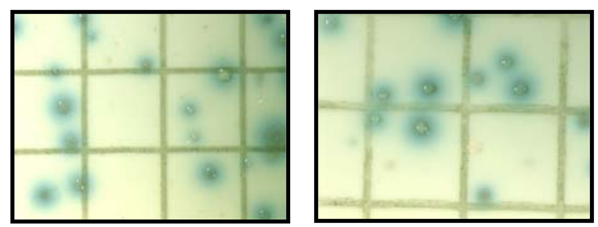


Figure 10. Samples A5AK0004 and A5AK0005 represent typical plates for Monmouth Park samples in October 2005. All colony diameters measured < 0.5 mm. Selected colonies were inoculated into confirmation media and mostly verified for enterococcus.

## Fecal coliform and enterococcus fail as EPA "IDEAL SOURCE IDENTIFIERS:"

Rate of Decay: "…no growth under any conditions."

Abundance in primary vs. secondary habitat: "…bears a significant resemblance to that found in contaminating fecal material."

(EPA's "Microbial Source Tracking Guide Document" (June 2005))

Because coliform and enterococcus survive and grow in sediments, seaweed, etc, and because of the specificity problems with Method 1600, we need to pursue Microbial Source Tracking techniques but:

## PAST LESSON: FECAL COLIFORM/FECAL STREPTOCOCCUS RATIO

"The failure of the fecal coliform/fecal streptococcus (FC/FS) ratio for fecal pollution source tracking is a lesson to heed in the current pursuit of microbial source tracking methods …

Initial assumptions about the comparable survival of coliforms and streptococci proved invalid …

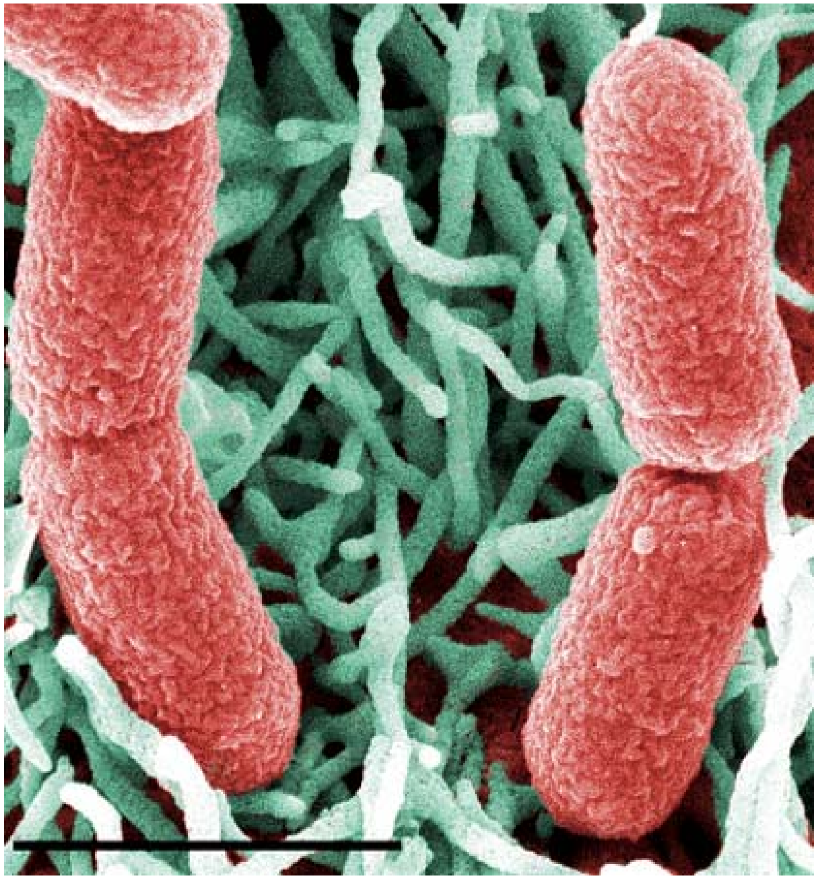
The lesson identifies the importance of testing survival assumptions for MST Source Identifiers before methods are widely applied." (EPA, 2005).

The EPA states in "Microbial Source Tracking Guide Document" (June 2005):the **horizontal transfer of resistance genes** between bacteria in the environment is potentially confounding to source identification when there is "extensive regrowth of recipients in the environment;" then goes on to **review studies that demonstrate how aquatic sediments can support significant bacterial survival and regrowth.**

## HGT

Shiga-toxin producing E. coli (O157:H7) is most famous example of HGT taking place in the cow gut. Jack-in-the-Box Deaths.

The bacteriophage genome (the pro-phage) survived within a host bacterium without lysing.



E. coli (O157:H7) adhering to intestinal cells

## Remaining slides will focus on:

**Mar vs. Bacteriophage as human indicators.**

**Using PCR to confirm Method 1600 results and the implications of using PCR.**


# MAR Testing

**MAR ASSUMPTIONS IGNORE THE POTENTIAL FOR HGT IN SURVIVOR CLONES**

Assumes that the primary environment of the bowel is equivalent to secondary environments like water or sediment.

EPA is funding “library” studies for “human indicators”, but what about testing what happens when to the bacterial species that best adapt to the secondary environment. What species survive and why? What happens to their pathogenicity? Do the environmental clones have a different resistance pattern than the original clones in the feces?

## DNA Persists in the Environment

DNA is protected from degradation by adsorbing to detritus, humic acid, and in particular, clay and sand particles. **Half lives** in freshwater and marine water are 3 to 5 hours, with high values of 45 to 83 hours on the ocean surface, and extremely high values of 140 and 235 hours for the **marine sediment (10 days)** (HO, 1998).

## POLLUTANTS FOUND IN SEDIMENTS PROMOTE HGT

Mutants of E. coli that selected for resistance to **pine oil** also showed resistance to multiple antibiotics (tetracycline, ampicillin, chloramphenicol, and nalidixic acid) (Moken et al , 1997).

In routine laboratory procedures for genetic transformation, **heavy metals** … are used to greatly increase the competence of cells for transformation (HO, 1998).
Antibiotic resistant genes, … have **heavy metal** resistance, such as mercury and antiseptics like **ammonia** compounds (White, 2000).

Elevated temperature **PAHs, PCBs and pesticides** cause prophage induction in natural populations suggests that such processes could in part be causing the elevated phage abundances seen in eutrophic estuaries, particularly in the summer months (Paul et al, 1999)

## ANTIBIOTICS THEMSELVES AS HGT PROMOTERS – Are AR bacteria more efficient survivors?

The antibiotic **tetracycline** acted as an ‘aphrodisiac’ for a number of bacteria, enhancing transfer frequencies up to 100-fold” in the gut (Steinbrecher et al, 2003)

Resistance plasmids encoding for many antibiotic resistance genes were transferred between pathogenic and non pathogenic Gram negative bacteria in several environments, including sea water. **In the presence of tetracycline concentrations that were not high enough to kill the bacteria, the rate of gene transfer between Vibrio cholerae and Aeromonas salmonicida increased 100 times** (Moriarity, 1999)

## BACTERIOPHAGES AS PROMOTERS (TRANSDUCTION) in the presence of Turbidity

**Turbidity**:  transduction frequencies were found to be enhanced as much as 100-fold in the presence of particulates (Ripp et al, 1995)

A marine phage host isolate is capable of transferring an antibiotic resistant plasmid among bacterial hosts … **up to 13 trillion transduction events per year** could occur in the Tampa Bay estuary … the presence of suspended **particulates** in the water column facilitates transduction by bringing the host and phage into close contact with each other (Jiang et al, 1998)

Bacteriophages themselves evolve by horizontal gene transfer and recombination; as many as 108 bacteriophages per ml. in aquatic environments, so that **one third of the total bacterial populations is subjected to a phage attack every 24 hours** (Ho, 1998)

## BIRDS FECES LEADING TO MISCLASSIFICATION

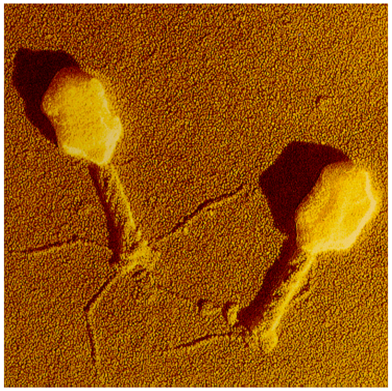
**Canada geese using manure lagoons at farms shed farm-animal antibiotic resistant bacteria** (Cole et al, 2005).

## ANIMAL ANTIBIOTIC GIVES FALSE POSITIVE FOR HUMAN ANTIBIOTIC

A antimicrobial drug used as an additive in animal feed in Europe (avoparcin) caused the poultry to have, and is associated with the human prevalence of, vancomycin resistant enterococci. So a residual of an animal antibiotic (that the people ate when they ate the animal meat) gave a positive test for a human antibiotic in feces. **Can other animal antibiotics produce ‘false’ positives as a human antibiotic after ingestion, or after release to the environment?** (McDonald et al, 1997)

**These examples may account for why MAR results can exceed 100% after the different source contributions are totalled.**

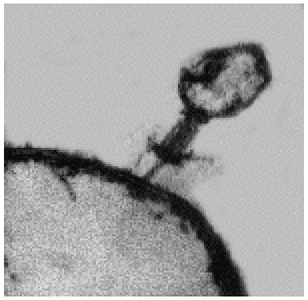
## MALE SPECIFIC F+RNA
# Bacteriophage



Four types, Type 2 most is consistent in the literature for humans and pigs.

More human strains are found in domestic sewage than in human feces (Scott et al, 2002).

There is limited but general agreement that the **F+RNA coliphage (unlike the somatic coliphage) does not reproduce in the environment because the pilus that serves as the site of attachment for virus most efficiently forms at 81 degrees F (25 C) or above (Scott et all, 2002; Woody, 1995).**

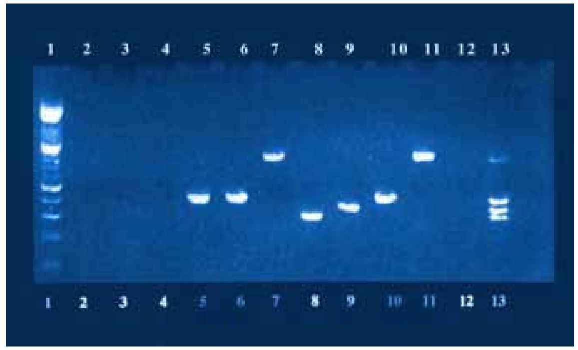


Sewage can exceed 81 degrees; shallow aquifers could reach 81 degrees or higher, but phage do not reach log phase of growth (Woody, 1995).

Furase found that Group 2 survive preferentially at lower temperatures as compared with other groups (Cole et al, 2003).

The only lab doing it in NJ is the DEP's because it is a difficult technique.

# PCR_RNA




Polymerase Chain Reaction: not as “human indicator” but to confirm species of interest.

RNA vs. DNA – study of bacterial mass

“freshwater and marine bacterioplankton assemblages are often numerically dominated by cells that are inactive or dormant, and that active cells usually constitute only a small portion of the bacterial community.” (due to grazing or infected by viruses) (del Giorgio et al, 1995). See also Haglund et al, 2002.

First study has evaluated the ability of PCR analysis of enterococcus to predict GI illness in swimmers – but: further studies needed because this tested DNA and noted that since viable organisms were not necessary, no die-off caused by UV sunlight was observed in the afternoon, but was observed in the culture based enterococcus (Wade, 2006).

Which of 19 entero species to analyse: Faecium and Faecalis cause most human disease

Once survivor species are identified, then can do pathogenicity studies on clones:

Strains of E.coli better adapted to external environment than GI habitat (Gordon, 2002); greater virulence may result in a decreased ability to thrive in secondary environments (decreased conservation of energy) (Mouslim et al, 2002).

The simplicity of PCR will make it grassroots driven unless government takes the lead.

REFERENCES


Cole, D; Long, S; and Sobsey, M. 2003. Evaluation of F+RNA and DNA coliphages as source-specific indicators of fecal contamination in surface waters. Applied Environmental Microbiology. Vol 69, No 11. pp – 6707-6514. http://www.pubmedcentral.gov/articlerender.fcgi?tool=pubmed&pubmedid=14602607 .

Cole, Dana, David J.V. Drum, David E. Stallknecht, David G. White, Margie D. Lee, Sherry Ayers, Mark Sobsey, and John J. Maurer. (2005). Free-living Canada Geese and Antimicrobial Resistance. Emerging Infectious Disease (CDC). Vol. 11, No. 6. http://www.cdc.gov/ncidod/EID/vol11no06/04-0717.htm

DelGiorgio, P. and Scarborough, G. 1995. Increase in the proportion of metabolically active bacteria along gradients of enrichment in freshwater and marine plankton: implications for estimates of bacterial growth and production rates. Journal of Plankton Research. Vol. 17. No. 10. Pps. 1905-1924.

Duan, D, Xu, L, Fei, X and Xu, H. 1995. Short Communications: Marine organisms attached to seaweed surfaces in Jizozhou Bay, China. World Journal of Microbiology & Biotechnology. Vol 11. Pps. 351-352.

EPA. 2005. Microbial Source Tracking Guide Document (EPA/600-R-05-064). Office of Research and Development.

Fallacara, DM et al. 2001. Fecal shedding and antimicrobial susceptibility of selected bacterial pathogens and a survey of intestinal parasites in free living waterfowl. Avian Disease. 45(1): 128-35. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11332473&dopt=Abstract

Feerst, E. Hovendon, B. Atherholt, T. 2002. The September 2002 Version of the Method 1600 Enterococcus Test: *Aerococcus viridans* as a False-positive Organism. NJDEP. Division of Science, Research and Technology.

Eichorst, S. (2000). Patterns of antibiotic resistance among bacteria isolated from the feces of adult and gosling resident Canada geese in a suburban area. Poster. North Central Region - District 1 Convention. Benedictine University. March 4, 2000. http://www.ben.edu/faculty/mtischler/bbb.htm

Gordon, D.; Bauer, S. and Johnson, J. 2002. The genetic structure of Escherichia coli populations in primary and secondary habitats. Microbiology. Vol. 148. p 1513-1522. http://mic.sgmjournals.org/cgi/content/abstract/148/5/1513

Haglund, A.; Tornblom, E. ; Bostrom, B.; and Tranvik, L. 2002. Large Differences in the Fraction of Active Bacteria in Plankton, Sediments, and Biofilm. Microbial Ecology. Vol 43. p 232-241.

Ho, Mae Wan et. Al. (1998). Gene Technology and Gene Ecology of Infectious Diseases. Microbial Ecology in Health and Disease. http://www.biotech-info.net/infectious_diseases.pdf

Jiang, S. et.al. (1998) Gene Transfer by Transduction in the Marine Environment. Applied and Environmental Microbiology. Vol. 64 No. 8. http://aem.asm.org/cgi/content/full/64/8/2780

Lee, y; Kwon, K; Cho, K.; Kim,H.; Park, J.; and Lee, H. 2003. Culture and Identification of Bacteria from Marine Biofilms. Journal of Microbiology. Microbiological Society of Korea.Vol 41, No.3. p. 183-188.

Makino, S.; Kobori, H.; Asakura, H.; Watarai, M.; Shirahata, T.; Ikeda, T.; Takeshi, K.; and Tsukamoto, T. 2000. Detection and characterization of Shiga toxin-producing Escherichia coli from seagulls. Epidemiology and Infection. Vol. 125. p 55-61.

McDonald, C. et.al. (1997) Vancomycin-Resistant Enterococci Outside the Health Care Setting: Prevalence, Sources, and Public Health Implications. Emerging Infectious Diseases. Vol. 3 No. 3 http://www.cdc.gov/ncidod/eid/vol3no3/mcdonald.htm

Moken, M. et. al. (1997) Selection of multiple antibiotic resistant (mar) mutants of Escherichia coli by using the disinfectant pine oil: roles of the mar and acrAB loci. Antimicrobial Agents and Chemotherapy. Vol. 41. No. 12.http://aac.asm.org/cgi/content/abstract/41/12/2770

Moriarty, D. (1999). Disease control in shrimp aquaculture with probiotic bacteria. Microbial Interactions in Aquiculture. Proceedings of the 8th International Symposium on Microbial Ecology. Halifax Canada. http://ag.arizona.edu/azaqua/tilapia/tilapia_shrimp/moriarty.PDF .

## REFERENCES


Mouslim, C.; Hilbert, F.; Huang, H. and Groisman, E. 2002. Conflicting needs for a Salmonella hypervirulence gene in host and and non host environments. Molecular Microbiology. Vol. 45. Issue 4. p 1019-1027. http://www.blackwell-synergy.com/doi/full/10.1046/j.1365-2958.2002.03070.x

North Lanarkshire Council. Accessed 3/23/06. Roosting Pigeons and Seagulls – Effects on Human Health. http://www.northlan.gov.uk/living+here/public+health/pest+control/roosting+pigeons+and+seagulls+effects+on+human+health.html

Paul, J.H. et. Al. (1999). Lysogeny and transduction in the marine environment. Proceedings of the 8th International Symposium on Microbial Ecology (Bell, Brylinsky and Johnson-Green, eds.) http://plato.acadiau.ca/isme/Symposium18/paul.PDF

Ripp, S. et. al. (1995) Effects of suspended particulates on the frequency of transduction among Pseudomonas aeruginosa in a freshwater environment. . Applied and Environmental Microbiology. Vol. 61. No. 4. http://aem.asm.org/cgi/reprint/61/4/1214

Scott, t; Rose, J; Jenkins, T; Farrah, S; and Lukasik, J. 2002. Microbial Source Tracking: Current Methodology and Future Directions. Applied and Environmental Microbiology. Vol 68, No.12 pp 5796-5803. http://aem.asm.org/cgi/reprint/68/12/5796.pdf

Steinbrecher, R. et. al. (2003) Horizontal Gene Transfer from GM Crops to unrelated organisms. GM Science Review Meeting of the Royal Society of Edinburgh on "GM Gene Flow: Scale and Consequences for Agriculture and the Environment." http://64.233.179.104/search?q=cache:w5k_y1stKboJ:www.royalsoced.org.uk/govt_responses/2003/GM_gene_flow/gm_steinbrecher.pdf+%22Horizontal+Gene+Transfer+from+GM+Crops+to+unrelated+organisms%22&hl=en

Wade, T; Calderon, R; Sams, E; Beach, M; Brenner, K.; Williams, A; and Dufour, A. 2006. Rapidly Measured Indicators of Recreational Water Quality are Predictive of Swimming Associated Gastrointestinal Illness. Environmental Health Perspectives. Vol. 114.No.1. http://www.ehponline.org/members/2005/8273/8273.html

White, D. (dwhite@cvm.fda.gov) (2/22/2000) FDA antimicrobial seminar. Formerly on http://www.fda.gov/cvm/antimicrobial/CVM-PES222.doc

Woody, M. and Cliver, D. 1995. Effects of Temperature and Host Cell Growth Phase on Replication of F-Specific RNA Coliphage QB. Applied and Environmental Microbiology. Vol 61, No.4 pp. 1520-1526.


- Home
- Beach Reports
- 24-Hour Response
- Health Alerts
- Public Health Preparedness
- Directions
- Contact Info
- Site Map
- Newsletters

Search

Monmouth County
Health Department
3435 Hwy. 9
Freehold, NJ 07728
(732) 431-7456

PublicHealth — Select

EnvironmentalProtection — Select

GeographicInformation — Select

## PUBLIC AND ENVIRONMENTAL HEALTH HISTORY    NATURAL FEATURES

- A brief history of health departments in Monmouth County
- Natural Features and Community Profile of Monmouth County
- Chronology of Public and Enviromental Events since the end of WWII
- Links to Public and Environmental Health History, Monmouth County History, and Geology


Suggestions? - Please email wsimmons@co.monmouth.nj.us

http://www.visitmonmouth.com/health/environmental/natural_history/natural_history.htm