



Assessment of Pathogen Strategies

Bacteria levels in receiving waters are a primary concern for federal, state, and local agencies. The primary sources of bacteria are generally attributed to combined sewer overflows (CSO) and stormwater. The USEPA is conducting a NY/NJ Harbor Project to develop Total Maximum Daily Loads (TMDLs) of pathogen indicators to the Harbor. This task has three major components that includes assessment of current standards, assessment of recreational standards and an assessment of shellfish standards. For each of these tasks there is a data evaluation, model evaluation based on a three year return period, and an evaluation of reductions necessary to meet the respective standards.

1. Assessment of Current Standards

This section addresses the attainment of current standards (excluding shellfish standards) based on recent water quality data (2008 – 2009) and model results that represents a three year return period.

The current classifications for New York and New Jersey are shown on Figures 1 and 2. The numerical standards associated with the classifications are shown on Tables 1 and 2.

Table 1. New York State Numeric Surface Water Quality Standards (Saline)

Class	Use	Bacteria (Pathogens)		
		Total Coliform ^(1,4) (per 100 mL)	Fecal Coliform ^(2,) (per 100 mL)	Enterococci ⁽³⁾ (per 100 mL)
SA	Shellfish	-	<14 10% > 49 “Adverse” Conditions	≤35
SD	Fish Survival	No Standard	No Standard	NA
1	Secondary Contact	≤10,000	≤2,000	NA
SB, SC	Primary Contact	≤2,400	≤200	≤35

⁽¹⁾ Total coliform criteria are based on monthly geometric means for Class I, and on monthly medians for Classes SB and SC; second criterion for SC and SB is for 80% of samples < 5,000.
⁽²⁾ Fecal coliform criteria are based on monthly geometric means.
⁽³⁾ The enterococci standard is based on geometric means per the USEPA Bacteria Rule and applies to the bathing season.

Table 2. New Jersey Numeric Surface Water Quality Standards

Classification	Use	Criteria
Shellfish Waters	Shellfishing	Total Coli. Geo Mean $\leq 70/100\text{mL}$ < 10% > 230 “Adverse” Conditions
SE1 and SC	Primary Contact	Enterococci: 30 day Geo. Mean $\leq 35/100\text{mL}$ Single Sample Maximum $\leq 104/100\text{mL}$
SE2	Secondary Contact (Fishing/Fish Propagation)	Fecal Coliform: 30 day Geo. Mean $\leq 770/100\text{mL}$
SE3	Secondary Contact (Fishing/Fish Migration)	Fecal Coliform: 30 day Geo. Mean $\leq 1500/100\text{mL}$

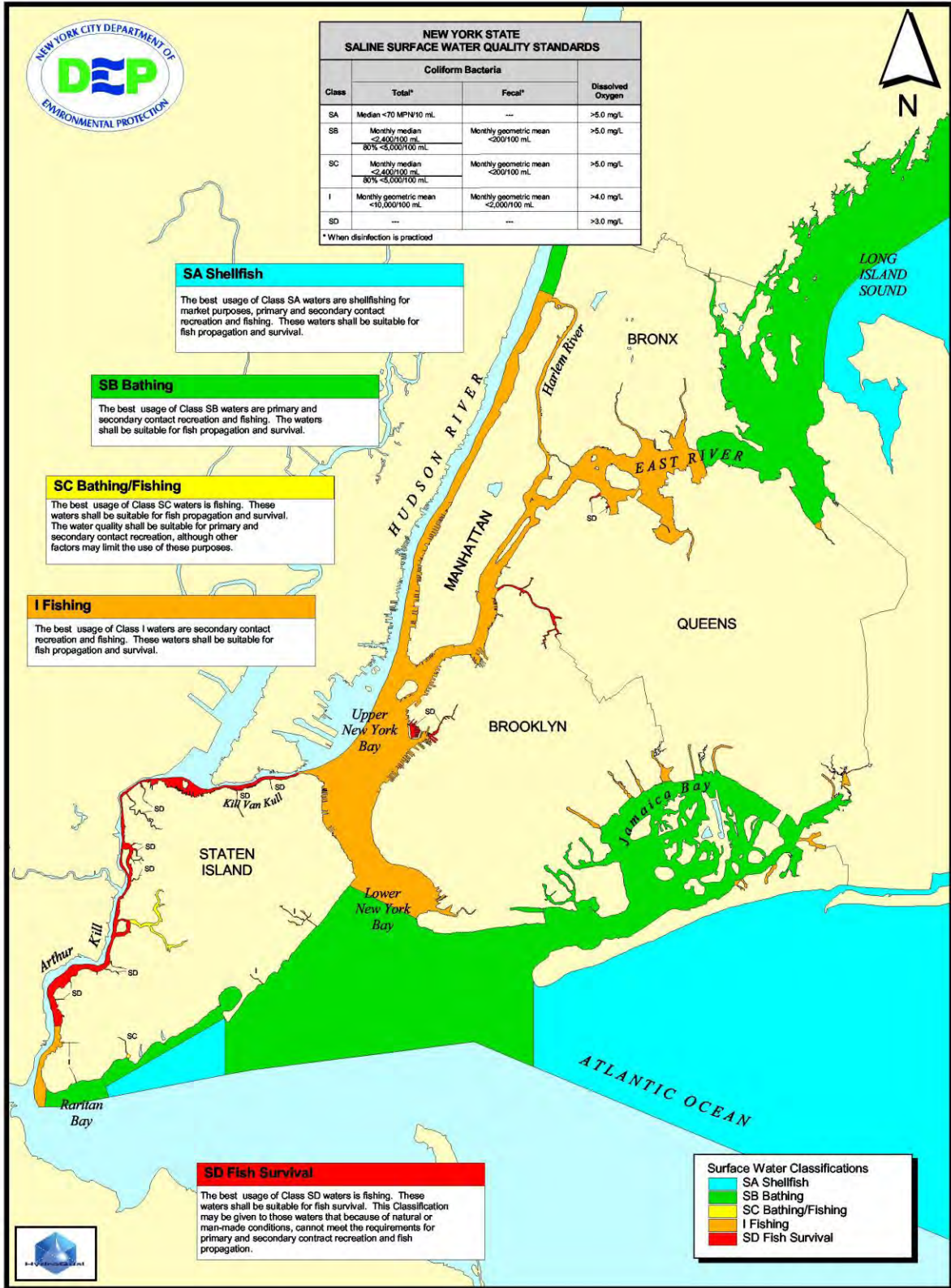


Figure 1 New York State Surface Water Classification

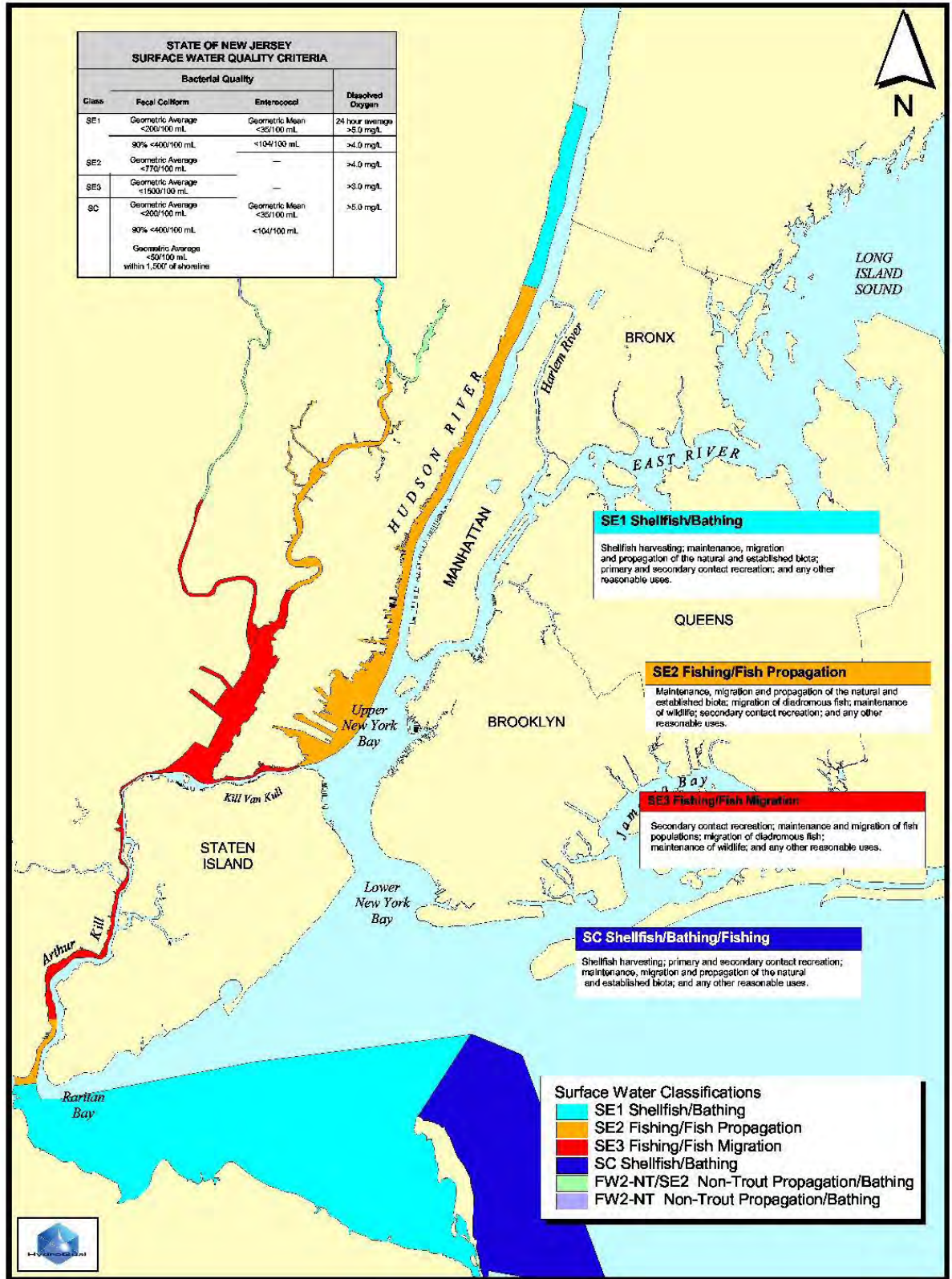


Figure 2. New Jersey Surface Water Classifications

Data Analysis

Data collected in 2008 and 2009 were evaluated for compliance given the classifications and standards given above. The basis for this analysis is the New York City Harbor Survey (NYHS) data and the New Jersey Harbor Discharge Group (NJHDG) Survey data. Both these groups survey their respective stations approximately once per week during the summer period. The station locations for these surveys are shown on Figures 3 and 4.

The geometric mean concentrations for fecal coliform bacteria were calculated for both the NYHS data and the NJHDG data. These results are shown on Tables 3 and 4. It is noted, however, the results shown on these tables are based on summer season geometric means since, at many locations there are less than five samples for a given 30 day period or a monthly period.

This analysis focuses on the open waters of the harbor. The tributaries in New York (i.e. Gowanus Canal, Bronx River, etc) are not considered part of the study. Likewise, the Second River, tributary to the Passaic River is not considered part of this analysis.

The results indicate that for the open waters of both the NYHS and NJHDG data, with the exception of the Hackensack River at the Oradell Dam, the seasonal geometric mean for fecal coliform measurements for 2008 – 2009 are below current water quality standards.



Figure 3. NYC Harbor Survey Station Locations



Figure 4. New Jersey Harbor Dischargers Group Survey Locations

**Table 3. Statistical Characteristics of NYHS 2008 – 2009
Fecal Coliform Data**

Station ID	Station Location	Standard	Geo Mean	Compliance
K01	The Kills	SD	26	N/A
K02	The Kills	SD	35	N/A
K03	The Kills	SD	55	N/A
K04	The Kills	SD	34	N/A
K05	The Kills	SD	17	N/A
K05A	Raritan Bay	2000	13	Y
E14	East River	2000	23	Y
E02	East River	2000	24	Y
E04	East River	2000	24	Y
E06	East River	2000	28	Y
E07	East River	2000	18	Y
E08	East River	2000	15	Y
E10	East River	2000	6	Y
N01	Hudson River	200	35	Y
N03B	Hudson River	2000	33	Y
N04	Hudson River	2000	31	Y
N05	Hudson River	2000	31	Y
N06	Upper New York Bay	2000	26	Y
N07	Upper New York Bay	2000	28	Y
N08	Lower New York Bay	2000	20	Y
N09	Lower New York Bay	200	9	Y
K06	Raritan Bay	200	3	Y
J12	Jamaica Bay	2000	43	Y
H01	Harlem River	2000	97	Y
H02	Harlem River	2000	8	Y

**Table 4. Statistical Characteristics of NJHDG 2008 – 2009
Fecal Coliform Data**

Station ID	Station Location	Standard	All Data	Compliance with Current WQ Standards
			Geo Mean	
1	Passaic/Totowa Ave.	FW2 ⁽¹⁾	128	NA ⁽²⁾
2	Passaic/Northwest St	FW2	217	NA
3	Passaic/Lincoln Ave.	FW2	255	NA
4	Passaic/Market St.	FW2	184	NA
5	Passaic/Dundee Dam	FW2	170	NA
6	Saddle River	1500	383	Y
7	Passaic/Union Ave.	770	335	Y
8	Passaic/Rutgers St.	770	275	Y
9	Second River	1500	1754	N
10	Passaic/Clay St.	1500	307	Y
11	Passaic/Jackson St.	1500	242	Y
12	Passaic/Kearney Pt.	1500	69	Y
13	Hackensack/Oradell D	SE1 ⁽¹⁾ 35	38	N
14	Hackensack/Berrys C	770	45	Y
15	Hackensack/Marion	770	73	Y
16	Hackensack/Mouth	1500	51	Y
17	Newark/Upper	1500	41	Y
18	Newark/Lower	1500	22	Y
19	Newark/Shooters Is.	1500	20	Y
20	Elizabeth	FW2	570	NA
21	Arthur Kill/Elizabeth	1500	72	Y
22	Rahway	1500	407	Y
23	Arthur Kill/Rahway	1500	37	Y
24	Arthur Kill/Reading	1500	22	Y
25	Raritan/Upstream	FW2	138	NA
26	Raritan/Basilone Br.	FW2	169	NA
27	Raritan/Wash. Canal	FW2	137	NA
28	Raritan Bay/West	SE1 ⁽¹⁾ 14 ^{sf}	22	N
29	Raritan Bay/Central	SE1 ⁽¹⁾ 14 ^{sf}	5	Y
30	Raritan Bay/Crookes P	NY - 200	3	Y
31	Hudson/GW Bridge	770	15	Y
32	Hudson/Lincoln T	770	27	Y
33	Hudson/Holland T	770	34	Y

⁽¹⁾ FW2 and SE1 classifications no longer use Fecal coliform as the criteria.

SE1 recreational criteria: Enterococci 30 day Geometric Mean < 35/100mL

SE1 shellfish criteria: Fecal Coliform < 14/100mL (adverse conditions)

⁽²⁾NA – Not applicable

Model Analysis of Current Conditions

The model analysis of current conditions is based on a thirteen year simulation and extrapolating to a three year return period. For each major waterbody a critical model segment is chosen for the evaluation. The results of the analysis are shown on Table 5. The table also shows the applicable water quality standard and whether the calculated concentrations attain the specific water quality standard.

**Table 5
Attainment of Current Water Quality Standards
Three Year Return Period**

Location	Fecal Coliform Max30dGM-3yr	NY Class	NY Standard	Attains NY Std	NJ Class	NJ Standard	Attains NJ Std
Arthur Kill	528	SD	None	na	SE3	1500	Y
Arthur Kill - Lower	233	I	2000	Y	SE2	770	Y
Arthur Kill - Upper	565	SD	None	na	SE3	1500	Y
East River	203	I	2000	Y	na	na	na
Eastchester Bay	113	SB	200	Y	na	na	na
Hackensack River	298(1)	na	na	na	SE1	35	N
Harlem River	197	I	2000	Y	na	na	na
Hudson River - Lower	107	I	2000	Y	SE2	770	Y
Hudson River - Upper	11(1)	SB	200	Y	SE1	35	Y
Kill Van Kull	272	SD	None	na	SE3	1500	Y
Lower New York Bay	51	SB	200	Y	na	na	na
Newark Bay	747	na	na	na	SE3	1500	Y
Passaic River - Lower	1730	na	na	na	SE3	1500	N
Passaic River - Upper	557	na	na	na	SE2	770	Y
Raritan Bay - NJ	44(1)	na	na	na	SE1	35	N
Raritan Bay - NY	91	SB	200	Y	na	na	na
Raritan Bay - NY2	38	SB	200	Y	na	na	na
Raritan River	141(1)	na	na	na	SE1	35	N
Sandy Hook	16(1)	na	na	na	SE1	35	Y
Upper New York Bay	136	I	2000	Y	SE2	770	Y

(1) Enterococci Standard = 35 (30 day)

It is noted that for most areas the current standards are based on fecal coliform bacteria. However, there are five areas in the New Jersey waters listed above that are classified as SE1 waters; the standard for these waters is an enterococci 30-day geometric mean concentration of 35. In these areas the maximum 30-day enterococci geometric mean concentration is shown in column 2.

Reductions Required for Current Standards

Only two areas would require reductions to meet standards at current standards – the lower Passaic River (fecal coliform) and the upper Hackensack River (enterococci). The Hackensack River is in Management Zone 15 and the Passaic River is in Management Zone 16. The percent CSO reduction necessary to attain water quality standards are calculated for these zones assuming a 3% stormwater reduction and a 10 % stormwater reduction. These results are shown on Table 6. Note that for the Hackensack River and Raritan River the calculated CSO reductions are greater than one. These areas are heavily influenced by stormwater and therefore stormwater reductions of greater than 10% would be necessary to meet the 30 day geometric mean concentration of 35.

Table 6. Percent CSO Reductions Necessary to Attain Current Water Quality Standards

	Hackensack MZ 15	Raritan River MZ 12	Lower Passaic MZ 16
CSO	197	34	1021
SW	101	107	709
TOTAL	298	141	1730
Total - 3%SW	295	138	1709
Total -10%SW	288	130	1659
Target	35	35	1500
Percent CSO Reduction (3% SW)	1.32	3.02	0.20
Percent CSO Reduction (10% SW)	1.28	2.80	0.16

II. Assessment of Primary Contact Recreation Criteria

This section addresses the attainment of primary contact recreation criteria based on the States Interpretation of the Beach Act. In this case, the criteria are based on a seasonal enterococci geometric mean concentration of 35 No./100mL. The assessment is based on recent water quality data (2008 – 2009) and model results that represent a three year return period.

Data Analysis

Data collected in 2008 and 2009 were evaluated for compliance of primary contact recreation. The basis for this analysis is the New York City Harbor Survey (NYHS) data and the New Jersey Harbor Discharge Group (NJHDG) Survey data. Both these groups survey their respective stations approximately once per week during the summer period. The station locations for these surveys are shown on Figures 3 and 4.

The geometric mean concentrations for enterococci were calculated for both the NYHS data and the NJHDG data. These results are shown on Tables 7 and 8.

This analysis focuses on the open waters of the harbor. The tributaries in New York (i.e. Gowanus Canal, Bronx River, etc) are not considered part of the study. Likewise, the Saddle River, Second River, tributaries to the Passaic River, Berrys Creek tributary to the Hackensack River, and the Rahway River are not considered part of this analysis.

The results indicate that for the open waters that there is a slight non-attainment in the Harlem River using the NYHS data and there is observed non-attainment in the Passaic River and Hackensack River using the NJHDG data

**Table 7. Statistical Characteristics of NYHS 2008 – 2009
Enterococci Data**

Station ID	Station Location	Standard	Seasonal Geo Mean	Compliance with Primary Contact
K01	The Kills	35	6	Y
K02	The Kills	35	5	Y
K03	The Kills	35	6	Y
K04	The Kills	35	4	Y
K05	The Kills	35	3	Y
K05A	Raritan Bay	35	3	Y
E14	East River	35	6	Y
E02	East River	35	5	Y
E04	East River	35	6	Y
E06	East River	35	6	Y
E07	East River	35	4	Y
E08	East River	35	3	Y
E10	East River	35	2	Y
N01	Hudson River	35	4	Y
N03B	Hudson River	35	7	Y
N04	Hudson River	35	7	Y
N05	Hudson River	35	4	Y
N06	Upper New York Bay	35	5	Y
N07	Upper New York Bay	35	4	Y
N08	Lower New York Bay	35	3	Y
N09	Lower New York Bay	35	2	Y
K06	Raritan Bay	35	2	Y
H01	Harlem River	35	36	N
H02	Harlem River	35	5	Y

**Table 8. Statistical Characteristics of NJHDG 2008 – 2009
Enterococcus Data
Seasonal Geometric Mean**

Station ID	Station Location	Standard	Seasonal	Compliance with Recreational Standards
			Geo Mean	
1	Passaic/Totowa Ave.	FW2 ⁽¹⁾	39	NA ⁽³⁾
2	Passaic/Northwest St	FW2	104	NA
3	Passaic/Lincoln Ave.	FW2	79	NA
4	Passaic/Market St.	FW2	33	NA
5	Passaic/Dundee Dam	FW2	56	NA
6	Saddle River	35	375	N
7	Passaic/Union Ave.	35	83	N
8	Passaic/Rutgers St.	35	111	N
9	Second River	35	821	N
10	Passaic/Clay St.	35	94	N
11	Passaic/Jackson St.	35	76	N
12	Passaic/Kearney Pt.	35	13	Y
13	Hackensack/Oradell D	35	15	Y
14	Hackensack/Berrys C	35	140	N
15	Hackensack/Marion	35	40	N
16	Hackensack/Mouth	35	16	Y
17	Newark/Upper	35	7	Y
18	Newark/Lower	35	4	Y
19	Newark/Shooters Is.	35	4	Y
20	Elizabeth	FW2	480	NA
21	Arthur Kill/Elizabeth	35	12	Y
22	Rahway	35	244	N
23	Arthur Kill/Rahway	35	7	Y
24	Arthur Kill/Reading	35	5	Y
25	Raritan/Upstream	FW2	245	NA
26	Raritan/Basilone Br.	FW2	48	NA
27	Raritan/Wash. Canal	FW2	34	NA
28	Raritan Bay/West	35	6	Y
29	Raritan Bay/Central	35	2	Y
30	Raritan Bay/Crookes P	35	2	Y
31	Hudson/GW Bridge	35	3	Y
32	Hudson/Lincoln T	35	3	Y
33	Hudson/Holland T	35	4	Y

⁽³⁾NA – Not applicable

Model Analysis of Primary Contact Recreational Criteria

The model analysis of primary contact recreation is based on a thirteen year simulation and extrapolating to a three year return period. For each major waterbody a critical model segment is chosen for the evaluation. The results of the analysis are shown on Table 9. The table also shows whether the calculated concentrations attain the primary contact standard of a seasonal enterococci geometric mean concentration of 35.

Table 9.
Attainment of Primary Contact Recreation Criteria
Three Year Return Period

Location	Enterococci Seasonal GM	Compliance with Primary Contact Recreational Criteria
Arthur Kill	20	Y
Arthur Kill - Lower	10	Y
Arthur Kill - Upper	17	Y
East River	9	Y
Eastchester Bay	7	Y
Hackensack River	50	N
Harlem River	9	Y
Hudson River - Lower	6	Y
Hudson River - Upper	4	Y
Kill Van Kull	10	Y
Lower New York Bay	3	Y
Newark Bay	21	Y
Passaic River - Lower	78	N
Passaic River - Upper	58	N
Raritan Bay - NJ	9	Y
Raritan Bay - NY	5	Y
Raritan Bay - NY2	3	Y
Raritan River	21	Y
Sandy Hook	4	Y
Upper New York Bay	7	Y

Reductions Required for Primary Contact Recreation Criteria

Only two areas would require reductions to meet primary contact recreation criteria standards – the lower Passaic River and the Hackensack River. The Hackensack River is in Management Zone 15 and the Passaic River is in Management Zone 16. The percent CSO reduction necessary to attain recreational water quality standards are calculated for these zones assuming a 3% stormwater reduction and a 10 % stormwater reduction. These results are shown on Table 6.

**Table 6. Percent CSO Reductions Necessary to Attain
Current Water Quality Standards**

	Hackensack MZ 15	Lower Passaic MZ 16
CSO	33	46
SW	17	32
TOTAL	50	78
Total - 3%SW	49	77
Total -10%SW	48	75
Target	35	35
Percent CSO Reduction (3% SW)	0.44	0.91
Percent CSO Reduction (10% SW)	0.40	0.87

III. Assess Compliance with States/NSSP Shellfish Criteria

The assessment of shellfish requirements is somewhat complex since the assessment needs to be done at “adverse” meteorological conditions. In this analysis, an “adverse” condition is considered to be at least 0.2 inches of rainfall. The regulations also require at least 15 samples. In this analysis, a full year of rainfall is used so that this analysis certainly satisfies that requirement. In addition, the task is to identify spatially where direct harvest standards could be met. An analysis to meet harvesting for depuration is also included. The following is a summary of the approach that was used for this analysis.

Approach for Shellfish Assessment

- **NJDEP’s Direct Harvest Total Coliform Shellfish Criteria:**
 - **70 Total Coliform per 100 mL** – 15 samples minimum - Geometric Mean
 - **230 Total Coliform per 100 mL (5 tube Test)** – 5 samples a year; 15 sample minimum – to be met in at least 90 % of the samples.

- **NJDEP’s Depuration Total Coliform Shellfish Criteria:**
 - **700 Total Coliform per 100 mL** – 15 samples minimum - Geometric Mean
 - **2300 Total Coliform per 100 mL (5 tube Test)** – 5 samples a year; 15 sample minimum – to be met in at least 90 % of the samples.

- **NYSDEC’s Direct Harvest Fecal Coliform Shellfish Criteria:**
 - **14 Fecal Coliform per 100 mL** – 5 sample minimum – Geometric Mean
 - **49 Fecal Coliform per 100 mL** – 5 sample minimum – to be met in at least 90% of the samples

- **NYSDEC’s Depuration Fecal Coliform Shellfish Criteria:**
 - **88 Fecal Coliform per 100 mL** – 5 sample minimum – Geometric Mean
 - **300 Fecal Coliform per 100 mL** – 5 sample minimum – to be met in at least 90% of the samples

- **FDA’s Suggestions on How to Implement the Above Criteria:**
 - Trigger Rainfall is 0.2 inches over a 48 hour period;
 - Model should not use monthly averages but rather hourly concentrations due to rainfall events ≥ 0.2 inches;
 - Identify the level of rainfall ≥ 0.2 inches that results in CSO, stormwater or other loads that cause an exceedence of the above criteria; and
 - Compliance with the 90th percentile criterion, such as NJ’s 230 Total Coliform per 100 mL or NY’s 49 Fecal Coliform per 100 mL, should be based on hourly model predicted concentrations - not a daily average.

- **Model Background:**
 - The model is based on 13 years of hydrological, weather, and loading data;
 - The model can identify storm events ≥ 0.2 inches of rainfall within a 48 hour period; and
 - Compliance assessment with all criteria is based on a 3 year return interval.

- **Methodology:**
 - For each of the 13 years of model output, HydroQual will determine the number of rainfall events ≥ 0.2 inches that occur annually;
 - The model will determine concentrations due to rainfall events ≥ 0.2 inches within a 48 hour period at 9:00 AM after completion of the rainfall.. This “9:00 AM” hourly concentration represents the way ambient grab samples are taken and provides representative pathogen concentrations similar to those that are monitored.
 - Geometric mean concentrations will be calculated for each of the 13 years. Probability distributions will then be developed for these geometric mean concentrations. From these distributions the simulation period that represents the 3 year return period will be selected. This simulation period will subsequently be used to assess compliance. This analysis will be done for both the Peak and “9:00AM” concentrations.

- Compliance will be assessed based on a 3 year return interval, with the States applicable criteria. For each criterion, it will provide the States an assessment of compliance at the “9:00 AM” concentration scenarios.

- Assessment of the load reductions necessary to meet the “9:00 AM” rainfall scenario for applicable criteria are supplied..

The results of these analyses are shown on thematic maps focusing on Raritan Bay and the upper Hudson River. The results of the analysis are shown on the following figures. All results are based on a 3-year return period for “adverse” meteorological conditions.

Fecal Coliform 9:00AM Concentrations – Raritan Bay

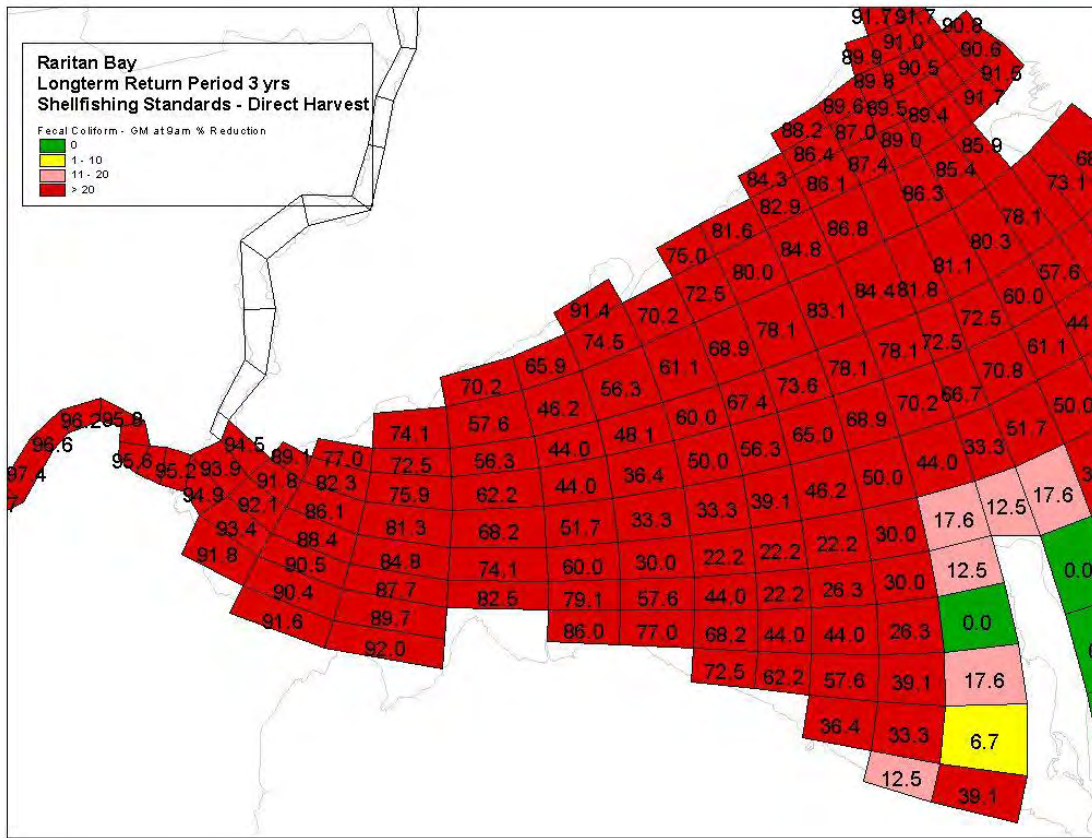
- Figure 5: Geometric Mean Concentrations
- Figure 6: 90th Percentile Concentration
- Figure 7: Reductions Necessary to Attain Geometric Mean for Direct Harvest
- Figure 8: Reductions Necessary to Attain 90th Percentile for Direct Harvest
- Figure 9: Reductions Necessary to Attain Geometric Mean for Depuration
- Figure 10: Reductions Necessary to Attain 90th Percentile for Depuration

Total Coliform 9:00AM Concentrations – Raritan Bay

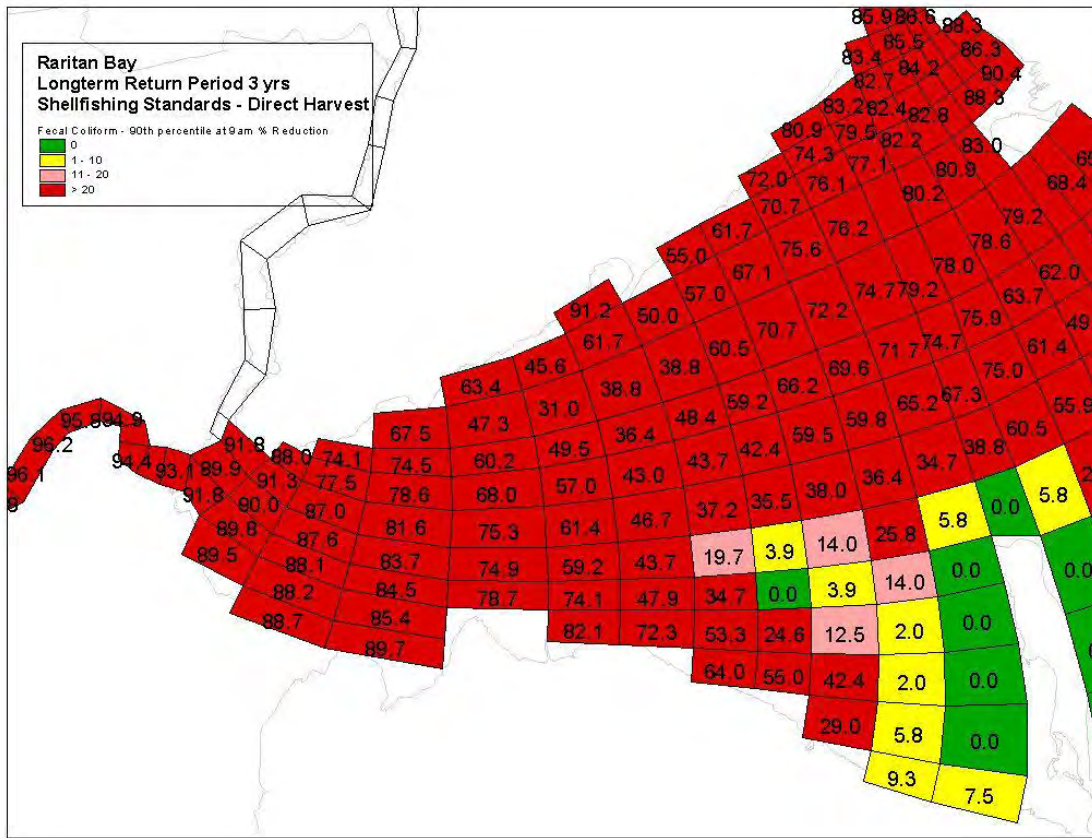
- Figure 11: Geometric Mean Concentrations
- Figure 12: 90th Percentile Concentration
- Figure 13: Reductions Necessary to Attain Geometric Mean for Direct Harvest
- Figure 14: Reductions Necessary to Attain 90th Percentile for Direct Harvest
- Figure 15: Reductions Necessary to Attain Geometric Mean for Depuration
- Figure 16: Reductions Necessary to Attain 90th Percentile for Depuration

Total Coliform 9:00AM Concentrations – Hudson River

- Figure 17: Geometric Mean Concentrations
- Figure 18: 90th Percentile Concentration
- Figure 19: Reductions Necessary to Attain Geometric Mean for Direct Harvest
- Figure 20: Reductions Necessary to Attain 90th Percentile for Direct Harvest
- Figure 21: Reductions Necessary to Attain Geometric Mean for Depuration
- Figure 22: Reductions Necessary to Attain 90th Percentile for Depuration



**Figure 7. Fecal Coliform Reductions to Attain Geometric Mean
 Direct Harvest
 “Adverse” Conditions
 9:00 AM
 Three Year Return Interval**



**Figure 8. Fecal Coliform Reductions to Attain 90th Percentile
 Direct Harvest
 “Adverse” Conditions
 9:00 AM
 Three Year Return Interval**

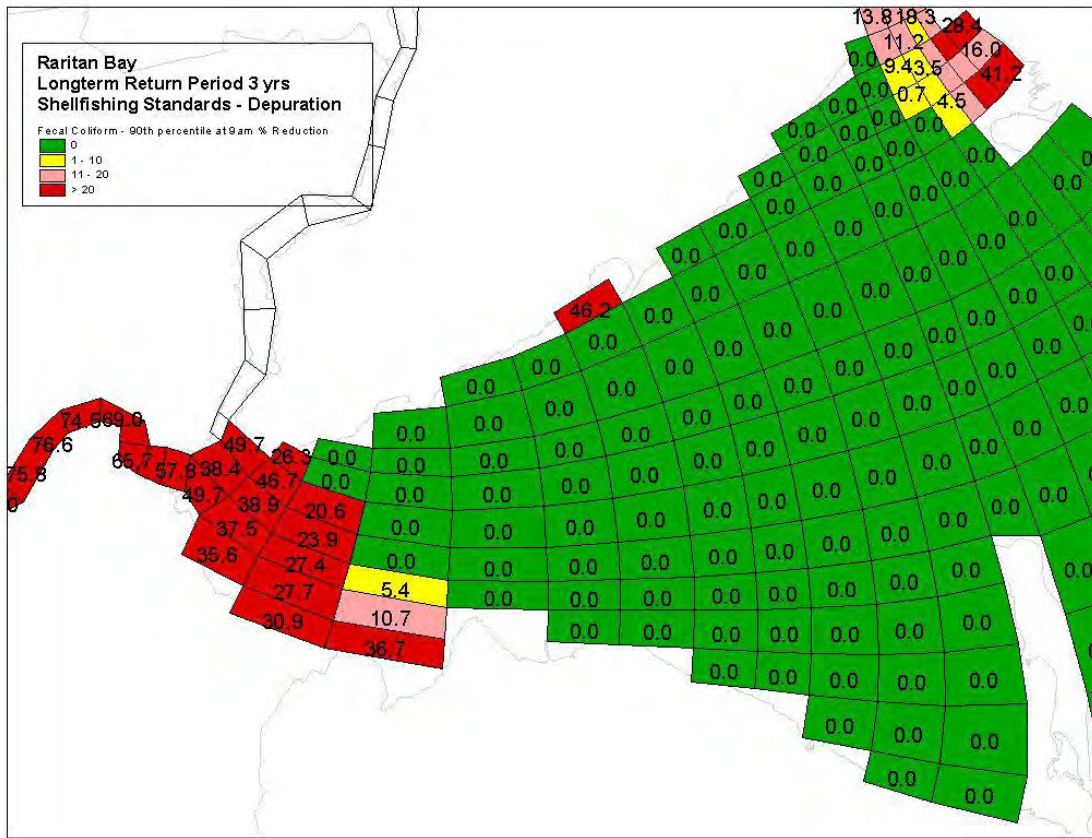


Figure 10. Fecal Coliform Reductions to 90th Percentile
Depuration
“Adverse” Conditions
9:00 AM
Three Year Return Interval

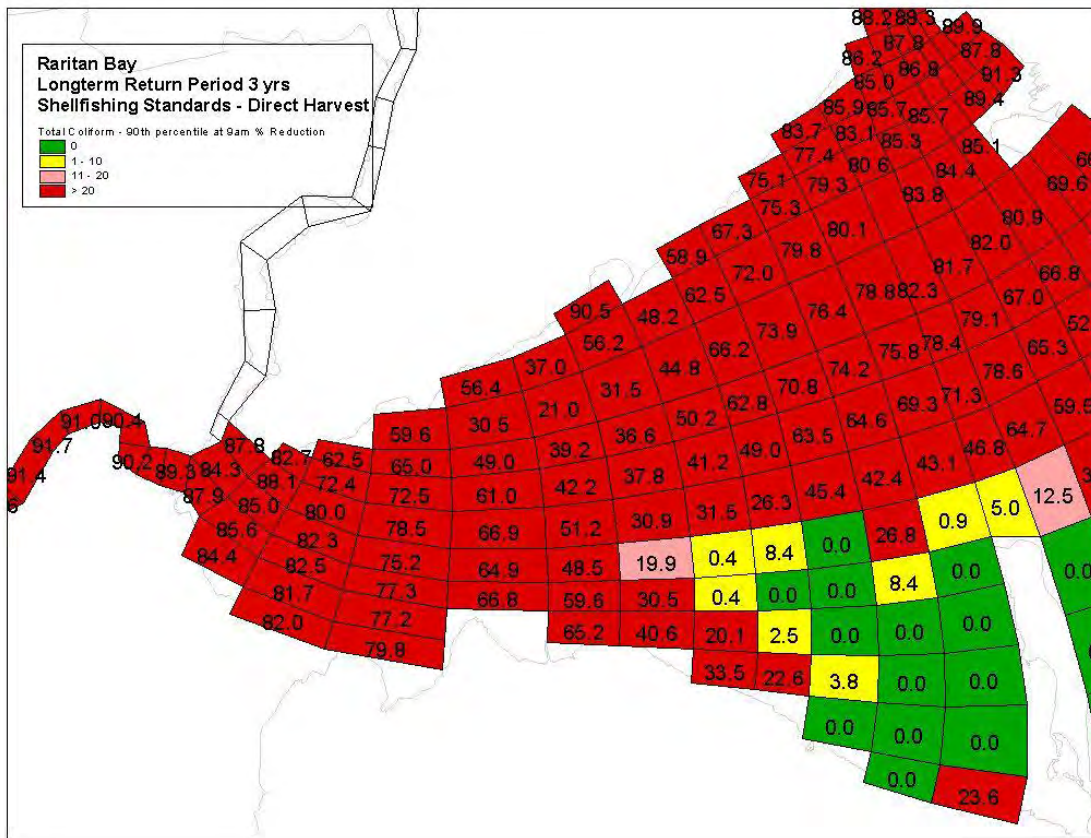


Figure 14. Total Coliform Reductions to Attain 90th Percentile
 Direct Harvest
 “Adverse” Conditions
 9:00 AM
 Three Year Return Interval

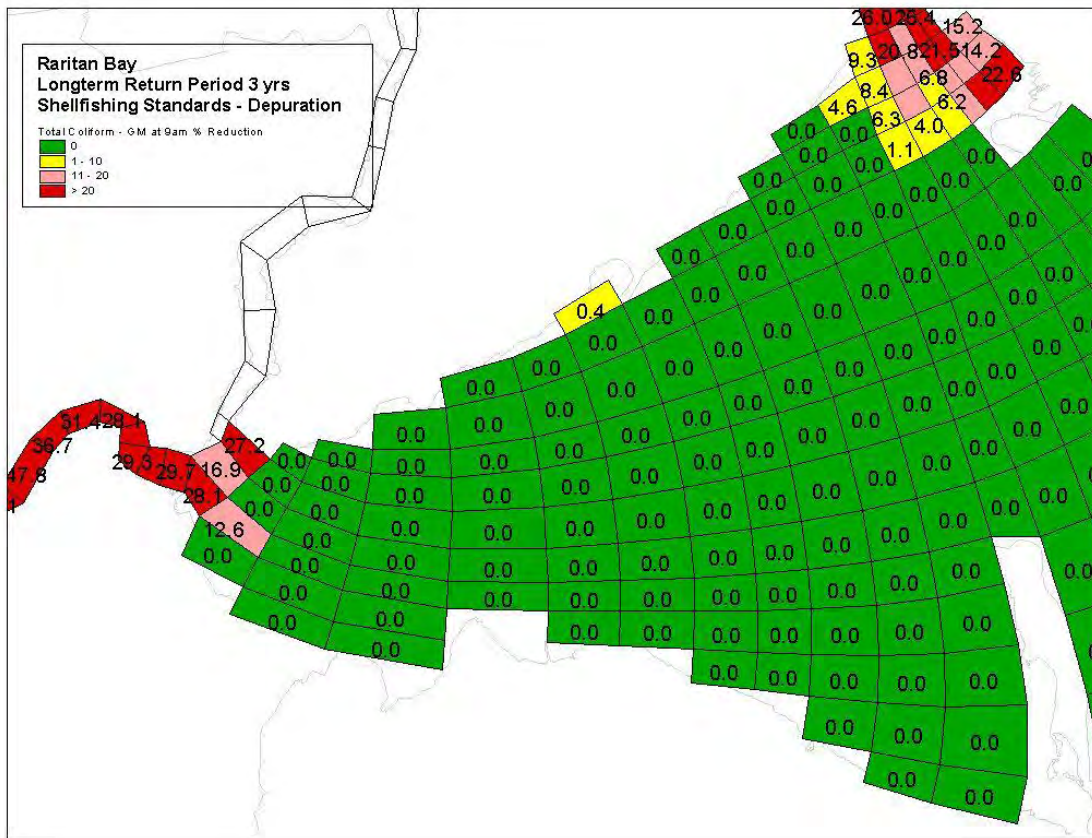
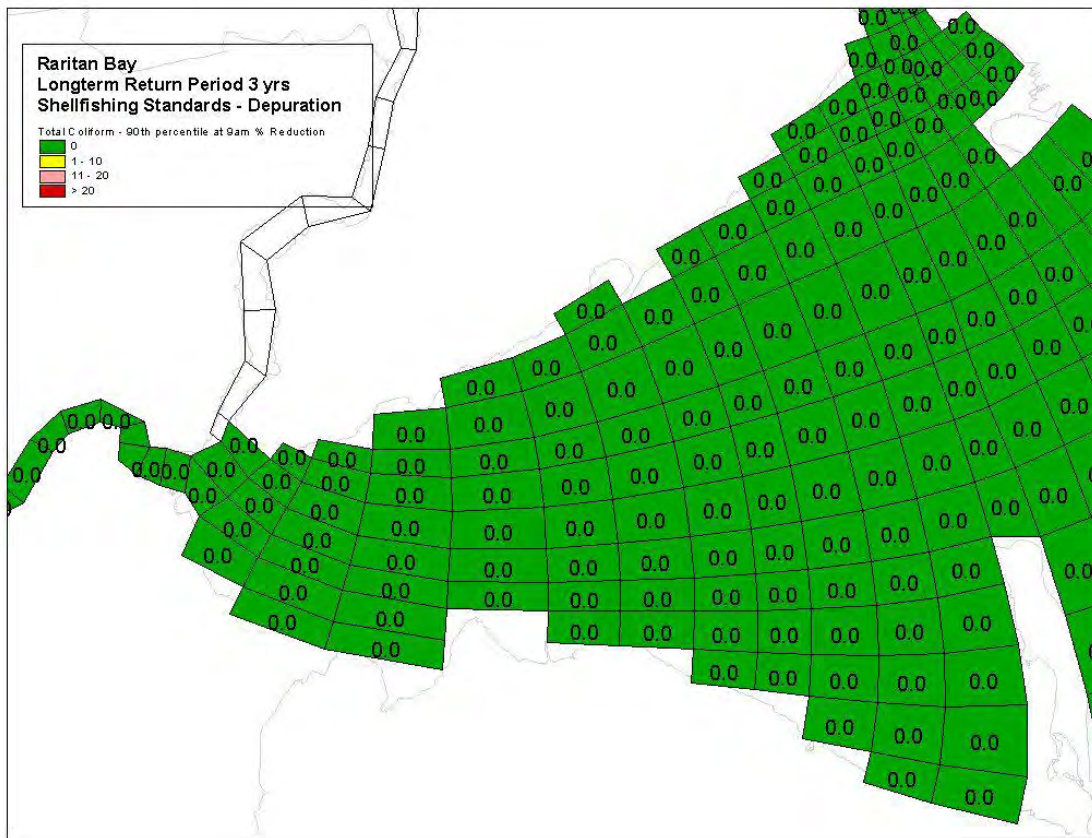
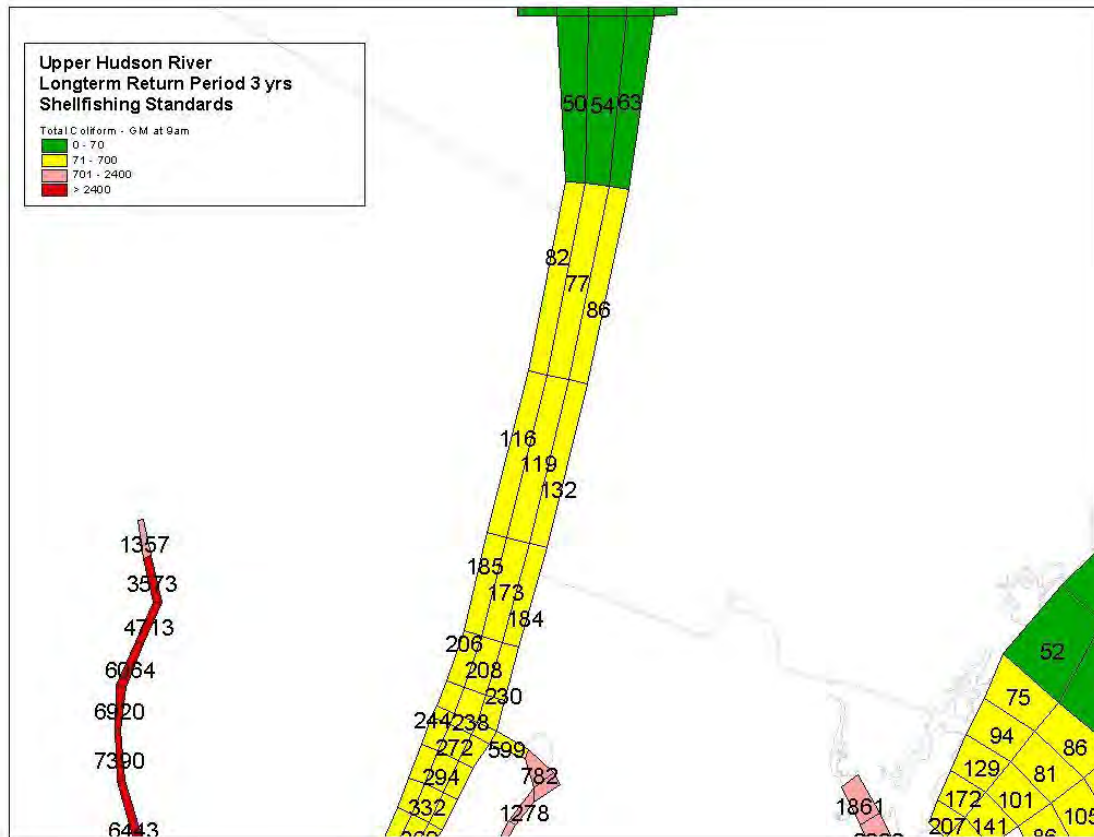


Figure 15. Total Coliform Reductions to Attain Geometric Mean Depuration
 “Adverse” Conditions
 9:00 AM
 Three Year Return Interval



**Figure 16. Total Coliform Reductions to 90th Percentile
Depuration
“Adverse” Conditions
9:00 AM
Three Year Return Interval**



**Figure 17. Total Coliform Geometric Means
“Adverse” Conditions
9:00 AM
Three Year Return Interval**

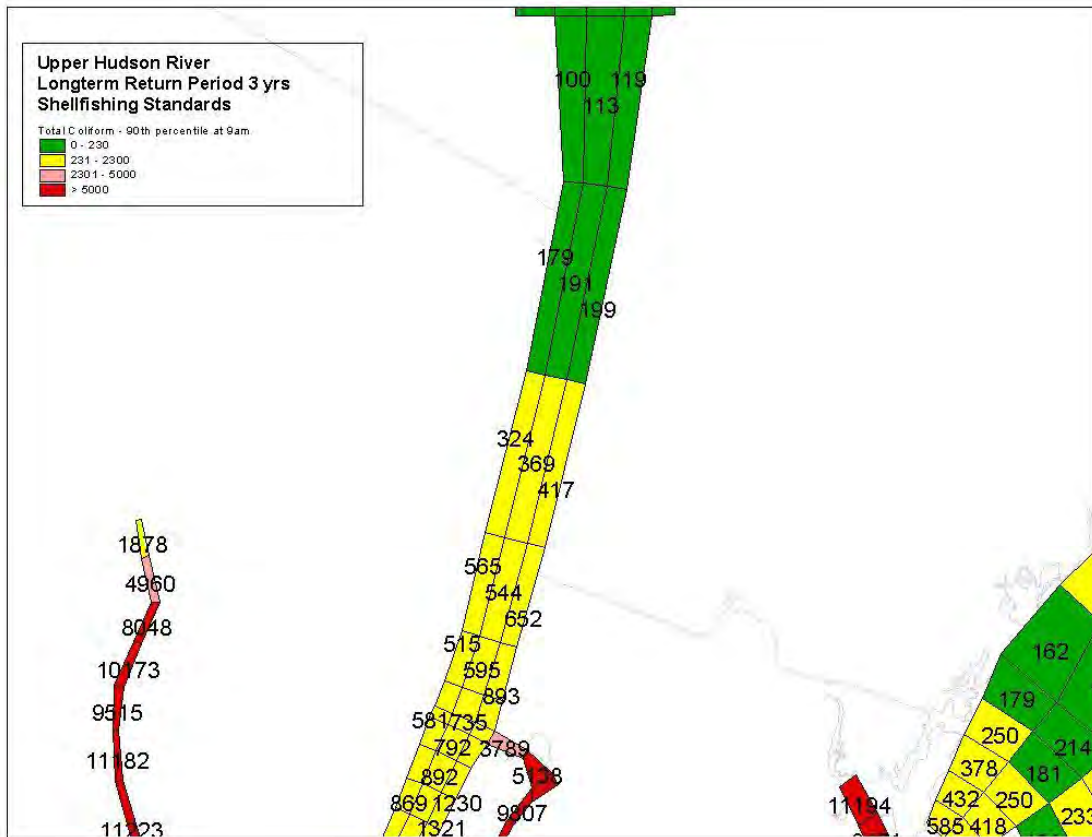
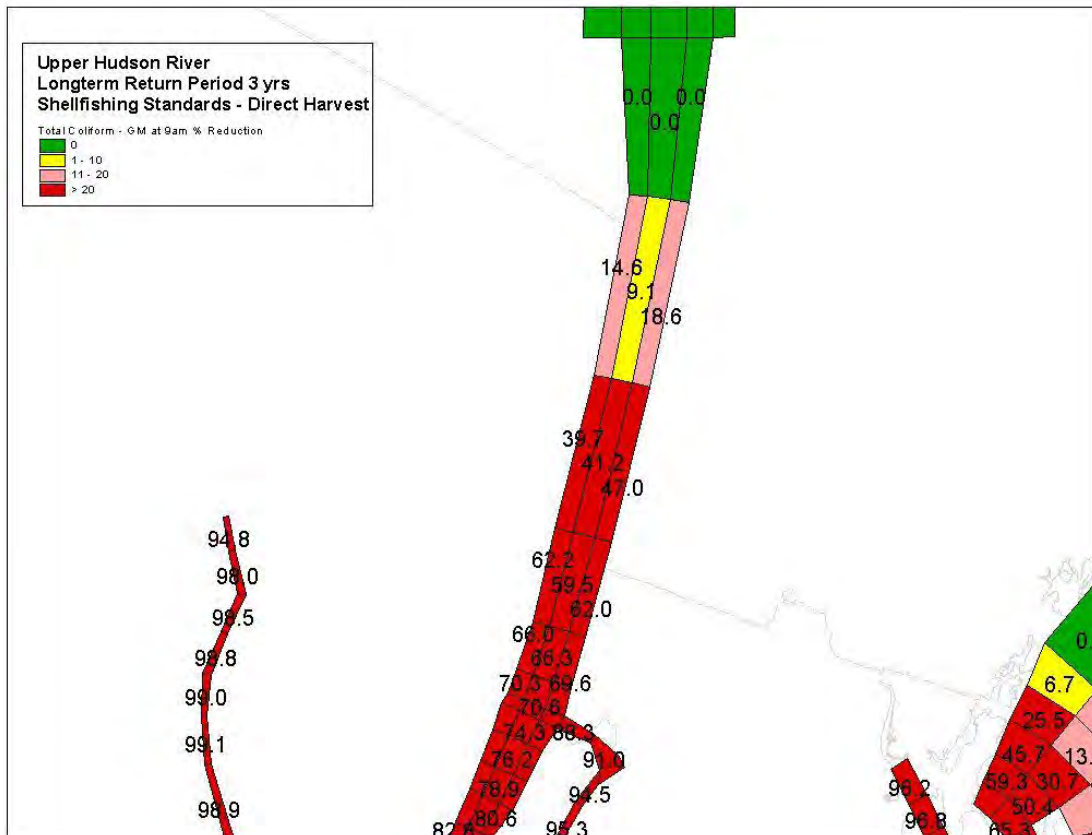
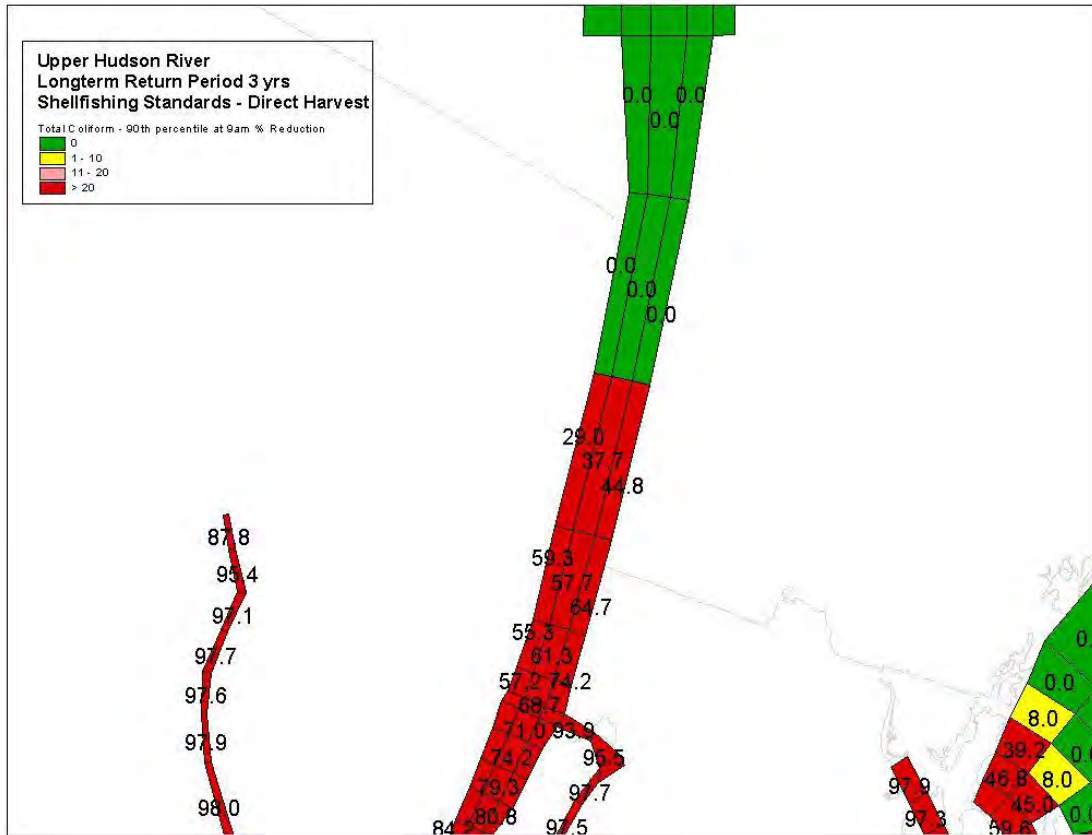


Figure 18. Total Coliform 90th Percentile
 “Adverse” Conditions
 9:00 AM
 Three Year Return Interval



**Figure 19. Total Coliform Reductions to Attain Geometric Mean
Direct Harvest
“Adverse” Conditions
9:00 AM
Three Year Return Interval**



**Figure 20. Total Coliform Reductions to Attain 90th Percentile
Direct Harvest
“Adverse” Conditions
9:00 AM
Three Year Return Interval**

