# Rockaway River Priority Stream Segment Study

## Executive Summary

The Rockaway River Watershed Cabinet (RRWC), in partnership with TRC Omni Environmental Corporation (TRC Omni), was contracted through NJDEP to complete the Rockaway River Priority Stream Segment Study. This project focused on identifying nonpoint source pollutant sources to address TMDL requirements for fecal coliform in the Rockaway River. The partners were charged by NJDEP with evaluating non point pollution sources, storm water runoff issues, and potential sources of fecal coliform. Additionally, partners were to identify and specify future projects to achieve the required water quality improvements in the Rockaway River. Over the course of the project, three key documents were prepared:

- *Rockaway River Priority Stream Segment Study* (August 2004),
- *Quality Assurance Sampling Plan for Rockaway River Watershed Priority Stream Segment Assessment & Stormwater Impact Study* (May 2005), and
- *Pathogenic Indicator and Pollutant Track Down Evaluations for The Rockaway River Watershed Priority Stream Segment Assessment & Stormwater Impact Study* (January 2006).

For the *Rockaway River Priority Stream Segment Study*, partners first undertook an extensive literature and data review of previous studies for the Rockaway River. After reviewing available reports, partners evaluated and analyzed water quality data for the segment of Rockaway River in question. Available data was limited to four sampling events completed by NJDEP in 1998 in support of the *2002 Integrated List of Waterbodies*. This data was supplemented with Stream Visual Assessment Protocol (SVAP) data collected by RRWC volunteers and TRC Omni staff. Partners compiled all data and characterized the portion of Rockaway River in question as a critical reach due to its transition from a relatively undeveloped forested drainage area to a developed urbanized corridor. Once defined as critical, partners identified gaps in data and pointed out preliminary relationships between fecal coliform levels and flow in the river.

In order to confirm initial concerns with storm water, non point pollution sources, and fecal coliform, partners prepared and implemented the *Quality Assurance Sampling Plan for Rockaway River Watershed Priority Stream Segment Assessment & Stormwater Impact Study* which resulted in the *Pathogenic Indicator and Pollutant Track Down Evaluations for The Rockaway River Watershed Priority Stream Segment Assessment & Stormwater Impact Study*.

The project partners completed seven months of water quality sampling consisting of six ambient sampling events, three low flow events, two baseline storm events, one intensive storm event and high flow event. In total, approximately 200 samples were collected and analyzed for fecal coliform and other key water quality parameters including TSS, TDS, phosphorus, fecal streptococci, temperature, and pH.

The data from these sampling events was analyzed and showed distinctive trends. Data clearly indicates that during low flow and ambient conditions in the Rockaway River fecal coliform concentrations were not exceeding the water quality criteria except at the most downstream sampling location. However, storm water events showed drastic increases in fecal coliform and regularly exceeded the 400 colonies/100 ml SWQS criterion. During these storm water sampling events, it was noted that rarely did fecal coliform concentrations exceed criteria at the most upstream station. The primary sources of bacteria contributing to the water quality impairment are coming from the immediately surrounding lands and drainage areas within this 1-mile segment of the Rockaway River. This intensive analysis clearly identified high flow storm water events where runoff from areas immediately adjacent to the River is flowing directly into the River appear to be the primary sources of the fecal coliform impairment in this segment of the Rockaway River.

The results of the priority stream segment study provided detailed scientific data isolating areas where concentrations of non-point source pollutants are greatest in this reach of the Rockaway River. To address the identified problem of fecal coliform contamination, partners recommended several management strategies and implementation projects for consideration.

- Active implementation and enforcement of the requirements for street sweeping, waterfowl feeding, and pet waste clean up in the communities

of Dover and Wharton as set forth in New Jersey's Stormwater Regulations.

- Implementation of several storm water BMP and restoration projects including:
    - Bowlby Pond and McKeel Brook drainage areas in Dover and Rockaway Township: These drainage areas have been disturbed by construction of the Rockaway Town Square Mall. Specifically, drainages that previously flowed through the area have been culverted and/or diverted. Restoration activities could include reconnecting the natural drainages, and/or day lighting or improving the outfall channel connection. These actions would enhance the system by reducing velocities and sediment entering the Rockaway River, restore natural hydrology to Bowlby Pond and McKeel Brook, and greatly enhance fish and wildlife populations in the area.
    - Treatment Wetland Construction and Floodplain Restoration along Green Pond Brook: This site is an approximately 3.9 acre parcel of land located on an active power line right-of-way in Wharton, near the intersection of Mount Pleasant Avenue and West Clinton (Route 15). The site is bordered on the northeast by the West Clinton Bridge, on the east by Green Pond Brook, on the south by the Rockaway River and a large forested wetland, and on the northwest by the roller rink parking lot. Currently, the area receives surface water runoff from the adjacent roller rink parking lot and the surrounding roads. It is assumed that the site historically was a forested floodplain associated with Green Pond Brook. The proposed restoration action at this site will include removal and off-site disposal of invasive species; excavation and removal of the root mate; installation of slope stabilizing, biodegradable filter fabric; and excavation of a series of wetland treatment ponds connected by one meandering channel. Native

emergent vegetation would be planted in the restored floodplain to enhance fish and wildlife habitat and to reduce sedimentation to the downstream reaches. Similarly, the area between the restored emergent and open water wetlands and existing parking lot will be graded and planted with scrub-shrub vegetation.

- Prepare a regional storm water management plan: The storm water regulations provide for and encourage municipalities and interconnected urban regions to work together in planning for storm water control through preparation of a Regional Stormwater Management Plan (NJAC 7:8-3). To meet new storm water regulations municipalities can work together to develop a Regional Storm Water Management Plan (RSWMP) based on the findings of this study and each municipality's Baseline Assessment completed as part of their individual municipal plan. A RSWMP can provide a better understanding of the impacts of surface runoff and storm water flows that impact this reach of the Rockaway River. The RSWMP should be designed to comply with the NJDEP Storm Water Regulations and permitting requirements to be met by each municipality. The plan would need to include at a minimum Dover Town, Wharton Borough, and Rockaway Township as well as Randolph Township, Mine Hill Township, Roxbury Township, and Jefferson Township.

TRC Omni

# *PATHOGENIC INDICATOR AND POLLUTANT TRACK DOWN EVALUATIONS FOR THE ROCKAWAY RIVER WATERSHED PRIORITY STREAM SEGMENT ASSESSMENT & STORMWATER IMPACT STUDY*

***Prepared For:***

***ROCKAWAY RIVER WATERSHED CABINET***

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# TABLE OF CONTENTS

**PAGE**

I. BACKGROUND AND SAMPLING OVERVIEW ..... 1
II. RESULTS AND ASSESSMENT ..... 10
1. Assessment of Pathogenic Indicators ..... 10
2. Assessment of Other Pollutants ..... 19
III. MANAGEMENT STRATEGIES ..... 24
1. Stormwater Management ..... 24
2. Riparian Area Management ..... 29
3. Park Land/Open Space Management ..... 33
4. Implementation ..... 35
IV. FUNDING SOURCES ..... 37
1. Wetland Program Development Grants, EPA ..... 37
2. Wetlands Reserve Program ..... 37
3. Wildlife Conservation and Appreciation Program ..... 38
4. Wildlife Links ..... 38
5. Watershed Protection & Flood Prevention ..... 38
6. Wildlife Habitat & Incentive Program (WHIP) ..... 38
7. Five Star Restoration Challenge Grants ..... 39
8. Dodge Foundation ..... 39
9. Private Stewardship Grants Program ..... 39
10. Schumann Foundation ..... 39
11. NJDEP 319(h) Non Point Source Pollution Control Grants ..... 40
V. CONCLUSION AND RECOMMENDATIONS ..... 41

## FIGURES

**PAGE**

FIGURE 1. ..... 4
FIGURE 2. ..... 8
FIGURE 3. ..... 10
FIGURE 4. ..... 11
FIGURE 5. ..... 12
FIGURE 6. ..... 13
FIGURE 7. ..... 14
FIGURE 8. ..... 19
FIGURE 9. ..... 21
FIGURE 10. ..... 22

## TABLES

TABLE 1. ESTIMATED DRAINAGE AREAS USED TO CALCULATE FLOW AT SAMPLING STATIONS ..... 7
TABLE 2. OBSERVED FECAL COLIFORM GEOMETRIC MEAN CONCENTRATIONS ..... 17

## LIST OF APPENDICES

APPENDIX A SAMPLING RESULTS
APPENDIX B STORM WATER PIPE SAMPLING LOCATIONS
APPENDIX C USACE RESTORATION PROJECTS
APPENDIX D VISIONS REPORT RESTORATION PROJECTS
APPENDIX E CONTACT INFORMATION FOR POTENTIAL FUNDING SOURCES

## I. BACKGROUND AND SAMPLING OVERVIEW

The Pathogenic Indicator and Pollutant Track Down Evaluations were initiated by the Rockaway River Watershed Cabinet (RRWC) to obtain water quality data under approved quality assurance protocols in order to better isolate the cause of bacteria, and other pollutants, in the Rockaway River Watershed between Dover and Roxbury Township. In the interest of its goal of continued environmental stewardship, RRWC with funds from the Priority Stream Segment Study program of the New Jersey Department of Environmental Protection (NJDEP) Division of Watershed Management, completed a detailed water quality sampling, analysis, and data assessment study for a portion of the Rockaway River. The Rockaway River Watershed Cabinet is evaluating a segment of the Rockaway River in Dover Town, Wharton Borough, and Roxbury Township to develop an implementation plan consistent with the NJDEP TMDL and nonpoint source program. The stream segment begins at the Blackwell Street crossing in Dover and continues upstream to the Interstate Highway Route 80 crossing (Figure 1). This four-mile segment flows through developed areas of the towns as well as significant areas of undeveloped forest and wetlands. In this reach, three tributary streams, Jackson Brook, Green Pond Brook, and Stephens Brook, join the Rockaway River.

The goal of this evaluation was to assist with the identification of impacts to the stream and specifically evaluate nonpoint source pollution sources, storm water runoff concerns, and potential sources of bacteria (fecal coliform). Specific sources of bacteria identified in the TMDL as contributing to the impairments include Hurd Park (goose population, no riparian buffer) and landfills in the Blackwell Street segment and wildlife and failing septic systems in the Longwood Valley segment. Sampling locations were selected to target the impacts from these locations. In addition, the sampling program was conducted to determine impacts to pollutant levels from the Morris County Bridge and Road Division property located along the Rockaway River in Wharton Borough. Storm water runoff from this property carries sediment and other pollutants into the Rockaway River and its adjacent floodplain wetlands. The Morris County Division of Roads and Bridges has prioritized this site for storm water retrofit activities and are implementing several site improvements that will reduce nonpoint source pollution from this site. In addition, a storm water BMP project, presently funded by a 319(h) grant, will

complement these existing efforts by creating a wetland adjacent to the property that will provide storage and treatment of site runoff.

Sampling for this project was designed to obtain data necessary to evaluate targeted pollutants with respect to flow conditions, seasonal variations, and pertinent weather conditions. In addition, pathogenic indicator assessment sampling was conducted during a storm water event from November 16, 2005 to November 17, 2005. The pathogenic indicator pollutants chosen for this investigation are fecal coliform and fecal streptococcus. These bacteria are present in large numbers in the feces and intestinal tracts of humans and other warm-blooded animals, and can enter water bodies from human and animal waste. The sampling plan was designed to assess impacts to water quality due to groundwater conditions, erosion and storm water runoff, which could then be examined to determine the effectiveness of BMP installations. In order to incorporate these assessments into an integrated plan, the sampling program was conducted as described in the *Quality Assurance Sampling Plan (QASP) for the Rockaway River Watershed Priority Stream Segment Assessment* (TRC Omni, May 3, 2005). This QASP detailed monitoring station networks including monthly ambient stream monitoring, dry weather low-flow sampling, storm water monitoring, and intensive storm water pollutant source tracking.

Sampling and analyses were performed in accordance with the QASP. Figure 1 details the sampling locations for the study. The stations detailed in the QASP comprise the following networks (station types):

- Two Boundary locations (RK1 and RK9) and two composite locations (RK3 and RK8) were sampled during ambient conditions. These locations also served as low-flow and storm water locations;
- Two local area flow monitoring stations (RK3 and RK 8);
- Eleven low-flow locations which also serve as storm water locations;
- Twelve baseline storm water locations;
- Six intensive storm water locations;
- Two Phosphorus Series monitoring stations, RK4 (downstream of Washington Pond) and RK6 (downstream of Hurd Park/Jackson Brook discharge to the Rockaway River).

Figure 1 also details the locations of three additional sample stations (RK7a, SB1, and MKB). The rationale for the addition of these stations is presented later in this report.

SEGMENT END (I-80)

RK1

ROXBURY TWP

DPW1

DPW2

RK3

RK2

STEPHENS BROOK

RK4

ROCKAWAY RIVER

GB1

GREEN POND BROOK

WHARTON BORO

RK5

DOVER TOWN

SEGMENT END (BLACKWELL STREET)

JB2

JB1

JACKSON BROOK

RK6

RK7

ROCKAWAY RIVER

RK8

RK9

ROCKAWAY RIVER WATERSHED
Priority Stream Segment Study

Figure 1
Proposed Sampling Sites

LEGEND

- Proposed Sampling Sites
- Rivers and Streams
- Municipalities
- Morris County DPW
- Hurd Park

N
W E
S

0 0.25 Miles

Prepared by:

TRC Omni Environmental Corporation

The original stream sampling stations were selected so that the sources of nonpoint pollutants could be identified. Tributary stations were selected in order to characterize substantial inputs into the Rockaway River priority segment study area. The following list describes the sampling stations detailed in the QASP:

RK1: Rockaway River, just upstream of the I-80 crossing

RK2: Rockaway River immediately downstream of its confluence with Stephens Brook and immediately upstream of the Morris County DPW property

RK3: Rockaway River at West Central Avenue Bridge

RK4: Rockaway River at North Main Street Bridge

RK5: Rockaway River at Railroad Bridge near Eileen Street

RK6: Rockaway River at Railroad Bridge near NJDOL in Dover

RK7: Rockaway River at Morris Street Bridge

RK8: Rockaway River at Mercer Street Bridge

RK9: Rockaway River at Blackwell Street Bridge

GB1: Green Pond Brook at Dewey Avenue

JB1: Jackson Brook immediately upstream of Hurd Park

JB2: Jackson Brook immediately downstream of the dam located in Hurd Park

DPW1: West Inlet to storm water Basin

DPW2: East Inlet to storm water Basin

Site RK1 is located on the Rockaway River, just upstream of the I-80 crossing. This site characterized water quality in the river as it enters the study area. Site RK2 is located on the Rockaway River immediately downstream of its confluence with Stephens Brook and immediately upstream of the Morris County DPW property. This site characterized water quality in the river after it received flow from the Stephens Brook and before it flows past the proposed storm water wetland site on the Morris County DPW property. Sites DPW1 and DPW2 characterized water quality in storm water prior to the proposed storm water wetland site on the Morris County DPW property. Site RK3 is located immediately downstream of the Morris County DPW site to characterize the segment of the River after storm water has discharged to the river from the DPW property.

Three tributary stations were selected in order to characterize substantial inputs from the major streams within the study area. Site GB1 is located at the NJDEP sampling station on Green Pond Brook to characterize flow in this tributary. Site JB1 is located on the Jackson Brook immediately upstream of Hurd Park. This site characterized the Brook prior to the impoundment at Hurd Park where a significant resident Canada goose population exists. This site is identified as a potential source of fecal coliform in the TMDL and a goose management and riparian buffer implementation project has been funded for the park by the NJDEP 319(h) program. Site JB2 is located on the Jackson Brook immediately downstream of the dam located in Hurd Park.

Sites RK4 through RK8 were used to access various sections in the developed areas along the Rockaway River. The final site is RK9 which is located on the Rockaway River at Blackwell Street. This is the NJDEP station used to characterize the river reach and justify the need for the fecal TMDL.

In order to make decisions concerning the collection of samples, flow conditions were assessed using the real-time gage in the Rockaway River, upstream of the reservoir, at Boonton (USGS 01380500). Flow was estimated at each sample station using drainage area ratios and the real-time readings at the downstream gauge, USGS 01380500. Table 1, on the following page, displays the estimated drainage areas used to calculate flows at the various sample stations in the study. This drainage area was divided by the drainage area at the USGS gage to determine the watershed drainage area ratio of the sample location to the drainage area at the gage location. The estimated flow at each sample station was determined by applying this ratio to the real time flow at the USGS gage. An estimated travel time for flow from the study area to the USGS gage was also incorporated into this calculation. Precipitation was assessed using data provided by the RRWC and measured on site by TRC Omni with rain gages.

Several additions and modifications to the sampling program, as detailed in the QASP, occurred during the study period. During the initial baseline storm event, samples were obtained at the wrong location for JB1. This new location was designated as SB1. Samples were obtained at JB1 and SB1 for the second baseline storm event. One high-flow event was completed by TRC Omni at thirteen (13) stations to further define areas identified with elevated fecal coliform during storm water events. The purpose of this event was to examine coliform levels under conditions of continuous high flow where the overland storm water runoff would be

presumed to already have removed accumulated pollutants. This event would be useful in determining if sanitary surcharges or septic system overflows were significant contributors to coliform loading under high flow conditions.

**Table 1. Estimated Drainage Areas Used to Calculate Flow at Sampling Stations**

| Sample Station | Estimated Drainage Area (acres) |
|---|---|
| DPW1 | 12 |
| DPW2 | 6 |
| GB1 | 9,675 |
| SB1 | 797 |
| JB1 | 3,045 |
| JB2 | 3319 |
| RK1 | 17,730 |
| RK2 | 19,300 |
| RK3 | 19370 |
| RK4 | 19,620 |
| RK5 | 29,840 |
| RK6 | 33,465 |
| RK7 | 33,958 |
| RK8 | 34,044 |
| RK9 | 35,275 |
| USGS Gage 01380500 | 75,460 |

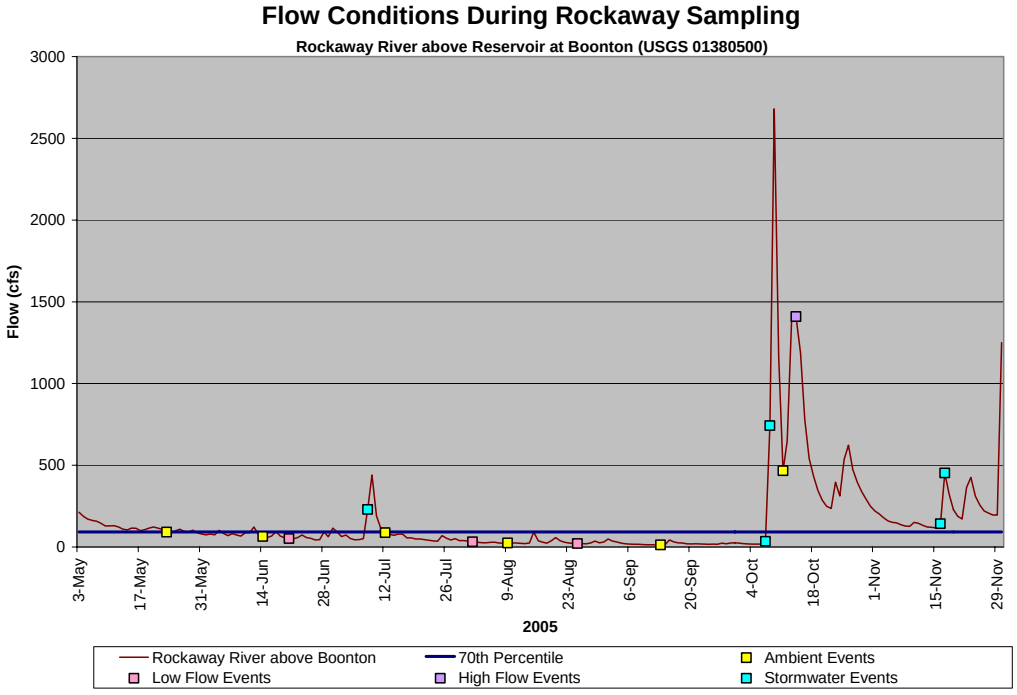
TRC Omni and RRWC performed six (6) ambient events, three (3) low-flow events, two (2) baseline storm events, one (1) high-flow event, and one (1) intensive storm sampling event to identify fecal coliform sources. Sampling for ambient and low-flow events was performed by RRWC and representatives from Rockaway Valley Regional Sewage Authority (RVRSA). Sampling for the three storm events was performed by TRC Omni field technicians. In addition, one high-flow event was completed at thirteen (13) stations by TRC Omni to further define areas with high fecal coliform and to narrow down potential sources of contamination by measuring fecal coliform and fecal streptococci. A summary of the laboratory results for the sampling conducted between May and November 2005 is presented in Appendix A. Figure 2 details the flow conditions in the Rockaway River associated with all of the sampling events detailed above.

Ambient sampling occurred on May 23, 2005; June 14, 2005; July 12, 2005; August 9, 2005; September 13, 2005; and October 11, 2005. During each event, two boundary locations, RK1 and RK9, and two composite locations, RK3 and RK8, were sampled by RRWC and RVRSA. Due to the consistency of the results, it was determined that it was not necessary to

perform the six (6) remaining events defined in the sampling plan. The parameters measured for these events were fecal coliform, fecal streptococci, pH, temperature, total dissolved solids (TDS) and total suspended solids (TSS). During ambient events composite sampling, at two locations (RK3 and RK8), for the analysis of TDS and TSS, was initiated 24 hours prior to the collection of the grab samples.

Low-flow sampling occurred on June 20, 2005; August 1, 2005; and August 25, 2005, when measured flow at USGS station 01380500 did not exceed d70, the stream flow that is exceeded 70% of the time. Low-flow grab sampling was performed at eleven (11) stations. The parameters measured at all locations were fecal coliform, pH, temperature, dissolved reactive phosphorus, total phosphorus, TDS and TSS. During low flow events, composite sampling at two locations (RK3 and RK8), for the analysis of TDS and TSS, was initiated 24 hours prior to the collection of the grab samples. In addition, dissolved reactive phosphorus and total phosphorus were measured only at stations RK4 and RK6.

**Figure 2.**




The two baseline storm water sampling events were performed on July 8, 2005 and October 7 and 8, 2005. During the July 8 event, samples were collected at approximately 7 am,

10 am, and 2 pm at fourteen (14) stations. Total precipitation of 1.9 inches was recorded during the initial baseline storm water sampling event. The first sample of the second event was collected on October 7 at about 3 pm, with the remaining two samples being collected on October 8 at approximately 8 am and 1 pm. Sampling for this event occurred at sixteen (16) stations. Total precipitation of 3.1 inches was recorded during this sampling event. Two additional sites (Location SB1 and a storm water pipe designated as IS1) were added during the second baseline storm water sampling event to further identify fecal coliform sources. TRC Omni was granted access to location IS1 for a limited time period, therefore only one sample (during round 1) was obtained at this location. The parameters measured at all locations were fecal coliform, pH, temperature, dissolved reactive phosphorus, total phosphorus, TDS and TSS. The composite sampling at two locations (RK3 and RK8), for the analysis of TDS and TSS, was conducted during the collection of the grab samples. Dissolved reactive phosphorus and total phosphorus were measured only at stations RK4 and RK6.

Sampling for the intensive storm water event was performed from November 16, 2005 to November 17, 2005. Three sets of samples were taken at each selected location starting approximately around 5 pm, 6 pm and 8 pm on November 16, 2005. Another set of samples were collected at all accessible sites with observable flow on November 17, 2005 to determine pollutant levels during the receding hydrograph. The parameters measured were fecal coliform, fecal streptococci, pH, temperature, TDS, and TSS. The composite sampling at two locations (RK3 and RK8), for the analysis of TDS and TSS, was conducted during the collection of the grab samples. Total precipitation of 1.0 inches was recorded on November 16, 2005 during the intensive storm water sampling event.

# II. RESULTS AND ASSESSMENT

## 1. Assessment of Pathogenic Indicators

A summary of the laboratory results for the sampling conducted between May and November 2005 is presented in Appendix A. In the study area, the Rockaway River is classified by NJDEP as FW2-NT. Figures 3 and 4 show sampling results compared with applicable criteria for fecal coliform concentrations in the Surface Water Quality Standards (SWQS) during the ambient and low flow sampling events. All locations met the 400 colonies/100ml SWQS during all of these sample events. It is evident from this data that during the ambient and low-flow sampling events fecal coliform concentrations increase as samples are collected further downstream.

**Figure 3.**

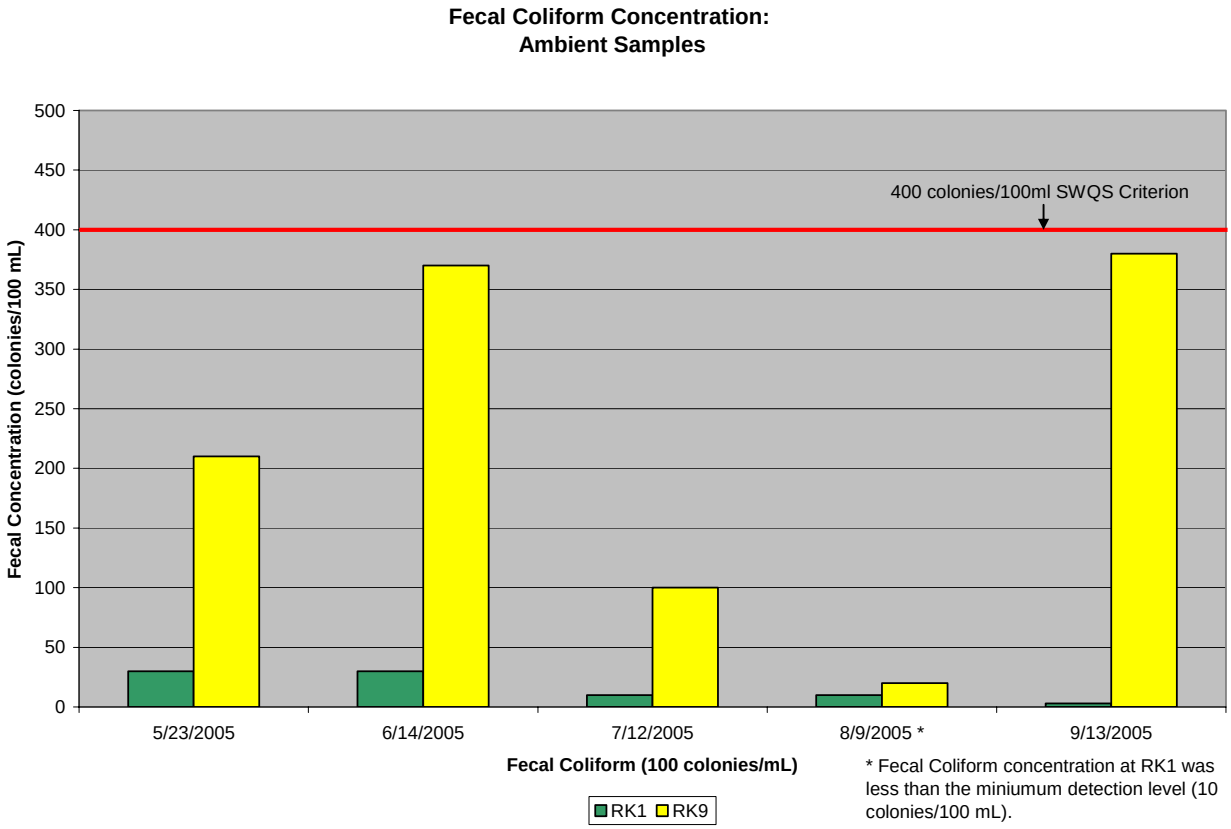
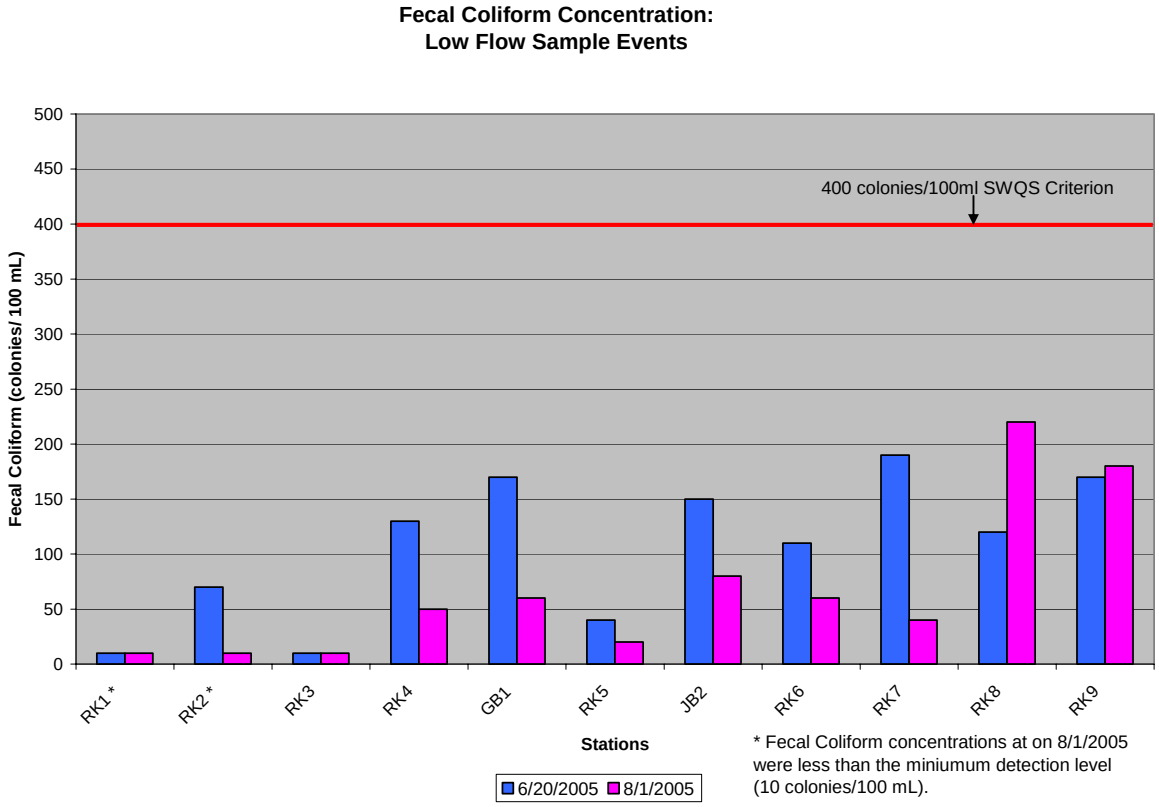
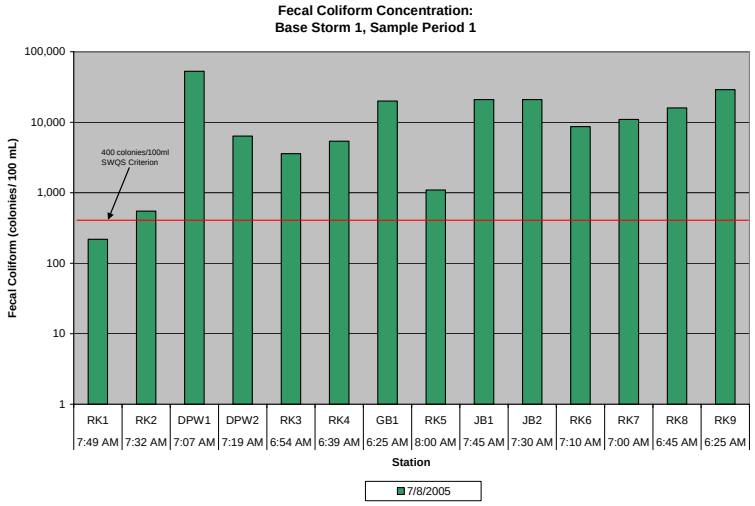


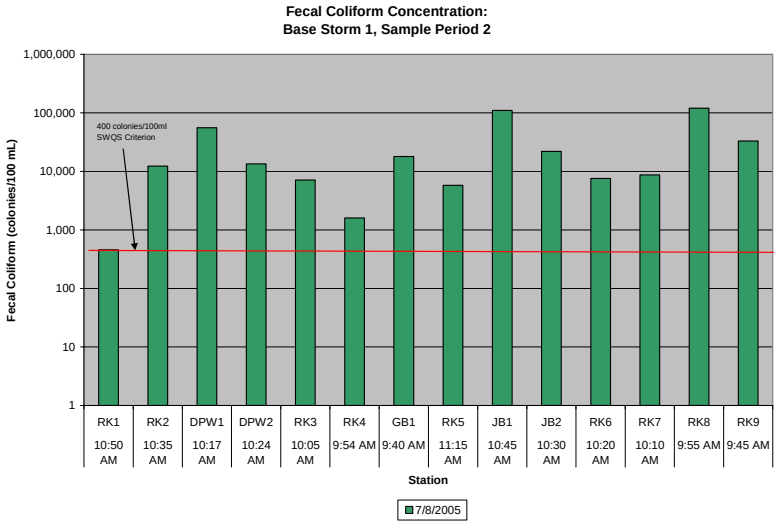
**Figure 4.**

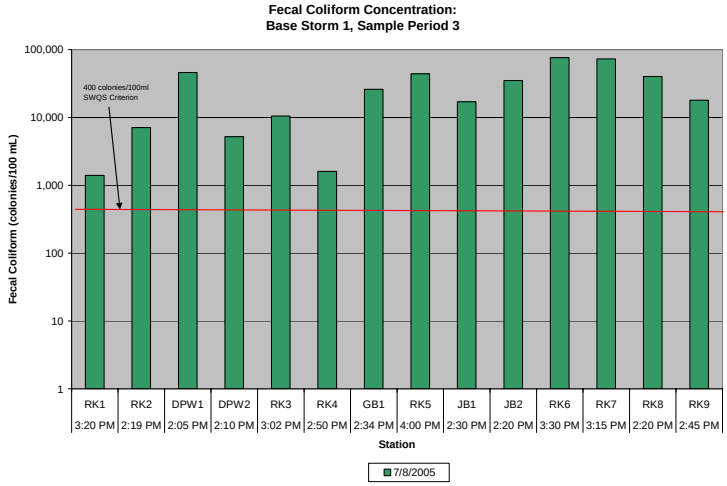



Figures 5 and 6 show sampling results compared with applicable criteria for fecal coliform concentrations in the SWQS during the base line storm water sampling events (note the use of a logarithmic scale to show fecal coliform concentrations). During the first baseline storm water event, all locations, with the exception of the first sample collected at station RK1, exceeded the 400 colonies/100ml SWQS coliform concentration during all three rounds of sampling. During the second baseline storm water event, a majority of the samples again exceeded the 400 colonies/100ml SWQS coliform concentration. The exceptions were all samples collected at RK4, and the initial samples collected at RK1, RK3, RK5 and RK6. In addition, the second sample collected at RK1 met the 400 colonies/100ml SWQS. It is evident from this data that during the baseline storm water sampling events fecal coliform concentrations increase significantly as samples are collected further downstream.

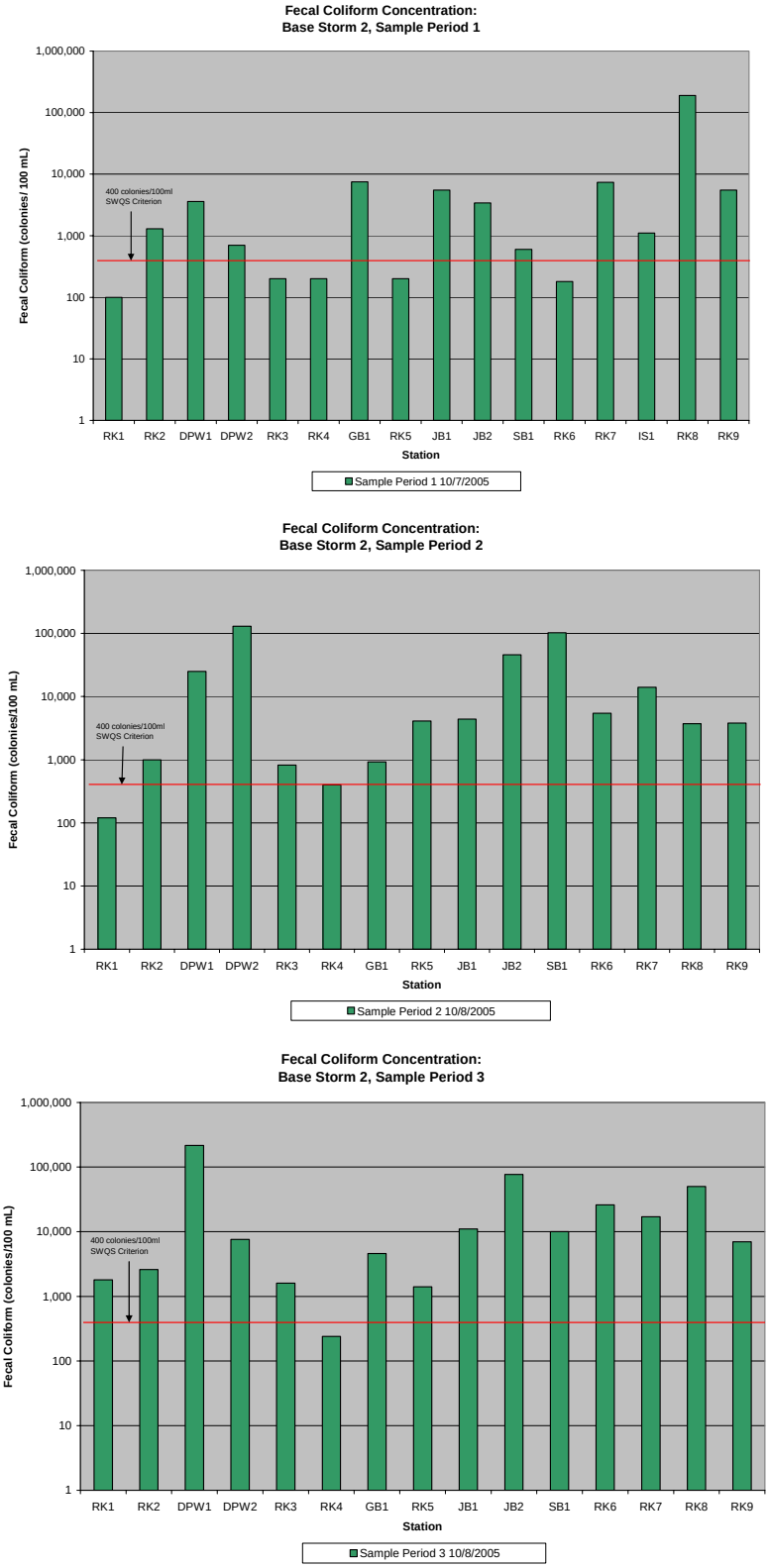
# Figure 5.


Fecal Coliform Concentration:
Base Storm 1, Sample Period 1
Fecal Coliform (colonies/ 100 mL)
100,000
10,000
1,000
100
10
1
400 colonies/100ml
SWQS Criterion
RK1 RK2 DPW1 DPW2 RK3 RK4 GB1 RK5 JB1 JB2 RK6 RK7 RK8 RK9
7:49 AM 7:32 AM 7:07 AM 7:19 AM 6:54 AM 6:39 AM 6:25 AM 8:00 AM 7:45 AM 7:30 AM 7:10 AM 7:00 AM 6:45 AM 6:25 AM
Station
7/8/2005


Fecal Coliform Concentration:
Base Storm 1, Sample Period 2
Fecal Coliform (colonies/100 mL)
1,000,000
100,000
10,000
1,000
100
10
1
400 colonies/100ml
SWQS Criterion
RK1 RK2 DPW1 DPW2 RK3 RK4 GB1 RK5 JB1 JB2 RK6 RK7 RK8 RK9
10:50 AM 10:35 AM 10:17 AM 10:24 AM 10:05 AM 9:54 AM 9:40 AM 11:15 AM 10:45 AM 10:30 AM 10:20 AM 10:10 AM 9:55 AM 9:45 AM
Station
7/8/2005

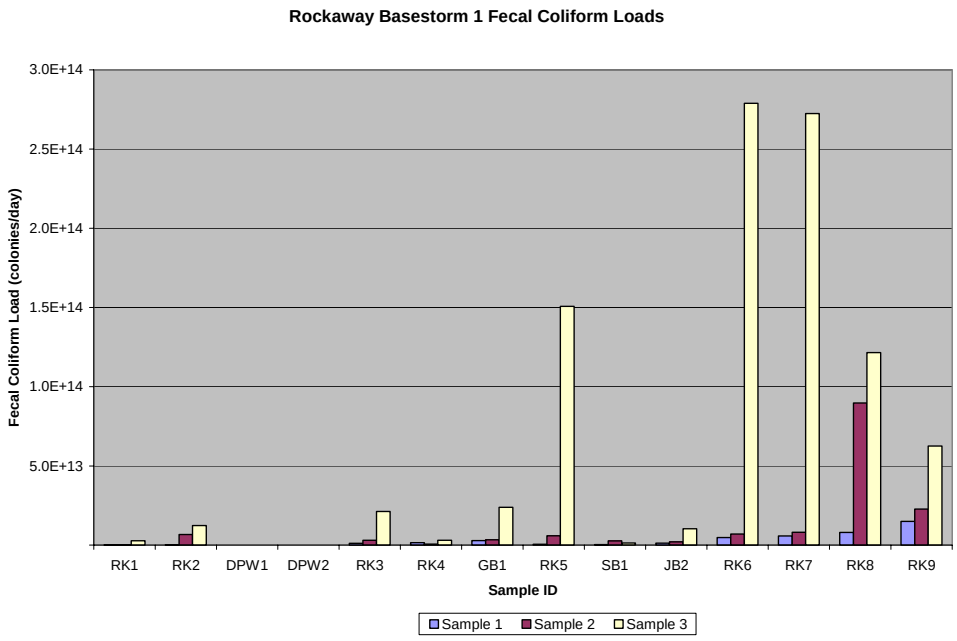

Fecal Coliform Concentration:
Base Storm 1, Sample Period 3
Fecal Coliform (colonies/100 mL)
100,000
10,000
1,000
100
10
1
400 colonies/100ml
SWQS Criterion
RK1 RK2 DPW1 DPW2 RK3 RK4 GB1 RK5 JB1 JB2 RK6 RK7 RK8 RK9
3:20 PM 2:19 PM 2:05 PM 2:10 PM 3:02 PM 2:50 PM 2:34 PM 4:00 PM 2:30 PM 2:20 PM 3:30 PM 3:15 PM 2:20 PM 2:45 PM
Station
7/8/2005

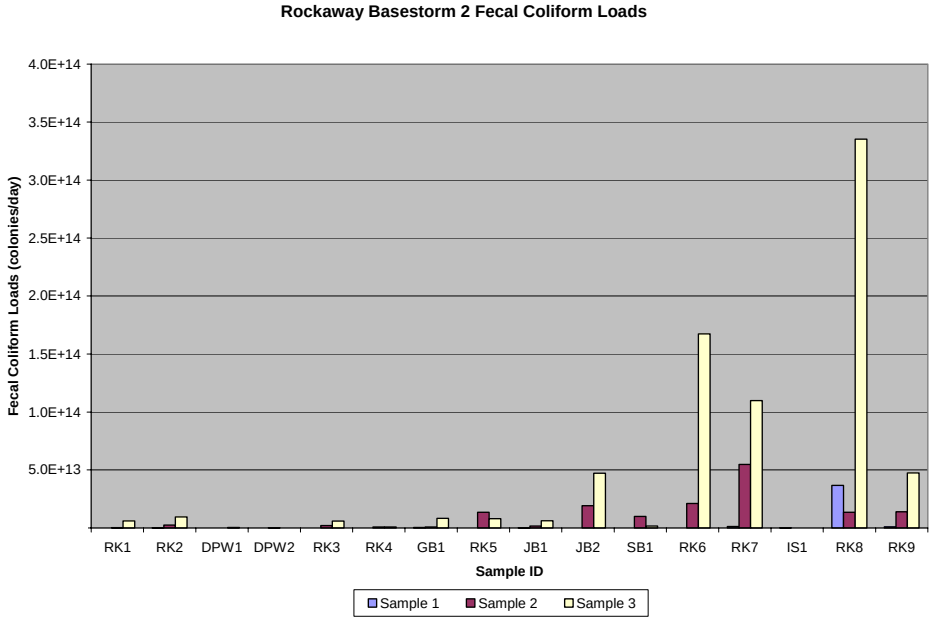
# Figure 6.


Fecal Coliform Concentration:
Base Storm 2, Sample Period 1
Fecal Coliform (colonies/ 100 mL)
1,000,000
100,000
10,000
1,000
100
10
1
400 colonies/100ml
SWQS Criterion
RK1 RK2 DPW1 DPW2 RK3 RK4 GB1 RK5 JB1 JB2 SB1 RK6 RK7 IS1 RK8 RK9
Station
Sample Period 1 10/7/2005
Fecal Coliform Concentration:
Base Storm 2, Sample Period 2
Fecal Coliform (colonies/100 mL)
1,000,000
100,000
10,000
1,000
100
10
1
400 colonies/100ml
SWQS Criterion
RK1 RK2 DPW1 DPW2 RK3 RK4 GB1 RK5 JB1 JB2 SB1 RK6 RK7 RK8 RK9
Station
Sample Period 2 10/8/2005
Fecal Coliform Concentration:
Base Storm 2, Sample Period 3
Fecal Coliform (colonies/100 mL)
1,000,000
100,000
10,000
1,000
100
10
1
400 colonies/100ml
SWQS Criterion
RK1 RK2 DPW1 DPW2 RK3 RK4 GB1 RK5 JB1 JB2 SB1 RK6 RK7 RK8 RK9
Station
Sample Period 3 10/8/2005

In order to select locations for the intensive sampling event, the fecal coliform loading was calculated using observed concentrations and estimated flow. The fecal coliform loading during the baseline storm events is detailed in Figure 7.

**Figure 7.**




As outlined in the sampling plan, a final intensive storm water event was planned utilizing data from the baseline events. The data obtained during the baseline events

confirmed the necessity to concentrate on establishing fecal coliform sources between locations RK4 and RK9. In addition, fecal coliform to fecal streptococci ratios were determined during the intensive storm water event in accordance with the NJDEP approved *Rockaway River Watershed Cabinet: Rockaway River Priority Stream Segment Assessment & Stormwater Impact Study Quality Assurance Sampling Plan* (TRC Omni, May 2005). The ratio of the fecal coliform to fecal streptococci varies for different animals. Ratios greater than 4.0 indicate human sources, while ratios less than 0.8 indicate animal sources. Ratios between 0.8 and 4.0 are considered inconclusive, or indicate contamination from both human and animal species. Because survival rates of these organisms vary in different environments, this ratio is not always reliable and is not currently accepted by NJDEP for source tracking, but can be useful as a preliminary indicator when utilized in conjunction with other procedures to determine pollution sources.

Thirteen (13) stations were sampled for the final intensive storm water event based on results from the two baseline sampling events and the added high-flow sampling. In addition, on the day following this sampling event another set of samples were collected at all accessible sites to determine pollutant levels during the receding hydrograph. Based on an examination of fecal coliform loads at all the locations and fecal coliform to fecal streptococci ratios during the high-flow event, the following sites were selected and sampled:

- RK9 – This station consistently showed higher fecal coliform loads during all of the storm water events. This station also corresponds to NJDEP's monitoring station previously used to determine water quality in this segment of the Rockaway River.
- RK4, RK6, RK7, RK7a and RK8 – These stations were chosen to further identify fecal coliform sources in the downstream portion of the priority stream segment. Because the data consistently show that fecal coliform loads are predominantly detected in the downstream portion of the study area, the focus of the intensive storm sampling event occurred in the Rockaway River

downstream of Washington Forge Pond through the Town of Dover. RK7a is a new location, added because of an underground sanitary sewerage pipe that runs underneath the stream between RK7 and RK7a.

- GB1 – Results from this station will further quantify fecal coliform loads from Green Pond Brook.
- JB2 – Results from this station will further quantify fecal coliform loads from Jackson Brook.
- MKB – McKeel Brook is an intermittent tributary that runs underground through Dover and terminates between RK8 and RK9. This location was selected to determine impact of this tributary with respect to fecal coliform. Samples were obtained beyond the southern terminus of Nelson Street on the north side of Rockaway River.
- Four (4) storm water pipes in Dover were selected to better understand the fecal coliform loading identified in the urbanized areas. The selected storm water pipes were identified on storm water maps obtained from the Town Engineer in Dover. The four selected storm water pipes were in the vicinity of the highest in-stream concentrations that were observed in the two baseline storm events and were identified as follows:
  - SWP1: Storm water pipe on west side of Union Street, south side of Rockaway River
  - SWP2: Storm water pipe at southern terminus of Passaic Street, north side of Rockaway River
  - SWP3: Storm water pipe on east side of North Bergen Street, south side of Rockaway River
  - SWP4: Storm water pipe on east side of Essex Street, south side of Rockaway River

A map of these sample stations is presented in Appendix B. At all of these sites, fecal coliform and fecal streptococci were analyzed in order to locate and identify sources of bacteria contamination.

Table 1 displays sampling results compared with applicable criteria for fecal coliform geometric mean concentrations in the SWQS during all of the sampling events. This table also shows the percent reduction required to meet the SWQS for fecal coliform geometric mean.

**Table 2. Observed Fecal Coliform Geometric Mean Concentrations**

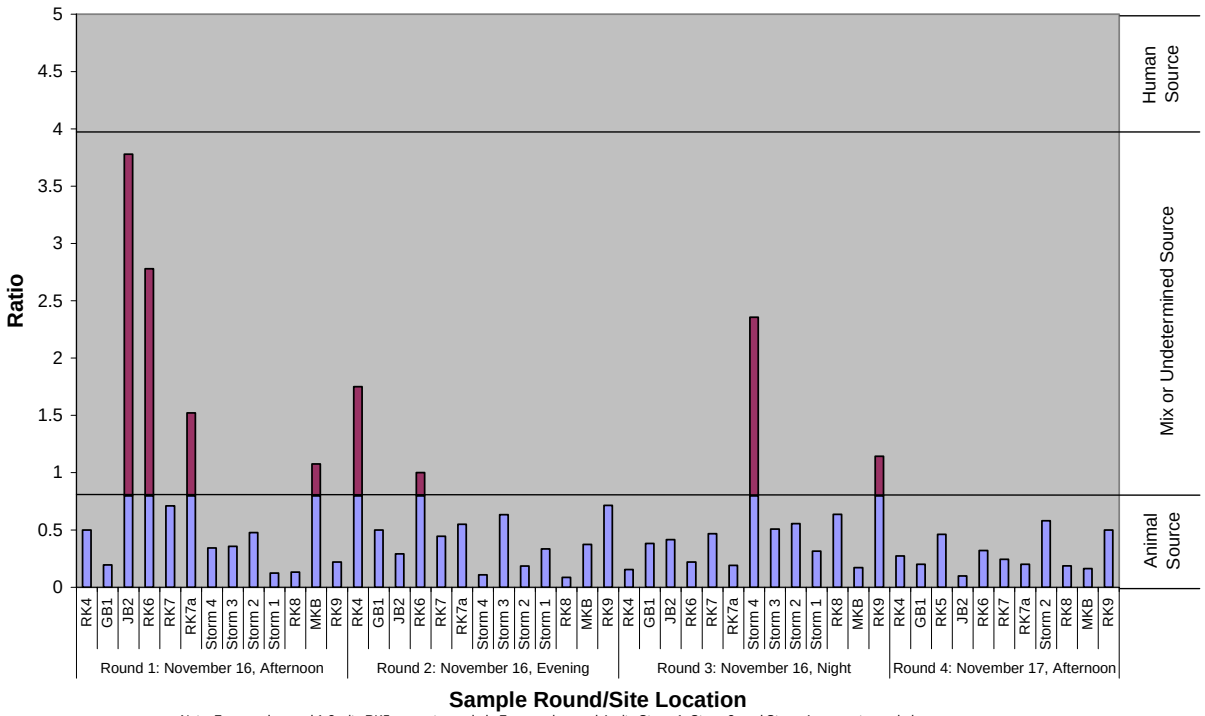
| Event Type | Site ID | Geometric Mean of Fecal Coliform results | Percent Reduction to meet SWQS |
|---|---|---|---|
| Ambient | RK1 | 11 | None Required |
| Ambient | RK9 | 160 | None Required |
| Low Flow | GB1 | 74 | None Required |
| Low Flow | JB2 | 132 | None Required |
| Low Flow | RK1 | 10 | None Required |
| Low Flow | RK2 | 22 | None Required |
| Low Flow | RK3 | 13 | None Required |
| Low Flow | RK4 | 80 | None Required |
| Low Flow | RK5 | 49 | None Required |
| Low Flow | RK6 | 93 | None Required |
| Low Flow | RK7 | 107 | None Required |
| Low Flow | RK8 | 185 | None Required |
| Low Flow | RK9 | 259 | 23% |
| Storm | DPW1 | 37,209 | 99% |
| Storm | DPW2 | 8,220 | 98% |
| Storm | GB1 | 2,710 | 93% |
| Storm | JB2 | 7,971 | 97% |
| Storm | MKB | 2,868 | 93% |
| Storm | RK1 | 512 | 61% |
| Storm | RK2 | 1,489 | 87% |
| Storm | RK3 | 1,387 | 86% |
| Storm | RK4 | 274 | 27% |
| Storm | RK5 | 1,399 | 86% |
| Storm | RK6 | 4,182 | 95% |
| Storm | RK7 | 7,544 | 97% |
| Storm | RK7a | 1,882 | 89% |
| Storm | RK8 | 7,585 | 97% |
| Storm | RK9 | 6,141 | 97% |
| Storm | SB1 | 11,200 | 98% |
| Storm | SWP 1 | 1,343 | 85% |
| Storm | SWP 2 | 6,045 | 97% |
| Storm | SWP 3 | 110,218 | 99% |
| Storm | SWP 4 | 19,878 | 99% |

All locations met the 200 colonies/100ml geometric mean SWQS for the ambient sample events. All locations except RK9 met the 200 colonies/100ml geometric mean SWQS for the low-flow sample events. Further investigation at RK9 during low flow, with testing to include is recommended All locations exceed the 200 colonies/100ml geometric mean SWQS for the storm water sample events. This data substantiates the relationship between fecal coliform exceedences and storm water runoff and emphasizes that the focus of remediation should concentrate on the lower section of this priority section. The data also shows that coliform concentrations observed during the receding hydrograph are significantly lower than the levels observed during the beginning and middle of the storm water event. This data indicates that residuals are washed with the storm water at the beginning of the storm and are not replenished during subsequent runoff as would be seen in the case of leaking sanitary sewerage pipes.

Figure 8 displays the average fecal coliform to fecal streptococci ratio at each sample location during the intensive storm water sampling event. Although some individual samples indicate inconclusive results, or mixed sources of fecal coliform contamination, the consistently low ratios at all locations would seem to indicate that the primary source of the microbiological contamination is due to animal sources, possibly wildlife, livestock, and/or pet waste.

**Figure 8.**

**Fecal Coliform to Fecal Streptococcus Ratio**




Note: For sample round 1-3, site RK5 was not sampled. For sample round 4, site Storm 1, Storm 3, and Storm 4 were not sampled.

## 2. Assessment of Other Pollutants

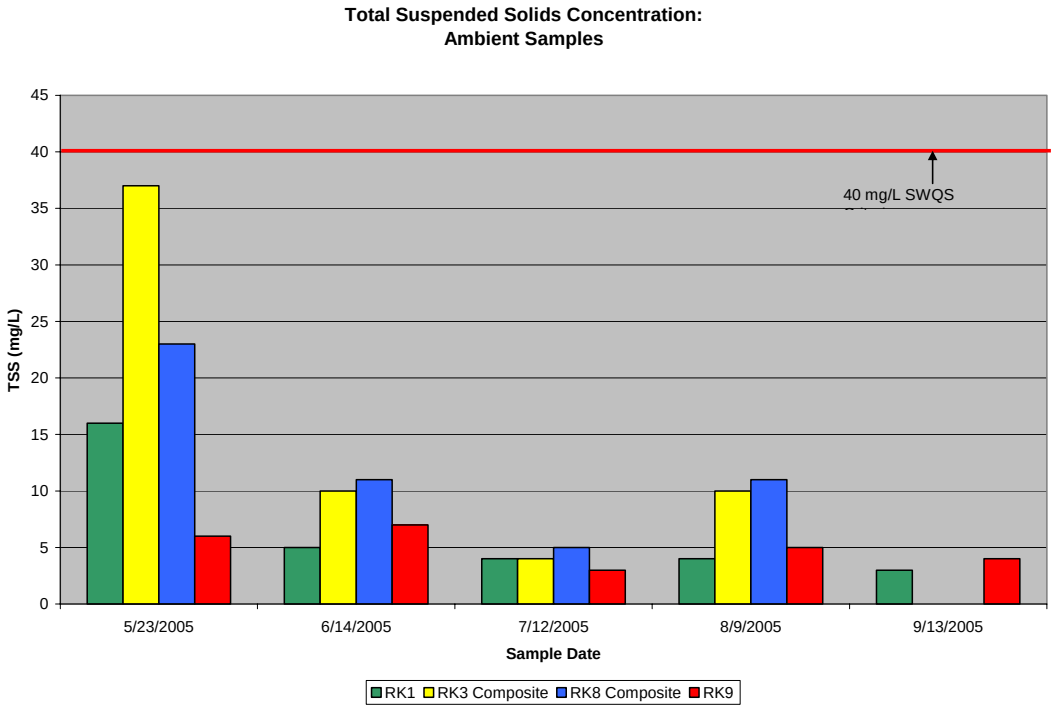
The chemical pollutants chosen for this investigation were phosphorus, TDS, and total suspended solids TSS. Phosphorus is an essential nutrient for plants and animals. Plants require nitrogen and phosphorus in an approximate 10 to 1 ratio and either nitrogen or phosphorus can be the limiting nutrient depending on relative availability. In freshwater, phosphorus is typically the limiting nutrient and is also usually easier to control than nitrogen. Phosphorus in streams comes from natural sources such as rocks, minerals, and animal wastes, as well as anthropogenic (generated by man) sources such as wastewater treatment plants or fertilized fields and lawns. Phosphorus in aquatic systems occurs in organic phosphorus (bound to organic matter) or inorganic phosphates, including orthophosphates ($PO_4^{-3}$ or $HPO_4^{-2}$) and polyphosphates. Plants require inorganic phosphorus, and dissolved orthophosphate is the most bioavailable form. Presently, a SWQS is established only for total phosphorus. The SWQS for total phosphorus in FW2-NT waters is 0.10 mg/l.

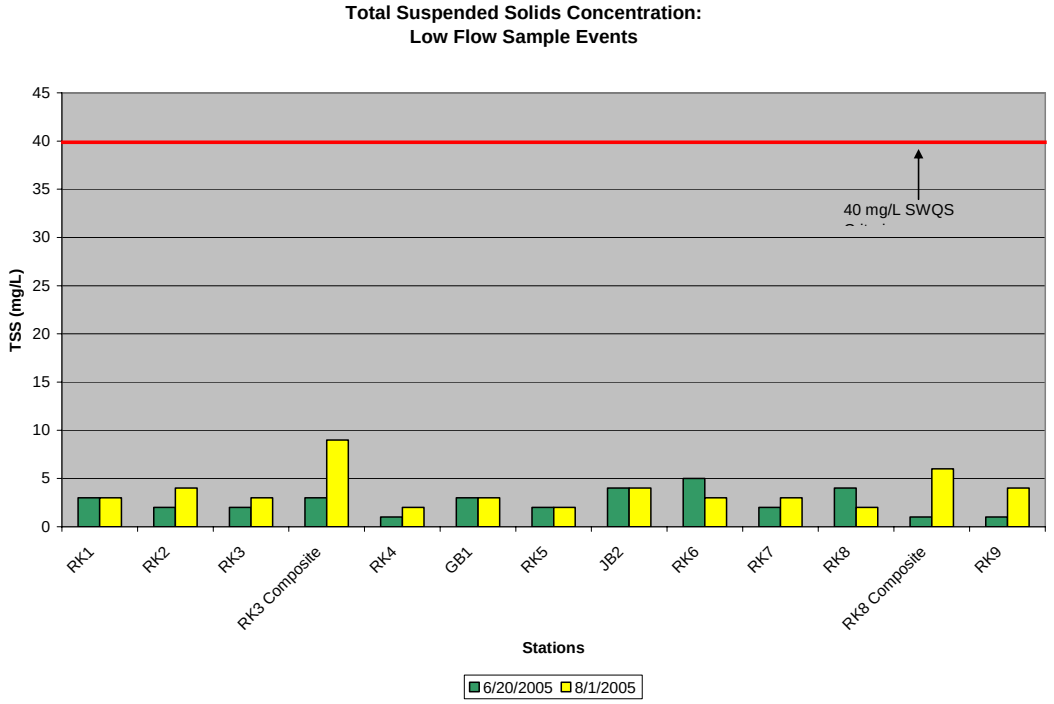
Total phosphorus and dissolved reactive phosphorus were measured only at stations RK4 and RK6 for the low-flow events and the two baseline storm events. At RK4 total phosphorus ranged from 0.03 mg/l to 0.05 mg/l with an average concentration of 0.04 mg/l, and dissolved orthophosphate ranged from 0.01 mg/l, the detection limit, to 0.03 mg/l. Therefore total phosphorus met the SWQS of 0.1 mg/l at this location during all sample events. At RK6 total phosphorus ranged from 0.02 mg/l, the detection limit, to 0.32 mg/l with an average concentration of 0.10 mg/l, and dissolved orthophosphate ranged from 0.01 mg/l, the detection limit, to 0.10 mg/l. At this location total phosphorus equaled or exceeded the SWQS for three of the nine collected samples. This data seems to indicate a fairly significant source of phosphorus affecting the Rockaway River between sample stations RK4 and RK6.

For all ambient, storm and high-flow events the concentrations of TDS were under the 500 mg/l SWQS stream standard for FW2-NT waters. Only once was the standard exceeded during a low-flow event (August 25 for station RK6), and this is considered an outlier as the results upstream and downstream of this location were under the 500 mg/l standard. The concentration of dissolved solids changes the ionic strength of the water and affects the water balance of aquatic organisms. Organisms in high TDS water tend to shrink, which affects the organisms' ability to maintain homeostasis and density and therefore makes it difficult to keep a proper location in the water column. Sources of TDS include industrial and municipal discharges, stormwater runoff, and eroding stream banks. The use of road salt in the winter can also increase TDS concentrations in streams and rivers. TDS does not appear to be a current concern in this segment of the Rockaway River.

Total suspended solids refer to the particles that will not pass through a glass fiber (approximately 2-micron) filter. High concentrations of TSS can result in a high load of adsorbed toxics or bacteria and increased turbidity. Additionally, high TSS can increase water temperature and inhibit productivity by blocking light. Sources of TSS include industrial and municipal discharges, storm water runoff, and eroding stream banks. Figures 9 and 10 detail observed TSS concentrations during the sampling events.

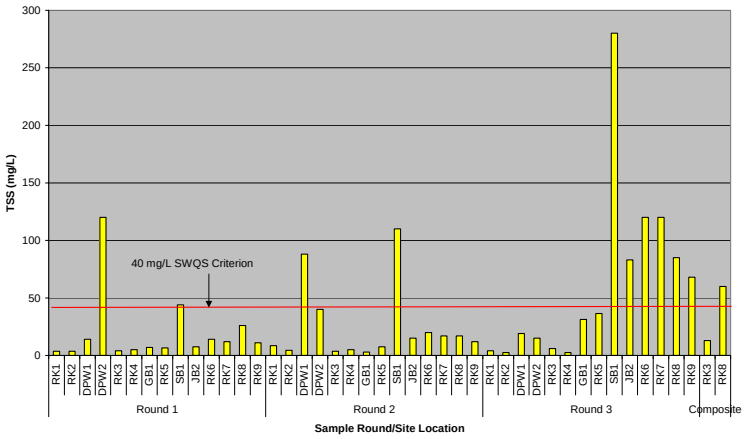
## Figure 9.


Total Suspended Solids Concentration:
Ambient Samples
TSS (mg/L)
45
40
35
30
25
20
15
10
5
0
40 mg/L SWQS
5/23/2005
6/14/2005
7/12/2005
8/9/2005
9/13/2005
Sample Date
RK1
RK3 Composite
RK8 Composite
RK9

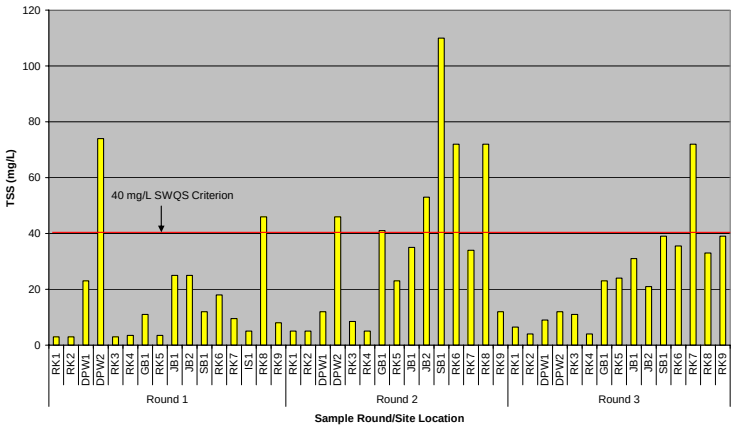

Total Suspended Solids Concentration:
Low Flow Sample Events
TSS (mg/L)
45
40
35
30
25
20
15
10
5
0
40 mg/L SWQS
RK1
RK2
RK3
RK3 Composite
RK4
GB1
RK5
JB2
RK6
RK7
RK8
RK8 Composite
RK9
Stations
6/20/2005
8/1/2005

# Figure 10.

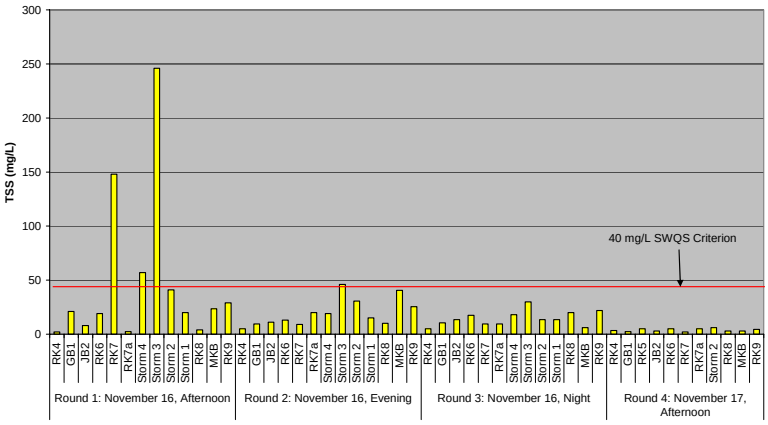
**Total Suspended Solids Concentration:**
**Base Storm Event 1**




**Total Suspended Solids Concentration:**
**Baseline Storm Event 2**




**Total Supended Solids Concentration:**
**Intensive Storm Event 1**




Note: For sample round 1-3, site RK5 was not sampled. For sample round 4, site Storm 1, Storm 3, and Storm 4 were not sampled.

For all ambient and low flow event samples, TSS was below the 40 mg/l SWQS for FW2-NT waters. Ambient composite samples were not collected on September 13 due to sampler malfunctions. All values that exceeded the TSS standard were during storm events, which suggest that control of TSS loading to the Rockaway River should focus on removal of suspended solids in storm water runoff.

## III. MANAGEMENT STRATEGIES

The results of the priority stream segment study provide detailed scientific data isolating areas where concentrations of non-point source pollutants are greatest in this reach of the Rockaway River. To address the identified problem of fecal coliform contamination, immediate, short-term (one to three years), and long-term actions (three years and beyond) are recommended for several management strategies.

### 1. Stormwater Management

Managing storm water is a priority issue throughout the study area. Developed and developing areas are placing great strain on existing storm water infrastructure and demanding that new control measures be implemented. In addition, traditional approaches to storm water management (i.e. traditional detention basin) do not address the necessary water quality controls required under the surface water quality standards for waterbodies and guidance set forth in the new storm water regulations.

#### A. *Immediate Action*

**Review, Implement, and Enforce Municipal Stormwater Permit Requirements**

The New Jersey Department of Environmental Protection (NJDEP) implemented the USEPA's Phase II rules into the New Jersey Storm Water Permitting Rules effective February 1, 2004. The municipal storm water regulation program (NJAC 7:14A) prescribes eight basic requirements that, when implemented together, are intended to result in significant reductions in the pollutants being discharged to receiving waters from municipal storm sewer systems. The regulations provide that these eight elements are the "minimum control measures" for compliance with the municipal program. The eight Statewide Basic Requirements (7:14A-25.6(b)) are:

- Public involvement/participation;
- Construction site stormwater runoff control;
- Post-construction stormwater management in new development and redevelopment;
- Public education on stormwater impacts;
- Prohibiting improper disposal of waste;

- Control of solid and floatable materials;
- Maintenance yards and highway service area program; and
- Employee training

Municipalities have some flexibility in determining what BMPs and measurable goals for each minimum control measure are most appropriate for its particular community. The municipality has the option to select BMPs from the menu of BMPs provided by NJDEP or to develop system specific BMPs. When the BMPs and measurable goals are submitted in the municipal permit application, those elements become the required storm water management program (SWMP) for the municipality. Additionally, municipalities are encouraged to develop BMPs that will allow the municipality to gauge and measure goals for permit compliance and program effectiveness. The goals will vary from municipality to municipality based on particular storm water problems of the municipality and the measures chosen to combat them.

To comply with the new regulations, municipalities must include in the permit submittal, the chosen Best Management Practices (BMPs) and measurable goals for each of the eight elements. Municipalities need to evaluate the effectiveness of their SWMP to meet the overarching goals of the stormwater regulation program, which are:

- Reduce pollutant discharges to the maximum extent practicable;
- Protect water quality; and
- Satisfy the appropriate requirements of the Clean Water Act.

Municipalities will be required to assess their progress in achieving their program's measurable goals. The most efficient, cost-effective approach to obtaining compliance with the stormwater rules involves dividing the effort into two phases. The first phase involves an initial Baseline Assessment of the municipality's infrastructure and current programs and resources to evaluate what elements will be most necessary to comply with the regulations and satisfy the eight required elements. The second phase is to prepare a municipal stormwater management plan as required by NJAC 7:14A and defined in NJAC 7:8. The plans that have been prepared and

submitted by the communities within this study area need to be reviewed and if necessary, additional emphasis needs to be placed on implementing BMPs and enforcing actions that address fecal coliform contamination in stormwater runoff.

Project partners need to work closely with Dover Town, Wharton Borough, and Rockaway Township as the communities most directly connected to the stream segment. Also, Randolph Township, Mine Hill Township, Roxbury Township, and Jefferson Township impact the watershed and drainage areas of the segment of the Rockaway River and should be involved throughout any stormwater planning and best management planning efforts.

**Implement and Enforce Clean up Ordinances and Programs**

As part of the new stormwater regulations, municipalities are required to adopt three key ordinances and programs that are key to reducing nonpoint source pollution in stormwater runoff from developed, urban areas. A focused effort is needed to implement and enforce:

- Pet Waste Clean Up Ordinances
- Waterfowl Feeding Ordinances
- Regularly Scheduled Street Sweeping Programs

Initial efforts need to target the developed areas of Dover Town and Wharton Borough while subsequent efforts need to include developed areas of the surrounding communities of Rockaway, Randolph, Mine Hill, and Roxbury

**B.** ***Short-Term Actions***

**Implement Stormwater BMPs**

New best management practices (BMPs) are being proposed and implemented throughout the state and opportunities to improve existing stormwater management practices in the study area should be addressed. An effective system not only safely and economically conveys excess runoff but also maximizes opportunities for attenuating, infiltrating, and filtering surface runoff close to where it is generated.

This reduces both total runoff volume and flow velocities, and results in less erosion and lower concentrations of nonpoint source pollution in water ways.

Development and redevelopment in the study area should require improvement of existing infrastructure to not only adequately convey stormwater but also filter stormwater pollutants. Traditional controls such as catch basins, piped discharge, and detention basins are not enough to prevent degradation to local streams and waterways. BMP techniques need to be included in the municipal stormwater plans and applied to retrofit existing systems. What is needed is a more creative use of available space and resources focusing on disconnecting impervious areas from drainage systems and filtering runoff from smaller storm events and the first flush of stormwater runoff using best management practices. Specific BMP designs are proposed in the *New Jersey Stormwater Best Management Practices Manual* (NJDEP; April 2004). Stormwater BMP examples include:

- Filter strips to filter runoff from roof tops and paved areas
- Infiltration measures, including infiltration trenches, vegetated swales and bioretention areas
- Upgrading existing detention areas to provide greater hydrologic and water quality benefits as well as flood prevention
- Installing approved pre-manufactured storm water treatment devices (approved by New Jersey Center for Advanced Technologies (NJCAT))

**Develop an outline of BMP training sessions for municipalities**

Municipal employees, in particular, the Public Works Department set the standard for others in the community and work daily to improve the quality of life for residents. Programs are required as part of the new stormwater regulations to educate those involved daily in handling nonpoint source pollutants and improving stormwater management. Based on this study, the following areas of emphasis are recommended for the communities in the area of concern:

- Goose Management,
- Pet Waste Management,
- Street Sweeping,
- In-stream Debris Removal,
- Stormwater Infrastructure Evaluation and Maintenance,
- Upkeep of Maintenance Facilities, and
- De-Icing Materials: Storage & Distribution.

This training program needs to include measures and strategies for enforcing municipal requirements and documenting progress throughout the community.

**C. *Long-Term Actions***

**Develop a Regional Stormwater Management Plan**

The stormwater regulations also provide for and encourage municipalities and interconnected urban regions to work together in planning for storm water control through preparation of a Regional Stormwater Management Plan (NJAC 7:8-3). To meet new stormwater regulations municipalities can work together to develop a Regional Storm Water Management Plan (RSWMP) based on the findings of this study and each municipality's Baseline Assessment completed as part of their individual municipal plan. A RSWMP can provide a better understanding of the impacts of surface runoff and stormwater flows that impact this reach of the Rockaway River. The RSWMP should be designed to comply with the NJDEP Storm Water Regulations and permitting requirements to be met by each municipality. The plan would need to include at a minimum Dover Town, Wharton Borough, and Rockaway Township as well as Randolph Township, Mine Hill Township, Roxbury Township, and Jefferson Township.

## 2. Riparian Area Management

### A. *Immediate Actions*

**Evaluate and Implement Restoration Projects identified in the "Upper Rockaway River Watershed Flood Control and Ecosystem Restoration Study" prepared by the US Army Corps of Engineers**

The USACE prepared a plan to identify and prioritize potential restoration sites throughout the upper Rockaway River watershed. Using a scoring matrix, the Study evaluated 47 sites, 22 of which received a score higher than zero. Of these 22 sites, the Study focused on nine priority sites that received a score greater than 50% of the maximum combined score. Of these nine priority sites, five sites are located along the Rockaway River in Dover, Wharton, and Roxbury. These five sites include:

- JB-3 (Burnt Meadow Brook-River Woodland Reserve). This site is an approximately 2.52 acre parcel of land that consists of a narrow vegetated berm, disturbed upland, and remnant forested floodplain. The site is located in Wharton, near the Shop Rite shopping complex located on West Clinton, and is bordered by the Rockaway River to the west. It appears that the river was channelized through this area in the past and that the excavated material was side-cast along the eastern bank of the river to create an artificial earthen berm and/or exaggerated streambank. These past activities have significantly altered the hydrology in this area and have adversely impacted the former floodplain. As a result, the Rockaway River flows very quickly downstream through this narrow channel. The proposed restoration at this site includes removing the earthen berm, placing the excavated material on the disturbed upland areas, and replanting the area with herbaceous ground cover. This work will significantly improve fish habitat by restoring the original streambed and floodplain and adding a diversity of habitats that are not currently available. The widening of the current riverbed through the removal of the berm will also provide secondary benefits such as a reduction in water velocities, and reestablishment of natural water and sediment storage in the floodplain during storm events.

- Site JB-4 (Drainage 633 Dover). This site is located within Dover and Rockaway Townships, and includes the Bowlby Pond area. The pond's drainage has been disturbed by construction of the Rockaway Town Square Mall. Specifically, drainages that previously flowed through the area have been culverted and/or diverted. Restoration activities could include reconnecting the natural drainages, and/or daylighting or improving the outfall channel connection. These actions would enhance the system by reducing velocities and sediment entering the Rockaway River, restore natural hydrology in the Bowlby Pond, and greatly enhance fish and wildlife populations in the area.
- JB-5 (Drainage 652 Dover). This site is an approximately 3.23 acre asphalt parking lot located in downtown Dover behind the Krause's food store on North Warren Street. In the past, the site was a pond (known as Dover Mill Pond) that was used to power an iron-working mill, and a parking lot associated with an outdoor movie theater and parking garage. The proposed restoration action at this site would involve the removal of the asphalt; excavation of the underlying fill material to create a narrow channel, small pond, and emergent wetlands; and, reestablishing areas of upland herbaceous and scrub-shrub vegetation (see Appendix D). A V-shaped inlet will be established through the existing concrete wall which will allow regular water exchange between the river and created pond. The side slopes would be contoured to enable planting native emergent wetland plant species.
- JB-8 (Jackson Brook Sub-basin-Drainage 646 Wharton). This site is an approximately 3.9 acre parcel of land located on an active powerline right-of-way in Wharton, near the intersection of Mount Pleasant Avenue and West Clinton (Route 15). The site is bordered on the northeast by the West Clinton Bridge, on the east by Green Pond Brook, on the south by the Rockaway River and a large forested wetland, and on the northwest by the roller rink parking lot. The site is dominated by common reed (Phragmites australis), a highly opportunistic, fast colonizing plant species that is regularly found in

disturbed wetland areas. Currently, the area receives surface water runoff from the adjacent roller rink parking lot and the surrounding roads. It is assumed that the site historically was a forested floodplain associated with Green Pond Brook. The proposed restoration action at this site will include removal and off-site disposal of the common reed; excavation and removal of the root mate; installation of slope stabilizing, biodegradable filter fabric; and excavation of a series of ponds connected by one meandering channel. Native emergent vegetation would be planted in the restored floodplain to enhance fish and wildlife habitat and to reduce sedimentation to the downstream reaches. Similarly, the area between the restored emergent and open water wetlands and the roller rink parking lot will be graded and planted with scrub-shrub vegetation.

- UR-1 (GPU Energy/Morris County Properties). This site is an approximately 8.6 acre parcel of land that is located in Roxbury Township and consists of a shallow pond and a narrow vegetated berm adjacent to the Rockaway River. Key ecological features of the restoration site include the shallow open water community of the pond, including areas of open water and emergent wetlands, and the vegetated berm. Preliminary restoration activities identified for Mill Pond based on current site conditions include improving fish and wildlife habitat diversity, as well as reducing high velocity flows and downstream sediment loading during storm events. Work would include reconfiguring the elevation of the berm to a consistent height above the river's surface water height; excavating accumulated pond sediments creating areas of deepwater habitat to enhance the diversity of fish habitat and species; and, reconstructing the existing man-made culvert to ensure adequate pond drainage. The proposed restoration will allow the pond to retain greater volume of water during storm events, thus reducing the water velocity and allowing sediments to settle out of the water column before the water re-enters the river.

Restoration concept plans were prepared for four of the five sites by the USACE. Copies of these plans and a map of the locations are included in Appendix C.

**B.** ***Short-Term Actions***

**Evaluate and Implement Recommendations set forth in the Jackson Brook Regional Stormwater Management Plan**

The County of Morris has completed a Watershed Stormwater Management Plan for Jackson Brook, a tributary of the Rockaway River. The plan considered water quality and quantity management strategies, and provides recommendations for management of stormwater in the Jackson Brook watershed under current and future land use conditions. Recommended facilities include modifying the dam at Hedden Pond in Hedden Park to provide additional detention benefits, conversion of two small former water supply reservoirs to detention facilities, and other improvements to effectively manage stormwater flows, protect the water quality of the streams, and preserve the waterway's ecosystem. Further water quality sampling is needed in the Jackson Brook watershed upstream of Hurd Park to isolate potential sources of fecal coliform bacteria in the in the stream.

**Encourage stream reconnaissance surveys**

The stream visual assessments and analysis conducted for this study are a work in progress. There is no end to this type of survey, and the project partners encourage that this type of reconnaissance be continued. This study should focus on continued monitoring of potential source of nonpoint source pollution, and in particular, fecal coliform sources. The stream reconnaissance not only documents the health of the waterways, it provides a baseline to monitor changing conditions over time and should involve the local community in planning and natural resource protection.

### 3. Park Land/Open Space Management

#### A. *Immediate Actions*

**Implement resident waterfowl management plan**

The NJDEP "Community-based Management Plan for Canada Geese" contains information about techniques and permitting requirements for managing resident populations of geese. Many parks in the area have significant populations of non-migratory Canada geese that are contributing significant nutrient and fecal coliform loading to those waterbodies. A goose management plan should be developed and implemented.

**Shoreline restoration**

Lakes and ponds serve an important functional value and are an attractive feature in our communities. However, water quality in many lakes and ponds is vulnerable to high levels of nutrients, fecal coliform and biochemical oxygen demand. Furthermore, many lakes and ponds are plagued by geese that contribute a significant nutrient and fecal coliform load to the system. Shorelines are also eroding. Sediment resulting from shoreline erosion is being deposited in the waterbody, along with sediment that is carried downstream by feeder tributaries. If sedimentation and nutrient enrichment continue to occur, waterbodies will reach a eutrophic state, thereby impacting wildlife habitat, severely degrading downstream water quality, and destroying recreational opportunities. Establishing a narrow buffer of dense, native vegetation at the water's edge that is between 2 and 3 foot in height, deters unwanted geese, provides filtering of overland stormwater runoff, and helps to stabilize soils along shorelines. With support of the NJDEP 319(h) program, the first project in this recommended action is underway at Hurd Park in Dover. The project is targeting a potential source of fecal coliform bacteria caused by a large resident goose population frequently found in the Park.

#### B. *Short-Term Actions*

**Demonstrate BMPs**

Public parks and open space areas are excellent sites for demonstrating new materials, techniques and best management practices. Examples of BMPs and

methods for "minimum disturbance" are outlined in the NJDEP's New Jersey Stormwater Best Management Practice Manual. Minimum disturbance as referred to by the NJDEP relates to fitting development into the terrain. For example, permeable paving techniques can be used to minimize site runoff and can be used for streets, parking areas, and sidewalks, while retaining natural filtration capacity. Porous pavement is most recommended for use as parking areas for office buildings, recreation facilities, and shopping centers. Other uses can be for emergency stopping areas along roadways, traffic islands, and road shoulders. Grid pavers are another type of permeable pavement recommended by the NJDEP. These include interlocking concrete blocks, brick, turf block, and stone, which allow water to infiltrate into the subsurface and are aesthetically pleasing. Mulched trails add a natural aspect to developments rather than concrete sidewalks, and further infiltration. Other types of infiltration best management practices for development can be found in the New Jersey Stormwater Management Practice Manual and include disconnecting impervious coverages, curb cuts and diversion devices, and decreased road widths.

With the support of the NJDEP 319(h) program, the first demonstration project is being implemented in the study area at the Morris County DPW facility located in Wharton Borough. The project will install a series of stormwater BMPs to mitigate uncontrolled runoff from discharging directly to flood plain areas and the Rockaway River. The BMPs will filter stormwater runoff to reduce nonpoint source pollutant loads leaving the site.

**Eliminate direct discharges, when possible**

In addition to shoreline degradation, storm water runoff discharging directly into waterways presents a water quality concern. Often, opportunities exist along waterways in parks and open space areas to retrofit stormwater discharge pipes that empty directly into a receiving waterbody by installing pre-manufactured treatment devices or daylighting pipes and discharging stormwater into vegetated swales or constructed wetlands to promote settling and nutrient uptake prior to flowing into a lake or pond. Either in-line systems or off-line systems can direct first flush flows

into treatment areas to remove sediment and other pollutants prior to flowing into receiving waters. While these retrofit solutions can become expensive, for large drainage areas, they can provide a cost-effective solution to treating stormwater runoff, protecting lakes and ponds from nonpoint source pollution and reducing future costs for maintenance and dredging

**Evaluate and Implement projects identified in "The Rockaway River and its Treasured Resources: Visions & Strategies for their Recovery" Plan**

This report was developed in partnership by Friends of the Rockaway River, the River Studio, and the Urban Conservation and Action Partnership and contains recommendations for restoring the river and its watershed. Specific recommendations for projects in the priority stream segment include:

- River Corridor Enhancement – GPU Energy & Morris County Properties
- Parkland Addition & Improvement – Hugh Force/Canal Park
- Parkland Addition & Improvement – Washington Forge Pond
- River Woodland Reserve – Burnt Meadow Brook Area
- Dover Center/Mill Pond and Riverfront Parkland Revitalization
- River Greenway – Dover

Appendix D identifies the locations of these proposed restoration sites along the Rockaway River and conceptual ideas and recommendations set forth for these projects.

## 4. Implementation

This list of management strategies provides a guide for potential projects to be implemented to improve surface water quality and improve the overall health of the Rockaway River. Key in successfully implementing these projects to achieve the required goals of reducing fecal coliform levels in the River will be working closely with the local municipalities to develop a goal oriented schedule and time table. This plan is intended to be a guide for the RRWC and its partners as they work to achieve water quality improvements in the Rockaway River. The study and recommendations should be viewed as a working document and periodically updated as new issues arise, new data

is collected, and when projects have been successfully completed. The following section provides a brief overview of potential sources of funding that may support the projects identified in the study.

## IV. FUNDING SOURCES

Below are a number of available funding sources that support restoration and BMP projects similar to those needed in the area. These programs have different emphases and proposal requirements and applicants should gather additional information from the grantor prior to submitting a project proposal. Appendix F provides contact information for these programs.

### 1. Wetland Program Development Grants, EPA

Wetland Program Development Grants, or WPDGs provide funds to increase the quantity and quality of wetlands in the U.S. Funding is provided to states, tribes, local governments, interstate agencies, intertribal consortia, and universities chartered as a part of the state government. Grants should be used to develop and refine wetland management programs by conducting or promoting the coordination of research, investigations, experiments, training, demonstrations, surveys, studies relating to the causes, effects, extent, prevention, reduction and elimination of water pollution. This grant program requires a 25% match. Three specific priorities of WPDG's include the following:

- Developing a comprehensive monitoring and assessment program,
- Improving the effectiveness of compensatory mitigation, and
- Refining the protection of vulnerable wetlands and aquatic sources.

### 2. Wetlands Reserve Program

This is a voluntary program that provides landowners with financial incentives to restore and protect wetlands in exchange for retiring marginal agricultural land. Landowners retain ownership of the land, limiting future usage. The Natural Resource Conservation Service will aid in developing a plan for restoration and maintenance of the site.

The type of land applicable for this source include farmed wetlands, prior converted wetlands, intensely managed pasture and hayland riparian areas, along with eligible buffer areas to be placed under a permanent of 30-year easement or restoration agreement.

**3. Wildlife Conservation and Appreciation Program**

Grants are provided to projects that bring together the U.S. Fish & Wildlife Service, state agencies, and private organizations and individuals. Efforts should include the identification of significant problems that can adversely affect fish and wildlife and their habitats, actions to conserve species and habitat, presentation of opportunities for the public to enjoy fish and wildlife through non-consumptive activities, monitoring of species, and identification of significant habitats. Private organizations must partner with the New Jersey Fish, Game & Wildlife Department.

**4. Wildlife Links**

This is a cooperative opportunity created by the National Fish & Wildlife Foundation and the U.S. Golf Association that funds innovative research, management, and education projects on golf courses. The overall goal of this program is to protect and enhance the wildlife, fish, and plant resources found on golf courses through proper planning and management. Golf course designers and superintendents are provided information and resources they need to promote wildlife enhancement on their facilities.

**5. Watershed Protection & Flood Prevention**

This program is only applicable when an approved watershed plan has been developed, which this study will be once reviewed and approved by NJDEP. Eligibility includes state agencies, county or a group of counties, municipality(ies), soil and water conservation district, and non-profit agencies. The project must be locally sponsored and have environmental, economic, and social benefits that exceed the costs for a favorable benefit-cost ratio.

**6. Wildlife Habitat & Incentive Program (WHIP)**

This program was created to develop upland wildlife habitat, wetland wildlife habitat, threatened and endangered species habitat, fish habitat, and other types of wildlife habitat. This source of funding is applicable for private landowners. Priority will be given to those projects that protect or enhance special habitat concerns of the state.

**7. Five Star Restoration Challenge Grants**

Projects must include a strong on-the-ground wetland, riparian, or coastal habitat restoration component. Projects should also be involved in outreach, education, and community stewardship. And, thus, the key to this grant is having at least five partners. This program focuses on innovative, collaborative approaches to restoring the nation's waters. Special preference will be given to those projects that are part of a larger watershed or community stewardship effort.

**8. Dodge Foundation**

The Dodge Foundation addresses the ideals of making this world both more human and more livable. One of their causes is to support the protection of open space. Dodge supports not for profit groups that possess a vision of the future displayed in their day-to-day activities. Dodge looks to fund groups that are actively protecting or restoring their local terrestrial and marine environments, and furthering community stewardship. Most of all, Dodge looks for groups embarking upon a patient, sensible, participatory process that links decisions about growth, progress, and public policy with quality and meaning of our lives. A special area of concern to the Foundation is the Highlands, but all areas of the state are considered in this effort to protect land.

**9. Private Stewardship Grants Program**

Often the costs associated with implementing conservation actions are greater than a private landowner can undertake. Therefore the U.S. Fish & Wildlife Service has established a program for landowners who wish to voluntarily create better conservation practices on their land for endangered and threatened species, as well as many other imperiled species. Typical projects include management of nonnative, competing species; restoration of streams that support imperiled species; restoration projects that utilized native vegetation to restore a rare and necessary plant community; implementation of measures to reduce species' risk from disease.

**10. Schumann Foundation**

This organization looks to support the conservation of natural resources, the revitalization of New Jersey's urban centers, and the restoration and protection of New

Jersey's environment. Projects should target sustainable economic growth and sound, coordinated land use planning. Non-profits are eligible.

**11. NJDEP 319(h) Non Point Source Pollution Control Grants**

Funds are distributed in New Jersey by the NJDEP Division of Watershed Management Non Point Source Pollution Department. For FY 2005, priority projects included those that address a significant source of NPS related impairment or threat as identified in an approved implementation plan such as a TMDL or Regional Stormwater Management Plan. Priority is also given to projects involving urban BMP retrofits that serve as a demonstration project for further implementations. It is expected that FY 2006 will prioritize projects that implement projects to further address known impairments or better manage stormwater.

## V. CONCLUSION AND RECOMMENDATIONS

The purpose of the Pathogenic Indicator and Pollutant Track Down Evaluation Study was to obtain water quality data under approved quality assurance protocols in order to better isolate the cause of bacterial and other pollutant contamination in the Rockaway River within the defined priority segment. Sampling and analyses were performed in accordance with the Quality Assurance Sampling Plan (QASP) under a variety of flow and precipitation conditions. All data and information obtained during the study are provided herein. The results and subsequent recommendations set forth in the report provide guidance for local communities to better manage storm water to address known impairments. All affected and interested parties need to work closely together to clearly identify and prioritize specific projects identified as recommended management strategies so that necessary water quality improvements can be achieved in the Rockaway River.

# Appendix A

Sampling Results

# Appendix A:  Rockaway 6034 Data

| Date | Event Type | Event Number | Station ID | Time | Fecal Coliforms colonies/100ml | Fecal Strep colonies/100ml | Flow cfs | pH SU | DOPO4 mg/l (ppm) | TP mg/l (ppm) | Total OPO4 mg/l (ppm) | FC/FS Ratio | TDS mg/l (ppm) | TSS mg/l (ppm) | Temperature oC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5/23/2005 | Ambient | 1 | RK1 | 9:50 | 30 | | 20.00 | 7.01 | | | | | 168 | 16 | 15.40 |
| | | | RK9 | 12:15 | 210 | | 39.70 | 7.68 | | | | | 270 | 6 | 14.20 |
| 5/24/2005 | Ambient | 1 | RK3 Composite | 11:10 | | | | | | | | | 245 | 37 | |
| | | | RK8 Composite | 11:35 | | | | | | | | | 278 | 23 | |
| 6/14/2005 | Ambient | 2 | RK1 | 8:25 | 30 | | 12.70 | 7.14 | | | | | 203 | 5 | 25.20 |
| | | | RK3 Composite | 8:25 | | | | | | | | | 226 | 10 | |
| | | | RK8 Composite | 8:25 | | | | | | | | | 241 | 11 | |
| | | | RK9 | 10:25 | 370 | | 25.20 | 7.58 | | | | | 253 | 7 | 24.10 |
| 6/20/2005 | Low Flow | 1 | GB1 | 11:10 | 170 | | 5.00 | 7.73 | | | | | 241 | 3 | 19.60 |
| | | | JB2 | 10:25 | 150 | | 1.72 | 7.02 | | | | | 368 | 4 | 18.30 |
| | | | RK1 | 0:25 | 10 | | 9.16 | 7.28 | | | | | 183 | 3 | 20.00 |
| | | | RK2 | 12:00 | 70 | | 9.97 | 7.33 | | | | | 212 | 2 | 19.70 |
| | | | RK3 | 11:40 | 10 | | 10.00 | 7.56 | | | | | 192 | 2 | 19.30 |
| | | | RK3 Composite | 11:40 | | | | | | | | | 212 | 3 | |
| | | | RK4 | 11:30 | 130 | | 10.10 | 7.69 | 0.01 | 0.04 | | | 220 | 1 | 19.60 |
| | | | RK5 | 10:50 | 40 | | 15.42 | 7.53 | | | | | 239 | 2 | 19.30 |
| | | | RK6 | 10:15 | 110 | | 17.30 | 7.68 | 0.01 | 0.02 | | | 271 | 5 | 18.70 |
| | | | RK7 | 9:50 | 190 | | 17.57 | 7.83 | | | | | 248 | 2 | 18.30 |
| | | | RK8 | 9:30 | 120 | | 17.50 | 7.70 | | | | | 244 | 4 | 18.10 |
| | | | RK8 Composite | 9:30 | | | | | | | | | 268 | 1 | |
| | | | RK9 | 9:20 | 170 | | 18.20 | 7.51 | | | | | 291 | 1 | 18.40 |

# Appendix A: Rockaway 6034 Data

| Date | Event Type | Event Number | Station ID | Time | Fecal Coliforms colonies/100ml | Fecal Strep colonies/100ml | Flow cfs | pH SU | DOPO4 mg/l (ppm) | TP mg/l (ppm) | Total OPO4 mg/l (ppm) | FC/FS Ratio | TDS mg/l (ppm) | TSS mg/l (ppm) | Temperature oC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/8/2005 | Base Storm | 1 | DPW1 | 7:07 | 53000 | | 0.01 | 7.09 | | | | | 100 | 14 | 19.20 |
| | | | | 10:17 | 56000 | | 0.01 | 7.27 | | | | | 51 | 88 | 19.00 |
| | | | | 14:05 | 46000 | | 0.04 | 9.12 | | | | | 110 | 19 | 20.00 |
| | | | DPW2 | 7:19 | 6400 | | 0.01 | 6.72 | | | | | 72 | 120 | 18.60 |
| | | | | 10:24 | 13400 | | 0.01 | 6.81 | | | | | 88 | 40 | 18.90 |
| | | | | 14:10 | 5200 | | 0.02 | 8.65 | | | | | 82 | 15 | 20.00 |
| | | | GB1 | 6:25 | 20000 | | 5.77 | 6.45 | | | | | 280 | 7 | 18.60 |
| | | | | 9:40 | 18000 | | 7.69 | 5.88 | | | | | 280 | 3 | 18.70 |
| | | | | 14:34 | 26000 | | 37.40 | 6.89 | | | | | 390 | 31 | 20.00 |
| | | | JB2 | 7:30 | 21000 | | 2.24 | 7.20 | | | | | 420 | 8 | 18.90 |
| | | | | 10:30 | 22000 | | 3.78 | 7.38 | | | | | 270 | 15 | 19.20 |
| | | | | 14:20 | 35000 | | 12.10 | 5.96 | | | | | 130 | 83 | 18.20 |
| | | | RK1 | 7:49 | 220 | | 12.00 | 6.68 | | | | | 240 | 4 | 18.90 |
| | | | | 10:50 | 460 | | 21.40 | 6.75 | | | | | 240 | 9 | 19.40 |
| | | | | 15:20 | 1400 | | 79.70 | 7.18 | | | | | 210 | 4 | 19.40 |
| | | | RK2 | 7:32 | 550 | | 13.00 | 6.45 | | | | | 250 | 4 | 20.10 |
| | | | | 10:35 | 12300 | | 22.00 | 6.87 | | | | | 250 | 5 | 20.50 |
| | | | | 14:19 | 7100 | | 70.60 | 6.50 | | | | | 220 | 3 | 20.00 |
| | | | RK3 | 6:54 | 3600 | | 12.30 | 6.49 | | | | | 270 | 4 | 20.00 |
| | | | | 10:05 | 7100 | | 17.50 | 6.86 | | | | | 260 | 4 | 19.70 |
| | | | | 15:02 | 10500 | | 82.40 | 6.83 | | | | | 230 | 6 | 19.60 |
| | | | RK4 | 6:39 | 5400 | | 11.70 | 6.38 | 0.02 | 0.05 | | | 270 | 5 | 21.30 |
| | | | | 9:54 | 1600 | | 17.70 | 6.61 | 0.03 | 0.05 | | | 280 | 5 | 20.70 |
| | | | | 14:50 | 1600 | | 79.00 | 6.86 | 0.02 | 0.05 | | | 240 | 3 | 19.70 |
| | | | RK5 | 8:00 | 1100 | | 20.20 | 7.76 | | | | | 270 | 7 | 19.90 |
| | | | | 11:15 | 5800 | | 41.50 | 7.63 | | | | | 310 | 8 | 19.60 |
| | | | | 16:00 | 44000 | | 140.00 | 7.09 | | | | | 270 | 37 | 19.50 |
| | | | RK6 | 7:10 | 8700 | | 22.60 | 7.58 | 0.03 | 0.05 | | | 270 | 14 | 19.70 |
| | | | | 10:20 | 7600 | | 37.30 | 7.33 | 0.03 | 0.08 | | | 280 | 20 | 19.20 |
| | | | | 15:30 | 76000 | | 150.00 | 7.00 | 0.10 | 0.32 | | | 180 | 120 | 18.70 |
| | | | RK7 | 7:00 | 11000 | | 21.60 | 7.42 | | | | | 290 | 12 | 19.90 |
| | | | | 10:10 | 8700 | | 37.87 | 7.17 | | | | | 280 | 17 | 19.20 |
| | | | | 15:15 | 73000 | | 152.51 | 7.05 | | | | | 170 | 120 | 18.80 |
| | | | RK8 | 6:45 | 16000 | | 20.18 | 7.14 | | | | | 270 | 26 | 19.80 |
| | | | | 9:55 | 120000 | | 30.55 | 7.30 | | | | | 260 | 17 | 19.30 |
| | | | | 14:20 | 40000 | | 124.00 | 7.00 | | | | | 170 | 85 | 19.00 |
| | | | RK9 | 6:25 | 29000 | | 21.00 | 7.05 | | | | | 300 | 11 | 19.40 |
| | | | | 9:45 | 33000 | | 28.10 | 6.94 | | | | | 260 | 12 | 19.00 |
| | | | | 14:45 | 18000 | | 142.00 | 6.53 | | | | | 140 | 68 | 18.80 |
| | | | SB1 | 7:45 | 21000 | | 2.06 | 6.97 | | | | | 300 | 44 | 16.00 |
| | | | | 10:45 | 110000 | | 3.67 | 7.02 | | | | | 270 | 110 | 15.80 |
| | | | | 14:30 | 17000 | | 11.80 | 5.99 | | | | | 160 | 280 | 17.30 |
| 7/9/2005 | Base Storm | 1 | RK3 Composite | | | | | | | | | | 203 | 13 | |
| | | | RK8 Composite | | | | | | | | | | 224 | 60 | |

# Appendix A: Rockaway 6034 Data

| Date | Event Type | Event Number | Station ID | Time | Fecal Coliforms colonies/100ml | Fecal Strep colonies/100ml | Flow cfs | pH SU | DOPO4 mg/l (ppm) | TP mg/l (ppm) | Total OPO4 mg/l (ppm) | FC/FS Ratio | TDS mg/l (ppm) | TSS mg/l (ppm) | Temperature oC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/12/2005 | Ambient | 3 | RK1 | 10:50 | 10 | | 21.60 | 7.15 | | | | | 146 | 4 | 23.80 |
| | | | RK3 Composite | 10:30 | | | | | | | | | 160 | 4 | |
| | | | RK8 Composite | 10:15 | | | | | | | | | 181 | 5 | |
| | | | RK9 | 10:00 | 100 | | 43.00 | 7.45 | | | | | 198 | 3 | 23.00 |
| 8/1/2005 | Low Flow | 2 | GB1 | 10:55 | 60 | | 3.97 | 7.91 | | | | | 213 | 3 | 22.90 |
| | | | JB2 | 10:20 | 80 | | 1.36 | 7.44 | | | | | 380 | 4 | 22.10 |
| | | | RK1 | 12:10 | < 10 | | 7.28 | 7.68 | | | | | 186 | 3 | 24.50 |
| | | | RK2 | 11:50 | < 10 | | 7.93 | 7.72 | | | | | 194 | 4 | 21.90 |
| | | | RK3 | 11:30 | 10 | | 7.96 | 7.93 | | | | | 197 | 3 | 22.10 |
| | | | RK3 Composite | 11:30 | | | | | | | | | 169 | 9 | |
| | | | RK4 | 11:10 | 50 | | 8.06 | 7.83 | < 0.01 | 0.03 | | | 176 | 2 | 24.50 |
| | | | RK5 | 10:40 | 20 | | 12.26 | 7.80 | | | | | 242 | 2 | 23.40 |
| | | | RK6 | 10:05 | 60 | | 13.80 | 7.93 | 0.02 | 0.02 | | | 223 | 3 | 22.70 |
| | | | RK7 | 9:45 | 40 | | 13.93 | 8.07 | | | | | 267 | 3 | 22.50 |
| | | | RK8 | 9:30 | 220 | | 13.96 | 7.66 | | | | | 264 | 2 | 22.50 |
| | | | RK8 Composite | 9:30 | | | | | | | | | 236 | 6 | |
| | | | RK9 | 9:15 | 180 | | 14.50 | 7.81 | | | | | 258 | 4 | 21.80 |
| 8/9/2005 | Ambient | 4 | RK1 | 11:00 | < 10 | | 5.87 | 7.67 | | | | | 159 | 4 | 23.00 |
| | | | RK3 Composite | 10:45 | | | | | | | | | 219 | 10 | |
| | | | RK8 Composite | 10:25 | | | | | | | | | 261 | 11 | |
| | | | RK9 | 10:15 | 20 | | 11.70 | 7.90 | | | | | 232 | 5 | 21.50 |
| 8/25/2005 | Low Flow | 3 | GB1 | 11:00 | 40 | | 2.56 | 7.97 | | | | | 446 | 2 | 18.80 |
| | | | JB2 | 10:30 | 190 | | 0.88 | 7.31 | | | | | 253 | 5 | 19.20 |
| | | | RK1 | 12:10 | 20 | | 4.70 | 7.70 | | | | | 217 | 4 | 21.10 |
| | | | RK2 | 11:50 | 30 | | 5.12 | 7.87 | | | | | 267 | 3 | 19.50 |
| | | | RK3 | 11:35 | 20 | | 5.13 | 8.01 | | | | | 244 | 3 | 19.80 |
| | | | RK3 Composite | 11:35 | | | | | | | | | 221 | 33 | |
| | | | RK4 | 11:20 | 80 | | 5.20 | 7.99 | 0.01 | 0.04 | | | 239 | 6 | 21.70 |
| | | | RK5 | 10:40 | 150 | | 7.91 | 8.08 | | | | | 243 | 12 | 20.00 |
| | | | RK6 | 10:15 | 120 | | 8.87 | 8.02 | 0.04 | 0.04 | | | 794 | 2 | 19.20 |
| | | | RK7 | 10:00 | 160 | | 9.00 | 8.17 | | | | | 322 | 2 | 19.10 |
| | | | RK8 | 9:50 | 240 | | 8.98 | 7.95 | | | | | 266 | 4 | 18.70 |
| | | | RK8 Composite | 9:50 | | | | | | | | | 258 | 22 | |
| | | | RK9 | 9:35 | 570 | | 9.35 | 7.97 | | | | | 278 | 3 | 18.90 |
| 9/13/2005 | Ambient | 5 | RK1 | 10:00 | 3 | | 3.76 | 7.70 | | | | | 193 | 3 | 19.30 |
| | | | RK3 Composite | 9:45 | | | | | | | | | 232 | 38 | |
| | | | RK8 Composite | 9:25 | | | | | | | | | 351 | 50 | |
| | | | RK9 | 9:10 | 380 | | 7.48 | 7.77 | | | | | 305 | 4 | 18.30 |
| 10/7/2005 | Base Storm | 2 | DPW1 | 14:50 | 3600 | | 0.01 | 7.67 | | | | | | 23 | 23.40 |
| | | | DPW2 | 14:45 | 700 | | 0.01 | 7.77 | | | | | 350 | 74 | 22.60 |
| | | | GB1 | 13:55 | 7500 | | 2.18 | 7.79 | | | | | 280 | 11 | 20.50 |
| | | | IS1 | 15:05 | 1100 | | | 7.18 | | | | | 250 | 5 | 20.10 |
| | | | JB1 | 14:45 | 5500 | | 0.77 | 7.35 | | | | | 260 | 25 | 20.50 |
| | | | JB2 | 14:30 | 3400 | | 0.84 | 7.37 | | | | | 440 | 25 | 20.40 |
| | | | RK1 | 15:35 | < 100 | | 5.60 | 7.70 | | | | | 310 | 3 | 21.40 |
| | | | RK2 | 13:45 | 1300 | | 6.10 | 7.91 | | | | | 270 | 3 | 20.10 |
| | | | RK3 | 14:20 | 200 | | 4.90 | 7.80 | | | | | 290 | 3 | 20.10 |
| | | | RK4 | 14:10 | 200 | | 4.40 | 7.82 | | 0.03 | < 0.01 | | 300 | 4 | 20.20 |
| | | | RK5 | 13:40 | 200 | | 6.70 | 7.68 | | | | | 290 | 4 | 19.80 |
| | | | RK6 | 14:15 | 180 | | 7.50 | 7.74 | 0.01 | 0.08 | 0.03 | | 310 | 18 | 20.20 |
| | | | RK7 | 14:00 | 7400 | | 7.60 | 7.81 | | | | | 300 | 10 | 20.40 |
| | | | RK8 | 13:45 | 190000 | | 7.90 | 7.21 | | | | | 160 | 46 | 21.20 |
| | | | RK9 | 13:40 | 5500 | | 7.90 | 7.07 | | | | | 150 | 8 | 21.00 |
| | | | SB1 | 15:30 | 600 | | 0.25 | 7.19 | | | | | 210 | 12 | 19.10 |

# Appendix A: Rockaway 6034 Data

| Date | Event Type | Event Number | Station ID | Time | Fecal Coliforms colonies/100ml | Fecal Strep colonies/100ml | Flow cfs | pH SU | DOPO4 mg/l (ppm) | TP mg/l (ppm) | Total OPO4 mg/l (ppm) | FC/FS Ratio | TDS mg/l (ppm) | TSS mg/l (ppm) | Temperature oC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10/8/2005 | Base Storm | 2 | DPW1 | 7:55 | 25000 | | 0.06 | 6.91 | | | | | 330 | | 20.90 |
| | | | | 13:15 | 216000 | | 0.09 | 7.33 | | | | | 250 | 9 | 23.00 |
| | | | DPW2 | 7:40 | 130000 | | 0.03 | 7.01 | | | | | 130 | 46 | 20.60 |
| | | | | 13:05 | 7600 | | 0.05 | 7.48 | | | | | 95 | 12 | 22.20 |
| | | | GB1 | 7:05 | 920 | | 41.00 | 6.84 | | | | | 160 | 41 | 20.00 |
| | | | | 12:25 | 4600 | | 73.00 | 6.75 | | | | | 150 | 23 | 20.20 |
| | | | JB1 | 7:50 | 4400 | | 15.00 | 7.29 | | | | | 130 | 35 | 19.90 |
| | | | | 13:10 | 11000 | | 23.00 | 7.14 | | | | | 140 | 31 | 20.30 |
| | | | JB2 | 7:40 | 46000 | | 17.00 | 7.55 | | | | | 120 | 53 | 19.90 |
| | | | | 13:00 | 77000 | | 25.00 | 7.31 | | | | | 130 | 21 | 20.30 |
| | | | RK1 | 8:35 | 120 | | 92.00 | 7.21 | | | | | 250 | 5 | 19.90 |
| | | | | 13:45 | 1800 | | 139.00 | 7.28 | | | | | 220 | 7 | 20.50 |
| | | | RK2 | 8:20 | 1000 | | 100.00 | 7.26 | | | | | 240 | 5 | 19.60 |
| | | | | 13:30 | 2600 | | 151.00 | 7.19 | | | | | 240 | 4 | 19.60 |
| | | | RK3 | 8:05 | 820 | | 101.00 | 7.13 | | | | | 260 | 9 | 19.50 |
| | | | | 12:50 | 1600 | | 152.00 | 7.41 | | | | | 250 | 11 | 19.80 |
| | | | RK4 | 7:20 | 400 | | 93.00 | 7.50 | | 0.04 | 0.02 | | 280 | 5 | 20.10 |
| | | | | 12:40 | 240 | | 154.00 | 7.38 | | 0.04 | < 0.01 | | 260 | 4 | 20.30 |
| | | | RK5 | 6:52 | 4100 | | 134.00 | 6.90 | | | | | 200 | 23 | 19.90 |
| | | | | 12:10 | 1400 | | 234.00 | 6.79 | | | | | 200 | 24 | 20.70 |
| | | | RK6 | 7:25 | 5440 | | 159.00 | 7.20 | < 0.01 | 0.14 | 0.08 | | 120 | 72 | 19.90 |
| | | | | 12:40 | 26000 | | 263.00 | 7.30 | 0.01 | 0.10 | 0.05 | | 150 | 36 | 20.30 |
| | | | RK7 | 7:10 | 14000 | | 160.00 | 7.31 | | | | | 160 | 34 | 20.00 |
| | | | | 12:30 | 17000 | | 264.00 | 7.37 | | | | | 160 | 72 | 20.30 |
| | | | RK8 | 7:00 | 3700 | | 149.00 | 7.16 | | | | | 160 | 72 | 20.00 |
| | | | | 12:15 | 50000 | | 274.00 | 7.35 | | | | | 160 | 33 | 20.40 |
| | | | RK9 | 6:50 | 3800 | | 150.00 | 6.93 | | | | | 130 | 12 | 20.00 |
| | | | | 12:00 | 7000 | | 277.00 | 6.90 | | | | | 150 | 39 | 20.30 |
| | | | SB1 | 8:05 | 102000 | | 4.00 | 6.90 | | | | | 230 | 110 | 19.00 |
| | | | | 13:25 | 10000 | | 6.30 | 6.68 | | | | | 200 | 39 | 19.70 |
| 10/9/2005 | Base Storm | 2 | RK3 Composite | | | | | | | | | | 187 | 21 | |
| | | | RK8 Composite | | | | | | | | | | 172 | 128 | |
| 10/11/2005 | Ambient | 6 | RK3 Composite | 10:30 | | | | | | | | | 142 | 4 | |
| | | | RK8 Composite | 10:05 | | | | | | | | | 145 | 16 | |
| | | | RK9 | 10:00 | 280 | | 218.00 | 7.51 | | | | | 152 | 3 | 15.90 |
| 10/14/2005 | High Flow | 1 | SB1 | 9:00 | 920 | | 14.80 | | | | | | | | |
| | | | GB1 | 8:35 | 240 | 320 | 179.00 | | | | | 0.75 | | | |
| | | | JB1 | 9:10 | 1500 | | 56.00 | | | | | | | | |
| | | | JB2 | 9:15 | 1000 | 640 | 62.00 | | | | | 1.56 | | | |
| | | | RK1 | 7:55 | 6000 | 780 | 329.00 | | | | | 7.69 | | | |
| | | | RK2 | 8:00 | 100 | | 358.00 | | | | | | | | |
| | | | RK3 | 8:05 | 140 | | 359.00 | | | | | | | | |
| | | | RK4 | 8:15 | 120 | | 364.00 | | | | | | | | |
| | | | RK5 | 8:40 | 380 | | 554.00 | | | | | | | | |
| | | | RK6 | 9:25 | 260 | | 621.00 | | | | | | | | |
| | | | RK7 | 9:37 | 220 | | 630.00 | | | | | | | | |
| | | | RK8 | 9:45 | 620 | | 632.00 | | | | | | | | |
| | | | RK9 | 9:58 | 2000 | 490 | 654.00 | | | | | 4.08 | | | |

# Appendix A: Rockaway 6034 Data

| Date | Event Type | Event Number | Station ID | Time | Fecal Coliforms colonies/100ml | Fecal Strep colonies/100ml | Flow cfs | pH SU | DOPO4 mg/l (ppm) | TP mg/l (ppm) | Total OPO4 mg/l (ppm) | FC/FS Ratio | TDS mg/l (ppm) | TSS mg/l (ppm) | Temperature oC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/16/2005 | Intensive Storm | 1 | GB1 | 17:20 | 3500 | 18000 | 15.39 | 7.82 | | | | 0.19 | 170 | 21 | 13.50 |
| | | | | 18:36 | 2000 | 4000 | 17.05 | 7.07 | | | | 0.50 | 160 | 10 | 12.40 |
| | | | | 20:47 | 1160 | 3040 | 22.18 | 7.55 | | | | 0.38 | 170 | 11 | 11.90 |
| | | | JB2 | 16:50 | 34000 | 9000 | 5.41 | 7.23 | | | | 3.78 | 210 | 8 | 14.70 |
| | | | | 18:10 | 7000 | 24000 | 5.37 | 6.40 | | | | 0.29 | 240 | 11 | 13.40 |
| | | | | 20:25 | 5000 | 12000 | 7.26 | 7.11 | | | | 0.42 | 260 | 14 | 12.20 |
| | | | MKB | 16:25 | 560 | 520 | | 6.57 | | | | 1.08 | 340 | 24 | 14.10 |
| | | | | 17:25 | 37000 | 99000 | | 6.77 | | | | 0.37 | 100 | 41 | 12.50 |
| | | | | 20:10 | 4800 | 28000 | | 7.46 | | | | 0.17 | 130 | 6 | 12.30 |
| | | | RK4 | 17:10 | 20 | 40 | 31.20 | 7.45 | | | | 0.50 | 200 | 2 | 12.50 |
| | | | | 18:25 | 140 | 80 | 34.58 | 7.03 | | | | 1.75 | 210 | 5 | 12.00 |
| | | | | 20:37 | 120 | 780 | 44.98 | 7.66 | | | | 0.15 | 210 | 5 | 12.00 |
| | | | RK6 | 16:40 | 25000 | 9000 | 54.55 | 7.12 | | | | 2.78 | 230 | 19 | 14.10 |
| | | | | 17:35 | 11000 | 11000 | 54.55 | 7.66 | | | | 1.00 | 200 | 13 | 13.40 |
| | | | | 20:15 | 2200 | 10000 | 71.40 | 7.45 | | | | 0.22 | 200 | 18 | 12.10 |
| | | | RK7 | 16:25 | 54000 | 76000 | 54.83 | 7.15 | | | | 0.71 | 170 | 148 | 14.70 |
| | | | | 17:55 | 20000 | 45000 | 59.29 | 7.05 | | | | 0.44 | 200 | 9 | 12.90 |
| | | | | 20:05 | 7000 | 15000 | 68.65 | 7.46 | | | | 0.47 | 200 | 10 | 12.10 |
| | | | RK7a | 16:20 | 700 | 460 | | | | | | 1.52 | 240 | 3 | |
| | | | | 17:50 | 28000 | 51000 | | 7.19 | | | | 0.55 | 190 | 20 | 13.10 |
| | | | | 8:00 | 4000 | 21000 | | 7.36 | | | | 0.19 | 190 | 10 | 12.40 |
| | | | RK8 | 16:15 | 340 | 2600 | 56.92 | 6.78 | | | | 0.13 | 270 | 4 | 13.70 |
| | | | | 16:35 | 4000 | 47000 | 56.92 | 6.92 | | | | 0.09 | 200 | 10 | 13.20 |
| | | | | 20:00 | 7000 | 11000 | 71.27 | 7.45 | | | | 0.64 | 190 | 20 | 12.10 |
| | | | RK9 | 17:40 | 880 | 4000 | 57.50 | 7.29 | | | | 0.22 | 240 | 29 | 13.80 |
| | | | | 17:40 | 30000 | 42000 | 62.17 | 7.12 | | | | 0.71 | 190 | 26 | 12.90 |
| | | | | 19:50 | 8000 | 7000 | 63.58 | 7.10 | | | | 1.14 | 180 | 22 | 12.10 |
| | | | Storm Outlet 1 | 16:55 | 11000 | 88000 | | 7.00 | | | | 0.13 | 68 | 20 | 15.10 |
| | | | | 18:00 | 20 | 60 | | 6.71 | | | | 0.33 | 40 | 15 | 12.80 |
| | | | | 20:20 | 11000 | 35000 | | 7.15 | | | | 0.31 | 140 | 14 | 11.90 |
| | | | Storm Outlet 2 | 16:50 | 53000 | 111000 | | 6.95 | | | | 0.48 | 68 | 41 | 13.80 |
| | | | | 18:00 | 7000 | 38000 | | 6.85 | | | | 0.18 | 110 | 31 | 13.30 |
| | | | | 20:30 | 10000 | 18000 | | 7.05 | | | | 0.56 | 130 | 14 | 11.70 |
| | | | Storm Outlet 3 | 17:05 | 114000 | 320000 | | 6.89 | | | | 0.36 | 120 | 246 | 13.90 |
| | | | | 18:15 | 81000 | 128000 | | 6.67 | | | | 0.63 | 62 | 46 | 12.50 |
| | | | | 20:45 | 145000 | 286000 | | 7.70 | | | | 0.51 | 49 | 30 | 11.10 |
| | | | Storm Outlet 4 | 17:15 | 34000 | 99000 | | 7.05 | | | | 0.34 | 51 | 57 | 14.10 |
| | | | | 18:25 | 7000 | 64000 | | 6.59 | | | | 0.11 | 49 | 19 | 11.90 |
| | | | | 21:00 | 33000 | 14000 | | 7.50 | | | | 2.36 | 30 | 18 | 11.70 |
| 11/17/2005 | Intensive Storm | 1 | GB1 | 14:50 | 100 | 500 | 60.26 | 7.26 | | | | 0.20 | 160 | 3 | 8.40 |
| | | | JB2 | 14:20 | 360 | 3600 | 18.97 | 7.50 | | | | 0.10 | 250 | 3 | 9.70 |
| | | | MKB | 13:25 | 680 | 4200 | | 6.91 | | | | 0.16 | 210 | 3 | 10.00 |
| | | | RK4 | 14:38 | 60 | 220 | 122.20 | 7.60 | | | | 0.27 | 170 | 4 | 8.70 |
| | | | RK5 | 15:00 | 120 | 260 | 185.86 | 7.14 | | | | 0.46 | 260 | 5 | 8.70 |
| | | | RK6 | 14:08 | 340 | 1060 | 208.44 | 7.80 | | | | 0.32 | 200 | 5 | 9.10 |
| | | | RK7 | 13:57 | 220 | 900 | 209.53 | 8.12 | | | | 0.24 | 190 | 2 | 8.90 |
| | | | RK7a | 13:50 | 160 | 800 | | 7.31 | | | | 0.20 | 200 | 5 | 9.30 |
| | | | RK8 | 13:16 | 300 | 1600 | 219.81 | 6.69 | | | | 0.19 | 200 | 3 | 9.50 |
| | | | RK9 | 13:05 | 440 | 880 | 222.05 | 5.81 | | | | 0.50 | 190 | 5 | 9.90 |
| | | | Storm Outlet 2 | 13:40 | 360 | 620 | | 6.80 | | | | 0.58 | 410 | 6 | 13.10 |

# Appendix B

Storm Water Pipe Sampling Map


# ROCKAWAY RIVER WATERSHED Priority Stream Segment Study

## Storm Water Pipe Sampling Map

LEGEND

- Storm Water Sampling Stations
- River Sampling Sites
- Rivers and Streams

N
W E
S

0 500 Feet

Prepared by:

TRC Omni Environmental Corporation

# Appendix C

USACE Restoration Projects

SEGMENT END (I-80)

ROXBURY TWP

UR-1

STEPHENS BROOK

JB-3

ROCKAWAY RIVER

GREENPOND BROOK

JB-8

WHARTON BORO

JB-4

DOVER TOWN

JB-5

JACKSON BROOK

ROCKAWAY RIVER

SEGMENT END
(BLACKWELL STREET)

# ROCKAWAY RIVER WATERSHED
# Priority Stream Segment Study

Figure 3
ACOE Proposed
Restoration Sites

LEGEND

- ACOE PROPOSED RESTORATION SITES
- Rivers and Streams
- Municipalities

N
W E
S

0 0.25 Miles

Prepared by:

TRC Omni Environmental Corporation

Clinton Street

'V' Inlet

Upper Rockaway River

Flow Direction

N. Warren Street

Bassett Highway

## Existing Environment

**LEGEND:**

- Created Herbaceous
- Created Herbaceous/Slope
- Created Open Water
- Created Palustrine Emergent
- Individual Tree Plantings
- Created Path
- Created Scrub-shrub
- Created Rock
- Created Deep Water

N

100 50 0 100 Feet

30 15 0 30 Meters

Source: Natural Color Aerial Photography, USACE 2000.

Figure 4. Site JB-5: Conceptual Restoration Design for the Upper Rockaway Flood Control and Ecosystem Restoration Study.

U.S. Army Corps of Engineers
New York District, 26 Federal Plaza
New York, NY 10278-0090

Date: 11/05/03

NEAFILE:e:/projects/Urock/aprs-figures/siteloc.apr

Primary benefits associated with restoring this site include the reintroduction of historic fish and wildlife habitat to a highly urbanized environment, restoration of historic hydrologic patterns, expansion of rare butterfly habitat within Dover, and a potential reduction in sedimentation to downstream resources. The proposed design may also promote the expansion of bog turtle habitat. Secondary benefits that could be attained include aesthetic and recreational improvements, as well as the advancement of the local community's plan for beautification of the area (Friends of the Rockaway River 1998).

Additional surveys and documentation of existing features will be required prior to the development of the final restoration plan at this site. Surveys that may be required in the future include a site-specific topographic survey, geo-technical surveys, soil surveys, site assessment and/or soil contaminants testing, and cultural resource survey. In addition, the final restoration plan/design could incorporate the establishment of a butterfly garden with native nectar producing plants if an assessment of butterfly habitat usage within the area indicates that this effort would be warranted.

### 4.2.2 MR2-1: Middle Rockaway Sub-basin #2- River Woodland Reserve

Site MR2-1 is an approximately 3.71 acre parcel of land located in Rockaway Borough near the intersection of Main Street and Franklin Avenue. Situated south of a lumberyard, the site is characterized as a vacant, disturbed upland that is bordered by the Rockaway River on the north and west, a railroad track on the east, and a forested area to the south.

**Existing Conditions**

A circular dirt path outlines a disturbed upland area in the center of the site. The site also includes an early successional meadow in the southern portion, and a forested "edge" community along the river. Near the center of the path is a manhole cover for the local sewage authority. A number of trails extend from the dirt path to the water's edge, allowing recreational fishermen access to the river and exacerbating streambank destabilization in some places.

The primary ecological features of the restoration site include the disturbed upland community, the riverbank, the meadow, and the surrounding forest. The disturbed upland area is sparsely vegetated with mugwort (*Ambrosia vulgaris*), common mullein (*Verbascum thapsus*), and various other species commonly found on recently disturbed sites. The riverbank consists of a 30 to 50-foot wide, dense forested buffer predominantly vegetated with boxelder (*Acer negundo*), willows (*Salix* spp.), silky dogwood (*Cornus amomum*), smooth sumac (*Rhus glabra*), multiflora rose, and silver maple. Dominant vegetation associated with the meadow community includes Queen Anne's lace (*Daucus carota*), calico aster (*Aster vimineus*), and rough-stemmed goldenrod (*Solidago rugosa*). The surrounding forest primarily consists of oaks (*Quercus* spp.) and maples. The site currently may provide some habitat along the riverbanks for the state listed threatened wood turtle (USFWS 2003). In addition, the Federally listed threatened bog turtle has historically been identified on the site, and the state endangered bobcat (*Felis refus*) has also been identified in the area (USFWS 2003).

**Proposed Restoration**

The proposed restoration action at this site will include excavation of the disturbed upland (potential fill material) to appropriate floodplain elevations, creation of channels and ponding areas, planting of native emergent wetland and submerged aquatic vegetation, planting upland scrub-shrub/forest and herbaceous vegetation, and creating a grass parking area (Figure 5). In order to reduce the velocity of flow through this reach of the river and to diversify the habitat type, a narrow channel will be created, parallel to the Rockaway River, to ensure a constant flow of water entering and exiting the newly restored system. Emergent wetland and submerged aquatic habitats will be created in conjunction with the new channel, and upland herbaceous and forest/scrub-shrub areas will be planted in the adjacent uplands. All excavated material will be reused on-site to create a consolidated and structured parking area and access path for recreational fishing. Potential areas of threatened or endangered species habitat will be identified and avoided or improved during all restoration activities.

The primary benefit of this restoration action will be an increase in fish and wildlife habitat, including rare or endangered species habitat. Additionally the restoration will establish a number of native habitat types rarely found nearby in the watershed. Improved hydrologic function will also be established by restoring the connection between the disturbed upland and the river. Secondary benefits will include site improvements for recreational fishing use and enhanced aesthetics.

Additional surveys and documentation of existing features will be required prior to the development of the final restoration plan at this site. Surveys that may be required in the future include a site-specific topographic survey, wetland delineation survey, fish and wildlife surveys, soil surveys, site assessment and/or soil contaminants testing, and cultural resource survey. In addition, a qualified herpetologist will be required to identify potential threatened or endangered turtle habitat prior to the development of the final restoration plan. Also, the exact use and location of the sewage line associated with the observed manhole cover must be investigated.

### 4.2.3 JB-3: Burnt Meadow Brook- River Woodland Reserve

Site JB-3 is an approximately 2.52 acre parcel of land that consists of a narrow vegetated berm, disturbed upland, and remnant forested floodplain. The site is located in Wharton, near the Shop Rite shopping complex located on West Clinton, and is bordered by the Rockaway River to the west, disturbed upland communities to the north and northeast, and a forested wetland to the south and southeast.

**Existing Conditions**

Based on the site visit, it appears that the river was channelized through this area in the past and that the excavated material was side-cast along the eastern bank of the river to create an artificial earthen berm and/or exaggerated streambank. The berm is approximately 25 feet wide and between 6 to 8 feet above the normal river surface, and there is no evidence that the river water is able to breach the berm. These past activities have significantly altered the hydrology in this

New Street

W New Street

Flow Direction

Path

Parking

Road

Parking

Franklin Avenue

## Existing Environment

**LEGEND**

- Created Forest/Scrub-shrub
- Created Herbaceous
- Created Mowed Grass
- Created Open Water
- Created Palustrine Emergent
- Existing Road
- Created Open Water/Submerged Aquatic Vegetation
- Created Scrub-shrub

N

100 50 0 100 Feet

30 15 0 30 Meters

Source: Natural Color Aerial Photography, USACE 2000.

Figure 5. Site MR2-1: Conceptual Restoration Design for the Upper Rockaway Flood Control and Ecosystem Restoration Study.

U.S. Army Corps of Engineers
New York District, 26 Federal Plaza
New York, NY 10278-0090

Date: 11/05/03

NEAFILE:e:/projects/Urock/aprs-figures/2003figures/concept_design/figx.mxd

area and have adversely impacted the former floodplain. As a result, the Rockaway River flows very quickly downstream through this narrow channel.

Key ecological features of this restoration site include the vegetated earthen berm, the Rockaway River, remnant floodplain, and adjacent upland communities. The berm is moderately vegetated with pole-sized red maple, American elm, redbud (*Cercis canadensis*), beech (*Fagus grandifolia*), and sycamore trees. Multiflora rose (*Rosa multiflora*) was the dominant understory species, and the groundcover/herbaceous vegetation includes silky dogwood, sensitive fern (*Onoclea sensibilis*), white snakeroot (*Eupatorium rugosa*), and poison ivy (*Toxicodendron radicans*). The former floodplain/riverbed habitat, located to the east of the berm, is extremely rocky and is sparsely vegetated with the same species composition and structure as the berm. There is a notable absence of understory and herbaceous growth in this floodplain area. Wood turtles have been documented at the site, and potential bog turtle habitat may occur on or adjacent to the proposed restoration site; focused surveys may be necessary in the future (USFWS 2003).

**Proposed Restoration**

The proposed restoration action for this includes improving native fish and wildlife habitat diversity, reestablishing historic hydrology, and reducing high velocity flows and downstream sediment loading during storm events. Specifically, fish and wildlife habitat improvements include the removing the earthen berm, placing the excavated material on the disturbed upland areas, and replanting the area with herbaceous ground cover (Figure 6).

The proposed restoration action will significantly improve fish habitat by restoring the original streambed and floodplain and adding a diversity of habitats that are not currently available. The widening of the current riverbed through the removal of the berm will also provide secondary benefits such as a reduction in water velocities, and reestablishment of natural water and sediment storage in the floodplain during storm events.

Additional surveys and documentation of existing features will be required prior to the development of the final restoration plan at this site. Surveys that may be required in the future include a site-specific topographic survey, wetland delineation survey, fish and wildlife surveys, soil survey, site assessment and/or soil contaminants testing, and cultural resource survey. In addition, a qualified herpetologist will be required to identify potential threatened or endangered turtle habitat prior to the development of the final restoration plan.

### 4.2.4 JB-8: Jackson Brook Sub-basin- Drainage 646 Wharton

Site JB-8 is an approximately 3.9 acre parcel of land located on an active powerline right-of-way in Wharton, near the intersection of Mount Pleasant Avenue and West Clinton (Route 15). The site is bordered on the northeast by the West Clinton Bridge, on the east by Green Pond Brook, on the south by the Rockaway River and a large forested wetland, and on the northwest by the roller rink parking lot. The site is dominated by common reed (*Phragmites australis*), a highly opportunistic, fast colonizing plant species that is regularly found in disturbed wetland areas.

Flow Direction

Restore Existing River Bed

Existing berm
to be removed

## Existing Environment

**LEGEND**

- Created Open Water
- Created Herbaceous
- Area of Existing Berm

N

100 50 0 100 Feet

30 15 0 30 Meters

Source: Natural Color Aerial Photography, USACE 2000.

Figure 6. Site JB-3: Conceptual Restoration Design for the Upper Rockaway Flood Control and Ecosystem Restoration Study.

U.S. Army Corps of Engineers
New York District, 26 Federal Plaza
New York, NY 10278-0090

Date: 11/05/03

NEAFILE:e:/projects/Urock/aprs-figures/2003figures/concept_design/figx.mxd

**Existing Conditions**

Construction of the powerline has created habitat conditions that favor the growth and establishment of common reed. Common reed grows in very dense stands that can grow up to 15 feet tall, thus shading out other wetland plant species and reducing an area's fish and wildlife habitat diversity and abundance. Over time, common reed stands create a thick fibrous mat that continues to increase in thickness, elevating the area's ground surface and further discouraging the growth of other wetland plants.

Currently, the area receives surface water runoff from the adjacent roller rink parking lot and the surrounding roads. In addition, it is likely that the Green Pond Brook provides an intermittent source of hydrology during storm, or high water, events. However, there is no evidence of a stream channel or drainage ditch within the site, nor were any springs/seeps observed. It is assumed that the site historically was a forested floodplain associated with Green Pond Brook.

The diversity of on-site vegetation is limited, and predominantly consists of common reed. Other plant species were observed in small pockets near the northern tip of the site, adjacent to the brook. Dominant species in these areas include marsh pepper knotweed (*Polygonum hydropiper*), jewelweed (*Impatiens capensis*), arrow tearthumb (*Polygonum sagittatum*), and straw-colored nutsedge (*Cyperus strigosus*). Red maple (*Acer rubrum*) is the dominant overstory species in the adjacent floodplain. Potential bog turtle and wood turtle habitat may exist in the vicinity of the proposed site, and wood turtles have been documented in this stretch of the river (USFWS 2003).

**Proposed Restoration**

The proposed restoration action at this site will include removal and off-site disposal of the common reed; excavation and removal of the root mat; installation of slope stabilizing, biodegradable filter fabric; excavation of a series of ponds connected by one meandering channel; and, (Figure 7). Native emergent vegetation would be planted in the restored floodplain to enhance fish and wildlife habitat and to reduce sedimentation to the downstream reaches. Similarly, the area between the restored emergent and open water wetlands and the Roller Rink parking lot will be graded and planted with scrub-shrub vegetation.

Primary benefits associated with this restoration action include an increase in fish and wildlife habitat diversity, restored hydrologic connection, reduced transport of upland sediment and non-point source pollutants to downstream reaches, and an increased area of potential rare turtle habitat. Secondary benefits include an increase in temporary water storage, a reduction in required vegetation maintenance within the right-of-way, and an improved aesthetic viewshed.

Additional surveys and documentation of existing features will be required prior to the development of the final restoration plan at this site. Surveys that may be required in the future include a site-specific topographic survey, wetland delineation survey, fish and wildlife surveys, soil survey, site assessment and/or soil contaminants testing, and cultural resource survey. In addition, a qualified herpetologist will be required to identify potential threatened or endangered turtle habitat prior to the development of the final restoration plan.

Mount

Clinton Street

Flow Direction

Upper Rockaway River

15

Green Pond Brook

Flow Direction

## Existing Environment

**LEGEND**

- Created Open Water
- Created Palustrine Emergent
- Created Scrub-shrub

N

100 50 0 100 Feet

30 15 0 30 Meters

Source: Natural Color Aerial Photograpy, USACE 2000.

Figure 7. Site JB-8: Conceptual Restoration Design for the Upper Rockaway Flood Control and Ecosystem Restoration Study.

U.S. Army Corps of Engineers
New York District, 26 Federal Plaza
New York, NY 10278-0090

Date:
11/05/03

NEAFILE:e:/projects/Urock/aprs-figures/2003figures/concept_design/figx.mxd

### 4.2.5 UR-1: GPU Energy/Morris County Properties

Site UR-1 is an approximately 8.6 acre parcel of land that is located in Roxbury Township and consists of a shallow pond and a narrow vegetated berm. The site is bordered by Mill Pond Road to the west, the West Dewey Avenue Bridge to the northwest, the Upper Rockaway River to the north, and forested areas to the east and south. The area surrounding the site includes a small community of approximately 10 residences at the southern end of Mill Pond Road and to east of the pond.

**Existing Conditions**

Known locally as Baker's Mill Pond, or simply Mill Pond, Site UR-1 is believed to be a remnant from the Morris Canal era, and may have historically been used as a basin for barge vessels. The Rockaway River flows towards Mill Pond from the north, under the West Dewey Avenue Bridge, and continues in a southeasterly direction. Water exchange between the pond and the river is limited due to an approximately 3-6 foot high, earthen berm that separates the two systems and holds water in the pond at a higher elevation than the river surface. However, during storm events there is some field evidence that the river overflows the berm; and provides an intermittent source of freshwater to the pond. The primary drainage outfall from the pond is a culvert located along the southern border of the pond that drains into a forested wetland community and eventually into Stephens Brook. In addition, there is an approximately 10-foot-wide outlet located at the northern end of the pond, along the eastern side of the berm that drains into the mainstem of the river.

Key ecological features of the restoration site include the shallow open water community of the pond, including areas of open water and emergent wetlands, and the vegetated berm. The emergent wetland vegetation includes arrow arum (*Peltandra virginica*), pickerelweed (*Pontederia cordata*), cattail (*Typha* spp.), and various sedges and rushes. Dominant overstory vegetation on the berm includes red maple, silver maple, American elm, green ash (*Fraxinus pennsylvanica*), southern arrow-wood (*Viburnum dentatum*), and common cottonwood (*Populus deltoides*). The understory is dominated by speckled alder (*Alnus rugosa*) and the groundcover/herbaceous vegetation includes marsh pepper knotweed, jewelweed, arrow tearthumb, white snakeroot, and poison ivy. According to the USFWS (2003), bog turtle and wood turtle habitat may be found near the proposed restoration site.

In general, the pond is shallow and provides very little habitat diversity for fish. Submerged plants or floating leaved plants were observed during the field survey but were not identified due to inaccessibility. Water flow was extremely limited, and the bottom substrate was primarily silts and fine grain material.

**Proposed Restoration**

Based on the more detailed on-site surveys completed after the restoration ranking, this site is characterized as a functioning, open water/emergent wetland with low-flow conditions. Although there are indications of altered hydrology that may be limiting fish and wildlife

diversity at the site, there appears to be fewer restoration opportunities than what was originally believed to exist.

Preliminary restoration activities identified for Mill Pond based on current site conditions include improving fish and wildlife habitat diversity, as well as reducing high velocity flows and downstream sediment loading during storm events. Fish and wildlife habitat improvements include reconfiguring the elevation of the berm to a consistent height above the river's surface water height; excavating accumulated pond sediments creating areas of deepwater habitat to enhance the diversity of fish habitat and species; and, reconstructing the existing man-made culvert to ensure adequate pond drainage (Figure 8).

Primary benefits associated with the proposed restoration design include improved fish and wildlife habitat, improved hydrology, and decreased sediment loading in downstream areas. Specifically, the proposed restoration activities will allow the pond to retain a greater volume of water during storm events, thus reducing the water velocity and allowing sediments to settle out of the water column before the water re-enters the river. Secondary benefits include additional flood storage and recreational opportunities.

Additional surveys will be necessary to identify the elevations of the reconstructed berm and deepwater habitats prior to the development of a detailed restoration plan. Specifically, detailed hydrologic and hydraulic (H&H) engineering studies, topographic survey, wetland survey, and bathymetric survey are likely to be required.

Berm

Locate culvert

Flow direction

Dewey Road

Mill Road

Resize and locate culvert

## Existing Environment

**LEGEND**

- Created Open Water/ Emergent
- Created Open Water/Submerged Aquatic Vegetation
- Created Deep Water
- Created Scrub-shrub

N

100 50 0 100 Feet

30 15 0 30 Meters

Source: Natural Color Aerial Photography, 2000, USACE.

Figure 8. Site UR-1: Conceptual Restoration Design for the Upper Rockaway Flood Control and Ecosystem Restoration Study.

U.S. Army Corps of Engineers
New York District, 26 Federal Plaza
New York, NY 10278-0090

Date: 11/05/03

NEAFILE:e:/projects/Urock/aprs-figures/2003figures/concept_design/figx.mxd

# Appendix D

Visions Report Restoration Projects

ROCKAWAY RIVER WATERSHED
Priority Stream Segment Study

Figure 4
Visions Report
Recommended Projects

SEGMENT END (I-80)

ROXBURY TWP

GPU/MORRIS COUNTY

WASHINGTON FORGE POND

STEPHENS BROOK

ROCKAWAY RIVER

GREENPOND BROOK

HUGH FORCE/CANAL PARK

BURNT MEADOW BROOK

WHARTON BORO

DOVER TOWN

SEGMENT END
(BLACKWELL STREET)

JACKSON BROOK

ROCKAWAY RIVER

DOVER CENTER/MILL POND

LEGEND

- Visions Report Sites
- Rivers and Streams
- Municipalities

N
W E
S

0 0.25 Miles

Prepared by:
TRC Omni Environmental Corporation

## Threats and Problems

Some nearby properties pose a threat to the Berkshire Valley Wildlife Management Area and the river system due to their current or proposed land uses. The most serious and imminent threat to the river and the wildlife management area is the 213 acre property near its southeastern border. This property, owned by the Wilf Development Company of Short Hills, is proposed for a 1,050 unit housing project. Conservation groups fear the proposed development, The Highlands of Morris, will impact wetlands, water quality, and downstream flooding on the Rockaway River which lies just off the property to the west. The project has been investigated by the NJDEP for violations of the State Freshwater Wetlands Act.

## Recommendations for Enhancement and Protection

The Visions Plan recommends that any freshwater wetland violations, if discovered, be corrected by on-site wetland restoration. Transitional area buffers around the site's wetlands should be reevaluated. The maximum buffer width (150 ft) provided by the New Jersey Freshwater Wetlands Act is recommended by the Visions Plan to protect wetlands and water resources on-site and downstream. The site's location atop the Rockaway Valley Aquifer and adjacent to the river and the wetlands should warrant maximum protection allowed by the Act. Drinking water supplies for thousands of New Jersey residents may be affected by this development. The property's adjacency with the Berkshire Valley WMA further justifies the maximum protection of the water resources allowed by law.

The Visions Plans recommends a less intensive use of the Wilf property be explored. The protection of water quality, wildlife habitat, and natural valley storage should be given greater emphasis than the present Highlands of Morris proposal offers.

The Visions Plan recommends that New Jersey acquire and add to the Berkshire Valley Wildlife Management Area approximately 40 acres of wetlands and woodlands on the Wilf Property in Rockaway Township and over 100 acres in Jefferson Township that have not been disturbed and are contiguous with the wildlife management area. The Plan also recommends that additional fishing access points, with modest parking, trash receptacles, rustic paths, and well kept natural shoreline, be established at selected points in the full reach of the Upper Rockaway.

# 6. River Corridor Enhancement— GPU Energy & Morris County Properties

Jefferson Township, Rockaway Township & Wharton

## Area Description

A public utility, GPU Energy, and the County of Morris own key properties along the Rockaway River between Route 80 in Jefferson and Hugh Force-Canal Park in Wharton. Extensive public works yards are found here. The GPU Energy property, with nearly 900 feet of frontage on state-owned wetlands bordering the Rockaway River, is separated from the river by approximately 175 feet. The Morris County Road Department's operations facility lies within 100 feet of the river along one section of its nearly 1,400 foot river frontage.

## Threats and Problems

Runoff from the GPU Energy & Morris County properties carries silt and other contaminants into the river and its wetlands at a popular trout fishing area and less than one mile upstream of Washington Forge Pond.

## Recommendations for Enhancement and Protection

The Visions Plan recommends the creation of a 250-foot wide wooded buffer along the river on the GPU Energy and Morris County properties. In addition, both sites should be retrofitted with state-of-the-art stormwater detention/ water quality basins to detain and filter site runoff before discharge into the wetlands and river.

# 7. Parkland Addition & Improvement— Hugh Force / Canal Park

Wharton & Roxbury Township

## Site Description

This Morris County park (currently named Hugh Force Park) fronts the river for 2,000 feet. A 2,600 foot watered section of the Morris Canal traverses the property paralleling the river for much of its length. The canal is supplied with fresh water by a small feeder from the Rockaway, which keeps it from stagnating. The Rockaway flows through the narrow park from west to east. Trout fishing is excellent here.

The Morris County Park Commission's West Morris Greenway may pass through Hugh Force/Canal Park on its southerly route through Morris County from the Farny Highlands in Rockaway Township through Roxbury and Washington Townships to the southwestern border of the county. This greenway and trail will encourage more visitors to the park.

A major tributary to the Rockaway, Stephens Brook, enters the river just upstream of Hugh Force/Canal Park after draining hundreds of acres of land in Roxbury Township – including Roxbury Auto Wreckers, County Concrete, Berkshire Valley Wildlife Management Area, and residential properties.

The 123 acre Irondale Mountain property is being acquired by Wharton Borough for permanent open space protection. The Irondale Mountain property lies immediately south of Hugh Force/Canal Park and has been the subject of residential development proposals.

A 38 acre property to the west in Roxbury Township and adjoining the park is being offered for sale as of the date of this printing. This property, currently in residential use, (9 rental houses) is zoned for industrial or commercial use and is owned by the Estate of Grace Marino. Sixteen acres of the 38 acre parcel are wetlands that border the Rockaway River. The site's location on the river and adjacent to the park increase its attractiveness for public protection and use.

### Threats and Problems

The 38-acre Marino property, if developed incompatibly, will compromise the water quality of the river, increase flooding downstream, and weaken the historic integrity of Hugh Force/Canal Park.

Additional funding must be secured to assure the protection of the 123 acre Irondale Mountain property.

### Recommendations for Enhancement and Protection

The 9.4 acre Hugh Force/Canal Park offers outstanding opportunities for river oriented recreational use and historical interpretation of the Morris Canal.

The Visions Plan recommends that public funds be used to purchase the Irondale Mountain and Marino property for watershed protection, natural valley storage, and public access. The public purchase of these two properties will secure the future of this scenic, historic and environmentally sensitive reach of the river corridor while allowing the linkage of Hugh Force/Canal Park on the south with the Berkshire Valley Wildlife Management Area to the north, ensuring the free movement of wildlife and future trails. The Visions Plan recommends an increased level of capital improvements, maintenance funding, and historic interpretation for the park. In addition, Wharton and the Morris County Park Commission are invited to consider renaming Hugh Force Park "Hugh Force-Canal Park," in recognition of the significance of the Morris Canal artifacts that lie within it.

## 8. Parkland Addition and Improvement—Washington Forge Pond — Wharton

### Site Description

Washington Forge Pond, located on the Rockaway River, is 1,300 feet long and averages 300 feet wide. The pond is owned by the Borough of Wharton which also holds title to 35% of the land bordering the pond. The pond and river are designated state waters.

A 9.5 acre undeveloped property lies on the west bank of the Rockaway River immediately upstream of Washington Forge Pond. The tract consists of wetlands, floodplain, and steeply sloping upland areas. These lands, with frontage on West Dewey Avenue, are zoned for multi-family housing; a development proposal was submitted to the Town in early 1998 for this use. A contract for purchase has been made by Heartland, a development company.

A 5.9 acre privately owned property fronting the pond's east bank for 700 feet lies vacant and underutilized. The property owner, Wharton Enterprises, leases the property for storing trucks and equipment. The site offers outstanding potential for use as a public park or for a redevelopment that capitalizes on this unique location on Washington Forge Pond.

Improvements at the pond include the historic restoration of the former Ross Silk Mill building near the dam, purchased in early 1997 by Maphx Corporation for office and production space. Restoration, which includes the removal of metal siding, refurbishment of brick walls and old windows, and the replication of the mill's landmark cupola, will exemplify the quality contribution that can be made by the private sector in both economic revitalization and heritage reclamation along the Rockaway. In addition, engineering work has recently been completed on the masonry and earthen dams and a short reach of the river channel by

L.E. Carpenter Company, the Borough of Wharton, and Morris County. Plans for the earthen dam include the construction of a 300 foot long boardwalk to provide public access to the pond for fishing, boating, and strolling.

## Threats and Problems

Siltation from upstream lands has reduced the depth of the pond diminishing fisheries habitat and human use for swimming, boating and fishing. Approximately 65% of the pond's shoreline is in private ownership, which limits the public's access to the water. Although the Borough of Wharton owns land adjoining the pond, it is presently not managed as parkland.

## Recommendations for Enhancement and Protection

This scenic and historic area deserves greater public interest and attention to its natural, scenic, and historic heritage.

The Visions Plan recommends that public funds be used to purchase the 9.5 acre West Dewey Avenue property for watershed protection, natural valley storage, and riverside access. Approaches to the river and pond through the tract could provide much needed opportunities for swimming, boating, fishing, and hiking.

The Visions Plan recommends that the 5.9 acre Wharton Enterprises property and a contiguous residential property fronting North Main Street and the river be acquired by a public entity for the creation of a riverside park, bringing scenic and environmental improvement to the area and public access to the river.

If public acquisition proves unfeasible for either of the above properties and plans for residential development proceed, agreements should be secured between owners and the Town for a suitable relationship between new structures and the Rockaway and Pond. Townhouses - conserving more open land than conventional housing - or other forms of cluster development would be potentially beneficial to the site overall as well as to development profitability. Ample plantings and other landscape features would further mitigate the impact of new development.

The Visions Plan recommends that public access along the earthen dam be secured by the Borough of Wharton from the Maphx Company. Construction of a pedestrian boardwalk along this river edge will ensure good access for fishing, boating, and strolling.

The Visions Plan recommends that a local initiative drawing upon federal, state, and local governments and private resources be undertaken to create a plan for dredging silt and managing stream flow into Washington Forge Pond in order to restore swimming, non-motorized boating, fishing, and other recreational use. This plan also should address threats to the historic character of the pond and the adjoining landscape by assuring that future changes in the area do not diminish its setting.

The Visions Plan recommends that future repairs and modifications to the dams and river channel be carefully evaluated to ensure that construction and earthmoving do not diminish this important Morris County historic and scenic resource.

# 9. River Woodland Reserve — Burnt Meadow Brook Area

Wharton & Dover

## Area Description

From Washington Forge Pond downstream to Route 46 in Dover lie 1.8 miles of river corridor that were classified as Trout Maintenance Waters by the New Jersey Department of Environmental Protection in 1994. This classification reflects improved conditions of the river over the past 30 years. Brook trout, New Jersey's lone species of native trout, finds this reach of river to have excellent conditions for survival. A steep river gradient allows the river to tumble down boulder strewn rapids providing excellent oxygen levels in the water. Riverside woodlands shade and provide cover for the trout keeping the water cool and fish protected from flying predators. In fact, the state record brook trout, 7 pounds, 3 ounces, was caught here in 1995 by Dover resident Andrew Dujack. The fish, believed to have been stocked in the river during previous years, obviously found the river habitat to its liking — and grew to state record size.

Burnt Meadow Brook, a major tributary of the Rockaway, joins the river through this reach. Burnt Meadow Brook, called the East Branch of the Rockaway River on a 1930's watershed map, drains thousands of acres of uplands, wetlands, lakes, and the extensive Picatinny Arsenal complex.

In Wharton, the lands on both sides of the river are large tracts in private ownership with the exception of 25 acres owned by the Borough. Major properties include the L.E. Carpenter Co., Wharton Enterprises, Longo Industries, Sammis Rockaway Associates, and the Wharton Warehouse Business Center.

GPU Energy owns a small but strategically located 1.3 acre property of forested wetlands bordering the Rockaway River for 800 feet.

Large portions of riverfront land on both sides of the river in Wharton have been used for heavy manufacturing purposes. The Thatcher Glass Company was the largest of the industrial giants once located along the river here. The nearly one-half mile long former Thatcher Glass building has been modified and leased to numerous businesses for warehousing and light manufacturing.

The Lockjoint Pipe Company was another major industry once located near the river in Wharton. Broken and discarded concrete pipe from the former Lockjoint Pipe Company was used as fill throughout this once extensive wetland area. This 16-acre site, now owned by Longo Industries, will house this growing company's operations. Other lands nearer the river are nondegraded high quality wetlands.

Downstream in Dover, GPU Energy operates an equipment yard on the banks of the river that encroaches to within 20 feet of the water's edge.

Property owned by the Town of Dover, including Waterworks Park, borders the river on both sides from the GPU Energy equipment yard site to Route 46.

## Threats and Problems

The 14.5 acre L.E. Carpenter site is severely contaminated and is being remediated under the direction of the U.S. Environmental Protection Agency's Superfund Program. The Rockaway River traverses the L.E. Carpenter property for nearly 800 feet. Toxic compounds from the L.E. Carpenter site have been found in sediment in the Rockaway River.

The L.E. Carpenter Company operated a vinyl wall covering manufacturing facility on the property. During its operations, solid and liquid wastes were disposed of in unlined lagoons, approximately 20 feet from the Rockaway River. While manufacturing is no longer conducted, a warehouse and office facility are still active. Portions of the site are located in the river floodplain with the entire site atop the Rockaway Valley Aquifer – which provides domestic water for Wharton, Dover and several downstream communities. Two of Wharton's public water supply wells are only 2,600 feet from this site.

Burnt Meadow Brook enters the river in this area, draining hundreds of acres of impervious road, parking lot, and building surfaces at Picatinny Arsenal, Rockaway Townsquare Mall, and suburban development. Runoff from these sites contributes to nonpoint source pollution, streambank erosion, and flooding downstream. In addition, the USEPA, working with the Department of the Army, has identified 142 areas of concern totaling hundreds of acres where toxic contaminants are believed to exist on the arsenal property. The potential for groundwater and surface water contamination of the Rockaway Valley Aquifer and of surface waters (Burnt Meadow Brook and the Rockaway River) are high.

The GPU Energy equipment yard in Dover lies within 20 feet of the river and is a source of sediment and other nonpoint pollutants that run off the site directly into the river.

Jackson Brook, a major tributary of the Rockaway, enters the river just upstream of the Route 46 bridge near Hurd Park. Draining large developments, many of which lack stormwater detention basins, Jackson and its tributary brooks – Wallace and Granny – have experienced severe streambank erosion, flooding, and other degradation, reducing or destroying these trout waters.

## Recommendations for Enhancement and Protection

The Visions Plan recommends the public acquisition of wetlands and adjoining floodplain lands along this reach of river in Wharton and Dover to form the Burnt Meadow Brook-River Woodland Reserve. Once protected, this woodland reserve of nearly 80 acres will forever serve as prime wildlife habitat, watershed protection, natural valley storage, and a blue ribbon trout fishing area. The possibility exists here for the enhancement of degraded wetlands through the New Jersey Wetlands Mitigation Program.

The Visions Plan calls for the aggressive cleanup of the L.E. Carpenter Superfund site to reduce public safety concerns from contaminated groundwater and soil.

The Visions Plan recommends that the edge of the GPU Energy equipment yard in Dover be pulled back to create a 50 foot wide wooded buffer along the river. A stormwater retention/water quality basin should be built on the GPU property to reduce flooding and water quality degradation downstream.

The Visions Plan strongly recommends the retrofitting of existing large residential and commercial developments with on-site, state-of-the-art stormwater detention and water quality basins. The Plan considers it important that this recommendation be adopted by the stormwater management study presently being conducted on the Jackson Brook subwatershed, as well as in future studies on the Burnt Meadow Brook subwatershed and other units of the Rockaway River system.

The Visions Plan recommends that the Town of Dover expand Waterworks Park to encompass adjoining Town-owned land along the river, including remnants of the Morris Canal and Towpath.

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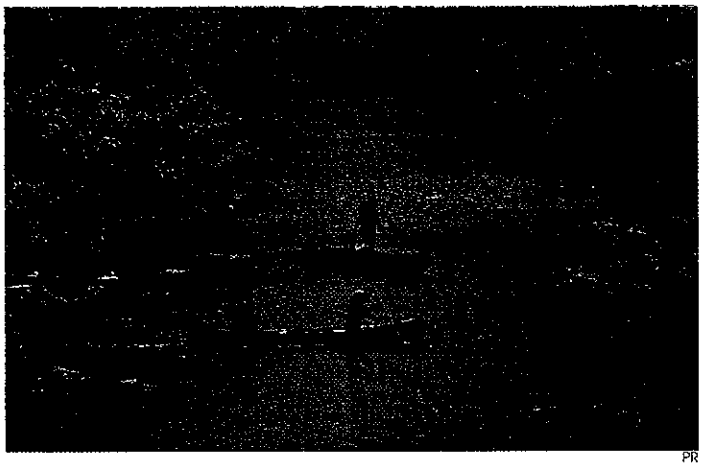
Route 46 marks the end of the proposed Upper Rockaway River Conservation Area.



PR

River cleanup volunteers removing tires, litter and debris

RBM

Riverside industrial land use near Highway 46

"Speak to the earth
and it shall teach thee."
–
Job 12:8

## Reach Two

# The Middle Rockaway River

Dover, Randolph Township, Rockaway Township, Rockaway Borough, Denville Township, Boonton Township & Boonton

### Reach Description

From Route 46 in Dover downstream approximately 12 miles to the Boonton Gorge, a wide variety of riverside conditions exist from undisturbed natural areas to highly impacted urban conditions.

In this reach, the middle Rockaway runs atop the Rockaway Valley Aquifer, the sole source of drinking water for several towns in the valley. The river corridor is traversed by the Morris Canal from Wharton to Boonton. The river, local supplies of iron ore, the canal, and later the railroad brought tremendous industrial and commercial growth to the towns of Wharton, Dover, Rockaway, and Boonton. This reach of river became a workhouse, providing power, supplying furnace cooling water, and serving as a sewer for many of the industries that located here. In addition, the river supplied millions of gallons of water daily to feed the Morris Canal's lock operations.

Today, four mill dams can be found on the middle Rockaway River, steadfast reminders of its important industrial heritage. Only a handful of the old industries remain, and though the river is much cleaner, old factory buildings, blighted landscapes, and contaminated soil and groundwater persist. Four USEPA Superfund National Priority Sites occupy ground along the middle Rockaway River and atop the Rockaway Valley Aquifer, threatening the drinking water supplies of several communities. Three additional Superfund sites lie within the watershed area in Rockaway Township and the Town of Boonton.

Generally the middle Rockaway is bordered by private land holdings, although some public title exists. Large landowners include the Howmet Corporation, McWilliams Forge Company, Allied Concrete, Weldon Asphalt, Denville Township, Jersey City, Northwest Covenant Medical Center, Rockaway River Country Club, Peace Pipe Country Club, Morris County Park Commission, Boonton Township, and the Town of Boonton. Remaining riverfront lands are comprised of a few still active farms and many smaller private properties in residential or commercial uses.

Pools are formed by the four dams, providing water depth for canoeing and warm water fishing. The longest pool exists behind Powerville Dam – in Boonton Township – which backs water for nearly three miles into Denville Township.

Five major tributaries to the Rockaway enter the river through this 12 mile reach, draining thousands of acres of land ranging from healthy upland and wetland forests to scattered housing to high density residential, commercial, and industrial uses. The five tributaries – Jackson Brook, Mill Brook, Den Brook, Beaver Brook, and Stony Brook – are classified as trout production or trout maintenance waters on part of their reaches. Each of the streams is experiencing degradation caused by development in its subwatershed. Flooding, streambank erosion, and poor water quality on the Rockaway itself is caused in large part by development along its tributaries.

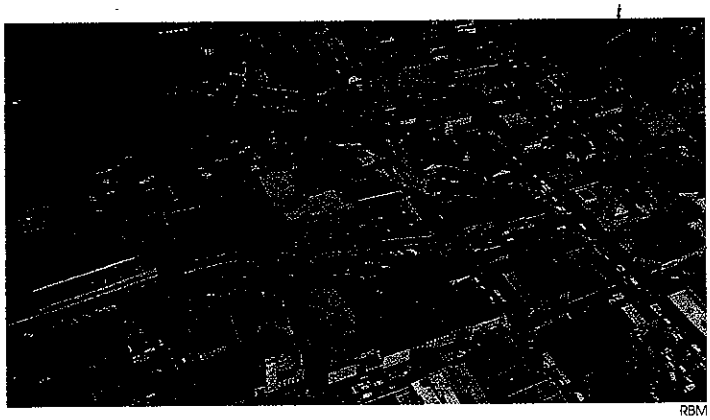
### Recommendations for Enhancement and Protection

The Visions Plan recognizes the complexity of issues — including resource protection and management, land ownership, socioeconomics, and politics that encompass the river as it courses through seven municipalities and past hundreds of property owners in the middle Rockaway River corridor. Here, opportunities for recapturing a healthy river, riverside lands, and aquifer while limiting flood damages will be accomplished by willing and enlightened property owners sharing a vision for a restored river and healthy environment.

***Recommendations by location within Reach Two:***

## 10. Dover Center/Mill Pond and Riverfront Parkland Revitalization

Dover



RBM

Central Dover in 1995. The Rockaway flows from left around surface parking which lies above the filled Mill Pond.

### Area/Site Description

On the banks of the river in Dover, between Route 46 and Warren Street, lie three contiguous commercial and office properties in private ownership. The three properties total over 11 acres and include an underused 6 acre paved parking lot that borders the river for nearly one-quarter mile. The properties encompass the original site of the Ulster Iron Works and its mill pond and dam.

With the opening of the Morris Canal in 1831 and the railroad in 1848, Dover was on its way to becoming a center for commerce.

The Morris Canal formed the southern border of the site for nearly one-quarter mile. Basset Highway was constructed on top of the former canal half a century ago. Much of the present day parking area on the site was once the mill pond, used to store and supply water to the iron works.

In 1956, New York developer Milton Ehrlich began construction of the main building that remains on the site today. Ehrlich planned to create an inner city shopping center. A large grocery store and an outdoor theater were two of the original tenants. Due to economic decline and the opening of the Rockaway Townsquare Mall, the project lost most of its major tenants. The movie screen and parking garage were demolished in 1983, leaving the large underused riverside parking area.

### Recommendations for Enhancement and Protection

In addition to the water quality and aesthetic benefits that would result from appropriate riverside redevelopment, the site is seen by many as key to the economic and quality of life revitalization that would allow this location to become a part of Dover's vital and attractive downtown once again.

The Visions Plan recommends redevelopment of the property through a public/private partnership to create a riverfront park and replica of a short canal section that would celebrate Dover's great canal and ironworks past, along with shops, offices, music, and entertainment venues, and possibly a hotel. The proposed redevelopment and riverfront park would enhance the river corridor, create jobs, provide townspeople with an enhanced civic and cultural core, and increase tax revenues - all in all improving the region's quality of life. (See graphic on page 40.)

## 11. River Greenway

Dover

### Area Description

This 1.2 mile reach of river extends from the first Route 46 bridge over the river downstream to Dover's border with Rockaway Township, near the Lakeland Bus Company ter-

AAC

Volunteers clearing invasive plants for the proposed Dover River Greenway

minal. Dover was named a Regional Center under the State Development and Redevelopment Plan. It is also one of three towns in the state participating in the pilot Strategic Neighborhood Assistance Program (SNAP) to revive its downtown and surrounding areas. It is a prime target of

various grant programs. In addition, a task force committee is studying Dover's potential as a transportation hub. The transportation hub concept envisions mass transit drawing drivers from area roads into Dover while boosting town businesses.

The river corridor in Dover between Route 46 and Sussex Street is characterized by concrete and stone walls rising vertically 6 to 10 feet from the water level to parking lots and the backyards of small businesses. Downstream of Sussex Street, masonry walls remain intermittently on the south side of the river. Small businesses, churches, and residences line the river here, with buildings, vehicles, and equipment storage often abutting the water. On the north side of the river from Sussex Street downstream to Salem Street, a freight railway called the Dover Rockaway Railway, owned by Morris County, parallels the river for one-half mile. The railway encroaches to within 10 feet of the river's edge. Further downstream, between Mercer and Salem streets, the railway is separated from the river by a 50 foot wide buffer of wooded floodplain owned by the Town of Dover. North of the railway throughout Dover lie businesses, industries, parking lots, residences, and a school. Notwithstanding these urban structures, the river is dressed with numerous riffles and pools which provide trout habitat, altogether presenting a popular fishing reach.

The abandonment of the Dover Rockaway Railway through town has been the subject of much local discussion and appears to be feasible now due to Route 46 improvement requirements.

## Threats and Problems

Flooding, a recurring problem in downtown Dover, is aggravated by the narrow and steeply walled river channel and presence of numerous buildings near the river. Overbank flow is most severe near Salem Street where the river turns sharply twice and passes beneath the East Blackwell Street bridge. Extensive developments in Rockaway Township, Randolph, and Mine Hill, many lacking adequate stormwater detention basins, drain into the Rockaway River in Dover, aggravating the severity of flooding there.

Floodplains and wetlands in Dover were built upon long ago. When the river rises and overtops the narrow channel walls, floodwaters quickly inundate yards, streets, parking lots, and buildings. The Dover Rockaway Railway, hugging the north bank of the river between Sussex and Mercer Streets, is itself a major constriction of the channel. It also locks up 2,000 linear feet of valuable and potentially productive, attractive, and recreationally accessible riverfront property.

Dover Municipal Well #4, closed in 1980 due to a high concentration of toxic halogenated organic solvents, is located less than 500 feet from the river on Rutan Avenue. Well #4 and Dover's other municipal wells draw from the Rockaway Valley Aquifer that lies beneath the river throughout much of the middle Rockaway River corridor. The USEPA Superfund Program placed Well #4 on its National Priorities List in 1983. The source of the toxic contaminants has not been identified.

## Recommendations for Enhancement and Protection

The Visions Plan recommends the creation of a greenway park and trail along the river through Dover. A river greenway would require the abandonment or realignment of the Dover Rockaway Railway between Sussex Street and Mercer Street. The proposed abandonment would allow removal of fill, pavement and ballast, recovering some fraction of the channel's flood storage capacity. It would also make possible the planting of native trees and shrubs and construction of a hard surfaced greenway trail. Railway abandonment would thus allow the transformation of nearly one-half mile of abused downtown Dover riverfront into a strongly attractive river greenway.

The proposed railway abandonment and greenway would cause minimal dislocation. Only one residence would need to be publicly acquired and relocated. The new greenway would in turn stimulate investment and business in greenway fronting properties. The computed dollar benefits of reduced flood damages, as the result of a widened river channel, should also be considered in any overall benefit/cost evaluation. The Intermodal Surface Transportation Efficiency Act (ISTEA), the nation's primary transportation funding source, could be tapped to finance railway abandonment and greenway construction. Grants through Regional Center status and participation in the SNAP program could also help make the significant improvements discussed along the river in Dover easily feasible.

The greenway would raise adjoining property values, create higher tax revenues and improve the quality of life of those living in Dover. Businesses and residences could begin to orient toward and take advantage of the river and greenway. Public improvements would encourage improvements to many of the privately owned properties along the greenway. Old railroad buildings and other underutilized business properties along the greenway could be converted to shops and restaurants. Residents and others could use the greenway trail to get to and from home, shopping, and work. The NJ Transit Rail and Lakeland Bus stations would be easily accessible from the greenway trail encouraging public transportation while taking cars off the streets.

The Vision Plan foresees the river greenway as an integral element in the transportation hub concept being proposed for Dover. The Regional Center designation has afforded Dover the opportunity to pursue significant quality of life, economic, and transportation improvements that the river greenway would help provide.

The Visions Plan recommends the river greenway and trail begin at the Route 46 bridge over the river and extend downstream (east) through the proposed Dover Center/Mill Pond and Riverfront Parkland Revitalization, past Town Hall, and through the heart of the downtown business district to the Lakeland Bus station. Two public housing projects, the library, post office, railroad station, a shopping center, churches, and numerous small shops and restaurants lie within two blocks of the proposed greenway.

The Visions Plan strongly recommends that major existing developments lacking stormwater detention basins be required to retrofit their sites to adequately protect downstream property owners and the public at large. This recommendation should be carried in the Jackson Brook subwatershed stormwater management study presently in progress.

The Visions Plan calls for the aggressive environmental cleanup of the Dover Well #4 Superfund site to lower the public health risks to all those using the Rockaway Valley Aquifer for water supply.

## 12. Brownfield Renewal and Greening—former Ruiz Property

Rockaway Township

### Site Description

Hugging the banks of the river in Rockaway Township for 0.4 mile between East Blackwell Street and the Rockaway River lies a 2.5 acre property zoned for industrial and commercial use. The tract has recently been purchased from the Ruiz estate for use as an auto repair facility. The Lakeland Bus Company lies across East Blackwell Street from the site and leases a parking lot on the former Ruiz property for parking use by their patrons. Downstream of the parking lot, the site narrows to a 20 foot width. On the whole, the former Ruiz property averages 90-110 feet wide. Two buildings stand on the property; both have been adapted for use by the new owners and their tenants.

### Threats and Problems

Due to past and present uses, this narrow property is believed to be contaminated with hazardous substances and in need of environmental cleanup. With its history and extensive frontage along the river and atop the Rockaway Valley Aquifer, the site's potential for contaminating surface and groundwater supplies is high. The new property owners are using the site intensively for the storage and repair of heavy equipment, trucks and automobiles. Chronic dumping of household and construction debris along the river side of the parking lot is an additional serious problem.

# Appendix E

Contact Information for Potential Funding Sources

## Restoration and Best Management Practice Projects
## Potential Funding Sources

| | *Name* | *Program* | *Deadline* | *Amount* | *Contact* | *Website* |
|---|---|---|---|---|---|---|
| *1* | Watershed Protection Development Grants | EPA-WPDG | February 14 | < $250,000 | Kathleen Drake (212) 637-3817 | http://www.epa.gov/region02/water/wetlands/grants.htm |
| *2* | Wetlands Reserve Program | Natural Resource Conservation Service | Continuous | NA | Wetland Reserve Program Contact (202) 720-1067 | http://www.nrcs.usda.gov/programs/wrp/ |
| *3* | Wildlife Conservation & Appreciation Program | Department of the Interior | September 1 | < 40% of project total costs | Review Federal Funding Options at website | http://cfpub.epa.gov/fedfund/ |
| *4* | Wildlife Links | National Fish & Wildlife Foundation & the U.S. Golf Association | September 15 | < $30,000/ yr, though multi-year funding is available | (202) 857-0166 | http://www.nfwf.org/programs.cfm |
| *5* | Watershed Protection & Flood Prevention Program | CFDA | none | NA | Review Federal Funding Options at website | http://12.46.245.173/cfda/cfda.html |
| *6* | Wildlife Habitat & Incentive Program (WHIP) | CFDA/NRCS | none | direct payments | Local NRCS Office or Review Federal Funding Options at website | http://12.46.245.173/cfda/cfda.html |
| *7* | Five Star Restoration Challenge Grants | NFWF/EPA | March 10 | < $25,000 | Matthew Hurly, NFWF (202) 857-0166 | http://nfwf.org/programs/5star-rfp.cfm |
| *8* | Dodge Foundation | private | June 1 | NA | Phone (973) 540-8442 | http://www.grdodge.org/environment_main.htm |

| | *Name* | *Program* | *Deadline* | *Amount* | *Contact* | *Website* |
|---|---|---|---|---|---|---|
| *9* | Private Stewardship Grants | U.S. Fish & Wildlife Service | Continuous | NA | (703) 358-2061 | http://www.fws.gov/endangered/grants/private_stewardship/index.html |
| *10* | Schumann Foundation | private | Jan. 15, Apr. 15, Jul. 15, or Oct. 15 | approximate maximum of $50,000 | 973-509-9883 | http://fdncenter.org/grantmaker/schumann/guide.html |
| *11* | NJDEP 319(h) NonPoint Source Pollution Grants | NJDEP/EPA | April 30 intent June 30 final proposal | NA | NJ Department of Environmental Protection, Watershed Management Program | http://www.state.nj.us/dep/watershedmgt/nps_program.htm |

** Please be advised that deadlines may change on an annual basis. Initial contacts should be made in advance to decipher if grant goals meet the criteria of each organization.

# Prioritization of Proposed Action Items

The Rockaway River Watershed Cabinet would like to provide the NJDEP Division of Watershed Management with supplemental information regarding the Priority Stream Segment Study recently completed and submitted to the Department for review and approval (entitled "Pathogenic Indicator and Pollutant Track Down Evaluations for the Rockaway River Watershed Priority Stream Segment Assessment and Stormwater Impact Study" dated January 23, 2006). As part of the final report, the Cabinet offers the following prioritization of proposed action items as identified in the plan, discussed in a subsequent presentation to NJDEP by TRC Omni on February 9, 2006, and reviewed by the Town of Dover.

## Proposed Priority Action Items

1. Flood plain restoration and treatment wetlands along Green Pond Brook: This project identified as JB-8 and previously proposed by the ACOE in the "Upper Rockaway River Watershed Flood Control and Ecosystem Restoration Study" is a key to filtering stormwater from a large shopping center and providing flood storage and water quality enhancements from one of the primary tributaries to the Rockaway River in this priority river segment.
2. Stormwater BMPs and bacteria source evaluation in downtown Dover: Key in addressing the water quality issue in this priority stream segment will be identification of the source of bacteria entering the river during storm events in the downtown area of Dover. Key in any evaluation and proposed infrastructure modification or BMPs will be coordination with the Town of Dover and their recently adopted Master Plan and Redevelopment Plans. The concept restoration design for the parking lot behind Bassett Hwy/Krausers (JB-5, Drainage 652 Dover) is contrary to the intentions of the Town of Dover's Master Plan Update for that area. The Town of Dover is finalizing a Redevelopment Plan that will call for a major redevelopment of this area. There will be a "River Park" included along the Rockaway in this area, but the improvement will be done by the redeveloper as part of a more comprehensive plan for the area. That plan is going to be reviewed by the Town of Dover Redevelopment Committee shortly and will proceed to eventual formal adoption in the very near future. The Town is working with the Highlands Council through an MP3 Grant to incorporate stream bank restoration and green areas along this stretch of the Rockaway River as part of the Redevelopment Plan. The Town hopes to embrace the River as a resource and key feature in its proposed Redevelopment Plan. The goal is to dramatically improve the River Corridor over what exists today, and make every effort to protect this portion of the River. The Redevelopment Plan will result in improvements to the water quality of stormwater runoff, create public river access opportunities, promote economic development in this area of Dover and be part of a comprehensive plan for the community.
3. Bowlby Pond stormwater management BMPs: This project identified at JB-4 and previously proposed by the ACOE proposes to implement sediment controls to reduce NPS loads in Bowlby Pond. The focus of these controls would be the existing school and athletic fields as well as any existing residential areas. As noted by the engineer in Dover, the report incorrectly points out that "The pond's (Bowlby Pond) drainage has

been disturbed by construction of the Rockaway Town Square Mall." The Rockaway Town Square Mall's drainage has been diverted and now travels north of Mount Pleasant Avenue and discharges into the Rockaway River via Green Pond Brook. It is completely separate from the Bowlby Pond Drainage. Also noted by the Town of Dover is that much of the Bowlby Pond watershed is currently under redevelopment as part of the closure of the North Sussex Street Landfill. The project includes the construction of a FedEx facility, hotel and office building and lies within a designated Redevelopment Area. The North Sussex Street Landfill will be properly capped and closed and site amenities include the construction of a major extended detention wetland basin to treat water prior to outletting into Bowlby Pond. The existing outlet of Bowlby Pond will be reconstructed to improve outlet flow, water quantity and quality. This project is currently under construction and has been through a five-year permit approval process with NJDEP for Landfill Closure, Landfill Disturbance, Wetlands and Stream Encroachment.

4. McKeel Brook Stormwater BMPs: McKeel Brook has been piped through the Town of Dover, but upstream reaches in Rockaway Township flow overland and drain large commercial and industrial complexes as well as residential neighborhoods. Several large detention basins exist that can be retrofitted for water quality controls along with velocity reductions and sediment load reductions, as well as diverting, capturing and treating first flush runoff to reduce bacteria.
5. Floodplain restoration along the Rockaway River: Two projects identified in the plan as JB-3 and UR-1 present key opportunities to improve floodplain dynamics, wetland hydrology and sediment load reductions to the Rockaway River that will have an immediate effect on water quality in the river.
6. Assess and implement restoration and stormwater management strategies identified in the Jackson Brook Regional Stormwater Management Plan upstream of Hurd Park: While the final report for the Priority Stream Segment Study indicates that Hurd Park contributes to the bacteria impairment in the Rockaway, upstream sampling also found significant bacteria concentrations in the waters upstream of Hurd Park. Further evaluation of proposed restoration projects and source identification within this tributary watershed is needed.

**Prioritization Process**

The evaluation process was completed using the project partners' best professional judgment as to sites that provide for a successful implementation project through:

- Accessibility (for equipment and laborers)
- Property ownership
- Realistic opportunity to implement a BMP
- Realistic opportunity for a BMP to correct a problem
- Example of watershed-wide issue vs. unique condition

In addition, the sites were also evaluated based on the following environmental concerns:

- Relationship to drainage area size impacted by BMP

- Relationship to key NPS source areas identified in the plan
- Ability for BMP to address known NPS issue
- Expected water quality benefits

The final step in the process is to prioritize sites based on real world application. This selection considers the following:

- Expected benefits
- Costs
- Final determination of property ownership (public versus private)
- Local support

In this final, on-going step, if the project partners determine that a restoration project cannot be successfully implemented at a specific site but needs be done in the immediate area, adjacent sites may be considered along the stream if appropriate conditions exist, property ownership can be determined and local partnerships can be established.

The objective of the Priority Stream Segment Project is to provide local communities with information regarding priority sites and locations to protect and improve water quality in the Rockaway River and address nonpoint source pollutant sources in the associated watershed areas. The prioritization process uses the available existing data and information collected throughout the project combined with the knowledge of local partners. The outcome of this process is to identify project sites where efforts can best be focused to address water resource protection goals. While several other projects have been discussed in the study, at this time, these six targeted action items present the greatest opportunity to immediately address the known water quality impairments in the Rockaway River. Again, the RRWC presents these priority action items for NJDEP review and consideration along with approval of the final report.

# Rockaway River Priority Stream Segment Study

**a project of the**
**Rockaway River Watershed Cabinet**

Presented by: Jeremiah Bergstrom
Michael Wright
June Hercek

February 9, 2006

TRC Omni

## Purpose

- Identify Source of Water Quality Impacts to the Stream
- Specifically Evaluate:
  - Nonpoint Source Pollution Sources
  - Stormwater Runoff Concerns
  - Potential Sources of Fecal Coliform
- Identify and Specify Future Projects to Achieve Water Quality Improvements (Goals).

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## Work Products

I. *Rockaway River Priority Stream Segment Study*, August 2004

II. *Quality Assurance Sampling Plan For Rockaway River Watershed Priority Stream Segment Assessment & Stormwater Impact Study*, May 2005

III. *Pathogenic Indicator and Pollutant Track Down Evaluations for The Rockaway River Watershed Priority Stream Segment Assessment & Stormwater Impact Study*, January 2006

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## I. Rockaway River Priority Stream Segment Study

- Review of Previous Studies
- Analysis of Existing Water Quality Data
- Conduct Visual Characterization
- Identify Gaps in Data
- Recommend additional sampling and monitoring to identify and clarify impairments

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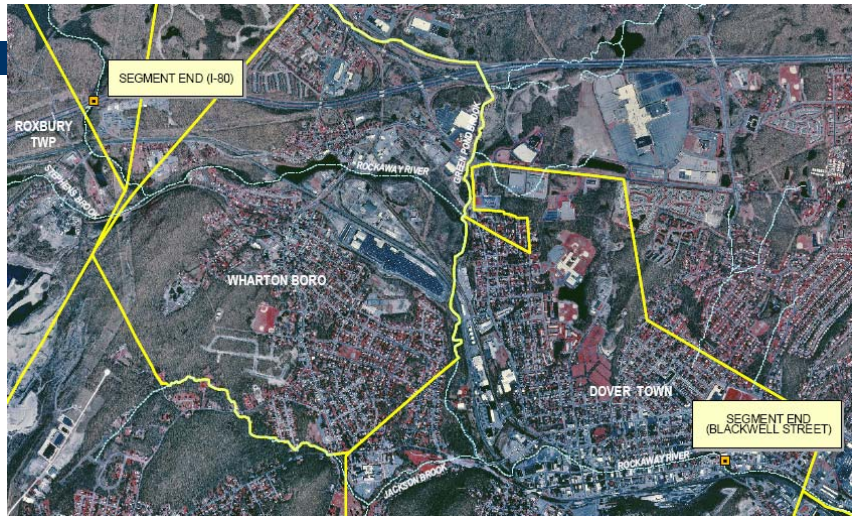
## Study Area

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## Review of Previous Studies

a. Watershed Management Area 6- Characterization and Assessment Report
b. TMDL for Fecal Coliform to Address 32 Streams in the Northeast Water Region
c. Upper Rockaway Watershed Flood Control and Ecosystem Restoration Study (US Army Corps of Engineers)
d. Jackson Brook Watershed Stormwater Management Plan
e. The Rockaway River and its Treasured Resources: Visions and Strategies for their Recovery
f. Rockaway River Sustainable Watershed Management Plan
g. Rockaway River Watershed Stream Corridor Analysis

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# Data Analysis

- Water Quality Data
  - Limited for this segment of Rockaway River
  - No current data within Federal EPA databases.
  - Data limited to sampling completed by NJDEP for *2002 Integrated List of Waterbodies.*

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## Existing Data Prior to PSS Study
## Rockaway River at Blackwell Street (#01379853)
## Conventionals Summary Table

| PARAMETER | NUMBER OF SAMPLES | MAXIMUM VALUE | AVERAGE | EXCEEDENCE % | ASSESSMENT |
|---|---|---|---|---|---|
| Total Phosphorus | 4 | 0.03 | 0.021 | 0.0% | Insufficient Data |
| pH | 4 | 7.8 | 7.7 (min) | 0.0% | Insufficient Data-Possibly Full Attainment |
| Temperature | 4 | 22 | 18.75 | 0.0% | Insufficient Data-Possibly Full Attainment |
| Dissolved Oxygen | 4 | 6.5 (min) | 9.1 | 0.0% | Insufficient Data-Possibly Full Attainment |
| Total Dissolved Solids | 4 | 223 | 158.5 | 0.0% | Insufficient Data-Possibly Full Attainment |
| Total Suspended Solids | 4 | 3 | 2.75 | 0.0% | Insufficient Data-Possibly Full Attainment |
| Nitrate | 4 | 0.35 | 0.32 | 0.0% | Insufficient Data-Possibly Full Attainment |
| Unionized Ammonia | 4 | 0.61 | 0.40 | 0.0% | Insufficient Data-Possibly Full Attainment |
| Fecal Coliform | 4 | 9200 | 483.7 (geometric mean) | 50.0% | Nonattainment |

Source: NJDEP 1998

# Data Analysis Continued

- Stream Visual Assessment Protocol
  - Methodology based on USDA “Stream Visual Assessment Protocol” (SVAP)
  - Ranks conditions for several elements using a scoring system from 1(worst) to 10 (best).
  - Completed by the Rockaway River Watershed Cabinet volunteers.

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## Stream Visual Assessment Protocol Survey Results

| SITE # | DATE | STREAM NAME | ACTIVE CHANNEL WIDTH | DOMINANT SUBSTRATE | CHANNEL CONDITION | HYDROLOGIC CONDITION | RIPARIAN LEFT | RIPARIAN RIGHT | BANK STABILITY LEFT | BANK STABILITY RIGHT | WATER APPEARANCE | NUTRIENT ENRICHMENT | BARRIERS | INSTREAM FISH COVER | POOLS | INVERTEBRATES | CANOPY COVER | MANURE | SALINITY | RIFFLE EMBEDDEDNESS | MACROINVERTEBRATES | TOTAL OVERALL SCORE | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 18-Jun-04 | Jackson Brook | 60 ft | silt | 5 | 8 | 2 | 3 | 7 | 7 | 7 | 5 | 5 | 4 | 3 | 5 | 1 | | | | | 4.8 | |
| 2 | | Jackson Brook | | cobble | 4 | 7 | 6 | 8 | 6 | 4 | 9 | 8 | 10 | 4 | 3 | 4 | 7 | | | 5 | | 6.1 | trash - tires; bottles; cans; debris in stream; beaver - cutting down trees |
| 3 | 18-Jun-04 | Rockaway River | 25 ft | cobble | 6 | 6 | 9 | 3 | 9 | 3 | 7 | 8 | 9 | 8 | 7 | | 4 | | | 8 | | 6.7 | open area along right side of streambank; some trash; looks like a hangout area/fishing |
| 4 | 18-Jun-04 | Rockaway River | 40 ft | cobble | 9 | 7 | 9 | 8 | 8 | 8 | 9 | 8 | 9 | 8 | 4 | 7 | 3 | | | 9 | | 7.6 | some garbage but most clean/nice wide buffer on both sides of banks |
| 5 | 18-Jun-04 | Rockaway River | 35 ft | cobble | 8 | 7 | 3 | 3 | 5 | 5 | 8 | 7 | 9 | 6 | 7 | 5 | 3 | | | 8 | | 6.0 | some trash - bottles |
| 6 | 18-Jun-04 | Rockaway River | 30 ft | cobble | 3 | 7 | 4 | 1 | 5 | 2 | 8 | 7 | 9 | 5 | 7 | 5 | 2 | | | 6 | | 5.1 | lots of goose droppings; right behind Wharton water pump house; across from railroad/industrial area |
| 7 | 18-Jun-04 | Rockaway River | 40 ft | cobble | 9 | 7 | 7 | 9 | 6 | 8 | 8 | 8 | 9 | 7 | 8 | 8 | 3 | | | 8 | | 7.5 | |
| 8 | 18-Jun-04 | Rockaway River | 40 ft | cobble | 8 | 7 | 9 | 9 | 8 | 8 | 8 | 7 | 5 | 8 | 8 | 6 | 8 | | | 8 | | 7.6 | dam up street from site (approx 100 m) |
| 9 | 18-Jun-04 | Rockaway River | 40 ft | gravel | 2 | 7 | 1 | 2 | 2 | 3 | 7 | 7 | 8 | 4 | 3 | 3 | 3 | | | 3 | | 3.9 | |
| 10 | 21-Jun-04 | Rockaway River | 20 - 60 ft | boulder | 8 | 7 | 7 | 7 | 9 | 9 | 9 | 7 | 9 | 8 | 7 | 8 | 3 | | | 8 | | 7.6 | some trash, problem from flooding |
| 11 | 21-Jun-04 | Rockaway River | 40 ft | boulder | 7 | 7 | 5 | 6 | 7 | 7 | 8 | 7 | 8 | 7 | 7 | 8 | 5 | | | 8 | | 6.9 | near Wharton DPW - close distance to river - could have sediment (sand/rock/etc.) runoff to river |
| 12 | 21-Jun-04 | Rockaway River | 45 ft | silt | 5 | 8 | 9 | 5 | 8 | 8 | 5 | 4 | 9 | 6 | 8 | 6 | 5 | | | | | 6.6 | this location is a large drainage area - location - county garage - salt area - near drainagearea/runoff/river |
| 13 | 21-Jun-04 | Rockaway River | 45 ft | boulder | 8 | 7 | 8 | 8 | 7 | 8 | 7 | 7 | 9 | 8 | 7 | 7 | 1 | | | 8 | | 7.1 | pond/wetland next to river |
| 14 | 21-Jun-04 | Rockaway River | 80 ft | cobble | 7 | 7 | 8 | 8 | 7 | 7 | 8 | 7 | 5 | 8 | 5 | 9 | 7 | | | 6 | | 7.1 | small pipe off bridge - there is runoff from bridge/Route 80 during storms/etc. |
| 15 | 21-Jun-04 | Green Brook | 25 ft | gravel, sand | 7 | 8 | 7 | 8 | 8 | 8 | 9 | 7 | 9 | 5 | 3 | 6 | 2 | | | | | 6.7 | |
| 16 | 21-Jun-04 | Washington | | | | | | | | | | | | | | | | | | | | | |
| 17 | 21-Jun-04 | Jackson Brook | | | 8 | 8 | 9 | 9 | 3 | 4 | 9 | 7 | 8 | 5 | 7 | 7 | 8 | | | 8 | | 7.1 | |

## Stream Visual Assessment Protocol Map


## Characterization Summary

- Critical reach in watershed.
- River transitions from relatively undeveloped forested drainage area into developed urbanized corridor.

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# Data Gaps

- Water quality data limited to four (4) NJDEP sampling events.
- Events were conducted between April and September 1998.
- Preliminary review identifies a direct relationship between fecal coliform levels and flow in the river.

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## NJDEP Sampling Results for Flow and Fecal Coliform

| Station | Sample Date | Flow (cfs) | Fecal Coliform (colonies/100ml) |
|---|---|---|---|
| Rockaway River @ Blackwell Street | 15-Apr-98 | 224 | < 20 |
| Rockaway River @ Blackwell Street | 23-Jun-98 | 145 | 170 |
| Rockaway River @ Blackwell Street | 11-Aug-98 | 47 | 3500 |
| Rockaway River @ Blackwell Street | 22-Sep-98 | 16 | 9200 |
| Green Pond Brook @ Dover | 23-Apr-98 | 31 | < 20 |
| Green Pond Brook @ Dover | 23-Jun-98 | 38 | 50 |
| Green Pond Brook @ Dover | 4-Aug-98 | 3 | 490 |
| Green Pond Brook @ Dover | 16-Sep-98 | 2.8 | 330 |
| Rockaway River @ Berkshire Valley | 15-Apr-98 | 124 | 20 |
| Rockaway River @ Berkshire Valley | 23-Jun-98 | 74 | 70 |
| Rockaway River @ Berkshire Valley | 11-Aug-98 | 35 | 5400 |
| Rockaway River @ Berkshire Valley | 22-Sep-98 | 6.4 | 490 |

## Recommendations

- Confirm correlation between fecal coliform levels and flow.
- Develop and implement a sampling plan to assess water quality.

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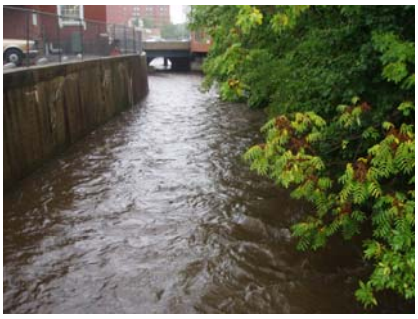
## II. QASP For Rockaway River Watershed Priority Stream Segment Assessment & Stormwater Impact Study



- Sampling Locations
- Spatial Extent of Study
- Temporal Aspects of Sampling
- Monitoring Parameters

TRC Omni

# Sampling Locations

- RK1: Rockaway River, just upstream of the I-80 crossing
- RK2: Rockaway River immediately downstream of its confluence with Stephens Brook and immediately upstream of the Morris County DPW property
- RK3: Rockaway River at West Central Avenue Bridge
- RK4: Rockaway River at North Main Street Bridge
- RK5: Rockaway River at Railroad Bridge near Eileen Street
- RK6: Rockaway River at Railroad Bridge near NJDOL in Dover
- RK7: Rockaway River at Morris Street Bridge
- RK8: Rockaway River at Mercer Street Bridge
- RK9: Rockaway River at Blackwell Street Bridge
- GB1: Green Pond Brook at Dewey Avenue
- JB1: Jackson Brook immediately upstream of Hurd Park
- JB2: Jackson Brook immediately downstream of the dam located in Hurd Park
- DPW1: West Inlet to storm water Basin
- DPW2: East Inlet to storm water Basin

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# Stream Sampling Stations

## Temporal Aspects

- Ambient Events (6)
- Low-Flow Events (3)
- Baseline Storm Events (2)
- Intensive Storm Event (1)
- High-Flow Event (1)

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## Ambient Events

- Completed by RRWC and representatives of RVRSA
- Sampling Occurred:
  - May 23, 2005
  - June 14, 2005
  - July 12, 2005
  - August 9, 2005
  - September 13, 2005
  - October 11, 2005
- Total # of Samples: 24
- Two (2) boundary locations RK1 and RK9
- Two (2) composite locations RK3 and RK8
- Parameters Measured:
  - Fecal coliform
  - pH
  - Temperature
  - TDS
  - TSS

TRC Omni

## Low-flow Events

- Completed by TRC Omni and RRWC
- Sampling Occurred:
  - June 20, 2005
  - August 1, 2005
  - August 25, 2005
- Measured flow did not exceed d70 at USGS station 01380500
- Total # of Samples: 39
- 11 stations sampled
- Parameters measured:
  - Fecal coliform
  - pH
  - Temperature
  - Dissolved Reactive Phosphorus
  - Total Phosphorus
  - TDS
  - TSS

TRC Omni

## Baseline Storm Events

- Completed by TRC Omni
- Sampling Occurred:
  - July 8, 2005
  - October 7-8, 2005
- Sampling occurred at 14 stations
- Total precipitation of 1.9" on July 8 and 3.1" on October 7-8.
- Parameters Measured:
  - Fecal coliform
  - pH
  - Temperature
  - Dissolved Reactive Phosphorus
  - Total Phosphorus
  - TDS
  - TSS
- Total # of Samples: 87

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# Intensive Storm Water Event

- Completed by TRC Omni
- Sampled from November 16-17, 2005.
- Three (3) sets of samples taken at each location during the storm.
- November 17 a fourth set of samples taken at accessible sites during the receding hydrograph (high-flow).
- Parameters Measured:
  - Fecal coliform
  - Fecal streptococci
  - pH
  - Temperature
  - TDS
  - TSS
- Total # of Samples: 50

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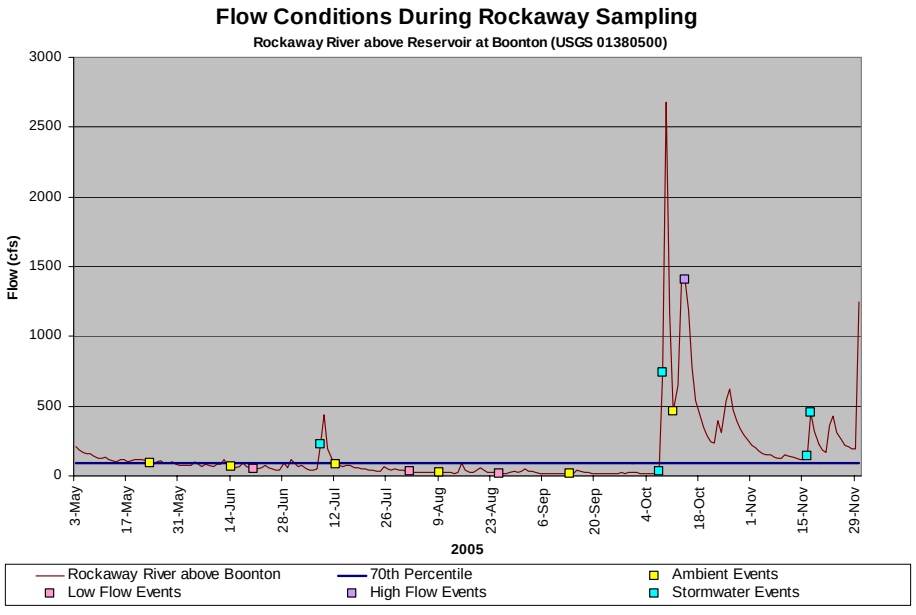

# III. Pathogenic Indicator and Pollutant Track Down Evaluations

- Assessment of Pathogenic Indicators
- Assessment of Other Pollutants
- Management Strategies & Recommendations for next steps

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# Pathogenic Indicators

- Rockaway River classified by NJDEP as FW2-NT
- 400 colonies/100 ml SWQS criterion
- 200 colonies/100 ml geometric mean SWQS criterion

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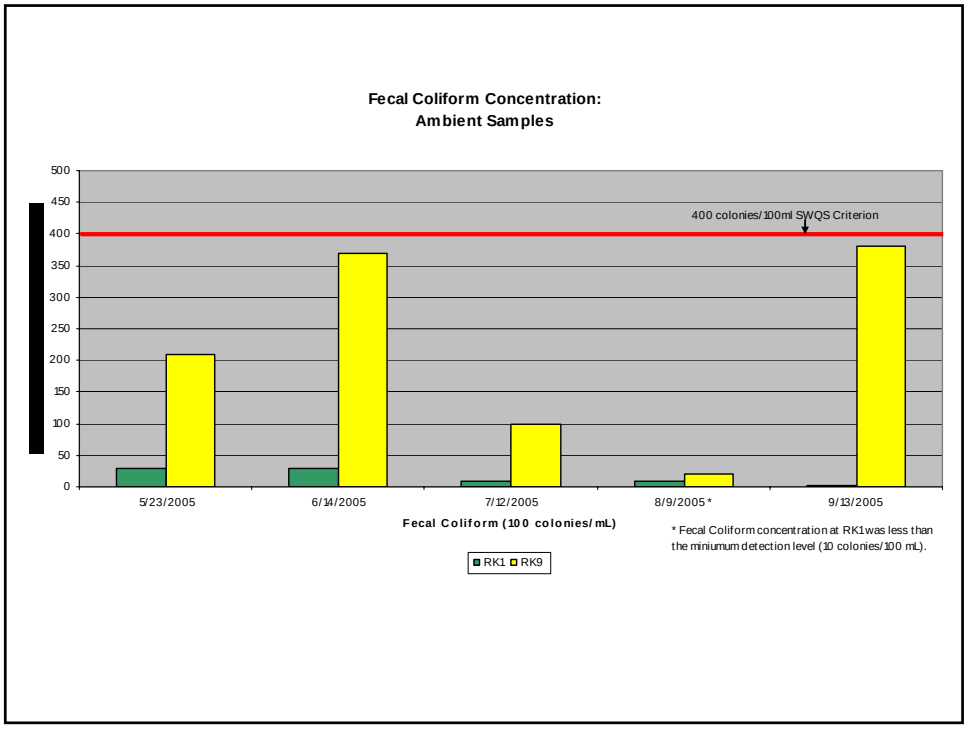
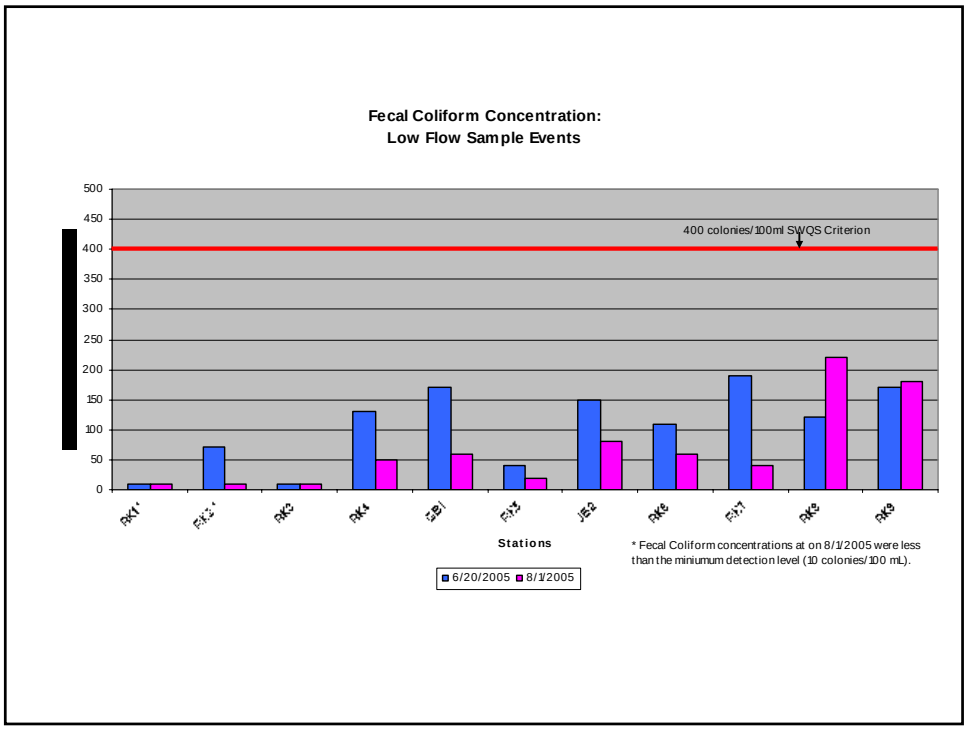
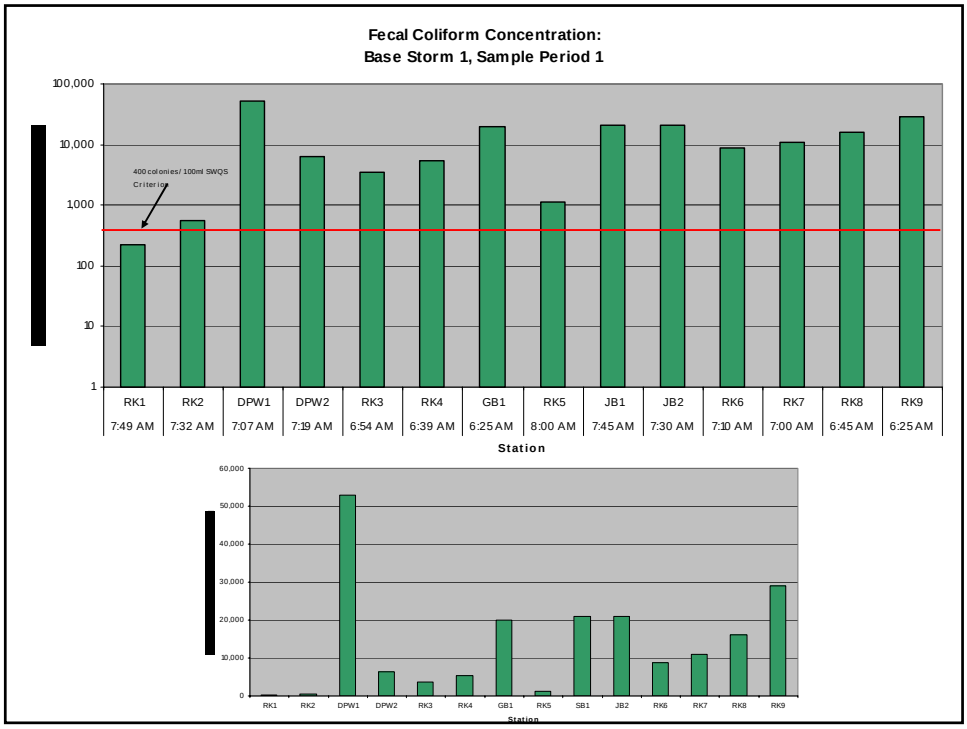
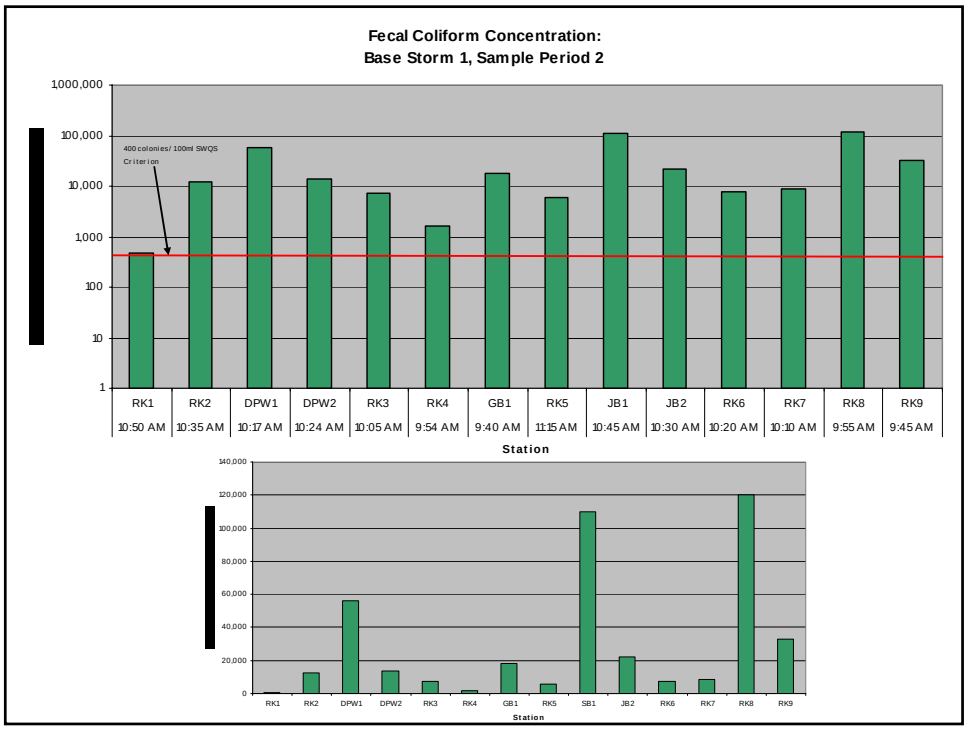
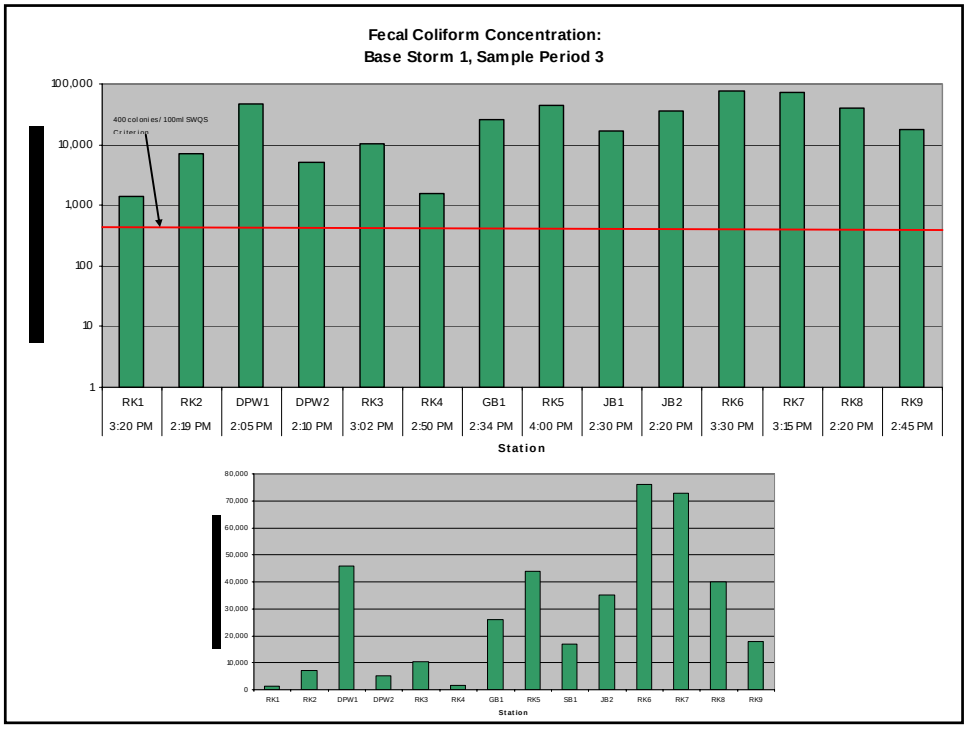
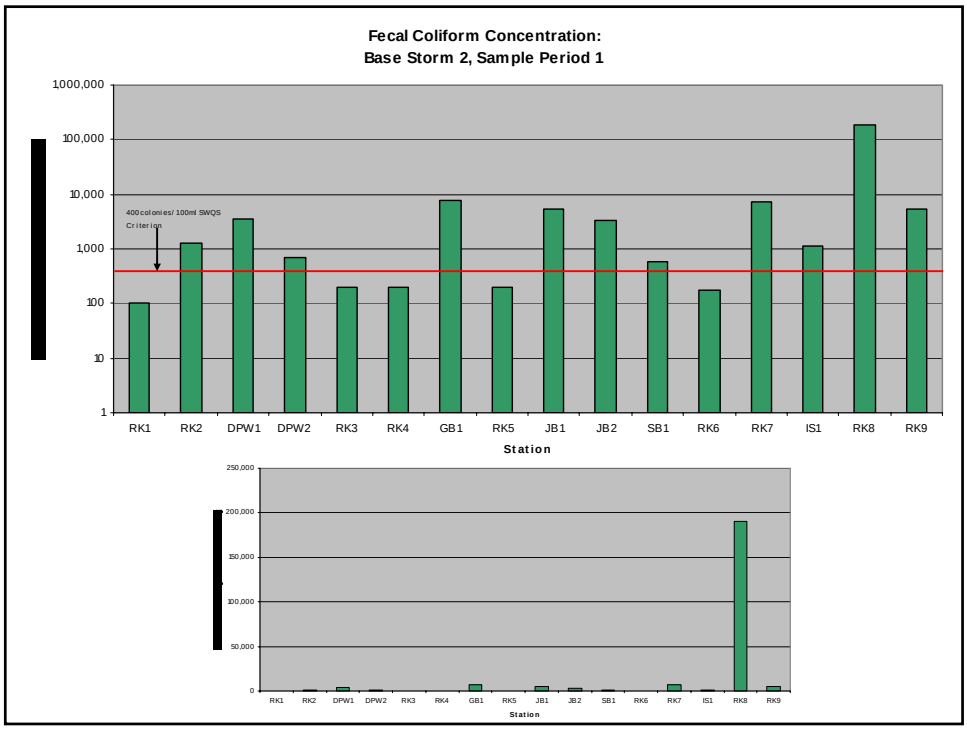

Fecal Coliform Concentration:
Ambient Samples
500
450
400
350
300
250
200
150
100
50
0
400 colonies/100ml SWQS Criterion
5/23/2005
6/14/2005
7/12/2005
8/9/2005*
9/13/2005
Fecal Coliform (100 colonies/mL)
RK1
RK9
* Fecal Coliform concentration at RK1was less than the miniumum detection level (10 colonies/100 mL).

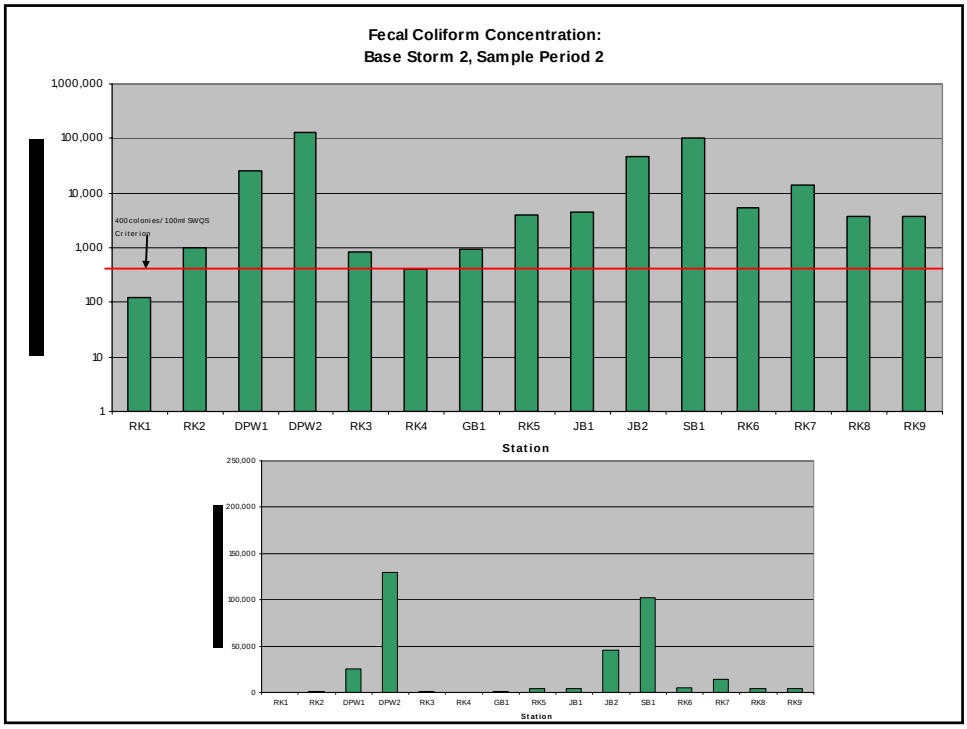

Fecal Coliform Concentration:
Low Flow Sample Events
500
450
400
350
300
250
200
150
100
50
0
400 colonies/100ml SWQS Criterion
RK1
RK2
RK3
RK4
RK5
RK6
RK7
RK8
RK9
Stations
6/20/2005
8/1/2005
* Fecal Coliform concentrations at on 8/1/2005 were less than the miniumum detection level (10 colonies/100 mL).

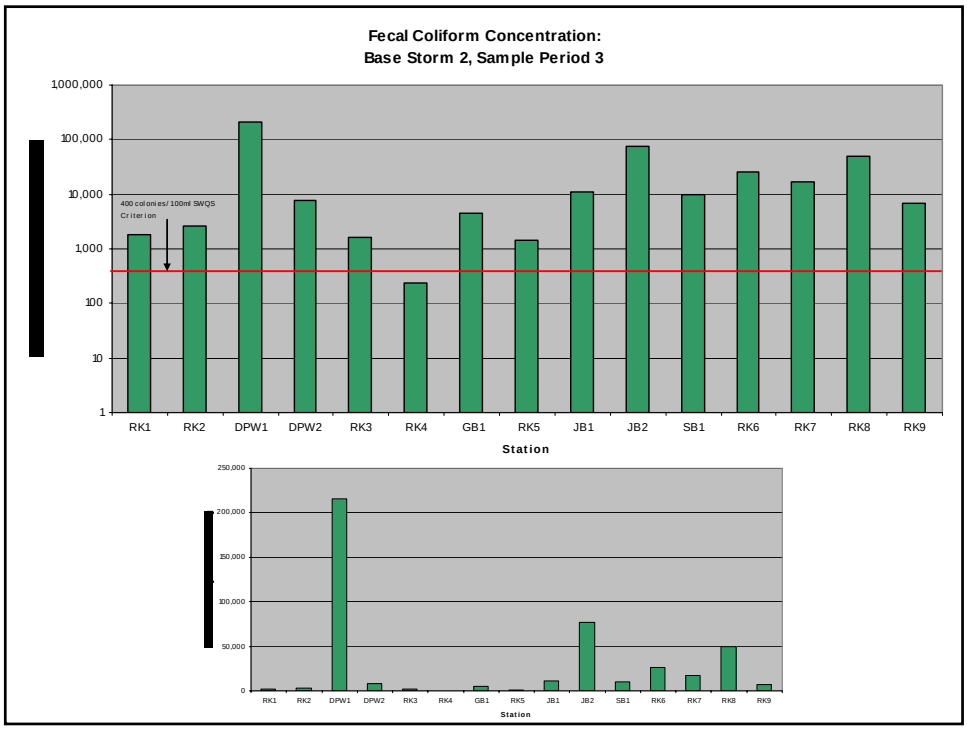

Fecal Coliform Concentration:
Base Storm 1, Sample Period 1
100,000
10,000
1,000
100
10
1
400 colonies/ 100ml SWQS Criterion
RK1 7:49 AM
RK2 7:32 AM
DPW1 7:07 AM
DPW2 7:19 AM
RK3 6:54 AM
RK4 6:39 AM
GB1 6:25 AM
RK5 8:00 AM
JB1 7:45 AM
JB2 7:30 AM
RK6 7:10 AM
RK7 7:00 AM
RK8 6:45 AM
RK9 6:25 AM
Station
60,000
50,000
40,000
30,000
20,000
10,000
0
RK1 RK2 DPW1 DPW2 RK3 RK4 GB1 RK5 SB1 JB2 RK6 RK7 RK8 RK9
Station

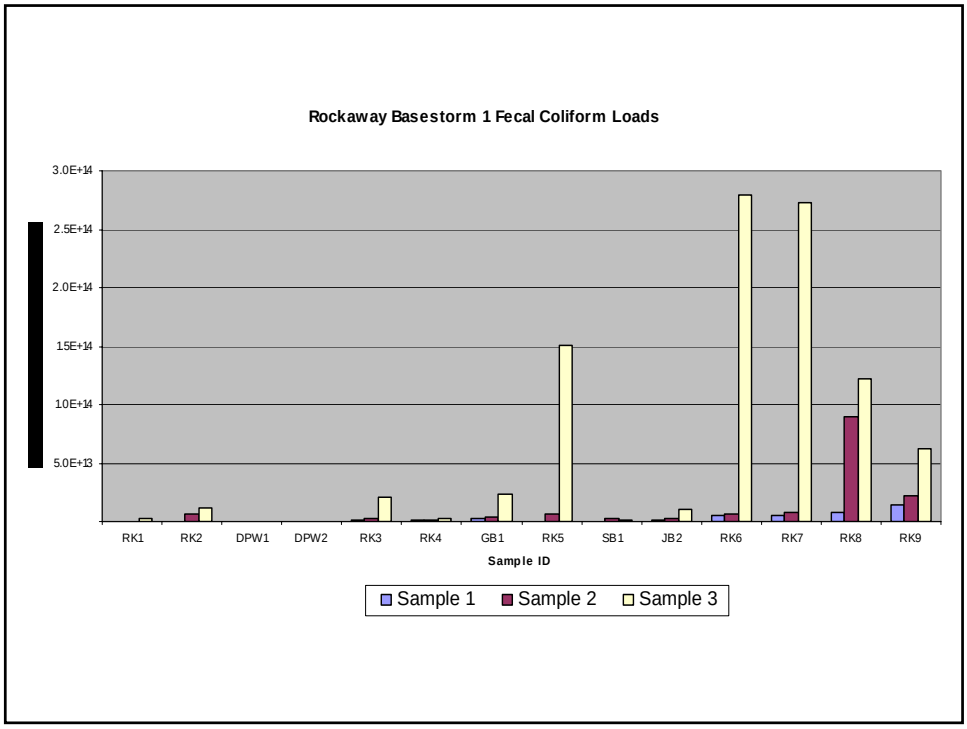

Fecal Coliform Concentration:
Base Storm 1, Sample Period 2
1,000,000
100,000
10,000
1,000
100
10
1
400 colonies/ 100ml SWQS Criterion
RK1 10:50 AM
RK2 10:35 AM
DPW1 10:17 AM
DPW2 10:24 AM
RK3 10:05 AM
RK4 9:54 AM
GB1 9:40 AM
RK5 11:15 AM
JB1 10:45 AM
JB2 10:30 AM
RK6 10:20 AM
RK7 10:10 AM
RK8 9:55 AM
RK9 9:45 AM
Station
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
RK1 RK2 DPW1 DPW2 RK3 RK4 GB1 RK5 SB1 JB2 RK6 RK7 RK8 RK9
Station

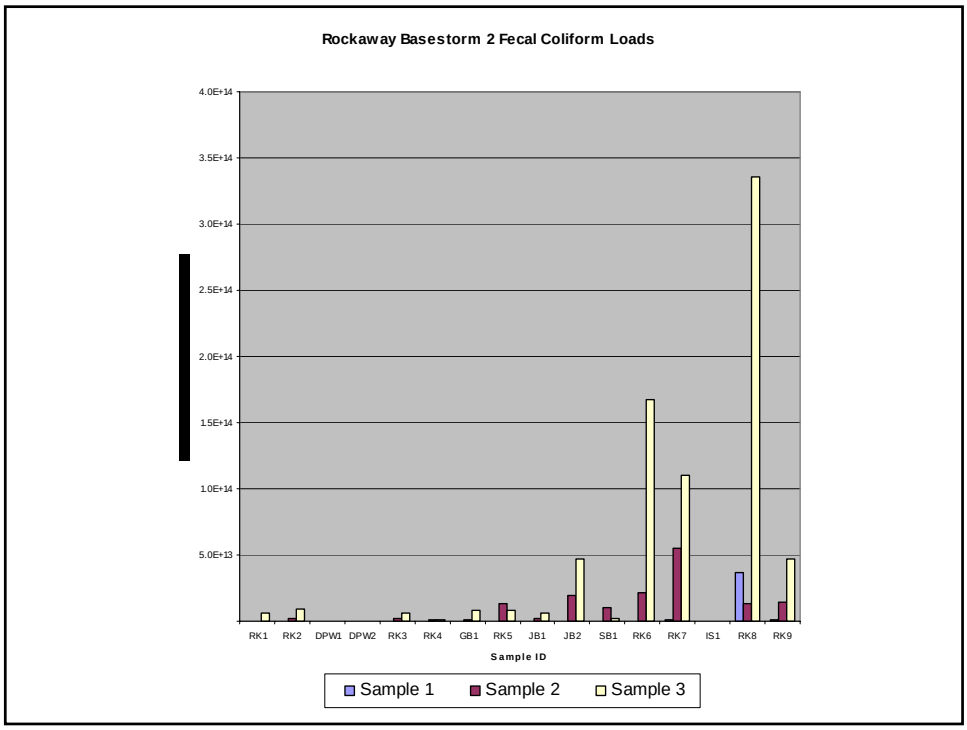

Fecal Coliform Concentration:
Base Storm 1, Sample Period 3
100,000
10,000
1,000
100
10
1
400 colonies/ 100ml SWQS
Criterion
RK1 RK2 DPW1 DPW2 RK3 RK4 GB1 RK5 JB1 JB2 RK6 RK7 RK8 RK9
3:20 PM 2:19 PM 2:05 PM 2:10 PM 3:02 PM 2:50 PM 2:34 PM 4:00 PM 2:30 PM 2:20 PM 3:30 PM 3:15 PM 2:20 PM 2:45 PM
Station
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
RK1 RK2 DPW1 DPW2 RK3 RK4 GB1 RK5 SB1 JB2 RK6 RK7 RK8 RK9
Station


Fecal Coliform Concentration:
Base Storm 2, Sample Period 1
1,000,000
100,000
10,000
1,000
100
10
1
400 colonies/ 100ml SWQS
Criterion
RK1 RK2 DPW1 DPW2 RK3 RK4 GB1 RK5 JB1 JB2 SB1 RK6 RK7 IS1 RK8 RK9
Station
250,000
200,000
150,000
100,000
50,000
0
RK1 RK2 DPW1 DPW2 RK3 RK4 GB1 RK5 JB1 JB2 SB1 RK6 RK7 IS1 RK8 RK9
Station


Fecal Coliform Concentration:
Base Storm 2, Sample Period 2
1,000,000
100,000
10,000
1,000
100
10
1
400 colonies/ 100ml SWQS Criterion
RK1 RK2 DPW1 DPW2 RK3 RK4 GB1 RK5 JB1 JB2 SB1 RK6 RK7 RK8 RK9
Station
250,000
200,000
150,000
100,000
50,000
0
RK1 RK2 DPW1 DPW2 RK3 RK4 GB1 RK5 JB1 JB2 SB1 RK6 RK7 RK8 RK9
Station


Fecal Coliform Concentration:
Base Storm 2, Sample Period 3
1,000,000
100,000
10,000
1,000
100
10
1
400 colonies/ 100ml SWQS Criterion
RK1 RK2 DPW1 DPW2 RK3 RK4 GB1 RK5 JB1 JB2 SB1 RK6 RK7 RK8 RK9
Station
250,000
200,000
150,000
100,000
50,000
0
RK1 RK2 DPW1 DPW2 RK3 RK4 GB1 RK5 JB1 JB2 SB1 RK6 RK7 RK8 RK9
Station


Rockaway Basestorm 1 Fecal Coliform Loads
3.0E+14
2.5E+14
2.0E+14
1.5E+14
1.0E+14
5.0E+13
RK1
RK2
DPW1
DPW2
RK3
RK4
GB1
RK5
SB1
JB2
RK6
RK7
RK8
RK9
Sample ID
Sample 1
Sample 2
Sample 3


Rockaway Basestorm 2 Fecal Coliform Loads
4.0E+14
3.5E+14
3.0E+14
2.5E+14
2.0E+14
1.5E+14
1.0E+14
5.0E+13
RK1
RK2
DPW1
DPW2
RK3
RK4
GB1
RK5
JB1
JB2
SB1
RK6
RK7
IS1
RK8
RK9
Sample ID
Sample 1
Sample 2
Sample 3

# Intensive Stormwater Event

- Targeted sampling in downtown Dover
- Sample 5 stormwater outfalls discharging directly to Rockaway River between RK6 and RK9
- Isolate stormwater drainage areas to evaluate potential fecal coliform sources

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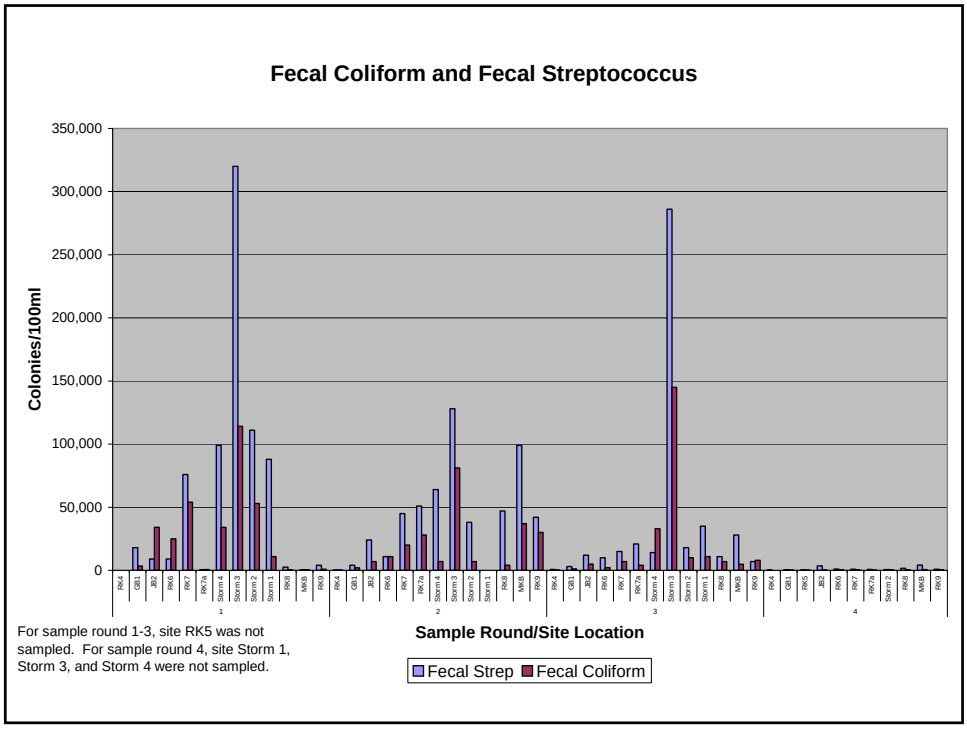
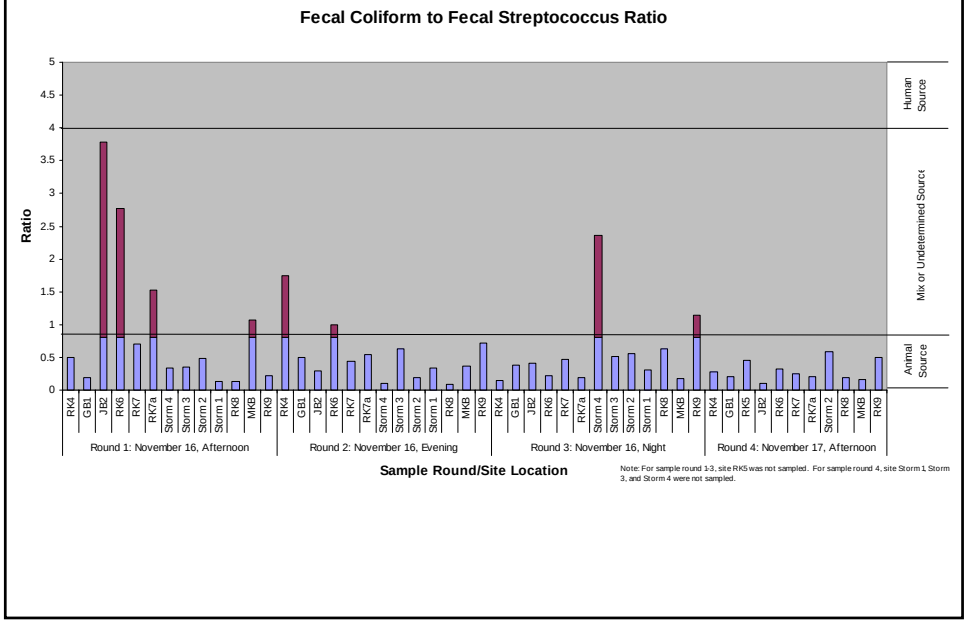
# Stormwater Pipe Sampling Map




For sample round 1-3, site RK5 was not sampled. For sample round 4, site Storm 1, Storm 3, and Storm 4 were not sampled.




Note: For sample round 1-3, site RK5 was not sampled. For sample round 4, site Storm 1, Storm 3, and Storm 4 were not sampled.

## Observed Fecal Coliform Geometric Mean Concentrations

| Event Type | Site ID | Geometric Mean of Fecal Coliform results | Percent Reduction to meet SWQS |
|---|---|---|---|
| Ambient | RK1 | 11 | None Required |
| Ambient | RK9 | 160 | None Required |
| Low Flow | GB1 | 74 | None Required |
| Low Flow | JB2 | 132 | None Required |
| Low Flow | RK1 | 10 | None Required |
| Low Flow | RK2 | 22 | None Required |
| Low Flow | RK3 | 13 | None Required |
| Low Flow | RK4 | 80 | None Required |
| Low Flow | RK5 | 49 | None Required |
| Low Flow | RK6 | 93 | None Required |
| Low Flow | RK7 | 107 | None Required |
| Low Flow | RK8 | 185 | None Required |
| Low Flow | RK9 | 259 | 23% |
| Storm | DPW1 | 37,209 | 99% |
| Storm | DPW2 | 8,220 | 98% |
| Storm | GB1 | 2,710 | 93% |
| Storm | JB2 | 7,971 | 97% |
| Storm | MKB | 2,868 | 93% |
| Storm | RK1 | 512 | 61% |
| Storm | RK2 | 1,489 | 87% |
| Storm | RK3 | 1,387 | 86% |
| Storm | RK4 | 274 | 27% |
| Storm | RK5 | 1,399 | 86% |
| Storm | RK6 | 4,182 | 95% |
| Storm | RK7 | 7,544 | 97% |
| Storm | RK7a | 1,882 | 89% |
| Storm | RK8 | 7,585 | 97% |
| Storm | RK9 | 6,141 | 97% |
| Storm | SB1 | 11,200 | 98% |
| Storm | SWP 1 | 1,343 | 85% |
| Storm | SWP 2 | 6,045 | 97% |
| Storm | SWP 3 | 110,218 | 99% |
| Storm | SWP 4 | 19,878 | 99% |

# Other Pollutants

- Phosphorus
- TDS – Total Dissolved Solids
- TSS – Total Suspended Solids

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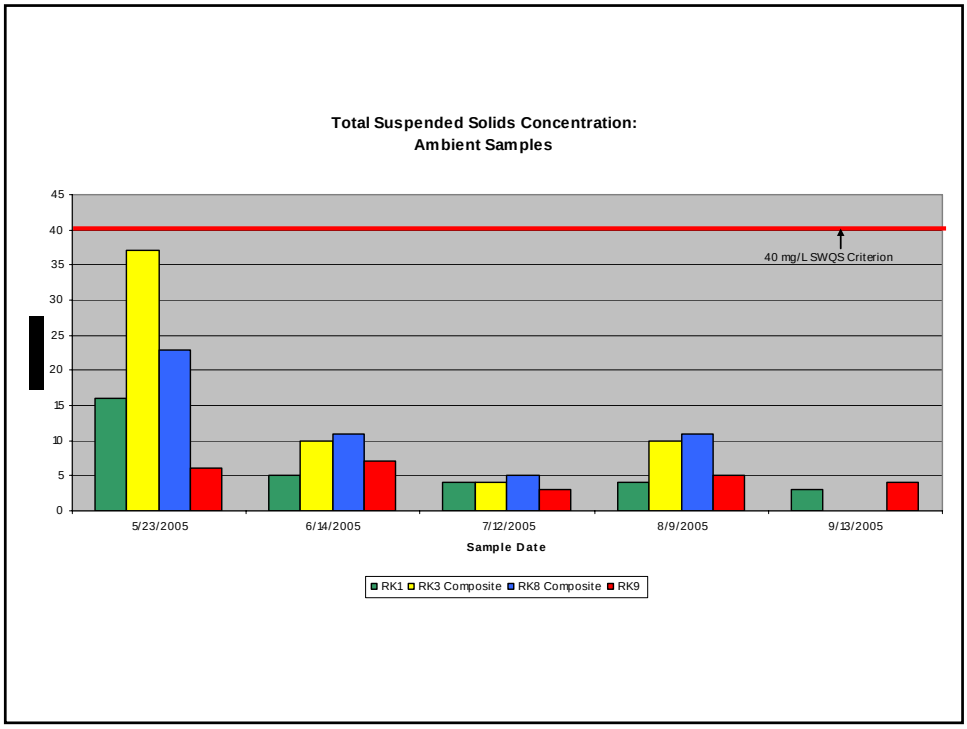
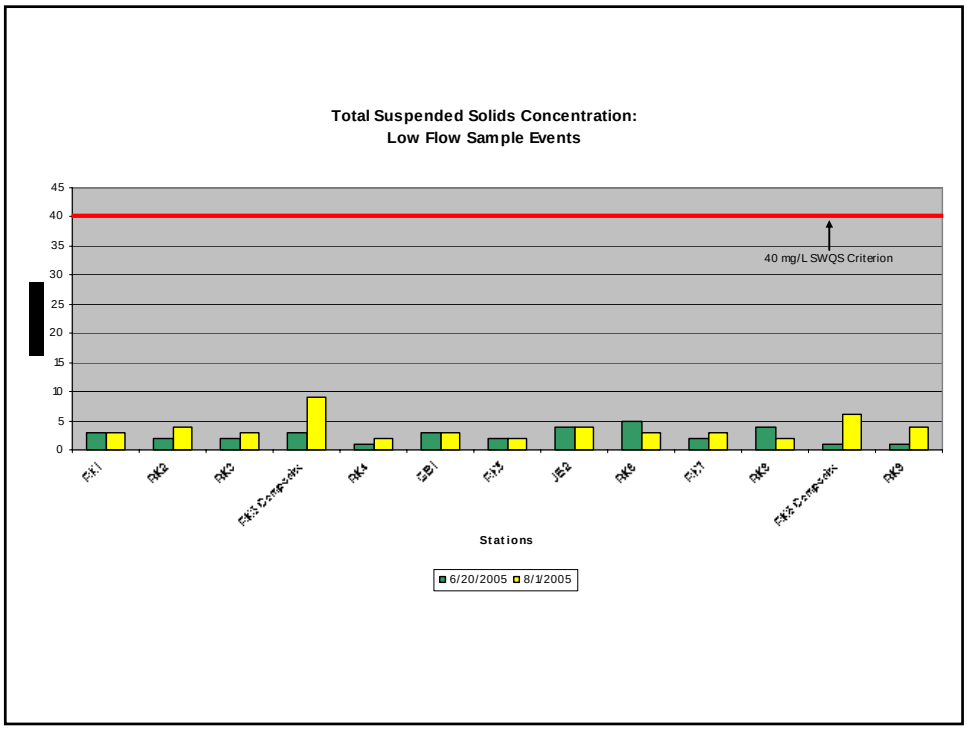
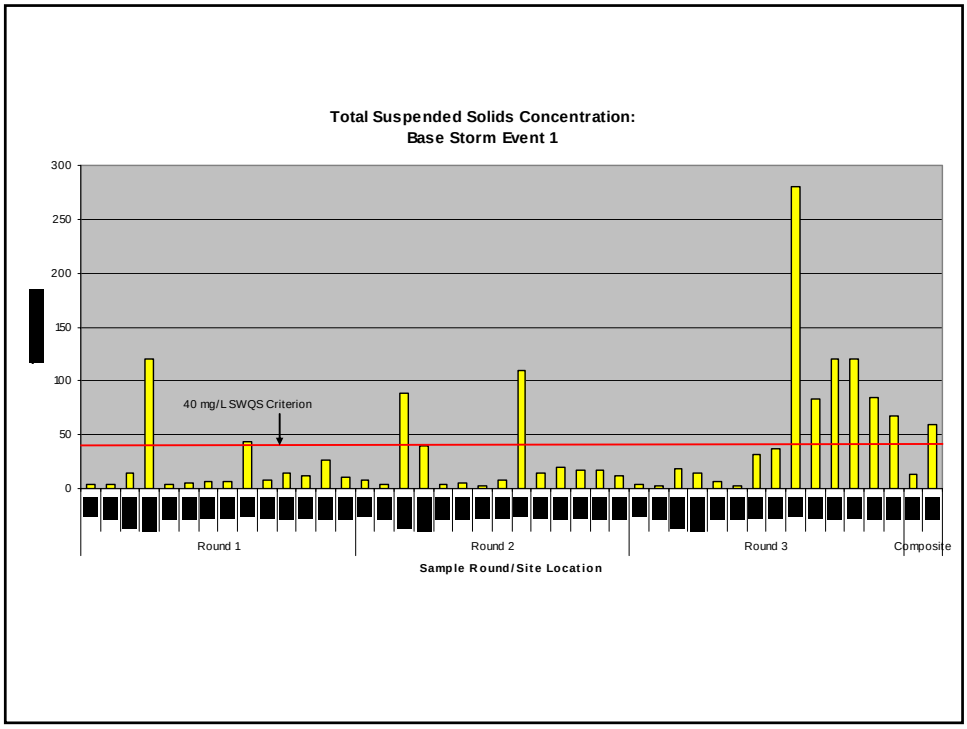
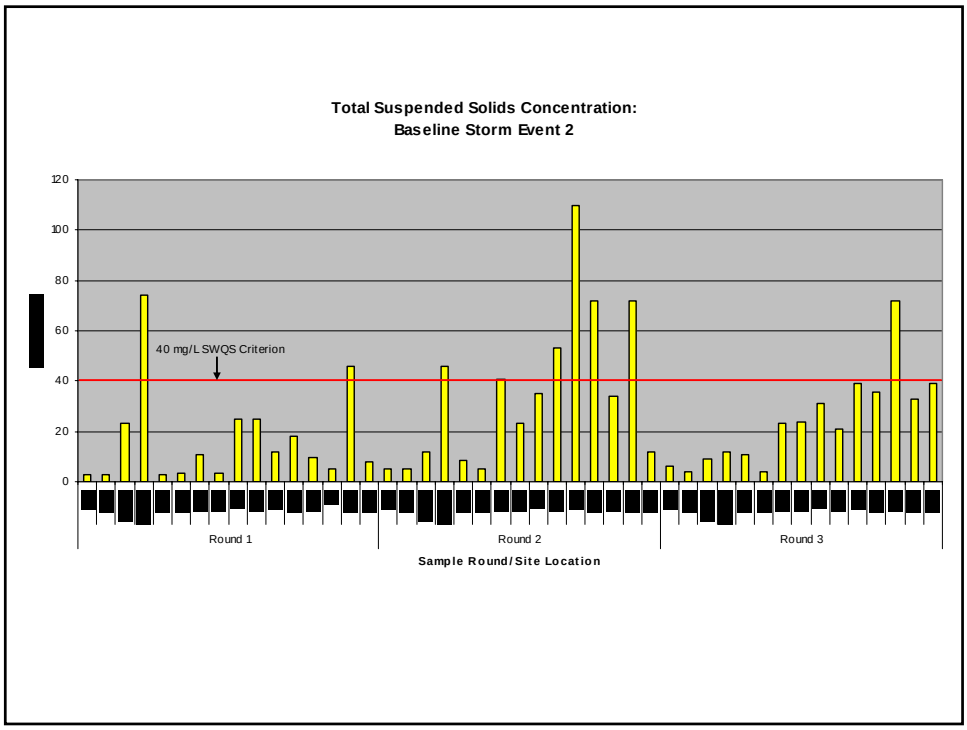
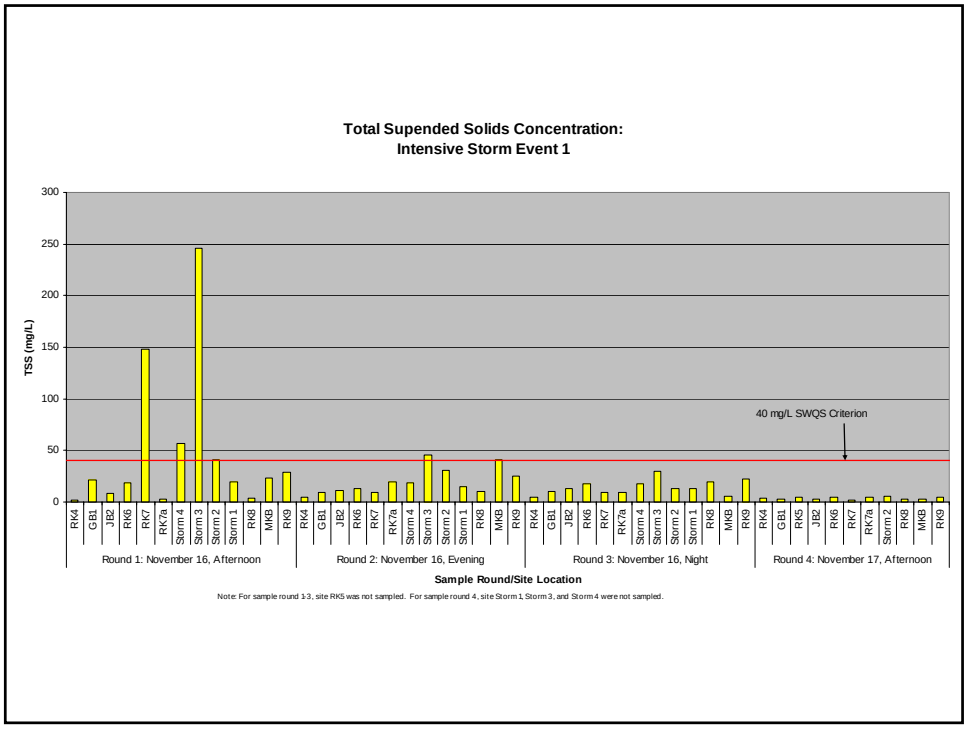
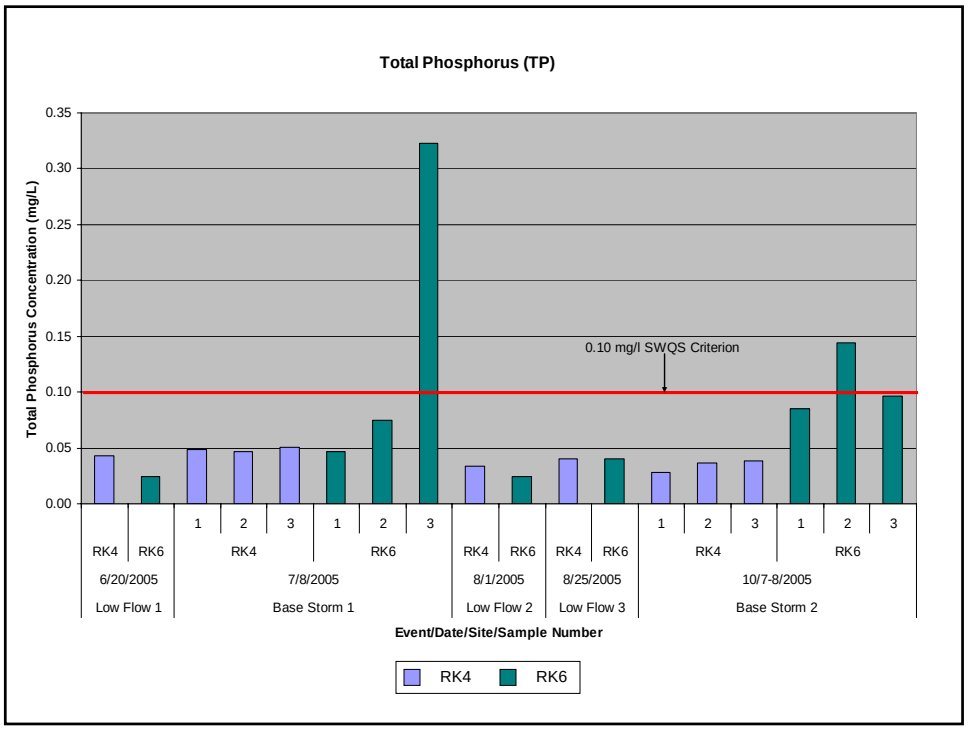

Total Suspended Solids Concentration:
Ambient Samples
45
40
35
30
25
20
15
10
5
0
40 mg/L SWQS Criterion
5/23/2005
6/14/2005
7/12/2005
8/9/2005
9/13/2005
Sample Date
RK1
RK3 Composite
RK8 Composite
RK9

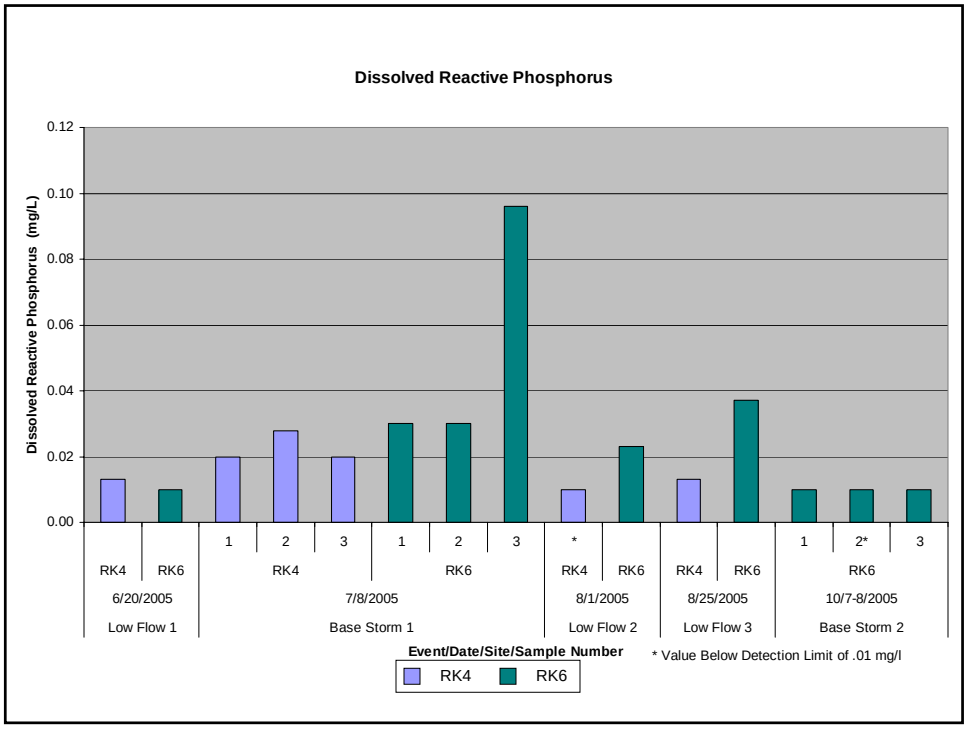

Total Suspended Solids Concentration:
Low Flow Sample Events
45
40
35
30
25
20
15
10
5
0
40 mg/L SWQS Criterion
Stations
6/20/2005
8/1/2005


Total Suspended Solids Concentration:
Base Storm Event 1
300
250
200
150
100
50
0
40 mg/L SWQS Criterion
Round 1
Round 2
Round 3
Composite
Sample Round/Site Location


Total Suspended Solids Concentration:
Baseline Storm Event 2
120
100
80
60
40
20
0
40 mg/L SWQS Criterion
Round 1
Round 2
Round 3
Sample Round/Site Location


Total Supended Solids Concentration:
Intensive Storm Event 1
TSS (mg/L)
300
250
200
150
100
50
0
40 mg/L SWQS Criterion
RK4 GB1 JB2 RK6 RK7 RK7a Storm 4 Storm 3 Storm 2 Storm 1 RK8 MK8 RK9 RK4 GB1 JB2 RK6 RK7 RK7a Storm 4 Storm 3 Storm 2 Storm 1 RK8 MK8 RK9 RK4 GB1 JB2 RK6 RK7 RK7a Storm 4 Storm 3 Storm 2 Storm 1 RK8 MK8 RK9 RK4 GB1 RK5 JB2 RK6 RK7 RK7a Storm 2 RK8 MK8 RK9
Round 1: November 16, Afternoon
Round 2: November 16, Evening
Round 3: November 16, Night
Round 4: November 17, Afternoon
Sample Round/Site Location
Note: For sample round 1-3, site RK5 was not sampled. For sample round 4, site Storm 1, Storm 3, and Storm 4 were not sampled.


Total Phosphorus (TP)
Total Phosphorus Concentration (mg/L)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.10 mg/l SWQS Criterion
1 2 3 1 2 3 RK4 RK6 RK4 RK6 1 2 3 1 2 3 RK4 RK6 RK4 RK6 1 2 3 1 2 3 RK4 RK6
6/20/2005 Low Flow 1
7/8/2005 Base Storm 1
8/1/2005 Low Flow 2
8/25/2005 Low Flow 3
10/7-8/2005 Base Storm 2
Event/Date/Site/Sample Number
RK4
RK6




# Management Strategies and Recommendations

- Stormwater Management
- Riparian Area Management
- Implementation Planning
- Monitoring and Assessment

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## Stormwater Management

- Immediate Action (Municipality)
  - Review, implement, and enforce municipal stormwater permit requirements
  - Implement and enforce clean up ordinances and programs
- Short-Term Action (Municipality)
  - Implement stormwater BMPs
  - Develop an outline of BMP training sessions for municipalities
- Long-Term Action (County/Municipalities)
  - Implement Recommendations set forth in the Jackson Brook Regional Stormwater Management Plan.
  - Develop a Regional Stormwater Management Plan for Rockaway River/McKeel Brook

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## Riparian Area Management

- Immediate Actions (RRWC/NJDEP)
  - Evaluate and implement restoration projects previously identified by USACE.
  - Evaluate and Implement projects identified in “The Rockaway River and its Treasured Resources: Visions & Strategies for their Recovery” plan.
  - Implement Morris County DPW BMP project
  - Implement Hurd Park shoreline restoration project

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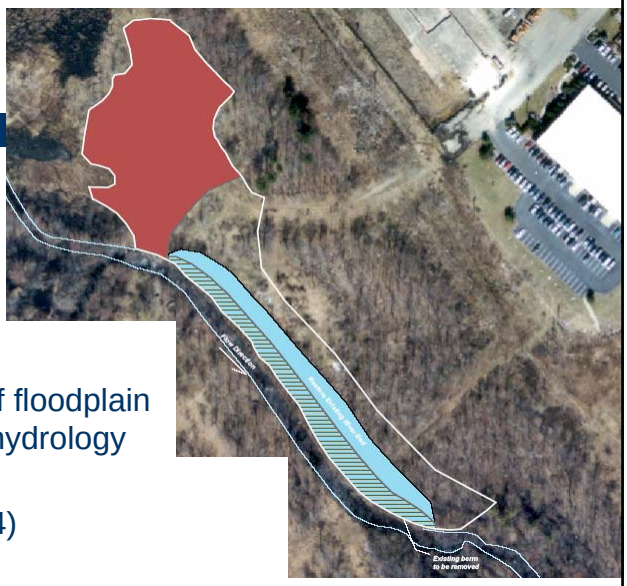
## JB-3



- 2.5 acre site
- Restoration of floodplain and wetland hydrology
- ~$109,924 (USACE 2004)

TRC Omni

## JB-4

- Focus on reducing velocities and sediment in ponds and downstream Rockaway River
- Design stormwater drainage Improvements
- Reestablish natural drainage connections
- Daylight storm sewers
- Retrofit direct discharges to ponds for sediment controls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## JB-5

- 3 acre site
- Filled pond (Dover Mill Pond)
- Reconstruct floodplain wetland hydrology
- Treat urban stormwater
- ~$258,659 (USACE 2004)

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## JB-8

- 4 acre site
- Located along Green Pond Brook
- Invasive species management and restoration of floodplain forest
- Construction of wetland ponds to treat stormwater runoff and high flows from Green Pond Brook
- ~$418,520 (USACE 2004)

TRC Omni

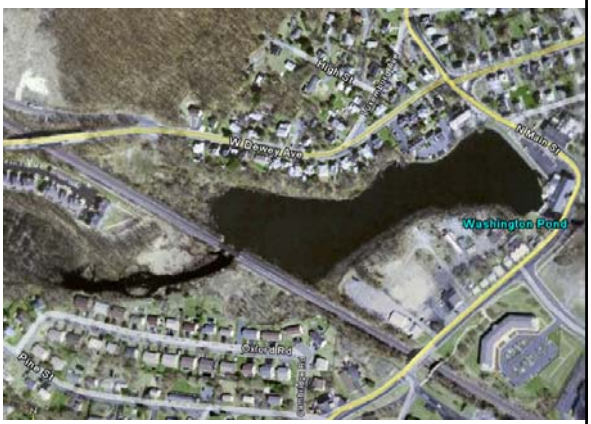
## UR-1


- 8.6 acre site
- Existing shallow pond
- Improve pond hydraulics, storage capacity, and habitat value
- Reduce velocities and sediment load to Rockaway River
- ~$126,270 (USACE 2004)

TRC Omni

## Washington Forge Pond

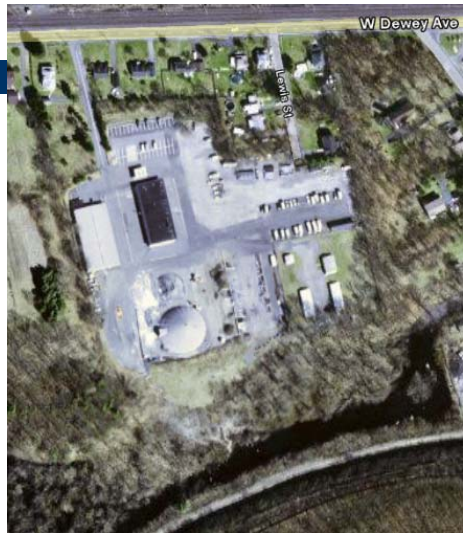
- 9.5 acre site
- Open space acquisition opportunity
- Improve flood storage and habitat value
- Improve management of privately owned shoreline areas




TRC Omni

# Morris County DPW Project

- 6 acre site
- Install stormwater BMPs to treat runoff discharging directly to flood plain areas and the Rockaway River
- Designs Complete and NJDEP Permits obtained December 2005
- Installation planned for Spring 2006
- ~$100,000 in 319(h) grant funds and ~$50,000 inkind match




TRC Omni

# Hurd Park Shoreline Restoration

- 4 acre site
- Implement goose management and install shoreline buffers totaling 1.5 acres to treat overland flow and deter waterfowl
- Design and permitting 2006
- Installation target of Spring 2007
- ~$200,000 in 319(h) grant funds and ~$20,000 inkind match


TRC Omni

## McKeel Brook Stormwater BMPs

- Focus on reducing velocities and sediment in streams, storm sewers and downstream Rockaway River
- Design stormwater drainage Improvements
- Reestablish natural drainage connections
- Daylight storm sewers
- Design and install “first flush” stormwater diversions

TRC Omni

## Riparian Area Management

- Short-Term Actions
  - Demonstrate BMPs
  - Eliminate direct discharges, when possible
  - Implement resident waterfowl management plans
  - Shoreline restoration
  - Continue annual stream reconnaissance surveys

TRC Omni

## Implementation

- Work closely with local municipalities to develop a goal oriented schedule and time table.
- Clearly identify and prioritize specific projects.

TRC Omni