Suffolk County Vector Control & Wetlands Management Long Term Plan & Environmental Impact Statement

MOSQUITO DITCH CONVEYANCE OF POLLUTANTS EXPERIMENT

Prepared for:

Suffolk County Department of Environment and Energy
Suffolk County Department of Health Services
Suffolk County Department of Public Works
Suffolk County, New York

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SUFFOLK COUNTY VECTOR CONTROL AND WETLANDS MANAGEMENT LONG - TERM PLAN AND ENVIRONMENTAL IMPACT STATEMENT

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1 Introduction

It has been believed by some that mosquito ditches constructed on salt marshes directly transport stormwater from uplands to the estuary, thereby short circuiting any natural filtration that the marsh might provide for what has been identified as pollutant-laden water. The literature review found no information regarding this potential negative aspect for ditching in marshes.

Cashin Associates, PC (CA) therefore set out to make some measurements to potentially test whether ditched marshes negatively affect the estuary by conveying stormwater directly to the estuaries without first processing the stormwater through the marsh surface. This work was funded by the County Legislature, and conducted by CA with assistance from the Bureau of Marine Resources and the Public and Environmental Health Laboratory (PEHL) of the Suffolk County Department of Health Services (SCDHS), and two subcontracted laboratories – the Sanudo laboratory, Marine Sciences Research Center, Stony Brook University, and H2M Laboratories, Melville, NY.

The sampling included measurements made at the selected sites under both wet weather and dry weather conditions. Two pairs of marshes were selected. One set (“Gilgo” marshes) was composed of one area that was ditched (“ditched Gilgo”), and one area that was unditched (“unditched Gilgo”). This pair of marshes had identical upland land use; the most notable feature (and expected major pollutant source) was Ocean Parkway. A second pair of ditched marshes (“Flanders” marshes) was selected, where each marsh had different upland land use. One was in parkland (“Hubbard”) and the other had moderate density housing with residential streets in its drainage (“Goose”). The null hypothesis of the experiment is that ditches convey pollutants to the estuary, short-circuiting pollutant removal processes that might occur on the marsh surface. The major conditions regarding this hypothesis are addressed in Table 1.

Table 1. Null Hypothesis: Ditches Convey Pollutants to the Estuary

Condition	**Result Supporting the Null Hypothesis**	**If not …**
Dry Weather at Gilgo	Estuarine water quality off both marshes the same	1) ditched Gilgo estuarine water quality worse: if traceable to ditches, null hypothesis supported 2) unditched Gilgo estuarine water quality worse; no comparison possible
Rain at Gilgo	Estuarine water quality at ditched Gilgo worse than unditched Gilgo, and impairments traceable to the ditches	Estuarine water quality at ditched Gilgo worse than ditched Gilgo under dry conditions, and deterioration greater at ditched Gilgo than unditched Gilgo, supports the null hypothesis
Dry at Flanders		1) Estuarine water quality at Hubbard worse than at Goose means no comparison is possible 2) Ditch water quality at Hubbard means no comparison is possible
Wet at Flanders	Estuarine water quality at Hubbard better than Goose, and impacts traceable to ditches	1) Estuarine water quality at Hubbard approximately the same as Flanders, and both worse than dry Flanders, and impacts traceable to ditches; then null hypothesis supported 2) Estuarine water quality at Hubbard better than goose, but impacts not traceable to ditches: null hypothesis not well supported

The marsh pairs were chosen in close proximity to each other in order to reduce some of the inherent variability associated with salt marshes (such as tidal regime, substrates, approximate age, and general morphology), and so that they had shared regional groundwater conditions, and so potentially had similar general groundwater quality. Also, due to the wet weather portion of the study, the use of geographically close pairs of marshes for study reduced the chances that precipitation at the study sites would be very different in quality, amounts, duration, or intensity. Furthermore, close sites allowed for nearly concurrent sampling. Although in close proximity to each other, the sites at each general location were separate enough from each other so that the estuarine water samples would not necessarily be similar due to immediate mixing.

2 Site Selection

Two pairs of marshes were selected. One pair consists of a ditched marsh and an unditched marsh with similar upland characteristics. The second pair consists of two ditched marshes with different upland characteristics (developed and undeveloped). The different upland characteristics of the pair of ditched marshes were chosen to test if the degree of development plays any role in different water quality impairments theoretically transmitted by the ditches.

Well over 95 percent of Suffolk County's salt marshes have been ditched as a past mosquito control practice. This reduced the chances of finding similar pairs of ditched and unditched salt marshes. In an effort to locate appropriate pairs of marshes, CA mapped the locations of all unditched salt marshes in the County. This was accomplished using USGS quadrangle maps and aerial photograph analysis. USGS quadrangle maps note the presence of most tidal wetlands. In many cases, ditches are also drawn on the marsh land. Therefore, for USGS-mapped wetlands, those with ditches drawn on the map were assumed to have been ditched. Those mapped wetlands without drawn ditches were examined using the 2001 County aerial photographs, which have a resolution of six inches. Those areas without visible ditches in the aerials were identified as unditched marshes. Thirty-two such marshes or marsh fragments were identified in this way (see Figure 1).

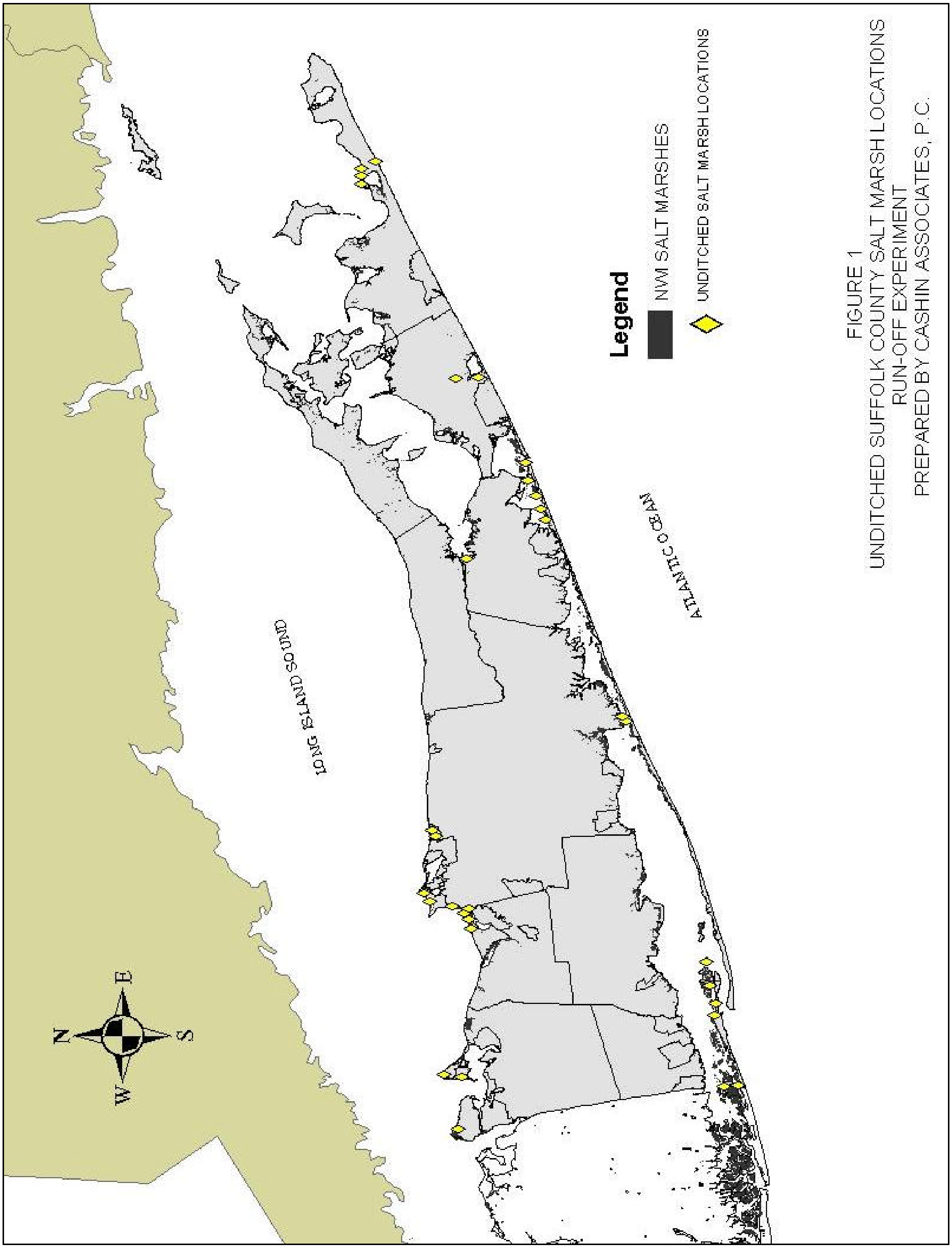

FIGURE 1
UNDITCHED SUFFOLK COUNTY SALT MARSH LOCATIONS
RUN-OFF EXPERIMENT
PREPARED BY CASHIN ASSOCIATES, P.C.

There are a number of unditched marshes on the North Shore in the Long Island Sound watershed. These were not considered, as the steep topography generally found there might promote run-off such as is not found in less steep terrain. Most salt marshes on Long Island are along the less steeply sloped south shore, or in the Peconic Estuary, and so the focus of the search fell there. In addition, marshes without an obvious source of polluted stormwater (such as those in the park settings or undeveloped land) were either eliminated or given a lower selection priority.

In the end, the only feasible site for this comparison appeared to be in Gilgo State Park. It was suboptimal in that it was a relatively pristine setting, and overall land use as a park was not likely to impact water quality. However, a major divided highway, Ocean Parkway, lies just south of the marsh. This roadway was identified as a potential source of contaminated run-off, especially if sampling could occur after an extended dry period when hydrocarbons and other automobile-petroleum product residues might accumulate on the road. A further complication is the estuary by the unditched portion of the marsh is farther from the road than the estuary is by the ditched portion of the marsh. This is because the unditched marsh is somewhat wider than the ditched portion of the marsh. This is noted in particular as it may bias the sampling results towards finding impacts from the ditching, as it may be easier to convey pollutants through the ditched portion of the marsh from the road simply because the marshland is narrower there, and not because the ditches convey the pollutants.

At Gilgo, the eastern portion of the marsh is unditched. West of this area is a ditched portion of the marsh. This pair of sites had been used by Audubon researchers in the 1970s to investigate the difference in bird use of ditched and unditched marshes, and so the site selection echoed earlier research choices (Post, 1970a; Post, 1970b; Post and Greenlaw, 1975; Merriam, 1983; Greenlaw, 1992).

It also proved more difficult than expected to select the second pair of marsh sites. General constraints included morphological similarity, so that if one marsh fronted on an enclosed embayment, so should the second. Because storms would play a role in the test, if enclosed embayments were to be used, it would be best if they had the same general orientation so that impacts from wind-driven water would be equivalent. The general size of the marshes and quality of ditches were to be similar. The marshes should be located close to one another, as discussed above, to limit storm, tide, and overall groundwater discharge quality differences, and yet should be located far enough from each other so as to enable two distinct estuarine samples to be collected.

Two marshes fringing the Peconic Bay in Flanders were eventually selected. The upland at the first marsh, located at Mill Creek, consists of undeveloped County parkland (Hubbard Creek Park). The second site, located on the west side of Goose Creek, has a fringe of residential development around it, plus roadway for access to the houses. The marsh at Goose Creek had previously been ditch plugged as part of an OMWM demonstration. However, site examination prior to sampling revealed that plugs in several ditches had noticeably failed. A ditch with a failed plug that did not retain water and had considerable flow during ebb tide was selected to be sampled.

Figure 2 maps the general location of the selected marshes.

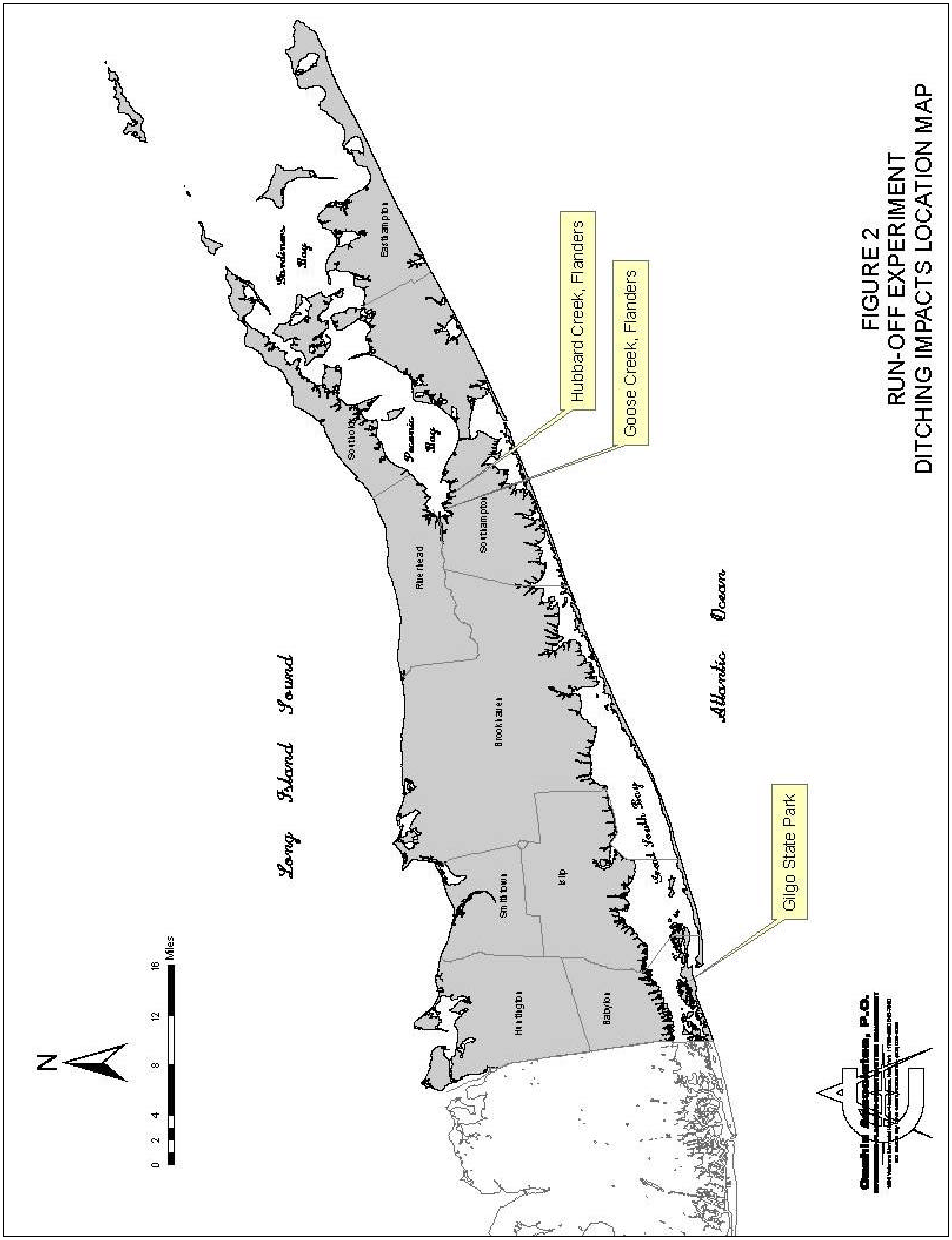

FIGURE 2
RUN-OFF EXPERIMENT
DITCHING IMPACTS LOCATION MAP

3 Methods

All ditched marshes had three sampling stations. One was in the estuary, and two were in a selected ditch. At the unditched marsh, only an off-shore sample was collected. Figures 3-5 illustrate the station locations. Two sets of samples were taken at each station, one for analysis by the SCDHS PEHL, and one for trace metals. The PEHL does not analyze for metals in seawater samples on a routine basis, as the salts in seawater would foul instrumentation dedicated to analyzing drinking water samples (albeit, both samples from Flanders were analyzed for metals). Three of the trace metal sample sets were analyzed by the Sanudo laboratory, Marine Sciences Research Center, Stony Brook University. The fourth was analyzed by H2M Laboratories, Melville, NY.

FIGURE 3
RUN-OFF EXPERIMENT
FLANDERS "GOOSE NECK" SAMPLING LOCATIONS

FIGURE 4
RUN-OFF EXPERIMENT
FLANDERS "HUBBARD" SAMPLING LOCATIONS

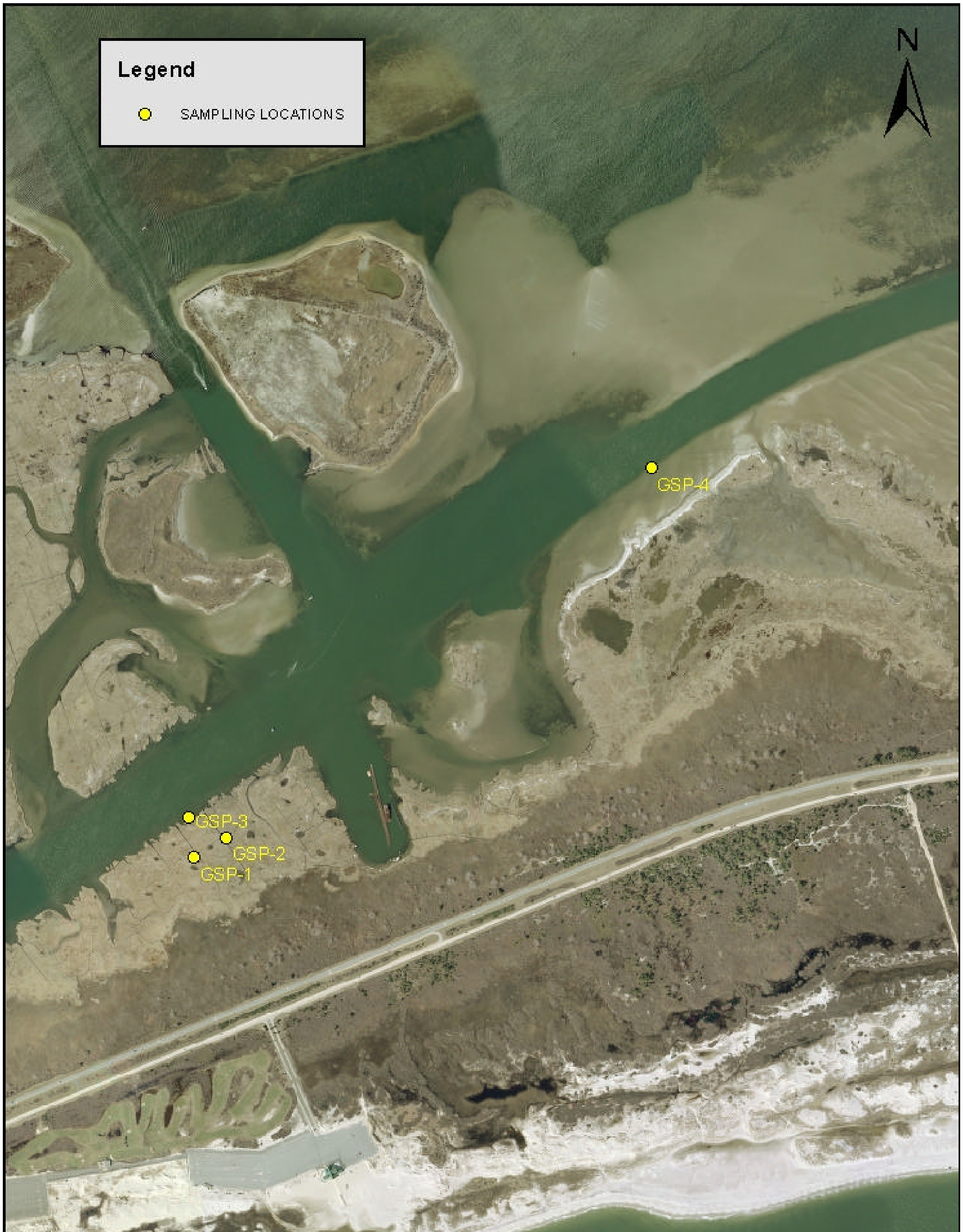

FIGURE 5
RUN-OFF EXPERIMENT
GILGO SAMPLING LOCATIONS

The PEHL is a participating laboratory in the Environmental Laboratory Approval Program (ELAP) of NYSDOH. Sampling parameters analyzed for in the PEHL samples were:

- general water quality parameters (salinity, DO, pH),
- coliform and fecal coliform
- the standard estuarine nutrient suite analyzed for by the PEHL (various nitrogen and phosphorus species)
- volatile organic compounds (analyte list based on County regulations for groundwater quality)
- semi-volatile organic compounds, including pesticides and pesticides degradates.

Samples were collected by trained SCDHS personnel following standard SCDHS procedures for the collection of sweater samples.

The Sanudo laboratory is a research laboratory associated with Stony Brook University (at the Marine Sciences Research Center). The Sanudo laboratory analyzed samples for the following dissolved trace metals:

- cadmium
- cobalt
- copper
- iron
- lead
- nickel
- silver
- vanadium
- zinc

These nine metals were selected by Dr. Sanudo, with input from CA, because most have been identified in various marine investigations as land-derived. Clean metals techniques (Sanudo and Gill, 1999) were used, including collecting samples using a 15 foot stainless steel boom so that the collection hose end was at least ten feet from the boat and/or samplers, the use of acid washed Teflon-coated tubing for the collection hose and all fittings of various pumps and filters, acid-washed pump tubing, and filtering through acid-washed 0.45 µm polysulfone cartridges into acid-washed polyethylene bottles (all acid-washing involved at least one month contact between quartz-distilled hydrochloric acid and the materials). The samples analyzed by the Sanudo laboratory were digested for at least a month using quartz-distilled hydrochloric acid, pre-concentrated using organic solvent extraction (as described in Buck et al., 2005), and quantified using a graphite furnace atomic absorption spectrophotometer in laboratory space under ultra-fine air filtration, "clean room" conditions. These techniques make it possible to have detections at the nanomolar (part per trillion/quadrillion) level for some metals. This means, for many samples, detectable quantities of metals in ambient conditions can be found, which is not always the case for standard analytical techniques (see, for example, the much higher detection limits reported by the PEHL and H2M).

H2M is an ELAP-participating laboratory. Samples analyzed by H2M were digested for one month using nitric acid. They were analyzed using atomic adsorption.

Prior to sampling, CA personnel received instruction in the appropriate clean-metals sampling techniques.

Dry weather samples were collected on a falling tide when no rain had fallen for at least 48 hours. Freely-draining ditches were selected at the Flanders marshes, and the same ditch as was sampled under wet weather conditions was sampled at Gilgo. Off-shore samples were then taken, also under falling tide conditions, within 10 meters of the unditched marsh at Gilgo, and at the mouth of the ditches. Flanders was sampled January 3, 2005. The last previous rain event (according to the National Weather Service at http://www.erh.noaa.gov/box/dailystns.shtml was December 23, 2004. Gilgo was sampled May 6, 2005, and the previous rain event had been on May 1, 2005. A trace amount (0.01 inches) of precipitation was also recorded for May 2.

On September 28, 2004, remnants of Hurricane Ivan were forecast to strike Long Island. Samplers were dispatched at 4 am to Gilgo. Rain began falling at 9:30. Sampling began at 10 am, when approximately 0.5 inches of rain had fallen, according to NEXRAD radar analysis. The previous rain event had been on September 18, 2004.

The wet weather sampling round was collected in the early morning of August 30, 2005 at the Flanders marshes. The weather system consisted of a series of thunderstorms. Samplers arrived at the marshes as a substantial storm, which generated flowing stormwater on local streets, was ending. The storm was quantified at Westhampton Beach as having generated 1.42 inches of precipitation, including the night before. Suffolk County was in the midst of an extended dry period at this time. Patchy rainfall occurred throughout the summer, but, by some accounts, the last island-wide storm system had been on July 8. Some substantial rainfalls (greater than 0.1 inches) were recorded for three days in total for August at Westhampton Beach (the last having occurred August 15). It is not known if local rainfall substantially impacted the Flanders marshes area over that time period.

Several factors prevented the opportunity to collect samples during an optimal wet weather event. These factors include inaccurate weather forecasts, slow-start rain storms, or storms that began during late night hours or off-work days. It had not been anticipated that forecasting and sampling appropriate rain storms would be so difficult.

The marshes at Gilgo State Park were sampled by boat. The boat was positioned upstream, facing the wind with the engine turned off to prevent exhaust fumes from contaminating the sample.

Samples analyzed by SCDHS were collected at a sub-surface depth of approximately six to 18 inches, using four-liter wide mouth Nalgene dipping bottles. These bottles were used as compositing devices so as to reduce the potential for sampling different water masses as the boat drifted. All information including the sampling date, the name of the bay being sampled, the area code, the names of the sampling crew, the vessel being used, the serial number(s) of any meters used, the general water color, the present and previous weather, the approximate wind speed and direction, and in the case of marine sites, the tidal stage, were all recorded on field data sheets prior to commencement of sampling. At each station, the samples collected were denoted by a check in the appropriate box. Any unusual conditions (water discoloration, odors, etc.) or problems encountered during sampling were noted in the "remarks" column.

SCDHS sampling protocols rely on thorough rinsing of all collection and sample bottles where appropriate to maintain the integrity of the sample collection. The four-liter bottles were rinsed at least twice with sample water before being filled. As appropriate volumes are transferred to individual sample bottles or to a filtration apparatus, these containers too were also thoroughly rinsed with sample water. After rinsing the entire apparatus with sample water (before fixing the filter pad), approximately the first 200 ml of filtrate was used to rinse the receiving flask. The sample bottles for the dissolved aliquots were also rinsed with a portion of the filtrate before being filled.

Trace metal samples were collected through Teflon tubing using a peristaltic pump with acid-washed C-Flex tubing in the pump head. The tubing was mounted to a 15-foot stainless steel pole extended from the bow of the boat to the sample location, upwind from boat exhaust. Samples were pumped through a 0.45 μm filter cartridge and into acid-washed polyethylene bottles. All sample containers without preservatives were rinsed with approximately 250 mL of sample water prior to collecting the sample.

Samples in Flanders were collected on foot. Estuarine samples were collected by extending the 15 foot stainless steel boom out from the marsh shoreline near the mouth of the ditch.

For nutrient samples, immediately after collection, sample water was placed into each of three new polyethylene bottles (after rinsing) that are color coded for specific analyses. A small air space is left at the top of each bottle to facilitate later mixing and all are placed on ice at less than four degrees Celsius. A portion of the sample water was filtered through a 0.45 μm Whatman GFC filter pad to remove particulates. While filtering, care was taken to limit the amount of vacuum applied (< 100 mm Hg) so that cells are not disrupted and contents forced through the filter pad. One aliquot, for the analysis of ammonium, nitrite, nitrate, and ortho-phosphate, was placed in a separate bottle unpreserved. These aliquots were frozen at the laboratory. A second aliquot, for total dissolved nitrogen (TDN) and total dissolved phosphorus (TDP), was placed another individual bottle. This aliquot was also preserved with sulfuric acid at the laboratory. All nutrient samples were kept on ice at less than 4 degrees Celsius.

Coliform bacteria samples were collected in pre-sterilized 125 ml wide-mouth plastic bottle. A small air space was left at the top to facilitate later mixing. Care was taken to avoid contaminating the sample during collection and storage (the top of the bottle was not be allowed to become immersed in melt water when placed in the cooler containing ice). During each sampling event, one additional sample (labeled TC) was collected to serve as a temperature control. Upon arrival at the laboratory, the temperature of that sample was measured and recorded. For the samples to be acceptable, the TC must be less than 4 degrees Celsius. Bacteriological samples were analyzed within 6-hours of collection.

For organic compound analyses, the various compounds sampled for are divided into analyte-groups, which include carbamate pesticides, dacthal metabolites, volatile organic compounds (VOCs), chlorinated pesticides and micro-extractables, semi-volatile organics, and herbicide metabolites. At each station, two VOC samples were collected in 40 ml vials that with a Teflon septum, to which 25 mg ascorbic acid had been pre-added by the lab. Five drops of 1:1 HCL were added in the field as an additional preservation. When collecting these samples, care was taken to avoid analyte loss by volatilization. To check for contamination during sample handling and transport to the lab, two trip blanks consisting of distilled water were also collected.

For each station, two chlorinated pesticides and micro-extractables samples were collected in 40 ml vials that have a Teflon septum, to which NaS_2O_3 has been pre-added by the lab. Five drops of 1:1 HCL were added in the field as an additional preservative. As with VOCs, two trip blanks (consisting of distilled water) were collected for each sampling event.

Two semi-volatile organics samples were collected in one liter brown glass bottles to which a preservative had already been added by the lab. The bottles were not rinsed or overfilled during collection. As a pH adjustment, 1:1 HCL is added in the field.

One herbicide metabolites sample was collected in a 125 ml wide-mouth brown glass bottle. No preservative was added.

One metal sample was collected during each event in a 250 ml polyethylene bottle that already contained a predetermined amount of nitric acid (added by lab). The sample was first filtered through a 0.45um Whatman GFC filter pad to remove particulates.

4 Results

Most of the analytes sampled for by the PEHL were not detected. The number of analytes varied from 225 for the first sampling run to 245 for the second Gilgo event, to 273 for the Flanders events. Flanders had the most analytes, as metals were tested for. The Gilgo wet weather event did not have certain pesticide break-down products analyzed for in the SVOCs fraction.

Table 2 lists the results for any analyte detected in the first three sampling events (excluding the Flanders wet weather event). The Flanders wet weather sampling is reported in Table 3.

Table 2. Sample Detections, Run-off experiment, first three sampling events

Sample ID:		**GSP-1**	**GSP-2**	**GSP-3**	**GSP-4**	**GSP-1**	**GSP-2**	**GSP-3**	**GSP-4**
Sample Location:		**Open ditch**	**Open ditch**	**Off shore**	**Unditched marsh**	**Open ditch**	**Open ditch**	**Off shore**	**Unditched marsh**
Sample Date:		**9/28/2004**	**9/28/2004**	**9/28/2004**	**9/28/2004**	**5/6/2005**	**5/6/2005**	**5/6/2005**	**5/6/2005**
Analyte	**Units**								
Field Parameters									
Conductivity	umho					**45600**	**45400**	**46900**	NA
pH	N/A					**7.68**	**7.86**	**7.88**	8.11
Sanitary Indicators									
Fecal Coliform	MPN/100 ml	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20
Total Coliform	MPN/100 ml	**170**	**80**	**130**	**130**	< 20	< 20	< 20	< 20
Nutrients									
Ammonia	mg/L	**0.02**	**0.04**	**0.02**	**0.01**	**0.0187**	**0.0236**	**0.5876**	**0.0077**
Dissolved Nitrogen	mg/L	**0.11**	**0.14**	**0.22**	**0.13**	**0.28**	**0.3**	**0.25**	**0.29**
Total Nitrogen	mg/L	**0.23**	**0.15**	**0.24**	**0.17**	**0.36**	**0.37**	**0.28**	**0.29**
Nitrate & Nitrite	mg/L	**0.560**	**0.121**	**0.005**	< 0.005	**0.00597**	**0.00797**	**0.00521**	**0.00809**
Dissolved Phosphorous	mg/L	< 0.025	**0.03**	< 0.025	**0.04**	**0.0613**	< 0.025	**0.0259**	< 0.025
Total Phosphorous	mg/L	< 0.025	**0.026**	< 0.025	< 0.025	**0.0503**	**0.046**	**0.0354**	**0.028**
Ortho-Phosphate	mg/L	**0.05**	**0.06**	**0.04**	**0.04**	**0.0208**	**0.0167**	**0.0102**	**0.0165**
PEHL Metals									
Aluminum	ug/L								
Arsenic	ug/L								
Barium	ug/L								
Cadmium	ug/L								
Calcium	ug/L								
Cobalt	ug/L								
Copper	ug/L								
Iron	ug/L								
Lead	ug/L								

Sample ID:		GSP-1	GSP-2	GSP-3	GSP-4	GSP-1	GSP-2	GSP-3	GSP-4
Magnesium	ug/L								
Manganese	ug/L								
Molybdenum	ug/L								
Nickel	ug/L								
Potassium	ug/L								
Silver	ug/L								
Sodium	ug/L								
Titanium	ug/L								
Vanadium	ug/L								
Zinc	ug/L								
Trace Metals (Sanudo)									
Cadmium	ug/L	0.04344	0.04156	0.04145	0.04559	0.07486	0.0488	0.04899	0.04543
Cobalt	ug/L	0.02861	0.02876	0.03625	0.03611	0.03028	0.03868	0.03573	0.02985
Copper	ug/L	0.54	0.54	0.57	0.63	0.53	0.63	0.48	0.45
Iron	ug/L	10.17	10.43	9.65	14.49	54.01	43.35	25.71	15.9
Lead	ug/L	0.0337	0.02502	0.03997	0.04039	0.35359	0.10712	0.07908	0.03643
Nickel	ug/L	0.29	0.25	0.31	0.28	0.66	0.58	0.38	0.28
Silver	ug/L	0.00113	0.00132	0.00177	0.00193	0.00274	0.00273	0.00179	0.00156
Vanadium	ug/L	1.23	1.11	1.33	1.3	1.02	0.96	0.94	0.81
Zinc	ug/L	0.063	0.6	0.53	0.63	2.11	1.14	0.93	0.51
VOCs									
Carbon disulfide	ug/L	< 0.5	< 0.5	**1**	**1**	< 0.5	< 0.5	< 0.5	< 0.5
Methyl sulfide	ug/L	< 0.5	< 0.5	**0.8**	**0.6**	**1.3**	**1.1**	< 0.5	< 0.5
Toluene	ug/L	< 0.5	< 0.5	< 0.5	**1**	< 0.5	< 0.5	**1.6**	< 0.5
Total Xylene	ug/L	< 0.5	< 0.5	< 0.5	**1**	< 0.5	< 0.5	**0.9**	< 0.5
SVOCs									
Triclosan	ug/L	< 0.2	**0.5**	**0.4**	**0.6**	< 0.2	< 0.2	< 0.2	< 0.2
1,2,4-Trimethylbenzene	ug/L	< 0.5	< 0.5	< 0.2	< 0.5	< 0.5	< 0.5	**0.6**	< 0.5
Number of PEHL ANALYTES		225	225	225	225	245	245	245	245

Sample ID:		**MC-1**	**MC-2**	**MC-3**	**GC-1**	**GC-2**	**GC-3**	**detection limits (trace metals)**
Sample Location:		**Head of ditch**	**Mid ditch**	**Mouth of ditch**	**Mid ditch**	**Mouth of ditch**	**Head of ditch**	
Sample Date:		**01/03/05**	**01/03/05**	**01/03/05**	**01/03/05**	**01/03/05**	**01/03/05**	
Analyte	**Units**							
Field Parameters								
Conductivity	umho	**23300**	**23900**	**36200**	**40500**	**39500**	**38200**	
pH	N/A	**6.3**	**6.9**	**7.4**	**7.7**	**7**	**6.7**	
Sanitary Indicators								
Fecal Coliform	MPN/100 ml	< 20	< 20	< 20	< 20	< 20	**40**	
Total Coliform	MPN/100 ml	**20**	< 20	**20**	< 20	**20**	**40**	
Nutrients								
Ammonia	mg/L	**0.01**	< 0.005	**0.01**	**0.0095**	**0.05**	< 0.005	
Dissolved Nitrogen	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	**0.09**	
Total Nitrogen	mg/L	**0.07**	< 0.05	< 0.05	< 0.05	< 0.05	**0.07**	
Nitrate & Nitrite	mg/L	**0.008**	**0.007**	**0.007**	**0.00687**	**0.0136**	**0.018**	
Dissolved Phosphorous	mg/L	< 0.025	**0.04**	**0.11**	< 0.025	**0.0472**	**0.14**	
Total Phosphorous	mg/L	**0.03**	< 0.025	**0.133**	**0.0429**	**0.046**	**0.166**	
Ortho-Phosphate	mg/L	< 0.005	< 0.005	< 0.005	< 0.005	**0.0207**	**0.02**	
PEHL Metals								
Aluminum	ug/L	**75.9**	**19.7**	**17**	**11.5**	**6.07**	**9.86**	
Arsenic	ug/L	< 10	< 10	**16.40**	< 10	< 10	< 10	
Barium	ug/L	**36.7**	**11.9**	**9.51**	**8.11**	**14.8**	**31.9**	
Cadmium	ug/L	< 5	< 5	< 5	< 5	< 5	< 5	
Calcium	ug/L	**141000**	**144000**	**238000**	**262000**	**305000**	**280000**	
Cobalt	ug/L	< 5	< 5	< 5	< 5	< 5	< 5	
Copper	ug/L	< 5	< 5	< 5	< 5	< 5	< 5	
Iron	ug/L	**210**	<100	<100	<100	**108**	**280**	
Lead	ug/L	< 5	< 5	< 5	< 5	< 5	< 5	
Magnesium	ug/L	**454000**	**460000**	**833000**	**933000**	**917000**	**857000**	

Sample ID:		**MC-1**	**MC-2**	**MC-3**	**GC-1**	**GC-2**	**GC-3**	**detection limits (trace metals)**
Manganese	ug/L	**34**	**99**	**22**	**12.4**	**110**	**333**	
Molybdenum	ug/L	< 5	< 5	**9.41**	**10.1**	**6.72**	< 5	
Nickel	ug/L	**8.84**	**9.5**	**16**	**17.7**	**17.6**	**16**	
Potassium	ug/L	**243000**	**249000**	**417000**	**461000**	**540000**	**493000**	
Silver	ug/L	< 5	< 5	< 5	< 5	< 5	< 5	
Sodium	ug/L	**4170000**	**4250000**	**6780000**	**7670000**	**7530000**	**7030000**	
Titanium	ug/L	**28.1**	**27.3**	**41.7**	**46.4**	**44.1**	**41.6**	
Vanadium	ug/L	< 5	< 5	< 5	< 5	< 5	< 5	
Zinc	ug/L	< 50	< 50	< 50	< 50	< 50	< 50	
Trace Metals (Sanudo)								
Cadmium	ug/L	0.02161	0.05271	0.09052	107.45	0.06949	0.08376	0.0009
Cobalt	ug/L	0.04954	0.03795	0.06101	0.11193	0.06389	0.04191	0.00012
Copper	ug/L	0.33	0.76	0.86	0.47	0.47	0.69	0.064
Iron	ug/L	256.32	71.68	33.8	318.74	113.8	3.81	0.045
Lead	ug/L	0.15383	0.05369	0.16678	0.06718	0.04576	0.01585	0.00166
Nickel	ug/L	0.32	0.39	1.14	0.48	0.52	0.64	0.012
Silver	ug/L	0.00131	0.00191	0.00248	0.00156	0.00123	0.00097	0.00033
Vanadium	ug/L	0.77	0.32	0.83	1.05	0.87	0.68	0.028
Zinc	ug/L	3.07	2.64	4.14	3.6	1.93	1.36	0.026
VOCs								
Carbon disulfide	ug/L	**1**	< 0.5	< 0.5	< 0.5	**0.5**	**0.6**	
Methyl sulfide	ug/L	**0.6**	< 0.5	**2.0**	**0.6**	**1**	**1.0**	
Toluene	ug/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	
Total Xylene	ug/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	
SVOCs								
Triclosan	ug/L	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	
1,2,4-Trimethylbenzene	ug/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	
Number of PEHL ANALYTES		273	273	273	273	273	273	

Table 3. Sample Detections, Run-off experiment, Flanders wet weather samples

Sample ID:		**MC-1**	**MC-2**	**MC-3**	**GC-1**	**GC-2**	**GC-3**	**detection limits (trace metals)**
Sample Location:		**Head of ditch**	**Mid ditch**	**Mouth of ditch**	**Mid ditch**	**Mouth of ditch**	**Head of ditch**	
Sample Date:		**08/30/05**	**08/30/05**	**08/30/05**	**08/30/05**	**08/30/05**	**08/30/05**	
Analyte	**Units**							
Field Parameters								
Conductivity	umho	**31900**	**23300**	**29400**	**17600**	**38500**	**40400**	
pH	N/A	**6.5**	**6.9**	**7.2**	**7.1**	**7.5**	**7.7**	
Sanitary Indicators								
Fecal Coliform	MPN/100 ml	<200	**70**	**230**	**300**	**40**	**20**	
Total Coliform	MPN/100 ml	**14000**	**9000**	**5000**	**1400**	**110**	**230**	
Nutrients								
Ammonia	mg/L	**0.0341**	**0.0457**	**0.0603**	**0.2736**	**0.0781**	**0.019**	
Dissolved Nitrogen	mg/L	**0.7**	**0.96**	**0.5**	**0.82**	**0.35**	**0.24**	
Total Nitrogen	mg/L	**1.9**	**0.98**	**0.58**	**1.2**	**0.36**	**0.36**	
Nitrate & Nitrite	mg/L	**0.00966**	**0.0115**	**0.0141**	**0.0112**	**0.0149**	**0.0128**	
Dissolved Phosphorous	mg/L	**0.0265**	**0.121**	**0.0963**	**0.207**	**0.0604**	**0.0579**	
Total Phosphorous	mg/L	**0.168**	**0.114**	**0.128**	**0.316**	**0.0807**	**0.102**	
Ortho-Phosphate	mg/L	<0.005	**0.0704**	**0.1035**	**0.2073**	**0.1107**	**0.0868**	
PEHL Metals								
Aluminum	ug/L	**82.5**	**32.1**	**31**	**36.9**	**9.07**	**14.8**	
Arsenic	ug/L	<10	**11**	<10	<10	<10	<10	
Barium	ug/L	**29.8**	**42.1**	**50.6**	**88.4**	**21.7**	**16.9**	
Calcium	ug/L	**193000**	**139000**	**185000**	**75300**	**254000**	**266000**	
Chromium	ug/L	**5.31**	**4.53**	**3.95**	**3.62**	**4.06**	**3.8**	
Cobalt	ug/L	**1.54**	**1.18**	**1.34**	<1	**1.74**	**1.79**	
Copper	ug/L	**5.46**	**9.45**	**12**	**8.21**	**17.5**	**19.9**	
Iron	ug/L	**0.89**	**0.71**	**0.28**	**0.3**	<0.1	<0.1	
Lead	ug/L	<1	<1	<1	**1.57**	<1	<1	

Sample ID:		**MC-1**	**MC-2**	**MC-3**	**GC-1**	**GC-2**	**GC-3**	**detection limits (trace metals)**
Magnesium	ug/L	**634000**	**457000**	**611000**	**350000**	**833000**	**869000**	
Manganese	ug/L	**188**	**660**	**253**	**270**	**135**	**112**	
Molybdenum	ug/L	**4.02**	**5.08**	**5.64**	**4.24**	**7.48**	**7.67**	
Nickel	ug/L	**8.24**	**6.7**	**8.9**	**5.29**	**12.4**	**13.5**	
Potassium	ug/L	**292000**	**218000**	**284000**	**179000**	**396000**	**413000**	
Sodium	ug/L	**5470000**	**3950000**	**5250000**	**3110000**	**7200000**	**7310000**	
Titanium	ug/L	**21.4**	**16.3**	**19.8**	**14**	**23.1**	**24.3**	
Uranium	ug/L	**1.17**	<1	**1.97**	<1	**2.82**	**2.96**	
Vanadium	ug/L	<1	<1	<1	**1.18**	<1	<1	
Zinc	ug/L	<50	<50	**55.5**	**54.5**	<50	<50	
Trace Metals (H2M)								
Cadmium	ug/L	<0.26	<0.26	<0.26	<0.26	<0.26	<0.26	0.26
Cobalt	ug/L	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	1.3
Copper	ug/L	<1.3	<1.3	**2.4**	<1.3	**3.9**	<1.3	1.3
Iron	ug/L	**1440**	**1080**	**419**	**325**	**57.9**	**12.5**	4.3
Lead	ug/L	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	1.3
Nickel	ug/L	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	0.012
Silver	ug/L	**2.8**	**2.4**	**2.3**	**1.6**	**3.4**	**3.4**	0.6
Vanadium	ug/L	<1.3	<1.3	**1.4**	**2.3**	<1.3	<1.3	1.3
Zinc	ug/L	**5.8**	<4.0	**4.4**	<4.0	<4.0	<4.0	4.0
VOCs								
Ethylbenzene	ug/L	<2.5	<2.5	<0.5	<2.5	**0.8**	<0.5	
Methyl sulfide	ug/L	**44**	**2.5**	**33**	<2.5	**3.6**	**7.9**	
Number of PEHL ANALYTES		273	273	273	270	270	270	

5 Discussion

5.1 Field Data

Field data showed Gilgo was saltier than Flanders, which corresponds to their relative settings in the estuary. Gilgo is close by the Fire Island Inlet, while Flanders is near the head of the Peconic system. For the Flanders wet weather sampling, the Goose sample at the head of the ditch was notably fresher, which indicates that run-off input may have occurred.

5.2 Sanitary Indicators

Coliform (total and fecal) were elevated under wet weather conditions at Gilgo compared to dry weather conditions. The results were not indicative that the ditches were transporting these bacteria into the estuary, however. Coliform results under dry conditions at Flanders did not appear to follow any clear pattern. Coliform under wet weather were also elevated at Flanders. Fecal coliform were highest at the head of the ditch at Goose, but total coliform were highest in the Hubbard samples.

5.3 Nutrients

Under wet weather conditions, nitrogen compounds were elevated at the ditched system at Gilgo and Flanders. Phosphorous compounds tended to be higher at the unditched site at Gilgo under wet conditions. With the exception of ammonia (which was much higher at the ditched site), the situation seemed to be reversed for nitrogen compounds. At Flanders, the highest levels of nutrients were found at Goose at the head of the ditch. They did not appear to have been transmitted down the ditch to the estuary, however. During dry weather, nutrients at Goose were higher overall than Hubbard. For Goose, concentrations in the estuary were higher than in the ditches, although some minor trend towards increasing concentrations down ditch may be discernable. Most of the nutrients were not detectable in the ditch at Hubbard.

5.4 PEHL Metals

At Flanders, where the metals were sampled for, concentrations of the major ions (sodium, magnesium, potassium, calcium) generally tracked salinity (as is to be expected). Some of the other results appear to correlate with salinity as well, especially for the wet weather data where there was a sharp distinction between the head of the ditch sample at Goose and other samples. Metals that appeared to follow salinity levels included cobalt, copper, molybdenum, nickel, titanium, and uranium. Metals that were elevated at the head of the ditch at Goose were barium, lead, and vanadium, but none of these three metals were found at the mid-ditch or estuary stations under wet weather conditions. Under dry weather conditions, most of the metals do not show any trends, with the possible exception of manganese and iron. These redox-active metals, which tend to be enriched in anoxic sediments such as those found in marshes, are generally higher in the ditches than the estuary, suggesting the ditches may be conveying them to the estuary.

5.5 Trace Metals

H2M was unable to duplicate the analytical work of the Sanudo laboratory, and so the trace metal discussion is restricted to the three samples where the Sanudo laboratory reported results. There are few indications of any trends in the detections reported by H2M, except that silver appears to track salinity and vanadium may be enriched at the head of the ditch at Goose (although it was also detected in the estuary off Hubbard).

At Gilgo, it is notable that the dry weather concentrations for copper and vanadium were greater than wet weather samples in general (comparing the unditched estuarine samples), and that many of the ditched system metals sampling results were much greater for the dry weather samples as compared to wet weather samples. This suggests that precipitation does not wash contaminants from the marsh or marsh uplands into the estuary.

To simplify the metals analysis, the results were normalized to the “more pristine” estuarine samples (the Hubbard estuarine sample, or the Gilgo unditched sample) (Tables 4 to 6). This analysis shows that nearly all of the results for the wet weather event at Gilgo were within the method variability (as defined by correspondence to a standard seawater sample). There are even some suggestions that the ditched area concentrations are lower than the unditched estuarine sample results. Under dry weather conditions at Gilgo, it appears that metals are enriched in the ditches as compared to the unditched area concentrations, which results in slightly elevated concentrations in the estuary offshore from the ditched area. However, the opposite was determined for Flanders, where most metals had lower concentrations at Hubbard in the ditches compared to the estuary (although some metals were slightly enriched in ditches at Goose as compared to the estuary at Goose).

Table 4. Gilgo Wet Weather Sampling Trace Metals Results, Relative to the Unditched Marsh

Wet	GSP-1	GSP-2	GSP-3	GSP-4	Variability
Cadmium	95%	91%	91%	100%	0%
Cobalt	79%	80%	100%	100%	4%
Copper	86%	86%	90%	100%	5%
Iron	70%	72%	67%	100%	9%
Lead	83%	62%	99%	100%	9%
Nickel	104%	89%	111%	100%	9%
Silver	59%	68%	92%	100%	
Vanadium	95%	85%	102%	100%	
Zinc	10%	95%	84%	100%	19%

Table 5. Gilgo Dry Weather Sampling Trace Metals Results Relative to the Unditched Marsh

Dry	GSP-1	GSP-2	GSP-3	GSP-4	Variability
Cadmium	165%	107%	108%	100%	0%
Cobalt	101%	130%	120%	100%	4%
Copper	118%	140%	107%	100%	5%
Iron	340%	273%	162%	100%	9%
Lead	971%	294%	217%	100%	9%
Nickel	236%	207%	136%	100%	9%
Silver	176%	175%	115%	100%	
Vanadium	126%	119%	116%	100%	
Zinc	414%	224%	182%	100%	19%

Table 6. Flanders Dry Weather Sampling Trace metals Relative to Hubbard Marsh Offshore

Dry	1a	2a	3a	4a	5a	6a	Variability
Cadmium	24%	58%	100%	119%	77%	93%	0%
Cobalt	81%	62%	100%	183%	105%	69%	4%
Copper	38%	88%	100%	55%	55%	80%	5%

Iron	758%	212%	100%	943%	337%	11%	9%
Lead	92%	32%	100%	40%	27%	10%	9%
Nickel	28%	34%	100%	42%	46%	56%	9%
Silver	53%	77%	100%	63%	50%	39%	
Vanadium	93%	39%	100%	127%	105%	82%	
Zinc	74%	64%	100%	87%	47%	33%	19%

5.6 Organics

The few detections of organic compounds showed no patterns.

6 Summary

Most of the data do not support the determination of any differences between water quality in the ditches and in the estuary, under wet conditions or dry. Wet weather samples at Goose did appear to have some elevated constituents at the head of the ditch, where a fresh water input may be described. The most sensitive analysis, for trace metals using clean metals techniques, found that some of the data did indicate higher concentrations within the ditches compared to concentrations in the estuary. However, there did not appear to be any indications that the ditches transmit contaminants to the estuary, as the data did not conform to any of the overall patterns described in the introduction (which were intended to describe clear evidence that ditches transmit contaminants to the estuary or serve as a source of contaminants of concern to the estuary).

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