Characterization and Analysis of Parking Lot Residue Using Regenerative Wet Vacuum Street Sweeper, Rehoboth Beach, DE

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Funding

- NPS 319 grant
- DelDOT sampling match
- Watershed Assessment laboratory analysis match

Why Street Sweeping?

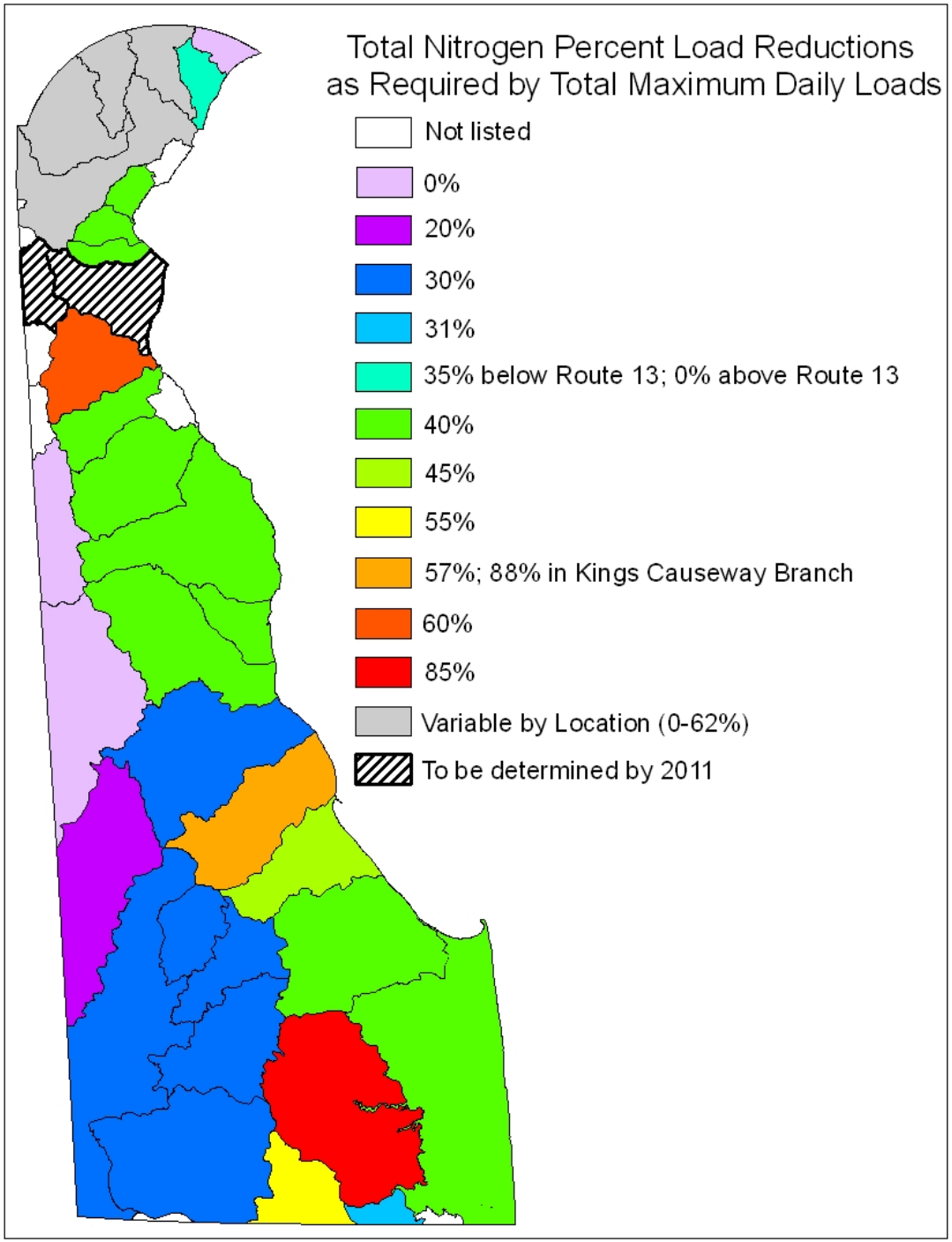
- Considered by most stormwater managers to be acceptable BMP to remove pollutants
- Very little data exists, especially for parking lots
- Stormwater managers, nationwide, are currently using street sweeping as a pollution control measure

Project Goals

- To gain greater insight on the effectiveness of parking lot sweeping using a vacuum-type sweeper
- To implement a Best Management Practice (BMP) that will help to improve water quality in the Inland Bays Watershed, Delaware

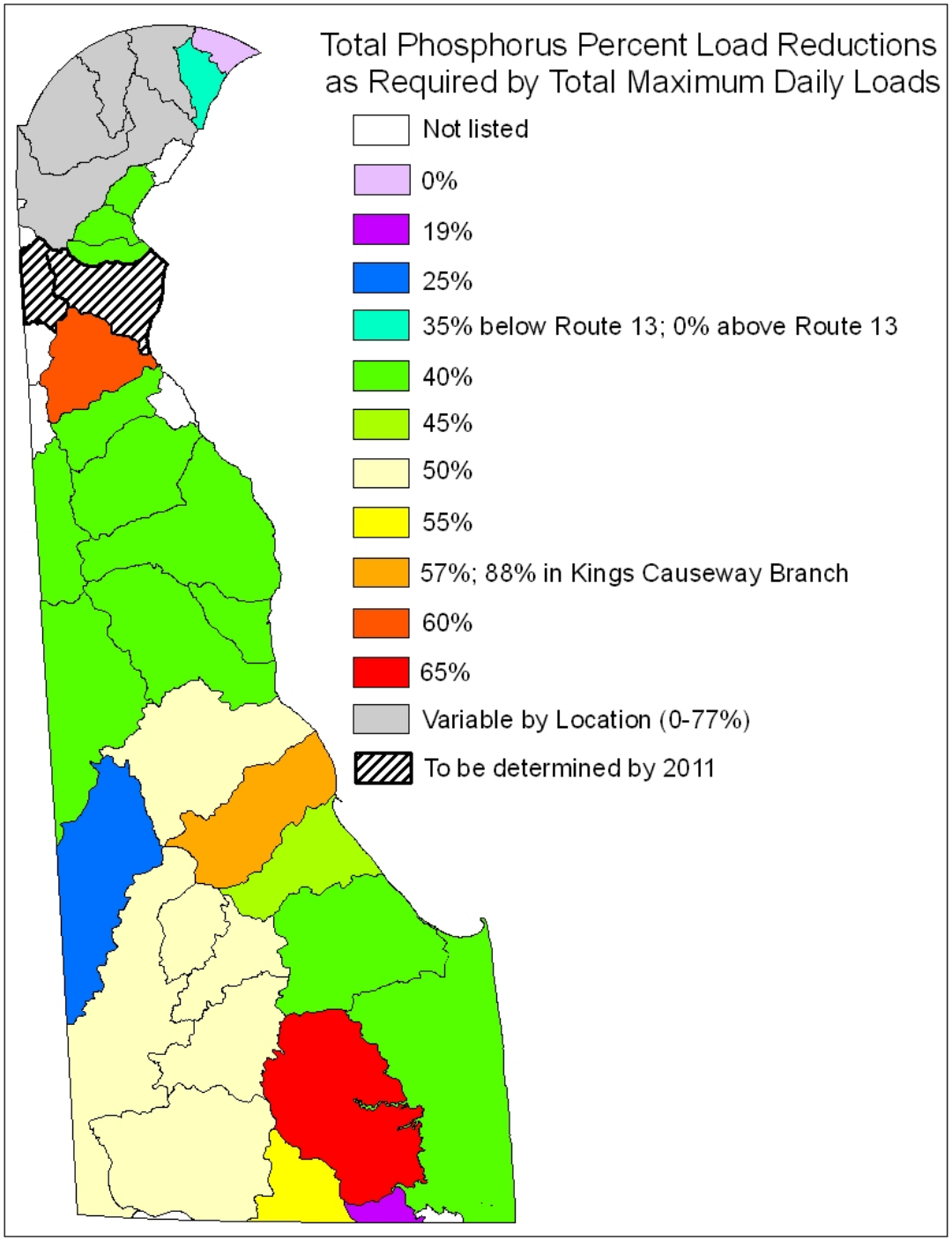
Nitrogen TMDL

- **Reduce by 40% for Inland Bays Watershed**



Phosphorus TMDL

- Reduce by 40% for Inland Bays Watershed



Business Selection

- Initial selection
  - Inland Bays Watershed
  - Large contiguous parking lots
  - One maintenance entity

Phone Survey

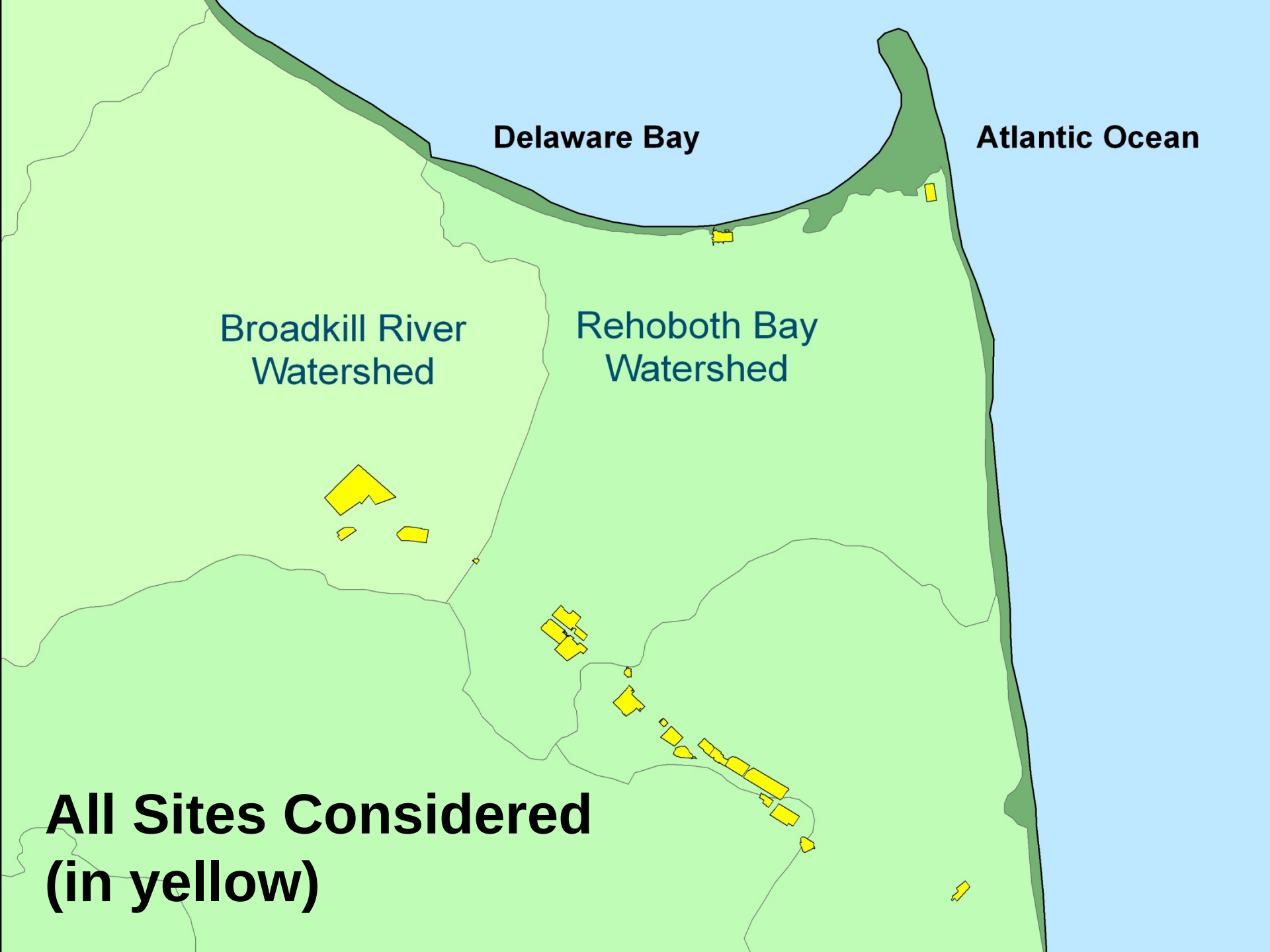
- Identify responsible party
  - Property management company
  - Owner
- Questions
  - Sweeping or not sweeping?
  - How often?
  - Vacuum sweeper or not?
  - Interest in participating in free sweeping as part of a study?

Final Business Selection

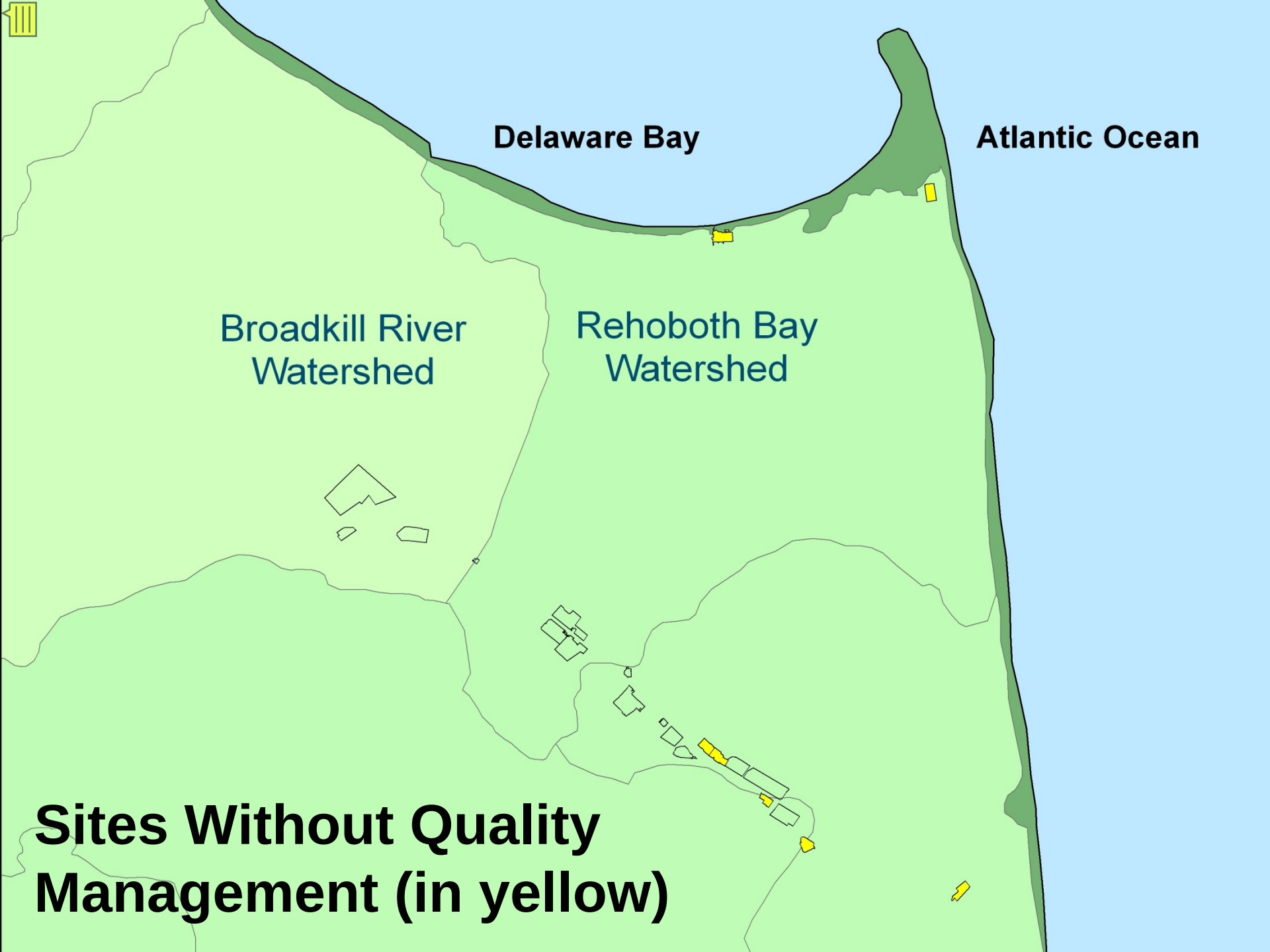
- Preference
  - Businesses not currently sweeping
  - Business with no water quality treatment (pre-1991 developments)
  - Rule out other circumstances (i.e.. unwilling property owner, short-term use)

Challenges

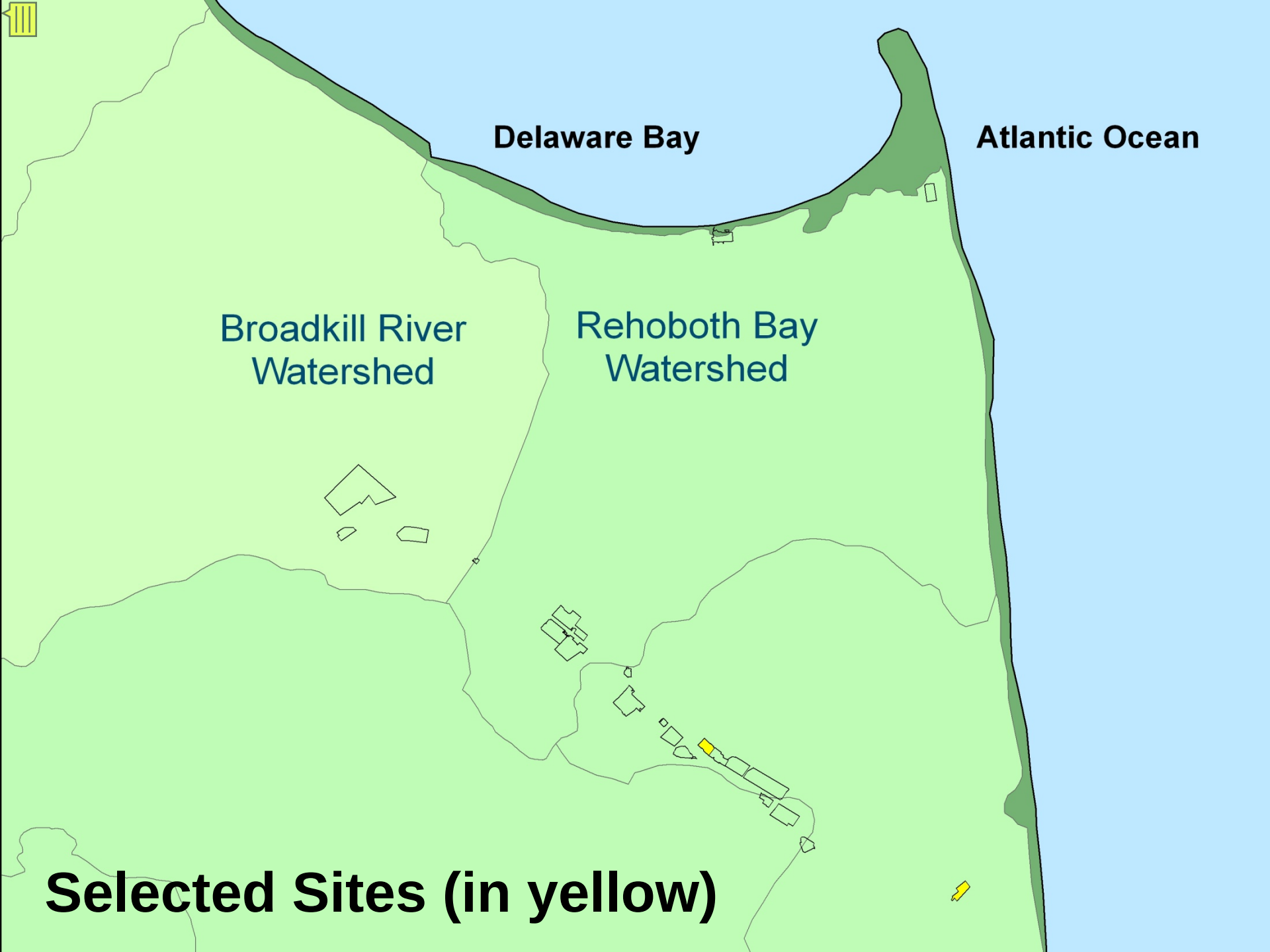
- Identifying maintenance entity
- Many businesses already street sweeping
- Participation
  - Fear of liability
  - Fear of fines (working with DNREC)


Delaware Bay
Atlantic Ocean
Broadkill River Watershed
Rehoboth Bay Watershed
All Sites Considered (in yellow)

Sites Not Sweeping (in yellow)



Sites Without Quality Management (in yellow)


Delaware Bay
Atlantic Ocean
Broadkill River Watershed
Rehoboth Bay Watershed
Selected Sites (in yellow)

Site Characterization

- Sites considered
  - Range: 0.7 Ac - 63.3 Ac
  - Mean: 10.9 Ac
- Sites Selected
  - Inland Bays Watershed
  - Asphalt Surface
    - Site 1: 4.145 Ac
    - Site 2: 2.821 Ac

Sites Selected

- Highly urban
- Atlantic Ocean to the east
- Poultry and farming to the west
- Seasonal tourist traffic
- Sand – predominant soil type

METHODS

Pollutant Removal From Street Sweeping (%)

Frequency	Technology	TSS	TP	TN
Monthly	Mechanical	9	3	3
	Regenerative Air/Vacuum	22	4	4
Weekly	Mechanical	13	5	6
	Regenerative Air/Vacuum	31	8	7

(Center for Watershed Protection 2008)

Sweeper Selection

- Schwarze
  - Spray bar
  - Vacuum sweeper
- Obtained Schwarze recommendation (office headquarters, Georgia)
- Two contractors in 30-mile radius
  - S 343 D
  - S 347 Lite

Sweeping & Sampling

- Lots swept 2 x /week for 13 months
  November 2006 – December 2007

- Contents sampled 1x /month for 13 months
  November 2006 – December 2007

TLC
MOBILE POWERSWEEPING
Georgetown, DE
(302) 856-3323
TLC
LE POWERSWEEPING
3323

STOP
TLC

Marlboro
2006/11/04

TLC
MOBILE POWERSWEEPING

2006/11/15

TLC
MOBILE POWERSWEEPING
SCHWARZE INDUSTRIES
HUNTSVILLE, AL
STOP

Physical Data Collection

- Sieve analysis
  25 mm, #5, #10, #60, #230, bottom pan
- Debris
- Garbage
- Cigarette butts
- Organic matter
- Approximation of total volume collected per sweep

Chemical Data Collection

- Total Petroleum Hydrocarbons
- Total Nitrogen
- Phosphorus
- Zinc
- Copper
- pH
- Salts
- Chloride

RESULTS
&
DISCUSSION

Phone Survey Results

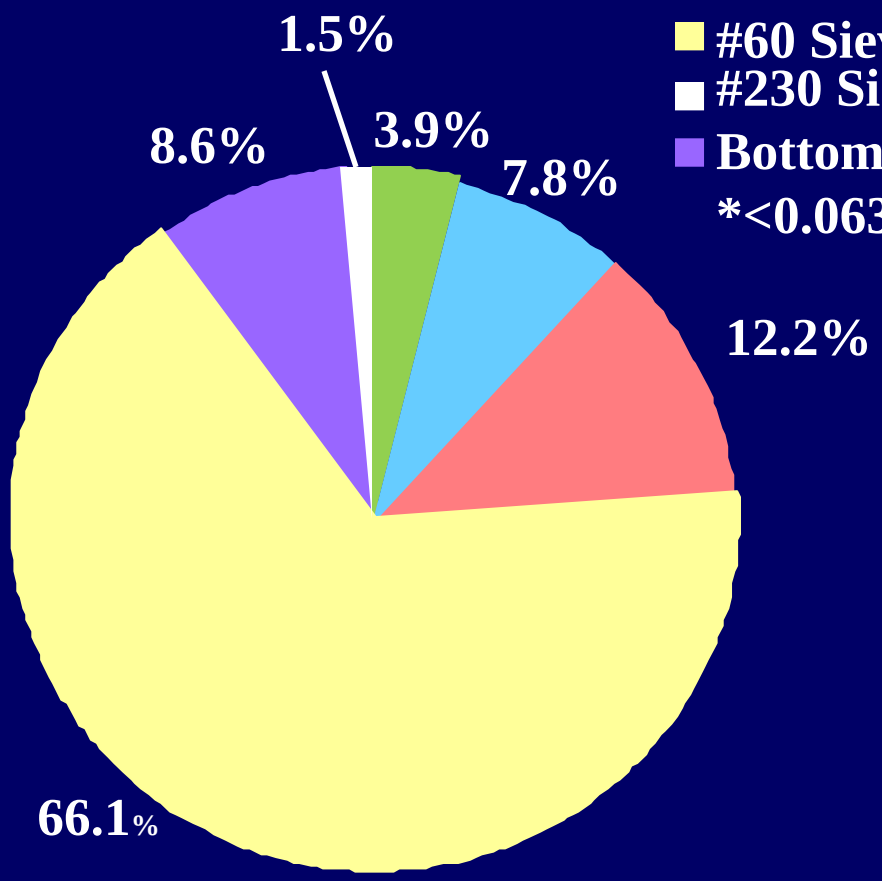
- 45.8% of businesses already performing sweeping (24 sites considered)
- 41.6% performing bi-weekly sweeping
- 83% of those sweeping used vacuum-type sweeper
- All swept lots for aesthetics (not water quality)

Phone Survey Results

	Inland Bays Watershed (n=24 sites)	Chesapeake Bay Watershed (n=19 communities)
Street sweeping performed (>1x/yr)	45.8%	47%
Bi-weekly	41.6%	12%
% vacuum sweepers	83%	11%

(Center for Watershed Protection 2007)

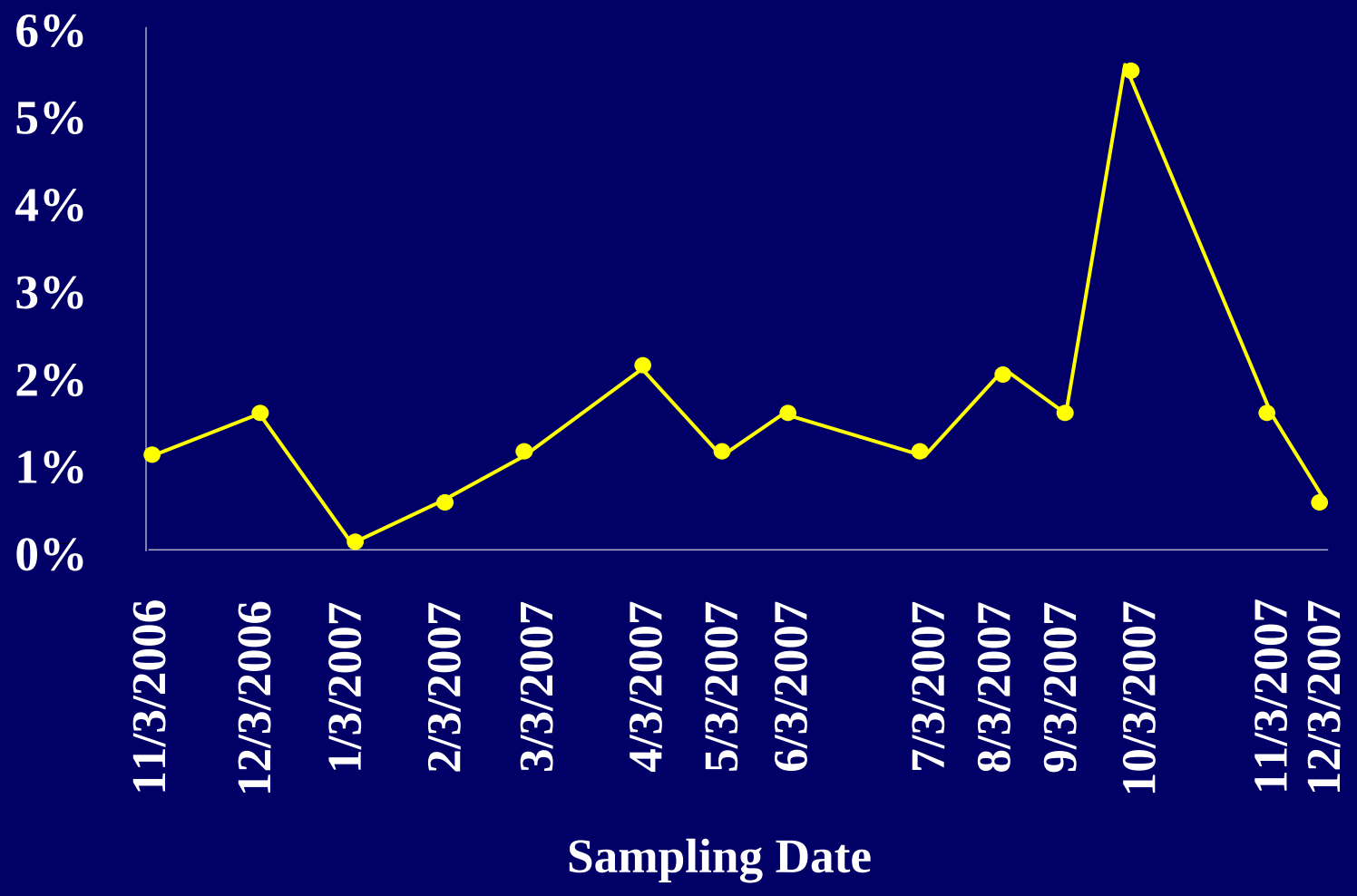
Average Percent by Volume Retained on Sieve



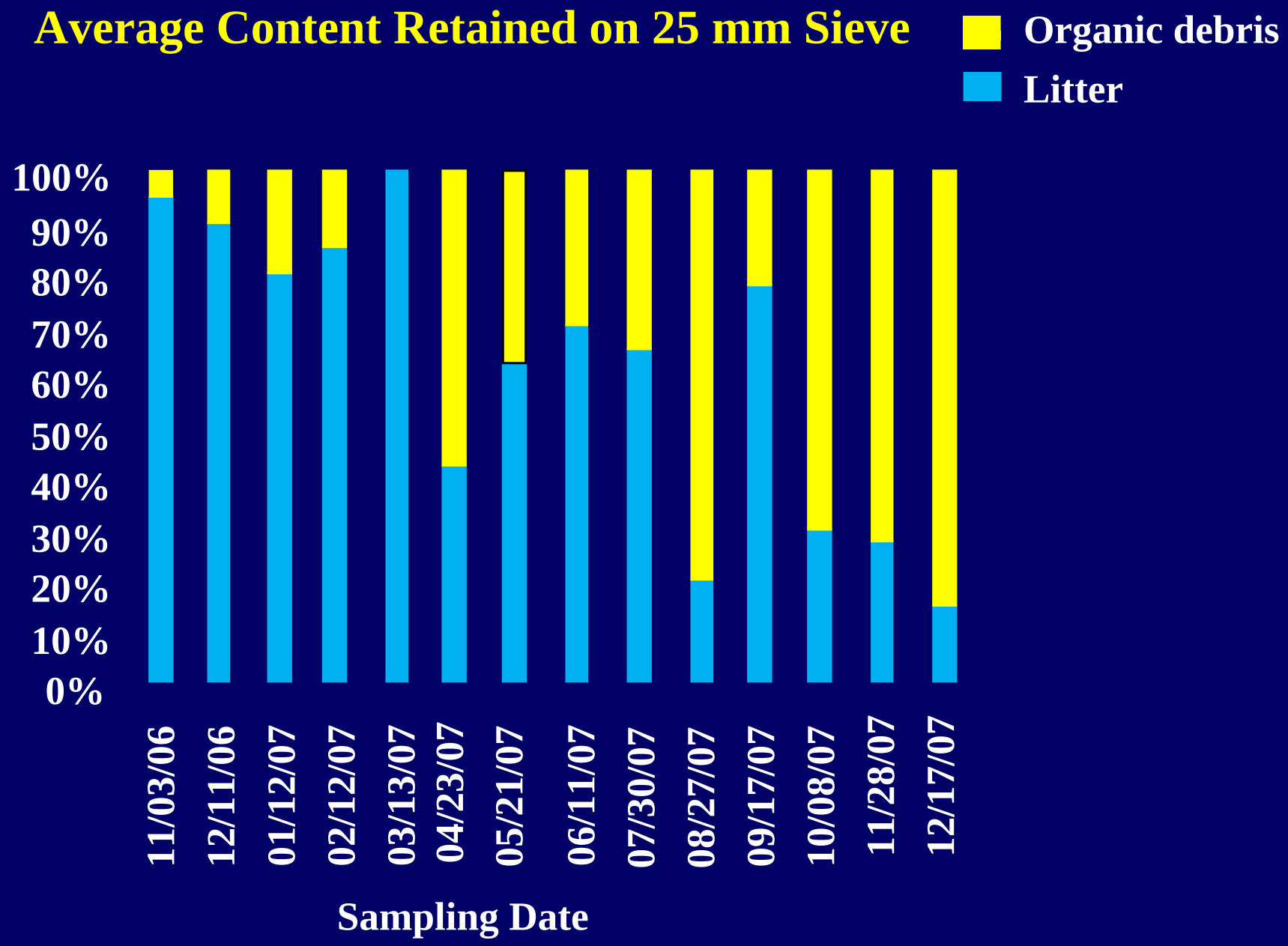
- 25 mm Sieve (litter, organic matter)
- #5 Sieve (litter, stones, organic matter)
- #10 Sieve (sand, organic matter)
- #60 Sieve (sand, organic matter)
- #230 Sieve (powder)
- Bottom Pan (dust)

*<0.063 mm passed through #230 sieve

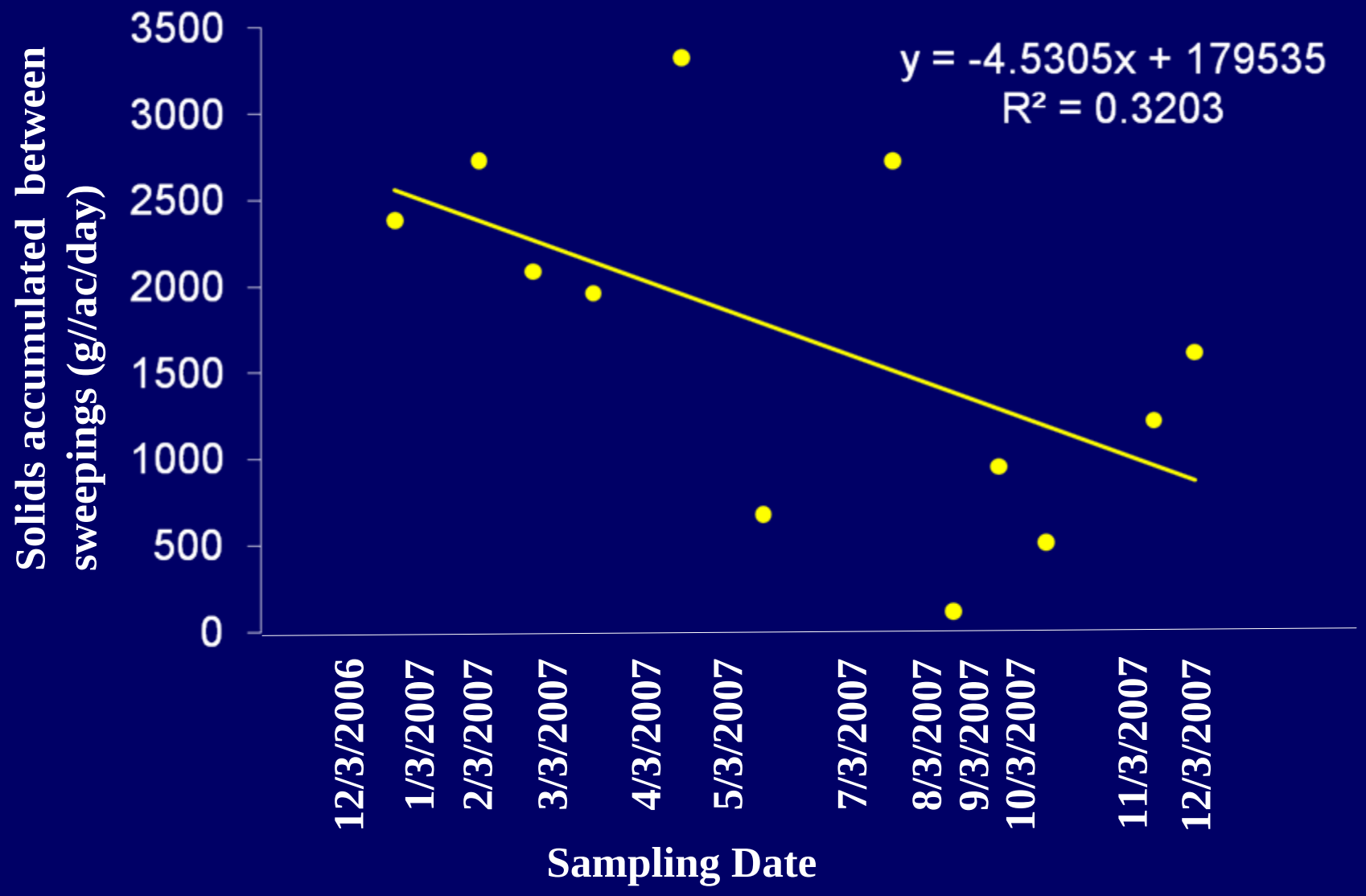
Percent by Volume Passing Through #230 sieve (<0.063 mm)



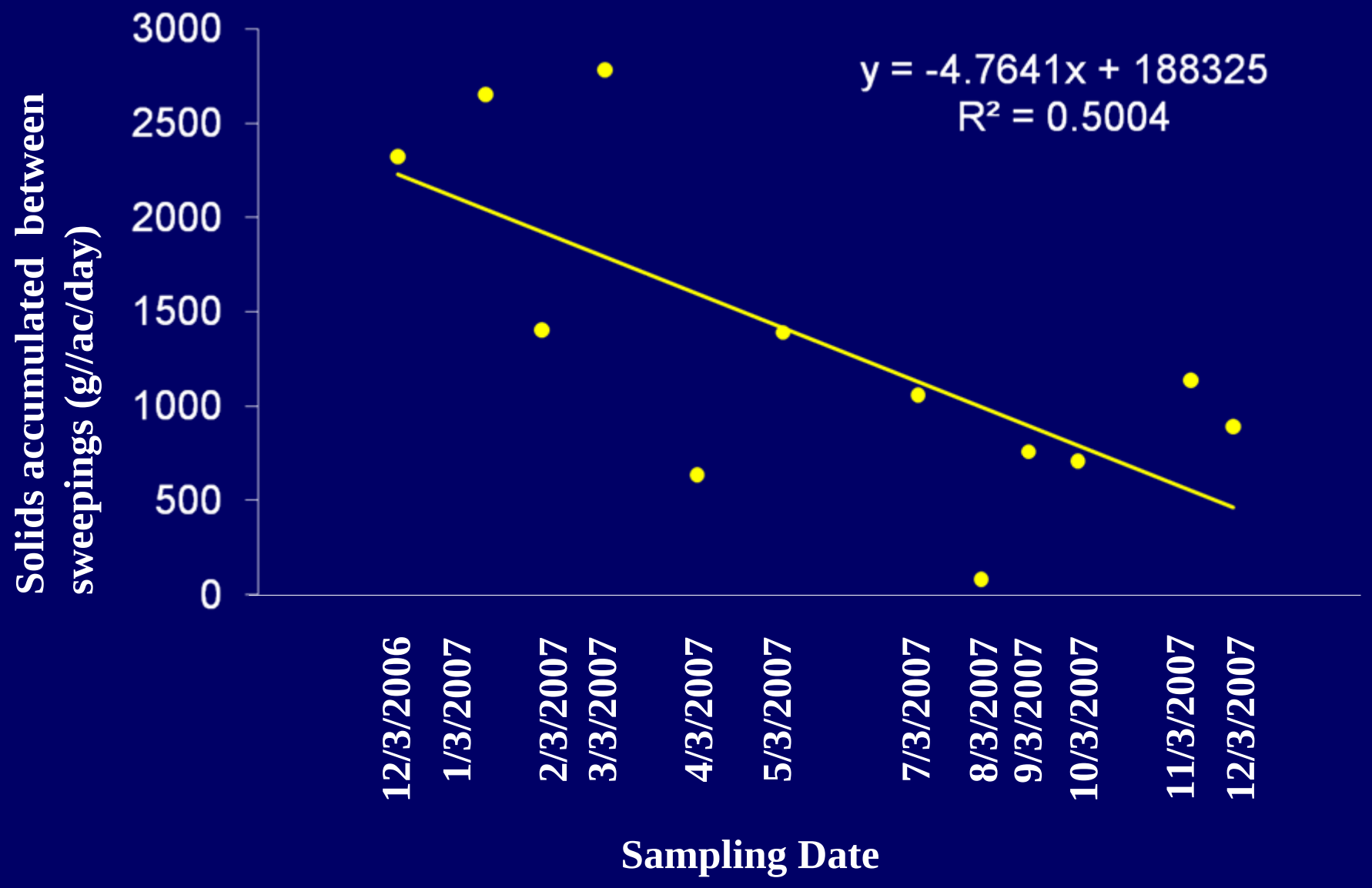
Average Content Retained on 25 mm Sieve



Solids Accumulation Between Sweepings (g/ac/day) for Site 1



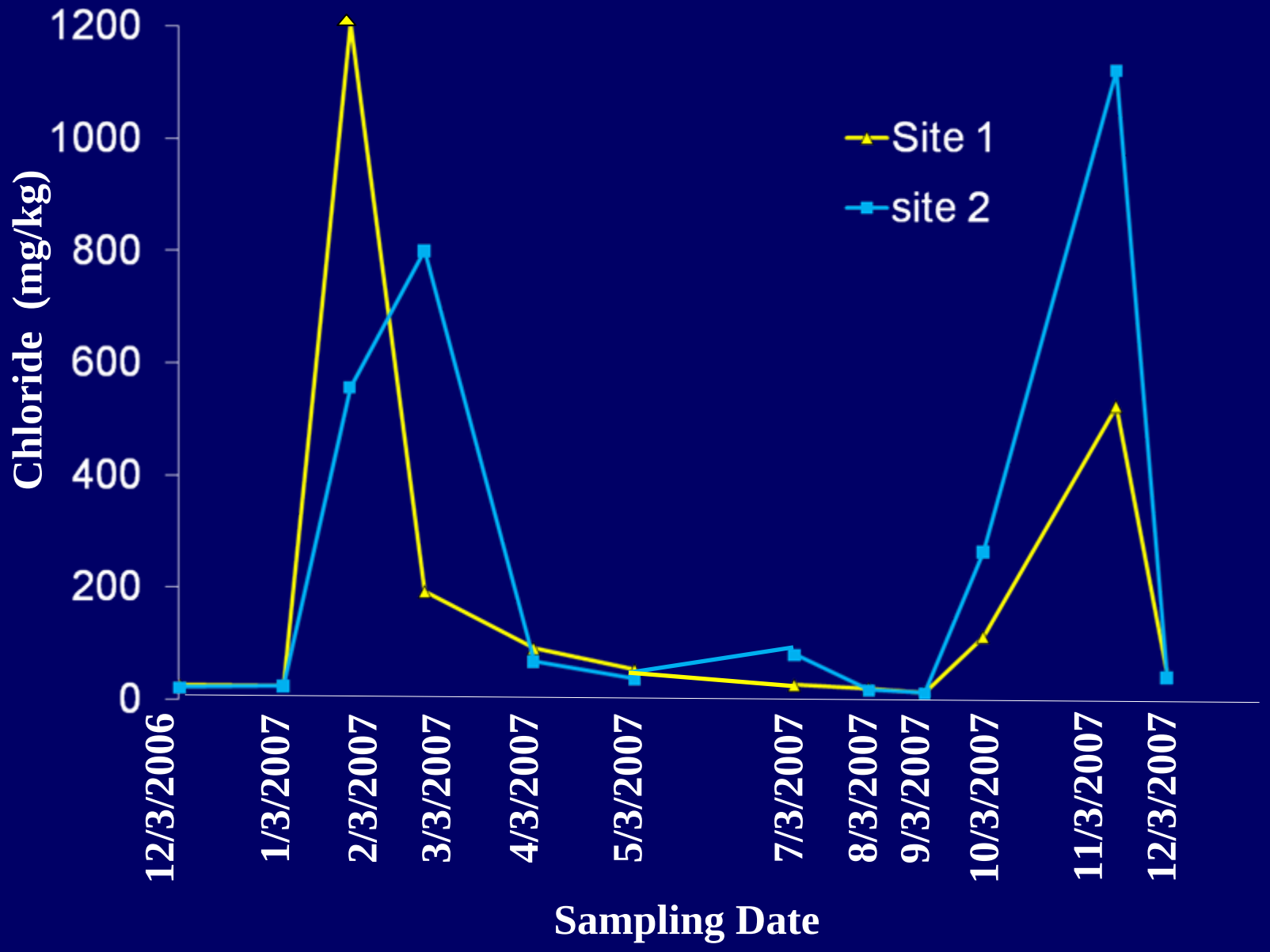
Solids Accumulation Between Sweepings (g/ac/day) for Site 2



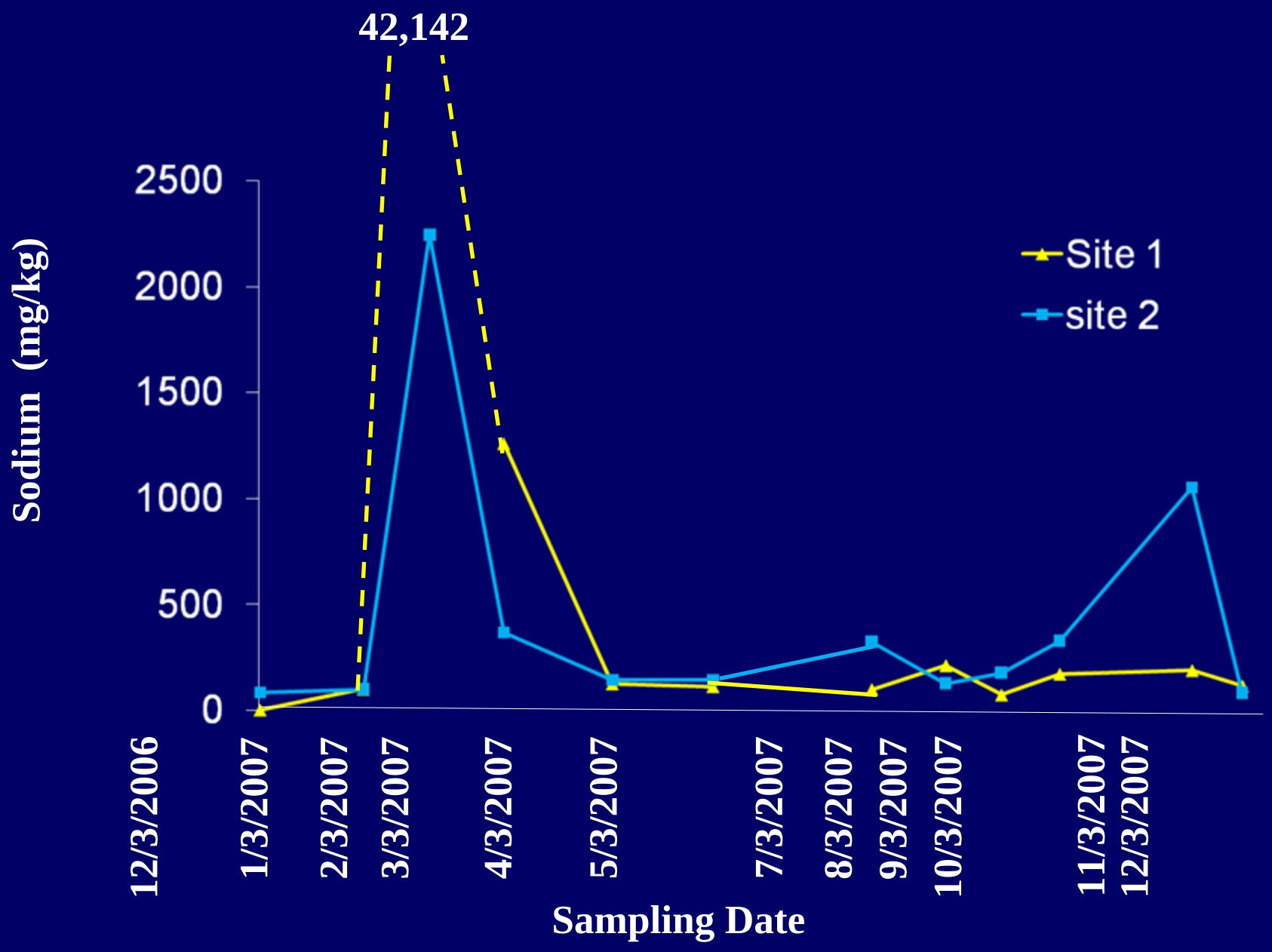
Estimate of the Annual Median, Minimum and Maximum Removed (lbs/acre)

	Median (lbs/Ac)	Min (lbs/Ac)	Max (lbs/Ac)
Chloride	0.019	0.002	1.918
Copper	0.010	0.003	0.282
Nitrate/nitrite	0.001	0	0.009
Petroleum Hydrocarbons	**0.453**	**0.011**	**4.986**
Total Phosphorus	**0.123**	**0.016**	**1.418**
Sodium	0.055	0	17.445
Total Kjeldahl Nitrogen	0.276	0.002	1.918
Total Nitrogen	**0.277**	**0.277**	**10.198**
Zinc	0.027	0.008	0.397

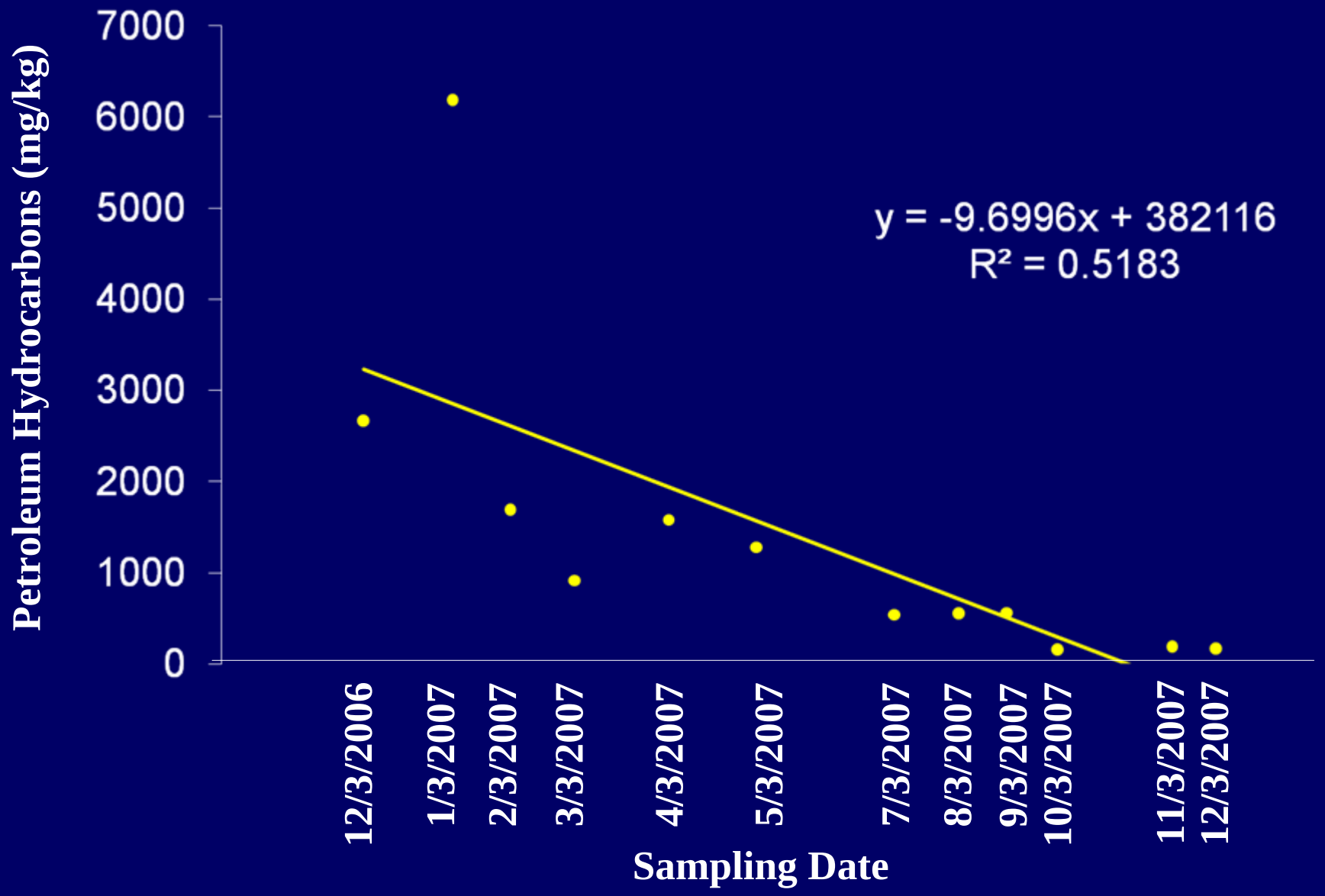
Concentration for Chloride (mg/kg) by Sampling Date



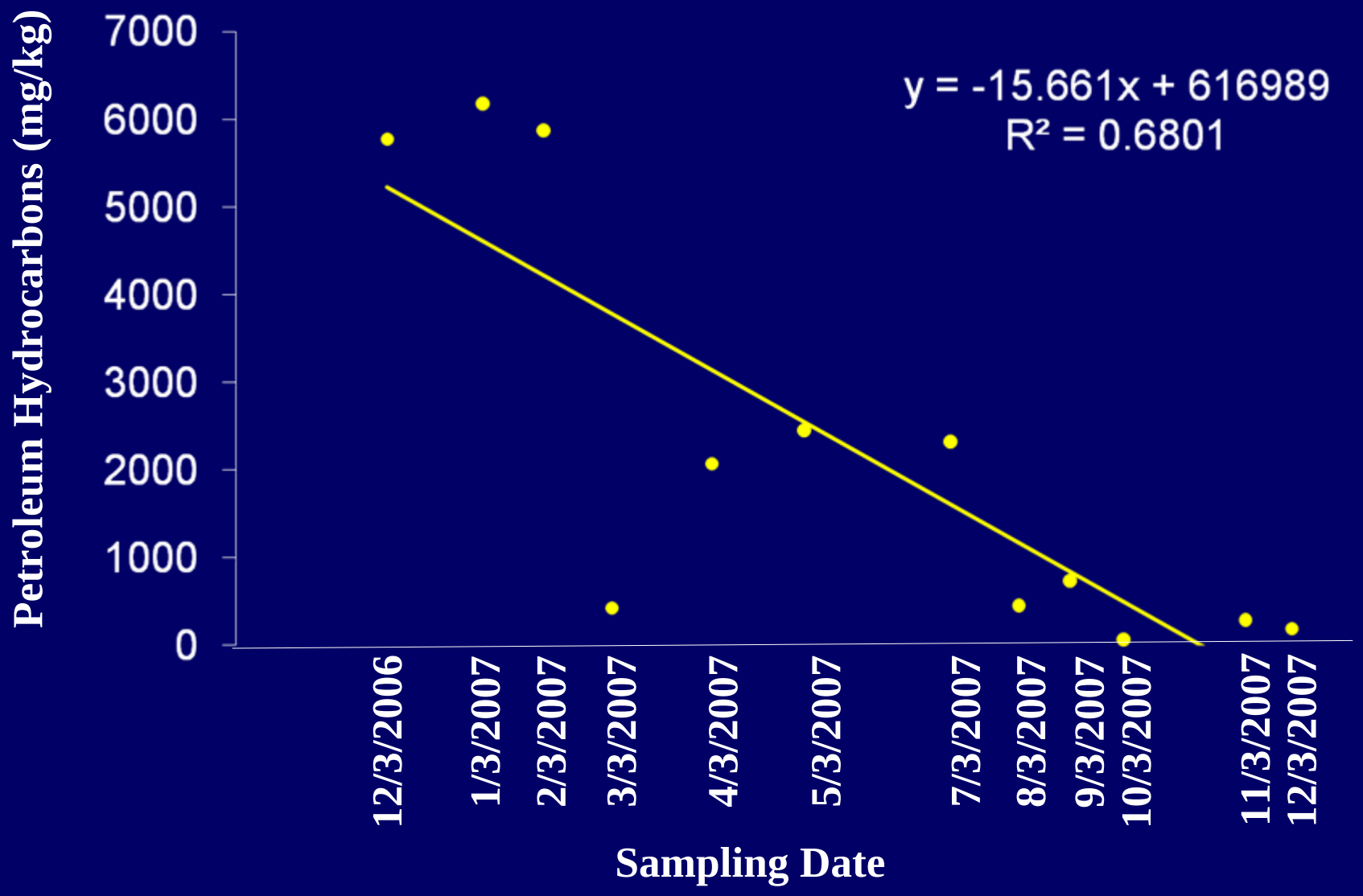
Concentration for Sodium (mg/kg) by Sampling Date



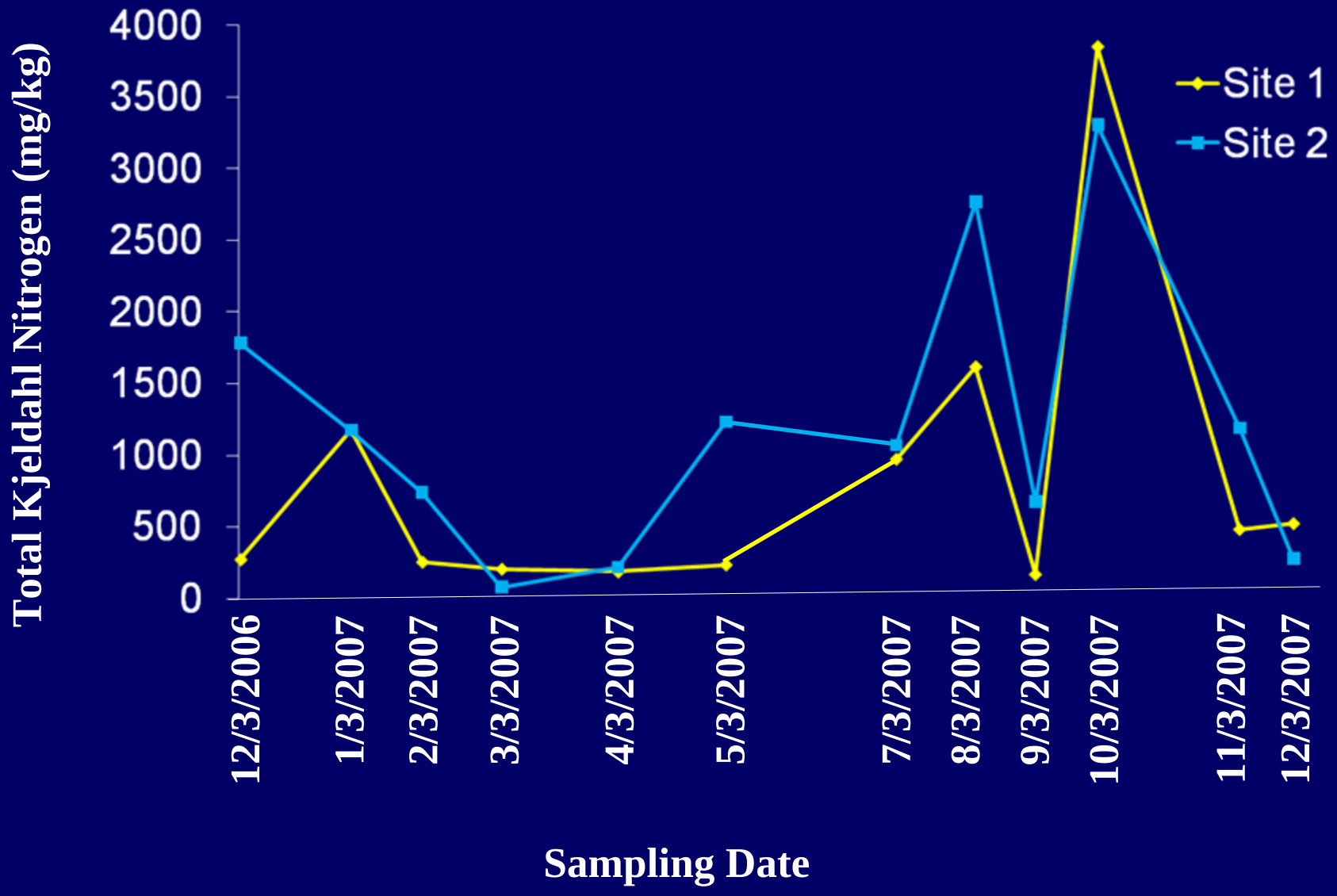
Relationship Between Petroleum Hydrocarbon Concentration and Sampling Date (Site 1)



Relationship Between Petroleum Hydrocarbon Concentration and Sampling Date (Site 2)



Relationship Between Total Kjeldahl Nitrogen and Sampling Date



Conclusions

- General reduction in petroleum hydrocarbons on parking lots over 1-year period
- General decrease in solids accumulation over 1-year
- Overall decrease in litter for % composition over time
- Removal rates for N and P were within expected range for street sweeping

Acknowledgements

- Delaware Department of Transportation
- KCI
- Delaware Department of Natural Resources and Environmental Control, Watershed Assessment
- Delaware Department of Natural Resources and Environmental Control, Nonpoint Source Section
- Center for Inland Bays
- Nelson Ortiz (TLC)