Sources of Mercury to New Jersey's Environment and TMDL Development: What's New?

Mike Aucott, Ph.D.
NJDEP Division of Science, Research & Technology
PO Box 409, Trenton, NJ 08625-0409
609-292-7530
Michael.Aucott@dep.state.nj.us

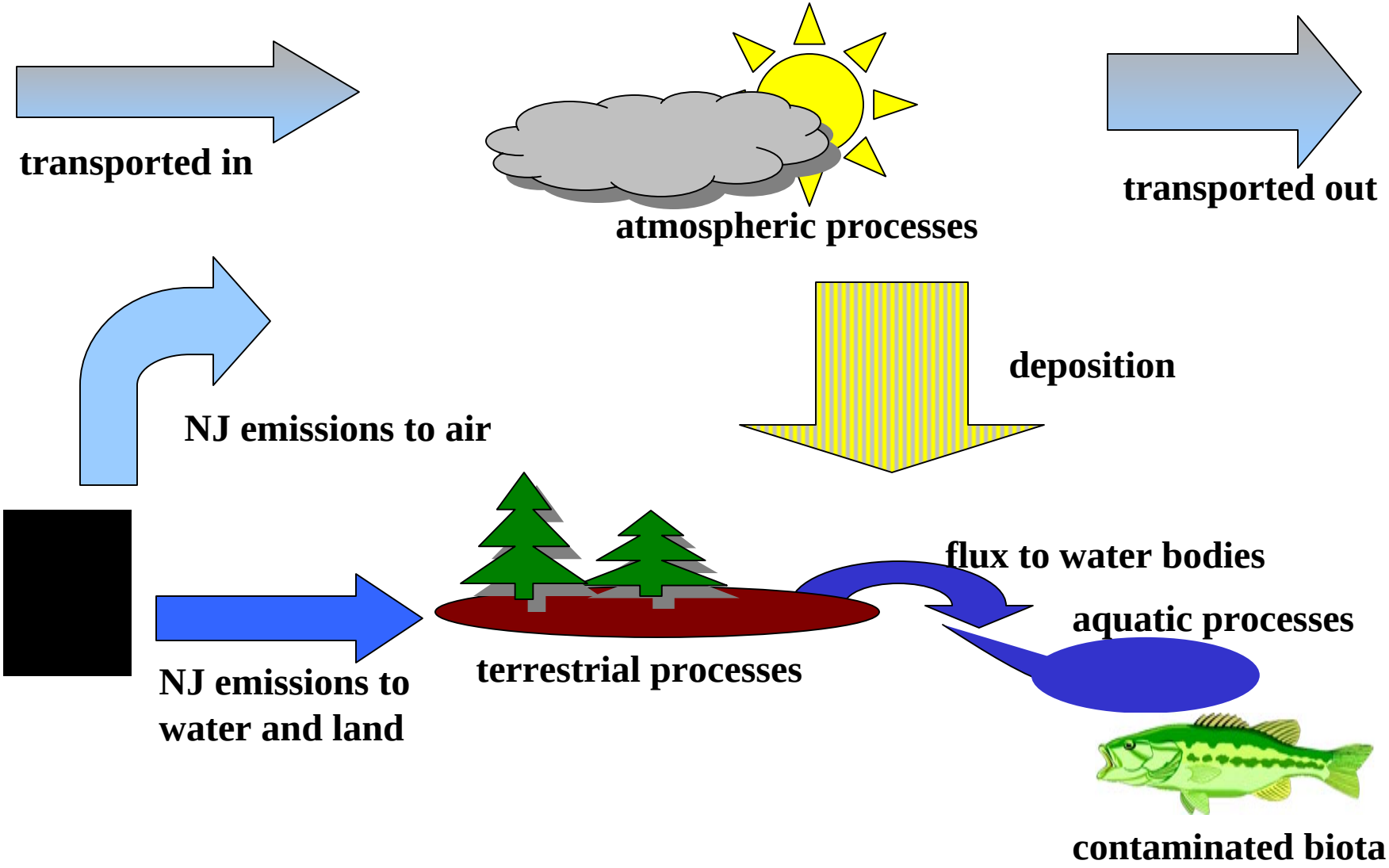
Thanks to my colleagues who have helped with this work, especially

Adriana Calle, Alan Dresser, Randy England, Mike McLinden, Charlie Pietarinen, Anne Witt, and Rudy Zsolway

TMDL Development Needs

- Good data on **sources** of releases to environment, both point, non-point, and background
- Clear understanding of current conditions of a water body, including its assimilative capacity and margin of safety and whether implementation of technology-based effluent limitations will result in attainment of water quality standards. Such understanding requires awareness of the **mercury cycle**.
- Plan for implementation of TMDL, follow-up monitoring, and public participation

Mercury cycle: key aspects

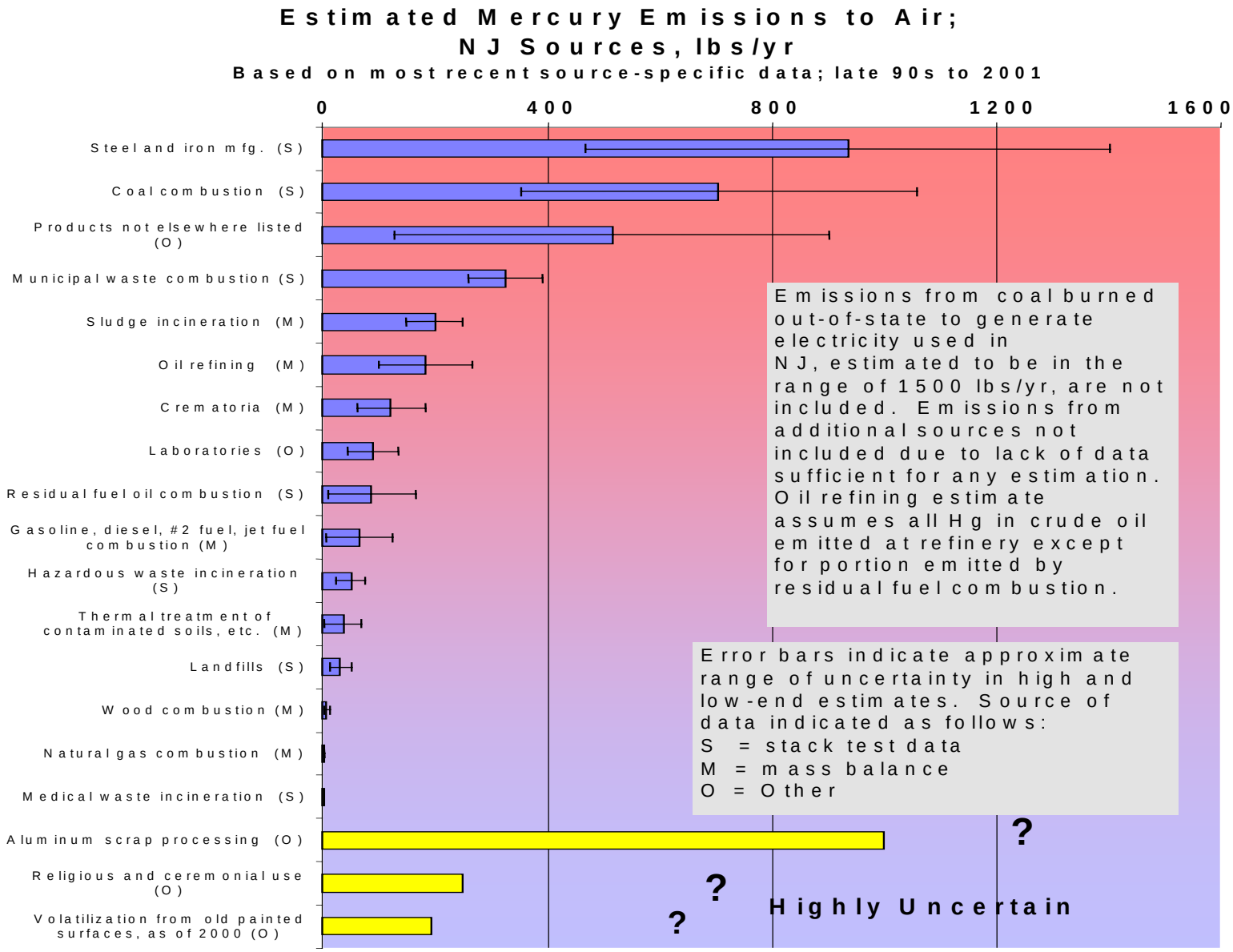


Emissions to water and land

- NJ Mercury Task Force estimated discharges to water were in the range of 1000 lbs/y
- New data on mercury contributions to wastewater
  - NY Academy of Sciences study estimated that emissions to water and land were a larger source of mercury to the NY/NJ harbor than air emissions
  - Evidence from a number of sources indicates dental offices contribute in the range of 50% of the mercury (in the form of amalgam particles) in wastewater, and that in NJ this may total in the range of 500-600 lbs/y; installation of amalgam separators could cut this source by >95%

Emissions to air

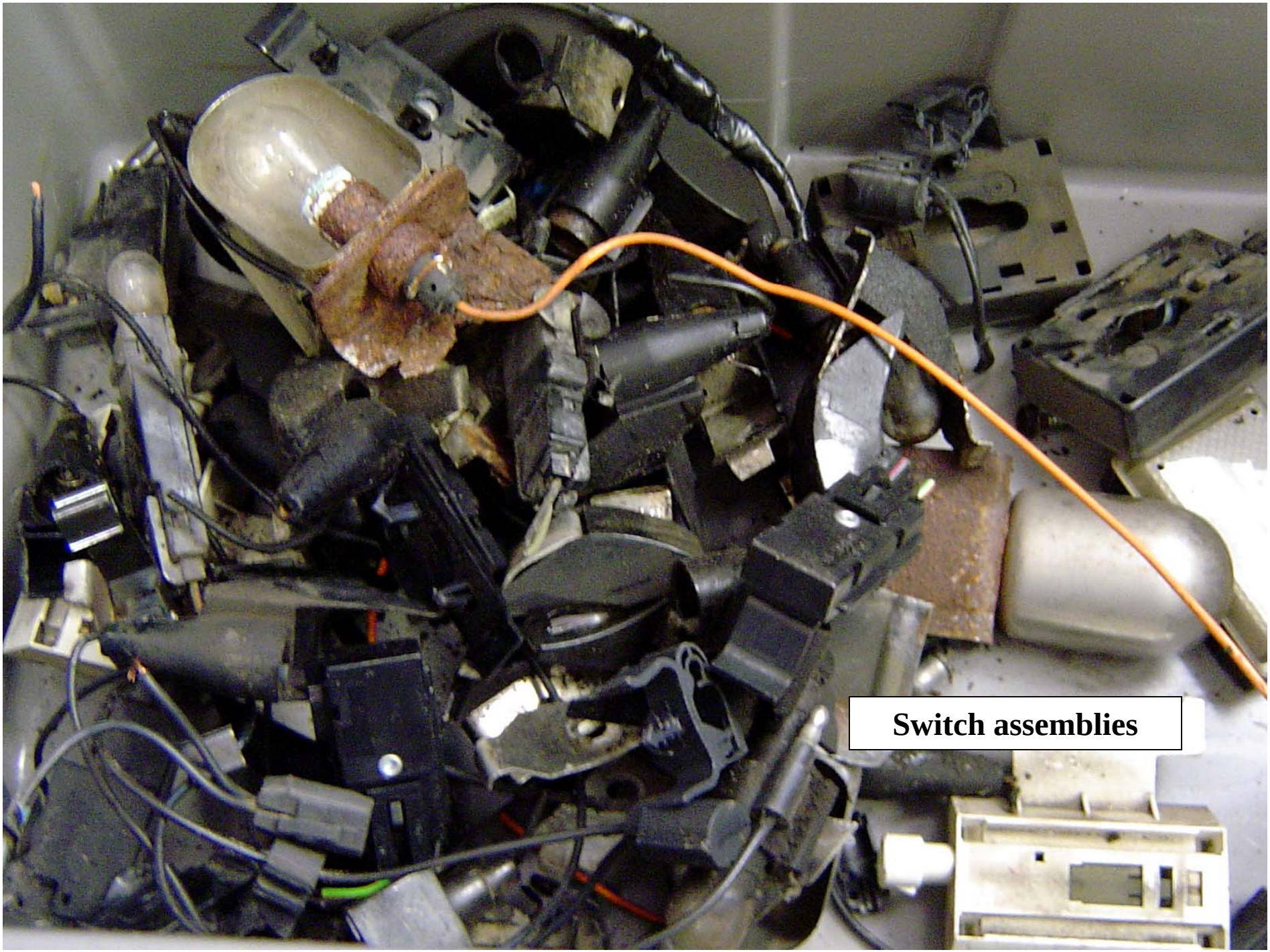
- Source estimates of NJ Mercury Task Force
- New data indicates
  - Much of the Hg emitted by iron and steel plants could come from mercury switches in discarded motor vehicles
  - Fluorescent tube breakage probably contributes > 200 lbs/y
  - Data from continued stack testing of coal-burning power plants, MSW incinerators, and iron & steel mfgrs. is consistent w. Task Force estimates
  - New NJDEP rules will soon substantially reduce emissions from iron & steel plants, coal-burning plants, and MSW incinerators
- Significant uncertainties remain for some sources and potential sources

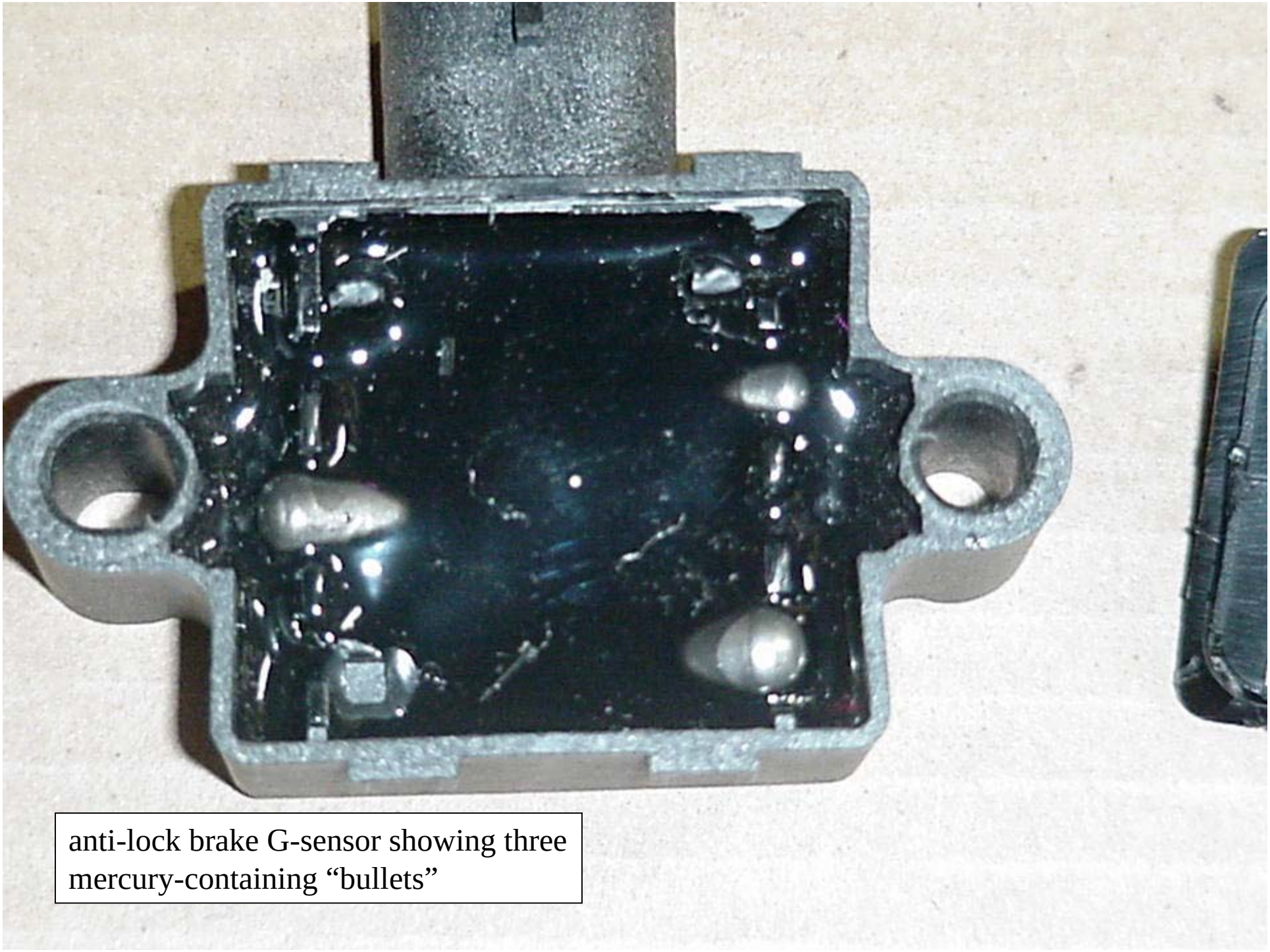


From: NJDEP, 2002, NJ Mercury Task Force Report, Volume I, p. 19,
http://www.state.nj.us/dep/dsr/mercury_task_force.htm

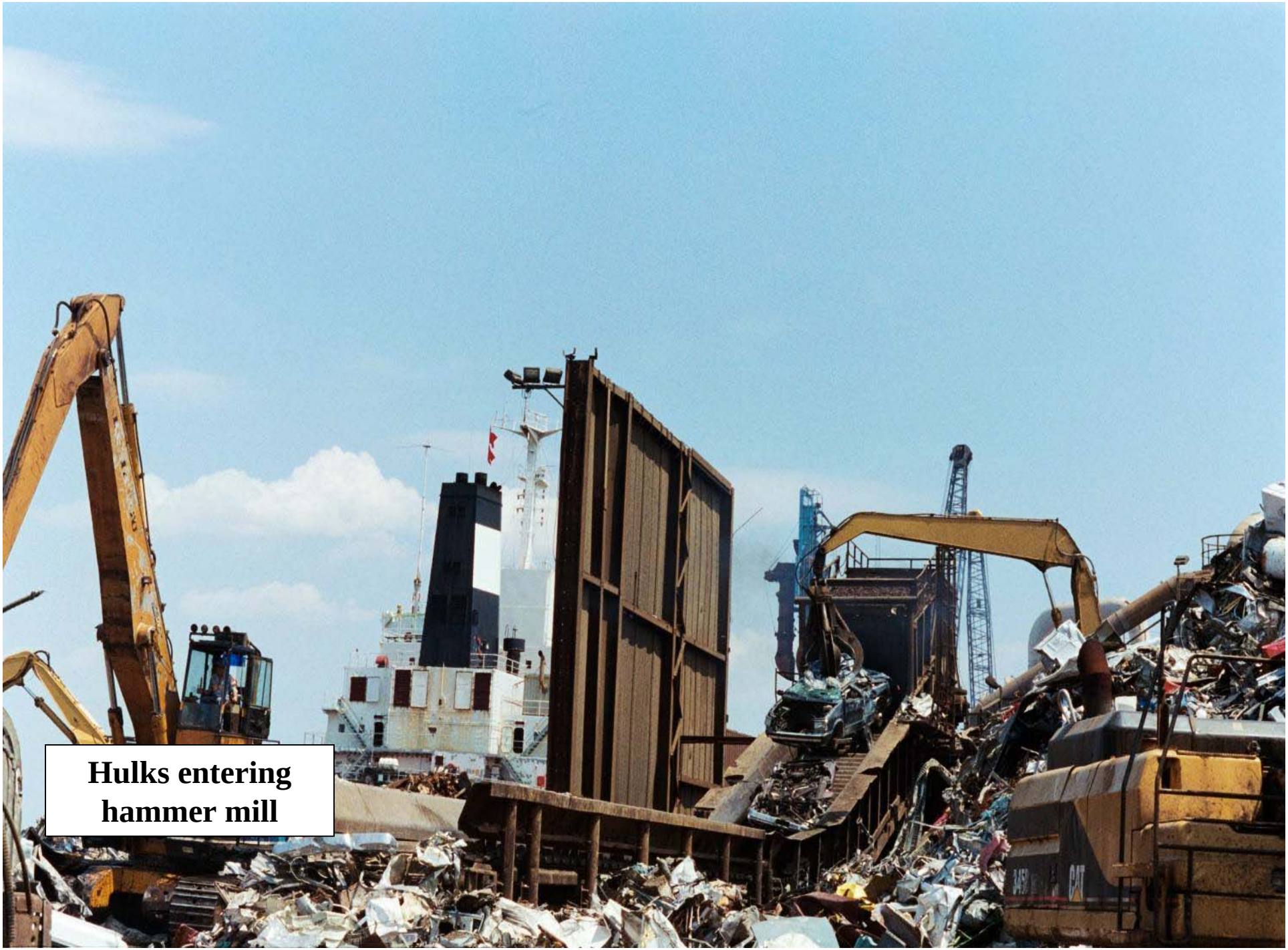

NJ steel manufacturing plant

dismantled end-of-life vehicles


Switch assemblies



anti-lock brake G-sensor showing three mercury-containing “bullets”


Hulks entering
hammer mill

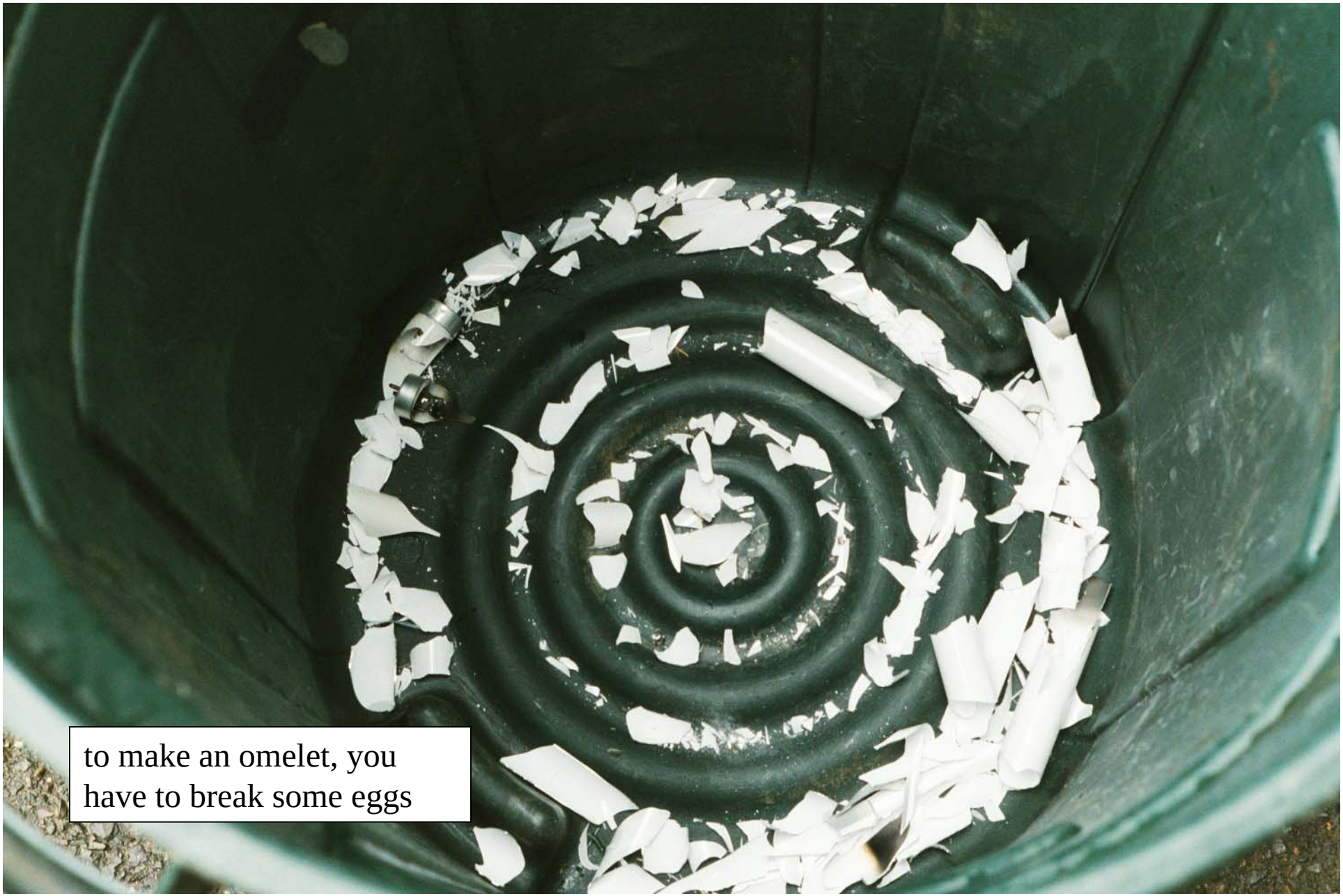

Shred


Scrap metal feedstock

coal-burning power plant (Mercer)

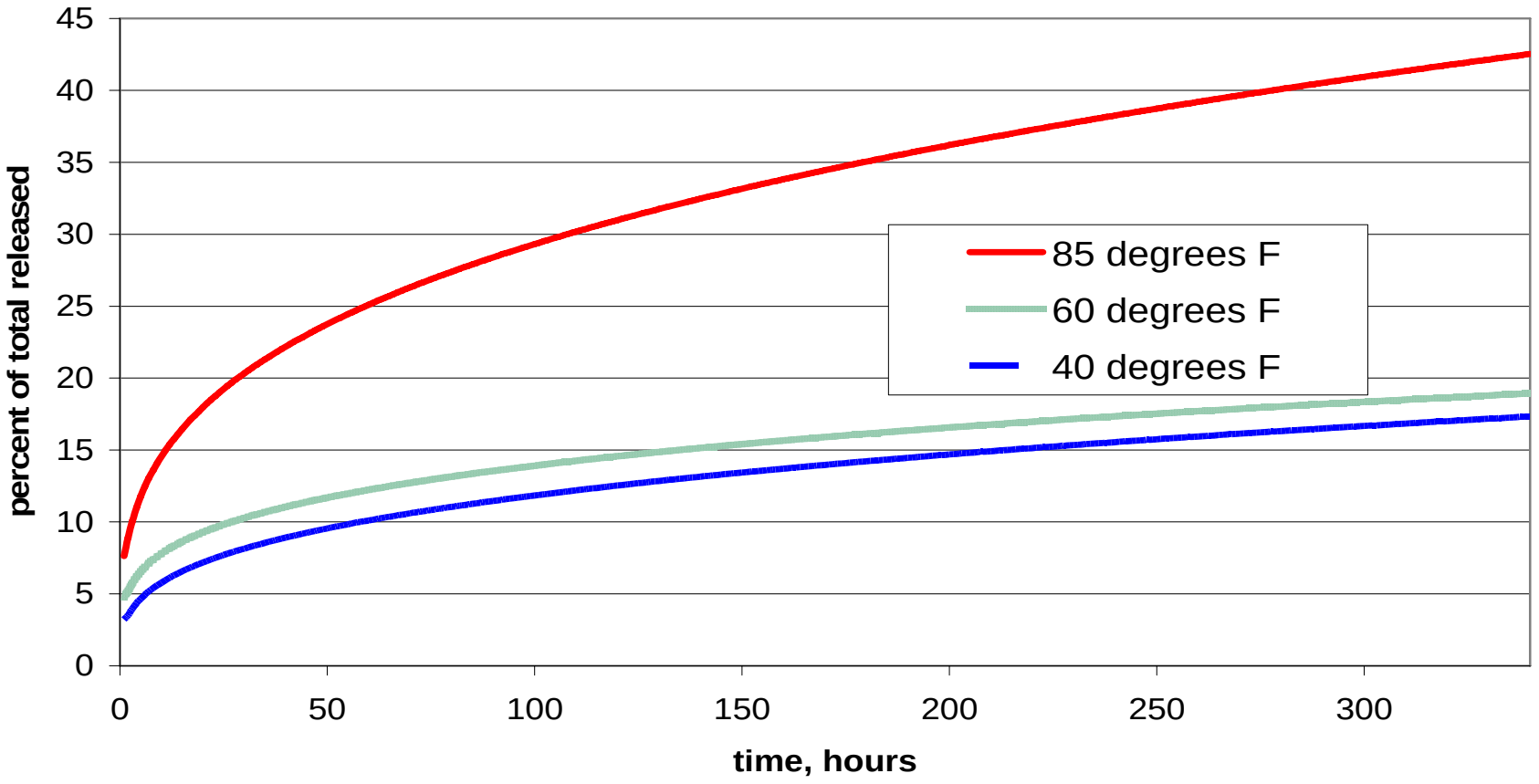
Essex resource recovery facility

fluorescent tubes awaiting recycling


to make an omelet, you
have to break some eggs

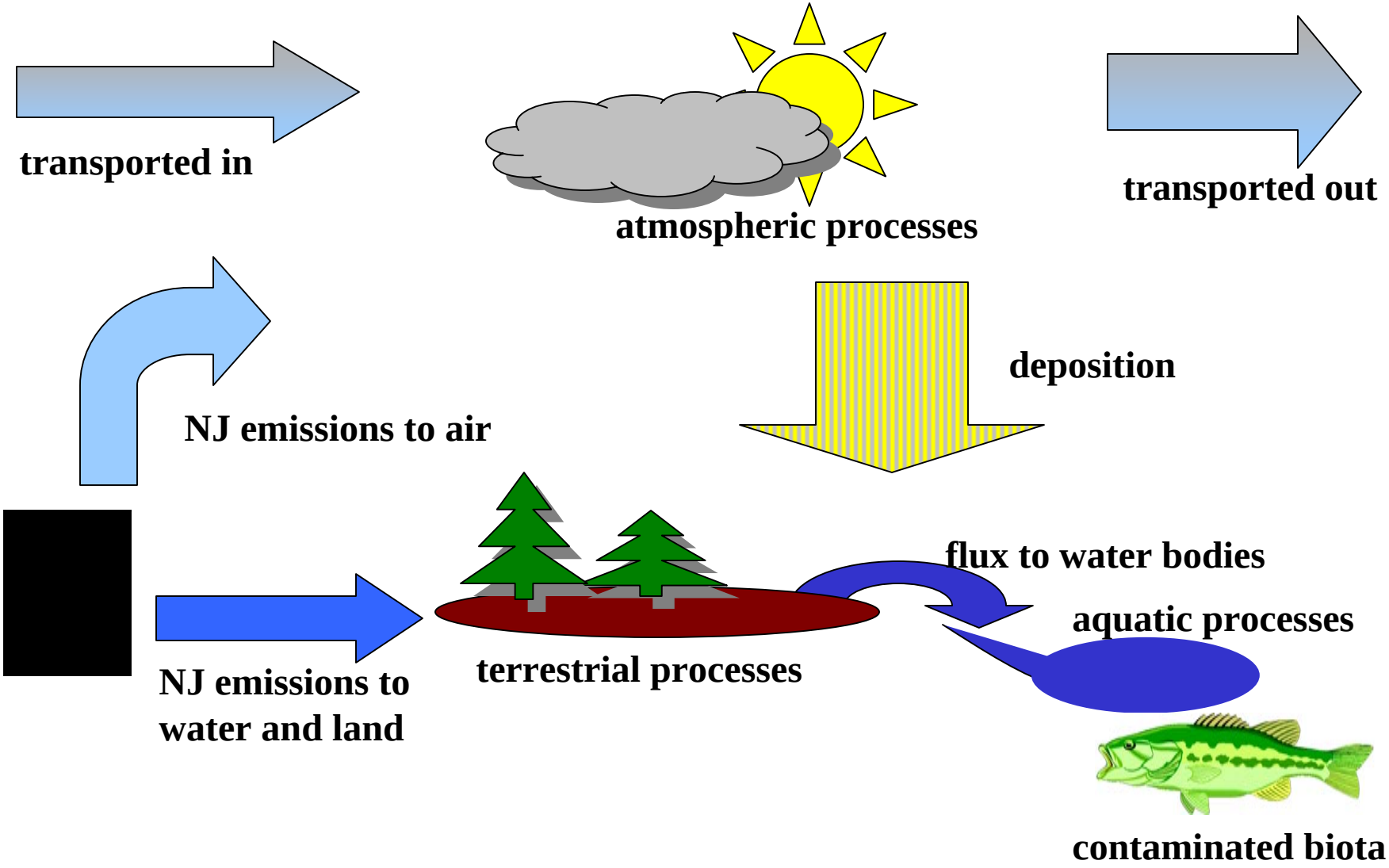
measuring mercury with the Jerome unit

Cumulative release of mercury from broken fluorescent tubes at three different temperatures



From: Aucott, Michael, Michael McLinden, and Michael Winka, 2003, Release of Mercury from Broken Fluorescent Bulbs, J. Air & Waste Manage. Assoc. 53:143-151.

Mercury cycle: key aspects



Atmospheric deposition

- NJ Mercury Task Force estimated about 1100 lbs/y falls on the state, including both wet and dry deposition.

- NJ Atmospheric Deposition Network (NJADN) - mean wet deposition of 12.1 ng/l; statewide deposition of about 13.8 µg/m2/y, (600 lbs/y). Variation suggests local factors important.

- Additional monitoring shows wet deposition in Warren County of 10.6 µg/m^2/y.

- Sediment studies at six NJ lakes find relatively recent and historic deposition rates were higher; much higher at one site. May reflect greater emissions earlier and also that dry deposition's contribution may be higher than thought

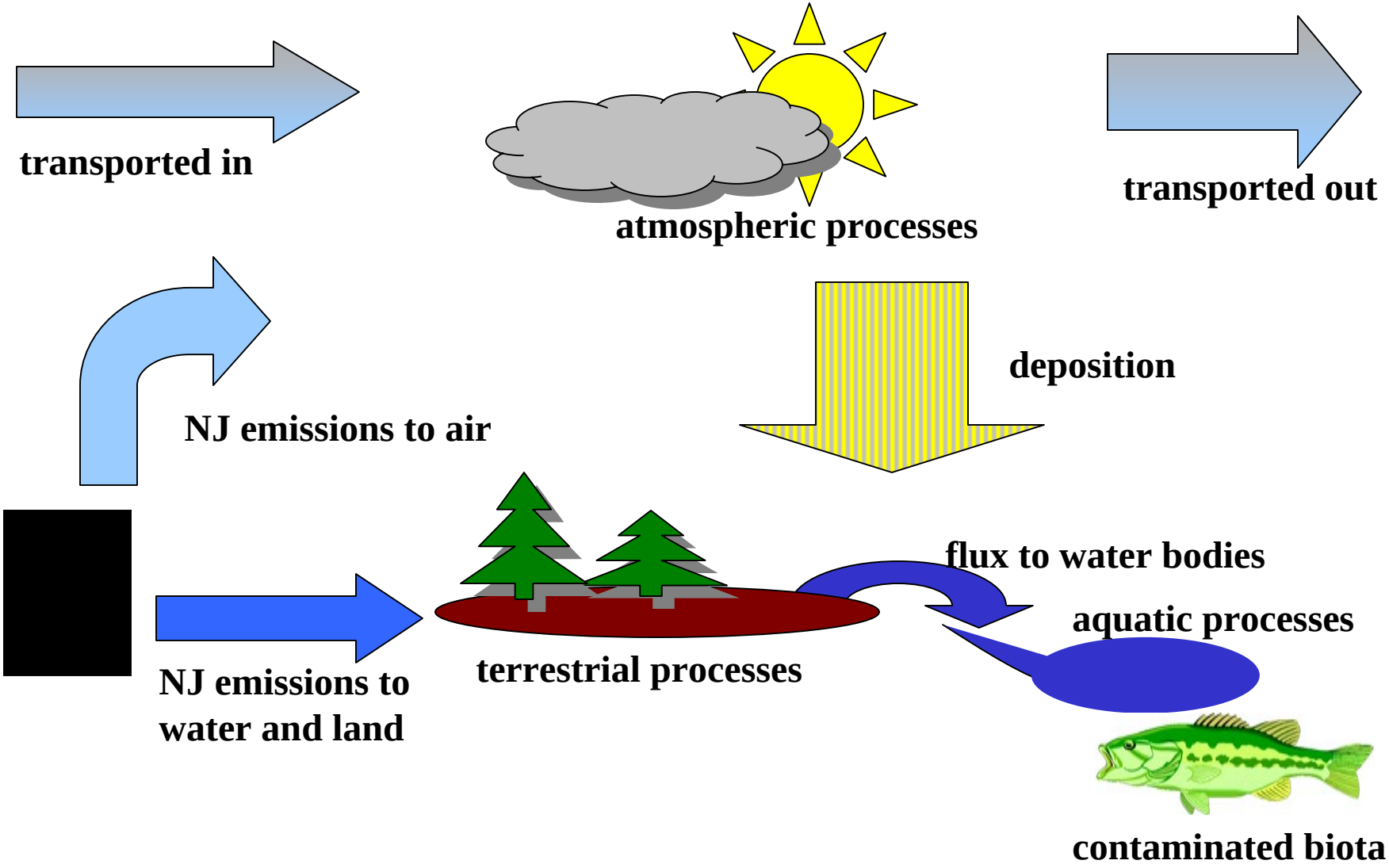
Atmospheric deposition, cont'd.

- Reactive gaseous mercury is important to dry deposition. New data shows mean background levels in the range of 5 to 10 pg/m^3, which suggests a statewide total dry deposition of 200 to 600 lbs/y.

- Particle-bound mercury deposition fluxes appear to be in the range of about 2 µg/m^2/y, which adds another 75 lbs/y to the statewide total.

- Bottom line: Task Force's estimate (guesstimate!) was probably about right. But, uncertainties remain, especially regarding dry deposition; sediment core data suggests total deposition could be higher.

Mercury cycle: key aspects



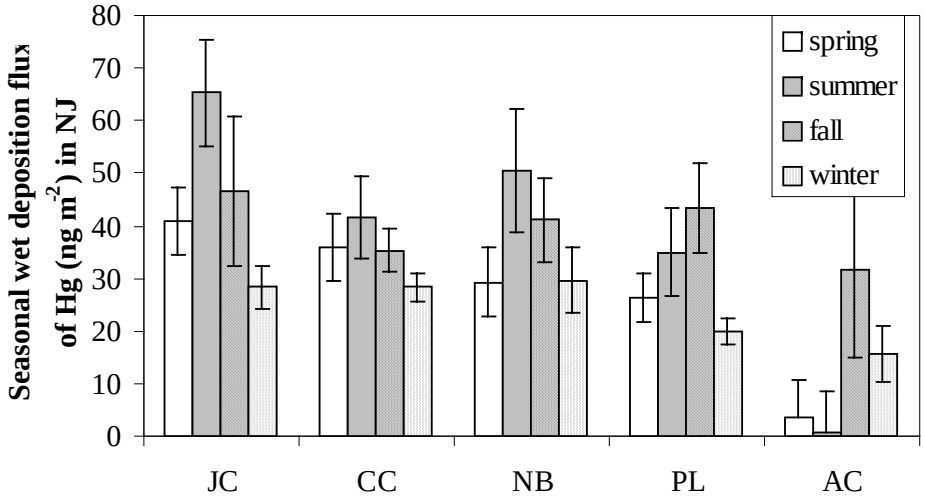
Atmospheric, terrestrial, and aquatic processes

- Evidence is building that there are “hot spots” of mercury deposition
- Fresh sources to a water body are more likely to be bio-available –emissions reductions can translate to reductions in biota relatively quickly.
- Areas with forest cover seem to have more deposition –leaves may adsorb atmospheric mercury and in effect act as a sponge for mercury.
- New, more detailed sampling and modeling efforts underway by USGS, EPA, and others offer much promise.
- Interesting and important work being done on flow of mercury in the coastal and marine environment. Much much of the methyl mercury in marine fish may originate in coastal zone sediments.

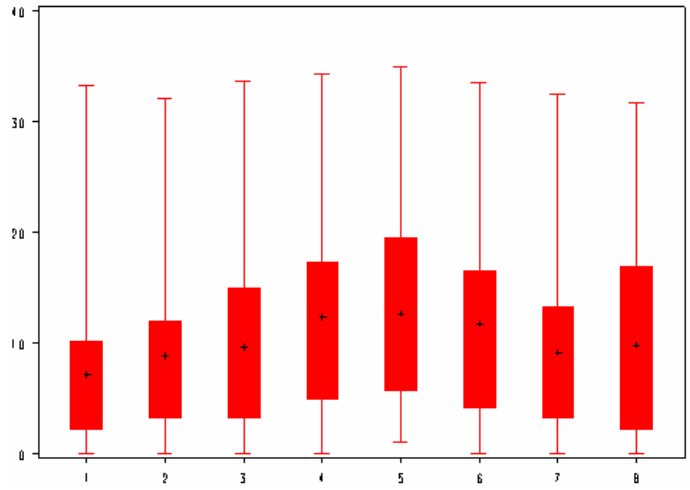
Atmospheric, terrestrial, and aquatic processes, cont'd.

- Strong seasonal variation in mercury deposition; may be related to ozone concentrations and/or photolytic processes

Wet deposition seasonality



Reactive gaseous mercury concentrations per time block



Atmospheric, terrestrial, and aquatic processes, cont'd.

- Most mercury deposited on land stays on land (background concentrations in streams are much lower than concentrations in rain).

- Much mercury movement to most water bodies is probably via sediment transport. Minimizing stormwater, runoff, and erosion should minimize mercury inputs to water bodies.

stormwater detention basin,
Hunterdon County

Much of the recent data confirm existing knowledge and support earlier hunches.

“The most exciting phrase to hear in science, the one that heralds new discoveries, is not ‘Eureka!’ (I found it!) but ‘Hmm…that's funny’....”

Isaac Asimov

Anything funny turning up?

- Maybe….

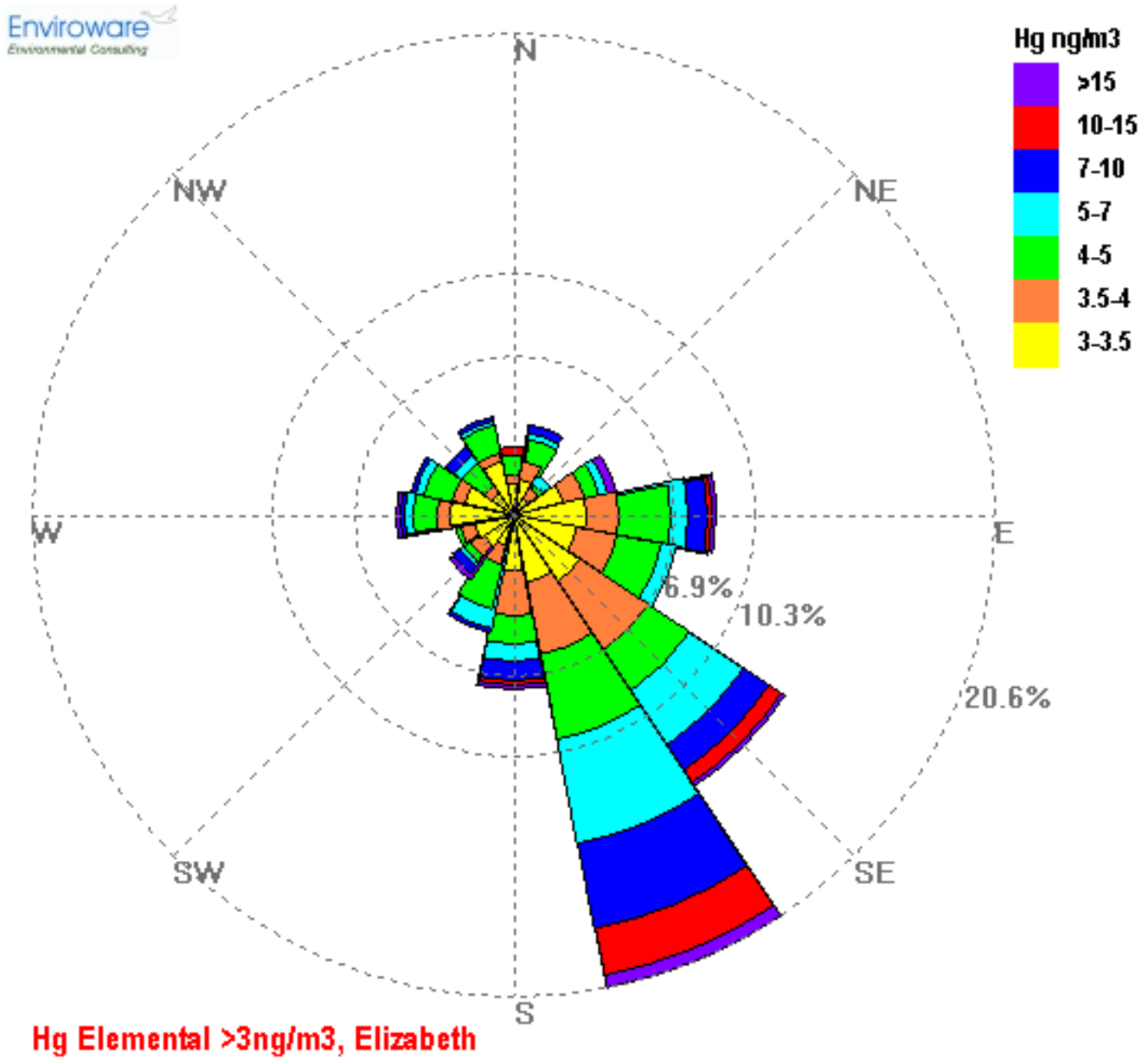
Tekran sampling unit at Elizabeth; measures elemental, reactive gaseous, and particle bound mercury.

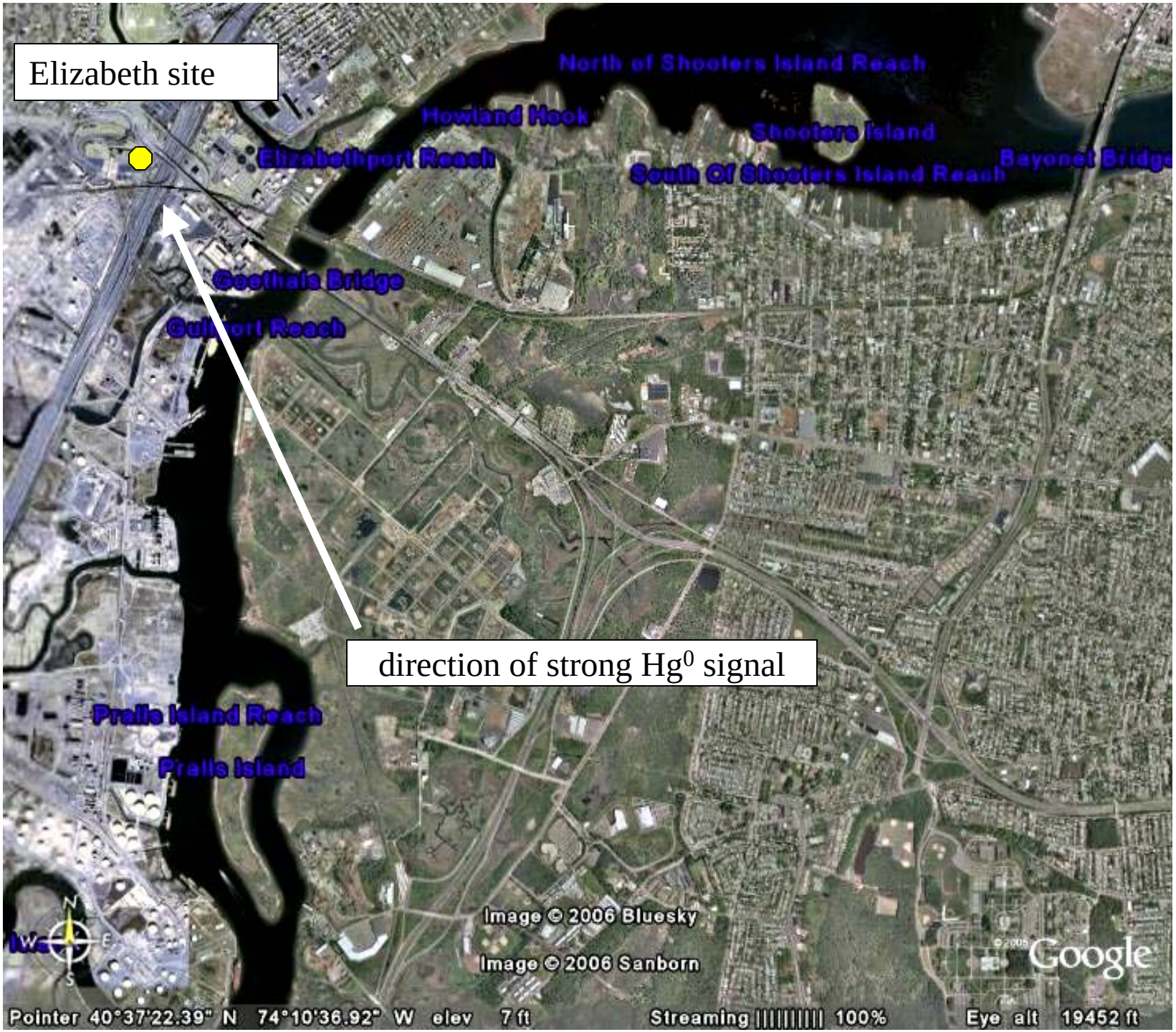
Units are also at Camden, New Brunswick, and Chester.

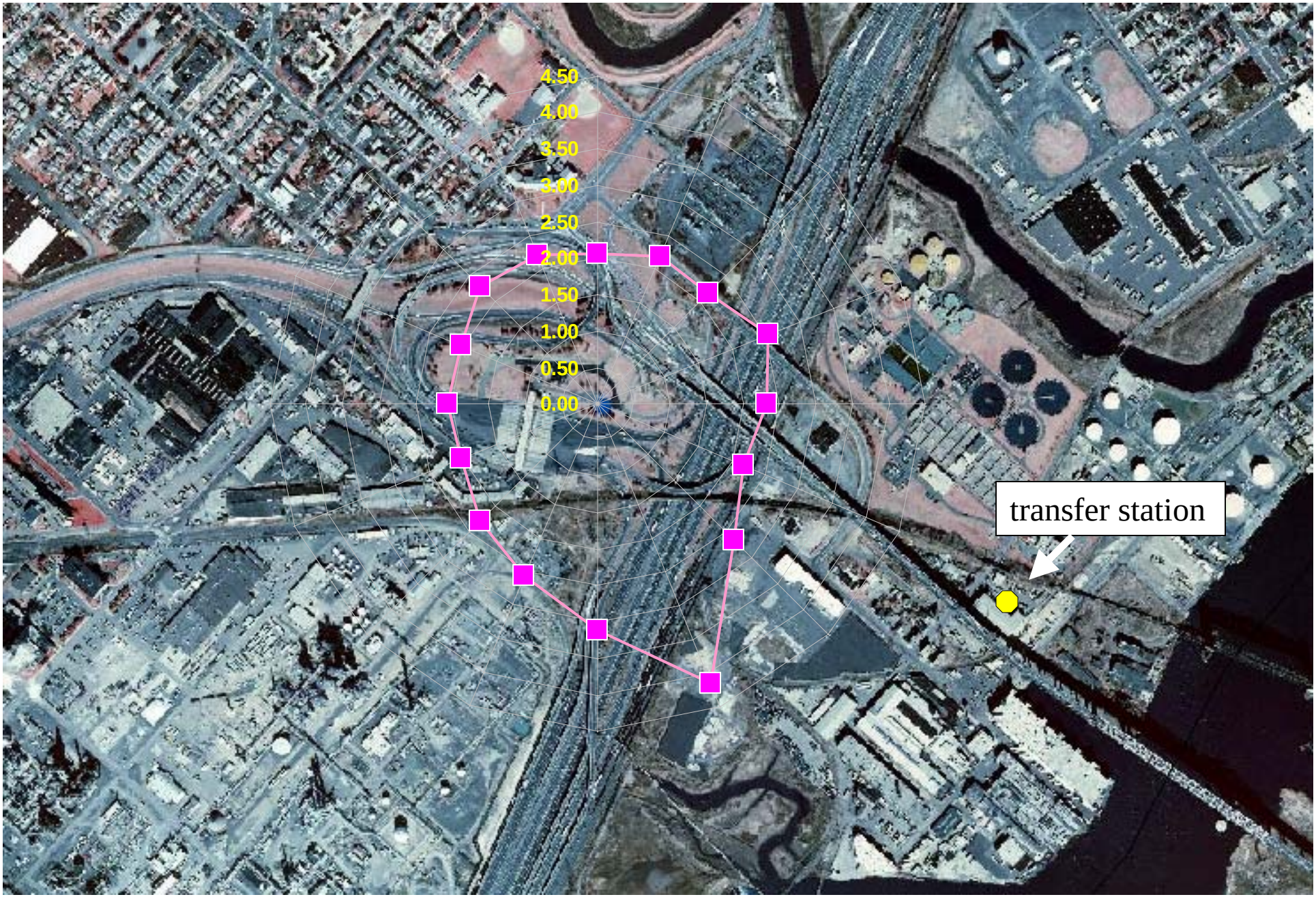
They are providing a wealth of data that are now being analyzed.


Elizabeth site

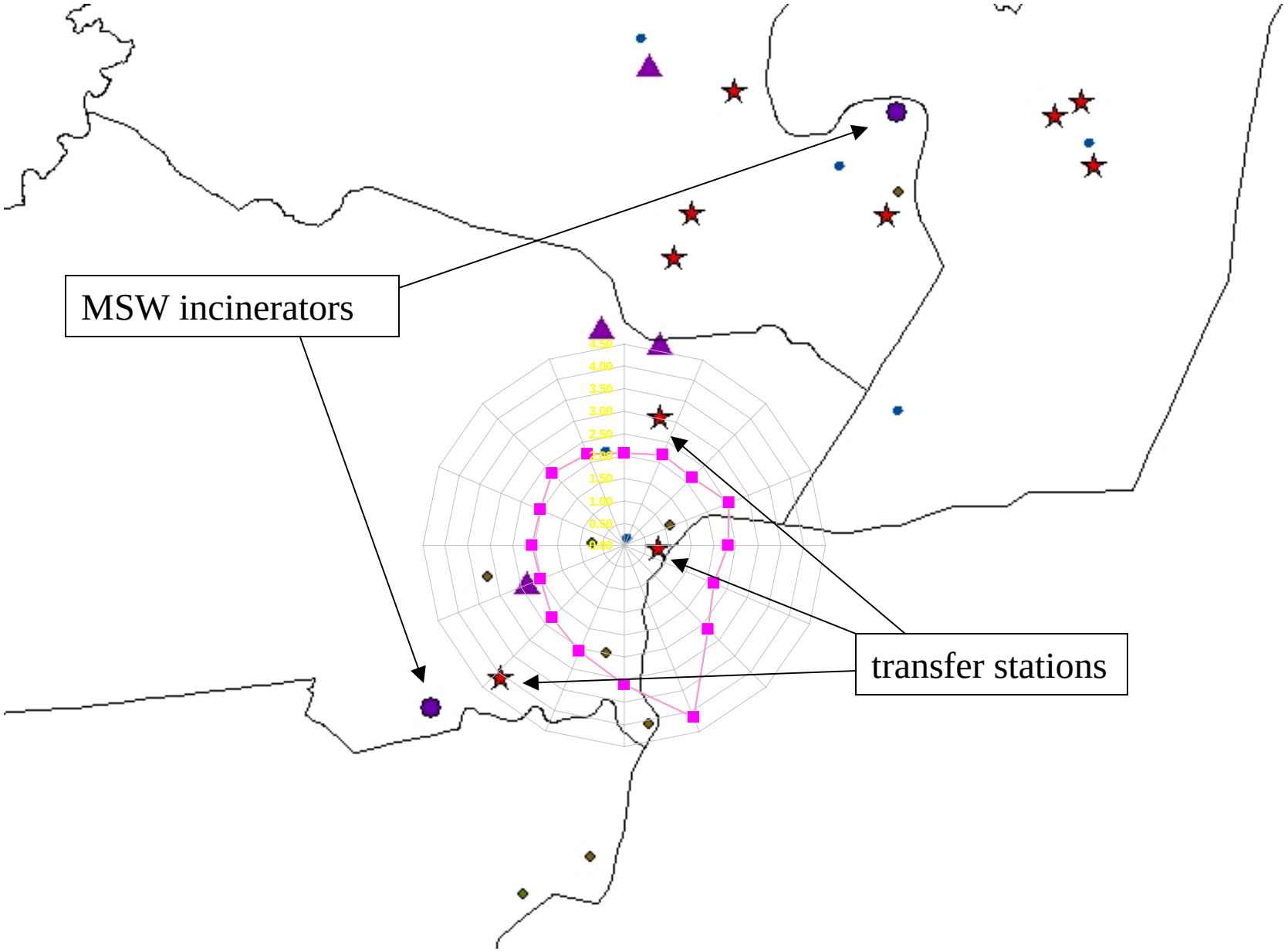
Pollution rose, Elizabeth site

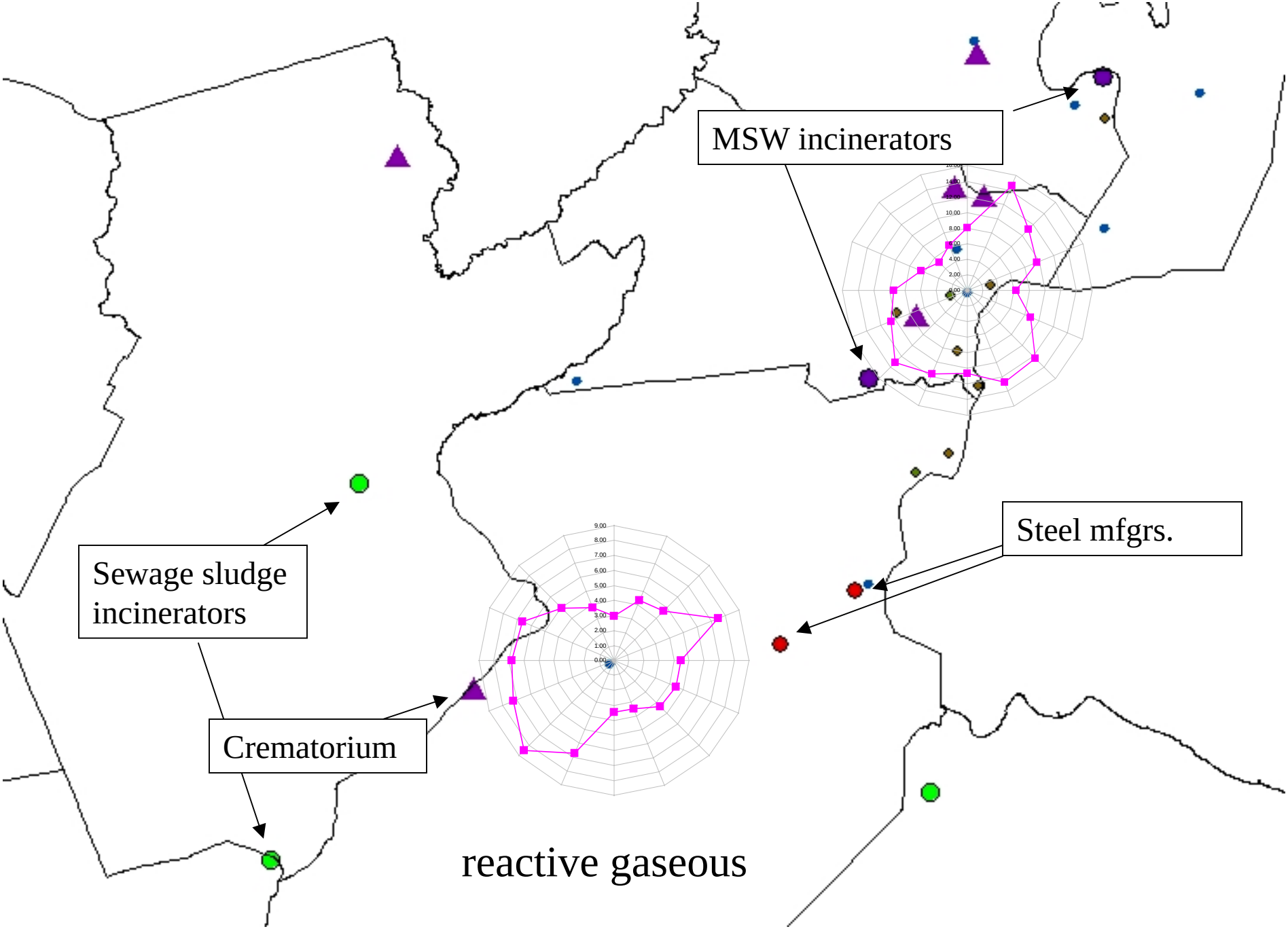


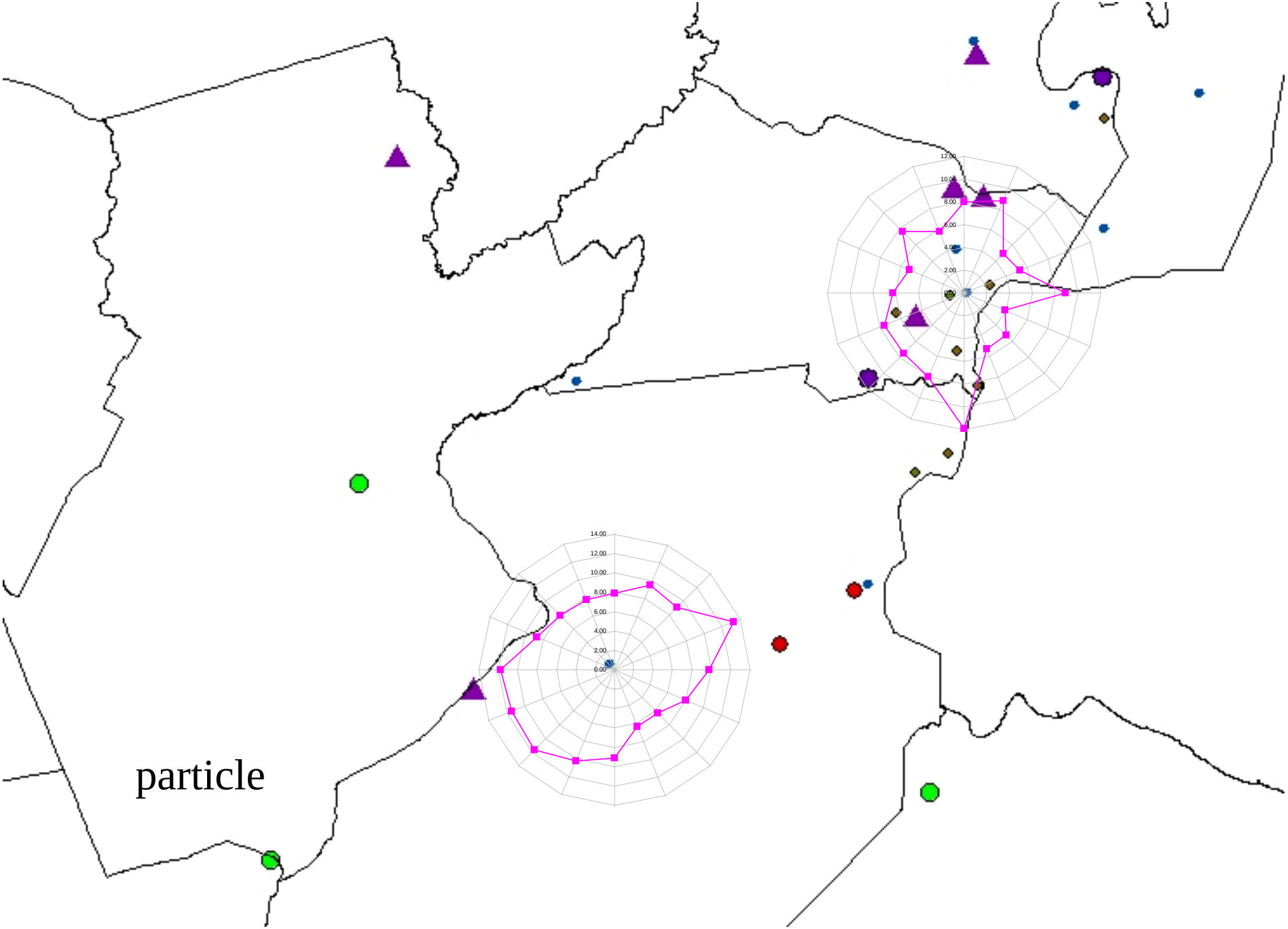

Elizabeth site
North of Shooters Island Reach
Howland Hook
Shooters Island
Elizabethport Reach
South Of Shooters Island Reach
Bayonet Bridge
Goethals Bridge
Prall's Island Reach
Prall's Island
direction of strong Hg0 signal
Image © 2006 Bluesky
Image © 2006 Sanborn
Google
Pointer 40°37'22.39" N 74°10'36.92" W elev 7 ft
Streaming 100%
Eye alt 19452 ft

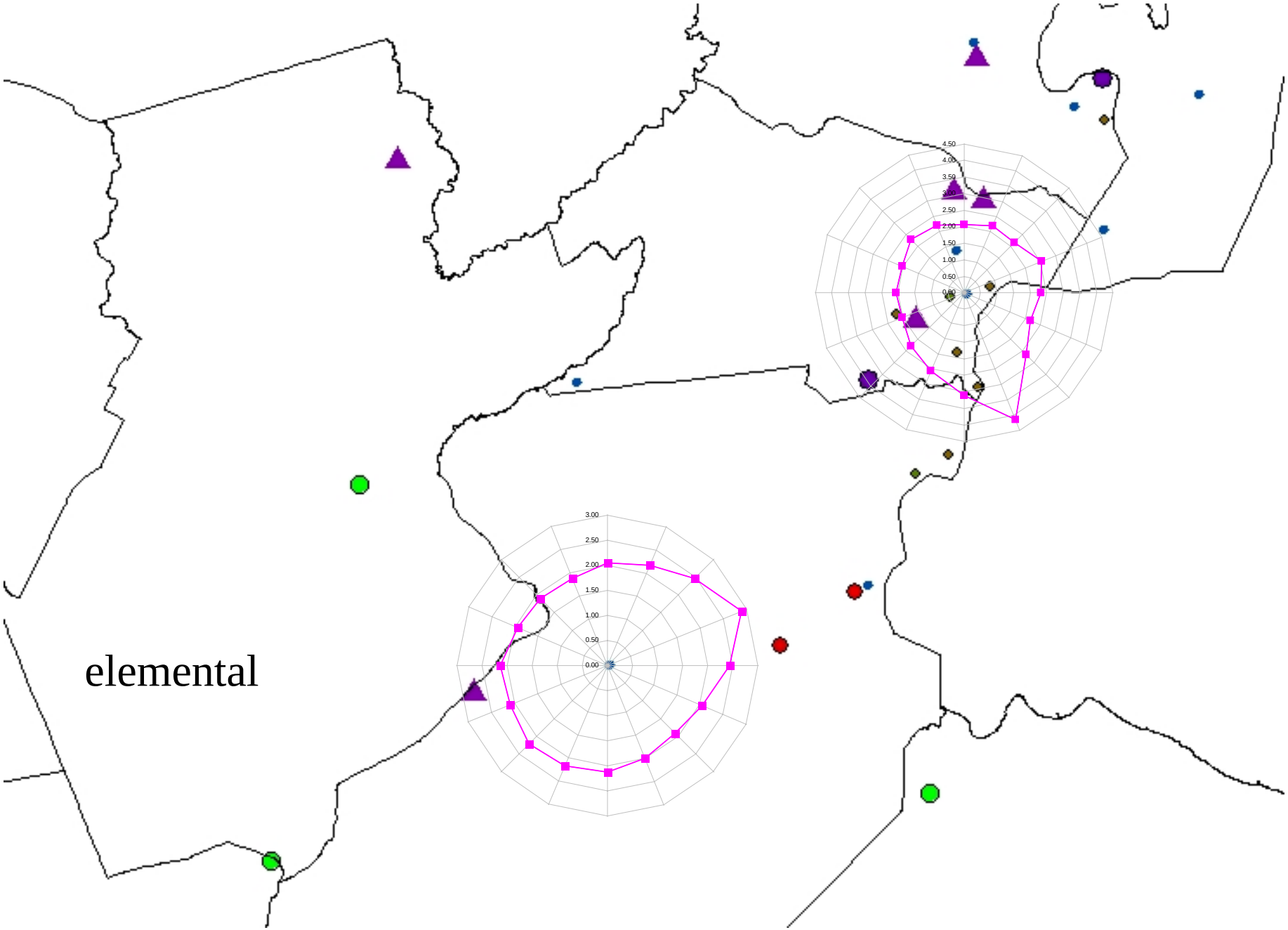

4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
transfer station

inside a trash transfer station


MSW incinerators
transfer stations
4,50
4,00
3,50
3,00
2,50
2,00
1,50
1,00
0,50
0,00


MSW incinerators
Steel mfgrs.
Sewage sludge incinerators
Crematorium
reactive gaseous


12.00
10.00
8.00
6.00
4.00
2.00
0.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
particle


4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
3.00
2.50
2.00
1.50
1.00
0.50
0.00
elemental


New Brunswick monitoring site

the working face of a landfill

“The beginning of knowledge is discovery of something we do not understand.”

Frank Herbert